Mason & Partridge Drain
Drain Study
Fruitland Township
Muskegon County, Michigan

PRELIMINARY ENGINEERING REPORT

David S. Fisher
Muskegon County Drain Commissioner

Project No. 12022.00
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1.0 INTRODUCTION

In July of 2012 The Muskegon County Drain Commissioner (MCDC) commissioned a drainage study based on significant drainage concerns from the White Lake Golf Club and several other areas of concern which have been brought to the forefront. At this time a formal petition has not been received at the MCDC office.

The purpose of this Drainage Study is to determine how two existing drains, the Mason Drain and the Partridge Drain, may be affecting drainage issues on the White Lake Golf Club. The main areas of concerns are in respect to vegetative overgrowth and poor flow of hydrology through the system. The Drainage Study will address existing drainage issues associated with both Drains and the Drainage Districts, and will include a comprehensive plan outlining recommendations for each system.

The Mason Drain is located in Sections 12 and 13 of Fruitland Township, Muskegon County, Michigan, just south of White Lake. The main drain is a 12-inch Vitrified Clay Pipe (VCP) located on the White Lake Golf Club and discharging to White Lake. An open drain continues to the east through the golf course and neighboring wooded area parallel to Michillinda Road before crossing Michillinda Road with a 12-inch Reinforced Concrete Pipe. The 12-inch culvert relays a significant drainage area south of Michillinda Road. There is also significant watershed area south of the golf course traversing along Scenic Drive via ditching and culverts which also contributes to this outlet.

The Partridge Drain is located in Sections 7 and 12 of Fruitland Township, Muskegon County, Michigan, just south of White Lake. The main drain is a 10-inch non-reinforced concrete pipe located between the edge of the roadway and Right of Way line on the west side of Lamos Road. The 10-inch pipe outlets just north of South Shore Drive to a deep ravine which has significant erosion control issues. There are currently two (2) other large diameter pipes discharging to this ravine as well as direct roadway runoff. The ravine channels runoff to White Lake.

The Mason Drain Drainage District is comprised of lands zoned by Fruitland Township and has several different area designations. The majority of area in the district is zoned Lake Michigan Shoreline (LMS), Inland Lakes (IL), Forest Preservation and Recreation (FPR) and Low Density Residential (LDR). The future land use for the properties within this drainage district is not anticipated to change significantly.

The Partridge Drain Drainage District is located adjacent to and east of the Mason Drain Drainage District. The Partridge Drain Drainage District is also comprised of lands zoned by Fruitland Township and is primarily comprised of residential designations including Rural Residential (RR), Low Density Residential (LDR), Medium Density Residential (MDR) and Medium High Density Residential along the White Lake waterfront. The future land use for the properties within this Drainage District is not anticipated to change significantly.

Overall the system was modeled using common Drain Commissioner design standards for pipe sizing for a 10-year storm event (24-hour event) and a 100-year event for streams and channels.

The soils within the Mason Drain & Partridge Drain Drainage Districts were analyzed to determine how the soils could be contributing to the problem (vegetative overgrowth and lack of...
water movement) and also as a tool to determine effective solutions. A large portion of the soils within the Drainage District (approximately 50 percent) are Plainfield sand (PlfabB), as identified by the USDA Soil Survey Map, with 0 to 6 percent slopes. The Plainfield sand series consists of very deep, excessively drained soils formed in sandy drift on outwash plains, valley trains, glacial lake basins, stream terraces and moraines and other upland areas. Permeability is rapid or very rapid. The majority of the remaining soils are primarily different types of well drained sand (Plainfield, Covert-Pipestone, Roscommon and Au Gres sands, etc). See Appendix D for a breakdown of the soil types for the Drainage District(s). All these soils are moderately well drained soils having very deep till profiles that are found in lake plain areas on the west side of Michigan. The presence of these soil types indicate that any ditch re-grading or widening will require extreme caution to assure long-term slope stability and decrease sedimentation within the system.

The main areas of concern in the Mason Drain related to soils, located in the linear ditch on the golf course, are classified as Tonkey and Deford soils (Td), as identified by the USDA Soil Survey Map. The Tonkey series consists of very deep, poorly drained and very poorly drained soils formed in stratified loamy and sandy glacifluvial deposits on lake plains, outwash plains, or glacial drainage ways. Slope ranges from 0 to 2 percent.

The large wetland complex in the Partridge Drain Drainage District, located on Lamos Road between South Shore Drive and Michillinda Road, consists of Pipestone-Covert-Saugatuck sands (PpsaaA), as identified by the USDA Soil Survey Map, with 0 to 3 percent slopes. This soil type consists of very deep, somewhat poorly drained soils with cemented subsoil. These soils formed in sandy glacifluvial deposits on lake plains, till plains and outwash plains.

The areas within the proposed Drainage District have some portions that may be wetland hydric soils or wetlands, according to the Michigan Department of Environment Quality (MDEQ) Muskegon County Wetland Inventory Map (see Appendix E). Based on a review of this map, it appears as though the linear wetland through the golf course contains wetland hydric soils. The large wetland complex in the Partridge Drain located on Lamos Road is a regulated wetland.

Research of the drainage systems indicates that there was some maintenance work done on the Mason Drain between South Shore Drive and the outlet at White Lake. A new drainage structure was placed and the pipe was replaced from the rear yard areas north of South Shore Drive to the outlet. There has also been a history of root intrusion in the main drain near South Shore Drive. The pipe has been cleaned twice in the last two years to remove large tree roots from the joints. More recently in October of 2012 the pipe in this location was experiencing blockages due to root intrusion and was cleaned and televised.

The Partridge Drain appears to have been relocated from its original location based on the comparison between the 1906 Final Order of Determination and the current physical location of the drain on the west side of Lamos Road. The outlet on the north side of South Shore Drive was historically located on publicly owned land by the route and course with rights for drainage and access purposes to the Drain Commissioner. It is our understanding that a portion of this property has been transferred to the neighboring property to the east. The neighboring property was building a new home at the time of this study.

Fitzgerald Henne & Associates, Inc. was asked to perform the following tasks in order to analyze the areas within the Mason Drain Drainage District and the Partridge Drain Drainage District:
• Review and research existing record information (County maps, aerial photographs, topographic information, County Road Commission records, existing land use information, etc.).

• Inventory and inspection of both Drains - documenting all problems, elevations and any issues associated with each Drain’s functionality. This will include all known issues (including but not limited to the existing 12-inch VCP tile on the White Lake Golf Club) and documentation of any new engineering related concerns.

• An overall drainage review of the study area and watershed district boundaries for the Mason Drain and Partridge Drain. This will include documentation of low areas and/or flooding and potential solutions.

• Perform hydraulic analysis for both drainage system(s) to determine overall drain capacity and determine recommendations.

• An in-depth analysis of the main problematic drainage issues identified on the White Lake Golf Club course (lack of flow on course, 12-inch tile for drainage, pond issues, etc). This analysis will include solutions to the drainage problem(s), recommendations for maintenance or improvements, and methods for implementation (drain petition, private work, drain maintenance, etc.) This analysis will also include any potential project partnerships based on the recommendations.

• Obtain from the Muskegon County GIS department all current parcel information for properties potentially within the proposed Drainage Districts.

• Obtain USGS datum benchmarks and State Plane coordinates for the area from the Muskegon County GIS department and the Muskegon County Road Commission.

• Review any MCDC and Fruitland Township records pertinent to the project, including any meeting notes or previous complaints associated with past stormwater issues within both Drainage Districts and the study area.

• Obtain from Fruitland Township the existing zoning and future land use and / or master plan for areas of the Drainage District for use in recommendations and analysis of the Drains and their watersheds.

• Obtain from the MDEQ any available wetland inventory information for the immediate study area and adjacent to both Drains all the way to their discharge points at White Lake.

• Research USDA Soil Survey Maps for the immediate area to understand sub-surface and geotechnical conditions that may impact design alternatives and recommendations for the main study area and both Drains.

• Obtain and review any design information (current floodplain issues, discharge requirements, legal lake levels, etc.) pertinent to White Lake that may affect the water levels downstream on both Drains, as well as any issues associated with additional discharges from the County Drains.
• Identify and meet with project partners associated with potential recommendations environmental discharge issues and areas of concern.

• Meet with property owners on-site in each of the study areas to document any drainage issues or concerns.

• Review with the MCDC and potential lining companies issues associated with the existing 12-inch tile of the Mason Drain on the White Lake Golf Club.

• Review existing Drain information including any additional inspection reports, maintenance and service records on adjacent or downstream drains, any complaint reports and any District Boundary, 433 Agreements or plat and site condominium information. Adjacent Drainage District information will be researched for determining and verifying County Drain Drainage District boundaries and identifying any gaps or overlaps.

• Review with the MCDC’s maintenance staff any service or repair work performed on both Drains from the upper terminus to the outlet at White Lake.

• Review and research existing record information pertinent to both existing Drains and the study area at the Muskegon County Road Commission. This may include Road Commission structures, culverts or ditches that may have been installed adjacent to the Drains. This will also include obtaining all survey data for elevations of all road crossings on the County Drains and any Road Commission culverts or ditches adjacent to these Drains that may impact recommendations or proposed work. For this proposal we assume that all baseline elevation data is available for all County road crossings of the County Drains.
2.0 EXISTING CONDITIONS AND DRAINAGE ANALYSIS

Mason Drain

The lands within the Mason Drain Drainage District are primarily low density rural residential properties and forested area. Increased development of the area to altering land uses (commercial or industrial) will most likely not occur. Therefore the system can be monitored and analyzed based on its current condition and site constraints to develop a consistent flow model for the entire Drainage District.

The overall problem with the Mason Drain is the vegetative overgrowth and lack of flow through the system. This concern is most noticeable in the linear ditch and pond on the White Lake Golf Club located near Michillinda Road.

The main drain is a 12-inch VCP pipe located primarily on the White Lake Golf Club and traversing in a northeasterly direction from the pond located in the southwest corner of the golf course (near hole #12 Green) to the outlet at White Lake. The outlet at White Lake is a 12-inch HDPE pipe across the beach sand to the edge of water.

The main drain north of South Shore Drive from the outlet continues on a diagonal path between two (2) residences. The residences are fairly close together and do not allow for easy maintenance should an issue occur with the pipe in that location. The visual inspection of the drainage structure just south of South Shore Drive showed the pipe across the road approximately 75 percent submerged indicating there may be an issue with the pipe under the roadway.

A repair to the 12-inch main drain was done between South Shore Drive and White Lake in the rear yards of those residences in the last 20 years. The repair included new PVC pipe and one (1) concrete drainage structure. The groundwater seepage which percolates through the rear yards in this location causing concentrated overland flow indicates that there may be underground springs at this location. The photos of the repair also show a significant amount of groundwater in the trench.

During preparation of this report it was reported to the MCDC that there was a blockage in the 12-inch main under South Shore Drive. MCDC consulted with Pollution Control Services (PCS) to make the necessary repairs to clear the line. Upon investigation it was found that large tree root balls were intruding through joints in the VCP pipe between CB 10 and MH 11. PCS informed FHAI that they had done the exact same treatment approximately 2-3 years ago. Following the cutting of the tree roots from the pipe the line was televised to make certain no breaks occurred in the pipe. The video confirmed the extensive root intrusion problem and also showed the entrance of two (2) service leads entering the pipe. Based on an external review of the homes near the services it is possible that the two lines are sanitary sewer lines.

The 12-inch main drain appears to be in good condition on the sections through the Golf Course. The pipe ranges in depth from 7 to 12 feet from the ground surface with access structures located approximately every 300 feet. The existing pipe is currently installed at an approximately 0.20 percent slope from the Golf Course pond to South Shore Drive which is extremely flat and limits flow through the system. Discussions with the Golf Course personnel indicate that the pipe was televised approximately 15 to 20 years ago and no physical record of the pipe condition exists. The access structures are square concrete structures which appeared...
very clean and in good condition. The inlet pipe at the pond did not have any protection and appeared susceptible to clogging although it did have a standpipe for overflow relief.

A linear wetland is located on the Golf Course running in an East-West direction and drains to the pond in the southwest corner. The linear wetland is a shallow drainage ditch with hydric wetland soils which make excavation and shaping difficult. The groundwater level coincides with the ditch centerline elevation in this area. Discussions with the Golf Course Superintendent indicate that several attempts have been made to excavate the ditch with no success due to the soil conditions. The consistent shallow water depths (less than 24 inches) promote ideal conditions for reed canary grass and cattails to take over which is currently the case. There is also a significant amount of algae bloom in the ponds. Both of these issues are most likely due to lack of flow through the overall system and sediment build up in the drainage system and ponds. There are five (5) existing 12-inch diameter PVC culverts located along this linear wetland for golf cart and pedestrian crossings.

The drainage ditch extends from the Golf Course to the east through the wooded area before crossing Michillinda Road approximately 1500 feet east of Scenic Drive. The drainage ditch through the wooded area is shallow but easily identifiable with very few obstructions. The 12-inch RCP culvert under Michillinda Road appears in good condition and conveys drainage from the areas south of Michillinda Road. The aforementioned drainage ditches are currently not included in the route and course of the Mason Drain.

The areas along Scenic Drive south of Michillinda are also flowing to the north towards the Golf Course pond but the stormwater is being detained in a constructed pond on private property approximately 500 feet southwest of the Golf Course pond. A 12-inch diameter concrete culvert under Scenic Road approximately 400 feet south of Michillinda Road allows water to drain to the constructed pond through a low lying area. The culvert was recently extended by the homeowner in order to construct a driveway to the property. The condition of the pipe should be evaluated.

The constructed pond at this location is storing the majority of the upstream runoff and not allowing continued flow through the system to the Golf Course pond and White Lake. The physical conditions in this area include a shallow defined ditch located on the northwest corner of the pond and running along the west side of the private driveway to residences on the east. A 12-inch pipe from the catch basin located in the private driveway to the ditch, which would allow drainage to the Golf Course, appears to be blocked and is not visible from the surface. However, the ditch is currently graded to flow back to the constructed pond and not toward Michillinda Road and the golf course. The current grading of the ditch and apparent pipe blockage are inhibiting the flow of water to the Golf Course pond. The depth and capacity of the constructed pond are also limiting factors to additional stormwater reaching the Golf Course pond. The existing ditch, constructed pond and culvert under Scenic Drive are currently not included in the route and course of the Mason Drain.

