Gould Engineering, Inc.

PRINCIPALS:
Victor J. Lukasavitz, PS
Steven J. Nagy, PE
Kevin B. Cleaver, PS

SENIOR ASSOCIATE:
David D. Hiler, PE

ASSOCIATES:
William R. Wascher, PS
Lisa M. Easterwood, CST
Kevin O'Brien, PS

PRELIMINARY ENGINEERING REPORT
FOR THE

SLACK LAKE, SAGINAW ROAD EXTENSION #1680

PREPARED FOR:

MR. JEFFREY WRIGHT
GENESEE COUNTY DRAIN COMMISSIONER
GENESEE COUNTY, MICHIGAN

PREPARED BY:

GOULD ENGINEERING, INC.
2040 E. Maple Avenue
Flint, Michigan 48507
Phone: (810) 743-9120
Fax: (810) 743-1797
www.gouldengineering.com

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Phone: 810.743.9120
Fax: 810.743.1797
2040 E. Maple Avenue
Flint, MI 48507-4256
www.gouldengineering.com

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1. Introduction

The Slack Lake, Saginaw Road Extension #1680 is a proposed extension of the existing Slack Lake Drain which terminates on the east line of Saginaw Road in Section 35 of Grand Blanc Township, just north of the I-75 interchange. The proposed drain would begin at the terminus of the existing drain and continue westerly approximately 400 feet to an existing water body, which is a collection point for a large upstream drainage system of approximately 800 acres. A mostly enclosed pipe system currently exists along this route, but it is not part of the county drain system. Recently, this outlet pipe system became plugged and over a period of months caused several feet of water to back up over the small lake and swamp area. Through efforts by the Genesee County Drain Commissioner's Office, the discharge of storm water was restored and the water receded. In an effort to maintain this outlet in the future and improve the storm water discharge, the property owner and residents desire to establish a county drain to provide for future maintenance of the storm system from Saginaw Road to the Lake. The purpose of this preliminary drainage study was to evaluate the existing pipe conveying the excess storm water runoff from the small lake to Saginaw Road, and to determine any necessary improvements.

2. Site Location

The drainage system being evaluated in this report is located in Section 35 of Grand Blanc Township and lies northwesterly of the Saginaw Road and I-75 interchange. A location map of the project area is located in Appendix 'A'. This study focuses on approximately 300 L.F. of enclosed pipe which serves as an outlet for a contributing drainage area of approximately 800 acres. The 800 acre drainage area is located within Sections 34 and 35 of Grand Blanc Township and Sections 2 and 3 of Holly Township.

3. Existing Drainage Course

Westerly of Saginaw Road (Area of Study)

The upper end of the overall drainage area consists of rural, undeveloped woodland and wetland areas in the vicinity of Slack Lake. This drainage area lies southwesterly of I-75 and is bisected by the Oakland and Genesee County line. Due to the large amount of wetlands and open water, significant storm water storage potential exists in this area. Excess storm water runoff drains in the northeasterly direction through a concrete pipe located beneath Lost Lake Road and the north and south bound lanes of I-75. This culvert is part of the State of Michigan's interstate freeway

system and is owned by the Michigan Department of Transportation (MDOT). On the northeasterly side of I-75, the runoff continues through a channel adjacent to the freeway. This channel intersects another large wetland area and conveys the excess storm water southeasterly to a small lake located northwesterly of the Saginaw Road and I-75 interchange. At the east end of this lake is an embankment constructed out of wood debris that is maintaining the lake's water level. The origination of this embankment is unknown. It may have began as a beaver dam and been altered by man with additional debris or may be entirely man-made. Below the embankment and approximately 50 feet easterly is a culvert that conveys storm water runoff to the west side of Saginaw Road, where it crosses Saginaw Road through a box culvert and enters the existing Slack Lake Drain. The proposed county drain would be established near the route of these existing culverts from the established county drain westerly to the east end of the small lake. The wood debris embankment does not meet Genesee County Drain Commissioner's Office - Surface Water Management requirements and is not proposed to become part of the county's system. It shall continue to be under the control of the property owner. The public storm sewer system and the embankment would ultimately manage the storm water discharge from the entire 800± acres. Photographs of the existing drainage area and course are located in Appendix 'B'.

