

Proposed Extractive Operation and Conditional Use
Norvell Sand and Gravel Site
American Aggregates of Michigan

BOOK 1

TABLE OF CONTENTS

- Conditional Use and Site Plan Application
- Project Report
- Exhibits
 - Exhibit 1 - Sealed Boundary Surveys (printed full scale)
 - Exhibit 2 - Site Plans (printed full scale)
 - Exhibit 3 - Traffic Impact Study
 - Exhibit 4 - Purchase Order
 - Exhibit 5 - Infrastructure Reports
 - Exhibit 6 - Wetland Delineation Report
 - Exhibit 7 - Threatened and Endangered Species Survey and Habitat Assessment
 - Exhibit 8 - Hydrogeological Report

CONDITIONAL USE AND SITE PLAN APPLICTON



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November 17, 2025

Norvell Township
ATTN: Clerk & Chair of the Planning Commission
c/o Peter Breckner, Zoning Administrator
300 Mill Rd.
Brooklyn, MI 49230

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

Dear Planning Chairperson:

We represent AAOM regarding the aforementioned Application to permit a sand and gravel mining operation in Norvell Township (the "Township"), Jackson County. As part of the Project, AAOM has purchased approximately 626.4 acres of land located in Norvell Township (collectively, the "Property"). .

Pursuant to the Ordinance, the Project is located in an Agricultural Residential District ("AG") as described in Article IV and is permitted as a Conditional Land Use under the classification of Article VII, Mining Activities and Operations. Sand and gravel mining in the state of Michigan is also governed pursuant to the Michigan Zoning Enabling Act ("MZEA"), and act to codify the laws regarding local units of government regulating the development of land use. See MCL, Act 110 of 2006. The Project will fill a demand for construction-grade sand and gravel for the local and regional construction industry, as well as increase the local tax base, diversify the local economy and provide job opportunities for the local community. Further, the extraction of these natural resources would not cause "very serious consequences," and therefore, not be in violation of the MZEA.

The Applicant hereby submits the attached Application and supporting documents and information for consideration by the Township. Enclosed with this correspondence are the following:

1. Six (6) copies of the completed signed Conditional Use/Site Plan Review Application (**Exhibit 1**) including;
 - a. Land use study with drawings (**Project Report**);
 - b. Geological/hydrological/engineering survey above the water table (**Project Report**);



Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 2

- c. Description of Proposed Use/Request (**Project Report**);
- d. A description of the vehicles, machinery and equipment proposed for use on the property, specifying the anticipated noise and vibration levels of each and their hours of operation (**Exhibit 2**, and **Project Report**) ;
- e. Six (6) copies of the Site Plan (**Exhibit 2**);
- f. Six (6) copies of Proposed Mining Plan (**Exhibit 2**);
- g. Six (6) copies of Site Reclamation Plan (**Exhibit 2**);
- h. Six (6) copies of Traffic Impact Study (**Exhibit 3**);
- i. Six (6) copies of Purchase Order (**Exhibit 4**);
- j. Six (6) copies of Infrastructure Reports (**Exhibit 5**);
- k. Six (6) copies of Wetland Delineation Report (**Exhibit 6**);
- l. Six (6) copies of Threatened and Endangered Species Survey and Habitat Assessment (**Exhibit 7**);
- m. Six (6) copies of Hydrogeological Report (**Exhibit 8**);
- n. Six (6) copies of Phase 1 Environmental Site Assessment (**Exhibit 9**);
- o. Six (6) copies of 2025 Market Study (**Exhibit 10**);
- p. Six (6) copies of Property Valuation Studies (**Exhibit 11**);
- q. Six (6) copies of Industrial Hygiene Exposure Assessment Report (**Exhibit 12**);
- r. One (1) copy of Focused Noise Estimation Report (**Exhibit 13**);
- s. One (1) fee payment (for Conditional Use Permit Application)
- t. A long-term plan designating all areas proposed for future excavation (**Project Report**); and

- ## The Project

The map displays the Project Site area, which is outlined in red. Two specific areas within the site are highlighted in green and labeled 'PROJECT SITE'. The map also shows surrounding roads, including Washtenaw Rd, and lakes, including Washtenaw Lake. A north arrow is located in the bottom right corner.

3

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 4

Based on our review of the Ordinance and the information provided below, the Applicant respectfully requests the review and approval of the Application by the Planning Commission and the Board of Trustees. To that end, we request that the Application be reviewed and placed on the Planning Commission's agenda at the first available date. If possible, to expedite this request, we request that a special meeting be scheduled.

I. Article 7, Mining Activities and Operations

The Intent and Purpose of Article 7, Mining Activities and Operations is provided in Section 7.1 of Article 7 of the Ordinance:

It is the intent and purpose of this Article. to promote the underlying spirit and intent of this Ordinance, but at the same time allow for the extraction of soil, sand, gravel, stone or valuable natural resources or earth materials ("mining activity" or "mining operation") in locations where they have been naturally deposited, and to ensure that 1) mining activity is limited to only those circumstances where there is a need for the natural resources by an applicant or in the market served by the applicant; 2) no very serious consequences would result from the extraction, by mining, of the natural resources; 3) the mining activity is compatible with adjacent uses of land, the natural environment, and the capabilities of public services and facilities affected by the land use; and 4) mining activities are consistent with the public health, safety, and welfare of the Township.

Pursuant to Section 7.2 of Article 7: "Mining activities in the Township shall be prohibited unless first authorized by the granting of a conditional use permit by the Township Board in accordance with Article 13, and unless operated in compliance with such conditional use permit."

II. Article 13 Conditional Use Review

The Purpose for Conditional Uses is provided in Section 13.1 of Article 13:

The formulation and enactment of this Ordinance are based upon the division of the unincorporated portions of Norvell Township into districts in each of which are permitted specified uses which are mutually compatible. In addition to such permitted compatible uses, however, it is recognized that there are certain other uses which may be necessary or desirable to allow in certain locations in certain districts, but because of their actual or potential impact on neighboring uses or public facilities, need to be carefully regulated with respect to their location for the protection of the Township. It is the purpose of this Article to specify the process that shall be followed in the review and approval of "conditional uses" as

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 5

authorized by the Use Tables of Article 4 and elsewhere in this Ordinance, including the standards by which such applications shall be evaluated to ensure conformance with this Ordinance and encourage public health, safety and welfare.

Site plan review is required as part of a Conditional Use Permit Application. See Article 13, Section 13.4. Under the Ordinance, certain uses require additional standards as provided in Section 13.6 of Article 13:

The Planning Commission shall review the circumstances and facts of each proposed use in terms of the following standards and required findings, and shall find and record adequate data, information, and evidence showing that such a use on the proposed site, lot or parcel:

- A. Will be harmonious with and in accordance with the general objectives, intent, and purpose of this Ordinance.
- B. Will be designed, constructed, operated, maintained, and managed so as to be harmonious and appropriate in appearance with existing or intended character of the general vicinity.
- C. Will be served adequately by essential public facilities and services, such as: highways, streets, police and fire protection, drainage structures, refuse disposal, or that the persons or agencies responsible for the establishment of the proposed use shall be able to provide
- D. Will not be hazardous or disturbing to existing or planned neighboring uses.
- E. Will not create excessive additional requirements at public cost for public facilities and services.

A written statement of findings and conclusions relative to the conditional use which specifies the basis for the decision and any conditions imposed shall be prepared by the Planning Commission and revised as necessary by the Township Board.

Re: **American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")**

November 17, 2025

Page 6

III. Article 12 Site Plan Review and Approval

Site Plan Review and Approval requires a site plan to be reviewed and approved by the Planning Commission and Township Board for all conditional uses. See Article 12, Section 12.2(F). The Ordinance lists the required data for a site plan in Article 12, Section 12.6:

A. **Site Plan Information:** A site plan shall include, at a minimum, the following except where the Planning Commission determines that the waiving of specific submittal items, due to the particular character of proposed development or site or surrounding conditions, shall not undermine the ability to effectively evaluate the extent to which the site plan complies with the standards of this Ordinance and protects the public health, safety and welfare. The Planning Commission or Township Board may subsequently void this waiver should deliberations reveal the need for additional information.

1. The applicant's full name, address and phone number, the name, address and phone number of the person and firm who prepared the plan, and the date each drawing was prepared or last revised.
2. A vicinity sketch showing the location of the property subject to the application in relation to the surrounding road system for a minimum distance of one-thousand (1,000) feet in all directions; the uses and locations of all structures and buildings within one-hundred (100) feet of the property; the delineation of driveways within one-hundred (100) feet of the property; and the zoning classification of the subject parcel and all surrounding parcels.
3. A property line survey, correlated with a legal description, showing property line dimensions and bearings, lot area in acres and square feet, and graphic scale.
4. Existing uses, buildings, structures, roads, easements and all other existing site improvements, including dimensions thereof, with a designation as to which are to be retained, removed, or otherwise altered.
5. Existing natural features on and within one hundred (100) feet of the site including woodland areas; wetlands; drainage courses, water bodies, and 100-year flood plain areas; topography at no greater than two-foot contour intervals; and soils by type and drainage features according to the County Soil Survey or well/boring logs.
6. Required front, side and rear yard setbacks for principal buildings.
7. Proposed lots including area, dimensions and lot line bearings; proposed principal and accessory uses, buildings, and structures including trash storage areas and screening, signs,

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 7

and lighting; the total number of dwelling units and dwelling density calculations; total and usable floor area of each non-residential building; carports and garages; proposed open spaces and type of recreation facilities to be provided; computations associated with the number of parking spaces required and provided including anticipated number of employees; and a project narrative that addresses the intended use of the property and each building proposed.

8. Proposed public rights-of-way and private easements, including their widths and purposes, and deed restrictions.

9. Proposed roads, drives, and alleys including widths, cross-sections and profiles; acceleration, deceleration and turn lanes; driveways, loading and unloading areas, parking spaces, and parking aisles, with an indication of the total number of spaces and typical space and aisle/driveway dimensions, the direction of travel, the inside radii of all curves including driveway curb returns, and the number of total parking spaces along with the consecutive numbering of such spaces; and sidewalks and other non-motorized travel ways. Proposed traffic control measures (including signs) shall also be indicated.

10. Proposed source and location of all public and private utilities including potable water, sewage disposal, and electrical and communication lines, and the necessary easements that exist or are to be established for installation, repair and maintenance of such utilities.

11. Proposed signs and light fixtures including the heights and construction type thereof.

12. A graphic illustration of the location and extent to which natural features on the site shall be disturbed or otherwise cleared including those under Subsection 5 above.

13. Proposed landscaping/screening plan in compliance with the requirements of the code and to provide any necessary screen to meet the review standards including the identification of proposed fences and walls and the heights and construction type thereof.

14. Proposed grading, storm drainage and storm water management plan, including soil erosion and sedimentation control measures and spot elevations to adequately portray drainage patterns and final elevations and grades. Such plan shall include the location of drainage easements, exterior drains, dry wells, catch basins, retention and/or detention areas, sumps and other facilities designed to collect, store or transport storm water. The point of discharge for all drains and pipes shall be specified on the site plan as well as invert and related elevations, and pipe lengths and slope, to construct the same. Such plans shall document the extent of clearing of vegetation and the extent of other clearing, cuts, fills, or other grading, and the finished floor elevations of all buildings. Minimum two-foot contour elevations shall be delineated.

15. Proposed location and specifications for any existing or proposed above or below

Re: **American Aggregates of Michigan’s (“Applicant” or “AAOM”) Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 (“Application”) for a proposed sand and gravel mining operation (“Project”)**

November 17, 2025

Page 8

ground storage facilities for any toxic or hazardous substances, as well as any containment structures or clear zones required by government authorities; a complete inventory of toxic or hazardous substances to be stored or used on the site, including the quantity of substances, substance names and characteristics; the proximity of such materials to ground water aquifers, wetlands, surface waters, existing and proposed wells, storm sewers, storm drains, and sanitary sewers; and a proposed storage and disposal plan for such materials including their transfer and/or transport.

16. Proposed elevation drawings of all buildings, and floor plans for all buildings to be occupied.

17. Proposed area of the parcel, in acres and square feet, to be dedicated to buildings, roads, access drives and parking areas, and the area of the parcel to be dedicated to landscaping and other dedicated open space areas.

18. A statement identifying all federal, state, county and local permits required, if any.

19. Proposed project completion schedule.

20. Other information deemed necessary by the Township to enable designated reviewing bodies to determine whether the proposed site plan shall conform to the provisions of this Ordinance.

21. Property Staking: All lot corners shall be conspicuously staked at the time a preliminary and final site plan application is submitted.

Response: *These requirements are met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

B. Review standards for site plan approval are listed in Article 12, Section 12.7 (A) and (B):

A. **Specific Site Development Standards:** Each site plan shall conform with the specific site development standards of this Ordinance such as requirements pertaining to lot area, lot width, setbacks, heights, permitted uses, existing nonconformities, signs, road access, potable water, sewage disposal, landscaping and screening, and the specific development standards of the Zoning Ordinance.

B. **General Site Plan Approval Standards:** In addition to compliance with the standards of Subsection (A) above, all site plans shall comply with the following general site plan approval standards:

- (1) All elements of the site plan shall be harmoniously and efficiently organized in relation to the size and character of the lot, the manner in which buildings and support facilities on the lot relate to one another, and the character of the proposal is viewed from nearby properties and roads.

Re: **American Aggregates of Michigan’s (“Applicant” or “AAOM”) Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 (“Application”) for a proposed sand and gravel mining operation (“Project”)**

November 17, 2025

Page 9

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- (2) The site plan shall be of a character that supports the purpose of the district in which the site is located.

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- (3) The site plan shall not impede the normal and orderly development, improvement, or enjoyment of surrounding property for uses permitted in the District, including matters pertaining to visual impacts from lighting, signage, outdoor storage, utility areas, and off-street parking.

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- (4) The site plan shall preserve the environmental character of the site insofar as practical by minimizing the removal or disturbances to on-site natural features such as trees, woodlands, soils, topography, water courses and wetlands.

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- (5) The site plan shall provide for the removal of storm water so as to minimize on-site flood conditions and assure the well being of the users of the property, while not adversely affecting adjacent properties and public and natural drainage systems due to flooding, erosion, sedimentation, increased rates or quantities of runoff, or other negative impacts. Storm water management plans shall rely on existing drainage patterns to the greatest extent practical and minimize topographic alterations, and incorporate the necessary measures to discourage soil erosion and sedimentation and the discharge of impurities into the groundwater and nearby water courses.

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- (6) The site plan shall provide vehicular and non-motorized circulation and parking in a manner that ensures for all users visually clear, safe, convenient and efficient travel in the site and at ingress and egress points, including minimizing congestion and conflicting turning patterns, minimizing negative impacts upon abutting properties and roads coordinating access with the existing and planned public circulation system and improvements thereto, avoiding unnecessary curb cuts and encouraging the use of shared drives where practical, and ensuring that all buildings shall be so arranged as to permit fire emergency access by some practical means to all sides.

Response: *This requirement is met. See Site Plan and Traffic Impact Assessment, attached as **Exhibits 2 and 3**.*

Re: **American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")**

November 17, 2025

Page 10

- (7) The site plan shall provide for adequate utilities, and the appropriate location of all necessary and proposed utilities. Underground facilities shall be provided to the greatest extent practical.

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- (8) Where a project is proposed for construction in phases, the project shall be so designed that each phase, when completed, shall be capable of standing on its own in terms of the presence of services, facilities, and open space, and shall contain the necessary components to ensure protection of natural resources and public health, safety and welfare. In developments that are intended to be of a mixed-use character, the Township Board may require a phasing plan to ensure that the intended dominant character of the development is preserved, such as the specification of a number or percentage of the proposed residential units in a predominantly residential development be constructed prior to the commercial units being constructed.

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- (9) Site plans shall conform to all applicable Township planning documents including the Norvell Township Master Plan, other applicable township ordinances, and county, state and federal statutes and standards including, but not limited to:
- a. Jackson County Department of Transportation
 - b. Jackson County Drain Commissioner
 - c. Jackson County Health Department
 - d. Michigan Dept. of Environment, Great Lakes, and Energy (EGLE)
 - e. Michigan Dept. of Transportation
 - f. Fire and Police Departments

Response: *This requirement is met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

IV. Article 7, Mining Activities and Operations

Section 7.1 states the Intent and Purpose of Article 7:

- A. It is the intent and purpose of this Article to promote the underlying spirit and intent of this Ordinance, but at the same time allow for the extraction of soil, sand, gravel, stone or valuable natural resources or earth materials ("mining activity" or "mining operation") in locations where they have been naturally deposited, and to ensure that 1) mining activity is limited to only those circumstances where there is a need for the natural resources by an applicant or in the market served by the applicant; 2) no very serious consequences would result from the extraction, by mining, of the natural resources; 3) the mining activity is compatible with adjacent uses of land, the natural environment, and the capabilities of public services and facilities affected by the land use; and 4) mining activities are consistent with the public health, safety, and welfare of the Township.
- B.

Re: **American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")**

November 17, 2025

Page 11

- C. Application of Section. The removal of soil, sand, gravel, stone and other valuable natural resources or earth materials shall be subject to the following requirements and conditions of this Article.

Section 7.2 Use Restrictions

- A. Conditional Use Permit Required.** Mining activities in the Township shall be prohibited unless first authorized by the grant of a conditional use permit by the Township Board in accordance with subsection Article 13, and unless operated in compliance with such conditional use permit.

A conditional use permit shall be denied if the application does not meet all the requirements of this Article, and unless, in addition to the requirements of this Article, the applicant has demonstrated that the natural resources intended to be extracted by the mining activity are valuable; there is a need for the natural resources by the applicant or in the market served by the applicant; and that no very serious consequences would result from the mining activity.

A conditional use permit shall be issued subject to the requirements in this Article and subject to the following restrictions, in addition to any further restrictions imposed by the Township at their discretion:

1. Relocating any materials from off premises to be stored or mixed with extracted on-premises material is not permitted under a conditional use permit granted under this Article. Relocating materials from off premises to be crushed or otherwise processed prior to transportation off premises is considered manufacturing and is not permitted on the same parcel or as part of the same operation of any mining activity or operation permitted under this Article., regardless of zoning district.

Response: *This requirement is met. The Project does not involve the relocation of sand and gravel materials to be stored or mixed with extracted materials from the premises or on-site manufacturing.*

2. Mining activity shall be prohibited within sixteen hundred (1,600) feet from the perimeter of subdivisions, site condominium developments, manufactured housing communities, multiple family developments (or any dwelling that is not otherwise located within such residential subdivisions, developments or communities), suburban residential and lake residential zoning districts, or any other natural resource as determined by the Township in its sole discretion.

Response: *This requirement is met. On information and belief, mining activity will not be done within 1,600 feet of any restricted locations. .*

3. The use of explosives in the Township to conduct mining activity or as part of a mining operation is prohibited.

Response: *The Applicant and the Project will comply with this requirement*

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 12

4. The production, manufacturing or processing of asphalt is not permitted.

Response: *The Applicant and the Project will comply with this requirement.*

5. A restoration plan shall be included and incorporated into the conditional use permit requirements.

Response: *This requirement is met. A restoration plan is included in Applicant's conditional use permit application, see **Exhibit 2**.*

B. Conditions for Approval. A conditional use permit may only be granted if the applicant has complied with all the requirements of this Article, including the following:

1. There shall be not more than one (1) main entrance way from a public road to the site for each six hundred sixty (660) feet of front lot line. All vehicles used for the transporting of materials from any site shall travel to and from the site on a street route which minimizes adverse impacts on residential neighborhoods. Additional entrances may be required in the discretion of the Township for emergency vehicle access.

Response: *This requirement is met. A Traffic Impact Study conducted by Applicant concluded that the proposed Project will not result in any significant operational impact to the adjacent road network and to the minimal agricultural residential neighborhoods located in the areas adjacent to the Project. See Traffic Impact Study attached as **Exhibit 3**. If required, the Applicant will obtain a road entrance permit from the Jackson County Department of Transportation*

2. Mineral mining, extractive operations, and processing activities including those relating to storage such as stockpiling, shall not take place before 7:00 a.m. or sunrise, whichever comes later; or after 8:00 p.m. or sunset, whichever comes first; and no such activities shall take place after 12:00 p.m. on Saturday, nor all day on Sunday, nor the following days - New Year's Day, Memorial Day, 4th of July, Labor Day, Thanksgiving Day, and Christmas Day, and during weekend (Friday through Sunday) events at the Michigan International Speedway so long as those events are publicly published and/or advertised.

Response: *This requirement is met. Mining operations for the Project will not occur during hours restricted by the Ordinance.*

3. Truck Loading/Shipping: From the period of April 1 through October 31 of each year, the hours of operation for all truck loading and shipping from the site shall be limited to the hours between 7:00 a.m. and 7:00 p.m., Monday through Friday, Saturday loading hours shall be limited to the hours between 7:00 a.m. and 12 noon. From the period from November 1 to March 31 of each year, the hours of operation for all truck loading and shipping from the site shall be limited to the hours between 7:00 a.m. and 5:00 p.m., Monday through Friday, Saturday loading hours shall be limited to the hours between 7:00 a.m. and 12 noon. No

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 13

loading/shipping shall take place on the following days - New Year's Day, Memorial Day, 4th of July, Labor Day, Thanksgiving Day and Christmas Day, and Michigan International Speedway race weekends (Friday through Sunday) Trucks traveling to and from the site shall only travel by way of lawful truck routes as established by ordinance or law. The applicant shall clean any and all spillage of material, dirt, rock, mud, and any other debris carried onto any public roads by trucks coming to or from the site or by other equipment. This cleaning shall occur promptly after the spillage of the material has occurred.

Response: *This requirement is met. All truck loading and shipping from the Project site will occur during hours limited by the Ordinance. The Applicant will comply with all requirements regarding cleanup of spillage of material under the Ordinance.*

4. On said lot, no excavating shall take place closer than one hundred fifty (150) feet to a street right-of-way line or a wetland, or within three hundred (300) feet to any lot line in a non-residential district.

Response: *This requirement is met. No excavating will take place within 150 feet of a street right-of-way line, within 150 feet of a designated wetland zone or within 300 feet of any lot line in a non-residential district.*

5. On said lot, for each ingress and egress, a paved driveway of not less than one hundred (100) feet in length, with a minimum width of twenty-two (22) feet shall be provided extending from the edge of the street. A crushed stone driveway at least two hundred (200) feet in length and twenty-two (22) feet in width shall be located from the terminus of the paved driveway into the site. Said driveways shall be constructed and maintained to support the maximum weight of vehicles. There shall be located on the site at all times a water truck of sufficient capacity for controlling dust on roads used by the mining operation located outside the site. Other ecologically safe dust suppressants that are organically based and non-hazardous to the environment, such as pine-sap-based emulsions or soy- bean-based products, may be used to control such dust. There shall be located on the site at all times equipment which will operate a rotary broom for cleaning up debris within the site or on public roads used by the mining operation when determined necessary by the Township Supervisor or his designee.

Response: *The Applicant and the Project will comply with this requirement.*

6. Any odors, smoke, fumes, or dust generated on said lot by any digging, excavating, processing, stockpiling, or transportation operation and borne or able to be borne by the wind shall be confined within the lines of said lot so as not to cause a nuisance or hazard on any adjoining lot or public road.

Response: *The Applicant and the Project will comply with this requirement.*

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 14

7. Any crushing equipment or device utilized on the premises shall be housed in a structure adequate to control noise and dust generated by crushing operation and associated processes. Crushing equipment located on the property shall not generate noise in excess of the number of decibels allowed in the Township's Noise Ordinance as amended.

Response: *The Applicant and the Project will comply with this requirement.*

8. Only materials mined from the property which is subject to this permit may be crushed on the premises.

Response: *The Applicant and the Project will comply with this requirement.*

9. No fill shall be allowed on the premises.

Response: *The Applicant and the Project will comply with this requirement.*

10. If a mining operation or mining activity creates a body of water, the owner, operator-and/or permittee shall place appropriate "KEEP OUT" "DANGER" signs around said premises not more than two hundred (200) feet apart.

Response: *This requirement will be met.*

11. EGLE Permit-A permit shall be required from the Michigan Department of Environment, Great Lakes and Energy (EGLE) Land and Water Management Division, (or its successor), for the creation of a body of water greater than five (5) acres in size or any other time or circumstance when such a permit is required by EGLE.

Response: *The Applicant and the Project will comply with this requirement if a body of water greater than 5 acres in size will be created.*

12. Building Berm Line for Operation Structures- To reduce the effects of airborne dust, dirt, noise and vibration, a berm consisting of natural earth materials of not less than fifteen (15) feet in height may be required to be built around the immediate perimeter of all equipment and structures used for sorting, washing, crushing and other similar operations.

Response: *The Applicant and the Project will comply with this requirement.*

13. Weighing of Trucks: All trucks loaded with mined materials leaving the site shall be weighed on certified scales and a weigh ticket shall be provided to the driver of any such truck. The Township Clerk or their respective designee may inspect the certified scales upon reasonable notice. Further, the Township Clerk shall be provided with a copy of all scale certifications conducted pertaining to the scales within the mining operation within 10 days of any such inspection. On-site scales shall be certified no less than annually.

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 15

Response: *The Applicant and the Project will comply with this requirement.*

14. Removal, processing or storage of natural resources excavated as part of the mining activity or operation shall not be conducted so as to cause the pollution by any material of any surface or subsurface watercourse, or body of water. Upon any evidence of contamination that should reasonably be known to the applicant, or upon notice of contamination, all appropriate regulatory agencies shall immediately be notified and the applicant shall immediately undertake any and all requirements imposed by any such regulatory agency to remediate such contamination or otherwise comply with the requirements of such agency. Notice of contamination known or suspected by the applicant shall be provided to the Township immediately upon such knowledge or suspicion of the applicant.

Response: *The Applicant and the Project will comply with this requirement.*

15. Removal, processing, or storage of natural resources excavated as part of the mining activity or operation shall not be conducted so as to cause or threaten to cause the erosion by water of any land outside of said lot or of any land on said lot such that earth materials are carried outside of the lines of said lot. Such removal shall not be conducted as to alter the drainage pattern of surface or sub-surface waters on adjacent or nearby properties in the area. In the event that such removal, processing, or storage shall cease to be conducted, it shall be the continuing responsibility of the owner or operator thereof to assure that no erosion or alteration of drainage patterns, as specified in this paragraph, shall take place after the date of the cessation of operation, and shall immediately remediate any such condition caused by the mining activity or operation.

Response: *The Applicant and the Project will comply with this requirement.*

16. Wherever topsoil exists on the site, suitable for growing turf or for other land use at the time the mining activity or mining operations begin, a sufficient quantity of topsoil shall be stockpiled on said site so that the entire site, when mining activity is completed may be recovered with a minimum of four (4) inches of topsoil. The replacement of such topsoil shall be made immediately following the termination of the mining activity. Such replacement shall be in a manner suitable for growing turf or for other land uses. Areas of restored topsoil shall be seeded or sodded with vegetation that will prevent erosion from wind or water. The top surface of a stockpile shall be reduced to a topography which provides proper drainage and favorable conditions for vegetation, minimizes erosion and is consistent with a described future use of the site after mining activity is complete.

Response: *The Applicant and the Project will comply with this requirement.*

17. Surface Overburden Stockpile: Stockpile overburden shall be sloped at an angle which minimizes erosion, promotes vegetation and is consistent with a future use of the site after mining activity is complete.

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 16

Response: *The Applicant and the Project will comply with this requirement.*

18. Where substantial natural vegetation is not expected within one (1) year or where erosion is occurring, or where the township Building Inspector and/or Zoning Administrator or the Township's engineers finds erosion likely to occur, which results or may result in injury or damage to fish and wildlife, the pollution of air or water, or which is causing or might cause injury to the person or property of others, surface overburden stockpiles shall be stabilized by planting with vegetative cover, or by other treatment to prevent erosion, pollution, or injury.

Response: *The Applicant and the Project will comply with this requirement.*

19. The site shall be screened with natural vegetation or by other method deemed suitable by the Township in its sole discretion. Screening vegetation that dies shall be immediately replaced.

Response: *The Applicant and the Project will comply with this requirement.*

20. All fixed equipment and machinery shall be located a minimum of three hundred (300) feet from any lot line.

Response: *The Applicant and the Project will comply with this requirement.*

21. The site shall be secured against trespass at all times. There shall be erected a chain link fence not less than six (6) feet in height around the periphery of the mining activity unless it is determined by the approval body that there would be other more appropriate means to secure the site against trespass. In making this determination the approval body may consider, but is not limited to considering other items such as, the location of the fence, the topography of the site, the natural features on or adjacent to the property, allowing for appropriate wildlife passage, and the impacts the fence may have on neighboring properties or views.

Response: *The Applicant and the Project will comply with this requirement.*

22. All areas from which natural resources have been extracted shall be rehabilitated progressively, and in accordance with the restoration plan that is approved as part of the conditional use permit, as they are worked out or abandoned to a condition of being entirely free of hazard, inconspicuous, and blended with the general surrounding ground form so as to appear reasonably natural.

Response: *The Applicant and the Project will comply with this requirement.*

23. If the conditional use permit is approved, the applicant shall post a performance bond, in an amount set by the Township Board, such amount to be sufficient to ensure restoration in

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 17

accordance the restoration plan that is approved as part of the conditional use permit. The performance bond shall be used by the Township to complete restoration in the event the applicant or his successor fails to restore the site in accordance with the approved restoration plan after the cessation of mining activities, or after the cessation of mining activity within each cell. The Township may, at its discretion, exercise its right to use the performance bond and revoke the conditional use permit, if the operation has been inactive for 18 months or more. "Inactive" means that little or no removal of material from the site has been performed, or that the amount of material removed is clearly insignificant relative to prior mining activity on the site.

Response: *The Applicant and the Project will comply with this requirement.*

24. Excavation Surcharge: To assist in the remediation of the adverse effects mining activity has on streets and roads in the Township, the permittee shall either 1) pay to Norvell Township an amount equal to a minimum of 4.0 cents per ton for each ton of any natural resource shipped from the site that has been mined from within the boundaries of Norvell Township or 2) request an individualized assessment of impact, the reasonable cost of such assessment to be borne by the permittee, to determine the individualized adverse impact the permittee's operations have or is likely to have on the streets and roads in the Township and the proportionate per tonnage surcharge that shall be paid to the Township. Under either 1) or 2) the permittee shall provide monthly to the Township Clerk a copy of the total number of tons trucked from the site. The excavation surcharge shall be paid annually by March 1 for the previous January through December period.

Response: *The Applicant and the Project will comply with this requirement.*

25. Any other conditions required by the Township to proportionately address the individual impact of the mining operation on the Township.

Response: *The Applicant will work with the Township to address the individual impact of the mining operation on the Township and any conditions required by the Township as a result.*

Section 7.3 Application Process

- I. **Pre-application conference.** A pre application conference shall be a prerequisite for a Conditional Use permit application to conduct mining activity. An applicant shall informally present relevant material related to the proposed mining activity, prior to a formal application for a conditional use permit request being placed with the Township to the Township Supervisor and/or their designee. The Township Supervisor or their designee shall review the relevant material with the applicant and shall discuss the following with the applicant: The relevant requirements of the Township's Zoning Ordinance, Site plan submission requirements, comprehensive plan, and other development policies, regulations and applicable Township Ordinances as well as key issues which should be addressed by the applicant. At this pre application conference, the applicant should be prepared to present an overview of their ideas for the mining operation. They should be prepared to discuss in general the scope, sketches of informal concept layouts, haul routes, buildings, and

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 18

equipment. Expected time frames shall be outlined as well as all criteria contained in this section as it relates to the general nature of their operations. They should have some idea of the possible future uses of the site and some concept of reclamation. The interested parties should be prepared to respond to questions from the Township Supervisor or their designee about their concepts and intentions. In the discretion of the Township Supervisor, a written report related to the proposed mining activity including but not limited to findings of fact regarding the proposed extraction operation, applicable ordinance provisions pertaining to extractive operations, and other township ordinance provisions may be forwarded to the Planning Commission with a copy to the applicant. The fee for a pre application conference meeting shall be set by the Township Board and paid in full by the applicant prior to the review.

Response: *An informal preconference between the Applicant and the Township Supervisor, Bill Sutherland, and Norvell Township Sheriff, Jay Trucheeon, was held on July 22, 2024. The Applicant presented a preliminary site plan, sketches of informal concept layouts, haul routes and equipment and other supporting documents which complied with the Township Ordinance and submission requirements, along with a discussion of AAOM's development plan and policies, an overview of their extractive operations, as well as any key issues and questions that were brought up by the Township. A second informal preconference was held on January 9, 2025 between Applicant and the Township Supervisor and Sheriff, where further discussions were held regarding the application submittal and reclamation and an end-of-use plans.*

II. Application. In addition to the provisions of Article 12 (Site Plan Review) and Article 13 (Conditional Uses), fifteen (15) copies of an application shall be filed with the Zoning Administrator and shall include the following:

1. Land use study/drawings shall be color coded, showing the existing land uses with specification of type of use, e.g., single-family residential, multiple-family residential, retail office, and density or individual units in areas shown, including:
 - a. Property within a radius of one (1) mile around the site; and
 - b. The property fronting on all vehicular routes within the Township contemplated to be utilized by trucks which will enter and leave the site.

Response: *These requirements are met. See **Project Report**.*

2. Geological/hydrological/engineering survey done above the water table. In the event that the mining operation shall take place above the water table, the following survey with written recommendations to the Township shall be provided by the Township's Engineer:

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 19

- (a) The engineer shall visit the proposed site and specify the number and location of soil borings for each stage of mining operation by cell to determine groundwater elevation.
- (b) Soil borings shall be taken based upon the Township Engineer's determination as specified in subsection (2) (a).
- (c) The location of the borings shall be noted on the site plan with a log of each boring showing the depth of boring, soil types, ground water elevation, and elevation of any mottled soils encountered.
- (d) The owner, operator and/or permittee shall reimburse the Township for all expenses associated with these analyses.

Response: *The Applicant has conducted a Hydrogeological Evaluation Report, attached as **Exhibit 8**. A survey with written recommendations by the Township engineer has yet to be provided.*

- 3. Geological/hydrological/engineering survey below the water table. In the event that the operation shall extend below the water table, the following shall be provided:
 - (a) A geological/ hydrological/engineering survey of the proposed site shall be prepared by certified professional experts, indicating:
 - i. Level of water table throughout the proposed area;
 - ii. Opinion as to each and every effect on the water table and private wells and property owners within the reasonably anticipated area of impact during and subsequent to the operation;
 - iii. A map of all public and private wells within such area;
 - iv. All qualitative and quantitative aspects of surface water, groundwater, and watershed anticipated to be impacted during and subsequent to the operation to the geographical extent reasonably expected to be affected; and
 - v. Opinion whether the exposure of subterranean waters and/or the impoundment of surface waters, where permitted, will establish a suitable water level at the level or levels proposed as part of the operation, and whether the same will not interfere with the existing subterranean water or cause any harm or impairment to the general public.

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 20

- vi. The geological/hydrological/ engineer certified professional experts, shall be selected by the owner, operator and/or permittee, and all expense associated with these analyses, shall be paid by the owner, operator and/or permittee.
 - vii. This geological/hydrological survey analyses shall be reviewed by the Township Engineer, with written recommendations to the Planning Commission. The owner, operator and/or permittee shall reimburse the Township for all expenses associated with this review.
- (b) An acknowledgement that if such survey indicates a possible impact upon public or private wells due to the mining activity, that the issuance of a conditional use permit shall include a condition that such impact shall be fully remediated by the applicant to the satisfaction of the Township.

Response: *N/A. Mining activity for the Project is not expected to go below the water table and no impact on public or private wells is anticipated.*

4. The applicant shall prepare a long-term plan designating all areas proposed for future excavation. A scheduling sequence shall be provided to indicate the planned dates or excavation of each area. For each scheduling sequence, a short-term (two-year) plan for excavation shall also be provided which designates the initial area to be excavated. In preparing the long, and short-term plans, the applicant shall develop the plans consistent with the two-year approval cycle for conditional use permits for mining operations as referenced in Section 7.4.
- A. Each short-term (two-year) plan shall include the following:
- i. A detailed proposal as to method of operation, what type of machinery or equipment will be used, estimated period of time that such operation will cover, and all haul roads and truck entrance locations to be used.
 - ii. Site clearance methods and debris clean up.
 - iii. A detailed statement as to exactly what content and type of deposit is proposed to be extracted, the depth of the deposit, and the depth of excavation.
 - iv. All wetlands shall be delineated by monumentation.
 - v. A map delineating access routes between the property and the nearest arterial road.
 - vi. The impact of the removal process and methods of removal on adjoining areas.
 - vii. The method and direction of the excavation.

Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 21

- viii. The depth of grade level over the entire site from which the materials will be removed.
- ix. Provisions for grading, re-vegetation and stabilization that will minimize soil erosion, sedimentation, and public safety concerns.
- x. The location of buildings, structures, equipment, stockpiles, roads, sediment ponds, drainage diversions, discharge points, or other features necessary to the mining activities and provision for the removal and restoration of the area at the projected termination.
- xi. The interim use or uses of reclaimed areas before the cessation of the entire quarrying operation.
- xii. Maps and other supporting documents may be required.

Response: *These requirements are met and addressed in the long term and the two-year plans. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- xiii. Color coded maps and plans shall be prepared which detail, for both the mining activity and the transport of product, the following:
 - a. Haul routes
 - b. Noise control and Dust control
 - c. De-watering process including the treatment of ponded or surface water
 - d. Drainage
 - e. Soil erosion control measures
 - f. Berming and screening from view
 - g. Mining activity limits

Response: *These requirements are met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- xiv. The site plan, in addition to displaying the information required in Article 12, Site Plan Review and Approval, and other provisions of the ordinance, shall display any staged, or cell, excavation and reclamation involving stripping of topsoil, stockpiling of top soil or product, excavation of product, grade slopes, and re-vegetation. A cross section perspective of each cell showing stages and timing of excavation and reclamation shall be provided. Reclamation of any given stage of a cell shall be completed, stable and inspected prior to mining extraction of any other stage of the cell. Description of the vehicles, machinery and equipment proposed for use on the property,

Re: **American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")**

November 17, 2025

Page 22

specifying the anticipated noise and vibration levels in dB, and their hours of operation. All mining activity shall be in compliance with the Township's Noise Ordinance as amended.

Response: *This requirement is met. See **Project Report**, Site Plan, attached as **Exhibit 2**, and Focused Noise Estimation Report, attached as **Exhibit 13**.*

- xv. Description of the vehicles, machinery and equipment proposed for use on the property, specifying the anticipated noise and vibration levels in dB, and their hours of operation. All mining activity shall be in compliance with the Township's Noise Ordinance as amended.\

Response: *This requirement is met. See **Project Report**, Site Plan, attached as **Exhibit 2**, and Focused Noise Estimation Report, attached as **Exhibit 13**.*

- xvi. A map demonstrating that trucks traveling to and from the site shall only travel by routes that comply with the Township's Truck Route ordinance, as amended.

Response: *This requirement is met. See **Project Report**, and Traffic Impact Study, attached as **Exhibit 3**.*

- xvii. Written plan describing how odors, smoke, fumes or dust generated by the mining operation will be confined within the boundaries (whether such boundaries consist of one parcel or lot, or more than one parcel or lot) of the premises on which the mining activity occurs so as not to cause a hazard or nuisance in the Township.

Response: *This requirement is met. See **Project Report**.*

- xviii. Written plan describing how areas from which natural resources have been extracted will be continuously rehabilitated once each respective area has been worked out or the applicant has no further immediate plans for excavation in the respective area.

Response: *This requirement is met. See **Project Report**.*

- xix. A detailed restoration plan that, upon approval of a conditional use permit, shall be filed with the Township Supervisor and the Building Inspector, for the restoration of the site which shall include the anticipated future use of the site after restoration, the proposed final topography indicated by contour lines of no greater intervals than two (2) feet, steps which shall be taken to conserve topsoil; proposed and final landscaping; and the location of future roads, drives, drainage courses, and/or other improvements contemplated. The following shall apply to all restoration plans and activities:

- a. The final slopes of the banks of any area where mining activity will have occurred shall in no event exceed a slope of 3:1 (3 feet horizontal to 1 foot vertical). Where ponded water results from such use, the slope extending into the water shall be maintained at a maximum depth of five (5) feet.

Re: **American Aggregates of Michigan’s (“Applicant” or “AAOM”) Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 (“Application”) for a proposed sand and gravel mining operation (“Project”)**

November 17, 2025

Page 23

- b. The filling of land with rubbish or garbage or any other waste matter in an area where mining activity has occurred is prohibited. Any back filling shall be with non-toxic, nonflammable, noncombustible solids.
- c. Following the termination of mining activity all exposed surfaces shall be seeded or sodded with vegetation that will prevent erosion from wind or water.
- d. The method of disposing of any equipment or structures used in the operation of the excavation upon completion of the excavation shall be specified, and no equipment or structures shall be left onsite after mining activity is complete, without the express approval of the Township.

Response: *These requirements are met. See **Project Report** and Site Plan, attached as **Exhibit 2**.*

- xx. The following information shall also be provided:
 - a. the estimated mining activity season start and stop dates;
 - b. the name of the financial institution (if any) backing the operation;
 - c. a list of names, addresses, and telephone numbers of persons, firms, or corporations having legal or equitable interest in the property, and those persons, firms or corporations that will be operating on the premises and responsible for conditional use permit compliance. The applicant shall be the holder of the conditional use permit and the party responsible for compliance with subsection Article 12 and the conditional use permit.
 - d. the anticipated ending date of the extracting operation as a whole, as well as anticipated end dates for each individual cell.

Response: *These requirements are met. See **Project Report**.*

Section 7.4 Permit Renewal

- A. Any approved permit or each renewal thereof shall be for a period of not more than two (2) years. Not less than 60 days prior to the expiration of a permit, the permit holder shall make arrangements with an engineer designated by the Township to inspect the premises for which the permit is issued. Such permit may be renewable on reapplication, a redetermination by the Planning Commission, and a redetermination and/or re- filing of a performance bond that is in an amount sufficient to ensure restoration in accordance with the approved restoration plan. No new cell shall be commenced until the previous cell has been completely restored and approved by the Township.

Response: *The Applicant will comply with all permit requirements.*

Re: **American Aggregates of Michigan’s (“Applicant” or “AAOM”) Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 (“Application”) for a proposed sand and gravel mining operation (“Project”)**

November 17, 2025

Page 24

III. Project Schedule

It is the intent of the Applicant at this time is to commence site work within 12 months after obtaining all required governmental approvals. A more detailed project schedule will be provided prior to issuance of building permits.

V. Applicable Law and the MZEA

MCL 125.3205(3) provides:

An ordinance shall not prevent the extraction, by mining, of valuable natural resources from any property unless very serious consequences would result from the extraction of natural resources. Natural resources shall be considered valuable for the purposes of this section if a person, by extracting the natural resources, can receive revenue and reasonably expect to operate at a profit.

(emphasis added)

Here, the Applicant will receive revenue and operate at a profit by extracting sand and gravel and providing construction grade aggregates for sale to markets in the local, regional and state construction industry. The sand and gravel that would be extracted from the proposed mining operation are the highest volume natural aggregate used in southern Michigan. This sand and gravel aggregate is used as the component for different sand and gravel products such as commercial asphalt used to build roads and shoulders, basement floors and walls, paver bricks, septic fields, and pipe bedding. This aggregate is also used for masonry and fill sand.

A. Need

A combination of growing demand coupled with the closing of several regional mining operations in the last twenty years, has led to a need in the market served by the Applicant for sand and gravel. At this time, the Applicant already has purchase agreements with customers to fulfill 80% of the anticipated production capacity of the proposed mining operation before the mine has even started operating, and these contracts demonstrate an adequate demand to support the operation solely within the company itself. Customer demand is discussed in greater detail in the Need section of the **Project Report**. Further, the continuing government funded road reconstruction and repair products, as well as regional commercial, industrial and residential construction projects will provide a continuing market for the extracted sand and gravel extracted from the proposed mining operation. *See Project Report.*

There is no doubt that the Applicant, by extracting the sand and gravel natural resources, will “receive revenue and reasonably expect to operate at a profit,” as required by statute and the Ordinance. MCL 125.3205(3).

Re: **American Aggregates of Michigan’s (“Applicant” or “AAOM”) Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 (“Application”) for a proposed sand and gravel mining operation (“Project”)**

November 17, 2025

Page 25

B. No Very Serious Consequences

Aside from demonstrating a need, MCL 125.3205(4) and the Ordinance, also requires the Applicant to demonstrate to the Township that no very serious consequences will occur as a result of the mining Project. The factors used in considering whether very serious consequences would result from the mining of natural resources are laid out in MCL 125.3205(5)(a)-(f):

(5) In determining under this section whether very serious consequences would result from the extraction, by mining, of natural resources, the standards set forth in *Silva v Ada Township*, 416 Mich 153 (1982), shall be applied and all of the following factors may be considered, if applicable:

- (a) The relationship of extraction and associated activities with existing land uses.
- (b) The impact on existing land uses in the vicinity of the property.
- (c) The impact on property values in the vicinity of the property and along the proposed hauling route serving the property, based on credible evidence.
- (d) The impact on pedestrian and traffic safety in the vicinity of the property and along the proposed hauling route serving the property.
- (e) The impact on other identifiable health, safety, and welfare interests in the local unit of government.
- (f) The overall public interest in the extraction of the specific natural resources on the property.

The Applicant has analyzed the Project in light of these factors and commissioned multiple comprehensive studies, including a Traffic Impact Study, a Property Valuation Study, Threatened and Endangered Species Survey and Habitat Assessment, and Focused Noise Estimation Report. See **Project Report**, and **Exhibits 3, 10, 11, 7, and 13**. These reports conclude that the extraction of sand and gravel by the proposed mining operation would not cause very serious consequences to the community in the vicinity of the Project. For example, the Traffic Impact Study concluded that:

The proposed mining operation will not result any significant operational impacts to the impacted road network no matter which of the three alternative routes is utilized. Further, no off-site improvements are required to mitigate adverse impacts along any of the proposed haul routes.

See Traffic Impact Study, attached as **Exhibit 3**.

In the Focused Noise Estimation Report, in looking at the noise limitations for an agricultural zoning district and the noise limitations under the Township’s noise ordinance, along with measuring the sound at the Project site and estimating noise levels associated with the operation of a crusher, concluded that “noise levels in the vicinity of the Project Site will increase as a result of the proposed mining activity due to the operation of mining equipment and trucks. It is anticipated that these impacts will be minor, short-term, limited to the hours of operation and mining season, and will be within the requirements of

Re: **American Aggregates of Michigan’s (“Applicant” or “AAOM”) Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 (“Application”) for a proposed sand and gravel mining operation (“Project”)**

November 17, 2025

Page 26

Township ordinances for both agricultural and residential districts. As such, they will not produce any serious consequences.” See Focused Noise Estimation Report, attached as **Exhibit 13**.

In another example, the Environmental Site Assessment conducted by ASTI Environmental (“ASTI”) reviewed the ecological conditions of the Project site and the impact of the Project on the site. See Wetland Delineation Report and Threatened and Endangered Species Survey and Habitat Assessment, attached as **Exhibits 6 and 7**. The studies concluded that while seven regulated wetlands and two lakes are located on the North Property of the Project, none of them are located within the mining site and none will be disturbed as part of the mining operations or construction of screening berms. No wetlands were found on the South Property. The conclusion of these studies, as well as the Surficial Water Hydrology assessment found in the **Project Report** and the Hydrogeologic Report attached as **Exhibit 8**, is that no direct impact to wetlands or lakes will occur as a result of the proposed mining operation. ASTI also conducted a rare species review of the Project site regarding endangered plant and animal species that are protected under state and federal acts. The report determined that no impacts are anticipated for endangered species identified as potentially present at the Project site.

There is no evidence that the health, safety and welfare interests of the local community would be negatively impacted by the Project. Some examples:

- the excavation process will utilize existing agricultural wells already on the site;
- water withdrawal will not exceed limits for the existing wells;
- less than 2 million tons of sand and gravel will be crushed per year in compliance with regulations of the Environmental Protection Agency (“EPA”) and the Michigan Department of Environment, Great Lakes and Energy (“EGLE”);
- Crushing equipment will be located at least 500 feet from any residential or commercial establishment, or any place of public assembly in compliance with EGLE regulations;
- A comprehensive fugitive dust control program designed to minimize dust emissions from the excavation site will be implemented by the Applicant in compliance with EPA and EGLE regulations;
- Screening berms will be constructed in the mining setback area to mitigate visual and noise impacts of the mining operation during each phase;
- A closed-loop system will utilize water recovered through the processing equipment to be used to wash the extracted sand and gravel and will be re-circulated to the processing plant, reducing the reliance on well and groundwater and ensuring that no processing water will be discharged into adjacent drainage systems or wetlands;
- The proposed mining site will be secured by fencing and warning signs which will ensure the Project site does not pose a safety hazard to the surrounding community;
- After completion of the final phase of the Project, reclamation measures by the Applicant will establish a landscape cover to prevent soil erosion and fugitive dust, drainage ways and wetlands will be delineated and protected, the Project land will be returned to productive agricultural, recreation or residential use, and all mining related equipment and structures will be removed from the site, all in compliance with the Township’s Ordinance requirements; and



Re: American Aggregates of Michigan's ("Applicant" or "AAOM") Application for Site Plan Approval, Conditional Use Permit and Mining Permit under Article 7 ("Application") for a proposed sand and gravel mining operation ("Project")

November 17, 2025

Page 27

- The Project will create local job opportunities, increase the local tax base and increase the long-term value of the Project site.

As is clear, every study conducted regarding the Project and its impact on the local community has concluded that the Project would have minimal impact on the surrounding community and has not indicated a single very serious consequence.

Under Michigan law, when a site plan contains the information required by the zoning ordinance and is in compliance with the zoning ordinance, it is to be approved. See MCL 125.3501(5); *Hessee Realty, Inc. v Ann Arbor*, 61 Mich App 319 (1975); *Keating Int'l Corp v Orion*, 51 Mich App 122 (1974), aff'd, 395 Mich 539 (1975). As Applicant AAOM has met all criteria under the Norvell Township Zoning Ordinance and the MZEA, the Application should be approved.

VI. Conclusion

The Applicant respectfully requests that the foregoing materials be considered by the Township and that the Application for a Conditional Use Permit be approved. On behalf of the Applicant, we thank you in advance for your timely attention to this Application and look forward to working with the Township throughout the zoning approval process.

Sincerely,

ZAUSMER, P.C.

A handwritten signature in blue ink, appearing to read "Stephen R. Estey", with a long horizontal line extending to the right.

Stephen R. Estey

SRE

Encls.

PROJECT REPORT

NOVEMBER 14, 2025

PROJECT REPORT
NORVELL SAND AND GRAVEL SITE

AMERICAN AGGREGATES OF MICHIGAN

SMITHGROUP
201 Depot Street Ann Arbor, MI 48104

**PROJECT REPORT
NORVELL SAND AND GRAVEL SITE
AMERICAN AGGREGATES OF MICHIGAN**

TABLE OF CONTENTS

SECTION 1 INTRODUCTION	1
1.1 Proposed Project	1
1.2 Project Phases	2
1.3 Regional and Local Context	3
1.4 Short-Term and Limited Impacts	3
1.5 Long-Term Impacts	3
1.6 Mitigation Measures to Reduce Adverse Impacts.....	4
1.7 Benefits of the Project.....	4
1.8 Summary	4
SECTION 2 DETAILED PROJECT DESCRIPTION	6
2.1 Proposed Mining Plan	6
2.2 Site Reclamation Plan	10
2.3 Future Land Use	11
SECTION 3 NEED.....	16
3.1 Project Need.....	16
3.2 Construction Aggregate Types and Uses	16
3.3 Geographic Market	16
3.4 Factors Influencing Supply.....	17
3.4.1 Production Capabilities	17
3.4.2 Unavailability of Land Suitable for Mining	17
3.4.3 Geological Limitations.....	17
3.4.4 Depletion of Permitted Aggregate Sources:	18
3.5 Customer Demand.....	19
3.6 Factors Influencing Demand	19
3.7 Conclusion	20
SECTION 4 FINDINGS	21
4.1 Land Cover, Wetlands, Streams, and Water Bodies	21
4.1.1 Existing Ecological Conditions and Study Methodology	21
4.1.2 Land Cover.....	21
4.1.3 Wetlands, Lakes, and Streams	23
4.1.4 Threatened and Endangered Species Habitat.....	23
4.2 Geology and Topography	25

4.3	Surface Water Hydrology	27
4.3.1	Project Site Surface Water Hydrology	27
4.3.2	On-Site Wetland Hydrology.....	30
4.3.3	Storm Water Permitting	32
4.3.4	Conclusions.....	32
4.4	Groundwater Hydrology.....	33
4.4.1	Shallow Groundwater Well and Staff Gauge Installation and Development.....	33
4.4.2	Geology	33
4.4.3	Hydrology.....	33
4.4.4	Groundwater Flow Direction	34
4.4.5	Conclusions.....	34
4.5	Environmental Contamination	36
4.5.1	Environmental Conditions	36
4.5.2	Product Storage and Emergency Planning	37
4.6	Soils and Agricultural Farmlands	38
4.6.1	Prime Farmland	40
4.7	Norvell Township.....	40
4.7.1	Master Plan Considerations.....	41
4.7.2	Zoning and Permitting Considerations.....	43
4.7.3	Land Use Considerations Along Haul Route	44
4.8	Real Estate Valuation	46
4.8.1	2025 Market Study.....	47
4.8.2	SRR Study Results.....	47
4.8.3	Phoenix Center Study Results.....	48
4.9	Community Services	48
4.10	Socioeconomic Environment	49
4.11	Air Quality.....	50
4.11.1	Dust and Fine Particulate Matter	50
4.11.2	Respirable Crystalline Silica	51
4.11.3	Conclusions.....	52
4.12	Noise	52
4.13	Vibration	55
4.14	Traffic.....	55
4.14.1	Scope.....	55
4.14.2	Methodology	56
4.14.3	Results	56

4.14.4 Crash Analysis	57
4.14.5 Pedestrian Safety	58
4.14.6 Proposed Driveway Location	58
4.14.7 Conclusions	59
4.15 Visual Quality	59
SECTION 5 MITIGATIVE MEASURES	61
5.1 Materials Handling	61
5.2 Soils	61
5.3 Storm Water Management and Wetlands	61
5.4 Groundwater	61
5.5 Terrestrial Systems	62
5.6 Air Quality	62
5.7 Noise	62
5.8 Traffic and Haul Route	63
5.9 Visual Quality	63
5.10 Conclusion	63

FIGURES

Figure 1 - Regional Map	1
Figure 2 - Site Map and Surroundings	2
Figure 3 - Mining Operations and Phasing Map – North Property	6
Figure 4 - Mining Operations and Phasing Map – South Property	7
Figure 5 - Island Lake of Novi	12
Figure 6 - Island Lake of Novi Plan	13
Figure 7 - Maple Lake Farms	14
Figure 8 - Kensington Ridge - under development by Del Webb	14
Figure 9 - Future Land Use Concept Plan – North Property	15
Figure 10 - Future Land Use Concept Plan – South Property	15
Figure 11 - Habitat Types	22
Figure 12 - Jackson County Quaternary Geology Map	26
Figure 13 - Existing Drainage Areas	28
Figure 14 - Proposed Drainage Areas	30
Figure 15 - Wetlands	31
Figure 16 - Groundwater Flow Map	35
Figure 17 - NRCS Soil Map	39
Figure 18 - Haul Route Options and Zoning Map	45

TABLES

Table 1 - Listed Species	24
Table 2 - Run-off Characteristics Comparison.....	29
Table 3 - Groundwater Elevations	36
Table 4 - Site Soil Classification	40

EXHIBITS

Exhibit 1 - Sealed Boundary Surveys (printed full scale)	
Exhibit 2 - Site Plans (printed full scale)	
Exhibit 3 - Traffic Impact Study	
Exhibit 4 - Purchase Order	
Exhibit 5 - Infrastructure Reports	
Exhibit 6 - Wetland Delineation Report	
Exhibit 7 - Threatened and Endangered Species Survey and Habitat Assessment	
Exhibit 8 - Hydrogeological Report	
Exhibit 9 - Phase 1 Environmental Site Assessment	
Exhibit 10 - 2025 Market Study	
Exhibit 11- Property Valuation Studies	
Exhibit 12 - Industrial Hygiene Exposure Assessment Report	
Exhibit 13 - Focused Noise Estimation Report	

SECTION 1 INTRODUCTION

American Aggregates of Michigan (“AAOM” or the “Applicant”) is filing an application for a Conditional Use Permit (“Application”) to allow for the extraction of sand and gravel from a site in Norvell Township, Michigan (the “Project”). This report has been prepared alongside the Application, letter in support of Application and supporting exhibits, to provide additional information about the Project, and specifically, to provide additional information relating to the “need” for the project and the “no very serious consequences” of the Project, as required under the Michigan Zoning Enabling Act, MCLA 125.3205 (“MZEA”).

1.1 Proposed Project

AAOM proposes to mine existing sand and gravel resources on two sites totaling approximately 626.4 acres (the “Project Site”). The Project Site located north of Horning Road measures approximately 384.7 acres (the “North Property”). The Project Site south of Horning Road measures approximately 241.7 acres (the “South Property”). See **Exhibit 1** to Application, Sealed Boundary Surveys. The Project Site is located in portions of T4S R2E, Sections 13, 14, and 24 of Norvell Township with the North and South Properties being bisected horizontally by Horning Road. See *Figure 1* below, Regional Map. The areas within the Project Site that are subject to mining activity total approximately 232.5 acres in size (“Mining Area”).

The Project objective is to extract natural resources from the Project Site to produce construction grade aggregates for sale to markets in the local metropolitan region, which is necessary to satisfy existing and anticipated demands, while shaping the land for productive post-mining use. There is a demonstrable internal and external need for the natural resources to be mined at the Project Site as discussed in further detail herein.

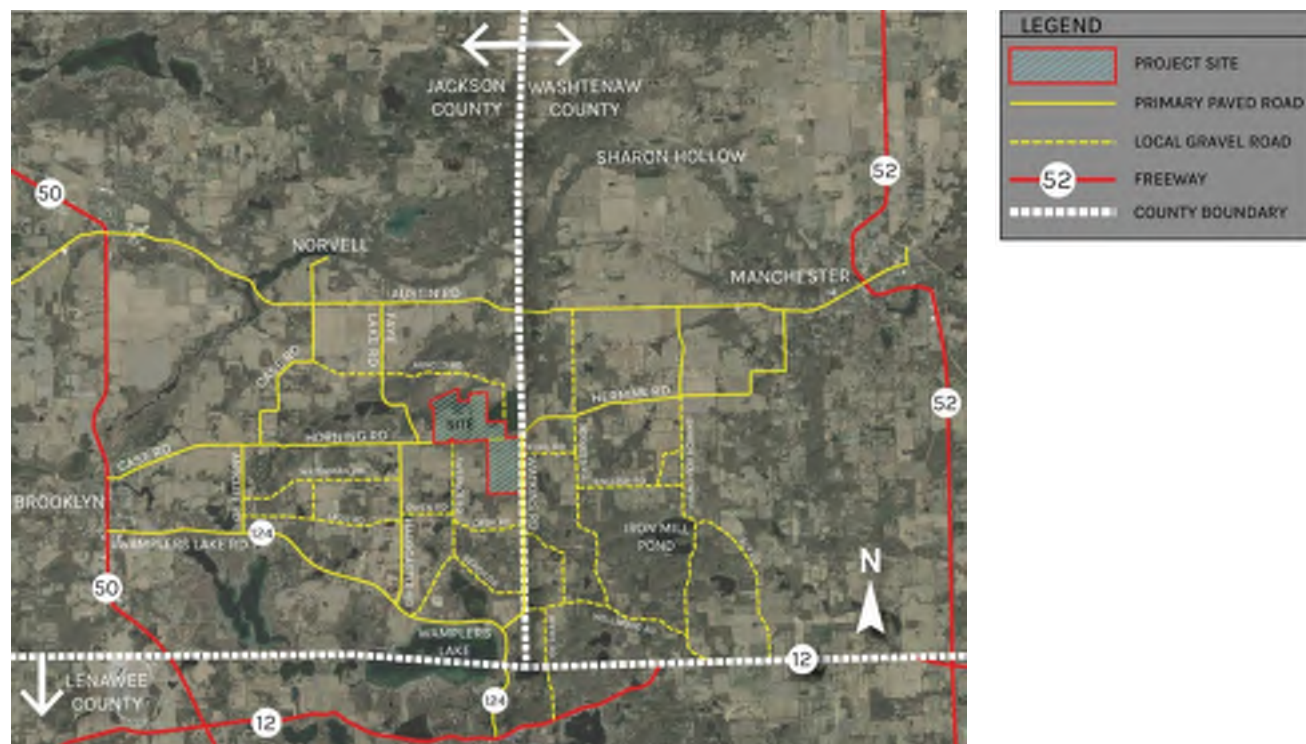


Figure 1 - Regional Map

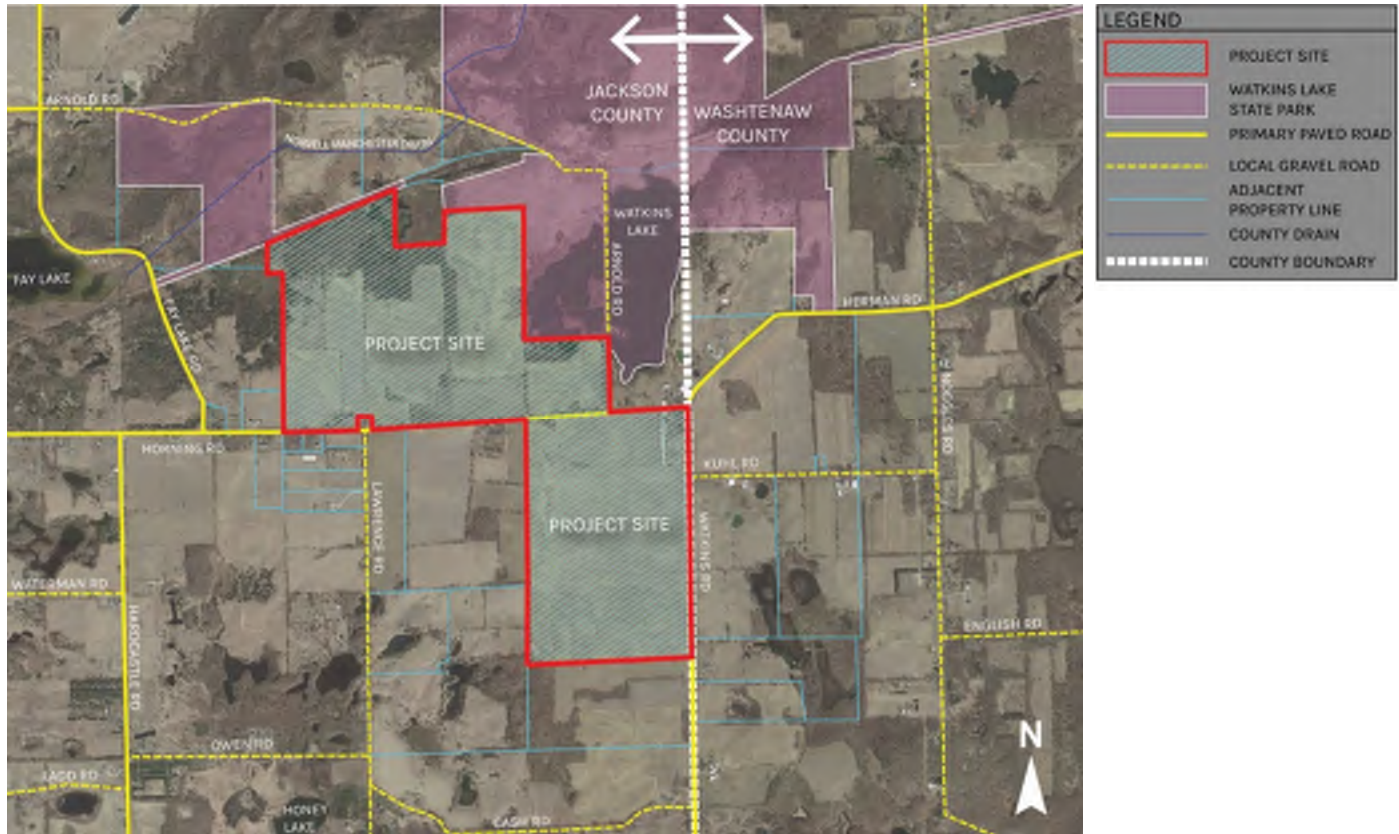


Figure 2 - Site Map and Surroundings

1.2 Project Phases

The estimated extraction activity will take place in six phases, which will be completed in approximately 15 to 20 years, subject to market conditions. Phases 1 through 4 will be conducted within the North Property and Phases 5 through 10 within the South Property. AAOM estimates that the Project Site contains approximately 7,700,000 cubic yards (or about 10,400,000 tons) of marketable sand and gravel reserves. See **Exhibit 2** to Application: Site Plans.

Typical aggregate mining equipment will be utilized during the mining activity, including bucket loaders, transport trucks and conveyors. An aggregate processing plant will be constructed on the North Property of the Project Site. Mining activity is not proposed to go below the water table. The preparation of the land for mining will be done on an as-needed basis, leaving existing land cover in place until removal is required for mining activities. Similarly, reclamation will be completed on an ongoing basis such that the area disturbed by mining at any one time will be limited to what is required for efficient, safe, and responsible operations. Mining and reclamation plans include mitigation measures to limit the impact of the mining activity on the community and natural environment. No developed land uses are planned for areas that have been reclaimed until the cessation of mining and final reclamation of the property.

At the completion of mining activity, site reclamation will result in a range of landform types and habitats, and a land shape conducive to future recreational, agricultural and/or residential development.

1.3 Regional and Local Context

The Project Site is surrounded by low density uses, including rural residential lots, recreational land, and agricultural fields. Norvell Township, though populated at a low density, is within 20 miles of Jackson and 30 miles from Ann Arbor. The North Property is adjacent to Watkins Lake and Watkins Lake State Park and Country Preserve to the north and northeast respectively. Michigan International Speedway resides 9 miles to the southeast. Given the existing and planned low density of development in the vicinity of the Project Site, and the mitigative measures planned to screen the site, the proposed mining activity will be compatible with the area and serve as an appropriate location for this Conditional Use.

AAOM's proposed mining operation will use Horning Road and Hardcastle Road as the traffic route, which is designated as a primary road and truck route by Jackson County, and designated as a truck route by Norvell Township.

1.4 Short-Term and Limited Impacts

AAOM anticipates the following short-term and minor impacts which will be mitigated as discussed in Section 1.6 below:

- A change in the visual character of the site and the potential for limited views of the mining activity.
- A limited impact on existing habitat. However, no threatened or endangered species will be impacted. High-quality woodland and wetland habitat will not be disturbed.
- An increase in dust levels generated by the site activities, which will be controlled within regulatory requirements through standard mitigation practices utilized by AAOM.
- Additional traffic on Horning Road and Hardcastle Road; however, this traffic will have no significant impact on the capacity or safety of the road (as studied and concluded in the Traffic Impact Study, attached as **Exhibit 3** to the Application).

AAOM will abide by all appropriate local, state and federal regulations in addressing these short-term impacts.

1.5 Long-Term Impacts

The Project Site's environment will be subject to minimal long-term impacts as a result of the proposed mining operation, including:

- A change in topographic shape of the Project Site.
- The incremental removal of approximately 14 acres of low-quality woodland over the life of the mining operation.

These long-term impacts are limited in significance as they do not represent a loss of unique resources of the area directly surrounding the Project Site and Jackson County.

1.6 Mitigation Measures to Reduce Adverse Impacts

As part of its plan to mine and reclaim the proposed Project Site, AAOM proposes to implement the following measures:

- Vegetative buffers will be left in an undisturbed state and screening berms will be constructed as needed to limit visual and noise impacts from the mining activities on adjacent property and public roads. High-quality woodland and wetland habitats will not be disturbed.
- Active mining zones will be secured through fencing and signage to prevent unauthorized access.
- The Project Site will be shaped by mining activity to maintain the fundamental drainage patterns of the existing Project Site.
- Storm water run-off from the Mining Area will be managed to avoid impacts to regulated wetlands, lakes, streams, or adjacent properties.
- The proposed processing plant will utilize a state-of-the-art process that significantly reduces the use of groundwater to levels below what is currently withdrawn to irrigate the existing crops farmed at the site.
- The Project Site will be reclaimed on an ongoing basis to limit the amount of exposed, un-vegetated land.
- Standard operational procedures will be utilized to limit potential impacts associated with mining activity, such as dust, equipment noise, and to protect groundwater; these measures will be consistent with regulatory requirements.

1.7 Benefits of the Project

The proposed Project provides many benefits to the community, including:

- Increasing the long-term value of the Project Site and positioning it for future recreational, agricultural and/or residential development.
- Providing the local community and the regional construction industry with a readily available source of construction-grade sand and gravel in close proximity to the demand.
- Increasing the local tax base.
- Creating local job opportunities.
- Increasing local economic activity.
- Diversifying the local economy.

1.8 Summary

Based on the investigations by AAOM and the assessment of numerous experts who evaluated the Project and provided conclusions in the reports attached to the Application, the Project Site is an appropriate and viable location for a sand and gravel mining operation, and the Project complies with all applicable local and state zoning requirements as set forth in the Application and further supported by this Report. This conclusion is supported by the following:

- The Project Site contains a reserve of sand and gravel resources which can be mined, processed, and sold with a reasonable expectation of financial return to support the local and regional construction industry. The local and regional market for sand and gravel will support a new operation on this site.

- The anticipated short- and long-term impacts are limited, and AAOM has proposed measures to reduce or eliminate impacts that may be inherent in the mining process to ensure the Project operates in compliance with applicable federal, state, and local laws and ordinances.
- There are no very serious consequences associated with the proposed sand and gravel mining operation.

SECTION 2 DETAILED PROJECT DESCRIPTION

2.1 Proposed Mining Plan

Of the 626.4-acre Project Site, 232.5 acres are included within the Mining Area. The remaining 393.9 acres are located in preservation areas or setbacks and will not be disturbed by sand and gravel extraction activity except for the construction of screening berms and entrance road and office facilities as indicated on the plans. Construction of earth berms will occur in the mining setback area to mitigate visual and noise impacts during each mining phase. During final reclamation work, land within the setbacks and buffer areas may experience minor landscape clearing and earth shaping to ensure a safe and smooth transition of grades; however, no such activity will impact regulated wetlands. See Site Plans, attached as **Exhibit 2** to Application.

The Site Plan outlines the specific sequence and location of mining, screening, and reclamation activities within each of ten phases of mining. These activities are summarized in this report on *Figures 3 and 4, Mining Operations and Phasing Maps*. Each of the phases outlined in the plans represent a period of approximately 2 years of mining. AAOM estimates that the entire mining operation will last approximately 20 years.. The mining activity and schedule outlined in this report are the best available estimates based on a thorough study of the Project Site's resources, market conditions, and decades of previous mining experience by AAOM. Actual extractive methods and phasing schedules may vary slightly.

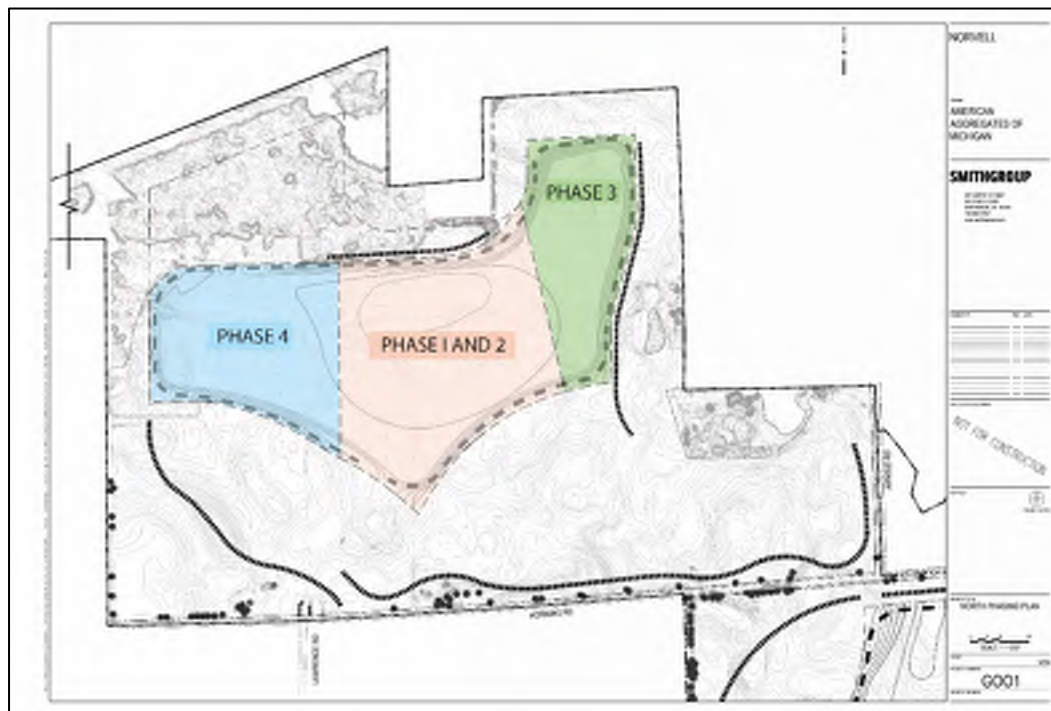


Figure 3 - Mining Operations and Phasing Map – North Property

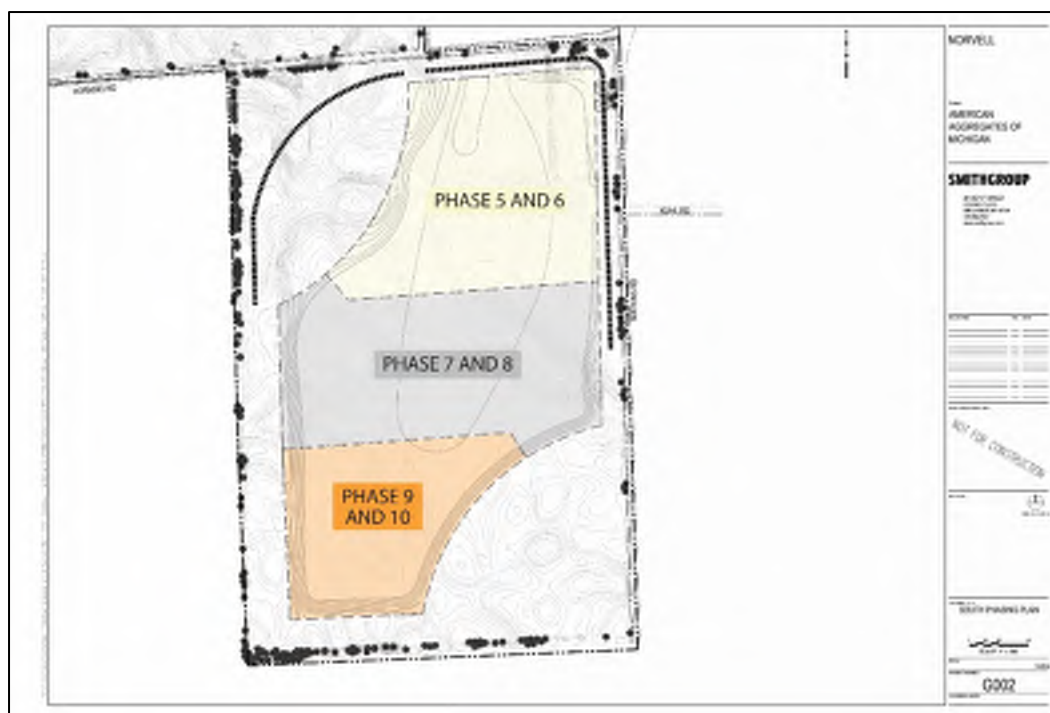


Figure 4 - Mining Operations and Phasing Map – South Property

In conformance with Township ordinances, the mining and processing activities will be limited to 7:00 a.m. (or sunrise, whichever is later), until 8:00 p.m. (or sunset, whichever is earlier), Monday through Friday, and Saturday from 7:00 a.m. (or sunrise, whichever is later) until 12:00 p.m. Truck loading and shipping will be limited to the hours of 7:00 a.m. to 7:00 p.m., Monday through Friday, and Saturday from 7:00 a.m. to 12:00 p.m. No extraction, processing, loading, or trucking will be allowed on Sunday.

The production process for sand and gravel is a continuous (not “just in time” or “batched”) operation, in which large inventories are accumulated and then depleted over time.

An existing agricultural well will supply water to the plant to wash the raw sand and gravel. The washing process removes the fine sand and silt from the deposit to meet the specifications for sand and gravel products established by the Michigan Department of Transportation (MDOT) and other users of the products. In its closed-loop system, the wash water utilized by the plant will be recovered through the processing equipment, allowing the fine sands and silts to settle out and the clear water to be re-circulated to the processing plant. Well water is used to supplement the re-circulating water as needed, given some process water is lost to moisture content of finished products; however, the closed-loop system greatly reduces the operation’s reliance on the well and groundwater. No processing water will be discharged into adjacent drainage ways or wetlands.

Access to the Project Site will occur off Horning Road and the preferred site entry is illustrated on the Site Plan at a point approximately 300 feet west of its intersection with Lawrence Road. A asphalt road will be constructed on the Project Site from the site entrance to the administrative office, and then extended to the processing plant. The administrative office, scales, and permanent bathrooms will be located in the south-central part of the north parcel, as indicated on the Site Plan. Permits for a potable water well, and septic disposal system installation at the Scale Trailer/Office will be required from the Jackson County Health Department.

Berms will be constructed as activity in each new phase is initiated, to provide screening and buffer areas.

In all cases, the screening berms will be built to meet the intent of the relevant ordinances, which is to screen adjacent uses from views of the mining activity and help mitigate any potential noise impacts. For all phases of work, the berm vegetation will be left unmown with natural grasses and flowers to blend into the rural character, except at the main site entrance along Horning Road, where the grass will be periodically mowed to ensure trucks and road users have unobstructed views as required by State law.

The proposed screening approach includes:

1. Earthen berms, 8 to 16 feet in height, along the perimeter of the Mining Area adjacent to neighboring land, as indicated on the Site Plan. Please note that a 15 foot berm height will be the standard; however, in areas where the berms are located along existing ridge lines in setback areas where the landform is already providing screening, berms may be less than 15 feet, but at least 8 feet in height.
2. Side slopes that are 3:1 (horizontal: vertical) on the side slopes facing adjacent properties, and 2:1 side slopes facing the Mining Area. This allows AAOM to consolidate the berm location and footprint of the berm within the setback.
3. The berm location may vary within the setback to take advantage of existing landforms and preserve existing trees in the setback where possible. These preserved trees will create a natural look to the berms consistent with the area's landscape character.
4. Berm areas will be seeded and mulched with materials meeting MDOT standards and will stabilize soils and prevent erosion. The berms will be left unmown to blend in with the agricultural landscape.

AAOM proposes to erect a 4-foot-high No.11 woven wire mesh security fence, topped with a single strand of barbed wire, to secure the active Mining Area. Signs will be posted at a spacing of no more than 200 feet along the fence, indicating "No Trespassing, Keep Out-Danger." Security fencing will be relocated from time to time throughout the mining period to ensure that the Mining Area always remains secured.

At the commencement of each new phase, AAOM will clear the vegetation from a predetermined area of the Project Site and remove the overburden from the area to be mined in the following years. Only those trees which are required to be removed to accommodate mining in the near-term will be removed, leaving the remaining trees in place to act as a screen. Topsoil and overburden will be stripped using a combination of excavators, off road trucks, pan scrapers, and bull dozers. Topsoil and overburden will either be utilized in reclamation of previously mined areas or will be stockpiled separately for future reclamation uses. No topsoil will be removed from the Project Site. For all phases, sand and gravel will be excavated using front end loaders, commencing at the base of the mining face, and working (generally) toward adjacent property lines. This approach allows the use of the face of the mining activity as a buffer, reducing the observable presence of mining activity. Front-end loaders will place the aggregate into hoppers, which feed belt conveyors that transport the raw material to the processing plant.

Concurrent with plant installation and through Phases 1 and 2 of the mining, screen berms 8 to 16 feet high will be constructed within the North Property along Horning Road beginning northwest of the Lawrence Road intersection and stretching approximately 3,000 feet east of Lawrence Road toward Arnold Road. The berms will be constructed of stripped overburden and graded to have a range in height to respond to site topography and screening needs. Once graded, the berms will be seeded with an appropriate seed mix and fully vegetated. An existing ridge line and trees west of Arnold Road will screen mining activity during Phase 1 and 2 from the east.

Phase 1 and 2 mining will encompass 46 acres and will be located on the north portion of the North Property of the Project Site. Initial efforts in Phase 1 will begin in the central area of the phase and will remove aggregate to an elevation of approximately 975 feet, which is approximately 10 feet above the groundwater table, and approximately 20 feet below the average existing grade. Initial mining efforts will focus on creating a level base for the installation of the long-term processing plant. The processing plant will extend to a height approximately 37 feet above its base for the majority of the plant, with a water clarifying tank extending to 48 feet in height. Details of the processing plant are included in the Site Plan. A state-of-the-art processing plant, using technology developed in Europe, will be used on this site. The plant includes an above ground holding tank which will store fresh water while a secondary above ground tank will recycle wastewater in preparation for reuse. Supplemental water will be sourced from the existing agriculture irrigation well on site. This new plant technology uses significantly less water in the processing of the aggregates than typical plants in the sand and gravel market. Plans of the processing plant and scale office are provided as **Exhibit 2** to the Application: Site Plans.

Once the plant, berms, and office facilities are fully operational the Phase 2 operations will extract the remaining aggregate from the Phase 1/Phase 2 area.

Work will continue into Phase 3 (approximately 23 acres in size) above the water table in a similar fashion to Phase 1 and 2, described above. The overburden stripped from Phase 3 will be utilized to partially reclaim the high bank slopes of Phases 1 and 2, extend the berm along Horning Road to Arnold Road, and create a berm from Horning Road north along Arnold Road to the existing forest edge. A conveyor will be extended into the Phase 3 area, and the mining activity will generally move from west to east.

As extraction is being completed in Phase 3, stripping of soils will start in the 30-acre Phase 4, and these materials will be integrated into any remaining reclamation needs from Phases 1 and 2 and stabilization of some of the high banks of Phase 3 and Phase 4 itself. Conveyors will be constructed to extend westward from the plant into Phase 4.

As Phase 4 nears completion, construction activity will begin to prepare for Phase 5, including the installation of a conveyor tunnel under Horning Road, and extension of a conveyor system extending east of the processing plant. As Phase 5 commences reclamation activities will be completed for all phases north of Horning Road, except for any land which is needed to support the processing and sale of aggregate, and the management of excess fine soils filtered out by the plant.

Phase 5 (25 acres) will begin in the northern portion of the South Property. Prior to extraction, the conveyor system will be extended through a tunnel to be constructed under Horning Road, connecting the North and South Properties. Construction of the conveyor tunnel will require a permit from the Jackson County Department of Transportation.

Overburden and topsoil will be stripped from Phase 5 and utilized to build screening berms around the west, north and east perimeter of Phases 5 and 6. A gap in the berm directly across from Arnold Road will be provided for gated access to the South Property. Aggregate extraction will begin on the north end of Phase 5 and move southward, and the conveyor extended as needed to provide reasonable proximity to the mining face.

Phase 6 (25 acres) is directly south of Phase 5. The conveyor system will be extended south as needed and mining will generally occur from north to south. Overburden from the stripping of Phase 6 will be used to initiate reclamation of the high banks and pit floor of Phase 5.

Phases 7 and 8 (47 acres together) are directly south of Phase 6. The conveyor system will be extended south as needed and mining will generally occur from north to south. Overburden from the stripping of Phase 7 and 8 will be used to build the remaining screening berms adjacent to Phases 7 through 10, and complete the reclamation of the high banks and pit floor of Phase 5 and 6.

Mining Phases 9 and 10 (37 acres together), are directly south of Phase 8. The conveyor system will be extended south and mining will generally occur from north to south. Overburden removed during Phase 9 and 10 will be used to reclaim the remaining high banks and pit floor of Phases 7 and 8, and initiate reclamation of Phase 9. The screening berm west, south, and east of Phase 7 through 10 will likely be removed and used to finalize the reclamation of Phases 9 and 10. Other screening berms may remain in place if the intended final use of the land, such as residential development, may benefit from their presence.

At the close of mining operations, all reclamation efforts will be finalized and the processing plant, administrative office and related facilities decommissioned and removed from the Project Site. No mining equipment or debris related to the operation will remain.

2.2 Site Reclamation Plan

AAOM has established a positive track record in the reclamation of sand and gravel operations and has returned many properties to productive, long-term use. Proper reclamation is designed to:

- Provide long-term opportunities for additional use or development.
- Return the disturbed land to productive use as agricultural fields, recreation, residential development, or other beneficial uses, to positively benefit the community.
- Properly establish a landscape cover to prevent soil erosion and dust.

Local governments establish requirements for reclamation. In Norvell Township, the requirements for reclamation of sand and gravel mines are contained in Article VI Conditional Uses – Section 6.7-A. Quarries, Mineral Mining, and Extractive Operations. A summary of the conditions established by this ordinance includes:

- Slopes should not exceed 3:1 (e.g., 1 foot of vertical drop for every 3 feet of horizontal distance).
- Overburden and topsoil are spread on the reclaimed grade and stabilized with plants.
- Slopes are treated to protect from erosion.
- Drainage ways and wetlands are delineated and protected.
- All mining related equipment will be removed from the site once mining activity is concluded at the site.

Reclamation activities will include relocating overburden and topsoil from stockpiles or new mining areas with a combination of excavators, off road trucks, pan scrapers, soil compactors, and bull dozers. Soils will be placed to provide smooth, continuous grades that will direct stormwater to low points that will act as groundwater infiltration areas. All disturbed soils will be seeded and mulched with materials meeting MDOT standards, and will stabilize soils and prevent erosion. As noted elsewhere, seeded areas will be left as unmown meadows.

AAOM agrees to follow these requirements and has adopted them as standard practice for all their operations. The proposed Site Reclamation Plans, included as Site Plans, **Exhibit 2** to the Application, conform to Township ordinances for slopes, topsoil, erosion control and wetland protection. The Site

Reclamation Plans submitted separately from this report illustrate the general land slope and configuration of the site, post-mining. The reclamation activities are specifically planned to shape the property for productive re-use, as discussed elsewhere in this report.

2.3 Future Land Use

From a post-mining reuse perspective, there are a number of activities that can be supported on the reclaimed land. Single-family homes on 1-acre minimum lots are allowed in the district, as is public recreational use. New development in the Township is encouraged to help maintain a rural, low-density character and to incorporate open space preservation. Accordingly, redevelopment of the site could cluster housing on 1 acre lots and create an open space network that allows for recreational and passive use of the open space, including trails, play fields, and equestrian facilities.

A Future Land Use Concept Plan is provided with this submittal to illustrate how the reclaimed site could be developed to productively re-use the property. See *Figures 9 and 10* below. AAOM has a successful track record of establishing post-mining development goals and shaping the land through mining and reclamation to set the stage for the land's next phase. AAOM is not in the business of land development nor home building, but as mining reaches a point where the end of the operation is near, AAOM seeks to partner with developers to produce redevelopment plans that are compatible with the community. While it is premature to speculate on the post-mining land uses of the Project Site, AAOM does anticipate that future uses will likely be recreational or residential.

AAOM and its affiliates have very successfully redeveloped aggregate mine sites in Michigan, several examples, include Island Lakes of Novi, Maple Lakes Farms in Milford Township and the ongoing Kensington Ridge development by Del Webb/Pulte Homes, also in Milford Township. See *Figures 5-8* below.

AAOM's Highland Township sand and gravel mine provides an excellent example of using mining to shape land for post-mining redevelopment, as the company reclaims the site on an ongoing basis. This process minimizes the amount of exposed land, addresses community concerns over reclamation, and prepares the site for productive reuse. Currently entering the final stages of Highland operations, AAOM is preparing final reclamation plans based on redevelopment goals, with the intent of seeking a development partner and local approval of development site plans.



Figure 5 - Island Lake of Novi



Figure 6 - Island Lake of Novi Plan



Figure 7 - Maple Lake Farms



Figure 8 - Kensington Ridge - under development by Del Webb

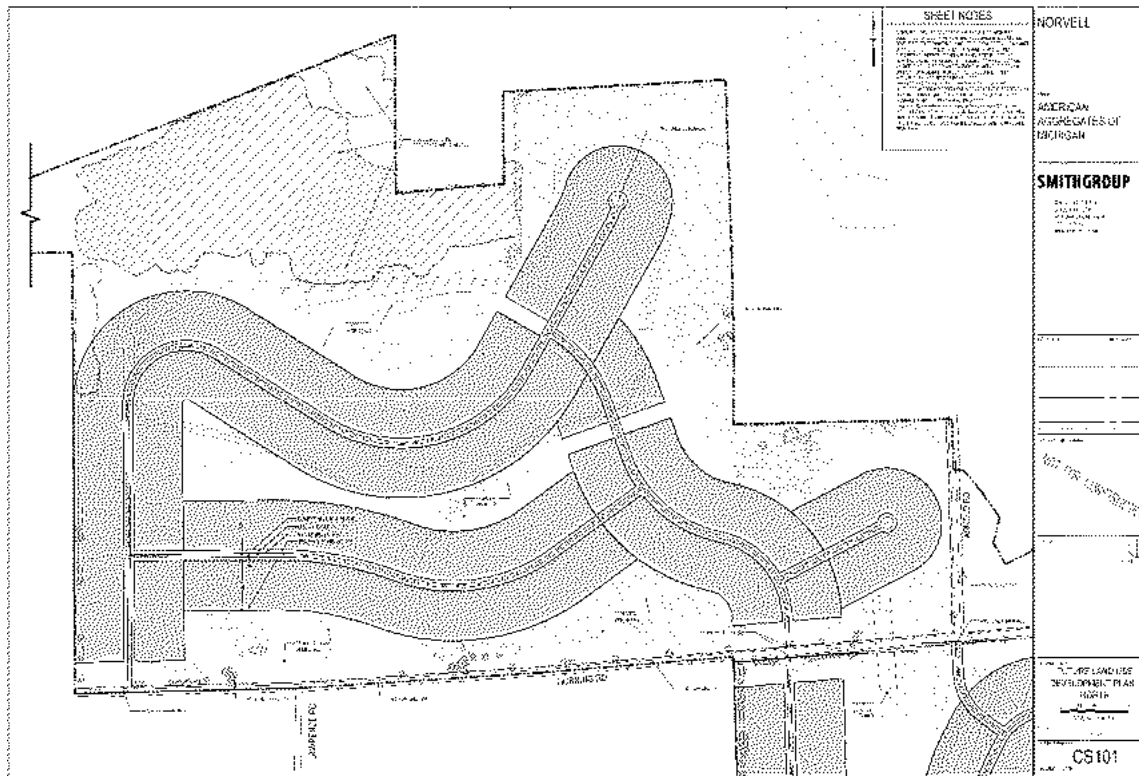


Figure 9 - Future Land Use Concept Plan – North Property

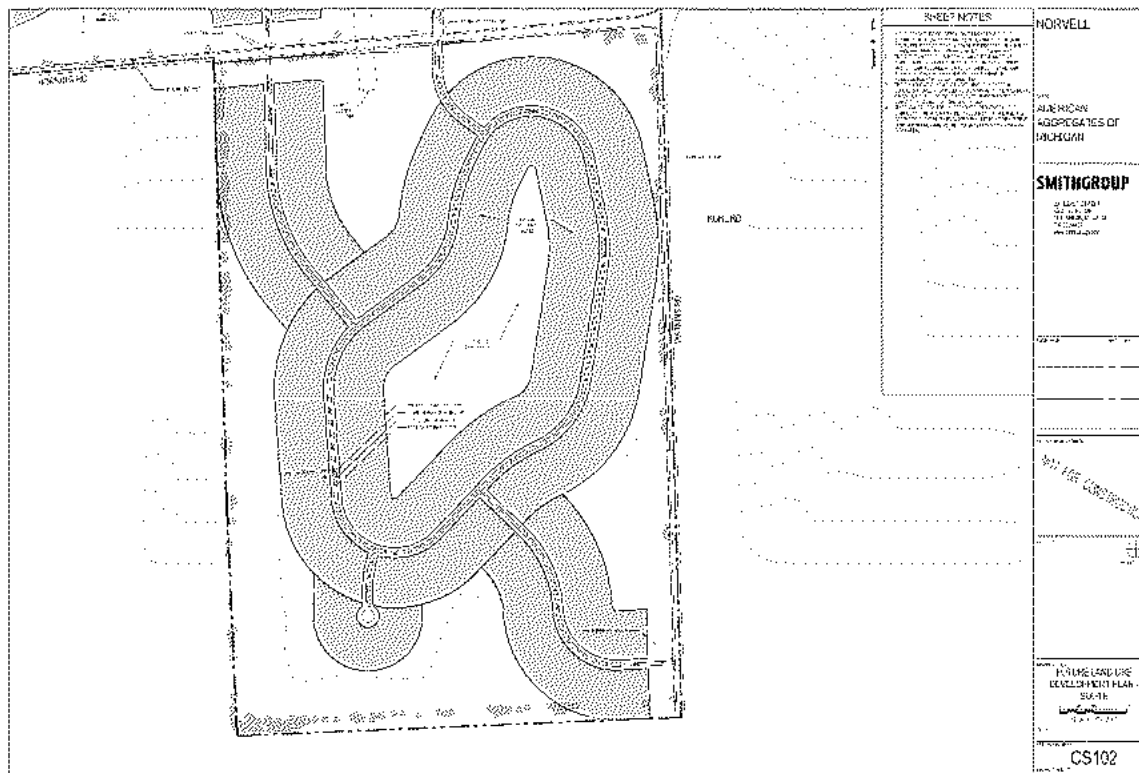


Figure 10 - Future Land Use Concept Plan – South Property

SECTION 3 NEED

3.1 Project Need

The MZEA, MCLA 125.3205, requires that there be a showing of need for proposed extracted natural resources. Further, Norvell Township Zoning Ordinance (No. 2025-58) Article 7, Sections 7.1 & 7.2 require that “there is a need for the natural resources by the applicant, or in the market served by the applicant”.

Roads, bridges, airports, schools, hospitals, housing, and commercial development all require concrete, asphalt, road gravel, and base materials derived from local sand and gravel deposits. These resources are also required to maintain, repair, and replace local infrastructure. A readily available source of sand and gravel is critical to facilitate economically viable construction and infrastructure projects. Norvell Township is home to 31 miles of unpaved gravel roads and 38 miles of paved roads, all of which require consistent, high-quality, available supply of construction aggregates. Norvell Township has various businesses and community entities requiring aggregates. Thousands of Township homeowners and residents require aggregates to build and maintain their residences, driveways, and patios. Furthermore, thousands of acres of Norvell Township farmland require access roads, farm roads, and driveways – all of which require aggregates.

3.2 Construction Aggregate Types and Uses

The majority of the construction aggregates used in the southern Michigan market area are produced through mining.

The proposed mining operation in Norvell Township will produce Sand and Gravel products including:

- 2NS sand is fine aggregate that, when combined with gravel and cement, produces concrete.
- 6A (1 ¼" X ½") gravel is the coarse aggregate component of concrete.
- 6AC (1 ¼" X ½") gravel is the coarse aggregate component of concrete for applications not exposed to weather. 6AC is also used extensively in septic fields.
- Pea Pebble (3/8") gravel, also known as 34R, is the aggregate for concrete paver bricks, pipe bedding, and drainage.
- Dense graded “20 series” includes a variety of materials used in commercial asphalt and for gravel roads, shoulders, and base.
- Crushed aggregate, referred to as ‘splits’, has excellent frictional properties and is utilized to meet demanding MDOT asphalt specifications.
- Masonry sand is used in masonry applications.
- Fill sand is used in various fill applications.

Mining is the only source for the sand required in the manufacturing of concrete, fill and masonry sand, and related products, making surface mines like the one proposed Project in Norvell Township critically important.

3.3 Geographic Market

The market area served by the proposed Project in Norvell Township extends to the I-275 corridor to the east, I-96 corridor to the north, the western line of Jackson County to the west, and the Michigan / Ohio state line to the south.

3.4 Factors Influencing Supply

Several factors determine whether current and future demand for construction aggregates will be met in the southern Michigan market. These factors include production capabilities, the availability of large enough parcels of land to support mining operations, geological limitations, and permitted reserves.

3.4.1 Production Capabilities

Existing operations cannot significantly increase production to meet aggregate demands because of limits on space, hours of operation, geologic limitations, and equipment capacity. As such, new mining sites are necessary to meet market demands, fulfill committed contracts, and enable continued growth and development in the State.

3.4.2 Unavailability of Land Suitable for Mining

Expansion of suburban and rural residential development in Jackson and Washtenaw counties, and southern Michigan in general, reduces the available mineable land. Fragmentation of land limits the availability of parcels large enough to support a modern sand and gravel operation.

3.4.3 Geological Limitations

In Southern Michigan, sand and gravel is produced from glacial deposits located in an arc to the west, northwest and north of Detroit, which runs from Branch County to Lapeer County.¹ Outside of this arc of clean sand and gravel deposits, the accessibility of sand and gravel deposits of economically viable quality and quantity is very limited as a result of the geological formations.

Since marketable sand and gravel products can only be produced from sites where they were deposited by glacial activity, aggregate producers are located in a limited band of land within the region. Sites outside of this band of glacial deposits are quite remote from the southern and southeastern Michigan construction market, located in places such as West Branch and Grand Rapids, Michigan.

Though many parcels of open land contain some sand and gravel in their geological formation, few sites possess the necessary attributes to produce aggregate products that both meet the requirements of MDOT and are in sufficient quantity to support investment in establishing an operation. MDOT's 2020 Standard Specification for Construction, and the specifications of other governmental agencies (most of whom rely upon MDOT), set the requirements for salable sand and gravel in the State. The qualities that a sand and gravel site must have include:

- The right quality and range of particle sizes necessary to meet product specifications.
- Limited thickness of clay and unmarketable materials.
- Parcels of suitable size and configuration.
- Reasonable access to roads capable of carrying gravel trucks

The proposed Project site in Norvell Township meets the geological and logistical attributes required to produce marketable sand and gravel products.

¹ Michigan Mineral Producers 2017, Office of Mineral Management, Michigan Department of Natural Resources.

3.4.4 Depletion of Permitted Aggregate Sources:

MSHA maintains a database of the existing mining operations that are active, based on the required reporting of hours worked at a given mining site. This database is a reliable indicator of both mining activity and the scale and capacity of the operations. Since the number of employee hours is directly correlated to the amount of aggregate produced.

This database identifies five active sand and gravel operations within a 20-mile radius of the Norvell site, including the Levy owned Pleasant Lakes Aggregates (PLA) site, discussed below. Two of the four remaining operations are entering their final years of production. Together, the two operations with diminished resources contribute more than one million tons of aggregates into the market area to be served by the proposed Norvell Township site. The two other sand and gravel mine sites, which have viable remaining reserves, are considered medium sized operations based on the number of hours reported to MSHA.

The only sand and gravel mine owned by Levy located in, and serving, the market area (defined above) is PLA. PLA is estimated to have approximately 8-10 years of reserves remaining. Therefore, PLA, too, is approaching the end of its useful production life. Numerous Levy operations located outside the market area, including Holly Sand and Gravel, AAOM Highland Plant, and Grange Hall Road Sand & Gravel, are in their final five years of active production.

The depletion of resources noted above is symptomatic of other sites in the defined market area. For example, a large number of operations in western Oakland County have concluded operations in the last 20 years, including Lyon Sand and Gravel, Milford Sand and Gravel, Sunset Excavating, Honeywell Lake Road, Holloway Sand & Gravel, American Aggregate's Brighton Plant, Kent Lake Sand & Gravel, and many others without replacement by operations of comparable scale. The depletion of permitted reserves without replacement has created a lack of available resources and demonstrates a clear need for additional mining operations to replace the lost supply.

Further underscoring the point, tens of millions of tons of aggregate (primarily stone products), are shipped into the southern Michigan market via boat, barge, or rail each year. This expensive supply arrangement is in place solely due to the lack of permitted reserves. Sufficient reserves exist in southern Michigan; however, insufficient quantities of reserves are currently permitted, leading to the importation of aggregates.

As demand for locally available construction aggregate outstrips production capabilities, the market will become increasingly reliant on imported construction materials. Increasing reliance on imported aggregates has a significant impact on the cost of construction and, thereby, the local and State economy. Construction aggregate is a low unit value commodity; the cost associated with the transportation method used to move aggregate from the producer to the market is of major significance.

Opponents of proposed sand and gravel operations often cite the number of permitted mines as evidence that new mining permits are not required to meet the market demand. However, the data relied upon by opponents is problematic for several reasons:

1. Data is included for mines operated by local units of government that do not sell materials to the commercial market.
2. Many permitted operations are depleted and closed.
3. Permitted portable mining plants are incapable of providing washed sand products that meet MDOT

specifications.

3.5 Customer Demand

AAOM has long-term agreements with owned and affiliated companies that will utilize the overwhelming majority of the products produced at the proposed Norvell Township operation. The company has a written purchase commitment (in place at the time of this submittal) to purchase and market 80% of the production capacity of the Norvell plant, which is adequate demand to support the operation solely within the company itself. This Purchase Order is provided in **Exhibit 4** to the Application.

The following internal customers that are affiliated with AAOM will also be served by the proposed Norvell Township operation:

1. Cadillac Asphalt, with facilities in Ann Arbor, Romulus, Rawsonville, Monroe and Novi
2. Superior Concrete, with facilities in Brighton, Ann Arbor, Novi, Romulus, and Brownstown Township

The remaining production capacity of the Norvell site will be utilized by:

1. Other concrete and asphalt plants located in all counties within the region
2. Construction sites in urban and suburban areas of metro Detroit, Ann Arbor, and Jackson, including residential, commercial, and industrial development/re-development
3. Government funded infrastructure and road repair, reconstruction, and expansion

Further, as recently as April 2024, Norvell Township distributed a memorandum outlining the need to repair over 8 miles of roads within the Township evidencing a local need for such product.

The proposed operation will provide community members and residents, Jackson County, and other local units of government with a readily accessible source of sand and gravel to support road and infrastructure improvements, public parks projects, and private land development.

3.6 Factors Influencing Demand

In the broader southern Michigan market, increased demand for sand and gravel products is related to:

- A. Federal Funding: The 2021 bipartisan Infrastructure Investment and Jobs Act continues to invest over \$10 billion in Michigan for roads, airports, bridges, utility infrastructure, Great Lakes shoreline restoration, and related infrastructure, all of which require sand and gravel resources;
- B. State of Michigan: In 2022 the State of Michigan adopted the Building Michigan Together Plan, a bipartisan plan to invest nearly \$5 billion in Michigan's infrastructure to improve transportation, parks, utility infrastructure, and support the development of new housing, all of which depend on the availability of sand and gravel products;
- C. Population Growth and Economic Development: Western Metro Detroit, the Ann Arbor area, southern Livingston County and Jackson County are all expected to grow in population over the next 10 years, contributing to the demand for sand and gravel products
- D. Infrastructure Conditions: Two independent groups issued reports that assess the condition of

Michigan's roads and other infrastructure, and outline strategies for meeting the needs of the state:

- 21st Century Infrastructure Commission Report (2016, prepared for Governor Rick Snyder)
- 2018 Report Card for Michigan's Infrastructure (2018, prepared by the American Society of Civil Engineers Michigan Section)

Both reports (attached as **Exhibit 5** to the Application) highlight major deficits in Michigan's infrastructure and recommend significant growth in investment to maintain and expand infrastructure to meet the needs of the future. As necessitated by the findings of the abovementioned reports, investment in Michigan's roadways has increased in recent years. Nearly every aspect of rebuilding Michigan's infrastructure requires sand and gravel, leading to strong, long-term market demand for these resources.

3.7 Conclusion

AAOM and its affiliated companies have been profitably operating sand and gravel mining operations in the Michigan market in a responsible manner for over 50 years. It is incontrovertible that valuable sand and gravel natural resources are present in the Project Property. It is evident that the proposed Project Site is well suited to host a sand and gravel mining operation. It is abundantly clear that the resources to be mined are needed in the market by. The Project Site's expedient permitting is critical because:

- A. Geological conditions limit where aggregate can be mined in the State. The sand and gravel on the Project Site has the correct coarseness and range of particle sizes to meet raw material requirements to produce concrete sand (MDOT 2NS), road gravel, fill sand, septic stone, and similar construction materials.
- B. The quality and quantity of sand and gravel available within the Project Site is sufficiently economically significant to warrant the installation of a processing plant, administrative office, and related facilities necessary to process sand and gravel products.
- C. The quantity of materials on the Project Site that are not sold as products (e.g., topsoil, overburden and inner-burden, and fine sand and silts) is large enough to meet reclamation needs for the Project Site and limited enough to allow for the efficient and profitable extraction of the sand and gravel resources.
- D. There is simultaneously an increased demand for aggregate and a growing lack of available resources, demonstrating a clear need for additional mining operations.
- E. AAOM has long-term agreements with internally owned and affiliated companies that will utilize the overwhelming majority of the products produced at the proposed Norvell township operation.

Given the evaluation of all factors herein: the sand and gravel reserves, configuration and size of the property, investment required to commence and sustain an operation, location of the site relative to key customers, the available road network, transportation costs, and anticipated revenue from the sale of product, the conclusion reached is that there is a clear need for the Project Site's natural resources, that the proposed mining operation is expected to make a reasonable profit, and that the site will help to ensure an adequate supply of sand and gravel in the market area.

SECTION 4 FINDINGS

4.1 Land Cover, Wetlands, Streams, and Water Bodies

A review of the existing ecological conditions of the Project Site was conducted by ASTI Environmental (“ASTI”) and is summarized below. See Wetland Delineation Report, attached as **Exhibit 6**, and Threatened and Endangered Species Survey and Habitat Assessment, attached as **Exhibit 7** to the Application.

4.1.1 Existing Ecological Conditions and Study Methodology

The Project Site is located in the River Raisin watershed in southeast Michigan. The review examined ten parcels of approximately 856 acres, including wetlands, lakes, and streams, and the Project’s potential impact on the habitat of any threatened and endangered species.

ASTI reviewed data from readily available sources including:

- U.S.GS topographic maps
- U.S.DA Web Soil Survey
- EGLE Wetland Map Viewer
- National Wetland Inventory (NWI) Wetland Mapper
- High resolution aerial photography
- GIS Information from Jackson and Washtenaw Counties
- Michigan Natural Resources Inventory (“MNFI”)
- U.S.FWS IPaC County Database Listing

ASTI compiled a map set of preliminary ecological conditions and completed numerous site inspections as part of its assessment of the presence of threatened and/or endangered plant and animal species. The site assessment for threatened and/or endangered species was conducted under the guidance and regulations of the Michigan Department of Natural Resources (“DNR”) under Part 365 of the Natural Resources and Environmental Protection Act (1994 P.A. 451) (“Endangered Species Protection Act”), and/or by the US Fish and Wildlife Service (“USFWS”) under the federal Endangered Species Act of 1973. ASTI obtained a Rare Species Review from the Michigan Natural Resources Inventory (“MNFI”) for the Project Site and conducted a federal endangered species review through the USFWS’ Information, Planning and Consultation System (“IPaC”).

4.1.2 Land Cover

As illustrated in *Figure 11: Habitat Types*, the South Property is active farmland, with very limited natural habitat value. The North Property is primarily agricultural land. The second most prevalent land cover is grassland, found in two locations of 15 to 20 acres in size each. Approximately 33 acres of Dry-Mesic Southern Forest exist in the northwest corner of the site; all of this forest is located within the proposed mining buffer and will be preserved. Two areas of Upland Forest, totaling approximately 29 acres, exist within the Mining Area, of which approximately 13 acres will be impacted by the mining activity. Some limited areas of scrub shrub vegetative cover also exist, primarily within the mining setbacks. Several wetland areas and water bodies are present in the proposed mining setback and preservation buffer, as discussed below.

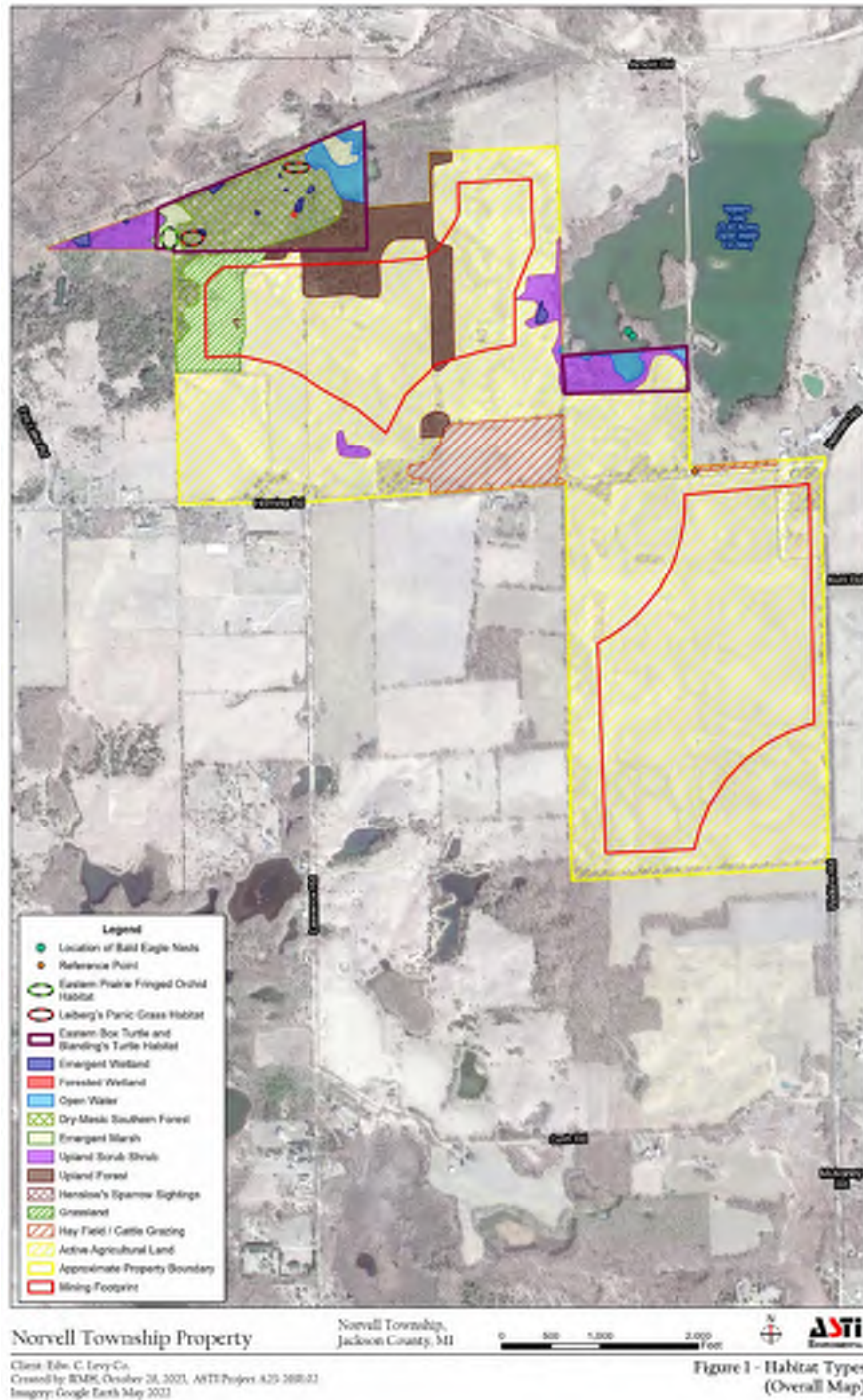


Figure 11 - Habitat Types

Given the overall size of the Mining Area, there is a limited amount of land that is not in agricultural production or is not previously farmland. The Upland Forest area disturbed by mining is limited in size, the species within the Upland Forest are not unique to the region, and the loss of this land cover is not considered significant.

4.1.3 Wetlands, Lakes, and Streams

The Project Site is comprised of varied topography with areas of rolling hills and depressions. Several wetland areas were observed on the North Property as well as an unnamed lake. No wetlands were found on the South Property. ASTI's interpretations generally indicate wetlands on the Project Site are aligned with lower areas observed on USGS mapping which are also generally aligned with mapped hydric soils identified. On-site wetlands were generally comprised of kettle hole formations in contact with underlying groundwater. ASTI has observed similar conditions on other sites in this region of Michigan.

Watkins Lake, adjacent to the Site, and the unnamed lake noted above are regulated by the Michigan Department of Environment, Great Lakes and Energy ("EGLE") under Part 301, Inland Lakes and Streams, because they have permanent open water greater than 5 acres in size. Seven wetland areas likely to be regulated by EGLE under Part 303, Wetlands Protection were identified on the North Property, and two wetlands not likely to be regulated were mapped in the same area. Wetlands meeting the following criteria are regulated under the Wetlands Protection Act;

- A portion of a wetland system greater than 5 acres in total size including off-site extents.
- Within 500 feet of a lake, as defined by EGLE.
- Exhibit an area of permanent open water greater than 1 acre but less than 5 acres, which is considered a regulated pond by EGLE; and/or
- Within 500 feet of a wetland that meets the definition of a pond as described above.

While the North Property does include seven wetlands and one lake assumed to be regulated on its northern edge, none of these natural features are within the Mining Site. The lake, and all wetlands within the site, including those assumed to be regulated or not, are part of preservation areas and within proposed setbacks, which will not be disturbed as part of the mining operation or construction of screening berms. No direct impacts to wetlands or lakes will occur as a result of the mining.

4.1.4 Threatened and Endangered Species Habitat

Based on the thorough assessment of available regulatory data bases and other resources, ASTI identified eleven species of plants and animals that warranted further Site specific investigation. These species, and their ranking of significance, are described below in *Table 1: Listed Species*. The table includes species that are considered:

- Federally Endangered
- Federally Threatened
- Federal Birds of Conservation Concern (BCC)
- State of Michigan Special Concern
- State of Michigan Endangered
- State of Michigan Threatened
- State of Michigan Special Concern

Common Name	Scientific Name	Status
Henslow's sparrow	Centronyx henslowii	State Endangered and Federal BCC
Bald eagle	Haliaeetus leucocephalus	State Special Concern
Wood Thrush	Hylocichla mustelina	Federal BCC
Leiberg's panic grass	Dichanthelium leibergii	State Threatened
Eastern Box Turtle	Terrapene carolina carolina	State Threatened
Blanding's Turtle	Emydoidea blandingii	State Special Concern
Indiana bat	Myotis sodalist	Federally Endangered
Northern long-eared bat	Myotis septentrionalis	Federally Threatened
Eastern massasauga rattlesnake	Sistrurus catenatus	Federally Threatened
Eastern prairie fringed orchid	Platanthera leucophaea	Federally Threatened and State Endangered
Mitchell's satyr butterfly	Neonympha mitchellii mitchellii	Federally Endangered and State Endangered

Table 1 - Listed Species

A detailed discussion of these species, their presence on site, the existence of suitable habitat, and the assessment of potential impacts from the proposed mining is included in **Exhibit 7** to the Application: Threatened and Endangered Species Survey and Habitat Assessment. These findings can be summarized as follows:

1. Of the eleven plant and animal species noted above, only two, the Henslow's sparrow and bald eagle, were visibly present at the site.
2. Likely habitat of sufficient quality exists at the Property to support all eleven species. However, all potential quality habitat is located outside of the proposed Mining Area, except for a 5-acre grassland that formerly used for cattle grazing, located on the northwestern edge of the proposed Mining Area. The proposed Mining Area consists primarily of active farmland, which does not provide quality habitat for the species noted above. Quality habitat outside of the proposed Mining Area will not be impacted by the proposed mining operation.
3. As noted above, a grassland was identified on the northwestern edge of the proposed Mining Area, which may provide suitable habitat for the Henslow's sparrow, a migratory bird. As a result, any activities conducted within this grassland will be completed in accordance with the seasonal limitations set by the U.S. Fish and Wildlife Service (USFWS) and the Michigan Department of Natural Resources (MDNR).
4. A pair of bald eagles were observed in the vicinity of Watkins Lake, along with an apparently active eagle's nest. The eagle's nest is located on adjacent property and greater than 660 feet from the proposed mining area. The USFWS recommends a 660-foot buffer for activities like mining from active eagle nests. No impact on the bald eagles is anticipated, since the eagles' nest is greater than 660 feet from the mining area.
5. The woodland modeled to be a potential habitat for the Indiana and Northern long-eared bats will be only marginally impacted by the mining activity. Seasonal limitations for the removal of woodland

trees suspected of being habitat is a typical conservation measure employed to resolving concern for these species; Levy intends to follow these restrictions for removal of all woodland trees, whether identified as potential habitat or not.

As a result, no impacts are anticipated for any of the threatened or endangered species due to this proposed Project.

4.2 Geology and Topography

The proposed site is located within a glacially formed geologic deposit within which minable sand and gravel may exist.

The 1982 Quaternary Geology Map of Michigan, with respect to Jackson County, and more specifically, Norvell Township, shows the area of the Project Site as part of a regional end moraine, glacial outwash, and postglacial alluvium. See *Figure 12 - Jackson County Quaternary Geology Map*. The approximate location of the Project Site itself is identified with a yellow circle-marker and arrow. The Project Site area is listed on this map as “End moraines of coarse-textured till” and “Glacial outwash sand and gravel and postglacial alluvium.”

An end moraine marks a standstill period of a glacier where materials of all sizes accumulate. Small streams, rivers and valleys are formed by the melting of ice, transporting and depositing material to different locations and thickness on and within the glacier. As the glacier receded to the north, the mixture of gravel, sands, silts, and clays were left behind. Glacial outwash is deposited by running water as the glacial ice melts. This leaves behind stratified layers, in varying thicknesses, of sand and gravel. Often these small outwash deposits are excellent sources for sand and gravel. Postglacial alluvium is also deposited by flowing water, typically in stream valleys or shallow basins since the end of the last glaciation. Alluvial deposits can consist of gravel, sand, silt, or clay.

A total of 85 borings have been drilled on site by AAOM, confirming the above geologic background information. The borings have an average depth of approximately 58 feet. In addition to the borings, ten observation wells were installed on the Project Site to identify water elevations. Material quality testing was conducted on 232 samples collected from the borings. The sieve analysis tests evaluated the quality of the bored material and were used to determine that the geologic resources found on the Project Site are a viable source of materials to produce quality construction grade aggregate. Specifically, these tests indicate the following:

- The sand and gravel on the Project Site have the correct coarseness and range of particle sizes to meet the raw material requirements to produce MDOT-compliant construction materials.
- The quality and quantity of sand and gravel discovered on the Project Site is economically significant enough to warrant the installation of a processing plant, administrative office, and related facilities necessary to produce sand and gravel products.
- The quantity of materials on the Project Site that will not be sold as products (e.g., topsoil, overburden and inner-burden clay and silts) is large enough to meet reclamation needs for the Project Site and limited enough to allow for the efficient and profitable extraction of the sand and gravel resources.

The on-site data collection, borings, geologic, and historical background provide sufficient evidence of a quality construction grade sand and gravel deposit. The magnitude of the property, in terms of overall

acreage, topography, and volume, support the quantity of reserves that AAOM has determined adequate to support this operation and permit application.

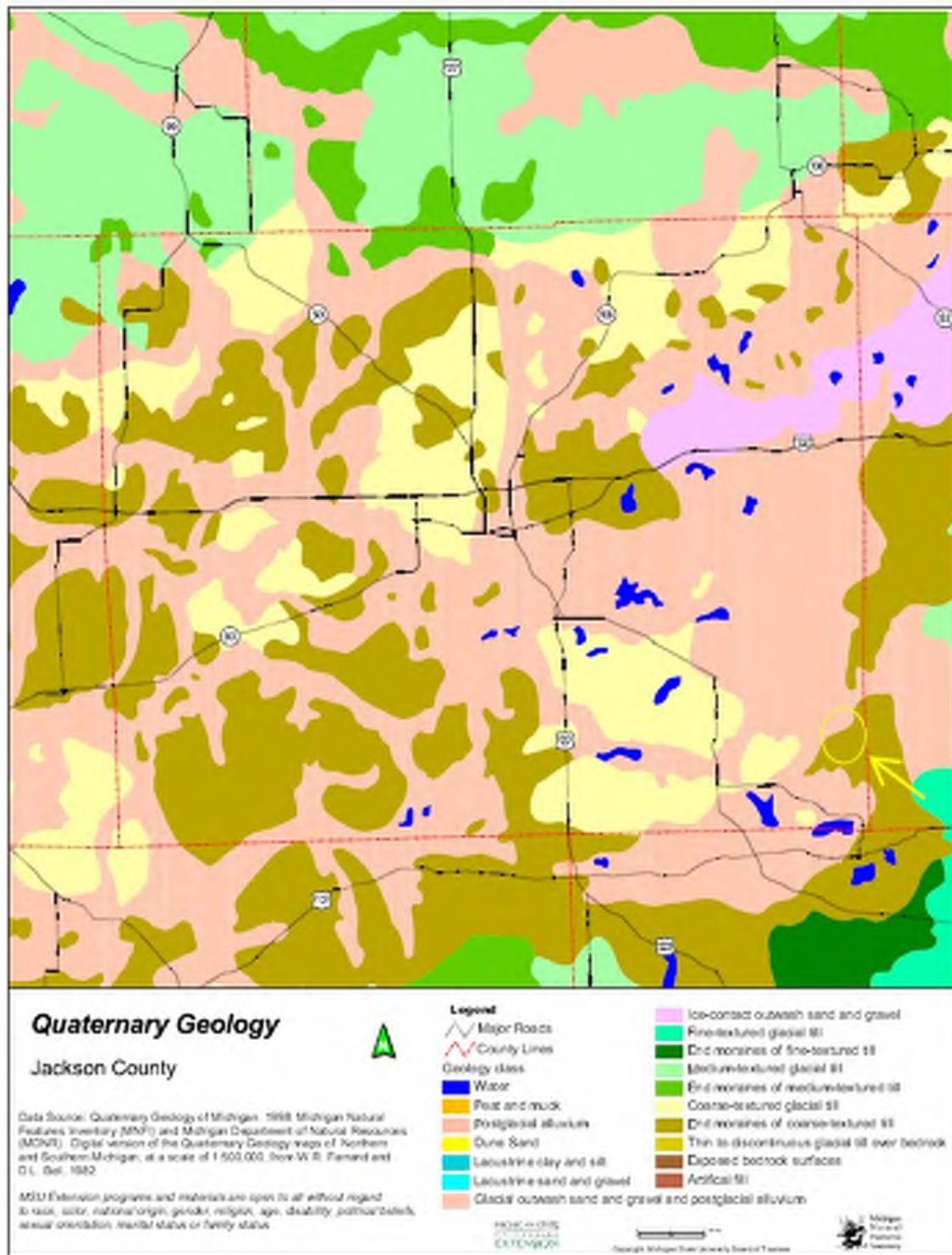


Figure 12 - Jackson County Quaternary Geology Map

The extraction of sand and gravel, by its very nature, will change the topographic shape of the Project Site. No significant short, or long-term, adverse impacts to the environment will result from the alteration of the topographic shape of the site. AAOM will adhere, at a minimum, to the final topographic grading guidelines as set forth in the Norvell Township Ordinance.

4.3 Surface Water Hydrology

A study of the surface water hydrology of the Project Site was conducted for the existing condition, the active mining phase, and for the proposed reclaimed site. The purpose of this study was to evaluate the potential impacts the proposed mining activity may have on surface water hydrology and existing wetlands at, and adjacent to, the Project Site to ensure the stability of these natural systems throughout and after the mining activity.

4.3.1 Project Site Surface Water Hydrology

The 626.4-acre Project Site is predominately agricultural fields but near property boundaries it also contains areas of wetlands, open water, woodlands and open area uplands. The soil on the Project Site generally contains coarse sand, gravel, and clay. Hydrologic Soil Group (HSG) "A" with a poor to fair condition was used for run-off calculations in this report, as it best fit characteristic soils with permeability while maintaining a conservative approach.

The existing site topography contains hilly slopes with small, isolated pockets of low areas throughout. For analysis, it has been divided into a northern sub-watershed and southern sub-watershed. Most of the current drainage areas drain to localized depressions or wetlands within the Project Site, while the remaining areas generally flow off-site, as shown in *Figure 13 - Existing Drainage Areas*. Approximately 67% of the existing site drains into itself, while the remaining acreage drains off site.

The proposed reclaimed site topography was also assessed to determine the changes to where stormwater runoff will flow (refer to *Figure 14 - Proposed Drainage Areas*).



Figure 13 - Existing Drainage Areas

The surface water hydrology for these drainage areas was studied for both the existing and proposed conditions. In the proposed reclaimed condition, the area within the mining limits is assumed to be HSG B poor pasture/grassland/range. According to the mining and operation plan, the site will be mined and reclaimed simultaneously. Therefore, limited amounts of the Project Site will have bare soil at any given time. A comparison of the run-off characteristics of the existing and proposed condition can be found in *Table 2: Run-off Characteristics Comparison* below. Curve Number (CN) is a measure of run-off potential based on soils, plant cover, amount of impervious areas, interception, and surface storage. Generally, the higher the CN number, the less permeable the land and the more run-off that area will cause. There is a slight increase in CN in the proposed condition based on the anticipated land cover/use, and therefore an increase in run-off being created.

Assuming a 10-Year Storm (3.36 inches), the annual rainfall for the existing condition of the northern portion creates 16.066 AF of run-off, while the southern portion creates 14.026 AF of run-off. Meanwhile the proposed condition for the northern portion creates 16.066 AF of run-off, while the southern portion creates 20.116 AF of run-off due to the change from predominately farmed land to mined land. An increase of approximately 43% for the southern portion, while the northern portion maintains approximately the same volume of runoff. Similar to the existing condition, the proposed run-off will remain on-site due to the large side slopes outlined in the Reclamation and Mitigative Measures Section of this report. Although the post-

mining soil condition will require more time for water to infiltrate to groundwater, the amount of off-site runoff should not increase, or have adverse effects due to the large containment area created by the proposed topography and berms. This amount of precipitation is representative of a significant storm event. During smaller storm events (which represent over 90% of all storm events), there will be no appreciable run-off from the Project Site.

Cover	Curve Number (CN)	Existing Condition N+S (ac)	Proposed Condition N+S (ac)
Woods/grass comb.	43	108	92
Pasture/grassland/range HSG A	61	517	301
Pasture/grassland/range HSG B	79	0	232
Total Area (ac)	n/a	625	625
Average CN	n/a	58	65

Table 2 - Run-off Characteristics Comparison

In the proposed and existing condition of the site, the majority of annual stormwater is either: a) utilized by plant cover, or b) drains via the ground surface to adjacent wetlands. Changes to the topography of the site related to the mining activity will modify the proportions of run-off that fits into each of these categories; however, it will not measurably change the net run-off leaving the Project Site. **This project should have minimal impact on the surrounding environment from a surface water and hydrology perspective. Although drainage patterns will change, most of the changes will be contained within the bounds of the Project Site.**



Figure 14 - Proposed Drainage Areas

4.3.2 On-Site Wetland Hydrology

The wetlands and waterbodies on the Project Site are hydraulically connected to groundwater. In *Figure 15 - Existing Wetlands* the location of the regulated wetland systems on the Project Site are identified by labels. These wetlands and waterbodies have approximately the same static water elevation as the site's groundwater. Groundwater-fed wetland and waterbody hydrology is primarily sustained by groundwater hydrology, with small contributions from storm water run-off and direct precipitation. **Given that changes to surface water patterns are considered minor, and that the existing wetlands and waterbodies are primarily sustained by groundwater, direct and indirect impacts to the wetlands from changes to the topographic shape of the site are not anticipated.**

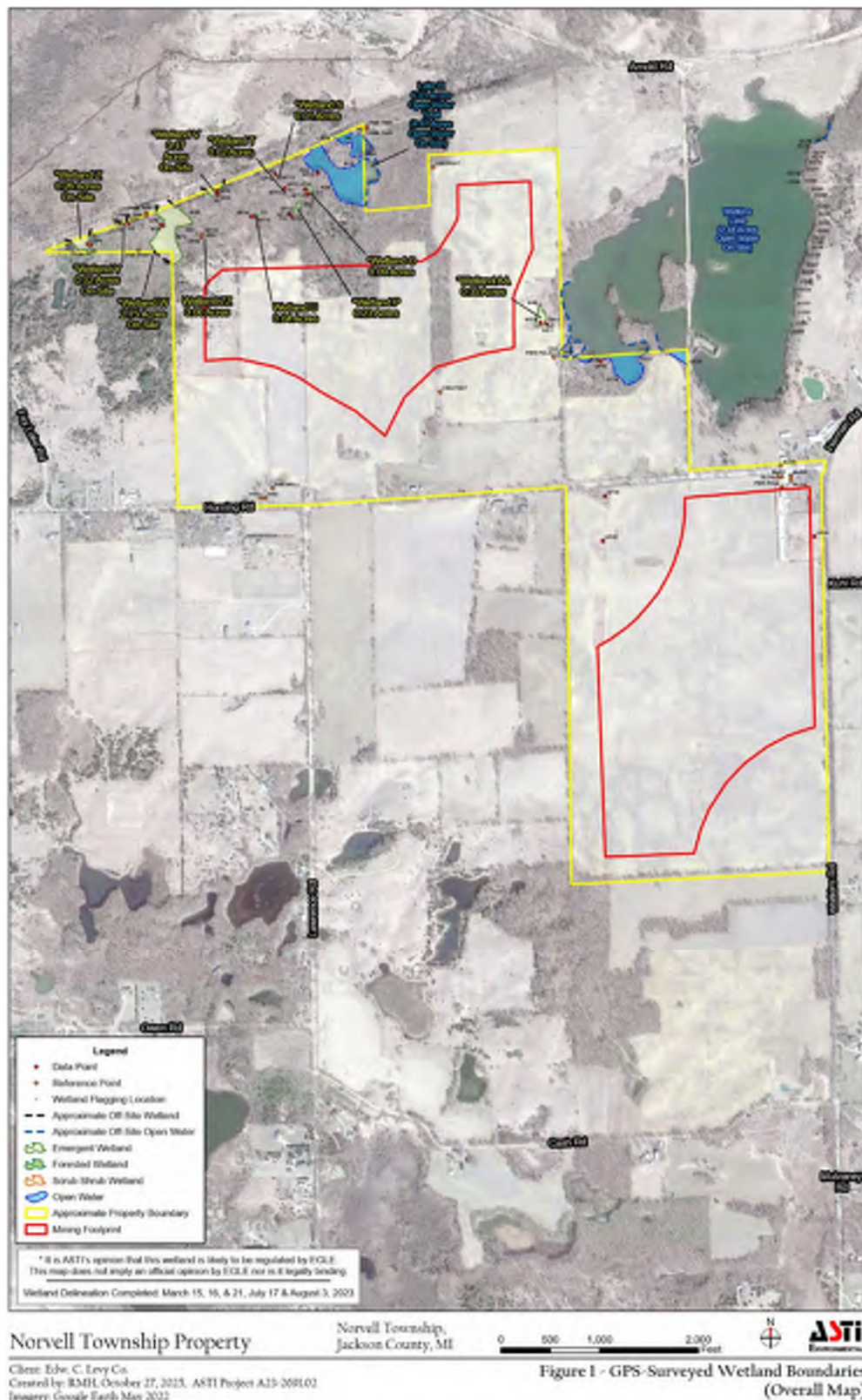


Figure 15 - Existing Wetlands

4.3.3 Storm Water Permitting

Federal National Pollution Discharge Elimination Systems (NPDES) permits are required for any operation that discharges waste or wastewater into the surface waters of the state.

The sand and gravel mining operations proposed for the Project Site will not discharge any waste or wastewater into the surface waters of the state, and therefore, an NPDES permit is not required.

Federal regulation (Title 40, Code of Federal Regulations, Part 122.26) requires that a regulated facility apply for industrial storm water permit coverage if storm water run-off exposed to industrial materials and/or industrial activities discharges to surface waters of the state.

There are three criteria that must be met to require a facility to obtain an industrial storm water permit:

- Standard Industrial Classification (SIC) Code is a regulated industrial activity.
- Storm water from the facility discharges to waters of the state.
- Industrial materials and/or activities are exposed to storm water.

In the case of the proposed sand and gravel mining operations at the Project Site, all three of these criteria are met and the site is required and shall obtain an industrial storm water discharge permit prior to commencing operations.

The operations at the Project Site would qualify for coverage under the EGLE General Permit for Industrial Storm Water Discharges. AAOM will meet all the requirements of the General Permit for Industrial Storm Water Discharges, which include:

- Visual assessment of storm water discharges.
- Implementation of a Storm Water Pollution Prevention Plan (SWPPP).
- Implementation of a short-term storm water characterization study.
- Oversight by an EGLE Certified Storm Water Operator over the facility's storm water treatment and control measures, including the SWPPP.
- Prohibition of storm water discharges that are contaminated.

A soil erosion and sedimentation control permit is required by the State of Michigan and is administered locally by the Jackson County Health Department, Environmental Health Division. This permit provides for the control of soil erosion and protects adjacent properties and the waters of the state from sedimentation. A permit is required when an area greater than 1 acre is disturbed, or when a site is disturbed that is within 500 feet of a waterway or wetland. The goal of the regulation is to prevent the loss of soil from a construction site that may impact other properties or important natural resources.

AAOM will obtain and maintain the required permits for the proposed operation as a basic condition of mining at the Project Site, as they currently do at other sand and gravel mining sites in southeast Michigan.

4.3.4 Conclusions

Reshaping the topography of the site is necessary to extract natural resources. **The analysis of the changes to the topography relative to the on-site and off-site storm water hydrology concludes that no impacts to area surface drainage and regulated wetlands are anticipated.** All necessary permits required to reshape the site will be obtained prior to the project start date.

4.4 Groundwater Hydrology

ASTI was retained by Levy to conduct a Preliminary Hydrogeological Evaluation and their report is found as **Exhibit 8: Hydrogeological Report** in the Application.

4.4.1 Shallow Groundwater Well and Staff Gauge Installation and Development

To investigate the groundwater at the Project Site, ASTI installed ten permanent shallow monitoring wells between June 5-16, 2023. On July 18, 2023, ASTI installed five staff gauges within the five largest surface water bodies on the Project Site. ASTI then surveyed the locations and elevations of the wells and staff gauges.

4.4.2 Geology

The well drilling confirmed the general geologic conditions found by the borings undertaken by AAOM. The unconsolidated glacial deposits in the area are generally between 3 and 60 feet thick and comprised of glacial outwash sand and gravel and post glacial alluvium. Soils identified by ASTI's field personnel during well installation were primarily comprised of sand with interbedded silt and silty clay units. The silts and silty clays appeared to be discontinuous while the sand layers appeared to be regionally contiguous.

The unconsolidated (sand and gravel) deposits overlie the Marshal Formation, a Mississippian-age sandstone formation which consists of a lower Marshall and Napoleon members. The Napoleon member is predominantly a medium-grained sandstone with some coarse sand intervals. The lower Marshall member, on the other hand, is mostly fine-grained sandstone with some very fine sand intervals.

4.4.3 Hydrology

Groundwater was encountered in the monitoring wells on the Project Site between approximately 5 and 40 feet below grade depending on the surface elevation. Groundwater elevations are generally higher on the South Property than on the North Property, which is consistent with the surface topography. Refer to the groundwater elevations summarized in *Table 3: Groundwater Elevations*.

In July and December of 2023, ASTI collected groundwater elevations from the ten permanent groundwater monitoring wells and surface water elevations from all five staff gauges. Through 2024 the wells and staff gauges were monitored every month. The groundwater level within each permanent monitoring well was measured to within 0.01 foot using an electronic water level meter. Staff gauges were read to within 0.01 feet from where the surface water intersected the graduated scale.

Because the staff gauge elevations show a significant correlation with the nearby groundwater (well) elevations, all 15 water levels were included in the mapping of the groundwater surface elevation. The correlation indicates that the wetlands and water bodies, including Watkins Lake, are directly connected to, and fed by, groundwater, and are not "perched" above the water table in which case they are fed only by surface runoff and direct precipitation.

Over the monitoring period the groundwater and surface water elevations were reasonably stable, with about 1 foot of seasonal fluctuation. Water elevations in the wells and the surface water bodies increased and declined in parallel fashion, providing additional evidence that the waterbodies and wetlands are hydraulically connected to the groundwater.

4.4.4 Groundwater Flow Direction

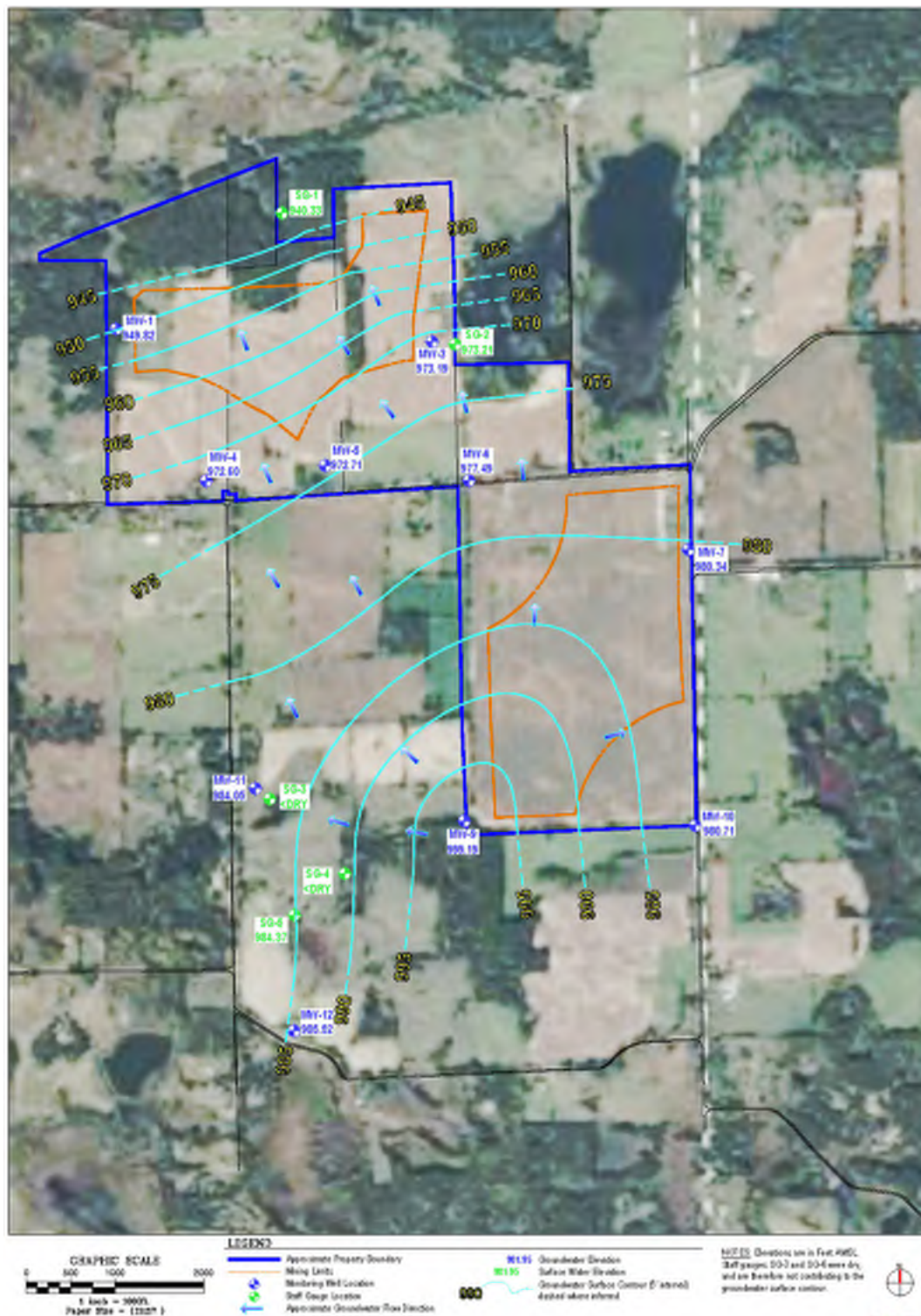
From the elevations measured during the monitoring events, a map was prepared that illustrates the elevation of groundwater at any given point on the site, and indicates the direction of groundwater flow, (refer to *Figure 16 - Groundwater Flow Map*). Based on the groundwater/surface water elevation data collected, groundwater generally flows from south to north on the Project Site. One exception to the general flow direction is in the central portion of the Project Site along the eastern border where the flow appears to bend to the east.

4.4.5 Conclusions

The groundwater elevation mapping was used by staff geologists at AAOM and the consultant team to establish a vertical elevation limit to the depth of the mining. As a standard practice, AAOM mines to a depth approximately 5 feet above the groundwater elevation to ensure that the groundwater is not disturbed by the mining unless a water body is being created. As a standard practice, AAOM will measure the groundwater elevation in the monitoring wells installed by ASTI on a monthly basis during active mining.

Significant direct or indirect impacts to the groundwater of the site and region, and those natural resources dependent on it, are not anticipated to result from the proposed mining activities on the site because:

1. No mining activity will occur below the uppermost groundwater level, so the groundwater will not be exposed to the atmosphere, preventing a potential increase in evaporative loss.
2. The surface water runoff patterns and volumes will not substantially change, and the majority of the site will continue to collect, store, and infiltrate stormwater into the groundwater table.
3. The processing plant proposed for the site will utilize existing irrigation wells for a water source, is designed as a low volume water use plant, and will recirculate the water used, such that the withdrawal rate from groundwater will not exceed the limits established in the permits for the existing wells or the demand of a typical rural residential subdivision.
4. Watkins Lake has been historically maintained by the prior property owner per a 2011 Michigan DNR agreement using a groundwater well. The DNR has determined that this arrangement is not transferable to AAOM as the new owner of the site, and the DNR has assumed responsibility for maintaining the lake levels using the well located on AAOM property, outside of the proposed mining area.
5. The use of monitoring wells on other sites operated by AAOM has demonstrated a long term track record of successfully mining sand and gravel without impact to the groundwater levels or to adjacent residential wells and natural resources.



Norvell Township Hydrogeological Investigation

Jackson County, MI

Client: American Aggregates of Michigan
JSTI Project A20-089023301, November 9, 2025

Figure 3 - July 2024 Groundwater and Surface Water Elevation Map



Figure 16 - Groundwater Flow Map

Location	Northing*	Easting*	Top of Casing Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^
MW-1	227073.88	13180282.75	987.66	29.78	957.88
MW-3	226929.51	13183847.06	984.01	8.24	975.77
MW-4	225361.28	13181296.99	1012.58	34.25	978.33
MW-5	225533.06	13182639.68	1021.43	46.55	974.88
MW-6	225363.22	13184261.11	1025.7	46.93	978.77
MW-7	224583.33	13186737.61	1009.92	24.24	985.68
MW-9	221522.95	13184209.75	1036.26	34.63	1001.63
MW-10	221472.03	13186812.67	1023.32	41.37	981.95
MW-11	221890.24	13181852.71	1006.53	18.7	987.83
MW-12	219155.65	13182290.54	1009.5	21.53	987.97
SG-1	228383.05	13182154.43	945.02	0.89	942.61
SG-2	226898.33	13184211.13	981.27	0.89	978.86
SG-3	221771.56	13182013.99	989.19	1.08	986.97
SG-4	220928.49	13182861.24	990.43	1.19	988.32
SG-5	220462.27	13182293.50	992.71	1.4	990.81

Notes:

* - Michigan State Plane, South Zone (2113) NAD83

^ - Orthographic elevation based on the EGM 2008 model

ft. AMSL = Feet above mean sea level

ft. btor = feet below top of riser

Table 3 - Groundwater Elevations

4.5 Environmental Contamination

4.5.1 Environmental Conditions

A Phase I Environmental Site Assessment (ESA) was performed on the Project Site. The primary purpose of this study was to identify any Recognized Environmental Conditions (REC) at the Project Site and establish a baseline of the Project Site's environmental conditions. ESAs are prepared as a matter of standard practice when property ownership is transferred, or significant lease arrangements are executed. The ESA completed on the Project Site was completed consistent with federal regulations and by the standard for all appropriate inquiry. The full report can be found in **Exhibit 9** to the Application, Phase 1 Environmental Site Assessment. The summary described in this report covers only the conditions related to properties within the Conditional Use Permit application.

The Phase I ESA included: 1) a site inspection on September 10, 12, and 16, 2024, 2) interviews with knowledgeable site contacts, 3) review of pertinent records from EGLE, Department of Licensing and Regulatory Affairs ("LARA"), Norvell and Manchester Townships, and Jackson and Washtenaw Counties, 4) acquisition and review of a federal and state database, and 5) review of historical aerial photographs, topographic maps, and city directories.

The site has historically, and is currently, used for farming. Most of the farmland has been row crops, and a 33-acre orchard at the intersection of Horning Road and Arnold Road. Portions of the site appear to have been used for raising cattle at some point. Today the site includes barns and related agricultural structures and two residential structures. An abandoned one-room schoolhouse exists near the intersection of Horning Road and Lawrence Road. The residential structures and schoolhouse are located either outside of the

mining site (i.e., the home at 14950 Horning Road) or within the mining setback buffer (i.e., the schoolhouse, and the home at 13720 Horning Road).

The research completed for the Phase 1 ESA identified five areas that are considered RECs. These sites (described below) are located within buffer areas that will not be impacted by mining activity or are at the edge of the Mining Area.

1. At 14950 Horning Road, (likely near the barns south of Horning Road), a 3,000 gallon diesel fuel underground storage tank (“UST”) was installed in 1978 and removed in 1998. While the removal was witnessed by an environmental consultant, no record of the event has been located; therefore, there is potential for residual impact from the former UST.
2. At 14950 Horning Road a rusty fertilizer tank (approximately 2,000 gallons) was observed resting directly on the ground. Because this tank is resting directly on the ground, the condition of the base of the tank may be compromised.
3. At 14950 Horning Road a floor drain was observed within a barn on the south side of Horning Road. At the time of the site observations, the barn contained an above-ground storage tank (AST), multiple drums, and smaller containers. The presence of a floor drain in this environment is a potential source of a release.
4. At the northwest quadrant of the intersection of Horning Road and Arnold Road, historical photographic records indicate that an orchard of approximately 33 acres in size existed. Pesticides like lead arsenate (a pesticide used at fruit orchards in the U.S. from the 1890s to the 1960s) can impact shallow soil at orchards. Typical impacts include metals that are stable over time and accumulate in shallow soil.
5. At 13720 Horning Road and 14950 Horning Road, a 250-gallon AST was observed. At these two locations, the potential for spills onto bare ground over a long period of time is considered a REC.

The RECs documented are typical for sites historically used for residential and agricultural purposes.

Each of the RECs identified in the Phase I ESA were further investigated in a Phase II ESA completed by Hydrologic and Associates, Inc. and documented in their report dated June 24, 2025, [Attachment/Appendix]. Phase II ESA field activities included the advancement of five soil borings, installation of two temporary monitoring wells, field screening of soil samples, and soil and groundwater sampling. All RECs were thoroughly investigated and closed. No environmental contamination was discovered eliminating any concern associated with the Phase I ESA RECs.

The Norvell Township Ordinance, Article VI Conditional Uses – Section 6.7-A. Quarries, Mineral Mining, and Extractive Operations stipulates that “the filling of land with rubbish or garbage or any other waste matter in the area where mining activity has occurred is prohibited.” AAOM will fully comply with this ordinance and does not import such materials to its mining sites.

4.5.2 Product Storage and Emergency Planning

AAOM will store diesel fuel, diesel emission fluid, gasoline, antifreeze, motor oil, hydraulic fluid, transmission fluid, grease windshield washer fluid, aerosol products such as paints, WD-40, and wasp and hornet spray, and various household cleaning products near the processing plant and administrative office for use and maintenance of mobile and plant equipment. To protect the environment from accidental release of petroleum products, as required by the EPA’s Oil Pollution Prevention Act and Michigan’s Part 5 Spillage of Oil and Polluting Materials rules, AAOM will develop and implement a combined Spill Prevention Control

and Countermeasure (“SPCC”) Plan and Pollution Incident Prevention Plan (“PIPP”). The purpose of these plans is to identify and implement strategies to prevent unintended release of oil products and ensure that in the event of a release a response plan is in place. Other than the products discussed above, AAOM will not store bulk quantities of hazardous materials at the Project Site. All materials listed will be stored, managed, and used as required by state and federal laws and as directed by the manufacturer. Safety Data Sheets will be maintained on-site for all appropriate hazardous materials.

AAOM has a strong track record of managing the use of hazardous materials at their operations, and of responsibly managing environmental issues proactively. AAOM maintains a staff of environmental engineers who are responsible for permitting the use of hazardous materials, monitoring site conditions, and ensuring ongoing compliance. As required by Township ordinances, any environmental contamination discovered at the site will be reported and managed in a timely manner, consistent with local, state, and federal law. Mining activity at the Project Site will not cause or exacerbate environmental contamination conditions on site or on adjacent properties.

4.6 Soils and Agricultural Farmlands

Soils representing 10 different soil series exist within the Jackson County site, as identified in the USDA Web Soil Survey, are found on the Project Site (refer to *Figure 17 - NRCS Soil Map*). These soils include: (Jackson County) – Boyer-Osthemo sandy loam, Boyer-Leoni complex, Brady sandy loam, Arkport-Okee loamy fine sands, Riddles sandy loam, Histosols and Aquents, Hillsdale-Riddles sandy loams, Oshtemo-Leoni complex, Houghton muck, Palms muck, and (Washtenaw County) – Kidder sandy loam, Riddles sandy loam. The majority of the soils on the Project Site are comprised of Riddles sandy loam, Boyer-Osthemo sandy loams, and Hillsdale-Riddles sandy loams. There are a few areas of muck hydric soil located within the wetlands as well as open water areas.

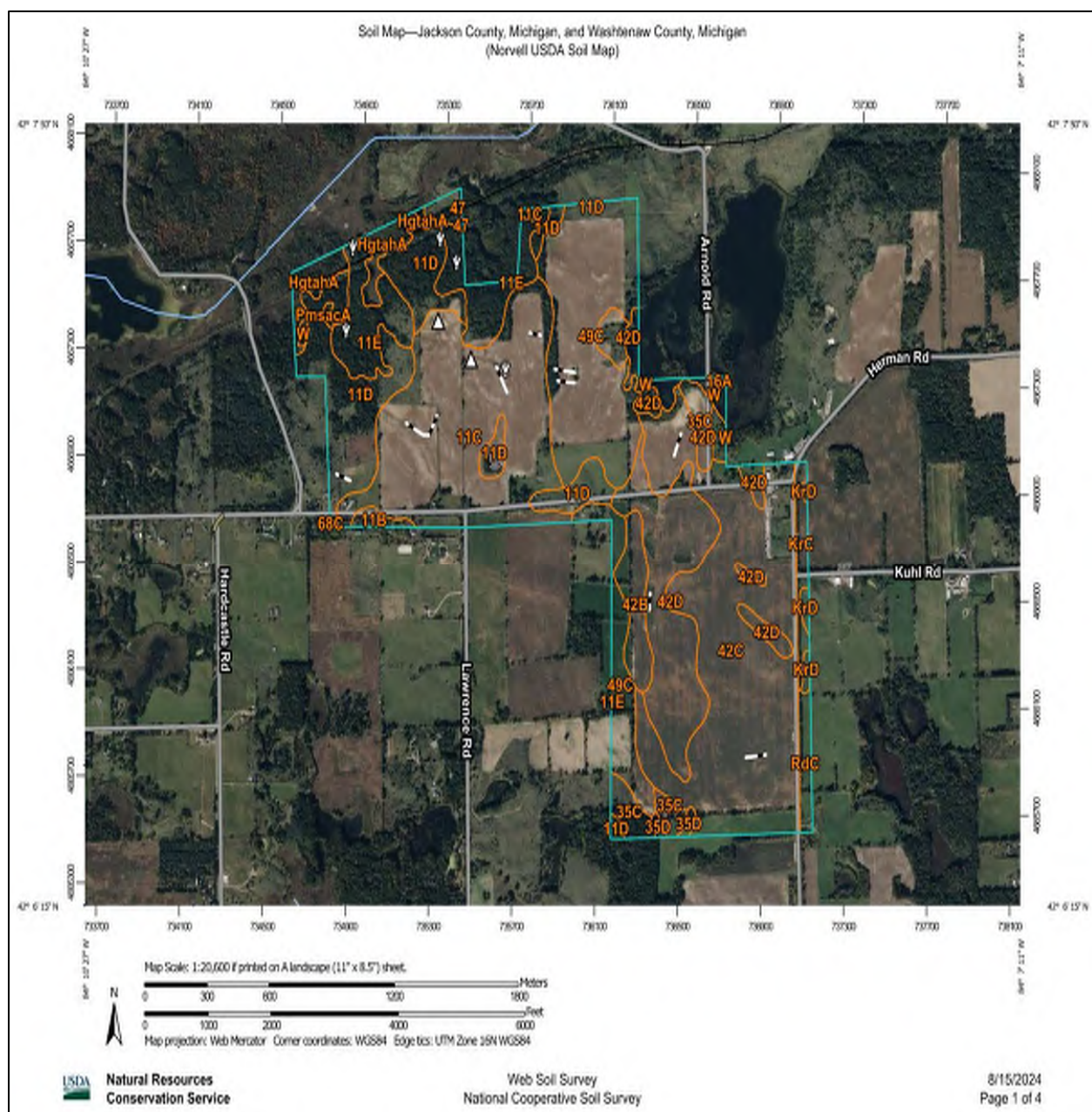


Figure 17 - NRCS Soil Map

Jackson County Soils	
11B: Boyer-Oshtemo sandy loam, 1-6% slopes	42C: Riddles sandy loam, 6-12% slopes
11C: Boyer-Oshtemo sandy loam, 6-12% slopes	42D: Riddles sandy loam 12-18% slopes
11D: Boyer-Oshtemo sandy loam, 12-18% slopes	47: Histosols and Aquifers, ponded
11E: Boyer-Leoni complex, 18-40% slopes	49C: Hillsdale-Riddles sandy loam, 6-12% slopes
16A: Brady sandy loam, 0-3% slopes	68C: Oshtemo-Leoni complex, 6-12% slopes
35C: Arkport-Okee loamy fine, 6-12% slopes	HgtahA: Houghton muck, 0-1% slopes
35D: Arkport-Okee loamy fine, 12-25% slopes	PmsacA: Palms muck, 0-1% slopes
42B: Riddles sandy loam, 1-6% slopes	W: Waters

Table 4 - Site Soil Classification

4.6.1 Prime Farmland

Prime farmland classification refers to soils that are especially suited for cultivation of food, feed, fiber, forage, and oilseed crops. Of the 626.4-acre Project Site, there are approximately 18.4 acres of prime farmland, which is 42B: Riddles sandy loam, on 1-6% slopes. While interpolating dimensions from soils maps is imprecise, it appears that all, or nearly all, of the 18.4 acres of prime farmland fall within the western mining setback of the South Property, which is in current agricultural production and will not be mined. Jackson County has approximately 103,763 acres of prime farmland enrolled in the Michigan Farmland and Open Space Preservation Program, according to the 2000-2025 Jackson County Community Comprehensive Plan. Proposed operations within the Project Site will have no impact on the regional soil resources and no topsoil will be removed from the Project Site.

4.7 Norvell Township

Norvell Township is located on the southeastern edge of Jackson County, bordering Washtenaw County, and is situated more specifically between Columbia Township of Jackson County, and Manchester Township of Washtenaw County. The rural township is 32.16 square miles in size, and according to the 2020 U.S. Census, has a population of 2,947. The Township is connected to the greater region by way of two state highways, M-12 (Michigan Avenue) that runs east to west and is south of the Township, and M-50 (Brooklyn Road) that runs north to south and is west of the Township. The Township consists of rolling terrain, agricultural fields, state parks, and natural features.

Though rural in character and having low population density, the Township is directly linked to the greater Detroit region, Jackson County, and Washtenaw County. Jackson County, home to Jackson, Michigan, is a key county along Interstate-94 and U.S.-127 making it an important transportation hub. It is also home to hundreds of lakes, and thousands of acres of park and open space. Washtenaw County is home to the Ann Arbor Metropolitan Statistical Area, the University of Michigan, Eastern Michigan University, Washtenaw Community College, and Concordia University. These areas are regional economic and job centers and are near Norvell Township. Most residents of Norvell Township commute to work outside of the Township. For proximity reasons, the Township is affected by suburban growth patterns in the region. The Township is not served by public water or sewer. Consequently, the density of development is much less in the Township than other suburban fringe areas.

The population of Norvell Township is shrinking, experiencing a 5% decline since 2010. The median age of Township residents has increased from 49 years in 2010 to 53.5 years as of 2020. Household trends within the Township show that the average household size has slightly decreased from 2.34 in 2010 to 2.31 in 2020. Median household value has also grown by 26% to \$176,500, while median household income within the Township has also increased by 26% to \$67,031.

4.7.1 Master Plan Considerations

Norvell Township's Master Plan provides information about the community's goals to help assess the impacts of a proposed land use change. Norvell Township adopted a new master plan on June 19, 2024. The Master Plan provide a clear overview of its intentions relative to community character, as follows:

Norvell Township and its residents take great pride in the peaceful, rural character the Township has preserved since its inception in 1859. The Township is fortunate to consist of large amounts of lakes, streams, farmland, forests, and wetlands, providing invaluable and limited resources. A major goal expressed by many township residents is the preservation of these resources.

It should also be noted that while the preservation of rural character within the Township is a top priority, the Township is still open for future development in clearly defined areas that would bring additional jobs and benefits to the community while still preserving the natural resources of the Township.

See Norvell Township Master Plan, p. 25.

The Norvell Township Master Plan notes that new larger scale projects will require sanitary sewer and water connections rather than the traditional well and septic options found throughout the Township. The strategic use of Township utilities will enable the Township to direct where new, larger scale projects can be built.

The proposed mining operation will not require the use of municipal water or sewer systems.

Several community wide goals included in the Norvell Township Master Plan are relevant in consideration of land use impacts related to the proposed sand and gravel mining operation:

Goal - "Promote a mix of development types to manage sustainable growth while preserving the rural character of the community."

Relevant Objectives:

- *Preserve scenic rural and agricultural views along designated roads.*
- *Limit sewer and utility expansion as a tool to direct residential and commercial growth to the appropriate areas*
- *Provide an avenue to allow for a diversity in housing types to support the changing demographics, such as young professionals, empty nesters, and the increasing elderly population*

The proposed mining operation includes large setback buffers, undulating screening berms, and maintenance of existing trees along property lines and roadways to maintain views along the corridor, limit views of mining activities, and maintain an overall rural character. The proposed plan does not require an extension of sewer and utility expansion. The reclamation of the site will allow for the reuse of the property for residential and/or recreational use consistent with the Township's

Master Plan. Exciting potential for sustainable development exists post-mining. The woodlands and views to Watkins Lake and Watkins Lake State Park will be preserved while offering opportunities to provide a mix of housing options and recreation that can help attract new residents to Norvell Township, and address the aging population and community. In the alternative, the area could be utilized as a recreational park with walking trails and open space preserves.

Goal - "Maintain and expand a safe and efficient transportation system in a manner compatible with the Township's rural character, safe driving conditions, and adequate access in all seasons..."

Relevant Objectives:

- *Work with the Jackson County Department of Transportation to limit uses and development that generate high traffic volumes or attract heavy vehicles to roads with sufficient capacity and/or develop a plan to support those uses.*

Potential haul routes through the Township have been assessed and a best-suited route identified (refer to the Traffic section of this report). The proposed route utilizes roadways currently designated as local truck routes and state highways.

Based on the assessment, no significant impacts are anticipated related to traffic volume or safety of other vehicles or pedestrians.

AAOM will work with the Jackson County Department of Transportation to ensure that the proper permits and permissions are granted for use of the haul road. The Township mining ordinance calls for an excavation surcharge to be assessed onto AAOM for the purpose of funding maintenance and improvement of local roads, ensuring the roads are maintained and in good repair. To avoid negatively impacting the haul routes, AAOM will actively coordinate with Jackson County Department of Transportation throughout the life of the mining operation.

Goal - "Ensure farming remains a viable option in Norvell Township through growth management, and the preservation of agricultural areas and open space..."

Relevant Objectives:

- *Inventory prime farmland, greenways, open space, and active farmland for preservation.*
- *Encourage, promote, and support a range of options for farmers and landowners to ensure preservation and continued viability of farming operations.*

The proposed mining operations will limit disturbance to existing agricultural use of the land on an incremental basis. An inventory of soils considered "prime farmland" soil types revealed that the overwhelming majority of the site is not considered prime farmland and that the operations will not impact the limited area considered prime.

Goal - "Encourage development of land in a sustainable manner that protects the environment for current and future generations."

Relevant Objectives:

- *Conserve the natural resources, open spaces, and important environmental assets of the Township.*

- *Promote building and site designs that are both energy efficient and environmentally sensitive.*
- *Encourage the use of low impact development techniques, including but not limited to native plantings, energy conservation strategies, and renewable energy sources.*

This report documents the extensive assessment of the natural and visual resources of the Project Site, identifies potential impacts to these resources, and proposes key mitigative measures which are proposed by AAOM to address any potential impacts. AAOM has successfully mined and reclaimed sites in Michigan with similar resources and challenges in compliance with local and state laws, and with sensitivity to the resources and the goals of the host community.

The mining and reclamation activity proposed will not directly or indirectly negatively impact regulated wetlands or water bodies, or threatened or endangered species.

The Project Site will remain undeveloped for the period of mining and reclamation activity, so as not to impact the character of the Township. Views of the mining activity from adjacent roads and properties will be screened through a combination of preserved natural wooded buffers, screening berms, and landscaping. Berms along Horning Road, from which the site will be most often viewed, will be undulating in height and shape to appear as a more natural part of the native terrain. Reclamation of the site will yield open rolling grasslands, consistent with the desired land character.

While the Norvell Township Master Plan does not specifically identify parcels of land appropriate for mining, the proposed site does not conflict directly with the values outlined in the document as noted above and will preserve this land for future recreational or residential use decades into the future.

4.7.2 Zoning and Permitting Considerations

The site is zoned AG-1 Agricultural District. The purpose and intent of this district is described in the Norvell Township Zoning Ordinance as:

“This district is composed of those areas of the Township whose principal use is and ought to be farming. The regulations of this district are designed to conserve, stabilize, enhance, and develop farming and related resource-utilization activities, to minimize conflicting uses of parcels, lots, buildings, and structures detrimental to or incompatible with farming activities, and to prohibit uses of parcels, lots, buildings, and structures which require streets, drainage, and other public facilities and services of a different type or quantity than those normally required by farming activities.”

Single-family homes on 1-acre minimum lots are allowed in the district, as is public recreational use, and the area around the proposed site includes agricultural, recreational, and residential use sites. Within the Township’s AG-1 District, land uses including “quarries, mineral mining and extractive operations” are permitted, subject to obtaining a Conditional Use Permit. The mining of natural resources such as sand and gravel is, from a geologist’s perspective, qualifies as “related resource-utilization activities” noted in the ordinance above.

All properties adjacent to the Project Site within Jackson County boundaries are zoned AG-1 (Agricultural District). Properties abutting the eastern property line of the South Property are located in Manchester Township, Washtenaw County and are in the Rural Agriculture District. These designations generally call for low density uses and development patterns.

4.7.3 Land Use Considerations Along Haul Route

AAOM has considered three options for a haul route, depicted in *Figure 18 – Haul Route Options and Zoning Map*, which also shows zoning designations for Norvell Township. While there is a preferred option, AAOM seeks input from members of the Township before a route selection is finalized and based upon such input alternate routes could be selected with approval from the Township. The following paragraphs inventory land uses along each of the three haul routes:

Haul Route A: Begins at the intersection of Watkins Road and Horning Road, continuing southbound on Watkins Road to the intersection of Watkins Road and Wellwood Road. All properties along this stretch are designated Agricultural and Rural Agriculture Districts. Trucks would turn right on Wellwood Road to head southwest towards M-124. This stretch is zoned as an Agricultural District until the intersection of M-124 and Wellwood Road which is zoned RS-1 (single family suburban residential district). All roads along Haul Route A are paved primary roads.

Haul Route B (Preferred): This route utilizes westbound Horning Road to Hardcastle Road. Trucks would turn left onto southbound Hardcastle Road and terminate at M-124, the end of Haul Route B. All properties along Haul Route B are zoned as AG-1 (Agricultural District) until the intersection of M-124 and Hardcastle Road where the northwest corner property is zoned C-2 (general commercial district). All roads along Haul Route B are paved primary roads, and designated truck routes.

Haul Route C: This route would utilize a short segment of Horning Road to access Lawrence Road before proceeding south to M-124. Lawrence Road is less desirable due to it being a gravel road with a larger quantity of residential homes connected to the route. All parcels along this route are zoned AG-1 except for the property along the southern side of the Lawrence Road and Beech Road intersection which is zoned RS-1 (single-family suburban residential district).

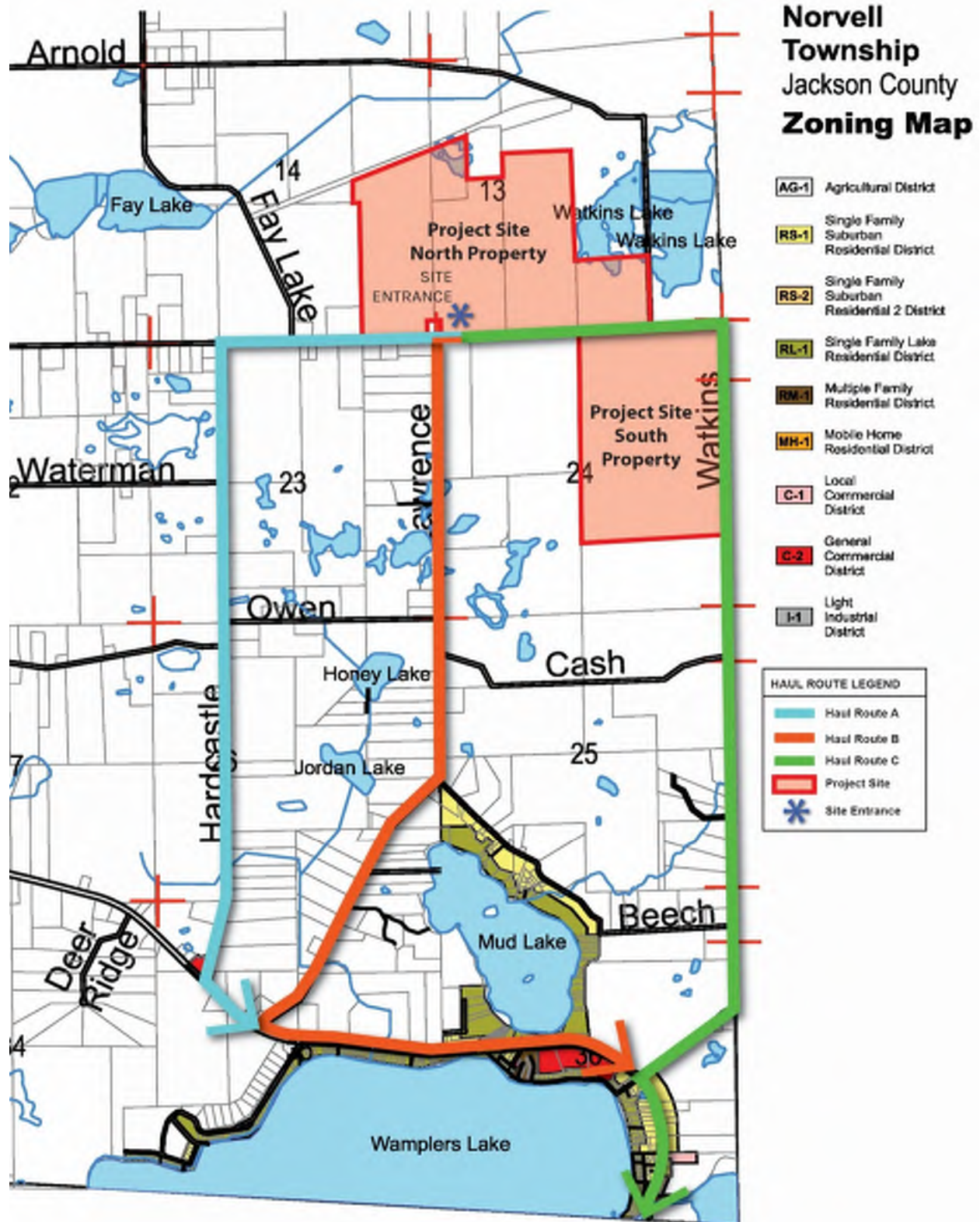


Figure 18 - Haul Route Options and Zoning Map

Each of the haul route options above assumes the use of Wampler's Lake Road (M-124) as the road from which truck traffic would enter and leave the Township. AAOM estimates 80% of the truck traffic will utilize M-124 East, while 20% of the truck traffic would travel M-124 West. The majority of the land area along M-124 in the Township is zoned AG-1 (Agricultural District). West of Hardcastle Road is a limited amount of C-2 (General Commercial), C-1 (Local Commercial), and RS-1 (Single-Family Suburban Residential) zoning districts. East of Hardcastle Road land use along M-125 is denser and includes C-2 (General Commercial), C-1 (Local Commercial), RS-1 (Single-family Suburban Residential), and RL-1 (Single-Family Lake Residential) zoning districts.

The Project Site has approximately 30,000 linear feet of boundary adjacent to properties zoned as AG-1 Agricultural District (Jackson County) and Rural Agricultural District (Washtenaw County). There are a relatively low number of single-family residences, recreation uses, woodlots, wetlands, and agricultural fields surrounding the proposed mine. Abutting the western edge of the North Property of the Project Site is one single-family residence, located on 10 acres of farmed land. Three homes are located on the south side of Horning Road. Two of these homes are on less than 10 acres of land, while the third property, which abuts the west property line of the South Property, is situated on 120 acres of land and includes woodlands and farmed open space. Two single-family homes are on the north side of Horning Road, one of which is surrounded on three sides by the proposed mining activities. The second home is located at the northeast corner of Arnold Road and Horning Road, adjacent to mining along their southern and western property lines. There is one property on the east side of Watkins Road along the eastern property line of the South Property. Noggle Farms is also located on the east side of Watkins Road.

The Project Site contains a significant sand and gravel deposit, is accessible from a truck route, and is in reasonable proximity to construction materials markets. The Project Site's adjacent low density land use and the absence of significant environmental impacts are notable. **The size and configuration of the Project Site and the distribution of the aggregate resources are such that the mining and reclamation activities can be conducted in compliance with the dimensional regulations established by the Township.**

4.8 Real Estate Valuation

Though low in density, residential properties are adjacent to both the Project Site and the truck haul route. Property value impacts are often a leading concern when a mining operation is proposed. The real estate valuation assessment provided in this report is based on a comprehensive study conducted for AAOM for this project site by Andrew Reed and Associates, which is attached to the application as **Exhibit 10: 2025 Market Study**.

The conclusions reached by Andrew Reed and Associates are summarized below, and are supported by two other studies conducted for similar sites, including an assessment from 2015 prepared by Stout, Risius, Ross ("SRR"), and a 2018 study conducted by Phoenix Center for Advanced Legal and Economic Public Policy Studies ("Phoenix Center"). These two additional studies are included in **Exhibit 11** to the Application: Property Valuation Studies.

The studies referenced above utilized different statistically verifiable methodologies in the assessment of property value impacts, but reached similar conclusions as outlined below.

4.8.1 2025 Market Study

In the summer of 2025, Andrew Reed & Associates, a firm that specializes in real estate appraisals and property valuation studies, conducted a study of the property valuation impacts on residential properties located in the vicinity of mining operations and along aggregate trucking haul routes.

The firm identified two control groups of housing along truck haul routes, and two control groups of housing adjacent to active sand and gravel mining. The analysis was based on a “match pair” methodology in which the properties adjacent to haul routes and mining operations were match to other properties that are very similar in most aspects, except that the matching homes were not located adjacent to haul routes and mining sites. Once the match pairs were identified, the analysts adjusted for minor differences in home size, date of sale, condition, number of baths, etc.

Of the 24 matched pairs of homes assessed along truck haul routes, 13 showed a positive impact on the value of the home along the haul route (averaging +12.1%), and 11 pairs showed a negative impact averaging (-7.3%). Overall, the study concluded that there was no impact to home value for being located along a haul route, and that home buyers are more concerned with other variables such as school districts.

The data for these match pairs was also evaluated to determine if the proximity to haul routes decreased the final sale price-to-list price ratio (SP: LP Ratio) or increased the days that the listed homes spent on the market (DOM). The results indicate that “there is no impact to the marketability and desirability to residential properties with exposure to a truck hauling route.”

Of the 7 matched pairs of homes assessed adjacent to active mining operations, 4 showed a positive impact on the value of the home adjacent to mining (averaging +9.5%), and 3 pairs showed a negative impact averaging (-7.6%). Overall, the study concluded that there was no impact to home value for being located adjacent to a mining operation.

A subdivision of homes was also evaluated in which homes directly adjacent to the mine were compared to otherwise similar homes more isolated from the mine. This analysis indicated a positive impact on home value for being adjacent to the mine site, perhaps due to the privacy offered.

Overall, this study found that truck haul routes and mining operations had no overall impact on the value or marketability of the adjacent homes.

4.8.2 SRR Study Results

The sale value of homes, and in some cases, developed but vacant lots, was evaluated within a set of years during which comparable homes were sold based on size, number of stories, size of garage, and other basic features. For example, within a given subdivision, the sale value of ranch style homes during 2010 were put into two distinct categories-those adjacent to a haul route or mine site, and those on the interior of the development. In this manner, the value difference of homes impacted by trucking or mining could be assessed.

In each of the five control groups evaluated, there was no correlation found between the location of a home adjacent to a mine site or truck haul route and a reduction in home sale value.

The second method of evaluating impacts focused on using the assessed value of homes over time, and comparing homes along truck haul routes, roads with higher traffic volumes that are not specifically gravel haul routes, and other homes in the community (excluding lakefront homes).

The assessed values were measured over a six-year period. The study found very little variation between typical homes, homes on a truck route, and homes on comparable busy roads. Furthermore, two local assessors were interviewed for the study, and they confirmed the study's findings that no difference in assessed value exists between homes on truck routes and homes on comparable similar roads with more limited trucking.

Based on the evidence found in the SRR study, there is no significant impact to property values for homes that are adjacent to sand and gravel mining sites or gravel truck haul routes as a result of mining and trucking.

4.8.3 Phoenix Center Study Results

The Phoenix Center effort cast a broader net in looking at impacts related to the proximity of residential homes to a set of quarries located throughout the United States. While the sites studied were quarries rather than sand and gravel operations, for purposes of property evaluation the study is applicable given the direct similarity of operations, i.e., the extraction, processing, and trucking of construction aggregates.

The Phoenix Center effort examined four sites located in Murfreesboro, Tennessee; Gurley, Alabama; Madera County, California; and, Delaware, Ohio.

The methodology assessed housing value changes (based on sales values) for homes located proximate to, and therefore potentially affected by, quarry operation and compared these values to homes located in the same region but distant from, and entirely unaffected by, quarry operations. They looked at value prior to and after mining operations commenced when possible. In this manner, the study could accurately assess the differences between the proximate and distant homes from the quarry, both before and after mining, to determine the true causal relationship of value related to mining.

For each of the sites studied, **the Phoenix Center concluded that the proximity to a mining operation had no negative impact on the value of homes near an operation as compared to homes more remote from mining activity. The Phoenix Center writes “We find no compelling statistical evidence that either the anticipation of, or the ongoing operation of, rock quarries negatively impact home prices.”**

4.9 Community Services

There are no sanitary sewers or water utilities present on, or adjacent to, the Project Site. Water will be supplied to the administrative office through a new drinking water well located near the office and sanitary sewer needs will be met with a new septic tank. The proposed sand and gravel processing plant will utilize existing agricultural wells, as discussed elsewhere in this report. The proposed project will not utilize or impact local community utilities.

During the mining operation, electric and communication services will be supplied to the administrative office, and new electrical services will be required by the processing plant and related equipment. This work will be coordinated directly between the private utility provider and AAOM.

Fencing pursuant to Township standards will be used to deter trespassing in the Mining Area. AAOM will communicate with local officials, including the Jackson County Sheriff Department and the Cambridge Fire Department, as the project progresses, informing officials of the project's progress and communicating any public safety issues. AAOM maintains its own security employees who regularly patrol their sites, proactively reducing property crime and nuisances. While the presence of the mining operation may create an interest in the status of the property from local community members, in the experience of AAOM this heightened interest does not result in significant increases of trespassing nor property crime. Impacts to community service related to public safety are anticipated to be very limited.

Processing plants and related facilities on mine sites are largely open steel frame structures containing limited potential for sustaining a damaging fire. Fuel storage for mining equipment on site slightly increases the risk of fire. Therefore, all fuel storage facilities will be installed and maintained to meet regulatory guidelines and will be limited to above ground storage tanks with secondary containment. In addition, a spill prevention program will be implemented to educate employees and ensure any spills are managed safely and with minimal environmental impacts. Impacts to community services related to fire safety are anticipated to be minimal. The Project Site will actively engage local first responders and will attempt to coordinate rescue drills, as AAOM does in other locations.

The mining operation will not cause a meaningful increase in Township population, therefore, there will be no negative impact to the public education or recreation systems.

4.10 Socioeconomic Environment

The 2020 U.S. Census shows that Norvell Township has experienced a population decline from 2,963 in 2010 to 2,947 in 2020. The median age of Township residents has also increased to 53.5 years while the average household size has decreased from 2.34 to 2.31.

The Township is largely rural in nature, and the predominant land uses are large lot single-family, agriculture, and recreation. Job sustaining industries and businesses are a much smaller part of the Township's land use matrix, indicating that most of the residents of Norvell Township commute to places in larger metropolitan regions for employment. As estimated in the American Community Survey (conducted by the U.S. Census Bureau), the average commute in 2022 for Norvell Township residents is 30 minutes, or more than 36% longer than the average Jackson County worker.

Median household income in Norvell Township is approximately 1% higher than the average for the State of Michigan, home ownership rates are 18.9% higher, and households in poverty are 5% compared to the state average of 13.1%. Jackson County is ranked 38th out of 83 counties in Michigan in terms of median household income.

AAOM estimates six to eight people will be employed at the start of the first phase of mining activity. Some of these positions will be filled by people currently working at the company; however, employment opportunities will be available to residents of Norvell Township. AAOM does not intend to provide trucking services for this operation; however, the proposed mining operation will support local trucking businesses. With the volume of materials expected to be mined, the locally based trucking community will likely experience a meaningful increase in job creation as a result of the mining operation.

Overall, the proposed project will not negatively impact the socioeconomic environment of Norvell Township and the surrounding communities and will create employment opportunities and increase

the tax base of the township.