It should be noted that there are several low lying areas throughout the District that are likely infiltrating a significant amount of water through the existing sandy well drained soils. Soil conditions can change dramatically in short distances throughout the study area. The soil conditions are certainly a factor and inhibiting some runoff from reaching the Golf Course.

The following table lists the condition and survey summary of various areas along the Mason Drain. Following this table is a series of pictures corresponding to some of the areas listed in the table.
### MASON DRAIN CONDITION SUMMARY:

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<tr>
<th>LOCATION</th>
<th>DESCRIPTION</th>
<th>ELEVATIONS</th>
<th>PIC #</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Drain</strong></td>
<td>12&quot; Main Drain Outlet at White Lake</td>
<td>12&quot; INV = 577.44</td>
<td>1</td>
<td>Pipe outlets at beach near the waters edge</td>
</tr>
</tbody>
</table>
| **Main Drain**    | MH #11 Located in the rear yards north of South Shore Drive                 | RIM ELEV = 587.72  
12" INV(SW) = 585.61  
12" INV(NE) = 583.59                                                   | 2&3   | 4' dia. Structure in good condition. 15"(NE) pipe capped off below 12"(NE) pipe. PVC Pipes. |
| **Main Drain**    | CB #10 Located on south side of South Shore Drive on White Lake Golf Club   | RIM ELEV = 613.56  
12" INV(SW) = 603.69  
12" INV(NE) = 603.95  
INV(SW) = 603.92                                                       | 4&5   | 4' square structure in good condition. Casting is broken. VCP Pipes.                        |
| **Main Drain**    | CB #9 Located on White Lake Golf Club                                       | RIM ELEV = 614.35  
12" INV(NE) = 603.95  
12" INV(SW) = 604.71                                                     | 6&7   | 4' square structure in good condition. VCP pipes.                                           |
| **Main Drain**    | CB #8 Located on White Lake Golf Club                                       | RIM ELEV = 614.75  
12" INV(SW) = 604.78  
12" INV(NE) = 604.71                                                     | 8     | 4' square structure in good condition. VCP pipes.                                           |
| **Main Drain**    | CB #7 Located on White Lake Golf Club                                       | RIM ELEV = 612.68  
12" INV(SW) = 605.00  
12" INV(NE) = 605.63                                                     | 10&11 | 4' square structure in good condition. VCP pipes.                                           |
| **Main Drain**    | Inlet to Main Drain at Golf Course Pond in SW corner.                      | 12" INV = 605.94                                                           | 12    | No protection at inlet. VCP pipe does have a stand pipe for overflow.                        |
| **Proposed**      | 12" pipe outlet to Golf Course Pond from Michillinda                        | 12" INV = 605.89                                                           | 13    | No protection at outlet.                                                                      |
| **Proposed**      | CB #5 Located on the north side of Michillinda Road near Scenic Drive      | RIM ELEV = 608.18  
12" INV(N) = 606.28  
12" INV(S) = 606.63                                                       | 14    | 2' diameter structure in fair condition. RCP pipes.                                          |
| **Proposed**      | CB #4 Located on the south side of Michillinda near Scenic Drive           | RIM ELEV = 611.37  
12" INV(S) = 608.22  
12" INV(N) = 608.43                                                       | 15    | 2' diameter brick structure in fair condition. RCP pipes.                                    |
| **Proposed**      | Centerline of Ditch from Constructed Pond towards Michillinda              | CL DITCH = 610.21  
CL DITCH = 610.99  
CL DITCH = 611.85                                                       | 16&17 | The ditch flows towards the constructed pond from Michillinda Road                           |
<p>| <strong>Proposed</strong>      | Constructed Pond                                                            | Pond Bottom= 608.37 Top of Bank = 610.21                                   | 18&amp;19 | Currently no overflow outlet in place                                                        |</p>
<table>
<thead>
<tr>
<th>LOCATION</th>
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<th>ELEVATIONS</th>
<th>PIC #</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed Branch #1</td>
<td>12-inch Concrete culvert at Scenic Road</td>
<td>12&quot; INV(W) = 610.42 12&quot; INV(E) = 608.84</td>
<td>20&amp;21</td>
<td>Pipe changes from RCP to HDPE on west side of roadway. Pipe 50% full of sediment.</td>
</tr>
<tr>
<td>Proposed Branch #2</td>
<td>Golf Course Culvert #1</td>
<td>12&quot; INV = 606.20</td>
<td>22</td>
<td>Culvert</td>
</tr>
<tr>
<td>Proposed Branch #2</td>
<td>Golf Course Culvert #2</td>
<td>12&quot; INV = 607.54</td>
<td>23</td>
<td>Culvert</td>
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<tr>
<td>Proposed Branch #2</td>
<td>Golf Course Culvert #3</td>
<td>12&quot; INV = 607.75</td>
<td>24</td>
<td>Culvert</td>
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<tr>
<td>Proposed Branch #2</td>
<td>Golf Course Culvert #4</td>
<td>12&quot; INV = 607.95</td>
<td>25</td>
<td>Culvert</td>
</tr>
<tr>
<td>Proposed Branch #2</td>
<td>Golf Course Culvert #5</td>
<td>12&quot; INV = 608.44</td>
<td>26&amp;27</td>
<td>Culvert</td>
</tr>
<tr>
<td>Proposed Branch #2</td>
<td>Ditch through Forested Area</td>
<td>CL DITCH = 609.23 TOP/BANK = 610.87</td>
<td>28&amp;29</td>
<td>Shallow Defined Ditch</td>
</tr>
<tr>
<td>Proposed Branch #2</td>
<td>Ditch through Forested Area</td>
<td>CL DITCH = 612.21 TOP/BANK = 612.49</td>
<td>30</td>
<td>Shallow Defined Ditch</td>
</tr>
<tr>
<td>Proposed Branch #2</td>
<td>Ditch through Forested Area</td>
<td>CL DITCH = 616.83 TOP/BANK = 617.27</td>
<td>31</td>
<td>Shallow Defined Ditch</td>
</tr>
<tr>
<td>Proposed Branch #2</td>
<td>12-inch Concrete culvert at Michillinda Road 1500 feet east of Scenic Drive</td>
<td>12&quot; INV(N) = 617.54 12&quot; INV(S) = 617.09</td>
<td>32&amp;33</td>
<td>Good Condition</td>
</tr>
</tbody>
</table>
Picture #1 shows the 12-inch outlet of the Mason Drain at White Lake. The pipe transitions from PVC to HDPE at the outlet. The fitting to make the transition does not fit properly and causes large amounts of beach sand to infiltrate.

Picture #2 is looking toward White Lake from the back yards of the residences on South Shore Drive. MH #11 is located near the vegetative overgrowth. These rear yard areas appear to have natural springs which continuously seep groundwater.
Picture #3 shows MH #11 near the vegetative overgrowth. During televising of the main drain between MH #10 and MH #11 evidence of possible sanitary sewer connections to the drain were visible.

Picture #4 shows the broken casting at MH #10 located on the Golf Course just south of South Shore Drive.
PICTURE #5

Picture #5 shows the interior of MH #10. The 4-foot precast structure is in good condition. The pipes were 75 percent submerged following a significant period of dry weather indicating the possibility of blockage. The blockage was later confirmed to be significant root intrusion in the line.

PICTURE #6

Picture #6 shows MH #9 located on the Golf Course and looking to the north.
Picture #7 shows the interior of MH #9. The 4-foot precast structure is in good condition. The 12-inch main drain is the only pipe(s) in the structure. This is consistent throughout the entire main drain.

Picture #8 shows the interior of MH #8. The 4-foot precast structure is in good condition.
PICTURE #9

Picture #9 shows the interior of MH #7. The 4-foot precast structure is in good condition.

PICTURE #10

Picture #10 shows the interior of MH #6. The 4-foot precast structure is in good condition.

PICTURE #11
Picture #11 shows the manhole cover at MH #6 located just downstream from the Golf Course pond near #12 green.

Picture #12 shows the 12-inch VCP pipe inlet to the main drain located at the Golf Course pond. The pipe is not properly protected with rodent grate and riprap, and is very susceptible to blockage.
Picture #13 shows the Golf Course pond looking north. The 12-inch VCP pipe from the existing catch basin on Michillinda Road outlets to the pond near the main drain inlet.

Picture #14 shows the interior of CB #5 located on Michillinda Road near Scenic Drive. The shallow structure is in fair condition.
Picture #15 shows the interior of CB #4 located at the private driveway at the 90 degree turn of Michillinda Road. The 2-foot diameter concrete block structure is in poor condition and has sediment buildup in the base of the structure.

Picture #16 shows the existing ditch located just north of the constructed pond. Currently, stormwater is not able to be released from the pond during heavy rain events.
Picture #17 shows the existing ditch looking north from the constructed pond toward Michillinda Road. The existing ditch is currently graded to flow back to the constructed pond and not toward the Golf Course pond north of Michillinda Road.

Picture #18 shows the existing constructed pond to the south of Michillinda Road and west of Scenic Drive. The pond is not a consistent depth and has no positive outlet due to the height and grading of the ditch north of the pond.
Picture #19 is the constructed pond looking north toward the existing ditch and Michillinda Road. The southern portion of the pond is the deepest with significant variation in depth to the north.

Picture #20 shows the 12-inch HDPE culvert on the west side of Scenic Drive flowing towards the constructed pond. The pipe is not properly protected with a rodent grate and riprap, and is approximately 50 percent full of sediment and debris. The pipe was extended by the homeowner during driveway construction.
Picture #21 shows the 12-inch concrete culvert and headwall on the east side of Scenic Drive. The headwall is in good condition.

Picture #22 shows culvert #1 near hole #12 on the Golf Course. This is typical of the culverts on the course due to the water table, poorly drained soils and heavy vegetative overgrowth. The 12-inch PVC culvert has only 50 percent of pipe capacity available and has very little base flow through the system.
PICTURE #23

Picture #23 shows culvert #2 near hole #16 on the Golf Course. The 12-inch PVC pipe is fully submerged and likely filled with sediment. This photo was taken during drought conditions in July 2012 and the water level is likely consistent with the water table level on the course.

PICTURE #24

Picture #24 shows culvert #3 near hole #15 on the Golf Course. The 12-inch PVC pipe is fully submerged and likely full of sediment. This picture also shows the levels of vegetative overgrowth typically seen on the course.
Picture #25 shows culvert #4 near hole #9 on the Golf Course. The pipe is 75 percent submerged. Due to the heavy growth in the middle of the drainage ditch, water runs along the edge of the ditch, decreasing the capacity.

Picture #26 shows culvert #5 near hole #1 on the Golf Course. The pipe is 75 percent submerged. The photo shows the water flow path along the edge of the ditch due to the heavy growth in the middle.
Picture #27 shows culvert #5 on the east edge of the Golf Course. The 12-inch PVC culvert allows runoff from the area(s) east of the course to reach the pond in the southwest corner of the course.

Picture #28 shows the only major log jam in the drainage ditch just east of the Golf Course.
Picture #29 is typical of the shallow drainage ditch in the wooded area east of the Golf Course. The ditch is defined and clear of any blockages.

Picture #30 shows the drainage ditch near the middle of the wooded area. The ditch is quite shallow in this location but still clearly defined.
Picture #31 shows the shallow drainage ditch just south of Michillinda Road. The ditch is clear of any blockages and clearly defined.

Picture #32 shows the 12-inch RCP culvert on the north side of Michillinda Road. The pipe is not properly guarded and is susceptible to blockages as seen in this photo.
Picture #33 shows the 12-inch RCP culvert on the south side of Michillinda Road. The pipe is not properly guarded and has leaf, sediment and debris buildup in the pipe, decreasing the capacity.
Partridge Drain

The Partridge Drain Drainage District is primarily comprised of residential lands including Rural Residential (RR), Low Density Residential (LDR), Medium Density Residential (MDR) and Medium High Density Residential along the White Lake water frontage. Increased development of the area to altering land uses (commercial or industrial) will most likely not occur. Therefore the system can be monitored and analyzed based on its current condition and site constraints to develop a consistent flow model for the entire Drainage District.

The topography within the Drainage District is such that a significant portion of the District’s overland flow is directed to the large wetland complex located on the east and west side of Lamos Road between South Shore Drive and Michillinda Road. The wetland complex allows a significant amount of stormwater storage during large rain events without detriment to neighboring properties. A 12-inch concrete pipe culvert is located under Lamos Road to necessitate drainage through the wetland. A 12-inch concrete outlet pipe is located on the west side of Lamos Road between the edge of pavement and Right of Way (ROW) line and outlets on the north side of South Shore Drive to a deep ravine outletting to White Lake. The pipe from the wetland to the outlet currently has no access points and the condition of the pipe is unknown.

The main issue with the Partridge Drain is the outlet on the north side of South Shore Drive at Lamos Road. There are currently three (3) separate pipes discharging to the ravine as well as a significant amount of roadway surface runoff from the east on South Shore Drive. The three (3) outlets have eroded the banks significantly over time to form a very deep ravine. The pictures following this narrative show the extent of the erosion.

The depth of the ravine and continued erosion has the potential of washing out the roadway and endangering the existing residence located on the west side of the ravine, due to its close proximity. The west bank currently has ivy growth and several small diameter trees which are slowing the rate of erosion near the household. The east bank is littered with small diameter trees and the neighboring property is currently undergoing minor grading for the construction of a new house.

The intersection of Lamos Road and South Shore Drive has also reported drainage issues. A portion of the roadway runoff from South Shore Drive west of the ravine is being channeled to the driveway of 6101 South Shore Drive. The homeowners at this residence have built a gravel berm at the driveway to divert roadway runoff from flooding their driveway and home. There is one (1) catch basin structure located in the east driveway entrance but the west driveway entrance appears to experience prolonged standing water. There is another catch basin in the lawn area approximately 25 feet east of the structure in the driveway which picks up very little runoff. The two catch basin structures are not connected and provide separate outlets to the ravine, causing further erosion problems to the banks.