Easterly of Saginaw Road (Area of Existing Slack Lake Drain)

According to historical records reviewed by Gould Engineering, Inc, including the 1960's era composite map and aerial imagery from 1997, the existing Slack Lake Drain appears to terminate on the east side of Saginaw Road near the existing box culvert beneath the road. From the east side of the road, the drain appears to meander in the easterly-southeasterly direction for approximately 850 feet before turning and continuing in the southeasterly direction. A marginally defined channel is visible from Saginaw Road for one-hundred feet (100') or so. After that, the channel dissipates and converges with a large wetland area, possibly due to the amount of sediment within the channel and the overgrowth of the wetland vegetation in this area.

As part of the preliminary drainage study, Gould Engineering, Inc. reviewed and plotted the drain route on file with the Genesee County Drain Commissioner's Office to confirm that it extended to the east side of Saginaw Road and follows the approximate route of the current drain location. It was found that the described route does not follow the present physical course of the drain through Section 35 of Grand Blanc Township. The described route does terminate on the east side of Saginaw Road, but at a point 450± feet north of the box culvert crossing and approximate present location of the drain. The map in Appendix "C" depicts the described route and the approximate

physical location of the existing drain. This misplacement of the described route is noted for the Drain Commissioner's information and consideration for future drain cleanout or improvements on the east side of Saginaw Road. Easements along this route may be required in the future.

For the purpose of this study, the east side of the Saginaw Road culvert is the point of beginning for this extension.

4. Basis of Evaluation and Design

A. Hydrology – (Stormwater Runoff/Detention)

DRAINAGE AREAS

The approximate drainage areas used in this study were determined from two foot (2') contours obtained from the Genesee County and Oakland County contour maps. Field observations were also completed to verify the drainage area determined from these contours. A map of the overall drainage area and sub-drainage areas is located in Appendix 'C'. It was determined that the overall drainage area lying westerly of the existing outlet to Saginaw Road is approximately 800 acres. This drainage area is comprised of two (2) sub-districts, one being the area lying southwesterly of I-75, and the other being the area lying northeasterly of I-75 which outlets through the culvert being studied as part of this report. Based on Genesee County Drain Commissioner's Office-SWM standards, the SCS Method was used to calculate peak runoff flows for a 4% chance (25-year) and 1% chance (100-year), 24 hour storm event.

SCS METHOD

The SCS Method was used to determine the amount of storm water runoff from the drainage areas identified in this report. This hydrology method uses the characteristics of the drainage areas to generate hydrographs and flows from the sub-areas. These characteristics include hydrologic soil types (A, B, C or D), the land use/coverage type and the time of concentration of the drainage areas.

The hydrologic soils group is used to classify the existing soils of the sub-areas into different types of infiltration rates. The infiltration rates of soils can vary from having high rates of infiltration similar to gravel and sandy soils to having very low rates of infiltration similar to dense clays. The hydrologic soil groups A, B, C and D are further described as follows:

Soil Group A - These soils have high infiltration rates and low runoff potential even when thoroughly wetted. Examples of these types of soils are sands and gravels.

Soil Group B - These soils have moderate infiltration rates when thoroughly wetted. These soils have moderately fine to moderately coarse textures and a moderate rate of water transmission.
Soil Group C - These soils have low infiltration rates when thoroughly wetted. These soils have moderately fine to fine texture and a low rate of water transmission.
Soil Group D - These soils have very low infiltration rates when thoroughly wetted and high runoff potential. Examples of these types of soils are clay soils which have high swelling potential and very low rates of water transmissions.

The land use/cover type of these soils further determines the amount of runoff from the drainage areas. The land use/cover type within the drainage sub-areas consist of various types of impervious surfaces such as pavements and water surface areas of the lakes, and pervious areas such as lawns, meadows, and wooded areas.

The overall drainage area for this study consists primarily of Soil Group B and C, with a small amount of Soil Group D soils scattered throughout. The primary land uses are woodlands, vegetated swamps and wetlands, and open water. The land uses are identified on a topographic and aerial photography map included in Appendix 'D'.

TIME OF CONCENTRATION

The time of concentration for various drainage paths was calculated in order to determine the rainfall intensity (I_{25} & I_{100}) for each drainage sub-area. The GCDC-SWM standard of thirty (30) minutes for rural areas was used as a minimum initial time of concentration for the existing drainage course. This minimum initial time plus the travel time calculated to the reservoirs determine the time of concentration.

