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**PRELIMINARY ENGINEERING REPORT
FOR THE
ELMS & VIENNA, FARRAND ROAD BRANCH #1688**

PREPARED FOR:

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

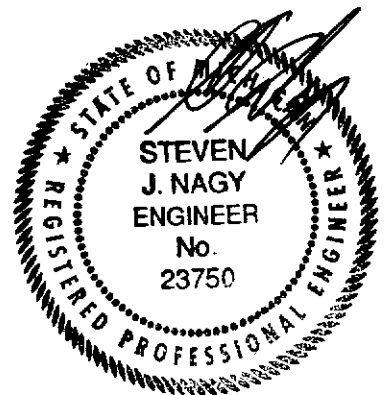
Scope of Services

Consulting Engineering
Services
Civil Engineering Design
Services
CADD Services
Surveying & Mapping
Services
Site Evaluation & Selection
Services
Land Development Services
Construction Development
Coordination Services

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1. Introduction

This preliminary engineering report for the Elms & Vienna, Farrand Road Branch #1688 evaluates the existing drainage course and existing culverts which comprise the drainage system. This report also discusses alternatives to improve the drainage course and culverts.

2. Site Location

The drainage area for the Elms & Vienna, Farrand Road Branch is located in portions of Sections 11, 12, and 13 of Montrose Township, Genesee County, Michigan. The overall drainage area is approximately 232± acres (0.36 square miles) and ultimately outlets to the Elms & Vienna Drain (Pitch Creek). The limits of the existing drainage area for the Elms & Vienna, Farrand Road Branch 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 Elms & Vienna, Farrand Road Branch #1688 is proposed to be improved and become a county drain. On February 5, 2008, a drainage Board of Determination meeting was held with local residents in order to discuss the drainage problems along the existing drainage course. At the meeting, several residents along Farrand Road reported flooding problems on their property and adjacent properties. One resident reported that 1/3 of his property is under water for 4 months each year and that he has gone through 8 sump pumps in the past 10 years. Other residents stated that the flooding problems along Farrand Road have worsened since the sanitary sewer was installed in 2007 at Elms Road and Farrand Road. The Board of Determination members determined there was a need for a drain project.

The existing natural drainage course outlets to the Elms & Vienna drain (Pitch Creek) at a point approximately 3,080 feet north of Farrand Road and approximately 1,890 feet west of Morrish Road. Please see Appendix 'C' – Existing Drainage Area Map. From the outlet at the Elms & Vienna drain (Pitch Creek), the existing natural drainage course travels upstream across farm fields in an easterly direction to an existing 48-inch round, corrugated steel pipe culvert beneath Morrish Road, located approximately 2,970 feet north of Farrand Road. From this point, the existing natural drainage system continues upstream through farm fields, wooded areas, and residential areas in an easterly, southeasterly, then southerly direction and ends at an existing 18-inch round, corrugated steel pipe culvert beneath Farrand Road, located approximately 1,300 feet west of Elms Road. In general, the existing natural drainage course lacks a defined channel, especially for the portion which extends southeasterly across the rear of the properties along Farrand Road.

Field visits by Gould Engineering, Inc. staff were performed 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)

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 232± acres (0.36 square miles). Therefore, based on Genesee County Drain Commissioner's Office-SWM standards, the Rational Method was used to calculate peak runoff flows for a 10% chance (10 year) storm event for the existing natural drainage course and proposed open drain improvements. A 4% chance (25 year) storm event was used to evaluate the existing county road crossings and their proposed improvements.

RATIONAL

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 alternatives. The land use of the overall drainage area includes rural residential areas, farmlands, and woodlands. The 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 for the calculations computed for this study.

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 thirty (30) minutes for rural basins 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.

EXISTING FLOWS

The overall drainage area was divided into sub-areas and storm water runoff flows calculated

at six (6) 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	Runoff Coefficient, $C_{weighted}$	Time of Concentration, T_c (minutes)	Intensity, I_{10} (in/hr)	Area (acres)	Peak Flow, $Q_{10} = (C_w)(I_{10})(A)$ (cfs)
ECP-1	0.30	93	1.50	50	22.5
ECP-2	0.31	108	1.24	79	30.4
ECP-3	0.30	129	1.05	109	34.3
ECP-4	0.30	147	0.95	157	44.7
ECP-5	0.30	178	0.80	205	49.2
ECP-6	0.30	206	0.72	232	50.1

B. Hydraulics – (Open Drain and Culverts)

OPEN DRAINS/CULVERTS

The GCDC-SWM standard for open drain and culvert evaluation (existing conditions and design alternatives) for open drain improvements is to evaluate and design for no surcharging, where surcharging is defined as water rising above the crown of the culvert or the banks of a ditch.