A portion of the runoff from South Shore Drive east of the ravine is being discharged at Lamos Road into the deepest portion of the ravine and is also exacerbating the erosion problem. The roadway currently does not have curb and gutter or ditching to safely channel runoff to the outlet effectively. Therefore, most of the stormwater is flowing along the edge of the roadway and ultimately through driveways and toward households located at lower elevations. The new residence being constructed adjacent to the ravine has graded the area near the roadway to
funnel toward the ravine, which is not armored properly to accept it. This activity will cause additional erosion problems in the future.

The stormwater along Lamos Road from approximately 1000 feet south and to South Shore Drive flows along the edge of the roadway. There is no defined road ditching along the southern portion of this stretch of road. A defined ditch then becomes apparent closer to South Shore Drive with low areas at the southeast and southwest corners of the intersection. The southwest corner has an existing catch basin which outlets to the ravine. The southeast corner does not have any infrastructure in place and stormwater may simply infiltrate into the sandy soils during routine rain events.

The Drain system was inspected on three different occasions on the following dates: July 3 and September 12, 2012 took place during a summer of extremely dry conditions. A third site visit took place on October 17, 2012 following approximately 4 inches of rainfall over the previous two days. The pictures shown were taken during the inspections.

The following table lists the condition and survey summary of various areas along the Partridge Drain. Following this table is a series of pictures corresponding to some of the areas listed in the table.
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DESCRIPTION</th>
<th>ELEVATIONS</th>
<th>PIC #</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partridge</td>
<td>12-inch Concrete Culvert at Lamos Road Wetland</td>
<td>12&quot; INV(W) = 611.39 12&quot; INV(E) = 611.66</td>
<td>34</td>
<td>Crossing appears to be in good condition</td>
</tr>
<tr>
<td>Partridge</td>
<td>12-inch Inlet at Lamos Road Wetland</td>
<td>12&quot; INV = 611.39</td>
<td>35&amp;36</td>
<td>Small headwall on the 12&quot; inlet</td>
</tr>
<tr>
<td>Partridge</td>
<td>Wetland on Lamos Road</td>
<td>N/A</td>
<td>37&amp;38</td>
<td>Regulated Wetland</td>
</tr>
<tr>
<td>Partridge</td>
<td>CB #3 Located in the SW corner of South Shore &amp; Lamos Roads</td>
<td>RIM ELEV = 605.71 15&quot; INV(N) = 604.01</td>
<td>39</td>
<td>2' dia. HDPE structure w/ 15&quot; CMP to CB #1.</td>
</tr>
<tr>
<td>Partridge</td>
<td>CB #1 Located in South Shore ROW at 6210 just west of the ravine.</td>
<td>RIM ELEV = 606.14 18&quot; INV(E) = 603.25 15&quot; INV (S) = 603.52</td>
<td>40</td>
<td>2' dia. block structure with 1' sump. 18&quot; pipe outlets to ravine.</td>
</tr>
<tr>
<td>Partridge</td>
<td>CB #2 Located in the Driveway of 6210 South Shore west of ravine.</td>
<td>RIM ELEV = 605.90 12&quot; INV(E) = 602.98</td>
<td>40</td>
<td>2' dia. block structure with no sump. 12&quot; RCP pipe turns to CMP and outlets to ravine.</td>
</tr>
<tr>
<td>Partridge</td>
<td>Outlet at ravine at intersection of South Shore and Lamos Roads</td>
<td>12&quot; INV(S) = 599.98 18&quot; INV(E) = 600.28 15&quot; INV(E) = 602.21 DITCH CL = 597.55</td>
<td>41,42,43,44 &amp; 45</td>
<td>Ravine has significant erosion from the multiple outlets and should be corrected immediately</td>
</tr>
<tr>
<td>Partridge</td>
<td>Culvert prior to White Lake</td>
<td>12&quot; INV(N) = 584.32 12&quot; INV (S) = 579.94</td>
<td>46&amp;47</td>
<td>12&quot; CMP Culvert at random location near property line</td>
</tr>
<tr>
<td>Partridge</td>
<td>Outlet to White Lake</td>
<td>N/A</td>
<td>48</td>
<td>Stream meanders from 12&quot; CMP Culvert to Waters Edge</td>
</tr>
<tr>
<td>Partridge</td>
<td>South Shore Drive east of Lamos Road</td>
<td>N/A</td>
<td>49&amp;50</td>
<td>Road runoff flows down the north side of the roadway discharging overland to the ravine and causing erosion</td>
</tr>
<tr>
<td>Partridge</td>
<td>South Shore Drive west of Lamos Road</td>
<td>N/A</td>
<td>51</td>
<td>Road runoff flows down the north side of the roadway discharging to the driveway at 6210 causing extensive standing water</td>
</tr>
<tr>
<td>Partridge</td>
<td>Southeast corner of Lamos Road &amp; South Shore Drive Intersection</td>
<td>N/A</td>
<td>52</td>
<td>Low area with no stormwater infrastructure</td>
</tr>
<tr>
<td>Partridge</td>
<td>Lamos Road south of South Shore Drive</td>
<td>N/A</td>
<td>53</td>
<td>Absence of road ditching causes runoff to flow along the roadway</td>
</tr>
</tbody>
</table>
Picture #34 shows the 12-inch concrete culvert under Lamos Road at the large wetland complex. The picture is taken on the east side of Lamos Road.

Picture #35 is looking northerly in the west ditch line of Lamos Road to the inlet pipe and upper terminus of the Partridge Drain.
Picture #36 is the 12-inch concrete inlet pipe from the wetland on Lamos Road and the upper terminus of the Partridge Drain. The pipe is not properly protected with rodent grate or riprap and was 50 percent blocked with debris.

Picture #37 is looking north on Lamos Road from the wetland area.
Picture #38 is taken along the west edge of Lamos Road in the wetland area.

Picture #39 shows CB #3 located in the southwest corner of Lamos Road and South Shore Drive. The CB pipe outlets separately from the main drain to the ravine on the north side of South Shore Drive.
PICTURE #40

Picture #40 shows CB #1 and CB #2 on the north side at 6210 South Shore Drive. The structures are not connected and provide separate outlets to the ravine, causing opportunity for further erosion to the ravine.

PICTURE #41

Picture #41 shows the three (3) outlet pipes (12-inch Concrete, 15-inch CMP and 18-inch CMP) to the ravine on the north side of South Shore Drive at Lamos Road and the extensive erosion problem.
Picture #42 shows the 12-inch CMP outlet pipe from CB#2 and the 18-inch CMP outlet pipe from CB#1. Both pipes illustrate the significant erosion that has taken place under the pipes from the lack of proper outlet protection.

Picture #43 shows the westerly bank and the close proximity of the ravine to the residence at 6210 South Shore Drive.
Picture #44 is an additional picture of the westerly bank at 6210 South Shore Drive.

Picture #45 is taken looking south back toward South Shore Drive and Lamos Road. This picture illustrates the condition of the ravine with several fallen and uprooted trees and erosion along the banks.
PICTURE #46

Picture #46 shows a 12-inch CMP culvert located near White Lake at the base of the ravine.

PICTURE #47

Picture #47 shows an unknown 6-inch clay tile in the direction of 6210 South Shore Drive discharging near the culvert of Picture #46 prior to White Lake.
Picture #48 shows the meandering drainage swale from the 12-inch CMP culvert to White Lake.

Picture #49 is looking east on South Shore Drive from Lamos Road. The roadway surface water runs along the north edge of the roadway. The new residence being constructed at the time of the report has constructed a berm to divert water to the ravine.
Picture #50 shows the riprap protection at the ravine constructed by the property owner. The riprap as constructed is not sufficient to stop further erosion in this location.

Picture #51 is looking west along South Shore Drive from Lamos Road. The residence at 6210 has constructed a berm to divert roadway runoff from ponding in the driveway.
Picture #52 is looking at the southeast corner of the Lamos Road and South Shore Drive intersection. The area collects roadway runoff from Lamos Road and South Shore Drive but has no stormwater infrastructure in place.

Picture #53 is looking south on Lamos Road from South Shore Drive. The picture illustrates the lack of roadway ditching on Lamos Road. Roadway runoff drains along the roadway before finally reaching ditches at the southeast and southwest corners of Lamos Road and South Shore Drive.
3.0 RECOMMENDATIONS & COST ANALYSIS

The following recommendations refer to drainage issues in areas within the Mason Drain Drainage District:

RECOMMENDATIONS TO THE MASON DRAIN:

• The 12 inch pipe at South Shore Drive should be relocated to allow enough area, relative to the homes, for proper maintenance should the pipe have to be exposed or replaced in the future. The current alignment of the pipe travels diagonally between two (2) residences on the north side of South Shore Drive. The pipe in this location has a history of blockages and root intrusion due to the large trees located on both sides of the roadway. The existing pipe can be abandoned in place with low strength flowable fill. Additionally, alternative construction methods to prevent root intrusion are outlined in the cost analysis. These methods are only recommended as a temporary solution to leave the existing pipe in its current location and alignment.

• The two (2) service leads entering the storm drain north of South Shore drive should be dye tested to verify if they are sanitary sewer services or footing tiles from the residences. The Muskegon County Health Department and Fruitland Township should be notified immediately and the pipes disconnected if they are found to be sanitary sewer leads.

• Televise 12-inch pipe from the Golf Course pond to the outlet at White Lake to evaluate the condition. The numerous joints of the 3-foot length sections of the existing VCP accompanied with the significant amount of large trees in the vicinity of the main drain may be causing capacity issues or restricting flow downstream. Depending on what is found there are several options available for repair including root cutting, joint sealing, pipe lining or complete removal and replacement of the pipe.

• Raise water levels in the ditch/pond on the golf course by constructing a water level control structure on the outlet pipe at the golf course pond and filling areas adjacent to the pond and drainage ditch as necessary along the golf course. The low water levels and lack of water movement in the golf course low lands are directly contributing to the significant vegetative overgrowth.

• By raising and maintaining the water levels in the pond via the control structure, additional grading measures to keep water within the banks of the pond and linear drainage ditch need to take place. There are two (2) possible methods to make this occur:
  o The first option (Option A) includes grading, to widen and deepen the existing ditch while also raising the adjacent land minimally, within approximately 100 feet of the pond and drainage ditch. This will allow the water to stay in the banks of the ditch but also allow for a consistent 24-inch depth of water or greater. The widening and deepening of the ditches would include an evaluation of the depth of the poorly drained native soils in this area.
  o The second option (Option B) would also raise the water levels but limit the amount of grading and utilize soil stability, walls and ditch enclosure. Based on
discussion with Golf Course personnel there are a few areas where the drainage
ditch does not add value to the golf hole so some segments can be enclosed with
pipe without detriment. The enclosed pipe sections on the golf course would be
enlarged (approximately 24-inch pipe) slightly to increase flow and the pipe end
sections would be protected with rodent guards and rip rap to keep the pipes free
of sedimentation and debris accumulation.

- Specific changes to the golf course could also be:
  - Enclose the ditch with a perforated HDPE pipe in front of the tee on the par 5 9th
    hole. The ditch is not needed for golf playability purposes.
  - Enclose the ditch with a perforated HDPE pipe in front of the tee on the par 3 11th
    holes. The ditch is not needed for golf playability purposes.

A combination of both options can be discussed and evaluated.

- The constructed pond located southwest of the Michillinda and Scenic Road intersection
  should be graded to allow more water (increased flow) to reach the Golf Course. This
can be done by lowering the embankment at the northwest corner of the pond and also
the drainage ditch to Michillinda. The embankment would act as a control to maintain
water levels in the pond but also allow flow to the golf course. As an additional measure
to increase flow to the golf course, the constructed pond could be lined with clay to
mitigate the loss of water through infiltration.

- Easements should be obtained on the Main Drain as well as the two (2) branch drains to
  allow for proper maintenance. We recommend 50 foot Easement widths for open drains
  and 40’ minimum widths for the enclosed storm sewer due the depth. A larger easement
  would be required for the constructed pond to accommodate maintenance activities.

- The 12-inch concrete culvert under Scenic Drive should be televised to evaluate the
  condition. The existing pipe transitions from concrete to HDPE and the outlet is 50% full
  of sediment. The outlet should be cleaned and properly guarded with end section and
  rip rap.

- Protect the culvert at Michillinda Road with flared end section and riprap to avoid erosion
  and sedimentation of the pipes.