B. Hydraulics – (Storm Sewer, Open Ditches and Culverts)

OPEN DRAINS/CULVERTS

The GCDC-SWM standard for open ditch and culvert evaluation (existing conditions and design alternatives) for drainage areas greater than 300 acres but less than 2 square miles is to evaluate and design for no surcharging for a four percent (4%) chance (25-year) storm event, where surcharging is defined as water rising above the crown of the culvert or the banks of a ditch. To satisfy this criteria and achieve maximum pipe efficiency, full pipe flow was designed for in all alternatives. The evaluations of the existing culverts assume that the culvert will be cleaned out and does not account for any sediment that may currently exist.

HAESTAD CULVERT MASTER

Haestad Method's CulvertMaster was used to evaluate the existing and proposed culverts. CulvertMaster computations utilize the design methods of the Federal Highway Administration (FHWA) HDS No. 5 and solves for various hydraulic variables, such as culvert capacity, headwater elevation, etc. A Manning's roughness coefficient of 0.013 and 0.024 was used for concrete and corrugated steel pipe culverts, respectively.

FLOW MASTER/PIPES

Haestad Method's FlowMaster program was also used to evaluate the existing system and design the proposed improvement alternatives. This program utilizes Manning's Equation to calculate capacities of circular pipe under partially full flow and full flow conditions for the calculated storm water runoff flows. The FlowMaster program also calculates the velocity of the water as it passes through the proposed storm sewer. This information is necessary in determining whether the velocities within the pipe are within the allowable range of approximately two (2) fps to ten (10) fps.

5. Evaluation of Existing Drainage Course and Culverts

Basis of Evaluation

The majority of the contributing watershed is comprised of wooded and low lying swamp area, as well as several small lakes and ponds, which results in a vast amount of ponding potential within the watershed. A sub-district was established for the area southwesterly of I-75, identified as the Slack Lake Area district, and another sub-district created for the area on the northeasterly side of the freeway, identified as the Area Northeast of I-75 district. A drainage district map depicting these sub-areas is included in Appendix 'C'. Because both sub-districts have large, flat swampy areas that eventually outlet through a single culvert, the reservoir routing procedure was used for both. The reservoir routing procedure accounts for the storage potential within the area defined as the reservoir, and determines the maximum outflow coming out of the reservoir based on the stage/storage curve and stage/discharge curve defined for the reservoir. In both cases, the reservoir is located at the outlet for the sub-district. Both sub-districts also have additional swampy and ponding areas which are anticipated to temporarily retain surface water runoff. In order to account for this temporary storage, a reduction factor was applied to the peak flow. The reduction factors used were determined by the SCS (1975) from experimental watersheds of less than 2000 acres and are included in the calculations in Appendix 'C'.

The total peak flow to the culvert outletting to Saginaw Road was computed by combining the routed outflow hydrograph from the Slack Lake sub-district with the flood hydrograph from the district lying northeasterly of I-75, and then routing this combined hydrograph through the reservoir located adjacent to the culvert. This peak flow was used to evaluate the existing system and design the various alternatives. In accordance with Genesee County Drain Commissioner's Office standards, a four percent (4%) chance (25 year) storm frequency was used as the basis of design for the culvert. The results and effects of the one percent (1%) chance (100 year) storm event was also evaluated as part of this study. Forthcoming are additional details relating to these sub-areas and the existing outlet. The flows generated are shown on the hydrograph printouts and on the map located in Appendix 'C'.

Due to the physical nature and geology of the watershed, it should be noted that the flows calculated in this study are used to evaluate and compare the existing drainage system with that of the proposed. The flows are estimated by the hydrology and hydraulic procedures and computations mentioned above utilizing available records and an assumption of the normal water elevations. In order to model the large reservoirs (wetland and lake areas), an assumption was made that the normal water elevation throughout the entire area was equal to the measured water elevation at the time of survey. These measured water elevations were within tolerance of the 2' contour elevations provided. In essence, the swamp and lake areas were viewed as a permanent water area which is already at its maximum elevation, and any excess rainfall would be temporarily stored as detention above the permanent water and would outlet through the culvert at the downstream end of the reservoir. As previously mentioned, the reservoir routing procedure was used to calculate the anticipated peak flows. The physical nature and geography of the overall drainage area may yield much more ponding and storage (detention) capability, and a longer time of concentration, than what can be determined from 2' contour maps. For example, Slack Lake may actually be slightly lower than the large surrounding wetland area, which would result in more storage capacity and less outflow. Various depressions may also exist throughout the watershed, particularly in the swampy areas, which would also lead to a reduction in runoff and lower peak flows. While the peak water elevations and flows calculated in this study may be higher than those actually experienced, by utilizing the same assumptions and calculations for both the existing conditions and the proposed improvements, a theoretical comparison and evaluation of the effects can be made.