FLOW MASTER/OPEN DRAINS

Haestad Method's FlowMaster program was used to evaluate the existing natural drainage course and design the proposed open drain improvements. FlowMaster uses Manning's Equation to calculate the water surface elevation within each open drain cross-section using the input flow, taking into consideration the affects of the downstream slope. The roughness, shape, and height vary along an open drain; the Manning's Equation takes into consideration all of these factors and has become one of the most widely used uniform flow formulas for evaluating open channels. The Manning's coefficient of roughness (n) used to evaluate the existing natural drainage course which traverse through existing farm fields was 0.040, as the drainage course is plowed and contains some vegetation. The Manning's coefficient of roughness (n) used to evaluate the remainder of the existing natural drainage course was 0.050, as the natural drainage course is not maintained and contains brush and weeds. The Manning's coefficient of roughness (n) used to evaluate the proposed open drain for the proposed improvement alternatives is 0.035. The FlowMaster program also calculates the velocity of water within the open drain cross-section. This information is necessary in determining whether the flow passing through the existing natural drainage course or proposed open drains are acceptable or whether they may 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 solve for various hydraulic variables, such as culvert capacity, headwater elevation, etc. A Manning's roughness coefficient (n) of 0.024 was used for corrugated steel pipe culverts and 0.013 was used for concrete culverts.

5. Evaluation of Existing Drainage System

Existing Natural Drainage Course Evaluation

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

Field surveys and field visits completed by Gould Engineering, Inc. have determined that portions of the existing natural drainage course lack defined channels, particularly in the areas between ECP-2 and ECP-5. In these areas, the flow acts more as "overland" flow than channelized flow. Between ECP-4 and ECP-5, this could be due to the existing farming operations. Also, as reported by local residents at the Board of Determination meeting and observed during Gould Engineering, Inc. field visits and field surveys, fill dirt has been placed in a portion of the existing natural drainage course located just north of the existing 18" culvert beneath Farrand Road. This became evident through the field survey information - the existing natural drainage course in this area is approximately one-foot (1') higher than the existing roadside ditch along the north side of Farrand Road (at cross-section A-A). Therefore, the existing ditches must back-up water for a depth of one-foot before the water can overtop this fill area and continue downstream along the natural drainage course. As reported by several local residents, this leads to flooding along Farrand Road.

The following table shows the calculated peak flows for a 10% chance (10 year) storm event and the corresponding water surface elevation and approximate width of the water surface along the existing natural drainage course, as the cross-sections are not well defined in some areas.

Ex. Drainage Course Cross-Section	Calculated Q_{10} (cfs)	Ex. Water Surface Elev. (WSE) of Drainage Course for Calculated Q_{10}	Approx. Width of WSE of Drainage Course for Calculated Q_{10} (feet)
A-A	22.5	676.1±	14±
B-B	30.4	672.4±	Greater than 57
C-C	34.3	670.2±	72±
D-D	34.3	668.6±	Greater than 91
E-E	44.7	666.2±	Greater than 101
F-F	44.7	665.7±	Greater than 157
G-G	49.2	665.3±	Greater than 129
H-H	49.2	664.3±	119±
I-I	49.2	662.2±	Greater than 65
J-J	49.2	661.3±	9±
K-K	49.2	661.7±	Greater than 75
L-L	50.1	660.5±	71±
M-M	50.1	659.5±	59±
N-N	50.1	654.6±	Greater than 56

Existing Culvert Evaluation

An evaluation of the existing culverts along the drainage course determined that the existing Farrand Road culvert is deficient in conveying the calculated runoff in accordance with GCDC-SWM requirements, resulting in the back-up or restriction of flow in the area upstream from the culvert south of Farrand Road. The existing 48-inch round, corrugated steel culvert beneath Morrish Road appears to be adequate in size to convey the calculated runoff. However, the existing culvert is approximately one-foot (1') below the existing downstream natural drainage course, and the downstream natural drainage course is deficient in size; therefore flow is restricted through the culvert and the upstream natural drainage course. This existing culvert is discussed further in the Proposed Improvement Alternatives section of this report.

The following table shows the calculated 4% chance (25 year) storm event flows to each culvert, the corresponding headwater (HW) elevation, and the elevation of the top inside of the culvert. Please see Appendix 'B' for calculations related to the existing culvert evaluations.

Ex. Culvert	Calculated Flow to Ex. Culvert, Q_{25} (cfs)	Headwater Elevation at Ex. Culvert	Elevation of Top Inside of Ex. Culvert
Ex. 18-inch round CSP beneath Farrand Road	25.5	676.63	675.45
Ex. 48-inch round CSP beneath Morrish Road	56.6	662.67	662.47

6. Proposed Improvement Alternatives

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

Alternatives 1 and 1A discuss improvements along the existing drainage course, including the addition of culverts along the open drain improvement for property connection. Alternative 1A involves some open drain re-routes to follow along property lines. Alternative 2 discusses improvements to the existing drainage course as a result of bypassing a portion of the existing flow along the south side of Farrand Road directly to the Elms & Vienna drain (Pitch Creek). Alternative 2A is a variation of the proposed route along the south side of Farrand Road, which routes the drainage south along property lines to the Elms & Vienna Drain (Pitch Creek). All of the improvement alternatives will require new easements along the proposed routes which are located outside of the existing Genesee County Road Commission road right-of-way. The following discusses each alternative in more detail:

• **ALTERNATIVE 1:**

Improvement Alternative 1 involves the cleaning, deepening, and widening of the existing drainage course, removal and replacement of the existing Farrand Road culvert (at ECP-1), and the addition of culverts along the proposed open drain for property cross-connection. This alternative includes a 42" x 29" corrugated steel pipe arch culvert (equivalent 36" round pipe) at Farrand Road and 49" x 33" corrugated steel pipe arch culverts (equivalent 42" round pipe) and 57" x 38" corrugated steel pipe arch culverts (equivalent 48" round pipe) along the improved open drain. The pipe arch culverts are required due to the minimal amount of cover available beneath Farrand Road and to minimize the depth of the proposed open drain improvement. Please see Appendix 'D' for a plan view drawing of proposed Improvement Alternative 1 and the calculations relating to the proposed open drain improvements and proposed culvert additions and improvements.

Alternative 1 proposes to clean, deepen, and widen the existing natural drainage course, because much of the existing drainage course lacks a defined open drain cross-section. The typical proposed open drain cross-section consists of a two foot (2') wide bottom and 2:1 (H:V) side slopes. Downstream of ECP-5, the proposed drain cross-section would consist of a three foot (3') wide bottom and 2:1 (H:V) side slopes. The open drain will be approximately 2.5-feet to 4.0-feet deep.

The existing 18-inch corrugated steel culvert beneath Farrand Road (located at ECP-1) is proposed to be removed and replaced with a 42" x 29" corrugated steel pipe arch culvert. The existing culvert cannot adequately convey the existing flow reaching the culvert. Therefore, water backs up along the ditches on the south side of Farrand Road and into the front yard areas of the homes along the south side of Farrand Road, as reported by local residents. The proposed culvert is intended to provide more adequate conveyance of the runoff in the immediate area. A pipe arch culvert is proposed due to limited amount of cover available beneath Farrand Road

The existing 48-inch corrugated steel culvert beneath Morrish Road (located at ECP-5) is proposed to remain in place, as the culvert is capable of adequately conveying the flow reaching the culvert once the downstream channel has been improved.

Additional proposed culverts along the drainage course are intended to provide access within properties which are split due to the open drain improvements. The proposed culverts P2 and P3 are proposed to be 49" x 33" corrugated steel pipe arches, and proposed culverts P4, P5, and P6 are proposed to be 57" x 38" corrugated steel pipe arches. Pipe arch culverts are required in order to minimize the depth of the improved open drain.

The following chart lists the proposed culvert sizes required in order to meet Genesee County Drain Commissioner's Office-Surface Water Management standards:

Culvert	Ex. Culvert Size & Type (inches)	Proposed Size & Type (inches)	Calculated Flow to Ex. Culvert, Q ₁₀ (cfs) or Q ₂₅ (cfs)	Headwater Elevation at Culvert	Upstream Elevation of Top Inside of Culvert
P1	18", round CSP	42" x 29", CSPA	Q ₂₅ = 25.5	674.84	674.91
P2	N/A	49" x 33", CSPA	Q ₁₀ = 34.3	669.66	669.87
P3	N/A	49" x 33", CSPA	Q ₁₀ = 34.3	668.54	668.51
P4	N/A	57" x 38", CSPA	Q ₁₀ = 49.2	664.59	664.68
P5	N/A	57" x 38", CSPA	Q ₁₀ = 49.2	663.80	663.96
E2	48", round CSP	(To Remain - As Is)	Q ₂₅ = 56.6	662.41	662.47
P6	N/A	57" x 38", CSPA	Q ₁₀ = 50.1	658.73	658.96

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 1 is \$241,167.00±. Further information related to this POPCC may be found in Section 9.

● **ALTERNATIVE 1A:**

Improvement Alternative 1A is similar to Improvement Alternative 1 in that it also involves the cleaning, deepening, and widening of the existing natural drainage course, removal and replacement of the existing Farrand Road culvert (at ECP-1), and the addition of culverts along the open drain to provide access within properties which are split due to the open drain improvements. Improvement Alternative 1A, however, proposes some drainage course re-routing so that the proposed open drain follows along existing property lines. Following property lines would eliminate the necessity for proposed culvert P2; all other proposed culverts and culvert improvements from Improvement Alternative 1 would be the same for Improvement Alternative 1A. In addition to re-routing part of the open drain along property lines, some minor swale work may be required along the existing drainage course route in order to provide positive drainage for some low areas. Please see Appendix 'D' for a plan view drawing of proposed Improvement Alternative 1A.

The additional open drain excavation for Alternative 1A compared to Alternative 1 is approximately 515 feet. The additional open drain excavation and the elimination of culvert P2 would result in a Preliminary Opinion of Probable Construction Cost of approximately \$250,670.00±, which is approximately \$9,503.00± more than Improvement Alternative 1.