**APPROXIMATE COST FOR IMPROVEMENTS TO THE MASON DRAIN:**
**Mason Drain Construction Costs**

**Main Drain Pipe Re-Alignment at South Shore Dr.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>Quantity</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4' Diameter Drainage Structure</td>
<td>EA</td>
<td>2</td>
<td>$5,000.00</td>
<td>$10,000.00</td>
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<tr>
<td>12&quot; Dia Class IV RCP Storm Sewer</td>
<td>LF</td>
<td>150</td>
<td>$60.00</td>
<td>$9,000.00</td>
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<tr>
<td>Tree, Rem, 12 inch to 24 inch</td>
<td>EA</td>
<td>3</td>
<td>$1,000.00</td>
<td>$3,000.00</td>
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<tr>
<td>HMA Roadway Removal and Replacement</td>
<td>SYD</td>
<td>65</td>
<td>$75.00</td>
<td>$4,875.00</td>
</tr>
<tr>
<td>Abandon &amp; Fill Existing Storm Sewer</td>
<td>CYD</td>
<td>10</td>
<td>$250.00</td>
<td>$2,500.00</td>
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<tr>
<td>Slope Restoration</td>
<td>SYD</td>
<td>800</td>
<td>$4.00</td>
<td>$3,200.00</td>
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<tr>
<td>Traffic Control</td>
<td>LS</td>
<td>1</td>
<td>$1,000.00</td>
<td>$1,000.00</td>
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<tr>
<td>Soil Erosion &amp; Sedimentation Control Measures</td>
<td>LS</td>
<td>1</td>
<td>$500.00</td>
<td>$500.00</td>
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<tr>
<td>Fence, Remove &amp; Reinstall</td>
<td>LF</td>
<td>75</td>
<td>$10.00</td>
<td>$750.00</td>
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**Miscellaneous Main Drain Improvements**

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<tr>
<td>Main Drain Pipe Lining</td>
<td>LF</td>
<td>1250</td>
<td>$80.00</td>
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<tr>
<td>Main Drain Pipe Bursting (Alternative)</td>
<td>LF</td>
<td>1250</td>
<td>$100.00</td>
<td>$125,000.00</td>
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**Proposed Branch 2 - Golf Course Drain Improvements (Option A)**

<table>
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<th>Item</th>
<th>Units</th>
<th>Quantity</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Control Structure</td>
<td>EA</td>
<td>1</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>Machine Grading, Golf Course (Fill)</td>
<td>LS</td>
<td>1</td>
<td>$30,000.00</td>
<td>$30,000.00</td>
</tr>
<tr>
<td>12-inch Dual Wall HDPE Storm Sewer</td>
<td>LF</td>
<td>100</td>
<td>$30.00</td>
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<tr>
<td>Golf Course Restoration</td>
<td>SYD</td>
<td>13300</td>
<td>$5.00</td>
<td>$66,500.00</td>
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**Proposed Branch 2 - Golf Course Drain Improvements (Option B)**

<table>
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<tr>
<th>Item</th>
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<tbody>
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<td>Water Control Structure</td>
<td>EA</td>
<td>1</td>
<td>$5,000.00</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>Machine Grading, Golf Course (Fill)</td>
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<td>12-inch Dual Wall HDPE Storm Sewer</td>
<td>LF</td>
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<td>$30.00</td>
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<td>Golf Course Restoration</td>
<td>SYD</td>
<td>6700</td>
<td>$5.00</td>
<td>$33,500.00</td>
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<td>Retaining Wall, Timber</td>
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<td>$8,000.00</td>
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**Research Items for Evaluation**

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<tr>
<td>Televise Main Drain from Wetland to Outlet</td>
<td>LF</td>
<td>1850</td>
<td>$3.00</td>
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<tr>
<td>Televise Culverts</td>
<td>LF</td>
<td>200</td>
<td>$2.00</td>
<td>$400.00</td>
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<td></td>
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**Proposed Branch 1 Drain Improvements**

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<tr>
<th>Item</th>
<th>Units</th>
<th>Quantity</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ditch Grading &amp; Stabilization</td>
<td>LF</td>
<td>120</td>
<td>$35.00</td>
<td>$4,200.00</td>
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<tr>
<td>Pond Grading &amp; Stabilization</td>
<td>LS</td>
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<td>$7,500.00</td>
<td>$7,500.00</td>
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<tr>
<td>12-inch HDPE Outlet Pipe to Ditch</td>
<td>LF</td>
<td>50</td>
<td>$30.00</td>
<td>$1,500.00</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Total</strong> $20,200.00</td>
</tr>
</tbody>
</table>

Fitzgerald Henne & Associates, Inc.

42
The following recommendations refer to drainage issues in areas within the Partridge Drain Drainage District:

RECOMMENDATIONS TO THE PARTRIDGE DRAIN:

- Additional storm manhole drainage structures should be placed on the outlet pipe for future maintenance activities. We recommend that structures be placed every 300 to 400 feet. This would equate to approximately 4 structures.
- The entire length (approximately 1530 feet) of the 12-inch diameter outlet pipe should be televised to assess the condition.
- The ravine north of South Shore Drive which currently serves as the outlet for the Partridge Drain should be enclosed. The current ravine is severely eroded and poses significant risk to the roadway and residences located on either side. The enclosed storm sewer should be 18 inches in diameter to accommodate flow from the entire Drainage District. The two (2) other pipes outletting to the ravine should be connected to a common manhole located on the main line.
- A Storm drain easement of appropriate size (50 feet minimum) should be acquired on the outlet north of South Shore Drive. The easement should be wide enough to accommodate construction and maintenance of the drain.
- A catch basin drainage structure should be added in the southeast corner of Lamos Road & South Shore Drive. This corner sits well below the roadway and receives a fairly large drainage area. A road crossing will be required and the structure should be connected with 12-inch Reinforced Concrete pipe to the catch basin in the southwest corner of the intersection.
- Curb, curb and gutter or HMA valley gutter should be installed along the north edge of South Shore Drive to collect runoff. It is anticipated that approximately 1000 lineal feet of curb would be required. Specifically this should benefit the property immediately west of the ravine that has experienced flooding from the roadway.
- Defined ditches on Lamos Road should be constructed from 1000 feet south of South Shore Drive to properly drain the roadway. The ditching will require construction of several culverts under driveways to maintain drainage.

Cost Prohibitive Option Researched

- The option of combining the Mason Drain & Partridge Drain into one district by extending storm sewer from the Lamos Road wetland complex to the Golf Course (Mason Drain) was also researched. This would allow stormwater overflow from the large wetland complex on Lamos Road to reach the Golf Course. The route would require easement acquisition across private property west of Lamos Road to the course. The approximate length to extend the Partridge Drain to the Golf Course is +/- 2000 lineal feet (LF) to reach the open drain section in the wooded area east of the course. It is not likely that a significant amount of additional flow would be generated from the wetland since water levels still need to be maintained there to preserve the wetland hydrology. The benefit of additional flow would only be derived from large storm events. The 2000 LF of storm drain is a significant construction and maintenance cost for marginal benefit or improvement to the flow conditions on the golf course.

APPROXIMATE COST FOR IMPROVEMENTS TO THE PARTRIDGE DRAIN:

43
### Enclose Outlet to White Lake

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>Quantity</th>
<th>Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing, Grubbing &amp; Snagging (Includes Tree Removal)</td>
<td>LS</td>
<td>1</td>
<td>$15,000.00</td>
<td>$15,000.00</td>
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<tr>
<td>4&quot; Diameter Drainage Structure</td>
<td>EA</td>
<td>3</td>
<td>$3,500.00</td>
<td>$10,500.00</td>
</tr>
<tr>
<td>18&quot; Dia Class IV RCP Storm Sewer</td>
<td>LF</td>
<td>285</td>
<td>$60.00</td>
<td>$17,100.00</td>
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<tr>
<td>18&quot; Dia Flared End Section, Conc</td>
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<td>$1,000.00</td>
<td>$1,000.00</td>
</tr>
<tr>
<td>Rip Rap on Geotextile Fabric</td>
<td>SYD</td>
<td>25</td>
<td>$25.00</td>
<td>$625.00</td>
</tr>
<tr>
<td>HMA Roadway Removal and Replacement</td>
<td>SYD</td>
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<tr>
<td>Machine Grading, Fill Ravine (Aggregate Surface)</td>
<td>LS</td>
<td>1</td>
<td>$10,000.00</td>
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<td>Slope Restoration</td>
<td>SYD</td>
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<td>Traffic Control</td>
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<tr>
<td>Soil Erosion &amp; Sedimentation Control Measures</td>
<td>LS</td>
<td>1</td>
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**Total** $67,875.00

### Miscellaneous Items to Improve Drain

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<tr>
<th>Item</th>
<th>Units</th>
<th>Quantity</th>
<th>Cost</th>
<th>Total</th>
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<tr>
<td>Additional Manholes on Main Drain for Access (48&quot; Dia.)</td>
<td>EA</td>
<td>4</td>
<td>$2,500.00</td>
<td>$10,000.00</td>
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<tr>
<td>Add CB &amp; Pipe at SE corner of South Shore &amp; Lamos</td>
<td>LS</td>
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<tr>
<td>Road Ditching on Lamos Road to South Shore</td>
<td>LF</td>
<td>1000</td>
<td>$4.00</td>
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<td>HMA Valley Gutter (or Curb) Along South Shore near Lamos</td>
<td>LF</td>
<td>500</td>
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**Total** $29,000.00

### Research Items for Evaluation

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<tr>
<td>Televise Main Drain from Wetland to Outlet</td>
<td>LF</td>
<td>1850</td>
<td>$3.00</td>
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<td>Televise Culverts</td>
<td>LF</td>
<td>200</td>
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**Total** $5,950.00
4.0 PROJECT TIMELINE

The following is an outline of the key steps to continue the project forward.

PETITION

The project, in accordance with Chapter 8 of the Michigan Drain Code of 1956, can be petitioned in two (2) different ways.

1. The project can be petitioned solely by the Township when it is necessary for the public health of the Township, when authorized by its governing body, if the municipality is liable to assessments at large for a percentage of the total amount assessed for the cost of the proposed work.

2. The project can be petitioned by any 5 freeholders whose lands shall be liable to an assessment for benefits of such work. The petition shall be made in writing to the commissioner setting forth the necessity of the proposed work. The Drain Commissioner shall proceed in the same manner provided for the location, establishment, and construction of a drain.

Only one (1) petition is necessary for any work necessary for the cleaning out, widening, deepening, straightening, consolidating, extending, relocating, adding new drains or branches and/or extending drains. Chapter 8 of the Drain Code encompasses the Cleaning, Widening, Deepening, Straightening and Extending of Drains.

As part of the recommendations in the Preliminary Engineering Report and to facilitate a more systematic approach to resolving some of the issues with each Drain, consolidation of the Drainage Districts would be beneficial and a more cost effective approach to managing the Drains. We recommend adding this to the permit language to consolidate the Mason and Partridge Drains. However, if the consolidation is pursued it is essential that the Township petition for the overall work due to the restrictions in the Drain Code (which for Drain consolidation would otherwise require 50% of the landowners adjacent to the Drain to sign the petition).

BOARD OF DETERMINATION

A Board of Determination (BOD) would be held following the filing of the petition. The BOD is comprised of three (3) disinterested residents from Muskegon County but not of a township, city or village affected by the drain. The Drain Commissioner is responsible to give public notice of the BOD as required by the open meetings act of the State of Michigan.
The BOD would determine the necessity of the proposed drain work and whether it is conducive to the public health, convenience and welfare. The BOD will also determine if the municipality (Township) will be responsible for a percentage of the cost of construction of the drain by reason of benefits at large for public health.

**NEXT STEPS IF PROJECT FOUND NECESSARY BY B.O.D.:**

1. Drain Commissioner will notify the municipalities, within 10 days following the filing of the order of determination by the Board of Determination, that it may be liable for a percentage of the cost of construction by reasons of benefit at large for public health.
2. Drain Commissioner will file a First Order of Determination establishing the commencement, route, terminus and type of construction of the Drain.
3. Drain Commissioner will consult with an Engineer to prepare drawings and specifications for construction of the drain improvements. The Drain Commissioner may choose to conduct scope meetings with the Drainage District to discuss the design with the property owners and stakeholders prior to bidding.
4. Provide Notice of Bid Letting and Notice of Day of Review of Apportionments to Landowners within District and municipalities.
5. Plans available to Contractors for Bidding
6. Bid Opening
7. Drain Commissioner will prepare a Computation of Cost for the project and assessment roll.
8. Day of Review of Apportionments. This is a public meeting where landowners within the district can meet with the Drain Commissioner to review and discuss their assessment.
10. Construction Begins
APPENDIX A –

Exhibit A: Study Area and District Boundary Exhibit
APPENDIX B –

Exhibit B: Storm Sewer Schematic Exhibit
APPENDIX C –

Property Owners Receiving Notice of Inspection with Sample Letter & Property Owner Meeting Notes
August 30, 2012

ALBRECHTSEN B DENNIS/SUSANA
5592 SOUTH SHORE DR
WHITEHALL, MI 49461

RE: Mason Drain and Partridge Drain
Project No. 12022
Parcel No. 61-06-107-100-0004-00

Dear ALBRECHTSEN B DENNIS/SUSANA:

The Muskegon County Drain Commissioner has been asked to study the Mason Drain and the Partridge Drain, which primarily traverse Section 12 of Fruitland Township, Muskegon County, Michigan, and may drain storm water through areas adjacent to or including your property.

Fitzgerald Henne & Associates, Inc. has been retained by the Drain Commissioner to analyze these drains and assess any drainage problems within them, particularly with respect to vegetative overgrowth and poor flow of storm water. To fully consider your interests and answer your questions, we will be on-site in the afternoon of Wednesday, September 12 to meet with you at your property and review any of your concerns. Please call our office at (517) 887-1100 before then to arrange an appointment on that afternoon. If you are unable to meet then or do not live in the area, please still call our office and speak with me about any related issues you may have.

Please note this study is a review to determine if the drains are functioning as designed or if improvements might be necessary. No actual improvements or maintenance will occur without further discussions/hearings that may be required or appropriate.

Thank you in advance for your help with this necessary effort, so that we can more accurately assess these drains and understand any drainage problems that you or your neighbors may have.

Sincerely,

FITZGERALD HENNE & ASSOCIATES, INC.