4.11 Air Quality

4.11.1 Dust and Fine Particulate Matter

The primary potential air pollutant associated with sand and gravel mining operations is particulate matter ("PM"), also known as dust. PM is one of six major pollutants regulated by the EPA and the Air Quality Division of the MDEQ. The EPA sets the National Ambient Air Quality Standards ("NAAQS") for the six criteria air pollutants. These standards protect public health (including the health of sensitive populations such as asthmatics, children, and the elderly) and the public welfare, including protection against decreased visibility and damage to crops, vegetation, and buildings. The units of measure for the PM standard are micrograms per cubic meter of air.

The EPA classifies and regulates dust by particle size, which is measured in microns. Dust or PM less than or equal to 10 microns in diameter is commonly referred to as PM₁₀. One micron is equivalent to one millionth of a meter. Potential sources of PM in a sand and gravel operation include aggregate processing, topsoil and overburden stripping, trucks and equipment using internal gravel roads within a mine, and mining of the aggregates (above the groundwater level, as is the case in the proposed mine). The proposed facility will utilize water during aggregate processing, thereby reducing dust generation.

Dust and fine PM from processing equipment and other sources is typically measured by opacity. Opacity is a measurement of how dense dust particles are in the air. Opacity is measured in percentages from 0% to 100% and measurement is performed by visible observation. When there is no visible dust, opacity is 0%.

The EPA regulates the emissions of PM from nonmetallic mineral crushing facilities through the New Source Performance Standards ("NSPS"), Subpart OOO. 40 CFR 60.670(a) which defines, in part, an affected facility as each individual piece of equipment, crusher, screen and conveyor. Based on this definition, the requirements of Subpart OOO apply to individual pieces of equipment and include, but are not limited to, equipment specific opacity limits, notification of equipment startup, and reporting and recordkeeping provisions.

EGLE enforces the Michigan Air Pollution Control Rules, restricting the level of PM that can be emitted. Michigan Air Pollution Control Rules require owners/operators of crushing facilities to obtain a pre-construction air pollution control permit, known as a Permit to Install. This permit contains a set of general and special conditions for the operation of a crushing facility and incorporates the testing, monitoring, and recordkeeping requirements from the NSPS. Together, state and federal regulations set the maximum levels of dust which can be emitted from a crushing facility.

The proposed sand and gravel operation will include a stone crusher, which qualifies for coverage under the General Permit to Install for Nonmetallic Mineral Crushing Facilities, a copy is included for reference in Submittal Document II.H. MDEQ Permit Requirements.

The General Permit to Install for Nonmetallic Mineral Crushing Facilities contains the following requirements, which will be met by AAOM.

- Installing and maintaining water sprays on all crushers and screens to control PM emissions,
- Implementing a fugitive dust plan as specified in the General Permit to Install to control PM emissions from vehicle traffic, stockpiles, and other sources,
- Labeling crushing equipment within 45 days of startup,
- Notifying MDEQ of crusher startup within 15 days of startup,
- Submitting to MDEQ the performance test procedure 14 days prior to conducting performance testing, allowing MDEQ the time to approve the test plan,
- Notifying MDEQ 7 days prior to conducting performance testing of the date of testing, allowing MDEQ the opportunity to participate or monitor testing,
- Maintaining PM emissions from each piece of equipment below the opacity limits listed in the General Permit to Install, (e.g., 15% for crushers, 10% for screens, 10% for conveyors),
- Conducting performance testing within 60 days of achieving maximum production rate, or no later than 180 days after initial startup,
- Maintaining a copy of the General Permit to Install on site,
- Limiting production to 2 million tons of crushed material per year, and
- Locating the crusher at least 500 feet from any residential or commercial establishment, or place of public assembly.

AAOM will comply with these permit requirements and will implement a series of mitigation measures related to air quality to ensure compliance. These measures include: 1) sequential reclamation to limit the amount of disturbed land, 2) management of topsoil/overburden stripping and reclamation earthmoving operations, 3) maintenance of on-site gravel haul roads, and 4) the use of water during material processing.

4.11.2 Respirable Crystalline Silica

Crystalline silica is a naturally occurring mineral, found in various forms like quartz, cristobalite, and tridymite, and is a common component of rocks, sand, soil, and many construction materials. It is a major component of the Earth's crust. As typically found in nature, crystalline silica does not pose a risk to human health.

The mining process, especially for hard rock and coal, relies upon mining techniques like drilling, blasting and extensive crushing that have the potential to create fine dust that may contain respirable crystalline silica (RCS). RCS has been identified as an occupational hazard in mining, with the potential to cause diseases such as silicosis, lung cancer, and chronic obstructive pulmonary disease (COPD). Respirable particles, those small enough to penetrate deep into the lungs, are generally defined as having a diameter of 10 microns or less. For reference, fine beach sand has a diameter of 90 microns and a typical human hair has a diameter of 70 microns.

Unlike hard rock mining, sand and gravel mining methods do not require drilling, blasting, jackhammering, sanding, sawing, or extensive crushing operations. Sand and gravel extraction is typically done with loaders, excavators and dredges, and aggregate processing primarily consists of screening and washing the sand and gravel to meet construction specifications. These processes generate very little respirable dust, which is further controlled using water-based dust suppression techniques.

On April 18, 2024, the Mine Safety and Health Administration (MSHA) issued its final rule, *Lowering Miners' Exposure to Respirable Crystalline Silica and Improving Respiratory Protection*, to reduce miner potential exposures to RCS. All types of mining operations, hard rock, coal, sand and gravel, underground and others, are covered under rule.

This rule has the following requirements.

- The permissible exposure limit (PEL) for RCS was lowered from 100 ug/m³ to 50 ug/m³ for a full shift exposure, calculated as an 8-hour time weighted average.
- The rule established an action level (AL) for RCS of 25 ug/m³ for a full shift, calculated as an 8-hour time weighted average.
- RCS exposure sampling for miners is required.
- Mine operators shall provide a medical surveillance program for miners.
- Any sampling event that exceeds the PEL for RCS must be reported to MSHA and corrective actions and resampling must be taken until the results are below the PEL .

In accordance with this new standard, Levy's Industrial Hygiene Staff retained Ensafé, an environmental, safety and health (EHS) consulting firm, to conduct RCS exposure sampling for miners at three sand and gravel mines located in southeastern Michigan with similar geologic conditions to the Project Site. In 2024, 22 samples were collected for miners at these sites. All sample results were below MSHA's AL of 25 ug/m³. The full documentation of this monitoring event is attached to the Application as **Exhibit 12: Industrial Hygiene Exposure Assessment**.

These results are consistent with the understanding that sand and gravel mining operations are not a major source of RCS.

4.11.3 Conclusions

There will be no significant impacts to air quality associated with the proposed mining operation. Use of water-based dust control measures are effective in controlling fugitive dust from sand and gravel mining operations. The proposed mining operation will comply with all Federal and State regulations and permit requirements. The mining and processing of sand and gravel will not pose a health threat from exposure to Respirable Crystalline Silica for employees or residents of Norvell Township.

4.12 Noise

The Norvell Township Ordinance has standards for acceptable limits of noise from operations and activities that may be of nuisance to the community. Specifically, regulatory Ordinance No. 22 Anti-Noise and Public Nuisance Ordinance was adopted in 1987 and applies to the proposed operation. The site is zoned as part of the Agricultural District, and no mining will occur within 1,000 feet of a dwelling (the standard set within Ordinance 22), therefore, for purposes of the noise limitations, the site is considered "Agricultural".

Norvell Township Ordinance No. 22 measures sound levels using "A weighted" metric, referred to as dBA, which is common for most noise measurement practices and community noise standards. The Project will limit mining and processing activities from 7:00 a.m. (or sunrise, whichever is later), until 8:00 p.m. (or sunset, whichever is earlier), Monday through Friday, and Saturday from 7:00 a.m. (or sunrise, whichever is later) to 12:00 noon. Ordinance 22 requires that within this timeframe activity within the agricultural

district emits less than 65 dBA, as measured at the” boundaries of the property under separate occupancy.” For residential districts, Ordinance 22 requires activity to emit less than 55 dBA, which is more restrictive than the agricultural district standard.

While the ordinance requires that the proposed mine operate below noise levels of 65dBA, the analysis below demonstrates that the proposed operation will comply with the more restrictive limit set by Ordinance 22 of 55 dBA for properties in a residential zoning district or with adjacent homes within 1,000 feet

Ordinance No. 22 adopts the noise standard for truck traffic established in the Michigan Vehicle Code, which states, measuring 50 feet from a vehicle, a stationary truck shall not generate over 88 dBA; at 35 mph or less the limit is 86 dBA; and over 35 mph the limit is 90 dBA. The ordinance also allows for permitted construction projects to emit a higher level of sound (80 dBA) on a temporary basis.

In its existing condition, noise on site is generated by traffic on adjacent public roads, the use of farm equipment and machinery on-site and adjacent off-site agricultural fields, activity on adjacent residential properties, and natural sounds such as wind in the trees, birds, etc. A commonly assumed daytime level of ambient noise levels for rural areas is between 30 and 45 dBA, with higher levels experienced when farm equipment is being used. Lands adjacent to local rural roads typically experience sound levels around 50 to 55 dBA.

Based on review of past studies, the study produced specifically for this site, and governmental guidelines, the following are basic assumptions about sound levels:

1. Sound levels decrease by 6 dBA every time you double the distance from the source. 10 dBA is perceived by the human ear as doubling the level of sound.
2. A 3 to 5 dBA increase is considered audibly different from background sounds.
3. Outdoor noise levels less than 55 dBA are assumed not to interfere with outdoor activities nor cause annoyance.
4. Noise generated from traffic on rural roads traveling at 45 mph can range from 68 to 84 dB when measured 50 feet from the roadway.
5. An earthen screening berm, at the proposed heights and locations, can attenuate approximately 10 to 15 dBA. While noise levels do not travel in a straight line, the bulk of noise travels in a direct path, and breaking the visual connection between the source of noise and the recipient of the sound is an effective method of minimizing noise issues.
6. Excavating the mine site such that the face is oriented away from the adjacent properties offers additional sound attenuation. The proposed operation is designed to excavate in this manner. The attenuation offered by the combination of mine face orientation and screening berm is about 15 dBA.
7. The closer to the berm that the source of the noise is, the more effective the sound reduction. As mining activity gets closer to a residence, though the positive effect of distance is reduced, a berm has an increasingly important role in attenuation.
8. Although some mobile equipment noise will be intermittent, the combined noise from the plant and mobile equipment occurs generally during plant operating hours.

For the estimation of sound levels expected at, and adjacent to, the Project Site, the environmental engineering firm GZA was asked to provide a detailed assessment. The results of their study are included in **Exhibit 13** to the Application: Focused Noise Estimation Report. The proposed plant equipment is

equivalent to the plant at another operation of AAOM, the Pleasant Lake Aggregates (“PLA”) operation in western Washtenaw County. Noise measurements were taken from a series of points around PLA to establish as baseline of noise levels. The proposed operation will also include stone crushing equipment, and the additional sound generated by the stone crusher was integrated into the estimate of sound levels.

There are three major sources for noise at a sand and gravel operation, such as the one proposed in Norvell Township; the initial work to strip overburden soils from a given phase of work and installation of screening berms, the processing plant, aggregate extraction, and conveying equipment, and trucks.

1. The proposed sand and gravel mining operation will generate additional short-term noise in the area from earthmoving equipment for the installation of berms and topsoil stripping. Utilizing typical sound levels created by earthmoving equipment, these sounds are expected to be within the standard set by the Township for construction projects. As outlined on the submitted site plans, the berm construction activity will be completed in four stages as the mining progresses through the Project Site. At each stage of berm construction, the earthwork will be completed in a concentrated timeframe, typically lasting four to eight weeks in duration. The impact from these activities is considered limited and temporary, and necessary to construct the noise attenuating berms.
2. The proposed processing plant at the site will be the loudest source of sound at the site. The plant will be located centrally within the Northern Property, where a combination of the proposed berms, mining face and existing woodlands will provide sound attenuation. The GZA report concludes that the sound levels experienced at the potential receptors closest to the plant (i.e., neighboring homes to the south and west, and along the property line to the north) will be below the agricultural and residential zoning noise limitations set by the township ordinance.

At the face of the mine, on the pit floor, excavators and conveyor equipment will operate no closer than approximately 1,600 feet from the nearest dwelling. As noted elsewhere, the active mining will occur below the surface grade and will utilize the mining face and screening berms as buffers for residences. With distance and berm buffer accounted for, the estimated level of noise at the adjacent property lines will be below the 55 dBA standard.

3. The third contributor to noise at sand and gravel sites is truck traffic. The location of the preferred site entrance and haul route through the site have been designed to minimize the gradients of the internal haul route. Similarly, the location of the preferred site entrance has been selected to be at a relatively flat section of Horning Road. These criteria will reduce the need for sudden acceleration and deceleration of trucks, limiting the noise impact. Trucks entering and leaving the site and traveling along the haul route will operate well within the Township standards outlined above.
4. The preferred off-site haul route follows existing designated truck routes. While additional truck traffic resulting from the proposed operation will sporadically increase noise levels along the route, the route is currently used and approved for truck traffic, limiting the additive impact. Further, the preferred haul route roads are publicly owned facilities that allow the legal use of trucks.

Mining equipment utilized at the plant site and in the pit require safety alarms that signal when the equipment is backing up. Back up alarms at this site will employ technology that measures background noise and sets the volume of the alarm accordingly. As a result, the alarm is quieter in quiet settings and loader only when necessary. In addition, the back up alarms will emit a “whoosing” or “pshh-pshh” sound

across a wide range of frequencies, which is less offensive than a traditional beeping alarm. These alarms effectively limit the impact of intermittent sounds, while maintaining conformance to safety regulations.

In summary, noise levels in the vicinity of the Project Site will increase as a result of the proposed mining activity due to the operation of mining equipment and trucks. It is anticipated that these impacts will be minor, short-term, limited to the hours of operation and mining season, and will be within the requirements of Township ordinances for both agricultural and residential districts. As such, they will not produce any serious consequences.

4.13 Vibration

Vibrations caused by the extraction and processing of sand and gravel are limited to those associated with standard earthmoving and processing equipment. **Vibration from these sources dissipates through the soil immediately surrounding the source and does not impact adjacent properties.**

No explosives will be used, or blasting undertaken at the proposed mine site.

4.14 Traffic

As noted above, Fishbeck, Inc., a traffic consultant, completed a Traffic Impact Study (“TIS”) for the proposed mining operation to assess alternative haul routes and potential traffic impacts. A full copy of the report can be found in *Exhibit 3* to the Application: Traffic Impact Study, and demonstrates no adverse impact.

4.14.1 Scope

The TIS was conducted to determine current and projected traffic conditions and impacts of the proposed mining activity. The study focused on the following roads within Norvell Township:

- Hardcastle Road
- Horning Road
- Watkins Road
- M-124 (Wampler’s Lake Road)
- Lawrence Road
- Wellwood Road
- U.S.-12 (Michigan Avenue)

The following intersections were accessed to study traffic volumes:

- Hardcastle Road and Horning Road
- Watkins Road and Horning Road
- M-124 and Hardcastle Road
- M-124 and Lawrence Road
- M-124 and Wellwood Road
- M-124 and U.S.-12

The TIS assumes the proposed mine will be fully operational in the year 2026 and uses this schedule to project traffic volumes. All truck trips will originate and destinate to U.S.-12, with 80% traveling to/from the east and 20% traveling to/from the west.

Three alternative routes were identified for consideration and assessment as a truck route between the site and U.S.-12, as follows:

- Haul Route A (Watkins Road): Horning Road to Watkins Road to Wellwood Road to M-124 to U.S.-12
- Haul Route B (Hardcastle Road): Horning Road to Hardcastle Road to M-124 to U.S.-12
- Haul Route C (Lawrence Road): Horning Road to Lawrence Road to M-124 to U.S.-12

The alternative routes, including the intersections noted above, were evaluated to document the traffic conditions as they exist today as well as to predict the impact of the proposed mining.

The ability of the intersections/roadways to accommodate traffic are measured using the level of service (“LOS”) methodology for signalized and non-signalized intersections as documented in the Highway Capacity Manual (HCM). LOS rating ranges from A to F with LOS A describing desirable traffic operations with little or no delay and free flow traffic, and LOS F representing extremely poor traffic operations characterized by excessive delays and long vehicle queues.

4.14.2 Methodology

Vehicular turning movement counts (“TMC”) were performed on Tuesday, February 14, 2023, during the weekday morning (7:00 a.m. to 9:00 a.m.) and afternoon (4:00 p.m. to 6:00 p.m.) peak periods at the six intersections. Schools were in session and no adverse weather conditions nor incidents occurred that would impact normal traffic volumes. The counts were recorded in 15-minute intervals to enable the identification of the peak hour factors (“PHF”) and the characteristics of the peaking hour and heavy vehicle activity in those hours.

To accurately assess the impacts to traffic volumes resulting from the proposed mining activity, Fishbeck projected future traffic volumes for the year 2026 with and without the future mining operation.

A 0.50% annual compounded growth rate was applied to account for ambient traffic growth based on data published by the U.S. Census Bureau and Southeast Michigan Council of Governments (“SEMCOG”). For the proposed mining activity scenario, trip generation was calculated utilizing the anticipated aggregate production volume (85,000 tons/month or 1,020,000 tons/year) assuming each truck carrying a capacity of 50 tons, and a forecast that is equal to nine inbound and nine outbound trucks per hour. Included in Fishbeck’s calculation are the site’s six to eight employees that will arrive in the morning and depart in the afternoon via passenger vehicle. Operating hours for the facility are anticipated to be 7:00 a.m. to 5:00 p.m. Monday through Friday.

4.14.3 Results

A LOS analysis for peak AM and PM hours based on traffic counts, traffic volume projections, traffic peaking characteristics, and intersection geometry was calculated for the following conditions:

- Existing (February 2023)

- Future No Build (2026, without new mining operation)
- Future Build Phase (2026, with new mining operation)

For the existing condition scenario, all roads and intersections operate at an LOS A except for northbound Boardman Drive (Left/Thru/Right) and southbound M-124 (Left/Thru/Right), which operate at an acceptable LOS B. All ratings were judged using AM and PM peak hours.

For the Future No Build condition, all intersection approaches within the Project Site are projected to continue to operate at the same LOS as existing conditions.

With the Project Site in full operation, including the addition of nine trucks per hour, all movements, approaches, and intersections are expected to continue to operate at an acceptable LOS A or B during both the AM and PM peak hours for each of the three routes assessed. Operational impacts of the proposed mine are negligible as compared to existing and background conditions.

The TIS indicates that the proposed mining operation will not result in any significant operational impacts to the impacted road network no matter which of the three alternative routes is utilized. Further, no off-site improvements are required to mitigate adverse impacts along any of the proposed haul routes.

4.14.4 Crash Analysis

Historical crash data at the six intersections analyzed was reviewed by referencing the most recent five years (January 1, 2018, through December 31, 2022) using available data on the Michigan Traffic Crash Facts (“MTCF”) website, which references the Michigan State Police Database. These data indicate zero crashes have occurred in the past five years at the following intersections:

1. Horning Road and Hardcastle Road
2. M-124 and Hardcastle Road
3. M-124 and Lawrence Road

A single reported crash occurred in the five-year study period at the intersection of Watkins Road and Horning Road. This crash involved an eastbound driver falling asleep and driving through the T-intersection. The driver was cited for careless driving and the crash resulted in property damage only (“PDO”).

A single reported crash occurred in the five-year study period at the intersection of M-124 and Wellwood Road associated with the slip lane. This crash was classified as a head-on left-turn crash with a serious injury (Level A). A vehicle traveling eastbound on M-124 attempted to turn left onto northbound Wellwood Road, striking a motorcyclist traveling westbound on M-124. The motorcyclist had the right of way.

At the intersection of M-124 and U.S.-12, seven reported crashes occurred in the last five years. Four of these crashes resulted in B-level minor injury and three resulted in PDO. The seven total crashes include one head-on left-turn, two rear-end, one sideswipe (opposite direction), and three coded as “other.” The two rear-end crashes involved eastbound left-turns from U.S.-12 to M-124 being struck from behind while yielding to opposing westbound traffic. One of these crashes resulted in B-level minor injury.

The five remaining crashes all involved a vehicle departing from a stop-controlled approach (M-124 or the opposing Boardman Drive). Four of the five at-fault drivers were cited for failure to yield, and the fifth fled

the scene. These five crashes involved vehicles on each of the four intersection approaches. There is no pattern indicating inadequate sight distance or other influence would restrict a driver's ability to perceive and yield appropriately to conflicting traffic.

The review of historical crash data indicates no pattern or concentration of crashes subject to countermeasure or that would be exacerbated by the proposed mining operation.

4.14.5 Pedestrian Safety

M-124 is signed and marked as a bicycle route, therefore crashes involving bicycles within the study area were reviewed. MTCF indicates zero bicycle/vehicle crashes have occurred on the study roadways in the most recent five years. There are also "Watch for Pedestrians" warning signage on U.S.-12 in the vicinity of M-124; therefore, crashes involving pedestrians were reviewed. MTCF indicates zero pedestrian/vehicle crashes have occurred on the study roadways in the most recent five years. The two pedestrian/bicycle crashes reported in the vicinity of the study area occurred within the residential neighborhood along the channel between Wampler's Lake and Iron Lake in Cambridge Township.

4.14.6 Proposed Driveway Location

The ordinance outlines a number of requirements related to the Project Site access driveway, including limiting truck access to a single point of egress for every 660 feet of front lot line, paving the entrance drive a distance of at least 100 feet into the Project Site, and providing a crushed stone driveway at least 200 feet beyond the limit of paving, at a minimum width of 22 feet. The proposed operation will exceed these requirements, in conformance with township ordinances. A single point of entry is proposed for customer trucks on the north side of Horning Road. Access points allowing employees to cross Horning Road from the North Property to the South Property are also proposed.

Though a windshield survey of sight distance along Horning Road, AAOM has identified three suitable locations (from a traffic planning perspective) for a customer site entrance. The preferred location is approximately 300 feet east of Lawrence Road.

The second potential location is at the southwest corner of the North Property and would limit the number of homes that trucks would pass on Horning Road. However, this location would result in trucks accelerating and decelerating in closer proximity to a small group of homes on Horning Road, and the noise of the trucks making the turns into and out of the Project Site would be more impactful to neighbors than driving further east on Horning Road to the preferred location.

Further east of the preferred location is a high point on Horning Road, providing adequate sight distance for site entry. However, trucks would need to accelerate and decelerate on Horning Road to get to the high point, and, similar to the option to the far west, the impact of truck noise would be more detrimental than the preferred location within a flatter segment of Horning Road.

AAOM seeks input from the community and the Jackson County Department of Transportation to determine the best entrance location.

4.14.7 Conclusions

The TIS evaluated three alternative routes to haul aggregates from the proposed site and the nearest state highways and reached the same conclusion of "no significant adverse impact to traffic operations" for all three.

Given the limited differences in traffic operations impact between the three alternatives, AAOM assessed the three routes in terms of:

- Limiting the distance from the site to a state trunkline highway
- Assessing road design and local designations of truck routes
- Limiting the number of curves and steep grades along the route
- Considering the density of land use (primarily residential) along each route

Based on this assessment, Levy has concluded that the preferred route among the alternatives studied is the Horning Road to Hardcastle Road to M-124 route, based on the roads' current Jackson County designation as primary roads, the Township designation of the roads as truck routes (per Norvell Township Ordinance No. 38), and the vertical profile of the roads, (i.e., fewer steep grades), which increases road safety and reduces noise impact of the trucks. This route is also the shortest distance between the proposed Project Site entrance and the state highway.

4.15 Visual Quality

The rural character of Norvell Township is valued by residents, as reflected in Township zoning ordinances and the Norvell Township Master Plan. The Project Site contains many of the typical elements of the rural landscape in Jackson County and contributes to the rural character and visual quality of the area. Views of the site landscape are described as follows.

The western boundary of the North Property is comprised of active farmland along the southern half and densely forested along the northern half. The northwestern boundary abuts a utility easement that is heavily screened by forest and wetlands and steep rolling hills with low points along the north border. The remaining North Property line shares a boundary with Watkins Lake and Watkins Lake State Park. The bordering areas of Watkins Lake State Park contain rolling hills, lush prairies, and mown walking paths for community enjoyment. The proposed Mining Area in this location is slightly elevated above the park, which slopes down to the north. Woodlands border the fringe areas of Watkins Lake along the west and south shores and will be protected during active mining. Mining is bound by the west side of Arnold Road; a farmstead shares the east border of Arnold Road.

The interior of the North Property contains rolling hills and is actively farmed. A large forest stands in the north and contains regulated wetlands, all of which will be protected. There are approximately 14 acres of forest stands within the proposed mining zone that will be removed. Those acres are adjacent to a mature 44-acre forest which will be preserved, limiting visual quality impacts and screening the operation from the north. Three homes are on the south side of Horning Road of the North Property, with the westerly two properties adjacent to one of the truck haul routes. The third property is slightly east of the North Property's preferred entrance.

The South Property is bound by agricultural fields along the west and south property lines. One residential home is located at the northwest corner of the South Property, though it is screened by an existing tree line

and will be buffered by berms during mining Phases 4 through 6. The eastern property line runs parallel to Watkins Road and is directly across from Noggle Farms in Manchester Township, Washtenaw County. One residential home is located on the east side of Watkins Road at the southeastern end of the South Property but will have minimal exposure to the proposed mining operation as mining will not occur near the property until the Project Site's final phases. The interior of the South Property is comprised of barren rolling hills that are actively farmed.

Inherent to sand and gravel extraction is altering the visual environment of the mine site. Most local ordinances and mining operators recognize the potential for impacting the visual character of the host community and require mitigation measures to reduce these impacts.

Mitigating factors at the proposed site include the following:

- AAOM has proposed the installation of earthen berms at the perimeter of the Mining Area where the Mining Area is adjacent to other properties and public roads. The berms will vary in height from 8 to 16 feet and will be located within the (150 foot wide minimum) mining setback.
- The mining ordinance requires a 1,600-foot setback from dwellings. In these areas, the proposed plan takes advantage of this substantial setback and existing ridgelines to pull the berms well away from adjacent neighbors to limit the visual presence of the berms and preserve rural character while also providing visual screening and noise mitigation.
- With the installation of screening berms, any views of the mining operation will be limited to a distant glimpse of the top of the processing plant (located at the center of the Project Site), and of construction equipment temporarily building screening berms.
- To retain some of the rural character along adjacent roads, AAOM proposes to preserve trees along roadways such as Horning Road and Watkins Road.
- An additional mining buffer is proposed along the northern edge of North Property to preserve trees and screen the operations.
- The approach for screening in the mining setback will be to preserve trees closest to residential homes and public roads and construct berms on the interior side of the setback.
- Overlapping berms will be constructed at the Project Site entrance to minimize views into the Mining Area from Horning Road.

A series of Site Cross Sections have been prepared to help understand the visual access neighbors and users of adjacent roadways will have of the Project Site. The Site Cross Sections can be found within ***Exhibit 2: Site Plans***, attached to the Application.

In addition, Photo Simulations from various key vantage points are being created, showing the viewshed of the Project Site both before and after mining activities. These visual simulations will be provided to the township subsequent to this submittal.

Where proposed buffer areas are wide enough and/or sufficiently wooded to provide substantial screening of the operations, no berms are proposed along the perimeter of the Project Site. For instance, no berms are proposed in the North Property along Watkins Lake nor in the north and west boundaries along the existing forest edges as these areas are natural buffers.

The overall impact on the Township's viewsheds as a result of the Project Site is considered minor, given the low-density land use of the area and the above-mentioned mitigating factors.

SECTION 5 MITIGATIVE MEASURES

AAOM plans to implement the following mitigative measures as part of the Project:

5.1 Materials Handling

AAOM establishes specific Materials Handling policies and procedures for each of its active mining sites, including:

- Use of double walled fuel storage tanks in compliance with State of Michigan requirements.
- The careful use and storage of hazardous materials, such as motor oil.
- Procedures for responding to emergency situations properly and expeditiously, including engaging the appropriate state and local authorities.

5.2 Soils

As mining operations proceed, overburden will be spread to achieve desirable grade for surface drainage and to blend with existing adjacent topography. Once the appropriate subgrade has been established, topsoil will be spread in accordance with Township zoning ordinances and then seeded with an appropriate seed mix. Stockpiles of overburden and topsoil will be temporarily seeded to prevent dust generation and erosion.

No topsoil will be removed from the Project Site, either through the sale of the topsoil or through erosion and sedimentation. The mining and reclamation plans propose a buffer between the active Mining Area and the edge of regulated wetland and water bodies. This buffer will prevent eroded sediments from leaving the Mining Area and impacting these natural features. Sedimentation and erosion control measures will be installed as necessary to prevent impacts to adjacent properties and wetlands.

5.3 Storm Water Management and Wetlands

Management of storm water throughout the mining and reclamation process is an important part of limiting impacts to the existing water bodies and wetlands on, and adjacent to, the Project Site.

AAOM proposes to mine and reclaim the land such that site storm water is directed to drain to low areas within the Mining Area to be collected, temporarily stored, and then allowed to infiltrate into the groundwater. This approach enhanced the recharge of groundwater and minimizes potential impacts from discharging storm water off-site.

All wetlands located on the Project Site are located outside of the mining area so they will not be directly impacted by mining operations. To prevent secondary impacts to wetlands, the area containing the wetlands will remain in its natural vegetated state to allow filtration of storm water entering the wetlands.

5.4 Groundwater

While no impacts are anticipated to groundwater flow or level, AAOM will actively monitor, on a monthly basis during active mining, groundwater conditions through the use of the ten existing monitoring wells on the site.

5.5 Terrestrial Systems

The loss of woodlands on site and the habitat values they provide will be mitigated in part through the following measures:

1. The preservation of environmentally valuable woodland and wetland habitat at the northwest corner of the Northern Property.
2. All woodlands removal will be scheduled during the fall and winter (October 1 through April 14) when impacts to bat and migratory bird populations are minimized.
3. Wildlife friendly erosion control matting will be specified, if used in reclamation of slopes and drainage ways.
4. Exclusionary fencing will be used between the Eastern massasauga rattlesnake habitat and the mining area on the northern edge of the Northern Property.
5. Overburden and topsoil removal will be undertaken before May 1 or after the fourth week of August in the grasslands area on the western edge of the Northern Property to minimize the risk of impacting the Henslow's Sparrow. In addition, additional acres of grassland will be incidentally created within the mining setbacks that may become habitat for migratory birds, like the Henslow's Sparrow.
6. Reclamation activities will be ongoing through the period of mining operations, limiting the amount of exposed land and stabilizing soils.

5.6 Air Quality

It is the intent of AAOM to practice protective and mitigative measures to minimize the generation of air pollutants and dust from mining operations. These measures include the following:

- Appropriate use of water trucks and broom tractors as necessary, on internal haul routes, entrance area, the plant area, and the extractive area.
- Timely reclamation of mined areas to prevent wind borne dust due to soil erosion.
- Use of process equipment, machinery and transport vehicles in compliance with federal and state emission regulations.
- Conducting daily observations of fugitive dust emissions from vehicles and processing equipment.
- Conducting weekly inspections of all emission control equipment.

5.7 Noise

Noise levels generated by the mining operations are not anticipated to have an impact on the community, and AAOM has proposed measures to minimize noise levels, meeting Township standards and requirements. AAOM will orient its mine face away from the nearest adjacent residences, allowing the mining face to act as a noise barrier. AAOM proposes to construct earth berms where required using the height standards established by local ordinances as a minimum and following the recommendations of the Noise Assessment. These berms will act as noise and visual barriers, enhancing the grade separation between mining operations and adjacent lands.

The proposed boundary of the processing plant site is approximately 2,250 feet from the closest residences located at the southwest corner of the North Property, 1,550 feet north of the nearest home on the south side of Horning Road, and 6,750 feet from the home on the east side of Watkins Road. The placement of

the processing plant this far from adjacent residences, and the construction of earthen screening berms, will result in significant reductions in noise impacts to nearby homes, as discussed previously in this report.

AAOM will use state-of-the-art back-up broadband alarms on all equipment. These alarms continually measure ambient sound levels in the immediate environment and emit a “whoosing” or “pshh-pshh” sound, meeting MIOSHA Safety Standards and minimizing noise impacts.

Proper equipment maintenance measures contribute to minimizing noise impacts, and AAOM regularly inspects and repairs conveyors, loaders, and plant equipment as part of routine plant operations.

5.8 Traffic and Haul Route

The Project Site entrance road will be surfaced as required by Township ordinances and the location will be approved by the Jackson County Department of Transportation. AAOM will contribute the required Excavation Surcharge, which is funding set aside to maintain the haul route. The Project Site entrance road and Horning Road will be cleaned regularly, and on an as-needed basis to keep local roads in a clean condition.

5.9 Visual Quality

Most of the changes in the visual environment will be visible only to people within the Project Site. The focus of mitigation measures for visual impacts is the adjacent residences and users of public roads. Mitigation measures will be installed and maintained by AAOM to reduce the visual impact of the mining activity through the use of screening berms and the preservation of existing trees and woodlands.

Mining operations will be nearly completely screened from views from adjacent homes and public roadways. Proposed berms will be in the mining setback as required by ordinance. Where possible, berms will be located on two-thirds of the 150-foot buffer such that existing trees can be preserved in a 50-foot-wide edge (closest to neighboring properties) or in the larger setback from dwellings to reduce the visual presence of the berm.

The height of the berms will vary along the length of the property perimeter to provide a more naturalistic and pleasing appearance. Minimum berm height will be 8 feet tall. The berm will be taller where the property is adjacent to residential structures to better screen views and reduce sound levels.

5.10 Conclusion

As is clear from this report and the supporting documents attached to the Application, the Project fulfills both requirements under the Township Ordinance and the MZEA that: 1) there is a need for the extracted sand and gravel; and 2) that “no very serious consequences” would result from the extraction of these natural resources.

As such, AAOM respectfully requests that the Township approve its Application for a Conditional Use Permit.

EXHIBITS

EXHIBIT 1

Provided under separate cover

EXHIBIT 2

Provided under separate cover

EXHIBIT 3

Norvell Site Traffic Impact Study

Varnum, LLP
Attorney-Client Privilege
Edw. C. Levy Co.

Project No. 230234
February 26, 2025

Norvell Site Traffic Impact Study

**Prepared For:
Varnum, LLP
Representing the Edw. C. Levy Co.**

**February 26, 2025
Project No. 230234**

Executive Summary.....	1
1.0 Project Overview.....	1
1.1 Introduction.....	1
1.2 Study Methodology	2
1.3 Roadway Characteristics.....	2
1.4 Study Intersections	2
1.5 Multimodal Characteristics	3
2.0 Existing Conditions Analysis	3
2.1 Existing Traffic Volumes.....	3
2.2 Traffic Operations Analysis Methodology	4
2.3 Existing Conditions Traffic Analysis	4
2.4 Existing Conditions Improvements	6
2.5 Crash Analysis	6
3.0 Future Conditions Analysis.....	7
3.1 Background Traffic Volumes	7
3.2 Trip Generation Forecast.....	7
3.3 Trip Distribution.....	8
3.4 Turn Lane Warrants	8
3.5 Future Conditions Traffic Analysis	8
4.0 Findings and Recommendations.....	13

List of Figures

Figure 1 – Project Location and Haul Route Alternatives.....	1

List of Tables

Table 1 – Roadway Characteristics.....	2
Table 2 – Intersection Characteristics.....	3
Table 3 – LOS Criteria	4
Table 4 – LOS Analysis for Existing Conditions	5
Table 5 – Site Trip Generation	8
Table 6 – LOS Analysis for Future Conditions – a.m. Peak Hour	8
Table 7 – LOS Analysis for Future Conditions – p.m. Peak Hour	10

List of Appendices

Appendix 1 – Traffic Volume Data
Appendix 2 – Existing LOS Output Reports
Appendix 3 – Crash Data
Appendix 4 – Background LOS Output Reports
Appendix 5 – Turn Lane Charts
Appendix 6 – Future LOS Output Reports

List of Abbreviations/Acronyms

AADT	Average Annual Daily Traffic
EB	eastbound
GHA	Gewalt Hamilton Associates
HCM	Highway Capacity Manual
ITE	Institute of Transportation Engineers
JCDOT	Jackson County Department of Transportation
Levy	Edw. C. Levy Co.
LOS	Level of Service
MDOT	Michigan Department of Transportation
mph	miles per hour
MTCF	Michigan Traffic Crash Facts
NB	northbound
PHF	Peak Hour Factor
SB	southbound
SEMCOG	Southeast Michigan Council of Governments
TDMS	Transportation Data Management System
TIS	Traffic Impact Study
TMC	Turning Movement Count
WB	westbound
WCRC	Washtenaw County Road Commission
vpd	vehicles per day

References

Michigan Department of Transportation, 2013, *Michigan Manual on Uniform Traffic Control Devices*.
Michigan Department of Transportation, 2017, *Geometric Design Guidance*.
Michigan Department of Transportation, 2021, *Electronic Traffic Control Device Guidelines*.
Transportation Research Board, 2016, *Highway Capacity Manual*, 6th Edition.
Transportation Research Board, 2000, *Highway Capacity Manual: 2000*.

Executive Summary

Fishbeck has completed a traffic impact study (TIS) for the Edw. C. Levy Co. (Levy). Levy proposes to mine a site on the west side of Watkins Road and on the north and south sides of Horning Road in Norvell Township, Jackson County, Michigan. Mining operations on the currently vacant site are assumed to be active and fully operational in the next five years. For the purposes of traffic assessment, this report assumes a start of operations in 2026.

Levy intends to extract raw materials from the site and haul this material to other sites. All truck trips will originate and destinate to US-12, with 80% traveling to/from the east and 20% traveling to/from the west. Levy evaluated three potential fixed haul routes, including:

Haul Route A (Watkins Road):	Watkins Road	↔	Wellwood Road	↔	M-124	↔	US-12
Haul Route B (Hardcastle Road):	Horning Road	↔	Hardcastle Road	↔	M-124	↔	US-12
Haul Route C (Lawrence Road):	Lawrence Road	↔	M-124	↔	US-12		

There are six intersections along the haul routes where truck turning movements will occur, including:

1. Hardcastle Road and Horning Road;
2. Watkins Road and Horning Road;
3. M-124 and Hardcastle Road;
4. M-124 and Lawrence Road;
5. M-124 and Wellwood Road; and
6. M-124 and US-12.

The objectives of this TIS are to determine what impacts, if any, the proposed project would have on adjacent roadway traffic operations, and to develop recommendations for any improvements necessary to mitigate potential project impacts at the studied intersections. Study analyses were completed relative to typical weekday a.m. and p.m. peak periods. This study was conducted according to the methodologies and guidance published by the Institute of Transportation Engineers (ITE), Jackson County Department of Transportation (JC DOT), Washtenaw County Road Commission (WCRC), Michigan Department of Transportation (MDOT), and applicable Township Ordinances. MDOT standards and guidelines were referenced where local standards/guidelines are not defined.

Vehicular turning movement counts (TMCs) were collected at the study intersections by Fishbeck subconsultant Gewalt Hamilton Associates (GHA). Data were collected on Tuesday February 14, 2023 during the weekday morning (7 a.m. to 9 a.m.) and afternoon (4 p.m. to 6 p.m.) peak periods. On this day area schools were in session and no adverse weather conditions or incidents occurred that would impact normal traffic volumes. Counts were collected in 15-minute intervals to identify peak hour factors (PHFs) and included heavy vehicle volumes.

Synchro (Version 11) was used to perform operational analyses based on methodology published in the 6th Edition and 2000 Edition of the *Highway Capacity Manual (HCM)* for each of the three alternative routes. Based on the results of this analysis, all intersection movements and approaches currently operate at an acceptable LOS A or B during both peak hours. SimTraffic simulations were also reviewed to observe network operations and vehicle queues. Under existing conditions, no adverse queueing is observed and study network operations are acceptable. Where turn-lane storage is provided, storage lane lengths are adequate and are not exceeded by vehicle queues.

In addition to capacity analyses, historical crash data at the at the six study intersections was reviewed. Crash data were referenced for the most recent five years (January 1, 2018, through December 31, 2022) of available data on the Michigan Traffic Crash Facts (MTCF) website, which references the Michigan State Police database. These data indicate that zero crashes have occurred in the past five years at the following intersections:

1. Horning Road and Hardcastle Road;

2. M-124 and Hardcastle Road; and
3. M-124 and Lawrence Road.

At the intersection of Watkins Road and Horning Road, a single reported crash occurred in the five-year study period. There was also a single crash reported in the most recent five years at the intersection of M-124 and Wellwood Road associated with the slip lane. At the intersection of M-124 and US-12, seven reported crashes occurred in the last five years. Overall, the review of historical crash data indicates no pattern or concentration of crashes subject to countermeasure or that would be exacerbated by the proposed mining operation.

Future traffic volumes were calculated for the year 2026 with and without the future mining operation. A 0.5% annual compounded growth rate was applied to account for ambient traffic growth based on data published by the US Census Bureau and the Southeast Michigan Council of Governments (SEMCOG). Truck traffic volumes in/out of the proposed site were forecast based on operational data provided by Levy. Levy expects to haul 85,000 tons of material per month from the subject site. Operational hours are expected to be from 7:00 a.m. to 5:00 p.m., Monday through Friday. Each truck will carry a capacity of 50 tons. The resultant truck trip generation forecast is equal to 9 inbound and 9 outbound trucks per hour. To facilitate this operation, Levy will have six employees on-site that will arrive in the morning and depart in the afternoon via passenger vehicles.

Future conditions were analyzed using Synchro/SimTraffic including background traffic growth and the forecast site trip generation. Based on the results of the future conditions analysis, all intersection approaches would continue to operate at an acceptable LOS A or B during both peak hours along each of the three alternative haul routes. Operational impacts as a result of the proposed mining operation are negligible as compared to existing and background conditions. SimTraffic simulations were also reviewed to observe network operations and vehicle queues. Under future conditions, no adverse queueing is observed and study network operations are acceptable along each of the potential haul routes.

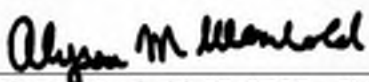
The analyses conducted for this TIS indicate the proposed mining operation will not result in any significant operational impact to the adjacent road network. The proposed site access configuration is appropriate and will acceptably facilitate site ingress and egress. Intersection movements and approaches along all of the potential proposed haul routes will continue to operate acceptably with negligible changes in delay as a result of the expected additional volume of trucks. SimTraffic simulations indicate that under future conditions, no adverse queueing is observed and study network operations are acceptable.

Based on the findings of this study as outlined herein, no off-site improvements are required to mitigate any adverse operational impacts of the proposed project at the study intersections along any of the potential proposed haul routes.

This study evaluated all three alternatives and reached the same conclusion of no significant impact to traffic operations for each alternative route. Levy has concluded that the preferred route among the alternatives studied is the Horning Road and Hardcastle route. This was based on the roadway's current designation as primary roads by JCDOT, the Township's designation of these roadways as truck routes per Norvell Township Ordinance 38, the vertical profiles of the roads (i.e. fewer steep grades), and the length of the route to provide access to a state highway.

The opinions, findings, and conclusions expressed in this TIS are those of Fishbeck and not necessarily those of Varum LLP, Levy, the Michigan Department of Transportation, Jackson County, Washtenaw County, Norvell Township, Manchester Township, or any other agency of jurisdiction.

Prepared By:


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Kyle Reidsma, PE, PTOE
Project Manager – Fishbeck

1.0 Project Overview

1.1 Introduction

Fishbeck has completed a traffic impact study (TIS) for the Edw. C. Levy Co. (Levy). Levy proposes to mine a site on the west side of Watkins Road and on the north and south sides of Horning Road in Norvell Township, Jackson County, Michigan. Mining operations on the currently vacant site are assumed to be active and fully operational in the next five years. For purposes of traffic assessment, this report assumes a start of operations in 2026.

Levy intends to extract raw materials from the site and haul this material to other sites. All truck trips will originate and destinate between the site and US-12, with 80% traveling to/from the east and 20% traveling to/from the west. Levy evaluated three potential fixed haul routes, including:

Haul Route A (Watkins Road):	Watkins Road	↔	Wellwood Road	↔	M-124	↔	US-12
Haul Route B (Hardcastle Road):	Horning Road	↔	Hardcastle Road	↔	M-124	↔	US-12
Haul Route C (Lawrence Road):	Lawrence Road	↔	M-124	↔	US-12		

The study roadways are under multiple jurisdictions. Watkins Road is under the jurisdiction of the Washtenaw County Road Commission (WCRC) north of Cash Road and under the jurisdiction of the Jackson County Department of Transportation (JCDOT) south of Cash Road. Wellwood Road, Horning Road, Hardcastle Road, Lawrence Road, and Wellwood Road are under the jurisdiction of JCDOT. M-124 and US-12 are under the jurisdiction of the Michigan Department of Transportation (MDOT). The project location and proposed haul route alternatives are displayed on Figure 1.

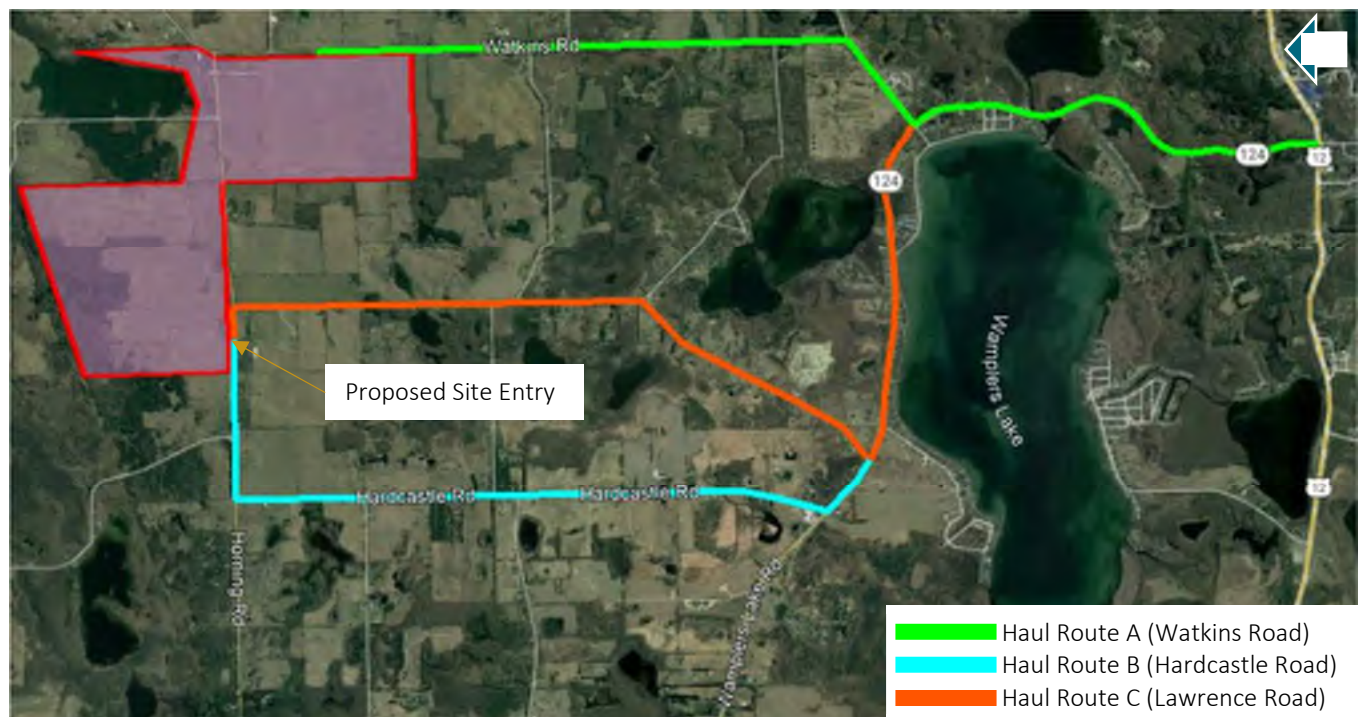


Figure 1 – Project Location and Haul Route Alternatives

1.2 Study Methodology

The objectives of this TIS were to determine what impacts, if any, the proposed project would have on adjacent roadway traffic operations, and to develop recommendations for any improvements necessary to mitigate the project impacts on the studied intersections. Study analyses were completed relative to typical weekday a.m. and p.m. peak periods. Study findings will also aide Levy in determining the most suitable haul route with respect to any operational needs to facilitate the proposed hauling operations.

This study was conducted according to the methodologies and guidance published by the Institute of Transportation Engineers (ITE), JCDOT, WCRC, MDOT, and Township Ordinance, as applicable. MDOT standards and guidelines were referenced where local standards/guidelines are not defined.

1.3 Roadway Characteristics

The characteristics of the roadways segments within the study limits are summarized in Table 1. Sources of referenced data include jurisdiction and truck operator maps published by JCDOT/WCRC/MDOT, MDOT National Functional Classification map, MDOT Transportation Data Management System (TDMS), MDOT Average Annual Daily Traffic (AADT) maps, Southeast Michigan Council of Governments (SEMCOG) traffic volume map, and JCDOT traffic count spreadsheets.

Table 1 – Roadway Characteristics

Roadway	Jurisdiction	Roadway Classification	Load Class	No. of Lanes	Speed Limit (mph)	ADT (vpd)	Commercial ADT (vpd)
US-12	MDOT	Principal Arterial	All-Season	2	55	6,500	500
M-124	MDOT	Major Collector	Seasonal Paved	2	35-55 ¹	2,000	35
Watkins Road (North of Cash Road)	WCRC	Minor Collector	Seasonal Paved	2	55 ²	700	40
Watkins Road (South of Cash Road)	JCDOT						
Wellwood Road	JCDOT	Minor Collector	Seasonal Paved	2	55 ²	900	not reported
Hardcastle Road ³	JCDOT	Minor Collector	Seasonal Paved	2	55 ²	700	not reported
Horning Road ³	JCDOT	Minor Collector	Seasonal Paved	2	55 ²	1,000	not reported
Lawrence Road	JCDOT	Local Road	Seasonal Unpaved	2	55 ²	not reported	

¹ Speed Limit 35 MPH between US-12 and Jackson County Line, 40 MPH between Jackson County Line and Wellwood Road, 50 MPH between Wellwood Road and Wamplers Heights Drive, and 55 MPH from Wamplers Heights Drive to the west.

² No Posted Speed Limit. Prima Facie 55 MPH.

³ Roadway signed as "Truck Route".

1.4 Study Intersections

The proposed potential haul routes were reviewed to determine the intersections to be included in the study analysis. There are five intersections along the proposed haul route alternatives where truck turning movements will occur, including:

1. Horning Road and Hardcastle Road;
2. Watkins Road and Horning Road;
3. M-124 and Hardcastle Road;
4. M-124 and Lawrence Road;

5. M-124 and Wellwood Road; and
6. M-124 and US-12.

The intersection of Watkins Road and Horning Road is not expected to carry truck traffic to/from the site for any of the three alternative routes; however, employees may pass through this intersection and was therefore included in the study analyses. The intersection of Watkins Road and Wellwood Road is free-flow along the proposed haul route; therefore, this intersection is not included in the study scope. Traffic controls and turn lane configurations at each of the study intersections are outlined in Table 2.

Table 2 – Intersection Characteristics

Intersection		Control	Turn Lane Configurations			
			NB	SB	EB	WB
Horning Road and Hardcastle Road	Main Intersection	NB Stop	Right Turn Slip Lane	-	No Turn Lanes Present	Left Turn Slip Lane
	Hardcastle Road and Slip Lane	SB Yield				
	Horning Road and Slip Lane	EB Stop				
Watkins Road and Horning Road		EB Stop	No Turn Lanes Present			-
M-124 and Hardcastle Road		SB Stop	-	No Turn Lanes Present		
M-124 and Lawrence Road		SB Stop	-	No Turn Lanes Present		
M-124 and Wellwood Road	Main Intersection	NB/SB Stop	No Turn Lanes Present	Right Turn Slip Lane	Left Turn Slip Lane	No Turn Lanes Present
	M-124 and Slip Lane	SB Stop				
	Wellwood Road and Slip Lane	EB Yield				
M-124 and US-12		NB/SB Stop	No Turn Lanes Present			Right Turn Lane

1.5 Multimodal Characteristics

The primary transportation system user in the study area is vehicular traffic and the primary user of the proposed site is truck traffic. Accordingly, this study focuses on the potential impacts to the vehicle transportation network. M-124 has paved shoulders that are approximately 8-10' wide. These shoulders are designated as a "Bike Route" with signs and pavement markings. There are no other non-motorized trails, pathways, or sidewalks along the proposed potential haul routes. Additionally, there are no fixed-route transit facilities within the study area.

2.0 Existing Conditions Analysis

2.1 Existing Traffic Volumes

Vehicular turning movement counts (TMCs) were collected at the study intersections by Fishbeck subconsultant Gewalt Hamilton Associates (GHA). Data were collected on Tuesday February 14, 2023, during the weekday morning (7:00 to 9:00 a.m.) and afternoon (4:00 to 6:00 p.m.) peak periods. On this day area schools were in session and no adverse weather conditions or incidents occurred that would impact normal traffic volumes. Counts were collected in 15-minute intervals to identify peak hour factors (PHFs) and included heavy vehicle volumes. Traffic volume data is provided in Appendix 1.

2.2 Traffic Operations Analysis Methodology

Synchro (Version 11) was used to perform operational analyses based on methodology published in the 6th Edition of the *Highway Capacity Manual (HCM6)*. For two of the study intersections, the existing slip lane and traffic control configurations are not included in HCM6 methodologies. Therefore, HCM 2000 and SimTraffic results were referenced for these two locations. Analyses were conducted during the a.m. and p.m. peak hours for all intersections within this study.

According to the most recent editions of the HCM, Level of Service (LOS) is a qualitative measure describing operational conditions of a traffic stream or intersection. LOS ranges from A to F, with LOS A representing desirable traffic operations characterized by low delay and LOS F representing extremely poor traffic operations characterized by excessive delays and long vehicle queues. LOS D is generally considered acceptable for most areas. Table 3 presents the HCM criteria for various LOS for unsignalized and signalized intersections. The color coding in the table is used in the capacity analysis summary tables later in this report, where applicable.

Table 3 – LOS Criteria

LOS	Average Stopped Vehicle Delay (seconds)	
	Unsignalized	Signalized
A	≤ 10	≤ 10
B	> 10 and ≤ 15	> 10 and ≤ 20
C	> 15 and ≤ 25	> 20 and ≤ 35
D	> 25 and ≤ 35	> 35 and ≤ 55
E	> 35 and ≤ 50	> 55 and ≤ 80
F	> 50	> 80

2.3 Existing Conditions Traffic Analysis

Synchro models for the existing network were created according to the MDOT *Electronic Traffic Control Device Guidelines, 2021*. Existing conditions models reflect current roadway configurations and traffic controls determined based on field observations and desktop review of aerial imagery including Google Earth street view.

Peak hour volumes across the study network typically occurred between 7:15 to 8:15 a.m. and 4:30 to 5:30 p.m. Conservatively, the peak hour volumes specific to each intersection were modeled. Heavy vehicle volumes and PHFs are typically modeled by approach; however, both were modeled by movement for this study to more specifically analyze the impacts of new truck turning movements at each intersection.

The intersection of Horning Road and Hardcastle Road includes a slip lane that allows traffic from NB Hardcastle Road to EB Horning Road (NB right turn) and traffic from WB Horning Road to SB Hardcastle Road (WB left turn) to by-pass the main intersection. The NB Hardcastle Road to EB Horning Road movement does not need to stop to continue onto Horning Road; whereas EB Horning Road is required to stop at the slip lane. The WB Horning Road to SB Hardcastle Road movement does not need to stop to continue onto Hardcastle Road; whereas SB Hardcastle Road is required to yield. HCM 6th Edition and 2000 methodologies cannot evaluate the slip lane on Hardcastle Road due to the intersection sign configuration layout, therefore, delays were calculated from SimTraffic.

The intersection of M-124 and Wellwood Road includes a slip lane that allows traffic from SB Wellwood Road to WB M-124 (SB right turn) and traffic from EB M-124 to NB Wellwood Road (EB left turn) to by-pass the main intersection. The SB Wellwood Road to WB M-124 movement is required to stop before continuing onto M-124. The EB M-124 to NB Wellwood Road movement is required to yield before continuing onto Wellwood Road. HCM 6th Edition methodologies cannot evaluate the slip lane on Wellwood Road due to the yield condition; therefore, HCM 2000 methodologies were used.

The resulting LOS and delay for the existing conditions are provided in Table 4. For all stop-controlled intersections results are reported for movements that must stop or yield to oncoming traffic.

Table 4 – LOS Analysis for Existing Conditions

Approach	Lane Group	LOS/Delay(s)	
		a.m. Peak Hour	p.m. Peak Hour
Horning Road and Hardcastle Road (minor stop-controlled)			
EB Horning Road	Thru/Right	Free movement	
WB Horning Road	Thru	Free movement	
NB Hardcastle Road	Left	A 0.0	A 9.0
Overall		A 0.0	A 0.9
WB Slip Lane	Left	Free movement	
NB Hardcastle Road at Slip Lane	Thru/Right	Free movement	
SB Hardcastle Road at Slip Lane	Thru	A 0.0	A 0.2
Overall		A 2.0	A 0.7
EB Horning Road at Slip Lane	Thru	A 0.0	A 0.0
WB Horning Road at Slip Lane	Left/Thru	Free movement	
NB Slip Lane	Right	Free movement	
Overall		A 0.0	A 0.0
Watkins Road and Horning Road (minor stop-controlled)			
EB Horning Road	Left/Right	A 8.8	A 8.9
NB Watkins Road	Left	A 7.2	A 7.4
	Thru	Free movement	
SB Watkins Road	Thru/Right	Free movement	
Overall		A 4.3	A 2.0
M-124 and Hardcastle Road (minor stop-controlled)			
EB M-124	Left	A 7.3	A 7.4
	Thru	Free movement	
WB M-124	Thru/Right	Free movement	
SB Hardcastle Road	Left/Right	A 8.8	A 9.0
Overall		A 2.1	A 1.4
M-124 and Lawrence Road (minor stop-controlled)			
EB M-124	Left	A 7.3	A 7.4
	Thru	Free movement	
WB M-124	Thru/Right	Free movement	
SB Lawrence Road	Left/Right	A 8.8	A 8.9
Overall		A 1.5	A 0.8
M-124 and Wellwood Road (minor stop-controlled)			
EB M-124	Thru/Right	Free movement	
WB M-124	Left	A 0.0	A 7.3
	Thru/Right	Free movement	
NB Wellwood Road	Left/Thru/Right	A 9.0	A 8.9
SB Wellwood Road	Left/Thru	A 9.2	A 9.5
Overall		A 1.2	A 2.2
EB M-124 at Slip Lane	Left	A 7.3	A 7.3
	Thru	Free movement	

Table 4 – LOS Analysis for Existing Conditions

Approach	Lane Group	LOS/Delay(s)	
		a.m. Peak Hour	p.m. Peak Hour
WB M-124 at Slip Lane	Thru	Free movement	
SB Slip Lane	Right	A 8.7	A 8.6
Overall		A 1.7	A 1.8
EB Slip Lane	Left	A 8.8	A 8.9
NB Wellwood Road at Slip Lane	Thru	A 0.0	A 0.0
SB Wellwood Road at Slip Lane	Thru/Right	Free movement	
Overall		A 1.3	A 1.3
US-12 and M-124/Boardman Drive (minor stop-controlled)			
EB US-12	Left	A 7.4	A 7.9
	Thru/Right	Free movement	
WB US-12	Left	A 0.0	A 7.6
	Thru/Right	Free movement	
NB Boardman Drive	Left/Thru/Right	B 10.7	B 12.1
SB M-124	Left/Thru/Right	B 11.6	B 12.4
Overall		A 2.5	A 2.4

Based on the results of this analysis, all movements, approaches, and intersections are expected to operate at an acceptable LOS A or B during both the a.m. and p.m. peak hours.

SimTraffic simulations were also reviewed to observe network operations and vehicle queues. Under existing conditions, study network operations are acceptable, with little to no vehicle queues at any of the study intersections and no spill-back from available storage lanes. No 95th percentile queue lengths for the turning movements exceed the provided storage lengths (where storage is provided). No 95th percentile queue length exceeds 41' (2 vehicles) during the a.m. or p.m. peak hours. Existing conditions output reports from Synchro/SimTraffic are included in Appendix 2.

2.4 Existing Conditions Improvements

No roadway or intersection improvements are required to mitigate any failing traffic operations based on the existing conditions analysis described above.

2.5 Crash Analysis

In addition to capacity analyses, historical crash data at the at the six study intersections was reviewed. Crash data were referenced for the most recent five years (January 1, 2018, through December 31, 2022) of available data on the Michigan Traffic Crash Facts (MTCF) website, which references the Michigan State Police database. Crash data including UD-10 crash reports cited below are provided in Appendix 3. These data indicate that zero crashes have occurred in the past five years at the following intersections:

4. Horning Road and Hardcastle Road;
5. M-124 and Hardcastle Road; and
6. M-124 and Lawrence Road.

At the intersection of Watkins Road and Horning Road, a single reported crash occurred in the five-year study period. This crash involved an EB driver falling asleep and driving through the T-intersection. The driver was cited for careless driving and the crash resulted in property damage only (PDO).

There was a single reported crash in the most recent five years at the intersection of M-124 and Wellwood Road associated with the slip lane. This crash was classified as a head-on left-turn crash with a serious injury (Level-A). A vehicle was EB on M-124, attempted to turn left onto NB Wellwood Road, and struck a motorcyclist who was driving WB on M-124. The motorcyclist had the right of way.

At the intersection of M-124 and US-12, seven reported crashes occurred in the last five years. Four of these crashes resulted in B-level minor injury and three resulted in PDO. The seven total crashes include one head-on left-turn, two rear-end, one sideswipe (opposite direction), and three coded as “other.” The two rear-end crashes involved EB left-turns from US-12 to M-124 being struck from behind while yielding to opposing WB traffic. One of these crashes resulted in B-level minor injury. The five remaining crashes all involved a vehicle departing from a stop-controlled approach (M-124 or the opposing Boardman Drive). Four of the five at-fault drivers were cited for failure to yield, and the fifth fled the scene. These five crashes involved vehicles on each of the four intersection approaches; whereby there is no pattern that would indicate inadequate sight distance or other influence that would restrict a driver’s ability to perceive and yield appropriately to conflicting traffic.

As M-124 is signed and marked as a bicycle route, crashes involving bicycles within the study area were reviewed. MTCF indicates that zero bicycle-vehicle crashes have occurred on the study roadways in the most recent five years. There is also “Watch for Pedestrians” warning signage on US-12 in the vicinity of M-124; therefore, crashes involving pedestrians were also reviewed. MTCF indicates that zero pedestrian-vehicle crashes have occurred on the study roadways in the most recent five years. The only two pedestrian/bicycle crashes reported in the vicinity of the study area occurred within the residential neighborhood along the channel between Wamplers Lake and Iron Lake in Cambridge Township.

Overall, the review of historical crash data indicates no pattern or concentration of crashes subject to countermeasure or that would be exacerbated by the proposed mining operation.

3.0 Future Conditions Analysis

3.1 Background Traffic Volumes

Future background traffic volumes were calculated for the year 2026 without the proposed mining operation. Data published by the US Census Bureau indicates that the population of Norvell Township decreased at a rate of 0.5% per year between 2010 and 2020. Data published by SEMCOG indicate that the population of Manchester Township increased at a rate of 0.4% per year between 2010 and 2020. Additionally, review of historical traffic volume data published by MDOT/SEMCOG indicate that study area traffic volumes have grown at a rate of approximately 0.4% per year since 2010. Typically, a growth rate of 0.5% per year is considered appropriate in these areas of Jackson and Washtenaw Counties. Therefore, a 0.5% annual compounded growth rate was applied to the existing 2023 traffic volumes to establish the future traffic volumes in 2026 when the site is expected to be fully operational.

Operational impacts at the study intersections as a result of this background traffic growth are negligible as compared to the results outlined in Table 4. Background conditions output reports from Synchro/SimTraffic are included in Appendix 4.

3.2 Trip Generation Forecast

Truck traffic volumes in/out of the proposed site were forecast based on operational data provided by Levy. Levy expects to haul a maximum of 85,000 tons of raw material per month from the subject site. Trucks are expected to arrive at the site empty and depart with a full material load. Operational hours are expected to be from 7:00 a.m. to 5:00 p.m., Monday through Friday. Each truck will carry a capacity of 50 tons. Truck trip generation can

therefore be estimated by calculating the number of trucks required to haul 85,000 tons of material per month and distribute those trucks over the number of working days and hours in a typical month.

The resultant truck trip generation forecast is shown in Table 5. Based on this information, a maximum of 9 trucks per hour will be assumed for this study. To facilitate this operation, Levy will have six employees on-site that will arrive in the morning and depart in the afternoon via passenger vehicle.

Table 5 – Site Trip Generation

Tons per Month	Tons per Truck	Trucks per Month	Working Days per Month	Trucks per Day
85,000	50	1,700	19 to 23	74 to 90
			Working Hours per Day	Trucks per Hour
			10	8 to 9

3.3 Trip Distribution

All trucks are expected to travel to/from the site via US-12. Truck trips were therefore assigned to each of the three haul route alternatives between the site and US-12. Based on information provided by Levy, 80% of truck traffic is expected to travel to/from the east on US-12, with 20% travelling to/from the west on US-12. The maximum expected operation of 9 trucks was assigned to enter and exit the site each peak hour. Truck turning movements at each intersection along the three haul route alternatives were added to the background 2026 traffic volumes. Heavy vehicle percentages for these movements were also adjusted proportionally. Six employees were assumed to enter the site in passenger vehicles in the morning and exit in the afternoon. Directionality of employee trips was based on the proportion of trips on the study network.

3.4 Turn Lane Analysis

An evaluation was performed in accordance with the MDOT *Geometric Design Guidance (2017)* to determine if auxiliary turn lanes are recommended at the site driveway for any of the three proposed haul routes. The results of the analysis indicate that the volume of traffic on each haul route and volume forecast to use this driveway do not exceed the thresholds to recommend a left turn lane, left turn passing flare right-turn lane, or right turn taper. All turn lane charts are provided in Appendix 5.

3.5 Future Conditions Traffic Analysis

The Synchro traffic analysis models were updated to reflect the site trip generation forecast, trip distribution, and turn lane requirements (none) outlined above. These models reflect expected intersection operations in 2026 when the site is fully operational for each of the three alternative haul routes. The resulting LOS and delay calculations are shown in Tables 6 and 7 for the respective a.m. and p.m. peak hours.

Table 6 – LOS Analysis for Future Conditions – a.m. Peak Hour

Approach	Lane Group	LOS/Delay(s)					
		Haul Route A (Watkins Road)		Haul Route B (Hardcastle Road)		Haul Route C (Lawrence Road)	
Horning Road and Hardcastle Road (minor stop-controlled)							
EB Horning Road	Thru/Right	Free movement					
WB Horning Road	Thru	Free movement					
NB Hardcastle Road	Left	A	0.0	A	0.0	A	0.0
Overall		A	0.0	A	0.0	A	0.0
WB Slip Lane	Left	Free movement					
NB Hardcastle Road at Slip Lane	Thru/Right	Free movement					
SB Hardcastle Road at Slip Lane	Thru	A	0.0	A	0.0	A	0.0

Table 6 – LOS Analysis for Future Conditions – a.m. Peak Hour

Approach	Lane Group	LOS/Delay(s)					
		Haul Route A (Watkins Road)		Haul Route B (Hardcastle Road)		Haul Route C (Lawrence Road)	
Overall		A	2.0	A	2.0	A	2.2
EB Horning Road at Slip Lane	Thru	A	0.0	A	0.0	A	0.0
WB Horning Road at Slip Lane	Left/Thru	Free movement					
NB Slip Lane	Right	Free movement					
Overall		A	0.0	A	0.0	A	0.0
Watkins Road and Horning Road (minor stop-controlled)							
EB Horning Road	Left/Right	A	8.9	A	8.9	A	8.9
NB Watkins Road	Left	A	7.2	A	7.3	A	7.2
	Thru	Free movement					
SB Watkins Road	Thru/Right	Free movement					
Overall		A	4.3	A	4.5	A	4.3
M-124 and Hardcastle Road (minor stop-controlled)							
EB M-124	Left	A	7.3	A	7.4	A	7.3
	Thru	Free movement					
WB M-124	Thru/Right	Free movement					
SB Hardcastle Road	Left/Right	A	8.9	A	9.5	A	8.9
Overall		A	2.1	A	2.8	A	2.1
M-124 and Lawrence Road (minor stop-controlled)							
EB M-124	Left	A	7.3	A	7.4	A	7.4
	Thru	Free movement					
WB M-124	Thru/Right	Free movement					
SB Lawrence Road	Left/Right	A	8.9	A	9.0	A	9.9
Overall		A	1.5	A	1.3	A	2.1
M-124 and Wellwood Road (minor stop-controlled)							
EB M-124	Thru/Right	Free movement					
WB M-124	Left	A	0.0	A	0.0	A	0.0
	Thru/Right	Free movement					
NB Wellwood Road	Left/Thru/Right	A	9.0	A	9.1	A	9.1
SB Wellwood Road	Left/Thru	B	10.0	A	9.4	A	9.4
Overall		A	1.9	A	1.0	A	1.0
EB M-124 at Slip Lane	Left	A	7.3	A	7.5	A	7.4
	Thru	Free movement					
WB M-124 at Slip Lane	Thru	Free movement					
SB Slip Lane	Right	A	8.7	A	8.8	A	8.8
Overall		A	1.8	A	1.5	A	1.4
EB Slip Lane	Left	A	9.0	A	8.8	A	8.8
NB Wellwood Road at Slip Lane	Thru	A	0.0	A	0.0	A	0.0
SB Wellwood Road at Slip Lane	Thru/Right	Free movement					
Overall		A	1.0	A	1.2	A	1.3
US-12 and M-124/Boardman Drive (minor stop-controlled)							
EB US-12	Left	A	7.6	A	7.6	A	7.6

Table 6 – LOS Analysis for Future Conditions – a.m. Peak Hour

Approach	Lane Group	LOS/Delay(s)					
		Haul Route A (Watkins Road)		Haul Route B (Hardcastle Road)		Haul Route C (Lawrence Road)	
	Thru/Right	Free movement					
WB US-12	Left	A	0.0	A	0.0	A	0.0
	Thru/Right	Free movement					
	Overall	A	0.0	A	0.0	A	0.0
NB Boardman Drive	Left/Thru/Right	B	10.9	B	10.9	B	10.9
SB M-124	Left/Thru/Right	B	12.3	B	12.3	B	12.3
Overall		A	2.8	A	2.8	A	2.8
Watkins Road and Site Driveway (minor stop-controlled)							
EB Site Driveway	Left/Right	A	9.3				
NB Watkins Road	Left	A	7.8				
	Thru	Free movement					
SB Watkins Road	Thru/Right	Free movement					
Overall		A	3.6				
Horning Road and Site Driveway (minor stop-controlled)							
EB Horning Road	Thru/Right			Free movement			
WB Horning Road	Left			A 7.3			
	Thru			Free movement			
NB Site Driveway	Left/Right			A 9.9			
Overall				A 1.9			
Lawrence Road and Site Driveway (minor stop-controlled)							
WB Site Driveway	Left/Right					A 9.7	
NB Lawrence Road	Thru/Right					Free movement	
SB Lawrence Road	Left					A 7.3	
	Thru					Free movement	
Overall						A 1.8	

Table 7 – LOS Analysis for Future Conditions – p.m. Peak Hour

Approach	Lane Group	LOS/Delay(s)					
		Haul Route A (Watkins Road)		Haul Route B (Hardcastle Road)		Haul Route C (Lawrence Road)	
Horning Road and Hardcastle Road (minor stop-controlled)							
EB Horning Road	Thru/Right	Free movement					
WB Horning Road	Thru	Free movement					
NB Hardcastle Road	Left	A	9.0	A	9.0	A	9.0
Overall		A	0.9	A	0.9	A	0.9
WB Slip Lane	Left	Free movement					
NB Hardcastle Road at Slip Lane	Thru/Right	Free movement					
SB Hardcastle Road at Slip Lane	Thru	A	0.1	A	0.2	A	0.2
Overall		A	0.5	A	0.9	A	0.5
EB Horning Road at Slip Lane	Thru	A	0.0	A	0.0	A	0.0
WB Horning Road at Slip Lane	Left/Thru	Free movement					

Table 7 – LOS Analysis for Future Conditions – p.m. Peak Hour

Approach	Lane Group	LOS/Delay(s)			
		Haul Route A (Watkins Road)		Haul Route B (Hardcastle Road)	Haul Route C (Lawrence Road)
NB Slip Lane	Right	Free movement			
Overall		A	0.0	A	0.0
Watkins Road and Horning Road (minor stop-controlled)					
EB Horning Road	Left/Right	A	8.9	A	8.9
NB Watkins Road	Left	A	7.4	A	7.4
	Thru	Free movement			
SB Watkins Road	Thru/Right	Free movement			
Overall		A	1.9	A	2.1
M-124 and Hardcastle Road (minor stop-controlled)					
EB M-124	Left	A	7.4	A	7.4
	Thru	Free movement			
WB M-124	Thru/Right	Free movement			
SB Hardcastle Road	Left/Right	A	9.0	A	9.9
Overall		A	1.4	A	2.1
M-124 and Lawrence Road (minor stop-controlled)					
EB M-124	Left	A	7.4	A	7.4
	Thru	Free movement			
WB M-124	Thru/Right	Free movement			
SB Lawrence Road	Left/Right	A	8.9	A	9.0
Overall		A	0.8	A	0.7
M-124 and Wellwood Road (minor stop-controlled)					
EB M-124	Thru/Right	Free movement			
WB M-124	Left	A	7.3	A	7.3
	Thru/Right	Free movement			
NB Wellwood Road	Left/Thru/Right	A	8.9	A	9.0
SB Wellwood Road	Left/Thru	B	10.1	A	9.7
Overall		A	1.9	A	1.0
EB M-124 at Slip Lane	Left	A	7.3	A	7.4
	Thru	Free movement			
WB M-124 at Slip Lane	Thru	Free movement			
SB Slip Lane	Right	A	8.6	A	8.7
Overall		A	1.9	A	1.6
EB Slip Lane	Left	A	9.1	A	8.9
NB Wellwood Road at Slip Lane	Thru	A	0.0	A	0.0
SB Wellwood Road at Slip Lane	Thru/Right	Free movement			
Overall		A	0.9	A	1.3
US-12 and M-124/Boardman Drive (minor stop-controlled)					
EB US-12	Left	A	8.1	A	8.1
	Thru/Right	Free movement			
WB US-12	Left	A	7.6	A	7.6
	Thru/Right	Free movement			

Table 7 – LOS Analysis for Future Conditions – p.m. Peak Hour

Approach	Lane Group	LOS/Delay(s)					
		Haul Route A (Watkins Road)		Haul Route B (Hardcastle Road)		Haul Route C (Lawrence Road)	
NB Boardman Drive	Left/Thru/Right	B	12.3	B	12.3	B	12.3
SB M-124	Left/Thru/Right	B	13.3	B	13.3	B	13.3
Overall		A	2.9	A	2.9	A	2.9
Watkins Road and Site Driveway (minor stop-controlled)							
EB Site Driveway	Left/Right	A	9.1				
NB Watkins Road	Left	A	8.3				
	Thru	Free movement					
SB Watkins Road	Thru/Right	Free movement					
Overall		A	2.8				
Horning Road and Site Driveway (minor stop-controlled)							
EB Horning Road	Thru/Right			Free movement			
WB Horning Road	Left			A 0.0			
	Thru			Free movement			
NB Site Driveway	Left/Right			A 9.5			
Overall				A 1.6			
Lawrence Road and Site Driveway (minor stop-controlled)							
WB Site Driveway	Left/Right					A 9.3	
NB Lawrence Road	Thru/Right					Free movement	
SB Lawrence Road	Left					A 0.0	
	Thru					Free movement	
Overall						A 2.8	

Based on the results of this future conditions analysis, all movements, approaches, and intersections are expected to continue to operate at an acceptable LOS A or B during both the a.m. and p.m. peak hours. Operational impacts as a result of the proposed mining operation are negligible as compared to existing and background conditions.

SimTraffic simulations were also reviewed to observe network operations and vehicle queues. Under future conditions, study network operations are acceptable, with little to no vehicle queues at any of the study intersections and no spill-back from available storage lengths (where storage is provided). No 95th percentile queue lengths for the turning movements exceed the provided storage length. Simulated future operations are similar to existing conditions; therefore, truck traffic associated with the proposed mining operation would not have a significant impact on queuing at any of the study intersections.

For Haul Route A (Watkins Road), the 95th percentile queue length on the site driveway would be 64' during the a.m. peak hour and 70' during the p.m. peak hour. For Haul Route B (Hardcastle Road), the 95th percentile queue length on the site driveway would be 51' during the a.m. peak hour and 64' during the p.m. peak hour. For Haul Route C, the 95th percentile queue length on the site driveway would be 56' during the a.m. peak hour and 55' during the p.m. peak hour. These queue lengths correspond to a single truck, and stacking of trucks at the site driveway is not expected during either peak hour for any of the three haul route alternatives. See Appendix 6 for the future conditions LOS and queueing analysis reports.

4.0 Findings and Recommendations

The analyses conducted for this TIS indicate the proposed mining operation will not result in any significant operational impacts to the adjacent road network, regardless of which of the three studied routes is used. The proposed site access configuration for either of the three alternatives is appropriate and will acceptably facilitate site ingress and egress. Intersection approaches along all of the potential proposed haul routes will continue to operate acceptably with negligible changes in delay as a result of the expected additional volume of trucks. SimTraffic simulations indicate that under future conditions, no adverse queueing is observed, and study network operations are acceptable. Review of historical crash data indicates no pattern or concentration of crashes subject to countermeasure or that would be exacerbated by the proposed mining operation.

Based on the findings of this study as outlined herein, no off-site improvements are required to mitigate any adverse operational impacts of the proposed project at the study intersections along any of the potential proposed haul routes.

This study evaluated three alternative routes to haul aggregates from the proposed site and the nearest state highways and reached the same conclusion of no significant impact to traffic operations for each studied route. Levy has concluded that the preferred route among the alternatives studied is the Horning Road and Hardcastle route. This was based on the roadway's current designation as primary roads by JCDOT, the Township's designation of these roadways as truck routes per Norvell Township Ordinance 38, and the vertical profiles of the roads (i.e. fewer steep grades) which increases road safety and reduces the noise impact of the trucks. The preferred route is the shortest distance between the proposed site entrance and the state highway.

Appendix 1

Traffic Volume Data

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#10/11/12 - Horning Road and Hardcastle Road	a.m. Peak Hour 02/14/23 7:00 - 8:00 AM		PHF		0.60	0.60	0.63	0.60		0.60		0.82			
			% Heavy		0%	0%	0%	0%		0%		4%			
		2023	Existing		8	0	5	2		0		23			
		2023	Existing Adj.		8	0	5	2		0		23			
		2026	Background		8	0	5	2		0		23			
			Truck Site Gen												
			% Heavy		0%	0%	0%	0%		0%		4%			
			Employees												
			Total Future		8	0	5	2		0		23			
			Truck Site Gen				9					9			
			% Heavy		0%	0%	64%	0%		0%		30%			
			Employees									1			
			Total Future		8	0	14	2		0		33			
			Truck Site Gen												
			% Heavy		0%	0%	0%	0%		0%		4%			
			Employees												
			Total Future		8	0	5	2		0		23			

Count Date:	2/14/2023
Count Year:	2023
Existing Adj. Year:	2023
Existing Adjustment Rate:	1.00
Growth Rate:	0.5%
Buildout Year:	2026
Scenario:	a.m. Peak Hour

Haul Route A: Watkins Road
Haul Route B: Hardcastle Road
Haul Route C: Lawrence Road

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#20 - Horning Road and Watkins Road	a.m. Peak Hour 02/14/23 7:30 - 8:30 AM		PHF	0.66		0.60				0.60	0.81			0.75	0.60
			% Heavy	0%		100%				0%	0%			11%	0%
		2023	Existing	21		1				2	13			9	5
		2023	Existing Adj.	21		1				2	13			9	5
		2026	Background	21		1				2	13			9	5
			Truck Site Gen												
			% Heavy	0%		100%				0%	0%			10%	0%
			Employees											1	
			Total Future	21		1				2	13			10	5
			Truck Site Gen												
			% Heavy	0%		100%				0%	0%			11%	0%
			Employees							4				1	
			Total Future	21		1				6	13			9	6
			Truck Site Gen												
			% Heavy	0%		100%				0%	0%			11%	0%
			Employees											1	
			Total Future	21		1				2	13			9	6

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#30 - M-124 and Hardcastle Road	a.m. Peak Hour 02/14/23 7:15 - 8:15 AM		PHF	0.60	0.75			0.90	0.60				0.60		0.60
			% Heavy	0%	3%			0%	29%				0%		0%
		2023	Existing	4	30			47	7				6		11
		2023	Existing Adj.	4	30			47	7				6		11
		2026	Background	4	30			48	7				6		11
			Truck Site Gen												
			% Heavy	0%	3%			0%	29%				0%		0%
			Employees		1										
			Total Future	4	31			48	7				6		11
			Truck Site Gen					9					9		
			% Heavy	0%	3%			0%	69%				60%		0%
			Employees		1										
			Total Future	5	30			48	16				15		11
			Truck Site Gen												
			% Heavy	0%	3%			0%	29%				0%		0%
			Employees		1										
			Total Future	4	31			48	7				6		11

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#40 - M-124 and Lawrence Road	a.m. Peak Hour 02/14/23 7:30 - 8:30 AM		PHF	0.60	0.69			0.64	0.60				0.60		0.60
			% Heavy	0%	14%			5%	0%				0%		0%
		2023	Existing	6	36			41	2				3		7
		2023	Existing Adj.	6	36			41	2				3		7
		2026	Background	6	37			42	2				3		7
			Truck Site Gen												
			% Heavy	0%	13%			5%	0%				0%	0%	0%
			Employees		1										
			Total Future	6	38			42	2				3	0	7
			Truck Site Gen		9			9							
			% Heavy	0%	31%			22%	0%				0%	0%	0%
			Employees												
			Total Future	6	46			51	2				3	0	7
			Truck Site Gen					9							
			% Heavy	0%	14%			5%	60%				75%	0%	0%
			Employees		1			4							
			Total Future	7	37			42	15				12	0	7

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#50/51/52 - M-124 and Wellwood Road	a.m. Peak Hour 02/14/23 7:15 - 8:15 AM	2023	PHF	0.60	0.60	0.60	0.60	0.60	0.65	0.60	0.89	0.60	0.60	0.71	0.60
			% Heavy	0%	0%	0%	0%	0%	8%	0%	6%	0%	0%	3%	0%
			Existing	1	1	2	7	0	13	0	32	14	6	40	0
			Existing Adj.	1	1	2	7	0	13	0	32	14	6	40	0
			Background	1	1	2	7	0	13	0	32	14	6	41	0
		2026	Truck Site Gen				9					9			
			% Heavy	0%	0%	0%	56%	0%	8%	0%	6%	33%	0%	2%	0%
			Employees									4	1		
			Total Future	1	1	2	16	0	13	0	32	27	7	41	0
			Truck Site Gen								9			9	
		Haul Route B	% Heavy	0%	0%	0%	0%	0%	8%	0%	27%	0%	0%	20%	0%
			Employees									4			
			Total Future	1	1	2	7	0	13	0	41	18	6	50	0
			Truck Site Gen								9			9	
			% Heavy	0%	0%	0%	0%	0%	8%	0%	24%	0%	0%	20%	0%
		Haul Route C	Employees								4				
			Total Future	1	1	2	7	0	13	0	45	14	6	50	0

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#60 - M-124 and US-12	a.m. Peak Hour 02/14/23 7:00 - 8:00 AM	2023	PHF	0.75	0.94	0.60	0.60	0.90	0.71	0.60	0.60	0.75	0.78	0.60	0.88
			% Heavy	0%	5%	0%	0%	10%	5%	0%	0%	0%	0%	0%	0%
			Existing	18	215	0	0	72	20	3	1	3	47	0	7
			Existing Adj.	18	215	0	0	72	20	3	1	3	47	0	7
			Background	18	218	0	0	73	20	3	1	3	48	0	7
		2026	Truck Site Gen	2					7				7		2
			% Heavy	9%	5%	0%	0%	10%	29%	0%	0%	0%	13%	0%	22%
			Employees	3					1						
			Total Future	23	218	0	0	73	28	3	1	3	55	0	9
			Truck Site Gen	2					7				7		2
		Haul Route B	% Heavy	9%	5%	0%	0%	10%	29%	0%	0%	0%	13%	0%	22%
			Employees	3					1						
			Total Future	23	218	0	0	73	28	3	1	3	55	0	9
			Truck Site Gen	2					7				7		2
			% Heavy	9%	5%	0%	0%	10%	29%	0%	0%	0%	13%	0%	22%
		Haul Route C	Employees	3					1						
			Total Future	23	218	0	0	73	28	3	1	3	55	0	9

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#100 - Watkins Road and Site Driveway	a.m. Peak Hour 02/14/23	2023	PHF								0.78			0.74	
			% Heavy											20%	
			Existing								15			10	
			Existing Adj.								15			10	
			Background								15			10	
		2026	Truck Site Gen			9				9					
			% Heavy	0%		100%				64%	0%			20%	0%
			Employees							5					1
			Total Future	0		9				14	15			10	1

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#200 - Horning Road and Site Driveway	a.m. Peak Hour 02/14/23	2023	PHF		0.66			0.60							
			% Heavy		4%			0%							
			Existing		22			7							
			Existing Adj.		22			7							
			Background		22			7							
		2026	Truck Site Gen			9				9					
			% Heavy		4%	90%	0%	0%		100%		0%			
			Employees			1	5								
			Total Future		22	10	5	7		9		0			

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#300 - Lawrence Road and Site Driveway	a.m. Peak Hour 02/14/23	2023	PHF								0.60			0.60	
			% Heavy								0%			0%	
			Existing								8			10	
			Existing Adj.								8			10	
			Background								8			10	
		2026	Truck Site Gen				9					9			
			% Heavy				100%		0%		0%	64%	0%	0%	
			Employees								5	1			
			Total Future				9		0		8	14	1	10	

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#10/11/12 - Horning Road and Hardcastle Road	p.m. Peak Hour 02/14/23 4:15 - 5:15 PM		PHF		0.83	0.60	0.70	0.65		0.75		0.67			
			% Heavy		0%	0%	0%	0%		33%		0%			
		2023	Existing		10	2	28	13		3		8			
		2023	Existing Adj.		10	2	28	13		3		8			
		2026	Background		10	2	28	13		3		8			
			Truck Site Gen												
			% Heavy		0%	0%	0%	0%		33%		0%			
			Employees												
			Total Future		10	2	28	13		3		8			
			Truck Site Gen				9					9			
			% Heavy		0%	0%	21%	0%		33%		50%			
			Employees				5					1			
			Total Future		10	2	42	13		3		18			
			Truck Site Gen												
			% Heavy		0%	0%	0%	0%		33%		0%			
			Employees												
			Total Future		10	2	28	13		3		8			

Count Date:	2/14/2023
Count Year:	2023
Existing Adj. Year:	2023
Existing Adjustment Rate:	1.00
Growth Rate:	0.5%
Buildout Year:	2026
Scenario:	p.m. Peak Hour

Haul Route A: Watkins Road
Haul Route B: Hardcastle Road
Haul Route C: Lawrence Road

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#20 - Horning Road and Watkins Road	p.m. Peak Hour 02/14/23 4:00 - 5:00 PM		PHF	0.60		0.60				0.60	0.67			0.83	0.75
			% Heavy	0%		0%				0%	0%			0%	0%
		2023	Existing	12		2				2	8			30	33
		2023	Existing Adj.	12		2				2	8			30	33
		2026	Background	12		2				2	8			30	33
			Truck Site Gen												
			% Heavy	0%		0%				0%	0%			0%	0%
			Employees								1				
			Total Future	12		2				2	9			30	33
			Truck Site Gen												
			% Heavy	0%		0%				0%	0%			0%	0%
			Employees	1											
			Total Future	13		2				2	8			30	33
			Truck Site Gen												
			% Heavy	0%		0%				0%	0%			0%	0%
			Employees	1											
			Total Future	13		2				2	8			30	33

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#30 - M-124 and Hardcastle Road	p.m. Peak Hour 02/14/23 4:45 - 5:45 PM		PHF	0.69	0.89			0.81	0.60				0.75		0.60
			% Heavy	0%	0%			1%	0%				0%		0%
		2023	Existing	11	75			71	2				3		10
		2023	Existing Adj.	11	75			71	2				3		10
		2026	Background	11	76			72	2				3		10
			Truck Site Gen												
			% Heavy	0%	0%			1%	0%				0%		0%
			Employees					1							
			Total Future	11	76			73	2				3		10
			Truck Site Gen					9					9		
			% Heavy	0%	0%			1%	82%				56%		0%
			Employees										4		1
			Total Future	11	76			72	11				16		11
			Truck Site Gen												
			% Heavy	0%	0%			1%	0%				0%		0%
			Employees					1							
			Total Future	11	76			73	2				3		10

Intersection	Time period	Year	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
#40 - M-124 and Lawrence Road	p.m. Peak Hour 02/14/23 4:45 - 5:45 PM		PHF	0.60	0.80			0.81	0.60				0.60		0.63
			% Heavy	0%	0%			3%	0%				0%		0%
		2023	Existing	6	70			68	5				1		5
		2023	Existing Adj.	6	70			68	5				1		5
		2026	Background	6	71			69	5				1		5
			Truck Site Gen												
			% Heavy	0%	0%			3%	0%				0%	0%	0%
			Employees					1							
			Total Future	6	71			70	5				1	0	5
			Truck Site Gen		9			9							
			% Heavy	0%	11%			14%	0%				0%	0%	0%
			Employees		4										
			Total Future	6	84			78	5				1	0	5
			Truck Site Gen					9							
			% Heavy	0%	0%			3%	64%				64%	0%	0%
			Employees										4		1
			Total Future	6	71			69	14				14	0	6

Horning Road and Hardcastle Road - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037007, Location: 42.117267, -84.166627



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Horning Eastbound				Horning Westbound				Hardcastle Northbound				
Time	T	R	U	App	L	T	U	App	L	R	U	App	Int
2023-02-14 7:00AM	4	0	0	4	0	2	0	2	0	5	0	5	11
7:15AM	3	0	0	3	1	0	0	1	0	5	0	5	9
7:30AM	0	0	0	0	2	0	0	2	0	7	0	7	9
7:45AM	1	0	0	1	2	0	0	2	0	6	0	6	9
Hourly Total	8	0	0	8	5	2	0	7	0	23	0	23	38
8:00AM	5	0	0	5	2	2	0	4	0	1	0	1	10
8:15AM	2	0	0	2	4	0	0	4	0	2	0	2	8
8:30AM	0	0	0	0	4	1	0	5	0	5	0	5	10
8:45AM	0	0	0	0	2	0	0	2	0	1	0	1	3
Hourly Total	7	0	0	7	12	3	0	15	0	9	0	9	31
4:00PM	2	0	0	2	10	5	0	15	1	2	0	3	20
4:15PM	3	0	0	3	7	2	0	9	1	2	0	3	15
4:30PM	2	0	0	2	6	2	0	8	1	3	0	4	14
4:45PM	3	2	0	5	5	4	0	9	0	1	0	1	15
Hourly Total	10	2	0	12	28	13	0	41	3	8	0	11	64
5:00PM	5	0	0	5	5	4	0	9	0	0	0	0	14
5:15PM	4	0	0	4	1	5	0	6	1	1	0	2	12
5:30PM	2	0	0	2	6	3	0	9	0	1	0	1	12
5:45PM	2	0	0	2	7	5	0	12	0	3	0	3	17
Hourly Total	13	0	0	13	19	17	0	36	1	5	0	6	55
Total	38	2	0	40	64	35	0	99	4	45	0	49	188
% Approach	95.0%	5.0%	0%	-	64.6%	35.4%	0%	-	8.2%	91.8%	0%	-	-
% Total	20.2%	1.1%	0%	21.3%	34.0%	18.6%	0%	52.7%	2.1%	23.9%	0%	26.1%	-
Lights	37	2	0	39	60	35	0	95	3	44	0	47	181
% Lights	97.4%	100%	0%	97.5%	93.8%	100%	0%	96.0%	75.0%	97.8%	0%	95.9%	96.3%
Articulated Trucks	0	0	0	0	1	0	0	1	0	1	0	1	2
% Articulated Trucks	0%	0%	0%	0%	1.6%	0%	0%	1.0%	0%	2.2%	0%	2.0%	1.1%
Buses and Single-Unit Trucks	1	0	0	1	3	0	0	3	1	0	0	1	5
% Buses and Single-Unit Trucks	2.6%	0%	0%	2.5%	4.7%	0%	0%	3.0%	25.0%	0%	0%	2.0%	2.7%

*L: Left, R: Right, T: Thru, U: U-Turn

Horning Road and Hardcastle Road - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

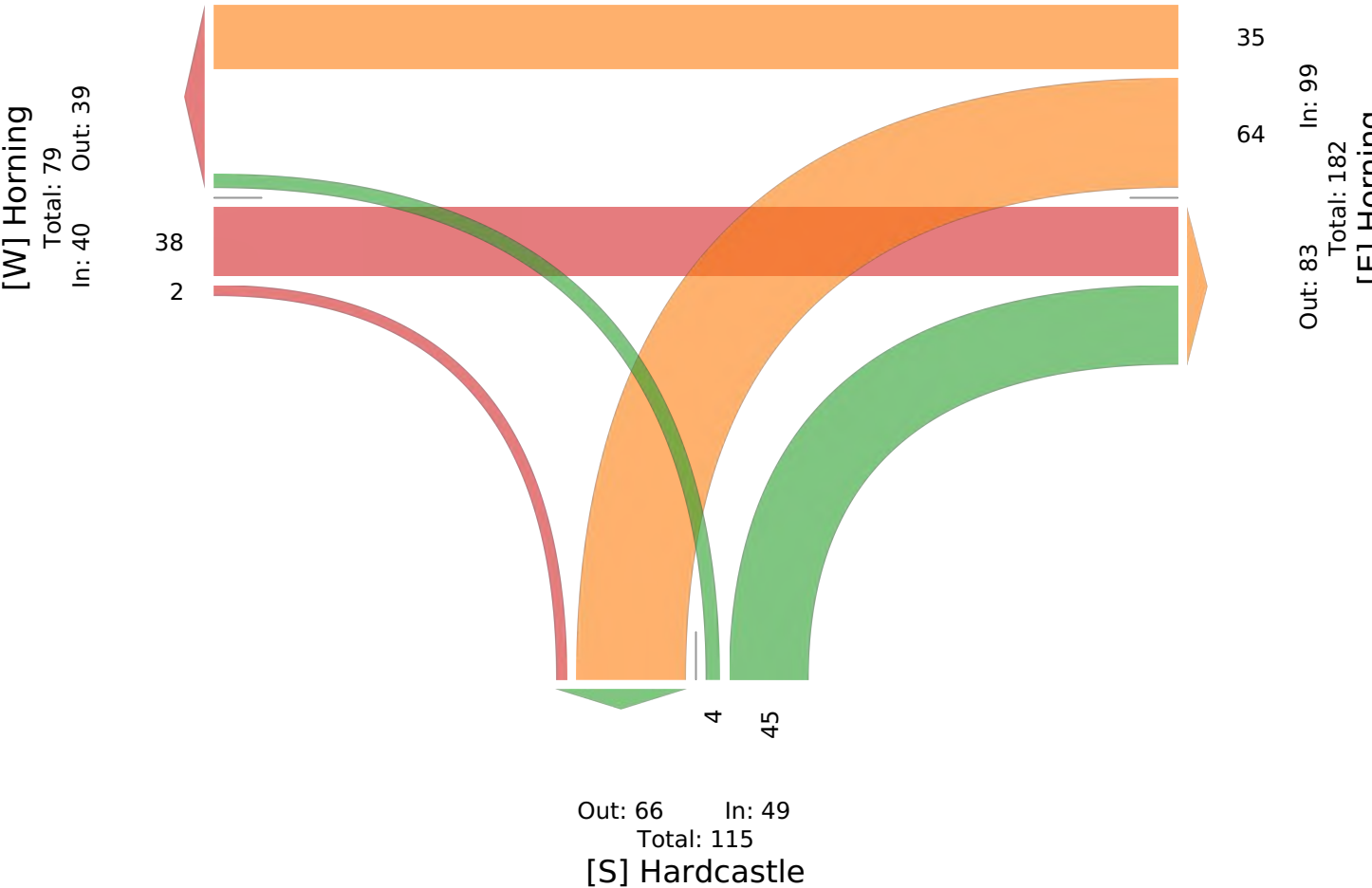
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037007, Location: 42.117267, -84.166627



Provided by: Gewalt Hamilton Associates Inc.
 625 Forest Edge Drive, Vernon Hills, IL, 60061, US



Horning Road and Hardcastle Road - TMC

Tue Feb 14, 2023

AM Peak (7 AM - 8 AM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037007, Location: 42.117267, -84.166627

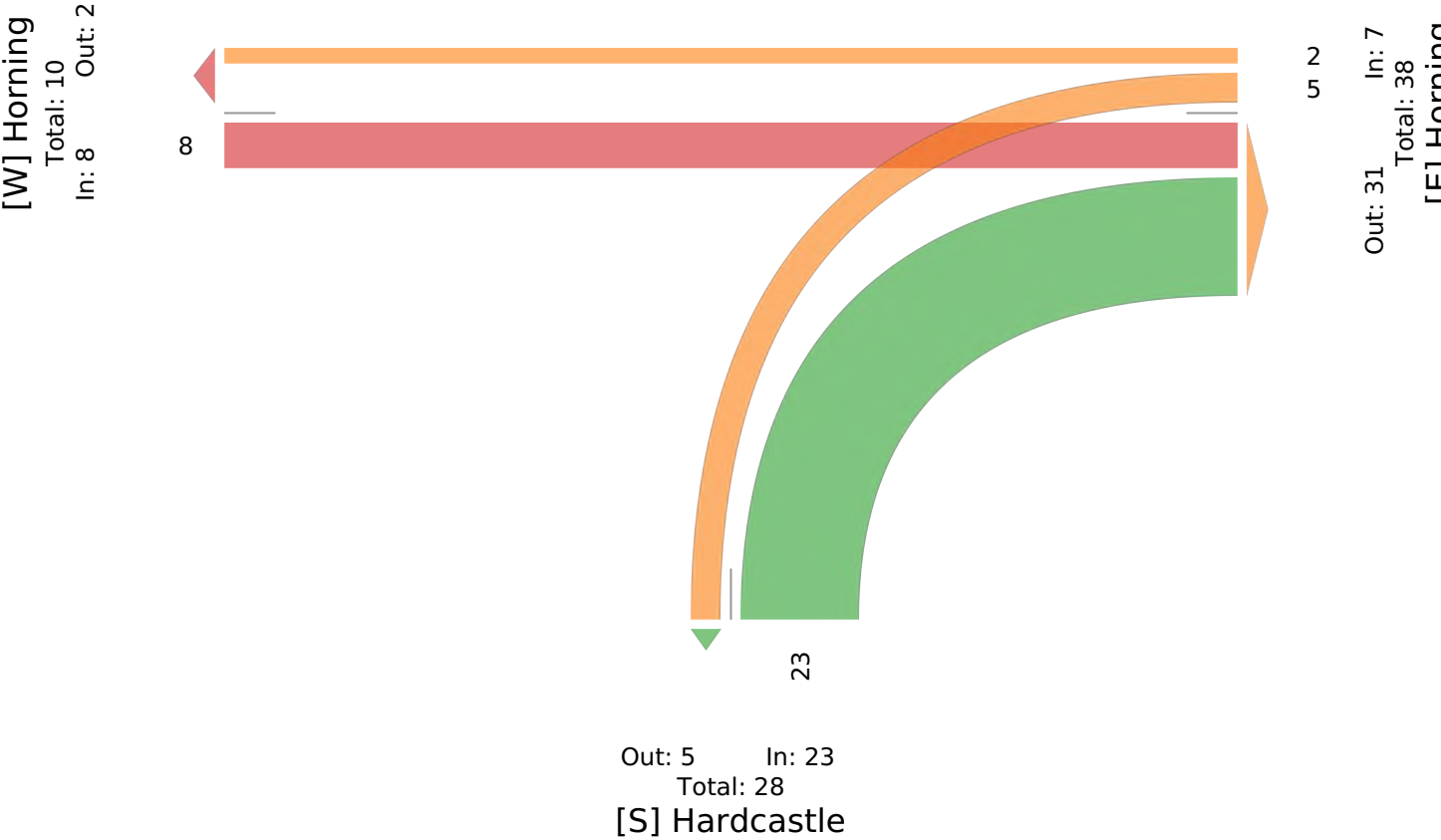


Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Horning Eastbound				Horning Westbound				Hardcastle Northbound				
Time	T	R	U	App	L	T	U	App	L	R	U	App	Int
2023-02-14 7:00AM	4	0	0	4	0	2	0	2	0	5	0	5	11
7:15AM	3	0	0	3	1	0	0	1	0	5	0	5	9
7:30AM	0	0	0	0	2	0	0	2	0	7	0	7	9
7:45AM	1	0	0	1	2	0	0	2	0	6	0	6	9
Total	8	0	0	8	5	2	0	7	0	23	0	23	38
% Approach	100%	0%	0%	-	71.4%	28.6%	0%	-	0%	100%	0%	-	-
% Total	21.1%	0%	0%	21.1%	13.2%	5.3%	0%	18.4%	0%	60.5%	0%	60.5%	-
PHF	0.500	-	-	0.500	0.625	0.250	-	0.875	-	0.821	-	0.821	0.864
Lights	8	0	0	8	5	2	0	7	0	22	0	22	37
% Lights	100%	0%	0%	100%	100%	100%	0%	100%	0%	95.7%	0%	95.7%	97.4%
Articulated Trucks	0	0	0	0	0	0	0	0	0	1	0	1	1
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	4.3%	0%	4.3%	2.6%
Buses and Single-Unit Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

* L: Left, R: Right, T: Thru, U: U-Turn

Horning Road and Hardcastle Road - TMC
 Tue Feb 14, 2023
 AM Peak (7 AM - 8 AM)
 All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
 All Movements
 ID: 1037007, Location: 42.117267, -84.166627



Horning Road and Hardcastle Road - TMC

Tue Feb 14, 2023

PM Peak (4 PM - 5 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037007, Location: 42.117267, -84.166627

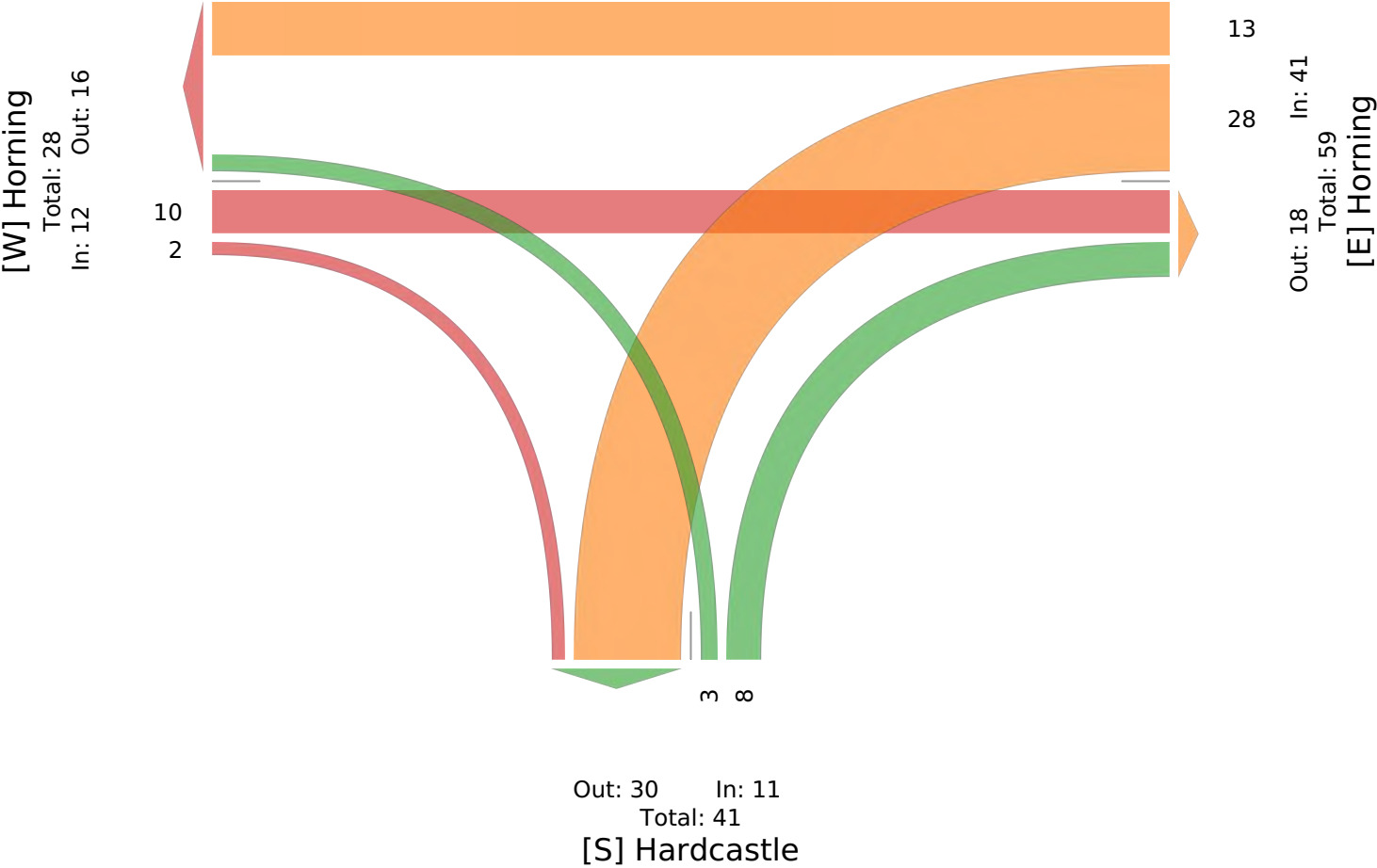


Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Horning Eastbound				Horning Westbound				Hardcastle Northbound				
Time	T	R	U	App	L	T	U	App	L	R	U	App	Int
2023-02-14 4:00PM	2	0	0	2	10	5	0	15	1	2	0	3	20
4:15PM	3	0	0	3	7	2	0	9	1	2	0	3	15
4:30PM	2	0	0	2	6	2	0	8	1	3	0	4	14
4:45PM	3	2	0	5	5	4	0	9	0	1	0	1	15
Total	10	2	0	12	28	13	0	41	3	8	0	11	64
% Approach	83.3%	16.7%	0%	-	68.3%	31.7%	0%	-	27.3%	72.7%	0%	-	-
% Total	15.6%	3.1%	0%	18.8%	43.8%	20.3%	0%	64.1%	4.7%	12.5%	0%	17.2%	-
PHF	0.833	0.250	-	0.600	0.700	0.650	-	0.683	0.750	0.667	-	0.688	0.800
Lights	10	2	0	12	28	13	0	41	2	8	0	10	63
% Lights	100%	100%	0%	100%	100%	100%	0%	100%	66.7%	100%	0%	90.9%	98.4%
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Buses and Single-Unit Trucks	0	0	0	0	0	0	0	0	1	0	0	1	1
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	0%	0%	0%	33.3%	0%	0%	9.1%	1.6%

* L: Left, R: Right, T: Thru, U: U-Turn

Horning Road and Hardcastle Road - TMC
 Tue Feb 14, 2023
 PM Peak (4 PM - 5 PM) - Overall Peak Hour
 All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
 All Movements
 ID: 1037007, Location: 42.117267, -84.166627



Watkins Road and Horning Road - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037008, Location: 42.118582, -84.132931



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Horning Eastbound				Watkins Northbound				Watkins Southbound				
Time	L	R	U	App	L	T	U	App	T	R	U	App	Int
2023-02-14 7:00AM	6	0	0	6	0	4	0	4	1	0	0	1	11
7:15AM	7	0	0	7	1	7	0	8	0	0	0	0	15
7:30AM	8	0	0	8	1	4	0	5	1	0	0	1	14
7:45AM	3	0	0	3	0	2	0	2	3	0	0	3	8
Hourly Total	24	0	0	24	2	17	0	19	5	0	0	5	48
8:00AM	4	0	0	4	1	4	0	5	2	2	0	4	13
8:15AM	6	1	0	7	0	3	0	3	3	3	0	6	16
8:30AM	1	0	0	1	0	1	0	1	0	1	0	1	3
8:45AM	2	0	0	2	0	4	0	4	0	2	0	2	8
Hourly Total	13	1	0	14	1	12	0	13	5	8	0	13	40
4:00PM	1	1	0	2	2	1	0	3	8	7	0	15	20
4:15PM	3	0	0	3	0	2	0	2	9	9	0	18	23
4:30PM	5	1	0	6	0	2	0	2	9	6	0	15	23
4:45PM	3	0	0	3	0	3	0	3	4	11	0	15	21
Hourly Total	12	2	0	14	2	8	0	10	30	33	0	63	87
5:00PM	1	2	0	3	0	0	0	0	6	4	0	10	13
5:15PM	0	0	0	0	1	5	0	6	4	1	0	5	11
5:30PM	0	4	0	4	2	4	0	6	8	6	0	14	24
5:45PM	1	1	0	2	0	2	0	2	5	8	0	13	17
Hourly Total	2	7	0	9	3	11	0	14	23	19	0	42	65
Total	51	10	0	61	8	48	0	56	63	60	0	123	240
% Approach	83.6%	16.4%	0%	-	14.3%	85.7%	0%	-	51.2%	48.8%	0%	-	-
% Total	21.3%	4.2%	0%	25.4%	3.3%	20.0%	0%	23.3%	26.3%	25.0%	0%	51.3%	-
Lights	51	9	0	60	8	48	0	56	62	60	0	122	238
% Lights	100%	90.0%	0%	98.4%	100%	100%	0%	100%	98.4%	100%	0%	99.2%	99.2%
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Buses and Single-Unit Trucks	0	1	0	1	0	0	0	0	1	0	0	1	2
% Buses and Single-Unit Trucks	0%	10.0%	0%	1.6%	0%	0%	0%	0%	1.6%	0%	0%	0.8%	0.8%

*L: Left, R: Right, T: Thru, U: U-Turn

Watkins Road and Horning Road - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037008, Location: 42.118582, -84.132931



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

[N] Watkins

Total: 222

In: 123

Out: 99

60

63

[W] Horning

Total: 129

In: 61 Out: 68

51

10

8

48

Out: 73

In: 56

Total: 129

[S] Watkins

Watkins Road and Horning Road - TMC

Tue Feb 14, 2023

AM Peak (7:30 AM - 8:30 AM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037008, Location: 42.118582, -84.132931



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Horning Eastbound				Watkins Northbound				Watkins Southbound				
Time	L	R	U	App	L	T	U	App	T	R	U	App	Int
2023-02-14 7:30AM	8	0	0	8	1	4	0	5	1	0	0	1	14
7:45AM	3	0	0	3	0	2	0	2	3	0	0	3	8
8:00AM	4	0	0	4	1	4	0	5	2	2	0	4	13
8:15AM	6	1	0	7	0	3	0	3	3	3	0	6	16
Total	21	1	0	22	2	13	0	15	9	5	0	14	51
% Approach	95.5%	4.5%	0%	-	13.3%	86.7%	0%	-	64.3%	35.7%	0%	-	-
% Total	41.2%	2.0%	0%	43.1%	3.9%	25.5%	0%	29.4%	17.6%	9.8%	0%	27.5%	-
PHF	0.656	0.250	-	0.688	0.500	0.813	-	0.750	0.750	0.417	-	0.583	0.797
Lights	21	0	0	21	2	13	0	15	8	5	0	13	49
% Lights	100%	0%	0%	95.5%	100%	100%	0%	100%	88.9%	100%	0%	92.9%	96.1%
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Buses and Single-Unit Trucks	0	1	0	1	0	0	0	0	1	0	0	1	2
% Buses and Single-Unit Trucks	0%	100%	0%	4.5%	0%	0%	0%	0%	11.1%	0%	0%	7.1%	3.9%

* L: Left, R: Right, T: Thru, U: U-Turn

Watkins Road and Horning Road - TMC

Tue Feb 14, 2023

AM Peak (7:30 AM - 8:30 AM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037008, Location: 42.118582, -84.132931



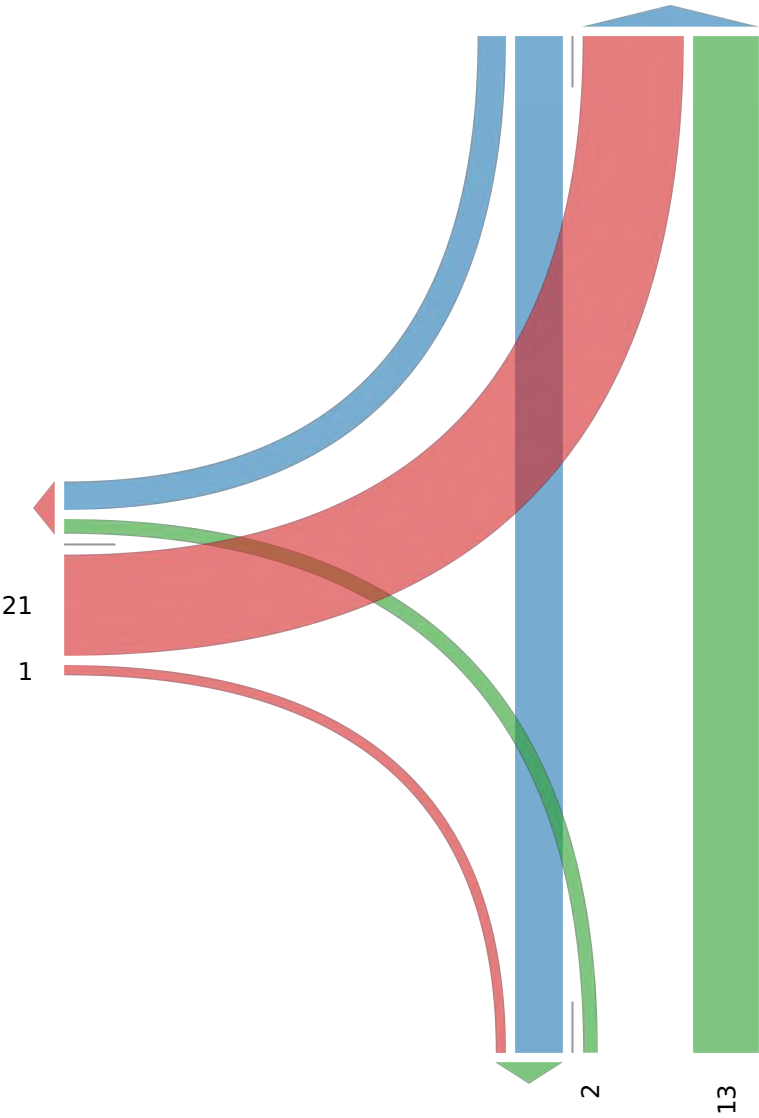
Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

[N] Watkins

Total: 48
In: 14 Out: 34

5 9

[W] Horning
Total: 29
In: 22 Out: 7



Out: 10 In: 15
Total: 25
[S] Watkins

Watkins Road and Horning Road - TMC

Tue Feb 14, 2023

PM Peak (4 PM - 5 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037008, Location: 42.118582, -84.132931



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Horning Eastbound				Watkins Northbound				Watkins Southbound				
Time	L	R	U	App	L	T	U	App	T	R	U	App	Int
2023-02-14 4:00PM	1	1	0	2	2	1	0	3	8	7	0	15	20
4:15PM	3	0	0	3	0	2	0	2	9	9	0	18	23
4:30PM	5	1	0	6	0	2	0	2	9	6	0	15	23
4:45PM	3	0	0	3	0	3	0	3	4	11	0	15	21
Total	12	2	0	14	2	8	0	10	30	33	0	63	87
% Approach	85.7%	14.3%	0%	-	20.0%	80.0%	0%	-	47.6%	52.4%	0%	-	-
% Total	13.8%	2.3%	0%	16.1%	2.3%	9.2%	0%	11.5%	34.5%	37.9%	0%	72.4%	-
PHF	0.600	0.500	-	0.583	0.250	0.667	-	0.833	0.833	0.750	-	0.875	0.946
Lights	12	2	0	14	2	8	0	10	30	33	0	63	87
% Lights	100%	100%	0%	100%	100%	100%	0%	100%	100%	100%	0%	100%	100%
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Buses and Single-Unit Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

* L: Left, R: Right, T: Thru, U: U-Turn

Watkins Road and Horning Road - TMC

Tue Feb 14, 2023

PM Peak (4 PM - 5 PM) - Overall Peak Hour

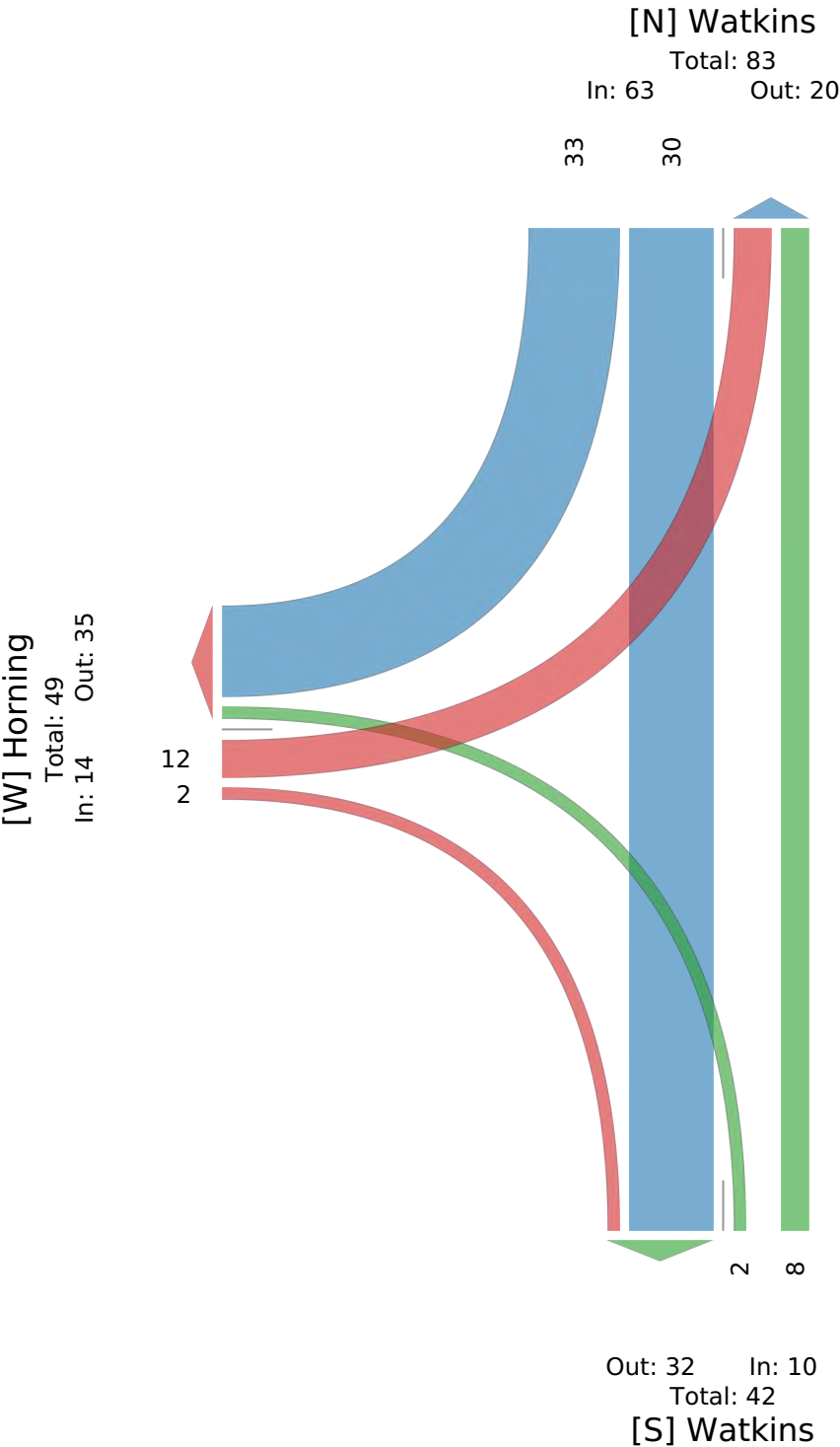
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037008, Location: 42.118582, -84.132931



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



Hardcastle and M-124 - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037006, Location: 42.084235, -84.167727

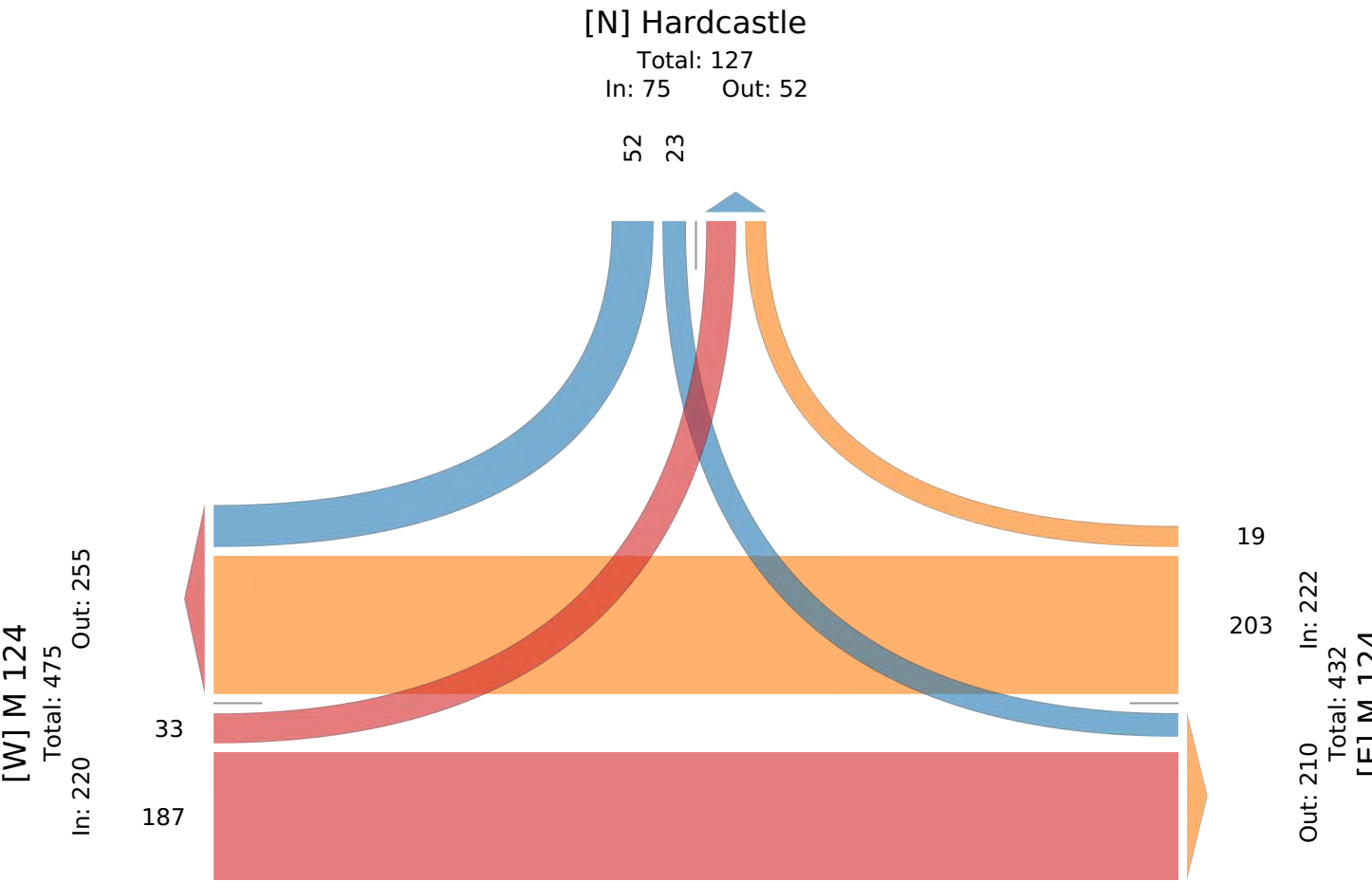


Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	M 124 Eastbound				M 124 Westbound				Hardcastle Southbound				
Time	L	T	U	App	T	R	U	App	L	R	U	App	Int
2023-02-14 7:00AM	4	10	0	14	3	1	0	4	0	1	0	1	19
7:15AM	3	7	0	10	12	0	0	12	1	5	0	6	28
7:30AM	0	4	0	4	13	5	0	18	1	3	0	4	26
7:45AM	1	9	0	10	12	2	0	14	1	2	0	3	27
Hourly Total	8	30	0	38	40	8	0	48	3	11	0	14	100
8:00AM	0	10	0	10	10	0	0	10	3	1	0	4	24
8:15AM	2	12	0	14	7	1	0	8	2	3	0	5	27
8:30AM	3	7	0	10	8	2	0	10	0	0	0	0	20
8:45AM	2	10	0	12	10	1	0	11	2	4	0	6	29
Hourly Total	7	39	0	46	35	4	0	39	7	8	0	15	100
4:00PM	1	8	0	9	16	2	0	18	4	4	0	8	35
4:15PM	0	14	0	14	15	1	0	16	2	4	0	6	36
4:30PM	2	15	0	17	13	2	0	15	2	7	0	9	41
4:45PM	1	18	0	19	22	0	0	22	1	3	0	4	45
Hourly Total	4	55	0	59	66	5	0	71	9	18	0	27	157
5:00PM	3	17	0	20	18	0	0	18	1	2	0	3	41
5:15PM	4	21	0	25	13	2	0	15	0	0	0	0	40
5:30PM	3	19	0	22	18	0	0	18	1	5	0	6	46
5:45PM	4	6	0	10	13	0	0	13	2	8	0	10	33
Hourly Total	14	63	0	77	62	2	0	64	4	15	0	19	160
Total	33	187	0	220	203	19	0	222	23	52	0	75	517
% Approach	15.0%	85.0%	0%	-	91.4%	8.6%	0%	-	30.7%	69.3%	0%	-	-
% Total	6.4%	36.2%	0%	42.6%	39.3%	3.7%	0%	42.9%	4.4%	10.1%	0%	14.5%	-
Lights	32	177	0	209	196	15	0	211	22	51	0	73	493
% Lights	97.0%	94.7%	0%	95.0%	96.6%	78.9%	0%	95.0%	95.7%	98.1%	0%	97.3%	95.4%
Articulated Trucks	0	2	0	2	4	1	0	5	1	0	0	1	8
% Articulated Trucks	0%	1.1%	0%	0.9%	2.0%	5.3%	0%	2.3%	4.3%	0%	0%	1.3%	1.5%
Buses and Single-Unit Trucks	1	8	0	9	3	3	0	6	0	1	0	1	16
% Buses and Single-Unit Trucks	3.0%	4.3%	0%	4.1%	1.5%	15.8%	0%	2.7%	0%	1.9%	0%	1.3%	3.1%

*L: Left, R: Right, T: Thru, U: U-Turn

Hardcastle and M-124 - TMC
Tue Feb 14, 2023
Full Length (7 AM-9 AM, 4 PM-6 PM)
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
All Movements
ID: 1037006, Location: 42.084235, -84.167727



Hardcastle and M-124 - TMC

Tue Feb 14, 2023

AM Peak (7:15 AM - 8:15 AM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037006, Location: 42.084235, -84.167727

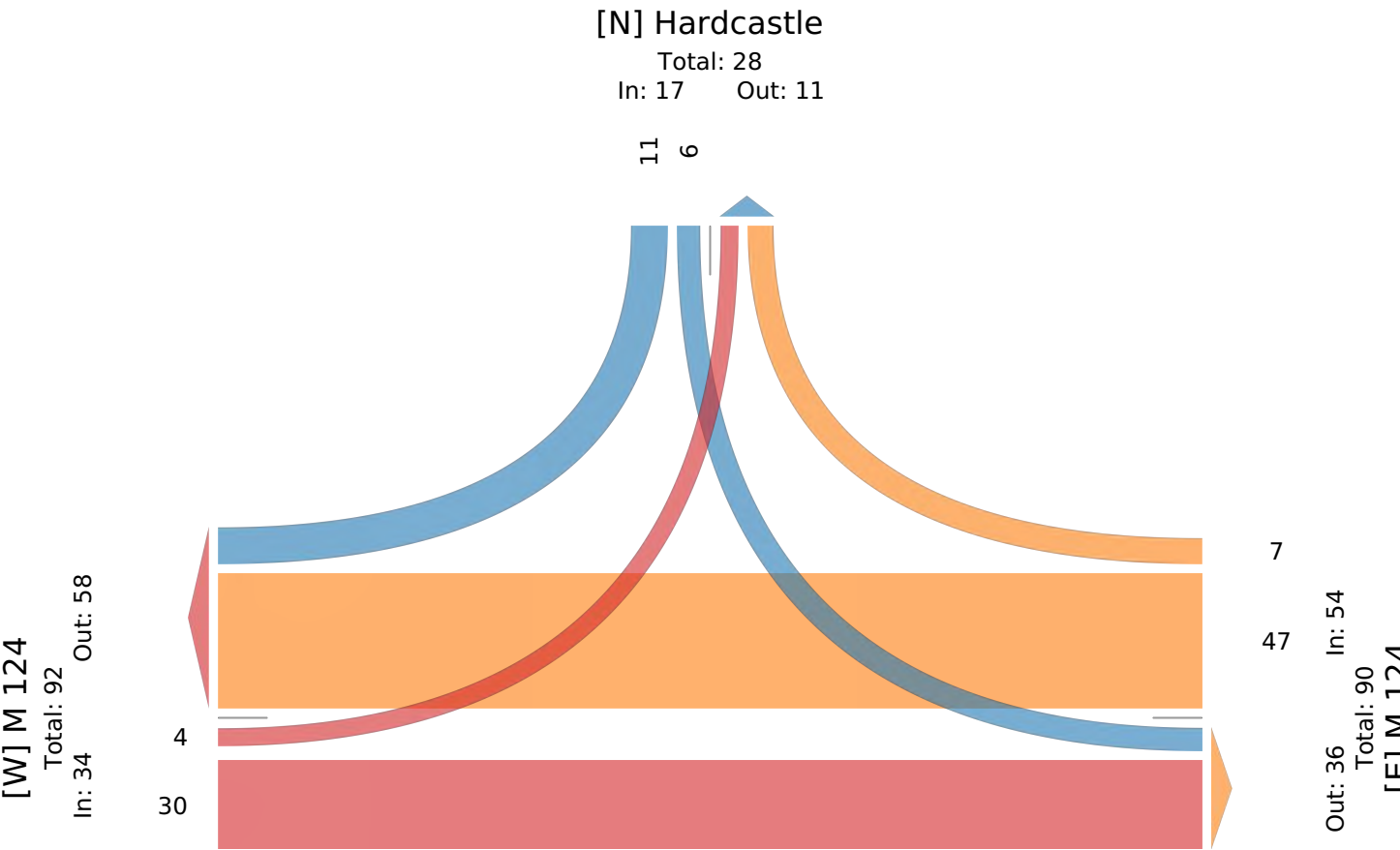


Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	M 124 Eastbound				M 124 Westbound				Hardcastle Southbound				
Time	L	T	U	App	T	R	U	App	L	R	U	App	Int
2023-02-14 7:15AM	3	7	0	10	12	0	0	12	1	5	0	6	28
7:30AM	0	4	0	4	13	5	0	18	1	3	0	4	26
7:45AM	1	9	0	10	12	2	0	14	1	2	0	3	27
8:00AM	0	10	0	10	10	0	0	10	3	1	0	4	24
Total	4	30	0	34	47	7	0	54	6	11	0	17	105
% Approach	11.8%	88.2%	0%	-	87.0%	13.0%	0%	-	35.3%	64.7%	0%	-	-
% Total	3.8%	28.6%	0%	32.4%	44.8%	6.7%	0%	51.4%	5.7%	10.5%	0%	16.2%	-
PHF	0.333	0.750	-	0.850	0.904	0.350	-	0.750	0.500	0.550	-	0.708	0.938
Lights	4	29	0	33	47	5	0	52	6	11	0	17	102
% Lights	100%	96.7%	0%	97.1%	100%	71.4%	0%	96.3%	100%	100%	0%	100%	97.1%
Articulated Trucks	0	1	0	1	0	1	0	1	0	0	0	0	2
% Articulated Trucks	0%	3.3%	0%	2.9%	0%	14.3%	0%	1.9%	0%	0%	0%	0%	1.9%
Buses and Single-Unit Trucks	0	0	0	0	0	1	0	1	0	0	0	0	1
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	14.3%	0%	1.9%	0%	0%	0%	0%	1.0%

* L: Left, R: Right, T: Thru, U: U-Turn

Hardcastle and M-124 - TMC
Tue Feb 14, 2023
AM Peak (7:15 AM - 8:15 AM)
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
All Movements
ID: 1037006, Location: 42.084235, -84.167727



Hardcastle and M-124 - TMC

Tue Feb 14, 2023

PM Peak (4:45 PM - 5:45 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037006, Location: 42.084235, -84.167727



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	M 124 Eastbound				M 124 Westbound				Hardcastle Southbound				
Time	L	T	U	App	T	R	U	App	L	R	U	App	Int
2023-02-14 4:45PM	1	18	0	19	22	0	0	22	1	3	0	4	45
5:00PM	3	17	0	20	18	0	0	18	1	2	0	3	41
5:15PM	4	21	0	25	13	2	0	15	0	0	0	0	40
5:30PM	3	19	0	22	18	0	0	18	1	5	0	6	46
Total	11	75	0	86	71	2	0	73	3	10	0	13	172
% Approach	12.8%	87.2%	0%	-	97.3%	2.7%	0%	-	23.1%	76.9%	0%	-	-
% Total	6.4%	43.6%	0%	50.0%	41.3%	1.2%	0%	42.4%	1.7%	5.8%	0%	7.6%	-
PHF	0.688	0.893	-	0.860	0.807	0.250	-	0.830	0.750	0.500	-	0.542	0.935
Lights	11	75	0	86	70	2	0	72	3	10	0	13	171
% Lights	100%	100%	0%	100%	98.6%	100%	0%	98.6%	100%	100%	0%	100%	99.4%
Articulated Trucks	0	0	0	0	1	0	0	1	0	0	0	0	1
% Articulated Trucks	0%	0%	0%	0%	1.4%	0%	0%	1.4%	0%	0%	0%	0%	0.6%
Buses and Single-Unit Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

* L: Left, R: Right, T: Thru, U: U-Turn

Hardcastle and M-124 - TMC

Tue Feb 14, 2023

PM Peak (4:45 PM - 5:45 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037006, Location: 42.084235, -84.167727



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

[N] Hardcastle

Total: 26
In: 13 Out: 13

10 3

[W] M 124

Total: 167
In: 86 Out: 81

11

75

2

71

Out: 78 In: 73

Total: 151

[E] M 124

Lawrence Road and M-124 - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037005, Location: 42.081758, -84.163828

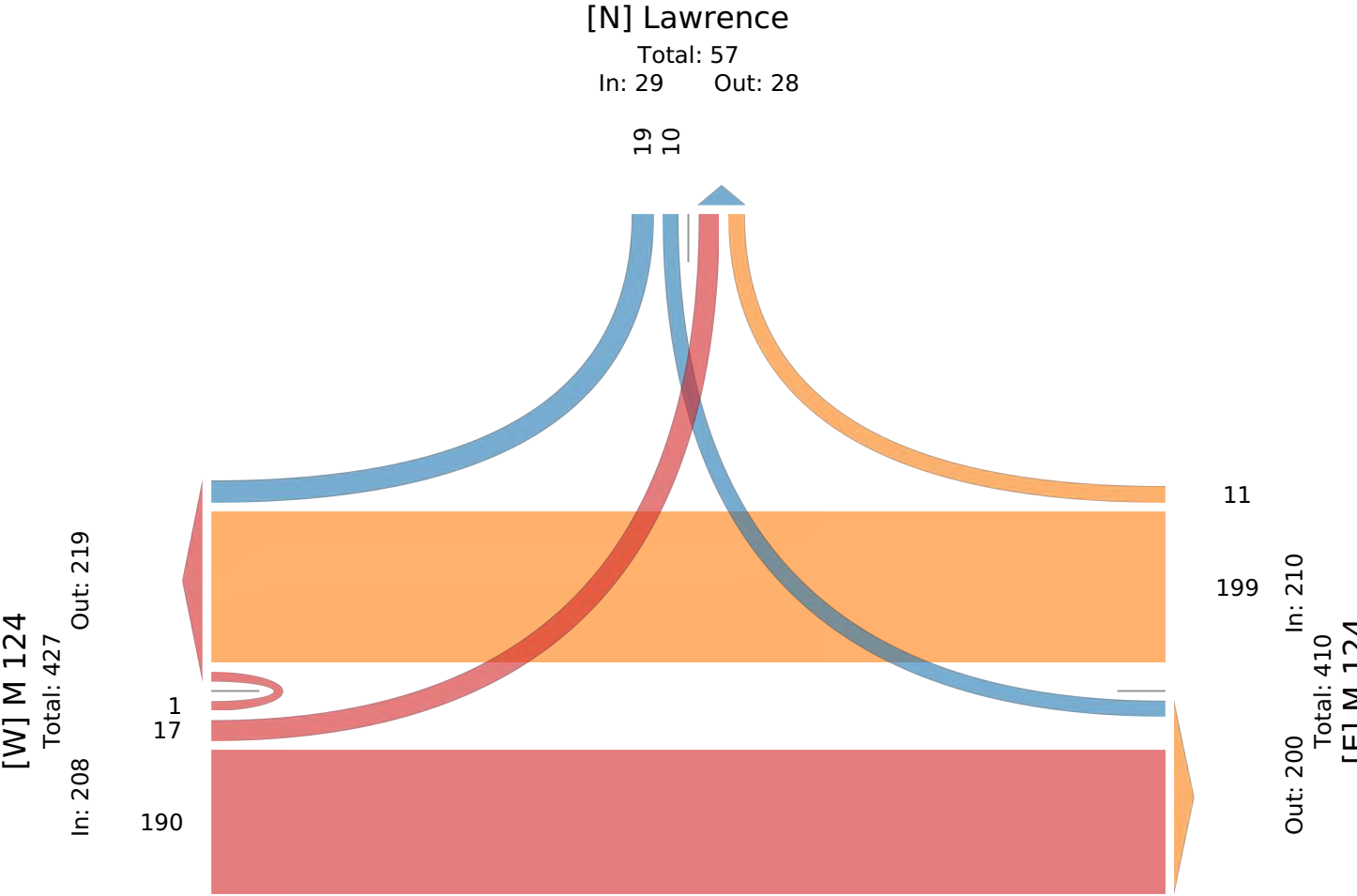


Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	M 124 Eastbound				M 124 Westbound				Lawrence Southbound				
Time	L	T	U	App	T	R	U	App	L	R	U	App	Int
2023-02-14 7:00AM	0	10	0	10	3	0	0	3	2	1	0	3	16
7:15AM	0	8	0	8	11	0	0	11	1	1	0	2	21
7:30AM	0	5	0	5	16	0	0	16	3	2	0	5	26
7:45AM	3	7	0	10	12	2	0	14	0	0	0	0	24
Hourly Total	3	30	0	33	42	2	0	44	6	4	0	10	87
8:00AM	2	11	0	13	8	0	0	8	0	2	0	2	23
8:15AM	1	13	0	14	5	0	0	5	0	3	0	3	22
8:30AM	0	6	0	6	10	1	0	11	0	1	0	1	18
8:45AM	1	10	1	12	8	0	0	8	1	1	0	2	22
Hourly Total	4	40	1	45	31	1	0	32	1	7	0	8	85
4:00PM	1	9	0	10	16	1	0	17	0	0	0	0	27
4:15PM	1	16	0	17	15	2	0	17	1	1	0	2	36
4:30PM	2	14	0	16	14	0	0	14	1	1	0	2	32
4:45PM	1	18	0	19	21	1	0	22	0	1	0	1	42
Hourly Total	5	57	0	62	66	4	0	70	2	3	0	5	137
5:00PM	3	15	0	18	18	1	0	19	0	1	0	1	38
5:15PM	0	22	0	22	14	0	0	14	1	2	0	3	39
5:30PM	2	15	0	17	15	3	0	18	0	1	0	1	36
5:45PM	0	11	0	11	13	0	0	13	0	1	0	1	25
Hourly Total	5	63	0	68	60	4	0	64	1	5	0	6	138
Total	17	190	1	208	199	11	0	210	10	19	0	29	447
% Approach	8.2%	91.3%	0.5%	-	94.8%	5.2%	0%	-	34.5%	65.5%	0%	-	-
% Total	3.8%	42.5%	0.2%	46.5%	44.5%	2.5%	0%	47.0%	2.2%	4.3%	0%	6.5%	-
Lights	17	180	0	197	189	11	0	200	10	17	0	27	424
% Lights	100%	94.7%	0%	94.7%	95.0%	100%	0%	95.2%	100%	89.5%	0%	93.1%	94.9%
Articulated Trucks	0	6	0	6	5	0	0	5	0	0	0	0	11
% Articulated Trucks	0%	3.2%	0%	2.9%	2.5%	0%	0%	2.4%	0%	0%	0%	0%	2.5%
Buses and Single-Unit Trucks	0	4	1	5	5	0	0	5	0	2	0	2	12
% Buses and Single-Unit Trucks	0%	2.1%	100%	2.4%	2.5%	0%	0%	2.4%	0%	10.5%	0%	6.9%	2.7%

*L: Left, R: Right, T: Thru, U: U-Turn

Lawrence Road and M-124 - TMC
Tue Feb 14, 2023
Full Length (7 AM-9 AM, 4 PM-6 PM)
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
All Movements
ID: 1037005, Location: 42.081758, -84.163828



Lawrence Road and M-124 - TMC

Tue Feb 14, 2023

AM Peak (7:30 AM - 8:30 AM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037005, Location: 42.081758, -84.163828

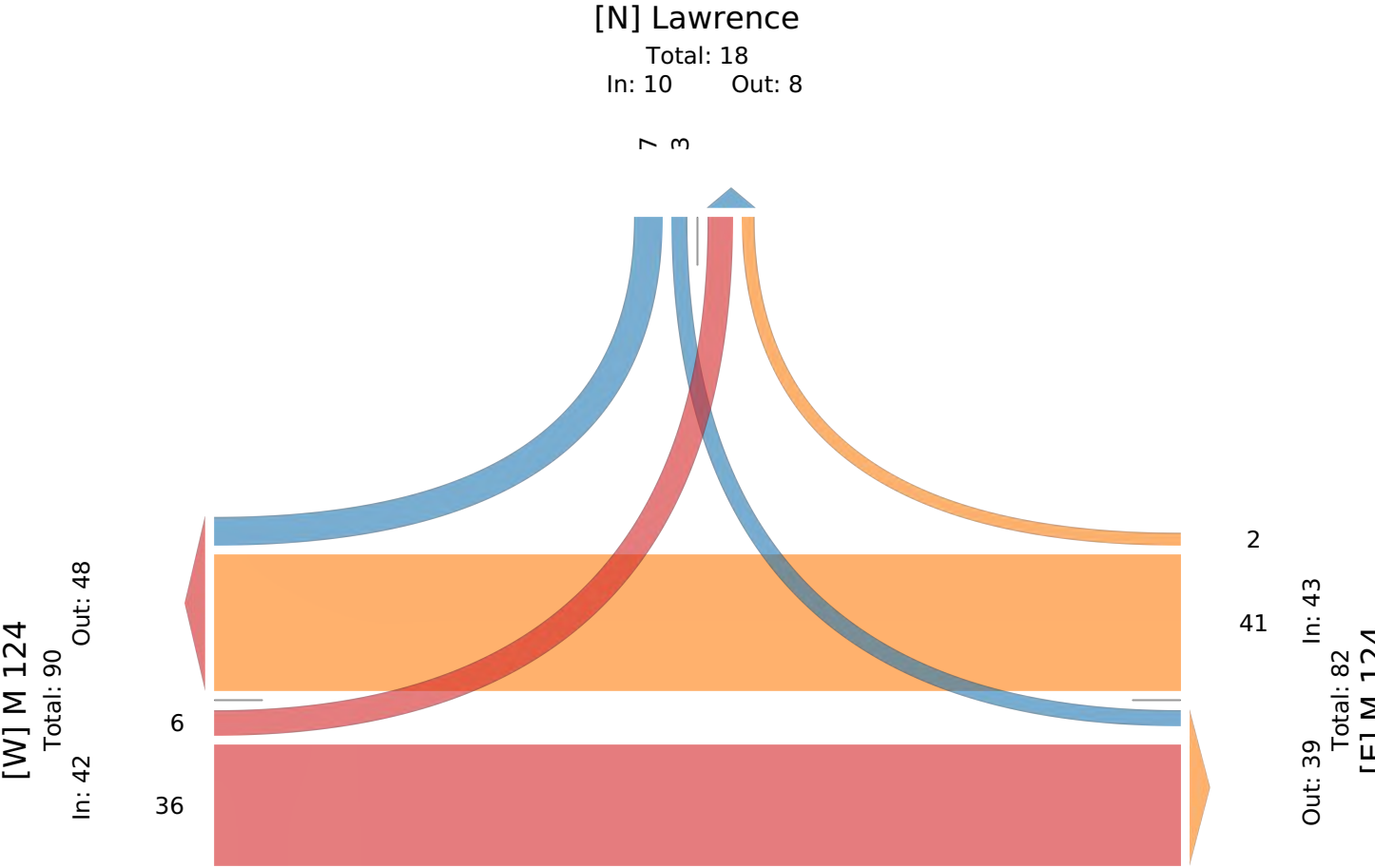


Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	M 124 Eastbound				M 124 Westbound				Lawrence Southbound				
Time	L	T	U	App	T	R	U	App	L	R	U	App	Int
2023-02-14 7:30AM	0	5	0	5	16	0	0	16	3	2	0	5	26
7:45AM	3	7	0	10	12	2	0	14	0	0	0	0	24
8:00AM	2	11	0	13	8	0	0	8	0	2	0	2	23
8:15AM	1	13	0	14	5	0	0	5	0	3	0	3	22
Total	6	36	0	42	41	2	0	43	3	7	0	10	95
% Approach	14.3%	85.7%	0%	-	95.3%	4.7%	0%	-	30.0%	70.0%	0%	-	-
% Total	6.3%	37.9%	0%	44.2%	43.2%	2.1%	0%	45.3%	3.2%	7.4%	0%	10.5%	-
PHF	0.500	0.692	-	0.750	0.641	0.250	-	0.672	0.250	0.583	-	0.500	0.913
Lights	6	31	0	37	39	2	0	41	3	7	0	10	88
% Lights	100%	86.1%	0%	88.1%	95.1%	100%	0%	95.3%	100%	100%	0%	100%	92.6%
Articulated Trucks	0	4	0	4	1	0	0	1	0	0	0	0	5
% Articulated Trucks	0%	11.1%	0%	9.5%	2.4%	0%	0%	2.3%	0%	0%	0%	0%	5.3%
Buses and Single-Unit Trucks	0	1	0	1	1	0	0	1	0	0	0	0	2
% Buses and Single-Unit Trucks	0%	2.8%	0%	2.4%	2.4%	0%	0%	2.3%	0%	0%	0%	0%	2.1%

* L: Left, R: Right, T: Thru, U: U-Turn

Lawrence Road and M-124 - TMC
Tue Feb 14, 2023
AM Peak (7:30 AM - 8:30 AM)
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
All Movements
ID: 1037005, Location: 42.081758, -84.163828



Lawrence Road and M-124 - TMC

Tue Feb 14, 2023

PM Peak (4:45 PM - 5:45 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037005, Location: 42.081758, -84.163828



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	M 124 Eastbound				M 124 Westbound				Lawrence Southbound				
Time	L	T	U	App	T	R	U	App	L	R	U	App	Int
2023-02-14 4:45PM	1	18	0	19	21	1	0	22	0	1	0	1	42
5:00PM	3	15	0	18	18	1	0	19	0	1	0	1	38
5:15PM	0	22	0	22	14	0	0	14	1	2	0	3	39
5:30PM	2	15	0	17	15	3	0	18	0	1	0	1	36
Total	6	70	0	76	68	5	0	73	1	5	0	6	155
% Approach	7.9%	92.1%	0%	-	93.2%	6.8%	0%	-	16.7%	83.3%	0%	-	-
% Total	3.9%	45.2%	0%	49.0%	43.9%	3.2%	0%	47.1%	0.6%	3.2%	0%	3.9%	-
PHF	0.500	0.795	-	0.864	0.810	0.417	-	0.830	0.250	0.625	-	0.500	0.923
Lights	6	70	0	76	66	5	0	71	1	5	0	6	153
% Lights	100%	100%	0%	100%	97.1%	100%	0%	97.3%	100%	100%	0%	100%	98.7%
Articulated Trucks	0	0	0	0	1	0	0	1	0	0	0	0	1
% Articulated Trucks	0%	0%	0%	0%	1.5%	0%	0%	1.4%	0%	0%	0%	0%	0.6%
Buses and Single-Unit Trucks	0	0	0	0	1	0	0	1	0	0	0	0	1
% Buses and Single-Unit Trucks	0%	0%	0%	0%	1.5%	0%	0%	1.4%	0%	0%	0%	0%	0.6%

* L: Left, R: Right, T: Thru, U: U-Turn

Lawrence Road and M-124 - TMC

Tue Feb 14, 2023

PM Peak (4:45 PM - 5:45 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037005, Location: 42.081758, -84.163828



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

[N] Lawrence

Total: 17

In: 6 Out: 11

5 1

[W] M 124

Total: 149

Out: 73

In: 76

6

70

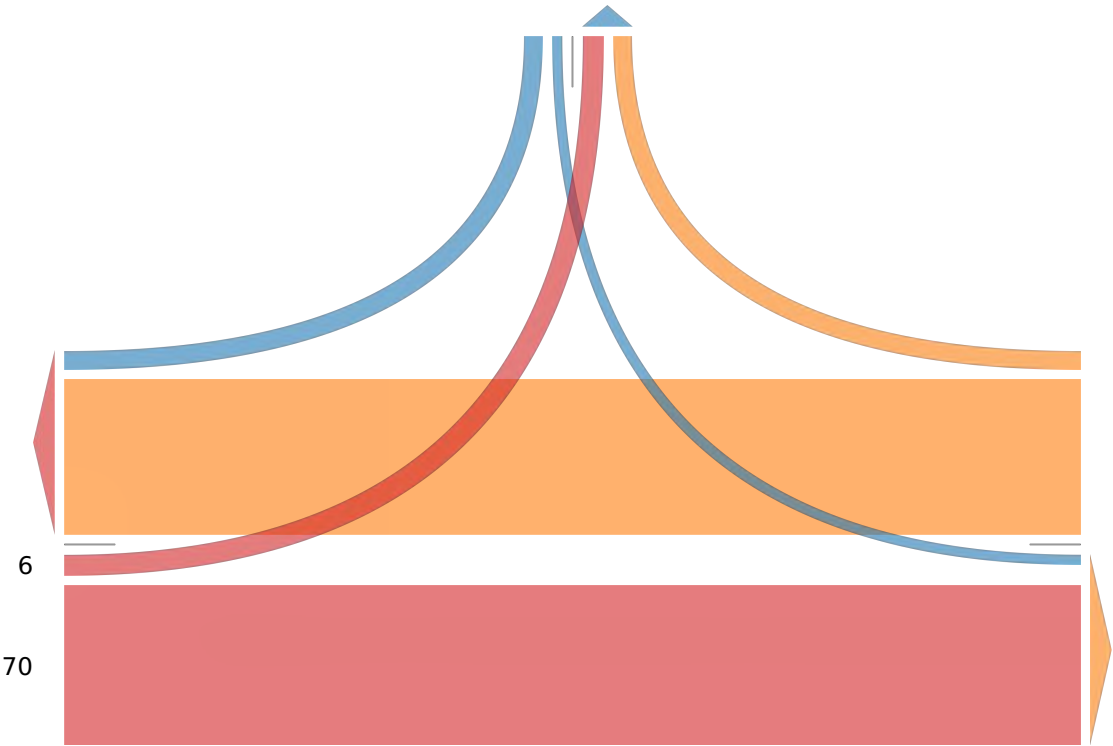
5

68

Out: 71 In: 73

Total: 144

[E] M 124



M-124 and Wellwood Road - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037009, Location: 42.07924, -84.138597



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Wellwood Eastbound					Wellwood Westbound					M 124 Northbound					M 124 Southbound					
Time	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	Int
2023-02-14 7:00AM	0	0	0	0	0	1	0	0	0	1	0	3	1	0	4	0	13	0	0	13	18
7:15AM	0	0	1	0	1	1	0	3	0	4	0	6	9	0	15	0	14	0	0	14	34
7:30AM	0	1	0	1	2	1	0	4	0	5	0	9	2	0	11	2	9	0	0	11	29
7:45AM	0	0	0	0	0	2	0	5	0	7	0	9	2	0	11	1	8	0	0	9	27
Hourly Total	0	1	1	1	3	5	0	12	0	17	0	27	14	0	41	3	44	0	0	47	108
8:00AM	0	0	1	0	1	3	0	1	0	4	0	8	1	0	9	3	9	0	0	12	26
8:15AM	0	0	0	0	0	2	0	2	0	4	0	7	2	0	9	7	8	0	0	15	28
8:30AM	0	0	0	0	0	1	0	0	1	2	0	6	1	0	7	0	6	0	0	6	15
8:45AM	2	0	0	0	2	0	0	0	0	0	1	7	3	0	11	0	9	0	0	9	22
Hourly Total	2	0	1	0	3	6	0	3	1	10	1	28	7	0	36	10	32	0	0	42	91
4:00PM	0	0	0	0	0	6	2	5	0	13	1	18	2	0	21	1	14	0	0	15	49
4:15PM	0	0	2	0	2	4	1	5	0	10	0	10	1	0	11	3	8	0	0	11	34
4:30PM	0	0	0	0	0	4	0	2	0	6	0	10	3	0	13	3	13	0	0	16	35
4:45PM	0	0	1	0	1	5	0	4	0	9	2	15	2	0	19	0	10	0	0	10	39
Hourly Total	0	0	3	0	3	19	3	16	0	38	3	53	8	0	64	7	45	0	0	52	157
5:00PM	0	0	1	0	1	2	1	5	0	8	0	12	1	0	13	1	10	0	0	11	33
5:15PM	0	0	0	0	0	3	0	0	0	3	1	15	8	0	24	2	17	0	0	19	46
5:30PM	0	1	1	0	2	8	0	2	0	10	0	15	3	0	18	5	9	0	0	14	44
5:45PM	0	0	0	0	0	3	0	3	0	6	0	14	4	0	18	2	9	0	0	11	35
Hourly Total	0	1	2	0	3	16	1	10	0	27	1	56	16	0	73	10	45	0	0	55	158
Total	2	2	7	1	12	46	4	41	1	92	5	164	45	0	214	30	166	0	0	196	514
% Approach	16.7%	16.7%	58.3%	8.3%	-	50.0%	4.3%	44.6%	1.1%	-	2.3%	76.6%	21.0%	0%	-	15.3%	84.7%	0%	0%	-	-
% Total	0.4%	0.4%	1.4%	0.2%	2.3%	8.9%	0.8%	8.0%	0.2%	17.9%	1.0%	31.9%	8.8%	0%	41.6%	5.8%	32.3%	0%	0%	38.1%	-
Lights	2	2	7	1	12	46	4	35	0	85	5	158	45	0	208	27	160	0	0	187	492
% Lights	100%	100%	100%	100%	100%	100%	100%	85.4%	0%	92.4%	100%	96.3%	100%	0%	97.2%	90.0%	96.4%	0%	0%	95.4%	95.7%
Articulated Trucks	0	0	0	0	0	0	0	2	1	3	0	3	0	0	3	3	3	0	0	6	12
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	4.9%	100%	3.3%	0%	1.8%	0%	0%	1.4%	10.0%	1.8%	0%	0%	3.1%	2.3%
Buses and Single-Unit Trucks	0	0	0	0	0	0	0	4	0	4	0	3	0	0	3	0	3	0	0	3	10
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	0%	0%	9.8%	0%	4.3%	0%	1.8%	0%	0%	1.4%	0%	1.8%	0%	0%	1.5%	1.9%

*L: Left, R: Right, T: Thru, U: U-Turn

M-124 and Wellwood Road - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

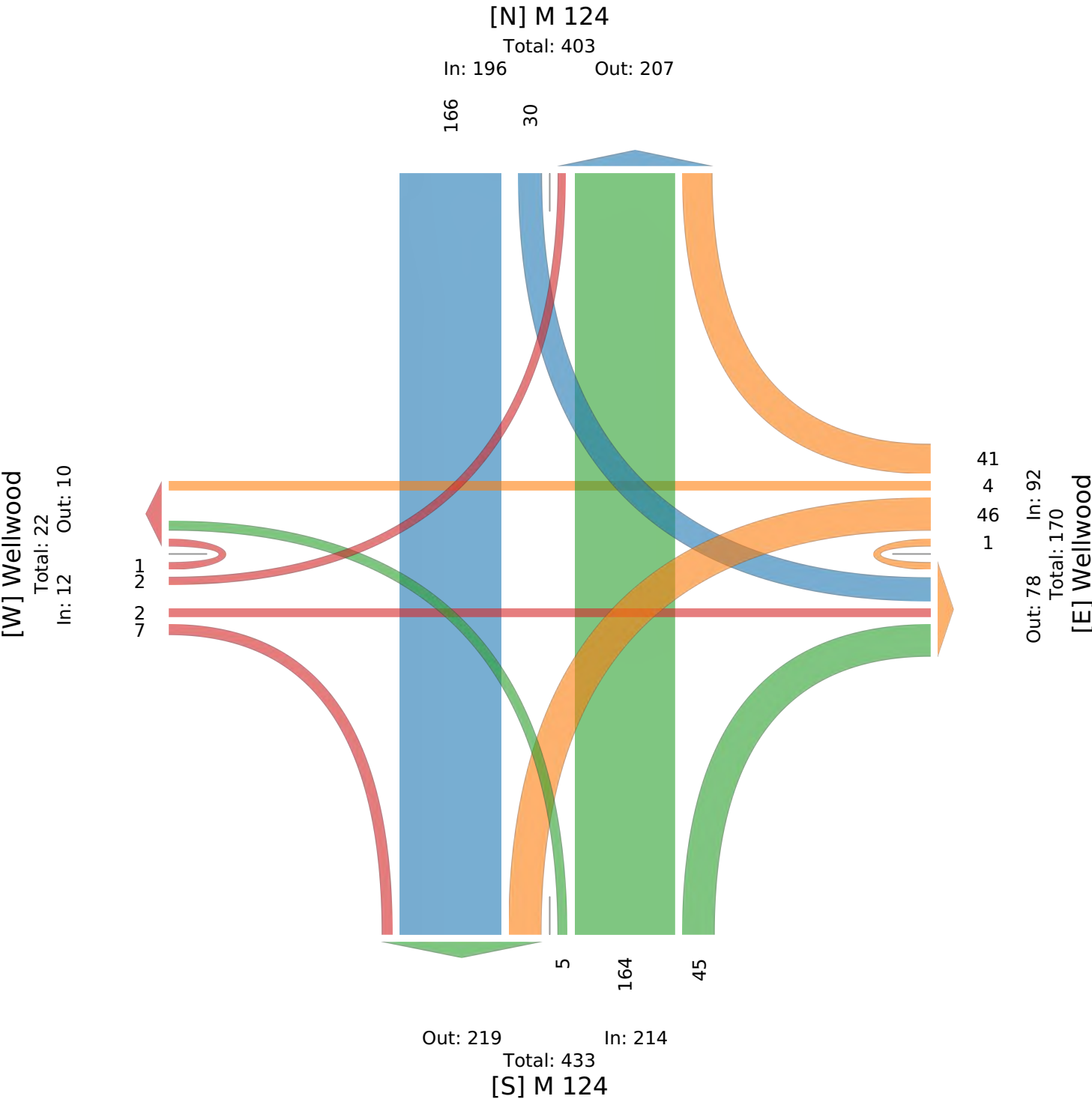
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037009, Location: 42.07924, -84.138597



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



M-124 and Wellwood Road - TMC

Tue Feb 14, 2023

AM Peak (7:15 AM - 8:15 AM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037009, Location: 42.07924, -84.138597



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Wellwood Eastbound					Wellwood Westbound					M 124 Northbound					M 124 Southbound					
Time	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	Int
2023-02-14 7:15AM	0	0	1	0	1	1	0	3	0	4	0	6	9	0	15	0	14	0	0	14	34
7:30AM	0	1	0	1	2	1	0	4	0	5	0	9	2	0	11	2	9	0	0	11	29
7:45AM	0	0	0	0	0	2	0	5	0	7	0	9	2	0	11	1	8	0	0	9	27
8:00AM	0	0	1	0	1	3	0	1	0	4	0	8	1	0	9	3	9	0	0	12	26
Total	0	1	2	1	4	7	0	13	0	20	0	32	14	0	46	6	40	0	0	46	116
% Approach	0%	25.0%	50.0%	25.0%	-	35.0%	0%	65.0%	0%	-	0%	69.6%	30.4%	0%	-	13.0%	87.0%	0%	0%	-	-
% Total	0%	0.9%	1.7%	0.9%	3.4%	6.0%	0%	11.2%	0%	17.2%	0%	27.6%	12.1%	0%	39.7%	5.2%	34.5%	0%	0%	39.7%	-
PHF	-	0.250	0.500	0.250	0.500	0.583	-	0.650	-	0.714	-	0.889	0.389	-	0.767	0.500	0.714	-	-	0.821	0.853
Lights	0	1	2	1	4	7	0	12	0	19	0	30	14	0	44	6	39	0	0	45	112
% Lights	0%	100%	100%	100%	100%	100%	0%	92.3%	0%	95.0%	0%	93.8%	100%	0%	95.7%	100%	97.5%	0%	0%	97.8%	96.6%
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	2
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3.1%	0%	0%	2.2%	0%	2.5%	0%	0%	2.2%	1.7%
Buses and Single-Unit Trucks	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	2
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	0%	0%	7.7%	0%	5.0%	0%	3.1%	0%	0%	2.2%	0%	0%	0%	0%	0%	1.7%

* L: Left, R: Right, T: Thru, U: U-Turn

M-124 and Wellwood Road - TMC

Tue Feb 14, 2023

AM Peak (7:15 AM - 8:15 AM)

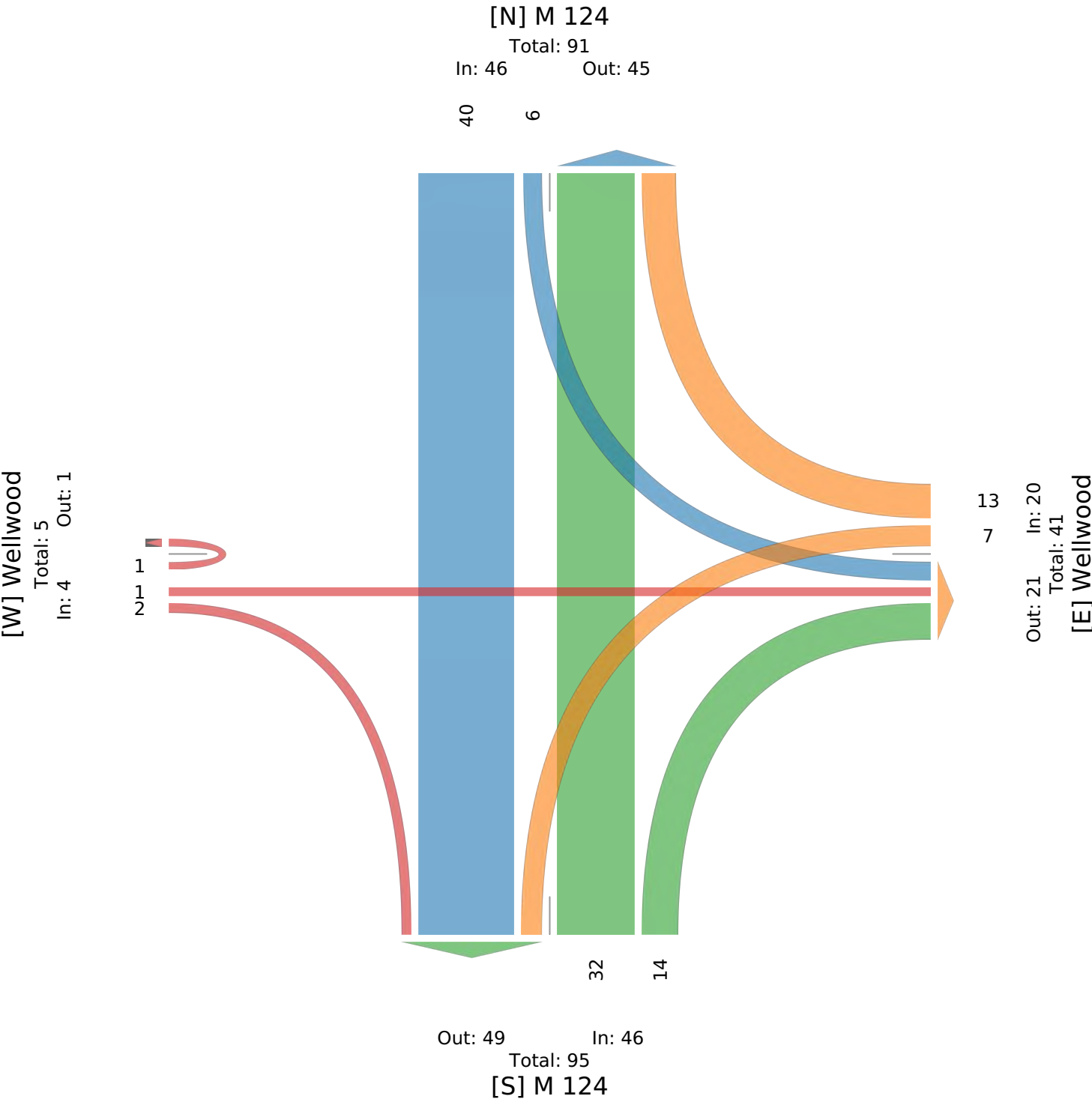
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037009, Location: 42.07924, -84.138597



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



M-124 and Wellwood Road - TMC

Tue Feb 14, 2023

PM Peak (4:45 PM - 5:45 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037009, Location: 42.07924, -84.138597



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Wellwood Eastbound					Wellwood Westbound					M 124 Northbound					M 124 Southbound					
Time	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	Int
2023-02-14 4:45PM	0	0	1	0	1	5	0	4	0	9	2	15	2	0	19	0	10	0	0	10	39
5:00PM	0	0	1	0	1	2	1	5	0	8	0	12	1	0	13	1	10	0	0	11	33
5:15PM	0	0	0	0	0	3	0	0	0	3	1	15	8	0	24	2	17	0	0	19	46
5:30PM	0	1	1	0	2	8	0	2	0	10	0	15	3	0	18	5	9	0	0	14	44
Total	0	1	3	0	4	18	1	11	0	30	3	57	14	0	74	8	46	0	0	54	162
% Approach	0%	25.0%	75.0%	0%	-	60.0%	3.3%	36.7%	0%	-	4.1%	77.0%	18.9%	0%	-	14.8%	85.2%	0%	0%	-	-
% Total	0%	0.6%	1.9%	0%	2.5%	11.1%	0.6%	6.8%	0%	18.5%	1.9%	35.2%	8.6%	0%	45.7%	4.9%	28.4%	0%	0%	33.3%	-
PHF	-	0.250	0.750	-	0.500	0.563	0.250	0.550	-	0.750	0.375	0.950	0.438	-	0.771	0.400	0.676	-	-	0.711	0.880
Lights	0	1	3	0	4	18	1	11	0	30	3	56	14	0	73	8	46	0	0	54	161
% Lights	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%	98.2%	100%	0%	98.6%	100%	100%	0%	0%	100%	99.4%
Articulated Trucks	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
% Articulated Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1.8%	0%	0%	1.4%	0%	0%	0%	0%	0%	0.6%
Buses and Single-Unit Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Buses and Single-Unit Trucks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

* L: Left, R: Right, T: Thru, U: U-Turn

M-124 and Wellwood Road - TMC

Tue Feb 14, 2023

PM Peak (4:45 PM - 5:45 PM) - Overall Peak Hour

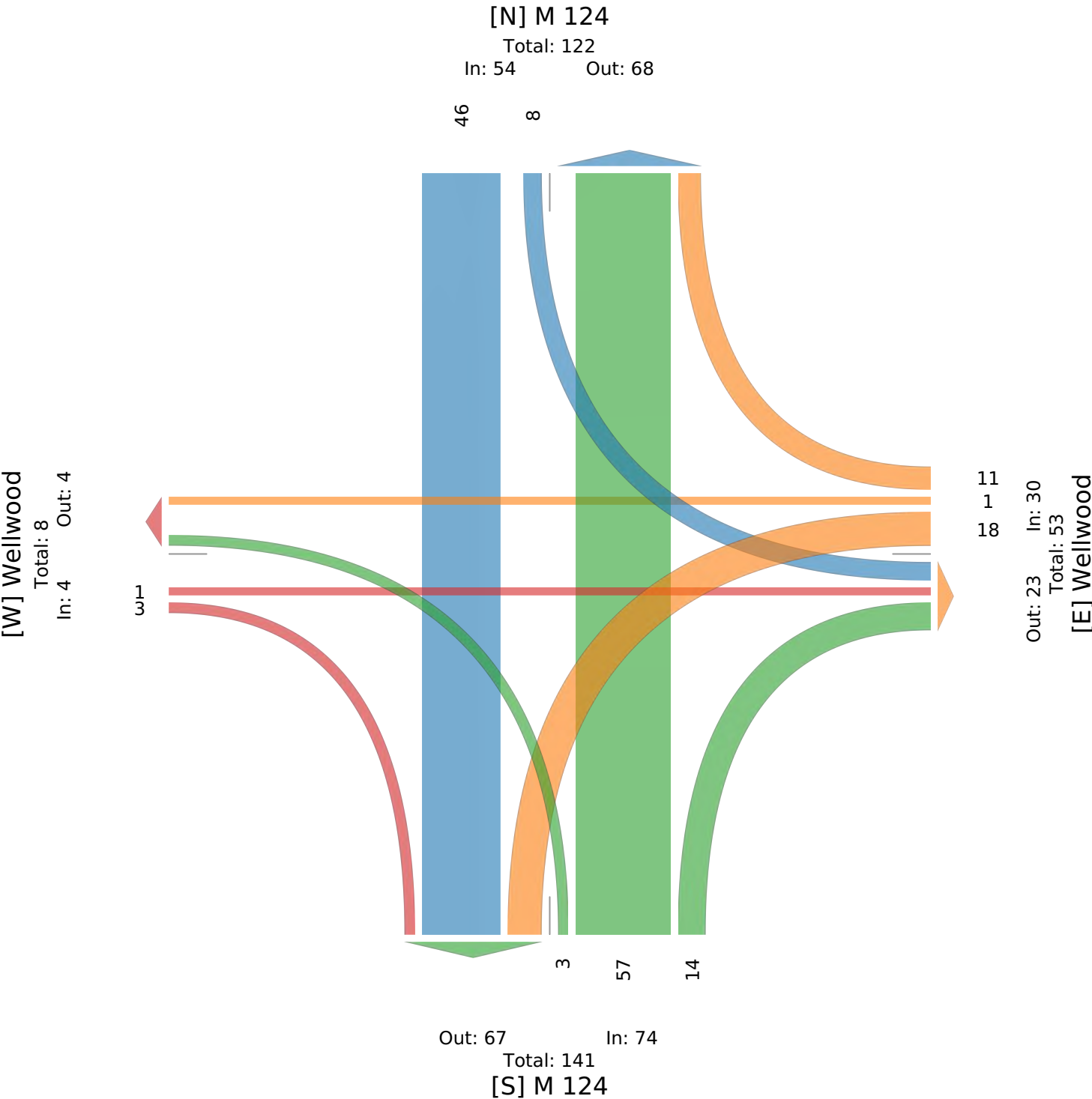
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037009, Location: 42.07924, -84.138597



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



M-124 and US-12 - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037010, Location: 42.056618, -84.140142



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	US 12 Eastbound					US 12 Westbound					Boardman Northbound					M 124 Southbound					
Time	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	Int
2023-02-14 7:00AM	3	55	0	0	58	0	19	2	0	21	0	0	1	0	1	10	0	2	0	12	92
7:15AM	5	51	0	0	56	0	20	6	0	26	1	0	1	0	2	15	0	2	0	17	101
7:30AM	4	57	0	0	61	0	15	7	0	22	2	0	1	0	3	12	0	1	0	13	99
7:45AM	6	52	0	0	58	0	18	5	0	23	0	1	0	0	1	10	0	2	0	12	94
Hourly Total	18	215	0	0	233	0	72	20	0	92	3	1	3	0	7	47	0	7	0	54	386
8:00AM	3	44	0	0	47	1	18	4	0	23	2	0	0	0	2	7	0	6	0	13	85
8:15AM	5	37	0	0	42	0	22	4	0	26	2	0	2	0	4	10	1	1	0	12	84
8:30AM	3	33	1	0	37	0	20	2	0	22	0	0	0	0	0	5	0	2	0	7	66
8:45AM	7	21	1	0	29	1	26	5	0	32	0	0	0	0	0	6	0	3	0	9	70
Hourly Total	18	135	2	0	155	2	86	15	0	103	4	0	2	0	6	28	1	12	0	41	305
4:00PM	6	33	3	0	42	0	56	14	0	70	1	0	1	0	2	12	2	5	0	19	133
4:15PM	3	47	0	0	50	0	56	10	0	66	2	2	2	0	6	10	1	5	0	16	138
4:30PM	4	33	3	0	40	0	45	9	0	54	1	0	3	0	4	8	1	4	0	13	111
4:45PM	3	29	1	0	33	1	48	20	0	69	1	1	0	0	2	12	0	3	0	15	119
Hourly Total	16	142	7	0	165	1	205	53	0	259	5	3	6	0	14	42	4	17	0	63	501
5:00PM	2	37	2	0	41	3	58	14	0	75	1	1	1	0	3	5	0	7	0	12	131
5:15PM	3	38	2	0	43	1	53	17	0	71	0	0	1	0	1	12	1	9	0	22	137
5:30PM	6	36	0	0	42	3	59	16	0	78	1	0	0	0	1	12	1	4	0	17	138
5:45PM	3	41	1	0	45	1	60	14	0	75	0	1	0	0	1	12	0	2	0	14	135
Hourly Total	14	152	5	0	171	8	230	61	0	299	2	2	2	0	6	41	2	22	0	65	541
Total	66	644	14	0	724	11	593	149	0	753	14	6	13	0	33	158	7	58	0	223	1733
% Approach	9.1%	89.0%	1.9%	0%	-	1.5%	78.8%	19.8%	0%	-	42.4%	18.2%	39.4%	0%	-	70.9%	3.1%	26.0%	0%	-	-
% Total	3.8%	37.2%	0.8%	0%	41.8%	0.6%	34.2%	8.6%	0%	43.5%	0.8%	0.3%	0.8%	0%	1.9%	9.1%	0.4%	3.3%	0%	12.9%	-
Lights	65	605	14	0	684	11	565	145	0	721	14	6	12	0	32	152	7	58	0	217	1654
% Lights	98.5%	93.9%	100%	0%	94.5%	100%	95.3%	97.3%	0%	95.8%	100%	100%	92.3%	0%	97.0%	96.2%	100%	100%	0%	97.3%	95.4%
Articulated Trucks	0	23	0	0	23	0	14	3	0	17	0	0	0	0	0	3	0	0	0	3	43
% Articulated Trucks	0%	3.6%	0%	0%	3.2%	0%	2.4%	2.0%	0%	2.3%	0%	0%	0%	0%	0%	1.9%	0%	0%	0%	1.3%	2.5%
Buses and Single-Unit Trucks	1	16	0	0	17	0	14	1	0	15	0	0	1	0	1	3	0	0	0	3	36
% Buses and Single-Unit Trucks	1.5%	2.5%	0%	0%	2.3%	0%	2.4%	0.7%	0%	2.0%	0%	0%	7.7%	0%	3.0%	1.9%	0%	0%	0%	1.3%	2.1%

*L: Left, R: Right, T: Thru, U: U-Turn

M-124 and US-12 - TMC

Tue Feb 14, 2023

Full Length (7 AM-9 AM, 4 PM-6 PM)

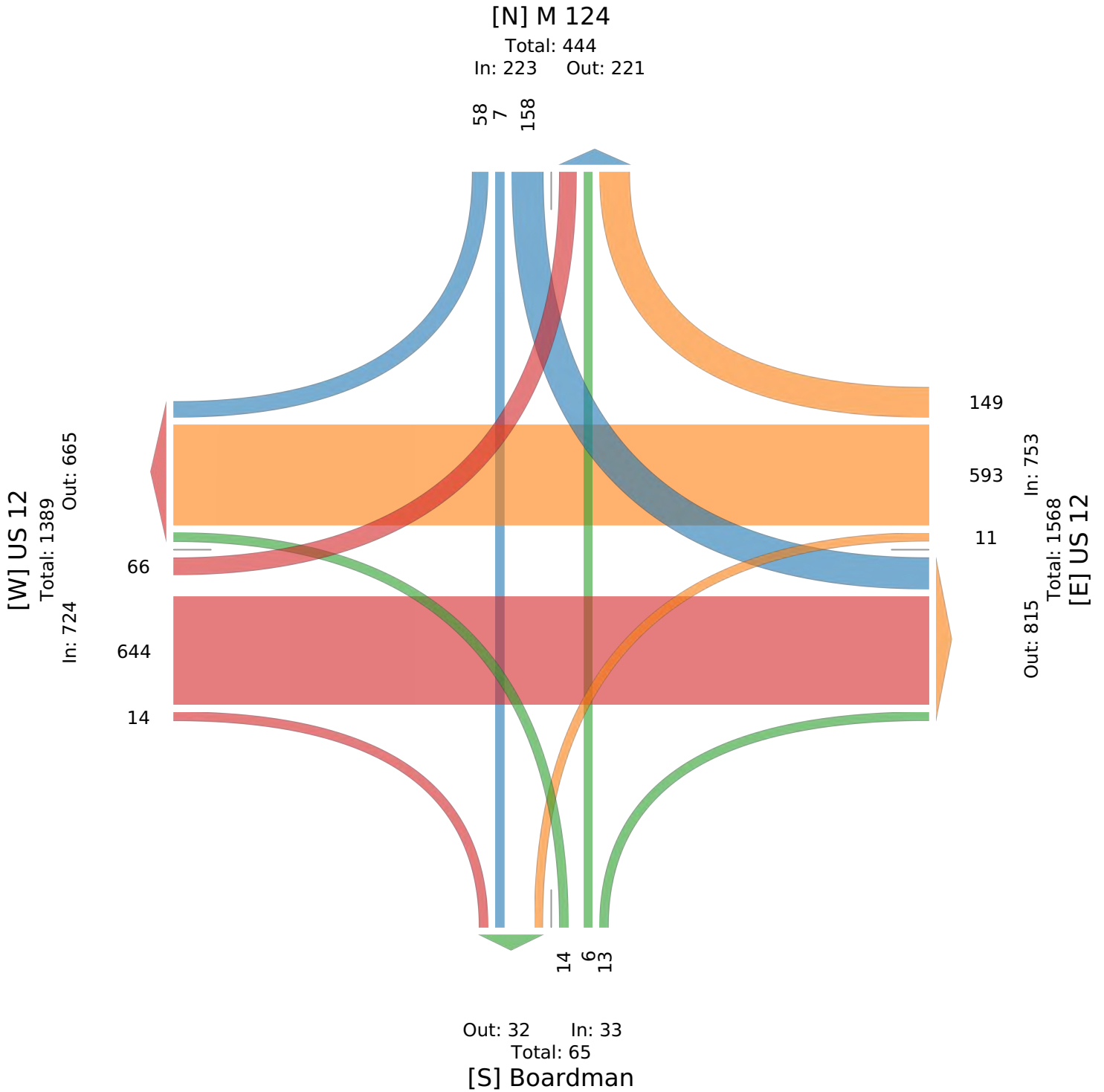
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037010, Location: 42.056618, -84.140142