- **ALTERNATIVE 2:**

Improvement Alternative 2 involves re-routing the flow from the drainage area south of Farrand Road to a proposed drainage system along the south side of Farrand Road. The re-routed portion of the drainage system would outlet to the Elms & Vienna Drain (Pitch Creek) at the Farrand Road crossing. The existing Farrand Road culvert (at PCP-1), would also be removed, replaced, and redirected to the south in order to also route some of the area north of Farrand Road to the re-routed drainage system along the south side of the road. By re-routing a portion of the drainage area, the existing natural drainage course downstream of Farrand Road would receive less storm water runoff. Please see Appendix 'E' for a plan view drawing of proposed Improvement Alternative 2 and the calculations relating to the proposed improvements along the south side of Farrand Road.

The proposed drainage system along the south side of Farrand Road for re-routing a portion of the existing drainage area consists of a cleaned, deepened, and widened roadside ditch. The proposed widened ditch consists of a two foot (2') wide bottom and 3:1 (H:V) side slopes, as the ditch is along the existing GCRC right-of-way. The ditch will be approximately 2.5-feet to 4.0-feet deep. Due to the depth and location of the proposed re-route drainage course, an easement for drainage purposes will need to be acquired adjacent to the existing GCRC right-of-way as the entire drainage course will not fit within the existing right-of-way. Also, the proposed drainage system was located along the south side of Farrand Road because an existing 42-inch sanitary sewer and a 6-inch medium pressure gas line are located within the right-of-way along the north side of Farrand Road.

The proposed drainage system along the south side of Farrand Road consists of a 35" x 24" corrugated steel pipe arch culvert beneath Farrand Road, 57" x 38" corrugated steel pipe arch drive culverts, and a long 36" concrete culvert. The existing 18-inch corrugated steel culvert beneath Farrand Road (located at PCP-1) is proposed to be removed and replaced with a 35" x 24" corrugated steel pipe arch culvert. The flow direction for the culvert is also proposed to be re-directed to the south in order to re-route some of the drainage area north of Farrand Road to the proposed drainage system along the south side of Farrand Road. A pipe arch culvert is proposed due to limited amount of cover available beneath Farrand Road. The long 36-inch concrete culvert is proposed in lieu of an open ditch, as an open ditch in this area would result in depths of approximately six-feet.

The following chart lists the proposed culvert sizes required in order to meet Genesee County Drain Commissioner's Office-Surface Water Management standards:

Proposed Alternative 2 Improvements South Side of Farrand Road

Culvert	Ex. Culvert Size & Type (inches)	Proposed Size & Type (inches)	Calculated Flow to Ex. Culvert, Q ₁₀ (cfs) or Q ₂₅ (cfs)	Headwater Elevation at Culvert	Upstream Elevation of Top Inside of Culvert
P1	18", round CSP	35" x 24", CSPA	Q ₂₅ = 4.8	674.72	674.87
P7	18", round CSP	57" x 38", CSPA	Q ₁₀ = 25.1	674.66	675.16
P8	12", round CSP	57" x 38", CSPA	Q ₁₀ = 25.1	674.49	675.02
P9	12", round CSP	57" x 38", CSPA	Q ₁₀ = 25.1	674.28	674.88
P10	12", round CSP	57" x 38", CSPA	Q ₁₀ = 25.1	674.10	674.78
P11	12", round CSP	57" x 38", CSPA	Q ₁₀ = 26.1	673.91	674.46
P12	18", round CSP	57" x 38", CSPA	Q ₁₀ = 26.1	673.72	674.25
36" Conc.	N/A	36", round Concrete	Q ₁₀ = 26.1	673.53	673.89
P13	18", round CSP	57" x 38", CSPA	Q ₁₀ = 30.6	671.05	671.86
P14	18", round CSP	57" x 38", CSPA	Q ₁₀ = 30.6	(not computed)	(not computed)

The Preliminary Opinion of Probable Construction Cost (POPCC) for Alternative 2 is \$212,155.00±. Further information related to this POPCC may be found in Section 9.

• **ALTERNATIVE 2A:**

Improvement Alternative 2A is similar to Improvement Alternative 2 in that it also involves the re-routing of a portion of the drainage area through a proposed drainage system along the south side of Farrand Road, cleaning, deepening, and widening of the existing natural drainage course, removal and replacement of the existing Farrand Road culvert (at PCP-1). Improvement Alternative 2A, however, proposes to re-route the drainage course along the south side of Farrand Road and then south along a property line to the Elms & Vienna Drain (Pitch Creek). Improvement Alternative 2A would eliminate approximately 930 feet of proposed roadside ditch deepening and widening and two (2) drive culverts (P13 and P14) along the south side of Farrand Road. However, construction of Improvement Alternative 2A would require approximately 200 feet of additional 36-inch concrete storm sewer and 765 feet of additional open drain excavation to reach the Elms & Vienna Drain (Pitch Creek). Please see Appendix 'E' for a plan view drawing of proposed Improvement Alternative 2A.