[Signature]
Brian J. Cenci, P.E.
Project Engineer

cc: David A. Fisher, Muskegon County Drain Commissioner
    Sam E. St. Amour, Fruitland Township Supervisor
MEETING NOTES WITH PROPERTY OWNERS FOR DRAIN INSPECTION

PROJECT: MCDC – Mason & Partridge Drain Study (12022.00)
DATES: Various
PRESENT AT MEETINGS: Brian Cenci, P.E. – Project Manager, FHAI
CC: David Fisher – Muskegon County Drain Commissioner
NOTES BY: Brian Cenci, P.E. – Project Manager, FHAI

NAME: Dave and Barb Dusenberry
LOCATION: 5640 Oak Tree Lane
PHONE NUMBER: unknown
DATE OF MEETING: September 12, 2012
TIME OF MEETING: 4:00 p.m.
TYPE OF MEETING: face-to-face
DISCUSSION ITEMS:
• Just moved to area
• No water issues
• Doesn’t look like basement has flooded

NAME: Frank Gary
LOCATION: 6060 South Shore Drive
PHONE NUMBER: (616) 291-1048
DATE OF MEETING: September 12, 2012
TIME OF MEETING: 6:30 p.m.
TYPE OF MEETING: Phone
DISCUSSION ITEMS:
• General questions about what was being done
• No real drainage issues on property
NAME: Craig Cars  
LOCATION: 530 Scenic Drive  
PHONE NUMBER: (616) 745-5519  
DATE OF MEETING: September 12, 2012  
TIME OF MEETING: 4:15 p.m.  
TYPE OF MEETING: Phone  
DISCUSSION ITEMS:  
• Water table high in area, has concerns regarding this  
• Owns an empty lot  
• Would like to build something but worried about high water table and putting in a new foundation

NAME: Ben & Marlene Kautz  
LOCATION: 5700 Oak Tree Lane  
PHONE NUMBER: (231) 740-7369  
DATE OF MEETING: September 12, 2012  
TIME OF MEETING: 4:30 p.m.  
TYPE OF MEETING: face-to-face  
DISCUSSION ITEMS:  
• Variable water table (Short wells for sprinkler systems in neighborhood)  
• Water table issue with some properties  
• 3-4” wells 60’-80’ (one water system)  
• No water issues on their property but know of other issues  
• Blise & Boswork have had water in basements before  
• Indicated that Brett Mickaleson has had issues too with basement flooding
NAME: Frank Lundell, President of White Lake Golf Club  
(Dale Augustin, GC Superintendent present)  
LOCATION: Clubhouse first, then on golf cart throughout course  
PHONE NUMBER: (231) 578-1083  
DATE OF MEETING: September 12, 2012  
TIME OF MEETING: 1:00 p.m.  
TYPE OF MEETING: face-to-face  
DISCUSSION ITEMS:  
• #15 – Par 3, comes into play, grounds area  
• #1 – Par 5, hazard in front is essential to play  
• #9 – Hazard is not in play, Par 5, in way of tees for ladies  
• #14 – Par 5, comes into play on 2<sup>nd</sup> hole  
• #12 – Par 4, cattails are issue (not as bad as #14 or #15), hazard a must, dug out  
• 5 Manholes from #12 to Lake  
• 6”- 8” of water in pond  
• Butterfield Woods has a lack of water with their short wells for irrigation  
• When #12 is flooded, sump pumps run constantly  
• #11 – ditch is a hindrance off tee, no real reason for playability  
• Pond on #12 will flood over with less than an inch of rain  
• Biggest issues appear to be on #12  
• No tile system on golf course  
• Ditch has never had a lot of water in it at any one time

NAME: Kenneth Ottman  
LOCATION: South side 6185 South Shore Drive  
PHONE NUMBER: (231) 894-6854  
DATE OF MEETING: September 12, 2012  
TYPE OF MEETING: Face-to-Face  
TIME OF MEETING: 1:40 p.m.  
DISCUSSION ITEMS:  
• The ditch/ravine on the Partridge Drain needs cleaning out near White Lake  
• Worried about access road (66’ modified to 33’ because of new house)  
• Enclosure would be ideal  
• Next closest access would be Scenic Drive
NAME: Bob Ingalls  
LOCATION: 6161 South Shore Drive  
PHONE NUMBER: (231) 894-7419  
DATE OF MEETING: September 12, 2012  
TYPE OF MEETING: Face-to-Face  
TIME OF MEETING: 12:40 p.m.  
DISCUSSION ITEMS:  
- Also owns 6958 South Shore Rd.  
- Most worried about access issue to White Lake because of the new house. Feels the ditch should be enclosed to allow for access.  
- Gets blue clay runoff from G.C.

NAME: Bruce Potter  
LOCATION: 6100 Michilinda  
PHONE NUMBER: (231) 206-0391  
DATE OF MEETING: September 11, 2012  
TYPE OF MEETING: Phone  
TIME OF MEETING: 11:00 a.m.  
DISCUSSION ITEMS:  
- No drainage issues  
- Golf course member (@ White Lake CC)  
- Understands the golf course has issues and would like to see something done

NAME: Tim & Ceryl Duthler  
LOCATION: 6210 South Shore Drive (on lake side, corner of Lamis)  
PHONE NUMBER: Tim Cell: (616) 481-9203  
                     Cheryl Cell: (616)558-0558  
DATE OF MEETING: September 12, 2012  
TYPE OF MEETING: Face-to-Face  
TIME OF MEETING: 3:30 p.m.  
DISCUSSION ITEMS:  
- Built property in 1990, CB’s were in  
- Issues with flooding into bedroom from road water, had berm put up to stop road runoff  
- Would like to see the drainage of the road at the intersection fixed  
- Road commission put in new catch basin but hasn’t helped flooding issues

NAME: Dan Beckman  
LOCATION: 5288 Scenic Drive  
PHONE NUMBER: (231) 578-4719  
DATE OF MEETING: September 12, 2012  
TYPE OF MEETING: Phone  
TIME OF MEETING: 3:45 p.m.  
DISCUSSION ITEMS:  
- Just general questions of what was being done, no real issues with any flooding
NAME: Mary Barry
LOCATION: 5262 Scenic Drive
PHONE NUMBER: N/A
DATE OF MEETING: September 12, 2012
TYPE OF MEETING: Face-to-Face
TIME OF MEETING: 3:45 p.m.
DISCUSSION ITEMS:
• Worried about well issues
• Owns an acre of property, just had general questions of what was being done

NAME: Don Sanchez
LOCATION: Fruitland Twp. Hall
PHONE NUMBER: (231) 766-3208
DATE OF MEETING: September 13, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 11:30 a.m.
DISCUSSION ITEMS:
• Called to see about study and what work was being done
• No issues he knew of on the Mason Drain
• Indicated that he thought there were some issues with the Partridge on the outfall to White Lake

NAME: David Muellenberg
LOCATION: N/A
PHONE NUMBER: (616) 957-9999
DATE OF MEETING: September 26, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 3:30 p.m.
DISCUSSION ITEMS:
• No drainage issues
• Had just gotten the letter and wanted to know the work that took place

NAME: Frank Shirley
LOCATION: W. Michillinda Road.
PHONE NUMBER: (517) 332-3233
DATE OF MEETING: September 17, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 10:00 a.m.
DISCUSSION ITEMS:
• Vacant property adjacent to the golf course
• No drainage problems
NAME: Doug Kniff  
LOCATION: 6301 South Shore  
PHONE NUMBER: (616) 676-3700  
DATE OF MEETING: September 12, 2012  
TYPE OF MEETING: Phone  
TIME OF MEETING: 8:01 a.m.  
DISCUSSION ITEMS:  
• Access to drain is hampered by the fact that the County Road Commission sold most of it and house is built on it.  
• No drainage problems on his property  
• Also unhappy about road commission ditch/tree removal  
• Plans to call MCDC w/questions

NAME: John Lokes  
LOCATION: 2121 Celebration Drive  
PHONE NUMBER: N/A  
DATE OF MEETING: September 7, 2012  
TYPE OF MEETING: Phone  
TIME OF MEETING: 2:30 p.m.  
DISCUSSION ITEMS:  
• Will be up north during the meeting time.  
• Interested in being kept updated during process  
• No questions at this time  
• No drainage issues with their property they are aware of

NAME: James Butterfield (Trust)  
LOCATION: 6595 South Shore Drive  
PHONE NUMBER: (231) 213-0290  
DATE OF MEETING: September 7, 2012  
TYPE OF MEETING: Phone  
TIME OF MEETING: 10:45 a.m.  
DISCUSSION ITEMS:  
• House built in 1888 by his grandparents  
• No flooding now – or ever, house is 605 ft. above White Lake on 20 acres  
• Standing water sits in wet area to the rear of property but that’s ok, it never gets to the road.
NAME: Bob Ingalls
LOCATION: 6161 South Shore Drive
PHONE NUMBER: (231) 894-7419
DATE OF MEETING: September 6, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 12:40 p.m.
DISCUSSION ITEMS:
- No issues on his property
- Drain that runs down Lamus at the road end – an area of contention because of right of way and acres to White Lake is impaired by drain/house.
- Please do not impair public access to White Lake w/ new construction

NAME: Kenneth Ottman
LOCATION: 6185 South Shore Drive
PHONE NUMBER: (231) 894-7419
DATE OF MEETING: September 6, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 10:05 a.m.
DISCUSSION ITEMS:
- Concerned with what amount County has control of
- Should be culverted?
- County made mistake with previous discussion re: 33 ft. of road allowed to be taken from drain

NAME: Frank Lundell
LOCATION: White Lake Golf Course
PHONE NUMBER: (231) 578-1083
DATE OF MEETING: September 6, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 9:00 a.m.
DISCUSSION ITEMS:
- Heard that the sprinkling wells have gone dry this summer along the fairway (for the adjacent residents)

NAME: David Campbell
LOCATION: No address with house, property in Section 14
PHONE NUMBER: (231) 894-8115
DATE OF MEETING: September 11, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 10:00 a.m.
DISCUSSION ITEMS:
- No drainage issues on property
NAME: Paul Kuipers
LOCATION: 6757 South Shore Drive
PHONE NUMBER: (231) 730-1145
DATE OF MEETING: September 5, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 4:45 p.m.
DISCUSSION ITEMS:
• No current drainage concerns
• However, when the golf course renovated the parking lot, Mr. Kuiper’s basement flooded. This only happened during the parking lot reconstruction and has not occurred since.
• Mr. Kuipers would like to view a sketch or pdf of how the drains go through his property. Would like it sent to him via email if possible (p.kuipers@ge.com)

NAME: Maria Gregory
LOCATION: P.O. Box 165 Ada
PHONE NUMBER: N/A
DATE OF MEETING: September 4, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 12:20 p.m.
DISCUSSION ITEMS:
• No drainage concerns

NAME: Dave Dewey
LOCATION: 5166 Scenic Drive
PHONE NUMBER: N/A
DATE OF MEETING: September 4, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 11:45 a.m.
DISCUSSION ITEMS:
• No drainage problems
• Property backs up to golf course
• You have permission to walk property and inspect if needed

NAME: Peter Pollack
LOCATION: 6141 South Shore Drive
PHONE NUMBER: (815) 385-0108
DATE OF MEETING: September 4, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 11:00 a.m.
DISCUSSION ITEMS:
• His property is 3 or 4 residential properties east of Lamus Rd.
• He said the area was “swampy” in the past but changes were made and now it’s better
NAME: Tim Duthler
LOCATION: 6210 South Shore Drive
PHONE NUMBER: (616) 481-9203
DATE OF MEETING: September 4, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 11:15 a.m.
DISCUSSION ITEMS:
• Property is a "low point" for several drains
• Mr. Duthler has built his own berm along his driveway to direct the river of storm water runoff
• Very concerned and would like to speak and/or meet with you. Can not make appt. times on September 12

NAME: Jim Allen
LOCATION: Gretchen Allen Trust: letter sent to 139 Wildroad Lake Forest, IL
PHONE NUMBER: (847) 234-3041
DATE OF MEETING: September 4, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 10:00 a.m.
DISCUSSION ITEMS:
• No drainage issues on this parcel at this time
• Mr. Allen is a member of the golf course and is concerned about the recent poor drainage on the course
• Parcel is in the Butterfield woods area

NAME: David Campbell
LOCATION: Letter sent to PO Box 363 Whitehall
PHONE NUMBER: (231) 894-8115
DATE OF MEETING: September 4, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 8:50 a.m.
DISCUSSION ITEMS:
• Mr. Allen does not own the above parcel
• This parcel is actually in Section 14
• Mr. Campbell owns the following parcels: 61061143000001-10 section 14 (no drainage ditch this parcel), and 6106114300000200 section 14 (this parcel does have a drainage ditch that does not get cleaned out very well. He does not feel it is his responsibility to keep it clean of debris)
NAME: Shirley Bayer
LOCATION: 6276 W. Michillinda Road
PHONE NUMBER: (231) 894-4257
DATE OF MEETING: September 4, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: 4:00 p.m.
DISCUSSION ITEMS:
- Never been flooded
- No problems

NAME: Larry Hembroff
LOCATION: South Shore Drive
PHONE NUMBER: (269) 274-1379
DATE OF MEETING: September 18, 2012
TYPE OF MEETING: Phone
TIME OF MEETING: N/A
DISCUSSION ITEMS:
- Drainage problems with some standing water on property
- Believes there are springs on property that cause many of the issues
- No basement
- Right & left sides of building has dampness and flooding

NAME: Steve Harvest
LOCATION: Cottage on South Shore Drive
PHONE NUMBER: (256) 876-0520
DATE OF MEETING: September 19, 2012
TYPE OF MEETING: Phone, message
TIME OF MEETING: N/A
DISCUSSION ITEMS:
- Lives in Alabama
- No drainage issues