Slack Lake Reservoir

This sub-drainage area contains a large amount of temporary storage and ponding throughout its area which reduces the peak runoff flow from this watershed. The runoff generated from a 4% chance (25-year) rain event over the Slack Lake sub-basin results in an increase in water elevation over the reservoir of approximately 0.1 feet (1-1/4± inches), with a peak flow of 44 cfs. This marginal increase in water surface elevation is contributed to the large, flat reservoir storage area consisting of lakes and swamps within this sub-basin. The peak flow is conveyed through an existing 72" concrete culvert beneath Lost Lake Road and the southbound lanes of the I-75 freeway. Another 72" concrete culvert conveys the flow beneath the northbound lanes of the freeway. A vertical difference in elevation of 1.6 feet exists between the upstream inlet near Lost Lake Road and the downstream outlet north of I-75. Once on the northeast side of the freeway, the runoff continues through a channel which converges with a large swampy area, which is part of the Area Northeast of I-75 Reservoir described below.

Area Northeast of I-75 Reservoir

The Area Northeast of I-75 Reservoir consist of the large, swampy area lying northeasterly of I-75, a channel adjacent to I-75, and the small lake located at the design point for this study. This reservoir has more of a tiered storage scenario, versus a flat, level area like the Slack Lake Area Reservoir. The upper portion, consisting of open water and swampy areas, connects to the lower area, which consists entirely of open water, through a channel running parallel to I-75. The upper portion has a normal standing water elevation of approximately 1.7 feet higher than the lower area. The water elevation in the small lake is controlled by a man-made embankment of wood debris constructed at its easterly end. The water that infiltrates or crests this embankment is collected in a small drainage channel that leads to an existing culvert which is approximately 5.5 feet below the top of the embankment. This culvert runs easterly and outlets into the roadside ditch on the west side of Saginaw Road. During the calculated rain events, the water elevation over this reservoir area temporarily increases as the culvert becomes surcharged.

This reservoir northeast of I-75 appears to have been changed over time. The early 1970's Genesee County Drain Commissioner 2' composite map for Section 35 of Grand Blanc Township suggests that the large swamp area located adjacent to I-75 and the small lake located westerly of Saginaw Road existed as one common water body with an equal elevation. These two areas were connected by a narrow strip located near the middle of the small pond. The 1969 USGS Quad Map (Goodrich Quadrangle) also depicts this configuration. According to the 2' composite map, if the

water elevation raised a foot or two, it would crest an area on the easterly end of the small lake (in the vicinity of the existing wood debris embankment) and flow overland towards Saginaw Road. Since the normal water elevation appeared to be below this crest point, some type of structure likely existed to maintain the normal water level. The Genesee County Metropolitan Planning Commission's aerial photography from May 7, 1997 indicates that sometime between the early 1970's composite and 1997, a change was completed in this area. The narrow area that once connected the two water bodies was filled and a new channel was dug adjacent to the I-75 right-of-way from the outlet of the 72" culvert beneath I-75 to the southern end of the small lake. Assuming that no modifications were made to the small lake's outlet structure that likely existed, the newly excavated channel should have maintained the same normal water elevation over the entire area that previously existed. Below are additional comments relating to the water elevation, wood debris embankment, and outlet.

Existing Outlet to Saginaw Road

As previously mentioned in this report, the water elevation of the small lake lying west of Saginaw Road is currently maintained by a wood debris embankment located at its easterly end. It is unknown how this embankment originated, or whether or not it existed prior to the Genesee County Drain Commissioner's excavation work to expose the inlet of the culvert and restore the flow to Saginaw Road. The water that infiltrates or overtops the embankment travels down to a rectangular concrete channel leading to the culvert. This culvert discharges into the roadside ditch on the west side of Saginaw Road before crossing the street through a 4' wide x 4.5' high concrete culvert and entering the upstream limits of the existing Slack Lake Drain. At the upstream end near the embankment, this culvert appears to be a 30" CMP. At Saginaw Road, the culvert appears to be a 24" concrete pipe. The downstream end is submerged in standing water and partially filled in with sediment, and the upstream end is damaged and crushed at its entrance. Somewhere along this culvert's approximately 275 foot length, the pipe switches from the 30" CMP to the 24" concrete. The full flow capacity of a 24" concrete is nearly the same as a 30" CMP, and therefore this culvert was modeled as a 24" concrete in this study. The culvert was also modeled assuming an improved entrance and full pipe flow. The effect of any sediment within the pipe and the crushed inlet was ignored in the evaluation of the existing system.