The additional 36-inch concrete storm sewer and the drainage course re-routing result in a Preliminary Opinion of Probable Construction Cost approximately \$45,000.00± more than Improvement Alternative 2.

Alternatives No. 2 and 2A address the drainage problems along Farrand Road and propose no work along the natural drainage course north of Farrand Road to Morrish Road and across Morrish Road to the Elms & Vienna Drain. Improvements to the natural drainage course were reviewed to see what effect rerouting the upstream portion of the drainage area has downstream. Rerouting the upstream drainage area results in almost the same flows downstream from PCP-3 (see Alternative 1)

and has a minor effect on the improvements to the natural drainage course. This is due to the timing differences between the upstream drainage area south of Farrand Road and the rest of the drainage area north of Farrand Road. The drain size and culvert sizes are essentially the same sizes as Alternative 1 with the exception of the very upstream end of the natural drainage course where the culvert sizes could be reduced slightly. Improving the natural drainage course north of Farrand Road in addition to the improvements along the south side of Farrand Road result in a Preliminary Opinion of Probable Construction Cost for work along both routes of approximately \$399,000.00±. Also, based on surveyed cross sections along the natural drainage course, low areas that exist could be regraded and filled to provide positive drainage if desired by the property owners to reduce storm water collecting in these areas.

8. Recommendations

Based on the preliminary opinion of probable construction costs, the most cost effective alternative is Improvement Alternative 2. Improvement Alternative 2 requires the least amount of new construction and would also result in less culverts and open drains to be maintained and cleaned. If constructed, Improvement Alternative 2 should be constructed as one project, with no phasing, in order to provide positive drainage along Farrand Road.

Also, the field work completed by Gould Engineering, Inc. has revealed that many of the drive culverts along the north and south sides of Farrand Road, east of Elms Road have invert elevations which do not allow for adequate drainage of the roadside ditches because some of the culverts have backfall which causes storm water to collect in areas. The culverts and ditch along the north and south side of Farrand Road would benefit from re-ditching and relaying the culverts within the roadside ditch. This work would not be a part of the County Drain project, but would be maintenance work related to the drainage system for the existing road. The Genesee County Road Commission is the local agency which maintains the existing roads and the roadside ditch drainage system. This maintenance work for the roadside ditches is dependent on an adequate outlet being constructed to drain the roadside ditches.

9. **Preliminary Opinion of Probable Construction Costs (POPCC)**

• **ALTERNATIVE 1:**

Item Description	Qty	Pay Unit	Unit Price	Amount
1. Clearing and Grubbing	7400±	L.F.	\$7.00±	\$51,800.00±
2. Open Drain Excavation, 2' Bottom	5454±	L.F.	\$6.00±	\$32,724.00±
3. Open Drain Excavation, 3' Bottom	1946±	L.F.	\$8.00±	\$15,568.00±
4. Machine Grading	7400±	L.F.	\$5.00±	\$37,000.00±
5. 42" x 29" Corrugated Steel Pipe Arch	45±	L.F.	\$120.00±	\$5,400.00±
6. 49" x 33" Corrugated Steel Pipe Arch	40±	L.F.	\$130.00±	\$5,200.00±
7. 57" x 38" Corrugated Steel Pipe Arch	60±	L.F.	\$160.00±	\$9,600.00±
8. Plain Rip Rap	50±	S.Y.	\$56.00±	\$2,800.00±
9. Restoration, open drain (seeding, fertilizer, mulch)	7400±	L.F.	\$5.50±	\$40,700.00±
10. Compacted Sand Backfill	45±	L.F.	\$10.00±	\$450.00±
11. Road Surface Removal & Replacement	50±	S.Y.	\$60.00±	\$3,000.00±
12. Soil Erosion & Sedimentation Control	1±	LSum	\$10,000.00±	\$10,000.00±
13. Traffic Control	1±	LSum	\$5,000.00±	\$5,000.00±
			Total	\$219,242.00±
			Contingency 10 %	\$21,925.00±
			Grand Total	\$241,167.00±

Note: The figures given for each item and the total figure of the POPCC is only a preliminary opinion based on data from similar projects as of the date of this study and are subject to change. Easement acquisitions, legal, financial, contract administration, engineering, permits, construction staking, and as-builts drawings are not included in these figures.