NAME: Dean Brown
LOCATION: 6324 Michilinda Rd.
PHONE NUMBER: (435) 705-0339
DATE OF MEETING: September 11, 2012
TYPE OF MEETING: Phone, message
TIME OF MEETING: N/A
DISCUSSION ITEMS:
- Lives in Utah almost year round
- No drainage issues
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<th>ADDRESS</th>
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<td>T&amp;D COTTAGE LLC</td>
<td>1427 BRETON RD SE</td>
<td>GRAND RAPIDS</td>
<td>MI</td>
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<tr>
<td>61-06-012-400-0022-10</td>
<td>TAYLOR AMY</td>
<td>5573 LAMOS RD</td>
<td>WHITEHALL</td>
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<tr>
<td>61-06-012-400-0020-00</td>
<td>THOMAS CONSTANCE M TRUST</td>
<td>6264 W MICHLINADA RD</td>
<td>WHITEHALL</td>
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<td>61-06-013-200-0003-00</td>
<td>TIGHE PROP INC/S T FRANK</td>
<td>1721 GILCREST AVE</td>
<td>EAST LANSING</td>
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<td>48823</td>
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<td>61-06-155-000-0006-00</td>
<td>TOOHEY SEAN F/ANNE K</td>
<td>252 GRACE AVE</td>
<td>ELMHURST</td>
<td>IL</td>
<td>60126</td>
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<td>TOWNSHIP OF FRUITLAND</td>
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<td>TURK FRANK J/SUZANNE M</td>
<td>308 WEST RIDGE RD</td>
<td>JOLET</td>
<td>IL</td>
<td>60431</td>
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<td>JOLET</td>
<td>IL</td>
<td>60435</td>
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<td>61-06-013-100-0021-00</td>
<td>TWARDOCK DAVID A</td>
<td>90 WHITTREDGE RD</td>
<td>SUMMIT</td>
<td>NJ</td>
<td>07901</td>
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<tr>
<td>61-06-107-100-0001-00</td>
<td>VIHTELIC LAWRENCE/PREMO MARY L</td>
<td>5527 BEECHMONT AVE</td>
<td>WHITEHALL</td>
<td>MI</td>
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<td>61-06-013-200-0002-00</td>
<td>WEERLING ALAN TRUST</td>
<td>1617 LEDGE HILL CT</td>
<td>VIRGINIA BEACH</td>
<td>VA</td>
<td>23456</td>
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<tr>
<td>61-06-170-000-0007-00</td>
<td>WEERSING SPENCER/SALLY TRUST</td>
<td>38 DA VINCI ST</td>
<td>LAKE OSWEGO</td>
<td>OR</td>
<td>97035</td>
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<tr>
<td>61-06-012-300-0033-00</td>
<td>WHITE LAKE GOLF CLUB</td>
<td>6777 SOUTH SHORE DR</td>
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<td>61-06-142-000-0017-00</td>
<td>WILLIAM HELEN/GLENN TRUST</td>
<td>1000 ALLENS CREEK RD</td>
<td>ROCHESTER</td>
<td>NY</td>
<td>14618</td>
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<td>61-06-107-300-0005-30</td>
<td>ZACK GREGG D TRUST</td>
<td>6008 W MICHLINADA RD</td>
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<td>61-06-155-000-0015-00</td>
<td>ZICKEL MARK J</td>
<td>5580 OAKTREE LN</td>
<td>WHITEHALL</td>
<td>MI</td>
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APPENDIX D –

Township Zoning Information
APPENDIX E –

Soil Survey Map of Area from USDA Soil Survey
Custom Soil Resource Report for Muskegon County, Michigan
Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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<td>La</td>
<td>Lake beaches</td>
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<td>MhB</td>
<td>Montcalm and Chelsea soils, 2 to 6 percent slopes</td>
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<td>Pf fabB</td>
<td>Plainfield sand, high ecological site, 0 to 6 percent slopes</td>
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<tr>
<td>Pf facF</td>
<td>Plainfield sand, dunes, 18 to 60 percent slopes</td>
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<td>PpsaaA</td>
<td>Pipestone-Covert-Saugatuck sands, 0 to 3 percent slopes</td>
</tr>
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<td>Ra</td>
<td>Roscommon and Au Gres sands</td>
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<td>RtB</td>
<td>Rubicon loamy substratum and Montcalm soils, 0 to 6 percent slopes</td>
</tr>
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<td>Td</td>
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</tr>
<tr>
<td>W</td>
<td>Water</td>
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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the
individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.
MAP LEGEND

Area of Interest (AOI)  
Soils  

Special Point Features  
- Blowout  
- Borrow Pit  
- Clay Spot  
- Closed Depression  
- Gravel Pit  
- Gravelly Spot  
- Landfill  
- Lava Flow  
- Marsh or swamp  
- Mine or Quarry  
- Miscellaneous Water  
- Perennial Water  
- Rock Outcrop  
- Saline Spot  
- Sandy Spot  
- Severely Eroded Spot  
- Sinkhole  
- Slide or Slip  
- Sodic Spot  
- Spoil Area  
- Stony Spot  

Very Stony Spot  
Wet Spot  
Other  

Special Line Features  
- Gully  
- Short Steep Slope  
Other  

Political Features  
- Cities  

Water Features  
- Streams and Canals  

Transportation  
- Rails  
- Interstate Highways  
- US Routes  
- Major Roads  
- Local Roads  

MAP INFORMATION

Map Scale: 1:18,900 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:15,840.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Coordinate System: UTM Zone 16N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Muskegon County, Michigan
Survey Area Data: Version 7, Sep 27, 2012
Date(s) aerial images were photographed: 6/16/2005; 6/6/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.
Map Unit Legend (Mason & Partridge Drain)

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CovabB</td>
<td>Covert-Pipestone sands, 0 to 6 percent slopes</td>
<td>83.6</td>
<td>5.2%</td>
</tr>
<tr>
<td>DNL</td>
<td>Dune land</td>
<td>57.8</td>
<td>3.6%</td>
</tr>
<tr>
<td>La</td>
<td>Lake beaches</td>
<td>6.3</td>
<td>0.4%</td>
</tr>
<tr>
<td>MhB</td>
<td>Montcalm and Chelsea soils, 2 to 6 percent slopes</td>
<td>8.2</td>
<td>0.5%</td>
</tr>
<tr>
<td>PlfabB</td>
<td>Plainfield sand, high ecological site, 0 to 6 percent slopes</td>
<td>1,032.6</td>
<td>64.4%</td>
</tr>
<tr>
<td>PlfabD</td>
<td>Plainfield sand, high ecological site, 6 to 18 percent slopes</td>
<td>31.9</td>
<td>2.0%</td>
</tr>
<tr>
<td>PlfabE</td>
<td>Plainfield sand, high ecological site, 18 to 30 percent slopes</td>
<td>45.3</td>
<td>2.8%</td>
</tr>
<tr>
<td>PlfacF</td>
<td>Plainfield sand, dunes, 18 to 60 percent slopes</td>
<td>35.4</td>
<td>2.2%</td>
</tr>
<tr>
<td>PpsaaA</td>
<td>Pipestone-Covert-Saugatuck sands, 0 to 3 percent slopes</td>
<td>57.2</td>
<td>3.6%</td>
</tr>
<tr>
<td>Ra</td>
<td>Roscommon and Au Gres sands</td>
<td>15.9</td>
<td>1.0%</td>
</tr>
<tr>
<td>RtB</td>
<td>Rubicon loamy substratum and Montcalm soils, 0 to 6 percent slopes</td>
<td>26.8</td>
<td>1.7%</td>
</tr>
<tr>
<td>Td</td>
<td>Tonkey and Deford soils</td>
<td>29.3</td>
<td>1.8%</td>
</tr>
<tr>
<td>W</td>
<td>Water</td>
<td>117.7</td>
<td>7.3%</td>
</tr>
<tr>
<td><strong>Subtotals for Soil Survey Area</strong></td>
<td></td>
<td><strong>1,547.9</strong></td>
<td><strong>96.5%</strong></td>
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<tr>
<td><strong>Totals for Area of Interest</strong></td>
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<td><strong>1,604.1</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Map Unit Descriptions (Mason & Partridge Drain)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas...
for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a soil series. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into soil phases. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A complex consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An association is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An undifferentiated group is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of
the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.
Muskegon County, Michigan

CovabB—Covert-Pipestone sands, 0 to 6 percent slopes

Map Unit Setting
- **Elevation:** 580 to 830 feet
- **Mean annual precipitation:** 33 to 37 inches
- **Mean annual air temperature:** 46 to 48 degrees F
- **Frost-free period:** 129 to 180 days

Map Unit Composition
- **Covert and similar soils:** 69 percent
- **Pipestone and similar soils:** 19 percent
- **Minor components:** 12 percent

Description of Covert

Setting
- **Landform:** Nearshore zones (relict), outwash plains
- **Landform position (two-dimensional):** Summit, shoulder, backslope
- **Landform position (three-dimensional):** Rise, talf
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear
- **Parent material:** Sandy glaciolacustrine deposits

Properties and qualities
- **Slope:** 0 to 6 percent
- **Depth to restrictive feature:** More than 80 inches
- **Drainage class:** Moderately well drained
- **Capacity of the most limiting layer to transmit water (Ksat):** Very high (20.00 to 59.98 in/hr)
- **Depth to water table:** About 18 to 24 inches
- **Frequency of flooding:** None
- **Frequency of ponding:** None
- **Maximum salinity:** Nonsaline (0.0 to 2.0 mmhos/cm)
- **Available water capacity:** Low (about 4.6 inches)

Interpretive groups
- **Land capability (nonirrigated):** 4s

Typical profile
- 0 to 8 inches: Sand
- 8 to 13 inches: Sand
- 13 to 18 inches: Fine sand
- 18 to 29 inches: Sand
- 29 to 47 inches: Fine sand
- 47 to 80 inches: Sand

Description of Pipestone

Setting
- **Landform:** Outwash plains, nearshore zones (relict)
- **Landform position (three-dimensional):** Talf
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear
- **Parent material:** Sandy glaciolacustrine deposits
Properties and qualities

- **Slope:** 0 to 3 percent
- **Depth to restrictive feature:** More than 80 inches
- **Drainage class:** Somewhat poorly drained
- **Capacity of the most limiting layer to transmit water (Ksat):** High to very high (6.00 to 59.98 in/hr)
- **Depth to water table:** About 6 to 12 inches
- **Frequency of flooding:** None
- **Frequency of ponding:** None
- **Maximum salinity:** Nonsaline (0.0 to 2.0 mmhos/cm)
- **Available water capacity:** Low (about 4.2 inches)

Interpretive groups

- **Land capability (nonirrigated):** 3w

Typical profile

- 0 to 2 inches: Sand
- 2 to 4 inches: Sand
- 4 to 13 inches: Sand
- 13 to 19 inches: Sand
- 19 to 28 inches: Fine sand
- 28 to 80 inches: Sand

Minor Components

Plainfield, high ecological site

- **Percent of map unit:** 7 percent
- **Landform:** Outwash plains, beach ridges
- **Landform position (three-dimensional):** Rise
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear

Kingsville

- **Percent of map unit:** 2 percent
- **Landform:** Outwash plains, nearshore zones (relict)
- **Landform position (three-dimensional):** Rise, dip
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear

Kaleva

- **Percent of map unit:** 1 percent
- **Landform:** Outwash plains, beach ridges
- **Landform position (three-dimensional):** Rise
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear

Saugatuck

- **Percent of map unit:** 1 percent
- **Landform:** Outwash plains, nearshore zones (relict)
- **Landform position (three-dimensional):** Talf
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear

Covert, stratified substratum

- **Percent of map unit:** 1 percent
- **Landform:** Nearshore zones (relict)
- **Landform position (two-dimensional):** Summit, shoulder, backslope
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

DNL—Dune land

Map Unit Setting
  Elevation: 570 to 1,970 feet
  Mean annual precipitation: 25 to 40 inches
  Mean annual air temperature: 37 to 55 degrees F
  Frost-free period: 80 to 180 days

Map Unit Composition
  Dune land: 100 percent

Description of Dune Land
  Setting
    Landform: Dunes

La—Lake beaches

Map Unit Setting
  Mean annual precipitation: 30 to 36 inches
  Mean annual air temperature: 45 to 48 degrees F
  Frost-free period: 140 to 150 days

Map Unit Composition
  Lake beaches: 100 percent

Description of Lake Beaches
  Setting
    Landform: Beaches
    Landform position (three-dimensional): Rise
    Down-slope shape: Concave
    Across-slope shape: Linear
    Parent material: Beach sand
MhB—Montcalm and Chelsea soils, 2 to 6 percent slopes

Map Unit Setting
- **Elevation:** 600 to 1,500 feet
- **Mean annual precipitation:** 30 to 36 inches
- **Mean annual air temperature:** 45 to 48 degrees F
- **Frost-free period:** 140 to 150 days

Map Unit Composition
- **Montcalm and similar soils:** 60 percent
- **Chelsea and similar soils:** 40 percent

Description of Montcalm

Setting
- **Landform:** Moraines, till plains
- **Landform position (three-dimensional):** Rise
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear
- **Parent material:** Loamy drift and/or sandy drift

Properties and qualities
- **Slope:** 2 to 6 percent
- **Depth to restrictive feature:** More than 80 inches
- **Drainage class:** Well drained
- **Capacity of the most limiting layer to transmit water (Ksat):** Very low (0.00 in/hr)
- **Depth to water table:** More than 80 inches
- **Frequency of flooding:** None
- **Frequency of ponding:** None
- **Available water capacity:** Low (about 3.8 inches)

Interpretive groups
- **Land capability classification (irrigated):** 3s
- **Land capability (nonirrigated):** 3s

Typical profile
- **0 to 11 inches:** Sand
- **11 to 18 inches:** Loamy sand
- **18 to 60 inches:** Loamy sand

Description of Chelsea

Setting
- **Landform:** Moraines, till plains
- **Landform position (three-dimensional):** Rise
- **Down-slope shape:** Linear
- **Across-slope shape:** Linear
- **Parent material:** Eolian sands

Properties and qualities
- **Slope:** 2 to 6 percent
- **Depth to restrictive feature:** More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.7 inches)

Interpretive groups
Land capability (nonirrigated): 4s

Typical profile
0 to 9 inches: Loamy fine sand
9 to 60 inches: Sand

PfabB—Plainfield sand, high ecological site, 0 to 6 percent slopes

Map Unit Setting
Elevation: 580 to 720 feet
Mean annual precipitation: 30 to 36 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 140 to 150 days

Map Unit Composition
Plainfield, high ecological site, and similar soils: 80 percent
Minor components: 20 percent

Description of Plainfield, High Ecological Site
Setting
Landform: Outwash plains, lake plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Properties and qualities
Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 4.0 inches)

Interpretive groups
Land capability (nonirrigated): 4s
Typical profile
0 to 9 inches: Sand
9 to 16 inches: Sand
16 to 36 inches: Sand
36 to 75 inches: Sand
75 to 80 inches: Sand

Minor Components
Brems
Percent of map unit: 12 percent
Landform: Lake plains, outwash plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Kaleva
Percent of map unit: 4 percent
Landform: Outwash plains, lake plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear
Across-slope shape: Linear
Spinks
Percent of map unit: 2 percent
Landform: Lake plains, outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Brethren
Percent of map unit: 2 percent
Landform: Outwash plains, lake plains
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear

