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PRELIMINARY ENGINEERING REPORT FOR THE DALY DRAIN, #0420

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1. Introduction

This preliminary engineering report for the Daly Drain #0420 evaluates the existing drainage course and the existing storm sewer and culverts which comprise the drainage system. This report also discusses alternatives to improve the drainage course, storm sewers, and culverts.

2. Site Location

The drainage area for the Daly Drain is located in portions of Sections 14, 15, 22, and 23 of Mt. Morris Township, Genesee County, Michigan. The overall drainage area is approximately 233+/- acres (0.36 square miles), and the drain ultimately outlets to the Lake Drain through an open ditch. The limits of the drainage area for the Daly Drain are shown on the Location Map located in Appendix 'A' and the Existing Drainage Area Map located in Appendix 'C'.

3. Existing Drainage Course

The Daly Drain #0420 is a county drain. On August 15, 2006, a drainage Board of Determination meeting was held with local residents at the Mt. Morris Township Hall in order to discuss the drainage problems along the existing drainage course. The property owner at 3091 W. Coldwater Road presented the problems occurring on his property and felt the drain was deficient in removing runoff from his property in a timely manner, which was leading to a loss of vegetation as well as damage to his home and septic field. The Board of Determination members supported the necessity of the petition for public health and for a study of the drain to be completed.

The existing drainage course outlets to the Lake Drain at a point approximately 1440 feet north of Coldwater Road and approximately 1580 feet east of Clio Road. Please see Appendix 'C' – Existing Drainage Area Map. From the outlet in the Lake Drain, the drainage system travels upstream through vacant wooded and non-wooded areas through an open ditch in a westerly and southwesterly direction to a point located approximately 260 feet east of Clio Road and approximately 1120 feet north of Coldwater Road. This open ditch portion of the Daly Drain was cleaned out in 2007 by the Genesee County Drain Commissioner's Office. From this point, the drainage system continues upstream through wooded, commercial, and residential areas through a 31-inch by 50-inch corrugated steel pipe arch storm sewer (equivalent round size of 42-inch) in a southerly direction to Coldwater Road. At Coldwater Road, the drainage system turns westerly and runs along the north side of Coldwater Road for approximately 580 feet through a 36-inch and a 10-inch storm sewer. From this point on the north side of Coldwater Road west of Clio Road, the drainage system continues upstream in a southwesterly direction along commercial and residential areas through a 10-

inch storm sewer to another portion of the drain located approximately 330 feet south of Coldwater Road and approximately 910 feet west of Clio Road. This portion of the drainage course is not well defined and consists of peat/bog like soils along the route. From this point, the drainage course continues upstream in a southeasterly direction through residential and wooded areas to a point approximately 140 feet west of Clio Road and approximately 1580 feet south of Coldwater Road. From the west side of Clio Road, the drainage system continues upstream through commercial areas and an apartment complex in a southeasterly direction through 36-inch corrugated steel pipe under Clio Road and ends at a low area on the east side of Clio Road, approximately 1880 feet south of Coldwater Road.

Field visits by Gould Engineering, Inc. staff were completed to review the existing drainage course, to verify the approximate limits of the overall existing drainage area, and to review the problem areas mentioned by local residents at the Board of Determination meeting.

4. Basis of Evaluation and Design

A. Hydrology – (Stormwater Runoff Calculations)

DRAINAGE AREAS

Topographic field data collected by Gould Engineering, Inc., field visit observations, and Genesee County Drain Commissioner's Office two foot (2') contour maps were used to determine the overall drainage area. Please see Appendix 'C' for a map of the overall drainage area. Gould Engineering, Inc. determined the overall drainage area to be approximately 233+/- acres. Therefore, based on Genesee County Drain Commissioner's Office-SWM standards, the Rational Method was used to calculate peak storm water runoff flows for a 10% chance (10 year) storm event.