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



M-124 and US-12 - TMC

Tue Feb 14, 2023

AM Peak (7 AM - 8 AM)

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037010, Location: 42.056618, -84.140142



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

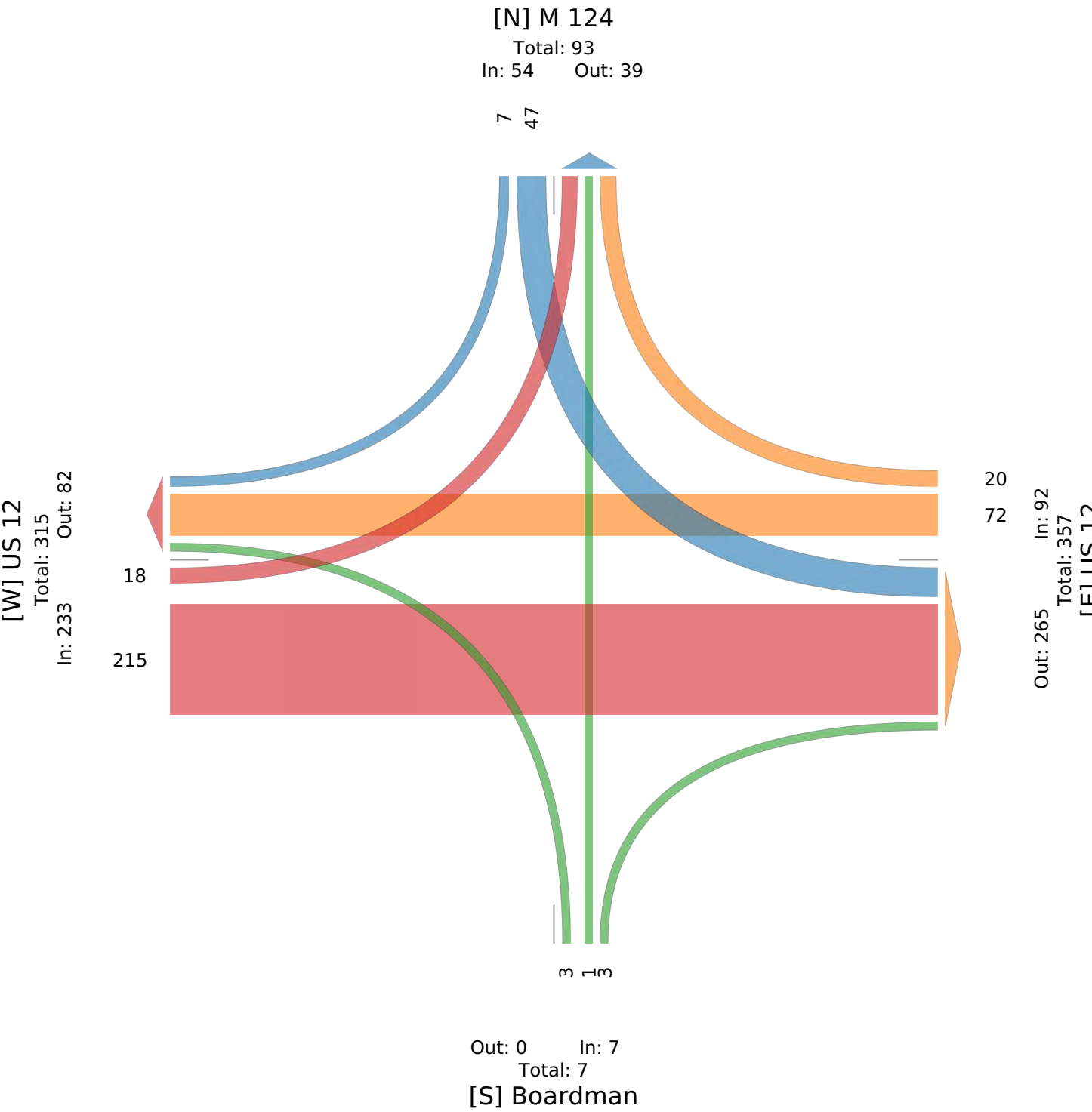
Leg Direction	US 12 Eastbound					US 12 Westbound					Boardman Northbound					M 124 Southbound					
Time	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	Int
2023-02-14 7:00AM	3	55	0	0	58	0	19	2	0	21	0	0	1	0	1	10	0	2	0	12	92
7:15AM	5	51	0	0	56	0	20	6	0	26	1	0	1	0	2	15	0	2	0	17	101
7:30AM	4	57	0	0	61	0	15	7	0	22	2	0	1	0	3	12	0	1	0	13	99
7:45AM	6	52	0	0	58	0	18	5	0	23	0	1	0	0	1	10	0	2	0	12	94
Total	18	215	0	0	233	0	72	20	0	92	3	1	3	0	7	47	0	7	0	54	386
% Approach	7.7%	92.3%	0%	0%	-	0%	78.3%	21.7%	0%	-	42.9%	14.3%	42.9%	0%	-	87.0%	0%	13.0%	0%	-	-
% Total	4.7%	55.7%	0%	0%	60.4%	0%	18.7%	5.2%	0%	23.8%	0.8%	0.3%	0.8%	0%	1.8%	12.2%	0%	1.8%	0%	14.0%	-
PHF	0.750	0.943	-	-	0.955	-	0.900	0.714	-	0.885	0.375	0.250	0.750	-	0.583	0.783	-	0.875	-	0.794	0.955
Lights	18	205	0	0	223	0	65	19	0	84	3	1	3	0	7	47	0	7	0	54	368
% Lights	100%	95.3%	0%	0%	95.7%	0%	90.3%	95.0%	0%	91.3%	100%	100%	100%	0%	100%	100%	0%	100%	0%	100%	95.3%
Articulated Trucks	0	5	0	0	5	0	3	1	0	4	0	0	0	0	0	0	0	0	0	0	9
% Articulated Trucks	0%	2.3%	0%	0%	2.1%	0%	4.2%	5.0%	0%	4.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2.3%
Buses and Single-Unit Trucks	0	5	0	0	5	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0	9
% Buses and Single-Unit Trucks	0%	2.3%	0%	0%	2.1%	0%	5.6%	0%	0%	4.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2.3%

* L: Left, R: Right, T: Thru, U: U-Turn

M-124 and US-12 - TMC
Tue Feb 14, 2023
AM Peak (7 AM - 8 AM)
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
All Movements
ID: 1037010, Location: 42.056618, -84.140142



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



M-124 and US-12 - TMC

Tue Feb 14, 2023

PM Peak (5 PM - 6 PM) - Overall Peak Hour

All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)

All Movements

ID: 1037010, Location: 42.056618, -84.140142



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

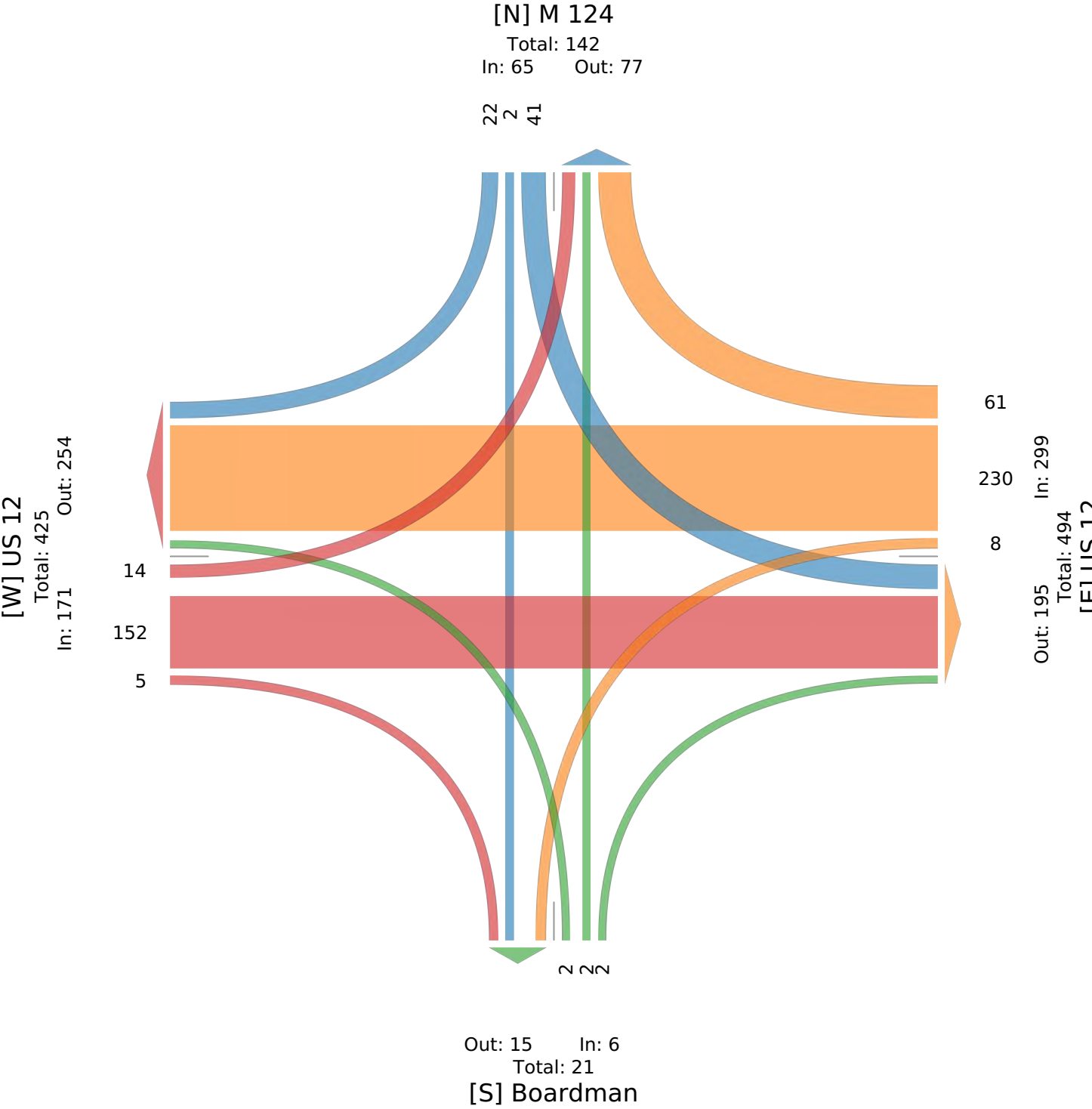
Leg Direction	US 12 Eastbound					US 12 Westbound					Boardman Northbound					M 124 Southbound					
Time	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	L	T	R	U	App	Int
2023-02-14 5:00PM	2	37	2	0	41	3	58	14	0	75	1	1	1	0	3	5	0	7	0	12	131
5:15PM	3	38	2	0	43	1	53	17	0	71	0	0	1	0	1	12	1	9	0	22	137
5:30PM	6	36	0	0	42	3	59	16	0	78	1	0	0	0	1	12	1	4	0	17	138
5:45PM	3	41	1	0	45	1	60	14	0	75	0	1	0	0	1	12	0	2	0	14	135
Total	14	152	5	0	171	8	230	61	0	299	2	2	2	0	6	41	2	22	0	65	541
% Approach	8.2%	88.9%	2.9%	0%	-	2.7%	76.9%	20.4%	0%	-	33.3%	33.3%	33.3%	0%	-	63.1%	3.1%	33.8%	0%	-	-
% Total	2.6%	28.1%	0.9%	0%	31.6%	1.5%	42.5%	11.3%	0%	55.3%	0.4%	0.4%	0.4%	0%	1.1%	7.6%	0.4%	4.1%	0%	12.0%	-
PHF	0.583	0.927	0.625	-	0.950	0.667	0.958	0.897	-	0.958	0.500	0.500	0.500	-	0.500	0.854	0.500	0.611	-	0.739	0.980
Lights	14	143	5	0	162	8	226	60	0	294	2	2	2	0	6	41	2	22	0	65	527
% Lights	100%	94.1%	100%	0%	94.7%	100%	98.3%	98.4%	0%	98.3%	100%	100%	100%	0%	100%	100%	100%	100%	0%	100%	97.4%
Articulated Trucks	0	6	0	0	6	0	3	1	0	4	0	0	0	0	0	0	0	0	0	0	10
% Articulated Trucks	0%	3.9%	0%	0%	3.5%	0%	1.3%	1.6%	0%	1.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1.8%
Buses and Single-Unit Trucks	0	3	0	0	3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	4
% Buses and Single-Unit Trucks	0%	2.0%	0%	0%	1.8%	0%	0.4%	0%	0%	0.3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.7%

* L: Left, R: Right, T: Thru, U: U-Turn

M-124 and US-12 - TMC
Tue Feb 14, 2023
PM Peak (5 PM - 6 PM) - Overall Peak Hour
All Classes (Lights, Articulated Trucks, Buses and Single-Unit Trucks)
All Movements
ID: 1037010, Location: 42.056618, -84.140142



Provided by: Gewalt Hamilton Associates Inc.
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



Appendix 2

Existing LOS Output Reports

HCM 6th TWSC
10: Hardcastle Road & Horning Road

2023 Existing Conditions
a.m. Peak Hour

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↶			↷	↶	↷
Traffic Vol, veh/h	8	0	0	2	0	0
Future Vol, veh/h	8	0	0	2	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	60	60	60
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	13	0	0	3	0	0

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	-	-	16
Stage 1	-	-	-	-	13
Stage 2	-	-	-	-	3
Critical Hdwy	-	-	-	-	6.4
Critical Hdwy Stg 1	-	-	-	-	5.4
Critical Hdwy Stg 2	-	-	-	-	5.4
Follow-up Hdwy	-	-	-	-	3.5
Pot Cap-1 Maneuver	-	-	0	-	1008
Stage 1	-	-	0	-	1015
Stage 2	-	-	0	-	1025
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	-	-	1008
Mov Cap-2 Maneuver	-	-	-	-	1008
Stage 1	-	-	-	-	1015
Stage 2	-	-	-	-	1025

Approach	EB	WB	NB
HCM Control Delay, s	0	0	0
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT
Capacity (veh/h)	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-
HCM Control Delay (s)	0	-	-	-
HCM Lane LOS	A	-	-	-
HCM 95th %tile Q(veh)	-	-	-	-

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBR	SWL	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.5	0.0	2.0

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.5	0.0	2.0

HCM 6th TWSC
12: Slip Ramp & Horning Road

2023 Existing Conditions
a.m. Peak Hour

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↑
Traffic Vol, veh/h	8	0	5	2	0	23
Future Vol, veh/h	8	0	5	2	0	23
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	63	60	82	82
Heavy Vehicles, %	0	0	0	0	4	4
Mvmt Flow	13	0	8	3	0	28

Major/Minor	Minor2	Major2	
Conflicting Flow All	19	-	0
Stage 1	19	-	-
Stage 2	0	-	-
Critical Hdwy	6.5	-	4.1
Critical Hdwy Stg 1	5.5	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	4	-	2.2
Pot Cap-1 Maneuver	879	0	-
Stage 1	884	0	-
Stage 2	-	0	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	0	-	-
Mov Cap-2 Maneuver	0	-	-
Stage 1	0	-	-
Stage 2	0	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	WBL	WBT
Capacity (veh/h)	-	-	-
HCM Lane V/C Ratio	-	-	-
HCM Control Delay (s)	-	-	-
HCM Lane LOS	-	-	-
HCM 95th %tile Q(veh)	-	-	-

HCM 6th TWSC
20: Watkins Road & Horning Road

2023 Existing Conditions
a.m. Peak Hour

Intersection						
Int Delay, s/veh	4.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	21	1	2	13	9	5
Future Vol, veh/h	21	1	2	13	9	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	66	60	60	81	75	60
Heavy Vehicles, %	0	100	0	0	11	0
Mvmt Flow	32	2	3	16	12	8
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	38	16	20	0	-	0
Stage 1	16	-	-	-	-	-
Stage 2	22	-	-	-	-	-
Critical Hdwy	6.4	7.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	4.2	2.2	-	-	-
Pot Cap-1 Maneuver	979	838	1609	-	-	-
Stage 1	1012	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	977	838	1609	-	-	-
Mov Cap-2 Maneuver	977	-	-	-	-	-
Stage 1	1010	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	8.8	1.2		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1609	-	969	-	-	
HCM Lane V/C Ratio	0.002	-	0.035	-	-	
HCM Control Delay (s)	7.2	0	8.8	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	4	30	47	7	6	11
Future Vol, veh/h	4	30	47	7	6	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	75	90	60	60	60
Heavy Vehicles, %	0	3	0	29	0	0
Mvmt Flow	7	40	52	12	10	18
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	64	0	-	0	112	58
Stage 1	-	-	-	-	58	-
Stage 2	-	-	-	-	54	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1551	-	-	-	890	1014
Stage 1	-	-	-	-	970	-
Stage 2	-	-	-	-	974	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1551	-	-	-	886	1014
Mov Cap-2 Maneuver	-	-	-	-	886	-
Stage 1	-	-	-	-	965	-
Stage 2	-	-	-	-	974	-
Approach	EB	WB		SB		
HCM Control Delay, s	1	0		8.8		
HCM LOS	A					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1551	-	-	-	965	
HCM Lane V/C Ratio	0.004	-	-	-	0.029	
HCM Control Delay (s)	7.3	0	-	-	8.8	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection						
Int Delay, s/veh	1.5					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	36	41	2	3	7
Future Vol, veh/h	6	36	41	2	3	7
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	69	64	60	60	60
Heavy Vehicles, %	0	14	5	0	0	0
Mvmt Flow	10	52	64	3	5	12
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	67	0	-	0	138	66
Stage 1	-	-	-	-	66	-
Stage 2	-	-	-	-	72	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1547	-	-	-	860	1003
Stage 1	-	-	-	-	962	-
Stage 2	-	-	-	-	956	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1547	-	-	-	854	1003
Mov Cap-2 Maneuver	-	-	-	-	854	-
Stage 1	-	-	-	-	955	-
Stage 2	-	-	-	-	956	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.2	0		8.8		
HCM LOS	A					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1547	-	-	-	953	
HCM Lane V/C Ratio	0.006	-	-	-	0.017	
HCM Control Delay (s)	7.3	0	-	-	8.8	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

HCM 6th TWSC
50: M-124 & Wellwood Road

2023 Existing Conditions
a.m. Peak Hour

Intersection												
Int Delay, s/veh	1.2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	1	1	2	7	0	0	0	32	14	0	40	0
Future Vol, veh/h	1	1	2	7	0	0	0	32	14	0	40	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	60	60	60	60	60	89	60	71	71	71
Heavy Vehicles, %	0	0	0	0	0	0	0	6	0	3	3	3
Mvmt Flow	2	2	3	12	0	0	0	36	23	0	56	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	104	115	56	107	104	-	56	0	0	-	-	0
Stage 1	56	56	-	48	48	-	-	-	-	-	-	-
Stage 2	48	59	-	59	56	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	881	779	1016	877	790	0	1562	-	-	0	-	-
Stage 1	961	852	-	971	859	0	-	-	-	0	-	-
Stage 2	971	850	-	958	852	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	881	779	1016	873	790	-	1562	-	-	-	-	-
Mov Cap-2 Maneuver	881	779	-	873	790	-	-	-	-	-	-	-
Stage 1	961	852	-	971	859	-	-	-	-	-	-	-
Stage 2	971	850	-	953	852	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	9		9.2		0		0					
HCM LOS	A		A									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBT	SBR						
Capacity (veh/h)	1562	-	-	912	873	-	-					
HCM Lane V/C Ratio	-	-	-	0.007	0.013	-	-					
HCM Control Delay (s)	0	-	-	9	9.2	-	-					
HCM Lane LOS	A	-	-	A	A	-	-					
HCM 95th %tile Q(veh)	0	-	-	0	0	-	-					

HCM 6th TWSC
51: M-124 & Slip Ramp

2023 Existing Conditions
a.m. Peak Hour

Intersection

Int Delay, s/veh 1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	13	33	0	6	40
Future Vol, veh/h	0	13	33	0	6	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	65	65	60	60	60	71
Heavy Vehicles, %	8	8	6	6	0	3
Mvmt Flow	0	20	55	0	10	56

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	-	55	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	6.28	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	3.372	-
Pot Cap-1 Maneuver	0	995	-
Stage 1	0	-	-
Stage 2	0	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	-	995	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

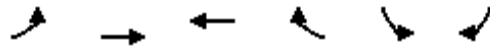
Approach	WB	NB	SB
HCM Control Delay, s	8.7	0	1.1
HCM LOS	A		

Minor Lane/Major Mvmt	NBTWBLn1	SBL	SBT
Capacity (veh/h)	-	995	1563
HCM Lane V/C Ratio	-	0.02	0.006
HCM Control Delay (s)	-	8.7	7.3
HCM Lane LOS	-	A	A
HCM 95th %tile Q(veh)	-	0.1	0

HCM Unsignalized Intersection Capacity Analysis

52: Wellwood Road & Slip Ramp

2023 Existing Conditions
a.m. Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↑	
Traffic Volume (veh/h)	0	15	7	13	6	0
Future Volume (Veh/h)	0	15	7	13	6	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.65	0.60	0.60
Hourly flow rate (vph)	0	25	12	20	10	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	32				47	22
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	32				47	22
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1593				968	1061
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	25	32	10			
Volume Left	0	0	10			
Volume Right	0	20	0			
cSH	1700	1700	968			
Volume to Capacity	0.01	0.02	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.8			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.8			
Approach LOS			A			
Intersection Summary						
Average Delay		1.3				
Intersection Capacity Utilization		13.3%	ICU Level of Service	A		
Analysis Period (min)		15				

HCM 6th TWSC
60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

2023 Existing Conditions
a.m. Peak Hour

Intersection												
Int Delay, s/veh	2.5											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕		↕			↕	
Traffic Vol, veh/h	18	215	0	0	72	20	3	1	3	47	0	7
Future Vol, veh/h	18	215	0	0	72	20	3	1	3	47	0	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	75	94	60	60	90	71	60	60	75	78	60	88
Heavy Vehicles, %	0	5	0	0	10	5	0	0	0	0	0	0
Mvmt Flow	24	229	0	0	80	28	5	2	4	60	0	8

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	108	0	0	229	0	0	375	385	229	360	357	80
Stage 1	-	-	-	-	-	-	277	277	-	80	80	-
Stage 2	-	-	-	-	-	-	98	108	-	280	277	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1495	-	-	1351	-	-	586	552	815	599	572	986
Stage 1	-	-	-	-	-	-	734	685	-	934	832	-
Stage 2	-	-	-	-	-	-	913	810	-	731	685	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1495	-	-	1351	-	-	573	542	815	586	562	986
Mov Cap-2 Maneuver	-	-	-	-	-	-	573	542	-	586	562	-
Stage 1	-	-	-	-	-	-	721	673	-	917	832	-
Stage 2	-	-	-	-	-	-	906	810	-	713	673	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.7	0	10.7	11.6
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	638	1495	-	-	1351	-	-	615
HCM Lane V/C Ratio	0.017	0.016	-	-	-	-	-	0.111
HCM Control Delay (s)	10.7	7.4	0	-	0	-	-	11.6
HCM Lane LOS	B	A	A	-	A	-	-	B
HCM 95th %tile Q(veh)	0.1	0	-	-	0	-	-	0.4

Intersection: 10: Hardcastle Road & Horning Road

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 11: Hardcastle Road & Slip Ramp

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 12: Slip Ramp & Horning Road

Movement

EB

Directions Served

T

Maximum Queue (ft)

30

Average Queue (ft)

8

95th Queue (ft)

29

Link Distance (ft)

90

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 20: Watkins Road & Horning Road

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	50	5
Average Queue (ft)	13	0
95th Queue (ft)	36	4
Link Distance (ft)	957	505
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 30: M-124 & Hardcastle Road

Movement	SB
Directions Served	LR
Maximum Queue (ft)	24
Average Queue (ft)	7
95th Queue (ft)	23
Link Distance (ft)	838
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	5	22
Average Queue (ft)	0	5
95th Queue (ft)	3	18
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB
Directions Served	LTR	LT
Maximum Queue (ft)	27	27
Average Queue (ft)	4	4
95th Queue (ft)	20	21
Link Distance (ft)	317	32
Upstream Blk Time (%)		0
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 51: M-124 & Slip Ramp

Movement	WB
Directions Served	R
Maximum Queue (ft)	46
Average Queue (ft)	10
95th Queue (ft)	35
Link Distance (ft)	73
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 52: Wellwood Road & Slip Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	NB	SB
Directions Served	LTR	LTR	LTR
Maximum Queue (ft)	24	35	53
Average Queue (ft)	2	8	20
95th Queue (ft)	12	30	41
Link Distance (ft)	745	472	476
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

HCM 6th TWSC
10: Hardcastle Road & Horning Road

2023 Existing Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	0.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	10	2	0	13	3	0
Future Vol, veh/h	10	2	0	13	3	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	60	65	75	60
Heavy Vehicles, %	0	0	0	0	33	0
Mvmt Flow	12	3	0	20	4	0

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	-	-	34
Stage 1	-	-	-	-	14
Stage 2	-	-	-	-	20
Critical Hdwy	-	-	-	-	6.73
Critical Hdwy Stg 1	-	-	-	-	5.73
Critical Hdwy Stg 2	-	-	-	-	5.73
Follow-up Hdwy	-	-	-	-	3.797
Pot Cap-1 Maneuver	-	-	0	-	906
Stage 1	-	-	0	-	934
Stage 2	-	-	0	-	928
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	-	-	906
Mov Cap-2 Maneuver	-	-	-	-	906
Stage 1	-	-	-	-	934
Stage 2	-	-	-	-	928

Approach	EB	WB	NB
HCM Control Delay, s	0	0	9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT
Capacity (veh/h)	906	-	-	-
HCM Lane V/C Ratio	0.004	-	-	-
HCM Control Delay (s)	9	-	-	-
HCM Lane LOS	A	-	-	-
HCM 95th %tile Q(veh)	0	-	-	-

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBT	NBR	SBT	SWL	All
Denied Del/Veh (s)	0.1	0.1	0.0	0.0	0.0
Total Del/Veh (s)	1.8	2.5	0.2	0.0	0.7

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.0	0.0
Total Del/Veh (s)	2.4	0.2	0.0	0.7

HCM 6th TWSC
12: Slip Ramp & Horning Road

2023 Existing Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↑
Traffic Vol, veh/h	10	0	28	13	0	8
Future Vol, veh/h	10	0	28	13	0	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	70	65	60	67
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	12	0	40	20	0	12

Major/Minor	Minor2	Major2	
Conflicting Flow All	100	-	0
Stage 1	100	-	-
Stage 2	0	-	-
Critical Hdwy	6.5	-	4.1
Critical Hdwy Stg 1	5.5	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	4	-	2.2
Pot Cap-1 Maneuver	794	0	-
Stage 1	816	0	-
Stage 2	-	0	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	0	-	-
Mov Cap-2 Maneuver	0	-	-
Stage 1	0	-	-
Stage 2	0	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	WBL	WBT
Capacity (veh/h)	-	-	-
HCM Lane V/C Ratio	-	-	-
HCM Control Delay (s)	-	-	-
HCM Lane LOS	-	-	-
HCM 95th %tile Q(veh)	-	-	-

HCM 6th TWSC
20: Watkins Road & Horning Road

2023 Existing Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	2					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	12	2	2	8	30	33
Future Vol, veh/h	12	2	2	8	30	33
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	67	83	75
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	20	3	3	12	36	44

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	76	58	80
Stage 1	58	-	-
Stage 2	18	-	-
Critical Hdwy	6.4	6.2	4.1
Critical Hdwy Stg 1	5.4	-	-
Critical Hdwy Stg 2	5.4	-	-
Follow-up Hdwy	3.5	3.3	2.2
Pot Cap-1 Maneuver	932	1014	1531
Stage 1	970	-	-
Stage 2	1010	-	-
Platoon blocked, %			
Mov Cap-1 Maneuver	930	1014	1531
Mov Cap-2 Maneuver	930	-	-
Stage 1	968	-	-
Stage 2	1010	-	-

Approach	EB	NB	SB
HCM Control Delay, s	8.9	1.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1531	-	941	-	-
HCM Lane V/C Ratio	0.002	-	0.025	-	-
HCM Control Delay (s)	7.4	0	8.9	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-

Intersection						
Int Delay, s/veh	1.4					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	11	75	71	2	3	10
Future Vol, veh/h	11	75	71	2	3	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	69	89	81	60	75	60
Heavy Vehicles, %	0	0	1	0	0	0
Mvmt Flow	16	84	88	3	4	17
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	91	0	-	0	206	90
Stage 1	-	-	-	-	90	-
Stage 2	-	-	-	-	116	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1517	-	-	-	787	973
Stage 1	-	-	-	-	939	-
Stage 2	-	-	-	-	914	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1517	-	-	-	778	973
Mov Cap-2 Maneuver	-	-	-	-	778	-
Stage 1	-	-	-	-	929	-
Stage 2	-	-	-	-	914	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.2	0		9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1517	-	-	-	928	
HCM Lane V/C Ratio	0.011	-	-	-	0.022	
HCM Control Delay (s)	7.4	0	-	-	9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection

Int Delay, s/veh 0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	70	68	5	1	5
Future Vol, veh/h	6	70	68	5	1	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	80	81	60	60	63
Heavy Vehicles, %	0	0	3	0	0	0
Mvmt Flow	10	88	84	8	2	8

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	92	0	0 196 88
Stage 1	-	-	- 88 -
Stage 2	-	-	- 108 -
Critical Hdwy	4.1	-	- 6.4 6.2
Critical Hdwy Stg 1	-	-	- 5.4 -
Critical Hdwy Stg 2	-	-	- 5.4 -
Follow-up Hdwy	2.2	-	- 3.5 3.3
Pot Cap-1 Maneuver	1515	-	- 797 976
Stage 1	-	-	- 940 -
Stage 2	-	-	- 921 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	1515	-	- 791 976
Mov Cap-2 Maneuver	-	-	- 791 -
Stage 1	-	-	- 933 -
Stage 2	-	-	- 921 -

Approach	EB	WB	SB
HCM Control Delay, s	0.8	0	8.9
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1515	-	-	-	938
HCM Lane V/C Ratio	0.007	-	-	-	0.01
HCM Control Delay (s)	7.4	0	-	-	8.9
HCM Lane LOS	A	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	-	0

Intersection												
Int Delay, s/veh	2.2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	1	3	18	1	0	3	57	14	0	46	0
Future Vol, veh/h	0	1	3	18	1	0	3	57	14	0	46	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	75	60	60	60	60	95	60	60	95	60
Heavy Vehicles, %	0	0	0	0	0	0	0	2	0	0	0	0
Mvmt Flow	0	2	4	30	2	0	5	60	23	0	48	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	131	141	48	133	130	-	48	0	0	-	-	0
Stage 1	48	48	-	82	82	-	-	-	-	-	-	-
Stage 2	83	93	-	51	48	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	846	754	1027	844	764	0	1572	-	-	0	-	-
Stage 1	971	859	-	931	831	0	-	-	-	0	-	-
Stage 2	930	822	-	967	859	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	843	752	1027	837	762	-	1572	-	-	-	-	-
Mov Cap-2 Maneuver	843	752	-	837	762	-	-	-	-	-	-	-
Stage 1	968	859	-	928	829	-	-	-	-	-	-	-
Stage 2	925	820	-	961	859	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	8.9		9.5		0.4		0					
HCM LOS	A		A									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBT	SBR					
Capacity (veh/h)	1572	-	-	927	833	-	-					
HCM Lane V/C Ratio	0.003	-	-	0.006	0.038	-	-					
HCM Control Delay (s)	7.3	0	-	8.9	9.5	-	-					
HCM Lane LOS	A	A	-	A	A	-	-					
HCM 95th %tile Q(veh)	0	-	-	0	0.1	-	-					

HCM 6th TWSC
51: M-124 & Slip Ramp

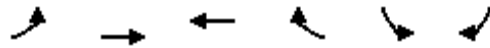
2023 Existing Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	1.8					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	11	57	0	8	46
Future Vol, veh/h	0	11	57	0	8	46
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	60	60	95	60	60	95
Heavy Vehicles, %	0	0	2	0	0	0
Mvmt Flow	0	18	60	0	13	48
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	60	0	-	60	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.2	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	0	1011	-	0	1556	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	1011	-	-	1556	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.6	0		1.6		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	- 1011		1556	-		
HCM Lane V/C Ratio	- 0.018		0.009	-		
HCM Control Delay (s)	- 8.6		7.3	0		
HCM Lane LOS	- A		A	A		
HCM 95th %tile Q(veh)	- 0.1		0	-		

HCM Unsignalized Intersection Capacity Analysis

52: Wellwood Road & Slip Ramp

2023 Existing Conditions
p.m. Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↑	
Traffic Volume (veh/h)	0	15	19	11	8	0
Future Volume (Veh/h)	0	15	19	11	8	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60
Hourly flow rate (vph)	0	25	32	18	13	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	50				66	41
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	50				66	41
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1570				944	1036
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	25	50	13			
Volume Left	0	0	13			
Volume Right	0	18	0			
cSH	1700	1700	944			
Volume to Capacity	0.01	0.03	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.9			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.9			
Approach LOS			A			
Intersection Summary						
Average Delay			1.3			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

HCM 6th TWSC
60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

2023 Existing Conditions
p.m. Peak Hour

Intersection												
Int Delay, s/veh	2.4											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	14	152	5	8	230	61	2	2	2	41	2	22
Future Vol, veh/h	14	152	5	8	230	61	2	2	2	41	2	22
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	93	63	67	95	90	60	60	60	85	60	61
Heavy Vehicles, %	0	6	0	0	2	2	0	0	0	0	0	0
Mvmt Flow	23	163	8	12	242	68	3	3	3	48	3	36
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	310	0	0	171	0	0	533	547	167	482	483	242
Stage 1	-	-	-	-	-	-	213	213	-	266	266	-
Stage 2	-	-	-	-	-	-	320	334	-	216	217	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1262	-	-	1418	-	-	461	447	882	498	486	802
Stage 1	-	-	-	-	-	-	794	730	-	744	692	-
Stage 2	-	-	-	-	-	-	696	647	-	791	727	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1262	-	-	1418	-	-	428	434	882	482	471	802
Mov Cap-2 Maneuver	-	-	-	-	-	-	428	434	-	482	471	-
Stage 1	-	-	-	-	-	-	778	715	-	729	685	-
Stage 2	-	-	-	-	-	-	655	641	-	769	712	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.9			0.3			12.1			12.4		
HCM LOS							B			B		
Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1				
Capacity (veh/h)	520	1262	-	-	1418	-	-	576				
HCM Lane V/C Ratio	0.019	0.018	-	-	0.008	-	-	0.152				
HCM Control Delay (s)	12.1	7.9	0	-	7.6	0	-	12.4				
HCM Lane LOS	B	A	A	-	A	A	-	B				
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.5				

Intersection: 10: Hardcastle Road & Horning Road

Movement	NB
Directions Served	L
Maximum Queue (ft)	34
Average Queue (ft)	3
95th Queue (ft)	21
Link Distance (ft)	81
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 11: Hardcastle Road & Slip Ramp

Movement	SB
Directions Served	T
Maximum Queue (ft)	5
Average Queue (ft)	0
95th Queue (ft)	4
Link Distance (ft)	81
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 12: Slip Ramp & Horning Road

Movement	EB
Directions Served	T
Maximum Queue (ft)	29
Average Queue (ft)	6
95th Queue (ft)	25
Link Distance (ft)	90
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 20: Watkins Road & Horning Road

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	26	5
Average Queue (ft)	8	0
95th Queue (ft)	26	3
Link Distance (ft)	957	505
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 30: M-124 & Hardcastle Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	15	25
Average Queue (ft)	1	7
95th Queue (ft)	9	22
Link Distance (ft)	635	838
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	4	17
Average Queue (ft)	0	3
95th Queue (ft)	3	12
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB	NB
Directions Served	LTR	LT	LTR
Maximum Queue (ft)	28	31	6
Average Queue (ft)	6	12	0
95th Queue (ft)	25	34	4
Link Distance (ft)	317	32	465
Upstream Blk Time (%)		1	
Queuing Penalty (veh)		0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 51: M-124 & Slip Ramp

Movement	WB	SB
Directions Served	R	LT
Maximum Queue (ft)	35	5
Average Queue (ft)	9	0
95th Queue (ft)	30	5
Link Distance (ft)	73	503
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 52: Wellwood Road & Slip Ramp

Movement	WB
Directions Served	TR
Maximum Queue (ft)	23
Average Queue (ft)	1
95th Queue (ft)	8
Link Distance (ft)	970
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	WB	NB	SB
Directions Served	LTR	LT	LTR	LTR
Maximum Queue (ft)	44	29	31	54
Average Queue (ft)	3	2	6	22
95th Queue (ft)	20	14	25	41
Link Distance (ft)	745	713	472	476
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

Appendix 3

Crash Data

Intersection of M-124 and Wellwood Road

Crash Data 2018 - 2022

ID #	Date	Crash Type	Road Conditions	Light	Injury	Alcohol or Drugs	Cause
2022124087	6/13/2022	Head-On Left Turn	Dry	Daylight	A	No	A vehicle was southbound on M-124, attempted to turn left onto eastbound Wellwood Road, and struck a motorcyclist who was driving westbound on M-124. The motorcyclist had the right of way.

Authority: 1949 PA 300, Sec.257.622
Compliance: Required MSP UD-10E
Penalty: \$100 and/or 90 days (Rev 11/2020)

External # 0116742
Crash ID 2605480

Page 01 of 01
File Class 93001

STATE OF MICHIGAN TRAFFIC CRASH REPORT

ORI MI 3813800		Department Name Jackson Co Sheriff's Office				Incident # 1381080022						
Crash Date 06/13/2022		Crash Time 14:41	No. of Units 02	Crash Type Head On-Left Turn	Special Circumstances ☒ None ☐ Fleeing Police ☐ Hit and Run ☐ Unknown ☐ School Bus ☐ Animal			Special Checks ☐ Fatal ☐ Non-Traffic Area ☐ ORV/Snowmobile				
County 38 - Jackson		Traffic Control None		Relation to Roadway On the Road		Weather Clear		Area INTR Other Related				
City/Twsp 10 - Norvell Twp		Contributing Circumstances 1st None		2nd		Light Daylight		Road Surface Condition Dry		Total Lanes 02	Speed Limit 35	Posted Yes
Work Zone (if applicable) Type Workers Present Activity Location												

LOCATION	Prefix		Primary Road Name WAMPLERS LAKE		Road Type RD		Suffix		Divided Roadway			
	Distance / Direction 20 Feet NW		Trafficway Not Physically Divided									
	Prefix		Intersecting Road Name WELLWOOD/WAMPLERS LAKE		Road Type CUTO		Suffix		Divided Roadway			

UNIT / DRIVER	Unit Number 01	Unit Known Yes	State MI	Driver License Number #####	Date of Birth (Age) ###/###/#### (53)	License Type ☒ Operator ☐ Chauffeur ☐ Moped	Endorsements ☐ Cycle ☐ Farm ☐ Recreation	Sex F	Race W	Total Occupants 03	Hazardous Action Careless Driving	
	Unit Type MV	Driver Information ##### TIPTON, MI 49287 (###) ###-####				Driver is Owner Yes	Injury O	Position Front - Left		Restraint Shoulder and Lap Belt		
	Driver Condition at Time of Crash 1st Appeared Normal				2nd		Driver Distracted By Not Distracted		Ejected	Trapped	Airbag Deployed Deployed - Front	
	Hospital NONE		Ambulance NONE									
	Alcohol Suspected No	Contributing Factor No	Alcohol Test Type ☐ Breath ☐ Blood ☐ Urine ☐ Field ☐ PBT ☐ Refused ☒ Not Offered			Alcohol Test Results ☐ Pending Test Results:		Interlock Device No				
	Drug Suspected No	Contributing Factor No	Drug Test Type ☐ Blood ☐ Urine ☐ Field ☐ Refused ☒ Not Offered			Drug Test Results ☐ Pending Test Results:		Citation Issued ☒ Hazardous CARELESS DRIVING ☐ Other				
	Vehicle Registration DHH4396		State MI	Vehicle Description 2019		Make CHRYSLER	Model PACIFICA		Color BLU			
	VIN 2C4RC1GGXKR722088		Vehicle Type Passenger Car, SUV, Van		Special Vehicles Not Applicable		Private Trailer Type		Vehicle Defect			
	Automation System(s) in Vehicle No		Automation System Level in Vehicle No Automation				Automation System Level Engaged at Time of Crash Automation Level Unknown					
	Insurance Company #####			Insurance Policy # #####			Towed By RALPHS			Towed To ASHLEYS BODY SHOP		

PASSENGERS	Passenger Information ##### TIPTON, MI 49287 (###) ###-####				Date of Birth (Age) ###/###/#### (67)	Sex F	Race W	Position 2nd Row - Right		Restraint Shoulder and Lap Belt		
					Injury O	Ejected	Trapped	Airbag Deployed Not Equipped				
	Hospital NONE				Ambulance NONE							
	Passenger Information ##### TIPTON, MI 49287 (###) ###-####				Date of Birth (Age) ###/###/#### (1)	Sex F	Race W	Position 2nd Row - Left		Restraint Child - Rear Facing		
					Injury O	Ejected	Trapped	Airbag Deployed Not Equipped				

TRUCK / BUS	Carrier Information				USDOT		MC	MPSC				
					Driver's CDL Type		Endorsements ☐ H ☐ P ☐ T ☐ N ☐ S ☐ X		CDL Exempt ☐ Farm ☐ Other			
	GVWR/GCWR ☐ 10,000 lbs. or Less ☐ 10,001 - 26,000 lbs. ☐ Greater than 26,000 lbs.		Vehicle Configuration		Cargo Body Type		Medical Card		Hazardous Material ☐ Placard ☐ Cargo Spill		ID #	Class #

OWNERS	Owner Information				Owner Information			

Damaged Property		Public	Owner & Phone	

Appendix 4

Background LOS Output Reports

HCM 6th TWSC
10: Hardcastle Road & Horning Road

2026 Background Conditions
a.m. Peak Hour

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↱	↱	
Traffic Vol, veh/h	8	0	0	2	0	0
Future Vol, veh/h	8	0	0	2	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	60	60	60
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	13	0	0	3	0	0
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	-	-	16	-
Stage 1	-	-	-	-	13	-
Stage 2	-	-	-	-	3	-
Critical Hdwy	-	-	-	-	6.4	-
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	-	-	-	-	3.5	-
Pot Cap-1 Maneuver	-	-	0	-	1008	0
Stage 1	-	-	0	-	1015	0
Stage 2	-	-	0	-	1025	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	1008	-
Mov Cap-2 Maneuver	-	-	-	-	1008	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	1025	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0		0	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT		
Capacity (veh/h)	-	-	-	-		
HCM Lane V/C Ratio	-	-	-	-		
HCM Control Delay (s)	0	-	-	-		
HCM Lane LOS	A	-	-	-		
HCM 95th %tile Q(veh)	-	-	-	-		

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBR	SWL	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.4	0.0	2.1

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.5	0.0	2.1

HCM 6th TWSC
12: Slip Ramp & Horning Road

2026 Background Conditions
a.m. Peak Hour

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↑
Traffic Vol, veh/h	8	0	5	2	0	23
Future Vol, veh/h	8	0	5	2	0	23
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	63	60	82	82
Heavy Vehicles, %	0	0	0	0	4	4
Mvmt Flow	13	0	8	3	0	28

Major/Minor	Minor2	Major2	
Conflicting Flow All	19	-	0
Stage 1	19	-	-
Stage 2	0	-	-
Critical Hdwy	6.5	-	4.1
Critical Hdwy Stg 1	5.5	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	4	-	2.2
Pot Cap-1 Maneuver	879	0	-
Stage 1	884	0	-
Stage 2	-	0	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	0	-	-
Mov Cap-2 Maneuver	0	-	-
Stage 1	0	-	-
Stage 2	0	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	WBL	WBT
Capacity (veh/h)	-	-	-
HCM Lane V/C Ratio	-	-	-
HCM Control Delay (s)	-	-	-
HCM Lane LOS	-	-	-
HCM 95th %tile Q(veh)	-	-	-

HCM 6th TWSC
20: Watkins Road & Horning Road

2026 Background Conditions
a.m. Peak Hour

Intersection						
Int Delay, s/veh	4.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	21	1	2	13	9	5
Future Vol, veh/h	21	1	2	13	9	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	66	60	60	81	75	60
Heavy Vehicles, %	0	100	0	0	11	0
Mvmt Flow	32	2	3	16	12	8
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	38	16	20	0	-	0
Stage 1	16	-	-	-	-	-
Stage 2	22	-	-	-	-	-
Critical Hdwy	6.4	7.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	4.2	2.2	-	-	-
Pot Cap-1 Maneuver	979	838	1609	-	-	-
Stage 1	1012	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	977	838	1609	-	-	-
Mov Cap-2 Maneuver	977	-	-	-	-	-
Stage 1	1010	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	8.8	1.2		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1609	-	969	-	-	
HCM Lane V/C Ratio	0.002	-	0.035	-	-	
HCM Control Delay (s)	7.2	0	8.8	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	4	30	48	7	6	11
Future Vol, veh/h	4	30	48	7	6	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	75	90	60	60	60
Heavy Vehicles, %	0	3	0	29	0	0
Mvmt Flow	7	40	53	12	10	18
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	65	0	-	0	113	59
Stage 1	-	-	-	-	59	-
Stage 2	-	-	-	-	54	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1550	-	-	-	888	1012
Stage 1	-	-	-	-	969	-
Stage 2	-	-	-	-	974	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1550	-	-	-	884	1012
Mov Cap-2 Maneuver	-	-	-	-	884	-
Stage 1	-	-	-	-	964	-
Stage 2	-	-	-	-	974	-
Approach	EB	WB		SB		
HCM Control Delay, s	1	0		8.9		
HCM LOS	A					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1550	-	-	-	963	
HCM Lane V/C Ratio	0.004	-	-	-	0.029	
HCM Control Delay (s)	7.3	0	-	-	8.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

HCM 6th TWSC
40: M-124 & Lawrence Road

2026 Background Conditions
a.m. Peak Hour

Intersection						
Int Delay, s/veh	1.5					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	37	42	2	3	7
Future Vol, veh/h	6	37	42	2	3	7
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	69	64	60	60	60
Heavy Vehicles, %	0	14	5	0	0	0
Mvmt Flow	10	54	66	3	5	12
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	69	0	-	0	142	68
Stage 1	-	-	-	-	68	-
Stage 2	-	-	-	-	74	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1545	-	-	-	856	1001
Stage 1	-	-	-	-	960	-
Stage 2	-	-	-	-	954	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1545	-	-	-	850	1001
Mov Cap-2 Maneuver	-	-	-	-	850	-
Stage 1	-	-	-	-	953	-
Stage 2	-	-	-	-	954	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.2	0		8.9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1545	-	-	-	950	
HCM Lane V/C Ratio	0.006	-	-	-	0.018	
HCM Control Delay (s)	7.3	0	-	-	8.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

HCM 6th TWSC
50: M-124 & Wellwood Road

2026 Background Conditions
a.m. Peak Hour

Intersection												
Int Delay, s/veh	1.2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	1	2	7	0	0	0	32	14	0	41	0
Future Vol, veh/h	1	1	2	7	0	0	0	32	14	0	41	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	60	60	60	60	60	89	60	71	71	71
Heavy Vehicles, %	0	0	0	0	0	0	0	6	0	3	3	3
Mvmt Flow	2	2	3	12	0	0	0	36	23	0	58	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	106	117	58	109	106	-	58	0	0	-	-	0
Stage 1	58	58	-	48	48	-	-	-	-	-	-	-
Stage 2	48	59	-	61	58	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	878	777	1014	874	788	0	1559	-	-	0	-	-
Stage 1	959	851	-	971	859	0	-	-	-	0	-	-
Stage 2	971	850	-	955	851	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	878	777	1014	870	788	-	1559	-	-	-	-	-
Mov Cap-2 Maneuver	878	777	-	870	788	-	-	-	-	-	-	-
Stage 1	959	851	-	971	859	-	-	-	-	-	-	-
Stage 2	971	850	-	950	851	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	9		9.2		0		0					
HCM LOS	A		A									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBT	SBR					
Capacity (veh/h)	1559	-	-	909	870	-	-					
HCM Lane V/C Ratio	-	-	-	0.007	0.013	-	-					
HCM Control Delay (s)	0	-	-	9	9.2	-	-					
HCM Lane LOS	A	-	-	A	A	-	-					
HCM 95th %tile Q(veh)	0	-	-	0	0	-	-					

HCM 6th TWSC
51: M-124 & Slip Ramp

2026 Background Conditions
a.m. Peak Hour

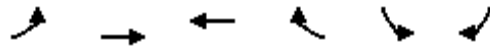
Intersection						
Int Delay, s/veh	1.7					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	13	33	0	6	41
Future Vol, veh/h	0	13	33	0	6	41
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	65	65	60	60	60	71
Heavy Vehicles, %	8	8	6	6	0	3
Mvmt Flow	0	20	55	0	10	58
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	55	0	-	55	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.28	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.372	-	-	2.2	-
Pot Cap-1 Maneuver	0	995	-	0	1563	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	995	-	-	1563	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.7	0		1.1		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	- 995		1563	-		
HCM Lane V/C Ratio	- 0.02		0.006	-		
HCM Control Delay (s)	- 8.7		7.3	0		
HCM Lane LOS	- A		A	A		
HCM 95th %tile Q(veh)	- 0.1		0	-		

HCM Unsignalized Intersection Capacity Analysis

52: Wellwood Road & Slip Ramp

2026 Background Conditions

a.m. Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↑	
Traffic Volume (veh/h)	0	15	7	13	6	0
Future Volume (Veh/h)	0	15	7	13	6	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.65	0.60	0.60
Hourly flow rate (vph)	0	25	12	20	10	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	32				47	22
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	32				47	22
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1593				968	1061
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	25	32	10			
Volume Left	0	0	10			
Volume Right	0	20	0			
cSH	1700	1700	968			
Volume to Capacity	0.01	0.02	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.8			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.8			
Approach LOS			A			
Intersection Summary						
Average Delay			1.3			
Intersection Capacity Utilization			13.3%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM 6th TWSC
60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

2026 Background Conditions

a.m. Peak Hour

Intersection												
Int Delay, s/veh	2.5											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕		↕			↕	
Traffic Vol, veh/h	18	218	0	0	73	20	3	1	3	48	0	7
Future Vol, veh/h	18	218	0	0	73	20	3	1	3	48	0	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	75	94	60	60	90	71	60	60	75	78	60	88
Heavy Vehicles, %	0	5	0	0	10	5	0	0	0	0	0	0
Mvmt Flow	24	232	0	0	81	28	5	2	4	62	0	8

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	109	0	0	232	0	0	379	389	232	364	361	81
Stage 1	-	-	-	-	-	-	280	280	-	81	81	-
Stage 2	-	-	-	-	-	-	99	109	-	283	280	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1494	-	-	1348	-	-	582	549	812	596	569	985
Stage 1	-	-	-	-	-	-	731	683	-	932	832	-
Stage 2	-	-	-	-	-	-	912	809	-	728	683	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1494	-	-	1348	-	-	569	539	812	583	559	985
Mov Cap-2 Maneuver	-	-	-	-	-	-	569	539	-	583	559	-
Stage 1	-	-	-	-	-	-	718	671	-	915	832	-
Stage 2	-	-	-	-	-	-	905	809	-	710	671	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.7	0	10.8	11.6
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	635	1494	-	-	1348	-	-	612
HCM Lane V/C Ratio	0.017	0.016	-	-	-	-	-	0.114
HCM Control Delay (s)	10.8	7.4	0	-	0	-	-	11.6
HCM Lane LOS	B	A	A	-	A	-	-	B
HCM 95th %tile Q(veh)	0.1	0	-	-	0	-	-	0.4

Intersection: 10: Hardcastle Road & Horning Road

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 11: Hardcastle Road & Slip Ramp

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 12: Slip Ramp & Horning Road

Movement

EB

Directions Served

T

Maximum Queue (ft)

30

Average Queue (ft)

8

95th Queue (ft)

29

Link Distance (ft)

90

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 20: Watkins Road & Horning Road

Movement	EB
Directions Served	LR
Maximum Queue (ft)	45
Average Queue (ft)	12
95th Queue (ft)	34
Link Distance (ft)	957
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 30: M-124 & Hardcastle Road

Movement	SB
Directions Served	LR
Maximum Queue (ft)	24
Average Queue (ft)	7
95th Queue (ft)	23
Link Distance (ft)	838
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	10	22
Average Queue (ft)	0	5
95th Queue (ft)	5	18
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB
Directions Served	LTR	LT
Maximum Queue (ft)	27	27
Average Queue (ft)	4	5
95th Queue (ft)	20	22
Link Distance (ft)	317	32
Upstream Blk Time (%)		0
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 51: M-124 & Slip Ramp

Movement	WB
Directions Served	R
Maximum Queue (ft)	50
Average Queue (ft)	11
95th Queue (ft)	36
Link Distance (ft)	73
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 52: Wellwood Road & Slip Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	NB	SB
Directions Served	LTR	LTR	LTR
Maximum Queue (ft)	21	36	54
Average Queue (ft)	2	8	20
95th Queue (ft)	12	31	42
Link Distance (ft)	745	472	476
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

HCM 6th TWSC
10: Hardcastle Road & Horning Road

2026 Background Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	0.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	10	2	0	13	3	0
Future Vol, veh/h	10	2	0	13	3	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	60	65	75	60
Heavy Vehicles, %	0	0	0	0	33	0
Mvmt Flow	12	3	0	20	4	0

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	-	-	34
Stage 1	-	-	-	-	14
Stage 2	-	-	-	-	20
Critical Hdwy	-	-	-	-	6.73
Critical Hdwy Stg 1	-	-	-	-	5.73
Critical Hdwy Stg 2	-	-	-	-	5.73
Follow-up Hdwy	-	-	-	-	3.797
Pot Cap-1 Maneuver	-	-	0	-	906
Stage 1	-	-	0	-	934
Stage 2	-	-	0	-	928
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	-	-	906
Mov Cap-2 Maneuver	-	-	-	-	906
Stage 1	-	-	-	-	934
Stage 2	-	-	-	-	928

Approach	EB	WB	NB
HCM Control Delay, s	0	0	9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT
Capacity (veh/h)	906	-	-	-
HCM Lane V/C Ratio	0.004	-	-	-
HCM Control Delay (s)	9	-	-	-
HCM Lane LOS	A	-	-	-
HCM 95th %tile Q(veh)	0	-	-	-

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBT	NBR	SBT	SWL	All
Denied Del/Veh (s)	0.1	0.1	0.0	0.0	0.0
Total Del/Veh (s)	2.0	2.3	0.4	0.0	0.7

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.0	0.0
Total Del/Veh (s)	2.3	0.4	0.0	0.7

HCM 6th TWSC
12: Slip Ramp & Horning Road

2026 Background Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↑
Traffic Vol, veh/h	10	0	28	13	0	8
Future Vol, veh/h	10	0	28	13	0	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	70	65	60	67
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	12	0	40	20	0	12

Major/Minor	Minor2	Major2	
Conflicting Flow All	100	-	0
Stage 1	100	-	-
Stage 2	0	-	-
Critical Hdwy	6.5	-	4.1
Critical Hdwy Stg 1	5.5	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	4	-	2.2
Pot Cap-1 Maneuver	794	0	-
Stage 1	816	0	-
Stage 2	-	0	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	0	-	-
Mov Cap-2 Maneuver	0	-	-
Stage 1	0	-	-
Stage 2	0	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	WBL	WBT
Capacity (veh/h)	-	-	-
HCM Lane V/C Ratio	-	-	-
HCM Control Delay (s)	-	-	-
HCM Lane LOS	-	-	-
HCM 95th %tile Q(veh)	-	-	-

HCM 6th TWSC
20: Watkins Road & Horning Road

2026 Background Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	2					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	12	2	2	8	30	33
Future Vol, veh/h	12	2	2	8	30	33
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	67	83	75
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	20	3	3	12	36	44
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	76	58	80	0	-	0
Stage 1	58	-	-	-	-	-
Stage 2	18	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.2	-	-	-
Pot Cap-1 Maneuver	932	1014	1531	-	-	-
Stage 1	970	-	-	-	-	-
Stage 2	1010	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	930	1014	1531	-	-	-
Mov Cap-2 Maneuver	930	-	-	-	-	-
Stage 1	968	-	-	-	-	-
Stage 2	1010	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	8.9	1.6		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1531	-	941	-	-	
HCM Lane V/C Ratio	0.002	-	0.025	-	-	
HCM Control Delay (s)	7.4	0	8.9	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection						
Int Delay, s/veh	1.4					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	11	76	72	2	3	10
Future Vol, veh/h	11	76	72	2	3	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	69	89	81	60	75	60
Heavy Vehicles, %	0	0	1	0	0	0
Mvmt Flow	16	85	89	3	4	17
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	92	0	-	0	208	91
Stage 1	-	-	-	-	91	-
Stage 2	-	-	-	-	117	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1515	-	-	-	785	972
Stage 1	-	-	-	-	938	-
Stage 2	-	-	-	-	913	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1515	-	-	-	776	972
Mov Cap-2 Maneuver	-	-	-	-	776	-
Stage 1	-	-	-	-	928	-
Stage 2	-	-	-	-	913	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.2	0		9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1515	-	-	-	927	
HCM Lane V/C Ratio	0.011	-	-	-	0.022	
HCM Control Delay (s)	7.4	0	-	-	9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection						
Int Delay, s/veh	0.8					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	71	69	5	1	5
Future Vol, veh/h	6	71	69	5	1	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	80	81	60	60	63
Heavy Vehicles, %	0	0	3	0	0	0
Mvmt Flow	10	89	85	8	2	8
Major/Minor	Major1	Major2	Minor2			
Conflicting Flow All	93	0	-	0	198	89
Stage 1	-	-	-	-	89	-
Stage 2	-	-	-	-	109	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1514	-	-	-	795	975
Stage 1	-	-	-	-	940	-
Stage 2	-	-	-	-	921	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1514	-	-	-	789	975
Mov Cap-2 Maneuver	-	-	-	-	789	-
Stage 1	-	-	-	-	933	-
Stage 2	-	-	-	-	921	-
Approach	EB	WB		SB		
HCM Control Delay, s	0.7	0		8.9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1514	-	-	-	937	
HCM Lane V/C Ratio	0.007	-	-	-	0.01	
HCM Control Delay (s)	7.4	0	-	-	8.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0	

Intersection												
Int Delay, s/veh	2.2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	1	3	18	1	0	3	58	14	0	47	0
Future Vol, veh/h	0	1	3	18	1	0	3	58	14	0	47	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	75	60	60	60	60	95	60	60	95	60
Heavy Vehicles, %	0	0	0	0	0	0	0	2	0	0	0	0
Mvmt Flow	0	2	4	30	2	0	5	61	23	0	49	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	133	143	49	135	132	-	49	0	0	-	-	0
Stage 1	49	49	-	83	83	-	-	-	-	-	-	-
Stage 2	84	94	-	52	49	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	844	752	1025	841	762	0	1571	-	-	0	-	-
Stage 1	969	858	-	930	830	0	-	-	-	0	-	-
Stage 2	929	821	-	966	858	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	841	750	1025	834	760	-	1571	-	-	-	-	-
Mov Cap-2 Maneuver	841	750	-	834	760	-	-	-	-	-	-	-
Stage 1	966	858	-	927	828	-	-	-	-	-	-	-
Stage 2	924	819	-	960	858	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	8.9		9.5		0.4		0					
HCM LOS	A		A									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBT	SBR					
Capacity (veh/h)	1571	-	-	925	830	-	-					
HCM Lane V/C Ratio	0.003	-	-	0.006	0.038	-	-					
HCM Control Delay (s)	7.3	0	-	8.9	9.5	-	-					
HCM Lane LOS	A	A	-	A	A	-	-					
HCM 95th %tile Q(veh)	0	-	-	0	0.1	-	-					

HCM 6th TWSC
51: M-124 & Slip Ramp

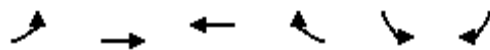
2026 Background Conditions
p.m. Peak Hour

Intersection						
Int Delay, s/veh	1.8					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	11	58	0	8	47
Future Vol, veh/h	0	11	58	0	8	47
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	60	60	95	60	60	95
Heavy Vehicles, %	0	0	2	0	0	0
Mvmt Flow	0	18	61	0	13	49
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	61	0	-	61	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.2	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	0	1010	-	0	1555	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	1010	-	-	1555	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.6	0		1.6		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	- 1010		1555	-		
HCM Lane V/C Ratio	- 0.018		0.009	-		
HCM Control Delay (s)	- 8.6		7.3	0		
HCM Lane LOS	- A		A	A		
HCM 95th %tile Q(veh)	- 0.1		0	-		

HCM Unsignalized Intersection Capacity Analysis

52: Wellwood Road & Slip Ramp

2026 Background Conditions
p.m. Peak Hour



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↱		↱	
Traffic Volume (veh/h)	0	15	19	11	8	0
Future Volume (Veh/h)	0	15	19	11	8	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60
Hourly flow rate (vph)	0	25	32	18	13	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	50				66	41
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	50				66	41
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1570				944	1036
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	25	50	13			
Volume Left	0	0	13			
Volume Right	0	18	0			
cSH	1700	1700	944			
Volume to Capacity	0.01	0.03	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.9			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.9			
Approach LOS			A			
Intersection Summary						
Average Delay			1.3			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

HCM 6th TWSC
60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

2026 Background Conditions
p.m. Peak Hour

Intersection												
Int Delay, s/veh	2.4											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕		↕			↕	
Traffic Vol, veh/h	14	154	5	8	233	62	2	2	2	42	2	22
Future Vol, veh/h	14	154	5	8	233	62	2	2	2	42	2	22
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	93	63	67	95	90	60	60	60	85	60	61
Heavy Vehicles, %	0	6	0	0	2	2	0	0	0	0	0	0
Mvmt Flow	23	166	8	12	245	69	3	3	3	49	3	36

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	314	0	0	174	0	0	539	554	170	488	489	245
Stage 1	-	-	-	-	-	-	216	216	-	269	269	-
Stage 2	-	-	-	-	-	-	323	338	-	219	220	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1258	-	-	1415	-	-	456	443	879	493	482	799
Stage 1	-	-	-	-	-	-	791	728	-	741	690	-
Stage 2	-	-	-	-	-	-	693	644	-	788	725	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1258	-	-	1415	-	-	423	430	879	477	468	799
Mov Cap-2 Maneuver	-	-	-	-	-	-	423	430	-	477	468	-
Stage 1	-	-	-	-	-	-	775	713	-	726	683	-
Stage 2	-	-	-	-	-	-	652	638	-	766	711	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.9			0.3			12.1			12.5		
HCM LOS							B			B		

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	515	1258	-	-	1415	-	-	570
HCM Lane V/C Ratio	0.019	0.019	-	-	0.008	-	-	0.156
HCM Control Delay (s)	12.1	7.9	0	-	7.6	0	-	12.5
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.5

Intersection: 10: Hardcastle Road & Horning Road

Movement	NB
Directions Served	L
Maximum Queue (ft)	39
Average Queue (ft)	3
95th Queue (ft)	20
Link Distance (ft)	81
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 11: Hardcastle Road & Slip Ramp

Movement	SB
Directions Served	T
Maximum Queue (ft)	5
Average Queue (ft)	0
95th Queue (ft)	4
Link Distance (ft)	81
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 12: Slip Ramp & Horning Road

Movement	EB
Directions Served	T
Maximum Queue (ft)	29
Average Queue (ft)	8
95th Queue (ft)	28
Link Distance (ft)	90
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 20: Watkins Road & Horning Road

Movement	EB
Directions Served	LR
Maximum Queue (ft)	26
Average Queue (ft)	8
95th Queue (ft)	25
Link Distance (ft)	957
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 30: M-124 & Hardcastle Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	15	24
Average Queue (ft)	1	7
95th Queue (ft)	10	22
Link Distance (ft)	635	838
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	9	17
Average Queue (ft)	0	3
95th Queue (ft)	5	12
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB	NB
Directions Served	LTR	LT	LTR
Maximum Queue (ft)	28	30	6
Average Queue (ft)	5	12	0
95th Queue (ft)	23	34	4
Link Distance (ft)	317	32	465
Upstream Blk Time (%)		1	
Queuing Penalty (veh)		0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 51: M-124 & Slip Ramp

Movement	WB	SB
Directions Served	R	LT
Maximum Queue (ft)	35	5
Average Queue (ft)	9	0
95th Queue (ft)	30	5
Link Distance (ft)	73	503
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 52: Wellwood Road & Slip Ramp

Movement	WB
Directions Served	TR
Maximum Queue (ft)	17
Average Queue (ft)	1
95th Queue (ft)	7
Link Distance (ft)	970
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	WB	NB	SB
Directions Served	LTR	LT	LTR	LTR
Maximum Queue (ft)	44	29	35	54
Average Queue (ft)	3	2	6	22
95th Queue (ft)	21	14	27	43
Link Distance (ft)	745	713	472	476
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

Appendix 5

Turn Lane Charts

Haul Route A (Watkins Road)

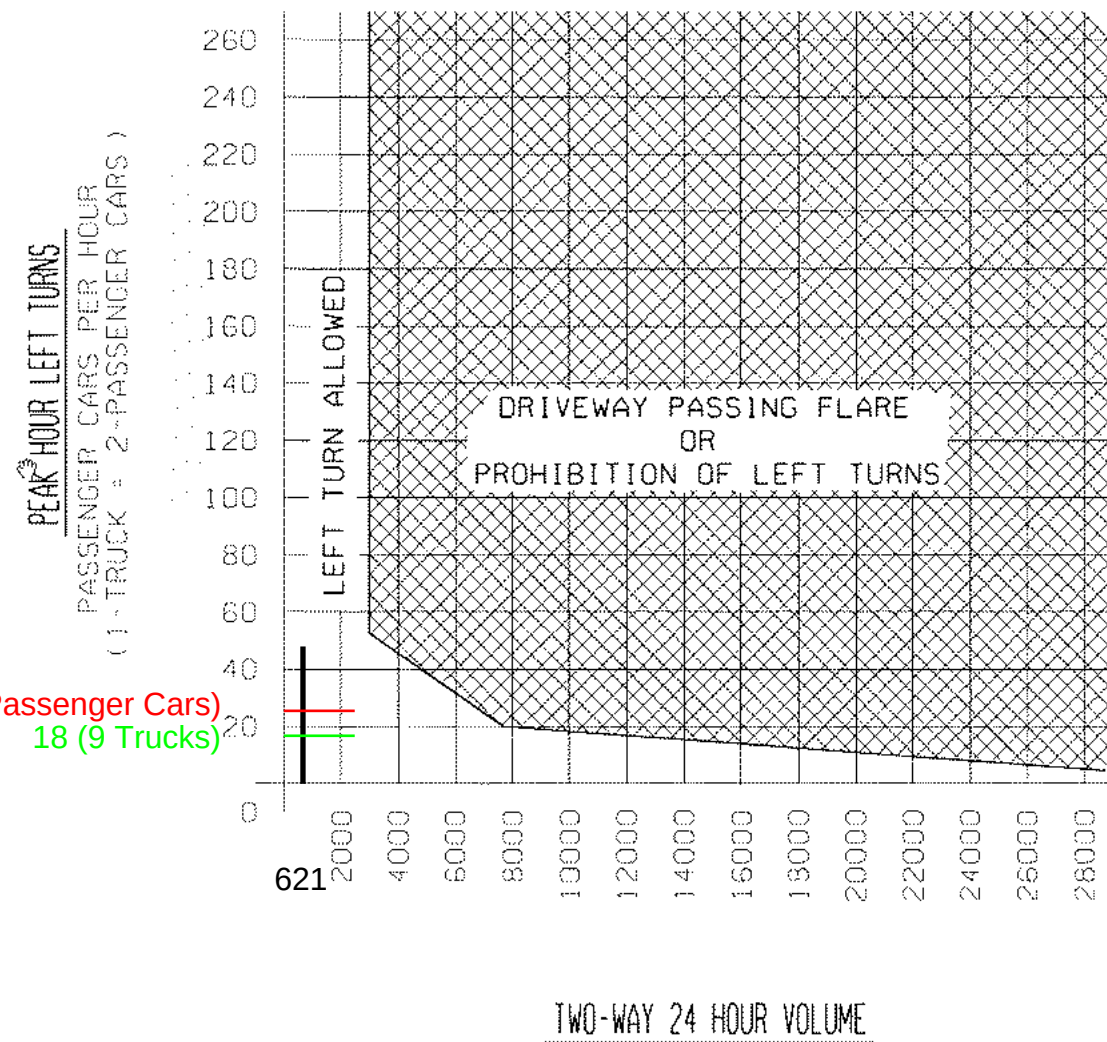
1.2.3 Traffic Volume Guidelines for Driveway Passing Flares

Driveways serving large developments along state trunkline highways frequently generate large numbers of left-turns. On two-lane, two-way roadways, this situation can aggravate the efficiency of traffic operations and often make shoulder maintenance difficult. In such situations, prohibition of left-turns at driveways to large developments or construction of driveway passing flares should be considered.

In an attempt to alleviate the types of problems outlined above, the following chart is provided showing the relationship between peak hour left-turns and 24-hour volumes. When peak hour left-turns and 24-hour volumes fall within the area above and to the right of the trend line, left-turns should be prohibited or a driveway passing flare be installed. If a driveway passing flare is constructed, the entire cost should be borne by the developer. For additional information and geometric design guidance regarding driveway passing flares, please refer to [Geometric Design Guide GEO-650](#).

Watkins Road and Site Driveway a.m. Peak Hour

Watkins Road and Site Driveway p.m. Peak Hour



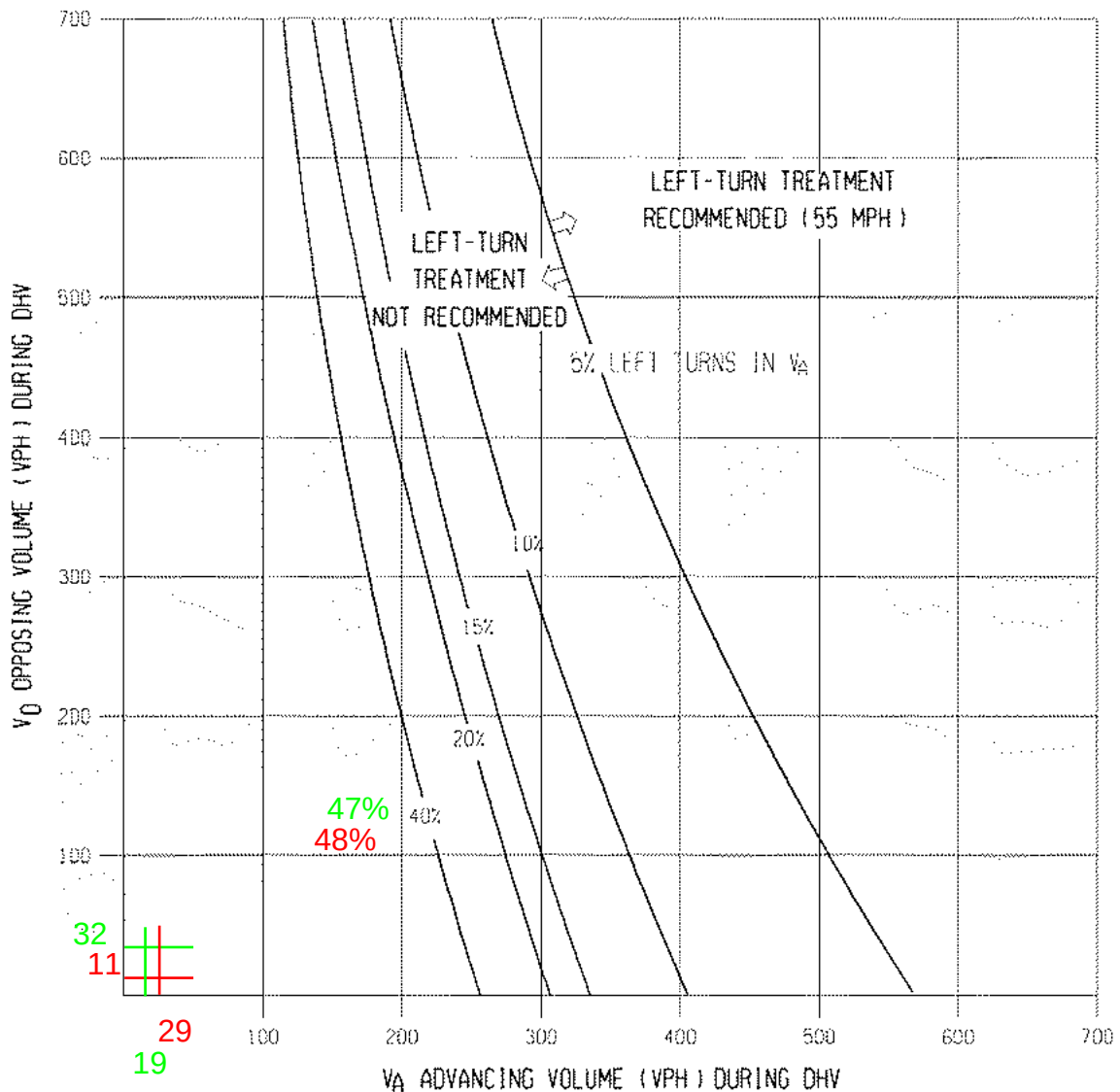
NOTE: This chart is based on Total Development and is for Two-Way Roadways.

Haul Route A (Watkins Road)

Watkins Road and Site Driveway a.m. Peak Hour

Watkins Road and Site Driveway p.m. Peak Hour

TWO-LANE HIGHWAYS WITH A POSTED SPEED OF 55 MPH OR GREATER



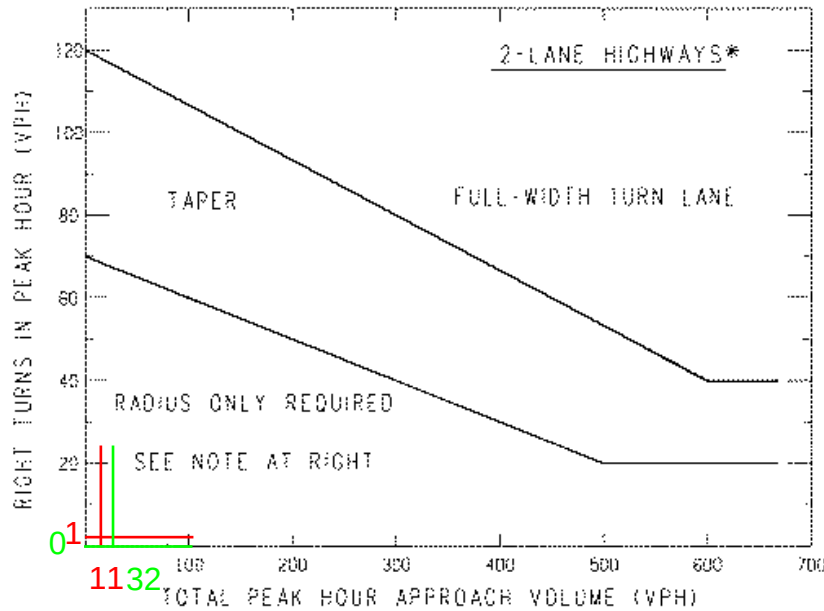
Instructions:

1. The family of curves represent the percentage of left turns in advancing volume (V_A). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of 5, the designer should estimate where the curve lies.
2. Read V_A and V_O into the chart and locate the intersection of the two volumes.
3. Note the location of the point in #2 relative to the line in #1. If the point is to the right of the line, then a left-turn lane is recommended. If the point is to the left of the line, then a left-turn is not recommended based on traffic volumes.

Haul Route A (Watkins Road)

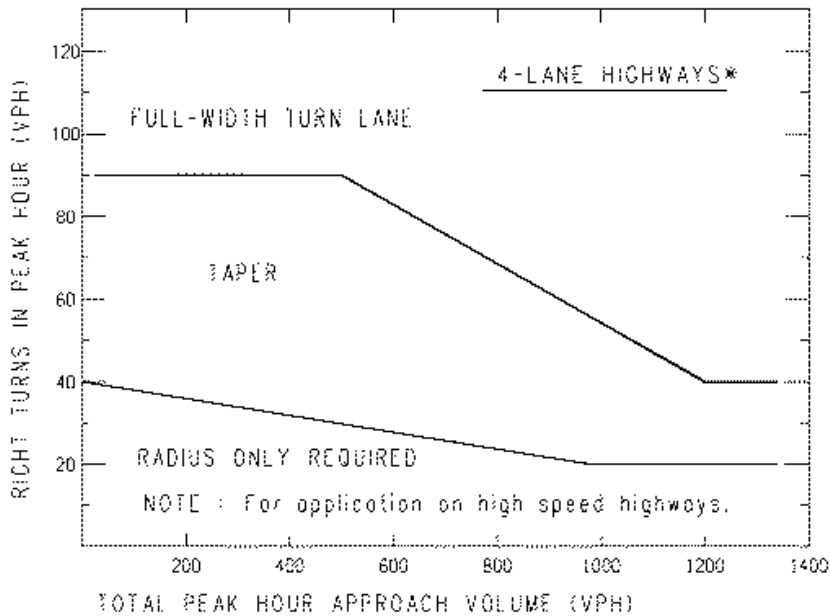
Watkins Road and Site Driveway a.m. Peak Hour

Watkins Road and Site Driveway p.m. Peak Hour



NOTE: For posted speeds at or under 45 mph, peak hour right turns greater than 40 vph, and total peak hour approach less than 300 vph, adjust right turn volumes.

Adjust peak hour
Right turns = Peak hour
Right turns – 20



*If a center left-turn lane exists (ie 3 or 5 lane roadway), subtract the number of left turns in approach volume from the total approach volume to get an adjusted total approach volume.

Sample Problem: The Design Speed is 55 mph. The Peak Hour Approach Volume is 300 vph. The Number of Right Turns in the Peak Hour is 100 vph. Determine if a right turn lane is recommended.

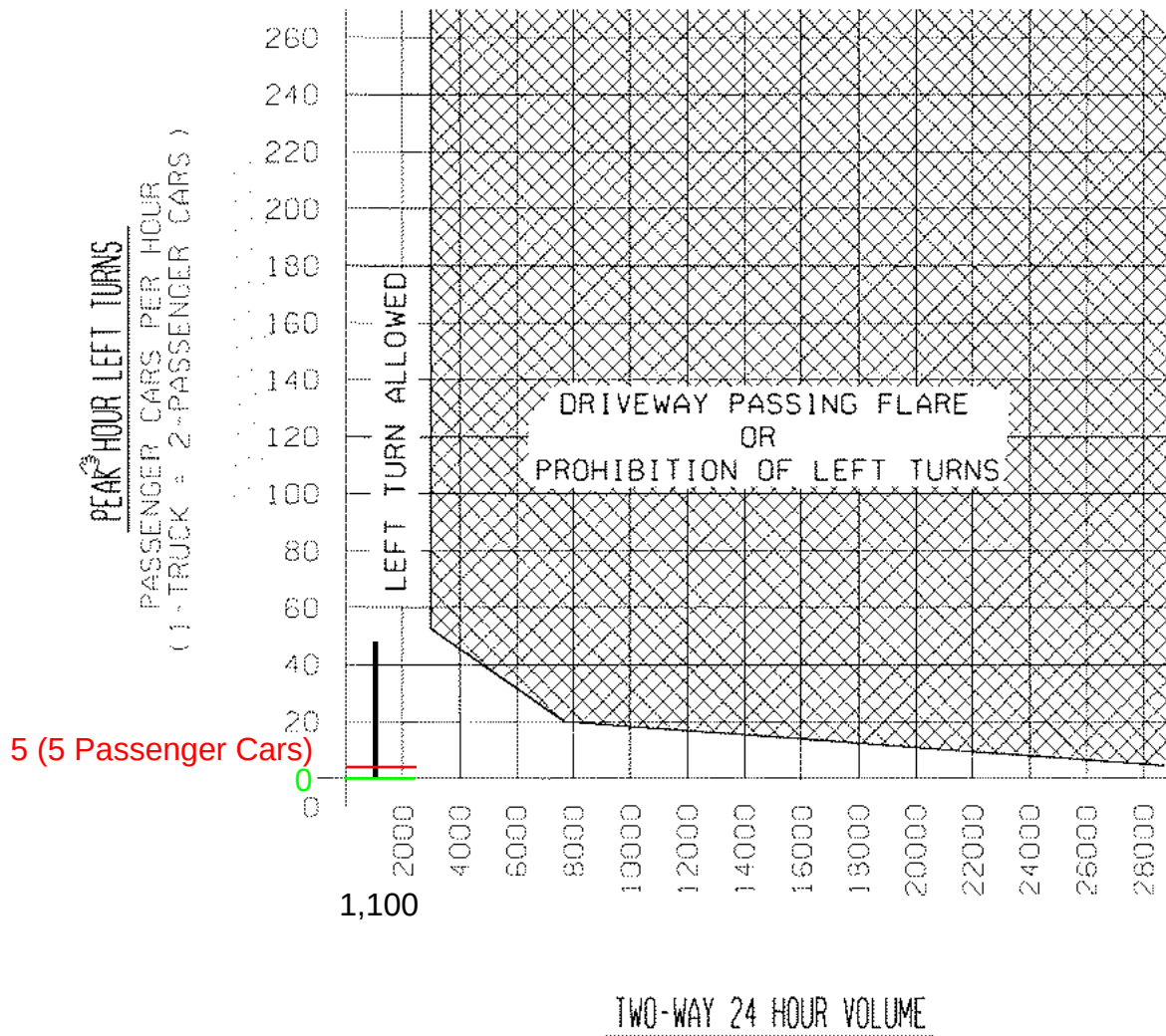
Solution: Figure indicates that the intersection of 300 vph and 100 vph is located above the upper trend line; thus, a right-turn lane may be recommended.

1.2.3 Traffic Volume Guidelines for Driveway Passing Flares

Driveways serving large developments along state trunkline highways frequently generate large numbers of left-turns. On two-lane, two-way roadways, this situation can aggravate the efficiency of traffic operations and often make shoulder maintenance difficult. In such situations, prohibition of left-turns at driveways to large developments or construction of driveway passing flares should be considered.

In an attempt to alleviate the types of problems outlined above, the following chart is provided showing the relationship between peak hour left-turns and 24-hour volumes. When peak hour left-turns and 24-hour volumes fall within the area above and to the right of the trend line, left-turns should be prohibited or a driveway passing flare be installed. If a driveway passing flare is constructed, the entire cost should be borne by the developer. For additional information and geometric design guidance regarding driveway passing flares, please refer to [Geometric Design Guide GEO-650](#).

Horning Road and Site Driveway a.m. Peak Hour
Horning Road and Site Driveway p.m. Peak Hour



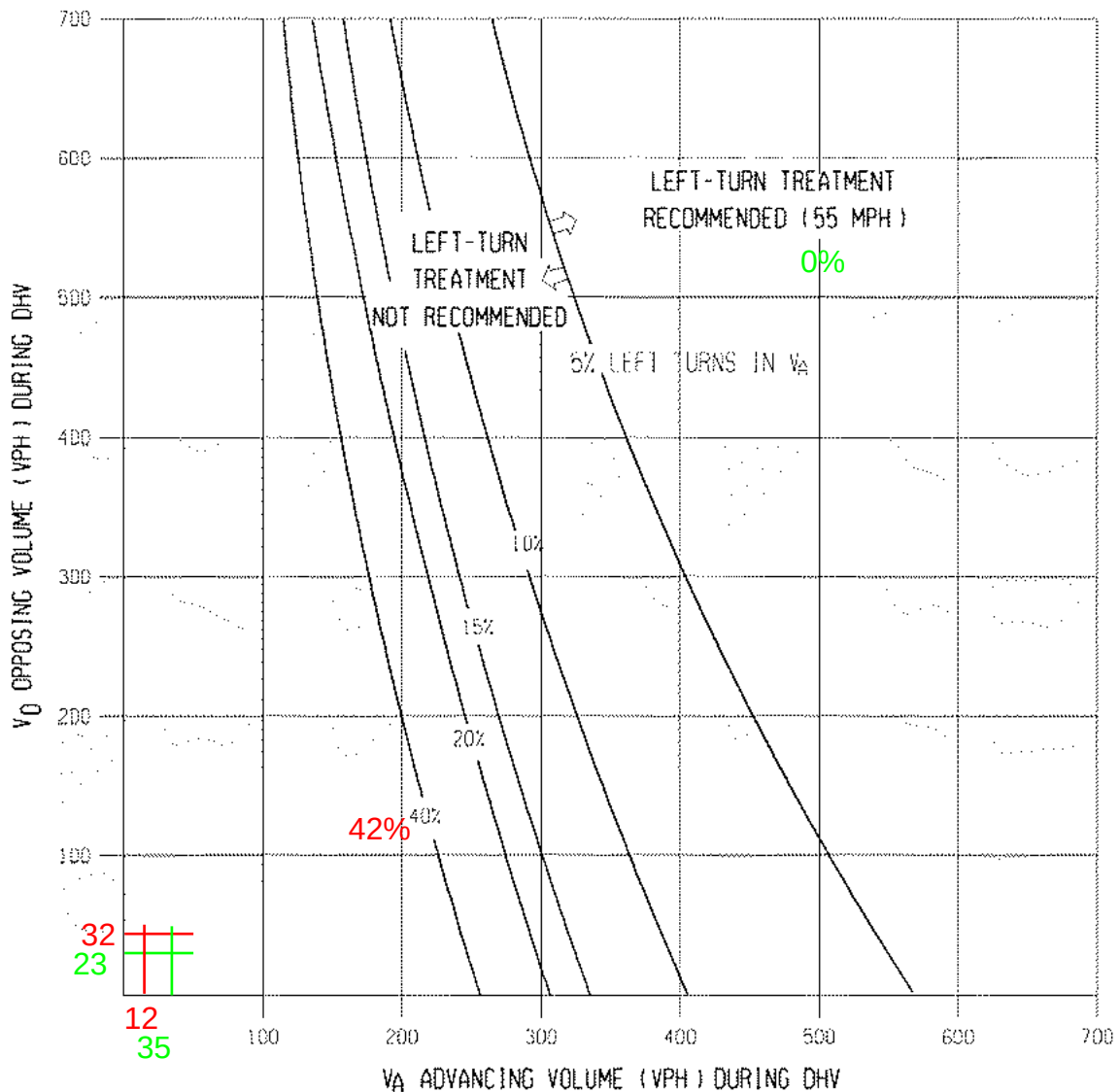
NOTE: This chart is based on Total Development and is for Two-Way Roadways.

Haul Route B (Hardcastle Road)

Horning Road and Site Driveway a.m. Peak Hour

Horning Road and Site Driveway p.m. Peak Hour

TWO-LANE HIGHWAYS WITH A POSTED SPEED OF 55 MPH OR GREATER



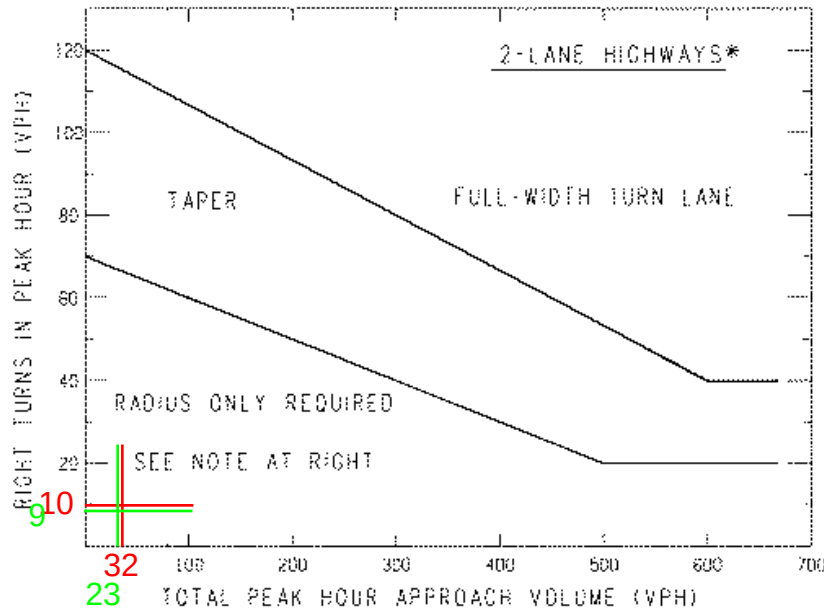
Instructions:

1. The family of curves represent the percentage of left turns in advancing volume (V_A). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of 5, the designer should estimate where the curve lies.
2. Read V_A and V_O into the chart and locate the intersection of the two volumes.
3. Note the location of the point in #2 relative to the line in #1. If the point is to the right of the line, then a left-turn lane is recommended. If the point is to the left of the line, then a left-turn is not recommended based on traffic volumes.

Haul Route B (Hardcastle Road)

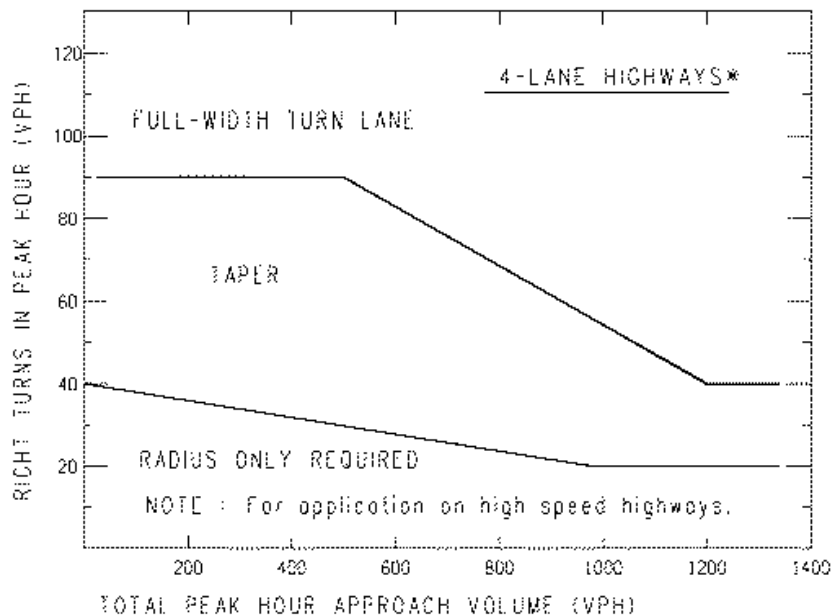
Horning Road and Site Driveway a.m. Peak Hour

Horning Road and Site Driveway p.m. Peak Hour



NOTE: For posted speeds at or under 45 mph, peak hour right turns greater than 40 vph, and total peak hour approach less than 300 vph, adjust right turn volumes.

Adjust peak hour
Right turns = Peak hour
Right turns – 20



*If a center left-turn lane exists (ie 3 or 5 lane roadway), subtract the number of left turns in approach volume from the total approach volume to get an adjusted total approach volume.

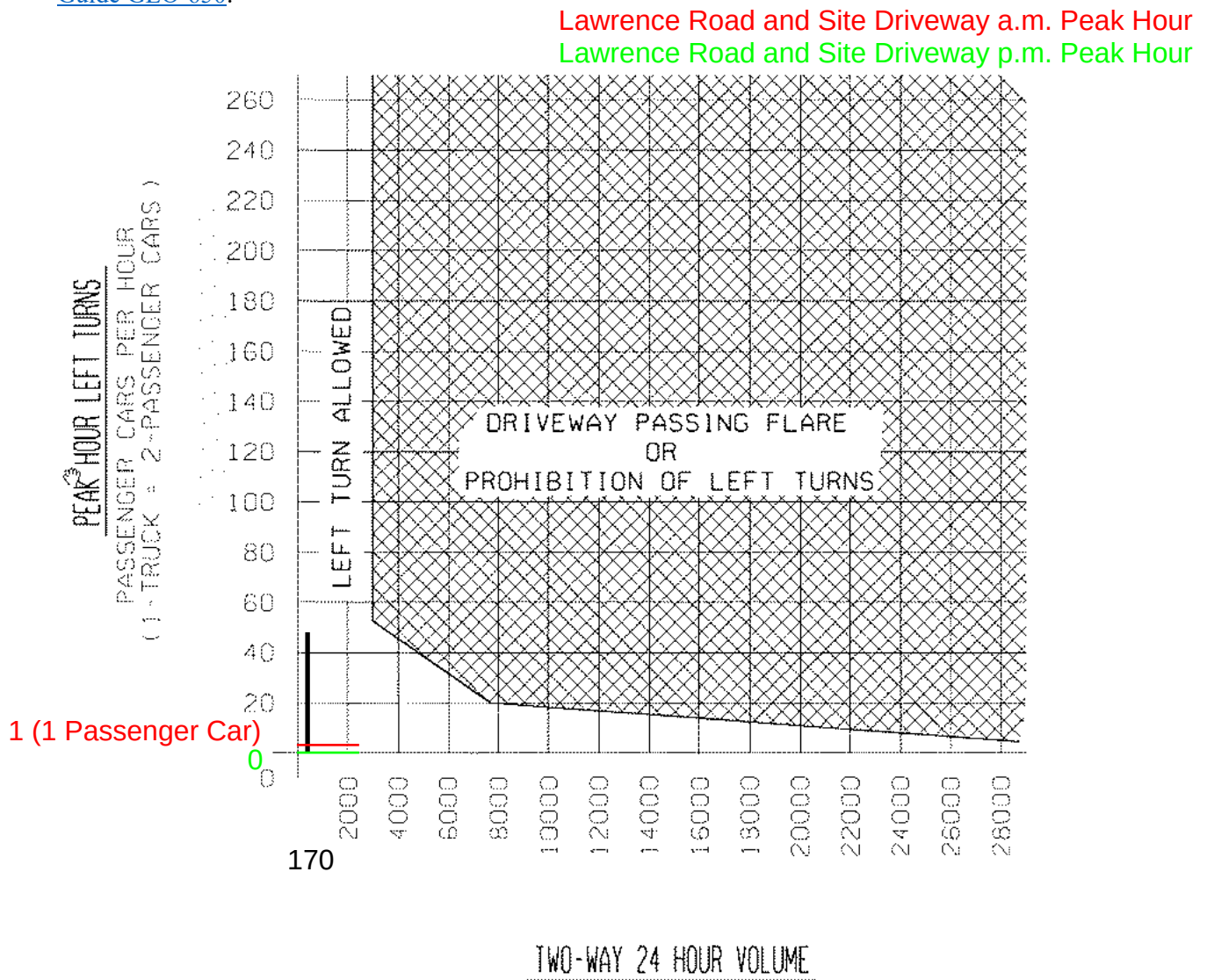
Sample Problem: The Design Speed is 55 mph. The Peak Hour Approach Volume is 300 vph. The Number of Right Turns in the Peak Hour is 100 vph. Determine if a right turn lane is recommended.

Solution: Figure indicates that the intersection of 300 vph and 100 vph is located above the upper trend line; thus, a right-turn lane may be recommended.

1.2.3 Traffic Volume Guidelines for Driveway Passing Flares

Driveways serving large developments along state trunkline highways frequently generate large numbers of left-turns. On two-lane, two-way roadways, this situation can aggravate the efficiency of traffic operations and often make shoulder maintenance difficult. In such situations, prohibition of left-turns at driveways to large developments or construction of driveway passing flares should be considered.

In an attempt to alleviate the types of problems outlined above, the following chart is provided showing the relationship between peak hour left-turns and 24-hour volumes. When peak hour left-turns and 24-hour volumes fall within the area above and to the right of the trend line, left-turns should be prohibited or a driveway passing flare be installed. If a driveway passing flare is constructed, the entire cost should be borne by the developer. For additional information and geometric design guidance regarding driveway passing flares, please refer to [Geometric Design Guide GEO-650](#).



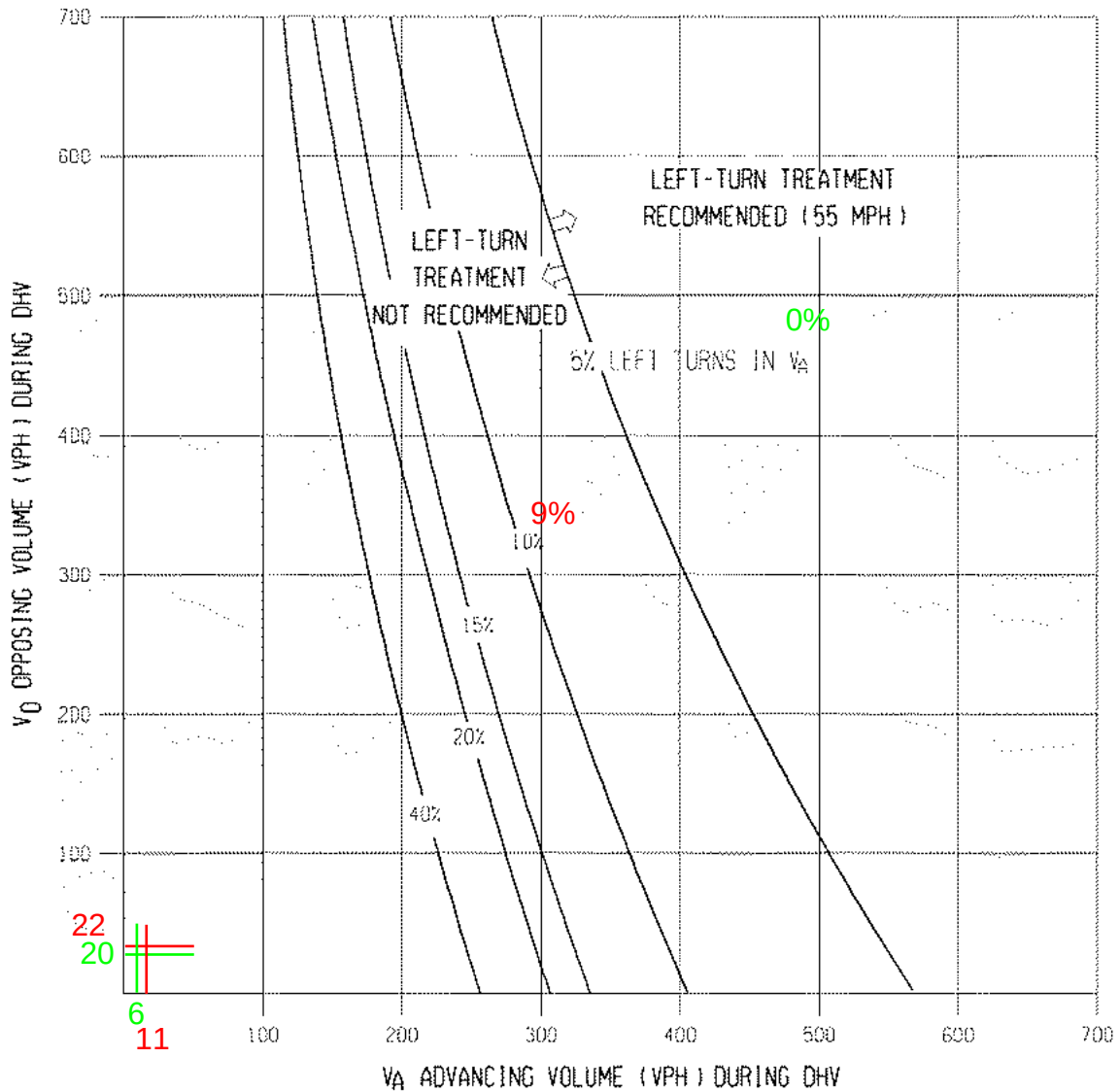
NOTE: This chart is based on Total Development and is for Two-Way Roadways.

Haul Route C (Lawrence Road)

Lawrence Road and Site Driveway a.m. Peak Hour

Lawrence Road and Site Driveway p.m. Peak Hour

TWO-LANE HIGHWAYS WITH A POSTED SPEED OF 55 MPH OR GREATER



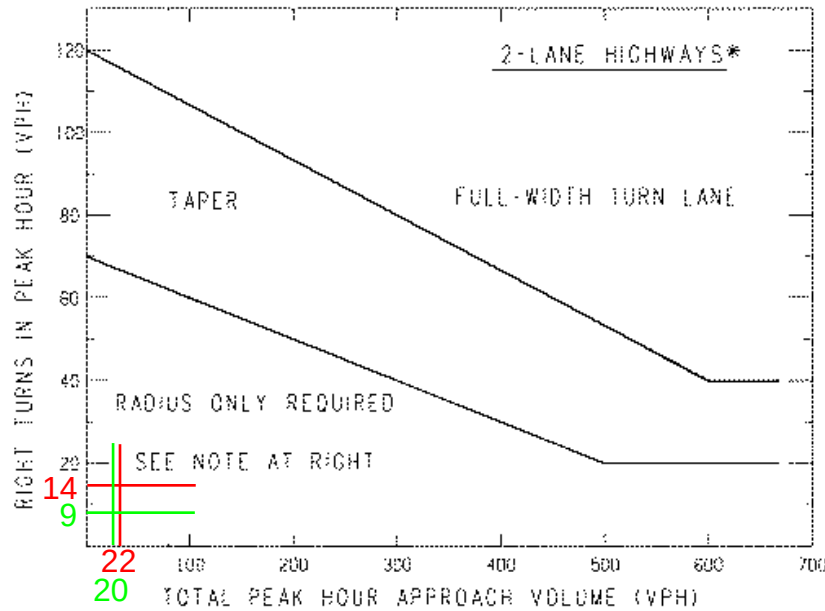
Instructions:

1. The family of curves represent the percentage of left turns in advancing volume (V_A). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of 5, the designer should estimate where the curve lies.
2. Read V_A and V_O into the chart and locate the intersection of the two volumes.
3. Note the location of the point in #2 relative to the line in #1. If the point is to the right of the line, then a left-turn lane is recommended. If the point is to the left of the line, then a left-turn is not recommended based on traffic volumes.

Haul Route C (Lawrence Road)

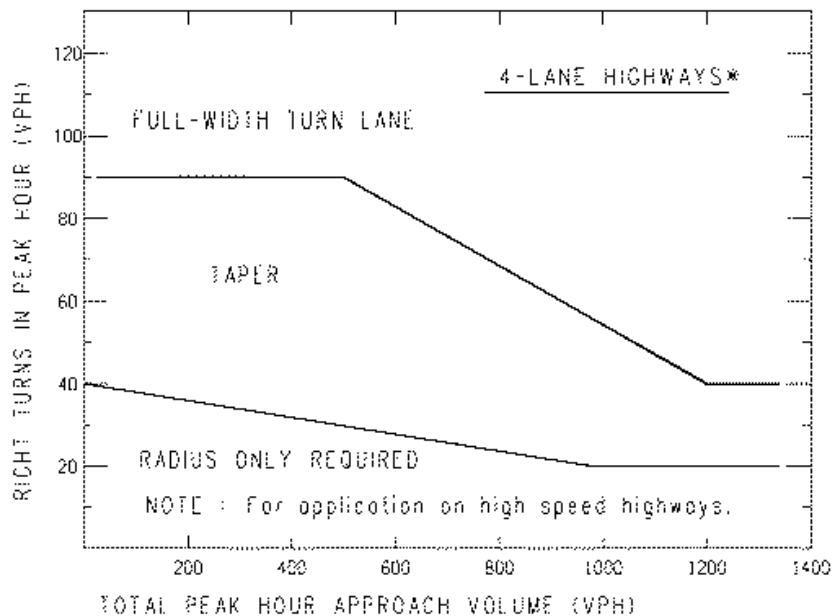
Lawrence Road and Site Driveway a.m. Peak Hour

Lawrence Road and Site Driveway p.m. Peak Hour



NOTE: For posted speeds at or under 45 mph, peak hour right turns greater than 40 vph, and total peak hour approach less than 300 vph, adjust right turn volumes.

Adjust peak hour
Right turns = Peak hour
Right turns – 20



*If a center left-turn lane exists (ie 3 or 5 lane roadway), subtract the number of left turns in approach volume from the total approach volume to get an adjusted total approach volume.

Sample Problem: The Design Speed is 55 mph. The Peak Hour Approach Volume is 300 vph. The Number of Right Turns in the Peak Hous is 100 vph. Determine if a right turn lane is recommended.

Solution: Figure indicates that the intersection of 300 vph and 100 vph is located above the upper trend line; thus, a right-turn lane may be recommended.

Appendix 6

Future LOS Output Reports

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	8	0	0	2	0	0
Future Vol, veh/h	8	0	0	2	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	60	60	60
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	13	0	0	3	0	0
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	-	-	16	-
Stage 1	-	-	-	-	13	-
Stage 2	-	-	-	-	3	-
Critical Hdwy	-	-	-	-	6.4	-
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	-	-	-	-	3.5	-
Pot Cap-1 Maneuver	-	-	0	-	1008	0
Stage 1	-	-	0	-	1015	0
Stage 2	-	-	0	-	1025	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	1008	-
Mov Cap-2 Maneuver	-	-	-	-	1008	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	1025	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0		0	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT		
Capacity (veh/h)	-	-	-	-		
HCM Lane V/C Ratio	-	-	-	-		
HCM Control Delay (s)	0	-	-	-		
HCM Lane LOS	A	-	-	-		
HCM 95th %tile Q(veh)	-	-	-	-		

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBR	SWL	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.4	0.0	2.0

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.4	0.0	2.0

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↕		↗
Traffic Vol, veh/h	8	0	5	2	0	23
Future Vol, veh/h	8	0	5	2	0	23
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	63	60	82	82
Heavy Vehicles, %	0	0	0	0	4	4
Mvmt Flow	13	0	8	3	0	28
Major/Minor	Minor2		Major2			
Conflicting Flow All	19	-	0	0		
Stage 1	19	-	-	-		
Stage 2	0	-	-	-		
Critical Hdwy	6.5	-	4.1	-		
Critical Hdwy Stg 1	5.5	-	-	-		
Critical Hdwy Stg 2	-	-	-	-		
Follow-up Hdwy	4	-	2.2	-		
Pot Cap-1 Maneuver	879	0	-	-		
Stage 1	884	0	-	-		
Stage 2	-	0	-	-		
Platoon blocked, %				-		
Mov Cap-1 Maneuver	0	-	-	-		
Mov Cap-2 Maneuver	0	-	-	-		
Stage 1	0	-	-	-		
Stage 2	0	-	-	-		
Approach	EB		WB			
HCM Control Delay, s						
HCM LOS	-					
Minor Lane/Major Mvmt	EBLn1	WBL	WBT			
Capacity (veh/h)	-	-	-			
HCM Lane V/C Ratio	-	-	-			
HCM Control Delay (s)	-	-	-			
HCM Lane LOS	-	-	-			
HCM 95th %tile Q(veh)	-	-	-			

Intersection						
Int Delay, s/veh	4.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	21	1	2	13	10	5
Future Vol, veh/h	21	1	2	13	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	66	60	60	81	75	60
Heavy Vehicles, %	0	100	0	0	10	0
Mvmt Flow	32	2	3	16	13	8
Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	39	17	21	0	-	0
Stage 1	17	-	-	-	-	-
Stage 2	22	-	-	-	-	-
Critical Hdwy	6.4	7.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	4.2	2.2	-	-	-
Pot Cap-1 Maneuver	978	837	1608	-	-	-
Stage 1	1011	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	976	837	1608	-	-	-
Mov Cap-2 Maneuver	976	-	-	-	-	-
Stage 1	1009	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Approach	EB		NB		SB	
HCM Control Delay, s	8.9		1.2		0	
HCM LOS	A					
Minor Lane/Major Mvmt			NBL	NBT	EBLn1	SBT SBR
Capacity (veh/h)	1608		-	968	-	-
HCM Lane V/C Ratio	0.002		-	0.035	-	-
HCM Control Delay (s)	7.2		0	8.9	-	-
HCM Lane LOS	A		A	A	-	-
HCM 95th %tile Q(veh)	0		-	0.1	-	-

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	4	31	48	7	6	11
Future Vol, veh/h	4	31	48	7	6	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	75	90	60	60	60
Heavy Vehicles, %	0	3	0	29	0	0
Mvmt Flow	7	41	53	12	10	18
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	65	0	-	0	114	59
Stage 1	-	-	-	-	59	-
Stage 2	-	-	-	-	55	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1550	-	-	-	887	1012
Stage 1	-	-	-	-	969	-
Stage 2	-	-	-	-	973	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1550	-	-	-	883	1012
Mov Cap-2 Maneuver	-	-	-	-	883	-
Stage 1	-	-	-	-	964	-
Stage 2	-	-	-	-	973	-
Approach	EB	WB		SB		
HCM Control Delay, s	1	0		8.9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1550	-	-	-	962	
HCM Lane V/C Ratio	0.004	-	-	-	0.029	
HCM Control Delay (s)	7.3	0	-	-	8.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection						
Int Delay, s/veh	1.5					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	38	42	2	3	7
Future Vol, veh/h	6	38	42	2	3	7
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	69	64	60	60	60
Heavy Vehicles, %	0	13	5	0	0	0
Mvmt Flow	10	55	66	3	5	12
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	69	0	-	0	143	68
Stage 1	-	-	-	-	68	-
Stage 2	-	-	-	-	75	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1545	-	-	-	854	1001
Stage 1	-	-	-	-	960	-
Stage 2	-	-	-	-	953	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1545	-	-	-	848	1001
Mov Cap-2 Maneuver	-	-	-	-	848	-
Stage 1	-	-	-	-	953	-
Stage 2	-	-	-	-	953	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.1	0		8.9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1545	-	-	-	950	
HCM Lane V/C Ratio	0.006	-	-	-	0.018	
HCM Control Delay (s)	7.3	0	-	-	8.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection												
Int Delay, s/veh	1.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	1	2	16	0	0	0	32	27	0	41	0
Future Vol, veh/h	1	1	2	16	0	0	0	32	27	0	41	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	60	60	60	60	60	89	60	71	71	71
Heavy Vehicles, %	0	0	0	56	0	0	0	6	33	3	3	3
Mvmt Flow	2	2	3	27	0	0	0	36	45	0	58	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	117	139	58	120	117	-	58	0	0	-	-	0
Stage 1	58	58	-	59	59	-	-	-	-	-	-	-
Stage 2	59	81	-	61	58	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.66	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.66	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.66	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	4.004	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	864	756	1014	744	777	0	1559	-	-	0	-	-
Stage 1	959	851	-	833	850	0	-	-	-	0	-	-
Stage 2	958	832	-	831	851	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	864	756	1014	740	777	-	1559	-	-	-	-	-
Mov Cap-2 Maneuver	864	756	-	740	777	-	-	-	-	-	-	-
Stage 1	959	851	-	833	850	-	-	-	-	-	-	-
Stage 2	958	832	-	827	851	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	9		10		0		0					
HCM LOS	A		B									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBT	SBR						
Capacity (veh/h)	1559	-	-	898	740	-	-					
HCM Lane V/C Ratio	-	-	-	0.007	0.036	-	-					
HCM Control Delay (s)	0	-	-	9	10	-	-					
HCM Lane LOS	A	-	-	A	B	-	-					
HCM 95th %tile Q(veh)	0	-	-	0	0.1	-	-					

Intersection						
Int Delay, s/veh	1.8					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	13	33	0	7	41
Future Vol, veh/h	0	13	33	0	7	41
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	65	65	60	60	60	71
Heavy Vehicles, %	8	8	6	6	0	3
Mvmt Flow	0	20	55	0	12	58
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	55	0	-	55	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.28	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.372	-	-	2.2	-
Pot Cap-1 Maneuver	0	995	-	0	1563	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	995	-	-	1563	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.7	0		1.2		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	-		995	1563	-	
HCM Lane V/C Ratio	-		0.02	0.007	-	
HCM Control Delay (s)	-		8.7	7.3	0	
HCM Lane LOS	-		A	A	A	
HCM 95th %tile Q(veh)	-		0.1	0	-	

HCM Unsignalized Intersection Capacity Analysis
52: Wellwood Road & Slip Ramp

2026 Future Conditions - Haul Route A (Watkins Road)
a.m. Peak Hour

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	28	16	13	7	0
Future Volume (Veh/h)	0	28	16	13	7	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.65	0.60	0.60
Hourly flow rate (vph)	0	47	27	20	12	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	47				84	37
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	47				84	37
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1573				923	1041
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	47	47	12			
Volume Left	0	0	12			
Volume Right	0	20	0			
cSH	1700	1700	923			
Volume to Capacity	0.03	0.03	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	9.0			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	9.0			
Approach LOS			A			
Intersection Summary						
Average Delay			1.0			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection												
Int Delay, s/veh	2.8											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	23	218	0	0	73	28	3	1	3	55	0	9
Future Vol, veh/h	23	218	0	0	73	28	3	1	3	55	0	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	75	94	60	60	90	71	60	60	75	78	60	88
Heavy Vehicles, %	9	5	0	0	10	29	0	0	0	13	0	22
Mvmt Flow	31	232	0	0	81	39	5	2	4	71	0	10
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	120	0	0	232	0	0	400	414	232	378	375	81
Stage 1	-	-	-	-	-	-	294	294	-	81	81	-
Stage 2	-	-	-	-	-	-	106	120	-	297	294	-
Critical Hdwy	4.19	-	-	4.1	-	-	7.1	6.5	6.2	7.23	6.5	6.42
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.23	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.23	5.5	-
Follow-up Hdwy	2.281	-	-	2.2	-	-	3.5	4	3.3	3.617	4	3.498
Pot Cap-1 Maneuver	1425	-	-	1348	-	-	564	532	812	560	559	926
Stage 1	-	-	-	-	-	-	719	673	-	901	832	-
Stage 2	-	-	-	-	-	-	905	800	-	689	673	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1425	-	-	1348	-	-	547	519	812	545	545	926
Mov Cap-2 Maneuver	-	-	-	-	-	-	547	519	-	545	545	-
Stage 1	-	-	-	-	-	-	701	656	-	878	832	-
Stage 2	-	-	-	-	-	-	895	800	-	667	656	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.9			0			10.9			12.3		
HCM LOS							B			B		
Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1				
Capacity (veh/h)	617	1425	-	-	1348	-	-	575				
HCM Lane V/C Ratio	0.017	0.022	-	-	-	-	-	0.14				
HCM Control Delay (s)	10.9	7.6	0	-	0	-	-	12.3				
HCM Lane LOS	B	A	A	-	A	-	-	B				
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.5				

Intersection						
Int Delay, s/veh	3.6					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	0	9	14	15	10	1
Future Vol, veh/h	0	9	14	15	10	1
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	78	74	92
Heavy Vehicles, %	0	100	64	0	20	0
Mvmt Flow	0	10	15	19	14	1
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	64	15	15	0	-	0
Stage 1	15	-	-	-	-	-
Stage 2	49	-	-	-	-	-
Critical Hdwy	6.4	7.2	4.74	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	4.2	2.776	-	-	-
Pot Cap-1 Maneuver	947	839	1279	-	-	-
Stage 1	1013	-	-	-	-	-
Stage 2	979	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	936	839	1279	-	-	-
Mov Cap-2 Maneuver	936	-	-	-	-	-
Stage 1	1001	-	-	-	-	-
Stage 2	979	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	9.3	3.5		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1279	-	839	-	-	
HCM Lane V/C Ratio	0.012	-	0.012	-	-	
HCM Control Delay (s)	7.8	0	9.3	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0	-	-	

Intersection: 10: Hardcastle Road & Horning Road

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 11: Hardcastle Road & Slip Ramp

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 12: Slip Ramp & Horning Road

Movement

EB

Directions Served

T

Maximum Queue (ft)

29

Average Queue (ft)

8

95th Queue (ft)

28

Link Distance (ft)

90

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 20: Watkins Road & Horning Road

Movement	EB
Directions Served	LR
Maximum Queue (ft)	51
Average Queue (ft)	13
95th Queue (ft)	36
Link Distance (ft)	957
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 30: M-124 & Hardcastle Road

Movement	SB
Directions Served	LR
Maximum Queue (ft)	23
Average Queue (ft)	8
95th Queue (ft)	23
Link Distance (ft)	838
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 40: M-124 & Lawrence Road

Movement	SB
Directions Served	LR
Maximum Queue (ft)	19
Average Queue (ft)	5
95th Queue (ft)	17
Link Distance (ft)	619
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB
Directions Served	LTR	LT
Maximum Queue (ft)	28	63
Average Queue (ft)	4	13
95th Queue (ft)	20	47
Link Distance (ft)	317	32
Upstream Blk Time (%)		1
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 51: M-124 & Slip Ramp

Movement	WB	NB	SB
Directions Served	R	T	LT
Maximum Queue (ft)	49	6	18
Average Queue (ft)	12	0	1
95th Queue (ft)	38	4	8
Link Distance (ft)	73	28	503
Upstream Blk Time (%)	0	0	
Queuing Penalty (veh)	0	0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 52: Wellwood Road & Slip Ramp

Movement	WB	SB
Directions Served	TR	L
Maximum Queue (ft)	19	12
Average Queue (ft)	1	0
95th Queue (ft)	12	6
Link Distance (ft)	970	73
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	NB	SB
Directions Served	LTR	LTR	LTR
Maximum Queue (ft)	19	31	84
Average Queue (ft)	2	6	27
95th Queue (ft)	11	26	59
Link Distance (ft)	745	472	476
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 100: Watkins Road & Site Driveway

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	75	9
Average Queue (ft)	19	0
95th Queue (ft)	64	6
Link Distance (ft)	1102	608
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

Intersection						
Int Delay, s/veh	0.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	10	2	0	13	3	0
Future Vol, veh/h	10	2	0	13	3	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	60	65	75	60
Heavy Vehicles, %	0	0	0	0	33	0
Mvmt Flow	12	3	0	20	4	0
Major/Minor	Major1	Major2		Minor1		
Conflicting Flow All	0	0	-	-	34	-
Stage 1	-	-	-	-	14	-
Stage 2	-	-	-	-	20	-
Critical Hdwy	-	-	-	-	6.73	-
Critical Hdwy Stg 1	-	-	-	-	5.73	-
Critical Hdwy Stg 2	-	-	-	-	5.73	-
Follow-up Hdwy	-	-	-	-	3.797	-
Pot Cap-1 Maneuver	-	-	0	-	906	0
Stage 1	-	-	0	-	934	0
Stage 2	-	-	0	-	928	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	906	-
Mov Cap-2 Maneuver	-	-	-	-	906	-
Stage 1	-	-	-	-	934	-
Stage 2	-	-	-	-	928	-
Approach	EB	WB		NB		
HCM Control Delay, s	0	0		9		
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT		
Capacity (veh/h)	906	-	-	-		
HCM Lane V/C Ratio	0.004	-	-	-		
HCM Control Delay (s)	9	-	-	-		
HCM Lane LOS	A	-	-	-		
HCM 95th %tile Q(veh)	0	-	-	-		

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBT	NBR	SBT	SWL	All
Denied Del/Veh (s)	0.1	0.1	0.0	0.0	0.0
Total Del/Veh (s)	1.5	2.3	0.1	0.0	0.5

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.0	0.0
Total Del/Veh (s)	2.2	0.1	0.0	0.5

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↔		↗
Traffic Vol, veh/h	10	0	28	13	0	8
Future Vol, veh/h	10	0	28	13	0	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	70	65	60	67
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	12	0	40	20	0	12
Major/Minor	Minor2	Major2				
Conflicting Flow All	100	-	0	0		
Stage 1	100	-	-	-		
Stage 2	0	-	-	-		
Critical Hdwy	6.5	-	4.1	-		
Critical Hdwy Stg 1	5.5	-	-	-		
Critical Hdwy Stg 2	-	-	-	-		
Follow-up Hdwy	4	-	2.2	-		
Pot Cap-1 Maneuver	794	0	-	-		
Stage 1	816	0	-	-		
Stage 2	-	0	-	-		
Platoon blocked, %				-		
Mov Cap-1 Maneuver	0	-	-	-		
Mov Cap-2 Maneuver	0	-	-	-		
Stage 1	0	-	-	-		
Stage 2	0	-	-	-		
Approach	EB	WB				
HCM Control Delay, s						
HCM LOS	-					
Minor Lane/Major Mvmt	EBLn1	WBL	WBT			
Capacity (veh/h)	-	-	-			
HCM Lane V/C Ratio	-	-	-			
HCM Control Delay (s)	-	-	-			
HCM Lane LOS	-	-	-			
HCM 95th %tile Q(veh)	-	-	-			

Intersection						
Int Delay, s/veh	1.9					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	12	2	2	9	30	33
Future Vol, veh/h	12	2	2	9	30	33
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	67	83	75
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	20	3	3	13	36	44
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	77	58	80	0	-	0
Stage 1	58	-	-	-	-	-
Stage 2	19	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.2	-	-	-
Pot Cap-1 Maneuver	931	1014	1531	-	-	-
Stage 1	970	-	-	-	-	-
Stage 2	1009	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	929	1014	1531	-	-	-
Mov Cap-2 Maneuver	929	-	-	-	-	-
Stage 1	968	-	-	-	-	-
Stage 2	1009	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	8.9	1.5		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1531	-	940	-	-	
HCM Lane V/C Ratio	0.002	-	0.025	-	-	
HCM Control Delay (s)	7.4	0	8.9	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection						
Int Delay, s/veh	1.4					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	11	76	73	2	3	10
Future Vol, veh/h	11	76	73	2	3	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	69	89	81	60	75	60
Heavy Vehicles, %	0	0	1	0	0	0
Mvmt Flow	16	85	90	3	4	17
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	93	0	-	0	209	92
Stage 1	-	-	-	-	92	-
Stage 2	-	-	-	-	117	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1514	-	-	-	784	971
Stage 1	-	-	-	-	937	-
Stage 2	-	-	-	-	913	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1514	-	-	-	775	971
Mov Cap-2 Maneuver	-	-	-	-	775	-
Stage 1	-	-	-	-	927	-
Stage 2	-	-	-	-	913	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.2	0		9		
HCM LOS	A					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1514	-	-	-	926	
HCM Lane V/C Ratio	0.011	-	-	-	0.022	
HCM Control Delay (s)	7.4	0	-	-	9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection						
Int Delay, s/veh	0.8					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	71	70	5	1	5
Future Vol, veh/h	6	71	70	5	1	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	80	81	60	60	63
Heavy Vehicles, %	0	0	3	0	0	0
Mvmt Flow	10	89	86	8	2	8
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	94	0	-	0	199	90
Stage 1	-	-	-	-	90	-
Stage 2	-	-	-	-	109	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1513	-	-	-	794	973
Stage 1	-	-	-	-	939	-
Stage 2	-	-	-	-	921	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1513	-	-	-	788	973
Mov Cap-2 Maneuver	-	-	-	-	788	-
Stage 1	-	-	-	-	932	-
Stage 2	-	-	-	-	921	-
Approach	EB	WB		SB		
HCM Control Delay, s	0.7	0		8.9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1513	-	-	-	935	
HCM Lane V/C Ratio	0.007	-	-	-	0.01	
HCM Control Delay (s)	7.4	0	-	-	8.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0	

Intersection												
Int Delay, s/veh	2.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	1	3	31	1	0	3	58	23	0	47	0
Future Vol, veh/h	0	1	3	31	1	0	3	58	23	0	47	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	75	60	60	60	60	95	60	60	95	60
Heavy Vehicles, %	0	0	0	29	0	0	0	2	39	0	0	0
Mvmt Flow	0	2	4	52	2	0	5	61	38	0	49	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	140	158	49	142	139	-	49	0	0	-	-	0
Stage 1	49	49	-	90	90	-	-	-	-	-	-	-
Stage 2	91	109	-	52	49	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.39	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.39	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.39	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.761	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	835	738	1025	770	756	0	1571	-	-	0	-	-
Stage 1	969	858	-	855	824	0	-	-	-	0	-	-
Stage 2	921	809	-	897	858	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	832	736	1025	764	754	-	1571	-	-	-	-	-
Mov Cap-2 Maneuver	832	736	-	764	754	-	-	-	-	-	-	-
Stage 1	966	858	-	852	822	-	-	-	-	-	-	-
Stage 2	916	807	-	892	858	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	8.9		10.1		0.3		0					
HCM LOS	A		B									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBT	SBR						
Capacity (veh/h)	1571	-	-	919	764	-	-					
HCM Lane V/C Ratio	0.003	-	-	0.006	0.07	-	-					
HCM Control Delay (s)	7.3	0	-	8.9	10.1	-	-					
HCM Lane LOS	A	A	-	A	B	-	-					
HCM 95th %tile Q(veh)	0	-	-	0	0.2	-	-					

Intersection						
Int Delay, s/veh	1.9					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	12	58	0	8	47
Future Vol, veh/h	0	12	58	0	8	47
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	60	60	95	60	60	95
Heavy Vehicles, %	0	0	2	0	0	0
Mvmt Flow	0	20	61	0	13	49
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	61	0	-	61	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.2	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	0	1010	-	0	1555	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	1010	-	-	1555	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.6	0		1.6		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	- 1010		1555	-		
HCM Lane V/C Ratio	- 0.02		0.009	-		
HCM Control Delay (s)	- 8.6		7.3	0		
HCM Lane LOS	- A		A	A		
HCM 95th %tile Q(veh)	- 0.1		0	-		

HCM Unsignalized Intersection Capacity Analysis
52: Wellwood Road & Slip Ramp

2026 Future Conditions - Haul Route A (Watkins Road)
p.m. Peak Hour

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	24	32	12	8	0
Future Volume (Veh/h)	0	24	32	12	8	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60
Hourly flow rate (vph)	0	40	53	20	13	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	73				103	63
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	73				103	63
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1540				900	1007
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	40	73	13			
Volume Left	0	0	13			
Volume Right	0	20	0			
cSH	1700	1700	900			
Volume to Capacity	0.02	0.04	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	9.1			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	9.1			
Approach LOS			A			
Intersection Summary						
Average Delay			0.9			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection												
Int Delay, s/veh	2.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	16	154	5	8	233	69	2	2	2	51	2	26
Future Vol, veh/h	16	154	5	8	233	69	2	2	2	51	2	26
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	93	63	67	95	90	60	60	60	85	60	61
Heavy Vehicles, %	13	6	0	0	2	12	0	0	0	14	0	8
Mvmt Flow	27	166	8	12	245	77	3	3	3	60	3	43
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	322	0	0	174	0	0	555	570	170	496	497	245
Stage 1	-	-	-	-	-	-	224	224	-	269	269	-
Stage 2	-	-	-	-	-	-	331	346	-	227	228	-
Critical Hdwy	4.23	-	-	4.1	-	-	7.1	6.5	6.2	7.24	6.5	6.28
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.24	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.24	5.5	-
Follow-up Hdwy	2.317	-	-	2.2	-	-	3.5	4	3.3	3.626	4	3.372
Pot Cap-1 Maneuver	1178	-	-	1415	-	-	445	434	879	465	477	779
Stage 1	-	-	-	-	-	-	783	722	-	711	690	-
Stage 2	-	-	-	-	-	-	687	639	-	749	719	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1178	-	-	1415	-	-	407	419	879	448	460	779
Mov Cap-2 Maneuver	-	-	-	-	-	-	407	419	-	448	460	-
Stage 1	-	-	-	-	-	-	763	704	-	693	683	-
Stage 2	-	-	-	-	-	-	640	633	-	724	701	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	1.1			0.3			12.3			13.3		
HCM LOS							B			B		
Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1				
Capacity (veh/h)	502	1178	-	-	1415	-	-	541				
HCM Lane V/C Ratio	0.02	0.023	-	-	0.008	-	-	0.196				
HCM Control Delay (s)	12.3	8.1	0	-	7.6	0	-	13.3				
HCM Lane LOS	B	A	A	-	A	A	-	B				
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.7				

Intersection						
Int Delay, s/veh	2.8					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	1	14	9	10	32	0
Future Vol, veh/h	1	14	9	10	32	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	66	82	92
Heavy Vehicles, %	0	64	100	0	0	0
Mvmt Flow	1	15	10	15	39	0
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	74	39	39	0	-	0
Stage 1	39	-	-	-	-	-
Stage 2	35	-	-	-	-	-
Critical Hdwy	6.4	6.84	5.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.876	3.1	-	-	-
Pot Cap-1 Maneuver	935	881	1117	-	-	-
Stage 1	989	-	-	-	-	-
Stage 2	993	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	927	881	1117	-	-	-
Mov Cap-2 Maneuver	927	-	-	-	-	-
Stage 1	980	-	-	-	-	-
Stage 2	993	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	9.1	3.2		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1117	-	884	-	-	
HCM Lane V/C Ratio	0.009	-	0.018	-	-	
HCM Control Delay (s)	8.3	0	9.1	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection: 10: Hardcastle Road & Horning Road

Movement	NB
Directions Served	L
Maximum Queue (ft)	39
Average Queue (ft)	2
95th Queue (ft)	18
Link Distance (ft)	81
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 11: Hardcastle Road & Slip Ramp

Movement	SW
Directions Served	L
Maximum Queue (ft)	4
Average Queue (ft)	0
95th Queue (ft)	3
Link Distance (ft)	120
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 12: Slip Ramp & Horning Road

Movement	EB
Directions Served	T
Maximum Queue (ft)	29
Average Queue (ft)	6
95th Queue (ft)	25
Link Distance (ft)	90
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 20: Watkins Road & Horning Road

Movement	EB
Directions Served	LR
Maximum Queue (ft)	26
Average Queue (ft)	7
95th Queue (ft)	24
Link Distance (ft)	957
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 30: M-124 & Hardcastle Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	16	20
Average Queue (ft)	1	6
95th Queue (ft)	9	21
Link Distance (ft)	635	838
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	10	18
Average Queue (ft)	0	4
95th Queue (ft)	5	15
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB
Directions Served	LTR	LT
Maximum Queue (ft)	28	63
Average Queue (ft)	3	25
95th Queue (ft)	18	58
Link Distance (ft)	317	32
Upstream Blk Time (%)		2
Queuing Penalty (veh)		1
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 51: M-124 & Slip Ramp

Movement	WB	SB
Directions Served	R	LT
Maximum Queue (ft)	31	20
Average Queue (ft)	6	1
95th Queue (ft)	25	9
Link Distance (ft)	73	503
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 52: Wellwood Road & Slip Ramp

Movement	SB
Directions Served	L
Maximum Queue (ft)	24
Average Queue (ft)	1
95th Queue (ft)	10
Link Distance (ft)	73
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	WB	NB	SB
Directions Served	LTR	LT	LTR	LTR
Maximum Queue (ft)	42	33	31	81
Average Queue (ft)	4	2	7	30
95th Queue (ft)	22	14	28	60
Link Distance (ft)	745	713	472	476
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 100: Watkins Road & Site Driveway

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	86	14
Average Queue (ft)	23	1
95th Queue (ft)	70	14
Link Distance (ft)	1101	1794
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 1

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↱	↱	
Traffic Vol, veh/h	8	0	0	2	0	0
Future Vol, veh/h	8	0	0	2	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	60	60	60
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	13	0	0	3	0	0
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	-	-	16	-
Stage 1	-	-	-	-	13	-
Stage 2	-	-	-	-	3	-
Critical Hdwy	-	-	-	-	6.4	-
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	-	-	-	-	3.5	-
Pot Cap-1 Maneuver	-	-	0	-	1008	0
Stage 1	-	-	0	-	1015	0
Stage 2	-	-	0	-	1025	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	1008	-
Mov Cap-2 Maneuver	-	-	-	-	1008	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	1025	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0		0	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT		
Capacity (veh/h)	-	-	-	-		
HCM Lane V/C Ratio	-	-	-	-		
HCM Control Delay (s)	0	-	-	-		
HCM Lane LOS	A	-	-	-		
HCM 95th %tile Q(veh)	-	-	-	-		

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBR	SWL	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.5	0.0	2.0

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.5	0.0	2.0

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↑
Traffic Vol, veh/h	8	0	14	2	0	33
Future Vol, veh/h	8	0	14	2	0	33
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	63	60	82	82
Heavy Vehicles, %	0	0	64	0	4	30
Mvmt Flow	13	0	22	3	0	40
Major/Minor	Minor2	Major2				
Conflicting Flow All	47	-	0	0		
Stage 1	47	-	-	-		
Stage 2	0	-	-	-		
Critical Hdwy	6.5	-	4.74	-		
Critical Hdwy Stg 1	5.5	-	-	-		
Critical Hdwy Stg 2	-	-	-	-		
Follow-up Hdwy	4	-	2.776	-		
Pot Cap-1 Maneuver	849	0	-	-		
Stage 1	860	0	-	-		
Stage 2	-	0	-	-		
Platoon blocked, %				-		
Mov Cap-1 Maneuver	0	-	-	-		
Mov Cap-2 Maneuver	0	-	-	-		
Stage 1	0	-	-	-		
Stage 2	0	-	-	-		
Approach	EB	WB				
HCM Control Delay, s						
HCM LOS	-					
Minor Lane/Major Mvmt	EBLn1	WBL	WBT			
Capacity (veh/h)	-	-	-			
HCM Lane V/C Ratio	-	-	-			
HCM Control Delay (s)	-	-	-			
HCM Lane LOS	-	-	-			
HCM 95th %tile Q(veh)	-	-	-			

Intersection						
Int Delay, s/veh	4.5					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	21	1	6	13	9	6
Future Vol, veh/h	21	1	6	13	9	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	66	60	60	81	75	60
Heavy Vehicles, %	0	100	0	0	11	0
Mvmt Flow	32	2	10	16	12	10
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	53	17	22	0	-	0
Stage 1	17	-	-	-	-	-
Stage 2	36	-	-	-	-	-
Critical Hdwy	6.4	7.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	4.2	2.2	-	-	-
Pot Cap-1 Maneuver	960	837	1607	-	-	-
Stage 1	1011	-	-	-	-	-
Stage 2	992	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	954	837	1607	-	-	-
Mov Cap-2 Maneuver	954	-	-	-	-	-
Stage 1	1005	-	-	-	-	-
Stage 2	992	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	8.9	2.8		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1607	-	947	-	-	
HCM Lane V/C Ratio	0.006	-	0.035	-	-	
HCM Control Delay (s)	7.3	0	8.9	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection						
Int Delay, s/veh	2.8					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	5	30	48	16	15	11
Future Vol, veh/h	5	30	48	16	15	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	75	90	60	60	60
Heavy Vehicles, %	0	3	0	69	60	0
Mvmt Flow	8	40	53	27	25	18
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	80	0	-	0	123	67
Stage 1	-	-	-	-	67	-
Stage 2	-	-	-	-	56	-
Critical Hdwy	4.1	-	-	-	7	6.2
Critical Hdwy Stg 1	-	-	-	-	6	-
Critical Hdwy Stg 2	-	-	-	-	6	-
Follow-up Hdwy	2.2	-	-	-	4.04	3.3
Pot Cap-1 Maneuver	1531	-	-	-	751	1002
Stage 1	-	-	-	-	827	-
Stage 2	-	-	-	-	837	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1531	-	-	-	747	1002
Mov Cap-2 Maneuver	-	-	-	-	747	-
Stage 1	-	-	-	-	823	-
Stage 2	-	-	-	-	837	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.3	0		9.5		
HCM LOS	A					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1531	-	-	-	837	
HCM Lane V/C Ratio	0.005	-	-	-	0.052	
HCM Control Delay (s)	7.4	0	-	-	9.5	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.2	

Intersection

Int Delay, s/veh 1.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	46	51	2	3	7
Future Vol, veh/h	6	46	51	2	3	7
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	69	64	60	60	60
Heavy Vehicles, %	0	31	22	0	0	0
Mvmt Flow	10	67	80	3	5	12

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	83	0	0 169 82
Stage 1	-	-	- 82 -
Stage 2	-	-	- 87 -
Critical Hdwy	4.1	-	- 6.4 6.2
Critical Hdwy Stg 1	-	-	- 5.4 -
Critical Hdwy Stg 2	-	-	- 5.4 -
Follow-up Hdwy	2.2	-	- 3.5 3.3
Pot Cap-1 Maneuver	1527	-	- 826 983
Stage 1	-	-	- 946 -
Stage 2	-	-	- 941 -
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1527	-	- 820 983
Mov Cap-2 Maneuver	-	-	- 820 -
Stage 1	-	-	- 939 -
Stage 2	-	-	- 941 -

Approach	EB	WB	SB
HCM Control Delay, s	1	0	9
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1527	-	-	-	928
HCM Lane V/C Ratio	0.007	-	-	-	0.018
HCM Control Delay (s)	7.4	0	-	-	9
HCM Lane LOS	A	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection												
Int Delay, s/veh	1											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	1	1	2	7	0	0	0	41	18	0	50	0
Future Vol, veh/h	1	1	2	7	0	0	0	41	18	0	50	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	60	60	60	60	60	89	60	71	71	71
Heavy Vehicles, %	0	0	0	0	0	0	0	27	0	3	20	3
Mvmt Flow	2	2	3	12	0	0	0	46	30	0	70	0

Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	131	146	70	134	131	-	70	0	0	-	-	0
Stage 1	70	70	-	61	61	-	-	-	-	-	-	-
Stage 2	61	76	-	73	70	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	846	749	998	842	763	0	1544	-	-	0	-	-
Stage 1	945	841	-	955	848	0	-	-	-	0	-	-
Stage 2	955	836	-	942	841	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	846	749	998	838	763	-	1544	-	-	-	-	-
Mov Cap-2 Maneuver	846	749	-	838	763	-	-	-	-	-	-	-
Stage 1	945	841	-	955	848	-	-	-	-	-	-	-
Stage 2	955	836	-	937	841	-	-	-	-	-	-	-

Approach	EB		WB		NB		SB	
HCM Control Delay, s	9.1		9.4		0		0	
HCM LOS	A		A					

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBT	SBR
Capacity (veh/h)	1544	-	-	885 838	-	-
HCM Lane V/C Ratio	-	-	-	0.008 0.014	-	-
HCM Control Delay (s)	0	-	-	9.1 9.4	-	-
HCM Lane LOS	A	-	-	A A	-	-
HCM 95th %tile Q(veh)	0	-	-	0 0	-	-

Intersection

Int Delay, s/veh 1.5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	13	42	0	6	50
Future Vol, veh/h	0	13	42	0	6	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	65	65	60	60	60	71
Heavy Vehicles, %	8	8	27	6	20	3
Mvmt Flow	0	20	70	0	10	70

Major/Minor	Minor1	Major1	Major2
Conflicting Flow All	-	70	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	6.28	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	3.372	-
Pot Cap-1 Maneuver	0	976	-
Stage 1	0	-	-
Stage 2	0	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	-	976	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	8.8	0	0.9
HCM LOS	A		

Minor Lane/Major Mvmt	NBTWBLn1	SBL	SBT
Capacity (veh/h)	-	976	1424
HCM Lane V/C Ratio	-	0.02	0.007
HCM Control Delay (s)	-	8.8	7.5
HCM Lane LOS	-	A	A
HCM 95th %tile Q(veh)	-	0.1	0

HCM Unsignalized Intersection Capacity Analysis
52: Wellwood Road & Slip Ramp

2026 Future Conditions - Haul Route B (Hardcastle Road)
a.m. Peak Hour

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	19	7	13	6	0
Future Volume (Veh/h)	0	19	7	13	6	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.65	0.60	0.60
Hourly flow rate (vph)	0	32	12	20	10	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	32				54	22
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	32				54	22
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1593				959	1061
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	32	32	10			
Volume Left	0	0	10			
Volume Right	0	20	0			
cSH	1700	1700	959			
Volume to Capacity	0.02	0.02	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.8			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.8			
Approach LOS			A			
Intersection Summary						
Average Delay			1.2			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection

Int Delay, s/veh 2.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	23	218	0	0	73	28	3	1	3	55	0	9
Future Vol, veh/h	23	218	0	0	73	28	3	1	3	55	0	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	75	94	60	60	90	71	60	60	75	78	60	88
Heavy Vehicles, %	9	5	0	0	10	29	0	0	0	13	0	22
Mvmt Flow	31	232	0	0	81	39	5	2	4	71	0	10

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	120	0	0	232	0	0	400	414	232	378	375	81
Stage 1	-	-	-	-	-	-	294	294	-	81	81	-
Stage 2	-	-	-	-	-	-	106	120	-	297	294	-
Critical Hdwy	4.19	-	-	4.1	-	-	7.1	6.5	6.2	7.23	6.5	6.42
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.23	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.23	5.5	-
Follow-up Hdwy	2.281	-	-	2.2	-	-	3.5	4	3.3	3.617	4	3.498
Pot Cap-1 Maneuver	1425	-	-	1348	-	-	564	532	812	560	559	926
Stage 1	-	-	-	-	-	-	719	673	-	901	832	-
Stage 2	-	-	-	-	-	-	905	800	-	689	673	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1425	-	-	1348	-	-	547	519	812	545	545	926
Mov Cap-2 Maneuver	-	-	-	-	-	-	547	519	-	545	545	-
Stage 1	-	-	-	-	-	-	701	656	-	878	832	-
Stage 2	-	-	-	-	-	-	895	800	-	667	656	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.9	0	10.9	12.3
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	617	1425	-	-	1348	-	-	575
HCM Lane V/C Ratio	0.017	0.022	-	-	-	-	-	0.14
HCM Control Delay (s)	10.9	7.6	0	-	0	-	-	12.3
HCM Lane LOS	B	A	A	-	A	-	-	B
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.5

Intersection

Int Delay, s/veh 1.9

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	22	10	5	7	9	0
Future Vol, veh/h	22	10	5	7	9	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	66	92	92	60	92	92
Heavy Vehicles, %	4	90	0	0	100	2
Mvmt Flow	33	11	5	12	10	0

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	44
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.1
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.2
Pot Cap-1 Maneuver	-	-	1577
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1577
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.3	9.9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	747	-	-	1577	-
HCM Lane V/C Ratio	0.013	-	-	0.003	-
HCM Control Delay (s)	9.9	-	-	7.3	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0	-	-	0	-

Intersection: 10: Hardcastle Road & Horning Road

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 11: Hardcastle Road & Slip Ramp

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 12: Slip Ramp & Horning Road

Movement

EB

Directions Served

T

Maximum Queue (ft)

29

Average Queue (ft)

6

95th Queue (ft)

25

Link Distance (ft)

90

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 20: Watkins Road & Horning Road

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	32	5
Average Queue (ft)	12	0
95th Queue (ft)	32	4
Link Distance (ft)	1263	505
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 30: M-124 & Hardcastle Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	4	72
Average Queue (ft)	0	17
95th Queue (ft)	3	51
Link Distance (ft)	635	838
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	5	18
Average Queue (ft)	0	5
95th Queue (ft)	4	17
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB
Directions Served	LTR	LT
Maximum Queue (ft)	28	28
Average Queue (ft)	4	4
95th Queue (ft)	20	20
Link Distance (ft)	317	32
Upstream Blk Time (%)		0
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 51: M-124 & Slip Ramp

Movement	WB	NB	SB
Directions Served	R	T	LT
Maximum Queue (ft)	45	11	6
Average Queue (ft)	8	0	0
95th Queue (ft)	30	6	0
Link Distance (ft)	73	28	503
Upstream Blk Time (%)	0	0	
Queuing Penalty (veh)	0	0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 52: Wellwood Road & Slip Ramp

Movement	SB
Directions Served	L
Maximum Queue (ft)	6
Average Queue (ft)	0
95th Queue (ft)	4
Link Distance (ft)	73
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	NB	SB
Directions Served	LTR	LTR	LTR
Maximum Queue (ft)	47	35	71
Average Queue (ft)	3	9	28
95th Queue (ft)	20	31	58
Link Distance (ft)	745	472	476
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 200: Site Driveway & Horning Road

Movement	NB
Directions Served	LR
Maximum Queue (ft)	74
Average Queue (ft)	12
95th Queue (ft)	51
Link Distance (ft)	1261
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

Intersection						
Int Delay, s/veh	0.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	10	2	0	13	3	0
Future Vol, veh/h	10	2	0	13	3	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	60	65	75	60
Heavy Vehicles, %	0	0	0	0	33	0
Mvmt Flow	12	3	0	20	4	0
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	-	-	34	-
Stage 1	-	-	-	-	14	-
Stage 2	-	-	-	-	20	-
Critical Hdwy	-	-	-	-	6.73	-
Critical Hdwy Stg 1	-	-	-	-	5.73	-
Critical Hdwy Stg 2	-	-	-	-	5.73	-
Follow-up Hdwy	-	-	-	-	3.797	-
Pot Cap-1 Maneuver	-	-	0	-	906	0
Stage 1	-	-	0	-	934	0
Stage 2	-	-	0	-	928	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	906	-
Mov Cap-2 Maneuver	-	-	-	-	906	-
Stage 1	-	-	-	-	934	-
Stage 2	-	-	-	-	928	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0		9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT		
Capacity (veh/h)	906	-	-	-		
HCM Lane V/C Ratio	0.004	-	-	-		
HCM Control Delay (s)	9	-	-	-		
HCM Lane LOS	A	-	-	-		
HCM 95th %tile Q(veh)	0	-	-	-		

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBT	NBR	SBT	SWL	All
Denied Del/Veh (s)	0.1	0.1	0.0	0.0	0.0
Total Del/Veh (s)	1.6	2.5	0.2	0.0	0.9

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.0	0.0
Total Del/Veh (s)	2.5	0.2	0.0	0.9

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↕		↗
Traffic Vol, veh/h	10	0	42	13	0	18
Future Vol, veh/h	10	0	42	13	0	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	70	65	60	67
Heavy Vehicles, %	0	0	21	0	0	50
Mvmt Flow	12	0	60	20	0	27
Major/Minor	Minor2		Major2			
Conflicting Flow All	140	-	0	0		
Stage 1	140	-	-	-		
Stage 2	0	-	-	-		
Critical Hdwy	6.5	-	4.31	-		
Critical Hdwy Stg 1	5.5	-	-	-		
Critical Hdwy Stg 2	-	-	-	-		
Follow-up Hdwy	4	-	2.389	-		
Pot Cap-1 Maneuver	755	0	-	-		
Stage 1	785	0	-	-		
Stage 2	-	0	-	-		
Platoon blocked, %				-		
Mov Cap-1 Maneuver	0	-	-	-		
Mov Cap-2 Maneuver	0	-	-	-		
Stage 1	0	-	-	-		
Stage 2	0	-	-	-		
Approach	EB		WB			
HCM Control Delay, s						
HCM LOS	-					
Minor Lane/Major Mvmt	EBLn1	WBL	WBT			
Capacity (veh/h)	-	-	-			
HCM Lane V/C Ratio	-	-	-			
HCM Control Delay (s)	-	-	-			
HCM Lane LOS	-	-	-			
HCM 95th %tile Q(veh)	-	-	-			

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	13	2	2	8	30	33
Future Vol, veh/h	13	2	2	8	30	33
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	67	83	75
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	22	3	3	12	36	44
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	76	58	80	0	-	0
Stage 1	58	-	-	-	-	-
Stage 2	18	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.2	-	-	-
Pot Cap-1 Maneuver	932	1014	1531	-	-	-
Stage 1	970	-	-	-	-	-
Stage 2	1010	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	930	1014	1531	-	-	-
Mov Cap-2 Maneuver	930	-	-	-	-	-
Stage 1	968	-	-	-	-	-
Stage 2	1010	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	8.9	1.6		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1531	-	940	-	-	
HCM Lane V/C Ratio	0.002	-	0.027	-	-	
HCM Control Delay (s)	7.4	0	8.9	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	11	76	72	11	16	11
Future Vol, veh/h	11	76	72	11	16	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	69	89	81	60	75	60
Heavy Vehicles, %	0	0	1	82	56	0
Mvmt Flow	16	85	89	18	21	18
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	107	0	-	0	215	98
Stage 1	-	-	-	-	98	-
Stage 2	-	-	-	-	117	-
Critical Hdwy	4.1	-	-	-	6.96	6.2
Critical Hdwy Stg 1	-	-	-	-	5.96	-
Critical Hdwy Stg 2	-	-	-	-	5.96	-
Follow-up Hdwy	2.2	-	-	-	4.004	3.3
Pot Cap-1 Maneuver	1497	-	-	-	667	963
Stage 1	-	-	-	-	807	-
Stage 2	-	-	-	-	790	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1497	-	-	-	660	963
Mov Cap-2 Maneuver	-	-	-	-	660	-
Stage 1	-	-	-	-	798	-
Stage 2	-	-	-	-	790	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.2	0		9.9		
HCM LOS	A					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1497	-	-	-	772	
HCM Lane V/C Ratio	0.011	-	-	-	0.051	
HCM Control Delay (s)	7.4	0	-	-	9.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.2	

Intersection						
Int Delay, s/veh	0.7					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	84	78	5	1	5
Future Vol, veh/h	6	84	78	5	1	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	80	81	60	60	63
Heavy Vehicles, %	0	11	14	0	0	0
Mvmt Flow	10	105	96	8	2	8
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	104	0	-	0	225	100
Stage 1	-	-	-	-	100	-
Stage 2	-	-	-	-	125	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1500	-	-	-	768	961
Stage 1	-	-	-	-	929	-
Stage 2	-	-	-	-	906	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1500	-	-	-	763	961
Mov Cap-2 Maneuver	-	-	-	-	763	-
Stage 1	-	-	-	-	922	-
Stage 2	-	-	-	-	906	-
Approach	EB	WB		SB		
HCM Control Delay, s	0.6	0		9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1500	-	-	-	920	
HCM Lane V/C Ratio	0.007	-	-	-	0.01	
HCM Control Delay (s)	7.4	0	-	-	9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0	

Intersection												
Int Delay, s/veh	2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	1	3	18	1	0	3	67	14	0	60	0
Future Vol, veh/h	0	1	3	18	1	0	3	67	14	0	60	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	75	60	60	60	60	95	60	60	95	60
Heavy Vehicles, %	0	0	0	0	0	0	0	15	0	0	15	0
Mvmt Flow	0	2	4	30	2	0	5	71	23	0	63	0

Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	157	167	63	159	156	-	63	0	0	-	-	0
Stage 1	63	63	-	93	93	-	-	-	-	-	-	-
Stage 2	94	104	-	66	63	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	814	729	1007	811	740	0	1553	-	-	0	-	-
Stage 1	953	846	-	919	822	0	-	-	-	0	-	-
Stage 2	918	813	-	950	846	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	811	727	1007	805	738	-	1553	-	-	-	-	-
Mov Cap-2 Maneuver	811	727	-	805	738	-	-	-	-	-	-	-
Stage 1	950	846	-	916	820	-	-	-	-	-	-	-
Stage 2	913	811	-	944	846	-	-	-	-	-	-	-

Approach	EB		WB		NB		SB	
HCM Control Delay, s	9		9.7		0.4		0	
HCM LOS	A		A					

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBT	SBR
Capacity (veh/h)	1553	-	-	905	801	-
HCM Lane V/C Ratio	0.003	-	-	0.006	0.04	-
HCM Control Delay (s)	7.3	0	-	9	9.7	-
HCM Lane LOS	A	A	-	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0.1	-

Intersection						
Int Delay, s/veh	1.6					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	11	67	0	8	60
Future Vol, veh/h	0	11	67	0	8	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	60	60	95	60	60	95
Heavy Vehicles, %	0	0	15	0	0	15
Mvmt Flow	0	18	71	0	13	63
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	71	0	-	71	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.2	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	0	997	-	0	1542	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	997	-	-	1542	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.7	0		1.3		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	-		997	1542	-	
HCM Lane V/C Ratio	-		0.018	0.009	-	
HCM Control Delay (s)	-		8.7	7.4	0	
HCM Lane LOS	-		A	A	A	
HCM 95th %tile Q(veh)	-		0.1	0	-	

HCM Unsignalized Intersection Capacity Analysis
52: Wellwood Road & Slip Ramp

2026 Future Conditions - Haul Route B (Hardcastle Road)
p.m. Peak Hour

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	15	19	11	8	0
Future Volume (Veh/h)	0	15	19	11	8	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60
Hourly flow rate (vph)	0	25	32	18	13	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	50				66	41
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	50				66	41
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1570				944	1036
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	25	50	13			
Volume Left	0	0	13			
Volume Right	0	18	0			
cSH	1700	1700	944			
Volume to Capacity	0.01	0.03	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.9			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.9			
Approach LOS			A			
Intersection Summary						
Average Delay			1.3			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection

Int Delay, s/veh 2.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	16	154	5	8	233	69	2	2	2	51	2	26
Future Vol, veh/h	16	154	5	8	233	69	2	2	2	51	2	26
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	93	63	67	95	90	60	60	60	85	60	61
Heavy Vehicles, %	13	6	0	0	2	12	0	0	0	14	0	8
Mvmt Flow	27	166	8	12	245	77	3	3	3	60	3	43

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	322	0	0	174	0	0	555	570	170	496	497	245
Stage 1	-	-	-	-	-	-	224	224	-	269	269	-
Stage 2	-	-	-	-	-	-	331	346	-	227	228	-
Critical Hdwy	4.23	-	-	4.1	-	-	7.1	6.5	6.2	7.24	6.5	6.28
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.24	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.24	5.5	-
Follow-up Hdwy	2.317	-	-	2.2	-	-	3.5	4	3.3	3.626	4	3.372
Pot Cap-1 Maneuver	1178	-	-	1415	-	-	445	434	879	465	477	779
Stage 1	-	-	-	-	-	-	783	722	-	711	690	-
Stage 2	-	-	-	-	-	-	687	639	-	749	719	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1178	-	-	1415	-	-	407	419	879	448	460	779
Mov Cap-2 Maneuver	-	-	-	-	-	-	407	419	-	448	460	-
Stage 1	-	-	-	-	-	-	763	704	-	693	683	-
Stage 2	-	-	-	-	-	-	640	633	-	724	701	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	1.1			0.3			12.3			13.3		
HCM LOS							B			B		

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	502	1178	-	-	1415	-	-	541
HCM Lane V/C Ratio	0.02	0.023	-	-	0.008	-	-	0.196
HCM Control Delay (s)	12.3	8.1	0	-	7.6	0	-	13.3
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.7

Intersection						
Int Delay, s/veh	1.6					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	14	9	0	35	14	1
Future Vol, veh/h	14	9	0	35	14	1
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	92	92	74	92	92
Heavy Vehicles, %	0	100	0	0	64	0
Mvmt Flow	23	10	0	47	15	1
Major/Minor	Major1	Major2		Minor1		
Conflicting Flow All	0	0	33	0	75	28
Stage 1	-	-	-	-	28	-
Stage 2	-	-	-	-	47	-
Critical Hdwy	-	-	4.1	-	7.04	6.2
Critical Hdwy Stg 1	-	-	-	-	6.04	-
Critical Hdwy Stg 2	-	-	-	-	6.04	-
Follow-up Hdwy	-	-	2.2	-	4.076	3.3
Pot Cap-1 Maneuver	-	-	1592	-	796	1053
Stage 1	-	-	-	-	856	-
Stage 2	-	-	-	-	838	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1592	-	796	1053
Mov Cap-2 Maneuver	-	-	-	-	796	-
Stage 1	-	-	-	-	856	-
Stage 2	-	-	-	-	838	-
Approach	EB	WB		NB		
HCM Control Delay, s	0	0		9.5		
HCM LOS	A					
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT	
Capacity (veh/h)	809	-	-	1592	-	
HCM Lane V/C Ratio	0.02	-	-	-	-	
HCM Control Delay (s)	9.5	-	-	0	-	
HCM Lane LOS	A	-	-	A	-	
HCM 95th %tile Q(veh)	0.1	-	-	0	-	

Intersection: 10: Hardcastle Road & Horning Road

Movement	NB
Directions Served	L
Maximum Queue (ft)	26
Average Queue (ft)	2
95th Queue (ft)	13
Link Distance (ft)	81
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 11: Hardcastle Road & Slip Ramp

Movement	
Directions Served	
Maximum Queue (ft)	
Average Queue (ft)	
95th Queue (ft)	
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 12: Slip Ramp & Horning Road

Movement	EB
Directions Served	T
Maximum Queue (ft)	34
Average Queue (ft)	8
95th Queue (ft)	30
Link Distance (ft)	90
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 20: Watkins Road & Horning Road

Movement	EB
Directions Served	LR
Maximum Queue (ft)	26
Average Queue (ft)	10
95th Queue (ft)	28
Link Distance (ft)	1263
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 30: M-124 & Hardcastle Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	16	58
Average Queue (ft)	1	18
95th Queue (ft)	8	49
Link Distance (ft)	635	838
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	5	17
Average Queue (ft)	0	4
95th Queue (ft)	5	15
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB	NB
Directions Served	LTR	LT	LTR
Maximum Queue (ft)	28	30	6
Average Queue (ft)	4	12	0
95th Queue (ft)	19	34	4
Link Distance (ft)	317	32	465
Upstream Blk Time (%)		1	
Queuing Penalty (veh)		0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 51: M-124 & Slip Ramp

Movement	WB	SB
Directions Served	R	LT
Maximum Queue (ft)	31	5
Average Queue (ft)	5	0
95th Queue (ft)	23	4
Link Distance (ft)	73	503
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 52: Wellwood Road & Slip Ramp

Movement	WB
Directions Served	TR
Maximum Queue (ft)	5
Average Queue (ft)	0
95th Queue (ft)	4
Link Distance (ft)	970
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	WB	NB	SB
Directions Served	LTR	LT	LTR	LTR
Maximum Queue (ft)	63	23	31	82
Average Queue (ft)	5	1	6	31
95th Queue (ft)	30	12	25	61
Link Distance (ft)	745	713	472	476
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 200: Site Driveway & Horning Road

Movement	NB
Directions Served	LR
Maximum Queue (ft)	79
Average Queue (ft)	20
95th Queue (ft)	64
Link Distance (ft)	1261
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↻			↑	↻	
Traffic Vol, veh/h	8	0	0	2	0	0
Future Vol, veh/h	8	0	0	2	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	60	60	60
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	13	0	0	3	0	0
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	-	-	16	-
Stage 1	-	-	-	-	13	-
Stage 2	-	-	-	-	3	-
Critical Hdwy	-	-	-	-	6.4	-
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	-	-	-	-	3.5	-
Pot Cap-1 Maneuver	-	-	0	-	1008	0
Stage 1	-	-	0	-	1015	0
Stage 2	-	-	0	-	1025	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	1008	-
Mov Cap-2 Maneuver	-	-	-	-	1008	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	1025	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0		0	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT		
Capacity (veh/h)	-	-	-	-		
HCM Lane V/C Ratio	-	-	-	-		
HCM Control Delay (s)	0	-	-	-		
HCM Lane LOS	A	-	-	-		
HCM 95th %tile Q(veh)	-	-	-	-		

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBR	SWL	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.5	0.0	2.2

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.1
Total Del/Veh (s)	2.5	0.0	2.2

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↑		↑
Traffic Vol, veh/h	8	0	5	2	0	23
Future Vol, veh/h	8	0	5	2	0	23
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	63	60	82	82
Heavy Vehicles, %	0	0	0	0	4	4
Mvmt Flow	13	0	8	3	0	28
Major/Minor	Minor2		Major2			
Conflicting Flow All	19	-	0	0		
Stage 1	19	-	-	-		
Stage 2	0	-	-	-		
Critical Hdwy	6.5	-	4.1	-		
Critical Hdwy Stg 1	5.5	-	-	-		
Critical Hdwy Stg 2	-	-	-	-		
Follow-up Hdwy	4	-	2.2	-		
Pot Cap-1 Maneuver	879	0	-	-		
Stage 1	884	0	-	-		
Stage 2	-	0	-	-		
Platoon blocked, %				-		
Mov Cap-1 Maneuver	0	-	-	-		
Mov Cap-2 Maneuver	0	-	-	-		
Stage 1	0	-	-	-		
Stage 2	0	-	-	-		
Approach	EB		WB			
HCM Control Delay, s						
HCM LOS	-					
Minor Lane/Major Mvmt	EBLn1	WBL	WBT			
Capacity (veh/h)	-	-	-			
HCM Lane V/C Ratio	-	-	-			
HCM Control Delay (s)	-	-	-			
HCM Lane LOS	-	-	-			
HCM 95th %tile Q(veh)	-	-	-			

Intersection						
Int Delay, s/veh	4.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	21	1	2	13	9	6
Future Vol, veh/h	21	1	2	13	9	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	66	60	60	81	75	60
Heavy Vehicles, %	0	100	0	0	11	0
Mvmt Flow	32	2	3	16	12	10
Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	39	17	22	0	-	0
Stage 1	17	-	-	-	-	-
Stage 2	22	-	-	-	-	-
Critical Hdwy	6.4	7.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	4.2	2.2	-	-	-
Pot Cap-1 Maneuver	978	837	1607	-	-	-
Stage 1	1011	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	976	837	1607	-	-	-
Mov Cap-2 Maneuver	976	-	-	-	-	-
Stage 1	1009	-	-	-	-	-
Stage 2	1006	-	-	-	-	-
Approach	EB		NB		SB	
HCM Control Delay, s	8.9		1.2		0	
HCM LOS	A					
Minor Lane/Major Mvmt			NBL	NBT	EBLn1	SBT SBR
Capacity (veh/h)			1607	-	968	- -
HCM Lane V/C Ratio			0.002	-	0.035	- -
HCM Control Delay (s)			7.2	0	8.9	- -
HCM Lane LOS			A	A	A	- -
HCM 95th %tile Q(veh)			0	-	0.1	- -

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	4	31	48	7	6	11
Future Vol, veh/h	4	31	48	7	6	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	75	90	60	60	60
Heavy Vehicles, %	0	3	0	29	0	0
Mvmt Flow	7	41	53	12	10	18
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	65	0	-	0	114	59
Stage 1	-	-	-	-	59	-
Stage 2	-	-	-	-	55	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1550	-	-	-	887	1012
Stage 1	-	-	-	-	969	-
Stage 2	-	-	-	-	973	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1550	-	-	-	883	1012
Mov Cap-2 Maneuver	-	-	-	-	883	-
Stage 1	-	-	-	-	964	-
Stage 2	-	-	-	-	973	-
Approach	EB	WB		SB		
HCM Control Delay, s	1	0		8.9		
HCM LOS	A					
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1550	-	-	-	962	
HCM Lane V/C Ratio	0.004	-	-	-	0.029	
HCM Control Delay (s)	7.3	0	-	-	8.9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection

Int Delay, s/veh 2.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	7	37	42	15	12	7
Future Vol, veh/h	7	37	42	15	12	7
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	69	64	60	60	60
Heavy Vehicles, %	0	14	5	60	75	0
Mvmt Flow	12	54	66	25	20	12

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	91	0	0 157 79
Stage 1	-	-	- 79 -
Stage 2	-	-	- 78 -
Critical Hdwy	4.1	-	- 7.15 6.2
Critical Hdwy Stg 1	-	-	- 6.15 -
Critical Hdwy Stg 2	-	-	- 6.15 -
Follow-up Hdwy	2.2	-	- 4.175 3.3
Pot Cap-1 Maneuver	1517	-	- 690 987
Stage 1	-	-	- 788 -
Stage 2	-	-	- 789 -
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1517	-	- 684 987
Mov Cap-2 Maneuver	-	-	- 684 -
Stage 1	-	-	- 782 -
Stage 2	-	-	- 789 -

Approach	EB	WB	SB
HCM Control Delay, s	1.3	0	9.9
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1517	-	-	-	771
HCM Lane V/C Ratio	0.008	-	-	-	0.041
HCM Control Delay (s)	7.4	0	-	-	9.9
HCM Lane LOS	A	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection												
Int Delay, s/veh	1											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	1	1	2	7	0	0	0	45	14	0	50	0
Future Vol, veh/h	1	1	2	7	0	0	0	45	14	0	50	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	60	60	60	60	60	89	60	71	71	71
Heavy Vehicles, %	0	0	0	0	0	0	0	24	0	3	20	3
Mvmt Flow	2	2	3	12	0	0	0	51	23	0	70	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	133	144	70	136	133	-	70	0	0	-	-	0
Stage 1	70	70	-	63	63	-	-	-	-	-	-	-
Stage 2	63	74	-	73	70	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	844	751	998	840	761	0	1544	-	-	0	-	-
Stage 1	945	841	-	953	846	0	-	-	-	0	-	-
Stage 2	953	837	-	942	841	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	844	751	998	836	761	-	1544	-	-	-	-	-
Mov Cap-2 Maneuver	844	751	-	836	761	-	-	-	-	-	-	-
Stage 1	945	841	-	953	846	-	-	-	-	-	-	-
Stage 2	953	837	-	937	841	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	9.1		9.4		0		0					
HCM LOS	A		A									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBT	SBR						
Capacity (veh/h)	1544	-	-	885	836	-						
HCM Lane V/C Ratio	-	-	-	0.008	0.014	-						
HCM Control Delay (s)	0	-	-	9.1	9.4	-						
HCM Lane LOS	A	-	-	A	A	-						
HCM 95th %tile Q(veh)	0	-	-	0	0	-						

Intersection						
Int Delay, s/veh	1.4					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	13	46	0	6	50
Future Vol, veh/h	0	13	46	0	6	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	65	65	60	60	60	71
Heavy Vehicles, %	8	8	24	6	0	20
Mvmt Flow	0	20	77	0	10	70
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	77	0	-	77	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.28	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.372	-	-	2.2	-
Pot Cap-1 Maneuver	0	967	-	0	1535	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	967	-	-	1535	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.8	0		0.9		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	- 967		1535	-		
HCM Lane V/C Ratio	- 0.021		0.007	-		
HCM Control Delay (s)	- 8.8		7.4	0		
HCM Lane LOS	- A		A	A		
HCM 95th %tile Q(veh)	- 0.1		0	-		

HCM Unsignalized Intersection Capacity Analysis
52: Wellwood Road & Slip Ramp

2026 Future Conditions - Haul Route C (Lawrence Road)
a.m. Peak Hour

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	15	7	13	6	0
Future Volume (Veh/h)	0	15	7	13	6	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.65	0.60	0.60
Hourly flow rate (vph)	0	25	12	20	10	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	32				47	22
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	32				47	22
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1593				968	1061
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	25	32	10			
Volume Left	0	0	10			
Volume Right	0	20	0			
cSH	1700	1700	968			
Volume to Capacity	0.01	0.02	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.8			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.8			
Approach LOS			A			
Intersection Summary						
Average Delay			1.3			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection

Int Delay, s/veh 2.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	23	218	0	0	73	28	3	1	3	55	0	9
Future Vol, veh/h	23	218	0	0	73	28	3	1	3	55	0	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	75	94	60	60	90	71	60	60	75	78	60	88
Heavy Vehicles, %	9	5	0	0	10	29	0	0	0	13	0	22
Mvmt Flow	31	232	0	0	81	39	5	2	4	71	0	10

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	120	0	0	232	0	0	400	414	232	378	375	81
Stage 1	-	-	-	-	-	-	294	294	-	81	81	-
Stage 2	-	-	-	-	-	-	106	120	-	297	294	-
Critical Hdwy	4.19	-	-	4.1	-	-	7.1	6.5	6.2	7.23	6.5	6.42
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.23	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.23	5.5	-
Follow-up Hdwy	2.281	-	-	2.2	-	-	3.5	4	3.3	3.617	4	3.498
Pot Cap-1 Maneuver	1425	-	-	1348	-	-	564	532	812	560	559	926
Stage 1	-	-	-	-	-	-	719	673	-	901	832	-
Stage 2	-	-	-	-	-	-	905	800	-	689	673	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1425	-	-	1348	-	-	547	519	812	545	545	926
Mov Cap-2 Maneuver	-	-	-	-	-	-	547	519	-	545	545	-
Stage 1	-	-	-	-	-	-	701	656	-	878	832	-
Stage 2	-	-	-	-	-	-	895	800	-	667	656	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.9			0			10.9			12.3		
HCM LOS							B			B		

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	617	1425	-	-	1348	-	-	575
HCM Lane V/C Ratio	0.017	0.022	-	-	-	-	-	0.14
HCM Control Delay (s)	10.9	7.6	0	-	0	-	-	12.3
HCM Lane LOS	B	A	A	-	A	-	-	B
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.5

Intersection						
Int Delay, s/veh	1.8					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	9	0	8	14	1	10
Future Vol, veh/h	9	0	8	14	1	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	60	92	92	60
Heavy Vehicles, %	100	0	0	64	0	0
Mvmt Flow	10	0	13	15	1	17
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	40	21	0	0	28	0
Stage 1	21	-	-	-	-	-
Stage 2	19	-	-	-	-	-
Critical Hdwy	7.4	6.2	-	-	4.1	-
Critical Hdwy Stg 1	6.4	-	-	-	-	-
Critical Hdwy Stg 2	6.4	-	-	-	-	-
Follow-up Hdwy	4.4	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	772	1062	-	-	1599	-
Stage 1	798	-	-	-	-	-
Stage 2	800	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	771	1062	-	-	1599	-
Mov Cap-2 Maneuver	771	-	-	-	-	-
Stage 1	798	-	-	-	-	-
Stage 2	799	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	9.7	0		0.4		
HCM LOS	A					
Minor Lane/Major Mvmt	NBT	NBRWBLn1	SBL	SBT		
Capacity (veh/h)	-	-	771	1599	-	
HCM Lane V/C Ratio	-	-	0.013	0.001	-	
HCM Control Delay (s)	-	-	9.7	7.3	0	
HCM Lane LOS	-	-	A	A	A	
HCM 95th %tile Q(veh)	-	-	0	0	-	

Intersection: 10: Hardcastle Road & Horning Road

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 11: Hardcastle Road & Slip Ramp

Movement

Directions Served

Maximum Queue (ft)

Average Queue (ft)

95th Queue (ft)

Link Distance (ft)

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 12: Slip Ramp & Horning Road

Movement

EB

Directions Served

T

Maximum Queue (ft)

29

Average Queue (ft)

5

95th Queue (ft)

23

Link Distance (ft)

90

Upstream Blk Time (%)

Queuing Penalty (veh)

Storage Bay Dist (ft)

Storage Blk Time (%)

Queuing Penalty (veh)

Intersection: 20: Watkins Road & Horning Road

Movement	EB
Directions Served	LR
Maximum Queue (ft)	46
Average Queue (ft)	12
95th Queue (ft)	34
Link Distance (ft)	957
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 30: M-124 & Hardcastle Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	5	22
Average Queue (ft)	0	7
95th Queue (ft)	4	22
Link Distance (ft)	635	838
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	10	54
Average Queue (ft)	0	14
95th Queue (ft)	5	45
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB
Directions Served	LTR	LT
Maximum Queue (ft)	28	28
Average Queue (ft)	4	5
95th Queue (ft)	20	22
Link Distance (ft)	317	32
Upstream Blk Time (%)		0
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 51: M-124 & Slip Ramp

Movement	WB	NB	SB
Directions Served	R	T	LT
Maximum Queue (ft)	50	10	12
Average Queue (ft)	12	0	1
95th Queue (ft)	39	7	9
Link Distance (ft)	73	28	503
Upstream Blk Time (%)	0	0	
Queuing Penalty (veh)	0	0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 52: Wellwood Road & Slip Ramp

Movement	SB
Directions Served	L
Maximum Queue (ft)	12
Average Queue (ft)	0
95th Queue (ft)	6
Link Distance (ft)	73
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	NB	SB
Directions Served	LTR	LTR	LTR
Maximum Queue (ft)	29	36	82
Average Queue (ft)	2	5	27
95th Queue (ft)	16	24	59
Link Distance (ft)	745	472	476
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 300: Lawrence Road & Site Driveway

Movement	WB
Directions Served	LR
Maximum Queue (ft)	68
Average Queue (ft)	15
95th Queue (ft)	56
Link Distance (ft)	3098
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

Intersection						
Int Delay, s/veh	0.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱			↱	↱	
Traffic Vol, veh/h	10	2	0	13	3	0
Future Vol, veh/h	10	2	0	13	3	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	60	65	75	60
Heavy Vehicles, %	0	0	0	0	33	0
Mvmt Flow	12	3	0	20	4	0
Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	-	-	34	-
Stage 1	-	-	-	-	14	-
Stage 2	-	-	-	-	20	-
Critical Hdwy	-	-	-	-	6.73	-
Critical Hdwy Stg 1	-	-	-	-	5.73	-
Critical Hdwy Stg 2	-	-	-	-	5.73	-
Follow-up Hdwy	-	-	-	-	3.797	-
Pot Cap-1 Maneuver	-	-	0	-	906	0
Stage 1	-	-	0	-	934	0
Stage 2	-	-	0	-	928	0
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	906	-
Mov Cap-2 Maneuver	-	-	-	-	906	-
Stage 1	-	-	-	-	934	-
Stage 2	-	-	-	-	928	-
Approach	EB		WB		NB	
HCM Control Delay, s	0		0		9	
HCM LOS					A	
Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBT		
Capacity (veh/h)	906	-	-	-		
HCM Lane V/C Ratio	0.004	-	-	-		
HCM Control Delay (s)	9	-	-	-		
HCM Lane LOS	A	-	-	-		
HCM 95th %tile Q(veh)	0	-	-	-		

11: Hardcastle Road & Slip Ramp Performance by movement

Movement	NBT	NBR	SBT	SWL	All
Denied Del/Veh (s)	0.1	0.1	0.0	0.0	0.0
Total Del/Veh (s)	1.5	2.4	0.2	0.0	0.5

11: Hardcastle Road & Slip Ramp Performance by approach

Approach	NB	SB	SW	All
Denied Del/Veh (s)	0.1	0.0	0.0	0.0
Total Del/Veh (s)	2.1	0.2	0.0	0.5

Intersection						
Int Delay, s/veh	0					
Movement	EBT	EBR	WBL	WBT	NEL	NER
Lane Configurations	↑			↔		↗
Traffic Vol, veh/h	10	0	28	13	0	8
Future Vol, veh/h	10	0	28	13	0	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	83	60	70	65	60	67
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	12	0	40	20	0	12
Major/Minor	Minor2	Major2				
Conflicting Flow All	100	-	0	0		
Stage 1	100	-	-	-		
Stage 2	0	-	-	-		
Critical Hdwy	6.5	-	4.1	-		
Critical Hdwy Stg 1	5.5	-	-	-		
Critical Hdwy Stg 2	-	-	-	-		
Follow-up Hdwy	4	-	2.2	-		
Pot Cap-1 Maneuver	794	0	-	-		
Stage 1	816	0	-	-		
Stage 2	-	0	-	-		
Platoon blocked, %				-		
Mov Cap-1 Maneuver	0	-	-	-		
Mov Cap-2 Maneuver	0	-	-	-		
Stage 1	0	-	-	-		
Stage 2	0	-	-	-		
Approach	EB	WB				
HCM Control Delay, s						
HCM LOS	-					
Minor Lane/Major Mvmt	EBLn1	WBL	WBT			
Capacity (veh/h)	-	-	-			
HCM Lane V/C Ratio	-	-	-			
HCM Control Delay (s)	-	-	-			
HCM Lane LOS	-	-	-			
HCM 95th %tile Q(veh)	-	-	-			

Intersection						
Int Delay, s/veh	2.1					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	13	2	2	8	30	33
Future Vol, veh/h	13	2	2	8	30	33
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	60	60	60	67	83	75
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	22	3	3	12	36	44
Major/Minor	Minor2	Major1		Major2		
Conflicting Flow All	76	58	80	0	-	0
Stage 1	58	-	-	-	-	-
Stage 2	18	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.2	-	-	-
Pot Cap-1 Maneuver	932	1014	1531	-	-	-
Stage 1	970	-	-	-	-	-
Stage 2	1010	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	930	1014	1531	-	-	-
Mov Cap-2 Maneuver	930	-	-	-	-	-
Stage 1	968	-	-	-	-	-
Stage 2	1010	-	-	-	-	-
Approach	EB	NB		SB		
HCM Control Delay, s	8.9	1.6		0		
HCM LOS	A					
Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1531	-	940	-	-	
HCM Lane V/C Ratio	0.002	-	0.027	-	-	
HCM Control Delay (s)	7.4	0	8.9	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	0.1	-	-	

Intersection						
Int Delay, s/veh	1.4					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	11	76	73	2	3	10
Future Vol, veh/h	11	76	73	2	3	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	69	89	81	60	75	60
Heavy Vehicles, %	0	0	1	0	0	0
Mvmt Flow	16	85	90	3	4	17
Major/Minor	Major1	Major2		Minor2		
Conflicting Flow All	93	0	-	0	209	92
Stage 1	-	-	-	-	92	-
Stage 2	-	-	-	-	117	-
Critical Hdwy	4.1	-	-	-	6.4	6.2
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1514	-	-	-	784	971
Stage 1	-	-	-	-	937	-
Stage 2	-	-	-	-	913	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1514	-	-	-	775	971
Mov Cap-2 Maneuver	-	-	-	-	775	-
Stage 1	-	-	-	-	927	-
Stage 2	-	-	-	-	913	-
Approach	EB	WB		SB		
HCM Control Delay, s	1.2	0		9		
HCM LOS				A		
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	
Capacity (veh/h)	1514	-	-	-	926	
HCM Lane V/C Ratio	0.011	-	-	-	0.022	
HCM Control Delay (s)	7.4	0	-	-	9	
HCM Lane LOS	A	A	-	-	A	
HCM 95th %tile Q(veh)	0	-	-	-	0.1	

Intersection

Int Delay, s/veh 1.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	6	71	69	14	14	6
Future Vol, veh/h	6	71	69	14	14	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	60	80	81	60	60	63
Heavy Vehicles, %	0	0	3	64	64	0
Mvmt Flow	10	89	85	23	23	10

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	108	0	0 206 97
Stage 1	-	-	- 97 -
Stage 2	-	-	- 109 -
Critical Hdwy	4.1	-	- 7.04 6.2
Critical Hdwy Stg 1	-	-	- 6.04 -
Critical Hdwy Stg 2	-	-	- 6.04 -
Follow-up Hdwy	2.2	-	- 4.076 3.3
Pot Cap-1 Maneuver	1495	-	- 662 965
Stage 1	-	-	- 793 -
Stage 2	-	-	- 782 -
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1495	-	- 657 965
Mov Cap-2 Maneuver	-	-	- 657 -
Stage 1	-	-	- 787 -
Stage 2	-	-	- 782 -

Approach	EB	WB	SB
HCM Control Delay, s	0.8	0	10.2
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1495	-	-	-	724
HCM Lane V/C Ratio	0.007	-	-	-	0.045
HCM Control Delay (s)	7.4	0	-	-	10.2
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection												
Int Delay, s/veh	2											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	0	1	3	18	1	0	3	67	14	0	60	0
Future Vol, veh/h	0	1	3	18	1	0	3	67	14	0	60	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	75	60	60	60	60	95	60	60	95	60
Heavy Vehicles, %	0	0	0	0	0	0	0	15	0	0	15	0
Mvmt Flow	0	2	4	30	2	0	5	71	23	0	63	0
Major/Minor	Minor2		Minor1		Major1		Major2					
Conflicting Flow All	157	167	63	159	156	-	63	0	0	-	-	0
Stage 1	63	63	-	93	93	-	-	-	-	-	-	-
Stage 2	94	104	-	66	63	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	-	4.1	-	-	-	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	-	2.2	-	-	-	-	-
Pot Cap-1 Maneuver	814	729	1007	811	740	0	1553	-	-	0	-	-
Stage 1	953	846	-	919	822	0	-	-	-	0	-	-
Stage 2	918	813	-	950	846	0	-	-	-	0	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	811	727	1007	805	738	-	1553	-	-	-	-	-
Mov Cap-2 Maneuver	811	727	-	805	738	-	-	-	-	-	-	-
Stage 1	950	846	-	916	820	-	-	-	-	-	-	-
Stage 2	913	811	-	944	846	-	-	-	-	-	-	-
Approach	EB		WB		NB		SB					
HCM Control Delay, s	9		9.7		0.4		0					
HCM LOS	A		A									
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBT	SBR						
Capacity (veh/h)	1553	-	-	905	801	-						
HCM Lane V/C Ratio	0.003	-	-	0.006	0.04	-						
HCM Control Delay (s)	7.3	0	-	9	9.7	-						
HCM Lane LOS	A	A	-	A	A	-						
HCM 95th %tile Q(veh)	0	-	-	0	0.1	-						

Intersection						
Int Delay, s/veh	1.6					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	0	11	67	0	8	60
Future Vol, veh/h	0	11	67	0	8	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	60	60	95	60	60	95
Heavy Vehicles, %	0	0	15	0	0	15
Mvmt Flow	0	18	71	0	13	63
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	-	71	0	-	71	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.2	-	-	4.1	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	0	997	-	0	1542	-
Stage 1	0	-	-	0	-	-
Stage 2	0	-	-	0	-	-
Platoon blocked, %			-			-
Mov Cap-1 Maneuver	-	997	-	-	1542	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	8.7	0		1.3		
HCM LOS	A					
Minor Lane/Major Mvmt	NBTWBLn1		SBL	SBT		
Capacity (veh/h)	-		997	1542	-	
HCM Lane V/C Ratio	-		0.018	0.009	-	
HCM Control Delay (s)	-		8.7	7.4	0	
HCM Lane LOS	-		A	A	A	
HCM 95th %tile Q(veh)	-		0.1	0	-	

HCM Unsignalized Intersection Capacity Analysis
52: Wellwood Road & Slip Ramp

2026 Future Conditions - Haul Route C (Lawrence Road)
p.m. Peak Hour

						
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	15	19	11	8	0
Future Volume (Veh/h)	0	15	19	11	8	0
Sign Control		Free	Free		Yield	
Grade		0%	0%		0%	
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60
Hourly flow rate (vph)	0	25	32	18	13	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	50				66	41
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	50				66	41
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				99	100
cM capacity (veh/h)	1570				944	1036
Direction, Lane #	EB 1	WB 1	SB 1			
Volume Total	25	50	13			
Volume Left	0	0	13			
Volume Right	0	18	0			
cSH	1700	1700	944			
Volume to Capacity	0.01	0.03	0.01			
Queue Length 95th (ft)	0	0	1			
Control Delay (s)	0.0	0.0	8.9			
Lane LOS			A			
Approach Delay (s)	0.0	0.0	8.9			
Approach LOS			A			
Intersection Summary						
Average Delay			1.3			
Intersection Capacity Utilization			13.3%	ICU Level of Service		A
Analysis Period (min)			15			

Intersection												
Int Delay, s/veh	2.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	16	154	5	8	233	69	2	2	2	51	2	26
Future Vol, veh/h	16	154	5	8	233	69	2	2	2	51	2	26
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	150	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	93	63	67	95	90	60	60	60	85	60	61
Heavy Vehicles, %	13	6	0	0	2	12	0	0	0	14	0	8
Mvmt Flow	27	166	8	12	245	77	3	3	3	60	3	43
Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	322	0	0	174	0	0	555	570	170	496	497	245
Stage 1	-	-	-	-	-	-	224	224	-	269	269	-
Stage 2	-	-	-	-	-	-	331	346	-	227	228	-
Critical Hdwy	4.23	-	-	4.1	-	-	7.1	6.5	6.2	7.24	6.5	6.28
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.24	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.24	5.5	-
Follow-up Hdwy	2.317	-	-	2.2	-	-	3.5	4	3.3	3.626	4	3.372
Pot Cap-1 Maneuver	1178	-	-	1415	-	-	445	434	879	465	477	779
Stage 1	-	-	-	-	-	-	783	722	-	711	690	-
Stage 2	-	-	-	-	-	-	687	639	-	749	719	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1178	-	-	1415	-	-	407	419	879	448	460	779
Mov Cap-2 Maneuver	-	-	-	-	-	-	407	419	-	448	460	-
Stage 1	-	-	-	-	-	-	763	704	-	693	683	-
Stage 2	-	-	-	-	-	-	640	633	-	724	701	-
Approach	EB			WB			NB			SB		
HCM Control Delay, s	1.1			0.3			12.3			13.3		
HCM LOS							B			B		
Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1				
Capacity (veh/h)	502	1178	-	-	1415	-	-	541				
HCM Lane V/C Ratio	0.02	0.023	-	-	0.008	-	-	0.196				
HCM Control Delay (s)	12.3	8.1	0	-	7.6	0	-	13.3				
HCM Lane LOS	B	A	A	-	A	A	-	B				
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-	-	0.7				

Intersection						
Int Delay, s/veh	2.8					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	14	1	11	9	0	6
Future Vol, veh/h	14	1	11	9	0	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	60	92	92	63
Heavy Vehicles, %	64	0	0	100	0	0
Mvmt Flow	15	1	18	10	0	10
Major/Minor	Minor1	Major1		Major2		
Conflicting Flow All	33	23	0	0	28	0
Stage 1	23	-	-	-	-	-
Stage 2	10	-	-	-	-	-
Critical Hdwy	7.04	6.2	-	-	4.1	-
Critical Hdwy Stg 1	6.04	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	4.076	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	844	1060	-	-	1599	-
Stage 1	861	-	-	-	-	-
Stage 2	873	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	844	1060	-	-	1599	-
Mov Cap-2 Maneuver	844	-	-	-	-	-
Stage 1	861	-	-	-	-	-
Stage 2	873	-	-	-	-	-
Approach	WB	NB		SB		
HCM Control Delay, s	9.3	0		0		
HCM LOS	A					
Minor Lane/Major Mvmt		NBT	NBRWBLn1	SBL	SBT	
Capacity (veh/h)		-	-	856	1599	-
HCM Lane V/C Ratio		-	-	0.019	-	-
HCM Control Delay (s)		-	-	9.3	0	-
HCM Lane LOS		-	-	A	A	-
HCM 95th %tile Q(veh)		-	-	0.1	0	-

Intersection: 10: Hardcastle Road & Horning Road

Movement	NB
Directions Served	L
Maximum Queue (ft)	43
Average Queue (ft)	3
95th Queue (ft)	20
Link Distance (ft)	81
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 11: Hardcastle Road & Slip Ramp

Movement	
Directions Served	
Maximum Queue (ft)	
Average Queue (ft)	
95th Queue (ft)	
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 12: Slip Ramp & Horning Road

Movement	EB
Directions Served	T
Maximum Queue (ft)	30
Average Queue (ft)	8
95th Queue (ft)	28
Link Distance (ft)	90
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 20: Watkins Road & Horning Road

Movement	EB
Directions Served	LR
Maximum Queue (ft)	26
Average Queue (ft)	7
95th Queue (ft)	25
Link Distance (ft)	957
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 30: M-124 & Hardcastle Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	20	23
Average Queue (ft)	1	7
95th Queue (ft)	8	23
Link Distance (ft)	635	838
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 40: M-124 & Lawrence Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	5	63
Average Queue (ft)	0	16
95th Queue (ft)	4	47
Link Distance (ft)	672	619
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 50: M-124 & Wellwood Road

Movement	EB	WB	NB
Directions Served	LTR	LT	LTR
Maximum Queue (ft)	28	30	5
Average Queue (ft)	4	12	0
95th Queue (ft)	20	33	4
Link Distance (ft)	317	32	465
Upstream Blk Time (%)		1	
Queuing Penalty (veh)		0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 51: M-124 & Slip Ramp

Movement	WB	SB
Directions Served	R	LT
Maximum Queue (ft)	31	26
Average Queue (ft)	7	1
95th Queue (ft)	26	12
Link Distance (ft)	73	503
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 52: Wellwood Road & Slip Ramp

Movement	WB	SB
Directions Served	TR	L
Maximum Queue (ft)	6	6
Average Queue (ft)	0	1
95th Queue (ft)	4	7
Link Distance (ft)	970	73
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 60: Boardman Drive/M-124 (Wamples Lake Road) & US-12

Movement	EB	WB	NB	SB
Directions Served	LTR	LT	LTR	LTR
Maximum Queue (ft)	45	13	31	85
Average Queue (ft)	5	0	6	31
95th Queue (ft)	23	6	26	62
Link Distance (ft)	745	713	472	476
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 300: Lawrence Road & Site Driveway

Movement	WB
Directions Served	LR
Maximum Queue (ft)	78
Average Queue (ft)	16
95th Queue (ft)	55
Link Distance (ft)	3098
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

EXHIBIT 4

This Purchase Order Number must appear on all orders, invoices, acknowledgements, packing lists, cartons, and correspondence.