As shown in the calculations in Appendix 'C', a 4% chance (25-year) storm event over the entire drainage area, routed through the two (2) reservoirs, produces a peak flow of 35 cfs, with a calculated increase in water elevation in the small lake and above the wood debris embankment of approximately 2.0 feet. This results in a hydraulic head of approximately 5.4 feet above the crown of

the existing culvert, and a pipe velocity of approximately 11 fps. The drawdown time of this natural reservoir is approximately 9 hours. As previously mentioned in this report, a problem did not arise until the existing outlet became blocked, and water ponded permanently at a higher elevation.

The wood debris embankment appears to maintain the elevation and surface area of the small lake, which helps support the large wetland environment located within this watershed. Without the embankment the water level within the small lake and the large wetland area adjacent to I-75 could be substantially reduced.

6. Proposed Improvement Alternatives

Three (3) alternatives were analyzed in order to improve the existing drainage course from the small lake to Saginaw Road.

Alternative 1 involves replacing only the damaged portion of the existing 24" pipe, raising the inlet, and improvements to the outlet. Alternatives 2 and 3 propose to completely replace the existing pipe with either a 24" or 27" concrete storm sewer, reduce the pipe slope and flow velocity, raise the inlet elevation, and realign the outlet with the 4'x4.5' concrete box beneath Saginaw Road. In all alternatives, it is proposed to raise the inlet to an elevation where the crown of the proposed pipe is near the top of the embankment and water elevation in the small lake. All three (3) alternatives will require a new easement along the route. As part of each alternative, it is also recommended to clean out the box culvert beneath Saginaw Road and that portion of the Slack Lake Drain lying easterly of the road. Once cleaned out, the existing box culvert beneath Saginaw Road will have sufficient capacity for the calculated 4% chance (25-year) and 1% chance (100-year) peak flows. The following discusses each alternative in more detail:

● ALTERNATIVE 1:

Alternative 1 recommends a video inspection of the existing culvert to determine its overall condition. If the majority of the culvert is structurally sound, then only improvements to the westerly end and at the outlet may be necessary. If the culvert is found to be in poor condition, then it is recommended that Alternative 2 or 3 be implemented.

Alternative 1 proposes to remove and replace the damaged portion of the existing culvert at the upstream end. The exact length of replacement will be determined by the video. If the 30" CMP only extends for a short distance, then at a minimum, it is recommended to remove and replace the CMP up to the transition to concrete pipe. One concern with the existing conditions is the 4.9 foot vertical difference between the inlet and the top of embankment. If the embankment was to fail or is

removed, the water elevation in the pond and upstream wetlands could be lowered by as much as 4.9 feet (the amount of drawdown could be less, depending on the water depth on the westerly side of the embankment). A decrease of this magnitude would likely have a negative effect on the upstream wetland environment, and would also cause a large amount of water over an extended period of time to drain through the wetland area on the east side of Saginaw Road. This inflow may exceed the storage and conveyance capacity of the wetland and cause street or yard flooding in that area. It is also desired to reduce the deep excavated cut to the culvert that currently exists. The deep cut could be improved by extending the culvert westerly towards the wood debris embankment. This would allow fill to be placed over the pipe and against the headwall which would help reduce the length of the deep channel excavation that currently exists. However, extending the pipe at its current depth would not be recommended due to the need to excavate the earth near the toe of the embankment. By removing material adjacent to the embankment, the structural integrity could be altered and diminished. Since the embankment is to remain private, it is recommended that no adjustments or modifications be made to its present condition. In order to help avoid undermining the embankment with excavation, to reduce the potential drawdown as a result of embankment failure, and to reduce the extent of the deep excavation cut, it is recommended to raise the elevation of the new pipe so that its crown is approximately at the elevation of the wood debris embankment, extend the pipe approximately 35 feet westerly, and install a headwall at the inlet. This would limit the drawdown potential to approximately two (2) feet in the event that the embankment fails or is removed. Raising the pipe and installing the headwall will also reduce the deep and steep side slopes that currently exist.