RATIONAL

In accordance with Genesee County Drain Commissioner's Office - Surface Water Management Division (GCDC-SWM) standards, the Rational Method may be used for drainage areas less than 300 acres. The Rational Method (Q = CIA) is used to calculate the peak storm water runoff flow rate (Q) to be used in the evaluation of the existing drainage course and the preliminary design of the various improvement alternatives. Also, the GCDC-SWM standard for drainage areas less than 300 acres is to determine runoff flows for a 10% chance (10 year) storm event.

The land use of the overall drainage area includes residential areas, commercial areas, an apartment complex, woodlands, non-wooded areas, and low areas. GCDC-SWM standard runoff coefficients (C) were used to calculate weighted C-values for each drainage sub-area. Please see Appendix 'B' for various charts and values used as a basis of analysis in this study's calculations.

TIME OF CONCENTRATION

The time of concentration for various drainage paths was calculated in order to determine the rainfall intensity (I_{10}) for each drainage sub-area. The GCDC-SWM standard of twenty (20) minutes 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 collection points determines the time of concentration to each collection point.

EXISTING FLOWS

The overall drainage area was divided into sub-areas and storm water runoff flows calculated at ten (10) collection points along the drainage course. The following chart identifies the Rational Method parameters used in calculating the peak flow at each collection point:

Collection Point	$C_{weighted}$	T_c (minutes)	I_{10} (in/hr)	Area (acres)	Peak Flow $Q_{10} = (C_w)(I_{10})(A)$ (cfs)
ECP-D1	0.59	50	2.25	29.1	39
ECP-D2	0.46	92	1.60	65.9	49
ECP-D3	0.44	108	1.30	84.8	49
ECP-D4	0.47	114	1.20	104.5	59
ECP-D5	0.48	119	1.15	126.7	70
ECP-D6	0.46	120	1.15	164.5	87
ECP-D7	0.45	121	1.15	183.3	95
ECP-D8	0.46	124	1.10	194.0	98
ECP-D9	0.45	128	1.10	201.7	100
ECP-D10	0.43	139	1.00	233.0	100

AREAS OF TEMPORARY FLOODING

The proposed areas of temporary flooding within the drainage district are areas which collect storm water runoff and store the runoff while out letting at a reduced flow. This reduced flow is typically less than the flow that would be experienced from direct storm water runoff. These proposed temporary flooded areas are based on inflow for the 10-year storm event. The outlet rate from these proposed flooded areas was based on a selected flow that accounts for draining the flooded areas in a reasonable time while reducing the flow into the downstream storm sewer system.

B. Hydraulics – (Open Ditch, Culvert and Storm Sewer Calculations)

OPEN DRAINS/CULVERTS

The GCDC-SWM standard for open ditch and culvert evaluation (existing conditions and design alternatives) for drainage areas less than 300 acres is to evaluate and design for no surcharging for a 10% chance (10 year) storm event. Surcharging is defined as water rising above

the crown of the culvert or the banks of an open ditch. To satisfy this criteria and achieve maximum pipe efficiency, full pipe flow was designed for in all improvement alternatives.

FLOW MASTER/OPEN DRAINS

Haestad Method's FlowMaster program was used to analyze the existing and proposed open ditch cross-sections. FlowMaster uses Manning's Equation to calculate the water surface elevation within each open ditch cross-section using the input flow and taking into consideration the affects of the downstream slope. The roughness, shape, and height vary along an open ditch. The Manning's Equation takes into consideration these factors and has become one of the most widely used uniform flow formulas for evaluating open ditches. Downstream of collection point ECP-D9, the Manning's coefficient of roughness (n) used to evaluate the open ditch cross-sections was 0.035, as the ditch was cleaned out by the GCDC in 2007. The other drainage course cross-sections were assigned an n-value of 0.050, as they are not improved and contain brush and weeds. The FlowMaster program also calculates the velocity of the water as it passes through the open ditch cross-section. This information is necessary in determining whether the velocity of the flow passing through the existing or proposed open ditch may or may not cause erosion.

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 0.024 was used for corrugated steel pipe culverts.