Purchase Order	Revision	Order Date	Revised Date
1181602	0	26-SEP-2025	

Page 1 of 3

SHIP TO: (unless specified at item below)

Edw. C. Levy Co.

Purchase Order

Norvell Sand and Gravel
14300 Horning Road
Brooklyn, MI 49230
United States

Invoice to: Edw. C. Levy Co.
9300 Dix Avenue
Dearborn, MI 48120

Supplier# 12760

Buyer	Buyer Phone	Fax	Buyer Email	Confirm To/Phone		
Steve Galloway	313 429 2014		sgalloway@levynet.com			
Payment Terms	Carrier	Shipping Terms	Freight			
		DESTINATION	Paid			
1. Seller shall make no changes to this order or in the design, configuration, material, parts or scope of work without written authorization of the purchasing agent. 2. The terms and conditions of purchase are as set forth in the enclosed document called "Terms and Conditions of Purchase Edw. C. Levy Co. Subsidiaries and Affiliates". 3. Any reference to your quotation is made for pricing only. 4. Shipping Instructions: a. If shipping is not free of charge, ship via the following instructions. Shipping will not be paid if it is charged on your invoice. b. For Parcel and Small Package: Ship Via UPS Account 2F77E4 c. For LTL or Shipments over 150 lbs.: Contact Unishippers at 1-800-713-2111 or email service.etl@unishippers.com and book using Account UL2401693						
Item	Description	Delivery By	Quantity	UOM	Per Unit	Total (USD)
1	2NS					
1-1			200,000.00	TN	0.00	0.00
2	FILL SAND					
2-1			50,000.00	TN	0.00	0.00
3	#3					
3-1			75,000.00	TN	0.00	0.00
4	#14					
4-1			75,000.00	TN	0.00	0.00
5	6A					
5-1			80,000.00	TN	0.00	0.00
6	6AC					
6-1			20,000.00	TN	0.00	0.00
7	MASON SAND					
7-1			20,000.00	TN	0.00	0.00

This Purchase Order Number must appear on all orders, invoices, acknowledgements, packing lists, cartons, and correspondence.

Purchase Order	Revision	Order Date	Revised Date
1181602	0	26-SEP-2025	

Item	Description	Delivery By	Quantity	UOM	Per Unit	Total (USD)
8	MAN SAND					
8-1			75,000.00	TN	0.00	0.00
9	MISC					
9-1			75,000.00	TN	0.00	0.00
*****TOTAL COST*****		0.00				

**TERMS AND CONDITIONS OF PURCHASE
EDW. C. LEVY CO. SUBSIDIARIES AND AFFILIATES**

1. **INVOICING:** All invoices must be sent to the stated Accounts Payable address. Issuance to another address shall delay payment. All invoices must show the Purchase Order Number and revision number, if applicable. Invoices not rendered in accordance with instructions will be returned and discount rate will be based upon the date the corrected invoice is received by Accounts Payable. Note: all iSupplier vendors must submit invoices via the iSupplier Portal.
2. **DISCOUNT POLICY:** Buyer will compute discount periods as commencing on the later or (i) the invoice date or (ii) the date the invoice was received by Buyer.
3. **PACKING:** All goods shall be shipped fully assembled (or where not practicable to do so; as completely assembled as permitted by the carrier), suitably packed and accompanied by packing list. Cartons containing packing lists must be as marked. Uncrated or bundled goods must be tagged with waterproof tags.
4. **IDENTIFICATION; SHIPPING NOTICES:** Show purchase order number, item number on all invoices, bills of lading, packing lists packages and pieces
5. **ADDITIONAL CHARGES:** No additional charges of any kind including charges for packing or transport will be allowed unless arranged for and agreed to in writing by Buyer at time of purchase.
6. **ACCEPTANCE OF PURCHASE ORDER AND MODIFICATION OF TERMS:** The Purchase Order is expressly subject to, and Seller's acceptance is expressly conditioned upon Seller's agreement to each and all of the terms and conditions contained on the face and reverse side of the subject purchase order and these terms and conditions hereof (collectively, the "Contract"). No addition to, or modification of, the terms and conditions hereof shall be binding upon Buyer and no goods or services shall be substituted for those specified herein except upon the written consent or instructions of the Buyer. Where Seller's quotation, order acknowledgment, invoice or other correspondence contains terms or conditions in conflict with, or in addition to the Buyer's terms and conditions, neither acceptance by Buyer of the goods and services nor payment therefore shall constitute a waiver by Buyer of any of the terms and conditions contained herein or assent to any other conditions. This order, including these terms and conditions, shall constitute the entire contract between the parties and it may not be amended, modified, or terminated orally by Seller. The Contract resulting from the acceptance of the Purchase Order shall be governed by the laws of the State from which this Purchase Order is placed. Any terms and/or conditions written by the Buyer and appearing in the main text of the Purchase Order that adds to or contradicts any of these terms shall take precedence.
7. **NONCONFORMING GOODS:** All goods received shall be subject to Buyer's right of inspection and rejection. Excess or defective goods or goods not in accordance with Buyer's specifications will be held for disposition in accordance with Seller's instructions at Seller's risk and expenses and if the Seller directs will be returned at Seller's expense. Returned goods may be replaced by Seller only upon Buyer's formal purchase order placed by the Buyer. If inspection disclosed that a portion of the goods received are not in accordance with the specification or descriptions hereof, Buyer shall have the right to cancel any unshipped portion of this order. Payment for goods or services furnished or performed pursuant to this order shall not constitute acceptance thereof by Buyer and such payments shall be deemed to have been made without prejudice to any and all claims the Buyer may have against the Seller.
8. **WARRANTY AND PRODUCTS LIABILITY:** Seller warrants for the longer of, (a) eighteen months, (b) any applicable manufacturer's warranty greater than eighteen months, and (c) the longest warranty given by Seller to any other buyer of the materials that all materials covered by this order conform to the blueprints, specifications, samples or instructions issued in connection herewith and that such materials are of first class material and workmanship free from defects and suitable for the purpose intended. In the event replacement of goods or material becomes necessary under this provision, Seller shall pay all shipping and delivery costs as well as any in and out cost incurred by Buyer relative to such replacement. The Seller agrees to defend, indemnify and hold harmless the Buyer and its employees from and against any and all products liability claims and all other liabilities whatsoever for damages, injuries, legal fees and other expenses incurred or suffered by the Buyer or its employees resulting in whole or in part from defective material, workmanship, or quality in such materials. Such warranties and remedies provided herein shall survive delivery, shall not be defined waived either by reason of acceptance or payment and shall be in addition to those implied by or available at law.
9. **DELAYS AND FORCE MAJEURE:** Shipment and delivery dates specified are of the essence. Seller shall not be liable for delays in the manufacture or delivery of goods and services and Buyer shall not be liable to accept any part of such goods and services to the extent that such delays are due to causes such as acts of God, acts of civil or military authorities, governmental priorities, terrorism, fire, floods, epidemics, war or riot, provided Seller uses its best efforts to remedy the situation and first allocates all available production and deliveries to Buyer, and provided further that Seller has notified Buyer promptly (but in any event within seven calendar days) of the occurrence which causes such delay.
10. **ADVERTISING:** Seller may not without written consent of the Buyer, advertise or publish in any manner the fact that Seller has furnished or contracted to furnish the materials or services specified.
11. **CONFIDENTIAL RELATIONS:** Seller shall treat as confidential all information specifications, drawings, blueprints, data and property furnished or paid for by Buyer and shall reveal the same only to its own employees to the extent necessary for the production of goods described in this purchase order.
12. **REMEDIES:** Buyer's remedies reserved in this Contract shall be cumulative and additional to any other or further remedies provided in law or equity. No waiver of any breach of any provisions of this Contract shall constitute a waiver of any other breach, or of such provision.
13. **BUYER'S PROPERTY:** Unless otherwise agreed in writing, all drawings, specifications, supplies, material, tools and equipment of every description, furnished or paid for by Buyer shall remain the property of the Buyer stored and maintained by Seller on its premises, separate and apart from Seller's property or that of any third party, it shall be marked "Property of the Buyer" by Seller and shall not be used except for work performed for Buyer. Seller shall bear the risk of loss or damage to such property and shall at its expense insure all such property for the replacement value thereof against loss or damage of any kind with loss payable to Buyer. Immediately, upon Buyer's request, such property shall be property prepared for shipment as specified by Buyer and delivered in good condition, except for normal wear and tear to the Buyer, FOB Buyer's plant.
14. **COMPLIANCE WITH LAWS AND THIS CONTRACT:** All goods and services furnished shall conform to this Contract, the requirements of all applicable federal state laws and regulation, local and municipal ordinances and the regulations of any agency or public authority having jurisdiction over the performance of any services hereunder or the manufacture, delivery or installation of any goods required to be manufactured delivered or installed hereunder, including, without limitation, the Fair Labor Standards Act, as amended, the Occupational Salary and Health Act, as amended, and the Equal Opportunity Provision of Executive Order 11246, as amended. The Seller agrees to defend, protect, indemnify and hold the Buyer harmless against any and all suits and any damages, claims, demands, fines, penalties, legal fees, and expenses arising out of Seller's violation of this Contract or of such laws, rules, regulations and ordinances. The performance of any work or the furnishing of any materials under this Contract shall constitute the Seller's warranty to the Buyer that the Seller has complied with this Contract and all such laws, rules, regulations and ordinances.
15. **PERSONAL INJURY, DEATH, PROPERTY DAMAGE AND OTHER DAMAGES:** Seller shall indemnify Buyer against and hold Buyer, its subsidiaries and affiliates harmless from any losses, claims, damages, liabilities, whether joint or several, and expenses of any kind or nature whatsoever, including legal fees, which may arise out of, result from, or incurred in connection with, Seller's performance of its obligations under this Contract (including, without limiting the generality of the foregoing, losses, claims, damages and liabilities, whether joint, or several, with respect to employees or agents of Seller, Seller's subcontractors, their employees or agents) to which Buyer may become subject, including, but not limited to, losses, claims, damages, liabilities and expenses (and actions in respect thereof) which relate to injury to or death of persons or damage to property that may have been caused or that may be alleged to have been caused, directly or indirectly, by Seller, its employees or agents. It is further agreed by the parties that should any of these provisions contravene or be invalid under the laws of the state that this Purchase Order is placed, such contravention or invalidity shall not invalidate this Agreement.
16. **INSURANCE:** Where fulfillment of this purchase order requires Seller to perform work on Buyer's premises, Seller shall procure at its own cost and keep enforced the following insurance, satisfactory to Buyer as to form and limits of liability until completion and final payment hereunder.
 - a. Workers' Compensation insurance, as required by the Workers Compensation laws of the state in which the work is being performed: and
 - b. Public liability and property damage insurance, including contractual liability insurance with the buyer as the named party and as required to cover liabilities assumed in this Contract, including in paragraphs 13 and 14, above and automobile liability and property damage insurance if automobiles, trucks, trailers or other vehicles are to be used.Prior to the commencement of any work hereunder, evidence of such insurance in policy, shall be delivered to the Buyer. Where any part of this purchase order is performed by a subcontractor of Seller, evidence of such insurance on behalf of such subcontractor similarly shall be provided by Seller to Buyer.
17. **LIENS AND CLAIMS:** Seller shall pay promptly all claims and demands for all labor performed and for machinery or any other material or equipment furnished in this performance of the work contemplated by the purchase order and shall fully protect and indemnify Buyer against all such claims and against any and all claims or debits on account of which liens might be obtained. Seller also shall indemnify Buyer against any legal fees incurred or sustained by Buyer by reason of such claims, debits or liens. Buyer as a result of work performed or materials furnished by Seller hereunder and in such cases to use sums otherwise payable by Buyer to Seller hereunder. Should there prove to be any such liens, claims or suits after final payment has been made by Buyer, Seller, expressly agrees to reimburse Buyer for any amounts that Buyer may be compelled to pay in satisfaction thereof, including all costs and legal fees.
18. **PATENTS:** Seller warrants that the manufacture, sale or use by Buyer or any materials covered by this order does not and will not infringe or contribute to infringement upon any United States or foreign letters patent and Seller agrees to defend, protect, indemnify and save harmless the Buyer, its successors, assigns, customers and users or its products, against any claim or demand based on such infringement or alleged infringement and, after notice, to appear and defend at the Seller's own expense any suits at law or in equity arising there from. Buyer may be represented in any such suits, actions or legal proceedings by counsel of its own selection. If such materials are protected by one or more patents and a decree or judgment be entered in a court of competent jurisdiction holding any such patent or its claim invalid, or so limited in scope as to impair its protection commercially, the Contract resulting from the acceptance of this order may forthwith be canceled by Buyer.
19. **AUDIT RIGHTS AND TIME AND MATERIAL WORK:** Where the purchase hereunder is to be determined by Seller's time or cost of material or otherwise from records to be maintained by Seller, the Seller will retain all records necessary for such determination for a period of at least two years after the completion of the purchase order and will permit Buyer access thereto upon two days notice during regular business hours for the purpose of audit of those records.
20. **PRICING ESCALATION:** Unless escalation terms are expressly provided for in the Contract, no escalation will be applicable to this Contract.
21. **ASSIGNMENT:** Seller shall not assign this Contract or any interest herein or any payments due or to become due hereunder without the written consent of Buyer. Any assignment consented to by Buyer shall entitle Buyer to withhold payment until Buyer has determined to whom such funds are payable and that Buyer is fully protected from any conflicting claims of Seller, Seller's assignee or any third party and from any loss or expense in connection therewith. Buyer may assert any counterclaim or setoff, which Buyer may have against Seller against any permitted assignee, whether or not; such counterclaim or setoff arose under or with respect to this Contract.
22. **TERMINATION:** Buyer may terminate this Contract in whole or in part for any reason by notice to Seller. Upon such termination, charges shall be limited to the value of goods completed and services rendered before date of termination. Buyer shall not be liable under this paragraph to pay for goods completed more than thirty days in advance to scheduled delivery. Cancellation charges shall be restricted to the costs incurred by Seller prior to the notification, of termination in the performance warranted work less expenses saved and with due credit for proceeds of resale; provided however, Buyer shall have no liability whatsoever for goods which are Seller's standard stock. No such termination shall relieve Seller of any of its obligations for any goods delivered or services rendered hereunder. In no event shall Buyer be liable for anticipated profits or for incidental or consequential damages, nor for damages due to negligence. Seller shall submit to Buyer a termination claim in the form specified by Buyer. Buyer may independently determine the amount due, if any, according to generally acceptable accounting principles and such determination shall be final and binding on Seller, in any event. Buyer shall not be liable for any termination claims submitted more than sixty days from date of termination.
23. **DEFAULT:** Buyer may cancel this Contract, in whole or in part in the event of Seller's failure to comply with the terms of this Contract. Such cancellation by Buyer shall be by notice to Seller and shall be effective upon communication of such notice, verbally or in writing. In addition to nonperformance, default includes an assignment for the benefit of creditors, the appointment of Seller's or the insolvency or bankruptcy of Seller.
24. **SETOFF.** Buyer and its affiliates (the "Buyer Group") may setoff against or recoup from any amounts owing to Seller or its affiliates (the "Seller Group") any amount owing to any member of the Buyer Group by any member of the Seller Group, including for damages resulting from breaches by Seller of its obligations to Buyer under this Contract or other contracts.
25. **SEVERABILITY:** If any term, clause or provision of this Contract is in violation of any applicable law, such term, clause or provision shall to such extent be deemed null and void, and the remainder of this Contract shall remain in full force and effect. In addition, no waiver of any breach of any provision hereof shall constitute a waiver of any other breach of such provision.
26. **COMPLETE AGREEMENT:** This Contract, together with any other documents expressly incorporated herein by reference constitutes the sole and entire agreement between Buyer and Seller with respect to the subject matter hereof, superseding completely any oral or written communications. Where Seller's quotation is referred to herein, such reference is made only for the purpose of the Seller to reference it information and in no way is be considered a Contract document.

EXHIBIT 5



21ST CENTURY INFRASTRUCTURE COMMISSION REPORT



Prepared for
Governor Rick Snyder

The 21st Century Infrastructure Commission's research is composed of two major works: this report titled "21st Century Infrastructure Commission Report," and a shorter executive summary, which is intended to highlight the most important elements of the full report. Both were published on Wednesday, November 30, 2016.

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S. Evan Weiner (Chair), Edw. C. Levy Co.
Janice Beecher, Michigan State University Institute of Public Utilities
Roger Blake, AT&T
Robert Daddow, Oakland County
Eric DeLong, City of Grand Rapids
Carl English, Consumers Energy; American Electric Power Service Corporation (retired)
Joi Harris, DTE Gas
Ben LaCross, Leelanau Fruit Company; Michigan Farm Bureau
R. Gavin Leach, Northern Michigan University
Mike Nystrom, Michigan Infrastructure & Transportation Association
Evan Pratt, Washtenaw County
Doug Rothwell, Business Leaders for Michigan
Brian Steglitz, American Water Works Association; City of Ann Arbor—Water Treatment Services
Helen Taylor, The Nature Conservancy
Louis J. Taylor, Wade Trim

Legislative Appointees

Ronald W. Brenke, American Council of Engineering Companies
Mike DeVries, AECOM
Brian Mills, Michigan State Housing Development Authority
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David Behen, Michigan Department of Technology, Management, and Budget
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Additional research support provided by Deloitte

Letter from Commission Chair

Dear Governor Snyder:

On behalf of Michigan's 21st Century Infrastructure Commission, I am pleased to present to you the Commission's final report, which we are confident will serve as a 50-year vision for improving the state's infrastructure system and enhancing the quality of life for all Michiganders. A robust, reliable, and sustainably funded infrastructure system allows for healthy communities, long-term economic prosperity, and more and better jobs—providing a solid foundation for our state's future.

This report is the first of its kind in the nation to offer comprehensive recommendations across asset types: water, transportation, energy, and communications infrastructure. It provides a current assessment of Michigan's infrastructure systems, a vision for the state's future, and how we can bridge the gap between those two things. The Commission, composed of industry experts, educators, business leaders, and government officials from across the state, came together to produce a set of implementable recommendations that prioritize the health and safety of Michigan's residents. Months of research, discussions with the public, and input from outside experts have allowed us to present a plan that we are confident will improve the quality of life for all Michiganders.

This report is an important first step in improving Michigan's infrastructure, but our work is not done. For too long, we have underinvested in our infrastructure systems and treated our assets as separate entities. In order to stay at the forefront of emerging technologies and remain competitive in an increasingly global world, we must start to think of our infrastructure systems in an integrated and holistic way.

Improving infrastructure today and for future generations is a responsibility every Michigander needs to take seriously. As Michigan looks to the future, it is essential that we have the infrastructure systems to match our goals. Sound and modern infrastructure is vital to the health and well-being of the people of Michigan and will help support our growing economy in the future. Michigan's residents deserve reliable, safe, and affordable infrastructure, and we look forward to creating a 21st century infrastructure system with you.

Sincerely,



S. Evan Weiner
Chair
21st Century Infrastructure Commission

Table of Contents

CHAPTER 1. Introduction	8
Background	9
The 21 st Century Infrastructure Commission	10
EXHIBIT 1. Michigan's Infrastructure Through the Years	11
National Infrastructure Spending	12
EXHIBIT 2. Return on Infrastructure Investment	12
EXHIBIT 3. Road Condition and Preservation	13
EXHIBIT 4. State and Local Capital Spending Comparison	14
Purpose	14
 CHAPTER 2. Future State of Michigan's 21st Century Infrastructure	 15
Guiding Principles	17
Outcomes	18
 CHAPTER 3. Asset Management and Michigan Infrastructure Council	 19
EXHIBIT 5. Asset Management Model	20
21 st Century Vision for Michigan	22
3.1 Regional Infrastructure Pilot	22
EXHIBIT 6. Example Snapshot of System Performance	24
3.2 Michigan Infrastructure Council	27
EXHIBIT 7. Michigan Infrastructure Council	27
 CHAPTER 4. Communications Recommendations	 32
4.1 Making Michigan a Smarter State	36
4.2 Improving Broadband Access and Adoption	39
EXHIBIT 8. Broadband Access and Adoption: Current State, Goals, and Gaps.....	39
4.3 Securing Michigan's Digital Infrastructure	43
 CHAPTER 5. Energy Recommendations	 47
5.1 Resource Adequacy	50
5.2 Energy Waste Reduction	51
5.3 Cleaner Energy Sources	53
EXHIBIT 9. Renewable Energy Capacity by Commercial Operation Date.....	53
5.4 Electric Reliability	54
5.5 Natural Gas Safety	57
EXHIBIT 10. Percent of At-Risk Natural Gas Pipeline in Michigan	57

5.6	Adaptable Regulation	58
5.7	Information Security.....	59
5.8	Business Attraction and Economic Development	60

CHAPTER 6. Transportation Recommendations..... 62

	EXHIBIT 11. Major Milestones of Michigan's Multimodal Transportation System.....	64
	EXHIBIT 12. Road Condition and Preservation	66
	EXHIBIT 13. Statewide Fatalities.....	67
6.1	Roads/Bridges – Road and Bridge Conditions.....	68
	EXHIBIT 14. Historical/Projected Trunkline Pavement Condition	68
6.2	Roads/Bridges – Bridges and Culverts	70
6.3	Roads/Bridges – Seasonal Weight Restrictions.....	71
6.4	Transit, Passenger, and Freight Rail.....	72
6.5	Marine Freight – Soo Locks	77
6.6	Marine Freight – Port Authority Landside Improvements.....	79
6.7	Marine Freight – Routine Port Maintenance	79
6.8	Aviation.....	81
6.9	Intelligent Vehicle Technology.....	82
6.10	Signalized Intersection Technology.....	84
6.11	Nonmotorized Transportation.....	85
6.12	Right-sizing.....	87
6.13	Act 51 Review.....	89
6.14	Local Revenue Generation Options	90
6.15	Road and Bridge User Fees.....	91
6.16	Tolling	92

CHAPTER 7. Water Recommendations 94

7.1	Ensuring Public and Environmental Health.....	98
7.2	Water Asset Management.....	100
7.3	21 st Century Water Infrastructure	102
7.4	Fiscally Sustainable Water, Sewer, and Stormwater Pricing Models	103
7.5	Green Infrastructure	106
7.6	Onsite Well and Wastewater Treatment Systems.....	109
7.7	Embracing New Technology to Develop 21 st Century Utilities.....	112
7.8	Dams	114

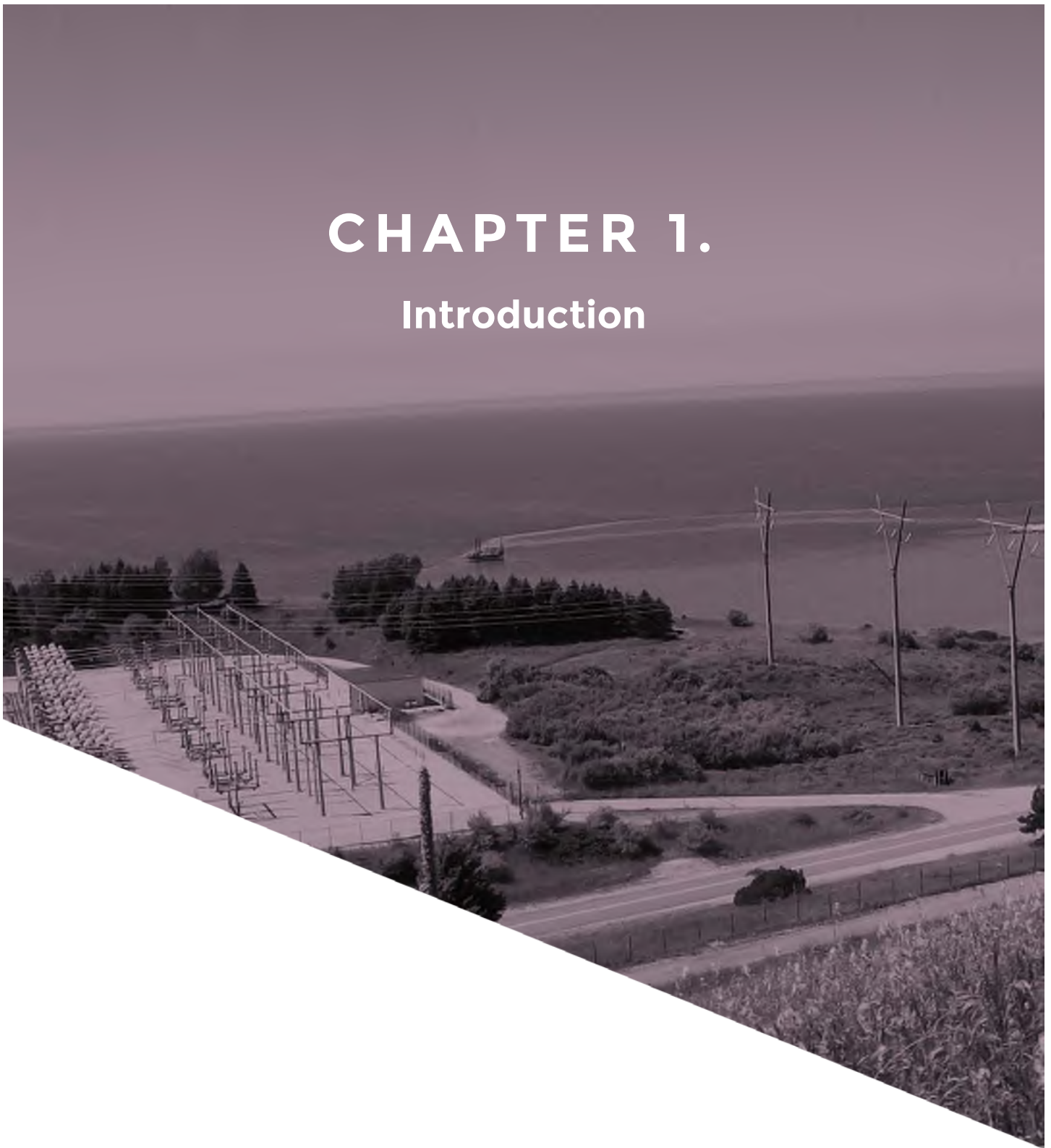
CHAPTER 8. Investing in 21st Century Infrastructure.....116

	Investing in 21 st Century Infrastructure Strategy and Asset Management.....	118
	Investing in 21 st Century Communications Infrastructure.....	119
	EXHIBIT 15. Communications Infrastructure Investment Gaps	121
	Investing in 21 st Century Energy Infrastructure	122

Investing in 21 st Century Transportation Infrastructure	122
EXHIBIT 16. Roads, Bridges, and Multimodal Transportation Annual Investment Gaps	125
EXHIBIT 17. Transportation Infrastructure Investment Gaps.....	126
Investing in 21 st Century Water Infrastructure	127
EXHIBIT 18. Water Infrastructure Investment Gaps	130
Addressing the Investment Gap	132
EXHIBIT 19. Infrastructure Investment Gaps Summary	132
EXHIBIT 20. State and Local Capital Spending Comparison	132
EXHIBIT 21. Examples: Revenue Generation Options.....	133
EXHIBIT 22. Infrastructure Bond Example	136
EXHIBIT 23. Infrastructure Investment Bank Example	137
Conclusion	139
CHAPTER 9. Call to Action	140
REFERENCES	142
APPENDIX A. Recommendations Table	149
APPENDIX B. Public Engagement	171
Public Engagement Schedule	171
Feedback from Public Engagement	173
EXHIBIT 24. Biggest Benefit of 21 st Century Infrastructure	173
EXHIBIT 25. Most Important Type of Infrastructure by Region.....	174
EXHIBIT 26. Best Infrastructure Systems to Retain and Attract Residents and Businesses	175
EXHIBIT 27. Themes by Region.....	176
APPENDIX C. Demographic Trends and Forecasts.....	179
Population.....	179
EXHIBIT 28. Michigan Population, 1970–2040.....	179
EXHIBIT 29. Share of Statewide Population by Age Group, 2010–2040.....	180
EXHIBIT 30. Domestic and International Migration: Michigan, 1980s–2030s.....	181
Employment.....	181
EXHIBIT 31. Michigan Total Employment and Labor Force, 1990–2040.....	181
EXHIBIT 32. Share of Michigan Employment by Sector, 1970–2040.....	182
APPENDIX D. Best Practices Research.....	183
Background.....	183
Elements of Success	183
Expert Interviews	188
Conclusion	189

CHAPTER 1.

Introduction

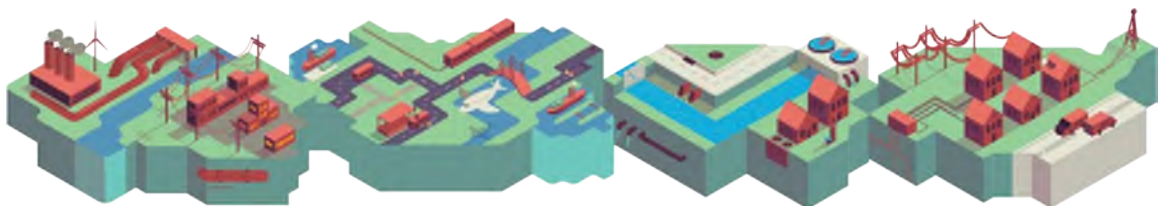


Background

Infrastructure is the foundation of Michigan's modern economy and quality of life. When most people hear the term "infrastructure," they often think of roads or bridges; however, these assets are just pieces of a larger, more complex picture that includes water and sewer systems, drains and stormwater systems, broadband and communication systems, and electricity and natural gas networks.

Michigan's infrastructure is aging, and maintenance has been deferred for decades, leaving us in a state of disrepair. Failing infrastructure interrupts daily life, slows commerce, jeopardizes public health, pollutes the environment, and damages quality of life. This is evidenced by the condition of our current system:

- **39 percent of roads** are in poor condition (TAMC 2015)
- **27 percent of bridges** are structurally deficient or functionally obsolete (MiBRIDGE 2016)
- Water contamination in the city of Flint threatens the health and safety of its residents
- Since 2008, an average of **5.7 billion gallons** of untreated sewage flowed into Michigan waterways (MDEQ October 2016 a.)
- **64 rivers** that drain 84 percent of Michigan's Lower Peninsula tested positive for human sewage (Verhougstraete et al. 2014)
- Nearly **25 percent of beaches** experienced closures in 2015 (MDEQ May 2016)
- Approximately **130,000 (10 percent) of the state's 1.3 million septic systems** are likely experiencing operational problems (Creagh 2016)
- Property damage from flooding is increasing (Saunders 2014)
- Approximately **12 percent of the state's households** lack access to advanced broadband service (Connect Michigan 2015)
- Planned power plant retirements in the Upper Peninsula have posed challenges to balancing reliability and affordability



Without intervention—including adequate planning, management, and investment—Michigan will continue to experience infrastructure failures, leading to impacts on our public health, environment, and overall quality of life.

The 21st Century Infrastructure Commission (referred to as “the Commission”) recognizes the need to ensure the health, safety and welfare of Michigan’s residents. Infrastructure planning, management, and investment that holistically acknowledges transportation, water, stormwater, energy, and communications needs is the best way to ensure protection of public health, the environment, and the state’s future economic growth.

A 21st century infrastructure system in Michigan must have resilient, adaptive, and robust infrastructure systems in both rural and urban communities. Outcome-based decision-making tools and appropriate incentives will drive the development of sound 21st century infrastructure systems. Michigan must establish regulatory and tax policies that encourage infrastructure innovation and investment, and build public confidence. In order to achieve efficiencies and support adequate investment, public and private partners at all levels must coordinate asset management and planning across infrastructure types and work together to leverage diverse, integrated, and sustainable funding.

The 21st Century Infrastructure Commission

To address the state’s infrastructure needs, Gov. Rick Snyder created the 21st Century Infrastructure Commission, an advisory body of 27 members¹ that has developed a long-term vision and associated recommendations to drive Michigan toward that vision. As Executive Order No. 2016-5 states, “[s]ound and modern infrastructure is vital to the health and well-being of the people of Michigan, as well as Michigan’s economy and vibrant communities.”

The commission’s vision states:

Michigan will lead the nation in creating 21st century infrastructure systems that will include, at a minimum, innovative technology, sustainable funding solutions, sound economic principles, and a collaborative and integrated asset management and investment approach that will enhance Michiganders’ quality of life and build strong communities for the future.

Throughout the process of building recommendations for this report, commissioners participated in monthly meetings of the full Commission, along with biweekly meetings of asset-focused subgroups. The Commission also included technical advisors in the process to ensure stakeholder input was heard and incorporated into discussion. In order to receive input from stakeholders

¹ William Moritz served the Commission in his capacity as interim director of the MDNR, but was replaced when Keith Creagh reassumed his post as director of the MDNR.

across Michigan, the group hosted six listening tour events in various locations throughout the state and regularly solicited input from the public through the 21st Century Infrastructure Commission website (for more information on the public engagement process and timeline, see Appendix B).

EXHIBIT 1. Michigan's Infrastructure Through the Years

1951	Public Act 51 is enacted, which dictates how transportation revenue is distributed in Michigan based on a funding formula.
1960s 1970s	The federal highway program expands our transportation infrastructure; Clean Water Act leads to significant investments in wastewater collection and treatment; our state park system undergoes expansion. Michigan's largest gas storage site, Belle River Mills, becomes active in 1965. Michigan sees its greatest development in electric generating facilities ever. The Comprehensive Transportation Fund is created in 1972.
1988	Michigan voters overwhelmingly approve the \$800 million Quality of Life bond.
1991	The Michigan Telecommunications Act is enacted, establishing a state regulatory framework for telecommunications technology.
1997	A \$.04 increase in the state gas tax is approved to help fix the state's roads and bridges.
1998	The Clean Michigan Initiative bond of \$675 million was passed by voters.
2002	Michigan voters approve the \$1 billion Great Lakes Water Quality bond.
2010	Merit Network announces the award of two multimillion dollar grants to build over 2,200 miles of fiber-optic infrastructure in Michigan.
2011	Gov. Rick Snyder delivers a special message on infrastructure calling for a goal of increasing infrastructure investment by \$1–\$1.4 billion a year.
2012	Governor Snyder delivers the first of two special messages on energy. Michigan Cyber Range is inaugurated by Governor Snyder.
2015	The state begins taking action to resolve the Flint water crisis. Governor Snyder signs a \$1.2 billion package to improve Michigan's roads.
TODAY	The 21 st Century Infrastructure Commission releases a visionary plan to address Michigan's infrastructure for the next 50 years.

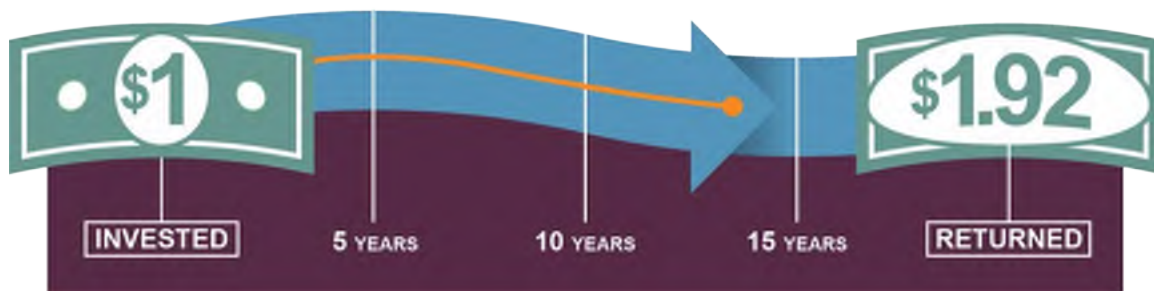
National Infrastructure Spending

Michigan is not alone in its infrastructure challenges. Infrastructure needs abound in communities and states across the country and around the world. In 2013, the American Society of Civil Engineers (ASCE) gave America's infrastructure overall a grade of "D-plus," and reports that the nation would need to spend an additional \$3.6 trillion by 2020 to raise national infrastructure to a state of good repair. Given the recent Flint water crisis and growing concern about the condition of underground infrastructure across the state, Michigan's portion of the investment needs has likely grown significantly.

During the past decade, states across the U.S. have been cutting public infrastructure spending, causing infrastructure investment to drop from a high of 3 percent of the nation's gross domestic product (GDP) in the late 1960s to less than 2 percent in 2014 (McNichol 2016). States have not been alone in cutting spending on infrastructure; since 2003, federal spending on infrastructure has fallen by almost 19 percent, while spending by states and municipalities has dropped by approximately 5 percent (McNichol 2016).

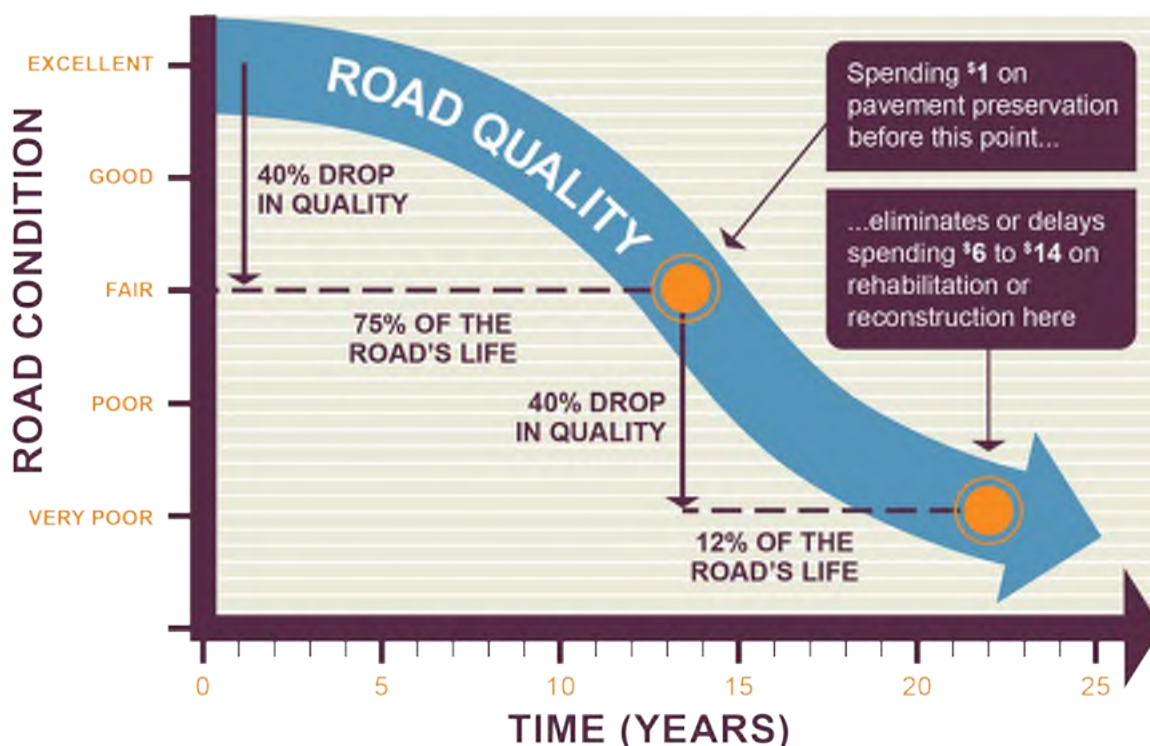
This decline in investment has emerged despite strong evidence that spending on physical infrastructure has a positive return on investment. The return on infrastructure investment is nearly twice initial spending because it is frequently less expensive to maintain existing infrastructure than it is to repair or replace it, and newly created infrastructure is far less likely to need repairs or replacements. On average, every \$1.00 spent on nonresidential construction has an economic impact of \$1.92. For transportation and power investment, \$1 returns \$4.24, while \$1 of spending on water and sewer assets returns \$2.03 in revenue (Cohen 2012).

EXHIBIT 2. Return on Infrastructure Investment



Not only are there sizable economic arguments for infrastructure investment, there is also a case to be made for making infrastructure improvements sooner rather than later. As shown in the example in Exhibit 3, deferring infrastructure investment will actually make a project more expensive, as the costs of infrastructure repair and or replacement increases as infrastructure quality declines.

EXHIBIT 3. Road Condition and Preservation



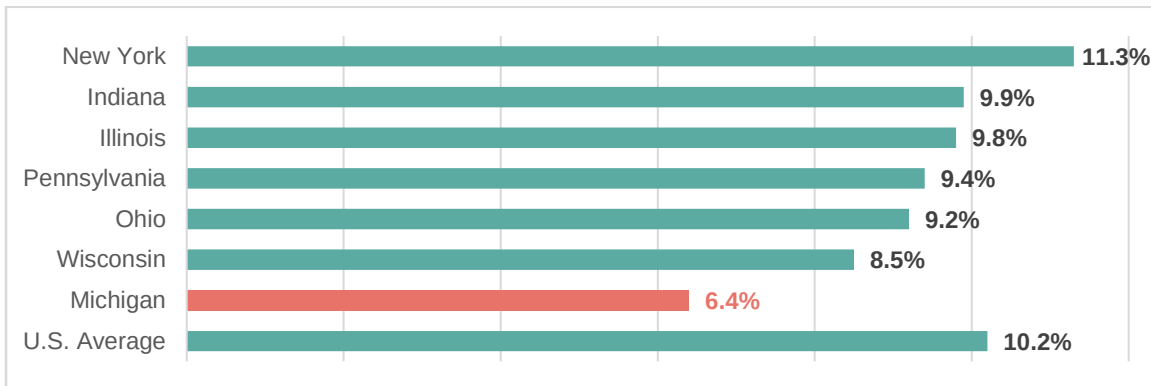
Source: AASHTO and TRIP 2009.

Current investment in infrastructure varies significantly by state. The share of a state's budget devoted to capital spending can vary greatly based on factors such as geographic size, population density, and the age of existing infrastructure. Several large states with small populations—Alaska, North Dakota, and South Dakota—spent more than 10 percent of their budget on capital expenses in 2013.

At the other end of the spectrum, however, three states—California, Vermont, and Michigan—spent less than 4 percent of their budgets on infrastructure.

As shown in Exhibit 4, Michigan's average annual investment of 6.4 percent between 2010 and 2014 positions the state at the bottom of the spectrum nationally; this is partially a result of our unwillingness to identify and fund needed investments (Deloitte 2016). In fact, from 2002 to 2013, Michigan had the third largest decline in state and local infrastructure spending as a share of GDP (McNichol 2016).

EXHIBIT 4. State and Local Capital Spending Comparison



Note: Percent of total expenditure, annual average 2010-14.
Source: Deloitte 2016.

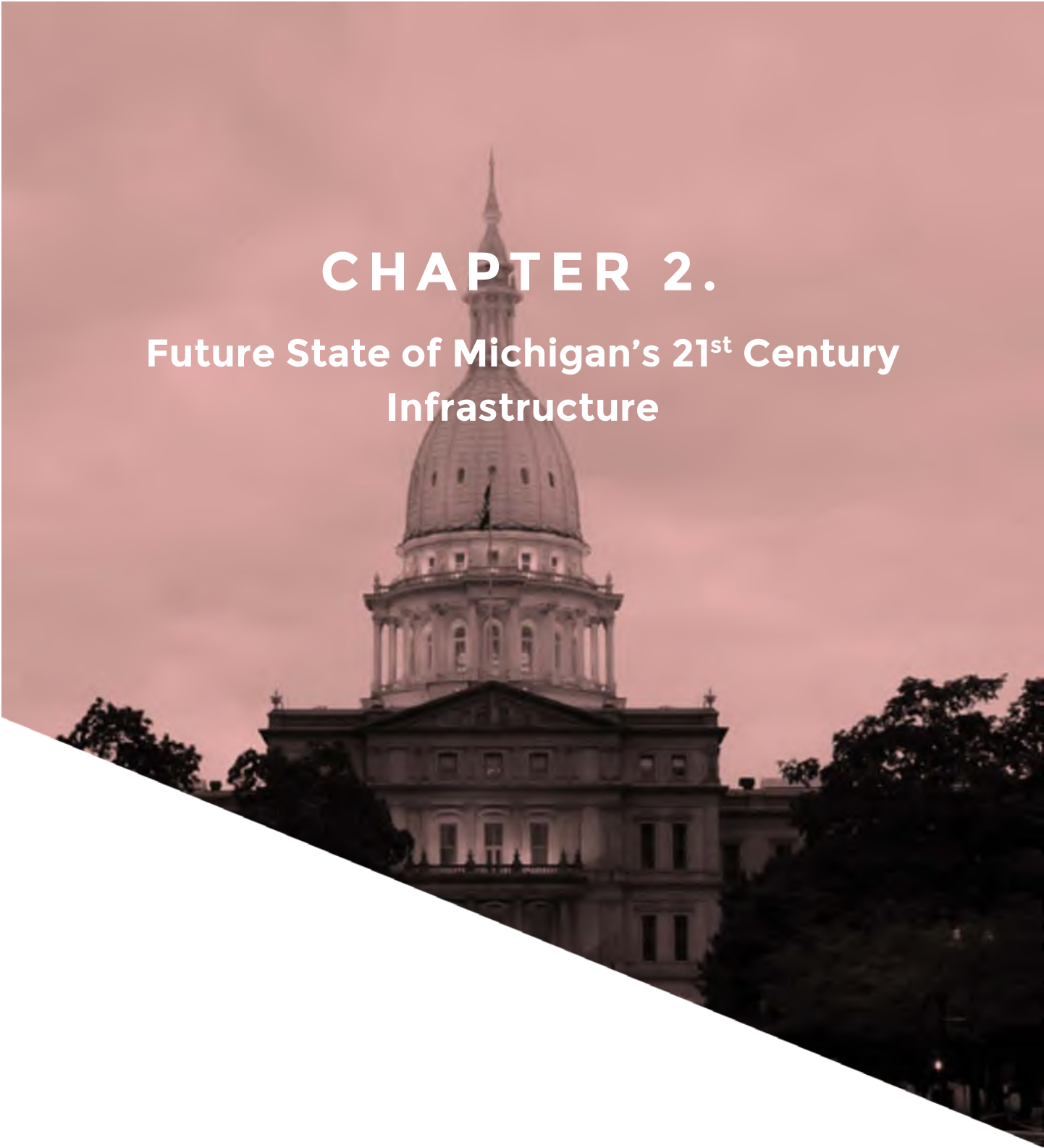
Purpose

The purpose of this report is to give policymakers and the public an overarching view of Michigan's infrastructure needs, as articulated by the Commission. The report identifies the need for a statewide asset management system and Michigan Infrastructure Council (Chapter 3), and makes specific recommendations in four key areas of infrastructure: communications (Chapter 4), energy (Chapter 5), transportation (Chapter 6), and water (Chapter 7). Funding challenges and opportunities are described in Chapter 8.

This report is not an operational plan, nor does it suggest a specific funding package. Instead, it outlines the challenges and opportunities facing Michigan's infrastructure system, identifies key recommendations for action, and provides a menu of short-term needs and long-term goals for consideration by policymakers and the public.

Recommendations are numbered according to the chapter in which they appear, and then by topic area. Where feasible, the Commission identified the anticipated investment needed for each recommendation in this report, and potential public or private funding sources. Several recommendations developed by the Commission are for consideration by the Michigan Legislature, and out of deference to the legislative process, the Commission did not attach cost figures to any legislative recommendations.

Finally, policymakers and the public should recognize that this report is part of a larger process to set the foundation for Michigan's future, articulated by Governor Snyder in his 2016 State of the State address, during which he also created the 21st Century Education Commission and the Building the 21st Century Economy Commission. The recommendations outlined in this report will provide job opportunities for Michigan's workforce, including engineers, skilled construction trades, and other skilled infrastructure occupations. The Commission encourages the Building the 21st Century Economy Commission to fully review and assess how this report's recommendations can be folded into their vision for Michigan's economic future.

A photograph of the Michigan State Capitol building at dusk, featuring a large dome and classical architecture, with a pinkish-red sky in the background. The bottom-left corner of the image is cut off by a diagonal white line.

CHAPTER 2.

Future State of Michigan's 21st Century Infrastructure

21ST CENTURY SMART STATE FUTURE STATE OF MICHIGAN

A smarter state improves quality of life by building infrastructure that optimizes technologies and enables new work processes, services, and products. This construction relies on evaluating residents' experiences with safety, security, health, energy, transportation, and communication. Michigan's future state will be experienced in the following ways:

TRAILS

- Statewide efforts like the Iron Belle Trail have improved cross-community trail linkages and economic development opportunities, continuing Michigan's legacy as "The Trail State."

SMART ENVIRONMENTS

- Medical devices transmit patient data from homes to hospitals and alert first responders in case of an emergency, allowing more residents to age in place.
- Street lights make communities safer by prompting city workers to replace the light bulb before it burns out.
- Technology alerts law enforcement of crime or suspicious activity as it happens so they can arrive on the scene sooner.
- Using data from intelligent sensors, control systems will optimize and manage the flow of people and vehicles out of urban infrastructure to coordinate intelligent mobility.

COMMUNICATIONS

- Advanced broadband technology enables employees to work from anywhere, at any time, and provides students with the ability to access educational resources even in the most rural areas.
- Michigan will continue to set industry standards in cyber security by finding innovative ways to defend critical information, control access and identity management, and embrace new and emerging technologies.

GREEN INFRASTRUCTURE

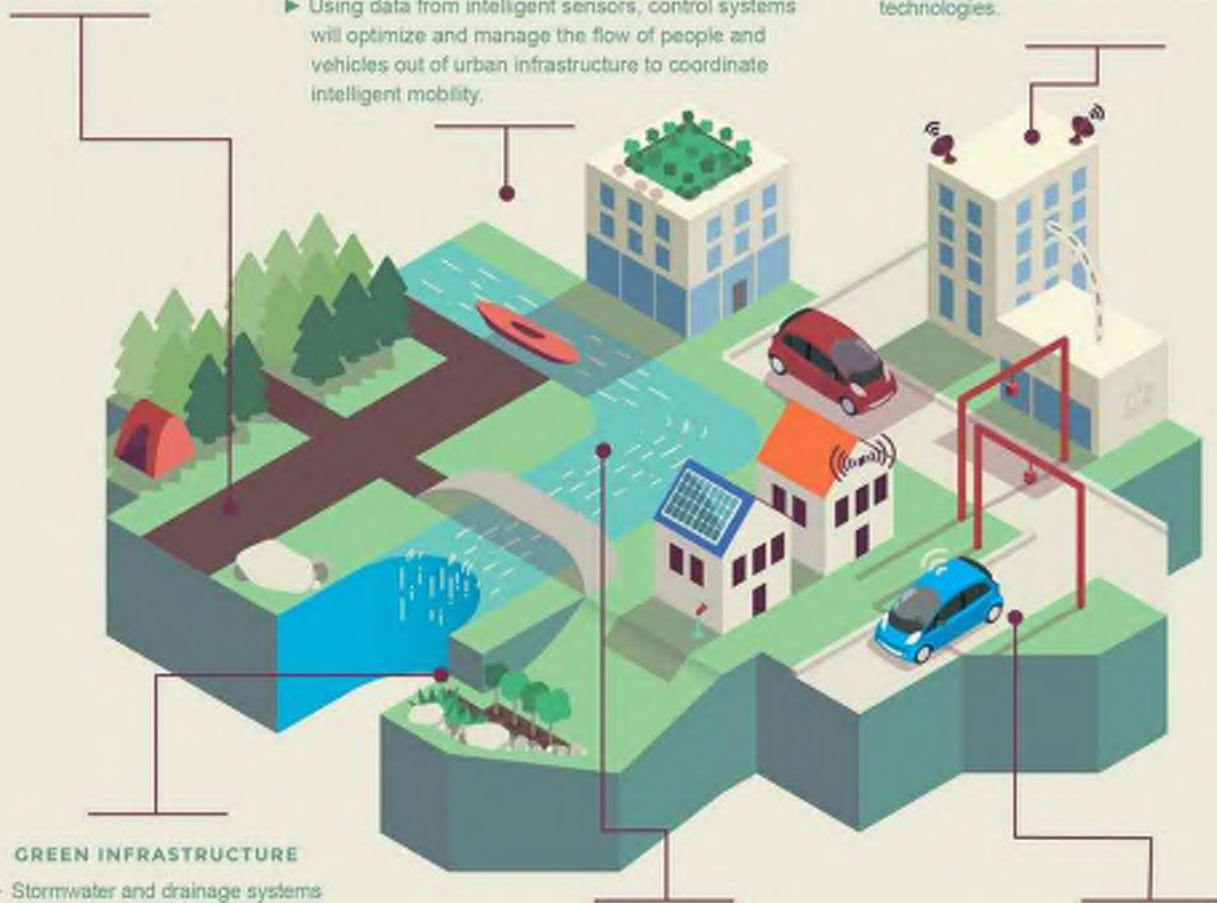
- Stormwater and drainage systems manage water in a way that maximizes benefits to people and nature.
- Michigan's road and rail systems ensure that rivers, streams, and drains remain free flowing to protect ecosystem health and safely move people and goods.

WATER

- Water utilities are financially stable and provide safe, reliable, and high-quality service for all residents.
- Water systems are designed and built using the best available cost-effective technologies to equitably provide services to residents and businesses.
- Infrastructure will monitor water quality and water levels and alert government officials to maintenance issues before larger, more costly problems develop.

TRANSPORTATION

- Michigan leads the way in research and development of intelligent vehicles.
- Intelligent traffic systems allow commuters to avoid congestion by suggesting alternative travel routes.



Guiding Principles

The 21st Century Infrastructure Commission's goal is to enhance Michigan residents' quality of life, drive economic growth, and create a strong foundation for vibrant communities. We can achieve this by planning for 21st century infrastructure systems that are safe, reliable, efficient, and cost-effective for all residents.

The Commission developed the following guiding principles to direct the recommendations for creating a 21st century infrastructure system for the state of Michigan:

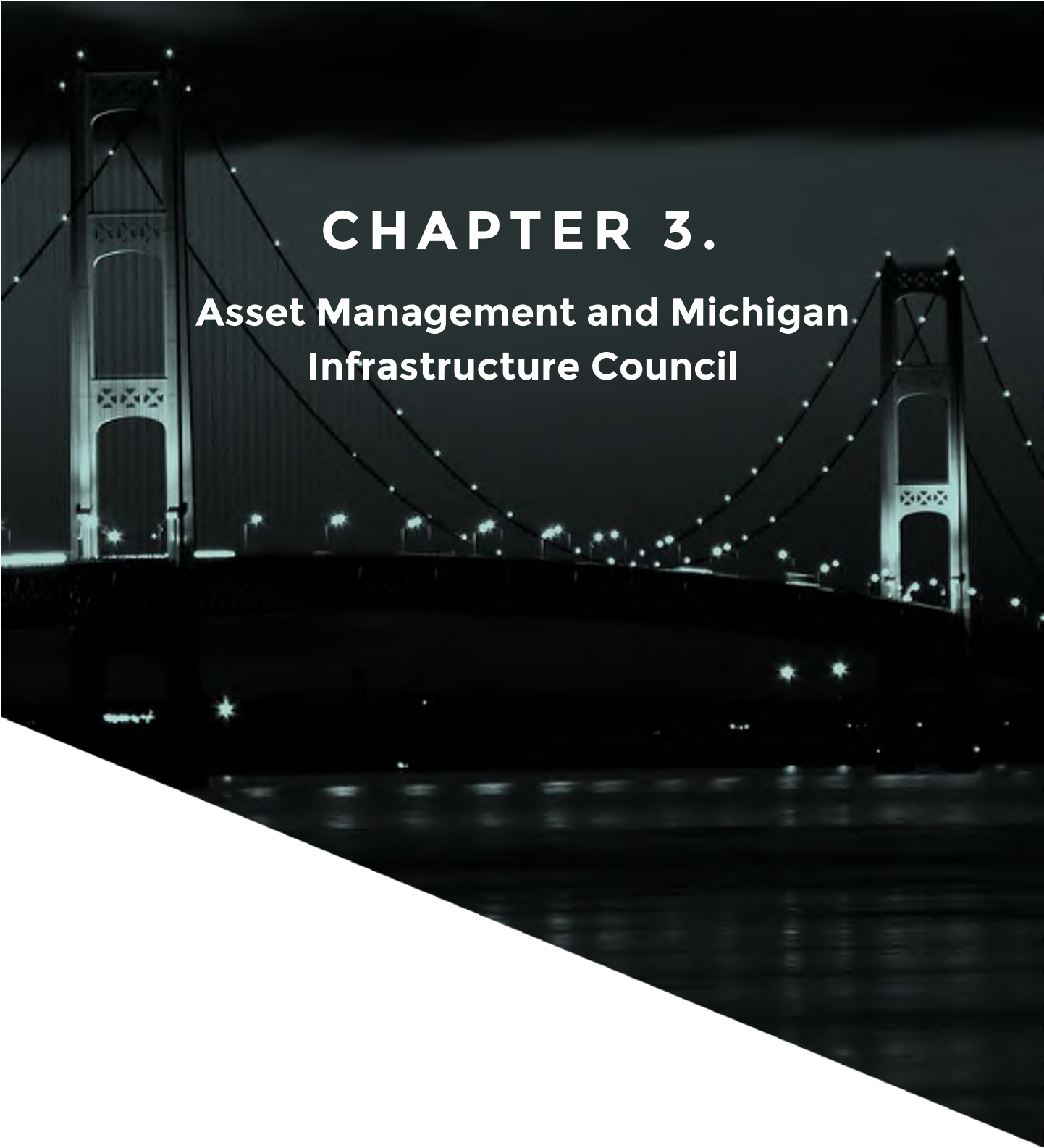
- **Create infrastructure systems that enhance quality of life, enable economic growth, and provide a strong foundation for vibrant communities.** Strong, modern infrastructure is vital to attracting and retaining residents and businesses. Infrastructure systems serve as the backbone for our communities; therefore, we should preserve, maintain, and improve our infrastructure systems.
- **Promote coordination, cooperation, and communication.** All levels of government and infrastructure entities in Michigan are incentivized to coordinate, cooperate, and communicate throughout the infrastructure planning, management, and implementation process. Programs and infrastructure projects need to have clear, established objectives and performance metrics, which track progress and effectiveness of work undertaken.
- **Build a culture of strategic investment through asset management.** Infrastructure asset management uses a continuous improvement model and a risk-based approach, ensuring infrastructure needs are prioritized and funded.
- **Design infrastructure systems that are adaptable, flexible, and resilient.** Michigan's infrastructure should be able to adapt to changing demographics and technologies, as well as climate impacts. To maximize public health protection, Michigan's infrastructure should also be safe and resilient in the face of cyber and physical threats.
- **Leverage a variety of public and private investment and financing resources.** A range of funding and financing options will ensure adequate investment in and operation of safe, reliable, efficient, and cost-effective infrastructure. Coordination of project planning and implementation across infrastructure sectors will facilitate optimal solutions as well as shared sourcing and cost allocation.
- **Encourage meaningful public engagement.** Transparency, accountability, and opportunities for public engagement are reflected in infrastructure planning, prioritization, economically sustainable funding models, and financing mechanisms that result in high levels of satisfaction with infrastructure service.
- **Prioritize environmental quality and sustainability efforts across all infrastructure sectors.** Sustainable practices, including green infrastructure, environmental efficiency, and beneficial reuse, are prioritized in infrastructure planning.
- **Embrace emerging technologies, visionary planning principles, and innovative approaches.** Infrastructure designers and providers embrace new technology and cutting edge planning principles to meet the needs of 21st century infrastructure systems in project planning, design, and implementation.

Outcomes

In addition to developing guiding principles, the Commission and its technical advisors—with input from stakeholders—assessed Michigan’s current and future state of infrastructure. The Commission then developed a series of recommendations to achieve this vision.

The Commission’s recommendations are organized across this report by four key types of infrastructure: communications, energy, transportation, and water. The Commission also developed a set of cross-cutting recommendations that impact all areas of infrastructure (presented in Chapter 3). Regardless of the type of infrastructure, however, the Commission developed recommendations that will lead Michigan to realize the following outcomes:

-  **Economic prosperity:** The state’s infrastructure system serves as the platform for our economic success, including our communities, businesses, and residents. Our infrastructure systems must be built for a 21st century Michigan to fully meet the state’s current needs and expectations. Modern infrastructure and coordinated investments are essential to support the economic prosperity of our state.
-  **A healthy environment:** The state’s infrastructure system is interconnected with the health of our people, environment, and communities. Investments in communications, energy, transportation, and water networks and technologies support a Pure Michigan that, in many ways, defines the character of our state.
-  **Reliable, high-quality service:** The state’s infrastructure system provides its users with reliable, high-quality services to support vibrant communities and business operations. Our transportation systems move people and cargo effectively and efficiently, our energy systems provide affordable and reliable electricity and heat to homes and businesses, our communications systems enable Michiganders to stay connected in a global world, and our water management systems protect and enhance public and environmental health.
-  **Value for investment:** The state’s infrastructure system is supported through wise investments that ensure we get the most value from limited financial resources. Through coordinated asset management across Michigan’s infrastructure systems, we can make strategic and optimal decisions about infrastructure repair and replacement to ensure greater value for our investments.



CHAPTER 3.

Asset Management and Michigan Infrastructure Council

Throughout its work, the 21st Century Infrastructure Commission encountered a set of key issues that impact all areas of Michigan's infrastructure system. This chapter highlights those issues, and two key recommendations to address them.

The first key issue Michigan faces in developing a 21st century infrastructure system is determining how to get more value out of our assets over their entire service life. The best way to accomplish this is through asset management—the practice of identifying and managing infrastructure in a cost-effective and efficient manner based on continuous collection of data (see Exhibit 5).

EXHIBIT 5. Asset Management Model



Asset management involves continually inventorying and assessing infrastructure condition so that planned maintenance can be done, which extends the service life of an asset before it has to be replaced. This makes it more economical to maintain performance. The result is cost savings for local communities and users, satisfaction for customers, and improved security, safety, and public health for our communities. Implemented in a standardized and systematic way across infrastructure types, asset management can improve coordination and increase cost savings even further.

Asset management is not a new concept for Michigan; we have been recognized by the Federal Highway Administration as a national leader in statewide transportation asset management data collection and planning, through the Michigan Transportation Asset Management Council (TAMC), but additional work is needed to make the state a leader in systematic, holistic infrastructure asset management and planning (U.S. DOT FHA 2014).

Communities that utilize effective asset management can attest that identifying strategic investments in preventive maintenance, repair, and rehabilitation of infrastructure assets is much more cost-effective than reconstructing the “worst first”.

The foundation of asset management, and a strong water infrastructure system, begins with inventorying your assets, says Bob Belair, manager of Canton Township’s Department of Public Works. “Data is key. Once you have data, then you can institute asset management.” For nearly 15 years, Canton Township has been collecting data on their water and sewer systems, including the size and material of pipes, valves, hydrants, manhole locations, pump stations, and lift stations. They’ve also scanned in about 70,000 as-built plans for their water and sewer systems, which include specific details of each section of pipe, including age. In addition, Canton Township collects data on when and where water main breaks happen. With all of this information, they were able to design an in-house risk assessment tool for their entire water system that helps with their budgeting and water main replacement program. This risk assessment tool identifies potential impacts to the community of water main breaks, helping to prevent water boil advisories, and maintain pipes to prevent them from breaking.

The second key issue is coordination in the way we plan for and manage infrastructure across and among levels of government, and with private sector entities that build and manage infrastructure. Traditionally, public infrastructure in Michigan has been managed individually by sector. Particularly in the case of water infrastructure, there is limited information regarding the location and condition of mains, lead service lines, and leaks, which complicates investment decisions. Planning and funding cycles for different types of infrastructure are often not coordinated, and public and private infrastructure owners may not be aware of each other’s planning and decision-making processes. This results in the inefficient use of public money. For example, when a road is reconstructed or resurfaced, there is not consistent coordination with water and sewer utilities, gas, electric and communications companies to plan underground projects. As a result, sometimes newly surfaced roads are ripped apart to enhance or repair underground utilities, increasing costs—potentially compromising the integrity of the new road surface and needlessly affecting public travel.

21st Century Vision for Michigan

The 21st Century Infrastructure Commission recommends a two-tiered approach to ensure Michigan is effectively implementing asset management and coordinated planning and investment across infrastructure types and at all levels of government:

First, early in 2017 the State should establish a **regional infrastructure pilot** to identify existing infrastructure data and gaps, determine an appropriate comprehensive database system to house this data, and begin to coordinate amongst asset management data and planning across infrastructure sectors. The regional infrastructure pilot would also operationalize a statewide asset management process and database system across infrastructure types. This pilot should be established through an Executive Order of the Governor. Key State departments, in conjunction with public agencies and private entities, will be responsible for leading and conducting this effort. The scope of this pilot program is to develop a comprehensive asset management database.

Second, by 2018 the Michigan Legislature should establish the **Michigan Infrastructure Council**, a body that coordinates infrastructure-related goals as described below (referred to as “the Council”). The Council, authorized by legislative statute, should have three main functions, with the overarching goal of improving the level of service to the public at the lowest annual cost:

- Leverage the development of the pilot for implementation and maintenance of a common statewide asset management process and database
- Develop a long-term, integrated infrastructure strategy for the state, and communicate relevant project information to decision-making bodies
- Design, oversee, and coordinate the distribution of incentives and funding and financing opportunities, with an eye toward ensuring that funding cycles and processes promote cooperation between asset owners and reward projects that address multiple infrastructure needs with a single project

These two approaches are described below in recommendations 3.1 and 3.2.

3.1 REGIONAL INFRASTRUCTURE PILOT

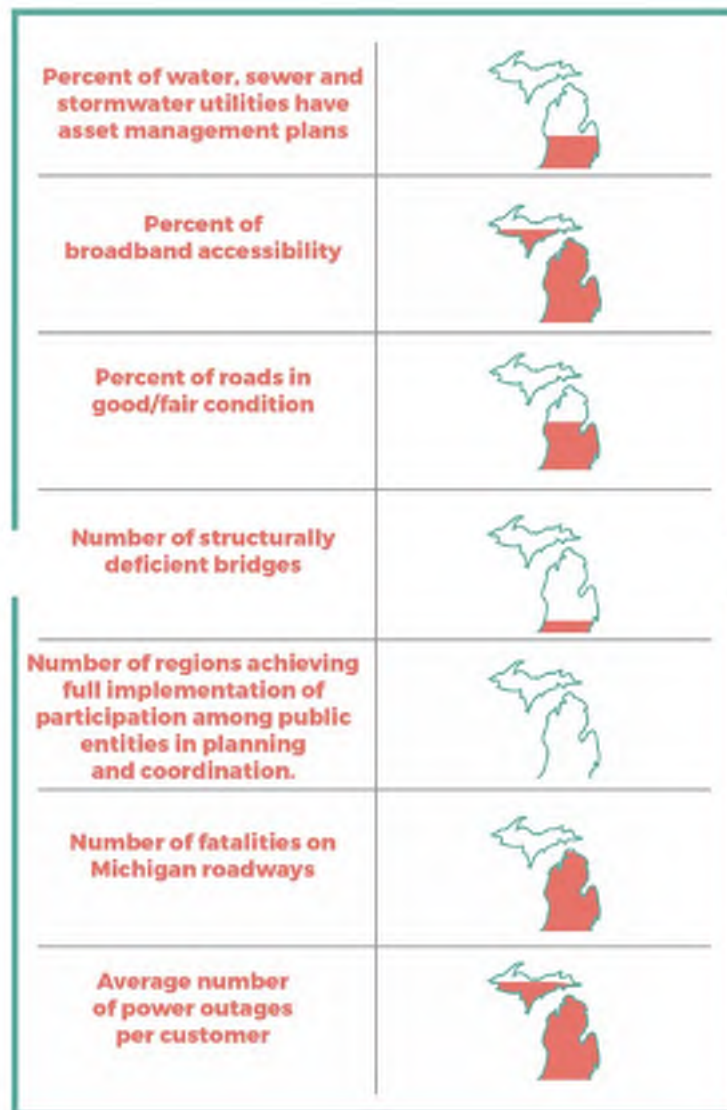
A regional infrastructure pilot should be immediately established to identify existing data and data needs within the region and an appropriate system to house and analyze this information. The regional infrastructure pilot should also immediately identify critical stakeholders to assist in this process and begin to coordinate asset management across infrastructure sectors. The regional infrastructure pilot should be established through an executive order of the Governor to test and operationalize a statewide asset management database system. Key departments within the executive branch should conduct this effort and serve as the pilot leaders, such as the Governor’s Office, the Michigan Department of Technology, Management and Budget (DTMB), the Michigan Department of Environment Quality (MDEQ), the Michigan Department of Natural Resources (MDNR), the Michigan Department of Transportation (MDOT), and the Michigan Public Service Commission (MPSC). Key stakeholders, including public agencies and private utilities, should also be included in the pilot. The process for establishing the pilot should include, at a minimum, the following steps:

- **Identify pilot region:** The pilot leaders should identify a pilot region (ideally a Michigan Prosperity Region) that is best positioned with a foundation of asset management practices, data collection, and the ability to coordinate amongst infrastructure stakeholders.
- **Leverage and expand the efforts of TAMC:** The initial focus should be on transportation, water, and sewer, and include other asset types as issues surrounding inventorying condition, prioritization, and improved decision making at both the project and system levels, and security are addressed and the best methods for coordinating with private asset owners are identified.
- **Develop database:** The pilot leaders should ensure the chosen software is compatible across asset types and aligns with current asset management efforts that may already be underway across the state. Existing data storage, asset tracking, and reporting tools should be leveraged, such as the TAMC's Investment Reporting Tool, Michigan Technological University's Roadsoft database, and the Michigan Geographic Framework repository.
- **Identify and define data elements:** The pilot leaders should identify, define, and inventory existing and needed infrastructure asset data and data elements (condition, material, age, remaining service life, ownership, planned investment, etc.). The database must use a core set of data elements that enable tracking and assessment of investments, management actions, asset status, and desired outcomes. Common data elements and performance measures will allow comparisons across communities and utilities. Pilot leaders should establish partnerships with federal, state, local, and private entities to help leverage geographic information systems (GIS) data and to develop processes to secure information as necessary to protect public health and safety. Database development must ensure balanced attention to the collection, management, integration, analysis of relevant data, and delivery of useful information to decision makers.
 - MDEQ should work with stakeholders to review and assess existing programs and identify best practices of their current sewer and stormwater asset management initiatives during the pilot phase. A summary of their macro data should be provided to the Michigan Infrastructure Council upon establishment to ensure ongoing efforts are compatible with various permits (i.e., Stormwater, Asset Management, and Wastewater [SAW] Program and National Pollutant Discharge Elimination System [NPDES] permits have embedded asset management requirements). New funding for drinking water, sewer, and stormwater asset management plans should integrate with the Michigan Infrastructure Council's goals, policies, and database.
- **Identify database system:** Pilot leaders should identify a database that uses a core set of data elements that enable tracking and assessment of investments, management actions, asset status, and desired outcomes. Database development must ensure balanced attention to the collection, management, integration, analysis of relevant data, and delivery of useful information to decision makers. The database system must allow for the following:
 - Infrastructure condition assessments, identification of investment needs and subsequent plans for the rehabilitation of old assets, and construction of new assets—with a measured goal of improved system ratings toward specific targets—and collaboration among participating entities on all of these activities (online and offline).

- Participation from public and private entities and facilitation among private and public asset holders, without requiring private sector partners to reveal confidential business information.
- A snapshot of the condition of assets and integrated infrastructure planning coordination and adaptive management of assets.

The pilot may also make recommendations as to additional functions a statewide system may benefit from, including analytic and decision-making tools as well as how to provide a user-friendly interface where a snapshot of state, regional, and local system performance can be viewed by the public (see Exhibit 6).

EXHIBIT 6. Example Snapshot of System Performance



- **Engage stakeholders and partners:** The pilot should identify key public and private infrastructure stakeholders in the region across water, transportation, energy, and communications infrastructure to help with this pilot. Stakeholder engagement will be critical during development of the database to agree on standards and policies that will allow for effective interoperability across data sets, while maintaining integrity and security of the data. Stakeholders will also be important in coordinating asset management planning across infrastructure sectors.
- **Identify regional structure and incentives:** The pilot should identify an appropriate regional structure and/or authority to plan, analyze, and coordinate infrastructure across assets at the regional level. This information would then be reported up to the Michigan Infrastructure Council for statewide aggregation. The Council would also identify State of Michigan incentives for these regional entities that would lead infrastructure planning and delivery in the region across sectors. Specifically, the regions identified by the pilot should address water and transportation regional planning efforts through the following steps:
 - a. Water:
 - i. Encourage and/or incent regional solutions for water, sewer, and stormwater needs in order to gain economies of scale. As a first step, the MDEQ should engage in the regional water quality planning process outlined in Section 208 of the federal Clean Water Act.
 - ii. Convene discussions with local communities, utilities, State of Michigan agencies, and professional associations to review local infrastructure asset management plans, master land use plans, and capital improvement plans. Support consolidation and reuse of existing infrastructure, ensure that new infrastructure investments are strategic and optimized, and address issues arising from excess capacity or stranded investment.
 - iii. Identify opportunities in communities through local master planning in communities to optimize systems experiencing declines in water usage or sewage output associated with demographic shifts.



b. Transportation:

- i. Identify and work with stakeholders across all modes to complete a comprehensive assessment and determine what transportation infrastructure is needed and the appropriate location to support the industries and communities expected in the future.
- ii. Work with local agencies and transportation stakeholders to identify areas of the state where excess road infrastructure undermines the potential for community success, develop context sensitive solutions to transportation problems, and encourage the use of design solutions that make more effective and beneficial use of the excess road capacity, while respecting and serving the community.
- iii. Work with local agencies to encourage cross-collaboration, particularly smaller jurisdictions that may not have sufficient expertise with context-sensitive solutions for right-sizing, encourage greater coordination between agencies, and provide technical assistance to local agencies seeking solutions that help right-size their infrastructure.



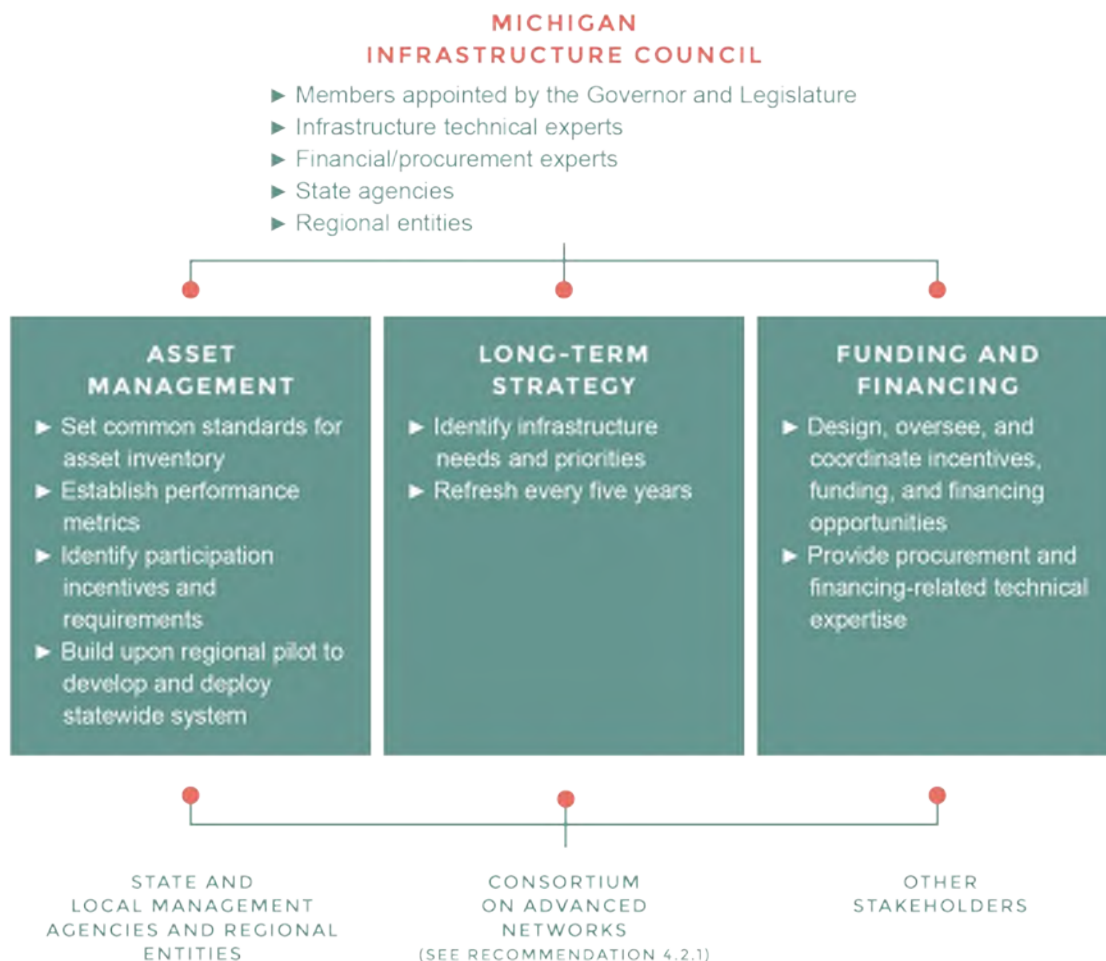
- **Asset management database statewide deployment:** Within one year of the establishment of the pilot, pilot leaders should provide a set of recommendations to the Michigan Legislature, Governor, and Michigan Infrastructure Council (contingent upon establishment by statute) for deployment of a statewide asset management database system and regional structure to plan asset management and direct information statewide. The statewide development and implementation of this database and regional structure should be recommended based upon the successes and lessons learned of the pilot.
- **Funding:** The estimated cost of the pilot program is \$2 million in state funding, which includes the development and completion of the pilot analytics database, initial data collection, and initial training.
- **Staffing:** Key state departments, regional, and local public and private stakeholders will provide staffing support to the pilot program.

3.2 MICHIGAN INFRASTRUCTURE COUNCIL

In order to coordinate and unify efforts to implement comprehensive asset management, the Michigan Legislature should create the Michigan Infrastructure Council. This Council should consist of members appointed by the Governor and the Legislature, including:

- Infrastructure technical experts from the public and private sectors representing transportation, water, energy, and communications
- Financial/procurement experts from public and private sectors
- Representatives of key state departments
- Representatives of regional entities

EXHIBIT 7. Michigan Infrastructure Council



At the Council's inception, terms of members should be staggered. At the end of initial appointments, terms should be three years in length. The chairperson of the Commission should be selected from among the voting members of the body. Key state departments, including a representative from the department or office selected to house the database, should provide qualified administrative staff, and regional entities should also provide qualified technical assistance to the Commission. The Council should have the following three main responsibilities, which are further detailed below:

- Expand the regional asset management infrastructure pilot to deploy the asset management database process and system
- Develop a long-term, integrated infrastructure strategy for publicly held assets in Michigan, as well as coordinate with private utilities
- Design, oversee, and coordinate incentives; funding; and financing opportunities for Michigan's various infrastructure asset types

Expand the Regional Asset Management Infrastructure Pilot to Deploy the Asset Management Database Process and System Statewide

The Council should lead deployment of the statewide asset management process and database system, and ensure inclusion of the following components:

- **Basic components:** Basic components of the system need to be determined, such as an inventory of assets; asset conditions; current and desired customer level of service; and operations, maintenance, capital, and replacement costs.
- **Consistent standards:** Consistent standards should be developed for collecting data on asset condition, risk-based asset planning, and making decisions regarding capital expenditure programs.
- **Key metrics:** Key metrics for the overall system rating at the state, regional, and agency level should be developed, along with the level of investment needed to hit targeted system ratings. Performance targets must be established and reported. An example dashboard that could be used to communicate
- **Public access to information:** Provide a user-friendly interface where a snapshot of state, regional, and local system performance can be viewed by the public (see example in Exhibit 6).
- **Security:** Protocols should be developed and implemented that ensure data security at the local, regional, and state levels.
- **Participation:** Participation benchmarks/minimum thresholds for state, regional, local, and private entities should be established. Entities that exceed those benchmarks will be provided incentives (see below).
- **Incentives and requirements:** To identify incentives that can be deployed through existing funding and regulatory authority, the Michigan Infrastructure Council will work with the MDEQ, DTMB, MPSC, MDNR, MDOT, and any other relevant agencies to conduct a review of all regulatory and financing programs for opportunities to require beneficial asset management.

- **Regions:** The Council should implement the recommendation from the pilot regarding the appropriate regional structure and/or authority to plan, analyze, and coordinate infrastructure across assets at the regional level.
- **Predictive analytics:** Tools are needed to identify repetitive patterns of failures, other trends, and areas of opportunity for preventative maintenance, demonstrate the savings of preventative investment, and compare annualized life-cycle costs for different options. Predictive analytics should be explored as part of the capabilities of the database.
- **Opportunities for coordinated project planning:** The database for public infrastructure planning would provide opportunities for coordination by allowing private-sector infrastructure owners (e.g., most communications and energy providers) to participate, in a way that maximizes the ability for coordinated project planning, without revealing confidential business information. The Council should develop an approach and system to enhancing communication at a stage early enough to permit coordination in planning (private asset owners receive notifications of potential public projects planned nearby and vice versa).
- **Funding:** The Michigan Legislature should appropriate adequate funds from the General Fund budget for the expansion of the statewide database. Funding should also be appropriated for the implementation of the statewide asset management system, including providing licenses to users at an affordable cost, training users on how to use the database, and providing ongoing staffing and user support.
- **Timeline:** After completion of the pilot, a rollout of the statewide system should be implemented within two years of the creation of the Michigan Infrastructure Council.
- **Additional considerations:**
 - Asset management responsibility, practices, data collection, and analysis will remain decentralized, as it is today, residing with the private, public, local, and state infrastructure asset owners.
 - The statewide framework and guidelines should be designed so that even though all asset owners (private, public, local, and state) will be encouraged to participate, there are different expectations for owners depending on capacity and how critical their assets are (e.g., local, rural asset owners with few infrastructure assets would not have the level of planning and reporting requirements as those in larger cities). A minimum value should be established for inclusion in the framework (e.g., assets valued under a certain monetary amount are not included in the asset management framework).

Develop a Long-term, Integrated Infrastructure Strategy for Publicly Held Assets in Michigan and Coordinate with Private Utilities

The Council should develop a long-term, integrated infrastructure strategy for publicly held assets in Michigan, as well as coordinate with private utilities. This strategy should include the following:

- **Comprehensive infrastructure plan:** Based on the information in the statewide infrastructure asset management database, the Council should develop and refresh an infrastructure plan at least every five years. The plan should include an articulation of infrastructure asset condition, needs, and priorities. The Council should also have the

ability to receive confidential information from private infrastructure owners and use that information in development of its infrastructure plan.

- **Investment needs:** Advise the Governor, the Michigan Legislature, local agencies, and private stakeholders of five-, ten- and 20-year investment needs to reach targeted overall system ratings, with a goal of leveling annual investments to long-term predictable amounts.
- **Accountability and transparency:** Make information readily available and accessible to the public through regularly published needs assessments/reports and dashboards that depict the condition and trends of infrastructure investments and operations at the local, regional, and state levels, including benchmarking against other states.
- **Communication regarding project decisions:** Recognizing that private and public decision-making timelines are difficult to align and that funding structures differ, the Council should play a vital advisory role to the various decision-making bodies. At the time funding or permitting decisions are made, the Council should advise decision makers whether projects are a) part of coordinated planning efforts, and thus especially cost-effective, or b) off-cycle when compared to planned investments by other infrastructure owners, and thus likely to needlessly increase costs.
- **Smarter state:** As mentioned in the communications infrastructure recommendations in Chapter 4 of this report, the Council should explore structural options including public-private partnerships (P3s) to ensure inclusion of network intelligence in infrastructure planning and monitoring. Retrofit technologies should be considered, pursued, and incorporated as they become available for upgrades and maintenance activities to existing and future infrastructure.

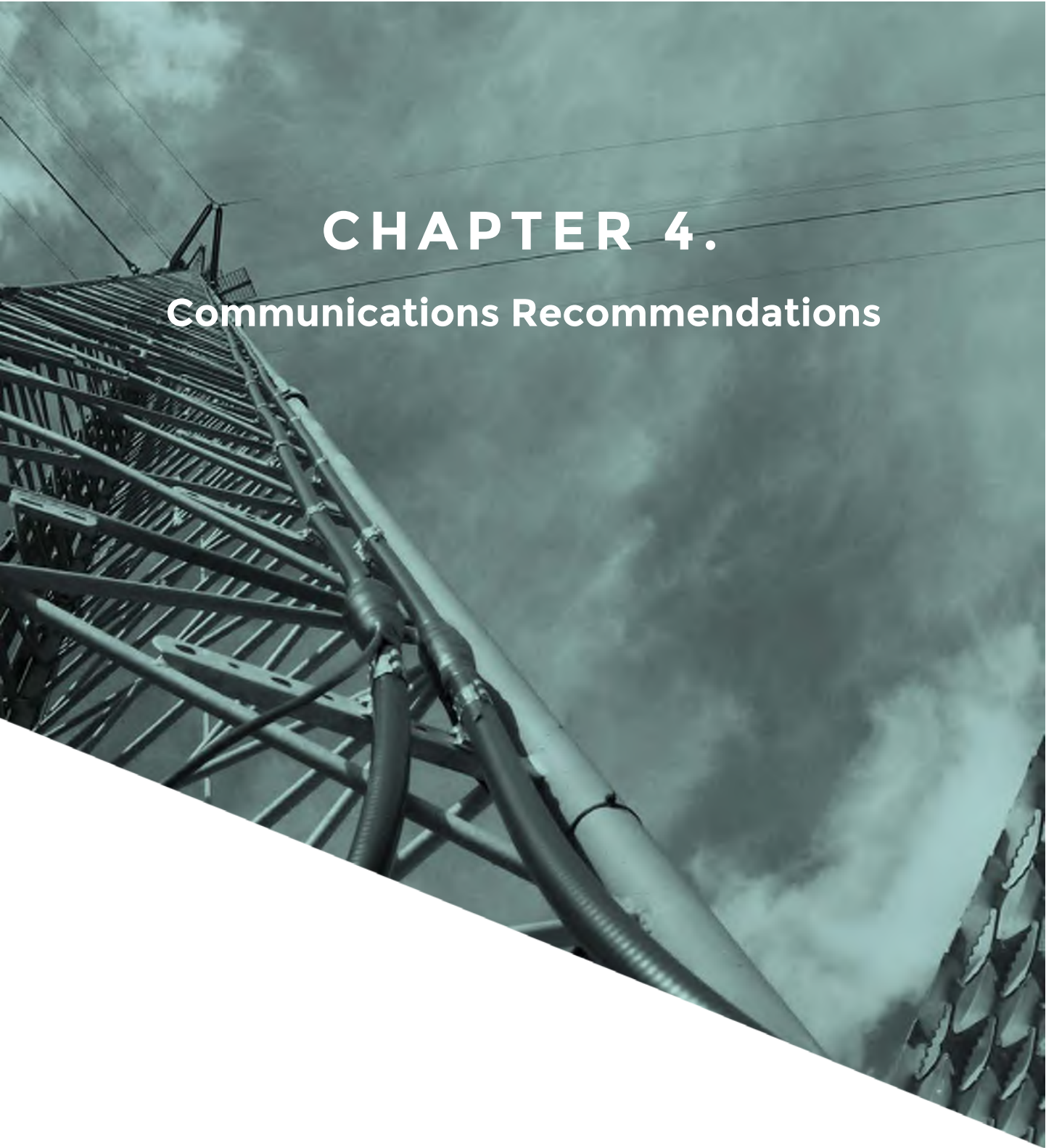
Design, Oversee, and Coordinate Incentives; Funding; and Financing Opportunities for Michigan's Various Infrastructure Asset Types

The Council should design, oversee, and coordinate incentives, funding, and financing opportunities for Michigan's various infrastructure asset types. The Council's work on funding and financing should include the following steps:

- **Incentives:** Identify and leverage incentives using existing funding and regulatory authority to ensure high participation among public entities in planning and coordination and private asset owners in participation in coordination opportunities.
- **Review of regulatory and financing programs:** Work with the Governor's office and all relevant state agencies on an ongoing basis to conduct a review of all regulatory and financing programs for opportunities to require asset management and use of the system.
- **Funding:** Research and provide advice to the Governor, state departments, and the Michigan Legislature on infrastructure funding capacity, level of effort and needs, innovative and new infrastructure funding sources and financing options, ways in which to leverage federal funds, and legislative and regulatory changes needed for improving infrastructure planning and management efficiencies.
- **Priorities:** Review regional planning efforts, identify funding needs, identify integrated planning opportunities, and determine a list of funding priorities by region for the State of Michigan, Governor's Office, and/or Legislature. Those priorities and opportunities should

be both made available to the public when determined and should provide the basis for recommendations to decision-making bodies regarding whether specific projects are in line with those priorities.

- **Procurement and financing expertise and coordination:** Provide procurement and finance-related technical expertise on projects determined to be high value and high risk for the State, including identifying opportunities for public and private infrastructure funding, financing, and procurement, as well as identifying, and potentially overseeing, alternative funding sources.

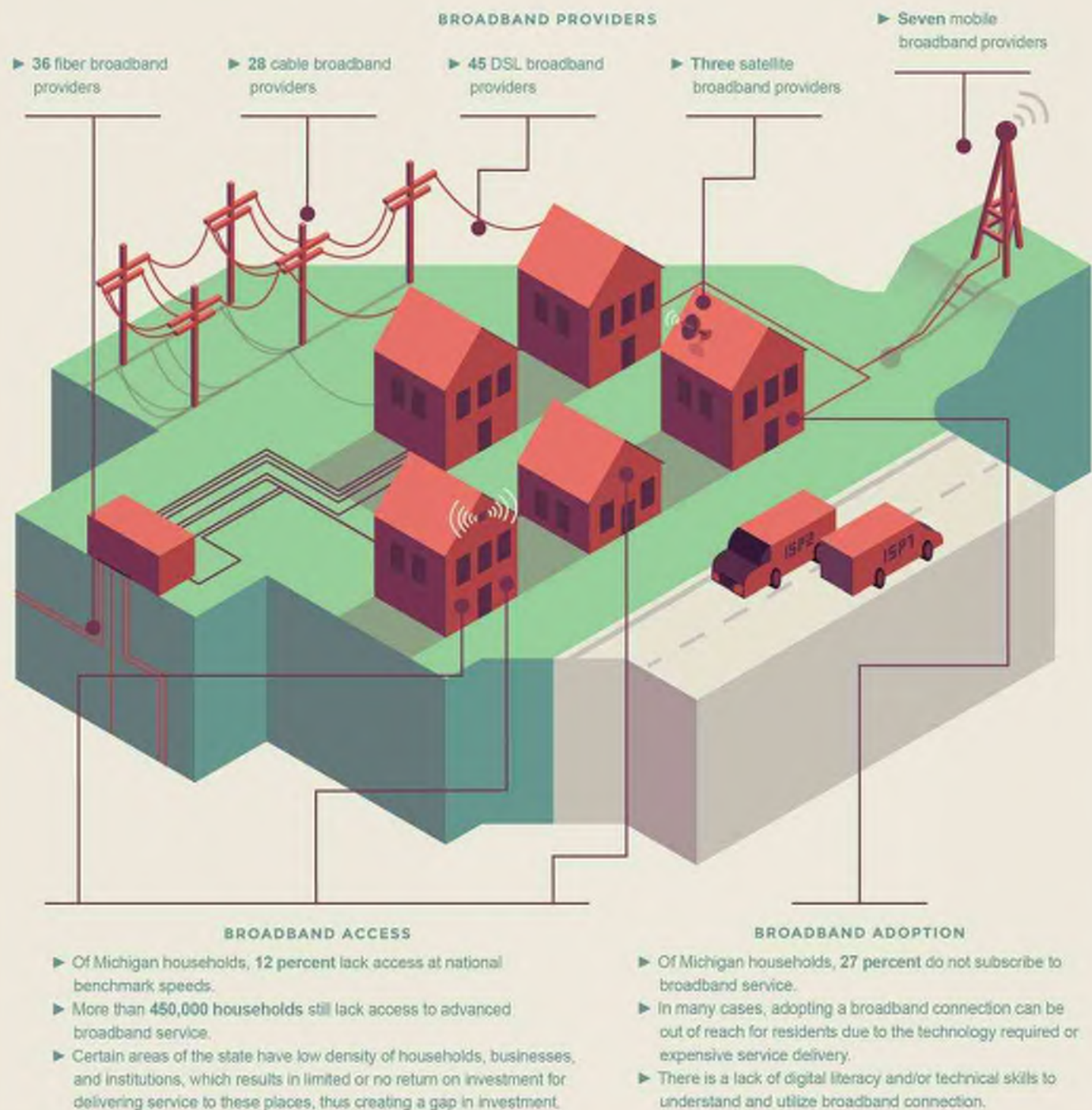


CHAPTER 4.

Communications Recommendations

CURRENT STATE OF MICHIGAN'S COMMUNICATION INFRASTRUCTURE

Infrastructure systems in Michigan should enhance residents' quality of life, enable economic growth, and create a strong foundation for vibrant communities. In order to obtain safe, reliable, and resilient communications systems in the 21st century, we must first understand the current reality of communication infrastructure in Michigan:



In order to unlock the potential of new technology, Michigan must ensure that secure, reliable, affordable, and universal advanced communications services are available to all residents. Affordable, high-speed broadband² service is essential for the advancement of education, health, public safety, research and innovation, civic participation, e-government, and economic development.

The Internet is already a part of everyday life for most Michiganders. People and businesses depend on it every day for communication, banking, commerce, leisure, and more. While access to the Internet and technology has, in many respects, made daily life easier, it comes with the risk that someone could access our private information. High-profile examples of cyber attacks have seemingly become more prevalent in daily life—from the recent hack of the Democratic National Committee, to attacks on the electric grid in Ukraine, to a breach of around five million Yahoo! accounts. As more devices connect online, and more information is shared over the Internet, the risk of cyber attacks increase.

It is vital to the safety of Michigan residents and the state's economic prosperity that critical information and assets are protected from cyber security threats.

Michigan must also recognize the way that current and emerging technologies are converging to create new opportunities and encourage an adaptive model that can enable new delivery methodologies for broadband such as fiber-optics, wireless, satellite, and other technologies yet to be developed. The most enduring and powerful technological changes on the horizon are the Internet of Things³ (IoT) and artificial intelligence/machine learning (AI).⁴ Combined, these technologies will transform the way in which we experience daily life. Technological innovation will enable a variety of new modes of human interaction and societal transformations, from aging in the home to viewing transportation as a service.

The IoT comprises an expansive system of connected remote sensors that can communicate real-time information, both to one another and a central controller, and perform remote control functions. Essentially, the IoT creates a connection between the physical and the digital worlds. Imagine a large office building that can monitor and control the pace of its elevators to optimize departures of cars from an attached parking structure, and sync with traffic lights, as well as with intelligent vehicles to minimize traffic congestion during rush hour. This system, as imagined, offers several potential benefits—including reduced fuel consumption, fewer greenhouse gas emissions, less time spent in traffic, and possibly even fewer collisions. These technologies will depend on communications infrastructure that can adapt to new demands and the changing nature of

² Broadband is a descriptive term for evolving digital technologies that provide consumers a signal switched facility offering integrated access to voice, high-speed data service, video-demand services, and interactive delivery services (FCC January 28, 2014).

³ IoT is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment (Gartner 2016).

⁴ Machine learning is a technical discipline that aims to extract certain kinds of knowledge/patterns from a series of observations. Depending on the type of observations provided, it splits into three major sub disciplines: supervised learning, where observations contain input/output pairs (a.k.a. labeled data); unsupervised learning, where those labels are omitted; and reinforced learning, where evaluations are given of how good/bad a certain situation is (Dawson 2016).

technology. As potential technological changes are identified, the State will need to ensure changes are developed deliberately, to protect the safety and security of individuals while balancing with concerns about privacy and autonomy.

The Internet of the 21st century will have a profound effect on the economy and lives of Michigan's residents. It will measure the quality of the air we breathe and the water we drink. It will benefit the quality of our commute and speed the flow of goods along the supply chain, ultimately to the consumer in a better and less expensive way. It will enhance public health and public safety; help the aging population stay independent longer and enhance the quality of the healthcare we receive; help us more efficiently consume energy; help enhance productivity from Michigan's crops; keep us safer and help deliver richer educational and recreational experiences for Michigan residents and visitors.

This chapter outlines a series of recommendations to ensure that Michigan is a communications leader, and that the state is prepared for the pervasive use of Internet-connected sensors and beacons, and that a priority is placed on ensuring network connectivity is available to people everywhere.

Recommendations Key

 EP	Economic Prosperity	 HE	A Healthy Environment
 QS	Reliable, High-quality Service	 VI	Value for Investment
 0-2	Implementation Start (in years)	 0-2	Implementation Complete (in years)

4.1 MAKING MICHIGAN A SMARTER STATE

Where is Michigan today?

Technologies offer tremendous potential; it is predicted that by the year 2020, there will be an estimated 50 billion things connected to the Internet, but there is still uncertainty about the number, type, and application of new technologies. There are no widely accepted technical standards for the IoT, including data storage, management, and sharing among stakeholders. This uncertainty makes it difficult to determine how Michigan must prepare itself for the future, yet the State lacks policies related to implementation of the IoT, specifically regarding to the ownership and sharing of data, security controls, and privacy. Any new policies and regulations must be properly balanced so Michigan can realize the benefits that stem from greater access to data, data sharing, and shared services. Where these technologies do exist, Michigan can leverage its buying power to help define product development and accelerate the maturation, effectiveness, and deployment of technologies.

For the most part, the technical capabilities required to achieve the vision of a “smarter state” have yet to be invented, and it is possible that some of the necessary components to achieve this will remain undeveloped during the next 30 to 50 years. According to the International Telecommunication Union (ITU)—an international organization charged with standardizing communications technologies, such as the 5G wireless network roadmap—the technology required to properly enable the IoT will not be broadly defined and available before 2020 (ITU September 2016).

What does a 21st century Michigan look like?

Michigan is a global leader in the development, deployment, and adoption of new technologies, and the creation of smart environments and communities. This includes leading in the promotion of technologies that support smarter city⁵ development; adoption of low-power, wide-area networks and state-of-the-art wireless technology networks; research into communications technology such as AI, machine-to-machine communication and machine learning; and deployment of IoT

21st Century Smarter State

A smarter state improves the quality of a citizen's life by constructing an infrastructure that optimizes IoT technologies to enable potentially radical new work processes, services, and products. This construction relies on evaluating residents' experiences related to, for example, safety, security, health, energy, transportation, and communication. In general terms, the smarter state creates contextualized or demographically aligned service offerings that match the aspirations of the residents, community and society. With the increasing volume of data and insights, the orchestration of context based on data and insights becomes a critical focus of improved governance methodologies.

⁵ Cities are becoming “smarter,” through better predictive analytics and real-time decision making as governments, businesses, and communities increasingly rely on technology to overcome the challenges from rapid urbanization. What makes a smarter city is the combined use of software systems, server infrastructure, network infrastructure, and devices to better connect several critical city infrastructure components and services: administration, education, healthcare, public safety, real estate, transportation, and utilities. The concept of the smarter city is pushing Chief Information Officers in federal, state, and local governments and their technology teams to further evaluate emerging technologies and engage with key stakeholders within and outside of their organizations to provide city administration and residents with better information and outcomes.

technology through flexible policies and regulations. Michigan also builds upon its rich history in transportation and logistics innovation by continuing to develop and commercialize technologies required for the next generation of intelligent vehicles, as well as manned and unmanned aerial vehicles (see section 6.9: Intelligent Vehicle Technology recommendations). Michigan's leadership position is underpinned by a robust cyber security ecosystem,⁶ and its established partnerships with the automotive, financial, healthcare, education, energy, military, law enforcement, critical infrastructure, and the private/public sectors. These advances promote a more connected, smarter Michigan that uses interactive, interconnected technology to identify and address problems before they become too big to solve.

Technology also promotes more effective collaboration—resulting in better service for businesses, visitors, and residents—and expands the economy while dramatically increasing Michigan's attractiveness as a place to live, work, and play. Technology will provide value to aging and disabled populations, including housing, transport, healthcare, communication and community support services, leisure, and culture (Skouby et al. 2014). Technologies will serve to create smart and enabling environments where people will find themselves empowered (Coetzee 2016). Smart infrastructure that leverages IoT technology and services can be transformative by improving mobility, wayfinding, communication, and access to information for the aging and populations with disabilities. A smarter Michigan will be safer, healthier, and more efficient for everyone.

Given the rapid pace of changes in technology, Michigan's progress is measured and reviewed annually to ensure its place as a top-five state, with a thorough review of the broader goals and benchmarks occurring every four years.

Some of the opportunities offered in a 21st century Michigan will include:

- Highways that allow commuters to quickly find an alternate route and avoid congestion from a highway accident
- Transit stops that provide easily accessible route information for visitors or other passengers
- Destinations that recognize return visitors and welcome them with information they can use to make their experience more enjoyable
- Street lights that make communities safer by prompting city workers to replace the light bulb before burning out
- Technology that alerts law enforcement of crime or suspicious activity as it happens so they can arrive on the scene sooner
- Infrastructure that monitors water quality and water level and alerts government officials to maintenance issues before larger, more costly problems develop
- Healthcare devices that allow patients to monitor their symptoms and alert them if they need to seek treatment
- Homes that allow residents to age in place

⁶ To keep pace with the ever-evolving and persistent cyber threats, Michigan's focus is on prevention, detection, response, and accountability, while increasing our key partnerships within the automotive, financial, healthcare, education, energy, military, law enforcement, critical infrastructure, and private/public sectors.

How do we get there?

- 4.1.1** The State of Michigan should create the Consortium on Advanced Networks (see recommendation 4.2.1) to develop a vision, a plan, and execution roadmap to enact the state's digital transformation by investing in emerging technologies, supporting academia in research related to the IoT, building an adaptive IoT workforce, and forming appropriate policies to create a smarter state. Ensuring appropriate security measures are included in all IoT implementation projects should be part of this roadmap. The Building the 21st Century Economy Commission, established by Governor Snyder in June 2016 to develop a comprehensive economic vision for Michigan, should consider this recommendation during their deliberations.

Estimated investment needed: Will utilize existing staff resources



- 4.1.2** The Michigan Economic Development Corporation (MEDC), in partnership with relevant state agencies, should create a fund to support efforts that will make Michigan a global leader in smart technology development and deployment. The fund will provide seed and matching funds to key stakeholders to incentivize innovation, research, and development on advanced communications and other smart technologies (including AI; machine-to-machine communication; machine learning; and transportation, water, wastewater, and stormwater technologies). The fund will also support cities in identifying, implementing, and funding smart technology investments that appropriately serve their communities.

Estimated investment needed: \$10 million of state funds annually



- 4.1.3** The DTMB should actively participate in relevant workgroups and committees of the National Association of Chief Information Officers and the International Telecommunications Union to position Michigan as a technological leader.

Estimated investment needed: Will utilize existing staff resources



- 4.1.4** The Michigan Infrastructure Council (see Chapter 3) should engage in P3s to ensure IoT adoption is included in infrastructure planning and retrofit technologies are considered, pursued, and incorporated as they become available for upgrades and maintenance activities to existing and future infrastructure.

Estimated investment needed: Will utilize existing staff resources

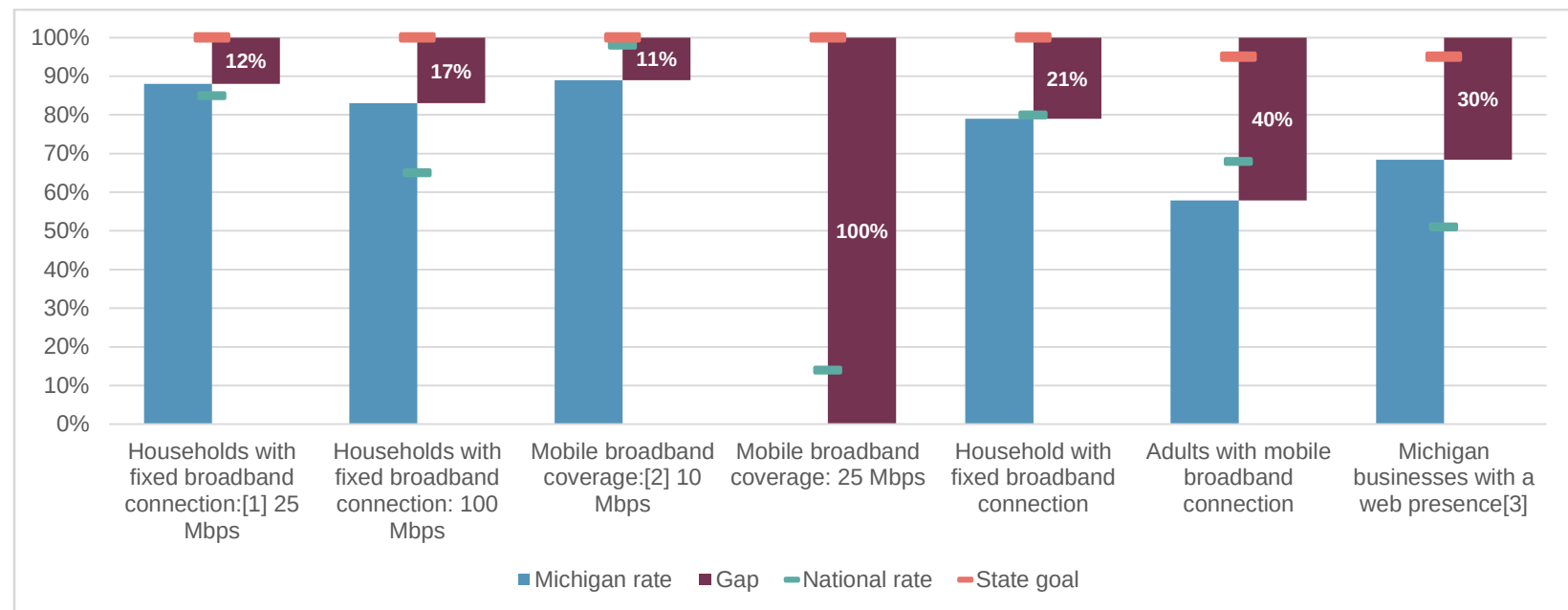


4.2 IMPROVING BROADBAND ACCESS AND ADOPTION

Where is Michigan today?

Michigan has made a concerted effort over the past decade to expand the availability of broadband services by leveraging federal programs, such as the Universal Service Fund and the Connect America Fund. Through incentives provided through these federal programs and investments made by the state's broadband providers, Michigan has come a long way in improving broadband access and adoption. Michigan's current achievement for broadband access and adoption is detailed below in Exhibit 8.

EXHIBIT 8. Broadband Access and Adoption: Current State, Goals, and Gaps



Source: Connect Michigan 2015; National Broadband Map 2014; U.S. Census Bureau 2016; Pew Research 2016; Todd 2015.

Despite efforts, there are still barriers to achieving these goals and addressing the gaps between the current and desired future states:

- Certain areas of the state have low density of households, businesses, and institutions, which results in limited or no return on investment for delivering service to these places—thus creating a gap in investment.
- The processes for installing communications infrastructure can often be long and cumbersome.
- There is limited federal, state, and local government authority to encourage or require broadband deployment in underserved areas.
- In many cases, adopting a broadband connection can be out of reach for residents, due to the technology required or service delivery being too expensive.
- Some people may not be aware of how broadband adoption can impact their quality of life.
- There is a lack of digital literacy and/or technical skills to understand and utilize a broadband connection.

What does a 21st century Michigan look like?

Michigan is a top-five state for broadband access and adoption, recognizing that broadband access is vital to ensuring residents and businesses to succeed. The deployment of broadband technology provides a range of potential benefits, such as expanded access to healthcare and educational resources, economic opportunities, and improved public safety, among other benefits. Michigan's residents and businesses have access to affordable advanced broadband services, even in previously unserved and underserved areas, and tools and training are available to adopt a broadband connection.

By promoting broadband access and adoption, thus creating a “broadband superhighway,” Michigan will:

- Enable interconnection of assets across infrastructure types, such as transit, water systems, energy, and governmental services
- Ensure every business has access to advanced broadband networks to enable local economic growth
- Ensure every student in the state has high-speed broadband network access at school and at home to enhance learning opportunities, eliminate the “homework gap”⁷ for P–20 students, grow opportunities for workforce career development, and increase the opportunity and percentage of Michigan residents attending, and graduating college
- Connect state and local governments in order to provide new, improved, enhanced, and more efficient services to their constituencies
- Improve and expand the ways transportation, healthcare, tourism, and other industries deliver products and services

⁷ The homework gap refers to the disadvantage for students especially those from low-income households who lack broadband access at home. This makes it more difficult to do school work that increasingly relies on Internet access (Pew Research Center April 2015).

Michigan's position as a top-five state for broadband access availability for residents, businesses, and institutions means that:

- All residents and businesses have access to a fixed broadband connection with a download speed of at least 25 Mbps and an upload speed of 3 Mbps by 2020 and a download speed of at least 100 Mbps by 2024.
- All community anchor institutions⁸ have access to a fixed broadband connection with download and upload speeds that meet the minimum recommended speeds for their sector by 2024.
- All areas of the state (geographic) have access to a mobile broadband connection with a download speed of at least 10 Mbps by 2020 and at least 25 Mbps by 2024.

As a top-five state for broadband adoption—where residents, businesses, and institutions have the opportunity and ability to fully engage in digital society and the digital economy—Michigan has achieved the following goals:

- 95 percent of residents have adopted a fixed and mobile broadband connection at home by 2024.
- 95 percent of Michigan businesses have a Web presence by 2020.
- All community anchor institutions have adopted a fixed broadband connection by 2024.

How do we get there?

4.2.1 The Governor should issue an executive order establishing the Michigan Consortium on Advanced Networks, an advisory body comprising stakeholders from the nonprofit, public, and private sectors and academia. The group would be charged with improving coordination among stakeholders in addressing mobile and fixed broadband access and adoption issues in the state, as well as making Michigan a smarter state. The Consortium would comprise individuals representing varied interests, such as state government, telecommunications providers, broadband providers, video service providers, wireless carriers, and more. The Governor would appoint the members of the Consortium, including its chair(s). The Consortium would also provide advice and counsel to the Michigan Infrastructure Council on communications-related infrastructure. In addition to helping Michigan become a smarter state (see recommendation 4.1.1), the Consortium would perform the following advisory functions:

- **Policy coordination:** Recommend policy changes to improve mobile and fixed broadband access in the state, including streamlining and expediting permit and approval processes for locating and constructing new broadband infrastructure.
- **Technical assistance:** Support local and state agencies in working with the private sector to increase mobile and fixed broadband access in Michigan, such as providing guidance on the creation of P3s to support the joint use of existing horizontal and vertical assets and

⁸ Community anchor institutions are schools; libraries; medical and healthcare providers; public safety entities; community colleges and other institutions of higher education; and other community support organizations and agencies that provide outreach, access, equipment, and support services to facilitate greater use of broadband service by vulnerable populations—such as low-income residents, the unemployed, and the elderly (FCC November 18, 2011).

network facilities to reduce over-building; expedite new connections for residents, businesses, and institutions; encourage economies of scale in rural communities; and support installing universal conduits for new construction projects.

- **Asset management:** Continue and expand efforts to map and research mobile and fixed broadband access and adoption to more efficiently respond to changing needs of communities, residents, businesses, institutions, and private-sector broadband providers.
- **Digital literacy education:** Expand, improve, and create pragmatic digital literacy programs at the state and local level. The programs should respond to the digital literacy and technology training needs of Michigan businesses and support a tech-savvy workforce, as well as inform consumers, businesses, tribal governments, and community anchor institutions about the importance of fixed and mobile broadband availability and adoption. Educational activities could include convening an annual statewide broadband conference with the purpose of providing an opportunity for cross-sector collaboration and the sharing of best practices in the expansion of mobile and fixed broadband access, adoption, and use across the state.
- **Funding options:** Provide funding—and help identify funding and financing from all available sources and programs—to entice investors to provide affordable mobile and fixed broadband access to households and businesses statewide, making Michigan a top-five state for mobile and fixed broadband access and adoption:
 - Providing a subsidy⁹ to stimulate private sector investment that makes available state-of-the-art broadband access to the portion of Michigan’s population that currently doesn’t have access to at least 10Mb/1MB fixed broadband service because of low population density and other factors that make service delivery uneconomical for providers.
 - Creating a financing program to remove the installation cost barrier for customers who want to pay for one-time costs for conduit or equipment to prepare the site to receive commercially available broadband connections to their home or building;
 - Developing a grant or revolving loan program to assist local units of government and private sector broadband providers in collaboratively establishing P3s to support the sharing and joint use of existing horizontal and vertical assets and network facilities to reduce over-building; expedite new connections for residents, businesses, and institutions; encourage economies of scale in rural communities; and support installing universal conduits for new construction projects across the various levels of right-of-way jurisdictions.
 - Monitoring and maximizing funding opportunities that support the adoption of mobile and fixed broadband among families and individuals that qualify for the

⁹ According to the Federal Communications Commission’s (FCC’s) Connect America Cost Model, the estimated subsidy required to make it economical for private sector broadband providers to invest in installing fiber-to-the-premises broadband access with a download speed of 100 Mbps infrastructure in rural areas of the state is approximately \$2.2 billion over 25 years (\$89 million annually). Of this total subsidy amount, \$645.7 million can be provided by the FCC’s Connect America Fund, leaving a balance of \$1.57 billion in subsidies needed over the next 25 years. This subsidy combined with the private investment it would stimulate—which is estimated to be an equal or greater amount—represents the estimated total cost of connecting the 17 percent of Michigan’s population that currently do not have access.

federal lifeline program, but who do not have access to a low-cost mobile and fixed broadband program.¹⁰

Estimated investment needed: \$50 million of state funding, annually over ten years¹¹



4.3 SECURING MICHIGAN'S DIGITAL INFRASTRUCTURE

Where is Michigan today?

While Michigan is already a top performer in cyber security¹² preparedness, the rate of advances in technology means that Michigan must constantly improve to stay ahead of threats (Spidalieri 2015). In order to provide state-of-the-art cyber security, Michigan must address several barriers. Currently, Michigan's public sector struggles to attract and retain top talent in the cyber field, due to significant wage discrepancies between the public and private sectors. Michigan has attempted to address this wage gap by creating an information technology (IT) student assistant classification and an entry level IT classification for students with associate's degrees, developing a performance pay schedule for longer-term high performing IT staff, and increasing new IT employee salaries upon hiring. Also, entities working in Michigan's cyber security ecosystem lack an exemption from Freedom of Information Act (FOIA) legislation, which creates a barrier to sharing cyber threat and vulnerability information between and amongst public and private entities.

The state's experience as a cyber security leader makes it evident that strong collaboration is an important step in ensuring this ecosystem remains strong and committed. Michigan has engaged private and public experts through recurring conferences and Chief Security Officer Kitchen Cabinet meetings, leveraged the Michigan Cyber Range, and formed the Michigan Cyber Civilian Corps to share best practices and network with seasoned cyber professionals.

What does a 21st century Michigan look like?

As more and more information gets shared and interactions occur online, Michigan will set industry standards in cyber security by finding innovative ways to defend critical information, manage access and identity management, and embrace new and emerging technologies. Michigan

¹⁰ The FCC's Lifeline program provides discounts on phone service for low-income consumers. The Commission expanded the program to include broadband services in 2016 (FCC August 11, 2016).

¹¹ Note that the recommended \$50 million annual investment is not enough to fully implement this recommendation, but the Commission is also recommending identifying funding from other available sources and programs—such as the Connect America Fund—to fill the gap.

¹² Cyber security encompasses a broad range of practices, tools, and concepts related closely to those of information and operational technology security. Cyber security is distinctive in its inclusion of the offensive use of information technology to attack adversaries (Walls 2013).

maintains its security and cyber-readiness through ongoing revision and refinement of the following five elements:

- A published cyber security strategic plan
- A published incident response strategy
- Governance structures and regulatory mechanisms in place to fight cyber crime
- Capacity and systems in place to support timely and coordinated information sharing of cyber threat intelligence across agencies and stakeholders
- Investment in cyber security research and development, education, and capacity building

How do we get there?

4.3.1 DTMB should develop a ubiquitous enterprise log management as a service system, or cyber hub,¹³ that allows the cyber security ecosystem to understand new, emerging and historical cyber threats by leveraging advanced and predictive analytics. This will allow Michigan and their partners to detect, respond to, and mitigate cyber incidents through real-time analysis.

Estimated investment needed: \$3 million of state funding annually for two years



4.3.2 DTMB should work to build a cyber-focused workforce, in partnership with the Merit Network, by continuing efforts of the Regional Cybersecurity Education Collaboration (RCEC). The vision of the RCEC is collaboration between the higher education community and key private sector partners to address the widening gap between the supply of skilled cyber security professionals and the demand for those skills. The overall goal is to provide a robust cyber security curriculum to institutions throughout Michigan via a mix of face-to-face and distance learning courses at two-year and four-year colleges.

Estimated investment needed: \$1 million of state funding annually for two years, and private donations for scholarships



¹³ A cyber hub is designed to operationalize existing cyber data, information, and intelligence for the cyber security ecosystem to establish a common operating picture by leveraging predictive and real-time analytics. Cyber hubs provide decision making support to enable organizations to anticipate and respond to cyber events.

- 4.3.3** DTMB should increase Michigan Civilian Cyber Corps (MiC3) membership to 200 members and invest in development and training for the MiC3. This increase in membership will ensure small and medium-sized organizations have a low-cost cyber security option in case of attacks. In addition, the corps will also support the cyber ecosystem in case of large-scale attacks to Michigan's critical infrastructure.

Estimated investment needed: \$2 million annually for five years from state and private funds



- 4.3.4** The Governor should create a shared virtual chief information security office (CISO) to provide consulting and advisory services to multiple local governments. Led by the chief information security officer, the virtual CISO will develop, implement, monitor, and support cyber program activities for multiple local governments. The virtual CISO would also serve as a conduit for cooperation among and between local governments and other state, federal, and nonprofit agencies to support the mission of cyber security. Participating agencies would pay for this service through annual fees.

Estimated investment needed: \$750,000 of state funding total over two years



- 4.3.5** DTMB should enhance threat intelligence gathering and sharing among states, federal agencies and private sector partners develop responses to common threats, in keeping with guidance published by the National Institute of Standards and Technology.

Estimated investment needed: \$3 million of state funding annually for five years



- 4.3.6** DTMB should advocate for changes to the state's Freedom of Information Act (FOIA) exemptions—which currently prevents Michigan agencies from communicating and coordinating with infrastructure asset owners about cyber and physical security threats/attacks—to allow for appropriate exemptions for agencies protecting Michigan's critical infrastructure. This could cover any communications between the government and private entities, as well discussions on defensive measures. Exemption in terms of cyber threat information is key because, it protects any vulnerability systems may have discovered as well as cyber security assessments and plans. It also protects any additional information that may be included in the data shared.

Estimated investment needed: Will utilize existing staff resources



- 4.3.7** Entities within the cyber security ecosystem should collaborate to develop a public awareness campaign and other learning opportunities to educate residents, consumers, and families about the reality of online risks and promote cyber safety practices among residents, particularly children and businesses. The public outreach program could include ways to alert residents and businesses about serious security failures, potentially delivered via MiPage. The vision is a system like a recall notification program for things like routers, Internet cameras, audio and video recording equipment, consumer devices (e.g., Amazon Echo, deadbolts, and Internet-connected locks). Residents purchase these items through normal retail channels, but are rarely provided with security updates or patches.

Estimated investment needed: \$1.25 million to \$2 million of state funding, annually for five years



- 4.3.8** Work with the cyber security ecosystem and other entities to design and encourage the adoption of a curriculum focusing on technology throughout the science, technology, engineering, and mathematics (STEM) education system to ensure the next generation's workforce is prepared to take on the challenges related to information technology and cyber security.

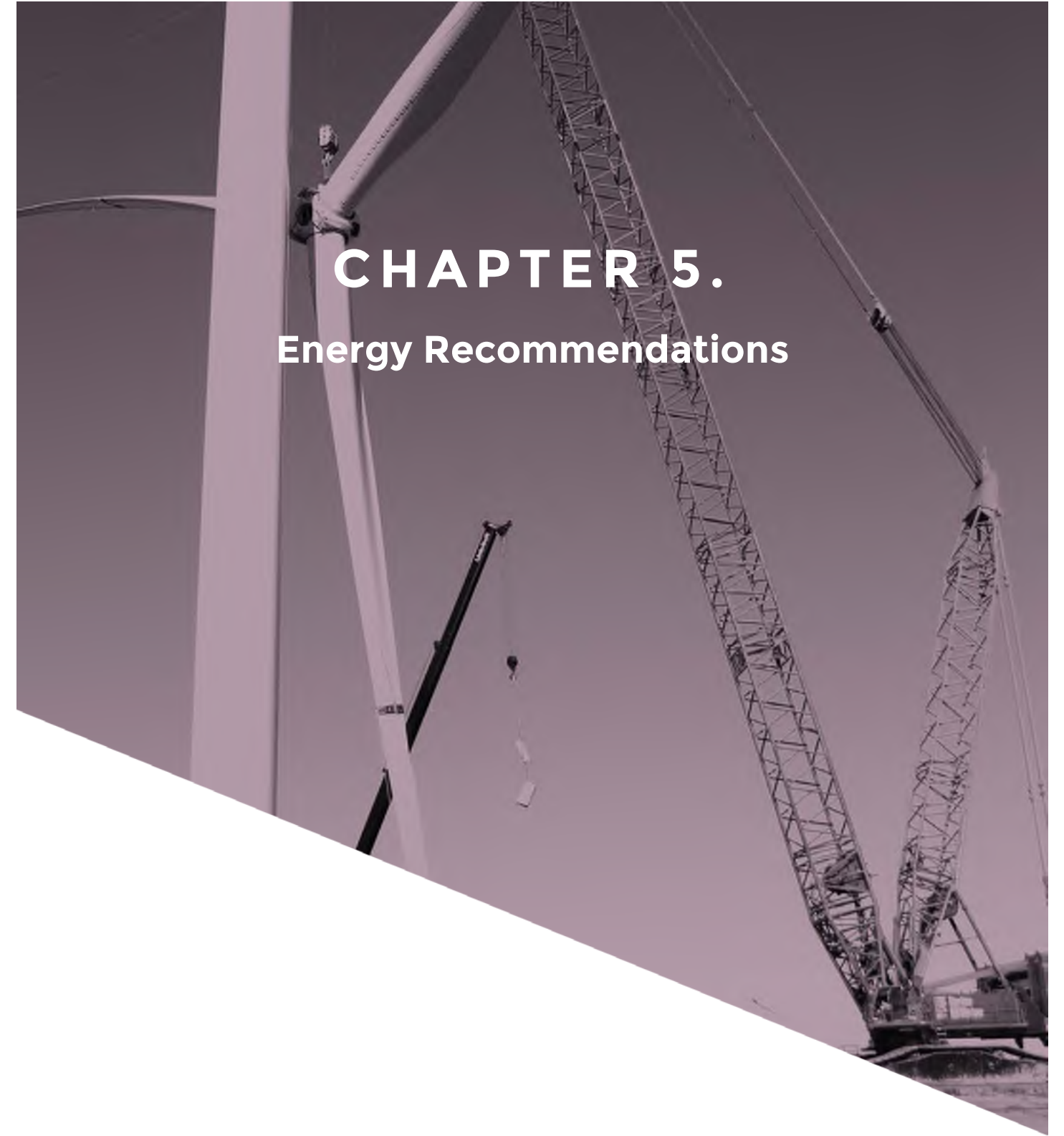
Estimated investment needed: \$960,000 of state funding annually (for staffing and materials) for five years



- 4.3.9** Michigan should develop a next-generation solution to centrally manage identity and authentication management for workers, partners, and residents. This includes a mature identity framework based on a consumption-based application program interface application economy, rather than pushing identity to individual applications. These enhancements will position Michigan to offer high-quality user experiences, maintain better security, and operate a less complex IT environment.

Estimated investment needed: \$5 million initially to develop, then \$3 million annually for five years





CHAPTER 5.

Energy Recommendations

CURRENT STATE OF MICHIGAN'S ENERGY INFRASTRUCTURE

Infrastructure systems in Michigan should enhance residents' quality of life, enable economic growth, and create a strong foundation for vibrant communities. In order to obtain efficient, reliable, and cost-effective energy systems in the 21st century, we must first understand the current reality of energy infrastructure in Michigan:

RESOURCE ADEQUACY

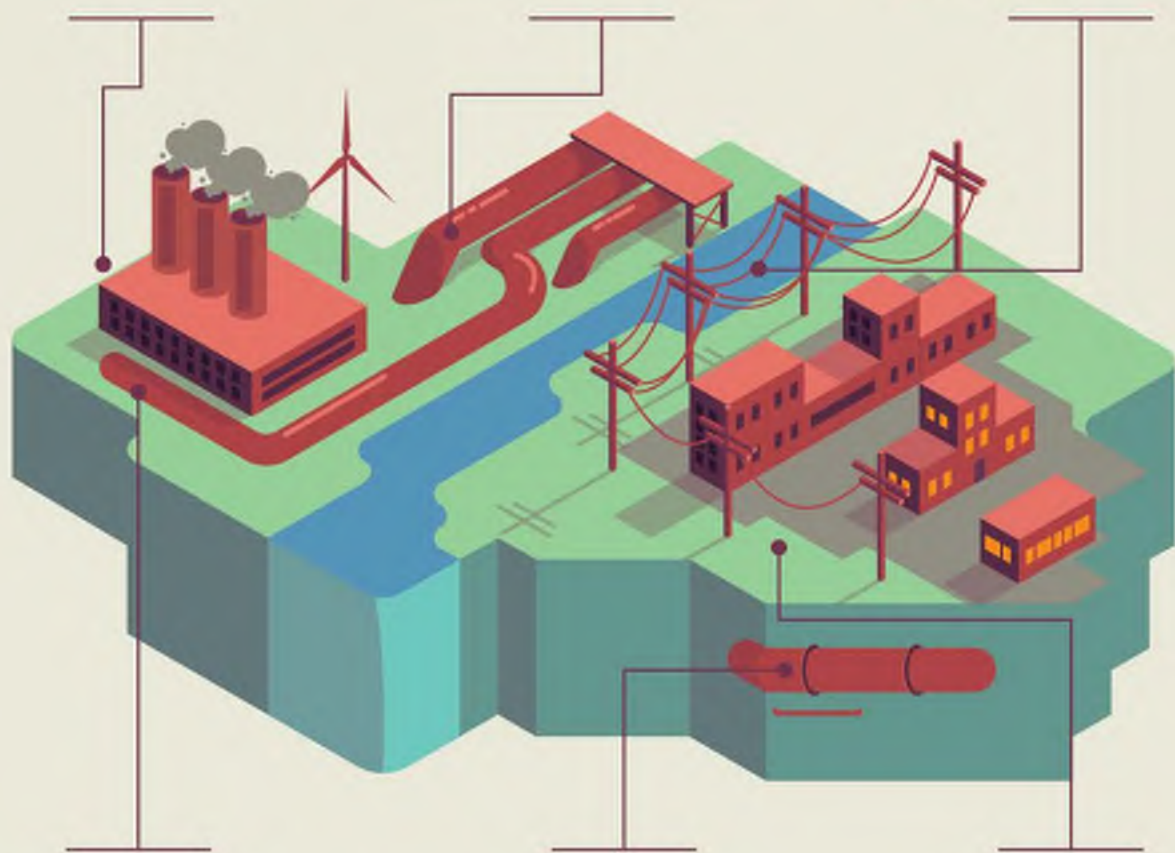
- ▶ Planned power plant retirements have raised concerns about the state having adequate electric resources to meet customers' demand.
- ▶ In 2017, much of Michigan's Lower Peninsula could fail to meet its reliability requirements by approximately 520 MW.

CLEANER ENERGY SOURCES

- ▶ Michigan has met its goals for reducing energy waste and building renewable energy generation.
- ▶ By 2015, Michigan received 9 percent of its electricity from renewable sources and reduced energy waste by 7 percent.

ELECTRIC RELIABILITY

- ▶ On average, Michigan customers experience less than one outage per year, meeting the Governor's goal.
- ▶ Michigan does not meet the Governor's goal for duration of electric outages. On average, Michigan customers experience outages for more than 150 minutes each year.



NATURAL GAS SAFETY

- ▶ Michigan has roughly 5,688 miles of at-risk natural gas distribution pipeline.
- ▶ As of 2015, utilities have replaced nearly 700 miles of these pipelines; however, another 6,700 miles have been identified for replacement over the next 25 to 30 years.

STORAGE CAPACITY

- ▶ Michigan has the most underground natural gas storage capacity of any state—11.6 percent of the nation's total storage capacity.

ECONOMIC DEVELOPMENT

- ▶ Despite higher-than-average industrial energy prices, Michigan has been successful in attracting new businesses. Utilities have worked to offer a variety of attractive services that help new businesses choose Michigan.

Energy is an integral part of modern day life. It powers Michigan's manufacturers, provides essential heating and cooling for homes and businesses, enables us to connect to and communicate with the global economy and world at large, and delivers countless other functions on a daily basis. Despite the crucial role energy plays in our lives, however, it is often taken for granted until its absence draws our attention. Recognizing this importance, Governor Snyder has spent considerable time during his administration developing goals related to energy, culminating in the release of his 2015 special message, *Ensuring Affordable, Reliable, and Environmentally Protective Energy for Michigan's Future*. The 21st Century Infrastructure Commission has used this work and the Governor's goals as the basis for their recommendations.

The energy sector is undergoing significant change. New technologies are a major driver of these changes as they unlock new opportunities for customers to monitor and control their energy use, make forms of renewable energy more affordable, increase the adoption of alternative fuel vehicles, and help reduce the environmental impact of energy use and production. In addition, a major shift is occurring in the nation's electric system, as many older electric generation resources are retiring due to age and stricter environmental regulations. Planned power plant retirements have raised concerns about whether there are adequate electric resources to meet customers' demand. Michigan only has to look to the recent events in the Upper Peninsula to see the impacts that power plant retirements can have on customers. When the largest power plant in the Upper Peninsula planned to retire, customers were forced to pay to prop up the plant, because shutting it down would have impacted reliability. Had it not been for efforts by the State and private partners to come to a better solution, customers would be trapped in a system that would not be adaptable, affordable, or equally reliable, and with a worse environmental outcome. This example highlights how vital it is to make smart decisions when it comes to planning for its energy future.

The following chapter outlines the Commission's recommendations to support Michigan's 21st century energy infrastructure and ensure that the sector will be built on a foundation of affordability, reliability, adaptability, and environmental protection.

The Commission's vision is that Michigan's energy system supports all our needs at reasonable prices, and that energy infrastructure generates and distributes resources efficiently fostering residents' and businesses' confidence in Michigan's long-term growth and continued success.

Recommendations Key

 Economic Prosperity	 A Healthy Environment
 Reliable, High-quality Service	 Value for Investment
 Implementation Start (in years)	 Implementation Complete (in years)

5.1 RESOURCE ADEQUACY

Where is Michigan today?

Michigan's risk of devastating outages is serious and growing. The MPSC's five-year electric capacity outlook, released on July 22, 2016, expressed concern that "load serving entities in the Lower Peninsula do not have adequate capacity within the state to meet reserve requirements. In addition, there is uncertainty about whether capacity supplies at the regional level will be available to fill this gap" (MPSC 2016).

Michigan's looming potential capacity shortfall could create reliability challenges during periods of peak demand in 2018.

Michigan has real experience with the devastating impacts a widespread outage can bring. In 2003, the Northeast blackout resulted in the loss of power to six million Michigan residents for up to two days. Michigan's economy lost an estimated \$1 billion when businesses and industrial production were forced to shut down. Detroit Metropolitan Wayne County Airport halted operations, General Motors was forced to close its warehouses, Ford Motor Company's production offices, and facilities ceased operation, and Marathon Oil Corporation's Detroit refinery lost 500,000 barrels of output (ELCON 2004).

Efforts are already underway to ensure Michigan has adequate generation and transmission capacity resources into the future. The MPSC, in cooperation with Michigan's primary regional transmission operator, the Midcontinent Independent System Operator (MISO), has filed a tariff change with the Federal Energy Regulatory Commission (FERC) that, if approved, would help resolve the state's potential capacity shortfall (MAE 2016). Legislative changes will still be necessary to fully implement and secure Michigan's energy future.

What does a 21st century Michigan look like?

Michigan ensures that its residents and businesses never experience massive power outages due to lack of electric supply. The State requires companies that provide electricity to Michigan customers to be prepared to serve customers' needs with adequate energy supplies.

How do we get there?

- 5.1.1** The Michigan Agency for Energy (MAE) and the MPSC should continue to work with MISO and other stakeholders to reform Michigan's current electric market structure by requiring all electric providers to protect their customers from massive outages due to lack of supply by securing adequate capacity resources. In addition, MAE and the MPSC should continue to collaborate with legislative partners, as needed, to ensure adequate generation and transmission capacity resources are developed.

Estimated investment needed: Covered by private sources



- 5.1.2** MAE and the MPSC should closely monitor all proposed solutions to the energy supply concerns in the Upper Peninsula and work with stakeholders to ensure resolution implementation by 2019.

Estimated investment needed: Covered by private sources



5.2 ENERGY WASTE REDUCTION

Where is Michigan today?

The Governor has made energy affordability a central tenet of his energy policy and has established a goal that Michigan's residential customers should spend less on their combined energy bills (electric and heat) than national averages.

To date, the state has met the Governor's goal for energy affordability; Michigan households' energy bills are below the national average.

In 2014, Michigan ranked 21st in the country, with a combined annual electric/gas bill of \$2,397.49 per household (U.S. EIA 2015; U.S. EIA 2016a; U.S. EIA 2016b; U.S. EIA 2016c).

However, despite the economic benefits of promoting efficient energy use and reducing energy waste, Michigan's current energy policy creates several barriers for the amount utilities can spend on their energy-efficiency programs and restricts customers' access to innovative financing programs for waste reduction efforts. This arbitrarily limits utilities' efforts to reduce energy, and restricts customers' ability to make decisions that could reduce their household energy burden.

Additionally, Michigan's current energy policy inhibits utilities from choosing energy waste reduction by not allowing utilities to decouple¹⁴ their electric rates. Currently, utilities' revenue is tied to the sale of electricity, which creates a challenge for utilities that pursue least-cost energy-efficiency measures because these investments reduce energy consumption and, in turn, revenue. State policies currently under consideration would enable utilities to choose to reduce energy waste without jeopardizing utilities' financial health.

What does a 21st century Michigan look like?

Michigan benefits from expanded options for customers choosing energy waste reduction through on-bill financing programs. The state's utilities invest in the most cost-effective energy resources, such as energy waste reduction, instead of being limited by arbitrary caps.

How do we get there?

- 5.2.1** The Michigan Legislature should remove the artificial cap on how much utilities can spend on energy-efficiency programs and provide the MPSC with the ability to evaluate energy waste reduction like any other resource.



- 5.2.2** The Michigan Legislature should ensure that there is no financial disincentive for the use of cost-effective energy waste reduction.



- 5.2.3** The Michigan Legislature should remove the prohibition on on-bill financing for energy waste reduction efforts.



¹⁴ Decoupling is an adjustable price mechanism that removes the link between the amount of energy sold and a utility's revenue requirement.

5.3 CLEANER ENERGY SOURCES

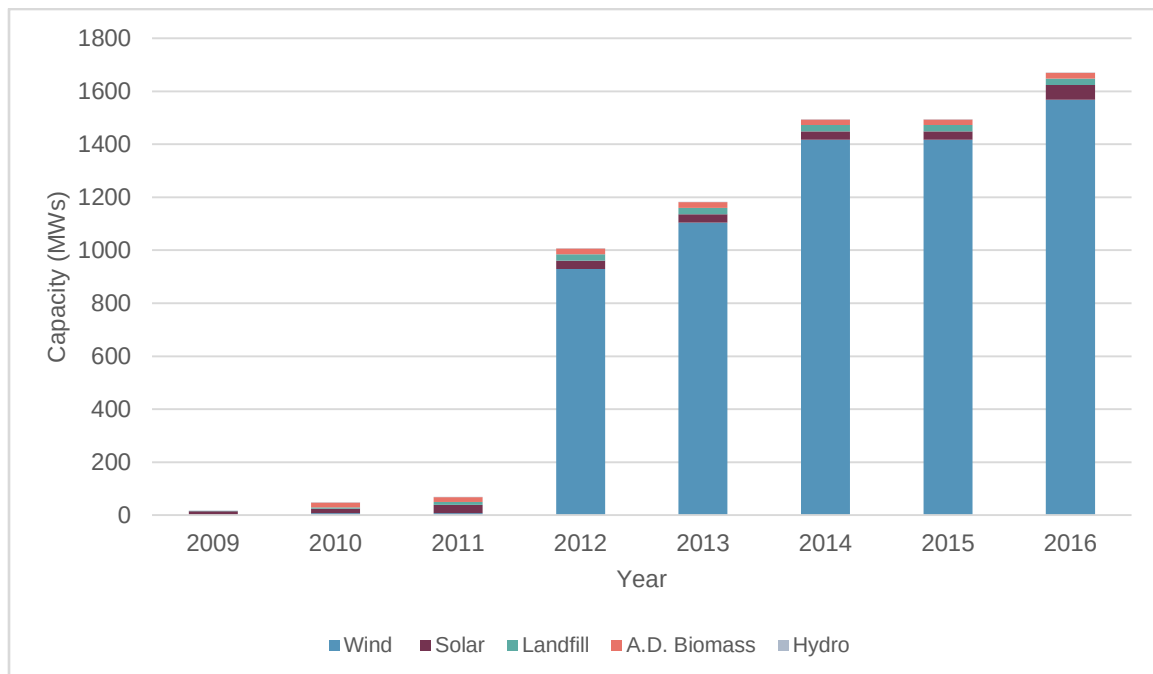


Where is Michigan today?

In 2008, Michigan established its first renewable energy standard, setting a goal of reducing energy waste and building renewable energy generation. By 2015, Michigan met these goals, receiving 9 percent of its electricity from renewable energy and reducing energy waste by 7 percent. Waste reduction has helped avoid significant costs associated with coal, natural gas, and energy production facilities while making Michiganders' homes and businesses more comfortable and energy bills more affordable. Since 2008, Michigan has met, exceeded, and maintained its mandate of 1 percent of energy waste reduction per year. However, existing law

prevents utilities from spending more than 2 percent of their budget on waste reduction, even if this forces them to buy more expensive equipment instead. By reducing the amount of energy produced by coal and replacing it with cleaner renewables, natural gas, and energy waste reduction, Michigan will help promote a cleaner environment.

EXHIBIT 9. Renewable Energy Capacity by Commercial Operation Date



Source: MPSC 2016.

What does a 21st century Michigan look like?

By sustaining current efforts and investment levels related to energy waste reduction, Michigan achieves its goal of meeting 30 percent of its electric energy needs from the cleanest sources, including renewable energy and energy waste reduction, by 2025. Over the same time period, Michigan reduces harmful emissions from its electric power sector, including emissions of mercury, sulfur oxides (SOx), nitrogen oxides (NOx), and particulate matter (PM).

How do we get there?

- 5.3.1** The MPSC and MAE should continue to work together to ensure continued investment in energy waste reduction, meeting at least 15 percent or more of Michigan's energy needs by eliminating energy waste between now and 2025, as well as meeting any of its additional capacity needs from a combination of cleaner technologies, including renewables and natural gas.

Estimated investment needed: Covered by private sources



- 5.3.2** Through coordinated efforts, the MPSC, MAE, and MDEQ should continue to ensure that emissions from the electric power sector are reduced by helping utilities choose the cleanest energy sources for the future, in consideration with affordability and reliability.

Estimated investment needed: Covered by private sources



- 5.3.3** The MPSC and MAE should work to reduce barriers to additional cost-effective renewable energy investment by reducing barriers to interconnection, net metering, and siting.

Estimated investment needed: Covered by private sources



5.4 ELECTRIC RELIABILITY

Where is Michigan today?

Governor Snyder has made electric reliability an important part of his overall energy goals, as it is vital to the health and success of Michigan families and businesses. He has put forward two goals related to the duration and frequency of electric outages that measure reliability using two industry standard metrics—the System Average Interruption Frequency Index (SAIFI) for outage frequency and the System Average Interruption Duration Index (SAIDI) for outage duration. The Governor's goals are that Michigan residents should experience, on average, less than 1.00 outage per year,

and total combined outages should last less than 150 minutes. As calculated using the current methodology, between 2008 and 2016, the average Michigan resident experienced outage frequencies that were consistently below the Governor's goals (see [Governor's Energy and Environment Dashboard](#)).¹⁵

Michigan has begun improving electric reliability by making investments that provide greater insight into the cause and location of an outage through the deployment of advanced metering infrastructure (AMI) or smart meters. AMI will improve efficient deployment of line workers by alerting utilities to areas affected by an outage without relying on customers to report disruption. As of today, Michigan utilities have installed 3,544,389 smart meters, and the MPSC expects that 90 percent of Michigan customers will have a smart meter installed by 2018.

In addition to the deployment of AMI, Michigan can do more to improve reliability by continuing to invest in the distribution system and by emphasizing ongoing efforts such as vegetation management, which keeps trees and other natural materials from contacting or damaging infrastructure assets. Michigan can also expand the metrics it uses to track reliability performance to include metrics that measure the outage experience for individual customers in order to provide a more comprehensive look into customer experience. Reliability metrics, such as customers experiencing long interruption durations (CELID) and customers experiencing multiple interruptions (CEMI), offer different ways to view the outage experience for individual customers. By incorporating these metrics into current reliability reporting, Michigan can better measure the impacts of electric outages and make more informed decisions related to improving reliability.

What does a 21st century Michigan look like?

Michigan meets the Governor's goals for reliability, continues reducing the frequency and duration of electric outages, and ensures that customers do not experience significant disruptions in their service. Michigan performs in the top half of states for the duration of electric outages and in the top quartile for the number of outages and prolonged outages (greater than three days) associated with major events that disrupt the economy and quality of life.¹⁶

¹⁵ The MPSC currently collects IEEE 1366 reliability indices from the regulated utilities annually in the following dockets: U-12270, U-16066, and U-16067. These indices are weighted annually based on the number of customers served by each utility in order to calculate the average Michigan citizen's reliability experience, which is posted on the Governor's dashboard.

¹⁶ Although SAIDI and SAIFI measure average customer reliability in Michigan, often the individual customer experiences can be disguised by these statistics. In order to ensure no customers are left behind with electric reliability goals, it is critical that measures are in place to ensure each individual customer has an expectation of high reliability.

How do we get there?

- 5.4.1** Michigan's utilities should take steps to expedite their response to outages and restore power to their customers in a timely manner by completing plans to deploy AMI while also evaluating additional measures, like vegetation management and other distribution investments. Smaller electric utilities that do not currently have plans to deploy AMI in their service territory should evaluate potential benefits and deploy where prudent and cost effective.

Estimated investment needed: Covered by private sources



- 5.4.2** The MPSC and MAE should convene a stakeholder group with the aim of establishing a performance goal for CELID and CEMI metrics and requirements in order for utilities to provide information related to these metrics, as well as their current reliability reporting.

Estimated investment needed: Covered by private sources



- 5.4.3** The MPSC should evaluate investments that provide greater insight into equipment condition and system loading, such as supervisory control and data acquisition, which will allow for greater insight into distribution system operation, enabling proactive maintenance to address problems prior to these issues resulting in an outage.

Estimated investment needed: Covered by private sources



- 5.4.4** The MPSC should evaluate proposed new capital investments through a transparent, forward-looking distribution system planning process, and monitor proposed changes to the distribution system planning process for each utility as needed on an ongoing basis.

Estimated investment needed: Covered by private sources



5.5 NATURAL GAS SAFETY

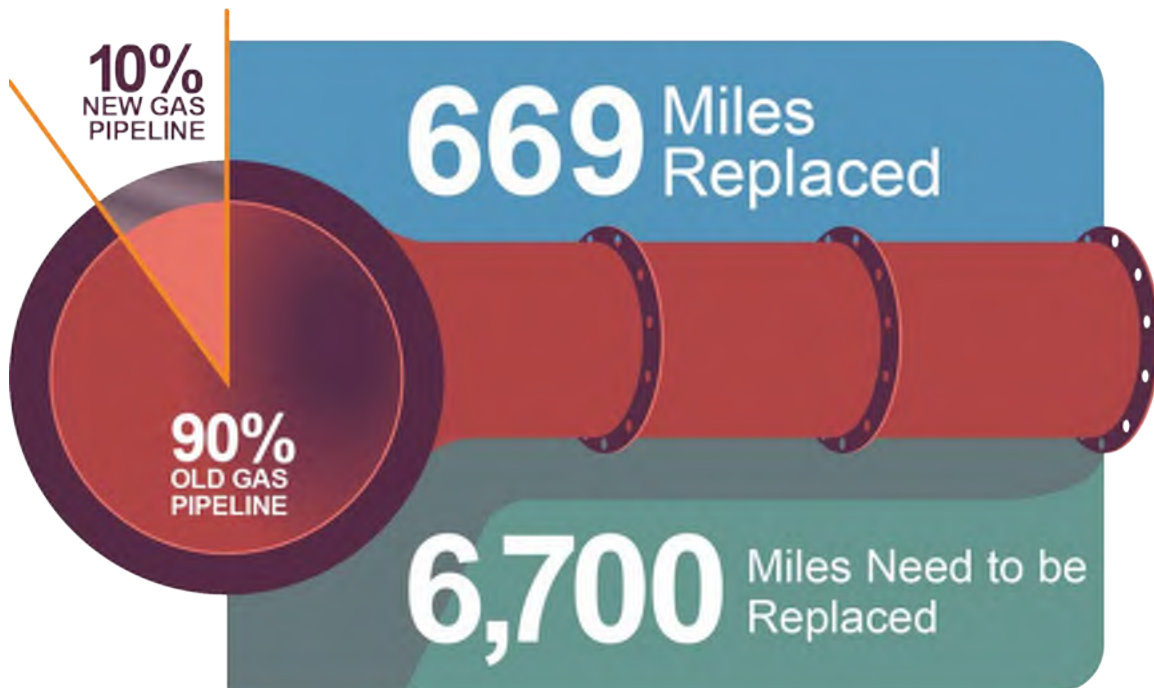
Where is Michigan today?

Many miles of Michigan's pipeline infrastructure that transports natural gas are outdated or have surpassed their useful lifespan, making them one of the State's most pressing issues regarding its energy future.

The federal Pipeline and Hazardous Materials Safety Administration (PHMSA) has identified roughly 5,688 miles of at-risk natural gas pipe in Michigan.¹⁷

This is approximately 50 percent of all the at-risk pipe identified in PHMSA's 11-state Central Region. The MPSC approved accelerated main replacement programs for utilities beginning in 2011, work towards replacing at-risk pipe is currently underway, and Michigan's natural gas utilities are working to replace all of the at-risk pipelines in the next 25 to 30 years. As of 2015, Michigan utilities have replaced 669 miles of at-risk main distribution pipeline. However, another 6,700 miles of at-risk distribution pipeline have been identified for removal and replacement (as shown in Exhibit 10).

EXHIBIT 10. Percent of At-Risk Natural Gas Pipeline in Michigan



¹⁷ At-risk pipe is identified as unprotected and protected bare steel, unprotected coated steel, cast/wrought iron, and copper pipe that is more susceptible to corrosion or leaks.

What does a 21st century Michigan look like?

In much the same way that the reliability of Michigan's electric grid is important, the state's natural gas system provides a vital source of energy that is used to heat millions of homes and provide electricity. Michigan's natural gas distribution system is well maintained and has received necessary upgrades that ensure safe, reliable operations.

How do we get there?

- 5.5.1** The MPSC should consider further accelerating plans to replace at-risk natural gas distribution pipe beyond the currently planned 25- to 30-year window by evaluating utilities' current replacement timelines. Emphasis should be placed on coordinating replacements with local investment in other infrastructure asset categories to accelerate progress and leverage investment.

Estimated investment needed: Covered by private sources



5.6 ADAPTABLE REGULATION

Where is Michigan today?

The energy sector is undergoing dramatic changes as the costs of renewable energy decline, new emerging technologies give consumers more control over their energy use, and environmental regulations force existing generation sources to curb emissions.

Over the past decade, Michigan's utilities have begun to transition their generation portfolios to include new, cleaner energy sources (such as wind and solar), but more can be done to ensure that the energy Michigan needs to power its future is reliable, affordable, and protective of the environment.

Under State law, there are currently regulatory barriers and incumbent funding structures that inhibit Michigan's ability to respond to and adopt new, emerging energy technologies. It is possible that the MPSC will be able to respond to new technologies through its existing regulatory authority, but some cases may call for legislative change. One major barrier is the Certificate of Need (CON) process, which only allows utilities to seek preapproval for projects with costs exceeding \$500 million and excludes renewable energy projects, emission control upgrades, and investment in energy waste reduction. Changes to the CON process are included in pending legislation before both chambers of the Michigan Legislature.

What does a 21st century Michigan look like?

Michigan's energy future is secure and its regulatory framework is adaptable, allowing the state's energy providers to pursue and adopt new and cleaner technologies.

How do we get there?

- 5.6.1** The Michigan Legislature, in consultation with MAE and the MPSC, should act to remove the barriers in the current CON process that prevent the MPSC from weighing all large investments against alternatives and determining the impact on reliability, affordability, adaptability, and protection of the environment.



- 5.6.2** The MPSC and MAE should continue efforts to ensure that Michigan's regulations are adaptable in the face of new technologies. The need for regulatory changes should be evaluated as new technologies emerge.

Estimated investment needed: Will utilize existing staff resources



5.7 INFORMATION SECURITY

Where is Michigan today?

Currently, state agencies cannot serve as a clearinghouse for security information or issues related to infrastructure assets, due to the nature of Michigan's Freedom of Information Act law. Under current provisions, if information related to security is shared with the State, that information could be obtained through a FOIA request from an outside individual. This undermines the State's ability to communicate and coordinate with infrastructure owners to protect critical assets from physical and cyber threats. Without an exemption to the FOIA, the State of Michigan cannot provide needed assistance related to coordination of and response to the security of critical infrastructure assets.

What does a 21st century Michigan look like?

Michigan has well-defined systems for sharing information about critical infrastructure assets so that it can effectively plan for and communicate about physical and cyber security threats. This information sharing system enables state agencies (e.g., the MPSC and MAE) to communicate with infrastructure asset owners effectively while balancing the need for increased transparency and information sharing regarding security concerns.

How do we get there?

- 5.7.1** The Michigan Legislature, together with MAE and the MPSC, should revise FOIA exemptions to allow the appropriate agencies to communicate with infrastructure asset owners about physical and cyber security, and alleviate concerns related to the security of sensitive information when the State is working with infrastructure asset owners.

Estimated investment needed: Covered by private sources



5.8 BUSINESS ATTRACTION AND ECONOMIC DEVELOPMENT

Where is Michigan today?

Energy affordability and utility-provided services are vital to Michigan businesses. In many cases, energy costs and utility service offerings can be important determinants for businesses' site selection. For manufacturing and industrial companies, energy costs can make up a significant portion of their total operating costs, and energy costs must not deter companies from investing in Michigan. As of May 2016, Michigan ranked 33rd in industrial electric price affordability within the United States.¹⁸

Despite having electricity and natural gas prices that are higher than the national average, Michigan has had recent success in securing new business development.

In 2015, Site Selection magazine ranked Michigan the sixth best in the nation for new and expanded corporate facilities; in that same year, there were 217 new projects in Michigan that met the magazine's selection criteria (MEDC 2016).¹⁹

However, given its industrial rates, Michigan will need to continue its efforts to retain and attract businesses through work with the state's utilities, regulators, and businesses to ensure that energy is not a limiting factor in Michigan's growth.

While price is a major consideration for businesses, it is not the only one. Many other factors can play a role in business' site selection decisions and can lead to business attraction despite higher energy prices. These aspects include utility-offered services, such as access to high-voltage

¹⁸ Unlike in many other states where industrial energy rates are subsidized by other customer classes, Michigan law requires rates to be based on cost of service.

¹⁹ To be included in the selection, projects must meet one of the following criteria: (a) involve a capital investment of at least \$1 million, (b) create at least 20 new jobs, or (c) add at least 20,000 square feet (1,858 square meters) of new floor area.

reliability assurances, energy-efficiency offerings and incentives, dynamic rate options, and specific energy sources. Utilities are already working with the MEDC to provide prospective businesses with a quote that estimates the cost of service for a new facility and location within five days. This helps customers get a real sense of their potential energy costs and avoid hidden or unexpected costs, as well as enabling them to work with a utility service provider to generate creative ideas for meeting companies' needs.

What does a 21st century Michigan look like?

Michigan attracts new businesses and energy-intensive industries by offering competitive energy prices, flexible rate structures, and programs that help companies control their energy costs.

How do we get there?

- 5.8.1** The MPSC and MAE should work together with utilities and companies to expand opportunities for industrial customers to participate in programs that help them reduce energy bills, such as demand response programs.

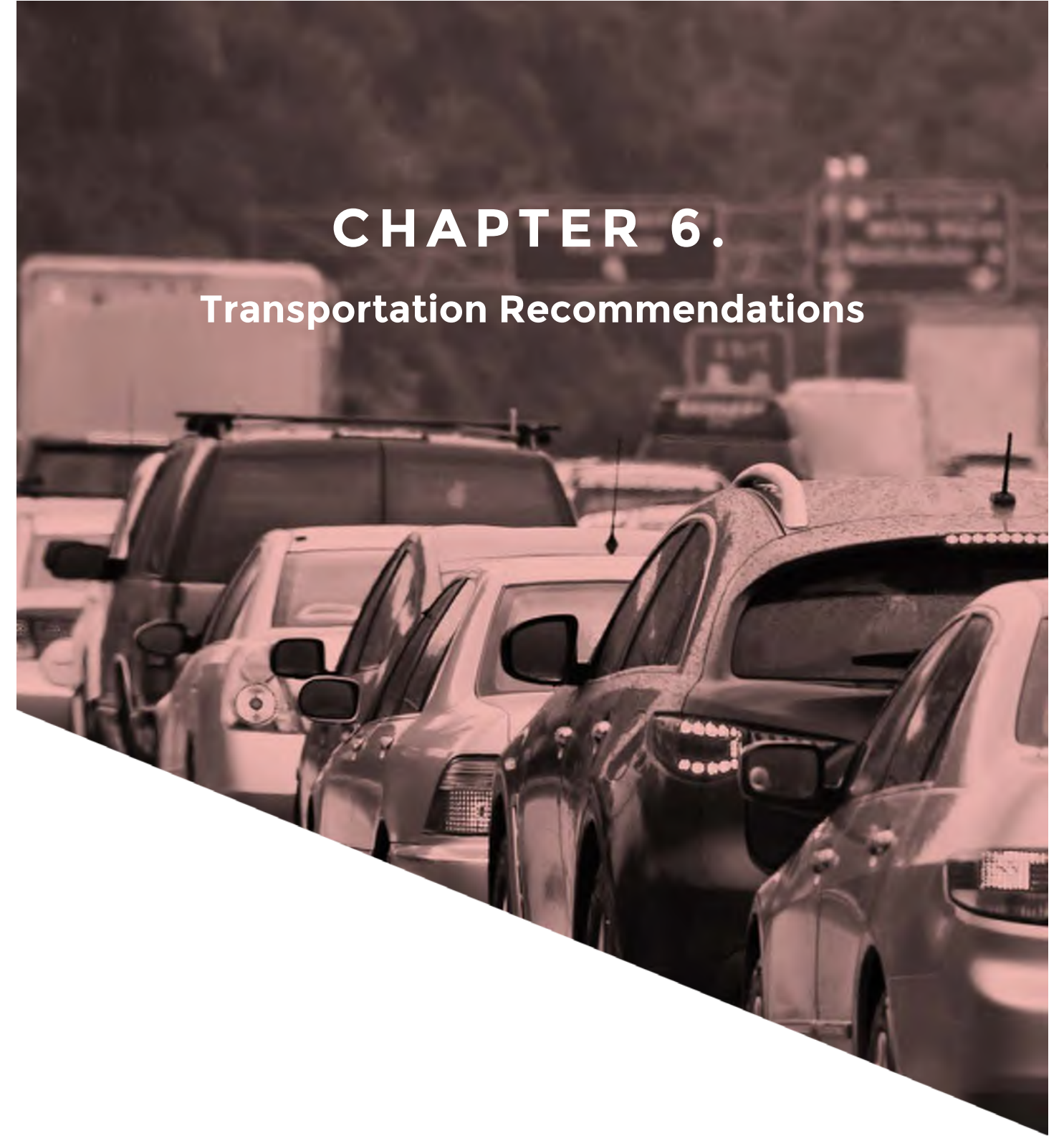
Estimated investment needed: Covered by private sources



- 5.8.2** The MPSC, MAE, and MEDC should confer regularly to continue improving the factors that impact business decisions and engage stakeholders about additional opportunities for business attraction.

Estimated investment needed: Covered by private sources





CHAPTER 6.

Transportation Recommendations

- ## 500 LOCKS

Michigan has long been a leader in transportation innovation, building the nation's first mile of concrete highway (1909), installing the first traffic light (1918), deploying the first highway snow plow (1922), and building two of the nation's first three-level interchanges to service the Willow Run bomber plant (1940s), and opening of the Mackinac Bridge – the longest suspension bridge in the Western Hemisphere (1957).

Michigan has a history of many multimodal successes. Michigan is a recognized global leader in intelligent vehicle technology. It is also home to over 20,000 miles of nonmotorized trails, the most of any state in the country. In 1929, Michigan built the first crisscrossed aviation runways at Ford Airport in Dearborn, and in 2002, the new McNamara Terminal at Detroit Metropolitan Airport opened for business. In 2013, Michigan was the first state outside the Northeast Corridor to implement 110 mile-per-hour intercity train speeds between Kalamazoo and the Michigan/Indiana border. And the upcoming opening of the new Gordie Howe International Bridge has the potential to revolutionize the logistics industry in Michigan, making it an internationally competitive intermodal transportation and distribution hub.

EXHIBIT 11. Major Milestones of Michigan's Multimodal Transportation System

1909	The nation's first mile of concrete highway is built in Michigan
1918	Michigan installs its first traffic light
1922	The state deploys the first highway snow plow
1940s	Michigan builds two of the nation's first two-level interchanges to service the Willow Run bomber plant
1957	The Mackinac Bridge opened—the longest suspension bridge in the Western Hemisphere

Transit has been a big part of Michigan's intermodal transportation history, including state support for rural and specialized transit that predated federal transit programs. The recent Regional Transit Authority (RTA) ballot initiative narrowly failed voter approval. This proposal would have provided Southeast Michigan with a long-term solution for regional transit. Proponents will continue to work toward new strategies on RTA funding.

Michigan has been a transportation leader in asset management for roads and bridges, solidified by the formation of the TAMC in 2000. Because of transportation's robust history of asset management and data collection, transportation agencies across the state have very clear and scientifically sound information on the condition of their infrastructure, reported annually to the State Transportation Commission and the Michigan Legislature.

Although Michigan remains a leader in asset management planning, due to a lack of funding it has struggled with implementing its transportation asset management plan. As a result, Michigan has been unable to develop and maintain a world-class, intermodal transportation system.

According to the 2015 report from the TAMC, 39 percent of federal aid roads under local jurisdiction are in poor condition and 27 percent of all bridges in the state are structurally deficient or functionally obsolete. State highways, which were only rated 8 percent poor as recently as 2008, are currently 16 percent poor and projected to deteriorate even more rapidly in the years to come. Many bus transit systems are fragmented, inefficient, expensive, and unreliable. In addition, Michigan lacks robust rail transit as an option for travelers. Transit connectivity to city centers from Michigan's airports is inconvenient, if available at all. Meanwhile, marine infrastructure suffers from under funding. For example, the largest lock in the Soo Locks—the Poe Lock—is 50 years old; it is the only passage from Lake Huron to Lake Superior for 1,000 foot freighters and an unplanned closure would cause great economic harm to the nation.

The solid, scientific asset management data on declining road and bridge condition in Michigan means that an undeniably large investment will be needed to repair those roads and bridges. Deteriorating road and bridge conditions are a factor in road-related accidents and injuries; by improving Michigan's road and bridge condition, Michigan's residents and out-of-state visitors will be afforded a safer and more reliable transportation system. Transportation agencies across the state are very grateful for the transportation revenue package signed into law in 2015.²⁰ The asset management analysis predicted this added investment would not be enough to revive and sustain the condition of Michigan's roads, bridges, and transit over the long term, let alone prepare Michigan for the 21st century.

The past decade of piecemeal approaches to transportation funding, at both the state and the federal level, have undermined our state's progress.

The condition of Michigan's transportation systems did not erode overnight, but over several decades.

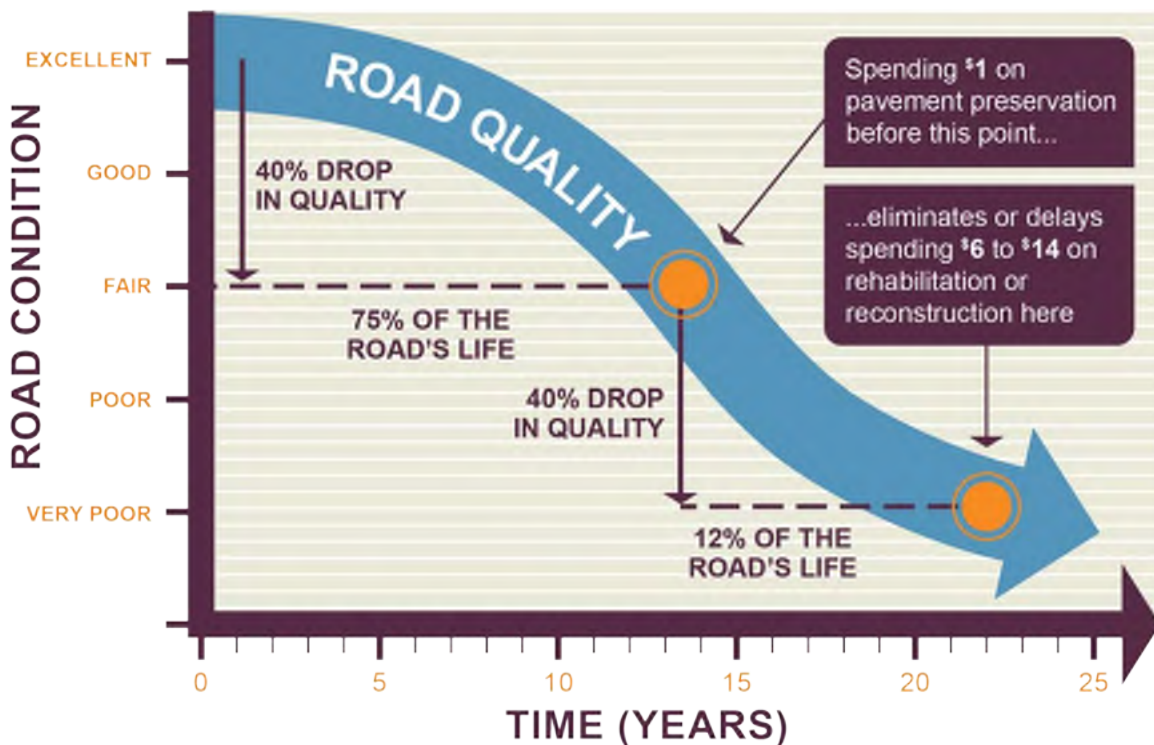
²⁰ In November 2015, the Michigan Legislature enacted a package of bills that provide new revenue for transportation. Beginning in 2017, there will be \$450 million of new revenue, increasing to \$1.2 billion (including \$600 million of general funds) by 2021.

Shifting demographics have also made it difficult for transportation systems to remain reliable and efficient. It will take several decades to bring Michigan's intermodal systems back to a state of good repair that residents, businesses and travelers can rely on.

Sustainable funding sources at the state, federal, and local level are required to halt the continuing deterioration of transportation infrastructure and allow Michigan to take advantage of 21st century technology that will provide improvements to transportation service and safety.

Investment in transportation infrastructure provides a significant economic impact. On average, every \$1.00 invested in the transportation sector infrastructure has an estimated economic impact of \$4.24. The sizeable economic benefits associated with infrastructure investment are not the only reason to invest. There is also a case to be made for making infrastructure improvements sooner rather than later because deferring infrastructure investment will actually make a project more expensive as the costs of infrastructure repair and or replacement increases as quality declines. As shown in Exhibit 12, spending \$1 on pavement preservation when a road is in fair condition eliminates or delays spending \$6 to \$14 on reconstruction when it is in very poor condition.

EXHIBIT 12. Road Condition and Preservation

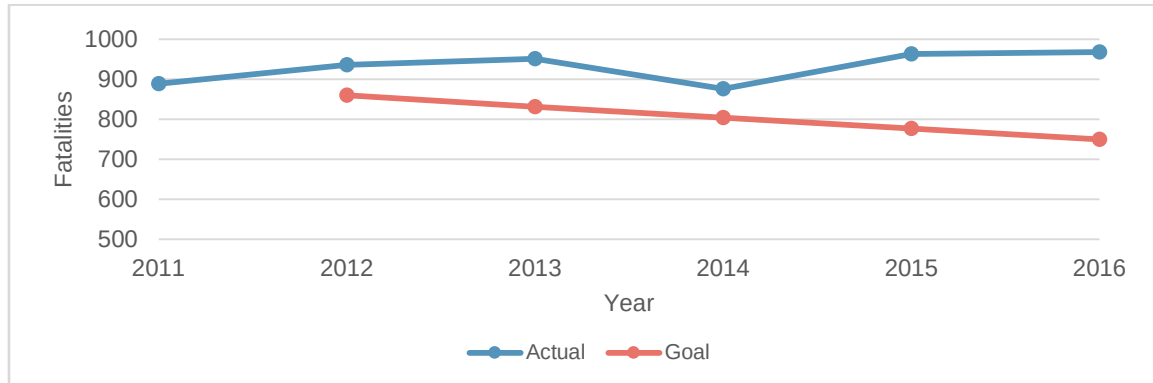


Source: AASHTO and TRIP 2009.

Value for money is important, but providing safe transportation systems is critical. As of November 29, 2016, there were 968 traffic deaths in Michigan in 2016 (MDOT n.d.). It is estimated that there will be more than 1,000 fatalities by the end of 2016. In addition to human suffering, fatalities and injuries cost Michigan nearly \$9.6 billion in 2010 (U.S. DOT NHTSA 2015). Michigan currently has an active program titled, Toward Zero Deaths, that works to reduce traffic fatalities. The graph

below shows historical and current statewide motor vehicle fatalities—it is clear that without the proper investment in road and bridge condition, we are headed in the wrong direction.

EXHIBIT 13. Statewide Fatalities



Note: Actual projection expected to reach more than 1,000 deaths by the end of 2016.

Source: MDOT n.d.

The following recommendations outline ways to improve investment in Michigan's transportation infrastructure, while dramatically improving public safety through improved road and bridge conditions and the use of futuristic technology. These proposals offer a variety of high-quality, interconnected, efficient, and safe travel choices to improve the quality of life for all residents and Michigan's businesses. Michigan is poised to lead the development and deployment of 21st century transportation technologies, including intelligent vehicle technology and a robust intermodal transportation system. These recommendations chart a visionary path for Michigan's transportation planning, funding, and delivery systems to ensure safe, reliable, efficient, and cost-effective solutions.

Recommendations are organized by mode of transportation, future innovations, and sustainable funding opportunities.

Recommendations Key

EP	Economic Prosperity	HE	A Healthy Environment
QS	Reliable, High-quality Service	VI	Value for Investment
0-2	Implementation Start (in years)	0-2	Implementation Complete (in years)

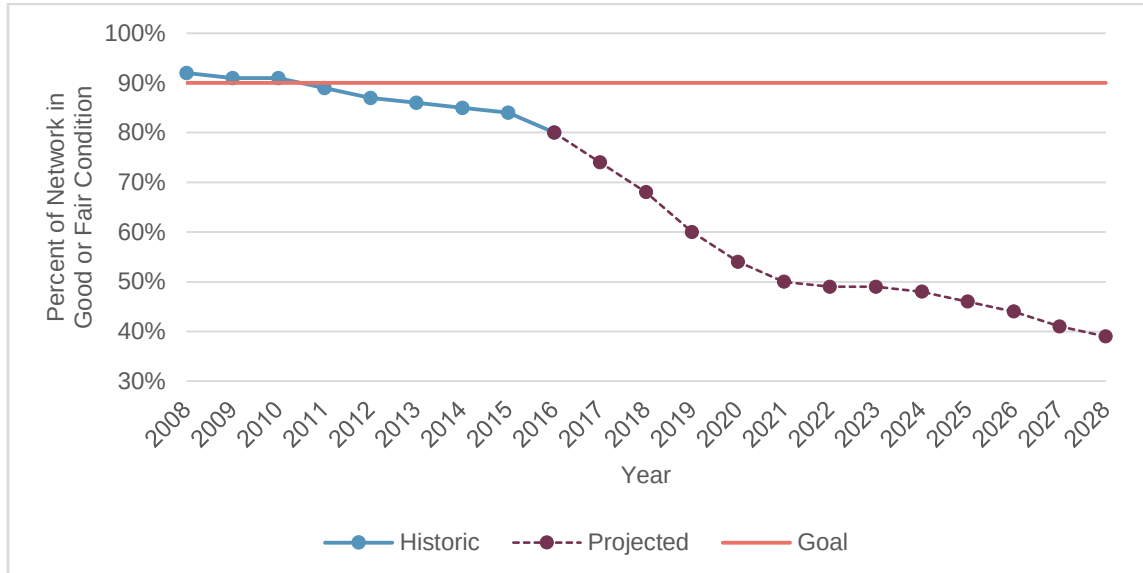
6.1 ROADS/BRIDGES – ROAD AND BRIDGE CONDITIONS

Where is Michigan today?