As a result of raising the inlet pipe, the existing hydraulic head is also reduced, which lowers the peak discharge and increases the temporary high water elevation within the small lake. This scenario of raising the inlet is discussed in Alternative 2 below. An improvement to the existing outlet near Saginaw Road is also recommended as part of this Alternative. Once the existing system is repaired and cleaned out, the pipe and exit velocity could exceed 10 fps during high flows. Protective measures including an outlet headwall with baffle and riprap are recommended at the outfall to avoid erosion and washout of the roadside ditch. A plan and profile view of the Alternative 1 improvements is included in Appendix ‘F’.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 1 is $23,220.00±. Further information related to this POPCC may be found in Section 8.

● **ALTERNATIVE 2:**

Alternative 2 involves completely removing and replacing the existing 24" concrete pipe with a new pipe of equal size. Additionally, the inlet near the east side of the embankment would be raised to reduce the potential amount of drawdown, a manhole would be added to reduce pipe slope, velocity, and depth, and its outlet would be moved approximately 10 feet southerly to align with the existing box culvert beneath Saginaw Road.

As shown in the supporting calculations included in Appendix 'G', as a result of raising the inlet of the proposed 24" concrete pipe, the hydraulic head that presently exists on the pipe is reduced. This results in a lower peak flow and a higher theoretical water elevation within the pond than the existing conditions. The 4% chance (25-year) flow is reduced by approximately 6 cfs to 29 cfs, which results in a calculated theoretical water elevation of nearly 0.50' above the existing theoretical high water elevation and 3.2' above the top of the embankment. The reduced outflow also increases the approximate drawdown time of this natural reservoir from 9 hours to 18 hours.

The velocity in the new 24" concrete pipe constructed at a slope to convey the calculated peak flow for a 4% chance storm event would be approximately 9.5 fps, which is generally acceptable for concrete pipe flow but may be greater than desirable for an outlet velocity. In order to reduce the velocity at the pipe's exit, it may be desirable to construct a larger pipe east of the catchbasin and further flatten the pipe grade. The following chart lists several pipe sizes that could be selected for the downstream portion of the proposed improvements, along with their required slope to convey the calculated flow and their corresponding velocities:

Proposed Pipe Size and Material	Proposed Pipe Slope (%)	Roughness Coefficient	Velocity (fps)	Calculated Peak Flow (cfs)	Full Flow Capacity (cfs)
24" Conc.	1.70	0.013	9.4	29	29
27" Conc.	0.90	0.013	7.4	29	29
30" Conc.	0.50	0.013	6.0	29	29
30" CMP	1.70	0.024	5.9	29	29

As shown above, by increasing from a 24" concrete to a 30" concrete for the downstream portion, the pipe velocity can be reduced to around six (6) fps. This is considered to be an acceptable velocity with the pipe realignment and the placement of riprap outlet protection between the two culverts. For the determination of probable construction cost, the upsizing to the 30" is proposed in this study.

A plan and profile view of the Alternative 2 improvements is included in Appendix 'G'. As with Alternative 1, to improve the site grading and inlet characteristics, a headwall is proposed at the entrance.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 2 is $44,316.00±. Further information related to this POPCC may be found in Section 8.

- **ALTERNATIVE 3:**

Alternative 3 also involves completely replacing the existing 24" concrete pipe, but evaluates increasing the pipe size, along with the other improvements mentioned in Alternative 2A, to more closely match the existing peak flow and highwater elevation. As mentioned in Alternative 2, the raising of the inlet reduced the hydraulic head on the culvert, which resulted in a reduced peak flow and a higher ponding elevation in the reservoir. With the reduction of the hydraulic head on the pipe, a larger pipe is needed to convey the same peak flow and yield the same theoretical water elevation as the smaller pipe. By matching the peak flow and water elevations determined in the existing conditions model, it is anticipated that the effects of the proposed improvements will be minimal both upstream and downstream.

As shown in the supporting calculations included in Appendix 'H', as a result of raising the inlet and increasing the proposed pipe size from 24" and 27", the calculated peak flow of 35 cfs closely matches that of the existing conditions model, and the corresponding water elevation only rises 0.10 feet. The calculated drawdown time of this natural reservoir is 11 hours, which is 2 hours more than the existing conditions model, but still relatively short.