EAGLE POINT STORM SEWER MODULE

The Eagle Point storm sewer module is a computer program which is used to evaluate the existing storm sewer network within the drainage district. This program is also used to design various storm sewer improvement alternatives. The basis for the program is Manning's equation for pipe flow and Bernoulli's equation for the hydraulic grade line (i.e. water elevations). Various input data such as existing or design pipe sizes, pipe types, lengths, invert elevations, and structure rim elevations are input into the program. The program performs multiple calculations throughout the storm sewer network to calculate various information which is used to evaluate the storm sewer networks. For those calculations which show hydraulic grade lines (i.e. water elevations) above the crown of the pipe or above structure rim elevations, this is considered surcharging. Surcharging is a situation in a pipe system where water elevations are above the pipe's crown or structure rim elevations. It should be noted that these surcharge elevations are to be viewed as a theoretical elevation needed to pass

the flow through the pipe. Some of the surcharge elevations would not likely be reached as any water above a structure rim elevation would flow to another area or create ponding around the structure on the surface. This occurrence of surcharging is an indication that the existing storm sewer is under-sized to handle the flows calculated. The GCDC-SWM standard for storm sewer design is to design for full pipe flow with no surcharging. The evaluation of the existing storm sewer network and the various design improvement alternatives are further discussed in later sections of this report.

5. Evaluation of Existing Drainage System

Existing Open Ditch Evaluation

Cross-sections of the existing open ditch portion of the drainage course were analyzed to determine if they were capable of conveying the calculated flow from a 10% chance (10 year) storm event.

Through field surveys and field visits completed by Gould Engineering, Inc., the outlet for the existing drainage course downstream of collection point ECP-D1 is an existing catch basin located near collection point ECP-D4 on the property located at 3091 W. Coldwater Road. This catch basin has a structure rim elevation of 755.4+/- while the ground elevation upstream near collection point ECP-D3 is approximately 750.9+/-. This indicates that runoff within this portion of the existing drainage system must build up to a depth of 4.5 feet prior to overflowing into the existing catch basin cover and draining from the area. The runoff also appears to seep back into the soil consisting of peat/bog like materials. In affect, this portion of the existing drainage system is a temporary flooded area upstream of collection point ECP-D4 and the area is referred to as the "Daly Lake" by local residents. Evaluation of the field survey data collected by Gould Engineering, Inc. and the existing contours provided by the Genesee County Drain Commissioner's Office indicate that this portion of the drainage course between collection points ECP-D2 and ECP-D4 is a significant low area.

The existing open ditch downstream of collection point ECP-D9 was cleaned out by the Genesee County Drain Commissioner's Office – Surface Water Management division in 2007 recently. These open ditch cross-sections appear to have adequate capacity to handle the peak flow for a 10% chance (10 year) storm event.

The following table shows the calculated peak flows for a 10% chance (10 year) storm event, the corresponding water surface elevation within the open ditch, and the top of bank elevation for each cross-section evaluated. In some instances along the drainage course upstream of collection point ECP-D4, the drainage cross-sections are not well defined.

Ex. Ditch Cross-Section	Calculated Q_{10} (cfs)	Ex. Water Surface Elev. (WSE) in open ditch	Ex. Top of bank of open ditch
AA	100.0	744.83+/-	747.6+/-
BB	100.0	744.33+/-	750.3+/-
CC	100.0	744.51+/-	748.8+/-
DD	100.0	744.87+/-	745.1+/-
EE	100.0	744.85+/-	749.0+/-
FF	49.0	752.85+/-	752.1+/-
GG	49.0	751.99+/-	751.5+/-
HH	49.0	752.36+/-	752.2+/-
II	49.0	754.53+/-	754.4+/-
JJ	49.0	755.15+/-	754.2+/-
KK	49.0	757.31+/-	760.7+/-

Existing Storm Sewer Evaluation

The existing storm sewer pipes range in size from a minimum of 10-inch diameter to a maximum of 31-inch by 50-inch diameter pipe arch (equivalent 42" round pipe) and are maintained by the Genesee County Drain Commissioner. All storm sewer pipes analyzed were either concrete or steel/metal in material. Please see Appendix 'C' for the existing drainage area map and calculations related to the existing storm sewer system evaluation.