In 2007, Michigan achieved clear goals that were set for the condition of roads and bridges (90 percent good/fair), but has not been able to sustain that high level of performance since. While transportation agencies are certainly very grateful for the legislative action that will provide some new state funding for transportation beginning in 2017, the reality is that the need for investment, particularly in roads and bridges, will not be fully addressed by that action. Beginning in 2017, \$450 million in new revenue from state gas taxes and vehicle registration fees will be distributed to more than 700 transportation agencies. That number rises to \$600 million in 2018, but the full distribution of the entire \$1.2 billion revenue package will not occur until 2021. Michigan's asset management agencies predict that without increased investment, road and bridge conditions will continue to deteriorate, and the conversation that has surrounded transportation funding in Michigan will remain necessary.

Michigan has 122,000 miles of roads, the ninth largest road network in the nation. Of all those miles, 36,500 miles are federally recognized as the most highly used portion of the system, carrying 96 percent of commercial traffic and 89 percent of all traffic in Michigan. It is imperative that Michigan repair these vital roads and bridges to ensure the safety of the traveling public.

EXHIBIT 14. Historical/Projected Trunkline Pavement Condition



Source: MDOT 2012.

Additional investment in highways and bridges will not only improve the condition of the systems that we use every day, it will also provide significant financial and safety benefits to the state and the public. Investing an additional \$1.6 billion in state highway and bridge infrastructure annually would create or sustain 18,000 jobs, increase the gross state product by \$1.5 billion annually, increase real personal income by \$1.1 billion annually, and decrease economic loss due to fatalities.

What does a 21st century Michigan look like?

Michigan's road and bridge conditions are 95 percent good/fair for Interstates and principal arteries; 85 percent good/fair for other state highways; and 85 percent good/fair for county primary and major city roads. Michigan has the safest roads in the nation, striving for zero traffic fatalities in the next 30 to 50 years. More robust investment in transportation from new and sustainable sources of funding preserves vital infrastructure that is integral to Michigan's economic success. Appropriate reinvestment in the most highly used roads and bridges ensures a safe and reliable transportation system, supports new business growth and development, expands international commerce, and bolsters Michigan's manufacturing, tourism, and agriculture industries.

6.1.1 The Michigan Infrastructure Council and transportation agencies should work with the Michigan Legislature to identify and enact revenue options that will provide predictable and sustainable funding sufficient to return most higher level roads and bridges to good or fair condition. Given the magnitude of the need, a strong combination of state, federal and local funding will be needed to adequately solve the problem.

Estimated investment needed: \$1 billion of state funds annually for Interstate and U.S. freeways and bridges; \$600 million of state funds annually for other state highways and bridges; \$600 million of state funds annually for other highly used roads and bridges under local jurisdiction²¹



²¹ Estimates of investment required for state highways were generated by MDOT; estimates for roads under local jurisdiction were derived from "Michigan's Roads Crisis: How Much Will It Cost to Maintain Our Roads and Bridges? 2014 Update;" both estimates take into account the revenue from the new funding package.

6.2 ROADS/BRIDGES – BRIDGES AND CULVERTS

Where is Michigan today?

Michigan roads have hundreds of thousands of bridges, culverts, and other drainage infrastructure components, many of which are decades old and on the verge of failure. State agencies have identified at least 65,000 points throughout the state where Michigan's road and rail systems intersect with surface water systems. Many of these points may be undersized for current and future watershed conditions, increasing the potential for flooding. When flooding occurs or structures fail there are safety, environmental, economic, and social impacts.



What does a 21st century Michigan look like?

Michigan's road and rail systems are designed to ensure that rivers, streams, and drains remain free flowing to protect ecosystem health, as well as investments in transportation infrastructure.

How do we get there?

- 6.2.1** State, county, and local agencies should design and install road-stream crossings to ensure safe pedestrian and vehicle passage, and natural stream function and aquatic organism passage. Design approaches should match the life cycle of the road-stream crossing to future watershed conditions.

Estimated investment needed: \$40 million of state funds



- 6.2.2** MDOT and MDNR should continue to follow state and federal required inspection processes for bridges, as well as hydraulic and drainage analysis for culverts. These agencies should complete regular statewide inspections of all in-service bridges to determine and record conditions using the newest available technologies and techniques. They should support research of new materials and accelerated processes for design and construction of bridges to maximize the life of structures while improving safety and reducing overall life-cycle costs. MDOT and MDNR should use asset management and preventative maintenance to extend the life of bridges.

Estimated investment needed: Will utilize existing staff resources



- 6.2.3** MDOT should work with local road agencies to encourage inspection of culverts greater than five feet in diameter at least once every five years. Inspection results should be included in local road agencies' asset management plans.²²

Estimated investment needed: \$4 million of state funds annually



- 6.2.4** MDOT should undertake a pilot project to inspect and document all culverts running under state trunkline highways in one county, for the purpose of assessing data collection costs for a statewide asset management inventory of state highway culverts.

Estimated investment needed: Will utilize existing staff resources



6.3 ROADS/BRIDGES – SEASONAL WEIGHT RESTRICTIONS

Where is Michigan today?

Michigan's paved roads are made of concrete or asphalt, and while they may appear solid, they can become particularly fragile during the spring months, when frost is leaving the ground. As frost melts beneath a paved road, the road bed can become saturated with water, making it unstable and susceptible to damage by trucks and heavy equipment.

To protect paved roads during the spring, Michigan road agencies have seasonal weight restrictions that limit heavy loads. MDOT and local road agencies may have different load restrictions based on the structural capacity of their roads. The depth of frost governs the restriction time frame. Restrictions are lifted when the frost is completely gone.

Trucking companies can respond to weight restrictions in a variety of ways—by reducing loads, adding trips, traveling more complicated routes, delaying deliveries, or even shutting down and laying off workers until restrictions are lifted. All of these responses drive up transportation costs.²³

Every day that can be subtracted from seasonal load and speed restrictions saves shippers money, but a few days' error in restricting loads can cause significant pavement damage, which costs taxpayers money. Because of different weather and soil conditions, there will always be variety in the duration of weight restrictions across the state, but MDOT uses automated ground-temperature collection coupled with statistical models of frost behavior to more precisely minimize the imposition

²² Inspection costs are estimated at between \$300 and \$350 per culvert.

²³ According to a 2015 survey by the American Transportation Research Institute, the average marginal cost of operating a truck is \$63.70 per hour.

of spring weight restrictions. Local road agencies typically follow MDOT's recommendations, but are not obligated to do so.

What does a 21st century Michigan look like?

Michigan's road agencies collaborate to develop consistent regional standards for identifying times when the roads can be reopened to transport goods by truck. Advances in technology allow transportation agencies to collect and report real-time data on weather and temperature conditions that has helped minimize the impact of seasonal weight restrictions. Based on asset management and economic priorities, a robust all-season network of roads adequately serves shippers.

How do we get there?

- 6.3.1** MDOT and local road agencies should work together to improve regional consistency and the permitting process in order to create coordinated seasonal weight restriction systems between road agencies.

Estimated investment needed: Will utilize existing staff resources



- 6.3.2** Based upon economic considerations, MDOT and local communities should evaluate and prioritize the need to convert additional roads to all-season conditions. Using the statewide asset management database (as referenced in Chapter 3), and in coordination with public agencies and private utilities, plan and fund the conversions to all-season roads in a timely and strategic manner.

Estimated investment needed: \$450,000 per lane mile, for the incremental additional cost of reconstructing as an all-season road rather than a seasonally-restricted road



6.4 TRANSIT, PASSENGER, AND FREIGHT RAIL

Where is Michigan today?

Michigan's bus transit, passenger rail, and freight rail systems are part of an intermodal transportation system with a diverse mix of facilities in both public and private ownership. All three of these systems compete for state funding from the Comprehensive Transportation Fund (CTF); therefore, improvements in any one mode come at the expense of the others. Each of these three modes is addressed below:

- **Bus transit:** Michigan's bus transit system is diverse, with 79 public transit agencies, including 20 urban transit organizations and 38 specialized transportation providers. Residents make more than 100 million trips annually on local public bus transit in Michigan.

Operation of bus transit systems contributes an estimated \$740 million to the economy each year and support over 5,000 jobs annually.

Transit provides mobility for those who do not own a car or cannot drive. Bus transit improves safety and air quality, reduces road traffic, and encourages economic development. Transit service in many Michigan communities needs improvement to better serve riders, such as county-wide service, Saturday/Sunday service, or service that crosses county lines. Investment is needed to ensure buses remain in a state of good repair to provide safe, efficient transit service.

There are also a number of efforts to expand transit service in urban areas. Unique partnerships can assist in these efforts, such as the QLine in Detroit, which is primarily privately funded. The bus rapid transit (BRT) service in Grand Rapids, along with other BRT systems nationwide, serve as a model for the four-county region of Southeast Michigan, and Lansing.

National models have shown that every dollar invested in light rail or rapid transit can return up to six dollars in economic benefits, including local economic development around transit stops.

Operations and capital improvements compete with other funding requirements from the CTF. The recent Southeast Michigan four-county RTA ballot initiative narrowly failed voter approval. This proposal would have provided Southeast Michigan with a long-term solution for regional transit, any publicly funded transit expansion in Michigan comes at the expense of all other transit in Michigan.

- **Intercity passenger rail:** In contrast to bus transit systems that are largely operated locally, intercity passenger rail service is provided by Amtrak, a federal entity. As required by federal law, the State of Michigan provides support for Amtrak passenger rail service from the CTF. Michigan also contracts with Amtrak for the operation of trains that add or extend service to three routes, linking Detroit/Pontiac, Grand Rapids, and Port Huron with Chicago. In 2012, MDOT acquired 135 miles of passenger rail track between Kalamazoo and Dearborn, which are being improved to expand existing 110-mile-per-hour (mph) passenger rail service in the Chicago-Detroit corridor. Improvements underway include double-tracking portions of the corridor; track rehabilitation; installation of new signals and positive train controls; station renovation, construction, or relocation in Pontiac, Troy, Dearborn, Jackson, and Battle Creek; and a multistate partnership to acquire new locomotives and rail cars. New stations have also been constructed in East Lansing and Grand Rapids to upgrade passenger service in other rail corridors.

Population, employment, and income across Midwestern states are projected to grow over the long term, and this growth is expected to result in an increase in intercity travel throughout the Midwest. The lack of existing passenger rail capacity and the sharing of track between freight and passenger trains currently create operational problems that restrict both mobility and economic development.

- **Freight rail:** Most of Michigan's freight rail assets are privately owned and maintained, and most investments are made by private companies. The freight rail system includes approximately 3,600 miles of tracks across the state, operated by 24 freight railroads, including four Class I railroads, two regional railroads, and 15 short-line railroads. MDOT oversees approximately 665 miles of State-owned rail lines.

Because most rail assets are privately held, the full need for additional investment is not known. MDOT uses CTF dollars to preserve state-owned rail lines, and provide freight economic development loans that encourage private investment. MDOT also provides dedicated Michigan Transportation Fund (MTF) and federal dollars to assist with safety enhancements at railroad crossings that benefit both railroads and road users. The ratio of public and private funding for rail projects varies depending on the project.

The Commission's vision to reinvent Michigan as a center of international trade requires developing freight infrastructure that will meet the modern-day demands of a globalized economy. MDOT competes for federal funds to assist with rail capital enhancements that will improve freight rail services. For example, the State of Michigan is taking the lead in a partnership with the four Class I railroads to develop the Detroit Intermodal Freight Terminal (DIFT), which will consolidate and expand the intermodal terminal capacity serving Southeast Michigan. For this \$539 million project, the State will provide 60 percent of the funding, with the private railroads providing 40 percent. The project, which will take several years to complete, will improve junction points among the railroads and provide improved access between the intermodal terminals and the highway system. Improved facilities and increased intermodal traffic will result in fewer long-distance truck trips on Michigan's highway system.

What does a 21st century Michigan look like?

Michigan has a reliable and safe rail system, consisting of an integrated freight network that serves a global economy, higher speed passenger rail, and a robust transit network that meets the needs of both urban and rural communities throughout the state.

- **Bus transit:** The four-county area in Southeast Michigan has a BRT solution. Transit systems are more reliable and provide a broader range of service, including county-wide, cross-county, and Saturday/Sunday service where appropriate. Buses are maintained in a state of good repair, emissions are reduced with clean diesel buses, repair costs are reduced, and reliability is increased. Urban areas of the state are served by BRT or commuter rail. Allowing BRT to have signal priority at intersections will make it a more efficient alternative, and reduce time between destinations. Greater use of mobile technology for transit systems allows more passengers easy access to information regarding the timing. These safe, efficient and cost-effective transit systems attract more riders.
- **Intercity passenger rail:** Rail service provides 110-mph service throughout the Detroit-Chicago corridor, and MDOT works with the railroads to install positive train control across the state, and initiates commuter rail service where appropriate, increasing ridership, creating jobs, and bringing economic opportunities and new talent to Michigan.

Good transit systems promote residential density and economic development along their corridors. Regional transit systems provide mobility and employment access to residents across a given region. Improvements to passenger rail service support economic development near rail stations, spurring investment that serves both existing neighborhoods and areas targeted for a transition from industrial uses to urban infill development. The introduction of passenger stations in existing or planned commercial settings strengthen business and development opportunities. Transit services, particularly in Michigan's large urbanized areas, are expanded to produce 21st century service, and Michigan cities will use these investments to compete nationally and globally.

- **Rail freight:** Investment in intermodal projects such as the DIFT in Southeast Michigan increases capacity and interconnectivity and helps provide for future intermodal freight demand to support Michigan's economic competitiveness. The DIFT creates 4,500 permanent jobs in Michigan, with 2,360 of those in the Detroit area, along with over 600 construction jobs in the peak construction year. Additionally, there is increased government revenue of more than \$1 billion (2008 dollars) by 2030 as a result of increased business activity. Efficiencies and reliability are improved, therefore reducing operating costs to shippers, air pollution, and crashes (MDOT 2010).

In rural areas like Northern Michigan and the Upper Peninsula, freight rail remains a critical option, particularly for exporting agricultural products and timber. The State preserves rail access in these underserved communities by working with private sector railroads to preserve and improve rail.

How do we get there?

- 6.4.1** The Michigan Legislature should enact alternative sources for transit funding or provide additional funding for the CTF to encourage robust bus transit, passenger rail, and rail freight systems in Michigan. Increasing the amount of available match funds from the State of Michigan will also allow transit agencies to seek greater federal capital funding.

Estimated investment needed: \$430 million per year of state funds from the CTF



- 6.4.2** Transit agencies should integrate new technology into their transit services and work with MDOT to support their efforts to modernize their technology systems.



- 6.4.3** MDOT should continue to work in partnership with the railroads to develop components of the DIFT as warranted by increasing volumes of railroad traffic.

Estimated investment needed: A one-time investment of \$539 million of public (\$323 million) and private (\$216 million) funding over several years



- 6.4.4** MDOT should identify current and future passenger and freight rail service needs and gaps in Michigan as part of its effort to update the federally required State Rail Plan and State Freight Plan.

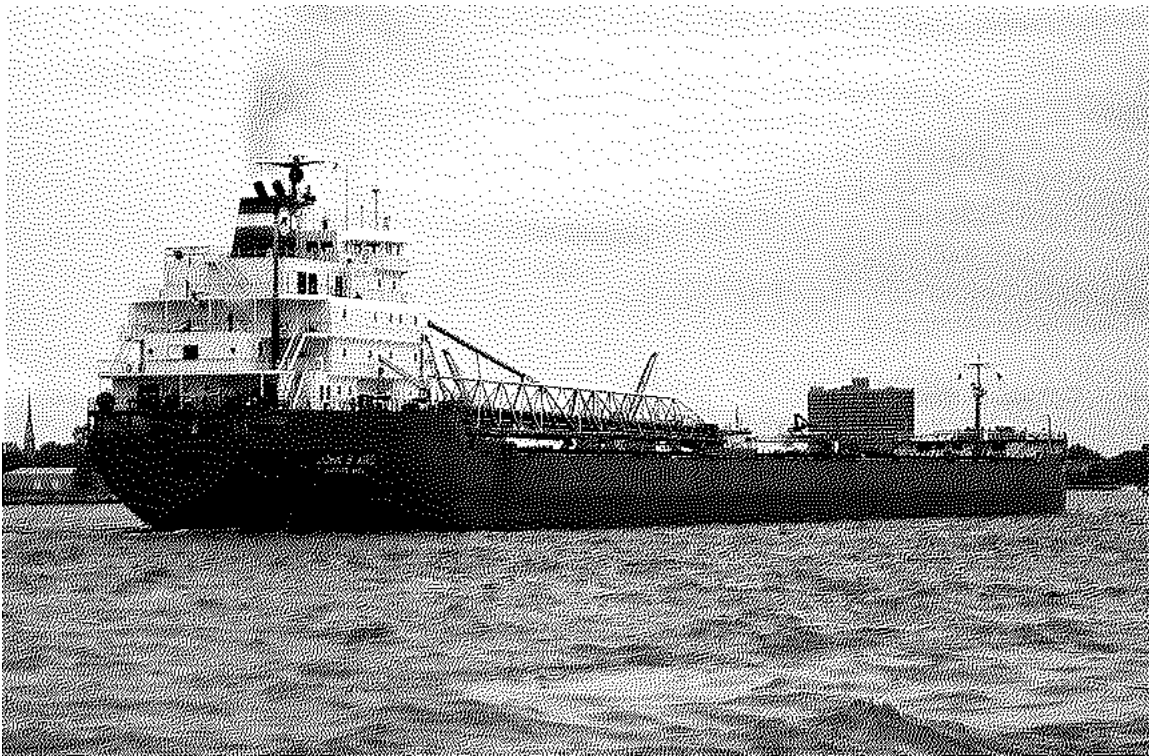
Estimated investment needed: Will utilize existing MDOT staff resources



6.5 MARINE FREIGHT – SOO LOCKS

Where is Michigan today?

The Soo Locks are a critical part of the freight transportation infrastructure of the Great Lakes region. Located on the St. Mary's River between Michigan and Ontario, the Soo Locks are owned and operated by the U.S. Army Corps of Engineers and provide a vital link between Lake Superior, the other Great Lakes, and the rest of the world. Nearly 4,000 American, Canadian, and foreign flag vessels pass through the locks annually, carrying more than 65 million tons of iron ore, stone, low-sulfur coal, grain, cement, and other cargoes. Approximately 80 percent of the raw materials used by U.S. steel manufacturers, as well as much of the low-sulfur coal used by regional electric utilities, pass through the locks. The nearly 50-year-old Poe Lock is the only lock capable of accommodating the largest Great Lakes vessels that carry 70 percent of all cargo passing through the locks and account for 3.2 percent of the total U.S. GDP (U.S. Department of Homeland Security October 2015; Kowall 2016). This critical reliance on a 50-year old single lock is unwise and unsustainable.



The U.S. Department of Homeland Security recently completed an analysis of the impacts resulting from a six-month unscheduled closure of the Poe Lock. The findings are staggering: there would be a complete shutdown of Great Lakes steel production; 75 percent of U.S. integrated steel production would cease; 80 percent of iron ore mining would cease; and nearly 100 percent of the North American appliance, auto, construction equipment, farm equipment, mining equipment, and railcar manufacturing would cease. There would be 11 million job losses in the U.S., plus more in

Canada and Mexico, and a \$1.1 trillion decrease in GDP (U.S. Department of Homeland Security October 2015). This would likely result in widespread bankruptcies and a recession.

Today, the construction of the new lock has been and remains stalled. In 1986, Congress authorized construction of a second large lock equal in size to the Poe Lock in order to provide the necessary capacity and redundancy. The new lock will be constructed on the site of two obsolete locks built during World War I that are now permanently closed. Except for some limited preliminary construction in 2009–2010, the project has stalled due to lack of federal funding. As originally authorized, the project required a nonfederal cost share of approximately 35 percent. Subsequent legislation in 2007 removed that requirement, and the project is now authorized for construction at full federal expense. A remaining obstacle is a low benefit-to-cost estimate for the project, the result of flawed assumptions in the original methodology. The U.S. Army Corps of Engineers is currently conducting an economic reevaluation based on more accurate assumptions. The study is scheduled to be completed in December 2017 and is expected to produce a significantly higher benefit-to-cost ratio, which will allow the Chief of Engineers to formally advance the project to Congress for funding.

What does a 21st century Michigan look like?

The Governor, Michigan's Congressional delegation, Michigan Legislature, and private stakeholders impacted by the Soo Locks work together to demonstrate the importance to national commerce of the new lock. As a result, a new lock is constructed with dimensions equal to the existing Poe Lock, providing long-term capacity, reliability, and redundancy for operation of the system. The potential for a long-term loss of 11 million jobs nationally and \$1.1 trillion hit to the U.S. economy is eliminated. As a vital component of the Great Lakes' regional transportation system, the Soo Locks infrastructure is maintained and updated to accommodate commerce needs.

How do we get there?

6.5.1 The Michigan Legislature should pass a resolution to urge the federal government to expedite completion of the Economic Reevaluation Report currently being prepared by the U.S. Army Corps of Engineers and to provide the necessary funding to construct the new lock.

Estimated investment needed: Approximately \$580 million of federal funding invested over several years

Implementation: Report should begin in the immediate term (0-2 years) and be completed in the short term (3-5 years)²⁴



²⁴ New lock construction should be completed in the medium to long term (6-11+ years)

6.6 MARINE FREIGHT – PORT AUTHORITY LANDSIDE IMPROVEMENTS

Where is Michigan today?

Michigan's Port Authority Act (P.A. 639 of 1978) authorizes the establishment of port authorities in cities and counties. To date, the Detroit/Wayne County Port Authority is the only such authority established under this act. Currently, the act defines port facilities as various infrastructure components related to marine transportation, which are specifically owned by the port authority. This ownership provision is viewed as a constraint to further develop a port's commercial or recreational maritime activities, because it limits the port authority's ability to work with landside private sector partners. In 2014, there were 29 active cargo ports that handled 68.1million tons of cargo (MDOT 2015).

What does a 21st century Michigan look like?

Public port authorities help develop the marine transportation system that serves Michigan's businesses and industries. Port authorities work in partnership with the private sector to address the needs of commerce, without jeopardizing existing private sector operations or investments. Michigan sustains or increases the commercial activity generated by its ports each year.

How do we get there?

- 6.6.1** The Michigan Legislature should consider legislation that provides port authorities with the flexibility to form private sector partnerships for the purposes of developing contiguous and adjacent landside infrastructure consistent with the local vision for the port.



6.7 MARINE FREIGHT – ROUTINE PORT MAINTENANCE

Where is Michigan today?

Maintenance of Michigan's port infrastructure is critical for the efficient operation of our intermodal transportation system. There are two major components of port infrastructure: onshore marine terminal facilities, and the in-water navigation channels that serve them. With only a few exceptions, the vast majority of terminals in Michigan are owned and operated by private companies, which are responsible for their maintenance.

Many of Michigan's commercial ports are served by federal navigation channels that were authorized by Congress. The U.S. Army Corps of Engineers is responsible for maintaining these channels, typically by dredging them to their authorized depths, with funds from the Harbor Maintenance Trust Fund. For the past few decades, many of these channels have not been

maintained at their full authorized dimensions because the federal administration has only released about half of the taxes collected and deposited into the trust fund. Recent federal legislation will eventually ensure that all the taxes collected will be used for their intended purpose, and maintenance of the federal channels should no longer be a major issue.

These federal navigation channels do not extend all the way to the shore, and individual terminal owners are responsible for dredging at their own docks and out to the federal channels. If channel dimensions are not maintained, vessels must be light loaded, or worse, become commercially unusable.

While the U.S. Army Corps of Engineers annually assesses the dredging needs for the federal channels, there is a lack of information regarding maintenance needs at the docks themselves as well as in the private navigation channels serving those docks. The Conference of Great Lakes and St. Lawrence Governors and Premiers established the Maritime Task Force which completed a first-ever maritime transportation system asset inventory. While the conference does not have the authority to inspect the infrastructure at private marine terminals, it does have an interest in understanding the total needs for the marine transportation system. Toward that end, the conference established the Maritime Data Working Group to update the existing marine transportation system asset inventory, identify available data and data gaps, and document public and private sector investments. While the dredging needs for public navigation channels are readily identifiable, those for private docks will likely remain incomplete. Data that are ultimately collected can be used to guide future public policy and funding decisions to increase the efficiency of the freight transportation system.

What does a 21st century Michigan look like?

Michigan has an extensive system of congressionally authorized federal navigation channels that were constructed and are maintained by the U.S. Army Corps of Engineers. All public channels are maintained at their congressionally authorized depth. The private sector has developed most of the landside port infrastructure, including marine terminals, based on the existence of these public navigation channels. The public channels are properly maintained in order to preserve continued operations of Michigan's commercial ports.

How do we get there?

6.7.1 The Office of the Governor, Michigan's Congressional delegation, and the Michigan Legislature should encourage Congress to provide the necessary funds and encourage the U.S. Army Corps of Engineers to prioritize fully maintaining the federal navigation channels at their congressionally authorized dimensions to ensure that port conditions do not deteriorate.

Estimated investment needed: Will utilize existing staff resources



- 6.7.2** The Conference of Great Lakes and St. Lawrence Governors and Premiers should specifically analyze the dredging needs for individual docks and nonfederal navigation channels, including privately owned facilities to the greatest degree possible.

Estimated investment needed: Will utilize existing staff resources



- 6.7.3** MDOT should encourage the appropriate state, county, and city road agencies to work together to perform infrastructure assessments that would evaluate the needs of “last mile” roads that serve as connectors linking port facilities with the highway system.

Estimated investment needed: Will utilize existing MDOT staff resources



6.8 AVIATION

Where is Michigan today?

Michigan's aviation infrastructure is supported through a complex system of federal, state, and local partnerships and funding mechanisms. While most view Michigan's aviation infrastructure simply as one of the 18 commercial service airports in cities like Detroit, Grand Rapids, and Flint, the state's other 217 general aviation airports and public heliports contribute to a robust and vibrant overall aviation system able to connect travelers, businesses, emergency responders, and others within minutes.

The State of Michigan continually monitors pavement condition using a measure termed Pavement Condition Index and is described on a range of 0 or failed pavement to 100 or excellent pavement. The overall PCI for the state's most utilized airports is 66. While airport pavements are critical and continually monitored, and maintained they are supplemented by unseen systems like weather observation stations, navigational aids, and instrument landing systems which aid in the safe arrival and departure of aircraft.

The continued rise in operating, maintenance, and construction costs coupled with major airlines reducing service to rural areas has increased the financial burden on local municipalities, which in most cases, own their airport. Programs like the Federal Aviation Administration Airport Improvement Program and the State of Michigan's Airport Improvement Program support local municipalities that require assistance in maintaining their existing infrastructure.

In recent years and in response to reduced revenue collections, the Michigan Legislature sought to increase funds available for airport improvements by dedicating a portion of sales tax revenue to the State Aeronautics Fund and MDOT's airport grant programs. This additional revenue helps support small community airports that serve as a lifeline to major hubs, and allows larger airports to attract additional federal grants.

What does a 21st century Michigan look like?

Michigan's airport infrastructure is included in the statewide asset management database. Michigan's future aviation system finds solutions for many of the fiscal challenges that exist today including decreased local resources available for airport improvement. The goal is to continue growing aviation's annual \$10 billion contribution to the economy (MDOT 2016).

Additionally, airports are faced with new challenges, including larger and heavier aircraft at the large commercial service airports and increased very light jet (VLJ) business and personal aircraft at the general aviation airports. The proliferation of unmanned aerial systems, some of which can carry a large payload and possibly passengers, may also pose unprecedented challenges and opportunities for community airports across the state.

How do we get there?

6.8.1 MDOT will complete a comprehensive assessment of general aviation needs across Michigan as part of the ongoing Michigan Airport System Plan update, as well as examine existing capacity, use, costs, and revenues the State receives in order to determine whether the system of airports properly supports the future needs of Michigan communities.

Estimated investment needed: A one-time cost of \$425,000 to update the plan, using state funds²⁵



6.9 INTELLIGENT VEHICLE TECHNOLOGY

Where is Michigan today?

Michigan is the global leader in intelligent vehicle²⁶ technology that includes connected, autonomous, and automated technologies. Michigan is currently vying for federal designation as the nation's testing facility for intelligent vehicle technology, but it is in direct competition with California's Silicon Valley and other centers of innovation. Planet M, an initiative run by the MEDC and MDOT, is working to make the state the global center of mobility and innovative transportation technology. In partnership with numerous auto manufacturing companies, technology companies, private stakeholders, and Michigan universities, the State is working to lead the nation in advancing this technology. Planet M is Michigan's initiative to advance intelligent vehicle technology, such as the U.S. Department of Technology's testing facility in Oakland County, a deployment in the city of Detroit, and the Safety Pilot Model Deployment/Ann Arbor Connected Vehicle Test Environment. MDOT also partnered with the University of Michigan to develop the Mcity Test Facility and to

²⁵ A consultant contract is already in place to develop the Michigan Airport System Plan.

²⁶ "Intelligent vehicle technology" refers to connected, autonomous, or automated vehicle technology throughout this chapter.

continue development of the American Center for Mobility at the site of the former Willow Run Ford Motor Company manufacturing complex in Ypsilanti.

There are implications for infrastructure investment that accompany these new technologies, but the industry is so new, and advancing so rapidly, that it is difficult to identify all of them with any certainty. However, Michigan remains committed to keeping its global leadership position.

What does a 21st century Michigan look like?

Advancements in intelligent vehicle technology optimize the movement of people and goods and dramatically increase safety, supporting the Toward Zero Deaths program. Intelligent vehicles are the most transformative transportation advancement in generations, reshaping 21st century transportation. The technology changes cities, commuting, the freight industry, and even the vehicle ownership model. Intelligent vehicle technology is the key to Michigan achieving its zero fatality goal in the next 30 to 50 years. Michigan is the world leader of this technology transformation.

Intelligent vehicle technology is part of a larger discussion about the Internet of Things (IoT), a system of interrelated objects that can transfer information over a network without requiring human-to-human or human-to-computer interaction (see Chapter 4). The implications of the IoT for the transportation industry are significant; it transforms the way manufacturers make vehicles and requires a change in how transportation agencies deliver services to meet the ever-changing needs of 21st century mobility. Advancements in technology dramatically increase safety by eliminating human error and environmental risks, and provide mobility to a greater portion of the population, including the elderly, disabled, and children. These advancements also shape Michigan's economy. As a focal point of the global automotive industry, Michigan gains much from new vehicle research, development, and manufacturing.

How do we get there?

- 6.9.1** The Michigan Legislature, Governor, and relevant stakeholders should pass, sign, and support the implementation of currently proposed legislation that will enable Michigan to stay at the forefront of the intelligent vehicle industry.



- 6.9.2** MDOT and the MEDC should work with auto manufacturing companies, technology companies, private stakeholders, and Michigan universities to support the development of intelligent vehicle through investment in research, and develop a plan to invest in the installation of new technology.

Estimated investment needed: Will utilize existing staff resources



- 6.9.3** The Governor’s Office and MDOT should promote Michigan as the focal point of the global intelligent vehicle industry.

Estimated investment needed: \$20 million of state funds per year for continued installation and implementation of intelligent vehicle technology



- 6.9.4** MDOT and the MEDC should leverage unique partnerships between governmental agencies, companies, universities, and other organizations to advance Michigan’s intelligent vehicle industry.

Estimated investment needed: \$2 million of state funds for staff time and consultant contract



- 6.9.5** The Michigan Infrastructure Council (see Chapter 3) should include an emerging technologies group that is tasked with research, education, and coordination of implementing innovative technologies that impact infrastructure planning and delivery, particularly the emerging autonomous vehicle industry.

Estimated investment needed: Will utilize existing MDOT staff resources or consultant contract



6.10 SIGNALIZED INTERSECTION TECHNOLOGY

Where is Michigan today?

Traffic congestion is prevalent on many arterial corridors in Michigan. Since traffic signals serve as the primary points of delay along these routes, improving traffic signal efficiency offers the greatest potential for reducing motorist delay and increasing safety. Much of Michigan’s traffic signal infrastructure is antiquated, particularly on county and city arterial networks. While traffic signal modernization is occurring throughout the state, there are hundreds of inefficient traffic signals still in operation.

What does a 21st century Michigan look like?

Recognizing that we cannot build our way out of congestion, Michigan improves the operation of what we have—without adding lanes. This is particularly relevant in urban areas where signalized arterial corridors are vital for moving traffic via multiple modes. Michigan leads the nation in traffic signal efficiency, maximizing the safety and capacity of signalized arterial corridors using state-of-

the-art technologies. Our traffic signals are “smarter,” in order to respond to changing traffic demands, reduce motorist delay, and increase safety. Comparatively, improved signal timing typically requires little or no infrastructure costs and produces a very high benefit to cost ratio by operating the existing system with greater efficiency and reduced congestion. For example, improvements to an 11-intersection arterial in Saint Augustine, Florida, showed reductions of 36 percent in arterial delay, 49 percent in arterial stops, and 10 percent in travel time, resulting in an annual fuel savings of 26,000 gallons and a cost savings of \$1.1 million (U.S. DOT FHA 2015).

How do we get there?

6.10.1 The Michigan Infrastructure Council should work with local road agencies to elevate traffic signal infrastructure as a key asset of similar importance to road condition and bridge condition and encourage each road agency to pursue a goal to modernize and optimize the timing of 90 percent of traffic signals in congested corridors with current and emerging technologies, including signal communications, interconnectivity, transit signal priority, and vehicle detection equipment.

Estimated investment needed: These investments are included in MDOT, county, local asset management plans, and annual budgets.²⁷



6.11 NONMOTORIZED TRANSPORTATION

Where is Michigan today?

Many Michigan communities have undertaken robust local planning efforts to invest in nonmotorized transportation through local “complete streets”²⁸ policies and nonmotorized plans.

In fact, Michigan is a leader in local implementation of nonmotorized transportation innovations, like the development of rail trails that preserve railroad right-of-way for use by pedestrians and bicyclists; road diets, where four-lane roads are converted to three vehicle lanes and two bike lanes; and local Complete Streets policies.

²⁷ The cost to update intersection timing is currently estimated at \$4,000 per signal, and the current cost to replace a signalized intersection with new technology is estimated at \$150,000 per intersection (DeVries 2016).

²⁸ Complete streets is a transportation policy and design approach that requires streets to be planned, designed, operated, and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation.

Meanwhile, MDOT and Michigan's metropolitan planning organizations collaborate on regional-level nonmotorized planning initiatives, and statewide efforts, such as the Iron Belle Trail, are improving cross-community trail linkage efforts.

While Michigan's nonmotorized transportation options continue to grow, it is still a patchwork system that can prevent nonmotorized users from making safe connections between communities. More regional coordination and cooperation is necessary to fully develop recreational tourism options that might help visitors fully utilize our world-class trail system and on-road bicycle route system.



What does a 21st century Michigan look like?

Michigan holds a top-five ranking in the development of bicycle and pedestrian infrastructure. Communities offer robust nonmotorized transportation options for both transportation and recreation purposes. Stretching from one corner of the state to the other, the completed Iron Belle Trail is one of the longest designated state trails in the nation, a recreational tourism draw that will bring visitors from across the world to enjoy Michigan's pristine forests, cool rivers, and charming towns.

Across Michigan, communities have adopted complete streets planning principles at the regional level to help knit together disparate sections of on-road bicycle facilities and off-road trail networks that were previously a patchwork system. With strong regional nonmotorized planning processes in place, communities statewide have created seamless regional nonmotorized system linkages that help people of all ages and abilities stay active and connect to jobs, housing, and services, both on bike and on foot.

How do we get there?

6.11.1 MDOT should continue to work with road agencies to encourage full integration of bicycle and pedestrian planning into transportation infrastructure planning, including by implementing performance measures that evaluate the connectivity of nonmotorized facilities.

Estimated investment needed: Will utilize existing MDOT staff resources



- 6.11.2** MDOT and MDNR should work with regional transportation coordinating bodies to encourage or incentivize communities to coordinate their nonmotorized investments and work toward improving connectivity across communities.

Estimated investment needed: Will utilize existing staff resources



- 6.11.3** MDOT and MDNR should study the potential to create new incentives or realign existing incentives to further enhance and encourage coordinated nonmotorized planning, both between communities and at the regional level.

Estimated investment needed: Will utilize existing staff resources



6.12 RIGHT-SIZING

Where is Michigan today?

Today, we are still using the road and bridge infrastructure that was built to support the state's booming 20th century manufacturing economy. Roads and bridges that once carried thousands of cars a day may currently carry much less traffic and present opportunities for right-sizing.

Right-sizing transportation infrastructure can take many forms. Right-sizing can involve adapting underused rights-of-way to safely serve bus, rail, bicycle, and pedestrian travel, as well as cars and trucks. It can mean managing operations to maximize the effectiveness of the existing system without adding new capacity. It can include modernizing existing infrastructure, incorporating new technology, updating to meet new safety standards, and adding capacity where appropriate.

Right-sizing infrastructure can also lead to a greater emphasis on placemaking and context-sensitive solutions that serve the needs of motorists, but are still aligned with local needs, whether a large urban downtown or a small town main street.

What does a 21st century Michigan look like?

In the 21st century, transportation infrastructure needs to support a greater variety of businesses and a new, more mobile workforce. New technology and continued innovation improve not just physical infrastructure but how the assets are used. More flexible designs and new transportation technology make transportation systems and the communities they serve safer and more adaptive, as well as technologically smarter and more connected. Better, more efficient, and more coordinated transportation alternatives make Michigan more attractive to young talent and better serve the mobility needs of an aging population. These modern transportation systems also better support Michigan's growing 21st century economy.

How do we get there?

- 6.12.1** MDOT should identify and work with stakeholders across all modes to complete a comprehensive assessment that determines the kind of transportation infrastructure that is needed—and where—to support the industries and communities Michigan expects to have in the future.

Estimated investment needed: Will utilize existing staff resources or a consultant contract



- 6.12.2** MDOT should continue to work with local agencies and transportation stakeholders to identify areas of the state where excess road infrastructure undermines the potential for community success, develop context sensitive solutions to transportation problems, and encourage the use of design solutions that make more effective and beneficial use of the excess road capacity.

Estimated investment needed: Will utilize existing staff resources or a consultant contract



- 6.12.3** The Michigan Infrastructure Council should work with local agencies to encourage and incent cross-collaboration and opportunities for consolidation to provide transparent, safe, efficient, and cost-effective solutions. To encourage right-sizing metrics for safety, operations and administration are utilized resulting in low-cost, high-quality outcomes.

Estimated investment needed: Will utilize existing staff resources



- 6.12.4** MDOT, metropolitan planning organizations, and regional planning organizations should encourage greater coordination between agencies and provide technical assistance to local agencies seeking solutions that help right-size their infrastructure.

Estimated investment needed: Will utilize existing staff resources



6.13 ACT 51 REVIEW

Where is Michigan today?

Public Act 51 of 1951 governs the distribution of transportation revenue in Michigan. The legislation provided reasonable formulas for the distribution of transportation revenue to state highways, county roads, and city and village streets based on the best data available to policymakers of the 1950s.

While so much has changed since 1951, Act 51 remains the formula by which transportation revenue is distributed in Michigan. There have been many amendments in the past 65 years, most notably the increase in state share to match federal funds in the late 1950s, creation of the CTF in the 1970s, the addition of the Transportation Economic Development Fund in the 1980s, and the creation of the TAMC at the start of this century. These amendments clearly reflect the times in which they were enacted.

The many amendments to Act 51 have created a complicated formula that is only fully understood by experts. Taxpayers and road users want greater transparency. Better data, as well as a greater federal emphasis on performance measurement, mean that transportation providers need to be more accountable for system performance. Technology and globalization now impact the future of transportation systems in ways that were unimaginable in 1951.

What does a 21st century Michigan look like?

Act 51 has been reviewed and updated to ensure that transportation funding is distributed in a way that serves Michigan's 21st century economy. Michigan's transportation funding mechanisms collect enough user fee revenues to preserve the system, and the State distributes fees to transportation agencies to appropriately meet needs. Road agencies across Michigan invest transportation funds to maximize public and road user benefits.

How do we get there?

6.13.1 The Michigan Infrastructure Council should work with the Michigan Legislature and transportation stakeholders to revise Act 51 to make the distribution of state transportation revenues simpler, equitable, more transparent, and more accountable, while improving system outcomes.

Estimated investment needed: Will utilize existing staff resources



6.14 LOCAL REVENUE GENERATION OPTIONS

Where is Michigan today?

Counties, cities, and villages depend heavily on state aid to tend to local roads and streets. The local agency shares of the MTF awarded through the Act 51 formula were once sufficient to maintain major local streets and cover much of the cost of minor local streets as well; however, fuel tax revenues have fallen as road maintenance costs have risen.

Most cities and villages and some counties supplement state street aid with local funds. Most counties require that townships contribute to the cost of improving county local roads. For the vast majority of municipalities, property taxes are the only locally controlled tax available for additional funding. Local funds may come from general purpose revenues or from a dedicated roads millage.

Using property taxes—including General Fund operating revenue or dedicated road millages—to fund local transportation infrastructure is problematic for several reasons. For example, some communities had large declines in taxable value during the recession or owing to outmigration, and the constitution limits the rate at which revenues recover with growth in the economy. Additionally, property taxes are paid by a community's residents and business owners and do not account for people who commute into municipalities for work or entertainment, nor do they vary with use and demand of transportation infrastructure in the way that fuel taxes and vehicle registration fees do.

What does a 21st century Michigan look like?

Transportation infrastructure has a significant impact on a community's economy, vitality, and sense of place. In the 21st century, local agencies have a greater variety of transportation revenue options. Good, reliable intermodal transportation systems attract economic development and help build strong, healthy communities for residents and businesses.

How do we get there?

6.14.1 The Michigan Legislature should enact legislation to enable new methods of generating local revenue to increase transportation investment including, but not limited to, a regional-option gasoline tax and impact fees from land developments that burden road systems or from permits for driveways that diminish traffic flow. Additional legislative considerations should include regional-option sales taxes, levied in addition to the Michigan sales tax, which are used for transit operations in many states and could be made eligible for road and transit infrastructure use as well as regional-option vehicle registration surtax. This existing authorization for the four-county Regional Transit Authority (RTA) area could be extended statewide to allow other regions to levy this surtax.



6.15 ROAD AND BRIDGE USER FEES

Where is Michigan today?

Road and bridge infrastructure is almost exclusively funded through a combination of user fees in the form of vehicle registration fees and federal and state gas taxes. Recent fluctuations in these once very predictable and reliable fees have exposed a need to identify and adopt a fair, stable, and predictable basis to supplement or supplant the motor fuels fee and registration tax.



The fuel taxes paid by each vehicle depend on the vehicle's fuel efficiency, and revenue falls as the overall efficiency of the vehicle fleet rises in response to new fuel-efficiency standards, or as fuel-burning vehicles are replaced by electric cars. This has been problematic for transportation agencies and will likely impact transportation revenue even more dramatically in the years to come.

Currently, other states are piloting a per-mile fee calculated by a device combining a GPS receiver with a cellular signal or dedicated radio transmitter, most notably in Washington, Oregon, and California. Such devices are in use for trucks in several European countries, as well. Although per-mile fees are more expensive to collect than fuel taxes, the hardware is regarded as proven.

What does a 21st century Michigan look like?

Michigan has a road and bridge user fee system that is equitable and serves as a stable funding source. A properly executed user fee system provides a long-term funding solution for deteriorating transportation infrastructure. The 21st century transportation system has a funding mechanism that keeps up with advancements in technology and infrastructure planning. The goal is to find a sustainable funding mechanism for transportation to replace the gas tax, which has been unreliable in the past.

How do we get there?

6.15.1 MDOT and the DTMB should pilot test a per-mile fee system (such as GPS-based) in Michigan and use that test to become the first state to distribute user fees among road jurisdictions or within regions based on the miles of travel in each jurisdiction or region.

Estimated investment needed: Between \$1 million and \$10 million to design and initiate the pilot, collect data and revenue, distribute revenue, and analyze the results²⁹



²⁹ Oregon is currently piloting a GPS fee of 1.5 cents per mile. The pilot is limited to 5,000 cars and light-duty commercial vehicles. Michigan's pilot project could potentially use the state vehicle fleet. As part of the pilot test, the State may refund fuel and registration taxes for vehicle owners electing to pay fees on a per-mile basis as calculated by on-board devices, including in-state truck operators.

6.16 TOLLING

Where is Michigan today?

State road user fees and federal aid are not sufficient to reconstruct the Interstate System in Michigan, nor in any other state. The cost of modernizing the system will be greater than the cost of original construction, now that it is in use and the nation's entire economy flows over it continuously. But neither Congress nor the Michigan Legislature is likely to restore the fuel tax to the purchasing power it had when the Interstate System was built.

Michigan's freeways were among the nation's first, and are now 50 to 60 years old. Reconstruction and improvement is years overdue, but due to budget constraints, most of the system is not programmed for work in the foreseeable future.

Federal law permits the use of tolls to finance infrastructure improvements in the following instances:

- Newly constructed lanes added to existing toll-free Interstate highways can be tolled so long as the facility has the same number of toll-free lanes after construction as it did before.
- The initial construction of highways, bridges, and tunnels on the Interstate System may be constructed as toll facilities, although Michigan is not contemplating the addition of new Interstate routes.
- Non-Interstate routes may be reconstructed as toll facilities. This includes routes such as US-23, US-131, M-10, etc.
- Any toll-free bridge can be reconstructed or replaced as a toll facility. Rhode Island is considering an innovative program where all Interstate bridges will be electronically tolled for commercial vehicles and the revenue used for investment in Interstate pavements and bridges.
- A range of tolling options are available under the federal Value Pricing Pilot program, as long as the tolls used on each facility vary with the level of congestion on the facility. There are a limited number of slots available for participation in this program, and while none of the slots are currently available, some are expected to open in the future.
- Toll-free Interstates can be reconstructed as toll facilities through the Interstate System Reconstruction and Rehabilitation Pilot Program (ISRRPP). Only three slots are available for participation in this program, and all three are taken now. However, it is expected that one or more slots will soon become available for other interested states, and Michigan could position itself to be assigned a slot in order to enable tolling.

Tolling under any of the existing federal authorities can only be accomplished if the Michigan Legislature authorizes the use of tolling in Michigan. Steps can be taken to secure a slot in one of the federal toll pilot programs prior to obtaining legislative approval. However, the use of toll finance needs to be authorized in state law before the state can move too far down the road to tolls.

What does a 21st century Michigan look like?

New revenue options, such as tolling, help Michigan compete with modern transportation systems across the world. Michigan is able to reconstruct freeways on a more immediate timeline, using toll-based revenue sources to cover the costs. Reasonably priced tolls cover the portion of the cost that is not covered by federal aid. Under a tolling system, the cost of freeway reconstruction would be removed from MDOT's budget, freeing existing road user fees that go to freeway reconstruction for use on the rest of Michigan's road system. Michigan's first toll road, US-23, is operational, generating \$138 million a year.

How do we get there?

- 6.16.1** MDOT should position Michigan to apply for the Interstate System Reconstruction and Rehabilitation Pilot program (ISRRPP) if one of the openings becomes available.

Estimated investment needed: Will utilize existing staff resources to develop the application³⁰



- 6.16.2** The Michigan Legislature should enact a bill authorizing toll finance as an option for road finance in Michigan to indicate to the Federal Highway Administration that Michigan is ready to implement a pilot tolling project through the ISRRPP.

Estimated investment needed: Will utilize existing staff resources

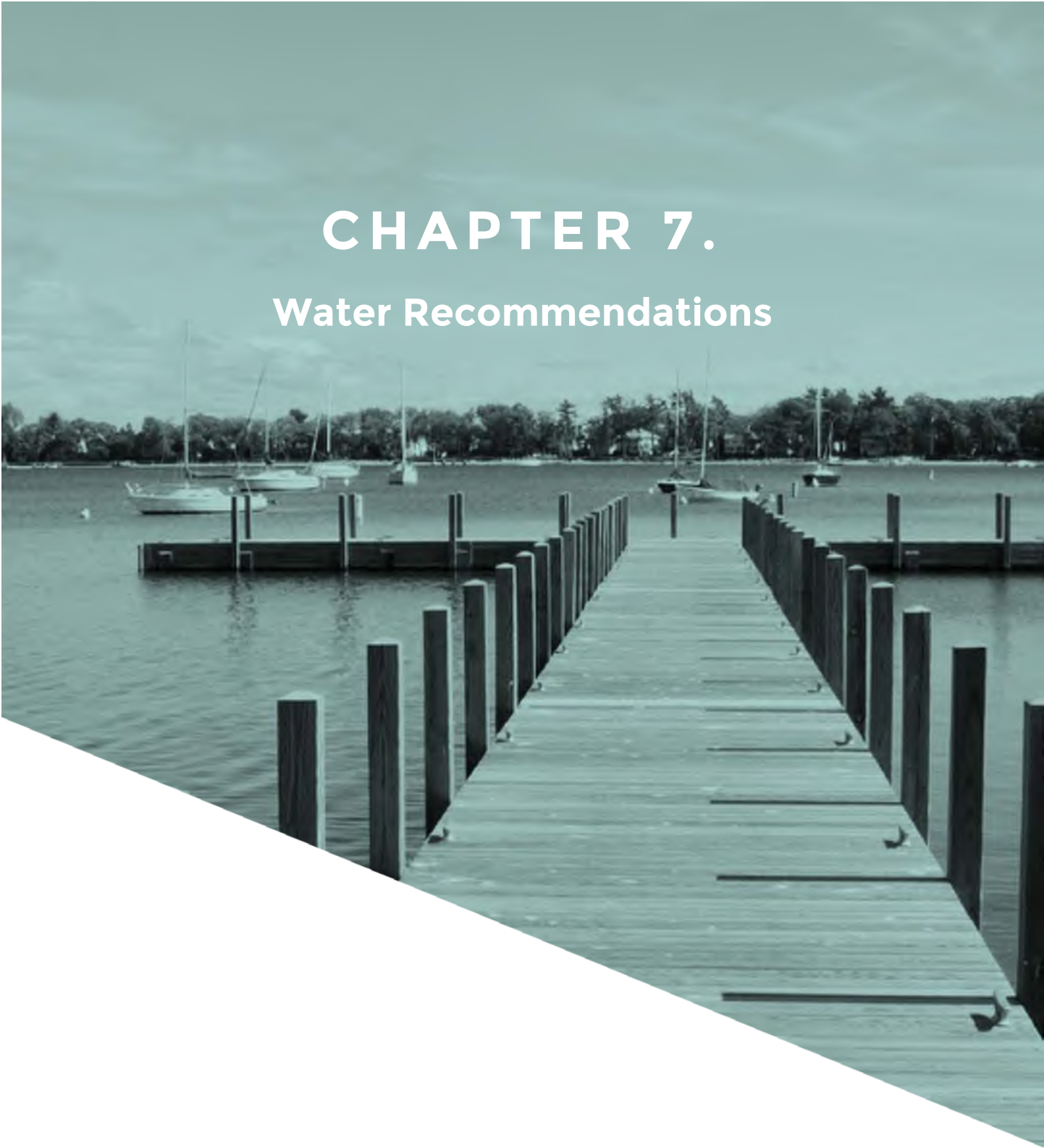


- 6.16.3** MDOT should work with the Office of the Governor and the Michigan Legislature to encourage Michigan's Congressional delegation to authorize toll finance on existing federal-aid roads.

Estimated investment needed: Will utilize existing staff resources



³⁰ If Michigan implemented tolling, there is an estimated \$325,000 per mile of initial capital costs for electronically tolled Interstates. (That would cost about \$87 million for the 270-mile length of Interstate 94 from Port Huron to New Buffalo).



CHAPTER 7.

Water Recommendations

CURRENT STATE OF MICHIGAN'S WATER INFRASTRUCTURE

Infrastructure systems in Michigan should enhance residents' quality of life, enable economic growth, and create a strong foundation for vibrant communities. In order to obtain safe, reliable, and resilient water systems in the 21st century, we must first understand the current reality of water infrastructure in Michigan:

DAMS

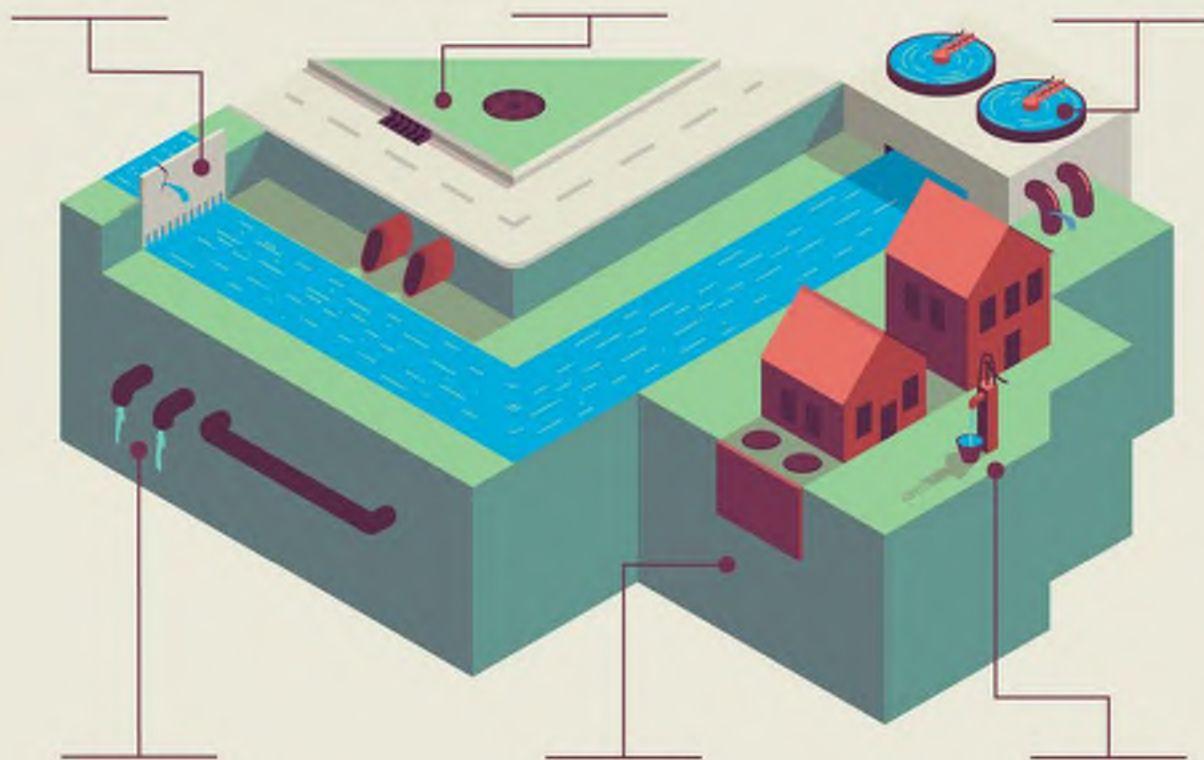
- ▶ Michigan has an estimated 2,600 dams, many of which were built decades ago.
- ▶ More than 10 percent of rated dams are in poor or unsatisfactory condition.

DRAINAGE SYSTEMS

- ▶ Drainage systems capture stormwater through open ditches, underground pipes, retention, and treatment systems to prevent flooding.
- ▶ 35,000 miles of county drains serve more than 17 million acres.
- ▶ Many communities lack sustainable funding mechanisms to support drainage systems.

MUNICIPAL WASTEWATER

- ▶ 1,080 community municipal wastewater treatment systems serve 70 percent of Michigan residents.
- ▶ Since 2008, an average of 5.7 billion gallons of untreated sewage flowed into Michigan waterways.



MUNICIPAL DRINKING WATER

- ▶ 1,390 community water systems supply 75 percent of the state's residents and businesses.
- ▶ Most water systems were built at least 50-100 years ago and need repair and replacement.
- ▶ Many water systems are continually underinvested.
- ▶ Drinking water systems commonly lose between 10 and 50 percent of the drinking water they produce due to leakage.

SEPTIC SYSTEMS

- ▶ Septic systems serve 30 percent of Michigan residents.
- ▶ Of the 1.3 million systems in the state, at least 10 percent are estimated to be failing. Some estimates suggest the rate may be as high as 25 percent.
- ▶ Michigan is the only state in the country without a sanitary code, which would provide a unified standard for septic system performance, inspections, and maintenance.

PRIVATE WELLS

- ▶ Of Michigan's residents and businesses, 25 percent obtain their water from more than 1 million private wells, the most of any state in the nation.
- ▶ Groundwater and private wells are critical to the success of agriculture.
- ▶ Groundwater resources must be protected to ensure access to safe drinking water.

Michigan has unparalleled fresh water resources, including 11,000 inland lakes, groundwater resources, and 36,000 miles of streams, wetlands, and beaches. This vast water network—combined with our unique position within the Great Lakes, the world’s largest freshwater system—provides exceptional opportunities. However, it also means we have a great responsibility to ensure Michiganders have the healthiest water system in the world.

Michigan’s water system provides drinking water to millions of people, sustains unique and pristine habitats, and offers world-class recreation opportunities. Residents rely on this system for public health and environmental, recreational, and economic benefits.

To sustain Michigan’s future, we must manage the state’s water resources wisely to protect and enhance their value, including maintaining and enhancing the viability of our water, sewer, and stormwater infrastructure systems.

Currently, Michigan has an \$800 million annual gap in water and sewer infrastructure needs, compiled from decades of deferred maintenance and a lack of knowledge on the condition of our water-related assets.³¹

The Flint water crisis has placed a national spotlight on the impacts of deteriorating infrastructure, declining population and system usage, fragmented decision making, and severe underinvestment in critical water infrastructure. Flint is not alone. Other Michigan communities need water infrastructure investment to address water quality concerns, including Oscoda Township and Ann Arbor. These two communities face the complex problem of chemicals that contaminate local groundwater supplies, causing hundreds of homeowners to abandon their wells and seek alternative drinking water sources. Michigan’s municipal systems need to be evaluated for defective and inadequate infrastructure to ensure long-term safety and public health.

Beyond drinking water, there are other challenges to Michigan’s water infrastructure. An average of 5.7 billion gallons of raw sewage flowed into Michigan’s waters between 2013 and 2014 (MDEQ October 2016 a.). Sixty-four rivers that drain 84 percent of the land area in the Lower Peninsula tested positive for human sewage (Verhougstraete et al. 2014). Nearly 25 percent of beaches experienced closures in 2015 (MDEQ May 2016). 20 percent of our beaches do not meet public health protection standards. Maintaining and updating our wastewater and stormwater infrastructure is critical to solve this problem so all Michigan residents can access these resources without risk to their health.

The Commission has recognized that a 21st century water infrastructure system begins with being able to identify the location and condition of Michigan’s water, sewer, and stormwater infrastructure. This knowledge and data will identify infrastructure shortcomings to develop a long-range plan for a safe, reliable, cost-effective and efficient system. In addition, this information will assist revisions to water and sewer rate structures, to reflect the full cost of providing service to maximize infrastructure investments and stop deferring needed maintenance activities.

³¹ The annual funding gap for water and sewer infrastructure needs is considered a conservative estimate using the best available information. As condition assessments and asset management plans are developed, this estimate may increase.

This chapter outlines a series of water-related recommendations to provide clean, safe water that enables a high quality of life, stimulates economic development, and protects public health and the environment.

Recommendations Key

 EP	Economic Prosperity	 HE	A Healthy Environment
 QS	Reliable, High-quality Service	 VI	Value for Investment
 0-2	Implementation Start (in years)	 0-2	Implementation Complete (in years)

7.1 ENSURING PUBLIC AND ENVIRONMENTAL HEALTH

Where is Michigan today?

Drinking water and wastewater investments, as well as regulatory programs, focus on sector and individual source compliance rather than systematic methods for supporting comprehensive environmental and public health outcomes. As evidenced by aging infrastructure—and the city of Flint, Oscoda Township, and other communities that are experiencing public health impacts associated with contaminants in drinking water—without adequate information, planning, and investment, the level of public and environmental health will continue to worsen.

What does a 21st century Michigan look like?

Michigan's water-related infrastructure investments and regulatory programs lead the nation in providing integrated approaches that successfully protect public safety and environmental health. The results are a safe, reliable, cost-effective and efficient water-related infrastructure system.

How do we get there?

- 7.1.1** The MDEQ should provide financial assistance to communities in need to invest in replacing aging infrastructure where there are immediate risks to public health or the environment due to lagging water infrastructure investments. Public health and environmental emergencies will be immediately mitigated by accessing emergency funds for failing infrastructure

Estimated investment needed: \$25 million of state funds annually, dependent on the number of immediate public health or environmental risks identified



- 7.1.2** The MDEQ should develop an outcome-based regulatory framework that ensures compliance is achieved, while enabling flexibility of means and methods through a permitting system that supports innovation to achieve public and environmental health goals. State and local programs should be revised to achieve these outcomes. Following these revisions, the State of Michigan should evaluate regulatory staffing levels and requirements for MDEQ and MDHHS as well as local training and certification to ensure that environmental and public health outcomes are achieved.

Estimated investment needed: Will utilize existing staff resources; the estimated investment needed should be reevaluated as regulations are revised



- 7.1.3** The MDEQ should use resources such as the recommendations of the National Drinking Water Advisory Council, municipal utilities, current U.S. Environmental Protection Agency (U.S. EPA) standards, and evolving research to inform legislative updates to the regulation of drinking water. As regulations are updated, communities may face additional costs to meet revised standards that may not be anticipated in local capital improvement plans or rate structures (i.e., the need to replace lead service lines). The MDEQ should partner with the Michigan Infrastructure Council, Michigan Department of Treasury, and drinking water utilities to determine the extent of potential financial impacts and provide funding to offset some of these costs to help communities meet revised standards.

Estimated investment needed: \$50 million in funding each year for ten years; administered through the Drinking Water Revolving Fund



- 7.1.4** The MDEQ should provide grants and technical assistance to schools to develop and implement a science-based drinking water quality testing and remediation program for lead and other contaminants. The program should use established guidelines to develop an appropriate level of testing for schools based on age, plumbing vintage and materials, and water quality.

Estimated investment needed: A one-time state investment of \$4.5 million



- 7.1.5** The MDEQ and MDHHS should incorporate science-based research in establishing drinking water standards and evaluate sources of drinking water contamination as technology advances, enabling better detection of pollutants to determine whether further controls are warranted in drinking water and wastewater systems.

Estimated investment needed: Will utilize existing staff resources



- 7.1.6** The MDEQ should continue to provide funding through the Clean Michigan Initiative (CMI) to assist with cleanup efforts of contaminated properties that threaten public health and drinking water supplies. This will require a new, successful ballot initiative to fund the CMI into the future.

Estimated investment needed: \$35 million of state funds each year for ten years



- 7.1.7** The MDEQ and MDHHS, local municipalities, and utilities should expand public outreach, engagement, and communication efforts regarding regulatory standards to manage risk and ensure public and environmental health are maintained, and the necessity of water supply, sewer, and stormwater investments.

Estimated investment needed: Will utilize existing staff resources, asset management plans, and rate structures



- 7.1.8** The MDEQ and MDHHS, in partnership with drinking water system operators, regional partners, and federal agencies, should expand comprehensive real-time surface and groundwater monitoring to detect potential threats to water supplies, develop early responses, and provide regular public reporting.

Estimated investment needed: \$1 million of state funds annually



7.2 WATER ASSET MANAGEMENT

Where is Michigan today?

Unlike Michigan's transportation system, there is no comprehensive state requirement for the collection of data on water and sewer infrastructure conditions. The lack of information about existing water infrastructure conditions and long-term investment needs jeopardizes service quality, safety, public health and reliability. This adds to the legacy costs for communities and utilities.

The lack of information about existing water infrastructure conditions and long-term investment needs compromises both service quality and reliability.

In addition, the technical and financial resources needed to adequately invest in infrastructure is beyond the reach of many service providers that operate in older communities. The problem is threefold: 1) the infrastructure is older and in need of a larger investment; 2) shrinking population has resulted in stranded capacity; and 3) the economic wherewithal of typical residential customers is far below what it was when systems were first put in place, with many at or below poverty indices.

What does a 21st century Michigan look like?

Michigan's drinking water, sewer, stormwater, and dam infrastructure systems all are regularly assessed and maintained to ensure the health and safety of Michigan's residents. The location and condition of public water infrastructure is identified, enabling strategic management and investment

in these systems. Michigan's investments are transparent and cost effective, facilitating a high level of public trust. This public trust is a foundation for sustained investment and quality service.

Local governments and water utilities have the necessary tools to regularly inventory, assess, and strategically invest in their water assets.

How do we get there?

7.2.1 The MDEQ should compile and evaluate asset management plans submitted under the first phase of the Stormwater, Asset Management, and Wastewater program. If necessary, the program should be updated to ensure that completed asset management plans are comprehensive and provide sufficient detail for planning purposes and meet MDEQ criteria. Following a program review and update, the MDEQ should provide additional funding to incent and assist municipalities and public utilities that have not established asset management plans for their stormwater and wastewater systems. Any updates to the program should also ensure that condition assessments and asset management plans are developed in a manner that enables consistent reporting in a statewide asset management database system supported by the State of Michigan (see Chapter 3).

Estimated investment needed: \$400 million of state funds, distributed at a rate of approximately \$80 million per year for five years³²



³² The SAW program was previously allocated \$450 million, which has supported the development of asset management plans for approximately 50 percent of the state's wastewater and stormwater systems.

7.2.2 The MDEQ should expand the current SAW program, to provide a portion of the funding necessary to complete condition assessments and the development of asset management plans for drinking water supply systems. Asset management plans for drinking water infrastructure should identify and prioritize infrastructure elements with risks to public health, such as lead service line replacement, which would decrease the risk of drinking water serving as a pathway of contamination. Asset management plans should develop local strategies to conduct coordinated lead service line replacement. Additionally, asset management plans should assess, maintain, and restore source watersheds and their ability to reliably and sustainably provide high-quality water for drinking water systems. Funding provided to these municipal agencies should be proportional to the size of the system (e.g., number of users, miles of infrastructure, and nature and extent of source watershed[s]). These revisions should ensure that condition assessments and asset management plans are developed in a manner that enables consistent reporting in the previously mentioned database.

Estimated investment needed: \$350 million distributed at a rate of \$70 million per year for five years³³



7.3 21ST CENTURY WATER INFRASTRUCTURE

Where is Michigan today?

Water-related infrastructure is aging and insufficient across urban, suburban, and rural areas of the state, particularly in our legacy cities.³⁴

The high cost of replacement and maintenance, combined with declining water usage creates a daunting challenge. Excess distribution capacity impedes effective operations, and antiquated infrastructure prevents dependable, cost-effective service delivery. These challenges can cause undesirable public health, environmental, and economic impacts. In some rural areas of the state, keeping and attracting land-based industries depends upon access to wastewater treatment systems, potable water, and drain infrastructure.

³³ \$350 million represents an average of \$250,000 per asset management plan for the state's approximately 1,400 community drinking water supplies.

³⁴ Legacy cities are considered "older, industrial urban areas that have experienced significant population and job loss, resulting in high residential vacancy and diminished service capacity and resources." For more information, see www.legacycities.org.

What does a 21st century Michigan look like?

Michigan's water-related infrastructure, including water supply, sewer, and stormwater systems, in conjunction with other infrastructure types, serves as the platform for economically and socially prosperous communities and supports a healthy environment. Our water systems are designed and built using the best available technologies to equitably provide services to residents and businesses.

How do we get there?

- 7.3.1** The Michigan Infrastructure Council and other asset management entities should partner with economic development entities to identify and prioritize areas for targeted infrastructure water, sewer, and stormwater replacements or upgrades. These targeted investments should be consistent with local land use master plans and seek to leverage the availability of investments in other infrastructure (such as roads and communications networks) and other business development assets (such as a labor force or production facilities); as well as maximize economic development, investment, and employment opportunities. The capital improvements in these areas should be reflected in the approved local program.

Estimated investment needed: Will augment existing programs



- 7.3.2** The Michigan Department of Agriculture and Rural Development (MDARD) should help support access to wastewater treatment capacity, potable water, and drain infrastructure in rural communities to promote land-based industries such as food, fiber crops, tourism, and mining, in order to keep rural communities competitive in a global economy.

Estimated investment needed: \$10 million of state funds annually



7.4 FISCALLY SUSTAINABLE WATER, SEWER, AND STORMWATER PRICING MODELS

Where is Michigan today?

Inadequate and inconsistent information on the condition of water infrastructure and resources prevent system managers from developing sustainable funding models.

Water and sewer rates do not always reflect the full cost of providing water and sewer service. This unintentionally undermines economic efficiency and the financial sustainability of those systems. In some cases, communities bill utilities to pay for services rendered that would otherwise have to be paid out of the General Fund. While these charges are legitimate if properly allocated, it can lead to mistrust—jeopardizing the ability of water utilities to sustain rates and revenues at adequate levels. In other cases, local general funds (usually financed largely by property taxes rather than user fees) are used to subsidize water rates, meaning that rate revenues are not sufficient to support capital and operating costs. This General Fund subsidization is unsustainable due to Michigan's tax structure, making underinvestment and risk of failure of water infrastructure more likely.

What does a 21st century Michigan look like?

Michigan's water and wastewater systems are adequately and sustainably funded in both the short and long term. Certainty and transparency exists for all parties and entities paying water utility rates. Using an enterprise concept for rate structures, revenues generated by rates cover all capital, operation, maintenance, and replacement expenditures based on asset management plans. Any subsidies or General Fund transfers to water infrastructure systems would be limited and transparent. Pricing models ensure Michigan gets the most value for investments in our water, wastewater, and stormwater systems, as well as provide an ideal level of service to customers. These systems ensure continuous improvement models to maximize value to all people and entities that benefit from these systems, and protects and sustains natural resources. Water infrastructure system operators employ asset and information management systems that provide customers the transparency and confidence that infrastructure is being well managed on a sustainable basis. Management systems are in place that ensure that water infrastructure maintenance and improvement is done in coordination with other infrastructure systems to provide customers with the most cost-effective deployment and operation.

How do we get there?

7.4.1 Through new policy, state auditing, regulatory processes, and technical support, Treasury and MDEQ should require self-sufficient transparent operation of enterprise organizations for water, sewer, and stormwater utilities that are supported by rate structures that cover all capital, operation, maintenance and replacement expenditures based on up-to-date asset management plans. This should include the development of mechanisms to provide financial assistance to ratepayers with a demonstrated financial need. The MDEQ should convene a stakeholder workgroup to develop these mechanisms in a context that fits Michigan's structure for fees and taxes.

Estimated investment needed: Establishment of requirements and development of financial assistance mechanisms funded through existing staff resources; \$1 million needed annually to seed the financial assistance program³⁵



³⁵ Funding amount should be reevaluated after rate structures are adjusted.

- 7.4.2** Utilities should engage in customer outreach when developing financing and ratemaking processes for all water, sewer, and stormwater utilities to achieve greater degrees of transparency.

Estimated investment needed: Will utilize existing staff resources



- 7.4.3** The MDEQ and Treasury should evaluate and modify Michigan's Water Pollution Control Revolving Fund, better known as the State Revolving Fund (SRF), to increase opportunities for participation in the program. At a minimum, the following components should be evaluated:

- Enhancing education and outreach to help market the program to communities and assist them through the SRF process
- Streamlining the SRF application process to make participation more attractive in a competitive interest rate environment
- Providing direct financial support through the project planning phase or allowing reimbursement for these costs once a loan is approved (the S2 grant program may serve as a model)
- Providing for a longer loan time horizon to parallel the life of infrastructure assets
- Providing for the option to discount the interest rate based on outcomes achieved (e.g., asset management, regional partnerships, public and environmental health benefits)
- Analyzing various interest and loan scenarios in relation to assuring the fund is sustainable in the long term

Estimated investment needed: Will utilize existing staff resources



- 7.4.4** The Michigan Legislature should adopt legislation authorizing stormwater utilities that is consistent with the *Bolt v. City of Lansing*³⁶ decision, establishes the requirements for structuring and charging a fee, and provides a streamlined process for local adoption. This legislation should establish the requirement for all users of stormwater services to pay for sustainable service delivery on a proportionate basis and provide incentives for alternate approaches to stormwater management.



³⁶ The *Bolt v. City of Lansing* decision has precluded most municipalities in Michigan from establishing stormwater utilities. The decision requires stormwater assessment to be based on the unique contributions of individual properties.

- 7.4.5** Water utility rate structures should incorporate incentives to promote water-use efficiencies to reduce operating costs and delay or eliminate the need for capital investment.

Estimated investment needed: Will utilize existing staff resources and rate structures



7.5 GREEN INFRASTRUCTURE

Where is Michigan today?

Michigan's water management systems were originally designed to remove water from property as swiftly as possible, which significantly altered streams and rivers, increased water quality problems, and degraded habitat. Variability of weather and climate could further strain existing drainage infrastructure and require new approaches to protect public health and prevent flooding and water pollution. Currently, there are few funding and financing mechanisms to support green infrastructure.

What does a 21st century Michigan look like?

Michigan leads the country by developing integrated and sustainable approaches to manage the quantity and quality of stormwater and surface water. A variety of optimization and simulation modelling approaches are used to assist water planners with developing and implementing plans. The impact of stormwater runoff on the total water cycle is significantly reduced and the state embraces low-impact design standards on land development projects. Michigan's water supply, wastewater, stormwater, and surface water management systems are integrated to provide the best outcomes for public and environmental health.

How do we get there?

- 7.5.1** The Michigan Department of Licensing and Regulatory Affairs (LARA), MDEQ, MDNR, and MDOT should encourage the integration of low-impact development/design standards and green infrastructure for stormwater management. Local jurisdictions should update their local ordinances to incorporate policies that incent the use of green infrastructure approaches that seek to optimize the joint benefits of stormwater management and green infrastructure—unless there are clear engineering, economic, environmental, or social reasons to select traditional engineering approaches. Model ordinance language from the Low Impact Design Manual for Michigan should be the basis for revisions. These ordinances should include stormwater quality and quantity planning for all projects.

Estimated investment needed: Will utilize existing staff resources



- 7.5.2** To enhance community resiliency and optimize costs, the MDEQ and MDNR should facilitate the development of tools that enable stormwater and wastewater system owners, managers, and operators to fiscally and operationally manage green infrastructure through asset management plans.

Estimated investment needed: Will utilize existing staff resources



- 7.5.3** Treasury and the MDEQ should update and revise funding and financing mechanisms that support infrastructure investments to incent evaluation and implementation of both efficiency-oriented approaches and green infrastructure.

Estimated investment needed: Will utilize existing staff resources



- 7.5.4** The MDEQ should periodically review and revise its programs and permitting requirements to ensure that engineering and design practices for sanitary sewer overflow (SSO) and combined sewer overflow (CSO) correction and stormwater management are based on assumptions that anticipate increased storm intensity and/or frequency.

Estimated investment needed: Will utilize existing staff resources



- 7.5.5** Drinking water, wastewater, and stormwater agencies should evaluate the resiliency of systems and facilities that enhance a community's readiness for increased storm intensity and/or frequency as well as their timely recovery as part of their asset management planning.

Estimated investment needed: See recommendation 7.2.1, SAW asset management funding



- 7.5.6** The MDEQ, MDARD, and county drain commissioners should develop draft revisions and then work with other stakeholders to provide recommendations to the Michigan Legislature to update the Michigan Drain Code (if appropriate) and municipal separate storm sewer system (MS4) program to better facilitate joint action and collaboration among jurisdictions to manage stormwater on a watershed basis. Chapter 22 of the drain code should be updated to allow petitions to request development of collaborative watershed management plans as well as watershed-based engineering and design studies. The code should also be updated to allow performance-based (rather than prescriptive) mechanisms to incent property owner behavior to achieve water quality and quantity outcomes.

Estimated investment needed: Will utilize existing staff resources



- 7.5.7** The MDEQ, MDARD, and county drain commissioners should develop draft revisions then work with other stakeholders to provide recommendations to the Michigan Legislature to address inconsistencies between the drain code and MS4 programs, with a goal of more explicitly authorizing projects focused primarily on management of water quality, especially in urbanized areas. MDEQ would still retain all authority over MS4 programs while allowing the drain commissioners to assist petitioning municipalities with implementation, particularly for permit requirements that are not grant eligible.

Estimated investment needed: Will utilize existing staff resources



- 7.5.8** Relevant state agencies, including the DTMB, and the MDEQ should assess properties to identify and implement opportunities to use green infrastructure to manage stormwater. The MDNR and MDOT should be the first agencies to conduct this evaluation.

Estimated investment needed: Will utilize existing staff resources



7.6 ONSITE WELL AND WASTEWATER TREATMENT SYSTEMS

Where is Michigan today?

Approximately 25 percent of Michigan residents and businesses obtain their water from private wells, of which there are more than one million—the most of any state in the nation (Creagh 2016). Michigan's farms also predominately use private wells for their agricultural operations. Moreover, about 30 percent of Michigan residents are served by onsite wastewater treatment systems, commonly called septic systems. It is estimated that 10 percent or more of Michigan's 1.3 million septic systems are failing (MDEQ 2016). While the majority of residents are connected to sanitary sewers, more than half of new home construction occurs in areas without sewer systems and requires onsite treatment system installation.

Michigan is the only state in the country without a sanitary code to protect its waters and public health.

Michigan does not have a uniform standard for septic system performance, inspections, or periodic maintenance.

Well and septic systems, when properly installed and maintained, can provide an environmentally sound and cost-effective method to supply and treat water on individual properties. Subdivisions and condominium developments not contiguous to municipal systems frequently use small community systems, which may not be as environmentally sound over the long term and are often not adaptable to new users. This suggests that, over time, these systems may be undercutting municipal rate bases and the opportunity of improving economies of scale. Once installed, the performance of individual onsite water and wastewater systems are not well tracked, and the apparent high failure rates for these systems threaten both environmental and public health.

What does a 21st century Michigan look like?

Onsite water wells and wastewater treatment systems provide safe, affordable drinking water as well as wastewater disposal in rural areas of Michigan where investments in community systems do not make economic sense. Michigan has programs that ensure that individual systems are safe, properly maintained, and do not cause individual or cumulative environmental consequences. Information that helps make data-driven decisions is collected, compiled, and made publicly available.

How do we get there?

- 7.6.1** The MDEQ, MDHHS, and LARA should revise regulations to require county and municipal governments, as well as water and sewer utilities, to use planning and permitting processes, taxes, fees, and other policies to promote connection to public water supply and wastewater treatment systems when they are available or when a new or expanded municipal system would be cost effective. This should include the development of utility service districts as part of asset management planning. New decentralized community systems should be required to demonstrate full life-cycle economic benefits, with consideration of other sustainability principles. For example, this may include the development of utility service districts as part of asset management planning.

Estimated investment needed: Will utilize existing staff resources



- 7.6.2** The MDEQ, MDHHS, and LARA, in partnership with local health departments, should encourage local governments to adopt ordinances requiring new homes and businesses with failed onsite wastewater treatment systems to connect to established community systems if they are available within 200 feet, consistent with Michigan Public Health Code (Act 368).

Estimated investment needed: Will utilize existing staff resources



- 7.6.3** The Michigan Legislature should pass new legislation that would enable local governments to adopt ordinances requiring homes and businesses to connect to community drinking water systems when onsite water wells fail if they are within 200 feet of an existing system.

Estimated investment needed: Will utilize existing staff resources



- 7.6.4** Communities should use Section 208 of the federal Clean Water Act to plan wastewater treatment facilities under an area-wide wastewater treatment management plan. In such cases, the MDEQ should use the permissive authority granted under Act 451, Part 21, Rule 39 to ensure that state or national permits (e.g., National Pollutant Discharge Elimination System) are addressed consistently with the approved Section 208 plan.

Estimated investment needed: Will utilize existing staff resources



- 7.6.5** The MDEQ and local health departments should strengthen permitting requirements to allow community systems only where a municipal system connection is not available, cost effective, or environmentally necessary. Community systems should be adaptable to future increases in the number of users, demonstrate a financially supported asset management plan, and provide for eventual connection to a municipal system.

Estimated investment needed: Will utilize existing staff resources



- 7.6.6** The MDEQ and MDHHS should work with the Michigan Legislature and local public health departments to update Michigan's Statewide Sanitary Code. The revised code should include 1) inspections of septic and community systems on a routine basis (e.g., every five years); 2) an approval route for alternative systems where public health or environmental quality is at risk; 3) minimum requirements for permitting; 4) a local health department–based, statewide registry of septic systems, including location, installation, and inspection dates; and 5) requirements for maintenance, pumping, repair, or replacement based on inspection results. This information should be included in the statewide asset management database system.

Estimated investment needed: Will utilize existing staff resources



- 7.6.7** The MDEQ and MDHHS should develop a financing mechanism such as a low-interest revolving loan fund or loan loss reserve program to support maintenance and replacement of existing onsite and community systems for system owners with a demonstrated need for financial assistance.

Estimated investment needed: \$20 million of state funds annually³⁷



³⁷ Michigan has an estimated 1.3 million septic systems, which have an average lifespan of about 25 years. This suggests that approximately 52,000—4 percent—of all septic systems should be replaced on an average annual basis. This may require annual investment of approximately \$780 million. Septic systems are private infrastructure that can affect public health and environmental quality. Similar to other investments property owners make, septic systems should be primarily funded privately. State support should be provided to owners of failed systems with demonstrated financial need. Michigan counties that have enacted inspection programs have estimated failure rates of approximately 25 percent; \$20 million annually assumes that approximately 10 percent of owners of failed systems would need financial assistance to replace their systems.

7.7 EMBRACING NEW TECHNOLOGY TO DEVELOP 21ST CENTURY UTILITIES

Where is Michigan today?

Most of Michigan's drinking water and wastewater management systems were built between 50 and 100 years ago and utilize outdated technology and approaches for treatment, distribution, and collection.

Many government procurement specifications and policies do not include mechanisms to evaluate and utilize new technologies or alternative materials that can provide cost savings and enhance environmental outcomes. Regulatory policies can discourage innovation because permitting entities are unfamiliar or uncomfortable with new technologies, materials, or use of old technologies and materials in new and novel ways.

What does a 21st century Michigan look like?

Michigan's water supply, wastewater, and stormwater utilities embrace ideas, partnerships, and cost-effective emerging technologies and materials. This holds substantial promise for more efficient water and energy use, recovery of resources (such as nutrients), and improvement of environmental and public health outcomes.

How do we get there?

- 7.7.1** The MDEQ, municipalities, and local utilities should put in place a process to periodically review and update new technologies, procurement manuals, or standard operating practices to allow for open competition for technology and materials meeting relevant professional standards (e.g., American Water Works Association, Michigan Water Environment Association). Regulatory programs should be updated to further enable innovative approaches to achieve environmental and public health outcomes.

Estimated investment needed: Will utilize existing staff resources



- 7.7.2** The MDEQ, municipalities, and local utilities should put in place a process to periodically review and update regulatory programs, implement methods of continuous improvement, and create standard work to further enable innovative approaches to achieve environmental protection and public health outcomes, as well as to control costs.

Estimated investment needed: Will utilize existing staff resources



- 7.7.3** The MDEQ should work with municipal utilities to amend the current wastewater regulatory framework to advance the State of Michigan's Water Resource Recovery Facility framework and educate municipalities about the benefits of these approaches.

Estimated investment needed: Will utilize existing staff resources



- 7.7.4** The MDEQ should work with municipal utilities to amend the current drinking water regulatory framework to advance the development of 21st century water utilities and inform municipalities about the benefits of these approaches.

Estimated investment needed: Will utilize existing staff resources



- 7.7.5** The MDEQ should encourage and incent strategies like resource recovery, as well as energy conservation and management options at wastewater and drinking water facilities, to help conserve resources and drive down costs. Revisions to Michigan's revolving loan fund could help incent those changes.

Estimated investment needed: Will utilize existing staff resources



- 7.7.6** The MDEQ should support innovation through partnerships and or funding with Michigan universities to expand research programs in the drinking water and wastewater fields.

Estimated investment needed: \$1 million of state funds annually



- 7.7.7** The MDEQ and water utilities should support new and emerging cost-effective technologies (such as smart metering and loss management technology) through permitting requirements that integrate water utilities with innovative communication and energy networks.

Estimated investment needed: Varying; the cost of new technologies should be integrated locally into cost of service



7.8 DAMS

Where is Michigan today?

Michigan is home to an estimated 2,600 dams—many of which were built decades ago to supply power and run mill operations (Lane 2016). While many of these structures continue to serve a valuable purpose, others are in disrepair, risking failure that can cause significant ecological and economic damage, and threaten public safety (MDEQ 2016).

These decades-old dams have deteriorated due to age, erosion, poor maintenance, flood damage, or antiquated design, and they are particularly vulnerable during high water flow events.

Since the early 20th century, more than 300 dam failures have been documented in Michigan.

In addition, significant adverse environmental effects of dams interrupting the natural flow of water, material, and organisms have been documented. The risk of failure, in conjunction with adverse effects on tributaries, suggests that dams that no longer serve a valuable purpose should be candidates for removal.

Dams are not routinely assessed for social and economic value and operational risks, which hinders reaching informed decisions on reinvestment, repair, removal, or replacement. Adequate, consistent, and long-term funding sources are limited for dam removal. Removal costs are highly variable and dependent on factors such as sediment contaminant levels, sediment volumes, surrounding infrastructure, wetland-related issues, and more. Furthermore, information is lacking regarding the number, condition, and ownership of low-head barriers that are not regulated under Parts 307 and 315 of the Natural Resources and Environmental Protection Act.

What does a 21st century Michigan look like?

Michigan has far fewer dams than it did at the turn of the 21st century. Given the original purposes for dam construction dating back to the 1800s, many of these relics have met their useful lifespan and have been removed or modified to help restore the natural functions of river ecosystems, such as upstream and downstream passage of biological organisms, nutrient transfer, and recreation. Dams that continue to provide benefits to society, such as reservoirs that provide water supply, recreational opportunities, and wildlife habitat and refuge, will have investment mechanisms to ensure their maintenance and structural integrity over their remaining useful life.

How do we get there?

7.8.1 The MDEQ's Dam Safety Program should maintain a publicly accessible geospatial data layer within the statewide asset management system that includes the number, condition, risk, and ownership of public, and private, regulated and nonregulated dams in the state. Working with partner organizations, the MDEQ should develop publicly available decision-support tools and training programs to assess risk, reinvestment and removal options for dams and low-head barriers. The tools should help communities and owners of dams evaluate potential safety, social-cultural, biological, ecological, and economic tradeoffs associated with the removal or maintenance of a dam. Utilizing the inventory of dams and the decision-support tool, the State should continue to support removal and maintenance of dams depending on the individual risks and benefits of each dam.

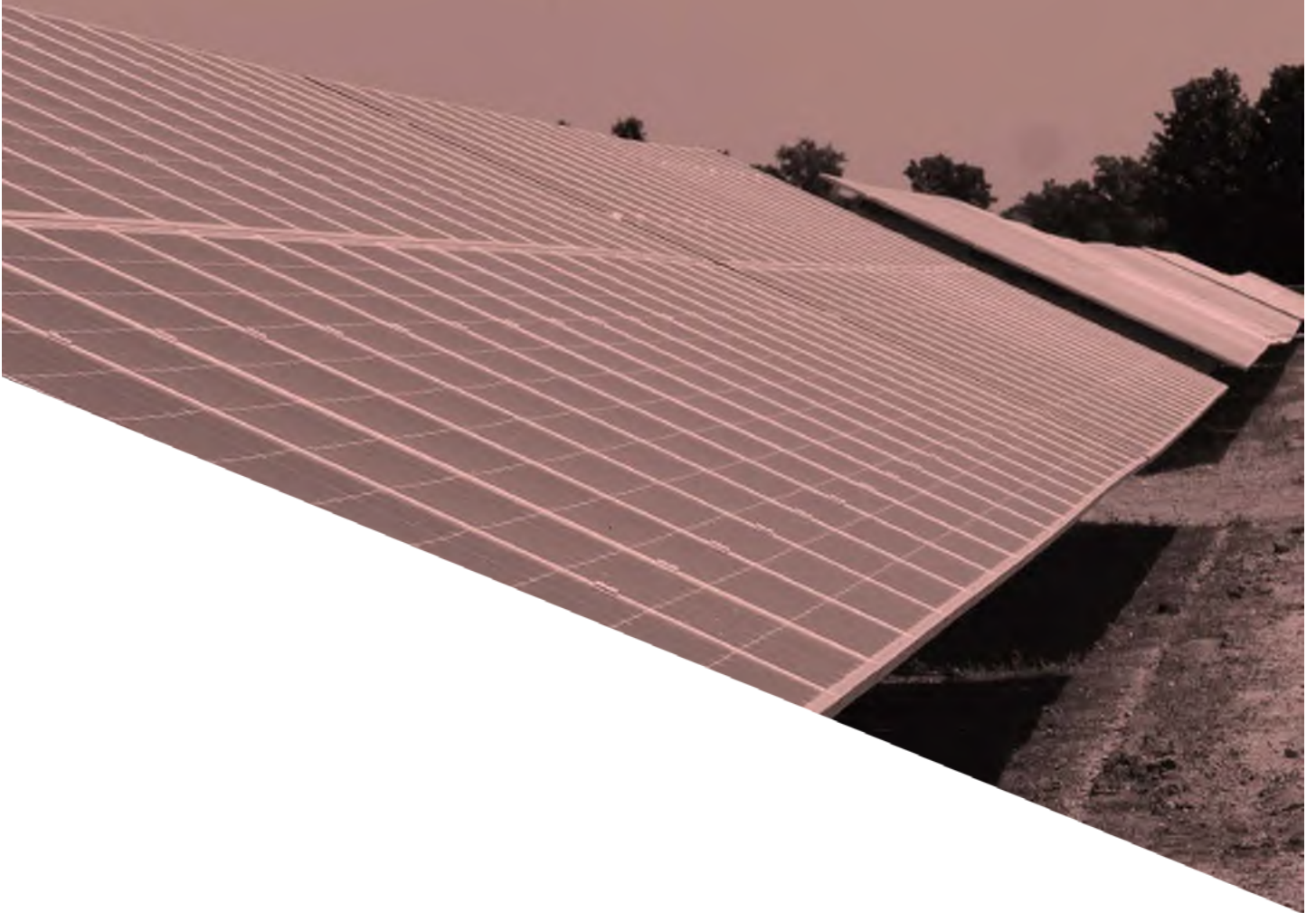
Estimated investment needed: \$227 million of state funding over 20 years³⁸



³⁸ The figure represents \$10 million to develop and update the dam inventory database and develop decision-support tools to help assess removal or maintenance options. The MDEQ's Dam Safety Program currently estimates that an additional \$225 million is needed for dam management, which may be refined with additional data.

CHAPTER 8.

Investing in 21st Century Infrastructure



Investing in our infrastructure—our roads and bridges; water, sewer, and stormwater systems; and energy and communications networks—is essential for ensuring 1) public health and safety, 2) quality of life, and 3) sustainable economic growth for all Michigan residents.

Michigan's transportation and water infrastructure is in poor condition, getting a D rating from the American Society of Civil Engineers. Infrastructure funding gaps are growing rapidly, adding to the accelerated deterioration of our systems. Current poor conditions now require total reconstruction efforts instead of less costly maintenance programs. According to the U.S. Census Bureau, Michigan spends \$470 per capita on transportation—the national average is \$795. The average annual capital spending as a percent of total spending is 2.4 percent less than the Great Lakes regional average. This means Michigan spends \$2.5 billion less per year than the rest of the Great Lakes states. Michigan is falling behind and needs a new model for the 21st century.

Investment in infrastructure provides a return on investment and can build a solid foundation for a 21st century Michigan that includes safe, reliable, cost-effective, and efficient infrastructure systems for the next 30 to 50 years.

This chapter provides an overview of report recommendations that require public investment to fully implement. It also outlines current and potential funding sources and financing mechanisms to meet 21st century infrastructure needs. The Commission identified the following principles to address funding needs, which will optimize further state investment:

- Maximize utilization of user fees in alignment with supply and demand principles
- Leverage federal funding, taking full advantage of all funding match opportunities
- Identify and prioritize efficiency and coordination through asset management
- Finance long-term investments to capitalize on the time value of money

The creation of a statewide asset management strategy and system and the Michigan Infrastructure Council will ensure the investments outlined in this chapter deliver 21st century infrastructure outcomes that:

- Coordinate across infrastructure types
- Identify and assess our water infrastructure
- Upgrade water infrastructure and clean up contaminated properties to keep Michigan's water drinkable, swimmable, and fishable
- Bring our roads and bridges to a good or fair condition
- Build on Michigan's reputation as a global center for intelligent transportation systems
- Develop Michigan as a top-five state for broadband access and adoption
- Establish Michigan as a global leader in smart technology development and adoption

Investing in 21st Century Infrastructure Strategy and Asset Management

The first key issue Michigan faces in developing a 21st century infrastructure system is assessing our current infrastructure and its condition. The best way to accomplish this is through asset management—the practice of managing infrastructure in a cost-effective and efficient manner based on continuous collection of data on the location and condition of infrastructure. Although Michigan is a national leader in transportation asset management data collection and planning, there is not a requirement for every road agency to have an asset management plan. Although most agencies deploy some elements of an asset management process, many have not adopted a written plan with goals, projections, a financial plan, and a corresponding capital improvement program. For water and sewer infrastructure location and condition, limited data exists at the local level, and no information exists at the statewide level.

The Commission has identified as a top priority the establishment of an information system allowing coordinated planning between communications, energy, transportation, and water projects at local, regional, and statewide levels. Coordinating asset management at all levels, along with implementing full-cost accounting practices will enable communities to ensure systems are financially self-sustaining and provide revenue through appropriate rate setting to cover the cost of that infrastructure over the whole useful life of that asset and the full cost of service.

As outlined in Chapter 3, the Commission recommends the creation of a regional infrastructure pilot to operationalize coordinated asset management. To initiate the pilot, the State should invest \$2 million for the initial development of an analytics database, data collection, and initial training for public and private stakeholders to inventory asset condition, identify needs, and develop plans. This will enable integrated infrastructure planning and adaptive management of assets. Additional funding will be required to expand deployment across the state.

A key recommendation to support development of 21st century infrastructure systems includes the establishment of the Michigan Infrastructure Council (referred to as “the Council”). The Council should assess the effectiveness of the pilot database and work toward implementation and maintenance of a common statewide asset management database. In addition to developing a long-term, integrated statewide infrastructure strategy in coordination with infrastructure decision-making bodies, the Council should design, oversee, and coordinate the distribution of incentives and funding for new infrastructure investments. The Council should ensure that funding cycles and processes promote cooperation and efficiencies between asset owners and reward projects that address multiple infrastructure needs with cost-effective collaboration and best practice funding and financing plans.

Investing in 21st Century Communications Infrastructure

Current Funding Sources and Financing Mechanisms

Michigan's communications infrastructure is funded primarily through the private sector based on an anticipated return on investment from consumer, business, and public sector subscribers. Other funding for communications infrastructure comes from federal programs, such as the Federal Communications Commission's Universal Service Fund Programs that have provided resources to Michigan, including the following:

- The Connect America Fund has provided a total of \$645.7 million to support delivering broadband access to rural areas.
- The Lifeline Program provides approximately \$6.5 million annually to support discounted broadband service for low-income consumers.
- The Schools and Libraries Program of the Universal Service Fund, commonly known as the E-Rate Program, provided approximately \$58 million annually between 1998 and 2015 to help schools and libraries to obtain affordable broadband.
- The FCC Healthcare Connect Fund provides funding to increase access to broadband for eligible healthcare providers, primarily in rural areas. In 2015, the program brought approximately \$3.25 million to Michigan to support broadband for rural healthcare providers (FCC August 26, 2016).

Beyond these federal funds from the Universal Service Fund, Michigan also received one-time funding of \$171 million from the American Recovery and Reinvestment Act of 2009. There has also been limited state and local investment in communications infrastructure, as well as direct investment through educational institutions, which usually target very specific needs.

Investment Needs

Broadband Access and Adoption

Through incentives provided by federal programs and investments made by the state's broadband providers, Michigan has come a long way in improving fixed and mobile broadband access and adoption. However, 17 percent of households in Michigan lack fixed broadband coverage with download speeds of 100 Mbps and 11 percent of Michigan households lack mobile broadband coverage with 25 Mbps download speeds. Although Michigan is keeping pace nationally, we fall short of our goal of 100 percent access for both fixed and mobile broadband.

As detailed in Chapter 4, the Commission recommends steps to close this gap and position Michigan as a top-five state for broadband access and adoption. This includes the establishment of an advisory body—the Michigan Consortium on Advanced Networks—to coordinate policy, provide technical assistance, expand mapping and research of broadband access and adoption, expand digital literacy programs, and identify funding and financing mechanisms for mobile and broadband access and adoption.

To address funding needs, the Consortium needs to ensure all opportunities for federal funding and matching funds are fully utilized, including private sources of funding and financing, as well as innovative delivery options. Expanding broadband access could also be funded by an increase in the fee charged to telecommunications providers through the METRO Act, which was designed to assist in managing and maintaining public rights-of-way and to reduce conflicts with providers. Providers currently pay an annual fee of five cents per linear foot, which generates between \$25 and \$30 million per year and is distributed to local governments on a formula basis (MML 2015). Funding could also be provided through a surcharge to broadband service subscribers or through the state's General Fund. Expanding broadband access could also be financed as part of an infrastructure bond, bank, or P3.

The Michigan Legislature may also consider creation of a broadband technology tax credit for broadband service providers to encourage deployment of high-speed access.

Smart Technologies

The Commission also recommends the creation of a fund to support efforts that will make Michigan a global leader in smart technology development and deployment. The fund would provide seed and matching funds to incent innovative research and development on advanced communications and other smart technologies. In addition, this fund would support cities in identifying, implementing, and funding smart technology investments that appropriately serve their community. The Commission recommends this fund be established by the MEDC in partnership with other relevant state agencies—it could be funded through the Michigan Strategic Fund or the state's General Fund.

Cyber Security

To maintain Michigan's position as a top-five state for cyber security, the Commission recommends steps to continually keep pace with and respond to threats for critical infrastructure, as well as develop and implement programs to attract and retain talent in the cyber field. Cyber security recommendations could be funded through the state's General Fund and administered by DTMB.

Exhibit 15 summarizes recommendations for needed investment in Michigan's communications infrastructure.

EXHIBIT 15. Communications Infrastructure Investment Gaps

Rec. #	Description	Annual Investment Gap	Investment Term	Total Investment Gap	Investment Impact
4.1.2	Smart Technology Fund: Seed and matching funds to incent innovation of smart technologies	\$10 million	5 years	\$50 million	Michigan is a global leader in the evolution, deployment, and adoption of new technologies, and the creation of smart environments and communities.
4.2.1	Broadband investment in areas of need	\$50 million	10 years	\$500 million	Michigan is a top-five state for broadband access and adoption.
4.3.1	Cyber hub development	\$3 million	2 years	\$6 million	Michigan remains a top-five state for cyber security, where residents, businesses, and institutions can fully and confidently engage in a digital society and the digital economy.
4.3.2	Regional cyber security education collaboration	\$1 million	2 years	\$2 million	
4.3.3	Michigan Civilian Cyber Corps	\$2 million	5 years	\$10 million	
4.3.4	Virtual chief information security office	\$375,000	2 years	\$750,000	
4.3.5	Threat intelligence enhancements	\$3 million	5 years	\$15 million	
4.3.7	Cyber safety public awareness campaign	\$2 million	5 years	\$10 million	
4.3.8	Technology curriculum design and adoption	\$960,000	5 years	\$4.8 million	
4.3.9a	Develop next-generation identity and authentication solutions	\$5 million	One-time	\$5 million	
4.3.9b	Implement next-generation identity and authentication solutions	\$3 million	5 years	\$15 million	
Total				\$618.6 million	

Investing in 21st Century Energy Infrastructure

Current Funding Sources and Financing Mechanisms

Despite being largely privately owned, the vast majority of Michigan's energy infrastructure is subject to regulation at the state, federal, or local level. These regulatory entities review utilities' prices, customer service, planning, and investment, allowing for reimbursement of appropriate expenditures. Generally speaking, to make investments in infrastructure, investor-owned utilities must first seek approval from regulators tasked with reviewing proposed expenditures and determining if costs are reasonable and prudent.

Investment Needs

Michigan's energy infrastructure has an existing funding structure for investment; thus, the Commission's recommendations do not include funding recommendations. However, the state's energy infrastructure is likely to require significant investment in the coming years. A majority of Michigan's electricity has traditionally been generated with coal as a fuel source, and most of the plants that were constructed in the sixties and seventies in Michigan were coal-fired. Many of those plants are coming to the end of their lives for regulatory and economic reasons. Other sources of energy, notably natural gas and renewable sources, will likely replace those plants. Reducing energy waste will also need to play an increasing role in our resource mix. The electric grid will need to undergo modernization to allow Michigan to take full advantage of these newer technologies and savings opportunities. Additionally, many of our natural gas pipelines were constructed with older materials and need to be replaced with newer materials that can provide better long-term safety.

Michigan needs to make many important and long-reaching energy decisions in the coming years. The state's decision-making processes should be improved to better look at the various alternatives and weigh them for adaptability, reliability, affordability, and protection of the environment. Updates to current federal and state processes for decision making could complement funding mechanisms in the current law to ensure Michigan's energy infrastructure meets—and continues to meet—the state's goals for reliability, affordability, and protection of the environment.

Investing in 21st Century Transportation Infrastructure

Current Funding Sources and Financing Mechanisms

Funding for the maintenance and preservation of Michigan's transportation system comes primarily from three sources: state fuel taxes, federal fuel taxes, and state vehicle registration fees. Only in the past few years has significant funding for roads been provided by Michigan's General Fund.

State Funding

Revenue from state gas and diesel taxes and registration fees is deposited into the MTF. The Michigan Constitution restricts the use of that revenue to roads, with up to 10 percent available for transit. Beginning in January 2017, the MTF will begin to see an increase in revenue, thanks to 2015 legislative action that will increase gas taxes by 7.3 cents per gallon, diesel taxes by 11.3 cents per gallon, and vehicle registration fees by 20 percent.

Funds flowing to the MTF are distributed to more than 700 transportation agencies across the state. After a series of administrative and other deductions are taken from the MTF, the remainder flows to MDOT, county road commissions, municipalities, and the CTF, which funds local bus transit, passenger and freight rail improvements, intercity bus transportation, and public ferries. These distributions are required by Public Act 51 of 1951, as amended.

The CTF derives its revenue from the MTF distribution, as well as 4.65 percent (of the 6 percent) of sales tax revenue collected from automotive-related retailers (gas stations and auto dealers). For example, in 2017, \$91 million in auto-related sales taxes will flow to the CTF (MDOT 2016). Appropriation of General Fund revenues to the CTF varies from year to year.

Federal Funding

Federal aid provides roughly one third of Michigan's transportation budget each year, and is a vital part of the transportation capital construction budget. Federal fuel taxes, and other minor federal transportation-related taxes, are credited to the federal Highway Trust Fund. Federal highway aid is not cash, but a reimbursement for qualifying capital expenditures. It cannot be used for routine maintenance, such as snow plowing or pothole patching, which must be funded from state revenues. Federal highway aid must be matched from state or local funds, typically at a ratio of 80:20 percent. About \$1.1 billion per year in federal funds is available for six major highway programs. Federal highway aid is divided by Act 51; 75 percent goes to state highways and 25 percent goes to local roads and streets.

Federal transit funding is generally allocated directly to public transit agencies. About \$240 million per year in federal transit aid is provided to local public transit agencies or for discretionary grants for public transportation projects.

In FY 2015, the U.S. Department of Transportation initiated the FASTLANE program, which provides competitive grant funding for projects that address critical freight issues facing our nation's highways and bridges. The inaugural FASTLANE program provided \$800 million in grants nationwide, although no Michigan projects were selected as part of that competitive process.

Local Funding

Local road and transit agencies in Michigan (83 county road commissions, 533 cities and villages, and 79 transit agencies) also invest in transportation infrastructure, and townships invest in county roads within their borders. According to Act 51 financial reports filed with the state, contributions by Michigan counties, cities, villages, and townships totaled \$192 million in 2015 for local road and bridge maintenance, construction, and reconstruction. Michigan townships contributed an additional \$46 million to road projects in 2015; cities and villages contributed an additional \$235 million to transportation (CRA 2016). Local government contributions are generated from a variety

of sources, including local general funds, special assessments, millages, and public-private partnerships.

In the past decade, as transportation agencies struggled to find sufficient funds to sustain the condition of their transportation systems, the number of county-wide millages used for roads increased from 11 counties to 28 counties (CRA 2016).

Investment Needs

Roads and Bridges

In 2007, Michigan achieved established goals for the condition of state highways and bridges (90 percent good/fair) through asset management planning; however, the state has not been able to sustain that high level of performance. Through the roads package passed by the Michigan Legislature in 2015, beginning in 2017, an expected \$450 million in new revenue from state gas taxes and vehicle registration fees will be distributed to more than 700 transportation agencies. That number rises to \$600 million in 2018, and the full distribution of the entire \$1.2 billion revenue package will occur in 2021. But even with these investments, an estimated \$2.2 billion annual gap will remain. Closing this gap is essential to reach the state's goals for road condition—95 percent good or fair condition for Interstates and principal arterials; 85 percent good or fair condition for state highways and bridges; and, 85 percent good or fair condition for local roads and bridges—and to ensure Michigan is building and maintaining 21st century transportation infrastructure.

Multimodal Transportation Systems

Michigan's bus transit, passenger rail, and freight systems all compete for the same funding from the CTF, which is funded largely through a distribution of the MTF. The estimated MTF transfer to the CTF for FY 2015–16 is \$169.3 million (Hamilton 2016). A smaller revenue source for the CTF is the auto-related sales tax, which was estimated to total \$97.1 million in FY 2015–16. Interest on the fund balance and other revenue sources bring the total CTF revenue to approximately \$267 million for FY 2015–16. While the CTF will receive a share of the increase to state gas taxes and registration fees in 2017 and beyond, the CTF was not included in the distribution of general funds proposed by the Michigan Legislature for roads and bridges in 2019, 2020, and 2021.

Recognizing that because of increasing fuel-efficiency standards, the gas tax will not remain a viable source of transportation funding indefinitely, the Commission has recommended alternative funding sources to fund roads and bridges. These alternatives are described in detail in Chapter 6 and outlined in Exhibit 21. While these options could help address the transportation funding gap in the long term, they will take time to implement. Meanwhile, a substantial funding shortfall remains (see Exhibit 16). Beyond further increases in the state gas tax and continued General Fund contributions, viable options to support critical road and bridge infrastructure in the near term are limited. Financing critical reconstruction needs through a bond, bank, or P3 should be considered. Increased federal funding for transportation must also be part of the solution. Through successful asset management, Michigan is well positioned to make good use of federal funding for transportation infrastructure.

EXHIBIT 16. Roads, Bridges, and Multimodal Transportation Annual Investment Gaps

Transportation Mode	Current Annual Investment	Annual Investment Need	Annual Gap
Interstates and other principal arterials	\$1.2 billion	\$2.2 billion	\$1.0 billion
State highways and bridges	\$250 million	\$850 million	\$600 million
Local roads and bridges	\$740 million	\$1.34 billion	\$600 million
Multimodal	\$420 million	\$850 million	\$430 million
Total	\$2.61 billion	\$5.24 billion	\$2.63 billion

Bridge and Culvert Inspections

As described in Chapter 6, there are safety, environmental, economic, and social impacts when there are bridge and culvert failures, especially when flooding occurs at older bridge or road-stream crossings. The Commission recommends an annual state investment to support design, installation and inspection of road-stream crossings to ensure safe passage, natural stream function, aquatic organism passage, support of commercial activity and uninterrupted traffic flow. Local inspections could be funded through the state's General Fund. Design changes and construction of new crossings identified as a result of inspections could be funded through the MTF.

Intelligent Vehicle Technology

As described in Chapter 6, cooperation between the public and private sectors is helping to position Michigan as the global center of mobility and intelligent vehicle technology. While Michigan is already preparing to implement intelligent vehicles, the implications for infrastructure investment are not certain, given rapidly advancing technologies. The Commission has made a series of recommendations to continue to advance Michigan as a global mobility center, including investment in continued installation and implementation of intelligent vehicle technology, partnership development, and continued implementation of traffic signal synchronization. These investments could be funded through a combination of general funds and the Michigan Strategic Fund, and P3s could be a potential financing or project delivery source.

Exhibit 17 summarizes recommendations for additional needed investment in Michigan's transportation infrastructure.

EXHIBIT 17. Transportation Infrastructure Investment Gaps

Rec. #	Description	Annual Investment Gap	Investment Term	Total Investment Gap	Investment Impact
6.1.1	Reconstruct Interstate and other principal arterials	\$1.0 billion	15 years	\$15 billion	95 percent of Interstates and other principal arterials are in good or fair condition.
6.1.1	Reconstruct other state highways	\$600 million	15 years	\$9 billion	85 percent of other state highways are in good or fair condition.
6.1.1	Reconstruct roads under county or city jurisdiction	\$600 million	15 years	\$9 billion	85 percent of county primary roads and city major streets are in good or fair condition.
6.2.1	Design and install stream crossings	\$40 million	5 years	\$200 million	Road infrastructure, wetlands, and water quality are protected and safe passage of people and freight is ensured through continued viability of culverts.
6.2.3	Inspect local culverts greater than five feet in diameter	\$4 million	5 years	\$20 million	
6.4.1	Invest in multimodal (bus transit, passenger rail, and freight) systems ³⁹	\$430 million	15 years	\$6.45 billion	Michigan has a reliable, safe, and integrated multimodal system serving both urban and rural communities throughout the state.
6.4.3	Develop components of the DIFT	\$323 million ⁴⁰	One-time	\$323 million	Rail yards in southeast Michigan are consolidated resulting in relieved congestion, improved service, and environmental justice.
6.9.2	Install and implement intelligent vehicle technology	\$20 million	10 years	\$200 million	Michigan's position as a global mobility center is advanced.
6.9.4	Advance intelligent vehicle technology industry through P3s	\$2 million	10 years	\$20 million	
Total				\$40.2 billion	

Source: U.S. DOT FHA 2016; MDOT 2016.

³⁹ Multimodal investments include operating assistance required by Act 51.

⁴⁰ Includes only public investment needs; the total investment need for the DIFT is \$539 million and this difference is expected to be funded through private investment. Tax increment financing could be utilized to support the public portion of the DIFT investment.

Investing in 21st Century Water Infrastructure

Current Funding Sources and Financing Mechanisms

Michigan's public drinking water and wastewater treatment systems are funded primarily through user fees, although some municipalities choose to underwrite these costs with general funds. When financing the initial capital improvements for new infrastructure and large-scale replacements, communities sometimes borrow money through the state's revolving loan funds, including the Clean Water State Revolving Loan Fund and the Drinking Water Revolving Loan Fund. Additionally, Michigan has a long history of voter support for general obligation bonds, such as the Clean Michigan Initiative and the Great Lakes Water Quality bond, to support environmental quality and water-related infrastructure. While the Clean Michigan Initiative has provided funding since 1998, the funds are expected to be fully depleted in 2017. Given current low interest rates, and to decrease administrative burden, many communities are turning to the open bond market to finance water infrastructure improvements. The USDA Rural Development Department also provides funding to rural communities to support water infrastructure. Private water wells, onsite wastewater treatment systems, stormwater infrastructure, and dams are the responsibility of individual owners.

Urban stormwater infrastructure is frequently funded when new development occurs as part of the original development costs. However, due to regulatory challenges, few communities have established a dedicated funding mechanism, such as a stormwater utility, to support maintenance and replacement costs, leaving municipalities to defer maintenance or pay for these expenses through their general funds. Drains outside of cities are frequently owned and operated by drain commissions as special purpose public corporations and paid for by property owners in the watershed on a proportional basis, depending on how much water they contribute to the drain.

Investment Needs

Asset Management

Michigan has an estimated \$800 million annual gap in water and sewer infrastructure needs, compiled from decades of deferred maintenance. However, there is a high level of uncertainty regarding this need, due to a lack of data on infrastructure condition. While revenue to support infrastructure needs is primarily provided by ratepayers and local general funds, investment in asset management planning is essential to aligning rates with needs.

The State began awarding funds through the Stormwater, Asset Management, and Wastewater (SAW) program in 2014 to assist communities in asset management planning for wastewater and stormwater systems; stormwater management planning; innovative technology and project planning; and design for wastewater and stormwater systems. SAW awards grants and low-interest loans for wastewater construction projects designed to protect water quality and public health. The funds for SAW are expected to be fully utilized by 2018, while most wastewater and stormwater systems will still need asset management plans. As described in Chapter 7, the Commission recommends additional state investment in asset management planning and expansion of SAW to include drinking water.

Asset management planning is a short-term investment that has a long-term impact; therefore, it is appropriate for financing. Current SAW grants for wastewater and stormwater asset management planning are funded through general obligation debt authorized through the Great Lakes Water Quality Bond of 2002. Debt service on the bond is provided through the General Fund. The State should utilize the remaining \$290 million of authorization available in the Great Lakes Water Quality Bond to provide additional SAW grants and continue to fund debt service through the General Fund. An additional \$460 million in general obligation debt will need to be issued to completely fund stormwater, wastewater, and drinking water asset management planning.

These investments will enable system managers to align water and sewer rates with the full cost of providing water, sewer, and stormwater service, ensuring fiscally sustainable pricing models. Sustainable pricing models are essential to ensure the most value for investments, protection of public health and the environment, reliable service to customers, and a reduction in local general fund subsidies for water. Accurate reporting of needs also positions Michigan to optimize federal funding allocation for wastewater and drinking water revolving loan funds.

Drinking Water and Wastewater Investments

As detailed in Chapter 7, the Commission recommends investments in the state's aging drinking water and wastewater infrastructure. These recommendations include dedicated funding to address immediate public health risks and to meet drinking water regulations, as well as funding to support drinking water testing and remediation in schools, contaminated site cleanup, and monitoring expansion. These investments will enable Michigan to protect public safety and environmental health and result in safe, reliable, cost-effective, and efficient water-related infrastructure systems.

Rural Water Infrastructure Improvements

As described in Chapter 7, Michigan does not have a uniform standard for septic system performance, inspections, or periodic maintenance. The Commission recommends appropriate state agencies develop a financing mechanism such as a low-interest revolving loan fund or loan loss reserve program to support maintenance and replacement of existing onsite and community systems for system owners with a demonstrated need for financial assistance. These investments will help ensure safe and affordable drinking water, as well as wastewater disposal in rural areas. The Commission also recommends investments in wastewater treatment capacity, potable water, and drain infrastructure in rural communities to promote land-based industries—such as food, fiber crops, tourism, and mining—which will help rural communities to compete in the global economy.

Water Technology Innovations

The Commission also makes recommendations to encourage water technology innovation, which can provide cost savings and enhance environmental outcomes. This includes partnerships with Michigan universities to expand research programs in the drinking water and wastewater fields.

Dam Maintenance and Removal

Dam deterioration and failures can cause significant ecological and economic damage, affecting public health. As described in Chapter 7, dams are not routinely assessed to ensure informed decisions on reinvestment, repair, removal, or replacement. Adequate, consistent, and long-term

funding sources are limited for dam removal and removal costs are highly variable. The Commission recommends investments to inventory dam conditions and provide ongoing funding for the maintenance and removal of dams depending on the individual benefits of each dam. These investments will help to ensure improved safety, fish and wildlife habitat, and recreation opportunities.

Exhibit 18 summarizes recommendations for needed investment in Michigan's water infrastructure.

EXHIBIT 18. Water Infrastructure Investment Gaps

Rec. #	Description	Annual Investment Gap	Investment Term	Total Investment Gap	Investment Impact
7	Water and sewer infrastructure capital investments	\$800 million ⁴¹	20 years	\$16 billion	All Michigan public water and sewer infrastructure is maintained resulting in reduced water main breaks, increased response to emergency infrastructure needs, and reduced public health risks.
7.1.1	Community infrastructure emergency response	\$25 million ⁴²	20 years	\$500 million	Public health and environmental emergencies are immediately mitigated by accessing emergency funds for failing infrastructure.
7.1.3	Drinking water infrastructure regulatory upgrades	\$50 million	10 years	\$500 million	All drinking water systems are upgraded to meet new state drinking water standards.
7.1.4	School drinking water testing and remediation planning	\$4.5 million	One-time	\$4.5 million	All Michigan schools use science-based methods to evaluate drinking water quality and develop appropriate remediation strategies.
7.1.6	Contaminated site cleanup	\$35 million	10 years	\$350 million	3,000 contaminated properties are cleaned up, protecting public health and drinking water supplies.
7.1.8	Real-time surface and groundwater monitoring expansion	\$1 million	20 years	\$20 million	Michigan's drinking water sources are protected with the highest level of security, resulting in early warnings to residents over concerns with water quality.
7.2.1	Stormwater and wastewater asset management planning	\$80 million ⁴³	5 years	\$400 million	All permitted drinking water, wastewater, and stormwater facilities identify and assess the condition of public water and sewer infrastructure.
7.2.2	Drinking water asset management planning	\$70 million	5 years	\$350 million	

⁴¹ This figure includes an estimated annual gap in water and sewer infrastructure needs. This is considered a conservative estimate using the best information available. As condition assessments are completed, this estimate is expected to increase. Ratepayers are the primary funding source for this investment gap.

⁴² Based on investment the State made in Flint for approximately 10 percent of the service line replacements, a similar amount may be needed for various other communities across the state.

⁴³ The average investment over the last three years is \$97 million; current SAW funding ends in 2018.

Rec. #	Description	Annual Investment Gap	Investment Term	Total Investment Gap	Investment Impact
7.3.2	Rural wastewater, potable water, and drain infrastructure	\$10 million	20 years	\$200 million	Five rural local units of government are selected each year for the research, planning, design, and/or construction of wastewater, potable water, or drain infrastructure projects to support rural economic development, public health and the environment.
7.6.7	Need-based septic system replacement and maintenance revolving loan program	\$20 million ⁴⁴	20 years	\$400 million	Onsite and community wastewater systems are maintained or replaced for those with demonstrated financial need protecting public health and environmental quality.
7.7.6	Water innovation partnerships	\$1 million	10 years	\$10 million	Michigan incorporates innovative technologies into infrastructure, resulting in reduced costs for residents and improved service.
7.8.1a	Dam database, inventory, and field assessments	\$2 million	One-time	\$2 million	The State, communities, and dam owners have decision-support tools and training to assess reinvestment and removal options for dams.
7.8.1b	Dam maintenance and removal	\$11.25 million	20 years	\$225 million	Michigan's 2,600 dams are maintained or removed, resulting in improved safety for unanticipated failures, improved fish and wildlife habitat, and better recreation opportunities.
Total				\$19 billion	

⁴⁴ This figure is based on the annual estimated cost of replacing 10 percent of failing septic systems. The State investment would subsidize low-income septic system owners who do not have resources to replace failing systems.

Asset management will help to ensure rates can fully align with infrastructure investment needs. The Council should work collaboratively with state departments to establish parameters for administration of these funding needs. In addition, a water infrastructure user fee could be established to support need-based infrastructure investments.

Addressing the Investment Gap

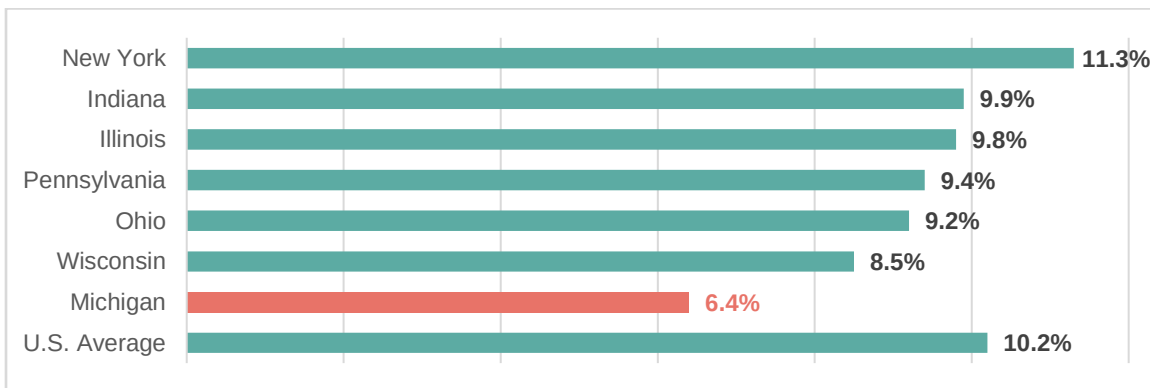
Michigan's infrastructure investment gap exceeds \$60 billion over the next 20 years with an **annual investment gap of nearly \$4 billion**, as seen in Exhibit 19.

EXHIBIT 19. Infrastructure Investment Gaps Summary

	Transportation	Water	Communications	Energy
Forecasted Annual Investment Gaps	Approximately \$2.7 billion	Approximately \$1 billion	Approximately \$70 million	N/A, largely private utility investment
Forecasted Investment Gaps Over the Next 20 Years	Approximately \$40 billion	Approximately \$19 billion ⁴⁵	Approximately \$600 million	N/A

As depicted in Exhibit 20, relative to neighboring states and the national average, Michigan underinvests in capital infrastructure spending at the state and local level (Deloitte 2016). Addressing this substantial gap will require a combination of local, state, federal, private, and user fee investments, as well as financing strategies to meet long-term needs.

EXHIBIT 20. State and Local Capital Spending Comparison



Note: Percent of total expenditure, annual average 2010-14.
Source: Deloitte 2016.

⁴⁵ This figure includes an estimated \$800 million annual gap in water and sewer infrastructure needs. This is considered a conservative estimate using best information available. As condition assessments are completed, this estimate is expected to increase and rate structures should be adjusted to serve as the primary source for funding this gap.

Potential Revenue Options

Exhibit 21 outlines examples of revenue sources that could provide funding for infrastructure needs. This is not an all-inclusive list of revenue sources; it does not include local user fees, federal funding opportunities, or private investment. This table and the descriptions that follow provide a menu of options for consideration to directly fund infrastructure needs or to provide revenue for debt service to finance long-term needs.

EXHIBIT 21. Examples: Revenue Generation Options

Potential Revenue Sources	Asset Type	Example Scenario	Estimated Annual Revenue Generation Potential
Dedicated sales tax for infrastructure	All infrastructure	1 percent increase	\$1.5 billion
Dedicated statewide property tax	All infrastructure	1 mill increase	\$325 million
Broadband service surcharge	Communications	\$1.54 per month surcharge on 2.7 million broadband service bills	\$50 million
METRO fee	Communications	11 cents per linear foot increase	\$50 million
Fuel tax	Transportation	10 cent per gallon increase	\$500 million
Local revenue generation options	Transportation	Up to \$40 county-wide registration fee or ten-cent county-wide gas tax	\$400-500 million
Mileage-based user fee	Transportation	1 cent per mile based on current average miles driven statewide	\$970 million
Nonmotorized transportation registration fee	Transportation	\$10 per year, for two million bikes, kayaks, canoes	\$20 million
Tolling	Transportation	5 cents per mile on 360 miles of US-23	\$138 million
Vehicle registration fee	Transportation	20 percent increase	\$200 million
Water infrastructure user fee	Water	\$1 per 10,000 gallons based on the state's annual water withdrawal	\$36 million

Definitions

- **Dedicated sales tax for infrastructure:** Sales taxes are collected when nonexempt goods and services are sold. A dedicated sales tax could be used to support infrastructure investment needs for all asset types. A constitutional amendment would need to be enacted, which would require a vote of the people.
- **Dedicated property tax for infrastructure:** Property taxes are a commonly used method of raising revenue to support public services and investment. Michigan provides funding to K–12 schools through a statewide dedicated property tax. A similar approach could be used to support infrastructure investments. A constitutional amendment may need to be enacted, which would require a vote of the people.

- **Broadband service surcharge:** There are approximately 2.7 million households with fixed, terrestrial broadband services. A surcharge placed on broadband bills could provide funding to support broadband access and adoption statewide.
- **METRO fee:** Telecommunications providers that own facilities located in a public right-of-way are subject to METRO fees that assess an amount for each linear foot of right-of-way use. Increasing the current fee from \$.05 to \$.16 could provide funding to support broadband access and adoption investment needs.
- **Fuel tax:** Fuel taxes are charged on gasoline sales to support transportation infrastructure on a per gallon basis. An additional fuel tax increase could generate funding to support road and bridge infrastructure investment needs.
- **Local revenue generation options:** Counties, cities, and villages supplement state aid with local funds. Currently, property taxes are the only locally controlled tax available for additional local funding. The Legislature could enable new methods of generating local revenue, such as regional-option sales taxes, gas taxes, vehicle registration fees, and land impact fees to invest in local road and transit infrastructure.
- **Mileage-based user fee:** An alternative or supplement to a fuel tax charges motorists based on the number of miles traveled. Depending on the complexity of the assessment, fees can be adjusted based on travel locations, times, congestion levels, road type, and ability of the user to pay.
- **Nonmotorized transportation registration fee:** Registration fees are a commonly used approach to support infrastructure investments for different modes of transportation. For example, motor vehicles, watercraft, and even airplanes are charged registration fees to support roads, harbors, and airports. Nonmotorized transportation registration fees on bicycles, kayaks, canoes, and other modes could generate revenue to support the development and maintenance of nonmotorized transportation routes.
- **Tolling:** Tolls are fees charged for passage on a public or private roadway that are used to support development and maintenance of roadways. Tolling on some Michigan freeways could provide funding to support road and bridge infrastructure investments needed for those freeways.
- **Vehicle registration fee:** Motor vehicles are required to register with the Secretary of State on an annual basis. These fees are used to support development and maintenance of roadways. An additional increase in the vehicle registration fee could generate funding to support transportation infrastructure needs.
- **Water infrastructure user fee:** Households and commercial operations use water for a variety of purposes such as cooking, cleaning, and hygiene. On a statewide basis, municipal water supplies withdraw approximately 360 billion gallons annually. A \$1 fee per 10,000 gallons could provide revenue to support water-related infrastructure investments (Great Lakes Commission 2015).

Financing Strategies

Historically, public funding for infrastructure has occurred on a “pay as you go” cycle in which annual operating and capital budgets allocate dollars to maintain or expand infrastructure. Increasingly, states and cities have relied on general obligation and other types of bonds to finance infrastructure projects. As states and countries diversify funding sources, some have set explicit limits or targets for levels of indebtedness. Oregon, for example, has capped the amount of debt the State will issue for infrastructure projects and has focused on other sources of funding such as fees, special revenues (e.g., lottery), and private investments (State of Oregon Office of the Governor 2012).

Today, best practice–level infrastructure management systems utilize a diverse mix of funding, including public and private investments, to maintain, improve, and expand infrastructure. In addition to the traditional public funding mechanisms like general funds and traditional bonds, some states and countries have utilized more innovative tools to ensure adequate capital to fund projects, and to improve efficiencies. These tools include infrastructure banks and P3s.

State Bond Financing

Bond financing is a funding strategy that involves the State borrowing money from bond holders with a promise to pay back the principal plus interest at a predetermined future date. This strategy lends itself well to some infrastructure projects. Bonding should only be used for projects with a long useful life, and bond funds should not be used to pay for operations. Bonds are generally structured to be paid back over the useful life of a project. The principal and interest on the bonds can be repaid with user fees or some other revenue source. One advantage of bond financing is that the users receiving the benefits can also be made to pay the costs of the system. For example, if bonds are used to pay for a water system, users can be charged for the debt service as part of their water bills. If funds were saved in advance to pay for a project, current taxpayers would be paying to support a project that benefits future taxpayers.

There are two primary types of bonds issued by the State of Michigan. General obligation (GO) bonds are backed by the full faith and credit of the State; nongeneral obligation (non-GO) bonds, also referred to as revenue bonds, are debt instruments supported by a dedicated revenue source or a state appropriation (Zin 2016).

GO bonds are provided for under Article IX, Section 15 of the Michigan Constitution. The full faith and credit pledge means that the debt service for these bonds has priority over other obligations. Basically, the State promises to do whatever it takes to pay these bonds, including raising taxes if necessary. Issuing GO bonds requires an affirmative vote of two-thirds of the Legislature, and a majority vote in a statewide general election.

Non-GO bonds are provided for under Article IX, Sections 9 and 13. The Legislature can authorize the issuance of these bonds through the enactment of statutes—a new statute is not needed every time bonds are issued. The Legislature can give the authority to issue bonds as needed to a government entity. Non-GO bonds are not backed by the full faith and credit of the State, and are subject to “appropriation risk,” meaning there is a risk that the Legislature will not appropriate sufficient funds to fully pay the debt service when bond payments are due. Non-GO bonds are seen as slightly riskier than GO bonds by lenders. They generally carry a lower bond rating and a slightly higher interest rate. Non-GO bonds are much more commonly issued due to the difficulty of issuing GO bonds.

The State should determine the most cost-efficient options over the longterm to fund and finance priority infrastructure needs. One financing option to consider is bond financing for priority infrastructure needs, given currently low interest rates, our favorable credit rating, and financing capacity. Michigan's current Moody's credit rating is Aa1 stable and our net tax-supported debt as a percentage of personal income is 1.8 percent compared to a median of 2.5 percent amongst other states. A bond could provide some funding for much needed investments in stormwater and drinking water asset management, critical drinking water infrastructure, road and bridge reconstruction, and expansion of broadband access statewide. Financing \$1 billion over 30 years at a 3 percent interest rate would require approximately \$50–\$55 million in annual debt service. This would equate to approximately \$13 per Michigan household annually or \$1.10 per month. The Council could advise on how the bond funding could be utilized and options for providing debt service in conjunction with appropriate authorities and agencies. Exhibit 22 includes an example of potential uses of an infrastructure bond.

EXHIBIT 22. Infrastructure Bond Example

Asset Type	Potential Investment	Example Investment
Water	Drinking water asset management	\$250 million
	Wastewater asset management	\$250 million
	Critical drinking water infrastructure	\$100 million
Transportation	State road and bridge reconstruction	\$250 million
	Matching funds for local transportation investments	\$100 million
Communications	Broadband access expansion	\$50 million
Total		\$1 billion

Infrastructure Banks

Infrastructure banks are state-owned banks that can finance and coordinate high-value infrastructure investments. Banks allow for borrowing (or loan guarantees) from public and private entities to fund public-serving infrastructure projects. Infrastructure banks can be used for projects requiring large lines of credit, which in some cases, allows an entity to multiply its infrastructure investment capacity. Infrastructure bank loans also use delayed-repayment mechanisms, which allows key projects to move forward even if they will not generate user fees or yield savings for many years (Miller et al. 2012).

Several states have public banks that play some role in infrastructure. One of the oldest such institutions is the Bank of North Dakota, although its infrastructure participation in recent years has been limited (Bank of North Dakota 2016). Created in 1994, the California Infrastructure and Economic Development Bank finances public infrastructure and private development to promote jobs, contribute to a strong economy, and improve quality of life (State of California 2015). The Pennsylvania Infrastructure Bank leverages state and federal funds to accelerate priority

transportation projects by providing low-interest loans (Pennsylvania Department of Transportation 2016). In addition, Connecticut recently established both an infrastructure bank to assist public and private entities with infrastructure financing and a green bank to finance energy efficiency projects (Connecticut Green Bank 2016; S.B. 402 2016).

Michigan may consider implementing a multisector infrastructure bank with a major focus on economic development as a solution to address the broad range of infrastructure needs. Legislation would need to be passed in Michigan to establish an infrastructure bank. Michigan has a history of comparable infrastructure financing mechanisms, including the Drinking Water State Revolving Loan Fund and the Clean Water State Revolving Loan Fund. A bank structured as an authority with a board could be aligned with the asset management planning and technical assistance body to vet and prioritize projects. The Council could serve as a planning and policy authority for an infrastructure bank in conjunction with appropriate boards and agencies. Exhibit 23 includes an example of potential uses of an infrastructure bank.

EXHIBIT 23. Infrastructure Investment Bank Example

Asset Type	Potential Investment	Example Annual Investment
Water	Drinking water system upgrades	\$50 million
	Community emergency response	\$25 million
	Septic system loan fund	\$20 million
Transportation	Local roads, bridges, and transit reconstruction	\$150 million
Communications	Broadband access expansion	\$25 million
Water and Transportation	Emergency needs	\$30 million
Total		\$300 million

Public-Private Partnerships

A **public-private partnership** is a long-term, performance-based, contractual arrangement between a public agency and a private sector entity. A P3 arrangement allows for the use of private dollars to construct a public asset, and the private investor is repaid through future, long-term revenue streams associated with constructed assets. P3s usually involve one or more private company investors, private equity funds, and/or institutional investors (Deloitte 2016).

In essence, P3 is another method available to public authorities to procure and deliver major infrastructure projects. P3s may take a variety of forms and generally involve some combination of key aspects of a project, including the design, construction, finance, operation, and maintenance. There is also a variety of payment mechanisms associated with P3 projects, which include user fees/tolls, service fee or availability payments, and milestone payments, among others. Financing

required for P3 deals may be raised by the private partner, or by the public authority, depending on the nature of the P3 transaction.

While P3 is not suitable for all infrastructure projects, on large or more complex projects it has proven to be effective at bringing innovation, optimized risk transfer, accelerated delivery, and a whole-life costing approach (that involve more sophisticated preventative and predictive asset management techniques, which can significantly reduce long-term cost of ownership of the asset) which can bring the lowest overall total cost of ownership to the public sector. Some form of P3s can be utilized in a number of sectors, including transportation, water and wastewater, social infrastructure (public buildings, universities, schools, court houses, corrections facilities, VA hospitals, social housing), energy and utilities, and technology (broadband, data centers).

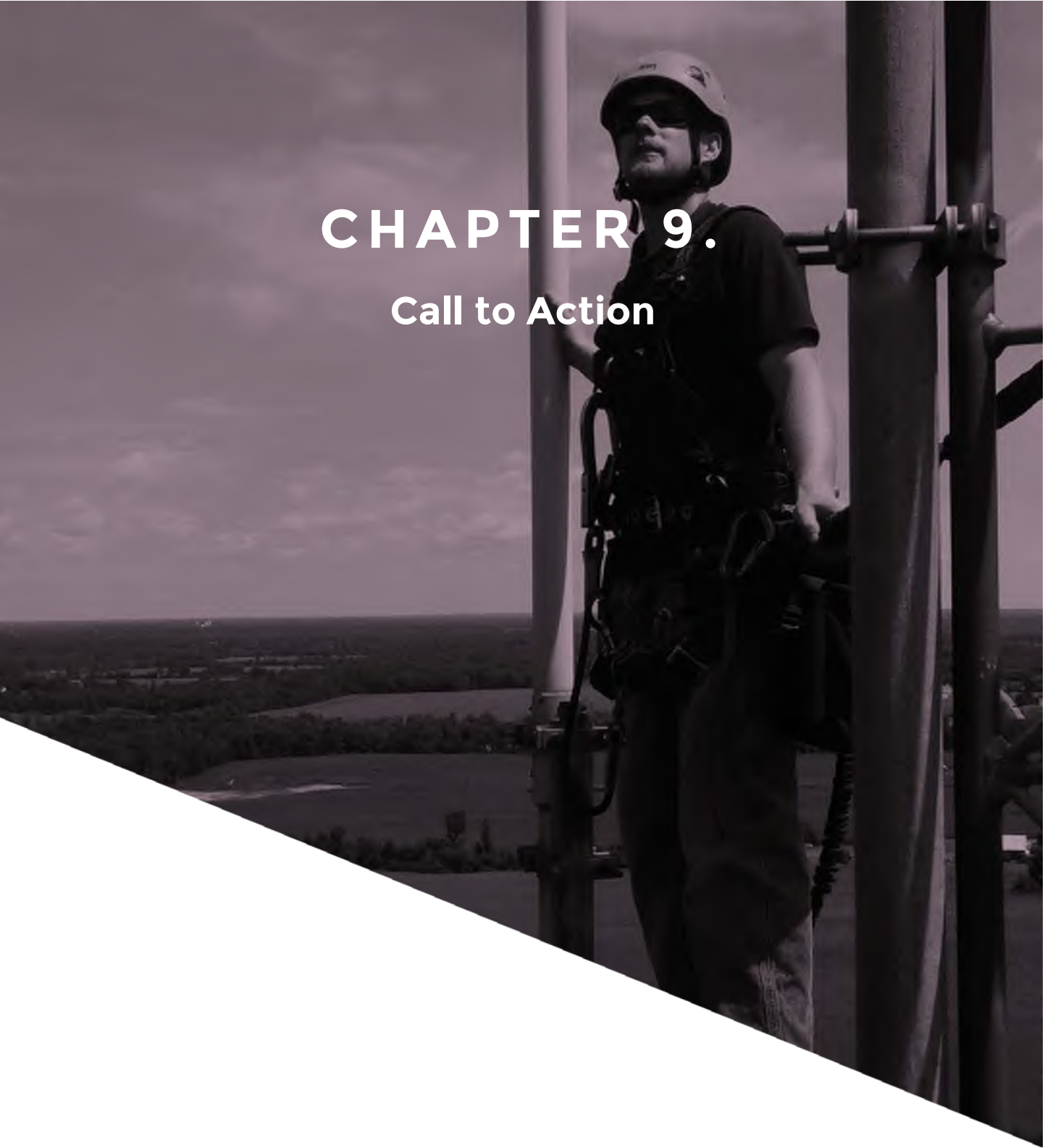
P3 may not deliver the cheapest source of financing but if well-structured can deliver infrastructure more efficiently and cost effectively over the whole life of the asset. The synergies inherent in private sector innovation across design, build, finance and maintenance can provide significant value to the public sector while ensuring high quality service to the public users. Better value includes fewer cost overruns and project delays (due to increased construction, operational, and demand efficiencies such that taxpayers or ratepayers do not bear costs if the project exceeds time expectations, goes over budget, or underperforms), as well as greater investment in durable, flexible infrastructure because of the private sector responsibility for the asset. All of this results in lower life-cycle costs through decreased energy usage, lower maintenance costs, and enhanced resiliency (Sabot 2014).

P3s build and operate many tolls and some bridges, water and energy assets, and airports. Virginia and Florida are two states that have led the way with the implementation of large-scale and innovative toll road P3s to improve infrastructure condition and boost capacity. Virginia has supplemented their economy with billions of dollars from the private sector leading to road upgrades such as express lanes and high occupancy toll (HOT) lanes. Florida encourages private investment in roads and has a Florida Council for P3s to share knowledge between the public and private sectors (Deloitte 2016).

The use of P3s is enhanced by the State of Michigan's creation of a public-private partnership commission, the use of design-build-finance for certain projects by the Michigan Department of Transportation, and encouragement for the state, municipalities, and private industry to undertake projects utilizing P3s. P3s are further encouraged by recent federal policy. Presently pending and working its way through the Michigan Legislature is a new P3 bill intended to further the development of infrastructure (Foster Swift 2016). This may provide a signal to private sector investors that the state is receptive to alternative project delivery options. The Council should explore opportunities to utilize P3s to support infrastructure investment needs, particularly in the transportation sector.

Conclusion

Michigan has an annual funding gap of nearly \$4 billion to address critically required infrastructure improvements and maintenance. Current taxes and user fees do not raise sufficient revenue and the state lacks sustainable funding sources to build infrastructure systems for today, as well as for the future. Coordinated asset management and the Michigan Infrastructure Council's leadership can help to prioritize infrastructure planning and investment, as well as provide incentives that encourage collaboration and efficiencies to deliver value to Michigan's residents, who pay the tab. User fees and existing ratepayer structures are the primary funding sources for improvements to infrastructure. Some one-time costs for system build-outs, management tools, and high-risk needs can be frontloaded in this low-interest environment. These one-time and immediate investments get Michigan back on track for safe and reliable infrastructure providing a return on investment, jobs, and economic prosperity. Now is the time to plan for the next 30 to 50 years, driving sound investments for the 21st century.

A full-page background image featuring a worker in a hard hat and safety harness standing on a metal structure, possibly a tower or scaffolding. The worker is looking off to the side. The background shows a vast landscape with fields and trees under a cloudy sky. The bottom-left corner of the image is cut off by a diagonal white line.

CHAPTER 9.

Call to Action

As called for in Governor Snyder's 2016-5 Executive Order, this report outlines ambitious goals for Michigan's infrastructure for the next 30 to 50 years. With implementation of these recommendations, Michigan will lead the nation in creating an integrated and holistic infrastructure planning, management, investment and delivery system—one that residents have confidence in. This system will prioritize public health and safety, and solidify Michigan's status as a global leader as we move forward into the 21st century.

Michigan's ability to achieve the 21st Century Infrastructure Commission's vision depends on policymakers taking action today, and prioritizing infrastructure as the foundation of strong communities and increased quality of life. Sound and modern infrastructure is vital to the health and well-being of the people of Michigan and will help support our growing economy.

Today, infrastructure is siloed in our state. There are 619 separate road agencies, 79 transit agencies, 1,390 drinking water systems, 1,080 wastewater systems, 116 electric utilities, ten natural gas utilities, and 43 broadband providers. Coordinated infrastructure planning and management is a necessary foundation to a successful future system. Michigan must implement an integrated asset management database system, create a Council to oversee long-term coordination and strategy, invest in infrastructure systems in a sustainable way, and remain committed to embracing emerging technologies. Achieving these overarching goals, in addition to the sector-specific recommendations put forth in this report, will ensure reliable, safe, efficient, and cost-effective systems.

As a first step, we must identify a strategic way to better manage our infrastructure in order to make informed decisions. Chapter 3 calls for the State to implement an effective statewide asset management system—one that collects reliable data and information across all types of infrastructure. A statewide coordinated infrastructure system would make Michigan a national leader in infrastructure management.

To initiate this game-changing endeavor, the Commission urges the Office of the Governor to establish a regional infrastructure pilot in early 2017 to begin operationalizing a statewide asset management database. By 2018, the Michigan Legislature should establish the Michigan Infrastructure Council, an entity that can leverage the lessons learned in the regional pilot and help to coordinate and unify infrastructure efforts across the state in the decades to come. The database and Council will help the State, regions, local governments, and utilities make informed, strategic decisions, save taxpayer dollars, create opportunities for coordinated infrastructure projects and ensure a 21st century infrastructure system.

Our residents deserve reliable, safe, efficient, and cost-effective infrastructure—a 21st century infrastructure system that creates a foundation for the future. This report is the first step in an entirely new approach to planning, managing, and delivering infrastructure in the state of Michigan. By outlining the challenges and opportunities facing Michigan's infrastructure system and identifying key recommendations for action, the Commission aimed to give policymakers and the public the information and vision needed to begin implementation. We must agree to modernize and invest in our infrastructure systems, recognizing that investments today will create jobs and economic opportunity, attract and retain businesses, and save taxpayer dollars. The Commission looks forward to working together to build this vision as Michigan looks to the 21st century and beyond.

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APPENDIX A.

Recommendations Table

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Communications	4.1	Making Michigan a Smarter State		
Communications	4.1.1	The State of Michigan should create the Consortium on Advanced Networks (see recommendation 4.2.1 below) to develop a vision, a plan, and execution roadmap to enact the state's digital transformation by investing in emerging technologies, supporting academia in research related to the IoT, building an adaptive IoT workforce, and forming appropriate policies to create a smarter state.	Immediate term (0-2 years)	Immediate term (0-2 years)
Communications	4.1.2	The Michigan Economic Development Corporation (MEDC), in partnership with relevant state agencies, should create a fund to support efforts that will make Michigan a global leader in smart technology development and deployment.	Short term (3-5 years)	Short term (3-5 years)
Communications	4.1.3	The DTMB should actively participate in relevant workgroups and committees of the National Association of Chief Information Officers and the International Telecommunications Union to position Michigan as a technological leader.	Immediate term (0-2 years)	Immediate term (0-2 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Communications	4.1.4	The Michigan Infrastructure Council (see Chapter 3) should engage in P3s to ensure IoT adoption is included in infrastructure planning and retrofit technologies are considered, pursued, and incorporated as they become available for upgrades and maintenance activities to existing and future infrastructure.	Short term (3-5 years)	Short term (3-5 years)
Communications	4.2	Improving Broadband Access and Adoption		
Communications	4.2.1	The Governor should issue an executive order establishing the Michigan Consortium on Advanced Networks, an advisory body comprising stakeholders from the nonprofit, public, and private sectors and academia. The group would be charged with improving coordination among stakeholders in addressing mobile and fixed broadband access and adoption issues in the state, as well as making Michigan a smarter state.	Immediate term (0-2 years)	Long term (11+ years)
Communications	4.2.1.1	Policy coordination: Support local and state agencies in working with the private sector to increase mobile and fixed broadband access in Michigan.		
Communications	4.2.1.2	Technical assistance: Provide guidance for local and state agencies working with the private sector to increase mobile and fixed broadband access in Michigan.		
Communications	4.2.1.3	Asset management: Continue and expand efforts to map and research mobile and fixed broadband access and adoption.		
Communications	4.2.1.4	Digital literacy education: Expand, improve, and create pragmatic digital literacy programs at the state and local level.		
Communications	4.2.1.5	Funding options: Provide funding—and help identify funding and financing from all available sources and programs—to entice investors to provide affordable mobile and fixed broadband access to households and businesses statewide, making Michigan a top-five state for mobile and fixed broadband access and adoption.		

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Communications	4.3	Securing Michigan's Digital Infrastructure		
Communications	4.3.1	DTMB should develop a ubiquitous enterprise log management as a service system, or cyber hub, ⁴⁶ that allows the cyber security ecosystem to understand new, emerging and historical cyber threats by leveraging advanced and predictive analytics.	Immediate term (0-2 years)	Immediate term (0-2 years)
Communications	4.3.2	DTMB should work to build a cyber-focused workforce, in partnership with the Merit Network, by continuing efforts of the Regional Cybersecurity Education Collaboration.	Immediate term (0-2 years)	Short term (3-5 years)
Communications	4.3.3	DTMB should increase Michigan Civilian Cyber Corps (MiC3) membership to 200 members and invest in development and training for the MiC3.	Short term (3-5 years)	Short term (3-5 years)
Communications	4.3.4	The Governor should create a shared virtual chief information security office to provide consulting and advisory services to multiple local governments.	Immediate term (0-2 years)	Immediate term (0-2 years)
Communications	4.3.5	DTMB should enhance threat intelligence gathering and sharing among states, federal agencies and private sector partners develop responses to common threats, in keeping with guidance published by the National Institute of Standards and Technology.	Short term (3-5 years)	Short term (3-5 years)
Communications	4.3.6	DTMB should advocate for changes to the state's Freedom of Information Act (FOIA) exemptions—which currently prevents Michigan agencies from communicating and coordinating with infrastructure asset owners about cyber and physical security threats/attacks—to allow for appropriate exemptions for agencies protecting Michigan's critical infrastructure.	Immediate term (0-2 years)	Immediate term (0-2 years)

⁴⁶ A cyber hub is designed to operationalize existing cyber data, information, and intelligence for the cyber security ecosystem to establish a common operating picture by leveraging predictive and real-time analytics. Cyber hubs provide decision making support to enable organizations to anticipate and respond to cyber events.

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Communications	4.3.7	Entities within the cyber security ecosystem should collaborate to develop a public awareness campaign and other learning opportunities to educate residents, consumers, and families about the reality of online risks and promote cyber safety practices among residents, particularly children and businesses.	Short term (3-5 years)	Short term (3-5 years)
Communications	4.3.8	Work with the cyber security ecosystem and other entities to design and encourage the adoption of a curriculum focusing on technology throughout the science, technology, engineering, and mathematics education system	Short term (3-5 years)	Short term (3-5 years)
Communications	4.3.9	Michigan should develop a next-generation solution to centrally manage identity and authentication management for workers, partners, and residents.	Short term (3-5 years)	Short term (3-5 years)
Energy	5.1	Resource Adequacy		
Energy	5.1.1	The Michigan Agency for Energy (MAE) and the MPSC should continue to work with MISO and other stakeholders to reform Michigan's current electric market structure by requiring all electric providers to protect their customers from massive outages due to lack of supply by securing adequate capacity resources.	Immediate term (0-2 years)	Ongoing efforts
Energy	5.1.2	MAE and the MPSC should closely monitor all proposed solutions to the energy supply concerns in the Upper Peninsula and work with stakeholders to ensure resolution implementation by 2019.	Immediate term (0-2 years)	Ongoing efforts
Energy	5.2	Energy Waste Reduction		
Energy	5.2.1	The Michigan Legislature should remove the artificial cap on how much utilities can spend on energy-efficiency programs and provide the MPSC with the ability to evaluate energy waste reduction like any other resource.	Immediate term (0-2 years)	Medium term (6-10 years)
Energy	5.2.2	The Michigan Legislature should ensure that there is no financial disincentive for the use of cost-effective energy waste reduction.	Immediate term (0-2 years)	Medium term (6-10 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Energy	5.2.3	The Michigan Legislature should remove the prohibition on on-bill financing for energy waste reduction efforts.	Immediate term (0-2 years)	Ongoing efforts
Energy	5.3	Cleaner Energy Sources		
Energy	5.3.1	The MPSC and MAE should continue to work together to ensure continued investment in energy waste reduction, meeting at least 15 percent or more of Michigan's energy needs by eliminating energy waste between now and 2025, as well as meeting any of its additional capacity needs from a combination of cleaner technologies, including renewables and natural gas.	Immediate term (0-2 years)	Medium term (6-10 years)
Energy	5.3.2	Through coordinated efforts, the MPSC, MAE, and MDEQ should continue to ensure that emissions from the electric power sector are reduced by helping utilities choose the cleanest energy sources for the future, in consideration with affordability and reliability.	Immediate term (0-2 years)	Medium term (6-10 years)
Energy	5.3.3	The MPSC and MAE should work to reduce barriers to additional cost-effective renewable energy investment by reducing barriers to interconnection, net metering, and siting.	Immediate term (0-2 years)	Ongoing efforts
Energy	5.4	Electric Reliability		
Energy	5.4.1	Michigan's utilities should take steps to expedite their response to outages and restore power to their customers in a timely manner by completing plans to deploy AMI while also evaluating additional measures, like vegetation management and other distribution investments. Smaller electric utilities that do not currently have plans to deploy AMI in their service territory should evaluate potential benefits and deploy where prudent and cost effective.	Immediate term (0-2 years)	Immediate term (0-2 years)
Energy	5.4.2	The MPSC and MAE should convene a stakeholder group with the aim of establishing a performance goal for CELID and CEMI metrics and requirements in order for utilities to provide information related to these metrics, as well as their current reliability reporting.	Immediate term (0-2 years)	Immediate term (0-2 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Energy	5.4.3	The MPSC should evaluate investments that provide greater insight into equipment condition and system loading, such as supervisory control and data acquisition, which will allow for greater insight into distribution system operation, enabling proactive maintenance to address problems prior to these issues resulting in an outage.	Immediate term (0-2 years)	Immediate term (0-2 years)
Energy	5.4.4	The MPSC should evaluate proposed new capital investments through a transparent, forward-looking distribution system planning process, and monitor proposed changes to the distribution system planning process for each utility as needed on an ongoing basis.	Immediate term (0-2 years)	Short term (3-5 years)
Energy	5.5	Natural Gas Safety		
Energy	5.5.1	The MPSC should consider further accelerating plans to replace at-risk natural gas distribution pipe beyond the currently planned 25- to 30-year window by evaluating utilities' current replacement timelines. Emphasis should be placed on coordinating replacements with local investment in other infrastructure asset categories to accelerate progress and leverage investment.	Immediate term (0-2 years)	Long term (11+ years)
Energy	5.6	Adaptable Regulation		
Energy	5.6.1	The Michigan Legislature, in consultation with MAE and the MPSC, should act to remove the barriers in the current CON process that prevent the MPSC from weighing all large investments against alternatives and determining the impact on reliability, affordability, adaptability, and protection of the environment.	Immediate term (0-2 years)	Immediate term (0-2 years)
Energy	5.6.2	The MPSC and MAE should continue efforts to ensure that Michigan's regulations are adaptable in the face of new technologies. The need for regulatory changes should be evaluated as new technologies emerge.	Immediate term (0-2 years)	Ongoing efforts

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Energy	5.7	Information Security		
Energy	5.7.1	The Michigan Legislature, together with MAE and the MPSC, should revise FOIA exemptions to allow the appropriate agencies to communicate with infrastructure asset owners about physical and cyber security, and alleviate concerns related to the security of sensitive information when the State is working with infrastructure asset owners.	Immediate term (0-2 years)	Immediate term (0-2 years)
Energy	5.8	Business Attraction and Economic Development		
Energy	5.8.1	The MPSC and MAE should work together with utilities and companies to expand opportunities for industrial customers to participate in programs that help them reduce energy bills, such as demand response programs.	Immediate term (0-2 years)	Immediate term (0-2 years)
Energy	5.8.2	The MPSC, MAE, and MEDC should confer regularly to continue improving the factors that impact business decisions and engage stakeholders about additional opportunities for business attraction.	Immediate term (0-2 years)	Immediate term (0-2 years)
Transportation	6.1	Road and Bridge Conditions		
Transportation	6.1.1	The Michigan Infrastructure Council and transportation agencies should work with the Michigan Legislature to identify and enact revenue options that will provide predictable and sustainable funding sufficient to return most higher level roads and bridges to good or fair condition.	Immediate term (0-2 years)	Long term (11+ years)
Transportation	6.2	Bridges and Culverts		
Transportation	6.2.1	State, county, and local agencies should design and install road-stream crossings to ensure safe pedestrian and vehicle passage, along with natural stream function and aquatic organism passage.	Immediate term (0-2 years)	Long term (11+ years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Transportation	6.2.2	MDOT and MDNR should continue to follow state and federal required inspection processes for bridges, as well as hydraulic and drainage analysis for culverts. These agencies should complete regular statewide inspections of all in-service bridges to determine and record conditions using the newest available technologies and techniques.	Short term (3-5 years)	Medium term (6-10 years)
Transportation	6.2.3	MDOT should work with local road agencies to encourage inspection of culverts greater than five feet in diameter at least once every five years. Inspection results should be included in local road agencies' asset management plans.	Short term (3-5 years)	Medium term (6-10 years)
Transportation	6.2.4	MDOT should undertake a pilot project to inspect and document all culverts running under state trunkline highways in one county, for the purpose of assessing data collection costs for a statewide asset management inventory of state highway culverts.	Immediate term (0-2 years)	Immediate term (0-2 years)
Transportation	6.3	Seasonal Weight Restrictions		
Transportation	6.3.1	MDOT and local road agencies should work together to improve regional consistency and the permitting process in order to create coordinated seasonal weight restriction systems between road agencies.	Short term (3-5 years)	Medium term (6-10 years)
Transportation	6.3.2	Based upon economic considerations, MDOT and local communities should evaluate and prioritize the need to convert additional roads to all-season conditions. Using the statewide asset management database (as referenced in Chapter 3), and in coordination with public agencies and private utilities, plan and fund the conversions to all-season roads in a timely and strategic manner.	Medium term (6-10 years)	Long term (11+ years)
Transportation	6.4	Transit, Passenger, and Freight Rail		
Transportation	6.4.1	The Michigan Legislature should enact alternative sources for transit funding or provide additional funding for the CTF to encourage robust bus transit, passenger rail, and rail freight systems in Michigan.	Immediate term (0-2 years)	Medium term (6-10 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Transportation	6.4.2	Transit agencies should integrate new technology into their transit services and work with MDOT to support their efforts to modernize their technology systems.	Immediate term (0-2 years)	Medium term (6-10 years)
Transportation	6.4.3	MDOT should continue to work in partnership with the railroads to develop components of the DIFT as warranted by increasing volumes of railroad traffic.	Immediate term (0-2 years)	Long term (11+ years)
Transportation	6.4.4	MDOT should identify current and future passenger and freight rail service needs and gaps in Michigan as part of its effort to update the federally required State Rail Plan and State Freight Plan.	Immediate term (0-2 years)	Short term (3-5 years)
Transportation	6.5	Soo Locks		
Transportation	6.5.1	The Michigan Legislature should pass a resolution to urge the federal government to expedite completion of the Economic Reevaluation Report currently being prepared by the U.S. Army Corps of Engineers and to provide the necessary funding to construct the new lock.	Immediate term (0-2 years)	Short term (3-5 years)
Transportation	6.6	Port Authority Landside Improvements		
Transportation	6.6.1	The Michigan Legislature should consider legislation that provides port authorities with the flexibility to form private sector partnerships for the purposes of developing contiguous and adjacent landside infrastructure consistent with the local vision for the port.	Immediate term (0-2 years)	Immediate term (0-2 years)
Transportation	6.7	Routine Port Maintenance		
Transportation	6.7.1	The Office of the Governor, Michigan's Congressional delegation, and the Michigan Legislature should encourage Congress to provide the necessary funds and encourage the U.S. Army Corps of Engineers to prioritize fully maintaining the federal navigation channels at their congressionally authorized dimensions to ensure that port conditions do not deteriorate.	Immediate term (0-2 years)	Ongoing efforts

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Transportation	6.7.2	The Conference of Great Lakes and St. Lawrence Governors and Premiers should analyze the dredging needs for individual docks and nonfederal navigation channels specifically, including privately owned facilities to the greatest degree possible.	Immediate term (0-2 years)	Ongoing efforts
Transportation	6.7.3	MDOT should encourage the appropriate state, county, and city road agencies to work together to perform infrastructure assessments that would evaluate the needs of “last mile” roads that serve as connectors linking port facilities with the highway system.	Immediate term (0-2 years)	Ongoing efforts
Transportation	6.8	Aviation		
Transportation	6.8.1	MDOT will complete a comprehensive assessment of general aviation needs across Michigan as part of the ongoing Michigan Airport System Plan update, as well as examine existing capacity, use, costs, and revenues the State receives in order to determine whether the system of airports properly supports the future needs of Michigan communities.	Immediate term (0-2 years)	Immediate term (0-2 years)
Transportation	6.9	Intelligent Vehicle Technology		
Transportation	6.9.1	The Michigan Legislature, Governor, and relevant stakeholders should pass, sign, and support the implementation of currently proposed legislation that will enable Michigan to stay at the forefront of the intelligent vehicle industry.	Immediate term (0-2 years)	Immediate term (0-2 years)
Transportation	6.9.2	MDOT and the MEDC should work with auto manufacturing companies, technology companies, private stakeholders, and Michigan universities to support the development of intelligent vehicle through investment in research, and develop a plan to invest in the installation of new technology.	Immediate term (0-2 years)	Immediate term (0-2 years)
Transportation	6.9.3	The Governor's Office and MDOT should promote Michigan as the focal point of the global intelligent vehicle industry.	Immediate term (0-2 years)	Ongoing efforts

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Transportation	6.9.4	MDOT and the MEDC should leverage unique partnerships between all governmental agencies, companies, universities, and other organizations to advance Michigan's intelligent vehicle industry.	Immediate term (0-2 years)	Ongoing efforts
Transportation	6.9.5	The Michigan Infrastructure Council (see Chapter 3) should include an emerging technologies group that is tasked with research, education, and coordination of implementing innovative technologies that impact infrastructure planning and delivery, particularly the emerging autonomous vehicle industry.	Short term (3-5 years)	Ongoing efforts
Transportation	6.10	Signalized Intersection Technology		
Transportation	6.10.1	The Michigan Infrastructure Council should work with local road agencies to elevate traffic signal infrastructure as a key asset of similar importance to road condition and bridge condition and encourage each road agency to pursue a goal to modernize and optimize the timing of 90 percent of traffic signals in congested corridors with current and emerging technologies, including signal communications, interconnectivity, transit signal priority, and vehicle detection equipment,	Short term (3-5 years)	Medium term (6-10 years)
Transportation	6.11	Nonmotorized Transportation		
Transportation	6.11.1	MDOT should continue to work with road agencies to encourage full integration of bicycle and pedestrian planning into transportation infrastructure planning, including by implementing performance measures that measure the connectivity of nonmotorized facilities.	Immediate term (0-2 years)	Medium term (6-10 years)
Transportation	6.11.2	MDOT and MDNR should work with regional transportation coordinating bodies to encourage or incentivize communities to coordinate their nonmotorized investments and work toward improving connectivity across communities.	Immediate term (0-2 years)	Medium term (6-10 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Transportation	6.11.3	MDOT and MDNR should study the potential to create new incentives or realign existing incentives to further enhance and encourage coordinated nonmotorized planning, both between communities and at the regional level.	Immediate term (0-2 years)	Short term (3-5 years)
Transportation	6.12	Right-sizing		
Transportation	6.12.1	MDOT should identify and work with stakeholders across all modes to complete a comprehensive assessment that determines the kind of transportation infrastructure that is needed—and where—to support the industries and communities Michigan expects to have in the future.	Immediate term (0-2 years)	Short term (3-5 years)
Transportation	6.12.2	MDOT should continue to work with local agencies and transportation stakeholders to identify areas of the state where excess road infrastructure undermines the potential for community success, develop context sensitive solutions to transportation problems, and encourage the use of design solutions that make more effective and beneficial use of the excess road capacity.	Immediate term (0-2 years)	Ongoing efforts
Transportation	6.12.3	The Michigan Infrastructure Council should work with local agencies to encourage and incent cross-collaboration and opportunities for consolidation to provide transparent, safe, efficient, and cost-effective solutions.	Immediate term (0-2 years)	Ongoing efforts
Transportation	6.12.4	MDOT, metropolitan planning organizations, and regional planning organizations should encourage greater coordination between agencies and provide technical assistance to local agencies seeking solutions that help right-size their infrastructure.	Immediate term (0-2 years)	Ongoing efforts
Transportation	6.13	Act 51 Review		
Transportation	6.13.1	The Michigan Infrastructure Council should work with the Michigan Legislature and transportation stakeholders to revise Act 51 to make the distribution of state transportation revenues simpler, equitable, more transparent, and more accountable, while improving system outcomes.	Immediate term (0-2 years)	Medium term (6-10 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Transportation	6.14	Local Revenue Generation Options		
Transportation	6.14.1	The Michigan Legislature should enact legislation to enable new methods of generating local revenue to increase transportation investment including, but not limited to, a regional-option gasoline tax and impact fees from land developments that burden road systems or from permits for driveways that diminish traffic flow. Additional legislative considerations should include regional-option sales taxes, levied in addition to the Michigan sales tax, which are used for transit operations in many states and could be made eligible for road and transit infrastructure use as well as regional-option vehicle registration surtax.	Immediate term (0-2 years)	Long term (11+ years)
Transportation	6.15	Road and Bridge User Fees		
Transportation	6.15.1	MDOT and the DTMB should pilot test a per-mile fee system (such as GPS-based) in Michigan and use that test to become the first state to distribute user fees among road jurisdictions or within regions based on the miles of travel in each jurisdiction or region.	Immediate term (0-2 years)	Medium term (6-10 years)
Transportation	6.16	Tolling		
Transportation	6.16.1	MDOT should position Michigan to apply for the Interstate System Reconstruction and Rehabilitation Pilot program (ISRRPP) if one of the openings becomes available.	Immediate term (0-2 years)	Short term (3-5 years)
Transportation	6.16.2	The Michigan Legislature should enact a bill authorizing toll finance as an option for road finance in Michigan to indicate to the Federal Highway Administration that Michigan is ready to implement a pilot tolling project through the ISRRPP.	Immediate term (0-2 years)	Medium term (6-10 years)
Transportation	6.16.3	MDOT should work with the Office of the Governor and the Michigan Legislature to encourage Michigan's Congressional delegation to authorize toll finance on existing federal-aid roads.	Immediate term (0-2 years)	Short term (3-5 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.1	Ensuring Public and Environmental Health		
Water	7.1.1	The MDEQ should provide financial assistance to communities in need to invest in replacing aging infrastructure where there are immediate risks to public health or the environment due to lagging water infrastructure investments.	Immediate term (0-2 years)	Long term (11+ years)
Water	7.1.2	The MDEQ should develop an outcome-based regulatory framework that ensures compliance is achieved, while enabling flexibility of means and methods through a permitting system that supports innovation to achieve public and environmental health goals. State and local programs should be revised to achieve these outcomes.	Short term (3-5 years)	Medium term (6-10 years)
Water	7.1.3	The MDEQ should use resources such as the recommendations of the National Drinking Water Advisory Council, municipal utilities, current U.S. Environmental Protection Agency (U.S. EPA) standards, and evolving research to inform legislative updates to the regulation of drinking water.	Immediate term (0-2 years)	Long term (11+ years)
Water	7.1.4	The MDEQ should provide grants and technical assistance to schools to develop and implement a science-based drinking water quality testing and remediation program for lead and other contaminants.	Immediate term (0-2 years)	Medium term (6-10 years)
Water	7.1.5	The MDEQ and MDHHS should incorporate science-based research in establishing drinking water standards and evaluate sources of drinking water contamination as technology advances, enabling better detection of pollutants to determine whether further controls are warranted in drinking water and wastewater systems.	Immediate term (0-2 years)	Ongoing efforts
Water	7.1.6	The MDEQ should continue to provide funding through the Clean Michigan Initiative (CMI) to assist with cleanup efforts of contaminated properties that threaten public health and drinking water supplies.	Immediate term (0-2 years)	Long term (11+ years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.1.7	The MDEQ and MDHHS, local municipalities, and utilities should expand public outreach, engagement, and state and local communication efforts regarding regulatory standard to manage risk and ensure public and environmental health are maintained, and the necessity of water supply, sewer, and stormwater investments.	Immediate term (0-2 years)	Ongoing efforts
Water	7.1.8	The MDEQ and MDHHS, in partnership with drinking water system operators, regional partners, and federal agencies, should expand comprehensive real-time surface and groundwater monitoring to detect potential threats to water supplies, develop early responses, and provide regular public reporting.	Short term (3-5 years)	Long term (11+ years)
Water	7.2	Water Asset Management		
Water	7.2.1	The MDEQ should compile and evaluate asset management plans submitted under the first phase of the Stormwater, Asset Management, and Wastewater program. If necessary, the program should be updated to ensure that completed asset management plans are comprehensive and provide sufficient detail for planning purposes and meet MDEQ criteria.	Immediate term (0-2 years)	Medium term (6-10 years)
Water	7.2.2	The MDEQ should expand the current SAW program, to provide a portion of the funding necessary to complete condition assessments and the development of asset management plans for drinking water supply systems.	Immediate term (0-2 years)	Medium term (6-10 years)
Water	7.3	21st Century Infrastructure Systems		
Water	7.3.1	The Michigan Infrastructure Council and other asset management entities should partner with economic development entities to identify and prioritize areas for targeted infrastructure water, sewer, and stormwater replacements or upgrades.	Immediate term (0-2 years)	Medium term (6-10 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.3.2	The Michigan Department of Agriculture and Rural Development (MDARD) should help support access to wastewater treatment capacity, potable water, and drain infrastructure in rural communities to promote land-based industries such as food, fiber crops, tourism, and mining, in order to keep rural communities competitive in a global economy.	Immediate term (0-2 years)	Long term (11+ years)
Water	7.3	Understanding Risk		
Water	7.3.1	The State of Michigan, local municipalities, and utilities should expand public outreach, engagement, and state and local communication efforts regarding how regulatory standards are developed to manage risk and ensure public and environmental health are maintained, as well as why water supply, sewer, and stormwater investments are necessary	Immediate term (0-2 years)	Ongoing efforts
Water	7.3.2	The State of Michigan, in partnership with drinking water system operators, regional partners, and federal agencies, should expand comprehensive real-time surface and groundwater monitoring to detect potential threats to water supplies, develop early responses, and provide regular public reporting	Immediate term (0-2 years)	Long term (11+ years)
Water	7.4	Fiscally Sustainable Water, Sewer, and Stormwater Pricing Models		
Water	7.4.1	Through new policy, state auditing, regulatory processes, and technical support, Treasury and MDEQ should require self-sufficient transparent operation of enterprise organizations for water, sewer, and stormwater utilities that are supported by rate structures that cover all capital, operation, maintenance and replacement expenditures based on up-to-date asset management plans.	Medium term (6-10 years)	Medium term (6-10 years)
Water	7.4.2	Utilities should engage in customer outreach when developing financing and ratemaking processes for all water, sewer, and stormwater utilities to achieve greater degrees of transparency.	Short term (3-5 years)	Medium term (6-10 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.4.3	The MDEQ and Treasury should evaluate and modify Michigan's Water Pollution Control Revolving Fund, better known as the State Revolving Fund (SRF), to increase opportunities for participation in the program.	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.4.4	The Michigan Legislature should adopt legislation authorizing stormwater utilities that is consistent with the <i>Bolt v. City of Lansing</i> ⁴⁷ decision, establishes the requirements for structuring and charging a fee, and provides a streamlined process for local adoption.	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.4.5	Water utility rate structures should incorporate incentives to promote water-use efficiencies to reduce operating costs and delay or eliminate the need for capital investment.	Immediate term (0-2 years)	Medium term (6-10 years)
Water	7.5	Green Infrastructure		
Water	7.5.1	The Michigan Department of Licensing and Regulatory Affairs (LARA), MDEQ, MDNR, and MDOT should encourage the integration of low-impact development/design standards and green infrastructure for stormwater management.	Immediate term (0-2 years)	Short term (3-5 years)
Water	7.5.2	To enhance community resiliency and optimize costs, the MDEQ and MDNR should facilitate the development of tools that enable stormwater and wastewater system owners, managers, and operators to fiscally and operationally manage green infrastructure through asset management plans.	Medium term (6-10 years)	Long term (11+ years)
Water	7.5.3	Treasury and the MDEQ should update and revise funding and financing mechanisms that support infrastructure investments to incent evaluation and implementation of both efficiency-oriented approaches and green infrastructure.	Immediate term (0-2 years)	Immediate term (0-2 years)

⁴⁷ The *Bolt v. City of Lansing* decision has precluded most municipalities in Michigan from establishing stormwater utilities. The decision requires stormwater assessment to be based on the unique contributions of individual properties.

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.5.4	The MDEQ should periodically review and revise its programs and permitting requirements to ensure that engineering and design practices for sanitary sewer overflow (SSO) and combined sewer overflow (CSO) correction and stormwater management are based on assumptions that anticipate increased storm intensity and/or frequency.	Immediate term (0-2 years)	Medium term (6-10 years)
Water	7.5.5	Drinking water, wastewater, and stormwater agencies should evaluate the resiliency of systems and facilities that enhance a community's readiness for increased storm intensity and/or frequency as well as their timely recovery as part of their asset management planning.	Immediate term (0-2 years)	Medium term (6-10 years)
Water	7.5.6	The MDEQ, MDARD, and county drain commissioners should develop draft revisions and then work with other stakeholders to provide recommendations to the Michigan Legislature to update the Michigan Drain Code (if appropriate) and municipal separate storm sewer system (MS4) program to better facilitate joint action and collaboration among jurisdictions to manage stormwater on a watershed basis. Chapter 22 of the drain code should be updated to allow petitions to request development of collaborative watershed management plans as well as watershed-based engineering and design studies.	Short term (3-5 years)	Medium term (6-10 years)
Water	7.5.7	The MDEQ, MDARD, and county drain commissioners should develop draft revisions then work with other stakeholders to provide recommendations to the Michigan Legislature to address inconsistencies between the drain code and MS4 programs, with a goal of more explicitly authorizing projects focused primarily on management of water quality, especially in urbanized areas.	Short term (3-5 years)	Medium term (6-10 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.5.8	Relevant state agencies, including the Department of Technology, Management, and Budget, and the MDEQ should assess properties to identify and implement opportunities to use green infrastructure to manage stormwater. The MDNR and MDOT should be the first agencies to conduct this evaluation.	Short term (3-5 years)	Medium term (6-10 years)
Water	7.6	Onsite Well and Wastewater Treatment Systems		
Water	7.6.1	The MDEQ, Michigan Department of Health and Human Services (MDHHS), and LARA should revise regulations to require county and municipal governments, as well as water and sewer utilities, to use planning and permitting processes, taxes, fees, and other policies to promote connection to public water supply and wastewater treatment systems when they are available or when a new or expanded municipal system would be cost effective.	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.6.2	The MDEQ, MDHHS, and LARA, in partnership with local health departments, should encourage local governments to adopt ordinances requiring new homes and businesses with failed onsite wastewater treatment systems to connect to established community systems if they are available within 200 feet, consistent with Michigan Public Health Code (Act 368).	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.6.3	The Michigan Legislature should pass new legislation that would enable local governments to adopt ordinances requiring homes and businesses to connect to community drinking water systems when onsite water wells fail if they are within 200 feet of an existing system.	Immediate term (0-2 years)	Immediate term (0-2 years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.6.4	Communities should use Section 208 of the federal Clean Water Act to plan wastewater treatment facilities under an area-wide wastewater treatment management plan. In such cases, the MDEQ should use the permissive authority granted under Act 451, Part 21, Rule 39 to ensure that state or national permits (e.g., National Pollutant Discharge Elimination System) are addressed consistently with the approved Section 208 plan.	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.6.5	The MDEQ and local health departments should strengthen permitting requirements to allow community systems only where a municipal system connection is not available, cost effective, or environmentally necessary. Community systems should be adaptable to future increases in the number of users, demonstrate a financially supported asset management plan, and provide for eventual connection to a municipal system.	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.6.6	The MDEQ and MDHHS should work with the Michigan Legislature and local public health departments to update Michigan's Statewide Sanitary Code. The revised code should include 1) inspections of septic and community systems on a routine basis (e.g., every five years); 2) an approval route for alternative systems where public health or environmental quality is at risk; 3) minimum requirements for permitting; 4) a local health department-based, statewide registry of septic systems, including location, installation, and inspection dates; and 5) requirements for maintenance, pumping, repair, or replacement based on inspection results.	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.6.7	The MDEQ and MDHHS should develop a financing mechanism such as a low-interest revolving loan fund or loan loss reserve program to support maintenance and replacement of existing onsite and community systems for system owners with a demonstrated need for financial assistance.	Immediate term (0-2 years)	Long term (11+ years)

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.7	Embracing New Technology to Develop 21st Century Utilities		
Water	7.7.1	The MDEQ, municipalities, and local utilities should put in place a process to periodically review and update new technologies, procurement manuals, or standard operating practices to allow for open competition for technology and materials meeting relevant professional standards (e.g., American Water Works Association, Michigan Water Environment Association).	Short term (3-5 years)	Medium term (6-10 years)
Water	7.7.2	The MDEQ, municipalities, and local utilities should put in place a process to periodically review and update regulatory programs, implement methods of continuous improvement, and create standard work to further enable innovative approaches to achieve environmental protection and public health outcomes, as well as to control costs.	Short term (3-5 years)	Medium term (6-10 years)
Water	7.7.3	The MDEQ should work with municipal utilities to amend the current wastewater regulatory framework to advance the State of Michigan's Water Resource Recovery Facility framework and educate municipalities about the benefits of these approaches.	Medium term (6-10 years)	Medium term (6-10 years)
Water	7.7.4	The MDEQ should work with municipal utilities to amend the current drinking water regulatory framework to advance the development of 21 st century water utilities and inform municipalities about the benefits of these approaches.	Medium term (6-10 years)	Medium term (6-10 years)
Water	7.7.5	The MDEQ should encourage and incent strategies like resource recovery, as well as energy conservation and management options at wastewater and drinking water facilities, to help conserve resources and drive down costs. Revisions to Michigan's revolving loan fund could help incent those changes.	Medium term (6-10 years)	Medium term (6-10 years)
Water	7.7.6	The MDEQ should support innovation through partnerships and or funding with Michigan universities to expand research programs in the drinking water and wastewater fields.	Short term (3-5 years)	Ongoing efforts

Asset Type	Rec. #	Rec.	Implementation Start	Implementation Complete
Water	7.7.7	The MDEQ and water utilities should support new and emerging cost-effective technologies (such as smart metering and loss management technology) through permitting requirements that integrate water utilities with innovative communication and energy networks.	Immediate term (0-2 years)	Immediate term (0-2 years)
Water	7.8	Dams		
Water	7.8.1	The MDEQ's Dam Safety Program should maintain a publicly accessible geospatial data layer within the statewide asset management system that includes the number, condition, risk, and ownership of public, and private, regulated and nonregulated dams in the state. Working with partner organizations, the MDEQ should develop publicly available decision-support tools and training programs to assess risk, reinvestment and removal options for dams and low-head barriers.	Short term (3-5 years)	Long term (11+ years)

APPENDIX B.

Public Engagement

Governor Snyder launched the 21st Century Infrastructure Commission on March 10, 2016. The goal of this Commission was to identify long-term strategies to help ensure that Michigan's infrastructure is updated and efficient. The 27-member Commission comprises industry experts from business, government, and infrastructure-related fields.

The Commission recognized early on that public engagement would be key to ensuring that the needs and expectations of Michigan residents are reflected in their final recommendations. To this end, the Commission developed a public engagement strategy with the following goals:

- Gather feedback and input from the public, both in person and online.
- In an effort of transparency, provide regular updates from the Commission.
- Increase exposure to the importance of creating a 21st century infrastructure plan and strategy via the listening tour stops.

Public Engagement Schedule

The following graphic outlines the public engagement schedule that commissioners engaged in throughout this process. Commissioners participated in three stakeholder roundtable discussions and three listening tour events hosted in six locations, traveling across Michigan between July and September 2016 to meet with residents and learn about their infrastructure needs.