• **ALTERNATIVE 2:**

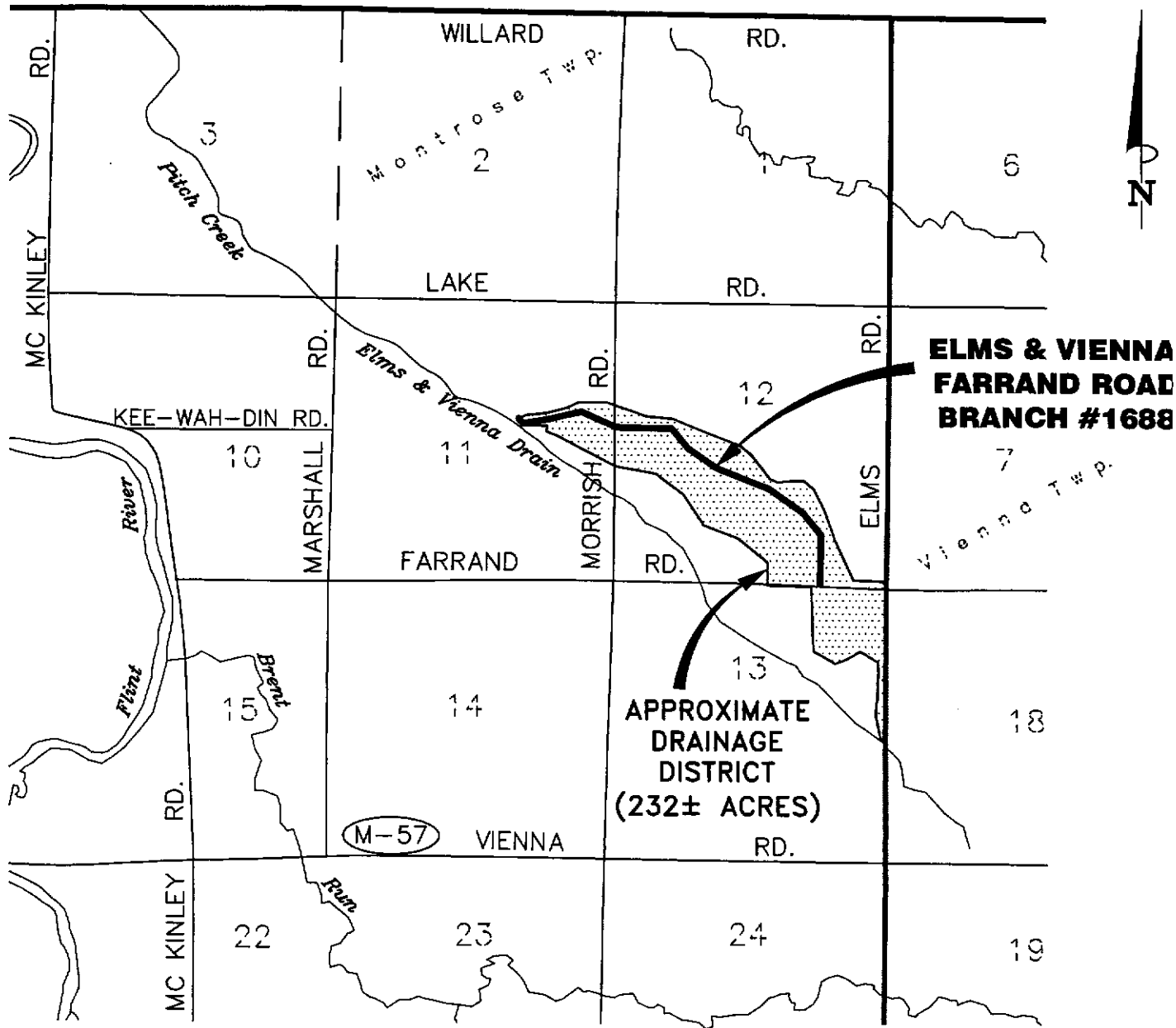
Item Description	Qty	Pay Unit	Unit Price	Amount
1. Selective Clearing & Grubbing	1366±	L.F.	\$7.00±	\$9,562.00±
2. Restricted Open Drain Excavation, 2' Bottom	1366±	L.F.	\$8.00±	\$10,928.00±
3. 35" x 24" Corrugated Steel Pipe Arch	45±	L.F.	\$110.00±	\$4,950.00±
4. 57" x 38" Corrugated Steel Pipe Arch	200±	L.F.	\$160.00±	\$32,000.00±
5. Plain Rip Rap	45±	S.Y.	\$56.00±	\$2,520.00±
6. Restoration, open drain (seeding, fertilizer, mulch)	1366±	L.F.	\$5.50±	\$7,513.00±
7. Restoration, storm sewer (seeding, fertilizer, mulch)	685±	L.F.	\$3.00±	\$2,055.00±
8. 5' diam. Drainage Structures, Catch Basin	4±	Each	\$3,000.00±	\$12,000.00±
9. Drainage Structure Covers	800±	Lb.	\$1.50±	\$1,200.00±
10. 36" Sewer, C76-III	685±	L.F.	\$90.00±	\$61,650.00±
11. Compacted Sand Backfill	945±	L.F.	\$10.00±	\$9,450.00±
12. Road Surface Removal & Replacement	50±	S.Y.	\$60.00±	\$3,000.00±
13. Driveway Removal & Replacement, Aggregate	276±	S.Y.	\$40.00±	\$11,040.00±
14. Soil Erosion & Sedimentation Control	1±	LSum	\$15,000.00±	\$15,000.00±
15. Traffic Control	1±	LSum	\$10,000.00±	\$10,000.00±
			Total	\$192,868.00±
			Contingency 10 %	\$19,287.00±
			Grand Total	\$212,155.00±

Note: The figures given for each item and the total figure of the POPCC is only a preliminary opinion based on data from similar projects as of the date of this study and are subject to change. Easement acquisitions, legal, financial, contract administration, engineering, permits, construction staking, and as-builts drawings are not included in these figures.