The evaluation of the upstream reaches of the existing storm sewer network begins at collection point ECP-D4. Much of the upstream area contributing to the existing storm sewer network is transported to the network along a drainage course through the wide low area that does not have a well-defined drainage path. The upstream drainage district reaching the existing storm sewer network consists mainly of wooded areas, residential areas, an apartment complex, and commercial areas.

The evaluation of the existing storm sewer network shows that the majority of the system is insufficient to handle the direct runoff peak flow generated for a 10% chance (10 year) storm event, especially the existing 10-inch storm sewer upstream of collection point ECP-D5. Therefore, surcharging of pipe crowns and structure rims, restriction of flow from the upstream drainage course, and subsequent flooding and water ponding is likely to be expected.

Existing Culvert Evaluation

An evaluation of the existing culverts along the drainage course determined that both of the culverts are deficient in conveying the calculated runoff in accordance with GCDC-SWM requirements, resulting in the back-up or restriction of flow in the upstream open ditch and low area. The following table shows the calculated peak 10% chance (10 year) storm event flows to each

culvert, the corresponding headwater (HW) elevation, and the elevation of the top of the culvert. Please see Appendix 'C' for calculations related to the existing culvert evaluations.

Ex. Culvert	Ex. Culvert Size and type (inches)	Calculated Flow to Ex. Culvert, Q_{10} (cfs)	Calculated Headwater Elevation	Ex. Top inside of culvert
Ex. 36" CMP Beneath Clio Rd.	36" CMP **	39.0	762.25 **	759.94
Ex. 48" CMP Outlet to Lake Drain	48" CMP	100.0	746.91 Note: Weir flow over crossing	745.30

** The evaluation of this culvert for the 10% chance (10 year) storm event takes into account that the drainage course immediately downstream of the existing 36" CMP culvert under Clio Road has silted in and is approximately 1.9 feet above the invert of the culvert. This siltation within the drainage course has an effect on the Ex. 36" culvert and increases the headwater on the culvert. The existing 36" was also evaluated as if the drainage course were cleaned out down to the invert of the 36". Evaluating the existing 36" based on this assumption resulted in the 36" culvert having a headwater elevation of 760.59± which is approximately 0.65' above the top inside of the culvert for a 10% chance (10 year) storm event. Because this culvert crosses under a county road, the culvert has to meet the GCDC requirements for a 4% chance (25 year) storm event. However, as the calculations show, the culvert does not meet the requirement even for a 10% chance (10 year) storm event. As mentioned in Section 4 of this report, the GCDC-SWM standard is that culverts have no surcharge for the design storm event. This evaluation of the existing 36" culvert does not account for storage in the low area upstream from the culvert. The effect of this storage will be discussed further in the discussions of the Improvement Alternatives.

6. Proposed Improvement Alternatives

Two (2) alternatives were analyzed in order to improve the existing drainage course so that it meets GCDC-SWM standards.

Alternatives 1 and 1A discuss improvements along the existing drainage course that include the removal and replacement of the existing drainage system in its current location. Alternatives 1A and 2A involve a reroute of the upper portion around the property located at 3091 W. Coldwater Road. Alternatives 2 and 2A discuss improvements to the existing drainage course as a result of allowing low areas within the drainage district to temporarily flood. Alternatives 1A and 2A will require new easements along the proposed re-route portions which are located outside of the existing Genesee County Road Commission road right-of-way. The following discusses each alternative in more detail.