LISTENING SESSIONS AND STAKEHOLDER DISCUSSIONS THROUGHOUT THE STATE

TRAVERSE CITY STAKEHOLDER ROUNDTABLE DISCUSSION

Small-business owners, community leaders, and local economic developers

TOPICS • Rural energy distribution • Agricultural processing waste management • Difficulties local governments face when trying to raise revenue for infrastructure investment	• Ensuring long-term sustainability of infrastructure systems • High-quality cell phone coverage • Solar and renewable energy

WEST MICHIGAN LISTENING TOUR

Over 60 members of the public as well as community and business leaders from the West Michigan region

TOPICS • Public education on the benefits of well-coordinated and well-planned infrastructure systems • Mobile congestion issues • High transportation costs for businesses	• Ensuring public safety when planning and managing public transportation, especially for special needs populations • Need for intermodal transportation systems

ESCANABA STAKEHOLDER ROUNDTABLE DISCUSSION

Sixteen small business owners, community and business leaders, and economic development representatives

TOPICS • Broadband access in rural areas of the state to help small businesses succeed and allow young talent to live and work anywhere	• Rail investment and maintenance needed, especially for short-line service • Stability of energy prices and delivery

NORTHERN MICHIGAN LISTENING TOUR

Over 100 members of the public as well as community and business leaders from the Northern Michigan region

TOPICS • Increase access to high-speed Internet and broadband • Lack of investment in the Soo Locks	• Sustainable, renewable, and efficient energy infrastructure

FLINT STAKEHOLDER ROUNDTABLE DISCUSSION

Flint and Genesee County community leaders and residents and members of the Flint Water Interagency Coordinating Committee

TOPICS • Lack of resources, tools, and funding for local governments in regards to infrastructure maintenance and investment	• The need for Michigan to have safe, reliable, and affordable water infrastructure

SOUTHEAST MICHIGAN LISTENING TOUR

Over 50 members of the public, as well as community and business leaders from the region, and representatives from the Detroit RiverFront Conservancy, Eastern Market, and the Detroit Experience Factory

TOPICS • Capacity issues of infrastructure systems • Embrace future "smart" technologies • Public safety when planning and managing public transportation	• Investment in high-quality, safe bike infrastructure • Regional transit system

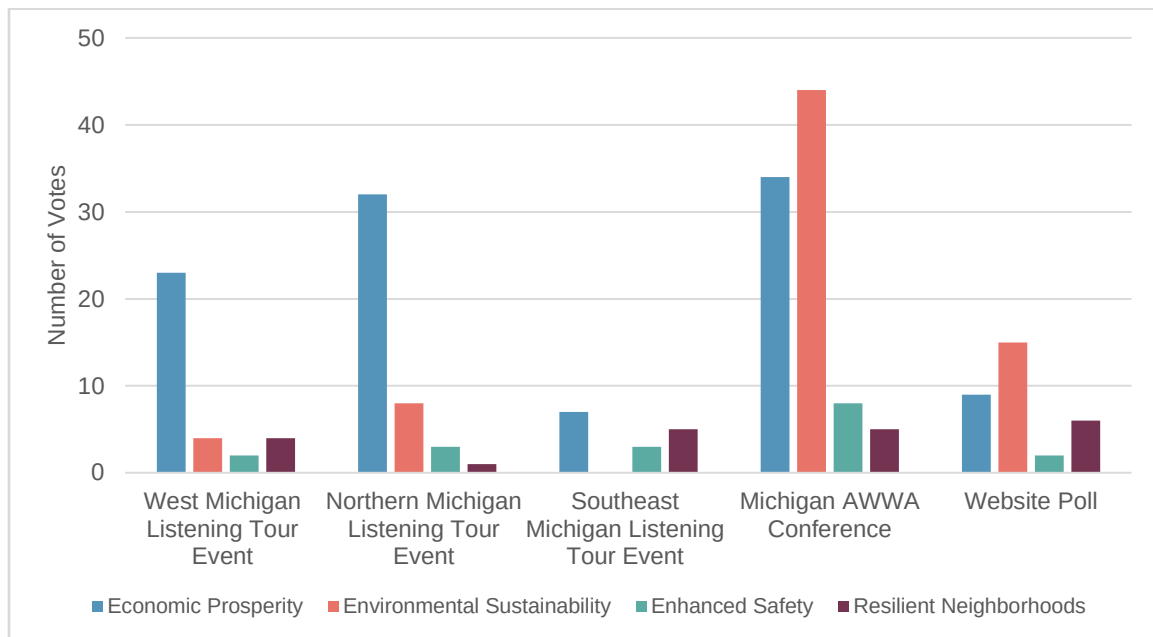


Feedback from Public Engagement

At each of the public outreach events hosted by the Commission, residents raised the need for a statewide, comprehensive asset management program, the expectation of affordable and safe water and sewer systems, and the need to embrace emerging “smart” technologies. In order to engage with and receive additional feedback from Michiganders statewide, commissioners solicited comment through their website (miinfrastructurecommission.com) and a public email address. Over 2,539 individuals visited the website, 176 answered poll questions, and 69 comments were posted to a public discussion board. Results of these interactions were compiled and presented to the Commission on a regular basis to help inform their decisions.

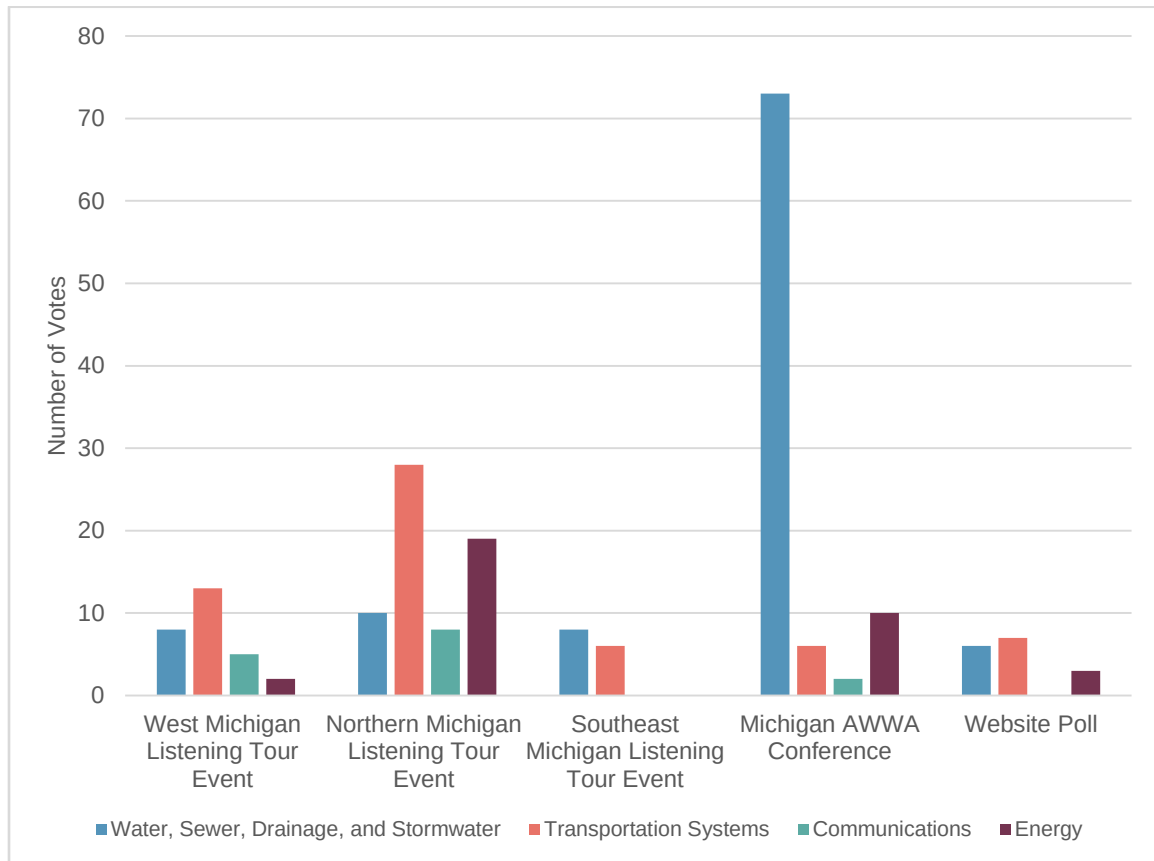
The public participated in multiple polls online and at listening tour events regarding the importance of infrastructure investment, which the Commission utilized while developing recommendations. Below are graphs indicating the results of these polls as of October 29, 2016.

EXHIBIT 24. Biggest Benefit of 21st Century Infrastructure



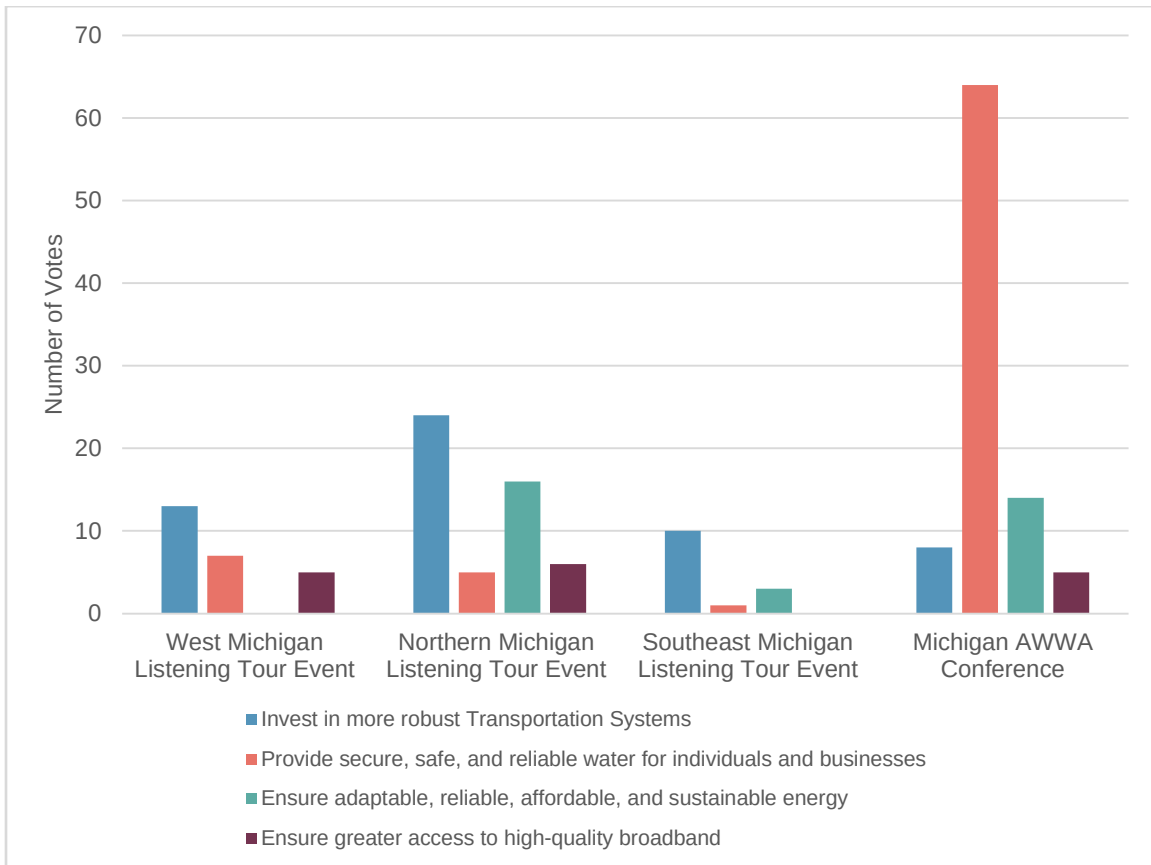
Source: Responses collected at three listening tours across the state and comments received through the Michigan Infrastructure Commission website.

EXHIBIT 25. Most Important Type of Infrastructure by Region



Source: Responses collected at three listening tours across the state and comments received through the Michigan Infrastructure Commission website.

EXHIBIT 26. Best Infrastructure Systems to Retain and Attract Residents and Businesses



Source: Responses collected at three listening tours across the state and comments received through the Michigan Infrastructure Commission website.

The following table provides a more detailed assessment of the major themes commissioners heard from listening tour attendees and roundtable discussion participants. A dot next to a theme indicates it was brought up by an attendee at the corresponding event.

EXHIBIT 27. Themes by Region

	Traverse City Roundtable	West Michigan Listening Tour	Escanaba Roundtable	Northern Michigan Listening Tour	Flint Roundtable	Southeast Michigan Listening Tour
Overarching Themes						
Create, maintain, and incentivize a comprehensive asset management program	●	●	●	●	●	●
Ensure long-term sustainability of infrastructure systems	●	●	●	●		●
Fix capacity issues with current infrastructure systems	●	●	●			●
Provide efficient, sustainable, affordable, cost-effective, and reliable infrastructure systems	●	●	●	●		●
Embrace future or “smart” technology	●	●	●	●	●	●
Utilize P3s	●	●	●	●		●
Water/Wastewater/Stormwater/Drainage						
Provide affordable and safe water and sewer systems	●	●	●	●	●	●
Manage and fund stormwater drains in a sustainable, comprehensive manner					●	●
Help local governments finance the creation and maintenance of culverts					●	
Educate the public on well and septic maintenance			●	●		●
Regulate and manage private property drinking water and sewer systems			●	●		
Communications and Energy						
Increase access to high-speed Internet and broadband	●	●	●	●		●
Address rural energy distribution issues (natural gas and propane)	●		●	●		
Ensure high-quality and reliable cell phone service	●		●	●		
Provide sustainable, renewable, and efficient energy infrastructure		●	●	●	●	●
Transportation Systems						
Ensure public safety when planning and managing public transportation, especially for special needs populations		●		●	●	●

	Traverse City Roundtable	West Michigan Listening Tour	Escanaba Roundtable	Northern Michigan Listening Tour	Flint Roundtable	Southeast Michigan Listening Tour
Transportation Systems						
Provide intermodal transportation systems	●	●		●	●	●
Invest in Soo Locks maintenance and the building of a new lock	●	●	●	●	●	
Plan for local capacity issues during peak tourism time	●					
Address mobile congestion issues		●				●
Transportation system repair needed	●	●	●		●	●
Address high transportation costs for businesses		●	●	●		
Create and utilize interconnected port and rail systems		●	●	●		
Seasonal weight restrictions on roadways are a hindrance to businesses			●			
Invest in high-quality, safe bike infrastructure			●			
Invest in air travel and commuter rail development that encourages tourism and local economic development			●	●		
Regional transit systems needed						●
Diversify transportation assets			●	●		
Policy and Funding						
Lack of resources, tools, and funding for local governments	●	●	●	●	●	●
Connect small businesses and communities to grant and financing opportunities	●				●	
Lack of new tools for local economic development		●				●
Create and enforce standards for basic levels of function and reliability for all infrastructure systems		●				
Reward/do not punish cities that invest in infrastructure without waiting for an emergency	●	●	●	●		
Spread investment costs across all current and future users		●				
Utilize user fees, local millages, low- and no-interest loans, and revolving loan funds		●				●
Better support for local governments in asset management and planning			●	●	●	●

	Traverse City Roundtable	West Michigan Listening Tour	Escanaba Roundtable	Northern Michigan Listening Tour	Flint Roundtable	Southeast Michigan Listening Tour
Policy and Funding						
Coordinate state agencies to jointly review routing and citing of permit applications				●		
Strategically invest and make efficient use of infrastructure		●	●	●		●
Redesign revenue collection systems						●
Other						
Invest in infrastructure workforce development	●	●	●	●	●	●
Educate the public on the benefits of well-coordinated and well-planned infrastructure systems	●	●				
Invest in systems that protect the environment	●		●	●		●
Engage younger generations in the infrastructure policy debate			●	●		
Prioritize public health in infrastructure planning and investment					●	
Enhance collaboration among service providers						●
Involve the deaf community, other special needs communities, and non-English-speaking communities in the planning of infrastructure systems					●	

APPENDIX C.

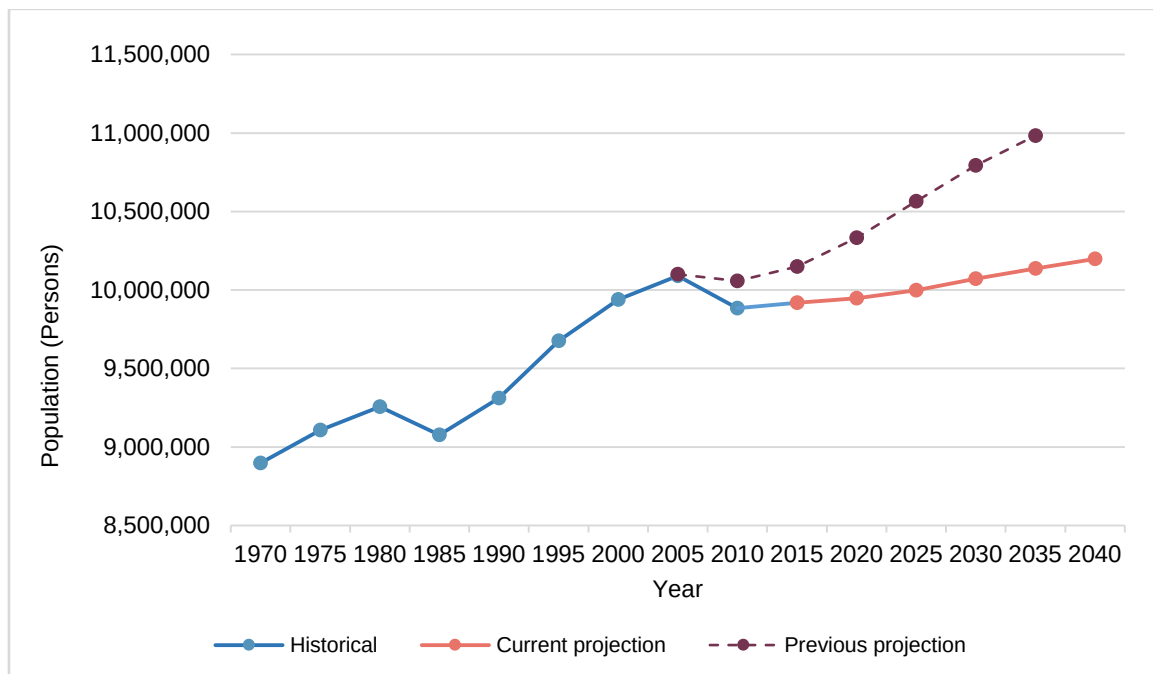
Demographic Trends and Forecasts

Michigan's demographic past and future add challenges to adequately funding its infrastructure systems. The demand for infrastructure is heavily shaped by population trends, and as communities grow, the need for greater infrastructure grows as well. As a community's population declines, however, there is a profound impact on an area's ability to maintain and operate its existing infrastructure systems.

Population

According to *Moving Michigan Forward: 2040 State Long-range Transportation Plan*, between 2000 and 2010, Michigan lost approximately 55,000 residents, as the nation experienced a major economic recession. While continuing population loss is not expected, it has contributed to a much lower forecast of Michigan's population growth than was previously projected.

EXHIBIT 28. Michigan Population, 1970–2040

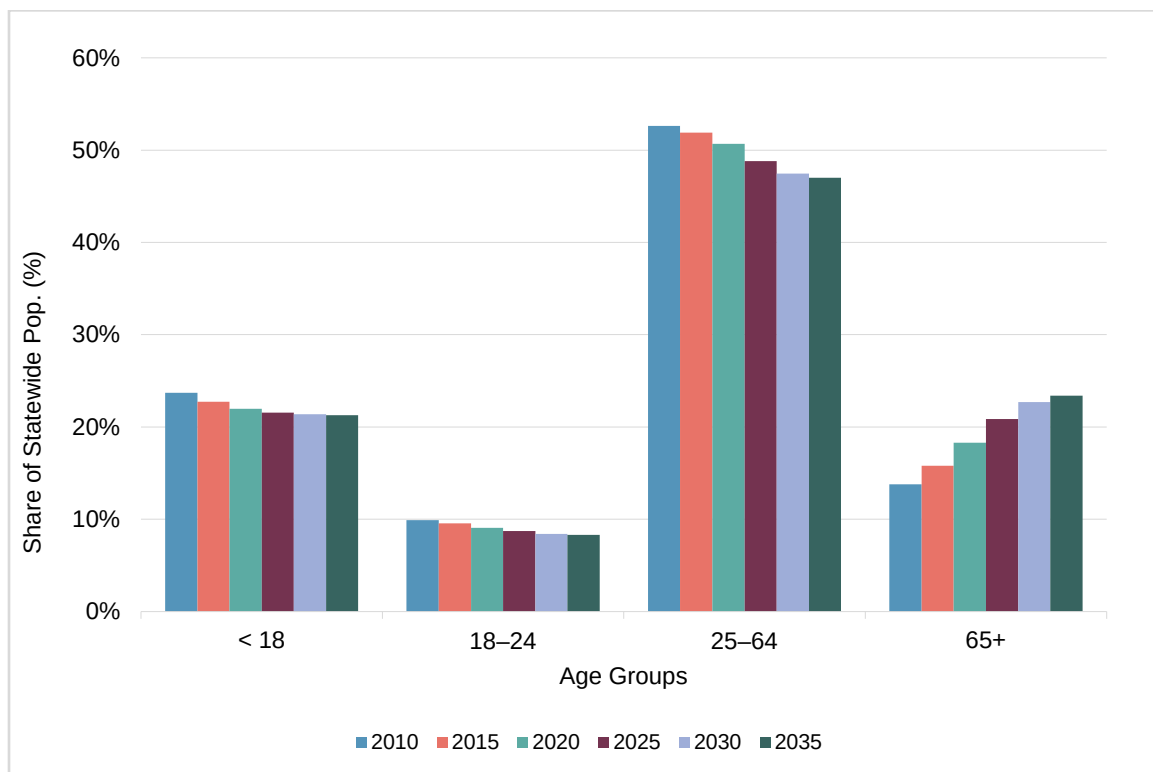


Source: MDOT July 2016.

Michigan's population growth will be accompanied by a significant shift in the share of age groups:

- Michiganders aged 25–64 will still make up the largest share of the state's population; however, this group will shrink from 51.9 percent of the population in 2015 to 47.2 percent by 2040. This decline will have important repercussions for Michigan, as it is also the largest working population and the most able to bear user fees and taxes to fund infrastructure service and delivery.
- All age groups will decline by 2040 except the group aged 65 years or older, which will increase by 82 percent from 2010 to 2040. An increase this significant will affect the types of infrastructure and services the state can provide to Michigan residents.

EXHIBIT 29. Share of Statewide Population by Age Group, 2010–2040



Source: MDOT July 2016.

Over the last four decades, Michigan has lost a significant number of residents who have moved to other states (domestic migration). The State Long Range Plan projects that net migration will remain negative through 2030, but migration overall will be positive. The bulk of this positive migration is due to international migration (people moving to Michigan from other countries), which is helping to offset outmigration and a shrinking labor force. Without international migration, Michigan would see declining populations through 2040.

EXHIBIT 30. Domestic and International Migration: Michigan, 1980s–2030s

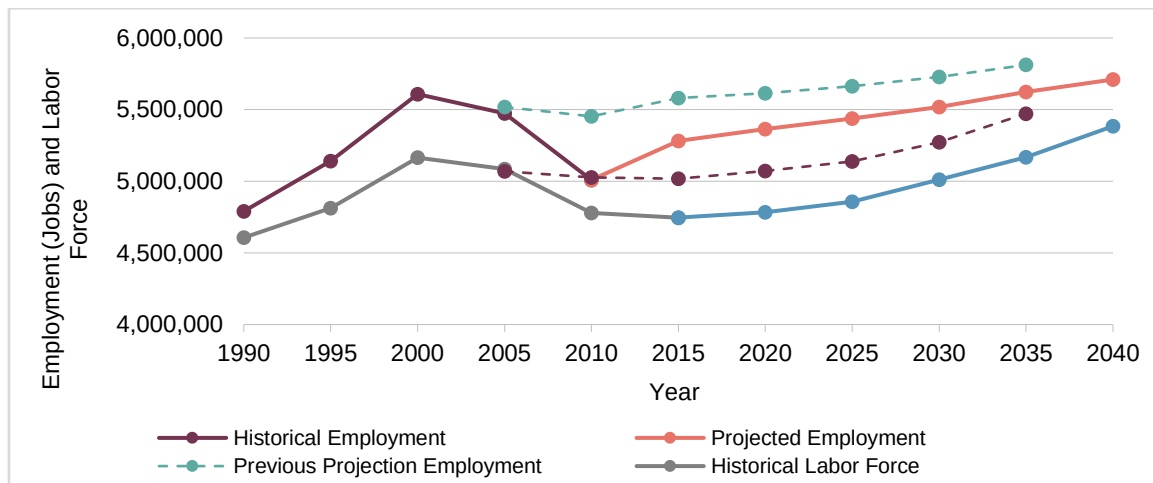
	1980s	1990s	2000s	2010s	2020s	2030s
International Migration	100,700	113,600	256,213	235,405	294,921	364,405
Domestic Migration (aged 65+)	-13,400	-20,400	-45,307	-35,091	-46,768	-44,172
Domestic Migration (aged < 65)	-658,500	-33,900	-690,100	-421,174	-291,795	-231,655
Total Net Migration	-571,200	59,300	-479,194	-220,860	-43,642	88,578

Source: MDOT July 2016.

Employment

Michigan lost more than 450,000 jobs during the economic recession between 2000 and 2010.⁴⁸ However, the state is recovering from these losses, and employment is projected to rebound slowly in the coming decades. The State Long Range Plan projects that total employment will grow at an annual rate of 0.7 percent through 2020, after which the growth rate is projected to slow to 0.3 percent per year. Michigan's total employment is expected to be constrained during this period due to a reduced projected labor force caused by the declining share of Michigan's working-age population. The labor force is projected to grow at 0.5 percent annually from 2015 to 2040, recovering to peak labor force levels by 2035. Michigan's total employment and labor force are shown below in Exhibit 31.

EXHIBIT 31. Michigan Total Employment and Labor Force, 1990–2040

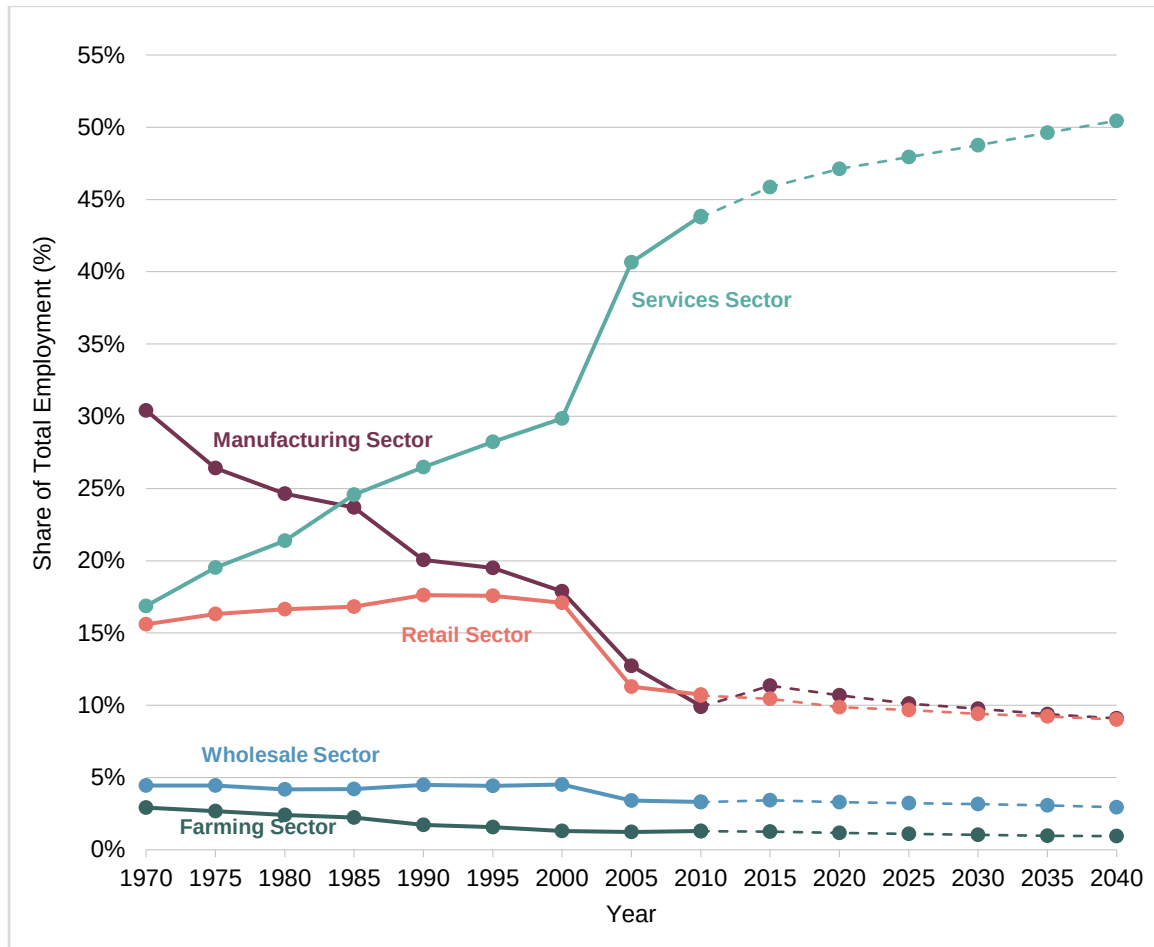


Source: MDOT July 2016.

⁴⁸ Monthly data on Michigan payroll jobs is also published by the U.S. Bureau of Labor Statistics (BLS). According to the BLS, Michigan recorded a sharp drop of 766,400 private sector payroll jobs from 2000 to 2010. However, the state has added 463,600 private sector jobs from December 2010 to September 2016.

The composition of Michigan's employment has changed significantly during the last 40 years and will continue to change during the 2010–2040 forecast period (Exhibit 32). The manufacturing sector's share of the employment base has dropped sharply and steadily, from 30 percent in 1970 to just 10 percent by 2010, and it is expected to continue to decline, though at a slower rate, to about 9 percent by 2040. The services sector, which includes healthcare, has increased dramatically from about 17 percent in 1970 to near 44 percent in 2010, and it is expected to grow to almost 50 percent by 2040.

EXHIBIT 32. Share of Michigan Employment by Sector, 1970–2040



Source: MDOT July 2016.

The projections of Michigan's population and employment composition will frame the types and levels of infrastructure services that are planned for Michigan's residents and businesses in the future.

APPENDIX D.

Best Practices Research

Background

The 21st Century Infrastructure Commission was charged with developing a plan to incentivize and encourage coordinated, long-term asset planning and management across multiple infrastructure types and all levels of government. To help the Commission better understand how Michigan could meet this charge, Public Sector Consultants (PSC) evaluated best practice models for integrated infrastructure planning and investment strategies from around the world, including more than ten different countries and 20 states across the U.S. PSC and the Executive Office of the Governor also interviewed several experts to supplement these best practice models. Deloitte Consulting also assisted with providing some research findings on best practices. This document summarizes the research that was presented to the Commission in June and July 2016.

Elements of Success

In PSC's review of infrastructure planning efforts from around the world, we found several models that utilize forward-looking, comprehensive, and integrated approaches to infrastructure asset management that reap the rewards of greater efficiency, access to additional investment resources, and more long-term technical solutions. Although each model has some unique processes or areas of focus, we identified six common elements of their success, including:

- Articulated vision for the future of infrastructure
- Planning processes that include a long-term planning horizon and regular updates
- Establishment of a coordinating or decision-making body
- Detailed asset inventory and condition assessment
- Projections of need based on nontraditional data and uncertainties (e.g., climate impacts, disruptive industry changes, etc.)
- Diverse mix of funding and financing tools

Articulated Vision for the Future of Infrastructure

States and countries that have adopted comprehensive and coordinated infrastructure planning processes have articulated a clear vision that describes desired outcomes or a desired future for their system. In many cases, the vision is codified in law or a policy resolution and has guided initial infrastructure asset management plans and subsequent updates. The vision for a future state often reflects a driving need—such as a rapidly growing population, impending climate risks, or power

outages due to capacity constraints—and is typically accompanied by a set of guiding principles to define how these places judge their future success. In California, for example, the Infrastructure Planning Act requires that any infrastructure proposed for funding in the state's plan must be consistent with the following priorities:

- Promote infill development and equity by rehabilitating, maintaining, and improving existing infrastructure and reusing previously developed, underutilized land, particularly in underserved areas.
- Protect environmental and agricultural resources.
- Encourage efficient development patterns by locating new infrastructure in an area appropriately planned for growth and served by adequate transportation and services, as well as by minimizing ongoing costs to taxpayers (State of California 2015)

Cities, including Portland, Oregon and London, England; states, including Minnesota, Ohio, and New York; and countries, including Canada and New Zealand, have developed forward-looking visions for their infrastructure systems. They aim to modernize their systems, advance their economic position, and build and maintain infrastructure that will protect public health and improve quality of life.

Long-term Planning Horizon

While infrastructure planning time horizons vary across states and countries, many comprehensive plans cover at least ten years, with most planning for 20 years or more. Most states and countries with longer planning horizons also have accompanying short-term action or budget plans. London, for example, has a comprehensive infrastructure plan that goes to 2050, but requires five-year business plans to ensure that economic changes and cost-to-consumer forecasts are continually included in the planning process (Greater London Authority 2014).

By law, the Governor of California is required to develop and submit a five-year infrastructure plan to the legislature along with the annual budget bill. The plan details proposed infrastructure investments, and outlines how those investments relate to the five-year plan objectives, including maintenance, improvements, and new infrastructure (State of California 2015).

Several other places utilize planning horizons for integrated infrastructure spanning ten or more years, including Oregon, New York, Canada, the United Kingdom, New Zealand, and Australia.

Coordinating Body

Another defining characteristic of model infrastructure planning systems is the establishment of a coordinating body or agency that is designed to break down traditional silo-based approaches to capital investment and infrastructure management and take a comprehensive look at statewide infrastructure investment. Through strategic collaboration and information sharing, a coordinating body can better leverage existing investment dollars and tactically allocate capital investment funding to maintain infrastructure, grow the economy, and create jobs. States and countries with infrastructure coordination bodies or agencies also focus on integrating project-level planning and investment across related infrastructure types or geographies to improve efficiencies and reduce costs.

PSC identified leading infrastructure coordinating bodies, including:

- **London:** After the 2012 Olympic Games were held in London, city government identified the need for citywide integrated infrastructure planning. As a coordinating body, the London Infrastructure Commission was created to continue this work and to carry out the vision of the London Infrastructure Plan 2050. This body is made up of economists; heads of global design and construction firms; public consultants in energy, water, transport, and information technology; infrastructure finance experts; and members of London First, an organization dedicated to making London the world's best city in which to do business (Whitelaw 2014).
- **Canada:** Canada's coordinating body, Infrastructure Canada, leads the country's federal efforts to ensure that Canadians benefit from world-class modern public infrastructure. The department makes investments, builds partnerships, develops policies, delivers programs, and fosters knowledge across the country. It works with provinces, territories, municipalities, the private sector, nonprofit organizations, and other federal departments and agencies, to address local and regional needs and advance national priorities. Infrastructure Canada reports to Parliament through the Minister of Infrastructure and Communities (Infrastructure Canada 2011).
- **New York:** The New York Works Task Force was initially charged with developing a long-term plan to strategically allocate capital investment funding in order to grow the economy and create jobs. Since completing the ten-year plan, the task force has worked closely with Regional Economic Development Councils to identify and invest in regional projects that maximize long-term economic growth (New York Works Task Force 2013).

Asset Management

An asset management plan, which includes a detailed inventory and assessment of public (and in some cases, private) assets, is another common element of a modern infrastructure management approach. The practice of asset management is used to guide systematic investment at strategic points in an asset's typical life cycle—including design, construction, Commissioning, operating, maintaining, repairing, modifying, replacing, and decommissioning or disposing of an asset.

Models of strong asset management approaches from around the globe include a comprehensive, baseline inventory of infrastructure that:

- Characterizes infrastructure condition
- Provides information on ownership
- Identifies key issues and risks associated with that infrastructure
- Tracks projected investment needs
- Measures progress
- Helps identify areas of integration between related infrastructure projects

London, England's infrastructure plan, for example, is integrated across housing, commercial, civil and public, energy, water, transportation, education, and medical/health facilities. The London Infrastructure Commission has worked with public and private parties to extensively map existing infrastructure, including condition and capacity assessments, and has aggregated data on

projected needs and planned projects into a comprehensive plan and online mapping tool. This tool allows people to see patterns of infrastructure development and concentration, identify opportunities for coordinated infrastructure construction, and track progress.

Planning for Uncertainty

Another best practice of coordinated infrastructure planning is recognizing that there is a great deal of uncertainty inherent in projecting the future. Therefore, model infrastructure planning processes are moving away from conventional, deterministic approaches that rely on single-scenario forecasting methods that acknowledge and accommodate various uncertainties (Wong 2013). New York, California, Minnesota, London, New Zealand, and Australia proactively evaluate and incorporate uncertainties into demand projections, infrastructure types, costs, and siting decisions.

Three primary uncertainties necessary to guide infrastructure plans are:

- Population change and density
- Technology innovation
- Nontraditional planning factors

Population Change and Density

Planning for uncertainty means using dynamic forecasting methods, including scenario planning and flexible design strategies, to better ensure infrastructure systems efficiently deliver services over the long term. During the 2000s, many older industrial cities in Michigan, as well as other states in the Great Lakes region lost a substantial percentage of their population. Although this phenomenon has serious implications for infrastructure service and delivery, most traditional population projections were not built to assume population loss.

Based on this experience, many planners recognize the need to better anticipate future changes in population and demand. When population does decline, some services can be downsized, but infrastructure is often immobile and costs tend to be fixed, so at times, it is more expensive to operate a system when demand is reduced (Hoornebeek and Schwarz 2009). While communities need to provide good service to the residents who remain in depopulating communities, they also need to anticipate future changes in population and demand—including growth. Planners and policymakers are increasingly looking to more dynamic forecasting methods that embrace uncertainty.

Technology Innovation

From smart meters to 5G mobile communication, processes at the best practice level address the profound impacts of technological change on infrastructure planning. For example, the London Infrastructure Plan 2050 devotes an entire chapter (“Open to Radical Change”) to methods for tackling the uncertain impacts of new technology and innovation. Given the potential changes expected to be introduced as new technologies emerge, the Commission engaged the global technology research firm Forrester to help provide insights into this evolving world. Forrester provided members of the Commission with an in-depth overview of current and anticipated technology trends that will likely drive a more connected, efficient society. Forrester’s team of

experts provided information about a variety of topics, including the IoT and how technology is enabling smarter cities.

Nontraditional Planning Factors

Best practice planning processes address the uncertainties presented by changing weather and climate patterns, from shifting precipitation levels to changing freeze-thaw cycles. These processes recognize the need for new approaches to understand vulnerabilities—across infrastructure systems and specific assets—to take appropriate actions to minimize risk and increase resiliency. Two U.S. states have moved to address this kind of uncertainty. Access Ohio 2040 calls for a Statewide Climate Variability Study and the Minnesota GO 50-Year Vision for Transportation addresses the trunk highway system's vulnerability to increased flooding events (Minnesota Department of Transportation 2012).

Model infrastructure plans also account for nontraditional planning factors, such as:

- Economic changes, such as major industry shifts and new types of businesses that disrupt industries
- Changing user preferences, such as the sharing economy (e.g., Uber) or desire for clean energy sources
- Decentralization of infrastructure services, such as the utility of the future concept
- Political changes, including major regulatory or legal changes

Funding and Financing

In most U.S. states, including Michigan, major infrastructure such as transportation, water, and wastewater systems are funded largely through public dollars, including tax revenue, license fees, and general obligation bonds. The energy sector is the exception, as generation, production, and distribution systems for electricity and natural gas are typically developed and managed privately or through P3s.

Historically, public funding for infrastructure has occurred on a pay-as-you-go cycle in which annual operating and capital budgets allocate dollars to maintain or expand infrastructure. Increasingly, states and cities have relied on general obligation and other types of bonds to finance infrastructure projects. As states and countries diversify funding sources, some have set explicit limits or targets for levels of indebtedness. Oregon, for example, has capped the amount of debt it will issue for infrastructure projects and has focused on other sources of funding such as fees, special revenues (e.g., lottery), and private investments (State of Oregon Office of the Governor 2012; State of Oregon 2016).

Today, best practice-level infrastructure management systems utilize a diverse mix of funding, including public and private investments, to maintain, improve, and expand infrastructure. In addition to the traditional public funding mechanisms like General Funds and traditional bonds, some states and countries have utilized more innovative tools to ensure adequate capital to fund projects and to improve efficiencies. These tools include infrastructure banks and P3s.

Infrastructure banks are state-owned banks that can finance and coordinate high-value infrastructure investments. These banks allow for borrowing (or loan guarantees) from public and

private entities to fund public-serving infrastructure projects, and can be used for projects requiring large lines of credit, which in some cases, allows an entity to multiply its infrastructure investment capacity. Infrastructure bank loans also use delayed-repayment mechanisms, which allows key projects to move forward even if they will not generate user fees or yield savings for many years (Miller, Costa, and Cooper 2012).

California and Pennsylvania each have an infrastructure bank (Deloitte 2016). Created in 1994, the California Infrastructure and Economic Development Bank finances public infrastructure and private development to promote jobs, contribute to a strong economy, and improve quality of life (State of California 2015). The Pennsylvania Infrastructure Bank leverages state and federal funds to accelerate priority transportation projects by providing low-interest loans (Pennsylvania Department of Transportation 2016).

P3s are another innovative tool that offer opportunities for government, business, and private sector organizations to collaboratively invest in and own public infrastructure, resulting in greater efficiencies. A 2009 study of the United Kingdom's infrastructure projects found that 65 percent of P3-related construction was on-budget, while only 54 percent of public sector-led projects were delivered on-budget. Similarly, a study of Australian P3s determined that these projects had cost overruns of 1 percent, compared to an average cost overrun of 15 percent for public-led projects. Europe uses P3s extensively, accounting for nearly 45 percent of global P3 projects (\$353 billion in infrastructure development) in 2011, compared to 9 percent in the U.S. (Istrate 2011).

Expert Interviews

To further inform the Commission, PSC and the Executive Office of the Governor conducted telephone interviews to gather information on how some communities are implementing infrastructure planning, including asset management and rate structure modifications. These interviews included the manager of the London Infrastructure Mapping Application (IMA) and a representative of the Washington, D.C. water and sewer authority.

City of London

In many states, including Michigan, data on the location and condition of infrastructure assets are managed and analyzed by separate entities, leading to planning and investment inefficiencies. The City of London has worked extensively on this issue, creating a coordinating body, the London Infrastructure Delivery Board, and a tool, the Infrastructure Management Application (IMA), to capture and assess data, prioritize projects, and fund infrastructure across the city.

In August 2016, PSC, the Executive Office of the Governor, and the infrastructure Commission met with Andrew McMunnigall via conference call to discuss how they implemented the London Infrastructure Delivery Board and the how they manage the £550,000⁴⁹ IMA asset management tool. These two innovations have been successful at providing the following:

- Insight for private and public stakeholders into London's future growth, development, and infrastructure project pipeline
- Opportunities for joint delivery of infrastructure projects, reducing construction costs and disruption (McMunnigall 2016)

District of Columbia Water and Sewer Authority

Washington, D.C. recently completed an 18-month process of restructuring their water and sewer rates. A solid revenue source is integral to sustaining water and sewer infrastructure over the long life of these assets, especially in times when water consumption is declining and maintenance is deferred. The District of Columbia Water and Sewer Authority restructured its rates to reflect the full cost of operating, maintaining, repairing, and replacing water and sewer infrastructure.

The new multiyear rate structure focuses on affordability—including providing qualifying households with discounts of up to 50 percent—while incorporating the full cost of service with fixed fees and charges instead of volumetric rates. These changes include instituting a water system replacement fee to fund one percent of water system replacement compared to the national average of one-third of one percent and instituting a system availability fee (a hook-up charge) for new developments.

The restructuring has required the District of Columbia Water and Sewer Authority to utilize innovative financing mechanisms for their water infrastructure assets. They have issued a \$2.6 billion 100-year bond for the D.C. Clean Rivers Project, which will create a deep underground tunnel system to alleviate combined sewer overflows. With such a long bond life, the asset matches the liability and has intergenerational equity such that the cost of the asset is spread across generations benefiting from it. The District of Columbia Water and Sewer Authority has also issued green bonds and social impact bonds. These bonds finance programs with environmental benefits, helping to identify the public value for such financing, in addition to identifying where the rate of return depends on the performance of green infrastructure (Kim 2016).

Conclusion

The 21st Century Infrastructure Commission examined these best practice elements, examples, and expert interviews throughout the Commission recommendation development process. The recommendations presented in this report have incorporated many of these methods and approaches to integrated infrastructure planning and investment strategies from around the world.

⁴⁹ Equal to \$721,985 using August 2016's exchange rate of 1.3127 USD:1 GBP.



Michigan Section of the American Society of Civil Engineers
INFRASTRUCTUREREPORTCARD.ORG/MICHIGAN

TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	4
METHODOLOGY	
GRADING CRITERIA.....	5
GRADING SCALE.....	6
MICHIGAN INFRASTRUCTURE GRADES SUMMARY.....	7
SOLUTIONS TO RAISE THE GRADE	8
INFRASTRUCTURE GRADES BY CATEGORY	
AVIATION.....	9
BRIDGES.....	18
DAMS.....	23
DRINKING WATER.....	28
ENERGY.....	36
NAVIGATION.....	43
RAIL.....	49
ROADS.....	53
SCHOOLS.....	59
SOLID WASTE.....	64
STORMWATER.....	70
TRANSIT.....	76
WASTEWATER.....	83
GET INVOLVED.....	90
MICHIGAN REPORT CARD COMMITTEE.....	90
ABOUT THE MICHIGAN SECTION OF ASCE	91



EXECUTIVE SUMMARY

Infrastructure is the fundamental facilities and systems serving a country, state, county, township, or city and is necessary for its economy to function. Infrastructure includes roads, bridges, water and sewer systems, dams, transit, aviation, railways, energy and schools. Infrastructure is the foundation of our everyday lives and touches all parts of how we live, work and play in Michigan. It is the backbone of Michigan's economy.

Quality infrastructure allows Michigan to be a frontrunner in various sectors including: research and development, manufacturing, farming, and tourism. Our transportation system (roads, bridges, transit, rail, etc.) allows Michiganders to travel to work every day, or Up North for summer weekends by the lake. Water systems deliver drinking water to our homes, communities, and businesses. School buildings provide a safe place for our children to learn. Sewer and treatment systems protect our neighborhoods from floods, and our lakes, rivers, and beaches from raw sewage, E. coli and other toxins.

Unfortunately, most of Michigan's infrastructure is old and outdated. In older Michigan cities, some systems date back to the late 1800s. For close to a decade the state suffered from a poor economy, resulting in Michigan under investing in infrastructure repairs and replacement. Imagine not changing your car's tires for 10 years. Now we are faced with highways that are full of potholes, bridges that are being propped with temporary supports, sinkholes destroying homes, and beaches being closed due to contamination. In general, most investments during those years were a result of emergencies. Emergency repairs can be inconvenient, cause safety issues, and are more costly than doing routine infrastructure maintenance or replacement.

Michigan residents, business owners, and policymakers must decide how much we value the personal and economic advantages that come from a modern, safe and efficient infrastructure network. The Michigan legislature took the first step in 2015 by increasing the investment in our transportation system, but much more needs to be done. The 21st Century Infrastructure Commission created by the Governor determined that an additional \$4 billion annual investment is needed to maintain our infrastructure. The good news is there are solutions to Michigan's infrastructure problems. We must support innovative policies, increase state funding, prioritize public health and safety, and be informed and vocal advocates for infrastructure. Maintenance and replacement must happen proactively instead of reactively. Just as you change your car's oil regularly, we must replace pipelines, repair dams, fix bridges, and resurface roads as needs arise.

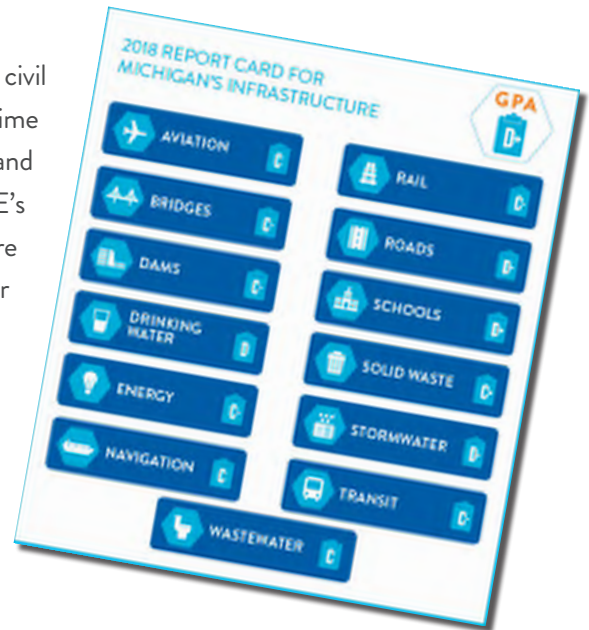
This document was created to help Michigan understand the state of our infrastructure. As civil engineers, our daily focus is on roads, bridges, water and wastewater systems, our energy grid and more. Civil engineers plan, design, construct, and maintain our infrastructure networks. It is not only what we were trained and educated to do, it is our job and our passion! The ASCE-MI 2018 Report Card provides an opportunity to share that information with the public. This document is a snapshot for residents, businesses, and policymakers to engage in conversation about where we are and where we want to be. We hope that this information provides the insight needed to start that conversation.



ABOUT THE INFRASTRUCTURE REPORT CARD

GRADING CRITERIA

ASCE-MI's 2018 Report Card Committee is a group of dedicated civil and environmental engineers from Michigan, who volunteered their time to collect and analyze data, prepare, review, and revise each section, and develop the final Report Card. The committee worked with ASCE's Committee on America's Infrastructure and ASCE Infrastructure Initiative staff to provide Michigan with a snapshot of the state of our infrastructure, as it relates to us at home, and on a national basis.



The Report Card Sections are analyzed based on the following eight criteria:

CAPACITY Does the infrastructure's capacity meet current and future demands?

CONDITION What is the infrastructure's existing and near-future physical condition?

FUNDING What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?

FUTURE NEED What is the cost to improve the infrastructure? Will future funding prospects address the need?

OPERATION AND MAINTENANCE What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?

PUBLIC SAFETY To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?

RESILIENCE What is the infrastructure system's capability to prevent or protect against significant multihazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?

INNOVATION What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?



GRADING SCALE



EXCEPTIONAL: FIT FOR THE FUTURE

The infrastructure in the system or network is generally in excellent condition, typically new or recently rehabilitated, and meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and are resilient to withstand most disasters and severe weather events.



GOOD: ADEQUATE FOR NOW

The infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable with minimal capacity issues and minimal risk.



MEDIOCRE: REQUIRES ATTENTION

The infrastructure in the system or network is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.



POOR: AT RISK

The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of significant concern with strong risk of failure.



FAILING/CRITICAL: UNFIT FOR PURPOSE

The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.



2018 REPORT CARD FOR MICHIGAN'S INFRASTRUCTURE



 AVIATION 

 RAIL 

 BRIDGES 

 ROADS 

 DAMS 

 SCHOOLS 

 DRINKING WATER 

 SOLID WASTE 

 ENERGY 

 STORMWATER 

 NAVIGATION 

 TRANSIT 

 WASTEWATER 



SOLUTIONS TO RAISE THE GRADE

If Michigan is ready to improve our infrastructure, ASCE-MI has some suggestions to start raising the grade:

1. SUPPORT INNOVATIVE POLICIES:

Michigan needs to be a leader in preparing our infrastructure for the future. We are the nation's gateway to Canada, the Great Lakes state (surrounded by 20% of America's freshwater), and the home of the automobile. Through investment and modernization, we can lead the way. With the greatest concentration of the auto industry in the world, Michigan must be a leader in freight movement and autonomous vehicles.

To better understand the problems that Michigan's infrastructure is facing, the state needs more and better data. As recommended by the 21st Century Infrastructure Commission, the Michigan legislature has proposed the creation of the Michigan Infrastructure Council (MIC), which will bring together policy experts, utility and infrastructure owners, regional representatives, finance experts, and statewide department directors to set up a statewide asset management system. This will ultimately lead to the development and publication of a 30-year integrated infrastructure strategy that will be updated every five years. The MIC will also include chairs from existing and future entities of the Michigan Public Services Commission, the Transportation Asset Management Council, and the Water Asset Management Council (a new council proposed by the Michigan legislature). The MIC will lead to greater insights into the condition of Michigan's infrastructure, the challenges we face in maintaining our infrastructure, and will provide more strategic solutions.

2. INCREASE STATE FUNDING:

The Michigan legislature took the first steps to increasing investment in our transportation network in 2015. To build on this action, the legislature must follow through and appropriate transportation funds in years 2019 to 2021 as promised. Additionally, the Michigan Department of Environmental Quality is in the process of redesigning the Clean Water State Revolving Fund and Drinking Water Revolving Fund, both of which provide financial support to

water systems through federal-state partnerships.

ASCE encourages Michigan citizens to be vocal and reach out to elected officials to let them know Michigan needs consistent and reliable funding to maintain and improve our transportation and water infrastructure and not wait for our systems to fail.

3. PRIORITIZE PUBLIC HEALTH AND SAFETY:

"Safety First" must be the approach to all of Michigan's infrastructure decisions. Integrated asset management is the critical first step in developing a foundation for safe and reliable infrastructure in Michigan. Asset management consists of continually inventorying and assessing the condition of Michigan's infrastructure so smart investments can be made to improve public health and safety.

Safety can further be improved by properly maintaining Michigan's infrastructure. Emergency infrastructure repairs are more costly and can lead to property damage, injuries and fatalities. Regular maintenance requires sufficient and reliable sources of funding. Proactive investment in infrastructure yields savings down the line and ensures the health and welfare of Michiganders. Autonomous vehicles have the potential of significantly reducing vehicle crashes that result in injuries and fatalities.

4. BE INFORMED, BE VOCAL:

ASCE's Michigan Section encourages you to learn more about your community's infrastructure needs and how your tax dollars are being spent to improve the state's infrastructure. Attend town halls or legislative events and get to know your elected officials. Use the Report Card for Michigan's Infrastructure to effectively inform lawmakers and the public about where to direct limited resources and how to improve Michigan's infrastructure.



SUMMARY

Michigan's 234 airports, including 18 commercial airports, contribute more than \$22 billion annually to the state's economy. Scheduled airlines transported more than 39 million passengers to and from Michigan airports in 2016, and the Detroit Metropolitan Airport was ranked 18th nationwide in total passengers for 2016. Beginning in 2008, as a result of the economic downturn, Michigan's aviation industry saw a significant decrease in aircraft operations. However, projections show a steady increase in general aviation activity and substantial growth for corporate and commercial activity over the next 15 years. Despite these projections, funding for airport infrastructure at the state and local level has declined in recent years.

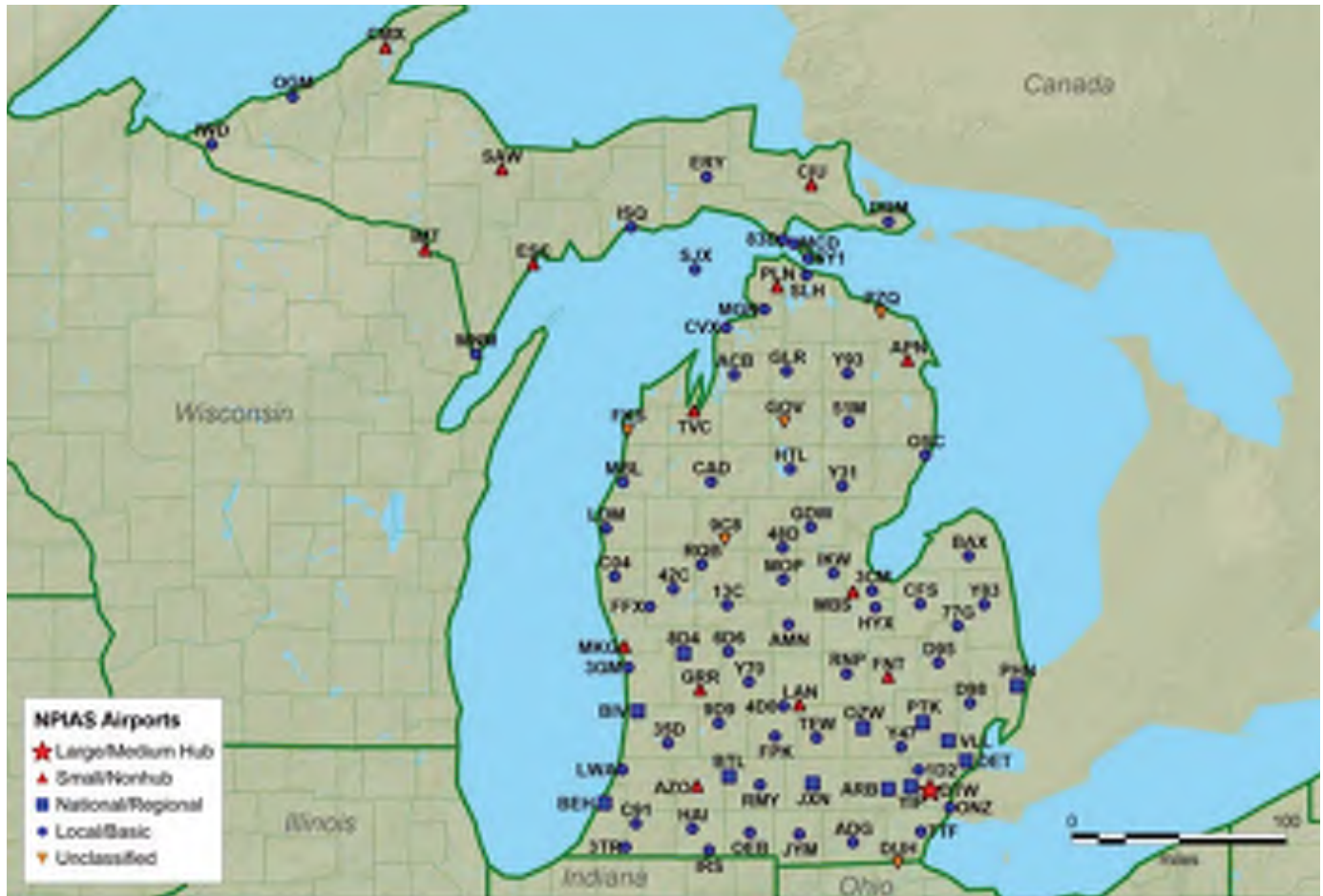
BACKGROUND

Aviation is an integral part of Michigan's transportation system, moving people and goods throughout the state, nation, and world. Michigan has a vibrant and diverse aviation community consisting of the airlines, business aviation, and recreational flyers. Every Michigan citizen is impacted by the benefits aviation provides.

The airports that support these activities are significant assets and essential to Michigan's economy. Good airports play a notable role when people and businesses consider Michigan as a place to live and work. Business growth in Michigan relies on a safe and efficient aviation system. With the geographic challenges of Michigan, access to all parts of the state in support of business, tourism, and emergency relief is critical. The economic impact of aviation in Michigan is estimated at more than \$22 billion annually.

Michigan has 234 airports across the state, including 18 commercial airports, which provide passenger air service. The 18 commercial air service airports include one large hub, two small hub, seven non-hub and eight Essential Air Service (EAS) facilities. These airports are geographically well-situated and meet Michigan's air service needs within the service threshold of 60 minutes or less surface travel time.

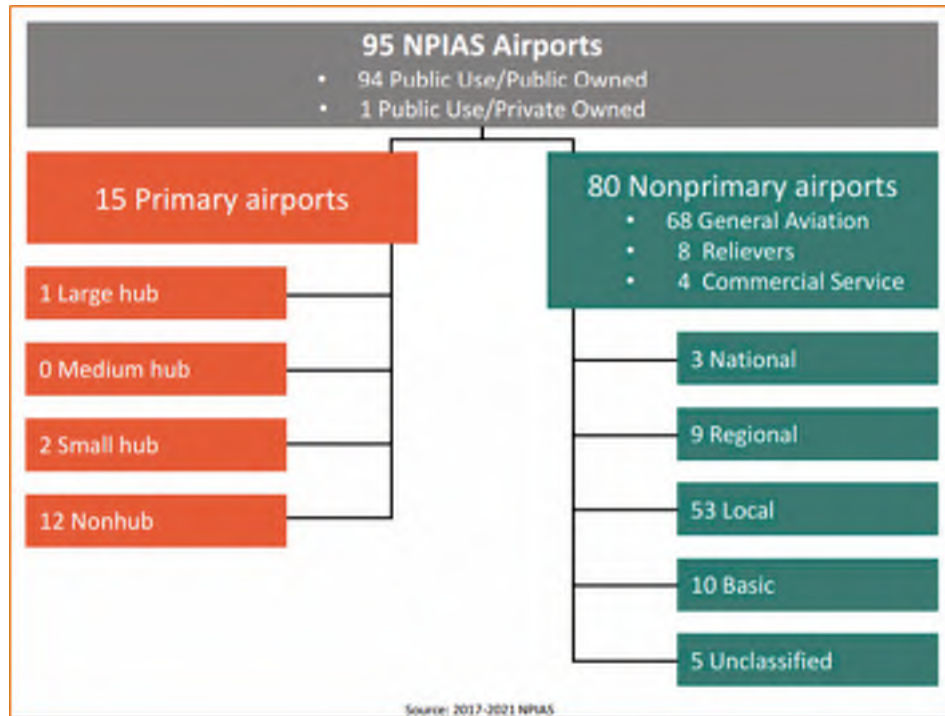
FIGURE 1. MAP OF NPIAS AIRPORTS IN MICHIGAN



The Michigan Airport System has remained stable both in capacity and condition. The number of airports in the system and services provided are relatively unchanged. The system of airports remains a vital part of Michigan's transportation link to national and global markets.

There are 95 airports in Michigan listed in FAA's National Plan of Integrated Airport Systems (NPIAS) 2017-2021, which lists airports significant to national air transportation and thus eligible to receive Federal grants under the Airport Improvement Program (AIP). Figure 2 shows the breakdown of those airports into categories and types.

FIGURE 2. NPIAS AIRPORTS IN MICHIGAN



CAPACITY

Table 1 lists the airports in Michigan with regularly scheduled air service. Almost all of Michigan's 10 million residents live within a 90-minute drive from one of these airports, and the large population centers are within a 30-minute drive from one of these airports.

TABLE 1. AIRPORTS IN MICHIGAN WITH REGULARLY SCHEDULED AIR SERVICE

ASSOCIATED CITY	AIRPORT NAME	FAA IDENTIFIER
Alpena	Alpena County Regional Airport	APN
Charlevoix*	Charlevoix Municipal Airport	CVX
Detroit	Detroit Metropolitan Wayne County Airport	DTW
Escanaba	Delta County Airport	ESC
Flint	Bishop International Airport	FNT
Grand Rapids	Gerald R. Ford International Airport	GRR
Hancock	Houghton County Memorial Airport	CMX
Iron Mountain	Ford Airport	IMT

TABLE 1. AIRPORTS IN MICHIGAN WITH REGULARLY SCHEDULED AIR SERVICE - CONTINUED

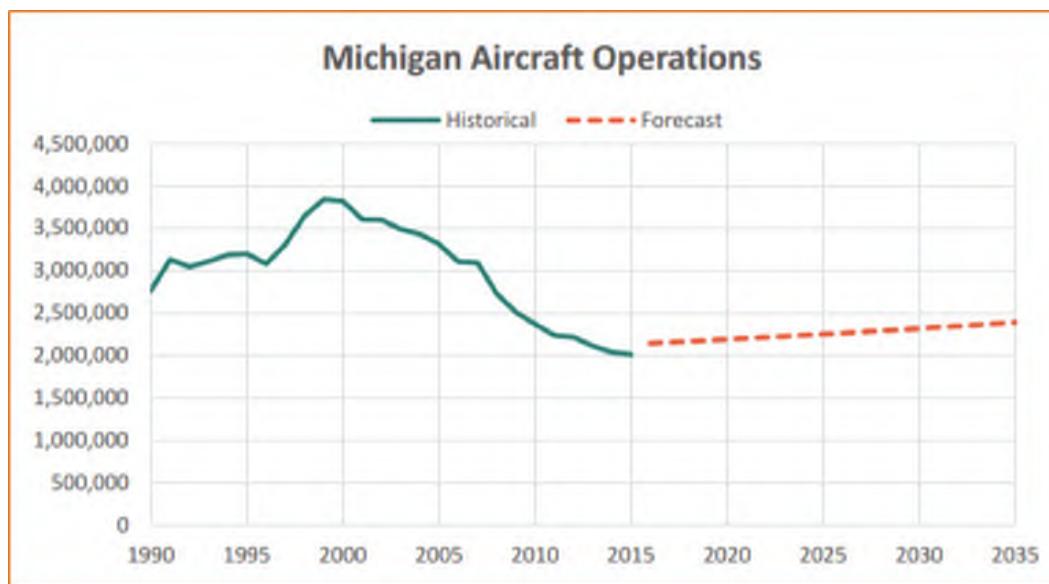
ASSOCIATED CITY	AIRPORT NAME	FAA IDENTIFIER
Ironwood	Gogebic-Iron County Airport	IWD
Kalamazoo	Kalamazoo/Battle Creek International Airport	AZO
Lansing	Capital Region International Airport	LAN
Manistee*	Manistee County- Blacker Airport	MBL
Marquette	Sawyer International Airport	SAW
Muskegon	Muskegon County Airport	MKG
Pellston	Pellston Regional Airport of Emmet County	PLN
Saginaw	MBS International Airport	MBS
Sault Ste. Marie	Chippewa County International Airport	CIU
Traverse City	Cherry Capital Airport	TVC

* Service at CVX and MBL varies

Source: MDOT Aeronautics

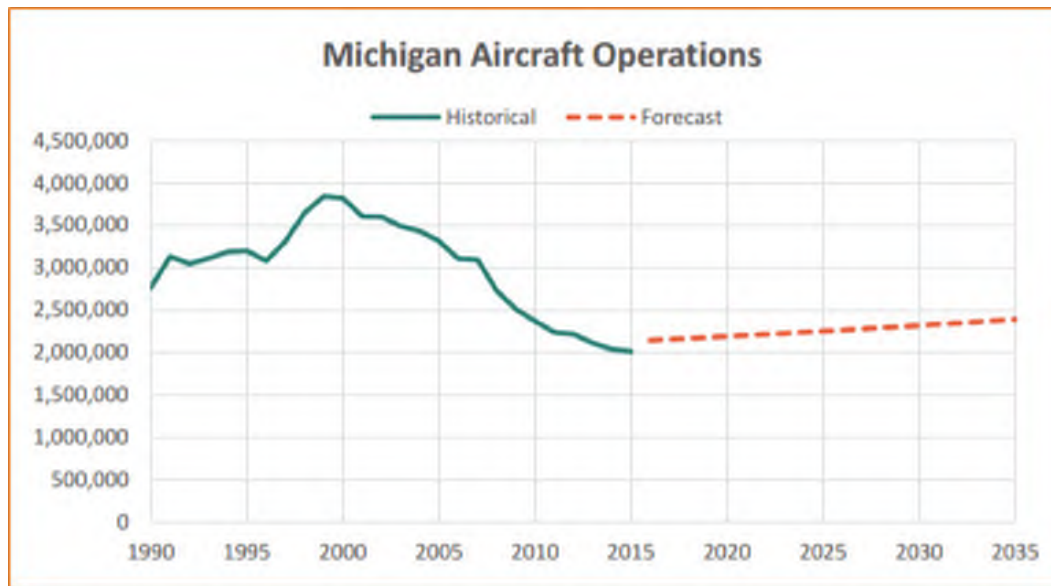
Although overall aviation activity (takeoffs and landings) throughout the state peaked in about 2000 and has declined steadily since then, aircraft operations have leveled off and are expected to begin and continue a slow and steady growth due to improved economic conditions in Michigan (see Figures 3 and 4 below).

FIGURE 3. AVIATION ACTIVITY IN MICHIGAN, 1990-PRESENT AND FORECASTED



Source: MDOT MASP, <http://mdotmasp.com>

FIGURE 4. NUMBER OF AIRCRAFT IN MICHIGAN, 1990-PRESENT AND FORECASTED



Source: MDOT MASP, <http://mdotmasp.com>

Beginning in 2008, the aviation industry saw a significant decrease in aircraft operations, especially in the general aviation sector. Forecasts show a steady increase in general aviation activity, but more substantial growth is projected for corporate and commercial activity.

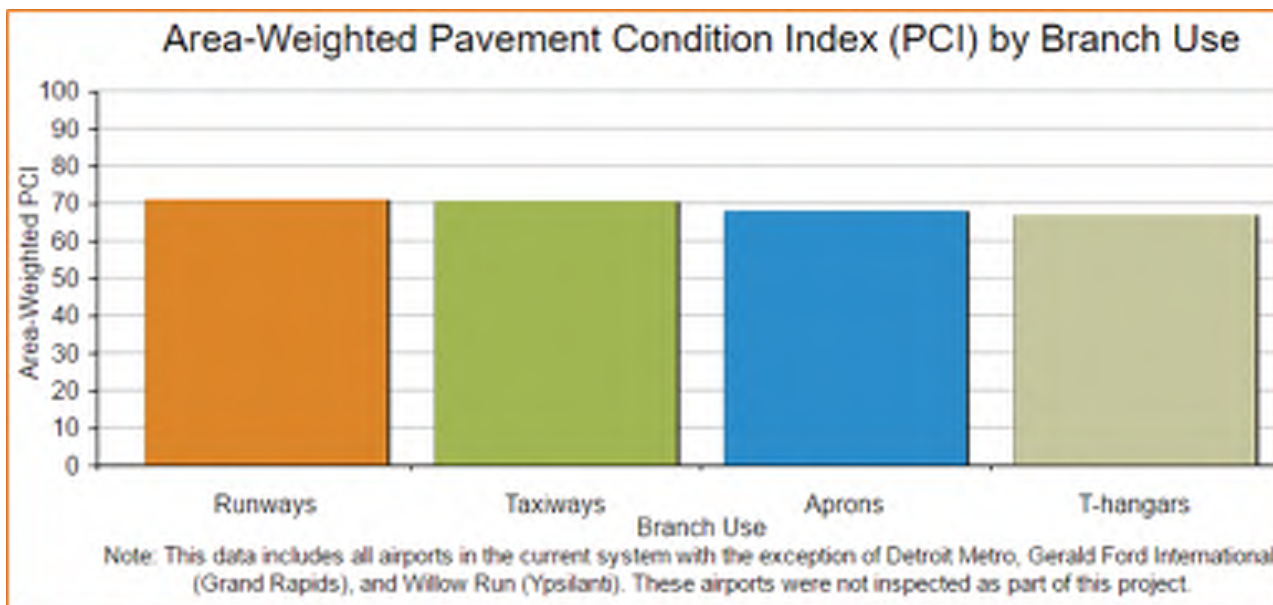
CONDITION

The condition and overall safety of the aeronautical infrastructure has been well monitored and maintained through an asset management concept described in the Michigan Aviation System Plan. This plan provides guidelines for maintenance and future development through a “systems approach.” This approach takes into consideration state, national, and local goals for safety and access to pertinent markets, to provide quality and economical aeronautical access in Michigan.

Through their Statewide Pavement Management System Update, the MDOT Office of Aeronautics evaluated almost all airports in Michigan in 2013 to 2015. This evaluation procedure uses the Pavement Condition Index (PCI) to quantify pavement conditions.

MDOT evaluated 153,331,665 square feet of airfield pavements from 2013 to 2015. Airfield pavements include runways (surfaces devoted to the landing and takeoff of aircraft), taxiways (surfaces utilized by aircraft to travel to and from runways), aprons (surfaces dedicated to aircraft parking), and T-hangar taxi lanes (smaller taxiways near and around hangars utilized to access hangars). The average PCI of airports in the state apart from independent airport authorities governing airports in Detroit, Grand Rapids, and Willow Run was 69. A PCI score of 69 is considered fair condition, in need of rehabilitation.

FIGURE 5. PAVEMENT CONDITION INDEX (PCI) AT AIRPORTS IN MICHIGAN



Source: MDOT Aeronautics 2015 Statewide Pavement Management Update, <http://mdotnetpublic.state.mi.us/apms>

INVESTMENT AND FUNDING

The bulk of capital funding improvements to the aviation system are provided with federal Airport Improvement Program (AIP) funding through the Federal Aviation Administration (FAA). Since 2005, this funding has remained flat. This funding program was most recently reauthorized by Congress under the Federal Aviation Administration Modernization and Reform Act of 2012, which has been extended until March 31, 2018. While Fiscal Year (FY) 2018 will probably be funded by continuing resolutions, a new authorization should be developed in 2018. Funding levels are unknown at this time but are being assumed at present levels. The funding categories and programs have remained unchanged since the 2005 report.

The stability of federal funding for airports remains a concern, as little progress has been made other than continuing resolutions at current funding levels. At the state level, fuel tax revenues have been flat while bond repayment obligations have increased, requiring the department to continually re-assess sources and participation levels in all aviation programs.

Although the federal Essential Air Service Program (EAS) has been under increased scrutiny for cost and effectiveness, it remains in effect for 2016, and is included in the new re-authorization. As of September 2015, air service is subsidized under the EAS Program at nine Michigan airports: Alpena County Regional (Alpena), Delta County (Escanaba), Houghton County Memorial (Hancock), Ford Airport (Iron Mountain), Gogebic County (Ironwood), Manistee-Blacker (Manistee), Muskegon County (Muskegon), Pellston Regional (Pellston), and Chippewa County International (Sault Ste. Marie). While no immediate changes are foreseen, continued EAS service is contingent upon federal funds being appropriated to the United States Department of Transportation (USDOT) for this program.

In the past, funding for the Small Community Air Service Development Program (SCASDP) was provided under the FAA Modernization and Reform Act of 2012 at the level of approximately \$5 million annually. Michigan communities enjoyed a good deal of success in securing SCASDP awards from USDOT, as shown below in Table 2. However, SCASDP funding was not included in the FY 2017 funding request by FAA, and the long-term future of the program is uncertain.

TABLE 2. FAA SCASDP AWARD BY FISCAL YEAR

YEAR	AIRPORT	CITIES SERVED	AMOUNT
2007	MBS International	Midland, Bay City, Saginaw	\$500,000
2007	Gogebic/Iron County	Ironwood	\$135,000
2008	Muskegon County	Muskegon	\$650,000
2009	Cherry Capital Airport	Traverse City	\$400,000
2010	Capital Region International	Lansing	\$750,000
2011	Delta County Airport	Escanaba	\$72,500
2011	Kalamazoo	Kalamazoo	\$500,000
2011	Manistee County-Blacker	Manistee	\$50,000
2015	Cherry Capital Airport	Traverse City	\$750,000

Source: MDOT Office of Aeronautics

State funding for airports has been in decline for several years. The three cents-per-gallon Aviation Fuel Excise Tax has been unchanged since its inception in 1931 and revenue from the tax has slowly decreased since 2005. The \$6 million revenue to the State Aeronautics Fund (SAF) from the Airport Parking Tax has continued. However, an increasing amount each year is dedicated to bond indebtedness from the 2002 Airport Safety and Protection (ASAP) Program.

Forecasts of state revenue to the SAF are beginning to see some positive signs, mainly due to lower fuel costs, and there are reasons to be optimistic in the future as well. In response to federal policy clarifications, the Legislature recently enacted provisions to redirect an amount equal to 2% of the sales tax on aviation fuel. These funds will be split, with 65% going to Detroit Metro and 35% to the SAF. This represents a more stable and predictable source for state aviation programs and ensures a minimum level of funding to match federal aid and support the system of airports. In addition, due to the dependence on the price of fuel, as increases occur revenue will follow. These bills were signed into law on December 23, 2015.

Local budget concerns have caused local agencies to examine their level of support for their airports as well. Many have been forced to examine the level of services they can provide within their decreasing budgets. Reduced levels of local funding put more pressure on state funds to match federal aid.



SAFETY AND RESILIENCE

Airports move people, goods, and services and are critical to Michigan's economy. This movement must occur safely at all times to ensure confidence and reliability in the system. Airports and airlines are responsible for ongoing safety and security upgrades to keep pace with changing mandates and security procedures.

Airport and aircraft operations must also continue during inclement weather, emergencies, and in all seasons. Many airports in Michigan support first responders such as police, fire, and medical units, and there are a number of military airfields in Michigan as well. All of these facilities support emergency operations and are critical to the response to natural and man-made disasters.

INNOVATION

Aviation-focused schools, academies, colleges, and university programs are available across the state to ensure that the next generation of high-tech and highly skilled aviation experts are available to compete for jobs in the aviation sector throughout Michigan. These include programs in pilot training, aircraft maintenance, aviation business administration, aeronautical engineering, flight science, and airspace engineering.

Michigan has a rich history of innovation, with the world's first paved airport in 1928 at Ford Airport in Dearborn (now home to Ford Proving Grounds), and the first mass-produced all-metal airliner, the Ford Tri-Motor, first produced in 1925. The same history and spirit of innovation should guide Michigan to consider new funding methods to address the state's aviation system needs.

Despite current funding challenges, Michigan maintains a complete and well-planned aviation system. This came about because of a continuing commitment by the state to maintain an active role in aviation planning and development. This commitment is evidenced by the state's decision to become a "block grant" state, which enables state, not federal, control of airport planning, programming, and development.



RECOMMENDATIONS TO RAISE THE GRADE

- Add \$0.03 tax per gallon of aviation fuel sold to the current \$0.03 per gallon to help mitigate the state funding shortfall.
- Eliminate the \$0.015 credit on the \$0.03 per gallon aviation fuel tax that benefits passenger airlines to significantly increase available funding.
- Increase the state sales tax on aviation parts and supplies by \$.01 to help to boost the aeronautic state fund.
- Remove the federally-imposed cap on Passenger Facility Charges (PFCs) to allow airports a tool to invest in their own facilities.
- Explore innovative third-party funding such as privatization, public private partnerships and other innovative funding mechanisms to help increase the amount of funding available for the state's vital aviation needs.
- Pass a long-term FAA reauthorization bill in 2018.

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SUMMARY

Michigan's over 11,000 bridges are critical connections in our surface transportation system providing crossings over waterways, roads and railroads. A deteriorating and inadequate highway transportation system costs Michigan motorists billions of dollars every year in wasted time and fuel, injuries and fatalities caused by traffic crashes, and wear and tear on their vehicles. Innovative bridge replacements (i.e. bridge slides



FORT STREET BRIDGE, DETROIT, MICHIGAN

and the use of prefabricated bridge elements) have helped reduce travel delays and disruptions during construction of new bridges in the last few years. Additionally, the Michigan legislature took the first steps to increasing investment in our transportation network in 2015. The 2015 infrastructure-funding package relies on a combination of increased user fees, registration fees and general funds. To build on the results of increased funding, the legislature must continue to appropriate the funds each year. These funds will assist state and local governments to move forward with numerous transportation projects. However, these funds are not sufficient to address the significant deterioration of the system. Approximately 1,234 bridges (11%) of the state's 11,156 bridges are structurally deficient, and the Michigan Department of Transportation (MDOT) anticipates, based on available funding, the number of state maintained bridges currently rated in poor condition will increase by 50% between 2016 and 2023, from 236 to 354 bridges.

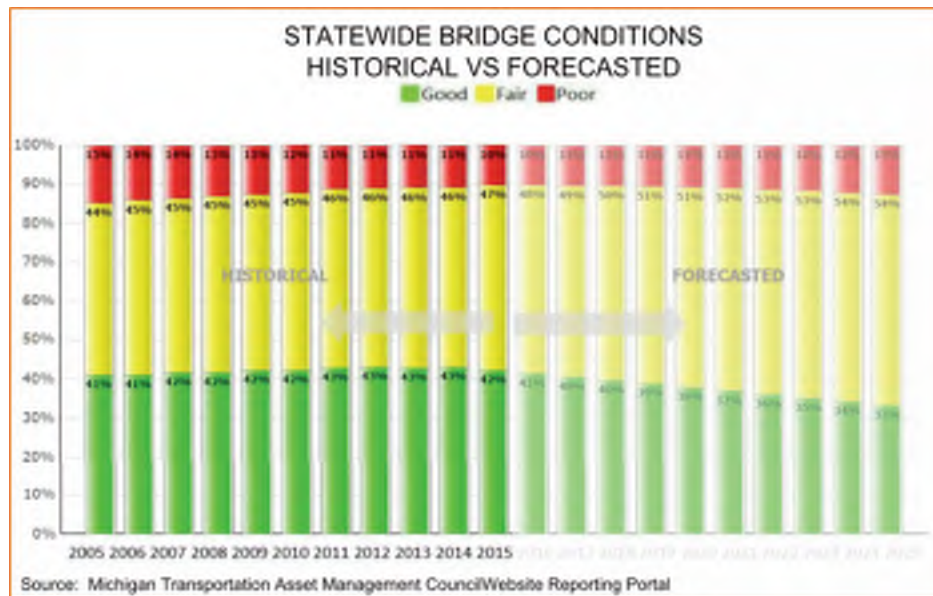
CONDITION AND CAPACITY

Safe and well-maintained bridges provide residents access to work, home, vacation areas, medical facilities, and schools, and allows businesses access to suppliers and markets. Michigan's population has increased each year from 2011 to 2016 and is currently at 9.9 million residents. Michigan has about 7.1 million licensed drivers. It is challenging for the agencies responsible for managing bridges to maintain and improve conditions due to the struggle of implementing a statewide-unified long-term asset management plan resulting from inadequate funding.

The Michigan Transportation Asset Management Council's forecasts of bridge conditions show an increase in bridges rated in fair condition, due to corresponding reductions in the percentage of bridges rated in good condition and poor condition.



M-8/I-75 BRIDGE, DETROIT, MICHIGAN



Without additional funding and implementation of a long-term plan, Michigan's bridges will continue to deteriorate and fail to meet demand. Bold action beyond the recently approved increases in state transportation funding is required to address long-term funding needs.

One in nine locally and state maintained bridges in Michigan show significant deterioration and are in need of repair. In 2008, 13% of the state's bridges were structurally deficient. In 2016 that figure had decreased to 11%, according to FHWA 2016 Bridge Inventory Data. However, the percentage of structurally deficient bridges in Michigan is still higher than the national average of 9.1%. 1,100 bridges in the state are posted for load, meaning vehicles of certain sizes and weights are prohibited from crossing the structure, thereby impeding the flow of goods and commerce and potentially impacting emergency services.



INVESTMENT AND FUNDING

According to FHWA's 2016 National Bridge Inventory, 1,918 bridges in Michigan are in need of repair, with the total cost to the state estimated at \$7 billion. Current mechanisms for state funding utilize vehicle-registration fees and motor-fuel taxes for the bulk of the state's transportation revenue. However, revenue from motor-fuel taxes will decline over time as fuel-efficiency increases and hybrid and electric vehicles become a larger percentage of the vehicle fleet. Other mechanisms for generating funds like Mileage Based User Fees should be explored.

In 2015, Michigan's governor signed into law an infrastructure-funding package that relies on a combination of increased user fees, registration fees and general funds. The 2015 transportation package will provide roads, bridges and transit a total of \$4.2 billion in additional funding through 2023. However, \$2.3 billion of the additional \$4.2 billion is not guaranteed. Beginning in 2019 the funds will be distributed at the discretion of the Michigan Legislature.

Additionally, even with the increases in transportation funding implemented at the State level over the next several years, funding levels are not sufficient to reverse the rate of deterioration of Michigan's bridges. Additional funding is required to make necessary repairs to bridges. Inadequate investment in the transportation system today will mean not only accelerated deterioration of Michigan's bridges, but also increased future maintenance costs.

According to the Michigan Governor's 21st Century Infrastructure Commission Report published in November 2016, Michigan's roads and bridges will require an estimated annual investment of:

- \$1 billion in State funds for Interstate and U.S. Route freeways and bridges,
- \$600 million of State funds for other state highways and bridges, and
- \$600 million of State funds for other highly used roads and bridges under local jurisdiction.

At the Federal level, motor fuel and other truck-related taxes that support the Highway Trust Fund (the major source of federal surface transportation funding) are eroding. Federal motor fuel tax rates have not increased since 1993, and drivers of passenger vehicles with average fuel efficiency currently pay about \$96 per year in federal gasoline taxes. Because of inflation, the 18.4 cent-per-gallon tax on gasoline enacted in 1993 is worth only about 11.5 cents today. This trend will likely continue as demand for gasoline decreases with the introduction and adoption of more fuel-efficient and alternative fuel vehicles. To maintain spending levels of about \$45-\$50 billion a year for highway and transit programs and to cover revenue shortfalls, Congress transferred a total of about \$63 billion in general revenues to the Highway Trust Fund on six occasions between 2008 and 2014. This approach has effectively ended the long-standing principle of "users pay" in highway finance, breaking the link between the taxes paid and the benefits received by highway users. In August 2014, the Congressional Budget Office estimated that \$157 billion in additional revenues would be required to maintain current spending levels plus inflation between 2015 and 2024.



INNOVATION

New technologies and materials are helping engineers build bridges to last longer and are improving maintenance techniques. Construction of bridges is faster or is being performed off-site resulting in less mobility impact to the public and businesses. New materials such as ultra-high performance concrete, high performance steel and composites can increase bridge life. Off-site construction of prefabricated beams, decks and substructures is occurring in order to reduce the amount of time traffic is disrupted while the bridge is being replaced. Bridges are being constructed adjacent to the existing bridge, and then traffic is switched over prior to the demolition of the existing bridge to minimize public and economic impact. MDOT has already successfully implemented several bridge slides and used prefabricated bridge elements in Michigan.

RECOMMENDATIONS TO RAISE THE GRADE

A deteriorating and inadequate highway transportation system costs Michigan motorists billions of dollars every year in wasted time and fuel, injuries and fatalities caused by traffic crashes, and wear and tear on their vehicles. Making needed improvements to Michigan's roads and bridges is key to providing a safer, more efficient transportation system that will decrease fatalities, decrease the amount of wasted time and money spent by motorists, and improve the State's economic livelihood. Therefore, we recommend the following to raise the bridge grade:

1. State leaders must acknowledge the bridge crisis and provide substantial and sustainable funding and asset management programs to assist Michigan in continuing on the road to success.
2. Bridge designers and owners should consider the costs of the bridge's entire lifecycle to make better long-term design decisions, and prioritize maintenance and rehabilitation.
3. Fix the federal Highway Trust Fund by raising federal motor fuel tax, creating a federal tax to replace the federal motor fuel tax, or studying and implementing mileage-based user fees.
4. Since Michigan receives a large amount of freight traffic, there should be a mileage based user fee implemented for freight movement or fees for permits related to truck size and weight.

DEFINITIONS

Structurally deficient – Bridges that require significant maintenance, rehabilitation, or replacement. These bridges must be inspected at least every year since critical load-carrying elements were found to be in poor condition due to deterioration or damage.

Functionally obsolete – Bridges that do not meet the current engineering standards, such as narrow lanes or low load-carrying capacity. A bridge that is both structurally deficient and functionally obsolete is only counted as structurally deficient.



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SUMMARY

There are approximately 2,600 dams in Michigan, of which about two-thirds are older than their typical 50-year design life. In the next five years, about 80 percent of Michigan's dams will be over 50 years old. Many of Michigan's dams were originally constructed to support power or mill operations. Some of these dams still serve this original purpose. In some cases, dams no longer serve their original purpose, but continue to form impoundments for water supply or for recreational purposes. However, many of Michigan's dams are abandoned or are in need of repair or removal. Abandoned dams or dams that are in a deficient condition pose a safety hazard to downstream residents, a risk of environmental degradation, and other damage to downstream properties if the dam were to fail. While there has been some improvement with the overall condition of Michigan's dams (mostly through the removal of dams) since the last Michigan Report Card in 2009, Michigan must make more progress to address dams in need of repair or removal. Expanded funding is needed to provide additional staffing for the Michigan Department of Environmental Quality (MDEQ) Dam Safety Unit, and for resources for dam owners to address dam repair or dam removal projects.

BACKGROUND

Throughout history, Michigan has supported the intensive use of rivers for economic development. Dams can provide many benefits, but if left unmanaged, can pose risks to public safety, local and regional economies, and the environment in the event of dam failure. Many dam owners, including public agencies, do not have the financial capability to repair and maintain dams, or to remove aging and abandoned dams. Owners of dams are responsible for maintenance and repair of their dams, but many owners of non-revenue generating dams do not set aside money to fund projects for the eventual repair or removal of these dams. The lack of sufficient state, federal, or other public-funding mechanisms to assist dam owners with these projects means that abandoned, deficient, or crumbling dams continue to remain unaddressed. This poses safety hazards to downstream residents and poses a risk to Michigan's environment and economy.

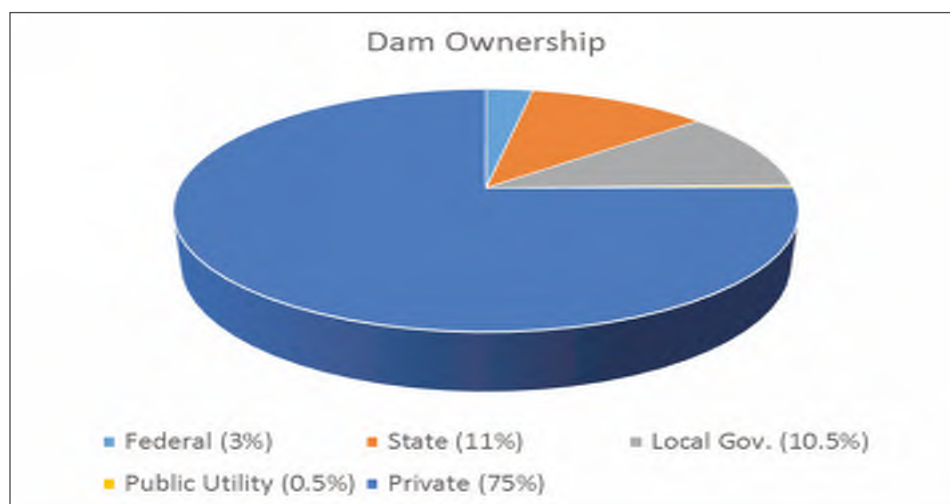
CONDITIONS AND CAPACITY

The Dam Safety Unit of the MDEQ maintains a database on dams in Michigan. There are approximately 2,600 dams in the MDEQ database or inventory. The 2,600 dams in the MDEQ database include 94 dams that generate hydropower and fall under the regulation of the Federal Energy Regulatory Agency (FERC). The National Inventory of Dams (NID), maintained by the U.S. Army Corps of Engineers, is a national dam database and lists 1,005 dams in their inventory for Michigan. The MDEQ's database contains more dams than the NID since the threshold for dam size included in the MDEQ database is lower than the threshold required for the NID.

Infrastructure age is a good indicator of overall condition since infrastructure (such as a dam) has a finite service life, allowing for the age of a dam to serve as a general qualitative indicator of condition. According to the MDEQ database, about two-thirds of Michigan's dams are older than the typical design life of 50 years. In the next 5 years, about 80 percent of Michigan's dams will be beyond their design life. Additionally, 271 of Michigan's dams were built prior to 1900, and have more than twice exceeded their typical 50-year design life. Michigan has averaged about two dam failures per year. While these failures typically have been on smaller dams without significant risk to public safety, these failures still result in environmental and economic damage.

Michigan has 140 "high" hazard potential dams (representing about 5 percent of Michigan's 2,600 dams). Hazard potential is not an indication of the dam's condition, but an indication of the potential for loss of life and property damage if the dam were to fail. A high hazard dam poses a high or serious risk of property damage or loss of life to downstream residents or a serious risk of environmental degradation if the dam were to fail. Almost 90 percent of Michigan's high hazard potential dams are greater than 50 years old. According to condition assessment data, Michigan's high hazard dams in the NID have an average rating of "Fair" (scoring about 79 on a 100-point scale). Average scores for Michigan's significant and low hazard dams in the NID are slightly higher than for high hazard dams, but remain in the rating range of "Fair".

The majority of dams (about 75 percent) in Michigan are under private ownership. The remaining dams are owned by a combination of local municipalities, the state and federal government, and public utility companies.

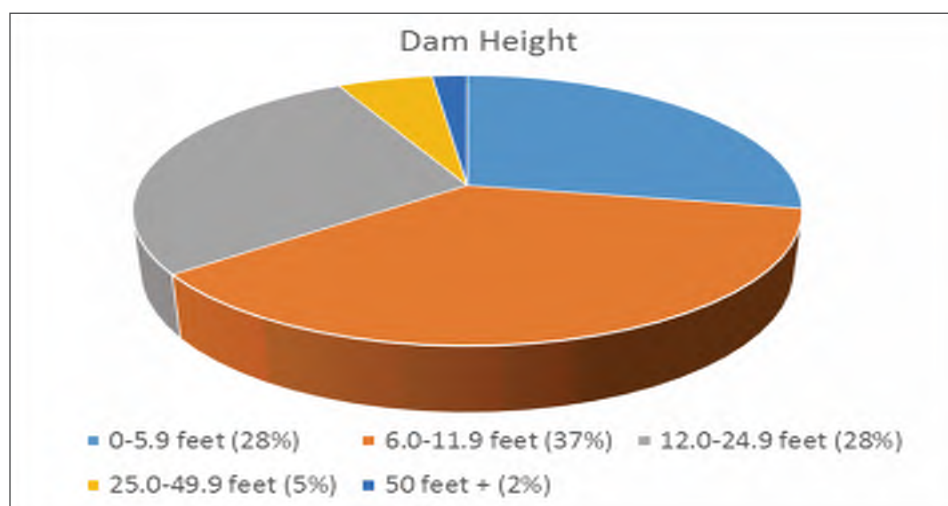


The MDEQ established its Dam Safety Program to ensure that a dam at serious risk of failure is identified and that dams are inspected and maintained in a safe condition. Dams regulated by the MDEQ must be inspected every three to five years, with the frequency of inspection depending on the hazard classification. Dams in Michigan regulated by FERC must also be inspected on a routine basis, with

the frequency of inspection a function of dam height and reservoir volume. Once dams are inspected, dam owners still need money to repair or remove the dams if the dams have deficiencies or pose a safety hazard. Deficiencies identified during dam inspections often remain uncorrected, sometimes for decades, because their owners do not have the money to repair or remove them.

Statistics on Michigan's 2,600 dams:

- About two-thirds of Michigan's dams have reached their typical 50-year design life;
- In the next 5 years, this number grows to approximately 80 percent;
- There are 271 dams over 100 years old;
- Only 86 new dams were built in the last 25 years;
- There are almost 300 dams with a "high" or "significant" hazard potential rating;
- The largest dam in Michigan has a height of 170 feet;
- 28 percent of dams are 6 feet in height or less;
- There are 94 dams in Michigan that are under the jurisdiction of FERC because of the amount of hydropower these dams produce; and,
- Since the early 20th century, more than 300 dam failures have been documented in Michigan.



There have been improvements to some of Michigan's dams since the 2009 ASCE Michigan Report Card. For example, 24 dams in Michigan have been removed since 2009, or an average of about three dams per year, and there are approximately 22 permit applications each year for repair work to dams regulated by the MDEQ. However, the combined rate of dam removals and repairs (about 25 total per year) is not keeping pace with the 241 dams that will exceed their expected design life in the next five years. There has been some good news in the fact that the slow but steady rate of removal of dams in Michigan since the 2009 ASCE Michigan Report Card has eliminated some problematic dams that have been a concern for many years in terms of their condition and potential for causing damage should the dam have failed. Primarily, because of these removals, the current grade of Michigan's dams has improved slightly to a "C-" from the 2009 grade of "D". The current grade is qualitatively consistent with the general condition of "Fair" assigned to Michigan dams in the NID.



INVESTMENT, FUNDING, AND FUTURE NEED

The choice to either repair or remove a dam is often difficult as there are safety, social-cultural, biological, ecological, and economic factors involved. Dam removal costs are highly variable and dependent on factors such as sediment contaminant levels, sediment volumes, surrounding infrastructure, wetland-related issues, and more. The many factors involved illustrate why the cost for dam repairs/maintenance/removal can be so high.

Lack of funding for addressing Michigan's aging dams has continued to slow progress on addressing Michigan's dams. According to a 2007 study, about 120 of Michigan's dams need at least \$50 million for repairs or rehabilitation. According to the 21st Century Infrastructure Commission Report, \$225 million is needed in additional state funding over the next 20 years to manage our aging dams in Michigan. This funding amount includes an initial investment of \$10 million to perform field assessments, upgrade the dam database, and procure decision-support tools and training to evaluate repair and removal options for Michigan's 2,600 dams. The remaining funding of \$215 million is the projected need to maintain or in some cases remove dams identified for attention by the upgraded database and decision-support tools. As previously discussed, many dam owners, including public agencies, do not have the financial capability to repair and maintain their dam, or to remove their aging or abandoned dam. As Michigan's dams continue to age, the need for state or federal funding, or funding from other sources, will increase. The rate at which Michigan's aging dam infrastructure is degrading has generated financial demands that far exceed the available funding to repair or remove these dams.

Funding mechanisms, such as the Michigan Department of Natural Resources Dam Management Grant, are a start toward dam funding needs. However, this funding alone is inadequate to keep pace with the financial demands of aging dams. From 2013 to 2015, this fund awarded slightly over \$1 million in Dam Management Grants. The MDNR directed three-quarters of the grants to dam removal, leaving many needs related to dam repair unfunded.

Governor Rick Snyder's 2016-5 Executive Order outlines ambitious goals for Michigan for the next 30 to 50 years. The 21st Century Infrastructure Commission Report states "Michigan must raise current annual infrastructure spending levels by an additional \$4 billion per year to close the investment gap". Closing Michigan's infrastructure funding gap, including dams, will require a combination of local, state, federal, and private investments, as well as financing strategies to meet long-term needs.

Funding for oversight of Michigan's dams by the MDEQ Dam Safety Unit is also lagging. Considering Michigan has 2,600 regulated dams, Michigan falls below the national average for budget funding on a per dam basis.

PUBLIC SAFETY AND RESILIENCE

To improve public safety and resilience, the risk and consequences of dam failures must be lowered. Since the early 20th century, more than 300 dam failures have been documented in Michigan. A recent example in Michigan is the 2003 Silver Lake Dam failure near Marquette which resulted in \$100 million in damages and economic losses of \$1 million per day. Concern about dam safety and environmental quality has become more prevalent over the last decade as more aging dams require repair. One positive for Michigan in addressing public safety is that approximately 97 percent of high and significant hazard potential dams have an Emergency Action Plan (EAP). An EAP outlines steps to be taken in the event of impending failure of a dam. Implementation of measures in an EAP can help to reduce the severity of damage should the dam fail, and can reduce the risk of loss of life.

By their nature, dams have a low level of resilience since dams cannot "recover" once significant degradation or movement is experienced. Multiple layers of redundancy are typically not provided in dam design and construction should a component fail. Therefore, when there is a dam failure, the consequences in terms of downstream damage can be relatively severe. This highlights the importance of proactive maintenance and monitoring of Michigan's dam infrastructure. Innovations in remote sensing technology, such as cameras, inclinometers, or piezometers that provide data through a web connection, can be utilized to allow for relatively rapid data collection in real time for larger more remote dams.



RECOMMENDATIONS TO RAISE THE GRADE

Some recommendations to improve the outlook for Michigan's dams include:

- Provide funding to the MDEQ Dam Safety Unit for additional staff to improve the dam inspection program and to support enforcement action for deficient dams. Currently, the MDEQ Dam Safety Unit has 3.3 full-time equivalent (FTE) staff. A 2006 informal audit of the MDEQ Dam Safety Unit by the Association of State Dam Safety Officials (ASDSO) recommended increasing the staffing level by 2 FTE staff.
- Create an asset management process to assist in making strategic and optimal decisions about dam improvements to ensure greater value for the investment. Establish performance metrics and ensure data transparency to the public regarding the condition of Michigan's dams.
- Develop educational materials and initiate a public relations campaign to educate the public on the need for proper maintenance and repair of dams, and to make the public aware of the current funding needs to address issues associated with Michigan's dams.
- Update the 2007 study to determine an appropriate current funding level to address the current condition of Michigan's aging dams. Set up a dedicated state fund for the repair, replacement, or removal of unsafe or failing dams, with the funding level based on the results of the recommended updated study.
- Provide funding to the federal program established to help dam owners with loans and matching grants for repair, replacement, or removal of unsafe, failing dams.

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DRINKING WATER

GRADE: D

SUMMARY

Michigan is nearly surrounded by the Great Lakes, which contain 21% of the world's fresh water, and is served by multiple subsurface aquifers¹. Yet certain drinking water system “owners” (e.g., municipalities) face scarcity concerns, contamination, and aging treatment/distribution systems that are not aligned with drinking water user needs. According to Public Sector Consultants (PSC) and 21st Century Infrastructure Commission reports, failure to adequately plan for and fund drinking water infrastructure could lead to major crises affecting millions of the State's residents. It is estimated that system owners in Michigan are underfunding system improvements for Safe Drinking Water Act (SDWA) compliance at between \$284 to \$563 million/year and this condition needs correction.

BACKGROUND

Approximately 77% of Michigan's population (9.9 million+/-) obtains their drinking water from the State's 1,400+/- Community Water Supply systems (CWS) with the balance supplied by Non-Community Water Supply (NCWS) systems or private wells - see Table 1. Aquifer or surface sources are employed depending on access, quality, and capacity need. Supply systems typically consist of a water source, transmission, treatment, and distribution to each user – see Definitions.

TABLE 1: MICHIGAN DRINKING WATER SOURCES AND REGULATORY OVERSIGHT

WATER SOURCE, SUPPLY SYSTEM (OWNER)	COUNT	% POP. SERVED	REGULATORY OVERSIGHT NOTES
Aquifer Wells (Private/ Agricultural owners)	Over 1.12 million wells	23%	Michigan Department of Environmental Quality (MDEQ) oversight; local health department (LHD) permitting; minimal water treatment
CWS – Aquifer Source (Note 1)	1,341 systems	19%	MDEQ oversight; review/approval of plans; significant water treatment
CWS – Surface Source (Note 1)	59 systems	58%	MDEQ oversight; review/approval of plans; significant water treatment
NCWS (Note 2)	10,000+ systems	Note 2	Primarily private owners serving 25+ people; MDEQ permit control with LHD oversight
TOTAL	>1.12 million wells; ~1,400 CWSs; 10,000+ NCWS	100%	MDEQ is primary State regulator for drinking water systems (Note 3)

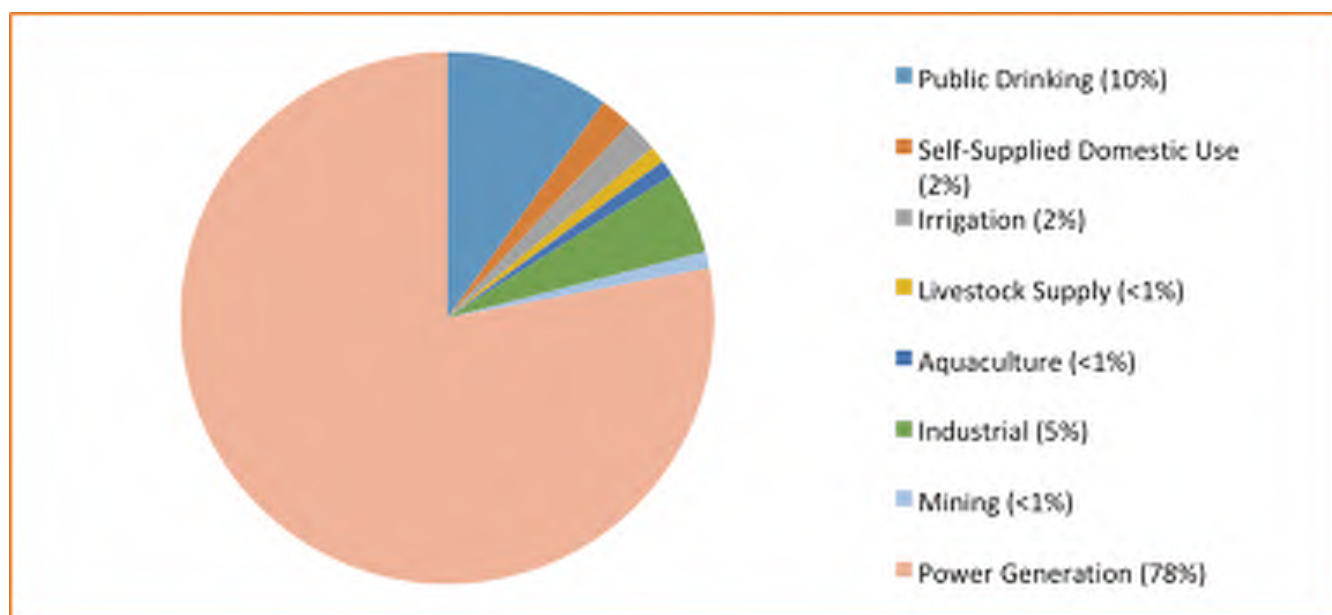
¹ Groundwater refers to all subsurface water in a saturated soil zone termed an aquifer, which contain sufficient permeable material to yield significant quantities to wells and springs. Per the USGS, groundwater with less than 1,000 milligrams per liter (mg/L) of dissolved solids is considered freshwater (potable) and the remainder is considered “saline” (requiring extended treatment before most uses). 27% of Michigan wells tap deep bedrock aquifers whereas 73% tap much shallower glacial aquifers.

Notes:

1. Municipalities and water authorities own approximately 50% of CWSs with balance owned by the State (e.g., prisons) or private entities (e.g., housing communities, apartment complexes, and universities). Only 65 CWSs equipped with water treatment; over 232 CWSs purchase treated water from other treatment-equipped CWSs.
2. NCWSs typically owned by schools, restaurants, motels, campgrounds, churches, and others serving limited-use groups and are primarily supplied by wells; part-time head count not included in “% population served” column.
3. MDEQ responsible for establishing water quality standards, monitoring/assessing quality, reviewing/approving plans, testing with-drawals for adverse impacts, other water/wastewater regulations.

In its latest 2010 report, the U.S. Geological Survey (USGS) reported that system owners in Michigan withdrew nominally 10,800 million gallons of water per day (mgd) split between groundwater (694 mgd) and surface water (10,106 mgd). Approximately 79% of the surface water came from the Great Lakes. Uses are shown in Figure 1. Much of the water used by thermoelectric power is for “once through” cooling and after minimal treatment is returned to surface water as “wastewater” versus being consumed; see the Wastewater Chapter.

FIGURE 1: TYPICAL DAILY WATER USE - MICHIGAN



The Michigan SDWA (Public Act 399 of 1976) enacted the Federal SDWA (Public Law 93-523 of 1974) for primacy and cited the MDEQ as the primary state authority over the drinking water program (see Table 1, Michigan Rules R 325.10101 to R 325.12820, and Part 127, Act 368 (Public Health Code) also).

CAPACITY, CONDITION, AND PUBLIC SAFETY

Drinking water systems are considered critical in terms of public safety, regardless of the population served. Public safety is influenced by inlet water capability/quality, treatment adequacy, and transmission and distribution (T&D) performance metrics such as condition and capacity.

A. WATER SOURCE AND SOURCE TREATMENT

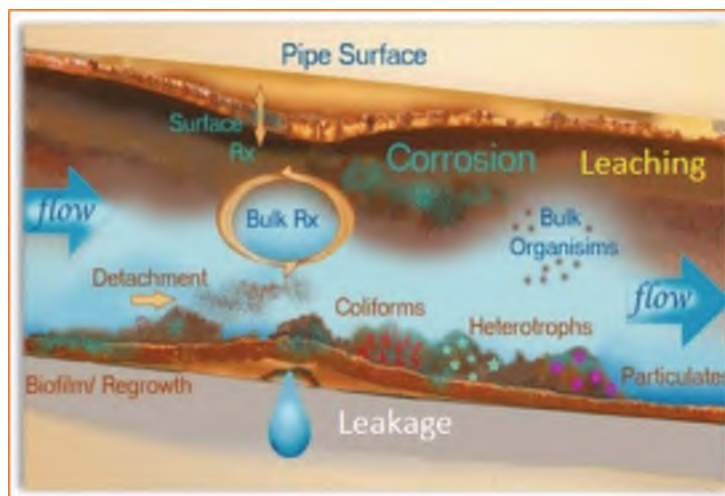
CWSs treat incoming raw water, with larger volume systems using multi-step processes (e.g., coagulation, sedimentation, filtration and chlorination). Many also use membrane filtration, lime/soda ash dosing (e.g., softening groundwater), and iron removal with oxidation/filtration to remove color, odor, arsenic, and impurities. Smaller volume systems tend to use simple screen filtration with corrosion inhibitors and disinfection additives. Well-based systems use little treatment beyond simple screening/softening and infrequently employ any quality monitoring. Larger CWSs possess significant underground T&D networks requiring both annual maintenance funds and periodic investment to replace/upgrade equipment. Michigan's abundant water sources have resulted in few instances where wastewater is recycled back into a potable water source.

All but six of 59 CWSs using surface water (Table 1) withdraw water from a Great Lake or connecting channel. These sources have sufficient capacity for user needs with active management. The remaining six CWSs with treatment withdraw water from inland rivers and are more likely to face withdrawal limits or source contamination. With increasingly stringent regulations, many of these systems have reverted to groundwater to supplement or replace surface water.

B. SYSTEM TREATMENT

Two treatment issues are prominent: (1) aging of existing equipment/processes; and (2) removing contamination caused by natural or anthropogenic substances (e.g., arsenic, nitrates, volatile organic compounds (VOCs)) or leaching from archaic piping/equipment (e.g., lead). Figure 2 addresses aging and treatment challenges. Many owners still employ dated treatment technologies.

FIGURE 2: DRINKING WATER SYSTEM CONTAMINATION AND AGING



Source: U.S. EPA



Michigan communities such as Ann Arbor and Flint, Oscoda Township, and twelve other counties face the need to address contamination, either via source switching or enhanced treatment. Hexavalent chromium, VOCs, trihalomethanes (from chlorine-based disinfection), 1,4-dioxane, natural radioactive materials, polyfluoroalkyl substances (PFAS), trihalomethanes, and arsenic are being found in local sources at levels approaching federal limits, challenging existing treatment. Clearly, the impact of lead-based piping and leaching caused by a source water switch in the City of Flint has raised awareness of water quality.

C. SUPPLY SYSTEMS AND PIPELINES

Supply systems including transmission and distribution (T&D) pipelines account for most of Michigan's built water infrastructure. Significant portions are well over 50 years old and beyond design service life, difficult to inspect/maintain, and located in corridors with other utilities/roadways. Within Detroit CWS alone, approximately 80% of its T&D was installed prior to 1940. Per the 2016 Michigan Infrastructure report, between 10 and 50 percent of the treated water is lost through leakage.

Booster pumping stations and storage are more likely to be maintained or replaced because, like treatment, they are accessible, deterioration is apparent, and their failure results in more dramatic user impact. While treatment receives greater attention, piping, valves, and pumps perform important functions. T&D maintenance is commonly deferred, particularly when funds are strained due to other critical monetary needs. Water main breaks, low pressure, leakage from corrosion/impact, and isolation failures commonly accelerate T&D rehabilitation. Failures become more frequent with aging, as susceptible materials (e.g., unlined iron/steel) corrode or enable biofilm build-up - see Figure 2. A national database of water main breaks was not found; cursory source review for 2016 through 2017 found many reported breaks in Michigan along with associated service outages and secondary damage (as compared to other states). In terms of water quality, Michigan was found to have fewer reported violations of federal water quality standards than average in a 2017 report by the Natural Resources Defense Council (NRDC).

OPERATIONS AND MAINTENANCE (O&M)

While most CWSs have O&M budgets, user fees (in the form of water rates) are frequently insufficient to cover costs of replacing old equipment/processes. Too often, this equipment must reach a critical stage of deterioration approaching failure before being addressed, as budgets for preventive maintenance are insufficient. New regulations requiring disinfection byproduct (DBP) control, microbial/pharmaceutical removal, security, and on-line monitoring detecting contaminants at part-per-trillion levels intensify funding needs. Given public health impacts quickly created by loss of treatment events, owners must have emergency plans/budgets.

Some owners have implemented innovative technologies, more durable materials, periodic flushing, preventive valve maintenance, and more frequent inspection to extend service life. Technologies such as cathodic protection, ultraviolet purification, trenchless construction, and internal lining of existing piping have reduced excavations, outages, social disruption, and life cycle costs.

Supply system rehabilitation should factor in life cycle cost of options with those for adjacent infrastructure (e.g., street replacement, storm/sanitary sewer rehabilitation, utility updating) at the same time. Use of asset management tools, geographic information system (GIS) mapping, and on-line monitoring are also best practices as cited in MDEQ's required asset management guidelines and CWS reporting requirements (MDEQ, 2013 and MDEQ, 2017).

INVESTMENT AND FUNDING

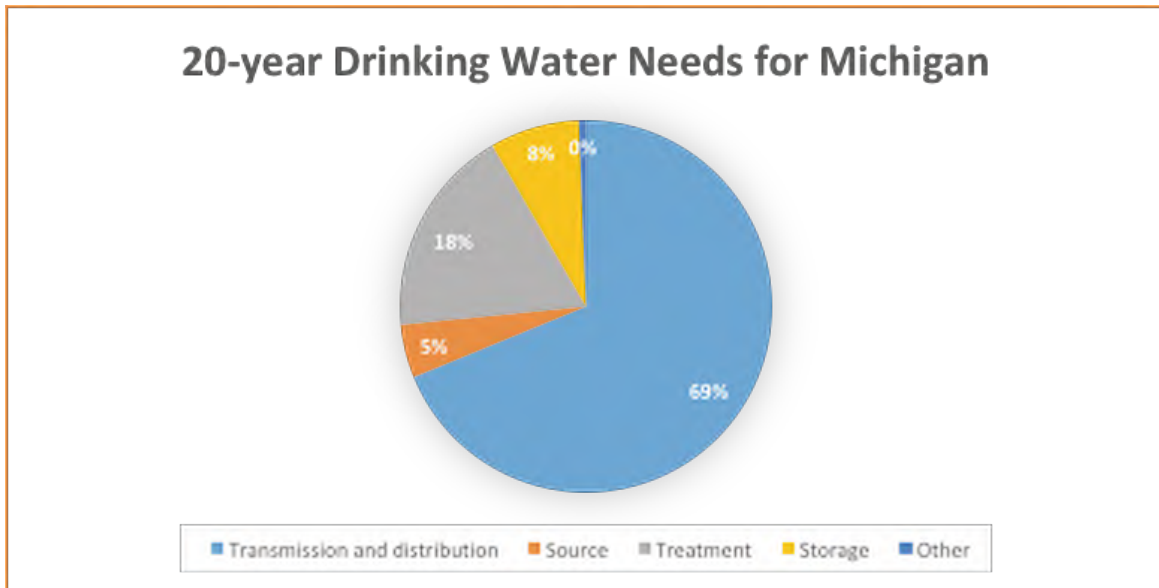
Rehabilitation is typically funded on an as-required basis, compliance with regulations, and in response to failures/aging. Rising treatment operating costs and insufficient user fees typically lead to funding gaps particularly when major rehabilitation or replacements are needed. Most system owners have recognized this and have begun investing in master planning, needs assessments, project development, and accessing state/federal funds in response.

In 2017, the EPA awarded a \$100 million grant to MDEQ to fund drinking water upgrades in Flint. The funding, via the Water Infrastructure Improvements for the Nation (WIIN) Act of 2016, enables Flint to replace nominally 18,000 lead service pipelines and make other critical infrastructure improvements. The Karegnondi Water Authority's raw water system, supplying Lake St. Clair water to Genesee County, Flint, and other jurisdictions, is scheduled to begin delivery in 2017/2018 forming a robust regional water network with the Great Lakes Water Authority. \$35 million was also set aside for 2018 spending from the Michigan Infrastructure Fund although the amount allocated for Drinking Water investment is unclear. These investments are crucial to preserving water infrastructure, but proper oversight is needed to assure that planned results are achieved.

Analysis of Michigan's drinking water periodically occurs via the EPA Drinking Water Infrastructure Needs Survey and Assessment (DWINSA). The SDWA requires that the EPA conduct this national survey every four years; 20-year capital funds for public systems eligible to receive Drinking Water State Revolving Fund (DWSRF) monies with need are defined. States like Michigan provide at least a 20% match for federal funds received, into the DWSRF. Surveys were performed in 1995, 1999, 2003, 2007, and 2011; Michigan and other state's needs have been found underfunded in each Survey. The last Survey in 2011 stated that the 20-year need for Michigan was nominally \$13.8 billion (U.S. EPA, 2014), roughly aligned with Figure 3. Plans for 2019 funding have been requested by DWSRF management, focused on disadvantaged communities. In summary, some funding is being established for replacing Michigan's drinking water infrastructure but at insufficient levels.



FIGURE 3: 20-YEAR MICHIGAN INFRASTRUCTURE NEEDS



*Source: U.S. EPA, 2013

Appropriated funding from DWINSAs must be directed to projects fitting the EPA established “criteria of need.” Federal /matching state funds placed in the DWSRF yield low interest loans offered to qualifying owners for public system upgrades. Additional federal funds are envisioned in 2018 to address national shortfalls; Michigan’s shortfalls have ranged between \$284 and \$563 million per year (PSC, 2016).

RESILIENCE AND INNOVATION

Michigan’s water infrastructure is subject to threats/stresses, including:

- Aging (including material degradation, dated treatment technology, leaching, biofilm buildup)
- Pollution
- Depleted/threatened aquifers or surface water withdrawal restrictions
- Hazardous materials
- Reduced urban demand vs. locally expanded demand (e.g., bottling, irrigation, oil/gas recovery) with shifting land use
- Climate, source quality, and weather change.

In general, existing Michigan systems are not considered resilient given their relative age and onset of damage including corrosion and fatigue. However, Michigan’s significant fresh water sources can support future user needs as long as systems are properly managed and resiliency is improved. Owners should track national best practices and innovations such as those which reduce life cycle costs, improve on-line monitoring of key parameters and contaminants, increase resilience, and use treated wastewater to replace fresh water (e.g., industrial uses).



RECOMMENDATIONS TO RAISE THE GRADE

Many but not all owners have completed master planning; the ability to secure funds and follow through on needed rehabilitation appears to be the more critical and missed step regardless. It is essential that each drinking water system be managed to: (1) prevent failures and lower life cycle costs, and (2) actively upgrade treatment to align with federal/state regulations and source water quality changes. System aging and importance mandate that adequate funding be secured and best practices be actively applied to maintain water quality/quantity.

Asset management inclusive of on-line monitoring is recommended for prioritizing rehabilitation in all private and public drinking water systems, aligned with MDEQ and LHD standards and changes imposed by natural and industrial contaminants, demand, and water availability (e.g., aquifer recharge, quality). A code to protect drinking water assets should be prepared by the MDEQ, Water Use Advisory Council, and stakeholders to ensure best practices consistent with the 21st Century Infrastructure Commission report are followed. Such a code must address shortfalls in current MDEQ oversight and owner practices, such as state Lead and Copper Rule (LCR) compliance, antiquated electronic data reporting, data mismanagement, and other concerns cited in EPA's 2017 audit report. Such a code, with well-defined owner compliance requirements would greatly reduce the likelihood of emergency events such as the recent City of Flint water supply crisis.

Increased drinking water funding is clearly needed; state/local funds such as the DWSRF, green bonds, and user fees (increased where required) must first be investigated and aligned with owner needs before limited federal funds for drinking water infrastructure are pursued. Owners must continuously bring fiscal needs of source treatment and supply system aging to the forefront with politicians, lawmakers, and budget committees. Proper asset management with life cycle cost-based solutions should be used to secure resources and to establish priority system-related actions.

DEFINITIONS

Community water supply (CWS): water system that provides year-round service to not less than 25 residents or not less than 15 living units, including municipalities, apartments, nursing homes, and mobile home parks.

Life cycle cost: The sum of initial capital and O&M costs over the expected or actual service life (selecting rehabilitation/replacement based on least life cycle cost is desired).

Non-community water supply (NCWS): water system that provides drinking or potable water to 25 or more persons at least 60 days per year or has 15 or more service connections, including schools, restaurants, motels, campgrounds, and churches (divided into "transient" and "non-transient").

On-line monitoring: Active detection of water flow, quality, and system performance, for leakage identification, quality deviations, and rehabilitation needs.

Owner: State agencies, municipalities, water authorities, businesses, and private individuals who own and operate drinking water supply systems supplying either public or private users. See Table 1.

Private water supply: system that serves one resident user/service connection (typically via well on-site with basic treatment prior to user supply); 25% of Michigan population is served via private supply systems.

Public water supply: Any system serving multiple users and which is not "private", including CWSs, transient and non-transient NCWSs, and smaller Type III public supply systems.



Supply system: Treatment and storage facilities and transmission and distribution (T&D) pipelines. Transmission conveys raw water (e.g., surface sources such as lakes and rivers and underground aquifers) to treatment. Treatment typically includes filtration, purification/softening, and disinfection process equipment. After treatment, distribution carries treated water directly to commercial and residential users or to storage (e.g., reservoirs, tanks, towers) for future use.

User: public, commercial, and individual consumers of drinking water (e.g., population served by system, collectively and individually).

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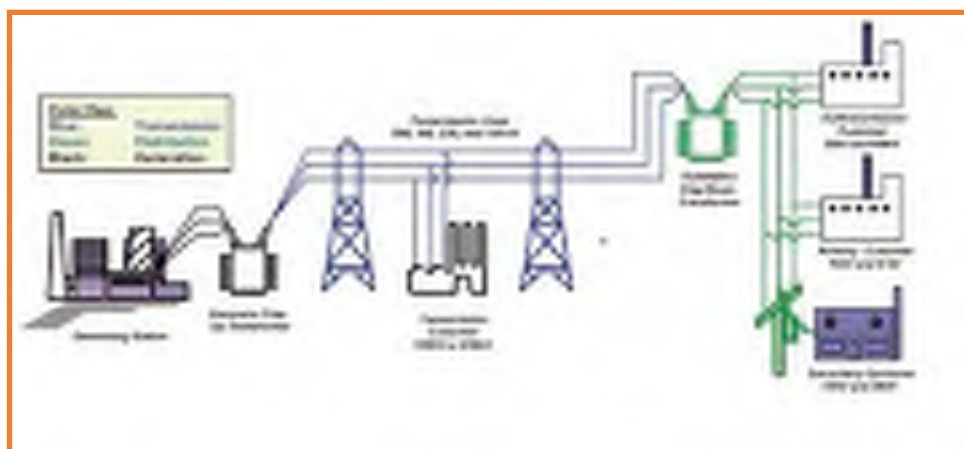
SUMMARY

Michigan's energy systems generally meet current needs. The status is threatened by increasing energy dependence and demand for high service reliability coupled with aging infrastructure, lack of investment to preserve function, exposure to physical and cyber threats, congestion, and dependence on externally sourced fossil and nuclear fuels. Diversification of the energy supply by expanding renewable energy, using electric transmission and distribution (T&D) systems, upgrading energy pipelines, and increasing resiliency are recommended to meet future needs, avoid energy disruptions, and lower the risk of future increased energy costs.

BACKGROUND

Michigan's energy infrastructure developed in parallel to industry demands and population center growth. Electricity generation focused on central, "base load" plants with high usage factors to meet local demands of steel mills, automotive manufacturing, other industry operations, and consumer needs (e.g. lights and appliances). T&D circuits were routed overhead from generation sources to consumers, as urban growth expanded into Michigan's Upper and Lower Peninsulas (UP, LP). Figure 1 below provides an overview of the electric power grid.

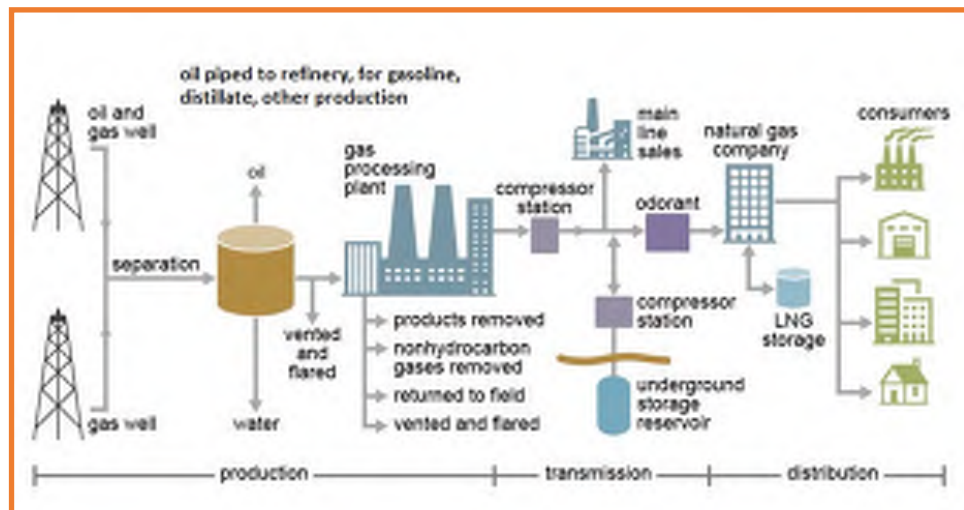
FIGURE 1. ELECTRIC POWER GRID



Source: U.S. Department of Energy (DOE)

Early central generation was built in southeast Michigan where heavy industry located due to Great Lakes and interstate roadway access. Generation spread to larger population bases, with expanded T&D infrastructure built in order to electrify rural areas (current owners per Table 1). Natural gas, petroleum and other energy pipelines were built by independent pipeline corporations (Table 1) to meet Michigan's growing demand, particularly in the southern LP where oil and gas deposits were discovered and where gas storage fields were defined. Figure 2 provides an overview of petroleum and natural gas systems.

FIGURE 2. PETROLEUM AND NATURAL GAS SUPPLY



Source: U.S. Energy Information Administration

Primary Michigan energy infrastructure owners are listed in Table 1. Aside from smaller public municipalities/cooperatives, ownership is primarily by private entities subject to public regulatory oversight. This is unique compared to other state infrastructure such as roads, which is publically owned, maintained, and regulated.

TABLE 1. PRIMARY MICHIGAN ENERGY INFRASTRUCTURE OWNERS

INFRASTRUCTURE	OWNERS	STATISTICS/NOTES
High Voltage Electricity Transmission	ITC Holdings (LP grid); American Transmission Co (UP grid)	High-voltage power grid; 138,000 kilovolts (kV) and higher via wires
Low Voltage Electricity Distribution	Alpena Power, Consumers Energy, DTE Electric, Indiana Michigan Power, Upper MI Energy Resources, Upper Peninsula Power, Wisconsin Electric Power (utilities); Wolverine Power (cooperative); others	Wires-based distribution from transmission wires to consumers. Other owners include cooperatives, municipalities, alternate energy suppliers (AESs)
Interstate Energy Pipelines (liquids, gases)	ANR (TransCanada), Enbridge, Great Lakes Gas Transmission, Northern Natural Gas, Panhandle Eastern, Trunkline, Vector	High pressure. Nexus, Rover gas pipelines being constructed from Marcellus shale region to MI. Over 10,000 pipe-miles (over 3,500 miles of liquids with balance natural gas)
In-State Energy Distribution Pipelines	Consumers Energy, DTE Energy, smaller distribution pipeline cos.	Low pressure. Over 100,000 gas gathering/distribution pipeline miles from processing to consumers
Michigan Refineries	(1) Petroleum Refinery (Marathon Detroit); (14) Gas Processing Plants, for in-state/interstate gas supplies	Refinery processes 132,000 barrels/day oil into gasoline, distillate, & related products. Processing plants purify/odorize/deliver to consumers
Michigan Gas Storage Fields	ANR, Blue Lake, Bluewater, Consumers Energy, DTE Energy, Southwest, Multiple smaller owners	1.1 trillion cubic feet storage in geological formations (MI – largest US volume); balances varying demand

Similarly unique, Michigan's electric infrastructure and energy costs are greatly affected by wholesale markets operated by the Midcontinent Independent Transmission System Operator (MISO). MISO oversees buying generation and selling electricity, as well as maintaining in-state grid stability and reliability. MISO markets and state/federal regulatory oversight both serve to control infrastructure investment and achieve low electricity rates. Gas and liquid (e.g., gasoline, distillate) transport lines into/through Michigan are subject to State and federal regulatory oversight and safety/security laws which address safe operation and new construction.

CAPACITY AND CONDITION

ELECTRICITY

Michigan's current electrical generation mix includes coal-fired, natural gas-fired, and nuclear power generation, and, to a smaller extent, renewables and other alternative sources (Table 2). Given its northern climate, Michigan has summer and winter peak demands in the range of nominally 29,000 to 30,000 MW. Per the 2017 Michigan Agency for Energy (MAE) report, a 2% demand reduction from 2016 has occurred from efficiency efforts and reduced air conditioning loads (cooler weather). Increasing renewable supply intermittency continues to challenge supply/demand stability in MISO markets.

TABLE 2. CURRENT ELECTRICITY GENERATION TRENDS/COMMENTARY

SOURCE	%	TREND	COMMENTARY
Petroleum	0.1	Rapidly decreasing use	Cost/emissions limits displacing use
Natural Gas	25.4	Increasing use	Operating cost, emissions, and speed of construction benefits
Coal	39.9	Decreasing use	Age/cost/emission factors
Nuclear	27.8	Existing reactors to operate until license expiry	Two reactors (Palisades, Fermi) serving MI; future additions not envisioned
Renewables	5.3	Increasing use	Regulations and costs/emissions driving growth
Others/Imports	1.5		Limited by cost and T&D constraints
TOTAL	100%		Efficiency is reducing demand; renewables and natural gas are key sources

Source: U.S. EIA, "2017 MI State Profile and Energy Estimates"

Given that Michigan's fossil fuel-based fleet is the second oldest in the country (average age of 49 years), investing in new generation and T&D to distribute remote renewables such as wind from the Thumb region to population centers are needed. Michigan's LP and UP configuration bordered by the Great Lakes challenges transmission import from Canada, between peninsulas, or from adjacent states, requiring lengthy T&D lines with points of congestion. Maintaining reliability and keeping electricity rates as low as achievable are goals.

In-state electricity demand has diminished since the 2007 economic slowdown. Specific factors include declines in residential demand, milder weather, reduced industrial production, and efficiency gains. Available 2017 statistics show Michigan has a reserve operating margin of 13% over recent year peak demand, which is close to U.S. norms. However, such margin is threatened by aging infrastructure and generation trends (Table 2). Power supply reliability is highly influenced by transmission grid condition, capacity, and performance, so MISO and private T&D owners (MISO participants) play vital roles in maintaining reliability. The Ludington Pumped Storage project is being expanded to 2,172 MW of renewable generation/storage, which greatly benefits resiliency.

Lack of robust transmission interconnection with the LP and Wisconsin has driven UP rates higher, and dispersed demand and reliance on older infrastructure have contributed to this. A 2017 MISO study requested by the Michigan Public Service Commission (MPSC) evaluated transmission expansion and generation alternatives, and confirmed that two smaller gas-fired generating plants, renewables, and local T&D upgrades were the most cost-effective solution. A new utility (Upper Michigan Energy Resources Corporation, or UMEREC) was formed to build, own, and operate this new generation.

No supply shortages or major transmission constraints are expected to impact the ability of UP/LP T&D owners to meet near term peak electric demands, but at least one new gas-fired, efficient generating plant is considered necessary for southeast Michigan to offset coal plant retirements and stabilize the grid.



PETROLEUM AND NATURAL GAS

Michigan's natural gas and motor gasoline/distillate demands for 2017 were estimated to be 928 trillion Btu (844 billion cubic feet) and 4.6 billion gallons respectively, by the MAE. Michigan's annual oil and gas production today as a percent of total demand are roughly 4 and 12%. Both gasoline and distillate (diesel) oil use in the UP and LP are expected to increase slightly as prices stay low, although longer-term projections show decreasing demand. The 2017 MAE report indicates a 4.1% reduction in natural gas compared to 2016 demand, as a result of mild weather and lower electricity demand. Demand will continue to be met via interstate pipelines particularly as in-state oil and gas reserves are depleted, unless alternatives such as electric vehicles reduce gasoline needs. Michigan's gas storage capacity in the form of underground caverns, salt domes, and empty oil/gas reefs capable of receiving pressurized gas provides a buffer against winter heat demands and increased prices. Storage capacity use should be maximized to enhance fuel security. In summary, petroleum/natural gas systems appear adequate to meet future needs.

OPERATIONS AND MAINTENANCE (O&M)

O&M on Energy Systems is conducted by private owners (Table 1) to meet with forecasted demand, and market, reliability, and regulatory requirements. O&M spending is minimized so as to maintain low energy prices to consumers. According to a 2016 Eaton report, Michigan has been in the top five states in the last three years for number of electric power outages. Over 60% were caused by weather, falling trees, and faulty equipment or error. Increased focus on pipeline safety occurred after an Enbridge diluted bitumen pipeline failed near Marshall in 2010. Between 2010 and 2017, few pipeline failures were reported until a gas transmission line failed in November 2017 near Auburn Hills. Increased scrutiny is also being applied to parallel, 60-year old Line 5 pipelines carrying liquid petroleum underwater from LP to UP, given risks of line failure. Aging management with testing and replacement of high-risk pipelines are part of annual O&M conducted by each owner within constraints posed by MPSC oversight.

INVESTMENT AND FUNDING

While current capacity exceeds demand, base load electric generation is aging and more efficient. Meanwhile, lower-emission gas-fired generation and renewable energy systems are under increased development. Per 2016 state energy laws, new generation need must be proven in integrated resource plans (IRPs) filed by owners with the MPSC against alternative measures such as energy efficiency. Impacts of increased electric vehicle use (EV), alternate biofuels, reduced consumer energy demand (e.g., peak shifting), and others also need consideration.

As current electricity rates are reasonably low, increased investments needed for improved aging management and sustainability should not increase rates so as to jeopardize economic growth. This exists for other delivered energy (natural gas, gasoline) rates wherein new natural gas pipelines are under construction to meet future demands. However, it is critical for state energy costs to remain affordable.

PUBLIC SAFETY, RESILIENCE AND INNOVATION

Michigan's energy infrastructure has generally proven resilient against natural/human stresses since the 2003 regional grid blackout, although climate change and increasing cyber threats pose risks. Continued renewal of aging infrastructure, hardening communications, and innovative smart grid/metering technology use is needed to limit outages and economic impacts. Electric infrastructure owners are vested in smart metering/sensing and renewables deployment, balancing regulatory requirements, and economies of scale, while meeting consumer concerns. Improving grid-related outage statistics and avoidance of pipeline-related failures are critical.

RECOMMENDATIONS TO RAISE THE GRADE

We recommend the following to raise Michigan's energy grade:

1. Stakeholders should continue pursuing reductions in energy demand, consumption and waste while maintaining rates as low as achievable to sustain and grow the economy (e.g., updating current energy code, pursuing grants and funds, and targeting efficiency and conservation).
2. Use select gas-fired distributed generation and renewable energy coupled with T&D investment to replace coal-fired generation, avoid capacity shortfalls (21st Century Infrastructure Commission report), overcome aging and congestion, and improve resilience. The 2017 solution to UP infrastructure is an example. The 2016 energy laws are expected to yield prudent infrastructure investments aligned with capacity needs and reduced T&D outages including companion emission reductions.
3. Creation of a life-cycle driven solutions for the Enbridge Line 5 underwater pipelines, given that petroleum spills pose significant risk to the Great Lakes. Planning and selection of a resilient solution is needed in 2018 to provide lead time to implement changes.
4. Concentrate focal points of near term investment to improve reliability metrics on new renewables, smart grid innovations, tree management, and aging infrastructure replacement.
5. High pressure pipeline test intervals should be reduced from 7 years to 5 years or less, and replacement of aging high-risk pipeline segments in urban areas should continue to occur by owners.
6. In 2018, the Nexus and Rover gas pipelines will increase low-cost natural gas supplies to meet future demands while increasing energy security (with increased opportunities for gas storage).

DEFINITIONS

British thermal unit (Btu): a measure of power, related to the heat content of various types of fuel; the amount of heat needed to raise the temperature of one pound of liquid water by one degree Fahrenheit.

Congestion: Flow of electricity or fluid in an energy system that is restricted or constrained below desired levels, either by the physical capacity or operational policies designed to preserve security and reliability.

Distributed generation: Scalable electricity generation located to where such is demanded (versus "centralized generation" which requires T&D infrastructure to distribute such to consumers).

Distribution lines: Wires that carry lower voltage electricity to consumers after transformation (voltage lower than 138 kV down to consumption-level voltage); term also used for pipelines delivering refined energy products (e.g., gasoline, odorized natural gas) at lower pressures to consumers.

Energy storage: Systems which capture energy produced via mechanical, electrical, and electrochemical means to enable energy dispatch at a later time when demanded.

Energy Systems (or Infrastructure): Systems which: (1) generate, transmit, and distribute electric power, and (2) collect, refine and transport fuels including solid (e.g., coal, biomass), liquid (e.g., oil, gasoline), and gaseous (e.g., natural gas) fuels, for delivery processing plants and consumers.



Grid: Interconnected system of transmission and distribution lines and related equipment that delivers high-voltage electricity from power generating plants to “substations”, where carried voltage is transformed and lowered to that suitable for distribution to consumers. Michigan’s grid is part of the Eastern Interconnection grid in the United States.

Power generating plant: Facility that uses a conventional fuel source (e.g., coal, natural gas, oil, uranium), or that captures a renewable energy source, to produce electricity.

Processing plant: Facility which refines, purifies, or extracts energy products from raw fuel stock (e.g., petroleum, natural gas) into those products used in power generation, heating, vehicular fuels, and other commodity uses.

Renewable energy: Energy generation using biomass, hydroelectric, geothermal, wind and solar sources (for electricity or fuel manufacture)

Testing: A variety of inspection, testing, and analysis techniques used to evaluate the physical conditions of energy systems typically without causing damage. Testing includes nondestructive tests (NDT), leakage surveys, remote sensing via instrumentation, and drone inspections.

Transmission lines: Wires that carry high voltage electricity from power generation plants to locations where bulk electricity is needed (typically at 138 kV and higher); term also used for pipelines which carry liquids or gases typically under high pressure from origin (e.g., wells) to processing plants, storage, or consumers needing elevated pressure service.

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SUMMARY

Michigan's navigation system includes coastal infrastructure, navigation harbors, channels, locks, and dams. The system contains approximately 50 harbors, 14 navigable waterways, the Soo Lock system, and numerous disposal facilities for depositing dredged material. Most of these harbors and waterways are recreational while some are commercial harbors.

The U.S. Army Corps of Engineers (USACE) is provided a limited amount of federal money each year to cover all maintenance and operations requirements including dredging, breakwater, confined disposal facility, etc. However, these annual funds have not kept pace with system needs, resulting in funding and need gaps that grow each year. Because commercial harbors are prioritized and exceed the available funding, recreational harbors are rarely maintained or improved. The USACE has only been able to perform some very minimal maintenance projects that serve recreation.

There is one major lock system in Michigan, the Soo Locks, located on the St. Mary's River in Sault Ste. Marie. The Soo Locks facility passes 80 million tons of commercial commodities annually. Construction of a second lock at this location is critical to sustaining the shipping industry. Likewise, maintenance activities must be provided to remain functional in the current lock system. A 2015 Department of Homeland Security study stated that a 30-day unscheduled closure of the Soo Locks would cost industry \$160 million and a breakdown lasting six months would cripple the United States economy with 11 million jobs lost. A shutdown of Great Lakes steel production caused by a sudden halt in ore transportation would in turn shutdown almost all North American appliance, automobile, construction, farm and mining equipment, and rail car production within weeks. Conversely, a new study commissioned by the U.S. Treasury Department stated that a second lock at this location will provide system resiliency that has an estimated economic benefit of \$1.7 billion.

BACKGROUND

The Great Lakes navigation system provides for interstate and international transportation of goods and materials. The system includes over 130 federal navigation projects with 610 miles of channels, 117 harbors, 140 miles of breakwaters, 20 dredged material disposal facilities, and the lock systems at Sault Sainte Marie, Chicago, and Buffalo. More than 50 of these harbors, 14 of the channels, and a significant portion of the breakwaters and dredged material disposal facilities lie within the State of Michigan.



The 10,000+ miles of Great Lakes shoreline includes some of the most beautiful, valuable, and vulnerable property in the Midwest. Cities and towns have flourished along the shores of the Great Lakes because of their natural beauty and the value they bring to commerce, navigation, and recreation. Most of these coastal cities were established as ports, taking advantage of the Great Lakes as their primary mode of transporting goods, material, and people.





Over 65 coastal cities and towns around the Great Lakes Michigan shoreline have federal navigation projects that include channels into harbors or rivers, which are protected by navigation structures like breakwaters and piers. These facilities are authorized to safeguard navigation activities in the federal harbors from waves and ice. However, they also provide critical flood and storm protection for buildings, roads, and facilities that developed in their shadow along the urban waterfront. In some cases, urban waterfront includes critical infrastructure for power generation, water supply, and wastewater treatment.

CONDITION AND CAPACITY

Most of the federal harbors in the Great Lakes were constructed between 1860 and 1940. At some of these harbors, commercial navigation has declined or ceased completely over the past 50 years. Recreation has become the major industry at many of the harbors, in some cases completely replacing commercial shipping. Currently, only about 30 navigation projects in Michigan support commercial navigation. Approximately 80% of Great Lakes harbor structures are older than the typical 50-year design life expected at the time of construction. Many others are more than 100 years old.

The coastlines are subjected to harsh, rapid changes in weather and wave conditions. Waves exceeding 10 feet, created by strong winds blowing across the lake surface, can deliver a powerful force capable of moving large stones weighing many tons each. Often, large waves combine with up to eight feet of storm surge, creating a substantial rise in water level. The combination of storm surge and large waves, especially when accompanied by ice, generates powerful forces on harbor structures and breakwaters. These elements can be exposed to these forces many times each year, which weaken structures with each succeeding event. Several significant storm events have been experienced over the past five to ten years, which have resulted in increased shoaling of navigation channels and accelerated deterioration of navigation structures, particularly along the southwest coast of Michigan. The USACE has developed a proposed long-term coastal resiliency study for the Great Lakes, but to date no funding has been received to initiate such a study.

Many breakwater structures were built with timber substructure, and as such are subject to accelerated wood decay when exposed to the air during periods of low lake levels. Lakes Michigan-Huron experienced a prolonged period of lower than average levels until 2014, when a rapid recovery to average to above average levels was experienced. Lower lake levels also exacerbate the negative affects to navigation associated with a lack of maintenance dredging by further reducing available drafts.

The Soo Lock system is critical to Great Lakes shipping. Nearly 4,000 vessels pass through the locks annually, carrying more than 65 million tons of freight. The nearly 50-year old Poe Lock is the only lock capable of accommodating the largest vessels that carry 70% of all cargo passing through the Great Lakes. A redundant Poe-sized lock is needed to provide long-term capacity and reliability for operation of the system.

OPERATIONS, MAINTENANCE, FUNDING AND FUTURE NEED

Federal funding for the maintenance and upkeep of federal harbors, breakwaters, piers, and channels is prioritized based on the national economic benefits of the facility related to commercial navigation. Navigation facilities that lack significant commercial navigation are not currently a high funding priority. Consequently, maintenance of recreational harbors and those with limited commercial traffic has been deferred and will continue to be deferred if funding levels do not significantly increase.

Constrained federal operations & maintenance (O&M) funding has resulted in assigning a lower priority to funding for those commercial harbors handling less than one million tons. The ongoing closure of coal-fired power plants at various Michigan harbors has resulted in the cessation of waterborne coal shipments, resulting in the likelihood that additional Michigan harbors will drop below this one-million ton threshold. With current available funding levels, the clear majority of harbor structures are not likely to be repaired in the foreseeable future. Over half of federal harbors are no longer considered a budget priority because they are not used commercially. With the lack of adequate maintenance, harbor structures will continue to deteriorate. Reduced maintenance could increase commercial shipping costs, reduce recreational usage opportunities, reduce protection of natural coastal assets, and reduce protection of infrastructure currently sheltered by harbor and breakwater structures. Replacement costs of harbor infrastructure, if not maintained, will be much more expensive than a maintenance investment today.



PIER WALKWAY WITH OUTER AND INNER LIGHTHOUSE IN ST. JOSEPH, MICHIGAN



The Water Resources Reform and Development Act (WRRDA) of 2014 included several key provisions that have improved the federal funding environment for Great Lakes and Michigan harbors. The bill established funding targets for utilization of the Harbor Maintenance Trust Fund (the source of O&M funding for the USACE coastal dredging projects throughout the nation), including prioritizing 10% of funds to the Great Lakes. As a result, O&M funding levels have been improving. Great Lakes funding levels in fiscal year 2016 were 63% greater than in 2012. As a result of the passage of WRRDA, and its successor the Water Infrastructure Improvements for the Nation (WIIN) Act, the improved federal O&M funding climate has resulted in more consistent/reliable maintenance dredging of these harbors to maintain authorized depths, including those harbors that have dropped below one million tons of cargo being handled on an annual basis. This increased O&M activity is allowing the USACE to begin addressing backlog dredging and improving lock and breakwater maintenance levels.

While the funding levels for maintenance of commercial harbors in the state has improved, recreational harbors continue to be a lower federal priority with minimal funding allocated to maintenance of the numerous recreational harbors located throughout the state. Operation and maintenance funding for harbors covers both coastal infrastructure (breakwaters, revetments and piers) and dredging.

Most federal navigable river channels located in Michigan waters handle substantial commercial navigation activity as they support multiple navigation/manufacturing facilities. As such, these projects receive reliable levels of operation and maintenance funding to ensure they can meet the minimum requirements of commercial navigation. However, there remains a need to address the presence of backlog shoaling in many of these projects, the removal of which would result in the navigation channels being cleared to their full authorized dimensions. Where the rivers or channels are navigable but do not support commercial use, then virtually no federal money is received.

The Corps of Engineers established a detailed Asset Renewal Plan that defines the requirements needed to maximize reliability and reduce the risk of catastrophic failure at the Soo Locks. The plan outlines the work necessary to reduce the risk of unscheduled closures of the Poe and MacArthur Locks and provide reliable infrastructure through the year 2035. Asset renewal priorities are continually reviewed and adjusted to address the highest risk components to the system. The Corps has seen increased funding for asset renewal requirements during recent budget cycles; however, constrained funding and competing demands nationwide prevent the Corps from fully funding critical asset renewal projects, jeopardizing the continued normal operation of the facility.

In addition to ensuring the reliability of the existing lock infrastructure at the Soo Locks, concerns exist over the fact that only one of the lock chambers (Poe Lock) is large enough to accommodate the largest Great Lakes freighters and as such that lock is considered the single point of failure for the overall Great Lakes navigation system. Congressional legislation in WRDA 2007 reinforced that a redundant Poe-sized lock is required and that the current Lock system must remain functional. A second lock would eliminate a single point of failure and would provide redundancy to this important navigation system. Currently, the USACE is in the process of completing an economic valuation study that is revisiting the benefits and costs associated with the authorized project to construct a new lock at this location.

RESILIENCE AND INNOVATION

The USACE has moved to a risk aversion decision-making process, to better prioritize which projects are addressed first. Asset renewal priorities are continually reviewed and adjusted to address the highest risk components to the system.

A redundant Poe-sized lock is needed to provide long-term capacity and reliability for operation of the system. A second lock at this location will provide system resiliency that has an estimated economic benefit of \$1.7 billion.



RECOMMENDATIONS TO RAISE THE GRADE

1. Address the presence of backlog shoaling and authorize funding projects that result in the navigation channels being cleared to their full authorized dimensions.
2. Fund the construction of a redundant Poe-sized lock at Sault Ste. Marie and allocate funds to provide maintenance activities in the current Lock system to remain functionality.
3. Utilize the federal Harbor Maintenance Trust Fund (the source of O&M funding for USACE coastal projects throughout the nation) and the Inland Waterways Trust Fund to full authorized levels.
4. Proceed with the USACE detailed Asset Renewal Plan that defines the requirements needed to maximize reliability and reduce the risk of catastrophic failure at the Soo Locks thereby reducing the risk of unscheduled closures of the Poe and MacArthur Locks and providing reliable infrastructure through the year 2035.

DEFINITIONS

Dredging - The act of removing silt, sediment, and other material from the bottom of bodies of water.

Locks - A device used for raising and lowering boats, ships and other watercraft between stretches of water of different levels on navigable waterways.

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SUMMARY

Michigan's rail system has approximately 3,600 miles of track that are operated by 26 private railroad companies. With the exception of 665 miles owned by the Michigan Department of Transportation (MDOT) and operated under contract, the infrastructure is privately owned. While Michigan is a peninsula state, there are three international border crossings by rail to Canada, one of the United States' and Michigan's largest trading partner. About 20 percent of the total freight moves in Michigan are made via rail. The rail system moves over \$194 billion in commodities, the largest of which include coal, transportation equipment, and agricultural products. Approximately 33 million tons move into the state and 22 million tons move out of the state by rail. Four of the seven Class I railroads operate in Michigan, as does Amtrak. Freight rail movements are projected to increase 49.8 percent, to 148 million tons, by 2030. Public dollars fund public at-grade crossing improvements and some very limited capital improvements. The needs associated with the limited state programs outpace the public dollars available.

BACKGROUND

Michigan's rail system has approximately 3,600 miles of track that are operated by 26 private railroad companies. Except for 665 miles owned by the Michigan Department of Transportation (MDOT) and operated under contract, the infrastructure is privately owned. The Michigan economy relies heavily on rail infrastructure, in part due to the state's neighboring location with Canada and that it's situated in the middle of a major, tri-national trading corridor. In 2014, 101 million tons of goods were moved via rail throughout the state. Top commodities moved by rail are motor vehicles and parts, followed by metallic ores and agricultural products including grains, sugar beets and soybeans. Freight rail movements are projected to increase 49.8 percent, to 148 million tons, by 2030.

In addition to freight, the Michigan rail infrastructure also serves passengers. Michigan has three intercity passenger rail routes operated by Amtrak that cover 521 route miles and serve 22 station communities. These routes directly serve approximately 750,000 passengers per year. All three routes link to the national rail network operated by Amtrak via Chicago and are listed below.



- The Pere Marquette Service connects Grand Rapids and Chicago via the CSX and Norfolk Southern (NS) corridors.
- The Blue Water Service connects Port Huron and Chicago via portions of Canadian National (CN), MDOT, Amtrak and NS corridors.
- The Wolverine Service connects Detroit/Pontiac and Chicago, with portions of the corridor owned by CN, NS, MDOT, Amtrak and Conrail. The Wolverine Service is part of the federally-designated high-speed rail corridor, with speeds up to 110 mph. The 135-mile segment between Kalamazoo and Dearborn is owned by MDOT.

There are two segments of additional light rail infrastructure in place, totaling approximately 3 miles, each in Detroit. The Q-Line operations began in May 2017. The People Mover has been in operation since 1987 and is expected to need capital improvements in the near future.

CAPACITY

Volume capacity constraints on the rail system is currently an infrequent issue in Michigan. However, the inability to accommodate increased capacity in the future is of concern, particularly in the Detroit metropolitan area, with federal freight forecasting models predicting a 50 percent growth in tonnage by 2030. MDOT recently completed a project in West Detroit to eliminate a congestion point for passenger and freight trains. However, a long-standing project to build a new consolidated intermodal freight terminal in Detroit to address long-term capacity limitations has not yet been constructed.

Railcars capable of carrying 286,000 pounds are becoming the nationwide standard for certain commodities. There are now some commodities moving up to 315,000 pounds per car. Heavier cars allow shippers to capitalize on the efficiencies and provide cost savings. However, limited segments of track and bridges cannot accommodate the heavier cars. More commonly, there are speed restrictions for heavier cars at bridges.

Unit train capacity is a broader concern. Unit trains ship a single commodity from origin to destination. To do that, there needs to be sufficient infrastructure to handle typically at least 90 cars at shipper/receiver facilities, as well as yards and sidings. Unit trains are particularly important for Michigan's agricultural industry to remain competitive in the national market. Typically, moving a commodity like corn via a unit train will provide a per-bushel savings to the farmer. Agricultural products are one of the top commodities that move by rail in Michigan.

Passenger rail ridership hit a record high in Michigan in 2013; and while ridership has been constrained by recent construction, it is expected to grow. With improvements to the services that have been implemented recently, such as internet access on passenger rail cars, as well as additional upcoming enhancements, it is expected that ridership growth will be only be strengthened. A capacity analysis for the Wolverine Service was completed in 2016 showing the analyzed impending need increase. To address that need there are plans to increase trips for the Wolverine Service to six trips per day by 2025 and up to 10 trips per day by 2035.

CONDITION

Track is generally kept in a condition appropriate for its current use. Unlike the highway system, rail speeds are assigned by segments of track, not routes. In turn, railroads can relatively quickly make track improvements when warranted. However, possibly even more so than the roadway system, due to the lack of alternative routing, trestle condition is critically important. Twenty-four of the 215 trestles (11%) on the MDOT-owned system are functionally deficient.



MDOT rates crossing surface condition for all of the approximately 4,800 public railroad crossings in the state. A significant majority of the railroad crossings are currently rated as in good/fair condition. While MDOT has a long history of making investments in state trunk line crossing surfaces, a new local rail crossing surface program was added in 2017 to improve local rail crossing surfaces.

The overall condition of passenger rail stations is good, with several recently completed projects that renovated existing or constructed new stations. And while the condition of passenger rail equipment is not good, all equipment (cabs and coaches) is planned to be replaced soon.

PUBLIC SAFETY

There has been an approximate 20 percent reduction in car-train crashes at Michigan's public crossings over the past five years. Approximately 50 percent of the state's public crossings have active warning devices, such as lights and gates. However, crashes still occur at crossings with or without active devices.

Conversely, the recent rise in injuries/fatalities related to trespassing incidents are of concern. Michigan continues to work closely with law enforcement agencies and the railroad industry investigating opportunities to reduce these types of incidents.

Implementation of federally-mandated Positive Train Control (PTC) is in process. PTC is designed to stop a train before a train-train collision, derailment due to speed, movement due to a misaligned track switch or unauthorized entrance into a work zone. It is required to be implemented by 2020. MDOT is overseeing the implementation of PTC on the MDOT-owned portion of the accelerated rail corridor, which will be implemented before the federal deadline.

INVESTMENT AND FUNDING

Almost all of Michigan's rail infrastructure is privately owned and maintained. Therefore, the vast majority of funding for this infrastructure comes from the private sector. Historically, the larger Class I railroads invest at a level to sustain current and future operations, while the smaller short line railroads are less capable of providing this level of investment.

Under the Passenger Rail Investment and Improvement Act of 2008 (PRIIA), all three passenger rail routes are now state supported. MDOT covers all operational and maintenance costs associated with the services that ticket revenues do not. In addition, MDOT funds all maintenance and capital work on the Kalamazoo-Dearborn segment of the accelerated rail corridor it owns.

Beyond the intercity passenger rail services, public dollars fund public at-grade crossing improvements and some very limited capital improvements. The needs associated with the limited state programs outpace the public dollars available. Despite limited available funding, an effort was made to document planned rail projects in 2008 with the Michigan Rail Plan. Only a small number of these planned projects have been completed to date.

RESILIENCE

A series of recent unrelated access and transportation-pricing events in Michigan have demonstrated how easily the system can impact the industries it serves. However, on balance, the rail industry as a whole was able to respond to these events in ways that worked to minimize the impacts of these events on the businesses that depend on rail.



RECOMMENDATIONS TO RAISE THE GRADE

1. Increase public funding for rail bridges and trestles, to improve functionally deficient structures and to improve speeds for heavier rail cars.
2. Improve capacity and efficiency of the system by constructing a consolidated intermodal freight terminal in the Detroit area, and by adding improved sidings, yards, and facilities to accommodate unit trains.
3. Increase and improve passenger rail service to meet current and projected demand.
4. Improve safety at rail crossings by providing more active warning devices.

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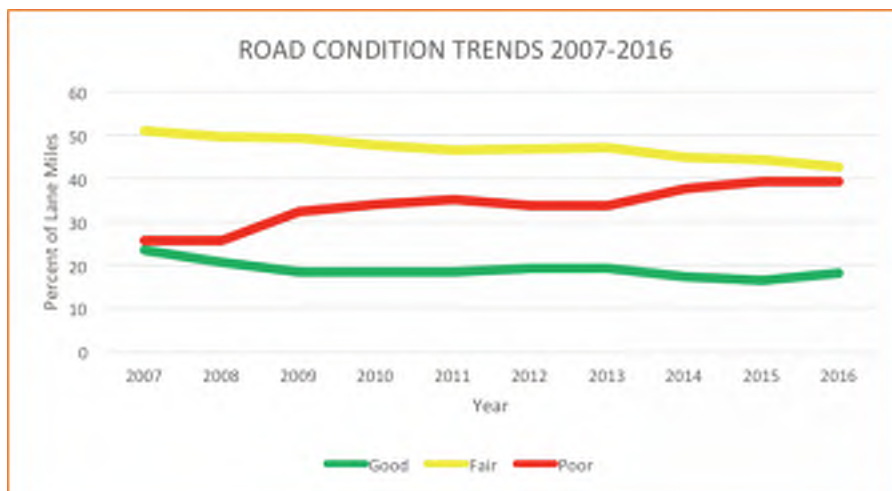


SUMMARY

Based on a 2016 assessment, 39 percent of Michigan’s 120,000 miles of paved roadways are rated in poor condition, 43 percent are rated in fair condition, and just 18 percent are rated in good condition. Nine years after a significant economic downturn, Michigan is recovering with its population and economy growing again, and vehicle travel is increasing in response to the growth. However, the rate of recovery may decrease if Michigan is not able to provide roads that are in good condition. In 2015, Michigan’s governor signed into law a road-funding package that relies on a combination of increased user fees, registration fees and general funds. These funds will assist state and local governments to move forward with numerous transportation projects but is not sufficient to address the significant deterioration of the system. Due to a 7 percent increase in poor condition roads since the 2009 ASCE Michigan Report Card, Michigan’s Road Grade has decreased from a “D” (based on 2009 report card) to a “D-” in 2018.

CONDITION AND CAPACITY

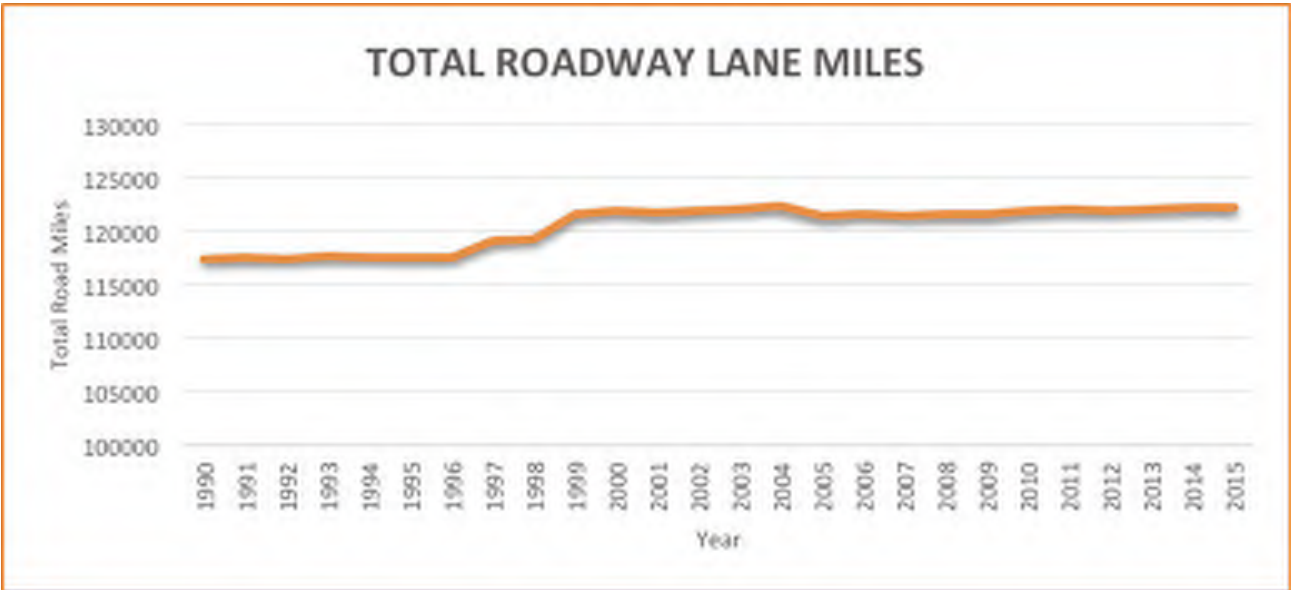
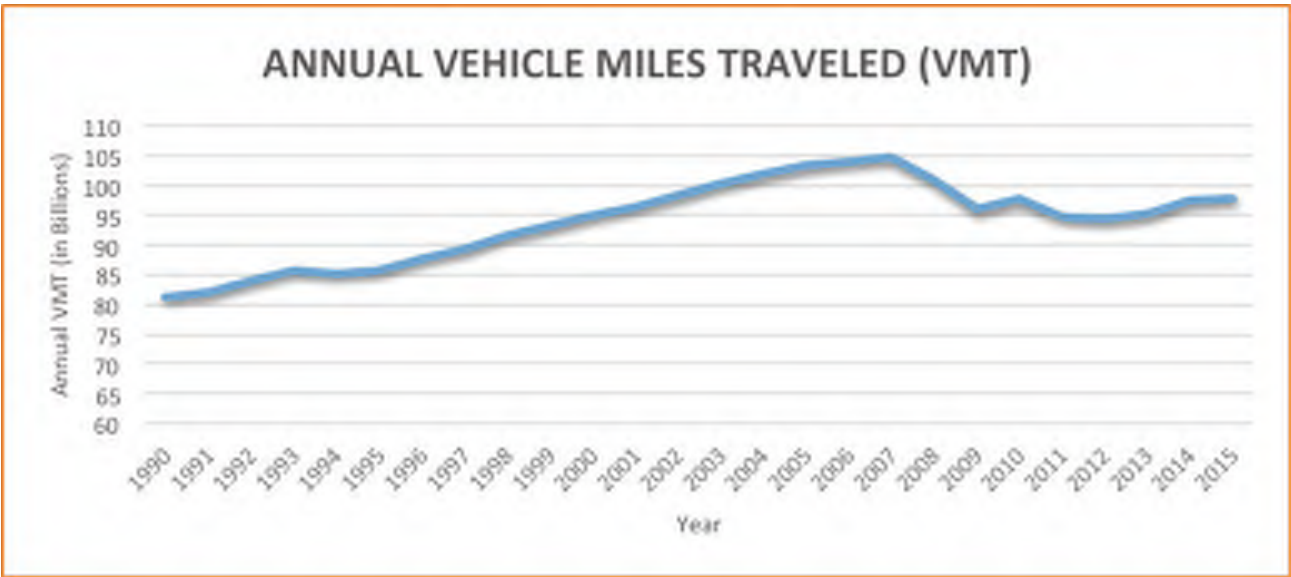
Michigan’s road system is deteriorating. According to the Michigan Transportation Asset Management Council, the percentage of poor rated Michigan’s federal-aid-eligible roads (i.e., state and primary local roads) continues to increase and the percentage of good and fair rated roads continues to decrease.





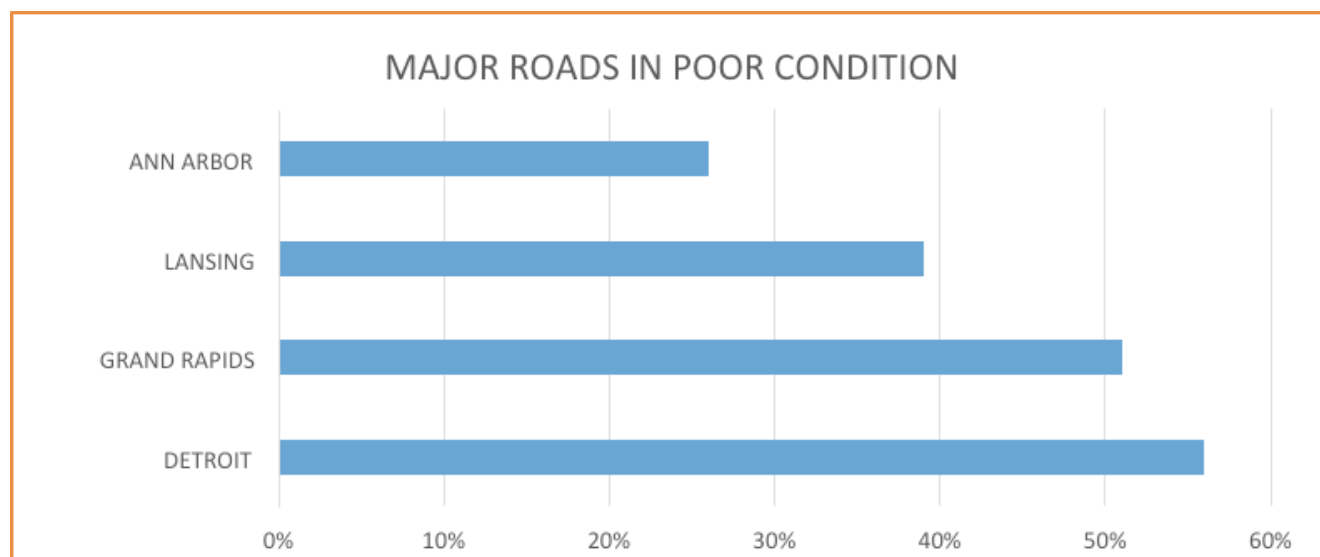
Michigan residents enjoy modern lifestyles relying on a high level of personal and commercial mobility. Annual vehicle travel in Michigan has increased over 20 percent between 1990 and 2015 and has increased 10 percent between 2013 and 2016. However, the number of roadway miles and lane miles have only increased approximately 4 percent, resulting in increased congestion and negative impacts to mobility.

Increased traffic volumes and congestion continue to impede motorists' travel and economic development. Increased vehicle miles traveled (VMT) will degrade the condition of an already deteriorated road network. In addition, traffic congestion will continue as a growing burden in Michigan's major urban areas impeding the State's economic development. In 2011, 39 percent of Michigan's urban highways (interstates and freeways) were congested compared to 23 percent in 2000.



An efficient transportation system is vital to successful commerce. Annually, \$520 billion in goods are shipped throughout Michigan, 78 percent of which are carried by trucks. A well-designed and highly accessible network of roads is more attractive for businesses to locate and expand. Numerous companies cite reliable access to the Interstate highway system and other major routes as a major factor in their choice. According to the national rankings from the 2016 Annual Report on the Performance of State Highway Systems, published by the Reason Foundation, Michigan is nationally ranked 35th worst in congested roads in urbanized area, 40th worst in rural interstate conditions and 41st worst in urban interstate conditions.

Consider this data published in 2015 by The Road Information Program (TRIP):



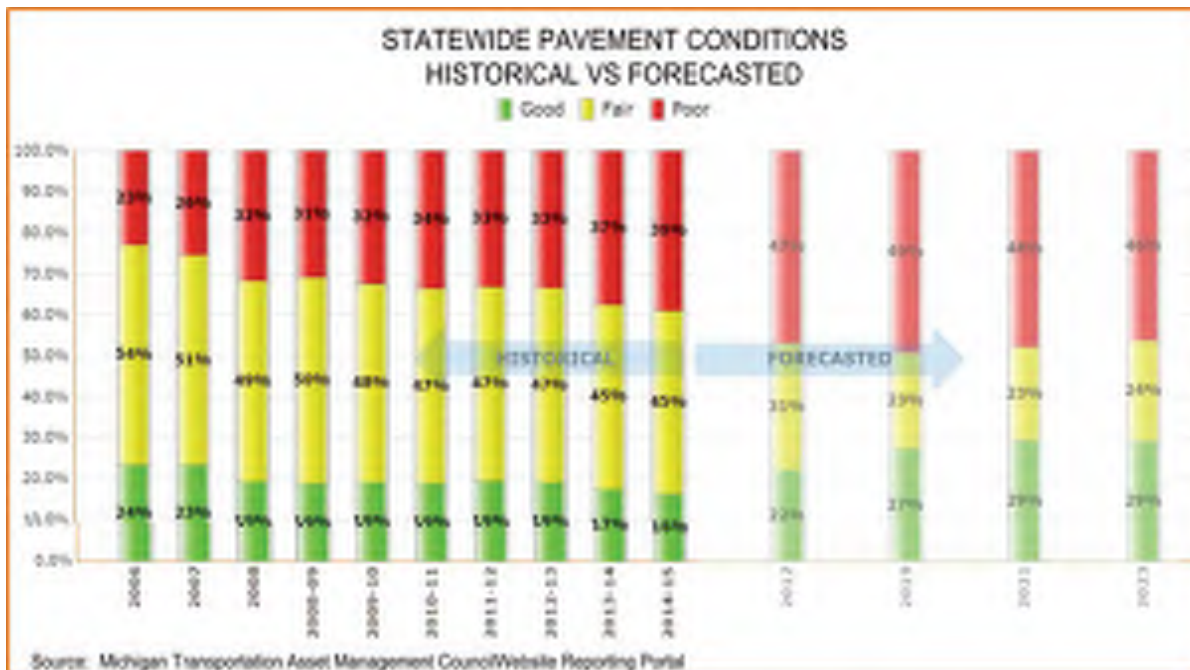
PUBLIC SAFETY

Safe and well-maintained roads provide residents access to work, home, vacation areas, medical facilities, schools, and businesses, and allows businesses access to suppliers and markets. In 2016, there were 312,172 recorded crashes on Michigan roadways and 1,064 traffic fatalities resulting from those crashes, according to the National Highway Traffic Safety Administration. The number of traffic fatalities on Michigan roadways has increased 22 percent since 2009, while over the same time period, the number of vehicle miles traveled on Michigan roads has only increased by 3.3 percent. The number of fatalities per 100 Million VMT in Michigan has increased from 0.91 in 2009 to 1.07 in 2016. The fatality rate in Michigan over this time period has held slightly lower than the national rate, which has ranged from 1.08 to 1.16 fatalities per 100 Million VMT.

Michigan's population has increased each year from 2011 to 2016 and is currently at 9.9 million residents. Michigan has about 7.1 million licensed drivers. It is challenging for the agencies responsible for managing roads to maintain and improve conditions due to the struggle of implementing a statewide-unified long-term asset management plan when faced with inadequate funding.

INVESTMENT AND FUNDING

According to forecasts by the Michigan Transportation Asset Management Council, the percentage of Michigan roads in good condition is expected to increase in the coming years, however, at the same time, the percentage of roads rated in poor condition is also expected to increase.



Even with recently enacted increases in transportation funding implemented at the State level over the next several years, funding levels will still not be sufficient to reverse the rate of deterioration of Michigan's roads. Additional funding is required to make necessary repairs to roads, to relieve current and future traffic congestion, and to improve public safety and the movement of freight. Inadequate investment in the transportation system today will mean not only accelerated deterioration of Michigan's roads, but also increased future maintenance costs.

According to the Michigan Governor's 21st Century Infrastructure Commission Report published in November 2016, Michigan's roads and bridges will require an estimated annual investment of:

- \$1 billion in State funds for Interstate and U.S. Route freeways and bridges
- \$600 million of State funds for other state highways and bridges
- \$600 million of State funds for other highly used roads and bridges under local jurisdiction



Current mechanisms for state funding utilize vehicle-registration fees and motor-fuel taxes for the bulk of the State's transportation revenue. However, revenue from motor-fuel taxes has steadily declined from a high of \$939 million in 2002 to \$850 million in 2016, primarily due to increases in vehicle fuel-efficiency. Diesel fuel tax revenues have also declined, from a high of \$157 million in 2003 to \$135 million in 2016. Implementation of increases in fuel taxes and registration fees being phased in over several years starting in 2017 are anticipated to help boost revenues, however, it will not be sufficient to fully meet transportation needs. Other mechanisms for generating funds should be considered.

At the Federal level, motor fuel and other truck-related taxes that support the Highway Trust Fund, the major source of federal surface transportation funding, are eroding. Federal motor fuel tax rates have not increased since 1993, and drivers of passenger vehicles with average fuel efficiency currently pay about \$96 per year in federal gasoline taxes. Because of inflation, the 18.4 cent-per-gallon tax on gasoline enacted in 1993 is worth about 11.5 cents today. This trend will likely continue as demand for gasoline decreases with the introduction and adoption of more fuel-efficient and alternative fuel vehicles. To maintain spending levels of about \$50 billion a year for highway and transit programs and to cover revenue shortfalls, Congress transferred a total of about \$63 billion in general revenues to the Highway Trust Fund on six occasions between 2008 and 2014. This approach has effectively ended the long-standing principle of "users pay" in highway finance, breaking the link between the taxes paid and the benefits received by highway users. In August 2014, the Congressional Budget Office estimated that \$157 billion in additional revenues would be required to maintain current spending levels plus inflation between 2015 and 2024.

INNOVATION AND RESILIENCE

New technologies and materials are helping roads become more sustainable and resilient such as use of recycled materials in pavement and full depth reclamation. Michigan Department of Transportation (MDOT) is in the process of developing innovative techniques and delivery methods to improve the State's roadways. MDOT has also invested in Intelligent Transportation System strategies to help manage roadway congestion in addition to recent capacity improvements. MDOT has installed sensors, closed caption TV cameras along major highways/freeways, and dynamic message signs capable of disseminating travel time or alert information to motorists. Michigan is a leader in the development of autonomous/connected vehicle technology, with research and development at the Mcity facility on the University of Michigan campus and the American Center for Mobility, an autonomous and connected vehicle testing facility being constructed on the site of the former Willow Run bomber plant. These technologies are aimed at improving safety and mobility, reducing congestion, and supporting efficiencies and economic growth.



RECOMMENDATIONS TO RAISE THE GRADE

A deteriorating and inadequate highway transportation system costs Michigan motorists billions of dollars every year in wasted time and fuel, injuries and fatalities caused by traffic crashes, and wear and tear on their vehicles. Making needed improvements to Michigan's roads is key to providing a safer, more efficient transportation system that will decrease fatalities, decrease the amount of wasted time and money spent by motorists, and improve the State's economic livelihood. Therefore, we recommend the following to raise the roads grade:

1. State leaders must acknowledge the roads crisis and provide substantial and sustainable funding and asset management programs to assist Michigan in continuing on the road to success.
2. Michigan is a national leader in the establishment and development of a statewide asset management approach to managing its diverse transportation investment for roads and bridges. It is vitally important to both continue, as well as expand, this effort at all jurisdictional levels in order to provide the most efficient and effective use of transportation investment.
3. Road designers and owners should review the total life cycle costs of the road to make strategic design decisions and prioritize maintenance and rehabilitation.
4. Fix the federal Highway Trust Fund by raising the federal motor fuel tax, creating a federal tax to replace the federal motor fuel tax, or studying and implementing mileage-based user fees.
5. Michigan receives a large amount of freight traffic and there should be a mileage-based user fee implemented for freight movement or fees for permits related to truck size and weight.

DEFINITIONS

Vehicle miles travelled (VMT) – The total mileage travelled statewide by all vehicles over one year.

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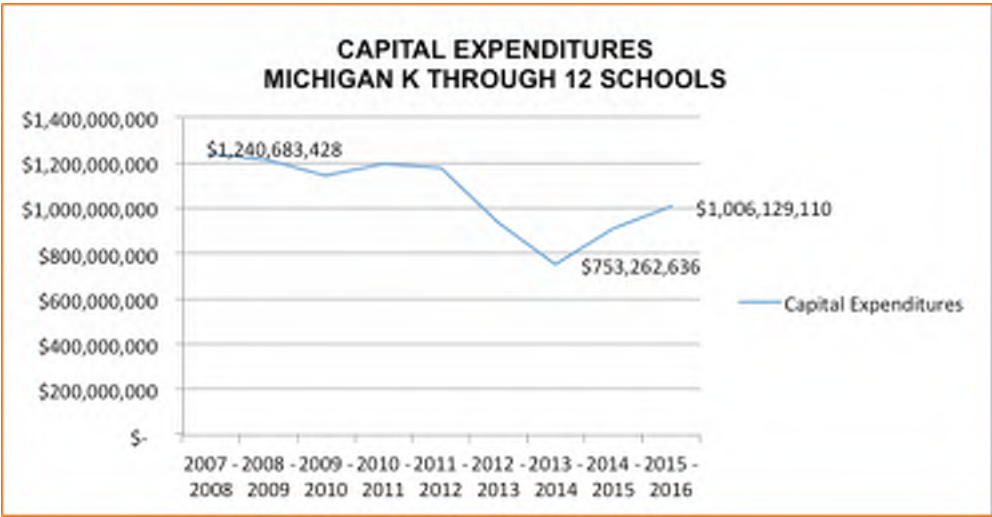


SUMMARY

The condition of Michigan's education facilities varies widely both across the state and within individual regions and districts. Nearly every district or organization has aging facilities, while some also have a mix of updated and newly constructed facilities. It is important to understand that access to funding for school facility improvements is largely based on the size of the local property tax base. The condition of Michigan's K through 12 schools varies based on a region's propensity to support property taxes for schools and the value of the region's taxable property. Overall, Michigan's schools have stabilized and shown slight improvements in enrollment numbers and facility funding. These improvements are driven by the improving economic conditions in Michigan and higher birthrates. As this trend continues, it is anticipated there will be less consolidation and closing of aging school facilities, and a movement will begin towards renovation, expansion, and construction to meet the future needs of Michigan's student population.

CONDITION

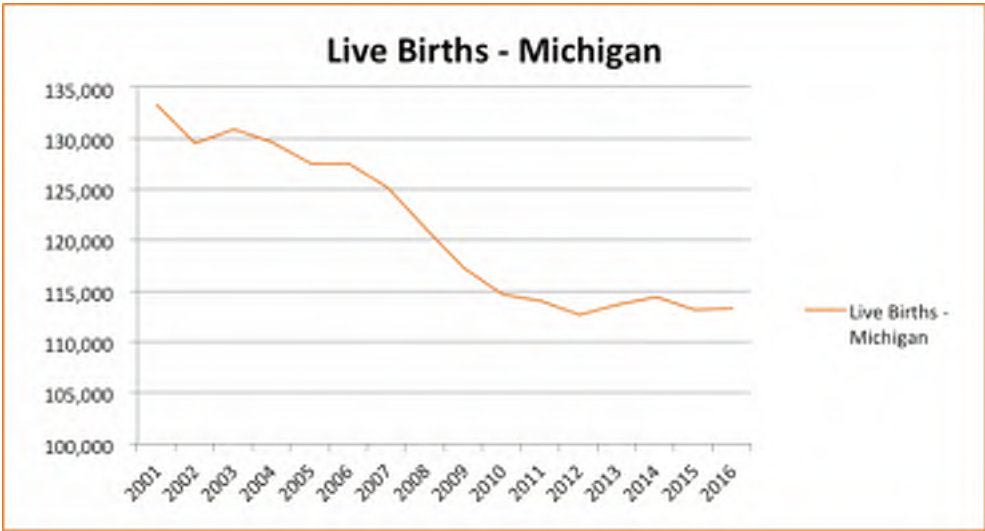
The condition of Michigan schools varies widely. While some districts have invested in significant renovations and some limited new buildings, many are utilizing structures and utility systems that are well beyond their design and useful life. Spending on capital expenditures by Michigan's schools declined from 2007 to 2014, but appears to be stabilizing, albeit at a level almost 30 percent below its average from the mid 2000's. In 2014, the US Department of Education published a report summarizing the overall surveyed condition of school facilities. The average reported number of years since the construction of the main instructional building in the Central Region (which includes Michigan) was 49 years with most recent renovation occurring 13 years ago. The condition of outdoor features such as parking lots, roadways, bus lanes, drop-off areas, sidewalks, playgrounds, athletic facilities, covered walkways and fencing was found to be rated as fair or poor at 39 percent of public schools, with the Central Region lagging all regions in nearly every outdoor feature category. Among public schools with permanent buildings, the environmental factors in permanent buildings were rated as unsatisfactory or very unsatisfactory in 5 to 20 percent of schools, depending on the system or characteristic rated. For example, indoor air quality rated unsatisfactory or very unsatisfactory in 9 percent of permanent school buildings, whereas heating systems rated poorly in 14 percent of schools. Given the limited capital expenditure funding in recent history, the condition of Michigan's school infrastructure continues to decline.



Source: Michigan Dept. of Education Bulletin 1011

CAPACITY

Based on the statewide declining enrollment of students, the capacity of Michigan schools continues to be adequate. The majority of capital expenditure in Michigan education has been focused on the renovation and replacement of existing facilities, rather than expanding space for students. As the population of Michigan remains stable, school enrollment projections are largely predicted by the birth rates in the state. Based on an analysis of birth rates for the last 16 years, the rate of births appears to be stabilized and may again be on the rise, predicting the need for additional facilities for future students.