The velocity in the new 27" concrete pipe constructed at a slope to convey the calculated peak flow for a 4% chance (25-year) storm event would be approximately 8.9 fps, which may be greater than desirable for an outlet velocity. In order to reduce the velocity at the pipe's exit, it may be desired to construct a larger pipe east of the catchbasin and further flatten the pipe grade. The following chart lists several pipe sizes that could be selected for the downstream portion of the proposed improvements, along with their required slope to convey the calculated flow and their corresponding velocities:

Proposed Pipe Size and Material	Proposed Pipe Slope (%)	Roughness Coefficient	Velocity (fps)	Calculated Peak Flow (cfs)	Full Flow Capacity (cfs)
27" Conc.	1.30	0.013	8.9	35	35
30" Conc.	0.75	0.013	7.2	35	35
36" Conc.	0.30	0.013	5.2	35	36
30" CMP	2.50	0.024	7.2	35	35
36" CMP	1.00	0.024	5.1	35	36

As shown above, by increasing from a 27” concrete to a 36” concrete for the downstream portion, the velocity can be reduced to around five (5) fps. This is considered to be an acceptable velocity with the pipe realignment and the placement of riprap outlet protection between the two culverts. For the determination of the probable construction cost, the upsizing to the 36” concrete is proposed in this study.

A plan and profile view of the Alternative 3 improvements is included in Appendix ‘H’. Likewise with the previous alternatives, to improve the site grading and inlet characteristics, a headwall is proposed at the entrance.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 3 is $48,096.00±. Further information related to this POPCC may be found in Section 8.

7. Recommendations

The recommended improvements for the proposed drain extension are based on the evaluation of the above alternatives and their associated probable construction costs. It is recommended to video the ±275 linear feet of existing storm sewer to determine its condition. If the existing pipe is found to be structurally sound without any breaks or settled areas, then Alternative 1 could be implemented. As part of the Alternative 1 improvements, it is recommended to raise the new 24” inlet as discussed in all alternatives to limit the amount of drawdown potential and improve the site conditions. It is unknown what type of outlet control structure existed before the wood debris embankment was placed, but it likely maintained a water elevation within the pond well above the invert of the existing pipe. Since a Genesee County Drain Commissioner owned and maintained water elevation control structure is not proposed as part of the improvements, reducing the amount of drawdown potential will help protect the upstream wetland environment and water bodies. The results of the 1% chance (100-year) storm event were also evaluated for the Alternatives. In Alternatives 1 and 2, the peak discharges from the 1% chance (100-year) and 4% chance (25-year) events are slightly decreased and the water elevation is slightly increased from the existing conditions. In Alternative 3, the peak flow and water elevation closely match the existing conditions for both storm events. In either case, the 1% chance storm event is not anticipated to have any negative effects on the proposed drainage system. This temporary natural storage of storm water in the upstream reservoirs westerly of Saginaw Road helps reduce the peak flow downstream, and even during the 1% chance storm event, the drawdown times for the detained storm water are still in the 24 hours or less range.

If the video of the existing culvert identifies poor or failing conditions, then it is recommended to completely remove and replace the existing outlet pipe according to the improvements proposed in Alternative 3. Although Alternative 3 proposes larger pipe than the existing, and has a slightly higher probable construction cost than Alternative 2, the calculations indicate that the extent of temporary ponding and peak flow will closely match the existing conditions. As previously mentioned, there has been minimal or no report of drainage problems in this area as long as the outlet pipe is functioning properly. By closely duplicating the existing conditions, a minimal change to the overall drainage system is anticipated. As part of Alternative 3, the outlet is proposed to be realigned with the box culvert beneath Saginaw Road to reduce erosion and provide for better storm water conveyance.

As part of the proposed improvements for either Alternative 1 or 3, it is recommended that the existing box culvert beneath Saginaw Road and the upper portion of the existing Slack Lake Drain on the easterly side of the road be considered for cleanout. Also, the aforementioned situation of the existing drainage course easterly of Saginaw Road not matching the described drain location from the Final Order of Determination should be reviewed and evaluated. The route of the existing drainage course beneath Pinehurst Lane should also be evaluated to determine if additional culverts are necessary to convey the storm water once the upstream improvements are completed. Presently there appears to be a few 15”± diameter CMP culverts beneath Pinehurst Lane to convey the storm water from the west to the east. These culverts may not be able to convey the storm water runoff without becoming surcharged and causing temporary ponding (detention) within the wetland area between Saginaw Road and Pinehurst Lane.