• **IMPROVEMENT ALTERNATIVE 1:**

Improvement Alternative 1 involves the removal and replacement of the existing mainline storm sewer system and consists of 43" x 68" elliptical concrete pipe (equivalent 54" round pipe) and 48" and 42" round pipe. The elliptical pipe is required due to the minimal amount of cover available along the lower portion of the drainage route which outlets to the open ditch. Please see Appendix 'D' for a plan view of proposed improvement Alternative 1 and calculations relating to the proposed storm sewer. The storm sewer is proposed to begin in the low area near collection point ECP-D3 just south of the existing catch basin on the property located at 3091 W. Coldwater Road. The proposed storm sewer replacement will follow the existing storm sewer route along Coldwater Road and east of Clio Road. The proposed improvement then runs north along the existing route to the existing open ditch that leads to and outlets to the Lake Drain. The existing 31" x 50" corrugated steel pipe arch outletting to the open ditch north of Coldwater Road is old and was constructed back in approximately 1961, and this pipe is undersized and near the end of its expected use and is proposed to be replaced. The proposed improvement for Alternative 1 follows the existing route along Coldwater Road due to other utilities that exist within the Coldwater Road right-of-way including a high-pressure 8" gas line, sanitary sewer, and watermain. The route and location of the existing 10-inch storm sewer that runs to the northeast from the catch basin on the property at 3091 W. Coldwater Road is unknown. The approximate location of the drainage easement for the 10-inch pipe runs through the northern portion of Cross Missionary Baptist Church building, however, it is unknown whether or not the 10" storm sewer is located under the church building. It is proposed to route the proposed new storm sewer outside of the church building influence, therefore additional new easements will be required along this portion of the drainage route.

The open ditch downstream from the proposed storm sewer improvement was cleaned out in 2007 by the GCDC-SWM and does not require any improvement. The existing 48" culvert at the open ditch outlet to the Lake Drain, however, has a headwater on it that creates weir flow over its crossing and backs up the storm water within the open ditch approximately 2.3' above the proposed elliptical storm sewer pipe outlet. The storage within the open ditch was evaluated to see if the headwater on the culvert was lower due to the storage volume upstream. However, the storage volume within the open ditch is not sufficient to reduce the headwater on the Ex. 48" culvert, so that its backwater is not affecting the storm sewer upstream. Therefore, it is proposed to entirely remove the Ex. 48" culvert or replace it with a 48" x 76" concrete horizontal elliptical pipe culvert (equivalent

60" round), which reduces the headwater down to approximately elevation 744.51, which is below the top inside of the storm sewer outlet elevation of 744.58.

No work is proposed along the drainage course from the 42 inch inlet proposed at collection point ECP-D3 to just downstream from the existing 36" under Clio Road. The drainage course just downstream from the existing 36" is proposed to be cleaned out enough so that the outlet from the existing 36" under Clio Road is not affected by the silted in drainage course. This reduces the headwater on the existing 36" as previously discussed in Section 5 of this report. The apparent low area upstream from the existing 36" culvert was looked at for the ability to temporarily flood it and evaluate the effect of the temporary flooding on the headwater of the existing 36". Accounting for temporary flooding in this area for the 4% chance (25 year) storm event, the headwater may be able to be reduced, and the existing 36" under Clio Road may not need to be replaced depending on the amount of surcharge above the culvert crown.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 1 is $586,916.00 ±. Further information related to this POPCC may be found in Section 8.

- **IMPROVEMENT ALTERNATIVE 1A:**

Improvement Alternative 1A involves the same pipe sizes as Alternative 1, but reroutes the proposed storm sewer west along Coldwater to the west side of the property at 3091 W. Coldwater Road and then south thru the property to collection point ECP-D3. In addition, a storm sewer line is proposed to run to the west and connect to the culvert under Bicentennial Drive. Please see Appendix 'D' for a plan view of this reroute option. This reroute involves more pipe to reach collection point ECP-D3. Generally, the older existing drains, like the Daly Drain, were originally constructed to follow the natural low area within the drainage district. In the case of the Daly Drain, this area is generally through the Cross Missionary Baptist Church property, then along Coldwater and past Clio Road to the east. Therefore, other routes north or south of Coldwater Road were not considered as the ground elevations are higher, which would increase the cost of construction due to the deeper depths. Also, additional easements would be required to be obtained along this reroute, whereas the original route and course of the Daly Drain has an existing easement.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 1A is $621,484.00 ±. Further information related to this POPCC may be found in Section 8.