10. Appendices

Appendix 'A'

- **Location Map**



APPENDIX 'A'

LOCATION MAP

SCALE: 1" = 3000'±

PRELIMINARY DRAINAGE STUDY FOR: **ELMS & VIENNA, FARRAND ROAD BRANCH #1688**

DATE: SEPTEMBER 9, 2008

PREPARED FOR:
 GENESEE COUNTY DRAIN COMMISSIONER
 SURFACE WATER MANAGEMENT DIVISION
 G-4608 BEECHER ROAD, FLINT, MICHIGAN 48532

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Appendix 'B'

- **Standard Charts and Values Used in Calculations**



GENESEE COUNTY DRAIN COMMISSIONER'S OFFICE

**-DIVISION OF
SURFACE WATER MANAGEMENT**

**JEFFREY WRIGHT
COMMISSIONER**

G-4608 BEECHER ROAD, FLINT, MI 48532
PHONE (810) 732-1590 FAX (810) 732-1474

Revised November 1, 2006
Effective immediately

**STORM SEWER DESIGN PARAMETERS
FOR GENESEE COUNTY**

IN AN EFFORT TO STANDARDIZE DESIGN PROCEDURES FOR STORM SEWERS AND OPEN CHANNELS IN GENESEE COUNTY, THE GENESEE COUNTY DRAIN COMMISSIONER HAS DEVELOPED THESE STANDARDS. IT IS HOPED THAT THESE STANDARDS WILL FACILITATE PLANNING FROM BOTH THE POSITION OF THE DESIGN AND REVIEWING ENGINEER.

IT IS RECOGNIZED THE DESIGN CONDITIONS VARY AND THERE IS NO SUBSTITUTE FOR THE JUDGEMENT OF AN EXPERIENCED ENGINEER. IN ALL CASES THIS JUDGEMENT SHOULD BE APPLIED.

MANY STREAMS LOCATED IN THIS COUNTY DO NOT HAVE STREAM GAGING DATA AVAILABLE OR THE PERIOD OF RECORD IS NOT OF SUFFICIENT LENGTH TO ALLOW THE DESIGN ENGINEER TO ESTIMATE FLOOD FLOWS BY USING FLOOD-FREQUENCY ANALYSIS AS DEVELOPED BY U.S.G.S. PRIOR TO DESIGN OF ANY STORM DRAIN IMPROVEMENT OR ENCLOSURE THE CONSULTANT SHALL INVESTIGATE ANY GAGING STATION, PARTIAL RECORD GAGING STATION OR CREST STAGE GAGES ON THE DESIGN BASIN FOR AVAILABLE PERTINENT DATA ON FLOOD FLOWS.

WHERE INSUFFICIENT DATA IS PRESENT TO DEVELOP BASIN HYDROLOGY BY THE ABOVE METHOD THE CONSULTANT SHALL DETERMINE FLOWS ALONG THE BASIN BY THE S.C.S. METHOD, THE RATIONAL METHOD, THE BRATER METHOD OR A COMBINATION OF ANY OF THE ABOVE NAMED METHODS. THE BASIN HYDROLOGY SHALL BE APPROVED BY THE GENESEE COUNTY DRAIN COMMISSIONER'S OFFICE PRIOR TO PROCEEDING WITH THE FINAL DESIGN OF A GIVEN PROJECT.

DESIGN PROJECTS SHALL BE DEVELOPED IN ACCORDANCE WITH THE FOLLOWING FLOOD FREQUENCIES.

- A. 100 YEAR STORM ON BASIN DEVELOPMENT PROJECT TO YEAR 2000:
1. CULVERTS OR BRIDGES CROSSING STATE HIGHWAYS OR EXPRESSWAYS WHERE THE UPSTREAM DRAINAGE AREA IS IN EXCESS OF 2 SQUARE MILES.
 2. DETENTION PONDS.
 3. DRAINAGE ENCLOSURES IN EXCESS OF 100 FEET WHERE THE UPSTREAM DRAINAGE AREA IS IN EXCESS OF 2 SQUARE MILES.