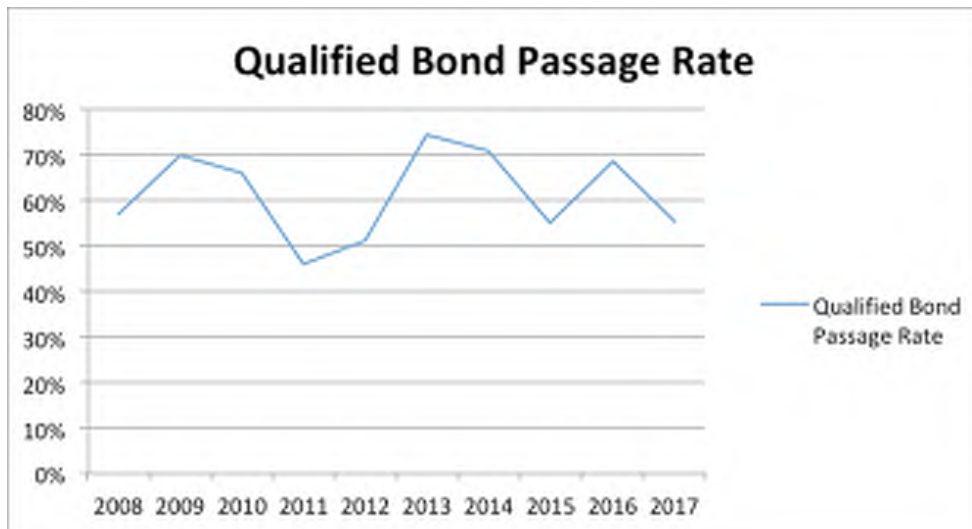


Source - Michigan Dept. of Education

INVESTMENT AND FUNDING

Very few dollars of state per-pupil funding for education in public schools remains available after paying basic educational staff and operational expenses. Instead, capital improvements in State of Michigan public schools are largely funded by local property tax millages. These millages require voter approval and have received mixed results in recent years. The average rate of passage of state qualified ballot questions from 2008 to 2017 was 61 percent. Districts with higher taxable values of property also required less millage to generate the same amount of funds, creating significant inequity between district facilities based on taxable value and propensity to approve additional property taxes.

While securing the funding for projects can be challenging, the need for funding is very apparent. The United States Department of Education (USDOE) survey indicated that 53% of respondents reported they needed to spend money on repairs, renovations and modernizations to put the school's onsite buildings in good overall condition. At a national level, the total amount needed was estimated to be approximately \$197 billion which equates to an average need of \$4.5 million per school.



Source - Michigan Dept. of Treasury

FUTURE NEED

The future needs of Michigan schools continues to point to renovations and upkeep bringing older facilities into the 21st century. Many districts are still utilizing facilities built in the 1950s and 1960s following the Baby Boom, in the condition they were originally constructed. Beyond utility and aesthetic renovations, teaching styles continue to evolve and favor team and project based environments with flexible spaces and technology rich environments. Older facilities typically do not support these teaching styles. While some new facilities have been approved and constructed in recent years, communities have largely only approved “use what you have” approaches rather than direct replacements. This has required creative approaches to modifying and adding to existing facilities to facilitate a new image and to incorporate 21st century teaching styles.



OPERATIONS AND MAINTENANCE

The majority of school funds are used directly to educate students. Operation and maintenance funds are primarily used to maintain day-to-day building operations, with little money remaining for longer term maintenance, repair, and replacement. As discussed earlier in this chapter, funding for these activities largely falls to the levy of property tax millage for public schools. Schools also vary in their financial ability to set aside funds for replacement of property and plant (roofing, boilers, athletic fields, etc.) with defined lifespans and significant replacement costs. These projects tend to be delayed and often necessitate a larger program or community supported response.

PUBLIC SAFETY

Michigan schools continue to focus on improving safety both through facilities and policy. Many continue to implement single secure points of entry, guiding visitors through a staff checkpoint during the daytime operational hours. There's been an attempt to strike a balance between fortifying schools and maintaining open, community facilities. Significant progress has been made in securing many facilities in the last five years.

RESILIENCE

Michigan schools have in many cases “made do” with existing facilities and have been remarkably resourceful in consolidating where needed and shoehorning modern technology in aging facilities. Often schools are repurposing space within aging structures to satisfy programming needs. While the minor changes allow for continuation of the education process, they do little to address the aging facility and infrastructure.

There are many districts that are considering adopting an “alternative calendar” that will lengthen the school calendar to year-round school thereby limiting the construction window in which facilities can be improved while unoccupied. Upgrading failing infrastructure is often invasive, loud, time consuming and presents many unique code challenges to maintain safety during construction. The pressure of the shortened construction window will only add to construction cost escalations experienced by material and trade shortages. Additionally, the alternative calendar will require that spaces used during summer are conditioned properly to ensure the educational process isn't impacted. This will increase the amount of infrastructure schools will need to maintain in the future driving long term maintenance costs higher.

SPOTLIGHT ON A MICHIGAN SCHOOL DISTRICT: Zeeland Public Schools' Facility Analysis and Strategic Funding Plan

Zeeland Public Schools completed and continue to update a district-wide study of the condition of all their facilities including roofing, energy systems, interiors, pavements and athletic facilities approximately 10 years ago. The study has helped to make informed decisions for future funding and expansion/contraction as student population changes.



RECOMMENDATIONS TO RAISE THE GRADE

1. Address facility funding inequity – While public schools receive very similar per pupil funding for education from the State of Michigan, major facility renovation projects are almost exclusively funded using local district or independent school district (ISD) wide property tax millages. Those with large property tax bases continue to have access to more capital than largely rural schools, who generally struggle to keep facilities operational. Additionally, schools with declining enrollment may struggle to secure funding to improve remaining facilities and continue to operate at a level similar to districts with growing student base. Adopt an equitable baseline facility funding source for districts across the state.
2. Development of Statewide Database of Condition of School Facilities – We recommend that documenting the current condition of school districts start with the Intermediate School Districts maintaining records and reporting to the State. Proper funding would be needed to support the collection and compilation of this information. If the State has a good understanding of the condition of its schools, it can make more informed decisions as to funding needs.

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SOLID WASTE

GRADE: C+

SUMMARY

Solid waste disposed in Michigan totaled nearly 16 million tons in 2016, similar to the previous year. The estimated residential recycling rate was 15 percent, less than half the US average. Daily per capita waste generation is approximately 5.6 pounds, nearly 27 percent greater than the national average of 4.4 pounds.

Overall, Michigan's collection, transfer and disposal infrastructure is robust and the industry competitive, with approximately 27 years of landfill disposal capacity remaining. Michigan is beginning to actively shift its overall solid waste philosophy toward a sustainable materials management approach to create economic opportunities through waste diversion, beneficial re-use, and recycling programs

CAPACITY AND CONDITION

In 2016, over 15 million tons of waste was disposed in Michigan landfills. Waste imported and disposed in Michigan landfills was nearly 4 million tons, approximately 23.6 percent of the 2016 total. For comparison, in 2014, the total landfilled waste in the U.S. was 258 million tons. Michigan represented 6 percent of the total waste disposed in landfills nationally, a value impacted by imported waste streams.

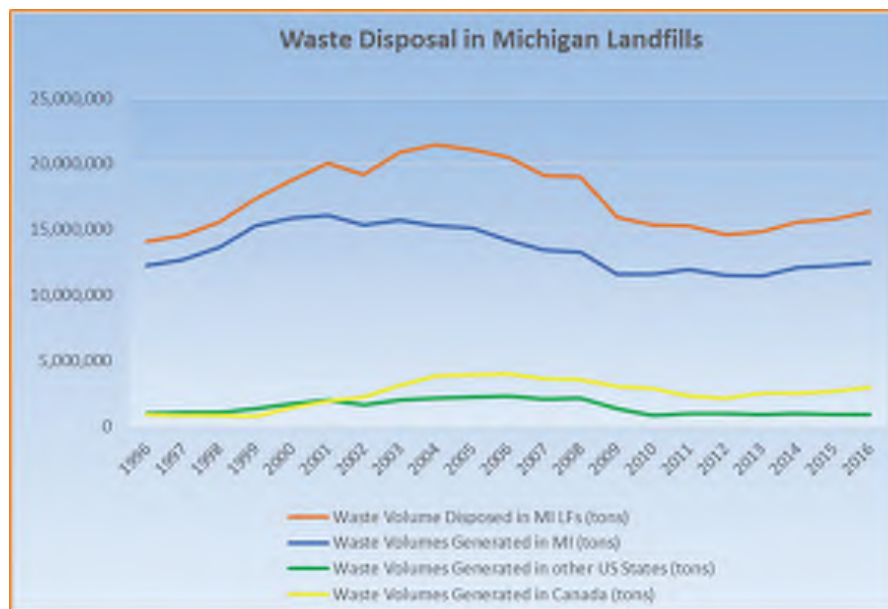
As shown on Table 1, since 1996 the overall total waste disposed in Michigan increased by 12.1 percent, but yearly fluctuations occurred that appear to coincide with economic cycles and fluctuations in the volumes of imported wastes. Peak landfilling occurred in 2004 (21.4 million tons) and the greatest volume of imported waste occurred in 2006 with 2.3 million tons from surrounding states and over 4 million tons from Canada, representing 30.9 percent of total landfilled waste in Michigan.

TABLE 1: OVERALL WASTE DISPOSAL FROM 1996 TO 2016

Year	Waste Disposed in MI LFs (tons)*	Waste Generated in MI (tons)*	Waste Generated in other US States (tons)*	Waste Generated in Canada (tons)*
1996	14,094,134	12,225,765	1,011,731	884,858
1997	14,556,547	12,698,550	1,025,504	834,960
1998	15,580,411	13,649,043	1,062,117	849,605
1999	17,319,155	15,260,745	1,344,031	780,930
2000	18,717,437	15,884,131	1,738,705	1,405,605
2001	20,083,537	16,087,345	1,992,590	1,964,913
2002	19,180,307	15,348,826	1,628,862	2,202,619
2003	20,871,810	15,689,023	2,026,456	3,144,343
2004	21,429,085	15,260,221	2,192,468	3,852,966
2005	21,098,372	15,145,748	2,204,076	3,959,364
2006	20,501,110	14,155,926	2,316,882	4,028,302
2007	19,129,356	13,411,074	2,057,287	3,660,995
2008	19,039,965	13,304,545	2,161,365	3,574,055
2009	15,945,906	11,583,788	1,343,994	3,018,124
2010	15,374,312	11,600,955	854,352	2,919,005
2011	15,242,667	11,952,640	962,318	2,327,700
2012	14,629,515	11,495,178	970,917	2,170,741
2013	14,867,088	11,411,053	928,567	2,531,572
2014	15,575,820	12,093,906	943,412	2,546,389
2015	15,805,947	12,282,504	890,966	2,686,981
2016	16,363,089	12,504,839	896,931	2,961,319

	From DEQ's 2005 Annual Report of Solid Waste Landfilled in MI
	From DEQ's 2016 Annual Report of Solid Waste Landfilled in MI
*	Annual Report from DEQ report in cubic yards. Numbers shown in this table have been converted using a 3:1 conversion factor

FIGURE 1: TREND OF ANNUAL WASTE DISPOSAL IN MICHIGAN LANDFILLS



As depicted on Figure 1, 2005 marked the beginning of a trend in declining annual waste disposal in Michigan landfills that extended to 2012. During this period, which roughly coincides with the national economic recession, the amount of solid waste landfilled in Michigan fell from 21 million tons to 14.6 million tons, an overall decrease of 30.7 percent. In the last four years, total landfilled waste increased slightly, with imports from other states and Canada remaining relatively stable, averaging 6 percent and 16.8 percent, respectively.

SOLID WASTE COMPOSITION

Michigan licensed landfills are categorized based on the type of waste disposed. These include: Type I (hazardous waste), Type II (residential, commercial, and institutional waste), which can also dispose of C&D and IW waste, and Type III (C&D and industrial wastes). Excluding hazardous waste facilities, there are 69 active Type II and Type III landfills (including all subcategories).

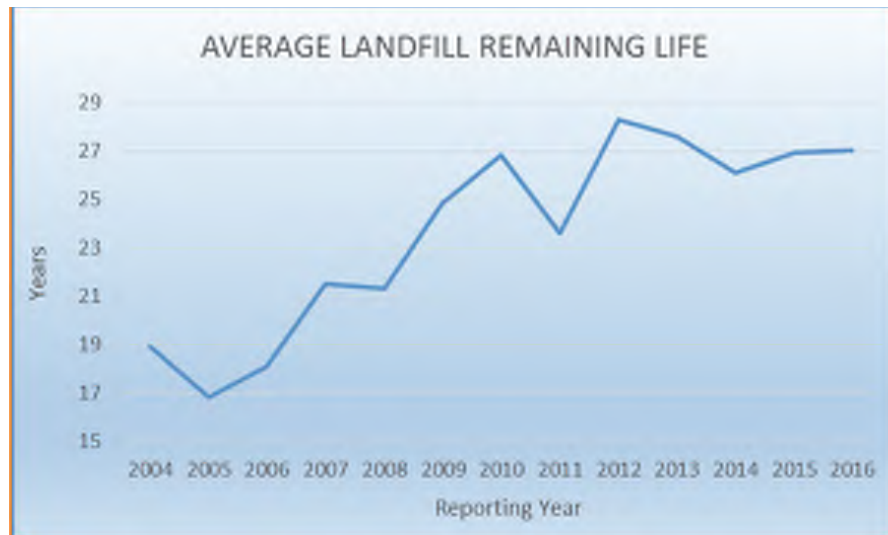
REMAINING LANDFILL DISPOSAL CAPACITY

Michigan law requires each county prepare a solid waste management plan to demonstrate waste disposal capacity of at least 10 years or submit annual reports to certify compliance. Any county that reports capacity less than 66 months is subject to automatic siting criteria enforced by MDEQ.

At present, all Michigan counties have access to disposal capacity in excess of 10 years, available in-county or via inter-county agreements. Based on MDEQ's 2016 database, the capacity of individual landfills varies widely (1 to 494 years); however, the total available capacity of Michigan's 47 non-captive Type II landfills located within the state's 83 counties is nearly 500 million cubic yards (166.5 million tons). At existing disposal rates, this equates to approximately 27 years of remaining disposal capacity.

As indicated in Figure 2, the overall remaining capacity trend of non-captive landfills has generally increased since 2004 when MDEQ began tracking this statistic.

FIGURE 2: AVERAGE LANDFILL REMAINING LIFE



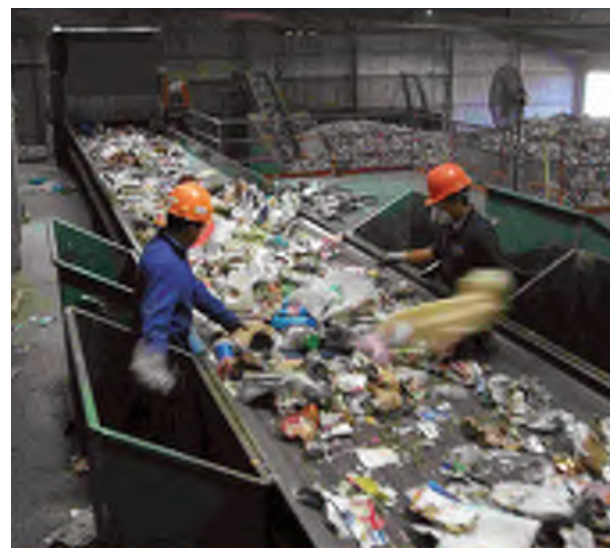
Michigan's substantial landfill capacity results in lower disposal rates than elsewhere in the Great Lakes Region. The Recycling Partnership's 2016 report indicates that within the U.S. Environmental Protection Agency (EPA) Region 5 states (i.e., Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin), the average landfill tipping fee ranges from \$28/ton (Indiana) to \$51/ton (Minnesota); Michigan's average is \$31/ton.

Combined, the abundant landfill capacity and low disposal fees, which result in lower rates for customers, are often cited as the primary factors contributing to Michigan's relatively low residential recycling rate. Landfill diversion and related sustainability issues will be addressed as part of pending county solid waste plan updates, many of which have not been revised for more than 10 years.

MSW RECYCLING FACILITIES

Based on available information, MSW recycling operations occur primarily at material recovery facilities (MRFs) owned and operated by both public and private sector organizations. There are 65 MRFs located in Michigan, seven located in the Upper Peninsula (UP), and 58 in the Lower Peninsula (LP). These facilities process the majority of traditional recyclables materials (e.g., metal, plastic, paper, and glass) generated in the state and sell to end-users in Michigan and elsewhere in the country. At present, due to recent facility fires and low-commodity pricing, only a few single-stream MRFs operate in southeast Michigan.

Although Michigan's current recycling rate is relatively low, existing infrastructure appears adequate to support increased activity and participation, especially if education programs are developed and implemented.





INVESTMENT AND FUNDING

Michigan's solid waste program is funded by a combination of fees and legislative appropriations that cover MDEQ staff salaries, expenses, and various grants distributed to local communities for recycling and pollution prevention activities. In 2016, the total budget allocated to MDEQ to administer the solid waste program was \$11,042,400. The MDEQ solid waste program employs 51 staff, or full-time equivalents (FTEs). The budget also included a \$1 million special legislative appropriation to support the Governor's recycling initiative. The initiative is a 15-point plan focusing on public education and technical assistance, convenient access to recycling for Michiganders, and better benchmarking and tracking of recycling rates. The state hopes to see results from the initiative in the upcoming years.

Nearly half of MDEQ's funding source is a \$0.12/cubic yard (\$0.36/ton), surcharge from all non-captive MSW landfills, which totaled nearly \$4.5M in 2016. Other major user fee-based funding sources include facility construction permits and operating licenses, as well as scrap tire, medical waste, and e-waste program registration and surcharge fees.

Approximately one-third of MDEQ's solid waste program budget is allocated to pollution prevention and recycling grants, with scrap tire pile cleanup and market development projects the major recipients. Michigan also charges a \$0.75/ton perpetual care fund surcharge for non-captive landfills, capped at \$2M per facility, for use to manage facility environmental protection systems during the 30-year post closure period or in the event of site abandonment.

Similar to Michigan, each of the six USEPA Region 5 Great Lakes states uses a variety of financial mechanisms to fund their respective solid waste programs. Each state collects a waste disposal surcharge, which ranges from \$0.36/ton to \$13.00/ton, with Michigan charging the least and Wisconsin the most. However, only slightly more than half of Wisconsin's surcharge directly supports their solid waste program. Ohio, compared to other Great Lakes states, is most analogous to Michigan with respect to solid waste management infrastructure and population, and appropriated nearly \$20.7M for their solid waste program in 2016 compared to Michigan's \$11.7M. This translates to \$1.78 per capita/year in Ohio and \$1.11 per capita/year in Michigan spent on solid waste management programs administered by the Ohio EPA and MDEQ, respectively.

RECOMMENDATIONS TO RAISE THE GRADE

Based on available data, Michigan's solid waste infrastructure (including: collection, transfer, and disposal) is robust and competitive. Michigan's solid waste infrastructure provides the means necessary to effectively manage residential, commercial, and industrial waste streams compliant with environmental standards at a reasonable cost. However, to increase Michigan's overall recycling rate and reduce landfilling, Michigan should take the following steps to raise the grade:

1. Follow Governor Snyder's "Michigan's Recycling Plan of Action" that includes increasing recycling from 15 to 30 percent by: developing a reliable measurement tracking and reporting system; increasing education, outreach, and technical assistance programs; marketing development and innovation support; updating county solid waste plans; and, continued state-level leadership and funding to enact the plan.
2. Complete on-going joint efforts between the MDEQ, industry, and other stakeholders, to revise Part 115 of Michigan's PA 451 (1994) that shifts current solid waste policy towards a material management approach less reliant on landfilling.

These initiatives, if fully-supported and funded, will place Michigan on path to improve its overall solid waste infrastructure performance and associated grade.



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STORMWATER

GRADE: D-

SUMMARY

Michigan's stormwater management system provides flood protection, improves the quality of life for residents, allows our businesses to operate safely and efficiently, provides for safe transportation, improves agricultural production, and extends the service life of roads, streets, and highways. Stormwater management impacts the water quality of streams, rivers and the Great Lakes which are a key component of Michigan's economy. Currently, Michigan lacks a systematic approach to inventorying, operating and maintaining our stormwater infrastructure, and few communities have dedicated funding sources for stormwater systems. Recent implementation of asset management programs are exposing the deterioration of our stormwater infrastructure, and unless a funding source is dedicated, Michigan's stormwater infrastructure/grade will continue to decline.

BACKGROUND

Michigan is home to more than 11,000 inland lakes, 51,000 miles of rivers, 6.5 million acres of wetlands, and more than 3,288 miles of freshwater coastline (the longest in the world). Additionally, Michigan has over 1,200 public beaches and over 1,400 public boat launches that support nationally recognized recreational opportunities. Stormwater management systems, by managing runoff and the associated pollutants from rainfall and snow melt, play an integral role in protecting and restoring these water resources. In fact, one in five of Michigan jobs is directly related to water resources. The state is increasingly reliant on freshwater resources to achieve economic development, tourism, and recreation opportunities.

Historically, design criteria focused on conveying stormwater from developed areas quickly and efficiently downstream through large infrastructure systems. Stormwater best management practices become more prevalent in the 1980s to provide greater flood control and to improve stormwater runoff quality. Modern design criteria, by contrast, focuses on opportunities to manage rainfall where it lands through green infrastructure systems (e.g. infiltration, filtration, and volume reduction) while also addressing flood control and conveyance alternatives.

Stormwater systems can include any combination of enclosed and open conveyance systems, underground and aboveground detention basins, and green infrastructure. Systems are owned and operated by cities, villages, townships, county road commissions, county drain commissioners, state and federal agencies, and a multitude of private entities. Michigan also has combined sewer areas, which are designed to collect everything from domestic sewage, to rainwater runoff, to industrial wastewater in the same pipe. Many lack adequate controls for wet-weather overflows, which result in untreated wastewater discharging to nearby bodies of water. To date, the total investment in eliminating uncontrolled Combined Sewer Overflows (CSOs) is estimated at \$4 billion.



Patterns in precipitation have also been changing across the Great Lakes Region and are evident in the increased frequency of extreme precipitation events that have occurred over the last decade. In August 2014, more than 6-inches of rainfall occurred in southeast Michigan over an 8-hour period resulting in over \$1.8 billion in damages and a federal disaster declaration. Since 1900, total annual precipitation has increased by approximately 11 percent in the Great Lakes Region. Since 1958, the amount of precipitation falling in the heaviest 1 percent of storms has increased by 37 percent (Source: Great Lakes Integrated Sciences and Assessments).

CAPACITY AND CONDITION

MUNICIPAL AND PRIVATE SYSTEMS

Local municipalities are commonly the first line of defense regarding stormwater issues that arise within their jurisdictional boundaries; however, the majority of local governments lack adequate financial means to address these issues. Recent condition assessments for several Michigan communities revealed that up to one third of storm sewer systems require structural rehabilitation to maintain their function in future years.

Based on an urban population of 7.4 million (U.S. Census, 2010) and typical per-capita quantities of storm sewer assets in Michigan communities, our estimate for the total urban stormwater infrastructure in Michigan is as follows:

- 38,000 miles of storm sewer pipe
- 725,000 manholes
- 1.6 million inlets and catch basins

Using the industry standards of storm sewers and manholes being replaced, on average, every 120 years, and inlets/catch basins being replaced, on average, every 40 years, the approximate annual statewide cost to cycle out old stormwater infrastructure with new will likely range from \$400 to \$500 million per year. This includes only conventional infrastructure within urban systems and does not include privately-owned stormwater assets.

While much of the stormwater infrastructure described is focused on separate storm sewer systems, CSOs and the reduction of stormwater entering these CSOs are still high priorities in Michigan. Green infrastructure now plays a major role in addressing uncontrolled CSOs in Michigan because it leads toward multiple outcomes including: reduced treatment costs, basement backups, street flooding and untreated overflows into local waterways. Green infrastructure also beautifies and stabilizes neighborhoods. Focusing on reducing stormwater runoff volume into CSOs enhances the capacities of these systems and increases the CSOs ability to achieve water quality standards.

PRIVATE DRAINAGE SYSTEMS

Private stormwater systems include catch basins and storm sewers under parking lots, minor storm sewers in residential areas outside of the right-of-way, and stormwater detention and retention ponds that are constructed to control peak flow rates. There is no asset management system in place to identify, track, and determine private stormwater system functionality or maintenance needs. This is largely due to lack of funding at the local level.

In many cases, both public and private storm sewer systems do not have the capacity to safely convey rainfall for the 5-year or 10-year rainfall event.

COUNTY DRAINAGE SYSTEMS

There are approximately 35,000 regulated county drains in Michigan, and more than 50 percent of the drains are open drains. More than 50 percent of the drains are over 75 years old, and more than 30 percent are over 100 years old.

Open drains are estimated at 65 percent of the total mileage, with the remaining 35 percent representing enclosed (pipes and culverts) systems. Replacement value of open drains is assumed to be about \$100/foot, and about \$200/foot for enclosed systems.

Current maintenance practices for County Drainage systems are impacted by antiquated funding limitations set by the State's Drain Code. Currently, only \$1,400 on average is invested per mile of County Drain per year. However, estimates suggest that this is an underinvestment of 80 percent to 90 percent.

The limited resources that County Drain Commissioners have are often dedicated to basic maintenance only, such as open drain mowing and service calls.

STATE AND COUNTY ROAD SYSTEMS

According to MDOT, 9,668 miles of road are state owned, 21,200 miles are owned by municipalities, and 89,444 miles are under the jurisdiction of County Road Commissions. It's estimated that approximately 80,000 miles of Michigan roads have linear drainage infrastructure. Typically, the drainage component of roadway projects is 5 to 15 percent of the total project cost.

Limited transportation budgets result in challenges when addressing the underinvestment in Michigan's transportation infrastructure, including stormwater management. Continued underinvestment in stormwater infrastructure for the transportation network exacerbates the challenges in improving the quality of the state's water resources.





OPERATIONS AND MAINTENANCE

ASSET MANAGEMENT

Asset management provides an opportunity to manage infrastructure in a more cost-effective manner, based on condition assessment and desired outcomes. While Michigan is a national leader with a statewide asset management program for roads, stormwater infrastructure is typically left out. Michigan is now leading a program to align underground infrastructure with roads in a more comprehensive asset management program, something no other state is doing.

Between 1982 and 2012, the total urbanized area in Michigan increased by nearly 50 percent. During the same time-period, the population increased by only 8 percent. This reveals that we are expanding the size of infrastructure without increasing revenue. In other words, land is being developed quickly, with a focus on subdivisions in urban fringe areas at the expense of urban cores. These newly developed communities require additional lane miles, drinking and sewer pipes, but lack the density of population to fully pay for the needed infrastructure expansion. Finally, with the addition of stormwater quality and quantity rules applying to urbanized areas, we have added more Best Management Practices (BMPs) to the developments. Adding these components to a development requires more inspection, maintenance, and system management in order to provide a well-functioning system. Maintaining these assets in the future will be more complex than it has been in recent decades.

RESILIENCE AND INNOVATION

Michigan has been a leader in development watershed management plans and programs that identify goals, objectives and actions to work towards achieving water quality standards and removing beneficial use impairments (BUIs) in local water resources.

Managing stormwater on a watershed basis to achieve local, regional and state environmental outcomes is critical to improving the state's stormwater infrastructure systems. Opportunities may include simple policy changes within codes and ordinances to more elaborate partnerships that seek to align resources through principles of asset management for construction of stormwater management systems.

Joint action and collaboration among jurisdictions to manage stormwater on a watershed basis is critical to strategically aligning financial and environmental objectives.

Michigan is behind other states with innovative materials and practices in stormwater infrastructure. Performance based specifications for new infrastructure are not required, which can shorten the actual service life of stormwater infrastructure.

INVESTMENT AND FUNDING

STORMWATER ENTERPRISE FUNDS IN MICHIGAN

Michigan is far behind its neighbors in the development of enterprise funds (i.e. "utilities") for municipal stormwater systems. This is largely due to legal precedent (*Bolt v Lansing* and *Jackson County v City of Jackson*) where stormwater utilities have been deemed "illegal taxes" under the Headlee Amendment of Michigan's Constitution. This has prevented the spread of stormwater utilities in Michigan. Currently, over 1,600 cities in the U.S. have a stormwater utility, while in Michigan, fewer than ten cities have one. Our neighboring states are far ahead of Michigan in establishing funding sources for stormwater: Ohio has 125 cities with a stormwater utility, Wisconsin has over 100, and Indiana has nearly 80.

Although there is proposed legislation to enable the creation of stormwater utilities in Michigan, it will be necessary for that legislation to be fully enacted before there is a mechanism to provide a dedicated funding source for this vital component of our infrastructure.



SAW GRANT PROGRAM

The State of Michigan, through the Michigan Department of Environmental Quality (MDEQ), has committed \$450 million to allow communities to develop Asset Management Plans for stormwater and wastewater systems. Nearly 280 individual applications were received for Stormwater Asset Management Plans, totaling over \$115 million in potential grant funding. Communities began developing these plans in early 2014, and the program should last through at least 2020 before the available funding is expended. Although the first round of Asset Management Plans were not due until May 2017, many communities are in the final stages of developing their Asset Management Plans; they have learned the following about their stormwater systems:

- Alarming budget gaps currently exist for stormwater systems since the vast majority of Michigan cities have no dedicated funding source. Current funding for stormwater often comes from the General Fund or the Road/Street Fund, both of which have other priorities. The funds are frequently diverted away from stormwater unless an emergency arises.
- Communities do not have funding or staffing to regularly inspect their storm sewer systems (as they do their wastewater collection systems). Because of this, public works staff are often unaware of where the next emergency will surface. Many communities have no rehabilitation/replacement programs for storm sewer systems.
- Deterioration forecast modeling for numerous Michigan communities has revealed that systems will begin to fail with increasing frequency unless more investment is made to systematically rehabilitate aging sewers (i.e. fixing cracks, replacing structurally deficient pipes, etc.). This problem is more acute for older communities where the average asset age is over 60 years. Although younger communities (recently-developed suburban areas) do not yet require immediate attention, they will age. Proactive asset rehabilitation and replacement programs will benefit all cities by reducing the frequency and cost of emergency repairs.

Several Michigan communities are exploring the concept of creating a stormwater utility as part of their SAW Grant budgets. These efforts have revealed that local property owners and businesses are generally amenable to a dedicated funding source for stormwater if that cost can be linked to demonstrated need and if property owners are charged based on their relative demands on the system.



RECOMMENDATIONS TO RAISE THE GRADE

Michigan is home to more than 11,000 inland lakes, 51,000 miles of rivers, 6.5 million acres of wetlands, and more than 3,288 miles of freshwater coastline (the longest in the world). However, the state and local jurisdictions lack a coordinated and collaborative approach to strategically invest in infrastructure improvements that support achieving sustainable state-wide high quality water resources. Michigan should take the following steps to raise the stormwater grade:

- 1. Establish a dedicated source of funding for stormwater systems.** This funding source needs to support collaborative planning, design, construction and long-term maintenance. Without a consistent, reliable source of funding, stormwater systems and the quality of our water resources will continue to deteriorate.
- 2. Integrate flexibility into regulatory programs for public agencies to address local stormwater challenges across jurisdictions.** Stormwater systems are owned by multiple jurisdictions that lack integrated and collaborative planning mechanisms. Regulatory programs are also structured by jurisdiction, further reducing collaboration. Changing precipitation patterns also warrant a more holistic approach when addressing water resource challenges.
- 3. Amend the County Drain Code to increase the statutory spending limit.** The limited resources that County Drain Commissioners have are often dedicated to basic maintenance only. Underinvestment is driven by a statutory spending limit of less than \$1 per foot of drain per year without a petition meeting the requirements of the Drain Code or a resolution to exceed the maintenance limits from a municipality.
- 4. Align infrastructure improvements to achieve a sustainable future for our water resources.** These improvements should include adopting principles of asset management across all infrastructure sectors, evaluating use of innovative materials, using performance based specifications, and securing multiple funding mechanisms.
- 5. Strengthen collaboration and partnerships across multiple agencies and jurisdictions.** Partnerships and collaboration are the cornerstone of integrated water resource management. While many partnerships were initially formed to address specific silo-based topics or permit requirements, it is important for existing and new partnerships to strategically address all elements of water resource planning objectives.

SOURCES

The storm water grades are based on information provided by a variety of sources including:

- A survey of 54 different Michigan communities including City, County, State and local government councils
- Governor's 21st Century Infrastructure Commission
- Michigan Water Strategy
- Southeast Michigan Council of Governments
- County Road Commissions
- County Drain (Water Resource) Commissions
- Cities, Towns and Villages
- Urban communities
- Rural communities



SUMMARY

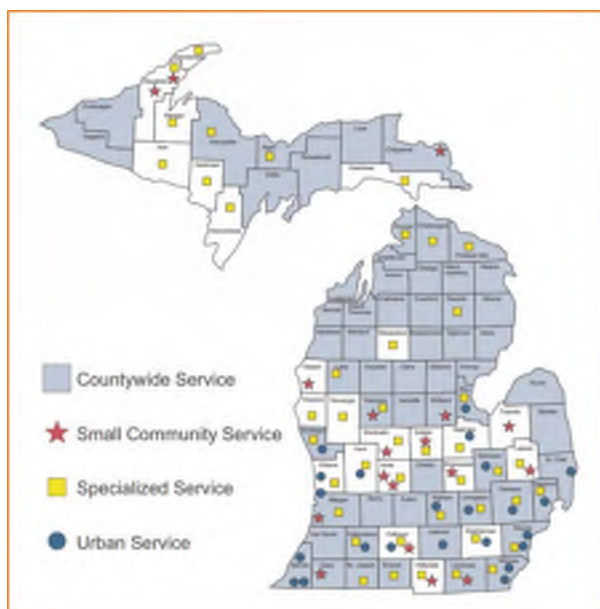
The 78 public transit agencies in Michigan provide 88.4 million passenger trips annually. While a majority of Michigan's residents have access to some form of public transportation, the reliability and availability of these services to many areas is inadequate, and some of the urban systems are unable to adequately meet transit demands. Existing fleets are aging, and some are already past useful life. Fortunately, the state and localities are making strides in addressing transit gaps and are investing in the existing infrastructure. In 2012, Detroit and the surrounding counties established the Regional Transit Authority (RTA) of Southeast Michigan, which oversees new bus routes, and improves transit safety, viability, and reliability. Since establishment of the RTA of Southeast Michigan there has been increasing ridership in these counties. The state will continue to experience significant challenges and opportunities as millennials and seniors, who view transit as the preferred mode of transportation, make housing choices in urban areas.

BACKGROUND

The State of Michigan has 78 public transit agencies, which provide transit services to the general public within their local service areas (Figure 1). Twenty-one of those public transit agencies serve urbanized areas. Service areas range from a single community to several counties. In addition, MDOT provides financial support to 38 specialized providers whose services focus on people with disabilities and senior citizens. Often these people are also part of specific social service programs. All 83 counties in Michigan have some form of transit service through the public transit agencies and specialized providers. However, transit may be limited in some areas in both terms of the service area and/or the individuals served.

Michigan transit has made significant improvements in recent years, including in the following areas:

FIGURE 1. LOCAL TRANSIT AGENCIES IN MICHIGAN



SILVER LINE BUS RAPID TRANSIT (BRT) – THE RAPID

Grand Rapids' transit partnership, The Rapid, opened the first BRT in Michigan in August of 2014, called the Silver Line. Since opening, this corridor has seen a 40 percent increase in ridership, with the Silver Line serving approximately 70,000 riders per month.



LAKER LINE BRT – THE RAPID

The Rapid is currently at a 90 percent design phase for the second BRT route, which will be called the Laker Line. This east-west BRT covers 13.1 miles along Lake Michigan Drive (M-45), connecting Grand Valley State University to downtown Grand Rapids' Medical Mile and to the existing Silver Line BRT. This will make The Rapid a true BRT network. The Laker Line is expected to open in 2020.

RTA OF SOUTHEAST MICHIGAN

The RTA was established via Public Act 387 of 2012 and is comprised of Wayne, Oakland, Macomb, and Washtenaw counties. The RTA has been charged with coordinating transit services within these four counties and recently completed a single Master Transit Plan. The RTA is also responsible for coordinating the operating and capital plans of all transportation agencies and authorities in southeast Michigan.

Q-LINE - DETROIT

The Q-Line is a light rail system which runs a 6.6-mile loop along Woodward Avenue from Grand Boulevard to Jefferson Avenue. Q-Line operations began in May 2017, and fare collection started in September 2017. Ridership on the Q-Line is expected to reach 5,000 riders per day after one year of operation.



In addition, there are multiple studies taking place within Michigan that are looking to bring additional enhancements to the existing transit network, which include:

CAPITAL AREA TRANSPORTATION AUTHORITY (CATA) BRT

CATA has developed preliminary plans for Bus Rapid Transit along the Michigan/Grand River Avenue corridor between Lansing and Meridian Township, which would connect downtown Lansing and the state capital area to the campus of Michigan State University and retail areas to the east. As of April 2017, planning for this project has been suspended "until such time as CATA has reasonable assurances as to the availability of adequate federal funding to support the BRT."

THE CONNECTOR IN ANN ARBOR

This is an alternatives analyses evaluation that recommends a hybrid light rail/streetcar system be constructed that connects northeast Ann Arbor to south Ann Arbor. Specifically, this system would likely connect the following: the University of Michigan campuses, downtown Ann Arbor, the medical center, the train station, and commercial areas. The alternatives analyses have been completed, and the next steps are the conceptual design and environmental review. A timeline has not been set for design.

FLINT'S MASS TRANSPORTATION AUTHORITY (MTA) CORRIDOR STUDY

This evaluation is currently in the study phase and is looking at the I-75 corridor between Bay City and Detroit, which will also include the I-69 corridor from Lansing to Port Huron. The MTA would like to consider a “Bus on Shoulder” program operating on I-75 and I-69 along with a major hub being placed near these two corridors.

BRT CORRIDOR SELECTION AND REFINEMENT STUDY – THE RAPID

The Rapid has teamed with the Grand Valley Metropolitan Council to conduct a study to select the next feasible corridor for a third BRT route. The study will focus on the urbanized areas of Grand Rapids and is expected to come up with a list of possible corridors. The study is expected to be completed in early 2018.

INVESTMENT, FUNDING, AND FUTURE NEED

Michigan’s transit agencies are funded through multiple sources, including federal and state funds, local millages, local general funds, farebox revenues, service contracts, and the sale of advertising. Federal funding is provided by the FAST Act, which is a five-year authorization bill that expires in FY 2020. Federal funds for urban transit are awarded directly to, and programmed by, the individual transit agencies (listed in Table 1 below). Federal funds for rural services are awarded to Michigan and programmed by MDOT.

TABLE 1: URBAN TRANSIT AGENCIES

Ann Arbor	Holland (Macatawa Area Express)
Battle Creek	Kalamazoo
Bay County (Bay City)	Jackson
Benton Harbor	Lansing
Detroit Department of Transportation (DDOT)	Livingston
Monroe County (SMART Lake Erie Transit)	Midland
Detroit Metro SMART	Muskegon
Detroit Transportation Corp.	Niles
Flint	Port Huron (Blue Water)
Grand Haven, Spring Lake, and Ferrysburg (Harbor Transit)	Saginaw
Grand Rapids (The Rapid)	



State funds for transit come from the Comprehensive Transportation Fund (CTF), which receives gas tax revenue and vehicle registration revenue from the Michigan Transportation Fund as well as a small portion of Michigan's sales tax on automobile related sales. The largest Michigan program supported by the CTF is state operating assistance to local transit agencies, most commonly called the Local Bus Operating (LBO) Program. LBO funding is provided to agencies in the form of reimbursement, as a percentage of their eligible operating expenses. The amount of CTF appropriated for the LBO program remained relatively static from FY 2006 to FY 2016 at approximately \$167 million per year and then increased about 11 percent in FY 2017 to approximately \$186 million, as a result of the new transportation revenue package.

In November of 2015 Michigan passed a series of surface transportation funding bills that included raising the gas tax to 26.3 cents per gallon, indexing the gas tax with inflation beginning in 2022, raising vehicle registration fees by 20 percent, and adding an annual surcharge to all electric or hybrid vehicles. When the plan is fully implemented in 2021, the CTF should increase by approximately \$59.5 million. This increase is a positive step forward, especially with the 11 percent increase of CTF appropriated for the LBO program in FY 2017, it may help reverse the trend of service cuts in some areas of Michigan.

The revenue increase in the CTF in FY 2017 also allowed for a 50 percent increase in the CTFs appropriated to match federal transit capital grants awarded to MDOT and individual transit agencies. Federal funds are needed to keep the current transit infrastructure in a state of good repair. Additionally, being able to provide the match allows Michigan to remain competitive in accessing available formula and discretionary grants from the Federal Transit Administration (FTA), including the FTA's Capital Improvements Grant program, which is a critical source of funding for BRT. However, the CTF increase is insufficient to fully support future expansion for local transit as well as all the other modes of transit that are dependent on the CTF. The revenue package, while creating a substantial one time increase to the LBO program in FY 2017, will not be able to keep pace with growth in demand for state operating assistance under the LBO program. This will be especially true if transit services expand in the southeast Michigan area under the leadership of the RTA.

CAPACITY AND CONDITION

Since 2009, local transit in Michigan has seen a 13 percent decrease in overall ridership numbers, as shown in Table 2 below. The ridership decline reflects decreases in both miles and hours of service (i.e., service cuts; however, ridership has declined more than service levels). Service cuts have been seen throughout Michigan, but cuts in southeast Michigan have the most significant impact on the overall decline.

TABLE 2: RIDERSHIP OF MICHIGAN'S 78 TRANSIT AGENCIES

YEAR	RIDERSHIP	OPERATING MILES	NUMBER OF VEHICLES	HOURS OF SERVICE
2009	99,640,358	99,256,007	2,979	6,378,746
2010	95,937,865	95,294,701	3,011	6,154,248
2011	96,306,968	91,597,572	2,968	6,097,452
2012	96,776,930	90,399,467	2,992	5,941,723
2013	94,847,672	88,026,144	2,968	5,747,478
2014	88,080,757	87,586,843	2,980	6,389,201
2015	87,012,000	90,208,209	2,980	6,062,619
2016	88,430,031	91,939,437	2,933	7,920,646



Although this recent history shows negative trends, the trend is reversing. With the formation of the RTA, and more stability in local revenues (including the resolution of the Detroit bankruptcy and a significant millage increase for the SMART service area), ridership in the greater Detroit area is increasing. Specifically, the Detroit Department of Transportation (DDOT) has seen an increase in ridership of about 10 percent in the last quarter of 2015. With additional BRT routes coming on line, including in places like Grand Rapids, transit is becoming an increasingly viable and reliable transportation option, and is providing services to customers that five years ago was not available.

Michigan's transit agencies continue to utilize and maintain an aging fleet of vehicles to provide transportation services. The percentage of rural and specialized fleets that are past useful life has increased from 15 percent in 2014 to 35 percent in 2016. In urban areas, approximately 45 percent of transit agencies reported in 2016 the need to replace at least a few vehicles.

OPERATIONS AND MAINTENANCE

MDOT uses the Public Transportation Management System (PTMS) to collect service data as well as an inventory of local transit assets. Based on PTMS data, MDOT's Rural and Specialized fleets reported 35 percent of the fleets being past useful life as defined by the FTA. MDOT's goal is to keep less than 20 percent of the rural and specialized fleets past FTA useful life. Therefore, more work needs to be done. Urban agencies reported on average 27 percent of their fleets are past FTA useful life. Urban agencies set their own goals for fleet condition.

SAFETY

The MAP-21 federal transportation funding package requires FTA to develop safety performance criteria for all modes of public transportation (rail, bus, etc.). Both MAP-21 and the FAST Act require all recipients of FTA funding to develop agency safety plans that include performance targets, strategies, and staff training. The FTA has been issuing rulemakings in response to MAP-21 and the FAST Act's provisions. It will be several years before the impacts of these new requirements on Michigan's transit providers are fully realized.

Michigan's transit agencies experience about 10 collisions per million vehicle miles of bus transit travel, which is very low when compared to the national average. According to PTMS Safety Data from 2012 to 2015, there was a 30 percent decrease in property damage only (PDO) accidents, and PDO accidents greater than \$25,000 in damage stayed about the same at an average of about 11 percent.



RECOMMENDATIONS TO RAISE THE GRADE

1. Continued investments in transit for rural areas and increased investment in urban transit systems is needed to continue properly serving the transportation needs of Michigan's citizens.
2. Increase the use of asset management principles by transit agencies, as required by MAP-21 and the FAST Act, with the specific requirements yet to be defined by the FTA.
3. Transit systems need funding to continue to improve reliability and to provide a wider range of service, especially as Michigan's population continues to grow. Additionally approximately 35 percent of existing fleets are past useful life as defined by the FTA. Therefore, in order to meet future growth and demand, Michigan's transit systems will require a combination of local, state, federal, and private investments, as well as financing strategies.

SOURCES

Information provided by PTMS Database.

Information provided by the Moving Michigan Forward 2040 State Long-Range Transportation Plan Transit White Paper.

Information provided by the Michigan Department of Transportation 2015-2019 Five-Year Transportation Program.

Information provided by the 2015 National Transit Summary and Trends.

The 21st Century Infrastructure Commission Report prepared for Governor Rick Snyder, dated November 30, 2016.

The Michigan Department of Transportation, Measuring and Reporting Michigan's Transit System Condition, dated 2016.



SUMMARY

Michigan is a water wonderland. It is surrounded by four of the five Great Lakes, and the state's 3,288 miles of shoreline are fed by 11,000 inland lakes, 51,000 miles of river systems and 6,500,000 acres of wetlands. It is essential that these valuable assets are protected, and our \$15 billion water economy is sustained by proper operation, maintenance, and rehabilitation of our wastewater infrastructure. Most wastewater facilities and infrastructure are buried, leading to lower priority of both funding and maintenance. The old cliché out of sight, out of mind is too often the approach to managing wastewater infrastructure.

Michigan has been making great strides in asset management through their Stormwater, Asset Management, Wastewater (SAW) grant funding, but should allocate additional funding for secondary treatment and conveyance system repairs, according to the 2012 EPA Clean Water Needs Survey. The EPA estimates \$690 million is needed for Michigan's secondary treatment, and \$702 million is needed for conveyance system repair/improvement needs. Additionally, the Michigan Infrastructure Commission (MIC) Report suggests that public health and safety could benefit by providing a uniform, statewide sanitary code that helps ensure safely operating septic systems. A statewide sanitary code does not currently exist in Michigan as it does in most other states.

BACKGROUND

On average, wastewater treatment facilities in Michigan are operating within their legal regulatory requirements. Operations and maintenance (O&M) staff are diligent in servicing and replacing equipment when needed. Effluent permit conditions are regularly met. However, many Water Resource Recovery Facilities (WRRFs) and virtually all the secondary treatment facilities in Michigan were built soon after implementation of the 1972 Clean Water Act. Many of these facilities are reaching their design 50-year service life and will require significant rehabilitation.

Approximately 30 percent of Michiganders are on septic systems and 130,000 (10 percent) of the State's 1.3 million septic systems are likely experiencing operational problems. Septic system failures often lead to untreated wastewater leaking into our soil and potentially into our groundwater. In 2015, according to MDEQ data, there were 4,138 septic failures reported to local Michigan health departments.



Historically, below-ground wastewater collection systems have received less attention than WRRFs and have only recently become a focus, particularly as sinkholes receive front page attention. Municipalities are beginning to increase their condition assessments of sewer systems and assign a standardized rating.

The estimated number and type of wastewater conveyance treatment facilities located in Michigan include:

MICHIGAN WASTEWATER INFRASTRUCTURE INVENTORY	
Municipal WRRF	247
Total WRRF	1,080
Lagoon System	232
Septic System [3]	1,300,000
RTB/CSO Facilities [8]	47
Miles of Sewer:	150,000

CONDITION

Several sanitary sewer condition data sets were consolidated to create the sample table below, which follow the NASSCO Pipeline Assessment and Certification Program (PACP) rating method. The miles of sewer analyzed in the table compose approximately 8 percent of the total miles of sewer in Michigan.

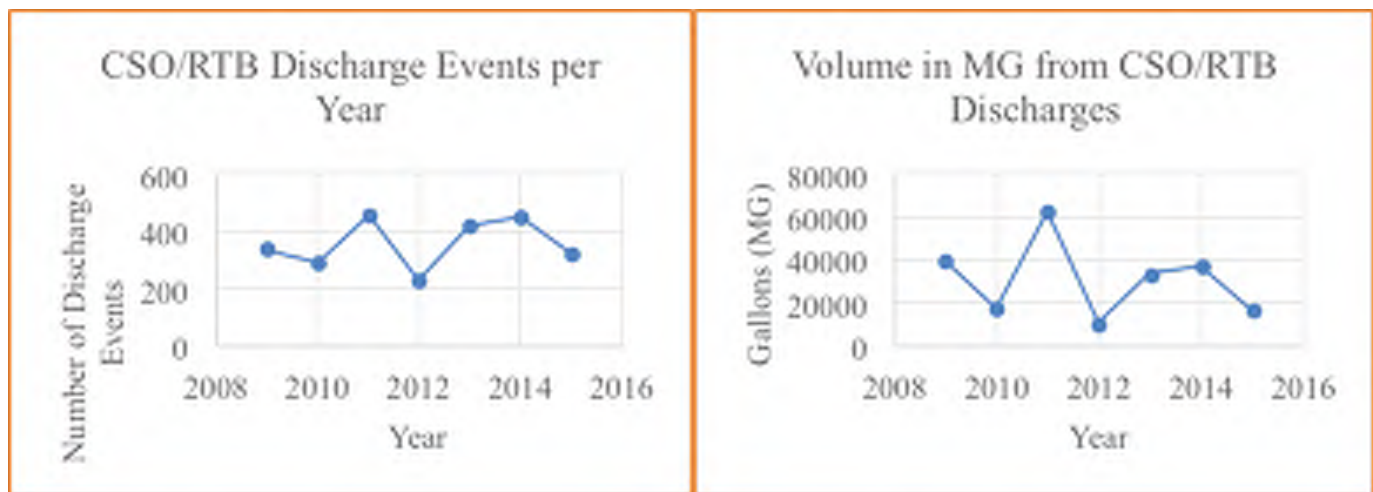
		LENGTH OF SANITARY SEWER	
		Length	Percentage
PACP SCORE:	Good - 0, 1, 2	1,630	81
	Fair - 3	253	13
	Poor - 4	70	3
	Failing - 5	53	3
TOTAL LENGTH: 2,006 MILES			

While the data from this small sample size indicates that 81 percent of the sewers inspected were in acceptable condition, many wastewater operators have not incorporated proper asset management practices into their public works activities. Asset Management Plans are an effective and increasingly utilized means for evaluating the condition of infrastructure. For those communities with a WRRF, Asset Management Plans are now a requirement of their National Pollutant Discharge Elimination System (NPDES) permit. As these assessment plans are prepared, actual conditions will become more apparent.

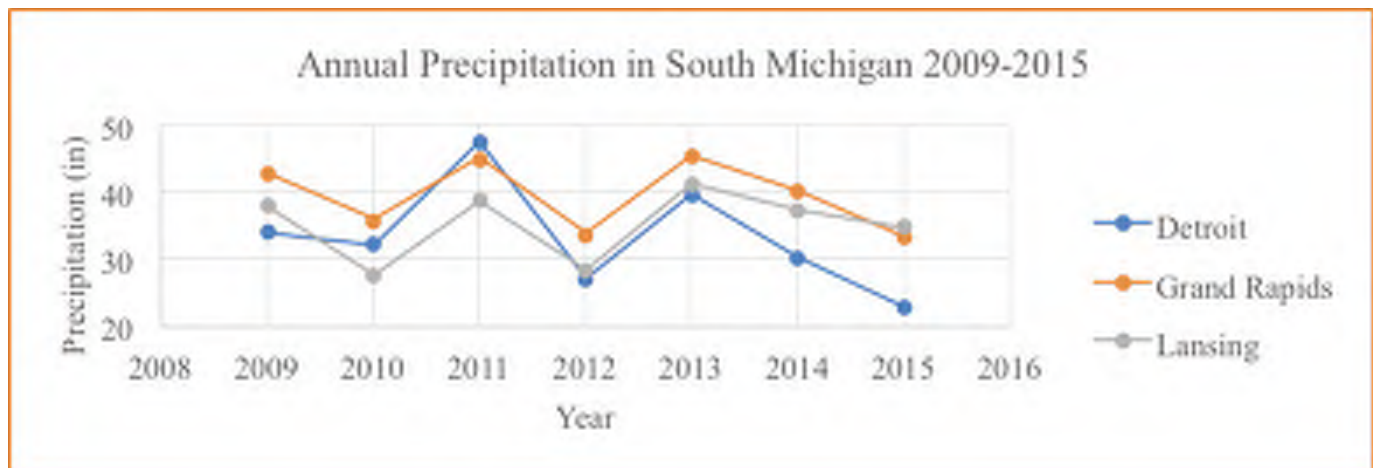
CAPACITY

Capacity is the amount of liquid (hydraulic capacity) and waste constituents (treatment capacity) the infrastructure can safely convey and treat. Almost all WRRFs in the state can effectively convey and treat dry weather flow. However, the same is not true for peak flow capacity when rainwater migrates into the collection system during wet weather events via infiltration and inflow.

According to the Michigan Department of Environmental Quality (MDEQ) CSO, SSO, and RTB 2015 Annual Report, Michigan has seen some varying amounts of CSO/RTB events from 2009-2015, with a peak occurring in year 2011, the year coinciding with the most rainfall. Combined sewer overflow (CSO) events occur when wastewater and stormwater drain into the same treatment system. Many of the state's sewer systems can experience capacity issues following heavy rain events, resulting in overflows. Deficient capacity has the potential to discharge untreated wastewater into our waterways, which makes it a key objective for the MDEQ to reduce these discharge events.



Source: MDEQ CSO SSO RTB 2015 Annual Report



Source: MDEQ CSO SSO RTB 2015 Annual Report



The total number of basement flooding events, which may also indicate capacity restriction, are occurring more frequently. Tens of thousands of basements flooded in Southeast Michigan during storms on May 26, 2011 and again on August 11, 2014. The frequency of extreme rain events, defined as greater than two inches in a single day, have increased by 89 percent between 1964 and 2013 and brings with it the increased risk of public health and safety concerns due to untreated wastewater discharges.

In recent years, an average of 5,750 Olympic sized swimming pools of untreated sewage flowed into Michigan waterways. Sixty-four rivers that drain 84 percent of Michigan's Lower Peninsula tested positive for human sewage. Nearly 25 percent of beaches experienced closures in 2015 and 20 percent of beaches in Michigan do not meet public health protection standards. In 2015, there were 324 reported CSO events discharging 16,205 million gallons of partially treated sewage. NPDES permit violations can result from facilities operating outside of their permit limitations. Within the last three years, there were 1,770 NPDES permit violations in the state of Michigan.

PERMIT VIOLATIONS WITHIN LAST 3 YEARS		PERMIT STATUS					TOTAL
		Admin. Continued	Effective	Expired	Not Needed	Terminated	
Permit Type:	Associated Permit Record:	--	--	2	--	--	2
	General Permit Covered Facility:	1	577	371	--	34	983
	NPDES Individual Permit:	1	299	232	1	252	785
TOTAL:		2	876	605	1	286	1770

Source: EPA Echo 1-17-2017

INVESTMENT AND FUNDING

Inadequate and inconsistent information on the condition of wastewater infrastructure and resources prevents system managers from developing sustainable funding models. In most cases, utility rate revenues do not adequately provide enough funding for all cost considerations of those utilities, most notably capital improvement and asset replacement costs. Investing in water and sewer infrastructure leads to lower maintenance and operation costs and supports the economy. According to the 21st Century Infrastructure Commission Report, every dollar spent on water and sewer assets can return up to \$2.03 in revenue.

Between 2010 and 2014, Michigan had the lowest national average annual state and local capital spending, which was an average of 6.4 percent of total expenditure annually between those years. Currently, Michigan has an estimated \$800 million annual gap in water and sewer infrastructure needs, compiled from decades of deferred maintenance and a lack of knowledge on the condition of our wastewater-related assets. Furthermore, it is estimated that \$25 million of state funds should be allocated annually for immediate public health risks and environmental emergencies due to failing wastewater infrastructure and \$780 million annually to upkeep failing septic systems that are approaching their 25-year design life.

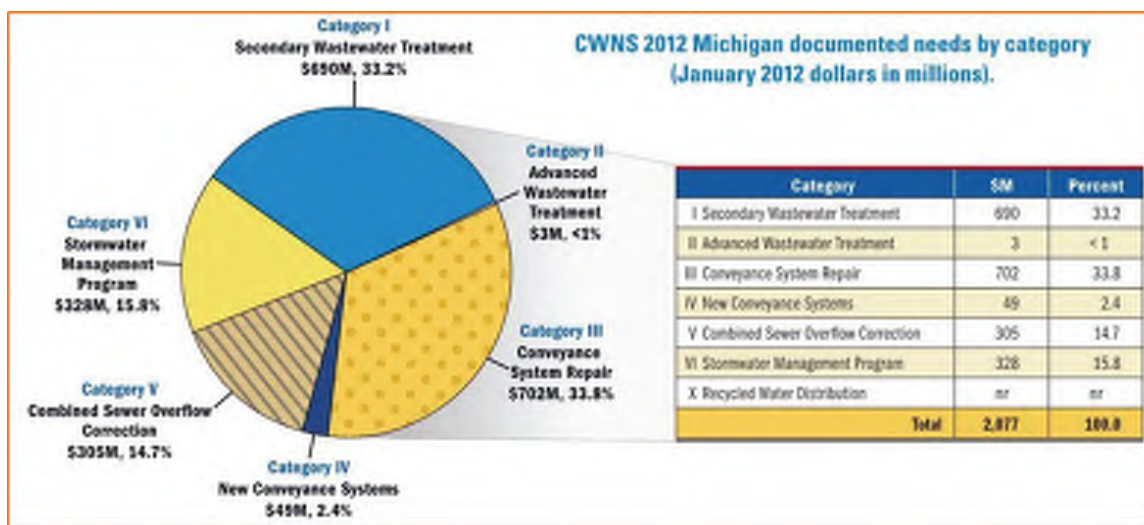
The State Revolving Fund (SRF) program awards approximately \$200 million annually in low interest loans for renovation projects. The five-year SAW grant program, initiated in 2013, is providing \$450 million in grant funding of up to \$2 million per community to help fund the development of Asset Management Plans and the resulting facility replacement expense. As the SAW program closes, it is estimated that another \$400 million should be invested at a rate of \$80 million a year for five years to revamp the SAW grant program, by providing additional funding to assist wastewater utilities that have not yet established asset management plans. These

updates should ensure the condition assessments and asset management plans are developed in a manner that enables consistent reporting in a statewide asset management database system.

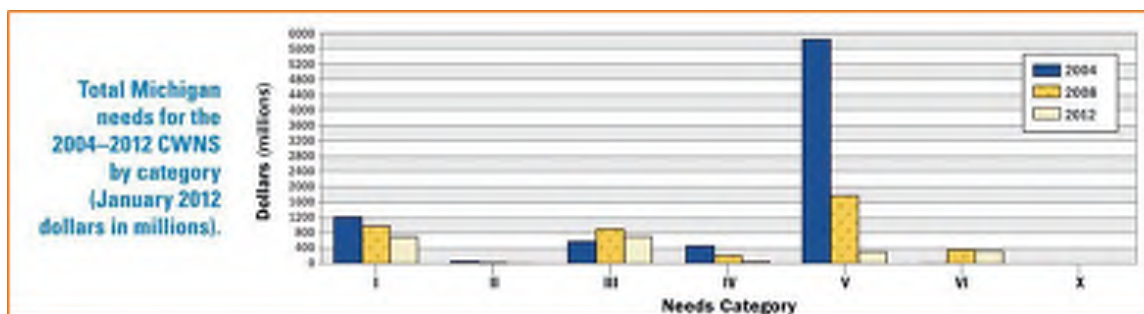
FUTURE NEED

Future need of wastewater collection and treatment systems can be represented as the projected amount of capital and rehabilitation investments which are needed to provide a safe, efficient, and dependable level of service. This can include wastewater treatment plant expansion and upgrades, sanitary sewer rehabilitation or replacement, expanded sanitary sewer service areas, and repair of failing septic systems.

According to the Clean Water Needs Survey for 2012 published by the EPA, Michigan has a projected need of \$2.077 billion to bring its wastewater collection, wastewater treatment, and stormwater systems to a dependable level of service. This equates to about \$208 per person.



Source: CWNS 2012



As indicated in the 2012 CWNS, essentially one third of the need is for treatment facilities and two-thirds for collection/conveyance systems. As permit required condition assessment continues, wastewater infrastructure needs and funding requirements will become much more apparent.



INNOVATION

In response to aging facilities, retiring workforce, reduced funding, and other factors, the National Association of Clean Water Agencies (NACWA), Water Environment Federation (WEF), and Water Environment & Reuse Foundation formed a joint work group to assess how to address these problems. The concept of Water Resources Utility of the Future (UOTF) grew from that effort. A UOTF focuses on the potential products that can be produced or resources that can be recovered. The most common are nutrients, energy, and water. These organizations worked with wastewater agencies to create the Leaders Innovation Forum for Technology (LIFT), which is conducting technology evaluations and many other activities to promote and implement innovation.

Within the State of Michigan, the Water Resources Division of the MDEQ issued a grant to the Michigan Water Environment Association to assist with the development and implementation of recycling metrics for the wastewater community. This effort resulted in a one of a kind summit to introduce the UOTF concept, establishing benchmarks, and conducting the state's first energy survey of wastewater treatment plants.

More wastewater treatment facilities in Michigan are now utilizing cutting edge technologies, such as biogas energy generation and combined heat and power, to re-use wastewater and bio-solids to promote energy reduction and recovery.

RESILIENCE

Resilience of wastewater treatment facilities and collection systems is imperative to public health and safety as these systems protect the environment and are relied upon daily by millions of users.

In Michigan, resilience is mandated statutorily and built into each WRRF located within the state. This includes: process and equipment redundancy, dual power source or back-up emergency power generation, and construction of pumping and treatment facilities above the 100-year floodplain elevation. Each of these measures are part of the design process and/or the construction permit review process. Additionally, materials resilient to wear and corrosion, such as stainless steel, ductile iron, HDPE, polyethylene encasement, and similar measures are commonplace.



RECOMMENDATIONS TO RAISE THE GRADE

1. Create a uniform, statewide sanitary code that helps ensure safely operating septic systems.
2. Ensure that condition assessments and asset management plans are developed in a manner that enables consistent reporting in a statewide asset management database system.
3. Allocate \$25 million of state funds annually for immediate public health risks and environmental emergencies due to failing wastewater infrastructure.
4. Allocate \$780 million annually to upkeep failing septic systems that are approaching their 25-year design life.
5. Invest another \$400M at a rate of \$80M/year for five years to revamp the SAW grant program by providing additional funding to assist wastewater utilities that have not yet established asset management plans.

DEFINITIONS

Combined Sewer Overflow (CSO) – An event resulting from combined storm and sanitary sewers being unable to accommodate the flow because of an exceeding of their capacity and untreated sewage is discharged into the environment prior to reaching sewage treatment facilities.

Sanitary Sewer Overflow (SSO) – An event where untreated sewage is discharged from a sanitary sewer system into the environment prior to reaching sewage treatment facilities.

Water Resource Recovery Facility (WRRF) – Traditionally known as a wastewater treatment plant; facility that provides physical, biological, and chemical treatment of wastewater to remove contaminants prior to discharging waters into the environment.

Clean Water Act of 1972 – The primary federal law in the United States governing water pollution; establishes the basic structure for regulating discharges of pollutants into waterways and regulating quality standards for surface waters.

Retention Treatment Basin (RTB) – Facility that receives excess combined sewage flow during wet weather events where the sewage is stored, screened and/or settled, and disinfected prior to discharge.

National Association of Sewer Service Companies (NAASCO) – Organization that set industry standards for the assessment, maintenance, and rehabilitation of underground infrastructure.

National Pollutant Discharge Elimination System (NPDES) – Permit program created in 1972 by the Clean Water Act that helps address water pollution by regulating point sources that discharge pollutants to waterways.

SOURCES

Information provided by the Michigan Water Environment Association (MWEA).

Information provided by the Michigan Department of Environmental Quality (MDEQ).

The State of Michigan, 21st Century Infrastructure Commission Report, dated November 2016.

The ASCE Michigan Section, Michigan Infrastructure Report Card, dated 2009.

The MDEQ, 2015 Statewide Failed Sewage System Evaluation Summary Report, dated August 2017.

The MDEQ, SSO/CSO and RTB Discharge Annual Report, dated 2015.

The EPA, Clean Water Needs Survey, dated 2012.

Information provided by the EPA, ECHO Enforcement and Compliance History: <https://echo.epa.gov/>

Information provided by the MDEQ, RTB/CSO Permit Search: <http://www.deq.state.mi.us/csosso/>

The Natural Resources Defense Council, Report on Extreme Storms in Michigan, dated December 2014.



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Use your zip code to find your Elected Officials.



KNOW

Check the MI Legislative Tracker to find legislation that you care about (hint... infrastructure)



DISCUSS

Now that you know who your Elected Officials are, **EMAIL THEM** and let them know that you care about Michigan's infrastructure



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Use our hashtag #ASCEMIReportCard or tag us to show your support of Michigan's Infrastructure



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SPECIAL THANKS TO:

Michigan Infrastructure & Transportation Association (MITA)
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EXHIBIT 6



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Sent Via Email Only

November 12, 2025

Mr. Thomas Forster II
Varnum LLP
101 N. Main Street
Suite 525
Ann Arbor, MI 48104

*RE: Wetland Delineation and Jurisdictional Assessment with GPS Survey - Revised
Norvell Township Property
Sections 13, 14, and 24, Norvell Township, Jackson County, Michigan
ASTI File No. A23-2691.02*

Dear Mr. Forster:

ASTI Environmental (ASTI) completed site investigations on March 15, 16, 21, July 17, and August 3, 2023 to delineate wetland boundaries on the above-referenced property located in Sections 13, 14, and 24 of Norvell Township, Jackson County (Property). Two waterbodies and nine wetlands likely regulated by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and two wetlands not likely regulated by EGLE were found on the Property (Figure 1 – *GPS-Surveyed Wetland Boundaries*). Waterbody and wetland boundaries, as depicted on Figure 1 were located using a professional grade, hand-held Global Positioning System unit (GPS) and all are located outside of the proposed mining limits.

SUPPORTING DATA AND MAPPING

The United States Geological Survey (USGS) Norvell and Onstead, Michigan 7.5' Quadrangle Maps, the USDA Web Soil Survey (WSS), the National Wetland Inventory Map (NWI), the EGLE Wetlands Map Viewer web site, and digital aerial photographs were all used to support the wetland delineation and subsequent regulatory status determination. All reviewed data indicated the presence of wetlands scattered in the northern portion of the Property. All reviewed data also indicated Watkins Lake in the northcentral portion of the Property.



The WSS indicates the Property is comprised of the soil complexes shown in Table 1 below:

Table 1 - Property Soils

Property Soils	*Hydric Soil per the WSS (Yes or No)
Boyer-Oshtemo sandy loams (6-12% slopes)	No
Boyer-Oshtemo sandy loams (12-18% slopes)	No
Boyer-Leoni complex (18-40% slopes)	No
Arkport-Okee loamy fine sands (6-12% slopes)	No
Arkport-Okee loamy fine sands (12-25% slopes)	No
Riddles sandy loam (1-6% slopes)	No
Riddles sandy loam (12-18% slopes)	No
Histosols and Aquents (ponded)	Yes
Hillsdale-Riddles sandy loams (6-12% slopes)	No
Houghton muck 0-1% slopes)	Yes

FINDINGS

ASTI investigated the Property for the presence of any lakes, ponds, wetlands, and watercourses. This work is based on *MCL 324 Part 301 (Inland Lakes and Streams)* and *Part 303 (Wetland Protection)*.

It should be noted that some municipalities have local wetland ordinances and natural features setbacks that may apply to a property. In addition, in some circumstances the US Army Corps of Engineers (USACE) may also have jurisdiction of wetlands or watercourses on a property. This is not the case for this Property.

The delineation protocol used by ASTI for this delineation is based on the US Army Corps of Engineers' *Wetland Delineation Manual*, 1987, the *Regional Supplement to the Corps of Engineer Wetland Delineation Manual: Midwest Region*, and related guidance/documents, as appropriate. Wetland vegetation, hydrology, and soils were used to locate the wetland boundaries.

Waterbodies

Portions of Watkins Lake and an unnamed waterbody (Lake R) were found in the northern portion of the Property (Figure 1). Both Watkins Lake and Lake R exhibit an area of permanent open water greater than five acres in size including offsite portions and, thus, meet the definition of an inland lake under Part 301.

Wetlands

Eleven wetlands were observed on the Property as shown on Figure 1 and as detailed below in Table 1 – Property Wetlands and Waterbodies.

Table 1 – Property Wetlands and Waterbodies

Wetland/ Waterbody Designation	Wetland/ Waterbody Type	Area on Property (acres)	Wetland/ Waterbody Flagging Numbering	Wetland Determination Sheet No.	Upland Determination Sheet No.	ASTI Opinion if Regulated by Part EGLE
O	Emergent	0.09	O-1 through O-5	WT15	UP16	Within 500 feet of Lake R. Regulated under Part 303.
P	Forested & Emergent	0.23	P-1 through P-15	WT14	UP15	Within 500 feet of Lake R. Regulated under Part 303.
Lake R	Inland Lake	4.87	R-1 through R-33 & RR-1 through RR-4	NA	UP13	Area of permanent open water >5 acres (Part 301 Inland Lake). Regulated under Part 301.
S	Emergent	0.01	S-1 through S-6	WT12	UP12	Within 500 feet of Lake R. Regulated under Part 303.
T	Emergent	0.02	T-1 through T-5	WT11	UP11	Within 500 feet of Lake R. Regulated under Part 303.
U	Emergent	0.04	U-1 through U-6	WT10	UP10	Isolated and less than 5 acres. Not regulated under Part 303.
V	Emergent	0.17	V-1 through V-3	WT9	UP9	Greater than 5 acres in size including off- site extents. Regulated under Part 303.
W	Emergent	2.75	W-1 through W-22	WT8	UP8	Greater than 5 acres in size including off- site extents. Regulated under Part 303.
Y	Emergent	0.02	Y-1 through Y-4	WT7	UP7	Greater than 5 acres in size including off- site extents. Regulated under Part 303.
Z	Emergent	0.26	Z-1 through Z-8	WT8	UP8	Greater than 5 acres in size including off- site extents. Regulated under Part 303.
AA	Emergent	0.35	AA-1 through AA-11	WT16	UP17	Within 500 feet of Lake R. Regulated under Part 303.
ZZ	Emergent	0.06	ZZ-1 through ZZ-9	WTZZ	UPZZ	Isolated and less than 5 acres. Not regulated under Part 303.



Wetland/ Waterbody Designation	Wetland/ Waterbody Type	Area on Property (acres)	Wetland/ Waterbody Flagging Numbering	Wetland Determination Sheet No.	Upland Determination Sheet No.	ASTI Opinion if Regulated by Part EGLE
Watkins Lake	Inland Lake	2.48	CC-1 through CC-26	NA	NA	Area of permanent open water >5 acres (Part 301 Inland Lake). Regulated under Part 301.

SUMMARY

Based upon the data, criteria, and evidence noted above, it is ASTI's professional opinion that the Property includes two waterbodies (a small portion of Watkins Lake and Lake R) and nine wetlands (Wetlands O, P, S, T, V, W, Y, Z, and AA), regulated by EGLE under the Natural Resources and Environmental Protection Act (1994 P.A. 451) Part 301, Inland Lakes and Streams and Part 303 Wetland Protection, respectively. In addition, two wetlands (Wetlands U and ZZ) not likely regulated by EGLE were identified. All waterbodies and wetlands are outside of the proposed mining limits as illustrated in Figure 1. As a result, there will be no direct impacts to waterbodies or wetlands from the proposed mining operations.

Please note that EGLE has the final authority on the extent of regulated wetlands, lakes, and streams in the State of Michigan. Any proposed impact to the areas that ASTI has identified as regulated will require an EGLE permit, and ASTI recommends EGLE verification of wetland regulatory status of any wetlands that ASTI deems non-regulated, prior to any wetland impacts.

Attached are Figure 1, which shows the GPS-surveyed locations of wetland flagging on the Property and completed USACE Wetland Data Forms. Please note that the data sheet numbers match the data collection sampling points shown on Figures 1 and on Table 1 above.

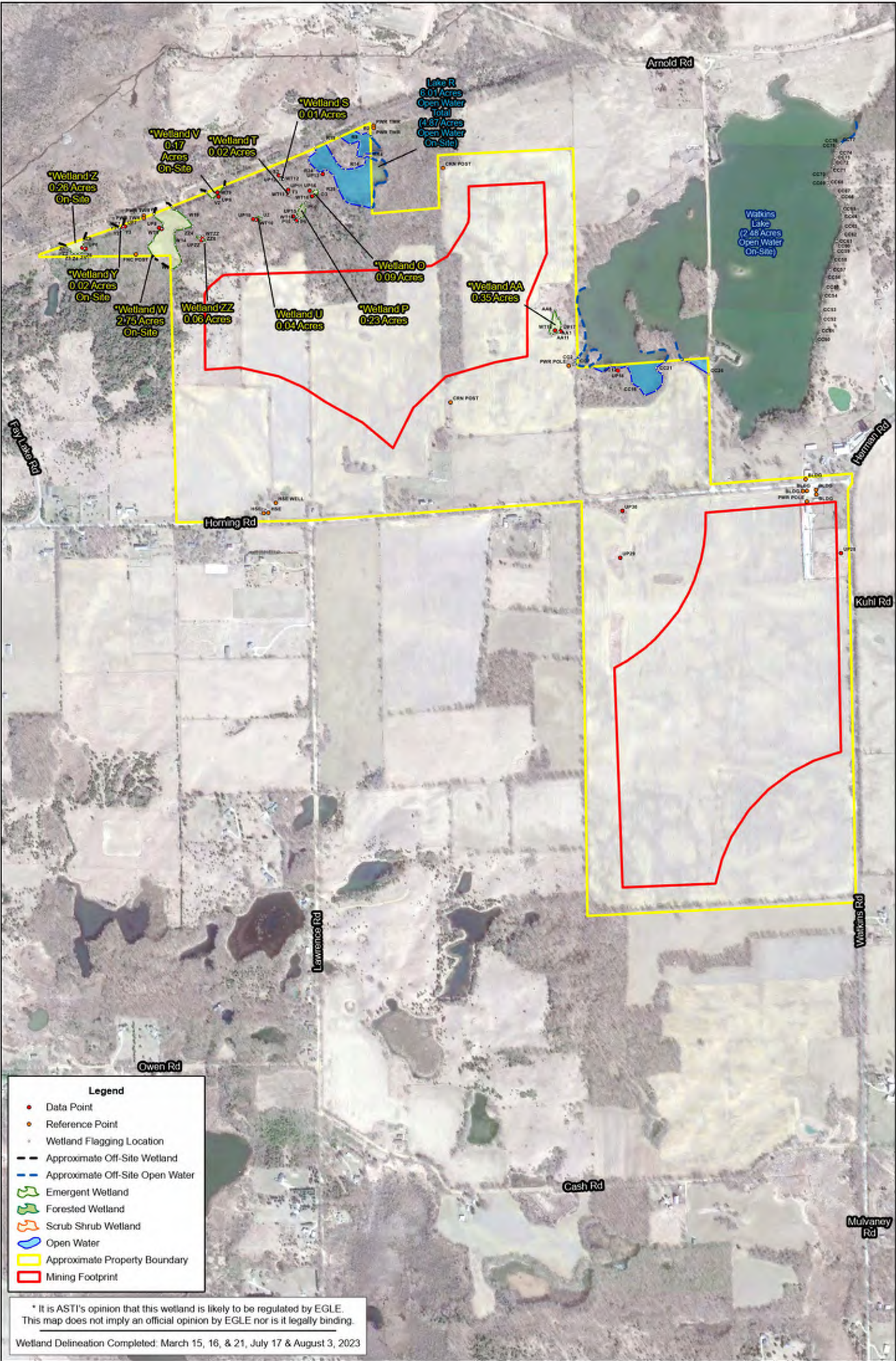
Thank you for the opportunity to assist you with this project. Please let us know if we can be of any further assistance in moving your project forward.

ASTI Environmental

Kyle Hottinger
Wetland Ecologist
Professional Wetland Scientist #2927

Dianne C. Martin
Director of Ecological Services
Professional Wetland Scientist #1313

Attachments: Figure 1 - *GPS-Surveyed Wetland Boundaries*
Completed USACE Wetland Data Forms



U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-15-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>UP6</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 14 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>slight slope</u>	Local relief (concave, convex, none): <u>slope</u>	
Slope (%): <u>2-4</u>	Lat: <u>42.124795</u>	Long: <u>-84.160298</u> Datum: <u>NAD83</u>
Soil Map Unit Name: <u>Boyer-Oshtemo loamy sands (12-18% slopes)</u>	NW1 classification: <u>none</u>	
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u> Hydric Soil Present? Yes <u> </u> No <u>X</u> Wetland Hydrology Present? Yes <u> </u> No <u>X</u>	Is the Sampled Area within a Wetland? Yes <u> </u> No <u>X</u>
Remarks: Upland adjacent to Wetland Z in the NW portion of the site.	

VEGETATION – Use scientific names of plants.

<table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Prunus serotina</u></td><td></td><td style="text-align: center;">20</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>2. <u>Juniperus virginiana</u></td><td></td><td style="text-align: center;">40</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. <u>Quercus rubra</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">FACU</td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">70</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Elaeagnus umbellata</u></td><td></td><td style="text-align: center;">50</td><td style="text-align: center;">Yes</td><td style="text-align: center;">UPL</td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">50</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u> </u></td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>6. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>7. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>8. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>9. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>10. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u> </u></td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	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Indicator Status	1. <u> </u>		0			2. <u> </u>								=Total Cover		Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u> 0 </u> (A) Total Number of Dominant Species Across All Strata: <u> 3 </u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u> 0.0% </u> (A/B) Prevalence Index worksheet: <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr> <td>OBL species <u> 0 </u></td> <td>x 1 = <u> 0 </u></td> </tr> <tr> <td>FACW species <u> 0 </u></td> <td>x 2 = <u> 0 </u></td> </tr> <tr> <td>FAC species <u> 0 </u></td> <td>x 3 = <u> 0 </u></td> </tr> <tr> <td>FACU species <u> 70 </u></td> <td>x 4 = <u> 280 </u></td> </tr> <tr> <td>UPL species <u> 50 </u></td> <td>x 5 = <u> 250 </u></td> </tr> <tr> <td>Column Totals: <u> 120 </u> (A)</td> <td><u> 530 </u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u> 4.42 </u></td> </tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u> </u> 2 - Dominance Test is >50% <u> </u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. 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2. <u>Juniperus virginiana</u>		40	Yes	FACU																																																																																																																																																																			
3. <u>Quercus rubra</u>		10	No	FACU																																																																																																																																																																			
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UPL species <u> 50 </u>	x 5 = <u> 250 </u>																																																																																																																																																																						
Column Totals: <u> 120 </u> (A)	<u> 530 </u> (B)																																																																																																																																																																						
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Remarks: (Include photo numbers here or on a separate sheet.)																																																																																																																																																																							

SOIL

Sampling Point: UP6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-8	10YR 3/2	100					Sandy	
8-18	10YR 4/3	90	10YR 3/2	10	C	M	Sandy	Faint redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	
☐ Sandy Gleyed Matrix (S4)	
☐ Sandy Redox (S5)	
☐ Stripped Matrix (S6)	
☐ Dark Surface (S7)	
☐ Loamy Mucky Mineral (F1)	
☐ Loamy Gleyed Matrix (F2)	
☐ Depleted Matrix (F3)	
☐ Redox Dark Surface (F6)	
☐ Depleted Dark Surface (F7)	
☐ Redox Depressions (F8)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-15-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>UP7</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 14 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>slope</u>	Local relief (concave, convex, none): <u>slope</u>	
Slope (%): <u>4-6</u>	Lat: <u>42.125385</u>	Long: <u>-84.158902</u> Datum: <u>NAD83</u>
Soil Map Unit Name: <u>Boyer-Oshtemo loamy sands (12-18% slopes)</u>		NWI classification: <u>none</u>
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u> Hydric Soil Present? Yes <u> </u> No <u>X</u> Wetland Hydrology Present? Yes <u> </u> No <u>X</u>	Is the Sampled Area within a Wetland? Yes <u> </u> No <u>X</u>
Remarks: Upland adjacent to Wetland Y in the NW portion of the site.	

VEGETATION – Use scientific names of plants.

<table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Juniperus virginiana</u></td><td></td><td style="text-align: center;">20</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">20</td> <td colspan="2" style="text-align: center;">=Total Cover</td> </tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Elaeagnus umbellata</u></td><td></td><td style="text-align: center;">80</td><td style="text-align: center;">Yes</td><td style="text-align: center;">UPL</td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">80</td> <td colspan="2" style="text-align: center;">=Total Cover</td> </tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Bromus inermis</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>6. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>7. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>8. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>9. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>10. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">10</td> <td colspan="2" style="text-align: center;">=Total Cover</td> </tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u> </u></td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td></td> <td colspan="2" style="text-align: center;">=Total Cover</td> </tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Juniperus virginiana</u>		20	Yes	FACU	2. <u> </u>					3. <u> </u>					4. <u> </u>					5. <u> </u>							20	=Total Cover		Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Elaeagnus umbellata</u>		80	Yes	UPL	2. <u> </u>					3. <u> </u>					4. <u> </u>					5. <u> </u>							80	=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Bromus inermis</u>		10	Yes	FACU	2. <u> </u>					3. <u> </u>					4. <u> </u>					5. <u> </u>					6. <u> </u>					7. <u> </u>					8. <u> </u>					9. <u> </u>					10. <u> </u>							10	=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	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Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u>	Total % Cover of:	Multiply by:	OBL species <u> 0 </u>	x 1 = <u> 0 </u>	FACW species <u> 0 </u>	x 2 = <u> 0 </u>	FAC species <u> 0 </u>	x 3 = <u> 0 </u>	FACU species <u> 30 </u>	x 4 = <u> 120 </u>	UPL species <u> 80 </u>	x 5 = <u> 400 </u>	Column Totals: <u> 110 </u> (A)	<u> 520 </u> (B)	Prevalence Index = B/A = <u> 4.73 </u>	
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SOIL

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☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: <u> </u> none Depth (inches): <u> </u>	Hydric Soil Present? Yes <u> </u> No <u> X </u>

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
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☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Water Table Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Saturation Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> (includes capillary fringe)	Wetland Hydrology Present? Yes <u> </u> No <u> X </u>

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: UP8
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): slope Local relief (concave, convex, none): slope
Slope (%): 8-10 Lat: 42.125385 Long: -84.158902 Datum: NAD83
Soil Map Unit Name: Boyer-Leoni complex (18-40% slopes) NWI classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes No X
Hydric Soil Present? Yes No X
Wetland Hydrology Present? Yes No X

Is the Sampled Area
within a Wetland? Yes No X

Remarks:
Upland adjacent to Wetland W in the NW portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Prunus serotina</u>		<u>20</u>	<u>Yes</u>	<u>FACU</u>
2. <u>Carya glabra</u>		<u>30</u>	<u>Yes</u>	<u>FACU</u>
3. <u>Quercus rubra</u>		<u>30</u>	<u>Yes</u>	<u>FACU</u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>80</u>	=Total Cover	
Sapling/Shrub Stratum	(Plot size: <u>15'</u>)			
1. <u>Elaeagnus umbellata</u>		<u>40</u>	<u>Yes</u>	<u>UPL</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>40</u>	=Total Cover	
Herb Stratum	(Plot size: <u>5'</u>)			
1. <u>Carex woodii</u>		<u>25</u>	<u>Yes</u>	<u>FAC</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
6. <u> </u>		<u> </u>	<u> </u>	<u> </u>
7. <u> </u>		<u> </u>	<u> </u>	<u> </u>
8. <u> </u>		<u> </u>	<u> </u>	<u> </u>
9. <u> </u>		<u> </u>	<u> </u>	<u> </u>
10. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>25</u>	=Total Cover	
Woody Vine Stratum	(Plot size: <u>15'</u>)			
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species
Across All Strata: 5 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 20.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>0</u>	x 1 = <u>0</u>
FACW species <u>0</u>	x 2 = <u>0</u>
FAC species <u>25</u>	x 3 = <u>75</u>
FACU species <u>80</u>	x 4 = <u>320</u>
UPL species <u>40</u>	x 5 = <u>200</u>
Column Totals: <u>145</u> (A)	<u>595</u> (B)
Prevalence Index = B/A = <u>4.10</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
 2 - Dominance Test is >50%
 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting
data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must
be present, unless disturbed or problematic.

**Hydrophytic
Vegetation**

Present? Yes No X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: UP8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-6	10YR 3/2	100					Sandy	
6-18	10YR 5/6	95	10YR 3/2	5	C	M	Sandy	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: UP9
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): slope Local relief (concave, convex, none): slope
Slope (%): 10-12 Lat: 42.125385 Long: -84.158902 Datum: NAD83
Soil Map Unit Name: Boyer-Oshemo sandy loams (12-40% slopes) NWI classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes No X
Hydric Soil Present? Yes No X
Wetland Hydrology Present? Yes No X

Is the Sampled Area
within a Wetland? Yes No X

Remarks:
Upland adjacent to Wetland V in the NW portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Quercus alba</u>		<u>40</u>	<u>Yes</u>	<u>FACU</u>
2. <u>Quercus rubra</u>		<u>30</u>	<u>Yes</u>	<u>FACU</u>
3. <u>Juniperus virginiana</u>		<u>10</u>	<u>No</u>	<u>FACU</u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>80</u>	=Total Cover	

Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Elaeagnus umbellata</u>		<u>40</u>	<u>Yes</u>	<u>UPL</u>
2. <u>Berberis thunbergii</u>		<u>10</u>	<u>Yes</u>	<u>FACU</u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>50</u>	=Total Cover	

Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
6. <u> </u>		<u> </u>	<u> </u>	<u> </u>
7. <u> </u>		<u> </u>	<u> </u>	<u> </u>
8. <u> </u>		<u> </u>	<u> </u>	<u> </u>
9. <u> </u>		<u> </u>	<u> </u>	<u> </u>
10. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	=Total Cover	

Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 0 (A)
Total Number of Dominant Species
Across All Strata: 4 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 0.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>0</u>	x 1 = <u>0</u>
FACW species <u>0</u>	x 2 = <u>0</u>
FAC species <u>0</u>	x 3 = <u>0</u>
FACU species <u>90</u>	x 4 = <u>360</u>
UPL species <u>40</u>	x 5 = <u>200</u>
Column Totals: <u>130</u> (A)	<u>560</u> (B)
Prevalence Index = B/A = <u>4.31</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
 2 - Dominance Test is >50%
 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting
data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must
be present, unless disturbed or problematic.

**Hydrophytic
Vegetation**

Present? Yes No X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: UP9

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-6	10YR 3/2	100					Sandy	
6-18	7.5YR 5/6	95	10YR 3/2	5	C	M	Sandy	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-15-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>UP10</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 14 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>slight slope</u>	Local relief (concave, convex, none): <u>slope</u>	
Slope (%): <u>2-4</u>	Lat: <u>42.125572</u>	Long: <u>-84.154303</u>
Soil Map Unit Name: <u>Boyer-Leoni complex (18-40% slopes)</u>		Datum: <u>NAD83</u>
Soil NWI classification: <u>none</u>		
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u> Hydric Soil Present? Yes <u> </u> No <u>X</u> Wetland Hydrology Present? Yes <u> </u> No <u>X</u>	Is the Sampled Area within a Wetland? Yes <u> </u> No <u>X</u>
Remarks: Upland adjacent to Wetland U in the NC portion of the site.	

VEGETATION – Use scientific names of plants.

<table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Prunus serotina</u></td><td></td><td style="text-align: center;">40</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>2. <u>Quercus alba</u></td><td></td><td style="text-align: center;">30</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. <u>Acer saccharinum</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">FACW</td></tr> <tr><td>4. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>5. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">80</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Elaeagnus umbellata</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">Yes</td><td style="text-align: center;">UPL</td></tr> <tr><td>2. <u>Berberis thunbergii</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>4. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>5. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">20</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. _____</td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>3. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>4. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>5. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>6. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>7. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>8. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>9. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td>10. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. _____</td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. _____</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Prunus serotina</u>		40	Yes	FACU	2. <u>Quercus alba</u>		30	Yes	FACU	3. <u>Acer saccharinum</u>		10	No	FACW	4. _____					5. _____							80	=Total Cover		Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Elaeagnus umbellata</u>		10	Yes	UPL	2. <u>Berberis thunbergii</u>		10	Yes	FACU	3. _____					4. _____					5. _____							20	=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. _____		0			2. _____					3. _____					4. _____					5. _____					6. _____					7. _____					8. _____					9. _____					10. _____								=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. _____		0			2. _____								=Total Cover		Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>0</u> (A) Total Number of Dominant Species Across All Strata: <u>4</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>0.0%</u> (A/B) Prevalence Index worksheet: <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr> <td>OBL species <u>0</u></td> <td>x 1 = <u>0</u></td> </tr> <tr> <td>FACW species <u>10</u></td> <td>x 2 = <u>20</u></td> </tr> <tr> <td>FAC species <u>0</u></td> <td>x 3 = <u>0</u></td> </tr> <tr> <td>FACU species <u>80</u></td> <td>x 4 = <u>320</u></td> </tr> <tr> <td>UPL species <u>10</u></td> <td>x 5 = <u>50</u></td> </tr> <tr> <td>Column Totals: <u>100</u> (A)</td> <td><u>390</u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u>3.90</u></td> </tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u> </u> 2 - Dominance Test is >50% <u> </u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u>	Total % Cover of:	Multiply by:	OBL species <u>0</u>	x 1 = <u>0</u>	FACW species <u>10</u>	x 2 = <u>20</u>	FAC species <u>0</u>	x 3 = <u>0</u>	FACU species <u>80</u>	x 4 = <u>320</u>	UPL species <u>10</u>	x 5 = <u>50</u>	Column Totals: <u>100</u> (A)	<u>390</u> (B)	Prevalence Index = B/A = <u>3.90</u>	
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SOIL

Sampling Point: UP10

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-5	10YR 3/2	100					Sandy	
5-18	10YR 4/4	75	10YR 3/2	15	C	M	Sandy	Distinct redox concentrations
			10YR 5/6	10	C	PL/M		Distinct redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: ☐ Histosol (A1) ☐ Sandy Gleyed Matrix (S4) ☐ Histic Epipedon (A2) ☐ Sandy Redox (S5) ☐ Black Histic (A3) ☐ Stripped Matrix (S6) ☐ Hydrogen Sulfide (A4) ☐ Dark Surface (S7) ☐ Stratified Layers (A5) ☐ Loamy Mucky Mineral (F1) ☐ 2 cm Muck (A10) ☐ Loamy Gleyed Matrix (F2) ☐ Depleted Below Dark Surface (A11) ☐ Depleted Matrix (F3) ☐ Thick Dark Surface (A12) ☐ Redox Dark Surface (F6) ☐ Sandy Mucky Mineral (S1) ☐ Depleted Dark Surface (F7) ☐ 5 cm Mucky Peat or Peat (S3) ☐ Redox Depressions (F8)	Indicators for Problematic Hydric Soils³: ☐ Coast Prairie Redox (A16) ☐ Iron-Manganese Masses (F12) ☐ Red Parent Material (F21) ☐ Very Shallow Dark Surface (F22) ☐ Other (Explain in Remarks) ³ Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: <u> </u> none Depth (inches): <u> </u>	Hydric Soil Present? Yes <u> </u> No <u> X </u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators: <u>Primary Indicators (minimum of one is required; check all that apply)</u>				<u>Secondary Indicators (minimum of two required)</u>			
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)		☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)		☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)		☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)		☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)			☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Water Table Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Saturation Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> (includes capillary fringe)	Wetland Hydrology Present? Yes <u> </u> No <u> X </u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: UP11
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): slight slope Local relief (concave, convex, none): slope
Slope (%): 2-4 Lat: 42.126349 Long: -84.153052 Datum: NAD83
Soil Map Unit Name: Boyer-Leoni complex (18-40% slopes) NWI classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes No X
Hydric Soil Present? Yes No X
Wetland Hydrology Present? Yes No X

Is the Sampled Area
within a Wetland? Yes No X

Remarks:
Upland adjacent to Wetland T in the NC portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Prunus serotina</u>		<u>30</u>	<u>Yes</u>	<u>FACU</u>
2. <u>Quercus alba</u>		<u>30</u>	<u>Yes</u>	<u>FACU</u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>60</u>	=Total Cover	
Sapling/Shrub Stratum	(Plot size: <u>15'</u>)			
1. <u>Elaeagnus umbellata</u>		<u>40</u>	<u>Yes</u>	<u>UPL</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>40</u>	=Total Cover	
Herb Stratum	(Plot size: <u>5'</u>)			
1. <u>Carex woodii</u>		<u>20</u>	<u>Yes</u>	<u>FAC</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
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7. <u> </u>		<u> </u>	<u> </u>	<u> </u>
8. <u> </u>		<u> </u>	<u> </u>	<u> </u>
9. <u> </u>		<u> </u>	<u> </u>	<u> </u>
10. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>20</u>	=Total Cover	
Woody Vine Stratum	(Plot size: <u>15'</u>)			
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species
Across All Strata: 4 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 25.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>0</u>	x 1 = <u>0</u>
FACW species <u>0</u>	x 2 = <u>0</u>
FAC species <u>20</u>	x 3 = <u>60</u>
FACU species <u>60</u>	x 4 = <u>240</u>
UPL species <u>40</u>	x 5 = <u>200</u>
Column Totals: <u>120</u> (A)	<u>500</u> (B)
Prevalence Index = B/A = <u>4.17</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
 2 - Dominance Test is >50%
 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present?

Yes No X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: UP11

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-6	10YR 3/2	100					Sandy	
6-18	10YR 5/6	95	10YR 3/2	5	C	M	Sandy	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
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☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: UP12
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): slope Local relief (concave, convex, none): slope
Slope (%): 10-12 Lat: 42.126736 Long: -84.153384 Datum: NAD83
Soil Map Unit Name: Boyer-Leoni complex (18-40% slopes) NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)

Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No

Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes No X
Hydric Soil Present? Yes No X
Wetland Hydrology Present? Yes No X

Is the Sampled Area
within a Wetland? Yes No X

Remarks:

Upland adjacent to Wetland S in the NC portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Prunus serotina</u>		<u>10</u>	<u>No</u>	<u>FACU</u>
2. <u>Quercus alba</u>		<u>40</u>	<u>Yes</u>	<u>FACU</u>
3. <u>Juniperus virginiana</u>		<u>5</u>	<u>No</u>	<u>FACU</u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>55</u>	=Total Cover	

Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Elaeagnus umbellata</u>		<u>30</u>	<u>Yes</u>	<u>UPL</u>
2. <u>Prunus serotina</u>		<u>10</u>	<u>Yes</u>	<u>FACU</u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>40</u>	=Total Cover	

Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Carex woodii</u>		<u>5</u>	<u>Yes</u>	<u>FAC</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
6. <u> </u>		<u> </u>	<u> </u>	<u> </u>
7. <u> </u>		<u> </u>	<u> </u>	<u> </u>
8. <u> </u>		<u> </u>	<u> </u>	<u> </u>
9. <u> </u>		<u> </u>	<u> </u>	<u> </u>
10. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>5</u>	=Total Cover	

Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species
Across All Strata: 4 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 25.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>0</u>	x 1 = <u>0</u>
FACW species <u>0</u>	x 2 = <u>0</u>
FAC species <u>5</u>	x 3 = <u>15</u>
FACU species <u>65</u>	x 4 = <u>260</u>
UPL species <u>30</u>	x 5 = <u>150</u>
Column Totals: <u>100</u> (A)	<u>425</u> (B)
Prevalence Index = B/A = <u>4.25</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
 2 - Dominance Test is >50%
 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present?

Yes No X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: UP12

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-8	10YR 3/2	100					Sandy	
8-18	10YR 5/6	95	10YR 3/2	5	C	M	Sandy	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-16-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>UP13</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 13 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>slope</u>	Local relief (concave, convex, none): <u>slope</u>	
Slope (%): <u>18-20</u>	Lat: <u>42.12677</u>	Long: <u>-84.151814</u>
Soil Map Unit Name: <u>Boyer-Leoni complex (18-40% slopes)</u>		Datum: <u>NAD83</u>
Soil NWI classification: <u>none</u>		
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u> Hydric Soil Present? Yes <u> </u> No <u>X</u> Wetland Hydrology Present? Yes <u> </u> No <u>X</u>	Is the Sampled Area within a Wetland? Yes <u> </u> No <u>X</u>
Remarks: Upland adjacent to Pond R in the NC portion of the site.	

VEGETATION – Use scientific names of plants.

<table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Acer saccharinum</u></td><td></td><td style="text-align: center;">20</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACW</td></tr> <tr><td>2. <u>Prunus serotina</u></td><td></td><td style="text-align: center;">20</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. <u>Quercus alba</u></td><td></td><td style="text-align: center;">40</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">80</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Elaeagnus umbellata</u></td><td></td><td style="text-align: center;">60</td><td style="text-align: center;">Yes</td><td style="text-align: center;">UPL</td></tr> <tr><td>2. <u>Berberis thunbergii</u></td><td></td><td style="text-align: center;">5</td><td style="text-align: center;">No</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">65</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Carex woodii</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FAC</td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>6. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>7. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>8. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>9. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>10. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">10</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u> </u></td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Acer saccharinum</u>		20	Yes	FACW	2. <u>Prunus serotina</u>		20	Yes	FACU	3. <u>Quercus alba</u>		40	Yes	FACU	4. <u> </u>					5. <u> </u>							80	=Total Cover		Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Elaeagnus umbellata</u>		60	Yes	UPL	2. <u>Berberis thunbergii</u>		5	No	FACU	3. <u> </u>					4. <u> </u>					5. <u> </u>							65	=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Carex woodii</u>		10	Yes	FAC	2. <u> </u>					3. <u> </u>					4. <u> </u>					5. <u> </u>					6. <u> </u>					7. <u> </u>					8. <u> </u>					9. <u> </u>					10. <u> </u>							10	=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u> </u>		0			2. <u> </u>								=Total Cover		Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>2</u> (A) Total Number of Dominant Species Across All Strata: <u>5</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>40.0%</u> (A/B) Prevalence Index worksheet: <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr><td>OBL species <u>0</u></td><td>x 1 = <u>0</u></td></tr> <tr><td>FACW species <u>20</u></td><td>x 2 = <u>40</u></td></tr> <tr><td>FAC species <u>10</u></td><td>x 3 = <u>30</u></td></tr> <tr><td>FACU species <u>65</u></td><td>x 4 = <u>260</u></td></tr> <tr><td>UPL species <u>60</u></td><td>x 5 = <u>300</u></td></tr> <tr><td>Column Totals: <u>155</u> (A)</td><td><u>630</u> (B)</td></tr> <tr><td colspan="2">Prevalence Index = B/A = <u>4.06</u></td></tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u> </u> 2 - Dominance Test is >50% <u> </u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u>	Total % Cover of:	Multiply by:	OBL species <u>0</u>	x 1 = <u>0</u>	FACW species <u>20</u>	x 2 = <u>40</u>	FAC species <u>10</u>	x 3 = <u>30</u>	FACU species <u>65</u>	x 4 = <u>260</u>	UPL species <u>60</u>	x 5 = <u>300</u>	Column Totals: <u>155</u> (A)	<u>630</u> (B)	Prevalence Index = B/A = <u>4.06</u>	
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SOIL

Sampling Point: UP13

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-4	10YR 3/2	100					Sandy	
4-18	10YR 4/6	85	10YR 3/2	15	C	M	Sandy	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-15-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>UP15</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 14 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>slope</u>	Local relief (concave, convex, none): <u>slope</u>	
Slope (%): <u>6-8</u>	Lat: <u>42.125643</u>	Long: <u>-84.152873</u>
Soil Map Unit Name: <u>Boyer-Leoni complex (18-40% slopes)</u>		Datum: <u>NAD83</u>
Soil NWI classification: <u>none</u>		
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u> Hydric Soil Present? Yes <u> </u> No <u>X</u> Wetland Hydrology Present? Yes <u> </u> No <u>X</u>	Is the Sampled Area within a Wetland? Yes <u> </u> No <u>X</u>
Remarks: Upland adjacent to Wetland P in the NC portion of the site.	

VEGETATION – Use scientific names of plants.

<table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Prunus serotina</u></td><td></td><td style="text-align: center;">20</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>2. <u>Quercus alba</u></td><td></td><td style="text-align: center;">40</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. <u>Carya ovata</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">FACU</td></tr> <tr><td>4. <u>Acer saccharinum</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">FACW</td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">80</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Elaeagnus umbellata</u></td><td></td><td style="text-align: center;">50</td><td style="text-align: center;">Yes</td><td style="text-align: center;">UPL</td></tr> <tr><td>2. <u>Prunus serotina</u></td><td></td><td style="text-align: center;">5</td><td style="text-align: center;">No</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">55</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Carex woodii</u></td><td></td><td style="text-align: center;">5</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FAC</td></tr> <tr><td>2. <u>Geum canadense</u></td><td></td><td style="text-align: center;">5</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FAC</td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>6. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>7. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>8. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>9. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>10. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">10</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u> </u></td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Prunus serotina</u>		20	Yes	FACU	2. <u>Quercus alba</u>		40	Yes	FACU	3. <u>Carya ovata</u>		10	No	FACU	4. <u>Acer saccharinum</u>		10	No	FACW	5. <u> </u>							80	=Total Cover		Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Elaeagnus umbellata</u>		50	Yes	UPL	2. <u>Prunus serotina</u>		5	No	FACU	3. <u> </u>					4. <u> </u>					5. <u> </u>							55	=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Carex woodii</u>		5	Yes	FAC	2. <u>Geum canadense</u>		5	Yes	FAC	3. <u> </u>					4. <u> </u>					5. <u> </u>					6. <u> </u>					7. <u> </u>					8. <u> </u>					9. <u> </u>					10. <u> </u>							10	=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u> </u>		0			2. <u> </u>								=Total Cover		Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>2</u> (A) Total Number of Dominant Species Across All Strata: <u>5</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>40.0%</u> (A/B) Prevalence Index worksheet: <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr><td>OBL species <u>0</u></td><td>x 1 = <u>0</u></td></tr> <tr><td>FACW species <u>10</u></td><td>x 2 = <u>20</u></td></tr> <tr><td>FAC species <u>10</u></td><td>x 3 = <u>30</u></td></tr> <tr><td>FACU species <u>75</u></td><td>x 4 = <u>300</u></td></tr> <tr><td>UPL species <u>50</u></td><td>x 5 = <u>250</u></td></tr> <tr><td>Column Totals: <u>145</u> (A)</td><td><u>600</u> (B)</td></tr> <tr><td colspan="2">Prevalence Index = B/A = <u>4.14</u></td></tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u> </u> 2 - Dominance Test is >50% <u> </u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u>	Total % Cover of:	Multiply by:	OBL species <u>0</u>	x 1 = <u>0</u>	FACW species <u>10</u>	x 2 = <u>20</u>	FAC species <u>10</u>	x 3 = <u>30</u>	FACU species <u>75</u>	x 4 = <u>300</u>	UPL species <u>50</u>	x 5 = <u>250</u>	Column Totals: <u>145</u> (A)	<u>600</u> (B)	Prevalence Index = B/A = <u>4.14</u>	
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SOIL

Sampling Point: UP15

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-4	10YR 3/2	100					Sandy	
4-18	10YR 4/6	95	10YR 3/2	5	C	M	Sandy	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
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☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-16-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: UP16
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): slope Local relief (concave, convex, none): slope
Slope (%): 4-6 Lat: 42.126326 Long: -84.15228 Datum: NAD83
Soil Map Unit Name: Boyer-Leoni complex (18-40% slopes) NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)

Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No

Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes No X
Hydric Soil Present? Yes No X
Wetland Hydrology Present? Yes No X

Is the Sampled Area
within a Wetland? Yes No X

Remarks:
Upland adjacent to Wetland O in the NC portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Prunus serotina</u>	<u>10</u>	<u>Yes</u>	<u>FACU</u>
2. <u>Quercus alba</u>	<u>10</u>	<u>Yes</u>	<u>FACU</u>
3. <u> </u>	<u> </u>	<u> </u>	<u> </u>
4. <u> </u>	<u> </u>	<u> </u>	<u> </u>
5. <u> </u>	<u> </u>	<u> </u>	<u> </u>
	<u>20</u> =Total Cover		

Sapling/Shrub Stratum (Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Elaeagnus umbellata</u>	<u>60</u>	<u>Yes</u>	<u>UPL</u>
2. <u>Rosa multiflora</u>	<u>20</u>	<u>Yes</u>	<u>FACU</u>
3. <u> </u>	<u> </u>	<u> </u>	<u> </u>
4. <u> </u>	<u> </u>	<u> </u>	<u> </u>
5. <u> </u>	<u> </u>	<u> </u>	<u> </u>
	<u>80</u> =Total Cover		

Herb Stratum (Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Phalaris arundinacea</u>	<u>5</u>	<u>Yes</u>	<u>FACW</u>
2. <u>Geum canadense</u>	<u>5</u>	<u>Yes</u>	<u>FAC</u>
3. <u>Phytolacca americana</u>	<u>15</u>	<u>Yes</u>	<u>FACU</u>
4. <u> </u>	<u> </u>	<u> </u>	<u> </u>
5. <u> </u>	<u> </u>	<u> </u>	<u> </u>
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10. <u> </u>	<u> </u>	<u> </u>	<u> </u>
	<u>25</u> =Total Cover		

Woody Vine Stratum (Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u> </u>	<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>	<u> </u>	<u> </u>	<u> </u>
	<u> </u> =Total Cover		

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species
Across All Strata: 7 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 28.6% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>0</u>	x 1 = <u>0</u>
FACW species <u>5</u>	x 2 = <u>10</u>
FAC species <u>5</u>	x 3 = <u>15</u>
FACU species <u>55</u>	x 4 = <u>220</u>
UPL species <u>60</u>	x 5 = <u>300</u>
Column Totals: <u>125</u> (A)	<u>545</u> (B)
Prevalence Index = B/A = <u>4.36</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
 2 - Dominance Test is >50%
 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting
data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must
be present, unless disturbed or problematic.

**Hydrophytic
Vegetation
Present?**

Yes No X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: UP16

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-4	10YR 5/3	100					Sandy	
4-18	10YR 4/2	75	10YR 6/8	20	C	PL/M	Sandy	Prominent redox concentrations
			10YR 4/3	5	C	M		Faint redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: <u> </u> none Depth (inches): <u> </u>	Hydric Soil Present? Yes <u> </u> No <u> X </u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Water Table Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Saturation Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> (includes capillary fringe)	Wetland Hydrology Present? Yes <u> </u> No <u> X </u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-16-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: UP17
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 13 T4S R2E
Landform (hillside, terrace, etc.): slope Local relief (concave, convex, none): slope
Slope (%): 4-6 Lat: 42.122563 Long: -84.143307 Datum: NAD83
Soil Map Unit Name: Hillsdale-Riddles sandy loams (6-12% slopes) NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)

Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No

Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes <u> </u>	No <u>X</u>
Hydric Soil Present?	Yes <u> </u>	No <u>X</u>
Wetland Hydrology Present?	Yes <u> </u>	No <u>X</u>

Is the Sampled Area within a Wetland?	Yes <u> </u>	No <u>X</u>

Remarks:

Upland adjacent to Wetland AA in the central portion of the site.

VEGETATION – Use scientific names of plants.

<u>Tree Stratum</u>	(Plot size: <u>30'</u>)	<u>Absolute % Cover</u>	<u>Dominant Species?</u>	<u>Indicator Status</u>
1.		<u>0</u>		
2.				
3.				
4.				
5.				
		<u> </u> = Total Cover		

<u>Sapling/Shrub Stratum</u>	(Plot size: <u>15'</u>)	<u>Absolute % Cover</u>	<u>Dominant Species?</u>	<u>Indicator Status</u>
1. <u><i>Juniperus communis</i></u>		<u>10</u>	<u>Yes</u>	<u>UPL</u>
2.				
3.				
4.				
5.				
		<u>10</u> = Total Cover		

<u>Herb Stratum</u>	(Plot size: <u>5'</u>)	<u>Absolute % Cover</u>	<u>Dominant Species?</u>	<u>Indicator Status</u>
1. <u><i>Bromus inermis</i></u>		<u>80</u>	<u>Yes</u>	<u>FACU</u>
2. <u><i>Phalaris arundinacea</i></u>		<u>10</u>	<u>No</u>	<u>FACW</u>
3. <u><i>Melilotus officinalis</i></u>		<u>10</u>	<u>No</u>	<u>FACU</u>
4.				
5.				
6.				
7.				
8.				
9.				
10.				
		<u>100</u> = Total Cover		

<u>Woody Vine Stratum</u>	(Plot size: <u>15'</u>)	<u>Absolute % Cover</u>	<u>Dominant Species?</u>	<u>Indicator Status</u>
1.		<u>0</u>		
2.				
		<u> </u> = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 0 (A)
Total Number of Dominant Species
Across All Strata: 2 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 0.0% (A/B)

Prevalence Index worksheet:

<u>Total % Cover of:</u>		<u>Multiply by:</u>
OBL species	<u>0</u>	x 1 = <u>0</u>
FACW species	<u>10</u>	x 2 = <u>20</u>
FAC species	<u>0</u>	x 3 = <u>0</u>
FACU species	<u>90</u>	x 4 = <u>360</u>
UPL species	<u>10</u>	x 5 = <u>50</u>
Column Totals:	<u>110</u> (A)	<u>430</u> (B)
Prevalence Index = B/A = <u>3.91</u>		

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
 2 - Dominance Test is >50%
 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting
data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must
be present, unless disturbed or problematic.

**Hydrophytic
Vegetation**

Present? Yes No X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: UP17

[illegible]

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
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☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		
Field Observations:			
Surface Water Present?	Yes ☐ No ☒	Depth (inches):	
Water Table Present?	Yes ☐ No ☒	Depth (inches):	
Saturation Present?	Yes ☐ No ☒	Depth (inches):	
(includes capillary fringe)		Wetland Hydrology Present? Yes ☐ No ☒	
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:			
Remarks:			

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-16-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>UP18</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 13 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>slope</u>	Local relief (concave, convex, none): <u>slope</u>	
Slope (%): <u>4-6</u>	Lat: <u>42.121519</u>	Long: <u>-84.141269</u>
		Datum: <u>NAD83</u>
Soil Map Unit Name: <u>Riddles sandy loams (12-18% slopes)</u>		NWI classification: <u>none</u>
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u> </u> No <u>X</u> Hydric Soil Present? Yes <u> </u> No <u>X</u> Wetland Hydrology Present? Yes <u> </u> No <u>X</u>	Is the Sampled Area within a Wetland? Yes <u> </u> No <u>X</u>
Remarks: Upland adjacent to Watkins Lake west of Arnold Road.	

VEGETATION – Use scientific names of plants.

<table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Quercus rubra</u></td><td></td><td style="text-align: center;">70</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FACU</td></tr> <tr><td>2. <u>Prunus serotina</u></td><td></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">FACU</td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">80</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Elaeagnus umbellata</u></td><td></td><td style="text-align: center;">60</td><td style="text-align: center;">Yes</td><td style="text-align: center;">UPL</td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">60</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u>Carex woodii</u></td><td></td><td style="text-align: center;">15</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FAC</td></tr> <tr><td>2. <u>Geum canadense</u></td><td></td><td style="text-align: center;">5</td><td style="text-align: center;">Yes</td><td style="text-align: center;">FAC</td></tr> <tr><td>3. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>4. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>5. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>6. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>7. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>8. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>9. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td>10. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td style="text-align: center;">20</td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1. <u> </u></td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2. <u> </u></td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td colspan="2" style="text-align: center;">=Total Cover</td></tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Quercus rubra</u>		70	Yes	FACU	2. <u>Prunus serotina</u>		10	No	FACU	3. <u> </u>					4. <u> </u>					5. <u> </u>							80	=Total Cover		Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Elaeagnus umbellata</u>		60	Yes	UPL	2. <u> </u>					3. <u> </u>					4. <u> </u>					5. <u> </u>							60	=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u>Carex woodii</u>		15	Yes	FAC	2. <u>Geum canadense</u>		5	Yes	FAC	3. <u> </u>					4. <u> </u>					5. <u> </u>					6. <u> </u>					7. <u> </u>					8. <u> </u>					9. <u> </u>					10. <u> </u>							20	=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1. <u> </u>		0			2. <u> </u>								=Total Cover		Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>2</u> (A) Total Number of Dominant Species Across All Strata: <u>4</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>50.0%</u> (A/B) Prevalence Index worksheet: <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr> <td>OBL species <u>0</u></td> <td>x 1 = <u>0</u></td> </tr> <tr> <td>FACW species <u>0</u></td> <td>x 2 = <u>0</u></td> </tr> <tr> <td>FAC species <u>20</u></td> <td>x 3 = <u>60</u></td> </tr> <tr> <td>FACU species <u>80</u></td> <td>x 4 = <u>320</u></td> </tr> <tr> <td>UPL species <u>60</u></td> <td>x 5 = <u>300</u></td> </tr> <tr> <td>Column Totals: <u>160</u> (A)</td> <td><u>680</u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u>4.25</u></td> </tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u> </u> 2 - Dominance Test is >50% <u> </u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. 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SOIL

Sampling Point: UP18

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-14	10YR 5/3	100					Sandy	
14-18	10YR 4/3	80	10YR 5/3	20	C	M	Sandy	Faint redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes _____ No <u>X</u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No <u>x</u> Depth (inches): _____ Water Table Present? Yes _____ No <u>x</u> Depth (inches): _____ Saturation Present? Yes _____ No <u>x</u> Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes _____ No <u>X</u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: Manchester Township Property
 Applicant/Owner: Edward C Levy Company
 Investigator(s): ASTI - BJK
 Landform (hillside, terrace, etc.): hillsdie
 Slope (%): 5-10 Lat: _____ Long: _____
 Soil Map Unit Name: Hillsdale-Riddles sandy laoms (18-30% slopes)

City/County: Manchester Twp.-Washtenaw Co.
 State: MI
 Section, Township, Range: Sec 18 T4S R3E
 Local relief (concave, convex, none): concave
 Datum: NAD83
 NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No _____ (If no, explain in Remarks.)
 Are Vegetation No , Soil No , or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes x No _____
 Are Vegetation No , Soil No , or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes _____ No <u>X</u> Hydric Soil Present? Yes _____ No <u>X</u> Wetland Hydrology Present? Yes _____ No <u>X</u>	Is the Sampled Area within a Wetland? Yes _____ No <u>X</u>
Remarks: Wetland Q - emergent/open water wetland in the SE portion of the site.	

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: <u>30'</u>) 1. <u>Prunus serotina</u> Absolute % Cover: <u>60</u> Dominant Species? <u>Yes</u> Indicator Status: <u>FACU</u> 2. <u>Carya cordiformis</u> <u>20</u> <u>Yes</u> <u>FACU</u> 3. <u>Ulmus americana</u> <u>10</u> <u>No</u> <u>FACW</u> 4. _____ 5. _____ <u>90</u> =Total Cover	Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>1</u> (A) Total Number of Dominant Species Across All Strata: <u>6</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>16.7%</u> (A/B)																
Sapling/Shrub Stratum (Plot size: <u>15'</u>) 1. <u>Berberis thunbergii</u> <u>5</u> <u>Yes</u> <u>FACU</u> 2. <u>Elaeagnus umbellata</u> <u>15</u> <u>Yes</u> <u>UPL</u> 3. _____ 4. _____ 5. _____ <u>20</u> =Total Cover	Prevalence Index worksheet: <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr> <td>OBL species <u>0</u></td> <td>x 1 = <u>0</u></td> </tr> <tr> <td>FACW species <u>10</u></td> <td>x 2 = <u>20</u></td> </tr> <tr> <td>FAC species <u>24</u></td> <td>x 3 = <u>72</u></td> </tr> <tr> <td>FACU species <u>92</u></td> <td>x 4 = <u>368</u></td> </tr> <tr> <td>UPL species <u>32</u></td> <td>x 5 = <u>160</u></td> </tr> <tr> <td>Column Totals: <u>158</u> (A)</td> <td><u>620</u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u>3.92</u></td> </tr> </table>	Total % Cover of:	Multiply by:	OBL species <u>0</u>	x 1 = <u>0</u>	FACW species <u>10</u>	x 2 = <u>20</u>	FAC species <u>24</u>	x 3 = <u>72</u>	FACU species <u>92</u>	x 4 = <u>368</u>	UPL species <u>32</u>	x 5 = <u>160</u>	Column Totals: <u>158</u> (A)	<u>620</u> (B)	Prevalence Index = B/A = <u>3.92</u>	
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Herb Stratum (Plot size: <u>5'</u>) 1. <u>Carex pensylvanica</u> <u>15</u> <u>Yes</u> <u>UPL</u> 2. <u>Alliaria petiolata</u> <u>20</u> <u>Yes</u> <u>FAC</u> 3. <u>Torilis arvensis</u> <u>2</u> <u>No</u> <u>UPL</u> 4. <u>Arctium minus</u> <u>2</u> <u>No</u> <u>FACU</u> 5. <u>Hackelia virginiana</u> <u>5</u> <u>No</u> <u>FACU</u> 6. <u>Verbena urticifolia</u> <u>2</u> <u>No</u> <u>FAC</u> 7. <u>Smilax rotundifolia</u> <u>2</u> <u>No</u> <u>FAC</u> 8. _____ 9. _____ 10. _____ <u>48</u> =Total Cover	Hydrophytic Vegetation Indicators: <u>1</u> - Rapid Test for Hydrophytic Vegetation <u>2</u> - Dominance Test is >50% <u>3</u> - Prevalence Index is ≤3.0 ¹ <u>4</u> - Morphological Adaptations ¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation ¹ (Explain) ¹ Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.																
Woody Vine Stratum (Plot size: <u>30'</u>) 1. <u>None</u> <u>0</u> 2. _____ <u> </u> =Total Cover	Hydrophytic Vegetation Present? Yes _____ No <u>X</u>																
Remarks: (Include photo numbers here or on a separate sheet.)																	

SOIL

Sampling Point: UPZZ

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-8	10YR 2/2	100			C	M	Loamy/Clayey	
8-18	7.5YR 4/6	100			C	M	Sandy	Contains gravel

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: ☐ Histosol (A1) ☐ Histic Epipedon (A2) ☐ Black Histic (A3) ☐ Hydrogen Sulfide (A4) ☐ Stratified Layers (A5) ☐ 2 cm Muck (A10) ☐ Depleted Below Dark Surface (A11) ☐ Thick Dark Surface (A12) ☐ Sandy Mucky Mineral (S1) ☐ 5 cm Mucky Peat or Peat (S3)	☐ Sandy Gleyed Matrix (S4) ☐ Sandy Redox (S5) ☐ Stripped Matrix (S6) ☐ Dark Surface (S7) ☐ Loamy Mucky Mineral (F1) ☐ Loamy Gleyed Matrix (F2) ☐ Depleted Matrix (F3) ☐ Redox Dark Surface (F6) ☐ Depleted Dark Surface (F7) ☐ Redox Depressions (F8)	Indicators for Problematic Hydric Soils³: ☐ Coast Prairie Redox (A16) ☐ Iron-Manganese Masses (F12) ☐ Red Parent Material (F21) ☐ Very Shallow Dark Surface (F22) ☐ Other (Explain in Remarks) ³ Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: <u> </u> none Depth (inches): <u> </u>	Hydric Soil Present? Yes <u> </u> No <u> X </u>
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
<u>Primary Indicators (minimum of one is required; check all that apply)</u>		<u>Secondary Indicators (minimum of two required)</u>	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
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☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Water Table Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> Saturation Present? Yes <u> </u> No <u> X </u> Depth (inches): <u> </u> (includes capillary fringe)	Wetland Hydrology Present? Yes <u> </u> No <u> X </u>
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-15-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>WT6</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 14 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>depression</u>	Local relief (concave, convex, none): <u>concave</u>	
Slope (%): <u>1-3</u>	Lat: <u>42.124819</u>	Long: <u>-84.160428</u>
Datum: <u>NAD83</u>		
Soil Map Unit Name: <u>Houghton muck (0-1% slopes)</u>		NWI classification: <u>PSS1/EM1Cd</u>
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u> Hydric Soil Present? Yes <u>X</u> No <u> </u> Wetland Hydrology Present? Yes <u>X</u> No <u> </u>	<table style="width:100%;"> <tr> <td style="width:60%;">Is the Sampled Area within a Wetland?</td> <td style="width:40%;">Yes <u>X</u> No <u> </u></td> </tr> </table>	Is the Sampled Area within a Wetland?	Yes <u>X</u> No <u> </u>
Is the Sampled Area within a Wetland?	Yes <u>X</u> No <u> </u>		
Remarks: Wetland Z - emergent wetland in the NW portion of the site.			

VEGETATION – Use scientific names of plants.

<table style="width:100%;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: left;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">=Total Cover</td> <td colspan="2"></td> </tr> </table> <table style="width:100%;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: left;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td><u>Toxicodendron vernix</u></td><td style="text-align: center;">20</td><td style="text-align: center;">Yes</td><td style="text-align: center;">OBL</td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">20</td> <td style="text-align: center;">=Total Cover</td> <td></td> </tr> </table> <table style="width:100%;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: left;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td><u>Carex lacustris</u></td><td style="text-align: center;">50</td><td style="text-align: center;">Yes</td><td style="text-align: center;">OBL</td></tr> <tr><td>2.</td><td><u>Carex stricta</u></td><td style="text-align: center;">30</td><td style="text-align: center;">Yes</td><td style="text-align: center;">OBL</td></tr> <tr><td>3.</td><td><u>Onoclea sensibilis</u></td><td style="text-align: center;">5</td><td style="text-align: center;">No</td><td style="text-align: center;">FACW</td></tr> <tr><td>4.</td><td><u>Typha latifolia</u></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">OBL</td></tr> <tr><td>5.</td><td><u>Asclepias incarnata</u></td><td style="text-align: center;">5</td><td style="text-align: center;">No</td><td style="text-align: center;">OBL</td></tr> <tr><td>6.</td><td></td><td></td><td></td><td></td></tr> <tr><td>7.</td><td></td><td></td><td></td><td></td></tr> <tr><td>8.</td><td></td><td></td><td></td><td></td></tr> <tr><td>9.</td><td></td><td></td><td></td><td></td></tr> <tr><td>10.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">100</td> <td style="text-align: center;">=Total Cover</td> <td></td> </tr> </table> <table style="width:100%;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: left;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">=Total Cover</td> <td colspan="2"></td> </tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.					3.					4.					5.							=Total Cover			Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.	<u>Toxicodendron vernix</u>	20	Yes	OBL	2.					3.					4.					5.							20	=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.	<u>Carex lacustris</u>	50	Yes	OBL	2.	<u>Carex stricta</u>	30	Yes	OBL	3.	<u>Onoclea sensibilis</u>	5	No	FACW	4.	<u>Typha latifolia</u>	10	No	OBL	5.	<u>Asclepias incarnata</u>	5	No	OBL	6.					7.					8.					9.					10.							100	=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.							=Total Cover			Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>3</u> (A) Total Number of Dominant Species Across All Strata: <u>3</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>100.0%</u> (A/B) Prevalence Index worksheet: <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr> <td>OBL species <u>115</u></td> <td>x 1 = <u>115</u></td> </tr> <tr> <td>FACW species <u>5</u></td> <td>x 2 = <u>10</u></td> </tr> <tr> <td>FAC species <u>0</u></td> <td>x 3 = <u>0</u></td> </tr> <tr> <td>FACU species <u>0</u></td> <td>x 4 = <u>0</u></td> </tr> <tr> <td>UPL species <u>0</u></td> <td>x 5 = <u>0</u></td> </tr> <tr> <td>Column Totals: <u>120</u> (A)</td> <td><u>125</u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u>1.04</u></td> </tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u>X</u> 2 - Dominance Test is >50% <u>X</u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. <table style="width:100%;"> <tr> <td style="width:60%;">Hydrophytic Vegetation Present?</td> <td style="width:40%;">Yes <u>X</u> No <u> </u></td> </tr> </table>	Total % Cover of:	Multiply by:	OBL species <u>115</u>	x 1 = <u>115</u>	FACW species <u>5</u>	x 2 = <u>10</u>	FAC species <u>0</u>	x 3 = <u>0</u>	FACU species <u>0</u>	x 4 = <u>0</u>	UPL species <u>0</u>	x 5 = <u>0</u>	Column Totals: <u>120</u> (A)	<u>125</u> (B)	Prevalence Index = B/A = <u>1.04</u>		Hydrophytic Vegetation Present?	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Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status																																																																																																																																																																					
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2.	<u>Carex stricta</u>	30	Yes	OBL																																																																																																																																																																					
3.	<u>Onoclea sensibilis</u>	5	No	FACW																																																																																																																																																																					
4.	<u>Typha latifolia</u>	10	No	OBL																																																																																																																																																																					
5.	<u>Asclepias incarnata</u>	5	No	OBL																																																																																																																																																																					
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Column Totals: <u>120</u> (A)	<u>125</u> (B)																																																																																																																																																																								
Prevalence Index = B/A = <u>1.04</u>																																																																																																																																																																									
Hydrophytic Vegetation Present?	Yes <u>X</u> No <u> </u>																																																																																																																																																																								
Remarks: (Include photo numbers here or on a separate sheet.)																																																																																																																																																																									

SOIL

Sampling Point: WT6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-24	10YR 2/1	100					Muck	24"+ muck

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☒ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☒ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	
☐ Sandy Gleyed Matrix (S4)	
☐ Sandy Redox (S5)	
☐ Stripped Matrix (S6)	
☐ Dark Surface (S7)	
☐ Loamy Mucky Mineral (F1)	
☐ Loamy Gleyed Matrix (F2)	
☐ Depleted Matrix (F3)	
☐ Redox Dark Surface (F6)	
☐ Depleted Dark Surface (F7)	
☐ Redox Depressions (F8)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes ☒ No ☐
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☒ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☒ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☒ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☒ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes ☒ No ☐ Depth (inches): <u> 2 </u> Water Table Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> Saturation Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No ☐
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes <u> X </u>	No <u> </u>	Is the Sampled Area within a Wetland?	Yes <u> X </u>	No <u> </u>
Hydric Soil Present?	Yes <u> X </u>	No <u> </u>			
Wetland Hydrology Present?	Yes <u> X </u>	No <u> </u>			
Remarks: Wetland Y - emergent wetland in the NW portion of the site.					

Tree Stratum		Absolute % Cover	Dominant Species?	Indicator Status
(Plot size: 30')				
1.		0		
2.				
3.				
4.				
5.				
			=Total Cover	
Sapling/Shrub Stratum		Absolute % Cover	Dominant Species?	Indicator Status
(Plot size: 15')				
1.		0		
2.				
3.				
4.				
5.				
			=Total Cover	
Herb Stratum		Absolute % Cover	Dominant Species?	Indicator Status
(Plot size: 5')				
1.	<i>Phalaris arundinacea</i>	100	Yes	FACW
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
		100	=Total Cover	
Woody Vine Stratum		Absolute % Cover	Dominant Species?	Indicator Status
(Plot size: 15')				
1.		0		
2.				
			=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species 0	x 1 = 0
FACW species 100	x 2 = 200
FAC species 0	x 3 = 0
FACU species 0	x 4 = 0
UPL species 0	x 5 = 0
Column Totals: 100 (A)	200 (B)
Prevalence Index = B/A = 2.00	

Hydrophytic Vegetation Indicators:

1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0¹

4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet)

Problematic Hydrophytic Vegetation¹ (Explain)

¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WT7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-24	10YR 2/1	100					Muck	24"+ muck

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histic Epipedon (A2)	☐ Coast Prairie Redox (A16)
☐ Black Histic (A3)	☐ Iron-Manganese Masses (F12)
☒ Hydrogen Sulfide (A4)	☐ Red Parent Material (F21)
☐ Stratified Layers (A5)	☐ Very Shallow Dark Surface (F22)
☒ 2 cm Muck (A10)	☐ Other (Explain in Remarks)
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: <u> </u> none Depth (inches): <u> </u>	Hydric Soil Present? Yes ☒ No ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☒ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☒ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
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☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☒ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes ☒ No ☐ Depth (inches): <u> 3 </u> Water Table Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> Saturation Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-15-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>WT8</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 14 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>depression</u>	Local relief (concave, convex, none): <u>concave</u>	
Slope (%): <u>1-3</u>	Lat: <u>42.125316</u>	Long: <u>-84.15758</u>
Datum: <u>NAD83</u>		
Soil Map Unit Name: <u>Houghton muck (0-1% slopes)</u>	NWI classification: <u>PEM1C</u>	
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u> Hydric Soil Present? Yes <u>X</u> No <u> </u> Wetland Hydrology Present? Yes <u>X</u> No <u> </u>	Is the Sampled Area within a Wetland? Yes <u>X</u> No <u> </u>
Remarks: Wetland W - emergent wetland in the NW portion of the site.	

VEGETATION – Use scientific names of plants.

<table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">=Total Cover</td> <td colspan="2"></td> </tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">=Total Cover</td> <td colspan="2"></td> </tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td><u>Schoenoplectus pungens</u></td><td style="text-align: center;">60</td><td style="text-align: center;">Yes</td><td style="text-align: center;">OBL</td></tr> <tr><td>2.</td><td><u>Typha latifolia</u></td><td style="text-align: center;">20</td><td style="text-align: center;">Yes</td><td style="text-align: center;">OBL</td></tr> <tr><td>3.</td><td><u>Carex lacustris</u></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">OBL</td></tr> <tr><td>4.</td><td><u>Carex stricta</u></td><td style="text-align: center;">10</td><td style="text-align: center;">No</td><td style="text-align: center;">OBL</td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr><td>6.</td><td></td><td></td><td></td><td></td></tr> <tr><td>7.</td><td></td><td></td><td></td><td></td></tr> <tr><td>8.</td><td></td><td></td><td></td><td></td></tr> <tr><td>9.</td><td></td><td></td><td></td><td></td></tr> <tr><td>10.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">100</td> <td style="text-align: center;">=Total Cover</td> <td></td> </tr> </table> <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td style="text-align: center;">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr> <td colspan="2"></td> <td style="text-align: center;">=Total Cover</td> <td colspan="2"></td> </tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	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Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u>	Total % Cover of:	Multiply by:	OBL species <u>100</u>	x 1 = <u>100</u>	FACW species <u>0</u>	x 2 = <u>0</u>	FAC species <u>0</u>	x 3 = <u>0</u>	FACU species <u>0</u>	x 4 = <u>0</u>	UPL species <u>0</u>	x 5 = <u>0</u>	Column Totals: <u>100</u> (A)	<u>100</u> (B)	Prevalence Index = B/A = <u>1.00</u>	
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Remarks: (Include photo numbers here or on a separate sheet.)																																																																																																																																																																							

SOIL

Sampling Point: WT8

[illegible]

HYDROLOGY

Wetland Hydrology Indicators:			
<u>Primary Indicators (minimum of one is required; check all that apply)</u>		<u>Secondary Indicators (minimum of two required)</u>	
☒ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☒ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☒ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☒ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		
Field Observations:			
Surface Water Present?	Yes ☒ No ☐	Depth (inches):	3
Water Table Present?	Yes ☒ No ☐	Depth (inches):	1
Saturation Present?	Yes ☒ No ☐	Depth (inches):	1
(includes capillary fringe)		Wetland Hydrology Present? Yes ☒ No ☐	
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:			
Remarks:			

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: WT9
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): depression Local relief (concave, convex, none): concave
Slope (%): 1-3 Lat: 42.126288 Long: -84.155584 Datum: NAD83
Soil Map Unit Name: Houghton muck (0-1% slopes) NWI classification: PSS1/EM1Cd

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No
Hydric Soil Present? Yes X No
Wetland Hydrology Present? Yes X No

Is the Sampled Area
within a Wetland? Yes X No

Remarks:
Wetland V - emergent wetland in the NW portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1.		0		
2.				
3.				
4.				
5.				
		=Total Cover		

Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1.		0		
2.				
3.				
4.				
5.				
		=Total Cover		

Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Typha latifolia</u>		40	Yes	OBL
2. <u>Phalaris arundinacea</u>		10	No	FACW
3. <u>Carex lacustris</u>		25	Yes	OBL
4. <u>Carex stricta</u>		25	Yes	OBL
5.				
6.				
7.				
8.				
9.				
10.				
		100 =Total Cover		

Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1.		0		
2.				
		=Total Cover		

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species
Across All Strata: 3 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>90</u>	x 1 = <u>90</u>
FACW species <u>10</u>	x 2 = <u>20</u>
FAC species <u>0</u>	x 3 = <u>0</u>
FACU species <u>0</u>	x 4 = <u>0</u>
UPL species <u>0</u>	x 5 = <u>0</u>
Column Totals: <u>100</u> (A)	<u>110</u> (B)
Prevalence Index = B/A = <u>1.10</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting
data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must
be present, unless disturbed or problematic.

**Hydrophytic
Vegetation**

Present? Yes X No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WT9

[illegible]

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☒ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☒ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☒ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☒ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		
Field Observations:			
Surface Water Present?	Yes ☒ No ☐	Depth (inches):	3
Water Table Present?	Yes ☒ No ☐	Depth (inches):	1
Saturation Present?	Yes ☒ No ☐	Depth (inches):	1
(includes capillary fringe)		Wetland Hydrology Present? Yes ☒ No ☐	
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:			
Remarks:			

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: WT10
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): depression Local relief (concave, convex, none): concave
Slope (%): 1-3 Lat: 42.125557 Long: -84.154174 Datum: NAD83
Soil Map Unit Name: Boyer-Leoni complex (18-40% slopes) NWI classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No
Hydric Soil Present? Yes X No
Wetland Hydrology Present? Yes X No

Is the Sampled Area
within a Wetland? Yes X No

Remarks:
Wetland U - emergent/vernal pool wetland in the NC portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1.		0		
2.				
3.				
4.				
5.				
		=Total Cover		
Sapling/Shrub Stratum	(Plot size: <u>15'</u>)			
1.		0		
2.				
3.				
4.				
5.				
		=Total Cover		
Herb Stratum	(Plot size: <u>5'</u>)			
1.	<u>Toxicodendron radicans</u>	10	Yes	FAC
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
		10 =Total Cover		
Woody Vine Stratum	(Plot size: <u>15'</u>)			
1.		0		
2.				
		=Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>0</u>	x 1 = <u>0</u>
FACW species <u>0</u>	x 2 = <u>0</u>
FAC species <u>10</u>	x 3 = <u>30</u>
FACU species <u>0</u>	x 4 = <u>0</u>
UPL species <u>0</u>	x 5 = <u>0</u>
Column Totals: <u>10</u> (A)	<u>30</u> (B)
Prevalence Index = B/A = <u>3.00</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0¹

 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet)

 Problematic Hydrophytic Vegetation¹ (Explain)

¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks: (Include photo numbers here or on a separate sheet.)
Sparse veg at time of inspection

SOIL

Sampling Point: WT10

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-2	10YR 3/1	100					Loamy/Clayey	
2-16	10YR 4/1	75	10YR 5/6	25	C	PL/M	Loamy/Clayey	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☒ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes ☒ No ☐
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☒ Surface Water (A1)	☒ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☒ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☐ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> Water Table Present? Yes ☐ No ☒ Depth (inches): _____ Saturation Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No ☐
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
 See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
 Requirement Control Symbol EXEMPT:
 (Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
 Applicant/Owner: Edward C Levy Company State: MI Sampling Point: WT11
 Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
 Landform (hillside, terrace, etc.): depression Local relief (concave, convex, none): concave
 Slope (%): 1-3 Lat: 42.126236 Long: -84.153051 Datum: NAD83
 Soil Map Unit Name: Boyer-Leoni complex (18-40% slopes) NWI classification: none
 Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
 Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
 Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u> Hydric Soil Present? Yes <u>X</u> No <u> </u> Wetland Hydrology Present? Yes <u>X</u> No <u> </u>	Is the Sampled Area within a Wetland? Yes <u>X</u> No <u> </u>
Remarks: Wetland T - emergent/vernal pool wetland in the NC portion of the site.	

VEGETATION – Use scientific names of plants.

<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td align="center">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td align="right">=Total Cover</td><td></td></tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td align="center">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td align="right">=Total Cover</td><td></td></tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td><u>Phalaris arundinacea</u></td><td align="center">20</td><td align="center">Yes</td><td align="center">FACW</td></tr> <tr><td>2.</td><td><u>Juncus effusus</u></td><td align="center">10</td><td align="center">Yes</td><td align="center">OBL</td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr><td>6.</td><td></td><td></td><td></td><td></td></tr> <tr><td>7.</td><td></td><td></td><td></td><td></td></tr> <tr><td>8.</td><td></td><td></td><td></td><td></td></tr> <tr><td>9.</td><td></td><td></td><td></td><td></td></tr> <tr><td>10.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td align="center">30</td><td align="right">=Total Cover</td><td></td></tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td align="center">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td align="right">=Total Cover</td><td></td></tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.					3.					4.					5.								=Total Cover		Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.					3.					4.					5.								=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.	<u>Phalaris arundinacea</u>	20	Yes	FACW	2.	<u>Juncus effusus</u>	10	Yes	OBL	3.					4.					5.					6.					7.					8.					9.					10.							30	=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.								=Total Cover		Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>2</u> (A) Total Number of Dominant Species Across All Strata: <u>2</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>100.0%</u> (A/B) Prevalence Index worksheet: <table style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr> <td>OBL species <u>10</u></td> <td>x 1 = <u>10</u></td> </tr> <tr> <td>FACW species <u>20</u></td> <td>x 2 = <u>40</u></td> </tr> <tr> <td>FAC species <u>0</u></td> <td>x 3 = <u>0</u></td> </tr> <tr> <td>FACU species <u>0</u></td> <td>x 4 = <u>0</u></td> </tr> <tr> <td>UPL species <u>0</u></td> <td>x 5 = <u>0</u></td> </tr> <tr> <td>Column Totals: <u>30</u> (A)</td> <td><u>50</u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u>1.67</u></td> </tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u>X</u> 2 - Dominance Test is >50% <u>X</u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u>	Total % Cover of:	Multiply by:	OBL species <u>10</u>	x 1 = <u>10</u>	FACW species <u>20</u>	x 2 = <u>40</u>	FAC species <u>0</u>	x 3 = <u>0</u>	FACU species <u>0</u>	x 4 = <u>0</u>	UPL species <u>0</u>	x 5 = <u>0</u>	Column Totals: <u>30</u> (A)	<u>50</u> (B)	Prevalence Index = B/A = <u>1.67</u>	
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Remarks: (Include photo numbers here or on a separate sheet.) Sparse veg at time of inspection																																																																																																																																																																							

SOIL

Sampling Point: WT11

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-9	10YR 3/1	80	5YR 4/4	20	C	PL	Mucky Loam/Clay	
9-18	10YR 3/1	80	10YR 5/6	20	C	PL/M	Loamy/Clayey	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	
☐ Sandy Gleyed Matrix (S4)	
☐ Sandy Redox (S5)	
☐ Stripped Matrix (S6)	
☐ Dark Surface (S7)	
☒ Loamy Mucky Mineral (F1)	
☐ Loamy Gleyed Matrix (F2)	
☐ Depleted Matrix (F3)	
☒ Redox Dark Surface (F6)	
☐ Depleted Dark Surface (F7)	
☐ Redox Depressions (F8)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes ☒ No ☐
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☒ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☒ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☒ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes ☐ No ☒ Depth (inches): _____ Water Table Present? Yes ☐ No ☒ Depth (inches): _____ Saturation Present? Yes ☒ No ☐ Depth (inches): 3 (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No ☐
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
 See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
 Requirement Control Symbol EXEMPT:
 (Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-15-23
 Applicant/Owner: Edward C Levy Company State: MI Sampling Point: WT12
 Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
 Landform (hillside, terrace, etc.): depression Local relief (concave, convex, none): concave
 Slope (%): 1-3 Lat: 42.126653 Long: -84.153267 Datum: NAD83
 Soil Map Unit Name: Boyer-Leoni complex (18-40% slopes) NWI classification: none
 Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
 Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
 Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u> Hydric Soil Present? Yes <u>X</u> No <u> </u> Wetland Hydrology Present? Yes <u>X</u> No <u> </u>	Is the Sampled Area within a Wetland? Yes <u>X</u> No <u> </u>
Remarks: Wetland S - emergent/vernal pool wetland in the NC portion of the site.	

VEGETATION – Use scientific names of plants.

<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Tree Stratum</th> <th style="text-align: center;">(Plot size: <u>30'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td align="center">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td align="right">=Total Cover</td><td></td></tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Sapling/Shrub Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td align="center">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.</td><td></td><td></td><td></td><td></td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td align="right">=Total Cover</td><td></td></tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Herb Stratum</th> <th style="text-align: center;">(Plot size: <u>5'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td><u>Phalaris arundinacea</u></td><td align="center">5</td><td align="center">Yes</td><td align="center">FACW</td></tr> <tr><td>2.</td><td><u>Juncus effusus</u></td><td align="center">15</td><td align="center">Yes</td><td align="center">OBL</td></tr> <tr><td>3.</td><td><u>Carex lacustris</u></td><td align="center">5</td><td align="center">Yes</td><td align="center">OBL</td></tr> <tr><td>4.</td><td></td><td></td><td></td><td></td></tr> <tr><td>5.</td><td></td><td></td><td></td><td></td></tr> <tr><td>6.</td><td></td><td></td><td></td><td></td></tr> <tr><td>7.</td><td></td><td></td><td></td><td></td></tr> <tr><td>8.</td><td></td><td></td><td></td><td></td></tr> <tr><td>9.</td><td></td><td></td><td></td><td></td></tr> <tr><td>10.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td align="center">25</td><td align="right">=Total Cover</td><td></td></tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Woody Vine Stratum</th> <th style="text-align: center;">(Plot size: <u>15'</u>)</th> <th style="text-align: center;">Absolute % Cover</th> <th style="text-align: center;">Dominant Species?</th> <th style="text-align: center;">Indicator Status</th> </tr> <tr><td>1.</td><td></td><td align="center">0</td><td></td><td></td></tr> <tr><td>2.</td><td></td><td></td><td></td><td></td></tr> <tr><td colspan="2"></td><td></td><td align="right">=Total Cover</td><td></td></tr> </table>	Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.					3.					4.					5.								=Total Cover		Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.					3.					4.					5.								=Total Cover		Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.	<u>Phalaris arundinacea</u>	5	Yes	FACW	2.	<u>Juncus effusus</u>	15	Yes	OBL	3.	<u>Carex lacustris</u>	5	Yes	OBL	4.					5.					6.					7.					8.					9.					10.							25	=Total Cover		Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	1.		0			2.								=Total Cover		Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>3</u> (A) Total Number of Dominant Species Across All Strata: <u>3</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>100.0%</u> (A/B) Prevalence Index worksheet: <table style="width:100%;"> <tr> <th style="text-align: left;">Total % Cover of:</th> <th style="text-align: left;">Multiply by:</th> </tr> <tr> <td>OBL species <u>20</u></td> <td>x 1 = <u>20</u></td> </tr> <tr> <td>FACW species <u>5</u></td> <td>x 2 = <u>10</u></td> </tr> <tr> <td>FAC species <u>0</u></td> <td>x 3 = <u>0</u></td> </tr> <tr> <td>FACU species <u>0</u></td> <td>x 4 = <u>0</u></td> </tr> <tr> <td>UPL species <u>0</u></td> <td>x 5 = <u>0</u></td> </tr> <tr> <td>Column Totals: <u>25</u> (A)</td> <td><u>30</u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u>1.20</u></td> </tr> </table> Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u>X</u> 2 - Dominance Test is >50% <u>X</u> 3 - Prevalence Index is ≤3.0¹ <u> </u> 4 - Morphological Adaptations¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation¹ (Explain) ¹Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic. Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u>	Total % Cover of:	Multiply by:	OBL species <u>20</u>	x 1 = <u>20</u>	FACW species <u>5</u>	x 2 = <u>10</u>	FAC species <u>0</u>	x 3 = <u>0</u>	FACU species <u>0</u>	x 4 = <u>0</u>	UPL species <u>0</u>	x 5 = <u>0</u>	Column Totals: <u>25</u> (A)	<u>30</u> (B)	Prevalence Index = B/A = <u>1.20</u>	
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Remarks: (Include photo numbers here or on a separate sheet.) Saprse veg at time of inspection																																																																																																																																																																							

SOIL

Sampling Point: WT12

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-8	10YR 3/1	100					Mucky Loam/Clay	
8-16	10YR 4/1	80	10YR 6/8	20	C	PL/M	Loamy/Clayey	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histic Epipedon (A2)	☐ Coast Prairie Redox (A16)
☐ Black Histic (A3)	☐ Iron-Manganese Masses (F12)
☐ Hydrogen Sulfide (A4)	☐ Red Parent Material (F21)
☐ Stratified Layers (A5)	☐ Very Shallow Dark Surface (F22)
☐ 2 cm Muck (A10)	☐ Other (Explain in Remarks)
☒ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes ☒ No ☐
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☒ Surface Water (A1)	☒ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☒ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☒ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
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☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☒ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes ☒ No ☐ Depth (inches): <u> 3 </u> Water Table Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> Saturation Present? Yes ☒ No ☐ Depth (inches): <u> 1 </u> (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No ☐
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-16-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: WT13
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 14 T4S R2E
Landform (hillside, terrace, etc.): depression Local relief (concave, convex, none): concave
Slope (%): 1-3 Lat: 42.120481 Long: -84.132923 Datum: NAD83
Soil Map Unit Name: Hillsdale-Riddles sandy laoms (18-30% slopes) NWI classification: PUBG
Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No
Hydric Soil Present? Yes X No
Wetland Hydrology Present? Yes X No

Is the Sampled Area
within a Wetland? Yes X No

Remarks:
Wetland Q - emergent/open water wetland in the NE portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Acer negundo</u>		<u>10</u>	<u>Yes</u>	<u>FAC</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>10</u>	<u>=Total Cover</u>	
Sapling/Shrub Stratum	(Plot size: <u>15'</u>)			
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
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5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	<u>=Total Cover</u>	
Herb Stratum	(Plot size: <u>5'</u>)			
1. <u>Phalaris arundinacea</u>		<u>100</u>	<u>Yes</u>	<u>FACW</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
6. <u> </u>		<u> </u>	<u> </u>	<u> </u>
7. <u> </u>		<u> </u>	<u> </u>	<u> </u>
8. <u> </u>		<u> </u>	<u> </u>	<u> </u>
9. <u> </u>		<u> </u>	<u> </u>	<u> </u>
10. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>100</u>	<u>=Total Cover</u>	
Woody Vine Stratum	(Plot size: <u>15'</u>)			
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	<u>=Total Cover</u>	

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species
Across All Strata: 2 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>0</u>	x 1 = <u>0</u>
FACW species <u>100</u>	x 2 = <u>200</u>
FAC species <u>10</u>	x 3 = <u>30</u>
FACU species <u>0</u>	x 4 = <u>0</u>
UPL species <u>0</u>	x 5 = <u>0</u>
Column Totals: <u>110</u> (A)	<u>230</u> (B)
Prevalence Index = B/A = <u>2.09</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting
data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must
be present, unless disturbed or problematic.

**Hydrophytic
Vegetation**

Present? Yes X No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WT13

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-8	10YR 3/1	95	10YR 6/8	5	C	PL	Sandy	
8-16	10YR 4/2	80	10YR 6/8	15	C	PL	Sandy	Prominent redox concentrations
			10YR 3/1	5	C	M		Faint redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	
☐ Sandy Gleyed Matrix (S4)	
☒ Sandy Redox (S5)	
☐ Stripped Matrix (S6)	
☐ Dark Surface (S7)	
☐ Loamy Mucky Mineral (F1)	
☐ Loamy Gleyed Matrix (F2)	
☐ Depleted Matrix (F3)	
☐ Redox Dark Surface (F6)	
☐ Depleted Dark Surface (F7)	
☐ Redox Depressions (F8)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes ☒ No ☐
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☒ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☒ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No ☒ Depth (inches): _____ Water Table Present? Yes _____ No ☒ Depth (inches): _____ Saturation Present? Yes ☒ No _____ Depth (inches): 4 (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No ☐
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Norvell Township Property</u>	City/County: <u>Norvell Twp.-Jackson Co.</u>	Sampling Date: <u>3-16-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>WT15</u>
Investigator(s): <u>ASTI - KAH & SPJ</u>	Section, Township, Range: <u>Sec 14 T4S R2E</u>	
Landform (hillside, terrace, etc.): <u>depression</u>	Local relief (concave, convex, none): <u>concave</u>	
Slope (%): <u>1-3</u>	Lat: <u>42.126183</u>	Long: <u>-84.15219</u> Datum: <u>NAD83</u>
Soil Map Unit Name: <u>Boyer-Leoni complex (18-40% slopes)</u>	NWI classification: <u>none</u>	
Are climatic / hydrologic conditions on the site typical for this time of year? Yes <u>x</u> No <u> </u> (If no, explain in Remarks.)		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> significantly disturbed? Are "Normal Circumstances" present? Yes <u>x</u> No <u> </u>		
Are Vegetation <u> </u> , Soil <u> </u> , or Hydrology <u> </u> naturally problematic? (If needed, explain any answers in Remarks.)		

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u> Hydric Soil Present? Yes <u>X</u> No <u> </u> Wetland Hydrology Present? Yes <u>X</u> No <u> </u>	Is the Sampled Area within a Wetland? Yes <u>X</u> No <u> </u>
Remarks: Wetland O - emergent wetland in the NC portion of the site.	

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>1</u> (A) Total Number of Dominant Species Across All Strata: <u>1</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>100.0%</u> (A/B)																
1. <u> </u>		<u>0</u>																			
2. <u> </u>																					
3. <u> </u>																					
4. <u> </u>																					
5. <u> </u>																					
		<u> </u> =Total Cover																			
Sapling/Shrub Stratum	(Plot size: <u>15'</u>)				Prevalence Index worksheet: <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 50%;">Total % Cover of:</th> <th style="width: 50%;">Multiply by:</th> </tr> <tr> <td>OBL species <u>0</u></td> <td>x 1 = <u>0</u></td> </tr> <tr> <td>FACW species <u>75</u></td> <td>x 2 = <u>150</u></td> </tr> <tr> <td>FAC species <u>0</u></td> <td>x 3 = <u>0</u></td> </tr> <tr> <td>FACU species <u>0</u></td> <td>x 4 = <u>0</u></td> </tr> <tr> <td>UPL species <u>0</u></td> <td>x 5 = <u>0</u></td> </tr> <tr> <td>Column Totals: <u>75</u> (A)</td> <td><u>150</u> (B)</td> </tr> <tr> <td colspan="2">Prevalence Index = B/A = <u>2.00</u></td> </tr> </table>	Total % Cover of:	Multiply by:	OBL species <u>0</u>	x 1 = <u>0</u>	FACW species <u>75</u>	x 2 = <u>150</u>	FAC species <u>0</u>	x 3 = <u>0</u>	FACU species <u>0</u>	x 4 = <u>0</u>	UPL species <u>0</u>	x 5 = <u>0</u>	Column Totals: <u>75</u> (A)	<u>150</u> (B)	Prevalence Index = B/A = <u>2.00</u>	
Total % Cover of:	Multiply by:																				
OBL species <u>0</u>	x 1 = <u>0</u>																				
FACW species <u>75</u>	x 2 = <u>150</u>																				
FAC species <u>0</u>	x 3 = <u>0</u>																				
FACU species <u>0</u>	x 4 = <u>0</u>																				
UPL species <u>0</u>	x 5 = <u>0</u>																				
Column Totals: <u>75</u> (A)	<u>150</u> (B)																				
Prevalence Index = B/A = <u>2.00</u>																					
1. <u> </u>		<u>0</u>																			
2. <u> </u>																					
3. <u> </u>																					
4. <u> </u>																					
5. <u> </u>																					
		<u> </u> =Total Cover																			
Herb Stratum	(Plot size: <u>5'</u>)				Hydrophytic Vegetation Indicators: <u> </u> 1 - Rapid Test for Hydrophytic Vegetation <u>X</u> 2 - Dominance Test is >50% <u>X</u> 3 - Prevalence Index is ≤3.0 ¹ <u> </u> 4 - Morphological Adaptations ¹ (Provide supporting data in Remarks or on a separate sheet) <u> </u> Problematic Hydrophytic Vegetation ¹ (Explain) ¹ Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.																
1. <u>Phalaris arundinacea</u>		<u>75</u>	<u>Yes</u>	<u>FACW</u>																	
2. <u> </u>																					
3. <u> </u>																					
4. <u> </u>																					
5. <u> </u>																					
6. <u> </u>																					
7. <u> </u>																					
8. <u> </u>																					
9. <u> </u>																					
10. <u> </u>																					
		<u>75</u> =Total Cover																			
Woody Vine Stratum	(Plot size: <u>15'</u>)				Hydrophytic Vegetation Present? Yes <u>X</u> No <u> </u>																
1. <u> </u>		<u>0</u>																			
2. <u> </u>																					
		<u> </u> =Total Cover																			
Remarks: (Include photo numbers here or on a separate sheet.)																					

SOIL

Sampling Point: WT15

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-16	10YR 3/1	75	5YR 4/4	25	C	PL	Mucky Loam/Clay	
16-20	10YR 6/1	100					Sandy	

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:	Indicators for Problematic Hydric Soils ³ :
☐ Histosol (A1)	☐ Coast Prairie Redox (A16)
☐ Histic Epipedon (A2)	☐ Iron-Manganese Masses (F12)
☐ Black Histic (A3)	☐ Red Parent Material (F21)
☐ Hydrogen Sulfide (A4)	☐ Very Shallow Dark Surface (F22)
☐ Stratified Layers (A5)	☐ Other (Explain in Remarks)
☐ 2 cm Muck (A10)	
☐ Depleted Below Dark Surface (A11)	
☐ Thick Dark Surface (A12)	
☐ Sandy Mucky Mineral (S1)	
☐ 5 cm Mucky Peat or Peat (S3)	
☐ Sandy Gleyed Matrix (S4)	
☐ Sandy Redox (S5)	
☐ Stripped Matrix (S6)	
☐ Dark Surface (S7)	
☒ Loamy Mucky Mineral (F1)	
☐ Loamy Gleyed Matrix (F2)	
☐ Depleted Matrix (F3)	
☒ Redox Dark Surface (F6)	
☐ Depleted Dark Surface (F7)	
☐ Redox Depressions (F8)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes ☒ No ☐
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:			
Primary Indicators (minimum of one is required; check all that apply)		Secondary Indicators (minimum of two required)	
☒ Surface Water (A1)	☒ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☒ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☒ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☒ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☒ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes ☒ No ☐ Depth (inches): 0.1 Water Table Present? Yes ☒ No ☐ Depth (inches): 16 Saturation Present? Yes ☒ No ☐ Depth (inches): 1 (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No ☐
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Midwest Region
See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R

OMB Control #: 0710-0024, Exp:11/30/2024
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Norvell Township Property City/County: Norvell Twp.-Jackson Co. Sampling Date: 3-16-23
Applicant/Owner: Edward C Levy Company State: MI Sampling Point: WT16
Investigator(s): ASTI - KAH & SPJ Section, Township, Range: Sec 13 T4S R2E
Landform (hillside, terrace, etc.): depression Local relief (concave, convex, none): concave
Slope (%): 1-3 Lat: 42.122586 Long: -84.143509 Datum: NAD83
Soil Map Unit Name: Hillsdale-Riddles sandy loam (6-12% slopes) NWI classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No
Hydric Soil Present? Yes X No
Wetland Hydrology Present? Yes X No

Is the Sampled Area
within a Wetland? Yes X No

Remarks:
Wetland AA - emergent wetland in the central portion of the site.

VEGETATION – Use scientific names of plants.

Tree Stratum	(Plot size: <u>30'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Salix nigra</u>		<u>30</u>	<u>Yes</u>	<u>OBL</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>30</u>	=Total Cover	

Sapling/Shrub Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Cephalanthus occidentalis</u>		<u>30</u>	<u>Yes</u>	<u>OBL</u>
2. <u>Acer negundo</u>		<u>5</u>	<u>No</u>	<u>FAC</u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>35</u>	=Total Cover	

Herb Stratum	(Plot size: <u>5'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u>Phalaris arundinacea</u>		<u>100</u>	<u>Yes</u>	<u>FACW</u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
3. <u> </u>		<u> </u>	<u> </u>	<u> </u>
4. <u> </u>		<u> </u>	<u> </u>	<u> </u>
5. <u> </u>		<u> </u>	<u> </u>	<u> </u>
6. <u> </u>		<u> </u>	<u> </u>	<u> </u>
7. <u> </u>		<u> </u>	<u> </u>	<u> </u>
8. <u> </u>		<u> </u>	<u> </u>	<u> </u>
9. <u> </u>		<u> </u>	<u> </u>	<u> </u>
10. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u>100</u>	=Total Cover	

Woody Vine Stratum	(Plot size: <u>15'</u>)	Absolute % Cover	Dominant Species?	Indicator Status
1. <u> </u>		<u>0</u>	<u> </u>	<u> </u>
2. <u> </u>		<u> </u>	<u> </u>	<u> </u>
		<u> </u>	=Total Cover	

Dominance Test worksheet:

Number of Dominant Species That
Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species
Across All Strata: 3 (B)
Percent of Dominant Species That
Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species <u>60</u>	x 1 = <u>60</u>
FACW species <u>100</u>	x 2 = <u>200</u>
FAC species <u>5</u>	x 3 = <u>15</u>
FACU species <u>0</u>	x 4 = <u>0</u>
UPL species <u>0</u>	x 5 = <u>0</u>
Column Totals: <u>165</u> (A)	<u>275</u> (B)
Prevalence Index = B/A = <u>1.67</u>	

Hydrophytic Vegetation Indicators:

 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0¹
 4 - Morphological Adaptations¹ (Provide supporting
data in Remarks or on a separate sheet)
 Problematic Hydrophytic Vegetation¹ (Explain)
¹Indicators of hydric soil and wetland hydrology must
be present, unless disturbed or problematic.

**Hydrophytic
Vegetation
Present?**

Yes X No

Remarks: (Include photo numbers here or on a separate sheet.)

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Midwest Region See ERDC/EL TR-10-16; the proponent agency is CECW-CO-R	OMB Control #: 0710-0024, Exp:11/30/2024 Requirement Control Symbol EXEMPT: (Authority: AR 335-15, paragraph 5-2a)

Project/Site: <u>Manchester Township Property</u>	City/County: <u>Manchester Twp.-Washtenaw Co.</u>	Sampling Date: <u>7-17-23</u>
Applicant/Owner: <u>Edward C Levy Company</u>	State: <u>MI</u>	Sampling Point: <u>WTZZ</u>
Investigator(s): <u>ASTI - BJK</u>	Section, Township, Range: <u>Sec 18 T4S R3E</u>	
Landform (hillside, terrace, etc.): <u>depression</u>	Local relief (concave, convex, none): <u>concave</u>	
Slope (%): <u>0</u> Lat: _____	Long: _____	Datum: <u>NAD83</u>
Soil Map Unit Name: <u>Hillsdale-Riddles sandy loams (18-30% slopes)</u>	NW1 classification: <u>None</u>	

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No _____ (If no, explain in Remarks.)

Are Vegetation No , Soil No , or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes x No _____

Are Vegetation No , Soil No , or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes <u>X</u> No _____ Hydric Soil Present? Yes <u>X</u> No _____ Wetland Hydrology Present? Yes <u>X</u> No _____	Is the Sampled Area within a Wetland? Yes <u>X</u> No _____
Remarks: Wetland Q - emergent/open water wetland in the SE portion of the site.	

VEGETATION – Use scientific names of plants.

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SOIL

Sampling Point: WTZZ

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-10	10YR 2/1	100			C	M	Loamy/Clayey	
10-18	10YR 4/2	90	10YR 5/6	10	C	M	Loamy/Clayey	Prominent redox concentrations

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:		Indicators for Problematic Hydric Soils ³ :	
☐ Histosol (A1)	☐ Sandy Gleyed Matrix (S4)	☐ Coast Prairie Redox (A16)	³ Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.
☐ Histic Epipedon (A2)	☐ Sandy Redox (S5)	☐ Iron-Manganese Masses (F12)	
☐ Black Histic (A3)	☐ Stripped Matrix (S6)	☐ Red Parent Material (F21)	
☐ Hydrogen Sulfide (A4)	☐ Dark Surface (S7)	☐ Very Shallow Dark Surface (F22)	
☐ Stratified Layers (A5)	☐ Loamy Mucky Mineral (F1)	☐ Other (Explain in Remarks)	
☐ 2 cm Muck (A10)	☐ Loamy Gleyed Matrix (F2)		
☐ Depleted Below Dark Surface (A11)	☒ Depleted Matrix (F3)		
☐ Thick Dark Surface (A12)	☐ Redox Dark Surface (F6)		
☐ Sandy Mucky Mineral (S1)	☐ Depleted Dark Surface (F7)		
☐ 5 cm Mucky Peat or Peat (S3)	☐ Redox Depressions (F8)		

Restrictive Layer (if observed): Type: _____ none Depth (inches): _____	Hydric Soil Present? Yes ☒ No _____
Remarks:	

HYDROLOGY

Wetland Hydrology Indicators:		Secondary Indicators (minimum of two required)	
Primary Indicators (minimum of one is required; check all that apply)			
☐ Surface Water (A1)	☐ Water-Stained Leaves (B9)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Aquatic Fauna (B13)	☐ Drainage Patterns (B10)	
☐ Saturation (A3)	☐ True Aquatic Plants (B14)	☐ Dry-Season Water Table (C2)	
☐ Water Marks (B1)	☐ Hydrogen Sulfide Odor (C1)	☐ Crayfish Burrows (C8)	
☐ Sediment Deposits (B2)	☒ Oxidized Rhizospheres on Living Roots (C3)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Drift Deposits (B3)	☐ Presence of Reduced Iron (C4)	☐ Stunted or Stressed Plants (D1)	
☐ Algal Mat or Crust (B4)	☐ Recent Iron Reduction in Tilled Soils (C6)	☒ Geomorphic Position (D2)	
☐ Iron Deposits (B5)	☐ Thin Muck Surface (C7)	☐ FAC-Neutral Test (D5)	
☐ Inundation Visible on Aerial Imagery (B7)	☐ Gauge or Well Data (D9)		
☐ Sparsely Vegetated Concave Surface (B8)	☐ Other (Explain in Remarks)		

Field Observations: Surface Water Present? Yes _____ No ☒ Depth (inches): _____ Water Table Present? Yes _____ No ☒ Depth (inches): _____ Saturation Present? Yes _____ No ☒ Depth (inches): _____ (includes capillary fringe)	Wetland Hydrology Present? Yes ☒ No _____
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:	
Remarks:	

EXHIBIT 7



Assessment • Remediation • Compliance
Restoration • Incentives

10448 Citation Drive, Suite 100
Brighton, MI 48116

800 395-ASTI
Fax: 810.225.3800

www.asti-env.com

Sent Via Email Only

November 12, 2025

Mr. Thomas Forster II
Varnum LLP
101 N. Main Street
Suite 525
Ann Arbor, MI 48104

*RE: Threatened and Endangered Species Survey and Habitat Assessment
Norvell Township Property
Norvell Township, Jackson County, Michigan
ASTI File No. A23-2961.02*

Dear Mr. Forster:

On May 11 and 25, June 14 and 28, July 17, and August 3, 2023, ASTI Environmental (ASTI) conducted threatened and endangered species assessments for those plant and animal species protected by the Michigan Department of Natural Resources (DNR) under Part 365 (Endangered Species Protection) of the Natural Resources and Environmental Protection Act (1994 P.A. 451) and/or by the US Fish and Wildlife Service (USFWS) under the federal Endangered Species Act of 1973, as amended, at the Norvell Township Property, Norvell Township, Jackson County, Michigan (Property).

The Property is currently comprised of upland and wetland habitat types. These habitat types include upland forest, upland scrub-shrub, active corn field, emergent wetland, forested wetland, open water, hay field/cattle grazing, dry-mesic southern forest, and grassland (Figure 1 – *Habitat Types*). There are also existing farming facilities on the Property. Adjacent properties predominantly include active agricultural land and rural residential properties. Watkins Lake State Park and County Preserve is located to the northeast. The proposed project involves developing the Property with a sand and gravel mining operation (Project). Figure 1 includes the proposed mining limits, based on the Township's required setbacks.

ASTI requested a Rare Species Review from the Michigan Natural Features Inventory (MNFI) for the Property. The results of the MNFI review, received in a letter dated May 28, 2023 (Appendix A – *MNFI Rare Species Review Letter*), documents an MNFI database search for known rare Michigan species and unique natural feature occurrences within a 1.5-mile radius of the Property.

The MNFI Rare Species Review also provides supplemental information regarding federally protected species within a 1.5-mile radius of the Property for projects involving federal funding or federal authorization. In addition, ASTI conducted a federal endangered species review through the U.S. Fish and Wildlife's (USFWS) Information, Planning and Consultation System (IPaC) for information pertaining to potential federal species that may occur on the Property (Appendix B – *USFWS IPaC Species List, Consistency Letter, and USFWS Coordination*).

Using this information, ASTI conducted a field investigation to map habitat types that exist within the Property and to directly search for listed species and/or associated species and habitats, as appropriate. The site inspection dates are within the survey window for all MNFI and IPaC identified rare species. From the database searches and field investigations, ASTI was able to render a professional opinion on whether protected species could occur, or do occur, on the Property. This information was also used to analyze potential project impacts using the IPaC, Michigan Determination Keys for federally listed species (Appendix B).

State Listed Species

According to the MNFI letter, sixteen State threatened and endangered species were identified by MNFI (Table 1 - *State Threatened and Endangered Species Documented within 1.5 Miles of the Property*). Of these sixteen listed species, MNFI provided comments for four species: State and Federally endangered Indiana bat (*Myotis sodalis*), the State threatened Eastern box turtle (*Terrapene carolina carolina*), the Federally and State threatened Eastern massasauga rattlesnake (*Sistrurus catenatus*), and the State threatened Leiberg's panic grass (*Dichanthelium leibergii*). Note that although MNFI provided comments on the box turtle, the box turtle was not included in Table 1 of the MNFI Rare Species Review letter.

Table 1. State Threatened and Endangered Species Documented within 1.5 Miles of the Property

Common Name	Scientific Name	Status
Silphium borer moth (1996)	<i>Papaipema silphii</i>	State Threatened
Purple wartback (2019)	<i>Cyclonaias tuberculata</i>	State Threatened
Indiana bat (2005)	<i>Myotis sodalis</i>	State and Federally Endangered
Wavyrayed lampmussel (2010)	<i>Lampsilis fasciola</i>	State Threatened
Blanchard's cricket frog (1927)	<i>Acris blanchardi</i>	State Threatened
Regal fritillary (2013)	<i>Speyeria idalia</i>	State Endangered
*Henslow's sparrow (2016)	*<i>Centronyx henslowii</i>	*State Endangered
Mitchell's satyr (2022)	<i>Neonympha mitchellii</i>	State and Federally Endangered
Slippershell (2017)	<i>Alasmodonta viridis</i>	State Threatened
Eastern box turtle	<i>Terrapene carolina carolina</i>	State Threatened
Eastern massasauga rattlesnake	(<i>Sistrurus catenatus</i>)	State and Federally Threatened
White lady slipper (2005)	<i>Cypripedium candidum</i>	State Threatened
Tall green milkweed (1981)	<i>Asclepias hirtella</i>	State Threatened

Common Name	Scientific Name	Status
Leiberg's panic grass (2008)	<i>Dichanthelium leibergii</i>	State Threatened
Edible valerian (2006)	<i>Valeriana edulis</i> var. <i>ciliata</i>	State Threatened
Side-oats grama grass (2008)	<i>Bouteloua curtipendula</i>	State Endangered
Northern bayberry (2008)	<i>Myrica pensylvanica</i>	State Threatened
Stiff gentian (2009)	<i>Gentianella quinquefolia</i>	State Threatened

Notes:

1. * MNFI did not include the Eastern box turtle (*Terrapene carolina carolina*) or the Eastern massasauga rattlesnake (*Sistrurus catenatus*) in their Rare Species Review letter Table 1; however, they provided comments for these species as part of Table 1.
2. Species in bold type were identified by MNFI to possibly be negatively impacted by the project and therefore required additional analysis.
3. * MNFI did not provide comments for this species. However, ASTI identified the species on the Property and, therefore, it required additional analysis.

MNFI identified 16 species of special concern and/or natural communities documented within 1.5 miles of the Property. Species of special concern and natural communities are not legally protected under state endangered species legislation; however, Blanding's turtles have been recently observed near the Property and are protected under the authority of the Department of Natural Resources Director's Order, Regulations on the Take of Reptiles and Amphibians, dated October 12, 2001 (Section 324 of PA 451). As a result, Blanding's turtles are addressed in this assessment.

In addition, bald eagles are listed as a species of special concern, and a pair of bald eagles were sighted near Watkins Lake. Bald eagles are protected under the Bald and Golden Eagle Protection Act. As a result, bald eagles are addressed in this assessment.

Federally Listed Species

MNFI also provided supplemental information regarding possible federally protected species that occur in Jackson County and may be impacted by the proposed Project. This supplemental information is for projects that will involve federal funding or federal agency authorization. In addition, pursuant to a 2011 Memorandum of Agreement between the Michigan Department of Environmental Quality (now EGLE) and the USEPA regarding Michigan's administration of Section 404 (wetlands) of the federal Clean Water Act, EGLE permit applications with reasonable potential to affect federally listed species shall be submitted for federal review. This review may take the form of EGLE attaching special conditions to a wetland (Part 303) or inland lake and stream (Part 301) permit such as restricting the timing of construction activities within the Property or it may result in a "red-file," requiring further USFWS review of the permit application. Please note that regardless of a federal project nexus, it is illegal to harm federally listed species; thus, ASTI has included a review of these species as part of this assessment.

MNFI indicates that according to the USFWS, the Property falls within the range of six federally listed species (including one candidate species) identified for Jackson County. For two of the six species listed, MNFI indicates that "there does not appear to be suitable habitat within the 1.5-mile search buffer," and therefore, these species were eliminated from further analysis. Candidate species are not yet afforded protection so

are also eliminated from further analysis. And finally, MNFI indicated that the Property intersects Eastern massasauga rattlesnake (EMR) “Tier Habitat” as designated by the USFWS. IPaC identified five federally listed species to consider, including three already listed by MNFI. Federally protected species listed by MNFI and IPaC were further assessed by ASTI and are listed below in Table 2 - *Federally Listed Species Requiring Further Assessment on the Property*.

Table 2. Federally Listed Species Requiring Further Assessment on the Property

Common Name	Scientific Name	Status
Indiana bat	<i>Myotis sodalis</i>	State and Federally Endangered
Northern long-eared bat	<i>Myotis septentrionalis</i>	State Threatened and Federally Endangered
Eastern massasauga rattlesnake	<i>Sistrurus catenatus</i>	Federally and State Threatened
Eastern Prairie Fringed Orchid	<i>Platanthera leucophaea</i>	Federally Threatened and State Endangered
Mitchell’s Satyr Butterfly	<i>Neonympha mitchelli mitchelli</i>	Federally and State Endangered

Migratory Birds

In addition, IPaC identifies migratory “birds of conservation concern” (BCC) for a project location. Ensuring the protection of migratory birds is related to any activity that results in the take (defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct). The take of all migratory birds is governed by the Migratory Bird Treaty Act’s (MBTA) regulations. The MBTA prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests except as authorized under a valid permit (50 CFR 21.11).

The IPaC Resource List under the MBTA listed 17 BCC species (Appendix B). IPaC states that it is important to avoid and minimize impacts to these birds, especially species of range-wide concern. ASTI included IPaC-listed BCC migratory birds as part of this assessment.

Existing Property Conditions

Existing habitat types on the Subject Property, both wetland and upland, as depicted on Figure 1 were assessed by ASTI staff during multiple site visits. These site visits included the following:

- A wetland delineation on March 15, 16, 21, July 17, and August 3, 2023.
- A meander survey within targeted, suitable habitats for identified protected species on May 11 and 25, June 14 and 28, July 17, and August 3, 2023.

The majority of the Property is active agricultural field currently growing corn. However, there are several areas of fallow field or areas left relatively undisturbed that can be characterized as natural habitat types. An overall graphic of the wetland and upland

habitat types observed on the Property are identified on Figure 1. Habitat type descriptions are provided in the following sections.

Dry-mesic Southern Forest

Dry-mesic southern forest consists of mature deciduous forest that is relatively free of anthropogenic disturbances. Vegetation includes white oak (*Quercus alba*), basswood (*Tilia americana*), red oak (*Quercus rubra*), pignut hickory, (*Carya glabra*), shagbark hickory (*Carya ovata*), black cherry (*Prunus serotina*), snakeroot (*Sanicula spp.*), and bedstraws (*Galium spp.*).

Grassland

Grassland consists of mostly open rolling field that does not appear to have been utilized for agricultural purposes for at least five years, although old fencing indicates prior use for livestock grazing. This area is dominated by grasses (*Bromus spp.*, *Agrostis spp.*). Other vegetation includes stinging nettles (*Urtica dioica*), milkweed (*Asclepias syriaca*), butterfly weed (*Asclepias tuberosa*), as well as scattered shrubs of autumn olive (*Elaeagnus umbellata*) and common juniper (*Juniperus communis*).

Hay Field/Cattle Grazing

These areas are grown and cut seasonally to produce hay or provide grazing for cattle. During the inspections they were dominated by clover (*Trifolium spp.*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), mouse-eared cress (*Arabidopsis thaliana*), and other annual grasses.

Upland Forest

Upland forest includes areas of mature deciduous trees and shrubs, including hedgerows, in the northern portion of the Property. Portions have been lumbered in the recent past, and this has opened up the canopy enough to allow invasive shrubs to establish in the understory. Based on these disturbances these areas do not meet the criteria of any MNFI natural community definition. The soils are sandy. Dominant vegetation includes black oak (*Quercus velutina*), red oak (*Quercus rubra*), black cherry (*Prunus serotina*), bitternut hickory (*Carya cordiformis*), black walnut (*Juglans nigra*), and gooseberry (*Ribes cynosbati*).

Upland Scrub-shrub

Upland scrub-shrub is dominated by rough goldenrod (*Solidago juncea*), autumn olive (*Elaeagnus umbellata*), nodding stickseed (*Hackelia deflexa*), honeysuckle (*Lonicera spp.*), and brambles (*Rubus spp.*).

Forested Wetland

Forested wetland is dominated by silver maple (*Acer saccharinum*), swamp white oak (*Quercus bicolor*), American elm (*Ulmus americana*), and false nettle (*Boehmeria cylindrica*).

Emergent Wetland

Emergent wetland is dominated by cattail (*Typha spp.*), but also includes reed canary grass, northern blueflag (*Iris versicolor*), royal fern (*Osmunda regalis var. spectabilis*), and sedges (*Carex spp.*). Standing water and inundation are prevalent.

Emergent Marsh

These are shallow-water wetlands dominated by sedges (*Carex camosa*, *Carex lacustris*, *Carex stricta*, *Carex stipata*).

Active Agricultural Land

These areas include active corn fields, active cow pastures, an old schoolhouse, and various farming outbuildings and facilities.

Assessment Methods and Results

ASTI completed a bird survey to assess the Property for potential protected bird species, as listed by MNFI and IPaC as migratory BCC species. In addition to the bird surveys, meander surveys for Leiberg's panic grass (State threatened), Eastern box turtle (State threatened), and Blanding's turtle (State special concern) were completed since suitable habitat was known to occur on the Property. Habitat assessments were completed for the Indiana bat and Northern long-eared bat (State and Federally endangered), the Eastern massasauga rattlesnake (State and Federally threatened) the Eastern prairie fringed orchid (Federally threatened and State endangered), and the Mitchell's satyr butterfly (State endangered and Federally threatened). And finally, IPaC Michigan Determination Keys were used to analyze Project impacts to all federally listed species, which included Indiana bat, Northern long-eared bat, Eastern massasauga rattlesnake (EMR), Eastern prairie fringed orchid, and Mitchell's satyr butterfly. Findings for each of the species and/or species habitats assessed are summarized below.

Bird Surveys

ASTI conducted bird surveys on May 11 and 25, June 14 and 28, and July 17, 2023. The surveys took place from dawn (approximately 6:00 AM) until 11:00 AM when birds would be most actively singing. The surveys in May were meander surveys throughout the entire Property with the goal of identifying any protected species that may be present. These surveys were also undertaken to consolidate future survey locations where potential habitat for listed protected species may occur. After a single Henslow's sparrow was observed during these surveys, subsequent surveys were focused specifically on suitable habitat for this species. Birds were identified by song and then visually with binoculars. When possible, pictures were taken with a 40X zoom lens, which allowed for positive identification.

Henslow's sparrow (*Centronyx henslowii*)

MNFI states that Henslow's sparrows are secretive and can be difficult to visually identify because they forage, sing, roost, and nest in low grasslands. The habitat includes "a variety of old field and pasture habitats such as weedy or grassy fields and meadows in low lying damp areas with widely scattered shrubs". The recommended survey period for Henslow's sparrow is from the first week of May through the first week of July. However, the active period, including nesting, can go through the fourth week of August.

ASTI conducted bird surveys on May 11 and 25, June 17 and 27, July 17th, and specifically for this species only on August 3, 2023.

Preferred Henslow's sparrow habitat is present within the grasslands of the northwestern portion of the Property, and it was in this area that a single sparrow was sighted and heard calling. ASTI used a GPS unit to map the areas where Henslow's sparrow was present on the Property (Figure 1).

ASTI recommends that any initial proposed activity in the grassland of the northwestern portion of the Property occur before or after the active period for this species, which is between May and the fourth week of August, to avoid impacts. It is ASTI's opinion that the single Henslow's sparrow sighting in this area was a male singing to attract a mate and claim territory. No females were noted, and no nests were sighted. Based on this, it is ASTI's opinion that after initial site clearing activity has taken place in preparation for mining, it is likely any potential returning Henslow's sparrows would have relocated to other nearby habitat without adverse effects. Normal project operations can continue at any time following this initial period. However, if initial activity within the grassland cannot occur outside of the active period, a permit from the Michigan Department of Natural Resources (MDNR) would be required.

Bald eagle (*Haliaeetus leucocephalus*)

As stated in MNFI, bald eagles will nest in a wide variety of habitats that provide suitable nest sites close to open water. Nests may be placed in snags or large live trees, as well as on constructed platforms or utility poles. Eagles will stay year-round as long as there is open water where they can forage. The upland forest adjacent to Watkins Lake was identified as preferred bald eagle habitat. A pair of adult bald eagles were observed in the vicinity of Watkins Lake during three site visits. A follow-up site visit on January 22, 2025, was undertaken to determine if the eagles were nesting near Watkins Lake. This site visit took place during the active nesting period, and just after dawn. This ensured an ideal situation for observing eagles if they were nesting. One adult bald eagle was observed at two different locations during the site visit. In addition, two eagle nests were identified within a peninsula of land into Watkins Lake. These nests are off-site of the Property. The nests have been located with GPS and are shown on Figure 1.