- **IMPROVEMENT ALTERNATIVE 2:**

Improvement Alternative 2 takes into consideration the effect of temporarily flooding the low area south of the property located at 3091 W. Coldwater Road. This temporary flooding reduces the flows into the proposed storm sewer downstream. The route of Alternative 2 is the same route as Alternative 1, however due to the temporary flooding, Alternative 2 has smaller pipe sizes consisting of 15", 18", 21", 36", and 42" round pipe and 38" x 60" elliptical pipe (equivalent 48" round pipe). Please see Appendix 'E' for a plan view of Alternative 2 and calculations. The 10% chance (10 year) elevation of the temporary flooding area is projected to be approximately Elev. 753.0±, which is approximately 2.4 feet lower than the current water elevation required to overflow into the existing catch basin. The elevation was determined by routing a 10% chance (10 year) storm event through the low area during several different storm duration lengths. A 15" diameter pipe was determined to be a sufficient size of pipe to drain the low area as a smaller pipe would hold the water in the flooded area longer due to a smaller outlet rate and a larger pipe would further increase the size of the downstream pipes. The following chart summarizes the various storm durations and resulting flows and elevations of the flooded area for a 10% chance (10 year) storm event.

Storm Event Duration (hrs)	Peak Inflow (cfs)	Peak Outflow (cfs)	Elevations (* Peak Elevations)
1.9	60.11	6.13	752.89
3.0	40.98	6.21	752.95
4.0	32.05	6.23	752.96
5.0	26.49	6.23	752.96 *
6.0	22.66	6.21	752.95
7.0	19.87	6.19	752.93
8.0	17.73	6.16	752.91
Rim Elevation of Existing Overflow Catch Basin = 755.4			

The temporary flooded area will also require a temporary flood easement to be granted to the Genesee County Drain Commissioner for the temporary flooding.

The open ditch downstream of the storm sewer does not need improvement as discussed in Alternative 1, and with the reduced flow due to the temporary flooding, the 48" culvert along the open ditch at the outlet to the Lake Drain would need to be entirely removed or replaced with a 43" x 68" concrete horizontal elliptical pipe (equivalent 54" round) so that it does not effect the storm sewer system upstream.

The existing 36" under Clio Road is being viewed under Alternative 2 the same as it was under Alternative 1 and not be replaced. Please see Alternative 1 for discussion.

Alternative 2 accounts for temporary flooding in the upstream low area and involves storm water runoff from approximately 104 acres of the 233 acres of the drainage district. The 104 acres being temporarily flooded in the low area is approximately 45% of the 233 acres, or almost half, of the drainage district and the time of concentration through the low area is significantly different than the lower portion along Coldwater Road to the outlet. Even though the 104 acres is being restricted, the downstream commercial and residential areas along Coldwater Road contribute a significant amount of water in a shorter time frame which does not allow the pipe sizes to be reduced further than one would expect.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 2 is $511,852.00 ±. Further information related to this POPCC may be found in Section 8.

- **IMPROVEMENT ALTERNATIVE 2A:**

Improvement Alternative 2A takes into consideration the effect of temporarily flooding the low area just like Alternative 2 and has the same pipe sizes as Alternative 2. The only difference with 2A is the reroute of the proposed storm sewer west along Coldwater Road for the same reasons stated in Alternative 1A. Again, this reroute involves additional pipe to get to the low area in the rear of the property at 3091 W. Coldwater Road.

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 2A is $530,805.00 ±. Further information related to this POPCC may be found in Section 8.

7. Recommendation

Based on the opinion of probable construction cost, the cost effective alternative is Alternative 2. Alternative 2 reduces the pipe sizes and the cost of the proposed improvements because the flows are reduced due to the temporary flooding as compared to Alternative 1 which collects the direct discharge and does not account for the reduced flows. Both Alternatives 1A and 2A are more expensive due to the additional storm sewer required along the longer route to get to the low area in the rear of the property at 3091 W. Coldwater Road.