PlfabD—Plainfield sand, high ecological site, 6 to 18 percent slopes

Map Unit Setting
Elevation: 580 to 770 feet
Mean annual precipitation: 30 to 36 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 140 to 150 days

Map Unit Composition
Plainfield, high ecological site, and similar soils: 82 percent
Minor components: 18 percent
Description of Plainfield, High Ecological Site

Setting

Landform: Outwash plains, lake plains
Landform position (two-dimensional): Summit, backslope, footslope, shoulder
Landform position (three-dimensional): Head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave, convex
Parent material: Sandy lacustrine deposits

Properties and qualities

Slope: 6 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 4.0 inches)

Interpretive groups

Land capability (nonirrigated): 7s

Typical profile

0 to 9 inches: Sand
9 to 16 inches: Sand
16 to 36 inches: Sand
36 to 75 inches: Sand
75 to 80 inches: Sand

Minor Components

Brems

Percent of map unit: 11 percent
Landform: Lake plains, outwash plains
Landform position (two-dimensional): Footslope, toeslope, backslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear

Thompsonville

Percent of map unit: 4 percent
Landform: Lake plains, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope, footslope, toeslope
Landform position (three-dimensional): Head slope, nose slope, side slope, base slope
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

Kaleva

Percent of map unit: 3 percent
Landform: Outwash plains, lake plains
Landform position (two-dimensional): Summit, backslope, footslope, shoulder
Landform position (three-dimensional): Head slope, nose slope, side slope, base slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Linear, concave, convex

PlfabE—Plainfield sand, high ecological site, 18 to 30 percent slopes

Map Unit Setting
  Elevation: 580 to 770 feet
  Mean annual precipitation: 33 to 37 inches
  Mean annual air temperature: 46 to 48 degrees F
  Frost-free period: 129 to 180 days

Map Unit Composition
  Plainfield, high ecological site, and similar soils: 89 percent
  Minor components: 11 percent

Description of Plainfield, High Ecological Site

Setting
  Landform: Outwash plains, lake plains
  Landform position (two-dimensional): Backslope, footslope, shoulder
  Landform position (three-dimensional): Head slope, nose slope, side slope, base slope, crest
  Down-slope shape: Convex, linear
  Across-slope shape: Concave, convex
  Parent material: Sandy lacustrine deposits

Properties and qualities
  Slope: 18 to 30 percent
  Depth to restrictive feature: More than 80 inches
  Drainage class: Excessively drained
  Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
  Depth to water table: More than 80 inches
  Frequency of flooding: None
  Frequency of ponding: None
  Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
  Available water capacity: Low (about 4.3 inches)

Interpretive groups
  Land capability (nonirrigated): 7s

Typical profile
  0 to 9 inches: Sand
  9 to 16 inches: Sand
  16 to 36 inches: Sand
  36 to 75 inches: Sand
  75 to 80 inches: Sand
Minor Components

Kaleva
Percent of map unit: 5 percent
Landform: Outwash plains, lake plains
Landform position (two-dimensional): Backslope, footslope, shoulder
Landform position (three-dimensional): Head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

Brems
Percent of map unit: 3 percent
Landform: Outwash plains, lake plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, crest
Down-slope shape: Linear
Across-slope shape: Linear

Spinks
Percent of map unit: 2 percent
Landform: Outwash plains, lake plains
Landform position (two-dimensional): Backslope, footslope, shoulder
Landform position (three-dimensional): Side slope, head slope, nose slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

Tekenink
Percent of map unit: 1 percent
Landform: Outwash plains, lake plains
Landform position (two-dimensional): Backslope, footslope, shoulder
Landform position (three-dimensional): Head slope, nose slope, side slope, base slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

PlfacF—Plainfield sand, dunes, 18 to 60 percent slopes

Map Unit Setting
Elevation: 580 to 810 feet
Mean annual precipitation: 30 to 36 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 140 to 150 days

Map Unit Composition
Plainfield, dune, and similar soils: 80 percent
Minor components: 20 percent
Description of Plainfield, Dune

Setting

Landform: Dunes on lake plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest, nose slope, head slope
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex
Parent material: Eolian sands

Properties and qualities

Slope: 18 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 3.9 inches)

Interpretive groups

Land capability (nonirrigated): 7s

Typical profile

0 to 2 inches: Sand
2 to 4 inches: Sand
4 to 8 inches: Sand
8 to 18 inches: Sand
18 to 24 inches: Sand
24 to 80 inches: Sand

Minor Components

Plainfield, dune

Percent of map unit: 14 percent
Landform: Dunes on lake plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, rise
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

Platteriver

Percent of map unit: 5 percent
Landform: Dunes on lake plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

Dune land

Percent of map unit: 1 percent
Landform: Dunes
Landform position (two-dimensional): Summit, shoulder, backslope, footslope
Landform position (three-dimensional): Side slope, base slope, head slope, nose slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Concave, convex

PpsaaA—Pipestone-Covert-Saugatuck sands, 0 to 3 percent slopes

Map Unit Setting
Elevation: 580 to 780 feet
Mean annual precipitation: 33 to 36 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 129 to 180 days

Map Unit Composition
Pipestone and similar soils: 50 percent
Covert and similar soils: 20 percent
Saugatuck and similar soils: 15 percent
Minor components: 15 percent

Description of Pipestone

Setting
Landform: Outwash plains, nearshore zones (relict)
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 59.98 in/hr)
Depth to water table: About 6 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 4.2 inches)

Interpretive groups
Land capability (nonirrigated): 3w

Typical profile
0 to 2 inches: Sand
2 to 4 inches: Sand
4 to 13 inches: Sand
13 to 19 inches: Sand
19 to 28 inches: Fine sand
28 to 80 inches: Sand
Description of Covert

Setting
Landform: Nearshore zones (relict), outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very high (20.00 to 59.98 in/hr)
Depth to water table: About 18 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 4.6 inches)

Interpretive groups
Land capability (nonirrigated): 4s

Typical profile
0 to 8 inches: Sand
8 to 13 inches: Sand
13 to 18 inches: Fine sand
18 to 29 inches: Sand
29 to 47 inches: Fine sand
47 to 80 inches: Sand

Description of Saugatuck

Setting
Landform: Outwash plains, nearshore zones (relict)
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glaciolacustrine deposits

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: 6 to 21 inches to ortstein
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 59.98 in/hr)
Depth to water table: About 6 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Very low (about 1.5 inches)

Interpretive groups
Land capability (nonirrigated): 3w
Typical profile
  0 to 1 inches: Slightly decomposed plant material
  1 to 8 inches: Sand
  8 to 13 inches: Fine sand
  13 to 17 inches: Sand
  17 to 20 inches: Fine sand
  20 to 32 inches: Fine sand
  32 to 80 inches: Fine sand

Minor Components

Kingsville
  Percent of map unit: 10 percent
  Landform: Outwash plains, nearshore zones (relict)
  Landform position (three-dimensional): Dip
  Down-slope shape: Linear
  Across-slope shape: Linear

Jebavy
  Percent of map unit: 2 percent
  Landform: Nearshore zones (relict), outwash plains
  Landform position (three-dimensional): Dip
  Down-slope shape: Linear
  Across-slope shape: Linear

Antung
  Percent of map unit: 2 percent
  Landform: Nearshore zones (relict), outwash plains
  Landform position (three-dimensional): Dip
  Down-slope shape: Linear
  Across-slope shape: Linear

Plainfield, high ecological site
  Percent of map unit: 1 percent
  Landform: Outwash plains, beach ridges, dunes
  Landform position (three-dimensional): Rise
  Down-slope shape: Linear
  Across-slope shape: Linear

Ra—Roscommon and Au Gres sands

Map Unit Setting
  Elevation: 600 to 1,000 feet
  Mean annual precipitation: 30 to 36 inches
  Mean annual air temperature: 45 to 48 degrees F
  Frost-free period: 140 to 150 days
Map Unit Composition

Roscommon and similar soils: 50 percent
Au gres and similar soils: 45 percent
Minor components: 5 percent

Description of Roscommon

Setting
Landform: Outwash plains, lake plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy lacustrine deposits

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 10 percent
Available water capacity: Low (about 5.6 inches)

Interpretive groups
Land capability (nonirrigated): 5w

Typical profile
0 to 5 inches: Loamy sand
5 to 36 inches: Sand
36 to 60 inches: Sand

Description of Au Gres

Setting
Landform: Outwash plains, lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy lacustrine deposits

Properties and qualities
Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.3 inches)

Interpretive groups
Land capability (nonirrigated): 4w
Typical profile
0 to 5 inches: Sand
5 to 11 inches: Sand
11 to 34 inches: Sand
34 to 60 inches: Sand

Minor Components
Croswell
Percent of map unit: 5 percent
Landform: Outwash plains, lake plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

RtB—Rubicon loamy substratum and Montcalm soils, 0 to 6 percent slopes

Map Unit Setting
Elevation: 600 to 1,200 feet
Mean annual precipitation: 30 to 36 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 140 to 150 days

Map Unit Composition
Rubicon, loamy substratum, and similar soils: 50 percent
Montcalm and similar soils: 40 percent
Minor components: 10 percent

Description of Rubicon, Loamy Substratum
Setting
Landform: Moraines, till plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy drift over loamy drift

Properties and qualities
Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water capacity: Low (about 5.4 inches)

**Interpretive groups**
- Land capability (nonirrigated): 6s

**Typical profile**
- 0 to 6 inches: Sand
- 6 to 32 inches: Sand
- 32 to 45 inches: Sand
- 45 to 60 inches: Loam

**Description of Montcalm**

**Setting**
- Landform: Moraines, till plains
- Landform position (three-dimensional): Rise
- Down-slope shape: Linear
- Across-slope shape: Linear
- Parent material: Loamy drift and/or sandy drift

**Properties and qualities**
- Slope: 0 to 6 percent
- Depth to restrictive feature: More than 80 inches
- Drainage class: Well drained
- Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
- Depth to water table: More than 80 inches
- Frequency of flooding: None
- Frequency of ponding: None
- Available water capacity: Low (about 3.8 inches)

**Interpretive groups**
- Land capability classification (irrigated): 3s
- Land capability (nonirrigated): 3s

**Typical profile**
- 0 to 11 inches: Sand
- 11 to 18 inches: Loamy sand
- 18 to 60 inches: Loamy sand

**Minor Components**

**Menominee**
- Percent of map unit: 5 percent
- Landform: Outwash plains, lake plains, till plains
- Landform position (three-dimensional): Rise
- Down-slope shape: Linear
- Across-slope shape: Linear

**Au gres**
- Percent of map unit: 5 percent
- Landform: Outwash plains, lake plains, till plains
- Landform position (three-dimensional): Rise
- Down-slope shape: Linear
- Across-slope shape: Linear
Td—Tonkey and Deford soils

Map Unit Setting

*Elevation:* 600 to 1,200 feet
*Mead annual precipitation:* 30 to 36 inches
*Mead annual air temperature:* 45 to 48 degrees F
*Frost-free period:* 140 to 150 days

Map Unit Composition

*Tonkey and similar soils:* 50 percent
*Deford and similar soils:* 45 percent
*Minor components:* 5 percent

Description of Tonkey

Setting

*Landform:* Outwash plains, lake plains
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Stratified sandy and/or loamy glaciofluvial deposits

Properties and qualities

*Slope:* 0 to 2 percent
* Depth to restrictive feature:* More than 80 inches
*Drainage class:* Poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* About 0 inches
*Frequency of flooding:* None
*Frequency of ponding:* Frequent
*Calcium carbonate, maximum content:* 30 percent
*Available water capacity:* High (about 9.2 inches)

Interpretive groups

*Land capability (nonirrigated):* 2w

Typical profile

0 to 10 inches: Sandy loam
10 to 33 inches: Sandy clay loam
33 to 60 inches: Loam

Description of Deford

Setting

*Landform:* Outwash plains, lake plains
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
**Parent material:** Sandy lacustrine deposits

**Properties and qualities**
- **Slope:** 0 to 2 percent
- **Depth to restrictive feature:** More than 80 inches
- **Drainage class:** Poorly drained
- **Capacity of the most limiting layer to transmit water (Ksat):** High to very high (5.95 to 19.98 in/hr)
- **Depth to water table:** About 0 inches
- **Frequency of flooding:** None
- **Frequency of ponding:** Frequent
- **Available water capacity:** Low (about 4.7 inches)

**Interpretive groups**
- **Land capability (nonirrigated):** 4w

**Typical profile**
- **0 to 5 inches:** Loamy sand
- **5 to 20 inches:** Fine sand
- **20 to 60 inches:** Fine sand

**Minor Components**
- **Roscommon**
  - **Percent of map unit:** 5 percent
  - **Landform:** Outwash plains, lake plains
  - **Landform position (three-dimensional):** Talf
  - **Down-slope shape:** Linear
  - **Across-slope shape:** Linear

**W—Water**

**Map Unit Composition**
- **Water:** 100 percent
References


APPENDIX F –

Existing State of Michigan
DEQ Wetland Inventory Map for Area
Muskegon County Final Wetland Inventory

This Michigan Department of Environmental Quality (DEQ) Wetland inventory map is intended to be used as a tool to assist in assisting watershed and county planning and natural resource management efforts. The ultimate goal of the NWI is to provide the most accurate inventory of wetlands as identified by the United States Department of Agriculture, Natural Resources Conservation Service (NRCS).

This map is not intended to be used to determine the specific locations and jurisdictional used for jurisdictional determinations. A permit is required from the MDEQ to conduct certain activities in wetlands regulated under Part 303.

More information regarding this map, including how to obtain a copy can be accessed at www.michigan.gov/deqwetlands.