According to the USFWS, *National Bald Eagle Management Guidelines*, not all bald eagle pairs react to human activities the same way. Some pairs nest within close proximity to human activity; others will abandon their nest with activity much farther away. USFWS indicates that the variability may be related to the activity, prior human experiences, and the tolerance of the nesting pair. Additionally, their sensitivity varies within the stages of the breeding season (late fall to early spring), with the most sensitive timeframe occurring during the first 12 weeks of the breeding season. Because of bald eagle sensitivity variables, for projects involving bald eagles, it must be determined if a permit from the USFWS, known as an incidental take permit, is required. "Take" is defined in the Bald Eagle Protection Act and means to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb.

The eagle nests are located on adjacent property next to Watkins Lake, not on the Property. The USFWS recommends a 660-foot buffer for activities like mining from active eagle nests, which will be met by this project. The proposed mining footprint is outside the recommended 660-foot buffer. Therefore, ASTI does not anticipate impact from the Project on the bald eagles.

Wood Thrush (*Hylocichla mustelina*)

This Federal migratory BCC was documented by song in the northwestern portion of the Property. It is most likely this species was utilizing the mixed deciduous forest located in this portion of the Property for seasonal breeding or nesting. The mining footprint excludes the area of potential habitat; therefore, ASTI does not anticipate impact from the Project.

Meander Surveys

During the meander surveys conducted on May 11 and 25, June 14 and 28, July 17, and August 3, 2023, ASTI directly searched for species within the suitable habitat for the listed species. Only those species where suitable habitat exists on the Property are detailed in the following sections.

Lieberg's panic grass (*Dichanthelium leibergii*)

Lieberg's panic grass is found in dry to wet-mesic prairies, savannas, and openings in oak forest. Suitable habitat exists on the Property within portions of the grasslands where other associated plants were growing, and portions of the upland and dry-mesic forests that exhibited an open canopy. Other related species such as *Dichanthelium oligosanthos subsp. Scribnerianum* and *Dichanthelium implicatum* were found in these habitats on the Property that may be suitable to Lieberg's panic grass and, thus, these areas were further assessed. A meander survey was completed, and this grass species was not found on the Property within suitable habitat during the optimal survey period.

Eastern box turtle (*Terrapene carolina carolina*)

The Eastern box turtle is a terrestrial turtle that typically occurs in forested habitats with sandy soils near a source of water such as a stream, pond, lake, marsh or swamp. They also may be found in adjacent, old fields and pastures. Access to unshaded nesting sites in sandy, open areas is critical for successful reproduction.

At the time of the Rare Species Review, this species was currently listed as a species of special concern. However, Eastern box turtles were elevated to state threatened on March 20, 2023, and the updates to the MNFI database had not taken effect at the time of the Rare Species Review, and, therefore, it is not included in MNFI's response. This species is now legally protected by Michigan's Endangered Species Act.

Although no turtles were observed, it is ASTI's opinion that suitable habitat for this species is present within two different areas on the Property (Figure 1). The areas of suitable habitat were assessed through a meander survey during optimal conditions for sighting these turtles. Surveys took place when turtles were most likely exhibiting seasonal nesting activity. In addition, one survey took place very soon after a rainstorm when turtles were most likely to emerge and be seen feeding. Even during these ideal

conditions, no Eastern box turtles were observed. However, turtles are mobile and, therefore, can come and go from the Property and may be missed during an inspection. As a result, it is ASTI's opinion that it should be assumed that this species may occur in the areas identified as potential habitat, and consideration of its protection should be incorporated into any future development.

However, as review of Figure 1 indicates, the proposed mining footprint excludes the area of higher quality, potential habitat in the northwestern and northeastern portions of the Property. Therefore, it is not anticipated that this species or its habitat will be impacted by the Project as proposed.

Blanding's turtle (*Emydoidea blandingii*)

Blanding's turtles are designated as a species of special concern. They generally inhabit shallow bodies of water with aquatic plants and muddy bottoms including marshes, ponds, swamps, lake inlets and coves, and river backwaters. These turtles also occupy terrestrial habitats in the spring and summer during the mating and nesting seasons, such as open uplands adjacent to wetlands, lawns, and gardens that have sunny areas with moist, but well-drained sandy or loamy soil.

It is ASTI's opinion that suitable habitat for this species is present within two different areas on the Property (Figure 1). Blanding's turtles occupy a broad range of habitats and are likely to be seen during the morning and day. Surveys took place in suitable habitat during the morning and early afternoon hours, and no turtles were found. However, as is the case with the box turtle, due to their mobility and the potential to miss observation on a given day, it is ASTI's opinion that it should be assumed that this species may occur in the areas identified as potential habitat, and consideration of its protection should be incorporated into any future development.

The proposed mining footprint excludes the area of higher quality potential habitat in the northwestern and northeastern portions of the Property. Therefore, it is not anticipated that this species or its habitat will be impacted by the Project as proposed.

Habitat Assessments

Habitat assessments were completed on the Property for species not directly surveyed. Findings are summarized in the following sections.

Indiana Bat (*Myotis sodalists*) and Northern long-eared Bat (*Myotis septentrionalis*)

Modeled bat habitat is mapped by USFWS within the northwestern portion of the Property (Figure 2 – *Modeled Bat Habitat Map*). ASTI did not evaluate the individual trees on the Property for suitable bat habitat. Approximately 0.56 acres of modeled bat habitat exists within the mining footprint.

The IPaC determination key for Indiana bat and Northern long-eared bat resulted in Not Likely to Adversely Affect (NLAA) for both species. This IPaC determination is based on agreeing to certain conservation measures which if not met, will nullify the IPaC determinations and will require further USFWS consultation. IPaC conservation measures for this Project include removal of trees within the USFWS modeled bat

habitat area totaling less than 10 acres, and that any removal will occur from October 1 through April 14. It should be noted that this Project will result in far less than 10 acres of modeled bat habitat removal as review of Figure 2 indicates. Please note that if the above listed BMPs are not implemented, then the NLAA determination will be nullified and additional USFWS consultation will be necessary.

Eastern Massasauga Rattlesnake (*Sistrurus catenatus*)

The Property intersects both Tier 1 and Tier 2 Eastern massasauga rattlesnake (EMR) habitat (Figure 3 – *USFWS Mapped EMR Habitat*). Tier 1 habitat means that the rattlesnake is known to occur within the Tier 1 mapped area; Tier 2 habitat means habitat that is highly suitable and EMR is likely present. However, the proposed Project does not intersect Tier 1 or Tier 2 habitat.

EMR require sites that contain a minimum of five contiguous acres of suitable habitat, including adjacent properties. Sites must contain all of the snake's microhabitat requirements, either on the subject site or on immediately adjacent properties. Table 4 – *EMR Requirements and Site Suitability* summarizes the microhabitat requirements of the EMR and documents the rationale for determining if the Property meets each requirement.

Table 4. EMR Requirements and Site Suitability

Habitat Requirement	Description of Habitat Need	On-Site?	On Immediately Adjacent Properties (not separated by barriers)	Field Notes	Is Habitat Requirement Met?
At least 5 total acres	A minimum of 5 contiguous acres of wetland and upland habitat	Yes	Yes	Area is greater than five acres in size	Yes
Basking areas	Either wetland or upland with open canopy, shorter vegetation, in close proximity to retreat cover	Yes	Unknown	Downed logs and trees throughout the fields and grasslands. Open canopy in some areas.	Yes
Retreat cover	Burrows, hummocks, rock piles, downed logs, dense vegetation	Yes	Unknown	Downed logs present in many areas, areas of dense sedges present in most wetlands	Yes
Foraging areas	Areas with dense grasses or sedges that will attract small mammals	Yes	Yes	Some areas of dense sedges present	Yes

Habitat Requirement	Description of Habitat Need	On-Site?	On Immediately Adjacent Properties (not separated by barriers)	Field Notes	Is Habitat Requirement Met?
Migratory corridors	Between 100-600 meters of migration route between hibernaculum and foraging areas, wetland and upland, with no major barriers	Yes	Yes	Adjacent to forested uplands and wetlands to the north, east and west	Yes
Hibernation structures	Crayfish burrows, mammal burrows	Yes	Unknown	Many crayfish burrows in the wetlands, mammal burrows in the forests and grasslands, snake holes identified in northwestern portion of the Property.	Yes

Based on ASTI's field observations, it is ASTI's opinion that it is possible that the EMR utilizes the Property. The site has areas that are greater than five acres of contiguous wooded habitat that include basking areas, migratory corridors, hibernation structures, and retreat cover, which together (six out of six) meet all the requirements for a site to be suitable habitat. In addition, snake holes and other snake species that utilize similar habitats, such as Northern black racer, were identified in the northwestern portion of the Property.

However, the proposed mining limits are located almost entirely in active cornfield, a type of land use that includes extensive and continued disturbance, which is not preferred habitat for the EMR. Additionally, the mining limits are outside of the USFWS Tier 2 mapped EMR habitat (Figure 3).

The IPaC determination key originally indicated that the Project May Affect this species; therefore, the USFWS was consulted to further assess potential impacts to this species. USFWS consultation noted that the Project is Not Likely to Adversely Affect this species due to the separation of the EMR habitat from the mining footprint, providing the following the conservation measures mentioned during USFWS coordination efforts are implemented:

- Wildlife friendly erosion control and site restoration materials are used;
- Those implementing the Project review the EMR factsheet (<https://www.fws.gov/media/estern-massasauga-rattlesnake-fact-sheet>) or watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake" video (https://youtu.be/~PfnXe_e02w);

- Sightings of any federally listed species including the rattlesnake are reported within 24 hours;
- Since construction activities will occur during EMR active season (from April 15 through October 15), exclusionary fencing must be installed between potential EMR habitat and the mining area, specifically along the northern boundary of the mining limits, and should follow measures outlined in Appendix D: *Exclusionary Fencing Installation Guidelines*;
- Spread of invasive species into EMR habitat is limited by cleaning vehicles and equipment between work sites;
- All imported fill material is free from contaminants and invasive species; and
- ASTI (or qualified expert) must be present during original construction activities to ensure no snakes are trapped within the mining limits.

Eastern Prairie Fringed Orchid (*Platanthera leucophaea*)

This species is found in moist soil of floodplain forests in southern Lower Michigan, as well as in moist to mesic woodlands, shaded to partially shaded riverbanks, woodland borders, wooded slopes, small openings in wooded areas, and thickets. This species was not identified in the original IPaC species list and, therefore, a survey was not done. ASTI believes suitable habitat exists in wetlands found in the northwestern portion of the Property. If impacts to those wetlands are anticipated, a species-specific survey for the Eastern prairie fringed orchid should be done. The ideal survey time is throughout July. However, based on review of the proposed mining footprint, the area of high-quality potential habitat for this species will not be impacted. Therefore, impacts to this species, if it exists on the Property, are not anticipated. It should be noted that the IPaC determination key indicated a No Effect for this species.

Mitchell's Satyr Butterfly (*Neonympha mitchelli mitchelli*)

This species is found in the following wetland types: prairie fens, tamarack swamps, wet prairies, sedge meadows, and shrub-carr wetlands. This species was not identified in the original IPaC species list and therefore, a survey was not done. ASTI believes suitable habitat exists in wetlands found in the northwestern portion of the Property. If impacts to those wetlands are anticipated, a species-specific survey for the Mitchell's satyr butterfly should be done. The ideal survey time is from mid-June through mid-July. However, based on review of the proposed mining footprint, the area of high-quality potential habitat for this species will not be impacted. Therefore, impacts to this species, if it exists on the Property, are not anticipated. Additionally, the IPaC determination key indicated that the Project would have No Effect on this species.

Summary

Table 5 - *Listed Species and Project Potential Impact*, summarizes the results of the MNFI and IPaC species determination key analysis based on ASTI's species and habitat assessment including a number of species not identified as a concern by either agency but observed by ASTI. Please note that IPaC also evaluates candidate and proposed listed species. However, these species are not yet protected, and therefore, are not addressed by ASTI.

Table 5. Listed Species and Project Potential Impact

Species	Ranking	Habitat	ASTI Assessment	IPaC Determination
Henslow's sparrow (<i>Centronyx henslowii</i>)	State Endangered and Federal BCC	Old field and pasture habitats such as weedy or grassy fields and meadows in low lying damp areas with widely scattered shrubs.	A single sparrow was sighted and heard calling in the northwestern portion of the Property. Proposed initial site clearing activity in the grassland of the northwestern portion of the Property should occur before May or after the fourth week of August to avoid potential impact. Provided the above conservation method is met, ASTI does not anticipate any impact from the Project.	State protected; not addressed by IPaC.
Bald eagle (<i>Haliaeetus leucocephalus</i>)	State Special Concern	Wide variety of habitats that provide suitable nest sites close to open water.	Eagles were seen multiple times in the vicinity of Watkins Lake. Two nests are located off-site adjacent to Watkins Lake. The mining footprint excludes the area of the existing nests and is greater than the recommended 660 feet buffer from an eagle's nest, as recommended by USFWS. Therefore, ASTI does not anticipate impact from the Project.	Potential impact not addressed by IPaC.
Wood thrush (<i>Hylocichla mustelina</i>)	Federal BCC	Mature deciduous and mixed woodlands.	Bird song noted in the northwestern portion of the Property. The mining footprint excludes the area of ideal habitat; therefore, ASTI does not anticipate impact from the Project.	Potential impact not addressed by IPaC.

Species	Ranking	Habitat	ASTI Assessment	IPaC Determination
Leiberg's panic grass (<i>Dichanthelium leibergii</i>)	State Threatened	Dry to wet-mesic prairies, savannas, and openings in oak forest.	No specimens were found during a meander survey during the ideal survey time. No impact anticipated.	State protected; not addressed by IPaC.
Eastern box turtle (<i>Terrapene carolina carolina</i>)	State Threatened	Forested habitats with sandy soils near a source of water or near wetlands. Also found in adjacent old fields and pastures.	No specimens were found under ideal conditions for the meander survey. However, their potential presence should be considered during site development. Because the mining footprint excludes the areas of ideal habitat and the turtle can move if it exists, ASTI does not anticipate impact from the Project.	State protected; not addressed by IPaC.
Blanding's turtle (<i>Emydoidea blandingii</i>)	State Special Concern; Protected under MDNR Director's Order	Shallow bodies of water with aquatic plants and muddy bottoms including marshes, ponds, swamps, lake inlets and coves, and river backwaters.	No specimens were found during a meander survey. However, their potential presence should be considered during site development. Because the mining footprint excludes the areas of ideal habitat and the turtle can move if it exists, ASTI does not anticipate impact from the Project.	State protected; not addressed by IPaC.
Indiana Bat (<i>Myotis sodalis</i>)	Federally Endangered	Winter habitat: caves and mines Summer habitat: Small to medium river and stream corridors with well-developed riparian woods; woodlots within 1 to 3 miles of small to medium rivers and streams; and upland forests.	Very few trees exist within the mining footprint and only approximately 0.56 acres of modeled bat habitat is located in the mining footprint. IPaC was utilized to determine potential impacts to this species.	NLAA – Not Likely to Adversely Affect – if potential bat roosting trees within the USFWS modeled bat habitat are left undisturbed or are removed from October 1 through April 14 and bat trees located outside of modeled bat habitat are left undisturbed from June 1 through July 31. If this BMP is not implemented, then the NLAA determination will be nullified and additional

Species	Ranking	Habitat	ASTI Assessment	IPaC Determination
				USFWS consultation will be necessary.
Northern Long-eared Bat (<i>Myotis septentrionalis</i>)	Federally Threatened	Winter habitat: caves and mines Summer habitat: Any forested areas with open understory where trees are exposed to direct sunlight and have sloughing bark or crevices. Will also roost in structures.	Very few trees exist within the mining footprint and only approximately 0.56 acres of modeled bat habitat is located in the mining footprint. IPaC was utilized to determine potential impacts to this species.	NLAA – Not Likely to Adversely Affect – if potential bat roosting trees within the USFWS modeled bat habitat are left undisturbed or are removed from October 1 through April 14 and bat trees located outside of modeled bat habitat are left undisturbed from June 1 through July 31. If this BMP is not implemented, then the NLAA determination will be nullified and additional USFWS consultation will be necessary.
Eastern Massasauga Rattlesnake (<i>Sistrurus catenatus</i>)	Federally Threatened	5 contiguous acres of suitable habitat including: basking areas, retreat cover, foraging areas, migratory corridors, and hibernation structures.	No specimens were found; however suitable habitat does exist on the Property. Project mining limits are well outside of mapped Tier 2 EMR habitat and almost exclusively consist of consistently disturbed farmland.	NLAA – Not Likely to Adversely Affect after further consultation with USFWS. However, conservation measures mentioned during USFWS coordination efforts must be implemented. If these BMPs are not implemented, then the NLAA determination will be nullified and additional USFWS consultation will be necessary.
Eastern prairie fringed orchid (<i>Platanthera leucophaea</i>)	Federally Threatened and State Endangered	Mesic prairie remnants, sedge meadows, and marsh edges.	No specimens were found; however, suitable habitat exists in wetlands found in the northwestern portion of the Property. The mining footprint excludes the area of ideal habitat; therefore, ASTI does not believe there will be impacts from the Project. IPaC was utilized to confirm no impacts to this species.	No Effect
Mitchell's Satyr Butterfly (<i>Neonympha mitchelli mitchelli</i>)	Federally Endangered and State Endangered	Prairie fens, tamarack swamps, wet prairie, sedge meadow, and shrub-carr wetlands.	No specimens were found; however, suitable habitat exists in wetlands found in the northwestern	No Effect

Species	Ranking	Habitat	ASTI Assessment	IPaC Determination
			portion of the Property. The mining footprint excludes the area of ideal habitat; therefore, ASTI does not anticipate impact from the Project. IPaC was utilized to confirm no impacts to this species.	

Conclusions

Regarding listed bird species, Henslow's sparrows and bald eagles were sighted on the Property. Since the Henslow's sparrow is a migratory bird, provided that as long as initial disturbance within the grassland in the northwestern portion of the Property occurs before May or after the fourth week of August, ASTI does not anticipate impacts to this species.

USFWS guidelines recommend a 660-foot vegetative buffer from active bald eagle nests. Since the proposed mining footprint exceeds this buffer, no further action is required. ASTI does not anticipate impacts from the Project on bald eagles.

Wood thrush is not afforded protection by Part 365. However, IPaC states that it is important to avoid and minimize impacts to migratory birds listed as BCC, especially species of range-wide concern, which the wood thrush is designated. The proposed mining footprint is located outside of the ideal habitat and the areas in which this species was observed by ASTI. Therefore, ASTI does not anticipate impacts from the Project to wood thrush.

Leiberg's panic grass was not found during a meander survey conducted within the ideal survey time. No further coordination with regulatory agencies is anticipated, and ASTI does not anticipate impacts from the Project to Leiberg's panic grass.

Eastern box turtle and Blanding's turtle were not found during meander surveys completed within the ideal survey times; however, because turtles are mobile, they can be missed during a meander survey. ASTI recommends that their presence be considered within identified suitable habitat during site development. However, all suitable habitat is located outside the limits of proposed mining, and these animals can move away from disturbance. Therefore, ASTI does not anticipate impacts from the Project to these turtle species.

USFWS modeled bat habitat for Indiana and Northern long-eared bats exists on the Property. However, only approximately 0.56 acres of modeled bat habitat exists within the mining footprint. However, if tree cutting/removal is proposed outside the prescribed timeframe (from October 1 through April 14), ASTI can perform a formal bat tree survey

in this area in order to confirm USFWS clearance. ASTI does not anticipate impacts to the Indiana bat and/or Northern long-eared bat species provided tree removal is conducted within the prescribed timeframe (from October 1 through April 14).

The IPaC determination key originally indicated that the Project May Affect the EMR, therefore, the USFWS was consulted to further assess potential impacts to this species. USFWS consultation concluded that the Project is Not Likely to Adversely Affect this species if the conservation measures mentioned during USFWS coordination efforts are implemented. Please note these measures have been listed in the EMR section above, and include that ASTI (or qualified expert) must be present during original construction activities to ensure appropriate fencing has been installed and that no snakes are trapped within the mining limits.

Suitable habitat exists on the Property in limited areas for the Eastern prairie fringed orchid and the Mitchell's satyr butterfly. The high-quality habitat areas ASTI has identified for these species are well outside of the mining footprint in the northwestern portion of the Property. In addition, the IPaC determination key indicated No Effect for both species. Therefore, ASTI does not anticipate impacts to these species.

Please let us know if we can be of further assistance.

Sincerely,

ASTI ENVIRONMENTAL

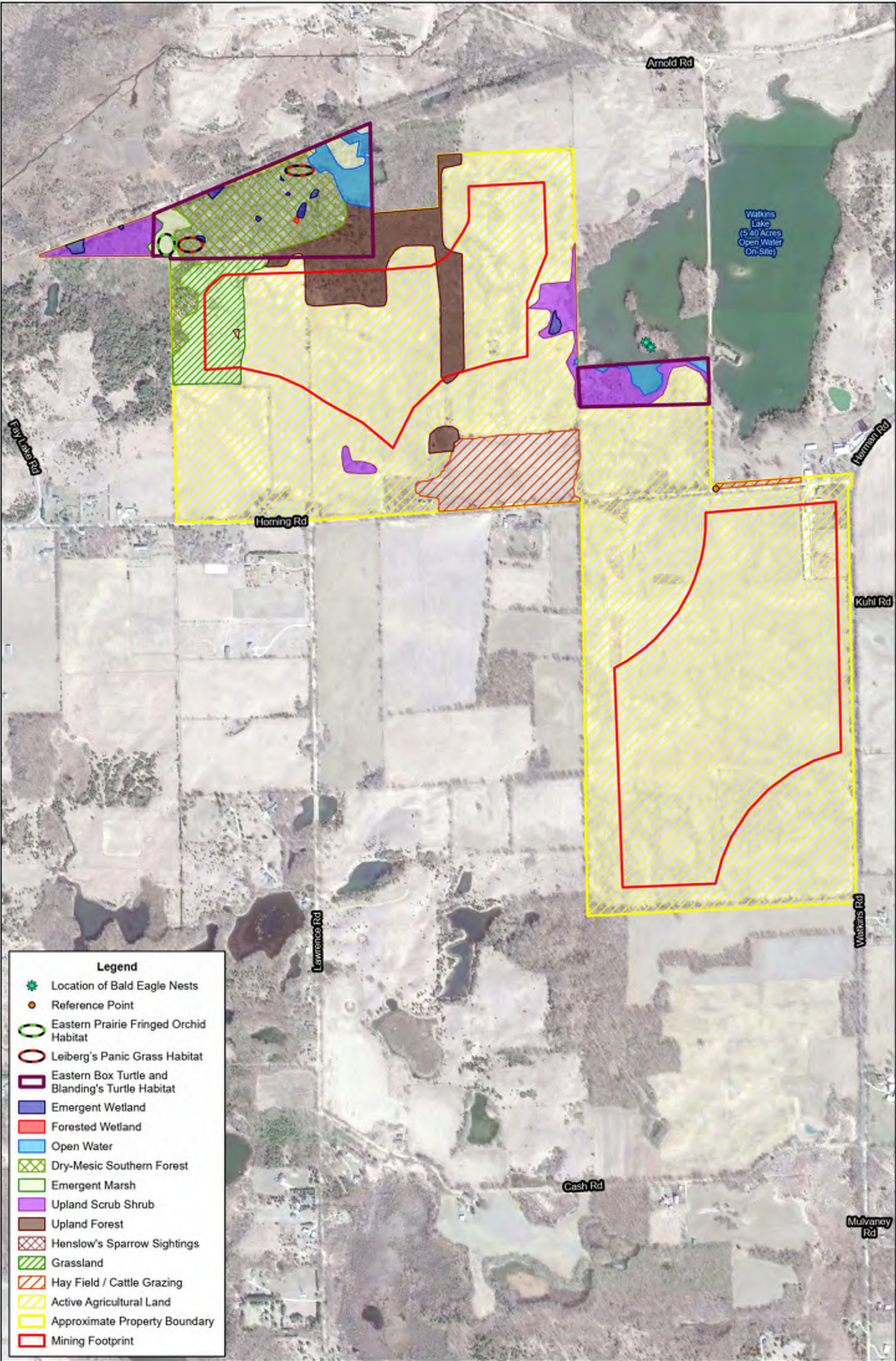
A handwritten signature in blue ink, appearing to read 'Brad Kassuba'.

Brad Kassuba
Professional Wetland Scientist #1330
Certified Wildlife Biologist
MDNR T&E Permit TE105

A handwritten signature in blue ink, appearing to read 'Dianne C. Marin'.

Dianne C Marin
Director of Ecological Services
Professional Wetland Scientist #1313
MDNR T&E Permit TE060

Attachments: Figure 1 – *Habitat Types*
 Figure 2 – *Modeled Bat Habitat Map*
 Figure 3 – *USFWS Mapped EMR Habitat*
 Appendix A: MNFI Rare Species Review Letter
 Appendix B: IPaC Species List, Consistency Letter, and USFWS Coordination

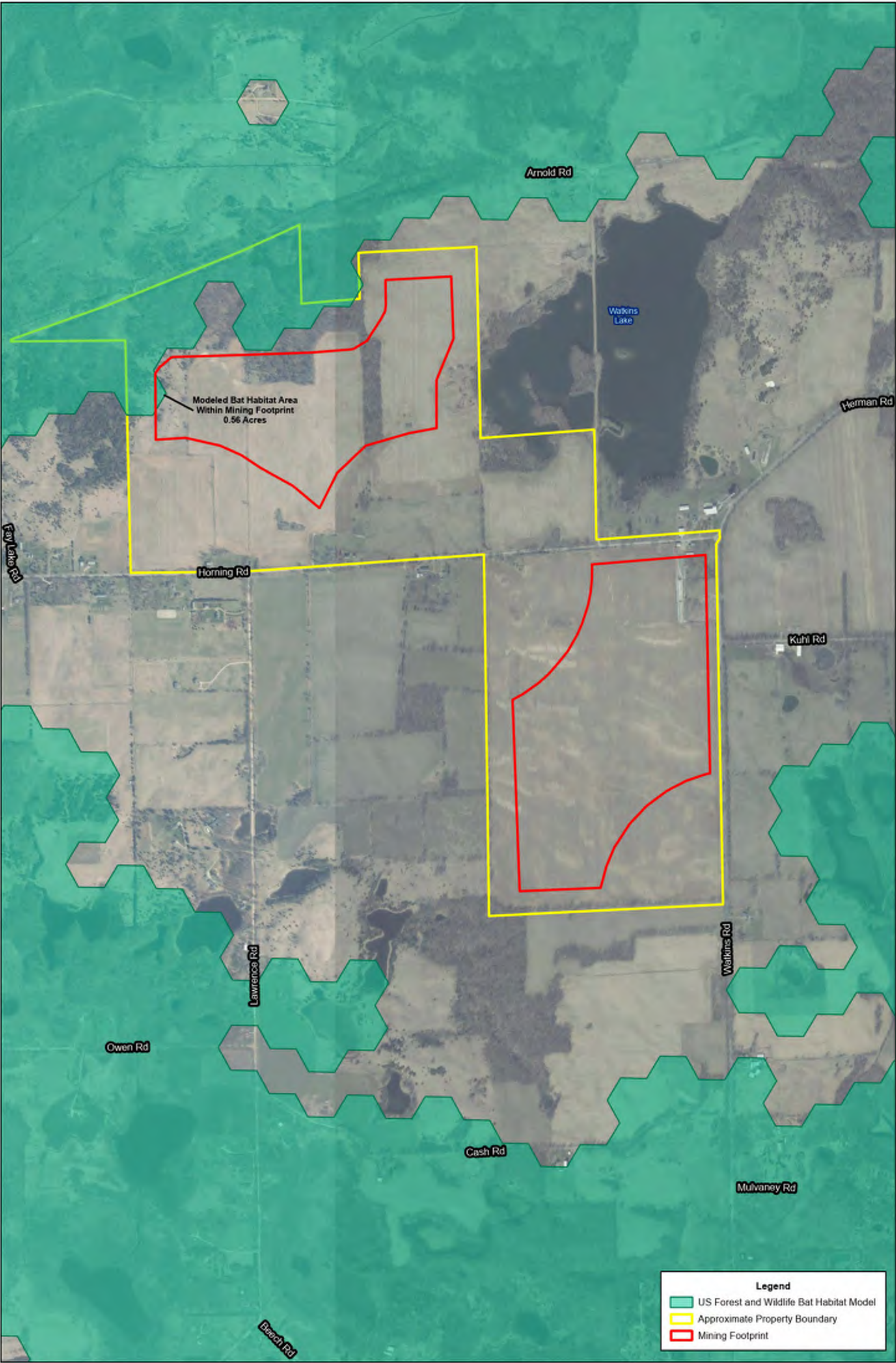


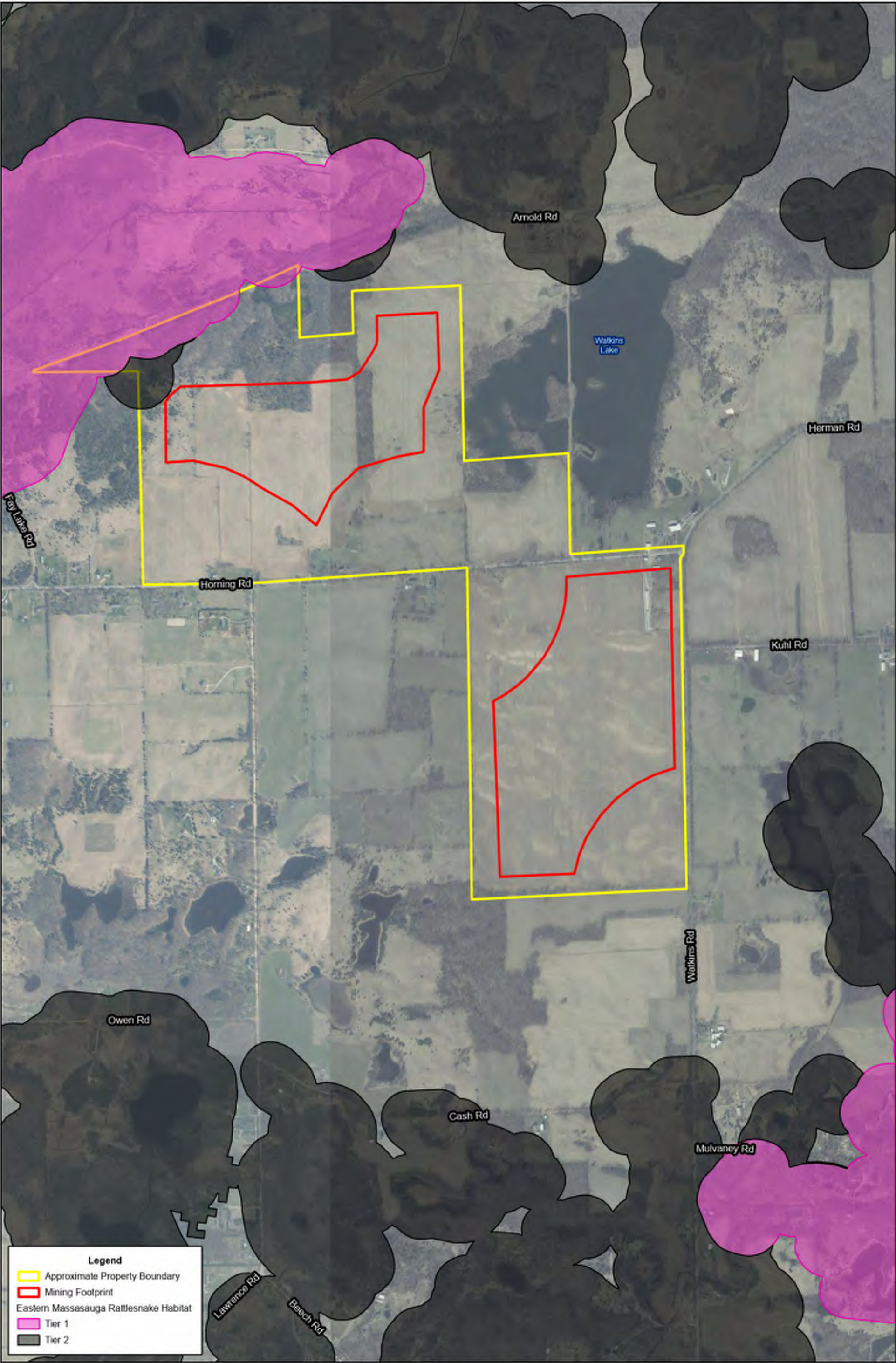
Norvell Township Property

Norvell Township,
Jackson County, MI

Client: Edw. C. Levy Co.
Created by: RMH, October 28, 2025, ASTI Project A23-2691.02
Imagery: Google Earth May 2022

Figure 1 - Habitat Types
(Overall Map)





Dana R. Knox
ASTI Environmental
734.474.0190

March 28, 2023

Re: Rare Species Review #3431 – Site Assessment, Jackson and Washtenaw counties, MI.

Hello Dana:

The location for the proposed project was checked against known localities for rare species and unique natural features, which are recorded in the Michigan Natural Features Inventory (MNFI) natural heritage database. This continuously updated database is a comprehensive source of existing data on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. Records in the database indicate that a qualified observer has documented the presence of special natural features. The absence of records in the database for a site may mean that the site has not been surveyed. The only way to obtain a definitive statement on the status of natural features is to have a competent biologist perform a complete field survey.

Under Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection, "a person shall not take, possess, transport, ...fish, plants, and wildlife indigenous to the state and determined to be endangered or threatened," unless first receiving an Endangered Species Permit from the Michigan Department of Natural Resources (MDNR), Wildlife Division. Responsibility to protect endangered and threatened species is not limited to the lists below. Other species may be present that have not been recorded in the database.



MSU EXTENSION

Michigan Natural
Features Inventory

PO Box 13036
Lansing MI 48901

(517) 284-6200
Fax (517) 373-9566

mnfi.anr.msu.edu

MSU is an affirmative-
action, equal-opportunity
employer.

Several at-risk species have been documented within 1.5 miles of the proposed activity and it is possible that adverse impacts will occur. This response reflects a desktop review of the database and MNFI cannot fully evaluate this project without visiting the area. MNFI offers several levels of [Rare Species Reviews](#), including field surveys which I would be happy to discuss with you.

Sincerely,

Michael A. Sanders

Michael A. Sanders
Environmental Review Specialist/Zoologist
Michigan Natural Features Inventory

Comments for Rare Species Review #3431:

It is important to note that it is the applicant's responsibility to comply with both state and federal threatened and endangered species legislation. Therefore, if a state listed species occurs at a project site, and you think you need an endangered species permit please contact: Casey Reitz, DNR-Wildlife Division, 517-284-6210, or ReitzC@michigan.gov. If a federally listed species is involved and, you think a permit is needed, please contact Jessica Pruden, U.S. Fish and Wildlife Service, East Lansing office, 517-351-8316, or Jessica.Pruden@fws.gov.

NOTE 1: special concern species and natural communities are not protected under endangered species legislation, but efforts should be taken to minimize any or all impacts. Please consult MNFI's [Rare Species Explorer](#) for additional information on Michigan's rare plants and animals.

Table 1: Occurrences of threatened and endangered species within 1.5 miles of project site

ELCAT	SNAME	SCOMNAME	USESA	SPROT	G_RANK	S_RANK	FIRSTOBS	LASTOBS	EORANK
Animal	<i>Papaipema silphii</i>	Silphium borer moth		T	G3G4	S1	1996-10-06	1996-10-06	BC
Animal	<i>Cyclonaias tuberculata</i>	Purple wartyback		T	G5	S2	1975	2019-06-14	E
Animal	<i>Myotis sodalis</i>	Indiana bat	LE	E	G2	S1	1995-Summer	2005-08-09	A?
Animal	<i>Lampsilis fasciola</i>	Wavyrayed lampmussel		T	G5	S2	1929	2010-09-18	C
Animal	<i>Acris blanchardi</i>	Blanchard's cricket frog		T	G5	S2S3	1927	1927-04-12	H
Animal	<i>Speyeria idalia</i>	Regal fritillary		E	G3?	SH	1890	1931	H
Animal	<i>Myotis sodalis</i>	Indiana bat	LE	E	G2	S1	2004	2004	E
Animal	<i>Centronyx henslowii</i>	Henslow's sparrow		E	G4	S3	2016-06-11	2016-06-11	BC
Animal	<i>Neonympha mitchellii mitchellii</i>	Mitchell's satyr	LE	E	G2T2	S1	2017-07-02	2022-07-07	D
Animal	<i>Alasmodonta viridis</i>	Slippershell		T	G4G5	S2S3	2017-06-09	2017-06-09	AB
Animal	<i>Alasmodonta viridis</i>	Slippershell		T	G4G5	S2S3	2017-06-20	2017-06-20	E
Animal	<i>Alasmodonta viridis</i>	Slippershell		T	G4G5	S2S3	2017-06-09	2017-06-09	E
Animal	<i>Alasmodonta viridis</i>	Slippershell		T	G4G5	S2S3	2017-08-07	2017-08-07	E
Plant	<i>Cypripedium candidum</i>	White lady slipper		T	G4	S2	1990	1990-05	BC
Plant	<i>Asclepias hirtella</i>	Tall green milkweed		T	G5	S2	1981	1981-09-01	D
Plant	<i>Dichanthelium leibergii</i>	Leiberg's panic grass		T	G4	S2	1981-09-01	2017-06-21	C
Plant	<i>Cypripedium candidum</i>	White lady slipper		T	G4	S2	1980	2005-06-01	B
Plant	<i>Valeriana edulis var. ciliata</i>	Edible valerian		T	G5T3	S2	2006-06-01	2006-06-01	A
Plant	<i>Dichanthelium leibergii</i>	Leiberg's panic grass		T	G4	S2	2008-06-25	2008-06-25	CD
Plant	<i>Bouteloua curtipendula</i>	Side-oats grama grass		E	G5	S1	2008-10-13	2008-10-13	C
Plant	<i>Myrica pensylvanica</i>	Northern bayberry		T	G5	S2	2008-06-25	2008-06-25	B
Plant	<i>Gentianella quinquefolia</i>	Stiff gentian		T	G5	S2	2009-09-10	2009-09-10	BC
Plant	<i>Cypripedium candidum</i>	White lady slipper		T	G4	S2			

Comments for Table 1:

Indiana bat – the federally endangered and state endangered Indiana bat (*Myotis sodalis*) has been known to occur in the area. Indiana bats are found only in the eastern United States and are typically confined to the southern three tiers of counties in Michigan. Indiana bats that summer in Michigan winter in caves in Indiana and Kentucky. This species forms colonies and forages in riparian and mature floodplain habitats. Nursery roost sites are usually located under loose bark or in hollows of trees near riparian habitat. Indiana bats typically avoid houses or other artificial structures and typically roost underneath loose bark of dead elm, maple and ash trees. Other dead trees used include oak, hickory and cottonwood.

Foraging typically occurs over slow-moving, wooded streams and rivers as well as in the canopy of mature trees. Movements may also extend into the outer edge of the floodplain and to nearby solitary trees. A summer colony's foraging area usually encompasses a stretch of stream over a half-mile in length. Upland areas isolated from floodplains and non-wooded streams are generally avoided.

Management and Conservation: the suggested seasonal tree cutting range for Indiana bat is between October 1 and March 31 (i.e., no cutting April 1-September 30). This applies throughout the Indiana bat range in Michigan.

Eastern box turtle – the state threatened eastern box turtle (*Terrapene carolina carolina*) has been known to occur throughout the area. The eastern box turtle is Michigan's only truly terrestrial turtle. This species typically prefers deciduous or mixed woodlands, especially those with sandy soils. They also utilize adjacent thickets, old fields, pastures, vegetated dunes, marshes, and bog edges. Access to water (e.g. small ponds, seepages, springs, bogs, or slow streams) is important, as is the availability of unshaded nesting sites.

Eastern box turtles are active from late April to late October and breeding typically occurs from late May to mid-October. Home ranges can be as large as 40 acres. Many box turtles are killed on roads and collected as pets each year. These turtles are diurnal and most active in spring and fall. During the summer they may have brief activity in the morning or falling rain, but otherwise spend much time buried in leaf litter, shallow burrows, under brush piles or rotting logs. Hibernation occurs most frequently in burrows or under leaf litter, less often submerged in a pond or stream.

Box turtles consume a wide variety of plant and animal foods with a taste for raspberries or blackberries. Most box turtles remain in a rather small home range (often less than 5 acres) for most of their lives. Nesting takes place in June and early July, with eggs being buried in an open, often elevated location. Hatchlings emerge in September and October.

Management and Conservation: loss of wooded habitat to various human uses is the most serious threat to the species. Conservation efforts should concentrate on protecting large tracts of habitat especially on public land to provide the box turtle additional protection from the effects of development. Wetland hydrology and quality should be maintained by preventing improper off-road vehicle use, implementing minimum development setback distances, leaving buffer zones during timber harvest, grazing and agricultural operations, minimizing use of herbicides and pesticides in or near wetlands, and/or controlling invasive plants. Upland nesting areas should be identified, protected and in some cases created. Construction of new roads should be minimized or routed to avoid separating foraging and/or overwintering habitat from nesting areas. Finally, the public should be educated about the laws protecting reptiles and amphibians and encouraged to leave wild turtles in their natural habitats rather than collecting them for pets.

Eastern massasauga rattlesnake – there are known occurrences in the area (see spatial data). Also, the project intersects both Tier 1 and Tier 2 eastern massasauga habitat as designated by the U.S. Fish & Wildlife Service (USFWS). Tier 1 is habitat where the species is known to occur; Tier 2 is habitat where the species may occur. The federally threatened and state threatened eastern massasauga rattlesnake (*Sistrurus catenatus*) is Michigan's only venomous snake and is found in a variety of wetland habitats. Eastern massasaugas occur throughout the Lower Peninsula but are not found in the Upper Peninsula. Populations in southern Michigan are typically associated with open wetlands, particularly prairie fens, while those in northern Michigan are known from open wetlands and lowland coniferous forests, such as cedar swamps. Some populations of Eastern massasaugas also utilize open uplands and/or forest openings for foraging, basking, gestation, and parturition (i.e., giving birth to young). Massasaugas usually hibernate below the frost line in crayfish or small mammal burrows, tree root networks or rock crevices in or along the edge of wetlands or in upland areas with presumably high-water tables. Massasauga habitats generally appear to be characterized by the following: (1) open, sunny areas intermixed with shaded areas, presumably for thermoregulation; (2) presence of the water

table near the surface for hibernation; and (3) variable elevations between adjoining lowland and upland habitats. During late spring, these snakes move into adjacent uplands they spend the warmer months foraging in shrubby fields and grasslands in search of mice and voles, their favorite food.

Often described as “shy and sluggish”, these snakes avoid human confrontation and are not prone to strike, preferring to leave the area when they are threatened. However, like any wild animal, they will protect themselves from anything they see as a potential predator. Their short fangs can easily puncture skin and they do possess potent venom. Like many snakes, the first human reaction may be to kill the snake, but it is important to remember that all snakes play vital roles in the ecosystem. Some may eat harmful insects. Others like the massasauga consider rodents a delicacy and help control their population. Snakes are also a part of a larger food web and can provide food to eagles, herons, and several mammals.

Management and Conservation: protection of extant populations and suitable wetland and adjacent upland habitats is crucial for successful conservation of the Eastern Massasauga. Maintaining or restoring open habitat conditions is critical for this species. Fragmentation of suitable wetland-upland habitat complexes by roads or other barriers should be avoided or minimized. Land management practices such as timber harvesting, mowing, disking or prescribed burning should be conducted in such a manner so as to minimize the potential for adverse impacts to massasaugas (e.g., conducting management activities during the snakes’ inactive season (November through early March) or on days when snakes are less likely to be active on the surface during the active season). Protecting suitable hibernation sites also is critical. Hydrological alterations such as drawdowns should be conducted prior to or after hibernation to reduce the potential for causing winter mortality due to desiccation or freezing. Sudden and/or permanent increases or decreases in water levels during the active season also can cause adverse impacts.

Leiberg's panic grass – the state threatened (ST) Leiberg's panic grass (*Dichanthelium leibergii*) has been known to occur in the area (T04S R02E Section 14 (NW portion of the project footprint). This species inhabits dry to wet-mesic prairies, savannas, and openings in oak forest. Survey Period: From first week of June to fourth week of August.

Management and Conservation: the habitat of this species has been severely degraded and diminished. Conservation and restoration of native prairie remnants is necessary. This species likely requires natural disturbances associated with prairie habitat such as prescribed fire and brush removal.

Table 2: Occurrences of special concern species/natural features within 1.5 miles of project site

ELCAT	SNAME	SCOMNAME	USESA	SPROT	G_RANK	S_RANK	FIRSTOBS	LASTOBS	EORANK
Animal	<i>Terrapene carolina carolina</i>	Eastern box turtle		SC	G5T5	S2S3	1905	1905	H
Animal	<i>Pantherophis spiloides</i>	Gray ratsnake		SC	G4G5	S2S3	1985	1985-SU	E
Animal	<i>Sistrurus catenatus</i>	Eastern massasauga	LT	SC	G3	S3	1982-07-20	2007-06-12	BC
Animal	<i>Emydoidea blandingii</i>	Blanding's turtle		SC	G4	S2S3	2006-03-30	2021-04-28	E
Animal	<i>Villosa iris</i>	Rainbow		SC	G5	S3	1975-07-13	1975-07-13	H
Animal	<i>Papaipema beeriana</i>	Blazing star borer		SC	G2G3	S2	2005-09-26	2005-09-26	BC
Animal	<i>Sistrurus catenatus</i>	Eastern massasauga	LT	SC	G3	S3	2003	2017-08-08	B
Animal	<i>Haliaeetus leucocephalus</i>	Bald eagle		SC	G5	S4	2012	2016	E
Animal	<i>Myotis septentrionalis</i>	Northern long-eared bat	LT	SC	G2G3	S1	1998	1998	E
Animal	<i>Spiza americana</i>	Dickcissel		SC	G5	S3	2016-06-11	2016-06-11	E

Animal	<i>Ammodramus savannarum</i>	Grasshopper sparrow		SC	G5	S4	2016-06-11	2016-06-11	C
Animal	<i>Lasmigona compressa</i>	Creek heelsplitter		SC	G5	S3	1925-07-19	1978-07-13	H
Animal	<i>Papaipema beeriana</i>	Blazing star borer		SC	G2G3	S2	2017-09-20	2017-09-20	BC
Animal	<i>Oecanthus laricis</i>	Tamarack tree cricket		SC	G3?	S3	2017-08-23	2017-09-04	BC
Animal	<i>Oecanthus laricis</i>	Tamarack tree cricket		SC	G3?	S3	2017-09-04	2017-09-04	BC
Animal	<i>Villosa iris</i>	Rainbow		SC	G5	S3	2017-06-09	2017-06-09	E
Animal	<i>Venustaconcha ellipsiformis</i>	Ellipse		SC	G4	S3	2017-06-09	2017-06-09	E
Animal	<i>Lasmigona compressa</i>	Creek heelsplitter		SC	G5	S3	2017-06-09	2017-06-09	E
Animal	<i>Venustaconcha ellipsiformis</i>	Ellipse		SC	G4	S3	2017-06-20	2017-06-20	E
Animal	<i>Venustaconcha ellipsiformis</i>	Ellipse		SC	G4	S3	2017-06-26	2017-06-26	E
Animal	<i>Venustaconcha ellipsiformis</i>	Ellipse		SC	G4	S3	2017-06-09	2017-06-09	E
Animal	<i>Villosa iris</i>	Rainbow		SC	G5	S3	2017-06-09	2017-06-09	E
Animal	<i>Villosa iris</i>	Rainbow		SC	G5	S3	2017-06-09	2017-06-09	E
Animal	<i>Venustaconcha ellipsiformis</i>	Ellipse		SC	G4	S3	2017-06-09	2017-06-09	E
Animal	<i>Villosa iris</i>	Rainbow		SC	G5	S3	2017-08-07	2017-08-07	E
Animal	<i>Emydoidea blandingii</i>	Blanding's turtle		SC	G4	S2S3	2017-07-29	2017-10-22	BC
Community	Prairie Fen				G3	S3	1996	2006-05-23	B
Community	Prairie Fen				G3	S3	1997	1997-07-11	C
Community	Prairie Fen				G3	S3	2008-06-25	2008-09-09	B
Community	Prairie Fen				G3	S3	2016-06-29	2016-07-25	BC
Community	Prairie Fen				G3	S3	2016-09-27	2016-09-27	BC
Community	Prairie Fen				G3	S3	2016-06-28	2016-07-15	BC
Plant	<i>Geum virginianum</i>	Pale avens		SC	G5	S1S2	2016-08-11	2016-08-23	D

Comments for Table 2:

Tamarack tree cricket - the state special concern tamarack tree cricket (*Oecanthus laricis*) has been known to occur in the area (T04S R02E Section 14 (NW portion of the project footprint). The tamarack tree cricket inhabits dense to open tamarack swamps and fens with trees of medium height (6 to 13 meters) in Michigan and Ohio. Occurs in both large intact wetland complexes as well as smaller, disturbed sites. It is believed that *O. laricis* lays its eggs in the bark of tamarack trees and is wholly dependent on the tree for this part of its life cycle. This species has a distinct song described as a fast trill. Adults have been found only during the period from late July to early September.

Management and Conservation: maintain and restore sensitive prairie fen and tamarack swamp habitat. Avoid draining, filling, and other hydrologic alteration. Avoid cutting tamarack but cutting/girdling associated shade-tolerant species such as red maple may be appropriate if tamaracks are being shaded out. Apply prescribed fire conservatively.

Blazing star borer moth – the state special concern blazing star borer moth (*Papaipema beeriana*) has been known to occur in the area (T04S R02E Section 14 (NW portion of the project footprint). This species inhabits lakeplain prairies, prairie fens, sand prairies, and barrens. Its larval host plant is blazing star or snake root (*Liatis* sp.). Eggs are laid on or near the food plant in the fall and hatch in the spring around mid-May. The final instar leaves the root and pupates in the soil near the plant. The pupae can be found from mid-August until mid-September. Adult flight occurs from mid-September through early October.

Management and Conservation: most major works on the genus have commented on the fire sensitivity of Papaipema eggs. Use of fire to control the pest species *P. nebris*. Land managers should always assume high mortality of Papaipema eggs in fall, winter, or spring burn units. To protect Papaipema populations retaining an adequate amount of the foodplant and to divide habitat into smaller burn units is recommended. No Papaipema site should ever be entirely burned in a single year. Foodplants spread over a large area or in several discrete patches reduce the risk from predators and parasitoids as compared to a comparable number of plants in a single dense patch. Most, if not all, of these parasitoids are native species and in most cases they do not need to be controlled. All known sites of beeriana on managed lands should be monitored periodically.

Blanding's turtle - the state special concern Blanding's turtle (*Emydoidea blandingii*) has been known to occur throughout the area. Blanding's turtles inhabit shallow bodies of water with some aquatic plant growth and a muddy bottom, such as marshes, ponds, swamps, lake inlets and coves, and river backwaters. Blanding's turtles are active from early April to late October. They are most often seen wandering overland in spring and fall. Females seeking nest sites may travel considerable distances and are commonly seen on or near roads. Most feeding occurs underwater and includes crayfish, insects, worms, leeches, snails, small fish, tadpoles, frogs, and some plants. Nesting occurs in June where eggs are buried in a sandy, sunny location. Hatchlings emerge in August or September. Blanding's turtles hibernate underwater (more rarely under debris close to water) from late October or early November until early April.

Management and Conservation: primary threats to the Blanding's turtles include loss or altering of wetland habitats and destruction on roads. The most critical conservation need for this species is protection and management of suitable wetland and adjacent upland habitats. Maintaining good water quality, restricting herbicide and pesticide use in or near wetlands, implementing minimum development set-back distances, leaving buffer zones during timber harvest, grazing and agricultural operations, and minimizing the construction of roads in or near suitable wetlands would be beneficial to this species. Timber harvesting can benefit this species by creating or maintaining open habitat conditions for thermoregulation and nesting. Minimizing adult mortality or removal is crucial for population viability given this species' life history. Thus, habitat management activities should be conducted in such a manner so as to minimize the potential for causing take of adults (e.g., timber harvesting during the inactive season). Minimizing road mortality and illegal collection also would be beneficial to this species. In some cases, on-site protection of nest sites and predator control may be necessary to facilitate or increase successful reproduction or population recruitment.

As a species of special concern, the Blanding's turtle is not protected under state or federal endangered species legislation, but it is becoming rare throughout its range and it is protected under the authority of the Department of Natural Resources Director's Order, Regulations on the Take of Reptiles and Amphibians, dated October 12, 2001 (section 324 of PA 451).

Bald eagle - the state special concern (SC) bald eagle (*Haliaeetus leucocephalus*) has been known to nest at several locations in the NE portion of the project area. Bald eagle nests are usually located within ½ - mile of water and at the top of tall, established trees. These birds prefer forested habitats adjacent to the shorelines of lakes, large rivers, floodings, and other bodies of water where prey is available throughout the breeding season which runs from mid-March through the end of June. Live trees are generally preferred over dead ones. In Michigan, eagles arrive on nesting territories between mid-February and mid-March. Nesting pairs are usually faithful to previous nesting sites. By October and November, immature bald eagles and most adults move southward, with many remaining in Michigan throughout the winter. Bald eagles are extremely sensitive to human activity during the first 12 weeks of the breeding season. Maintain a ¼ - mile buffer zone around the nest from mid-March through the end of June. Any maintenance and construction activities within the buffer zone should take place between August and February.

Management and Conservation: effective August 8, 2007, the bald eagle in the lower 48 States was removed from the Federal List of Endangered and Threatened Wildlife (Federal Register Vol. 72, No. 130; July 9, 2007) but are still protected under the Migratory Bird Treaty Act, the Lacey Act and the [Bald and Golden Eagle Protection Act](#): which prohibits anyone from “taking” bald eagles, including their parts, eggs or nests.

To help provide clarity on the management of bald eagles after delisting, the U.S. Fish and Wildlife Service (USFWS) published National Bald Eagle Management Guidelines in May 2007. These guidelines as well as other information regarding bald eagles can be viewed at the USFWS [Midwest Bald Eagle page](#). The management guidelines were established to help people minimize harmful impacts, especially where they may constitute a “disturbance.” A variety of human activities can potentially interfere with bald eagles, affecting their ability to forage, nest, roost, breed or raise young. A [permit](#) from USFWS is recommended if you are unable to minimize or prevent disturbance, injury of potential mortality of bald or golden eagles as a result of an otherwise lawful activity. For permit information in Michigan, please contact Chris Mensing, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, East Lansing office, 517-351-8316, or Chris_Mensing@fws.gov.

Grasshopper sparrow - the state special concern grasshopper sparrow (*Ammodramus savannarum*) has been known to occur in the NE part of project area. This small sparrow is readily identified by its’ high pitch insect-like buzzy song "tik-tuk tikeeeeeeeeeeez". Grasshopper sparrows can be found in native prairies, cultivated fields, old fields, hayfields, pastures and open savanna; they seem to prefer drier sites with tall dense vegetation. The nest is generally well concealed on the ground by overhanging vegetation. Spring arrival occurs in April and May and by mid-May grasshopper sparrows are on their breeding ground. Two broods are possible during the breeding season, which means nesting can last into August. Fall migration is complete by late October.

Management and Conservation - all vegetation management activities (mowing, controlled burns and brush clearing) should be conducted in the fall (October and November) after the fall migration. A rotational burn disturbance regime should be implemented when possible to promote a diversity of grassland habitat. Herbicide or insecticide applications should also be avoided during the nesting season.

Codes to Accompany Occurrence Tables:

State Protection Status Code Definitions (SPROT)

E: Endangered
T: Threatened
SC: Special concern

Federal Protection Status Code Definitions (USES)

LE = listed endangered
LT = listed threatened
LELT = partly listed endangered and partly listed threatened
PDL = proposed delist
E(S/A) = endangered based on similarities/appearance
PS = partial status (federally listed in only part of its range)
C = species being considered for federal status

Global Heritage Status Rank Definitions (GRANK)

The priority assigned by [NatureServe](#)'s national office for data collection and protection based upon the element's status throughout its entire world-wide range. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

G1 = critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3: Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4: Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.

G5: Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

Q: Taxonomy uncertain

State Heritage Status Rank Definitions (SRANK)

The priority assigned by the Michigan Natural Features Inventory for data collection and protection based upon the element's status within the state. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

S1: Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.

S2: Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3: Rare or uncommon in state (on the order of 21 to 100 occurrences).

S4 = apparently secure in state, with many occurrences.

S5 = demonstrably secure in state and essentially ineradicable under present conditions.

SX = apparently extirpated from state.

Element Occurrence (EO) ranks refer to the viability or ecological integrity of the occurrence; they provide an assessment of the likelihood that if current conditions prevail the EO will persist for a defined period of time, typically 20-100 years

Here are the EO Codes:

- A - Excellent estimated viability/ecological integrity
- A? - Possibly excellent estimated viability/ecological integrity
- AB - Excellent or good estimated viability/ecological integrity
- AC - Excellent, good, or fair estimated viability/ecological integrity
- B - Good estimated viability/ecological integrity
- B? - Possibly good estimated viability/ecological integrity
- BC - Good or fair estimated viability/ecological integrity
- BD - Good, fair, or poor estimated viability/ecological integrity
- C - Fair estimated viability/ecological integrity
- C? - Possibly fair estimated viability/ecological integrity
- CD - Fair or poor estimated viability/ecological integrity
- D - Poor estimated viability/ecological integrity
- D? - Possibly poor estimated viability/ecological integrity
- E - Verified extant (viability/ecological integrity not assessed)
- F - Failed to find
- F? - Possibly failed to find
- H - Historical
- H? - Possibly historical
- X - Extirpated
- X? - Possibly extirpated
- U - Unrankable
- NR - Not ranked

Section 7 Comments for Rare Species Review #3431

ASTI Environmental

Jackson County Section

March 28, 2023

For projects involving Federal funding or a federal agency authorization

The following information is provided to assist you with Section 7 compliance of the Federal Endangered Species Act (ESA). The ESA directs all Federal agencies "to work to conserve endangered and threatened species. Section 7 of the ESA, called "Interagency Cooperation, is the means by which Federal agencies ensure their actions, including those they authorize or fund, do not jeopardize the existence of any listed species." Listed species and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS).

The project falls within the range of following federally listed, proposed and candidate species which have been identified by USFWS to potentially occur in Jackson County, Michigan:

Indiana bat - there appears to be suitable habitat (and known occurrences) in the area. Indiana bats (*Myotis sodalis*) (federally and state endangered) are found only in the eastern United States and are typically confined to the southern three tiers of counties in Michigan. Indiana bats that summer in Michigan winter in caves in Indiana and Kentucky. This species forms colonies and forages in riparian and mature floodplain habitats. Nursery roost sites are usually located under loose bark or in hollows of trees near riparian habitat. Indiana bats typically avoid houses or other artificial structures and typically roost underneath loose bark of dead elm, maple and ash trees. Other dead trees used include oak, hickory and cottonwood. Foraging typically occurs over slow-moving, wooded streams and rivers as well as in the canopy of mature trees. Movements may also extend into the outer edge of the floodplain and to nearby solitary trees. A summer colony's foraging area usually encompasses a stretch of stream over a half-mile in length. Upland areas isolated from floodplains and non-wooded streams are generally avoided.

Management and Conservation: the suggested seasonal tree cutting range for Indiana bat is between October 1 and March 31 (i.e., no cutting April 1-September 30). This applies throughout the Indiana bat range in Michigan.

Northern long-eared bat - There appears to be suitable habitat and there is a known occurrence within 1.5 miles of the project sites and this activity occurs within the designated WNS zone (i.e., within 150 miles of positive counties/districts impacted by WNS).

Northern long-eared bat (*M. septentrionalis*) (federally threatened and state special concern) numbers in the northeast US have declined up to 99 percent. Loss or degradation of summer habitat, wind turbines, disturbance to hibernacula, predation, and pesticides have contributed to declines in Northern long-eared bat populations. However, no other threat has been as severe to the decline as White-nose Syndrome (WNS). WNS is a fungus that thrives in the cold, damp conditions in caves and mines where bats hibernate. The disease is believed to disrupt the hibernation cycle by causing bats to repeatedly awake thereby depleting vital energy reserves. This species was federally listed in May 2015 primarily due to the threat from WNS.

Also called northern bat or northern myotis, this bat is distinguished from other *Myotis* species by its long ears. In Michigan, northern long-eared bats hibernate in abandoned mines and caves in the Upper Peninsula; they also commonly hibernate in the Tippy Dam spillway in Manistee County. This species is a regional migrant with migratory distance largely determined by locations of suitable hibernacula sites.

Northern long-eared bats typically roost and forage in forested areas. During the summer, these bats roost singly or in colonies underneath bark, in cavities or in crevices of both living and dead trees. Roost trees are selected based on the suitability to retain bark or provide cavities or crevices. Common roost trees in southern Lower Michigan include species of ash, elm and maple. Foraging occurs primarily in areas along woodland edges, woodland clearings, and over small woodland ponds. Moths, beetles, and small flies are common food items. Like all temperate bats this species typically produces only 1-2 young per year.

Management and Conservation: when there are no known roost trees or hibernacula in the project area, we encourage you to conduct tree-cutting activities and prescribed burns in forested areas during October 1 through March 31 when possible, but you are not required by the ESA to do so. When that is not possible, we encourage you to remove trees prior to June 1 or after July 31, as that will help to protect young bats that may be in forested areas but are not yet able to fly.

Eastern massasauga rattlesnake – there are known occurrences in the area (see spatial data). Also, the project intersects both Tier 1 and Tier 2 eastern massasauga habitat as designated by the U.S. Fish & Wildlife Service (USFWS). Tier 1 is habitat where the species is known to occur; Tier 2 is habitat where the species may occur. The federally threatened and state threatened eastern massasauga rattlesnake (*Sistrurus catenatus*) is Michigan's only venomous snake and is found in a variety of wetland habitats. Eastern massasaugas occur throughout the Lower Peninsula but are not found in the Upper Peninsula. Populations in southern Michigan are typically associated with open wetlands, particularly prairie fens, while those in northern Michigan are known from open wetlands and lowland coniferous forests, such as cedar swamps. Some populations of Eastern massasaugas also utilize open uplands and/or forest openings for foraging, basking, gestation, and parturition (i.e., giving birth to young). Massasaugas usually hibernate below the frost line in crayfish or small mammal burrows, tree root networks or rock crevices in or along the edge of wetlands or in upland areas with presumably high-water tables. Massasauga habitats generally appear to be characterized by the following: (1) open, sunny areas intermixed with shaded areas, presumably for thermoregulation; (2) presence of the water table near the surface for hibernation; and (3) variable elevations between adjoining lowland and upland habitats. During late spring, these snakes move into adjacent uplands they spend the warmer months foraging in shrubby fields and grasslands in search of mice and voles, their favorite food.

Often described as "shy and sluggish", these snakes avoid human confrontation and are not prone to strike, preferring to leave the area when they are threatened. However, like any wild animal, they will protect themselves from anything they see as a potential predator. Their short fangs can easily puncture skin and they do possess potent venom. Like many snakes, the first human reaction may be to kill the snake, but it is important to remember that all snakes play vital roles in the ecosystem. Some may eat harmful insects. Others like the massasauga consider rodents a delicacy and help control their population. Snakes are also a part of a larger food web and can provide food to eagles, herons, and several mammals.

Management and Conservation: protection of extant populations and suitable wetland and adjacent upland habitats is crucial for successful conservation of the Eastern Massasauga. Maintaining or restoring open habitat conditions is critical for this species. Fragmentation of suitable wetland-upland habitat complexes by roads or other barriers should be avoided or minimized. Land management practices such as timber harvesting, mowing, disking or prescribed burning should be conducted in such a manner so as to minimize the potential for adverse impacts to massasaugas (e.g., conducting management activities during the snakes' inactive season (November through early March) or on days when snakes are less likely to be active on the surface during the active season). Protecting suitable hibernation sites also is critical. Hydrological alterations such as drawdowns should be conducted prior to or after hibernation to reduce the potential for causing winter mortality due to desiccation or freezing. Sudden and/or permanent increases or decreases in water levels during the active

season also can cause adverse impacts.

Mitchell's satyr butterfly – there does not appear to be suitable habitat within 1.5 miles of the project site. The federally endangered and state endangered Mitchell's satyr butterfly (*Neonympha mitchellii mitchellii*) is restricted to calcareous wetlands known as prairie fens. In Michigan, this habitat is characterized by scattered tamaracks, poison sumac, and dogwood with a ground cover of sedges, shrubby cinquefoil, and a variety of herbaceous species with prairie affinities. Adult Mitchell's satyr butterflies are active two to three weeks each summer, with males emerging before females. Adult flight dates are from mid-June to mid-July. Larvae hibernate near the bottom of a sedge. The larval food plant is thought to be several species of sedge. The caterpillar is green with white stripes.

Management and Conservation: the primary threat to the continued survival of this species is habitat loss and modification. Many of the wetland complexes occupied currently have been altered or drained for agriculture or development. Wetland alteration is responsible for extirpating the single known satyr population in Ohio.

Poweshiek skipperling - there does not appear to be suitable habitat within the 1.5-mile search buffers. In Michigan, the federally and state endangered poweshiek skipperling (*Oarisma poweshiek*) inhabits alkaline wetlands known as fens. This habitat is characterized by scattered tamaracks, poison sumac, and dogwood clones with a ground cover of sedges and other herbaceous species. This rare insect has a single generation each year. Egg laying is believed to occur on sedges and rushes sometimes around early July. Poweshiek larvae (caterpillar stage) hibernate through the winter on the food source on which they have been feeding on. In early April, they become active and continue developing until they pupate and emerge as adult butterflies. Adults have a lifespan of only 1-2 weeks and can be seen in late June through the first three weeks of July. Nectar plants include black-eyed susan (*Rudbeckia hirta*) and palespike lobelia (*Lobelia spicata*).

Management and Conservation: The primary threat to the continued survival of this species is habitat loss and modification. Many of the wetland complexes occupied currently have been altered or drained for agriculture or development. Wetland alteration also can lead to invasion by exotic plant species such as glossy buckthorn (*Rhamnus frangula*) and purple loosestrife (*Lythrum salicaria*).

Candidate Species

Monarch Butterfly (*Danaus plexipuss*) on December 15, 2020, the U.S. Fish and Wildlife Service announced that listing the monarch as endangered or threatened under the Endangered Species Act is warranted but precluded by higher priority listing actions. The decision is the result of an extensive status review of the monarch that compiled and assessed the monarch's current and future status. The monarch is now a candidate under the Endangered Species Act; we will review its status annually until a listing decision is made.

Management and Conservation: neither section 7 of the Endangered Species Act nor the implementing regulations for Section 7 contain requirements for federal agencies with respect to candidate species. Habitat loss and fragmentation has occurred throughout the monarch's range. Pesticide use can destroy the milkweed monarchs need to survive. A changing climate has intensified weather events which may impact monarch populations.

USFWS Section 7 Consultation Technical Assistance can be found at:

<https://www.fws.gov/midwest/endangered/section7/index.html>

The website offers step-by-step instructions to guide you through the Section 7 consultation process with prepared templates for documenting “no effect.” as well as requesting concurrence on "may affect, but not likely to adversely affect" determinations.

Please let us know if you have questions.

Michael Sanders, MNFI
Cell: 517-980-5632



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Michigan Ecological Services Field Office
2651 Coolidge Road Suite 101
East Lansing, MI 48823-6360
Phone: (517) 351-2555 Fax: (517) 351-1443



In Reply Refer To:
Project Code: 2025-0041623
Project Name: Norvell Township

01/14/2025 14:41:21 UTC

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

Official Species List

The attached species list identifies any Federally threatened, endangered, proposed and candidate species that may occur within the boundary of your proposed project or may be affected by your proposed project. The list also includes designated critical habitat if present within your proposed project area or affected by your project. This list is provided to you as the initial step of the consultation process required under section 7(c) of the Endangered Species Act, also referred to as Section 7 Consultation.

Under 50 CFR 402.12(e) (the regulations that implement section 7 of the Endangered Species Act), the accuracy of this species list should be verified after 90 days. You may verify the list by visiting the IPaC website (<https://ipac.ecosphere.fws.gov/>) at regular intervals during project planning and implementation. To update an Official Species List in IPaC: from the My Projects page, find the project, expand the row, and click Project Home. In the What's Next box on the Project Home page, there is a Request Updated List button to update your species list. Be sure to select an "official" species list for all projects.

Consultation requirements and next steps

Section 7 of the Endangered Species Act of 1973 requires that actions authorized, funded, or carried out by Federal agencies not jeopardize Federally threatened or endangered species or adversely modify designated critical habitat. To fulfill this mandate, Federal agencies (or their designated non-Federal representative) must consult with the Fish and Wildlife Service if they determine their project may affect listed species or critical habitat.

There are two approaches to evaluating the effects of a project on listed species.

Approach 1. Use the All-species Michigan determination key in IPaC. This tool can assist you in making determinations for listed species for some projects. In many cases, the determination key

will provide an automated concurrence that completes all or significant parts of the consultation process. Therefore, we strongly recommend screening your project with the **All-Species Michigan Determination Key (Dkey)**. For additional information on using IPaC and available Determination Keys, visit <https://www.fws.gov/media/mifo-ipac-instructions> (and click on the attachment), or for a video overview, please visit: <https://www.youtube.com/watch?v=FfcerNCiL0I>. Please carefully review your Dkey output letter to determine whether additional steps are needed to complete the consultation process.

Approach 2. Evaluate the effects to listed species on your own without utilizing a determination key. Once you obtain your official species list, you are not required to continue in IPaC, although in most cases using a determination key should expedite your review. If the project is a Federal action, you should review our section 7 step-by-step instructions before making your determinations: <https://www.fws.gov/office/midwest-region-headquarters/midwest-section-7-technical-assistance>. If you evaluate the details of your project and conclude “no effect,” document your findings, and your listed species review is complete; you do not need our concurrence on “no effect” determinations. If you cannot conclude “no effect,” you should coordinate/consult with the Michigan Ecological Services Field Office. The preferred method for submitting your project description and effects determination (if concurrence is needed) is electronically to EastLansing@fws.gov. Please include a copy of this official species list with your request.

For all **wind energy projects**, please contact this field office directly for assistance, even if no Federally listed plants, animals or critical habitat are present within your proposed project area or may be affected by your proposed project.

Migratory Birds

Please see the “Migratory Birds” section below for important information regarding incorporating migratory birds into your project planning. Our Migratory Bird Program has developed recommendations, best practices, and other tools to help project proponents voluntarily reduce impacts to birds and their habitats. The Bald and Golden Eagle Protection Act prohibits the take and disturbance of eagles without a permit. If your project is near an eagle nest or winter roost area, see our Eagle Permits website at <https://www.fws.gov/program/eagle-management> to help you avoid impacting eagles or determine if a permit may be necessary.

Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit <https://www.fws.gov/partner/council-conservation-migratory-birds>.

We appreciate your consideration of threatened and endangered species during your project

planning. Please include a copy of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Bald & Golden Eagles
- Migratory Birds
- Wetlands

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Michigan Ecological Services Field Office

2651 Coolidge Road Suite 101

East Lansing, MI 48823-6360

(517) 351-2555

PROJECT SUMMARY

Project Code: 2025-0041623

Project Name: Norvell Township

Project Type: Mine Closure

Project Description: Norvell Township, Michigan, Sand/gravel Mining, 2025

Project Location:

The approximate location of the project can be viewed in Google Maps: <https://www.google.com/maps/@42.116337099999996,-84.13298662520191,14z>



Counties: Jackson and Washtenaw counties, Michigan

ENDANGERED SPECIES ACT SPECIES

There is a total of 7 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 1 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries¹, as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

-
1. [NOAA Fisheries](#), also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Indiana Bat <i>Myotis sodalis</i> There is final critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5949 General project design guidelines: https://ipac.ecosphere.fws.gov/project/IL2AD4RQNNGZLHDTBM64VVKD34/documents/generated/6982.pdf	Endangered
Northern Long-eared Bat <i>Myotis septentrionalis</i> No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Endangered

BIRDS

NAME	STATUS
Whooping Crane <i>Grus americana</i> Population: U.S.A. (AL, AR, CO, FL, GA, ID, IL, IN, IA, KY, LA, MI, MN, MS, MO, NC, NM, OH, SC, TN, UT, VA, WI, WV, western half of WY) No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/758	Experimental Population, Non-Essential

REPTILES

NAME	STATUS
Eastern Massasauga (=rattlesnake) <i>Sistrurus catenatus</i> No critical habitat has been designated for this species. This species only needs to be considered under the following conditions: - For all Projects: Project is within Tier1 Habitat - For all Projects: Project is within EMR Range Species profile: https://ecos.fws.gov/ecp/species/2202 General project design guidelines: https://ipac.ecosphere.fws.gov/project/IL2AD4RQNNGZLHDTBM64VVKD34/documents/generated/5280.pdf	Threatened

INSECTS

NAME	STATUS
Mitchell's Satyr Butterfly <i>Neonympha mitchellii mitchellii</i> No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8062	Endangered
Monarch Butterfly <i>Danaus plexippus</i> There is proposed critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/9743	Proposed Threatened

FLOWERING PLANTS

NAME	STATUS
Eastern Prairie Fringed Orchid <i>Platanthera leucophaea</i> No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/601	Threatened

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

USFWS NATIONAL WILDLIFE REFUGE LANDS AND FISH HATCHERIES

Any activity proposed on lands managed by the [National Wildlife Refuge](#) system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

BALD & GOLDEN EAGLES

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act ² and the Migratory Bird Treaty Act (MBTA) ¹. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their habitats, should follow appropriate regulations and consider implementing appropriate avoidance and minimization measures, as described in the various links on this page.

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1. The [Bald and Golden Eagle Protection Act](#) of 1940.
 2. The [Migratory Birds Treaty Act](#) of 1918.
 3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

There are Bald Eagles and/or Golden Eagles in your [project](#) area.

Measures for Proactively Minimizing Eagle Impacts

For information on how to best avoid and minimize disturbance to nesting bald eagles, please review the [National Bald Eagle Management Guidelines](#). You may employ the timing and activity-specific distance recommendations in this document when designing your project/activity to avoid and minimize eagle impacts. For bald eagle information specific to Alaska, please refer to [Bald Eagle Nesting and Sensitivity to Human Activity](#).

The FWS does not currently have guidelines for avoiding and minimizing disturbance to nesting Golden Eagles. For site-specific recommendations regarding nesting Golden Eagles, please consult with the appropriate Regional [Migratory Bird Office](#) or [Ecological Services Field Office](#).

If disturbance or take of eagles cannot be avoided, an [incidental take permit](#) may be available to authorize any take that results from, but is not the purpose of, an otherwise lawful activity. For assistance making this determination for Bald Eagles, visit the [Do I Need A Permit Tool](#). For assistance making this determination for golden eagles, please consult with the appropriate Regional [Migratory Bird Office](#) or [Ecological Services Field Office](#).

Ensure Your Eagle List is Accurate and Complete

If your project area is in a poorly surveyed area in IPaC, your list may not be complete and you may need to rely on other resources to determine what species may be present (e.g. your local FWS field office, state surveys, your own surveys). Please review the [Supplemental Information on Migratory Birds and Eagles](#), to help you properly interpret the report for your specified location, including determining if there is sufficient data to ensure your list is accurate.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to bald or golden eagles on your list, see the "Probability of Presence Summary" below to see when these bald or golden eagles are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle <i>Haliaeetus leucocephalus</i> This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Golden Eagle <i>Aquila chrysaetos</i> This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds elsewhere

PROBABILITY OF PRESENCE SUMMARY

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read ["Supplemental Information on Migratory Birds and Eagles"](#), specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Green bars; the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during that week of the year.

Breeding Season (■)

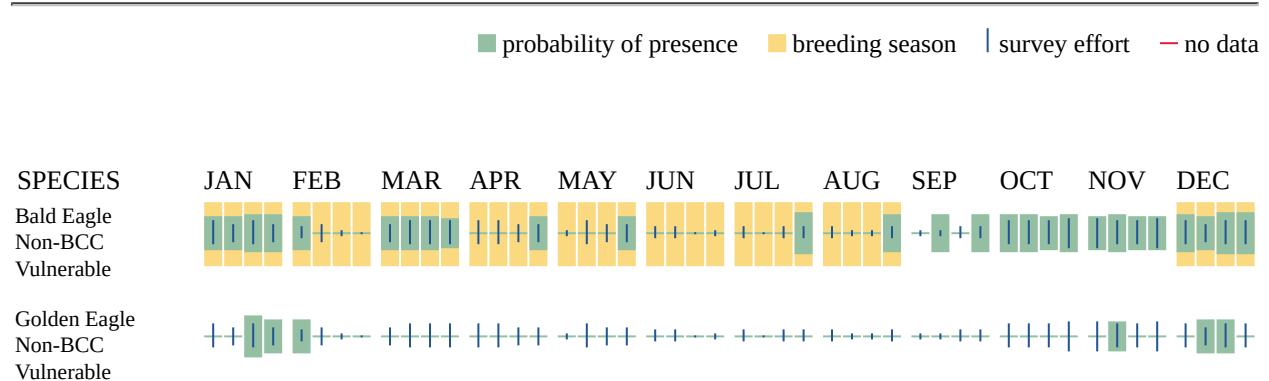
Yellow bars; liberal estimate of the timeframe inside which the bird breeds across its entire range.

Survey Effort (|)

Vertical black lines; the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data (—)

A week is marked as having no data if there were no survey events for that week.



Additional information can be found using the following links:

- Eagle Management <https://www.fws.gov/program/eagle-management>
- Measures for avoiding and minimizing impacts to birds <https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds>
- Nationwide avoidance and minimization measures for birds <https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf>
- Supplemental Information for Migratory Birds and Eagles in IPaC <https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action>

MIGRATORY BIRDS

The Migratory Bird Treaty Act (MBTA) ¹ prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (Service). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The Service interprets the MBTA to prohibit incidental take.

-
1. The [Migratory Birds Treaty Act](#) of 1918.
 2. The [Bald and Golden Eagle Protection Act](#) of 1940.

3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the "Probability of Presence Summary" below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle <i>Haliaeetus leucocephalus</i> This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Black Tern <i>Chlidonias niger surinamenis</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3093	Breeds May 15 to Aug 20
Black-billed Cuckoo <i>Coccyzus erythrophthalmus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9399	Breeds May 15 to Oct 10
Bobolink <i>Dolichonyx oryzivorus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9454	Breeds May 20 to Jul 31
Canada Warbler <i>Cardellina canadensis</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9643	Breeds May 20 to Aug 10
Chimney Swift <i>Chaetura pelagica</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9406	Breeds Mar 15 to Aug 25
Eastern Whip-poor-will <i>Antrostomus vociferus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/10678	Breeds May 1 to Aug 20
Golden Eagle <i>Aquila chrysaetos</i> This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds elsewhere

NAME	BREEDING SEASON
Grasshopper Sparrow <i>Ammodramus savannarum perpallidus</i> This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/8329	Breeds Jun 1 to Aug 20
Henslow's Sparrow <i>Centronyx henslowii</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3941	Breeds May 1 to Aug 31
Lesser Yellowlegs <i>Tringa flavipes</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Pectoral Sandpiper <i>Calidris melanotos</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9561	Breeds elsewhere
Red-headed Woodpecker <i>Melanerpes erythrocephalus</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9398	Breeds May 10 to Sep 10
Rusty Blackbird <i>Euphagus carolinus</i> This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9478	Breeds elsewhere
Semipalmated Sandpiper <i>Calidris pusilla</i> This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9603	Breeds elsewhere
Upland Sandpiper <i>Bartramia longicauda</i> This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9294	Breeds May 1 to Aug 31
Wood Thrush <i>Hylocichla mustelina</i> This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9431	Breeds May 10 to Aug 31

PROBABILITY OF PRESENCE SUMMARY

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read ["Supplemental](#)

[Information on Migratory Birds and Eagles](#)", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Green bars; the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during that week of the year.

Breeding Season (■)

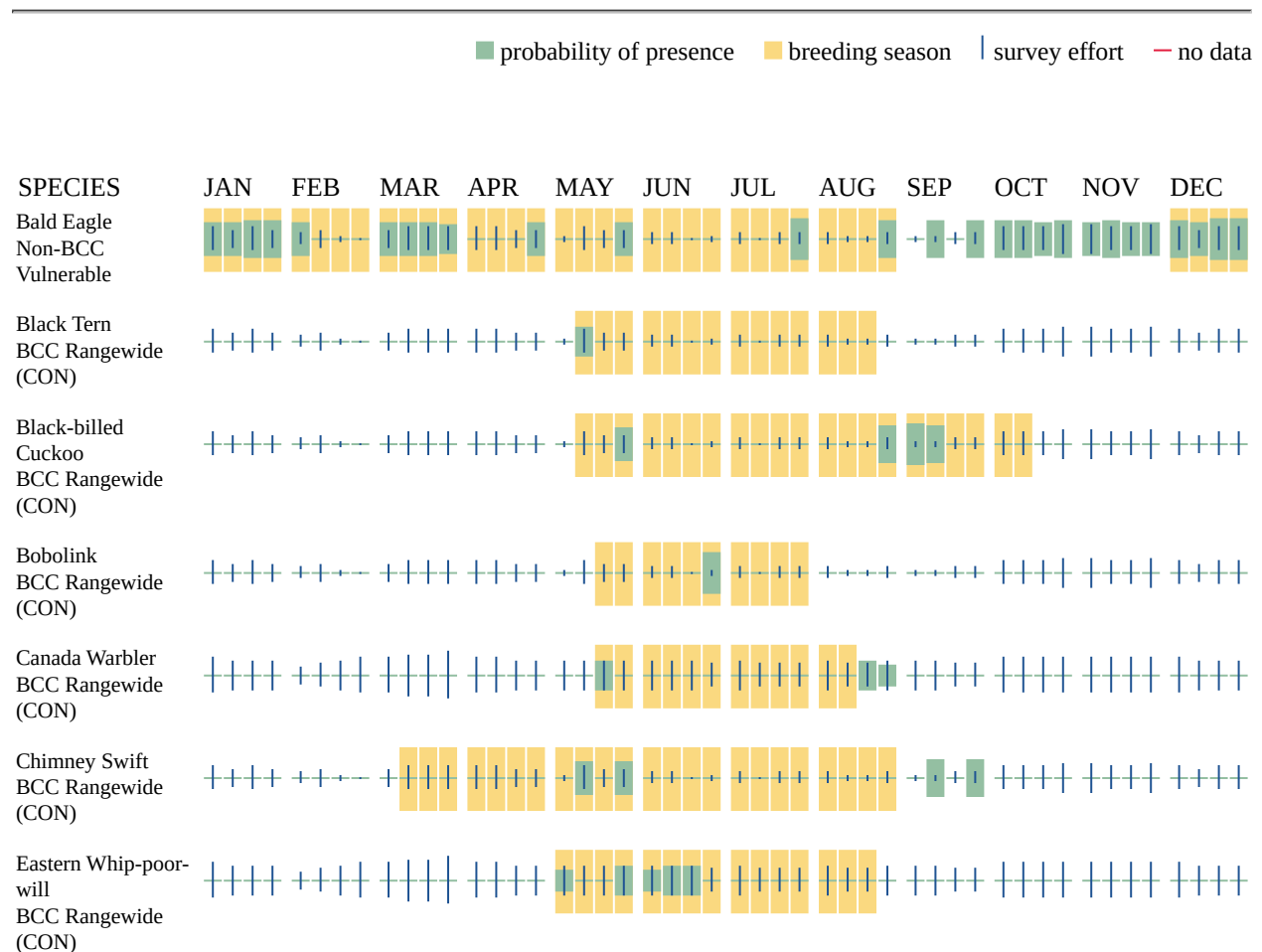
Yellow bars; liberal estimate of the timeframe inside which the bird breeds across its entire range.

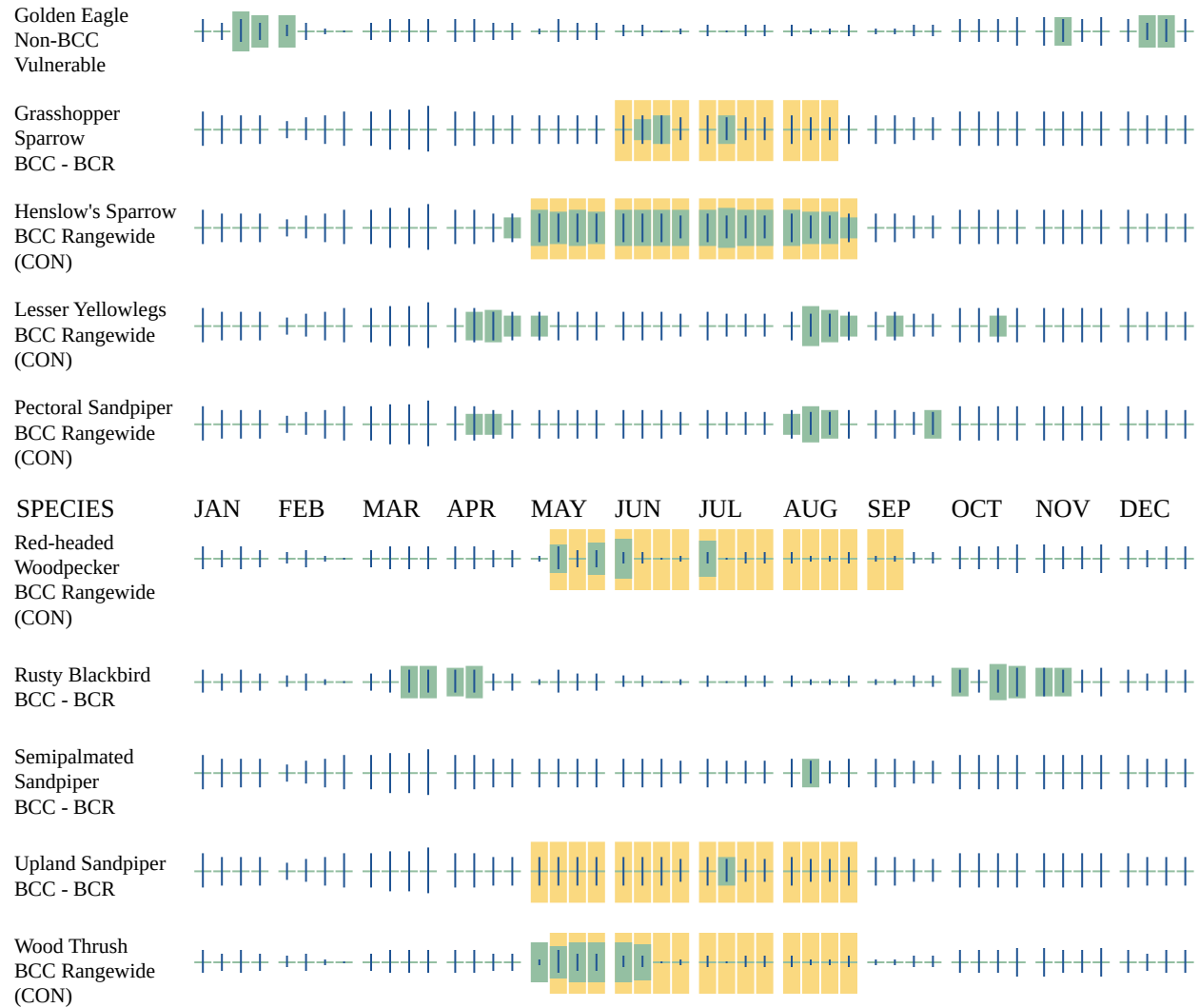
Survey Effort (|)

Vertical black lines; the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data (—)

A week is marked as having no data if there were no survey events for that week.





Additional information can be found using the following links:

- Eagle Management <https://www.fws.gov/program/eagle-management>
- Measures for avoiding and minimizing impacts to birds <https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds>
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC <https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action>

WETLANDS

Impacts to [NWI wetlands](#) and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local [U.S. Army Corps of Engineers District](#).

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

FRESHWATER POND

- PUBF
- PUBG

FRESHWATER FORESTED/SHRUB WETLAND

- PSS1/EM1Cd

LAKE

- L1UBH

FRESHWATER EMERGENT WETLAND

- PEM1C

IPAC USER CONTACT INFORMATION

Agency: Private Entity
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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Michigan Ecological Services Field Office
2651 Coolidge Road Suite 101
East Lansing, MI 48823-6360
Phone: (517) 351-2555 Fax: (517) 351-1443



In Reply Refer To:
Project code: 2025-0041623
Project Name: Norvell Township

01/15/2025 17:36:57 UTC

Subject: Technical Assistance letter for 'Norvell Township' for specified federally threatened and endangered species and designated critical habitat that may occur in your proposed project area consistent with the Michigan Determination Key for project review and guidance for federally listed species (Michigan Dkey).

Dear Brad Kassuba:

The U.S. Fish and Wildlife Service (Service) received on **January 15, 2025** your effect determination(s) for the 'Norvell Township' (the Action) using the Michigan DKey within the Information for Planning and Consultation (IPaC) system. The Service developed this system in accordance with the Endangered Species Act of 1973 (ESA) (87 Stat.884, as amended; 16 U.S.C. 1531 et seq.).

Based on your answers and the assistance of the Service's Michigan DKey, you made the following effect determination(s) for the proposed Action:

Species	Listing Status	Determination
Eastern Massasauga (=rattlesnake) (<i>Sistrurus catenatus</i>)	Threatened	May affect
Eastern Prairie Fringed Orchid (<i>Platanthera leucophaea</i>)	Threatened	No effect
Indiana Bat (<i>Myotis sodalis</i>)	Endangered	NLAA
Mitchell's Satyr Butterfly (<i>Neonympha mitchellii mitchellii</i>)	Endangered	No effect
Monarch Butterfly (<i>Danaus plexippus</i>)	Proposed Threatened	No effect
Northern Long-eared Bat (<i>Myotis septentrionalis</i>)	Endangered	NLAA
Whooping Crane (<i>Grus americana</i>)	Experimental Population, Non-Essential	No effect

Please carefully review this letter. Your Endangered Species Act requirements are not complete.

For non-Federal representatives: Please note that when a project requires consultation under section 7 of the Act, the Service must consult directly with the Federal action agency unless that agency formally designates a non-Federal representative (50 CFR 402.08). Non-Federal representatives may prepare analyses or conduct informal consultations; however, the ultimate responsibility for section 7 compliance under the Act remains with the Federal agency. Please include the Federal action agency in additional correspondence regarding this project.

Eastern Massasauga (EMR):

EMR may be present in the Action area. The following projects are not within the scope of the Michigan DKey: prescribed fire; new roads or trails that create a permanent barrier to EMR movement; projects that alter hydrology permanently, or temporarily if during the inactive season; projects that are large in scale; and projects that do not apply recommended conservation measures. Project-specific review is needed for these types of projects. **Please coordinate with the Michigan Ecological Services Field Office to further evaluate effects of the Action on EMR.**

Northern Long-eared Bat:

Effective March 31, 2023, the northern long-eared bat was reclassified from a threatened species to an endangered species (87 FR 73488, 88 FR 4908). This reclassification changed the northern long-eared bat's protections under the ESA, removing the previous 4(d) rule, as these can only be applied to threatened species. As with the Indiana bat, unpermitted take of northern long-eared bat occurring on or after March 31, 2023, is now prohibited by section 9 of the ESA. To assist with the transition from the 4(d) rule, the Service developed an Interim Consultation Framework that considers projects that are consistent with the 4(d) rule. The Interim Consultation Framework and associated Standing Analysis only consider and address the effects of covered actions that are expected to occur from March 31, 2023 until April 1, 2024; however, we are extending the interim northern long-eared bat tools and guidance until summer 2024 (at which time we expect final tools to be issued). The new tools will be posted on [the Service's Northern Long-eared Bat page](#).

Your project is consistent with a "not likely to adversely affect" determination under the Interim Consultation Framework. If new information about your action indicates listed bats may be present and adversely affected in a manner not considered as part of this consultation, please reinstate consultation with our office. For more information on how to avoid adverse effects to listed bats, please refer to the guidance available on the Service's Northern Long-eared Bat page.

Bats of Conservation Concern:

Implementing protective measures for bats, including both federally listed and non-listed species, indirectly helps to protect Michigan's agriculture and forests. Bats are significant predators of nocturnal insects, including many crop and forest pests. For example, Whitaker (1995) estimated that a single colony of 150 big brown bats (*Eptesicus fuscus*) would eat nearly 1.3 million pest insects each year. Boyles et al. (2011) noted the "loss of bats in North America could lead to agricultural losses estimated at more than \$3.7 billion/year, and Maine and Boyles (2015) estimated that the suppression of herbivory by insectivorous bats is worth >1 billion USD

globally on corn alone. In captive trials, northern long-eared bats were found to significantly reduce the egg-laying activity of mosquitoes, suggesting bats may also play an important role in controlling insect-borne disease (Reiskind and Wund 2009). Mosquitoes have also been found to be a consistent component of the diet of Indiana bats and are eaten most heavily during pregnancy (6.6%; Kurta and Whitaker 1998). Taking proactive steps to help protect bats may be very valuable to agricultural and forest product yields and pest management costs in and around a project area. Such conservation measures include limiting tree clearing during the bat active season (varies by location) and/or the non-volant period (June through July), when young bats are unable to fly, and minimizing the extent of impacts to forests, wetlands, and riparian habitats.

Bald and Golden Eagles:

Bald eagles, golden eagles, and their nests are protected under the Bald and Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a-d) (Eagle Act). The Eagle Act prohibits, except when authorized by an Eagle Act permit, the “taking” of bald and golden eagles and defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.” The Eagle Act’s implementing regulations define disturb as “...to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.”

If the Action may impact bald or golden eagles, additional coordination with the Service under the Eagle Act may be required. For more information on eagles and conducting activities in the vicinity of an eagle nest, please visit <https://www.fws.gov/library/collections/all-about-eagles>. In addition, the Service developed the National Bald Eagle Management Guidelines (May 2007) in order to assist landowners in avoiding the disturbance of bald eagles. The full Guidelines are available at <https://www.fws.gov/media/national-bald-eagle-management-guidelines-0>.

If you have further questions regarding potential impacts to eagles, please contact Chris Mensing, Chris_Mensing@fws.gov or 517-351-2555.

Monarch butterfly and other pollinators

In December 2020, after an extensive status assessment of the monarch butterfly, we determined that listing the monarch under the Endangered Species Act is warranted but precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants. Therefore, the Service added the monarch butterfly to the candidate list. The Service will review its status each year until we are able to begin developing a proposal to list the monarch.

The Endangered Species Act does not establish protections or consultation requirements for candidate species. Some Federal and State agencies may have policy requirements to consider candidate species in planning. We encourage implementing measures that will remove or reduce threats to these species and possibly make listing unnecessary.

For all projects, we recommend the following best management practices (BMPs) to benefit monarch and other pollinators.

Monarch and Pollinator BMP Recommendations

Consider monarch and other pollinators in your project planning when possible. Many pollinators are declining, including species that pollinate key agricultural crops and help maintain natural plant communities. Planting a diverse group of native plant species will help support the nutritional needs of Michigan's pollinators. We recommend a mix of flowering trees, shrubs, and herbaceous plants so that something is always blooming and pollen is available during the active periods of the pollinators, roughly early spring through fall (mid-March to mid-October). To benefit a wide variety of pollinators, choose a wide range of flowers with diverse colors, heights, structure, and flower shape. It is important to provide host plants for any known butterfly species at your site, including native milkweed for Monarch butterfly. Incorporating a water source (e.g., ephemeral pool or low area) and basking areas (rocks or bare ground) will provide additional resources for pollinators.

Many pollinators need a safe place to build their nests and overwinter. During spring and summer, leave some areas unmowed or minimize the impacts from mowing (e.g., decrease frequency, increase vegetation height). In fall, leave areas unraked and leave plant stems standing. Leave patches of bare soil for ground nesting pollinators.

Avoid or limit pesticide use. Pesticides can kill more than the target pest. Some pesticide residues can kill pollinators for several days after the pesticide is applied. Pesticides can also kill natural predators, which can lead to even worse pest problems.

Planting native wildflowers can also reduce the need to mow and water, improve bank stabilization by reducing erosion, and improve groundwater recharge and water quality.

Resources:

<https://www.fws.gov/initiative/monarchs>

<https://www.fws.gov/library/collections/pollinators>

Coordination with the Service is not complete if additional coordination is advised above for any species. Please email our office at MIFO_DKey@fws.gov and attach a copy of this letter, so we can discuss methods to avoid or minimize potential adverse effects to those species.

Bat References

Boyles, J.G., P.M. Cryan, G.F. McCracken, T.H. Kunz. 2011. Economic Importance of Bats in Agriculture. *Science* 332(1):41-42.

Kurta, A. and J.O. Whitaker. 1998. Diet of the Endangered Indiana Bat (*Myotis sodalis*) on the Northern Edge of Its Range. *The American Midland Naturalist* 140(2):280-286.

Reiskind, M.H. and M.A. Wund. 2009. Experimental assessment of the impacts of northern long-eared bats on ovipositing *Culex* (Diptera: Culicidae) mosquitoes. *Journal of Medical Entomology* 46(5):1037-1044.

Whitaker, Jr., J.O. 1995. Food of the big brown bat *Eptesicus fuscus* from maternity colonies in Indiana and Illinois. *American Midland Naturalist* 134(2):346-360.

Summary of conservation measures for your project You agreed to the following conservation measures to avoid adverse effects to listed species and our concurrence is only valid if the measures are fully implemented. These must be included as permit conditions if a permit is required and/or included in any contract language.

Mitchell's satyr: Avoid ground disturbance and use of chemicals in prairie fen, shrub carr, tamarack swamp, tamarack savanna, wet meadow or wet prairie habitat.

Listed bats: When installing new or replacing existing permanent lights, you will use downward-facing, full cut-off lens lights (with same intensity or less for replacement lighting); or for those transportation agencies using the BUG system developed by the Illuminating Engineering Society, the goal is to be as close to 0 for all three ratings with a priority of "uplight" of 0 and "backlight" as low as practicable. You will direct temporary lighting away from suitable listed bat habitat during the active season.

Listed bats: Any cutting/trimming of potential roost trees for northern long-eared bat (trees ≥ 3 inches in diameter [at breast height] with cracks, crevices, cavities, and/or exfoliating bark) will occur outside the northern long-eared bat summer roosting period (that is, limited to the period of October 1 through April 14). Prescribed fire and/or pesticide/herbicide application will also occur during October 1 through April 14 where potential roost trees are present.

Tree cutting/trimming and/or prescribed burning will not clear ≥ 20 contiguous acres of forest or fragment a connective corridor between 2 or more forest patches of at least 5 acres.

Listed bats: When installing new or replacing existing permanent lights, you will use downward-facing, full cut-off lens lights (with same intensity or less for replacement lighting); or for those transportation agencies using the BUG system developed by the Illuminating Engineering Society, the goal is to be as close to 0 for all three ratings with a priority of "uplight" of 0 and "backlight" as low as practicable. You will direct temporary lighting away from suitable northern long-eared bat habitat during the active season.

Listed bats: Any cutting/trimming of potential roost trees for Indiana bat (trees ≥ 5 inches in diameter [at breast height] with cracks, crevices and/or exfoliating bark) will be limited to the inactive season for Indiana bat (October 1 through April 14). Prescribed fire and/or pesticide application will also occur during the inactive season where potential roost trees are present.

Tree cutting/trimming and/or prescribed burning will not clear ≥ 10 contiguous acres of modeled forested habitat or fragment a connective corridor between 2 or more forest patches of at least 5 acres.

Listed bats: Tree cutting/trimming and/or prescribed burning will not clear ≥ 10 contiguous acres of forest (including both modeled and unmodeled potential habitat) or fragment a connective corridor between 2 or more forest patches of at least 5 acres.

Action Description

You provided to IPaC the following name and description for the subject Action.

1. Name

Norvell Township

2. Description

The following description was provided for the project 'Norvell Township':

Norvell Township, Michigan, Sand/gravel Mining, 2025

The approximate location of the project can be viewed in Google Maps: <https://www.google.com/maps/@42.116337099999996,-84.13298662520191,14z>



QUALIFICATION INTERVIEW

1. Are there any possible effects to any listed species or to designated critical habitat from your project or effects from any other actions or projects subsequently made possible by your project?

Select "Yes" even if the expected effects to the species or critical habitat are expected to be 1) extremely unlikely (discountable), 2) can't meaningfully be measured, detected, or evaluated (insignificant), or 3) wholly beneficial.

Select "No" to confirm that the project details and supporting information allow you to conclude that listed species and their habitats will not be exposed to any effects (including discountable, insignificant, or beneficial effects) and therefore, you have made a "no effect" determination for all species. If you are unsure, select YES to answer additional questions about your project.

Yes

2. This determination key is intended to assist the user in the evaluating the effects of their actions on Federally listed species in Michigan. It does not cover other prohibited activities under the Endangered Species Act (e.g., for wildlife: import/export, Interstate or foreign commerce, possession of illegally taken wildlife, purposeful take for scientific purposes or to enhance the survival of a species, etc.; for plants: import/export, reduce to possession, malicious destruction on Federal lands, commercial sale, etc.) or other statutes. Click yes to acknowledge that you must consider other prohibitions of the ESA or other statutes outside of this determination key.

Yes

3. Is the action the approval of a long-term (i.e., in effect greater than 10 years) permit, plan, or other action? (e.g., a new or re-issued hydropower license, a large-scale land management plan, or other kinds of documents that provide direction for projects or actions that may be conducted over a long term (>10 years) without the need for additional section 7 consultation).

No

4. Is the action being funded, authorized, or carried out by a Federal agency?

No

5. Does the action involve the installation or operation of wind turbines?

No

6. Are there at least 30 days prior to your action occurring? Endangered species consultation must be completed before taking any action that may have effects to listed species. The Service also needs 30 days to review projects before we can verify conclusions in some dkey output letters. For example, if you have already started some components of the project on the ground (e.g., removed vegetation) before completing this key, answer “no” to this question. The only exception is if you have a Michigan Field Office pre-approved emergence survey (i.e., if you have conducted pre-approved emergence surveys for listed bats before tree removal, you can still answer yes to this question).

Yes

7. Does the action involve constructing a new communications tower or modifying an existing communications tower?

No

8. Does the activity involve aerial or other large-scale application of any chemical (including insecticide, herbicide, etc.)?

No

9. Does your project include water withdrawal (ground or surface water) greater than 10,000 gallons/day?

No

10. Will your action permanently affect hydrology?

No

11. Will your action temporarily affect hydrology?

No

12. Will your project have any direct impacts to a stream or river (e.g., Horizontal Directional Drilling (HDD), hydrostatic testing, stream/road crossings, new storm-water outfall discharge, dams, other in-stream work, changes to water quality or hydrology, etc.)?

No

13. Does your project have the potential to indirectly impact the stream/river or the riparian zone (e.g., cut and fill, horizontal directional drilling, hydrostatic testing, construction, vegetation removal, discharge, changes to water quality or hydrology, etc.)?

No

14. Will your action disturb the ground or existing vegetation? This includes any off road vehicle access, soil compaction, digging, seismic survey, directional drilling, heavy equipment, grading, trenching, placement of fill, pesticide application, vegetation management (including removal or maintenance using equipment or chemicals), cultivation, development, etc.

Yes

15. Is the action a utility-scale solar development project?

Note:Solar projects are considered utility scale if they will be 1 megawatt or larger.

No

16. [Hidden semantic] Does the action intersect the MOBU AOI?

Automatically answered

Yes

17. Under the ESA, monarchs remain warranted but precluded by listing actions of higher priority. The monarch is a candidate for listing at this time. The Endangered Species Act does not establish protections or consultation requirements for candidate species. Some Federal and State agencies may have policy requirements to consider candidate species in planning. We encourage implementing measures that will remove or reduce threats to these species and possibly make listing unnecessary. If your project will have no effect on monarch butterflies (for example, if your project won't affect their habitat or individuals), then you can make a "no effect" determination for this project. Are you making a "no effect" determination for monarch?

Yes

18. [Hidden Semantic] Does the action intersect the Eastern massasauga rattlesnake area of influence?

Automatically answered

Yes

19. Will your action impact less than 0.5 acres of [suitable Eastern massasauga rattlesnake habitat](#)?

No

20. [Hidden Semantic] Does the action area intersect the Mitchell's satyr area of influence?

Automatically answered

Yes

21. Does your project include alteration or fill of 3 or more acres of wetland?

No

22. Does any portion of the action occur in prairie fen, shrub carr, tamarack swamp, tamarack savanna, wet meadow, or wet prairie? For more information on suitable [Mitchell's satyr habitat](#).

No

23. [Hidden Semantic] Does the action area intersect the whooping crane (ex. Pop) area of influence?

Automatically answered

Yes

24. [Hidden Semantic] Does the action area intersect the area of influence for Eastern prairie fringed orchid?

Automatically answered

Yes

25. The project has the potential to affect federally listed bats. Does the action area contain any known or potential bat hibernacula (natural caves, abandoned mines, or underground quarries)?

No

26. Has a presence/absence bat survey or field-based habitat assessment following the Service's Range-wide [Indiana Bat and Northern Long-eared Bat Summer Survey Guidelines](#) been conducted within the action area?

No

27. Does the action involve removal/modification of a human structure (barn, house or other building) known to contain roosting bats?

No

28. Does the action include removal/modification of an existing bridge or culvert?

No

29. Does the action include temporary or permanent lighting of roadway(s), facility(ies), and/or parking lot(s)?

Yes

30. Will you apply the following Avoidance and Minimization Measures for bats?

1. When installing new or replacing existing permanent lights, use [downward-facing, full cut-off lens lights](#) (with same intensity or less for replacement lighting); or for those transportation agencies using the [BUG system developed by the Illuminating Engineering Society](#), the goal is to be as close to 0 for all three ratings with a priority of "uplight" of 0 and "backlight" as low as practicable.

2. Direct temporary lighting away from suitable habitat during the active season.

Yes

31. Does the action include one or more of the following: (1) tree cutting/trimming, (2) prescribed fire, (3) pesticide (including insecticide and/or rodenticide), and/or (4) herbicide/fungicide application?

Yes

32. Does the action include herbicide application?

No

33. Will the action clear >10 acres of contiguous forest (i.e., connected by 1,000 feet or less) or fragment a riparian or other connective forested corridor (e.g., tree line) between 2 or more forest patches of at least 5 acres? For more information, see [Appendix II](#).

No

34. Does the action area contain potential NLEB bat roost trees (trees ≥ 3 inches in diameter [at breast height] with cracks, crevices, cavities and/or exfoliating bark)? For more information, see [Appendix IV](#).

Yes

35. Does the action area contain potential Indiana bat roost trees (trees ≥ 5 inches in diameter [at breast height] with cracks, crevices and/or exfoliating bark)? For more information, see [Appendix III](#).

Yes

36. Does the action include emergency cutting/trimming of hazard trees in order to prevent imminent loss of human life and/or property?

No

37. [Semantic] Is any portion of the action area within 5 miles of a known bat hibernaculum?

Automatically answered

No

38. [Hidden Semantic] Does the action area intersect the SE_LP_S Michigan Modeled Bat Habitat?

Automatically answered

Yes

39. Your project intersected modeled bat habitat.

Will all tree cutting/trimming, prescribed fire, and/or insecticide/rodenticide application be restricted to the inactive (hibernation) season for listed bats (that is, conducted during October 1 through April 14)?

Select N/A if the project does not include at least one of these activities.

Yes

40. Will the action clear >10 acres of modeled bat habitat?

To determine whether it is >10 acres, you can download the shapefile or kmz here: [Indiana bat model](#). For more information on the development of the Indiana bat habitat suitability model, see [Appendix I](#).

No

41. [Hidden Semantic] Does the action area intersect the Indiana bat AOI?

Automatically answered

Yes

42. [Hidden Semantic] Does this project intersect the northern long-eared bat area of influence?

Automatically answered

Yes

IPAC USER CONTACT INFORMATION

Agency: Private Entity
Name: Brad Kassuba
Address: ASTI Environmental
Address Line 2: 10448 Citation Drive, Suite 100
City: Brighton
State: MI
Zip: 48116
Email: kassuba1@att.net
Phone: 2484259846

From: [Bradley Kassuba](#)
To: tgreen@edwclevy.net
Cc: [Dana Knox](#)
Subject: FW: [EXTERNAL] Ipac Letter
Date: Thursday, January 30, 2025 12:39:16 PM
Attachments: [image001.png](#)
[Norvell Township Wetland Map.pdf](#)

Good news! Please see attached email correspondence from USFWS regarding the Eastern Massasauga Rattlesnake issue.

We have a confirmation that the project will not affect the EMR as long as we implement the conservation measures listed. I will summarize those for you soon, but two main take aways are installing silt fencing along the northern boundary and having me (or someone else qualified) go out and check that no snakes are present during original construction activities.

Bradley Kassuba

Prof. Wetland Scientist III

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asti-env.com | peagroup.com | [linkedin](#)

From: MIFO DKey, FW3 <MIFO_DKey@fws.gov>
Sent: Thursday, January 30, 2025 9:17 AM
To: Bradley Kassuba <bkassuba@asti-env.com>
Cc: MIFO DKey, FW3 <MIFO_DKey@fws.gov>
Subject: Re: [EXTERNAL] Ipac Letter

You don't often get email from mifo_dkey@fws.gov. [Learn why this is important](#)

Brad,

Thank you for your emails, maps of the project area, and consideration of listed species pursuant to the Endangered Species Act (Act). I have reviewed your project maps and project area description detailed in your January 29 email, in addition to the conservation measures your propose to implement and mentioned in our January 23, 27,

and 29 emails.

The project area is located in the vicinity of known or high potential habitat (Tiers 1 or 2 habitat) for the eastern massasauga rattlesnake (EMR). However, you have stated the project area is mostly agricultural fields, there are no prairie fens in the vicinity, and wetlands will not be impacted. You have also stated that mining will cease 5 to 10 feet above the water table to avoid impacting the groundwater and altering the hydrology.

Upon review of your project and email conversations, I have found that the proposed action (as described and including all identified conservation measures discussed in our January 27 and 29 emails) are consistent with the determination "not likely to adversely affect" for eastern massasauga rattlesnake.

If the project is modified or new information becomes available that suggests listed species or habitats may be affected in a manner or to an extent not previously considered, please contact our office for further assistance.

Feel free to file copies of this email in your administrative records for this project, and email or call me if you have any questions or concerns. Thank you for your cooperation in helping to conserve threatened and endangered species.

From: Dandridge, Tameka N <tameka_dandridge@fws.gov>
Sent: Thursday, January 30, 2025 7:35 AM
To: MIFO DKey, FW3 <MIFO_DKey@fws.gov>
Subject: Fw: [EXTERNAL] Ipac Letter

Tameka N Dandridge
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Michigan Ecological Services Field Office
2651 Coolidge Road, Suite 101
East Lansing, MI 48823

517-325-9618

tameka_dandridge@fws.gov

From: Bradley Kassuba <bkassuba@asti-env.com>
Sent: Wednesday, January 29, 2025 3:46 PM
To: Dandridge, Tameka N <tameka_dandridge@fws.gov>
Subject: RE: [EXTERNAL] Ipac Letter

Hi Tameka,

Regarding your first question: Mining will cease 5-10 feet above the water table, with the aim to be consistently at 10 feet above. Please note there are no prairie fens documented on the Property. In addition, we are also not aware of any such habitat in the near vicinity. Please see attached NWI map showing the Property and impact areas well beyond any mapped wetlands. ASTI did a wetland study on site, and the wetlands outside the impact area to the northwest are common emergent wetlands, not a prairie fen. There is one small isolated wetland shown on the map, however that is not an existing wetland (this area was verified in the field), and is currently an active hay field for cattle. In summary, there is no wetland impacts proposed.

Regarding your second question: Any proposed tree removal will only take place within the mining impact area as shown in red on the map you previously received from me. In summary, tree removal will only take place in the upland forest areas adjacent to the agricultural fields, not the wetlands. These forested areas are mostly previously disturbed areas or hedgerows.

Regarding your last concern: Our client is willing to incorporate the conservation efforts you have listed in your email response as needed. Fencing can be installed along the northern perimeter to avoid any possible encroachment to the potential habitat areas. ASTI will have a required biologist (likely myself) in the work area to ensure no EMR are trapped in the work area prior to beginning construction activities.

Let me know if there is anything else you need from me at this point. I hope to hear from you soon.

Thank you,

Bradley Kassuba

Prof. Wetland Scientist III

Office: 810.225.2800 | **Main:** 800.395.2784

bkassuba@asti-env.com



10448 Citation Dr., Suite 100, Brighton, MI 48116

asti-env.com | peagroup.com | [linkedin](#)

From: Dandridge, Tameka N <tameka_dandridge@fws.gov>

Sent: Monday, January 27, 2025 2:53 PM

To: Bradley Kassuba <bkassuba@asti-env.com>

Subject: Re: [EXTERNAL] Ipac Letter

You don't often get email from tameka_dandridge@fws.gov. [Learn why this is important](#)

Hi Brad

Thanks for sending the project site graphic with the habitat types. It was very helpful.

I have a few more questions and a recommendations.

- About how far above the water table will digging cease? I'm asking because eastern massasauga rattlesnakes (EMR) have been documented in the areas surrounding your project site and prairie fens could be adversely impacted by changes in the ground water levels.
- Will there be any tree cuttings/removal in the uplands near the wetlands adjacent to the project area?
- It's unlikely EMR will occur in the agricultural area, but they could be present near the wetlands or the on the edges of wetlands and uplands. Because EMR have been documented near the surrounding area, we recommend incorporating

conservation measures in your project plans to ensure no adverse effects to the snakes. Are you able to incorporate these measures?

EMR INFO:

Habitat for EMR is typically associated with open to forested wetlands and adjacent uplands. During colder months (generally October through April), EMR hibernate below the frost line in crayfish or small mammal burrows, tree root networks or rock crevices in areas where the water table is near the surface (areas where the soil is saturated but not inundated) and with consistent hydrology to support over-winter survival. Hibernacula are typically near wetland edges, or slightly upland (typically within 500 meters of regulated wetland). EMR stay in the area around their hibernacula until overnight temperatures warm up enough for them to move to their active season range.

Below are conservation measures we recommend near wetlands and upland areas adjacent to uplands:

- Avoid direct impacts to EMR (e.g., crushing by heavy equipment)
 - For work conducted during the active season (generally April 15 - October 15 in Southern Lower Peninsula), use exclusionary fencing to keep EMR out of the area of disturbance.
 - Prior to access of suitable habitat by any equipment (including for vegetation removal), install exclusionary fencing around the work area. Exclusionary fencing will serve as a barrier to keep EMR out of these areas of disturbance.
 - The exclusionary fencing will typically be traditional silt fence that is set up outside of all areas of disturbance and other types of fencing (e.g., snow fence used to delineate the work zone). Do not use fencing materials that can entangle or injure snakes.
 - The exclusionary fencing should be checked regularly (*i.e.*, at least weekly for the duration of the project) to ensure the integrity of the barrier.
 - Ideally, the exclusionary fencing would be installed during the inactive season to ensure snakes are not trapped inside the work zone. If that is not possible, the fencing should be installed a minimum of 1 day before construction activities begin.
 - During the active season, the work area (*i.e.*, interior of exclusionary fencing) should be cleared of EMR by a trained individual (someone who has received training in identification of EMR, its life history, and protection status; or otherwise approved by the Service) to ensure no EMR are trapped in the work area prior to beginning construction activities.
 - Any snakes found within the exclusionary fencing should be safely moved

out of the area of disturbance by a qualified individual. For more information on how to safely move snakes, see <https://www.youtube.com/watch?v=HjlkDXT85g>.

- Once construction activities are complete, the exclusionary fence must be properly removed from the site.
- Exclusionary fencing is not necessary if the work can be conducted entirely within the inactive season.

If EMR hibernacula is present near your site...

- Do not disturb potential hibernation habitat (**e.g.** crayfish burrows, small mammal burrows) during the inactive season.
 - If work will occur during or close to the inactive season, do not disturb crayfish burrows or other areas that harbor potential hibernation sites for EMR. In areas with suitable hibernation habitat in Tier 1 (e.g. crayfish burrows), ground-disturbing work should be conducted well within the EMR active season (June–August) to avoid when snakes are likely to be hibernating and most vulnerable. During this time, they are most likely to be able to move out of the way of disturbance and have greater chances to find alternative hibernation sites. Exclusionary fencing should be utilized, as described above.
 - **Destroying potential hibernacula may still impact snakes indirectly. Potential hibernation areas should be avoided to the extent possible.**
- Avoid spread of invasive species into EMR habitat by following best practices. This includes inspecting and cleaning equipment and vehicles between work sites as needed to avoid the spread of invasive plant materials.
- Ensure all imported fill material is free from contaminants or invasive species. Use exclusionary fencing, described above, around the area to be filled and have the site “cleared” by a qualified individual prior to placing fill.
- Minimize vehicle activity in known/presumed occupied EMR habitat to the extent possible. During EMR active season, speed limits at facilities and access roads (i.e., 2-track and gravel) in occupied habitat should be <15 MPH, to the extent practicable.

- Use wildlife-safe materials for erosion control and site restoration throughout the project area. Do not use erosion control products containing plastic mesh netting or other similar material that could entangle eastern massasauga rattlesnake (EMR). Several products for soil erosion and control exist that do not contain plastic netting including net-less erosion control blankets (for example, made of excelsior), loose mulch, hydraulic mulch, soil binders, unreinforced silt fences, and straw bales. Others are made from natural fibers (such as jute) and loosely woven together in a manner that allows wildlife to wiggle free.
- To increase human safety and awareness of EMR, those implementing the project should first watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake" video (available at https://www.youtube.com/watch?v=-PFnXe_e02w), or review the EMR factsheet (available at <https://www.fws.gov/media/eastern-massasauga-rattlesnake-fact-sheet>).
- During project implementation, require reporting of any federally listed species, including EMR, to the Service within 24 hours.

Please do not hesitate to contact me if you have any questions or concerns.

Tameka N Dandridge

Fish and Wildlife Biologist

U.S. Fish and Wildlife Service

Michigan Ecological Services Field Office

2651 Coolidge Road, Suite 101

East Lansing, MI 48823

517-325-9618

tameka_dandridge@fws.gov

From: Bradley Kassuba <bkassuba@asti-env.com>
Sent: Thursday, January 23, 2025 9:15 AM
To: Dandridge, Tameka N <tameka_dandridge@fws.gov>
Subject: [EXTERNAL] Ipac Letter

This email has been received from outside of DOI - Use caution before clicking on links, opening attachments, or responding.

Hi Tameka,

It was good to talk with you yesterday regarding project code 2025-0041623 for the proposed Norvell Township sand and gravel mining operation. IPaC determination key indicated that the Project May Affect the Eastern Massasauga rattlesnake (EMR) and therefore I am following up with you to further asses and get a confirmation that the Project is Not Likely to Adversely Affect this species.

As we discussed there is no alteration to hydrology proposed, and the mining is taking place above the water table. In addition, the trails and roads that exist in the agricultural fields will be utilized to set up the operation. A site map showing the habitat types and the proposed mining impact area (in red) is attached for your review.

It is our professional opinion that EMR habitat does not exist within the mining project envelope, as it is mostly active agricultural fields. There are grasslands adjacent to the mining envelope in the northwestern portion of the site that are of moderate quality.

Let me know if you need anything else at this point. I hope to hear from you soon.

Bradley Kassuba

Prof. Wetland Scientist III

Office: 810.225.2800 | **Main:** 800.395.2784

bkassuba@asti-env.com

EXHIBIT 8

2024 Hydrogeological Evaluation Report

Norvell Township Site
Norvell Township, Michigan

American Aggregates of Michigan Inc.

November 6, 2025

ASTI ENVIRONMENTAL



2024 Hydrogeological Evaluation Report
Norvell Township Site
Norvell Township, Michigan

November 6, 2025

Prepared For:

American Aggregates of Michigan Inc.
9300 Dix Avenue
Dearborn, MI 48120

Report Prepared By:

ASTI Environmental
10448 Citation Drive, Suite 100
Brighton, Michigan 48116
(810) 225-2800

ASTI Project No. A23-2691.03

Report Prepared by:



Emily Manetz
Environmental Scientist



Evie Murgia
Hydrogeologist

Report Reviewed by:



Carrie Kempf
Department Manager



TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Title Page	i
Table of Contents	ii
1.0 Project Description	1
2.0 Work Plan	1
2.1 Shallow Groundwater Well Installation	1
2.2 Staff Gauge Installation	2
2.3 Well Development	2
2.4 Surveying	2
3.0 Local Geology and Hydrogeology	3
3.1 Geology	3
3.2 Groundwater and Surface Water Level Measurements	4
3.3 Groundwater Flow Direction	5
3.4 Conclusions	6

FIGURES

- 1 Sample Location Map
- 2 July 2023 Groundwater Elevation Contour Map
- 3 July 2024 Groundwater Elevation Contour Map

TABLES

- 1 2023 and 2024 Groundwater and Surface Water Elevations

ATTACHMENTS

- A Boring Logs with Monitoring Well Completion Details
- B Historical Elevation and Water Level Data

1.0 PROJECT DESCRIPTION

ASTI Environmental (ASTI) was retained by American Aggregates of Michigan Inc. to conduct a Hydrogeological Evaluation as part of the application for a mining permit on approximately 695 acres of land on 10 parcels within Jackson County (Property). For this investigation, ASTI installed 10 permanent shallow monitoring wells that were screened in the first aquifer encountered beneath the Property to estimate the groundwater elevations and flow direction. In addition to the wells, ASTI installed five staff gauges within significant surface water bodies on the Property to evaluate whether the surface water bodies are hydraulically connected to the shallow groundwater aquifer.

Depths to groundwater and heights of surface water on the staff gauges were measured twice in 2023 (July and December) and monthly in 2024. Groundwater and surface water elevations were calculated from the data. The elevations are listed in a table, presented on figures, and discussed in the following sections.

2.0 WORK PLAN

2.1 Shallow Groundwater Well Installation

Between June 5 and 16, 2023, ASTI installed 10 permanent shallow monitoring wells at the Property. Groundwater was encountered in sand layers between approximately 5 and 40 feet below grade depending on the surface elevation. The monitoring wells were installed using a hollow-stem auger drilling rig. The shallow wells were constructed as follows:

- Well screens and risers were constructed with 2-inch-inside diameter, Schedule 40 PVC.
- The well screens were constructed using 10-foot-long #10 slot.
- Each well was installed such that the bottom of the well screen was placed approximately seven feet below the groundwater surface, such that each screen straddled the water table (at the time of installation).
- Well sand pack was installed in the borehole annulus from at least one foot below the bottom of the well screen to at least two feet above the well screen.

- The remainder of the annulus was filled with hydrated bentonite chips and topped with six inches of sand.
- The monitoring wells were finished with locking stick-up protective casings.

During the installation of the monitoring wells, soils extracted with the drill rig were inspected and classified in the field. Refer to Figure 1 for the locations of the 10 shallow monitoring wells.

2.2 Staff Gauge Installation

On July 18, 2023, ASTI installed five staff gauges within the five largest surface water bodies on the Property. The staff gauge locations are depicted in Figure 1. Each staff gauge consists of a 6-foot-long, metal fencepost driven at least 3 feet into the bottom of the water body with a 1-meter, graduated stream gauge permanently bolted to it. Each stream gauge was marked in feet, with graduations every 0.02 foot allowing readings to be collected with an accuracy of 0.01 foot. Each staff gauge was placed into at least one foot of water.

2.3 Well Development

Following installation, the monitoring wells were developed to improve the hydraulic connection with the formation and to remove silt and fine sand particles mobilized by the drilling process. Development was conducted by surging each well with a surge block to create alternating inward and outward movement of water through the well screen and sand filter pack. Sediments from the aquifer that accumulated in the well were removed by over pumping (pumping at rates higher than used during typical sampling). Well development continued until the purged water was visually clear following surging. Purge water from the well development was discharged to the ground surface around the wells.

2.4 Surveying

Following the installation, ASTI surveyed the locations and elevations of the wells and staff gauges. The survey was conducted using a survey-grade GPS unit. The survey was completed within the Michigan State Plane coordinate system using the NAD83 datum. Locations were surveyed to within ± 0.1 foot horizontally and ± 0.01 foot vertically. The vertical elevations are relative to the height above the World Geodetic System reference ellipsoid. The elevations were later converted to orthographic elevation using the EGM 2008 model. Well elevations were surveyed at a marked location on the north side of the top of the casing.

For the staff gauge locations, the survey elevation was from the top of the graduated stream gauge (3.33 feet). Table 1 presents the survey coordinates for the wells and staff gauges, along with the top-of-well casing and top-of-gauge elevations. Water elevations are presented in feet above mean sea level (AMSL).

Monitoring well MW-9 was re-surveyed to confirm its top-of-casing elevation. The original survey results for all other monitoring wells were consistent with topographic maps and aerial imagery; however, MW-9 appeared as an outlier, with a calculated groundwater elevation approximately 10 feet higher than that of surrounding wells. Given this inconsistency, a resurvey was conducted to verify the accuracy of its casing elevation. The re-survey was performed using a level loop survey method, with MW-10 serving as the reference point. Results from the re-survey confirmed that MW-9's casing elevation had been previously misrecorded. Considering the error identified in MW-9, all monitoring wells and staff gauges were subsequently re-surveyed by a licensed land surveyor. The updated elevations were used in groundwater elevation calculations and incorporated into the contour maps, which are further discussed below.

3.0 LOCAL GEOLOGY AND HYDROGEOLOGY

3.1 Geology

The Property is in the Southeastern Interlobate region of Michigan. The region is characterized by many depressions, lakes, and morainic ridges. The interlobate area is characterized by highly varied and complex landform surfaces that contain numerous lakes and swamps and have a hilly topography. Short, steep slopes are common in this region, and soils are extremely variable over short distances, with sandy and gravelly soils dominating. "Kettles" (spring-fed lakes) are ubiquitous in the interlobate region. The unconsolidated glacial deposits in the area are generally between 1 and 20 meters thick and comprised of glacial outwash sand and gravel and post-glacial alluvium. Soils identified by ASTI's field personnel during the well installation were primarily sand with interbedded silt and silty clay units. The silts and silty clays appear to be discontinuous, while the sand layers appear to be regionally connected. Refer to the boring logs presented in Attachment A for details regarding the lithology encountered in each of the monitoring well borings.

The unconsolidated deposits overlie the Marshall Formation, a Mississippian-age sandstone formation, which consists of a lower Marshall and Napoleon members. The total thickness of the Marshall Formation appears to vary between 40 and 110 meters. Generally, the Marshall Formation is sparsely fossiliferous, sometimes cross-bedded and rippled, very fine- to coarse-grained sandstone of buff, tan, or gray color. The Napoleon member is predominantly a medium-grained sandstone with some coarse sand intervals, non-fossiliferous, and commonly cross-bedded and rippled.

3.2 Groundwater and Surface Water Level Measurements

In July and December 2023, ASTI measured depths to groundwater in the 10 monitoring wells and surface water levels at each of the 5 staff gauges. From January to December 2024, ASTI mobilized to the Property monthly to measure depths to groundwater in the monitoring wells and surface water levels at the staff gauges. The groundwater levels were measured from the marked location on the top of each casing to within 0.01 foot using an electronic water level meter. Staff gauges were read to within 0.01 foot from the top of the gauge to the top of surface water using the graduated scale. The measurements were used to calculate the groundwater and surface water elevations for each monthly event. Refer to the groundwater and surface water elevation data summarized in Table 1. As stated above, groundwater and surface water elevation data have been recalculated using latest elevation survey results and the dataset presented herein, including tables and figures, have been produced using the re-collected and correct elevation data.

Horning Road divides the properties included in the mining permit application. The group of properties north of Horning Road are referred hereafter as the “north property,” and those south of Horning Road as the “south property.” Surface water gauges SG-3, SG-4, and SG-5 were installed in areas that provided monitoring data for this investigation; however, these gauges are now located outside of the properties included in the mining application. These gauges are referred to as “off-site” in Table 1.

Within the north property, groundwater elevations typically range from approximately 949 feet to 978 feet throughout the year. In 2024, measurements indicate that the average groundwater elevation was approximately 969 feet, with a relatively minor seasonal fluctuation of about 0.9 foot. Surface water elevations in the north property span from around 940 feet to 973 feet, although there were periods during which water levels fell below the gauge

reference point and were recorded as “dry” in Table 1. On average, the surface water elevation in 2024 was about 960 feet.

The south property, in contrast, does not contain any permanent surface water features. Groundwater levels in this area were generally higher than those in the north property, ranging from approximately 980 feet to 1000 feet. In 2024, the average groundwater elevation in the south property was about 987 feet, with a measured annual fluctuation of roughly 1.2 feet. Despite these slightly greater fluctuations compared to the north property, seasonal variation remained relatively minimal, suggesting that overall groundwater conditions are also stable in this portion of the Property.

In both the north and south properties, groundwater elevations showed limited seasonal variation, with changes of approximately 1 foot. The north property also featured moderate fluctuations in surface water elevations, but these generally remained within a narrow range of about 0.5 foot annually. Periods of temporarily “dry” readings in the off-site property were likely attributable to seasonal reductions in water level. Although gauges SG-3, SG-4, and SG-5 are no longer included within the future mining application boundary, their data contributed to the broader understanding of site hydrogeology. Overall, these findings suggest that groundwater and surface water within the properties adjacent to Horning Road exhibit stable elevations with relatively little annual fluctuations.

3.3 Groundwater Flow Direction

Groundwater flow directions were estimated from the July 2023 and July 2024 data. Figure 2 shows the groundwater surface elevations for July 2023, and Figure 3 shows the groundwater surface elevations for July 2024. Based on a review of the groundwater elevations and staff gauge surface water elevations, ASTI interprets that the surface water bodies on the Property are hydraulically connected to the groundwater and are generally expressions of the groundwater elevation. As shown on Figures 2 and 3, ASTI interpolated the groundwater and surface water elevations between data points to create the general configuration of the top of groundwater beneath the study area (including both the north and south properties, and the off-site property). Estimated groundwater flow directions are also depicted on the figures.

Seasonal fluctuations in both groundwater and surface water levels experienced little change throughout 2024, suggesting relatively stable hydrologic conditions. In addition to Watkins

Lake, wetlands and other surface water features in the north property appear to be hydrologically connected to the groundwater system. Monitoring data show that groundwater and surface water levels typically rise and fall in tandem, with both systems experiencing decreases during drier periods in late fall and winter and increases in spring and summer. Although the range of change for both groundwater and surface water is relatively small, the timing of these fluctuations further supports a likely hydraulic connection between the shallow aquifer and the wetland or surface water features.

Because staff gauge elevations show a strong correlation with nearby groundwater elevations, surface water elevations are incorporated into the groundwater surface contouring where applicable. As shown in Figures 2 and 3, the general groundwater surface configuration remained consistent between July 2023 and July 2024, with minor variations in localized elevations. Surface water gauges SG-3 and SG-4 were omitted from both contour maps. In July 2024, among other months, these gauges were dry, indicating that surface water in this area is not consistently present. In July 2023, their recorded elevations deviated from adjacent monitoring locations and distorted the groundwater surface contours, suggesting they may have been influenced by localized conditions rather than reflecting the greater area groundwater elevation.

Based on groundwater and surface water elevation data, groundwater generally flows from south to north across the north property. Just south of Horning Road, the hydraulic gradient flattens, indicating a transition zone where groundwater flow shifts. Data suggest the presence of a groundwater divide in the southern portion of the study area where MW-9 represents a localized high, with flow directions radiating away at least to the west, north, and east.

3.4 Conclusions

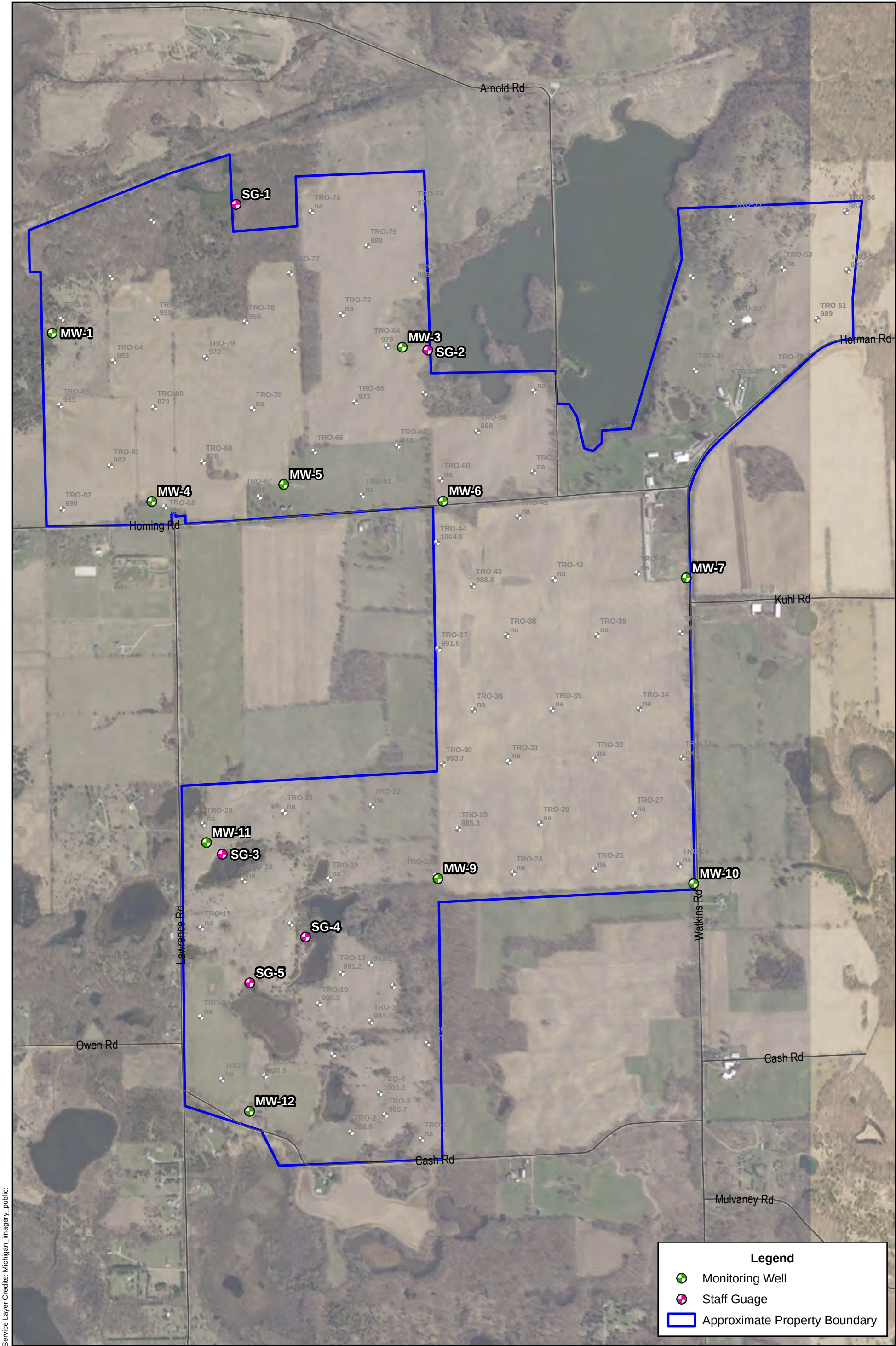
- Groundwater Elevation Ranges: Based on monitoring data, groundwater elevations in the north property range from approximately 949 feet to 978 feet, while elevations in the south property range from approximately 980 feet to 1,000 feet.
- Groundwater Flow Direction: Flow is generally from south to north across the study area, consistent with the observed hydraulic gradients and nearby surface water features. Data suggest the presence of a groundwater divide in the southern portion

of the study area where MW-9 represents a localized high, with flow directions radiating away at least to the west, north, and east.

- Seasonal Groundwater Variation: Overall, groundwater elevations exhibit minimal seasonal fluctuation, with observed annual changes of roughly 0.9 foot in the north property and 1.2 feet in the south property. Data indicates that overall groundwater conditions are stable in the Property.
- Hydraulic Connection to Surface Water: Surface water bodies, including both Watkins Lake and wetlands in the north property, appear hydraulically connected to the local groundwater system, as evidenced by simultaneous rises and declines in water levels.

FIGURES

- 1 – Sample Location Map
- 2 – July 2023 Groundwater Elevation Contour Map
- 3 – July 2024 Groundwater Elevation Contour Map

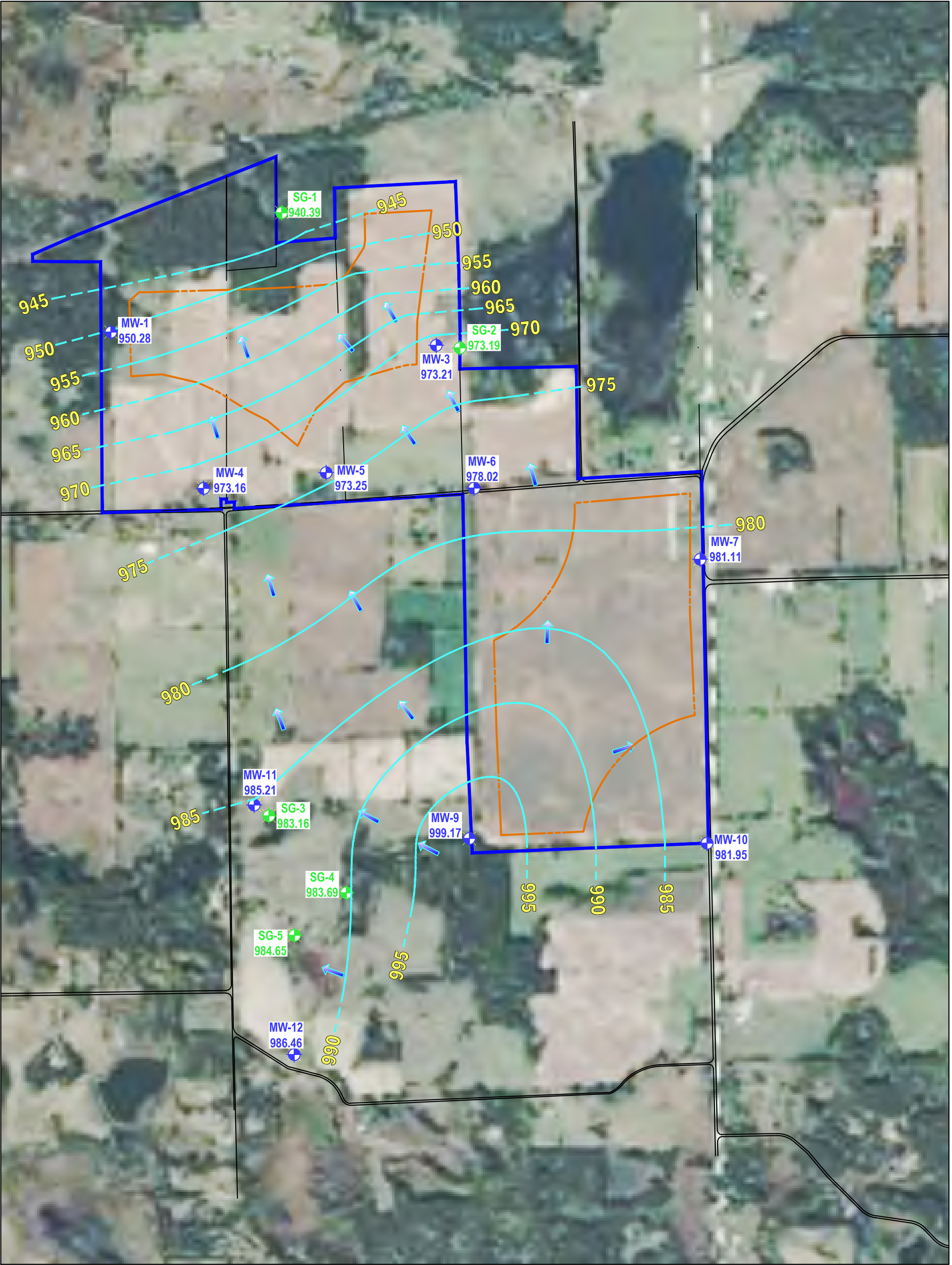


Norvell Township

Norvell Township, MI

Created for: Edward C Levy Company
Created by: RMH, September 27, 2023, ASTI Project 3-12691

Figure 1 - Sample Location Map



GRAPHIC SCALE

0 500 1000 2000

1 inch = 1000ft.
Paper Size = (11x17)

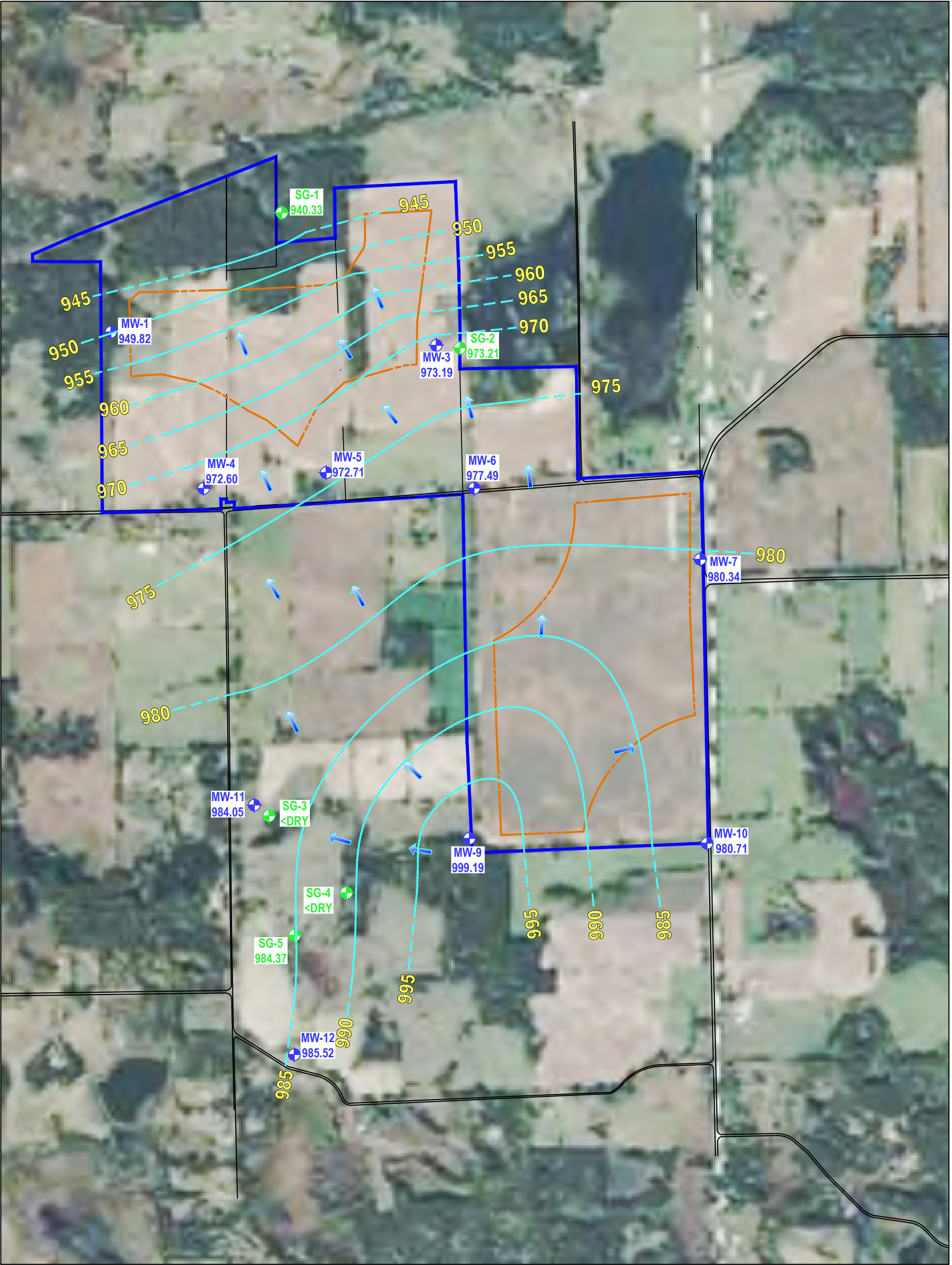
LEGEND

- Approximate Property Boundary
- Mining Limits
- Monitoring Well Location
- Staff Gauge Location
- Approximate Groundwater Flow Direction

NOTES: Elevations are in Feet AMSL.
Staff Gauges SG-3 and SG-4 are not used in contour.

981.95 Groundwater Elevation
981.95 Surface Water Elevation
Groundwater Surface Contour (5' interval)
dashed where inferred.

N



GRAPHIC SCALE

0 500 1000 2000

1 inch = 1000ft.
Paper Size = (11x17)

LEGEND

- Approximate Property Boundary
- Mining Limits
- Monitoring Well Location
- Staff Gauge Location
- Approximate Groundwater Flow Direction

981.95 Groundwater Elevation

981.95 Surface Water Elevation

990 Groundwater Surface Contour (5' interval) dashed where inferred.

NOTES: Elevations are in Feet AMSL. Staff gauges SG-3 and SG-4 were dry, and are therefore not contributing to the groundwater surface contour.

N

Norvell Township Hydrogeological Investigation

Client: American Aggregates of Michigan

ASTI Project A23-2691.03, RMH, November 6, 2025

Jackson County, MI

Figure 3 - July 2024 Groundwater and Surface Water Elevation Map



TABLES

- 1 2023 and 2024 Groundwater and Surface Water Elevations

Table 1 - 2023 and 2024 Groundwater and Surface Water Elevations

Norvell Township, Michigan

ASTI Project: A23-2691.03

				July 18, 2023		December 4, 2023		January 26, 2024	
Location	Northing*	Easting*	Top of Casing Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^
Monitoring Wells									
MW-1	227073.88	13180282.75	980.06	29.78	950.28	30.52	949.54	30.75	949.31
MW-3	226929.51	13183847.06	981.45	8.24	973.21	7.20	974.25	8.15	973.30
MW-4	225361.28	13181296.99	1007.41	34.25	973.16	35.00	972.41	35.30	972.11
MW-5	225533.06	13182639.68	1019.8	46.55	973.25	47.28	972.52	47.50	972.30
MW-6	225363.22	13184261.11	1024.95	46.93	978.02	47.57	977.38	47.90	977.05
MW-7	224583.33	13186737.61	1005.35	24.24	981.11	25.08	980.27	25.40	979.95
MW-9	221522.95	13184209.70	1033.8	34.63	999.17	35.05	998.75	35.39	998.41
MW-10	221469.05	13186811.15	1023.32	41.37	981.95	42.55	980.77	42.90	980.42
MW-11	221890.24	13181852.71	1003.91	18.70	985.21	19.79	984.12	19.90	984.01
MW-12	219155.65	13182290.54	1007.99	21.53	986.46	22.81	985.18	30.70	977.29
				Surface Water Above Bottom of 3.33' Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of 3.33' Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^
Location	Northing*	Easting*	Top of Staff Gauge Elevation (ft. AMSL)^						
Staff Gauges									
SG-1	228383.05	13182154.43	942.93	0.89	940.39	0.67	940.30	Unable to locate - downed trees	
SG-2	226898.33	13184211.13	975.6	0.89	973.19	0.60	972.9	0.91	973.21
SG-3	221771.56	13182013.99	985.38	1.08	983.16	0.39	982.47	0.43	982.51
SG-4	220928.49	13182861.24	985.8	1.19	983.69	0.40	982.9	0.50	983.00
SG-5	220462.27	13182293.50	986.55	1.40	984.65	1.12	984.37	1.90	985.15

Notes:

* - Michigan State Plane, South Zone (2113) NAD83

^ - Orthographic elevation based on the EGM 2008 model

ft. AMSL = Feet above mean sea level

ft. btor = feet below top of riser

DRY - Surface water or groundwater not present on day of monitoring

Key:

Property North of Horning Rd.

Property South of Horning Rd.

Off-Site

Table 1 - 2023 and 2024 Groundwater and Surface Water Elevations

Norvell Township, Michigan
ASTI Project: A23-2691.03

February 27, 2024		March 29, 2024		April 26, 2024		May 31, 2024		June 28, 2024		July 29, 2024	
Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^
30.50	949.56	30.50	949.56	30.02	950.04	30.08	949.98	30.16	949.90	30.24	949.82
8.80	972.65	8.18	973.27	8.11	973.34	8.28	973.17	8.39	973.06	8.26	973.19
34.85	972.56	34.79	972.62	34.96	972.45	34.97	972.44	35.03	972.38	34.81	972.60
47.12	972.68	47.01	972.79	47.12	972.68	47.19	972.61	47.24	972.56	47.09	972.71
47.45	977.50	47.41	977.54	47.48	977.47	47.51	977.44	47.57	977.38	47.46	977.49
24.71	980.64	24.73	980.62	24.82	980.53	24.89	980.46	25.01	980.34	25.01	980.34
34.30	999.50	34.37	999.43	34.44	999.36	34.49	999.31	34.55	999.25	34.61	999.19
42.47	980.85	42.42	980.90	42.41	980.91	42.39	980.93	42.52	980.80	42.61	980.71
19.30	984.61	19.39	984.52	19.34	984.57	19.46	984.45	19.71	984.20	19.86	984.05
22.40	985.59	22.24	985.75	22.13	985.86	22.07	985.92	22.27	985.72	22.47	985.52
Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^
0.76	940.39	0.82	940.45	0.89	940.52	0.87	940.50	0.71	940.34	0.70	940.33
0.90	973.20	0.90	973.20	1.12	973.42	1.01	973.31	0.89	973.19	0.91	973.21
0.46	982.54	0.42	982.50	0.48	982.56	0.38	982.46	0.21	982.29	DRY	DRY
0.68	983.18	0.61	983.11	0.62	983.12	0.57	983.07	0.42	982.92	DRY	DRY
1.80	985.05	1.78	985.03	1.82	985.07	1.49	984.74	1.12	984.37	1.12	984.37

Notes:

* - Michigan State Plane, South Zone (2113) NAD83

^ - Orthographic elevation based on the EGM 2008 model

ft. AMSL = Feet above mean sea level

ft. btor = feet below top of riser

DRY - Surface water or groundwater not present on day of monitoring

Key:

Property North of Horning Rd.

Property South of Horning Rd.

Off-Site

Table 1 - 2023 and 2024 Groundwater and Surface Water Elevations

Norvell Township, Michigan
ASTI Project: A23-2691.03

August 30, 2024		September 30, 2024		October 31, 2024		November 27, 2024		December 30, 2024	
Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^
30.33	949.73	30.55	949.51	30.69	949.37	30.80	949.26	30.94	949.12
8.42	973.03	8.73	972.72	8.86	972.59	8.94	972.51	8.91	972.54
34.79	972.62	35.07	972.34	35.25	972.16	35.38	972.03	35.56	971.85
47.17	972.63	47.39	972.41	47.57	972.23	47.72	972.08	47.91	971.89
47.60	977.35	47.83	977.12	47.99	976.96	48.15	976.80	48.36	976.59
25.12	980.23	25.38	979.97	25.57	979.78	25.76	979.59	25.91	979.44
34.62	999.18	34.89	998.91	35.06	998.74	34.99	998.81	35.13	998.67
42.74	980.58	42.96	980.36	43.11	980.21	43.27	980.05	43.57	979.75
20.17	983.74	20.52	983.39	20.59	983.32	DRY	DRY	DRY	DRY
22.76	985.23	23.13	984.86	23.46	984.53	23.68	984.31	23.88	984.11
Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^	Surface Water Above Bottom of Staff Gauge (ft.)	Surface Water Elevation (ft. AMSL)^
0.68	940.31	0.62	940.25	DRY	DRY	DRY	DRY	DRY	DRY
0.70	973.00	0.48	972.78	0.32	972.62	0.31	972.61	0.44	972.74
DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY

Notes:

* - Michigan State Plane, South Zone (2113) NAD83

^ - Orthographic elevation based on the EGM 2008 model

ft. AMSL = Feet above mean sea level

ft. btor = feet below top of riser

DRY - Surface water or groundwater not present on day of monitoring

Key:

Property North of Horning Rd.

Property South of Horning Rd.

Off-Site

ATTACHMENTS

Attachment A

Boring Logs with Monitoring Well Completion Diagrams



Boring ID:

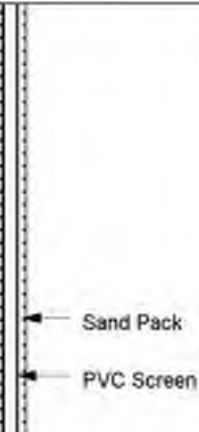
MW-1

Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/6/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 25' bgs
 Depth to GW (ft. bgs.): 24' bgs
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 227073.88
 Northing
 13180282.75
 Easting
 957.88
 Groundwater Elevation (ft. AMSL)
 987.66
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Silty Sand: Topsoil, medium to fine-grained, organics, brown to gray, loose (loamy sand)				
2		Silty Sand: medium to very fine-grained, trace clay, brown, slightly moist, loose (loamy sand)			70	
3						
4						
5						
6						
7						
8		Silty Sand: medium to fine-grained, trace clay and organics, brown, very moist (loamy sand)			80	
9						PVC
10						Bentonite
11						
12		Sand: very coarse to fine-grained, poor sorting, some gravel, iron rich lenses throughout around 3mm thick (sand)			80	
13						
14						
15						
16					60	
17						

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18		Sand: very coarse to fine-grained, poor sorting, some large gravel, crushed rock, very moist, iron rich lenses throughout around 3mm thick, wet at 24' (sand) END OF BORING			60	
19						
20						
21						
22					30	
23						
24						
25						
26						
27						
28						
29						

Comments:

N/A

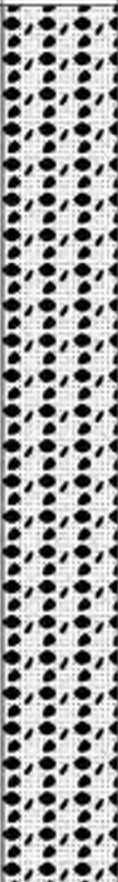

Boring ID:
MW-2

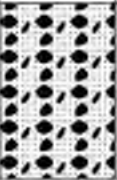
Client: Edward C Levy Co.
Project Name: Norvell
Project Number: 3-12691
Date Completed: 6/13/23
Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
Drilling Method: Direct Push Probe
ASTI Geologist: AAA
Total Depth (ft. bgs.): 50' bgs
Depth to GW (ft. bgs.): N/A
Well Type: Permanent
Casing Diameter: 2-Inch
Casing Material: PVC
Surface Completion: Stick up

Survey Data:
 N/A
 Northing
 N/A
 Easting
 N/A
 Ground Elevation
 N/A
 Top of Casing Elevation

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
0		Silt: Topsoil from 0'-0.5', organics, trace clay, brown (silt)				
1						
2						
3		Sandy Silt: trace gravel and clay, light brown (silt loam)			100	
4		Silty Clay: trace sand and gravel, light brown with dark brown mottles, very moist, medium dense (silty clay)				
5						
6						
7						
8					70	
9		Silty Sand: very coarse to very fine-grained, poorly sorted, some gravel, trace clay, light brown to brown, loose (loamy sand)				
10						
11		Clayey Sand: coarse to medium-grained, trace silt and gravel, light brown, very moist (sandy loam)			85	
12						
13		Silty Sand: poorly sorted, some gravel (loamy sand)				
14						
15						
16						
17					60	
18						
19		Sand: fine to medium-grained, well sorted, trace silt				
20					50	

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram			
21		Gravel and Sand: very coarse to medium-grained, very poorly sorted (sand)			50				
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36		Sand: very coarse to coarse-grained, well sorted, brown to gray, slightly moist, loose			50				
37									
38									
39		Gravel and Sand: very coarse to medium-grained, very poorly sorted, slightly moist (sand)			50				
40									
41		Sand: very fine to fine-grained, well sorted, trace silt, loose (sand)			50				
42									
43		Gravel and Sand: very coarse to medium-grained, very poorly sorted (sand)			55				
44									
45									
46									

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
47					55	
48						
49						
50						

Comments:

No well installed - unsaturated to 50' bgs



Boring ID:

MW-3

Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/12/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 15' bgs
 Depth to GW (ft. bgs.): 14' bgs
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 226929.51
 Northing
 13183847.06
 Easting
 975.77
 Groundwater Elevation (ft. AMSL)
 984.01
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Silty Sand: Topsoil, very fine to medium-grained, organics, trace gravel, brown to light brown, loose (loamy sand)			70	
2		Silty Sand: very fine to fine-grained, trace gravel, brown to light brown, loose (loamy sand)				
3		Silty Sand: trace clay and gravel, brown to dark brown, moist, loose (loamy sand)				Bentonite
4		Clayey Sand: light brown to gray, loose (sandy loam)			60	
5						
6		Sandy Clay: trace coal-like material, light brown to gray with brown to dark brown mottles, medium dense (sandy clay)				
7		Clayey Sand: light brown to gray, loose (sandy loam)				PVC
8						
9		Clayey Sand: coarse to very fine-grained, poor sorting some gravel, light brown to gray, moist, loose (sandy loam)			80	
10		Sand: medium to very fine-grained, well sorted, light brown, loose (sand)				
11		Sand: medium to very fine-grained, well sorted, trace to some clay, light brown, very moist, loose (sand)				
12		Clayey Sand: very fine to fine-grained, well sorted, trace gravel, gray with dark brown mottles (sandy loam)				Sand Pack
13		Sand: very coarse to fine-grained, poorly sorted, trace to some gravel, gray, loose wet at 14' (sand)				PVC Screen
14		END OF BORING				
15						
16						
17						

Boring ID: MW-3

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18						
19						

Comments:

N/A



Boring ID:

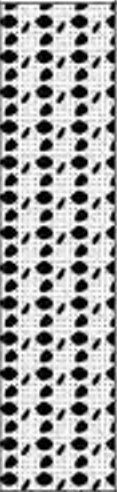
MW-4

Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/7/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 35' bgs
 Depth to GW (ft. bgs.): 34' bgs
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 225361.28
 Northing
 13181296.99
 Easting
 978.33
 Groundwater Elevation (ft. AMSL)
 1012.58
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Silty Sand: Topsoil, medium to fine-grained, organics, brown to gray, dry, loose, rock at 5' (loamy sand)			20	
2		Silty Sand: fine to medium-grained, trace organics, brown (loamy sand)				
3						
4						
5		Silty Sand: fine-grained, trace large gravel and organics, brown (loamy sand)			75	
6		Silty Sand: fine-grained, trace gravel, organics and clay, brown, moist (loamy sand)				
7						
8		Silty Sand: fine-grained, some clay, trace large gravel and organics, brown, moist, medium dense (loamy sand)				
9						
10						
11		Silty Sand: very coarse to medium-grained, brown, moist, loose (loamy sand)			60	
12						
13						
14						PVC
15		Gravel and Sand: very coarse to coarse-grained, poorly sorted, trace to some silt, brown, crushed rock at 22.5' (sand)			70	Bentonite
16						
17						

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18					70	
19						
20						
21						
22						
23						
24						
25						
26						
27						
28		Sand: very coarse to medium-grained, sorted, trace gravel, orange iron staining (sand)			60	
29						
30						
31						
32						
33						
34						
35						
36						
37						
38		Gravel and Sand: very coarse to coarse-grained, poorly sorted, trace to some silt, brown, crushed rock at 29.5', wet at 34' (sand)			65	
39						

Comments:

N/A

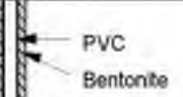
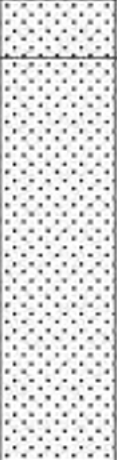

Boring ID:
MW-5

Client: Edward C Levy Co.
Project Name: Edit-Text
Project Number: 3-12691
Date Completed: 6/6/23
Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
Drilling Method: Direct Push Probe
ASTI Geologist: AAA
Total Depth (ft. bgs.): 45' bgs
Depth to GW (ft. bgs.): 44' bgs
Well Type: Permanent
Casing Diameter: 2-Inch
Casing Material: PVC
Surface Completion: Stick up

Survey Data:
 225533.06
 Northing
 13182639.68
 Easting
 974.88
 Groundwater Elevation (ft. AMSL)
 1021.43
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Silty Sand: Topsoil first 0.25', some organics, trace gravel, brown (loamy sand)			70	
2		Silty Sand: coarse-grained, trace clay, orangy brown, medium dense (loamy sand)				
3		Sand: fine to medium-grained, light brown to tan, loose (sand)				
4						
5		Sand: fine to medium-grained, light brown to tan, moist, loose (sand)				
6						
7		Sand: very coarse to fine-grained, poorly sorted, some gravel, light brown to gray, loose, large gravel at 15-20' (sand)			80	
8						
9						
10						
11						
12					85	
13						
14						
15						
16						
17					85	

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18					85	 PVC Bentonite
19						
20						
21						
22		Sand: fine to very fine-grained, well sorted, trace silt, light brown to tan (sand)			70	
23		Sand: very coarse to fine-grained, poorly sorted, some gravel, light brown to gray, loose (sand)				
24						
25						
26					60	
27						
28						
29						
30		Sand: very coarse to fine-grained, poorly sorted, some gravel, light brown to gray, slightly moist, loose (sand)			60	
31						
32						
33						
34		Sand: very coarse to fine-grained, sorted, some gravel, light brown to gray, loose, wet at 44' (sand)			75	
35						
36						
37						
38		END OF BORING			30	 Sand Pack
39						
40						
41						
42						
43						

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
44					30	 PVC Screen
45						
46						
47						
48						
49						

Comments:

N/A



Boring ID:

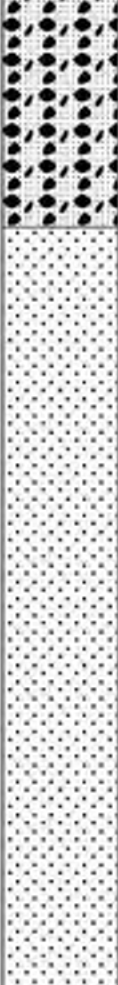
MW-6

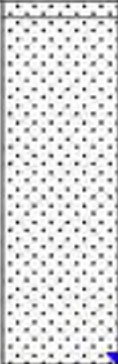
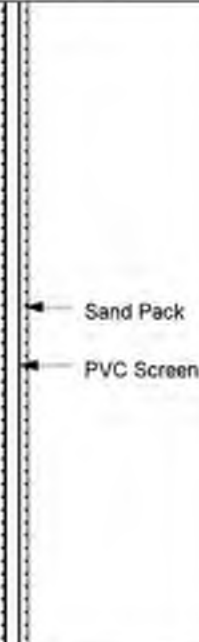
Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/6/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 50' bgs
 Depth to GW (ft. bgs.): 50' bgs
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 225363.22
 Northing
 13184261.11
 Easting
 978.77
 Groundwater Elevation (ft. AMSL)
 1025.7
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Silty Sand: fine to medium-grained, some organics, brown, dry, loose (loamy sand)				
2						
3		Silty Sand: medium to fine-grained, trace organics, light brown, slightly moist, loose (loamy sand)			35	
4		Clayey Sand: very fine-grained, some silt, brown, medium dense (sandy loam)				
5						
6						
7						
8					70	
9						
10						
11						
12						
13					90	
14						
15						
16					75	
17		Clayey Sand: very fine-grained, some silt, brown with dark				

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram	
18		brown mottles, moist, loose (sandy loam)			75		
19							
20		Silty Sand: very coarse to very fine-grained, poorly sorted, trace gravel, brown, moist, loose (loamy sand)			95		
21		Clayey Sand: very fine-grained, some silt, brown with dark brown mottles, moist, loose (sandy loam)					
22							
23		Sandy Clay: trace gravel, brown to gray, medium stiff (sandy clay)					
24					85		
25		Silty Sand: medium-grained, trace clay and gravel, brown, moist, loose (loamy sand)					
26							
27		Silty Sand: very fine-grained, well sorted, light brown (loamy sand)					
28					95		
29		Gravel and Sand: poorly sorted, brown to gray, loose (sand)					
30							
31		Sand: coarse to fine-grained, well sorted, brown to tan, orange stain iron lenses throughout around 1mm thick, loose (sand)					
32					85		
33							
34							
35							
36					50		
37							
38							
39							
40							
41							
42							
43							

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram			
44		Sand: very fine-grained, well sorted, light brown to tan, moist to very moist, loose, wet at 50' (sand)			50	 Sand Pack PVC Screen			
45									
46		END OF BORING			50				
47									
48									
49									
50									
51									
52									
53									
54									
55									

Comments:

N/A



Boring ID:

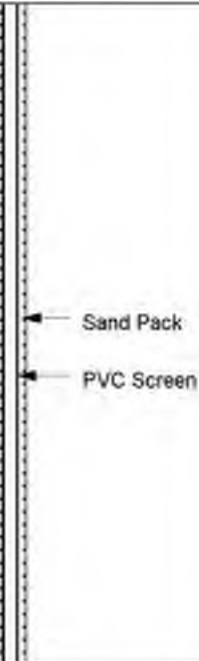
MW-7

Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/6/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 25' bgs
 Depth to GW (ft. bgs.): 24' bgs
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 224583.33
 Northing
 13186737.61
 Easting
 985.68
 Groundwater Elevation (ft. AMSL)
 1009.92
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Silty Sand: Topsoil, medium to fine-grained, organics, brown to gray, loose (loamy sand)				
2		Silty Sand: medium to very fine-grained, trace clay, brown, slightly moist, loose (loamy sand)			70	
3						
4						
5						
6						
7						
8		Silty Sand: medium to fine-grained, trace clay and organics, brown, very moist (loamy sand)			80	
9						PVC
10						Bentonite
11						
12		Sand: very coarse to fine-grained, poor sorting, some gravel, iron rich lenses throughout around 3mm thick (sand)			80	
13						
14						
15						
16					60	
17						

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18		Sand: very coarse to fine-grained, poor sorting, some large gravel, crushed rock, very moist, iron rich lenses throughout around 3mm thick, wet at 24' (sand) END OF BORING			60 30	 Sand Pack PVC Screen
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						

Comments:

N/A



Boring ID:

MW-8

Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/16/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 40' bgs
 Depth to GW (ft. bgs.): N/A
 Well Type: N/A
 Casing Diameter: N/A
 Casing Material: N/A
 Surface Completion: N/A

Survey Data:
 _____ N/A
 _____ Northing
 _____ N/A
 _____ Easting
 _____ N/A
 _____ Ground Elevation
 _____ N/A
 _____ Top of Casing Elevation

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
0		Sandy Silt: organics, trace gravel, brown to gray, dry (silt)				
1						
2		Silty Sand: medium to fine-grained, trace clay, medium dense (loamy sand)			85	
3						
4		Silty Sand: medium to fine-grained, some clay, trace gravel, light brown, slightly moist, medium dense (loamy sand)				
5						
6		Sand: very fine to fine-grained, well sorted, trace gravel and silt, light brown, dry, loose (sand)				
7						
8		Silty Sand: medium to fine-grained, some clay, trace gravel, light brown, very moist, medium dense (loamy sand)			75	
9						
10		Gravel and Sand: fine to very coarse-grained, very poorly sorted, trace iron lensing at 11', 13', and 14.5', large gravel from 18-20' (sand)				
11						
12						
13					70	
14						
15						
16						
17						
18					90	
19						
20					70	

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
21					70	
22						
23						
24						
25						
26						
27						
28		Sand: very fine to fine-grained, trace gravel, light brown to tan, slightly moist, loose (sand)			60	
29		Gravel and Sand: fine to very coarse-grained, very poorly sorted, dry (sand)				
30						
31						
32					65	
33						
34						
35						
36		END OF BORING			65	
37						
38						
39						
40						

Comments:

Well not installed - unsaturated to 40' - hit refusal at 40' bgs or above with three attempts

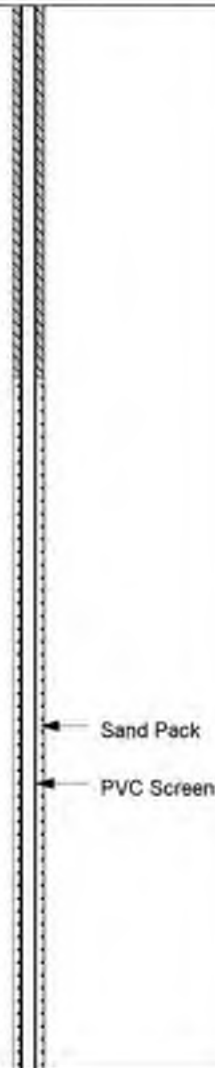

Boring ID:
MW-9

Client: Edward C Levy Co.
Project Name: Norvell
Project Number: 3-12691
Date Completed: 6/16/23
Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
Drilling Method: Direct Push Probe
ASTI Geologist: AAA
Total Depth (ft. bgs.): 35' bgs
Depth to GW (ft. bgs.): 31' bgs
Well Type: Permanent
Casing Diameter: 2-Inch
Casing Material: PVC
Surface Completion: Stick up

Survey Data:
 221522.95
 Northing
 13184209.75
 Easting
 1001.63
 Groundwater Elevation (ft. AMSL)
 1036.26
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Sandy Silt: some organics, trace gravel, brown to gray, dry (silt)				
2		Silty Sand: medium to fine-grained, trace clay, light brown, dry, medium dense (loamy sand)			85	
3		Silty Sand: medium to fine-grained, some clay, trace gravel, light brown to brown, moist, medium dense (loamy sand)				
4						
5						
6						
7					75	
8						
9		Sand: very coarse to very fine, poorly sorted, trace to some gravel, trace silt, light brown, loose (sand)				
10						
11						
12					80	PVC
13						Bentonite
14		Gravel and Sand: very coarse to fine-grained, very poorly sorted, slightly moist to moist, iron staining at 17.5', light brown very fine-grained sand lens around 1" thick at 18', crushed rock at 27.5', wet at 31' (sand)				
15						
16					85	
17						

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram	
18					85		
19							
20					55		
21							
22							
23							
24					55		
25							
26							
27							
28					55		
29							
30							
31					55		
32							
33							
34							
35	Silty Clay: trace gravel, brown, medium stiff, very fine-grained sand lens around 1" thick at 34.5 (silty clay)						
36	END OF BORING						

Comments:

N/A



Boring ID:

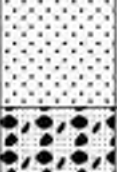
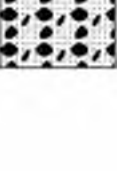
MW-10

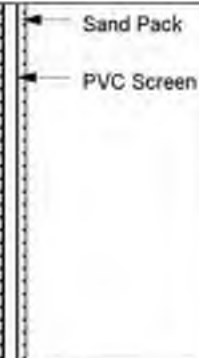
Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/13/23
 Site Address: Watkins Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 45' bgs
 Depth to GW (ft. bgs.): 45' bgs
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 221472.03
 Northing
 13186812.67
 Easting
 981.95
 Groundwater Elevation (ft. AMSL)
 1023.32
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		Silt: very fine to fine-grained, some sand, trace organics, brown (silt)			70	
2						
3		Silty Sand: fine to medium-grained, light brown, dry, medium dense (loamy sand)				
4		Clayey Sand: coarse to medium-grained, light brown, dry, medium dense (sandy loam)				
5						
6		Silty Clay: medium to fine-grained, trace sand and gravel, light brown, soft (silty clay)			95	
7						
8						
9						
10		Gravel and Sand: very coarse to fine-grained, poorly sorted, brown to light brown, loose (sand)			60	
11						
12						
13						
14						
15						
16					40	
17						

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18		Sand: very coarse to medium-grained, trace silt and gravel, light brown, slightly moist, loose (sand)			40	 PVC Bentonite
19						
20						
21		Gravel and Sand: very coarse to fine-grained, poorly sorted, brown to light brown, loose, crushed rock at 37.5' and 39' (sand)			50	
22						
23						
24					10	
25						
26						
27					40	
28						
29						
30					55	
31						
32						
33					65	
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
44		Sand: very coarse to medium-grained, sorted, trace gravel, light brown to tan, loose, wet at 45'			65	
45		END OF BORING				
46						
47						
48						
49						
50						

Comments:

N/A



Boring ID:

MW-11

Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/2/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 18' bgs
 Depth to GW (ft. bgs.): 13' bgs
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 221890.24
 Northing
 13181852.71
 Easting
 987.83
 Groundwater Elevation (ft. AMSL)
 1006.53
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0		NO RECOVERY				Cement
1						
2					0	Bentonite
3						
4						
5						
6						
7					0	PVC
8						
9						
10						
11						
12		SAND: medium-grained, well sorted, tan, moist, saturated at			60	Sand Pack
13		13' bgs (sand)				PVC Screen
14						
15						
16						
17						

Boring ID: MW-11

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18						

Comments:

N/A



Boring ID:

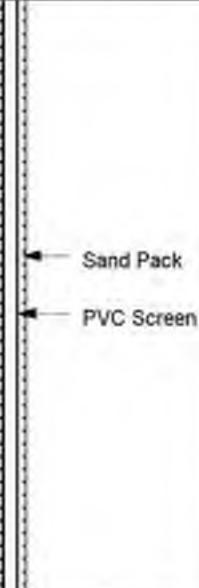
MW-12

Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/2/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: BJE
 Total Depth (ft. bgs.): 20' bgs
 Depth to GW (ft. bgs.): N/A
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 219155.65
 Northing
 13182290.54
 Easting
 987.97
 Groundwater Elevation (ft. AMSL)
 1009.5
 Top of Casing Elevation (ft. AMSL)

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
-3						Casing
-2						Cap
-1						Casing
0						Cement
1		SAND: fine to medium-grained, well sorted, brown, moist, sharp contact (sand)				
2						
3						
4						
5						
6						
7						
8						PVC
9						Bentonite
10						
11						
12						
13		SILT: brown, moist, gradational contact (silt)				
14		SILTY CLAY: brown, stiff, gradational contact (silty clay)				
15						
16						
17		SILTY CLAY: gray, moist, stiff, sharp contact (silty clay)				

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
18		SAND: medium-grained, well sorted, brown, wet (sand)				 Sand Pack PVC Screen
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						

Comments:

N/A



Boring ID:

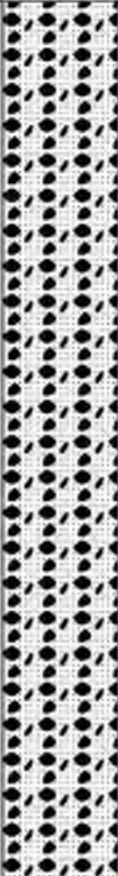
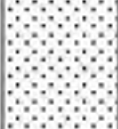
MW-13

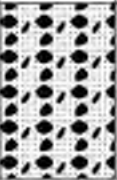
Client: Edward C Levy Co.
 Project Name: Norvell
 Project Number: 3-12691
 Date Completed: 6/13/23
 Site Address: Horning Road
 Norvell Twp, MI

Driller: Fibertec
 Drilling Method: Direct Push Probe
 ASTI Geologist: AAA
 Total Depth (ft. bgs.): 50' bgs
 Depth to GW (ft. bgs.): N/A
 Well Type: Permanent
 Casing Diameter: 2-Inch
 Casing Material: PVC
 Surface Completion: Stick up

Survey Data:
 _____ N/A
 _____ Northing
 _____ N/A
 _____ Easting
 _____ N/A
 _____ Ground Elevation
 _____ N/A
 _____ Top of Casing Elevation

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
0		Silt: Topsoil from 0'-0.5', organics, trace clay, brown (silt)				
1						
2						
3		Sandy Silt: trace gravel and clay, light brown (silt loam)			100	
4		Silty Clay: trace sand and gravel, light brown with dark brown mottles, very moist, medium dense (silty clay)				
5						
6						
7						
8					70	
9		Silty Sand: very coarse to very fine-grained, poorly sorted, some gravel, trace clay, light brown to brown, loose (loamy sand)				
10						
11		Clayey Sand: coarse to medium-grained, trace silt and gravel, light brown, very moist (sandy loam)				
12					85	
13		Silty Sand: poorly sorted, some gravel (loamy sand)				
14						
15						
16						
17					60	
18		Sand: fine to medium-grained, well sorted, trace silt				
19						
20					50	

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram			
21		Gravel and Sand: very coarse to medium-grained, very poorly sorted (sand)			50				
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36		Sand: very coarse to coarse-grained, well sorted, brown to gray, slightly moist, loose			50				
37									
38									
39		Gravel and Sand: very coarse to medium-grained, very poorly sorted, slightly moist (sand)			50				
40									
41		Sand: very fine to fine-grained, well sorted, trace silt, loose (sand)			50				
42									
43		Gravel and Sand: very coarse to medium-grained, very poorly sorted (sand)			55				
44									
45									
46									

Depth (ft.)	Graphic Log	Lithologic Description	PID (ppm)	Sample Depth	Recovery	Well Diagram
47					55	
48						
49						
50						

Comments:

No well installed - unsaturated to 50' bgs

Attachment B

Historical Elevation and Water Level Data

Table 1 - Groundwater Elevations

Norvell Township, Michigan

ASTI Project: 3-12691

Location	Northing*	Easting*	Top of Casing Elevation (ft. AMSL)^	Depth to Water (ft. btor)	Groundwater Elevation (ft. AMSL)^
MW-1	227073.88	13180282.75	987.66	29.78	957.88
MW-3	226929.51	13183847.06	984.01	8.24	975.77
MW-4	225361.28	13181296.99	1012.58	34.25	978.33
MW-5	225533.06	13182639.68	1021.43	46.55	974.88
MW-6	225363.22	13184261.11	1025.7	46.93	978.77
MW-7	224583.33	13186737.61	1009.92	24.24	985.68
MW-9	221522.95	13184209.75	1036.26	34.63	1001.63
MW-10	221472.03	13186812.67	1023.32	41.37	981.95
MW-11	221890.24	13181852.71	1006.53	18.7	987.83
MW-12	219155.65	13182290.54	1009.5	21.53	987.97
SG-1	228383.05	13182154.43	945.02	0.89	942.61
SG-2	226898.33	13184211.13	981.27	0.89	978.86
SG-3	221771.56	13182013.99	989.19	1.08	986.97
SG-4	220928.49	13182861.24	990.43	1.19	988.32
SG-5	220462.27	13182293.50	992.71	1.4	990.81

Notes:

* - Michigan State Plane, South Zone (2113) NAD83

^ - Orthographic elevation based on the EGM 2008 model

ft. AMSL = Feet above mean sea level

ft. btor = feet below top of riser

ASTI ENVIRONMENTAL
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- **DEVELOPMENT INCENTIVES AND GRANT MANAGEMENT**
- **ECOLOGICAL ASSESSMENTS AND RESTORATION**
- **ENVIRONMENTAL ASSESSMENTS AND IMPACT STATEMENTS**
- **ENVIRONMENTAL OPPORTUNITIES ASSESSMENT**
- **GIS MAPPING**
- **HAZARD MITIGATION PLANNING**
- **MINING AND RECLAMATION ASSISTANCE**
- **REMEDIATION IMPLEMENTATION, OPERATION AND MAINTENANCE**
- **PHASE I ESA AND ENVIRONMENTAL DUE DILIGENCE ASSESSMENTS**
- **REGULATORY COMPLIANCE AND PERMITTING**
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