Compiled by DEQ-LWMD on December 15, 2006.
APPENDIX G –

Storm Sewer Structure Inventory Reports
## Structure Inventory Report Form

**Project Name:** Mason and Partridge Drains  
**Project Number:** 12082

**Structure Number:**  
**Location:**

**Date:** 9/30/12  
**Inspected by:** TS/IG

**Type:**  
- [ ] Sanitary  
- [ ] Storm  
- [ ] Combination  
- [x] Beehive  
- [ ] Catchbasin  
- [ ] Flat Grate  
- [ ] Other: __________

**Photo (See Attached):**

**Overall Structure Comments:**

**Pipe Elevation:** 606.14

<table>
<thead>
<tr>
<th>Pipe Direction</th>
<th>Pipe Size</th>
<th>Pipe Material</th>
<th>Distance Rim to Invert</th>
<th>Invert Elevation</th>
<th>Comments</th>
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<tbody>
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<td>18&quot;</td>
<td>CMP</td>
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**Structure Material:**  
- [x] Block  
- [ ] Precast  
- [ ] Brick  
- [ ] PE  
- [ ] Other: __________

**Diameter:** 2"  
**Sump:** 1"  
**Casting Adjustment Material:**  
- [x] Brick  
- [ ] Precast Rings  
- [ ] Other: __________

**Adjustment Height:** 35
**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** MASON AND PARTRIDGE DRAINS  
**PROJECT NUMBER:** 12022

**STRUCTURE NUMBER:** 7  
**LOCATION:**

**DATE:** 9/20/12  
**INSPECTED BY:** 7S/1G

**TYPE:**
- [ ] SANITARY
- [ ] CASTING TYPE:
  - [ ] MANHOLE
  - [ ] STORM
  - [ ] CURB-INLET
  - [ ] COMBINATION
  - [ ] BEEHIVE
  - [ ] CATCHBASIN
  - [x] FLAT GRATE
  - [ ] OTHER: ____________
- [ ] OTHER:

**PHOTO (SEE ATTACHED):**

**OVERALL STRUCTURE COMMENTS:**

**RISSELEVATION:** 605.90

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<th>PIPE SIZE</th>
<th>PIPE MATERIAL</th>
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<th>INVERT ELEVATION</th>
<th>COMMENTS</th>
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<td>2.92</td>
<td>602.98</td>
<td>HALFWAY TO OUTLET TURNS TO 15&quot; CMP</td>
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</table>

**STRUCTURE MATERIAL:**
- [x] BLOCK
- [ ] PRECAST
- [ ] BRICK
- [ ] PE
- [ ] OTHER: ____________

**DIAMETER:** 7  
**SUMP:** ____________

**CASTING ADJUSTMENT MATERIAL:**
- [ ] BRICK
- [ ] PRECAST RINGS
- [ ] OTHER: ____________

**ADJUSTMENT HEIGHT:** ____________

---

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**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** MASON AND PARTRIDGE DRAWS  
**PROJECT NUMBER:** 12022

**STRUCTURE NUMBER:** 3  
**LOCATION:** 

**DATE:** 9/80/12  
**INSPECTED BY:** 7/5/16

**TYPE:**  
- [ ] SANITARY  
- [ ] STORM  
- [ ] COMBINATION  
- [x] CATCHBASIN  
- [ ] CURB INLET  
- [ ] BEEHIVE  
- [ ] FLAT GRATE  
- [ ] OTHER: 

**PHOTO (SEE ATTACHED):** 

**OVERALL STRUCTURE COMMENTS:**

**RIME ELEVATION:** 605.71

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<th>PIPE SIZE</th>
<th>PIPE MATERIAL</th>
<th>DISTANCE RIM TO INVERT</th>
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<td>CMI</td>
<td>10.70</td>
<td>604.71</td>
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**STRUCTURE MATERIAL:**  
- [ ] BLOCK  
- [ ] PRECAST  
- [ ] BRICK  
- [ ] PE  
- [x] OTHER: HDPE

**DIAMETER:** 2"  
**SUMP:** 0

**CASTING ADJUSTMENT MATERIAL:**  
- [ ] BRICK  
- [ ] PRECAST RINGS  
- [ ] OTHER: 

**ADJUSTMENT HEIGHT:** 0

---

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### Structure Inventory Report Form

**Project Name:** Mason and Partridge Drains  
**Project Number:** 18022

**Structure Number:** 4  
**Location:**

**Date:** 9/20/12  
**Inspected by:** TS/IG

**Type:**  
- [ ] Sanitary  
- [ ] Storm  
- [ ] Combination  
- [x] Catchbasin  
- [ ] Flat Grate  
- [ ] Other: ____________________________

**Photos (See Attached):**

**Overall Structure Comments:**

**Pipe Elevation:** 611.37

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**Structure Material:**
- [ ] Block  
- [x] Precast  
- [x] Brick  
- [ ] PE  
- [ ] Other: ____________________________

**Diameter:** 2"  
**Sump:** 0

**Casting Adjustment Material:**
- [x] Brick  
- [ ] Precast Rings  
- [ ] Other: ____________________________

**Adjustment Height:** 35

---

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**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** MASON AND PARTRIDGE DRAINS  
**LOCATION:**

**DATE:** 9/20/12  
**INSPECTED BY:** TS/IG

**TYPE:**
- [ ] SANITARY
- [ ] STORM
- [ ] COMBINATION
- [ ] CATCHBASIN
- [ ] OTHER:_____________

**CASTING TYPE:**
- [ ] MANHOLE
- [ ] CURB-INLET
- [ ] BEEHIVE
- [ ] FLAT GRATE
- [ ] OTHER:_____________

**PHOTO (SEE ATTACHED):**

**OVERALL STRUCTURE COMMENTS:**

**RIM ELEVATION:** 608.18

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</tbody>
</table>

**STRUCTURE MATERIAL:**
- [ ] BLOCK
- [X] PRECAST
- [ ] BRICK
- [ ] PE
- [ ] OTHER:_____________

**DIAMETER:** 2

**SUMP:**

**CASTING ADJUSTMENT MATERIAL:**
- [ ] BRICK
- [X] PRECAST RINGS
- [ ] OTHER:_____________

**ADJUSTMENT HEIGHT:** 0

---

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**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** MASON AND PARTRIDGE DRAINS  
**PROJECT NUMBER:** 12022

**STRUCTURE NUMBER:** 6  
**LOCATION:**

**DATE:** 9/10/12  
**INSPECTED BY:** TS/IG

**TYPE:**  
☐ SANITARY  
☒ STORM  
☐ COMBINATION  
☐ CATCHBASIN  
☐ OTHER: __________  

**CASTING TYPE:**  
☒ MANHOLE  
☐ CURB-INLET  
☐ BEEHIVE  
☐ FLAT GRATE  
☐ OTHER: __________  

**PHOTO (SEE ATTACHED):**

**OVERALL STRUCTURE COMMENTS:**

**RL/ELEVATION:** 612.68

**PIPE DIRECTION** | **PIPE SIZE** | **PIPE MATERIAL** | **DISTANCE FROM INVERT** | **INVERT ELEVATION** | **COMMENTS**
---|---|---|---|---|---
NE | 12" | CLAY | 6.68 | 60600 |
SW | 12" | CLAY | 6.66 | 60602 |

**STRUCTURE MATERIAL:**  
☐ BLOCK  
☒ PRECAST  
☐ BRICK  
☐ PE  
☐ OTHER: __________  

**DIAMETER:** 4'50  
**SUMP:**

**CASTING ADJUSTMENT MATERIAL:**  
☒ BRICK  
☐ PRECAST RINGS  
☐ OTHER: __________  

**ADJUSTMENT HEIGHT:** 0.7

---

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## Structure Inventory Report Form

**Project Name:** Mason and Partridge Drains  
**Project Number:** 18022  

**Structure Number:** 7  
**Location:**  

**Date:** 9/20/12  
**Inspected By:** TS/IG  

**Type:**  
- □ Sanitary  
- □ Storm  
- □ Combination  
- □ Catchbasin  
- □ Other:  

**Casting Type:**  
- □ Manhole  
- □ Curb-Inlet  
- □ Beehive  
- □ Flat Grate  
- □ Other:  

**Photo (See Attached):**  

**Overall Structure Comments:**  

**Pipe Material:**  

<table>
<thead>
<tr>
<th>Pipe Direction</th>
<th>Pipe Size</th>
<th>Pipe Material</th>
<th>Distance Rim to Invert (ft)</th>
<th>Invert Elevation (ft)</th>
<th>Comments</th>
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<tbody>
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<td>Clay</td>
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<tr>
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<td>Clay</td>
<td>9.36</td>
<td>608.39</td>
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</table>

**Structure Material:**  
- □ Block  
- □ Precast  
- □ Brick  
- □ PE  
- □ Other:  

**Diameter:** 4  
**Sump:**  

**Casting Adjustment Material:**  
- □ Brick  
- □ Precast Rings  
- □ Other:  

**Adjustment Height:** 65
**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** Mason and Partridge Drains  
**PROJECT NUMBER:** 18022

**STRUCTURE NUMBER:** 8  
**LOCATION:**

**DATE:** 9/20/12  
**INSPECTED BY:** T5/1G

**TYPE:**  
- [ ] SANITARY  
- [ ] CASTING TYPE:
  - [ ] MANHOLE  
- [ ] STORM  
- [ ] CURB-INLET  
- [ ] COMBINATION  
- [ ] BEEHIVE  
- [ ] CATCHBASIN  
- [ ] FLAT GRATE  
- [ ] OTHER: __________  

**PROTO (SEE ATTACHED):**

**OVERALL STRUCTURE COMMENTS:**

**PIPE ELEVATION:** 614.35

<table>
<thead>
<tr>
<th>PIPE DIRECTION</th>
<th>PIPE SIZE</th>
<th>PIPE MATERIAL</th>
<th>DISTANCE FROM INVERT</th>
<th>INVERT ELEVATION</th>
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**STRUCTURE MATERIAL:**  
- [ ] BLOCK  
- [X] PRECAST  
- [ ] BRICK  
- [ ] PE  
- [ ] OTHER: __________

**DIAMETER:** 4'/8"  
**SUMP:**

**CASTING ADJUSTMENT MATERIAL:**  
- [ ] BRICK  
- [ ] PRECAST RINGS  
- [ ] OTHER: __________

**ADJUSTMENT HEIGHT:** 0.8"
**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** Mason and Partridge Drains  
**PROJECT NUMBER:** 12022

**STRUCTURE NUMBER:** 9  
**LOCATION:**

**DATE:** 9/01/12  
**INSPECTED BY:** 7/5/12

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<tr>
<th>PIPE DIRECTION</th>
<th>PIPE SIZE</th>
<th>PIPE MATERIAL</th>
<th>DISTANCE RIM TO INVERT</th>
<th>INVERT ELEVATION</th>
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<tr>
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<td>1190</td>
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<td>1143</td>
<td>603.92</td>
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**PIPE DIRECTION:**

**PIPE SIZE:**

**PIPE MATERIAL:**

**DISTANCE RIM TO INVERT:**

**INVERT ELEVATION:**

**COMMENTS:**

**PHOTO (SEE ATTACHED):**

**OVERALL STRUCTURE COMMENTS:**

**N/SE ELEVATION:** 615.35

**DIA:** 4 1/2  
**DIA:** 1/4  
**DIA:** 1 1/2

**SUMP:**

**CASTING ADJUSTMENT MATERIAL:**

**ADJUSTMENT HEIGHT:** 0.85

**STRUCTURE MATERIAL:**

**DIAMETER:**

**CASTING ADJUSTMENT MATERIAL:**

**ADJUSTMENT HEIGHT:**

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**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** Mason and Partridge Drains  
**PROJECT NUMBER:** 18022

**STRUCTURE NUMBER:** 10  
**LOCATION:**

**DATE:** 9/80/12  
**INSPECTED BY:** T S / J G

**TYPE:**  
- [ ] SANITARY  
- [ ] STORM  
- [ ] COMBINATION  
- [ ] CATCHBASIN  
- [ ] OTHER: __________

**CASTING TYPE:**  
- [ ] MANHOLE  
- [ ] CURB-INLET  
- [ ] BEEHIVE  
- [ ] FLAT GRATE  
- [ ] OTHER: __________

**PHOTO (SEE ATTACHED):**

**OVERALL STRUCTURE COMMENTS:** Broken, Casting

**PIPE ELEVATION:** 613.56

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**STRUCTURE MATERIAL:**  
- [ ] BLOCK  
- [X] PRECAST  
- [ ] BRICK  
- [ ] PE  
- [ ] OTHER: __________

**DIAMETER:** 9" 5/8  
**SUMP:**

**CASTING ADJUSTMENT MATERIAL:**  
- [X] BRICK  
- [ ] PRECAST RINGS  
- [ ] OTHER: __________

**ADJUSTMENT HEIGHT:** 0.95
**STRUCTURE INVENTORY REPORT FORM**

**PROJECT NAME:** MASON AND PARTRIDGE DRAINS  
**PROJECT NUMBER:** 12022  
**STRUCTURE NUMBER:** 11  
**LOCATION:**  
**DATE:** 9/20/12  
**INSPECTED BY:** TS/IG  
**TYPE:**  
- [ ] SANITARY  
- [X] STORM  
- [ ] COMBINATION  
- [ ] CATCHBASIN  
- [ ] CURB-INLET  
- [ ] BEEHIVE  
- [ ] FLAT GRATE  
- [ ] OTHER:  
**CASTING TYPE:**  
- [X] MANHOLE  
- [ ] OTHER:  

**PIPE ELEVATION:** 587.72 FROM TOTAL STATION  

<table>
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<th>PIPE DIRECTION</th>
<th>PIPE SIZE</th>
<th>PIPE MATERIAL</th>
<th>DISTANCE, RIM TO INVERT</th>
<th>INVERT ELEVATION</th>
<th>COMMENTS</th>
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<td>PVC</td>
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<td>583.59</td>
<td>&quot;HOPE-CAPPED OFF TO NE-BELOW THIS PIPE&quot;</td>
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**STRUCTURE MATERIAL:**  
- [ ] BLOCK  
- [X] PRECAST  
- [ ] BRICK  
- [ ] PE  
- [ ] OTHER:  

**DIAMETER:** 4"  
**SUMP:** 2.2  

**CASTING ADJUSTMENT MATERIAL:**  
- [ ] BRICK  
- [ ] PRECAST RINGS  
- [ ] OTHER:  

**ADJUSTMENT HEIGHT:** 0