- B. 50 YEAR FLOOD FLOWS WITH BASIN DEVELOPMENT TO YEAR 2000:
1. ENCLOSED STORM SEWERS IN NEW PROPOSED PLATS.
- C. 25 YEAR FLOOD FLOWS WITH BASIN DEVELOPMENT TO YEAR 2000:
FOR IMPROVEMENTS IN THIS CATEGORY, THE CONSULTANT SHALL DESIGN THE STRUCTURE WITHOUT APPRECIABLY ALTERING THE FLOOD STAGE OF THE CHANNEL. THE EFFECT OF THE 100 YEAR FLOOD FLOW MUST ALSO BE SHOWN.
1. COUNTY ROAD CROSS CULVERTS AND BRIDGES.
 2. OPEN CHANNEL DEVELOPMENT OR IMPROVEMENT (FLOW TO BE CONTAINED WITHIN THE CHANNEL).
 3. DRAIN ENCLOSURES WHERE THE DRAINAGE AREA IS GREATER THAN 300 ACRES BUT LESS THAN 2 SQUARE MILES.
- D. 10 YEAR FLOOD FLOWS WITH BASIN DEVELOPMENT TO YEAR 2000:
1. OPEN CHANNELS, CULVERTS OR DRAIN ENCLOSURES WHERE THE DRAINAGE AREA IS NOT IN EXCESS OF 300 ACRES.

FLOW ESTIMATION: HYDROLOGY

MANY DIFFERENT METHODS OF ARRIVING AT A GIVEN CFS FOR A SELECTED SPOT IN A DRAINAGE OUTLET HAVE BEEN DEVELOPED OVER THE YEARS. BECAUSE OF ITS GENERAL RECOGNITION AND WIDE USE WITHIN THE COUNTY, THE DRAIN COMMISSIONER WILL ACCEPT THE RATIONAL METHOD FOR FLOW COMPUTATION WHERE THE DRAINAGE AREA IS LESS THAN 100 ACRES. ENGINEERS ELECTING TO USE THIS METHOD FOR LARGER DRAINAGE AREA WILL BE REQUESTED TO ALSO USE AN ALTERNATE METHOD FOR COMPARISON.

THE FOLLOWING CRITERIA SHALL BE USED IN DETERMINING THE VARIABLES OF THE RATIONAL FORMULA $Q=CIA$.

1. **AREA** - THE AREA OF A BASIN OR SUB-BASIN SHALL BE DETERMINED BY USE OF 2' CONTOUR MAPS AVAILABLE AT THE COUNTY OFFICE WITH AN APPROPRIATE FIELD CHECK OR BY USE OF ESTABLISHED COUNTY DRAIN MAPS ON FILE AT G-4608 BEECHER RD.
2. **INTENSITY** - THE RAINFALL INTENSITY - DURATION FREQUENCY CURVES ATTACHED SHALL BE USED FOR STORM DRAIN DESIGN IN GENESEE COUNTY. COMPUTATION OF AN ACCURATE TIME OF CONCENTRATION IS CRITICAL TO THE USE OF THESE CURVES. FOR URBAN STORM SEWERS AT TIME OF CONCENTRATION SHALL BE THE

SUMMATION OF THE INLET TIME PLUS THE TIME OF FLOW IN THE SEWER. FOR URBANIZED AREA A MINIMUM INITIAL TIME OF 20 MINUTES SHALL BE ACCEPTABLE FOR DESIGN AND FOR AVERAGE RURAL BASINS AN INITIAL TIME OF CONCENTRATION OF 30 MINUTES WILL PRESENT AN ADEQUATE TIME FOR STORM FLOWS TO PEAK. THE FLOW TIME IN AN ENCLOSED SYSTEM SHALL BE CALCULATED BY STANDARD DESIGN CHARTS. FOR CHANNEL VELOCITY THE STANDARD MANNING EQUATION $V=1.486 R^{2/3} S^{1/2}$ SHALL BE ACCEPTED. A CHART LISTING ACCEPTED N VALUES FOR STORM SEWER DESIGN IS ENCLOSED FOR USE IN DESIGN ANALYSIS.

3. **RUNOFF COEFFICIENT** - THE BASIN DEVELOPMENT SHALL BE PROJECTED TO THE YEAR 2000 AND THE RUNOFF COEFFICIENT MUST BE DETERMINED ON THE BASIS OF THIS PROJECTED DEVELOPMENT USING THE FOLLOWING:

A	FLAT UNDEVELOPED LANDS, FARMS, NONWOODED	0.25
B	WOODLANDS & SLOPED UNDEVELOPED LAND	0.30
C	PARKS, CEMETARIES, PLAYGROUNDS, DISTURBED GROUND	0.35
D	RESIDENTIAL	0.40
E	APARTMENTS, CONDOMINIUMS OF LT. MANUFACTURER	0.50
F	COMMERICAL AND INDUSTRIAL	0.70
G	IMPERVIOUS AREAS (PARKING, ROOF, ETC..)	0.95
H	OPEN WATER	1.00

OUTLET CONDITIONS

ALL STORM SYSTEMS SHALL BE DESIGNED TO EXIT INTO AN OUTLET WITH SUFFIEICIENT CARRYING CAPACITY TO CARRY THE ADDITIONAL DESIGN FLOW.

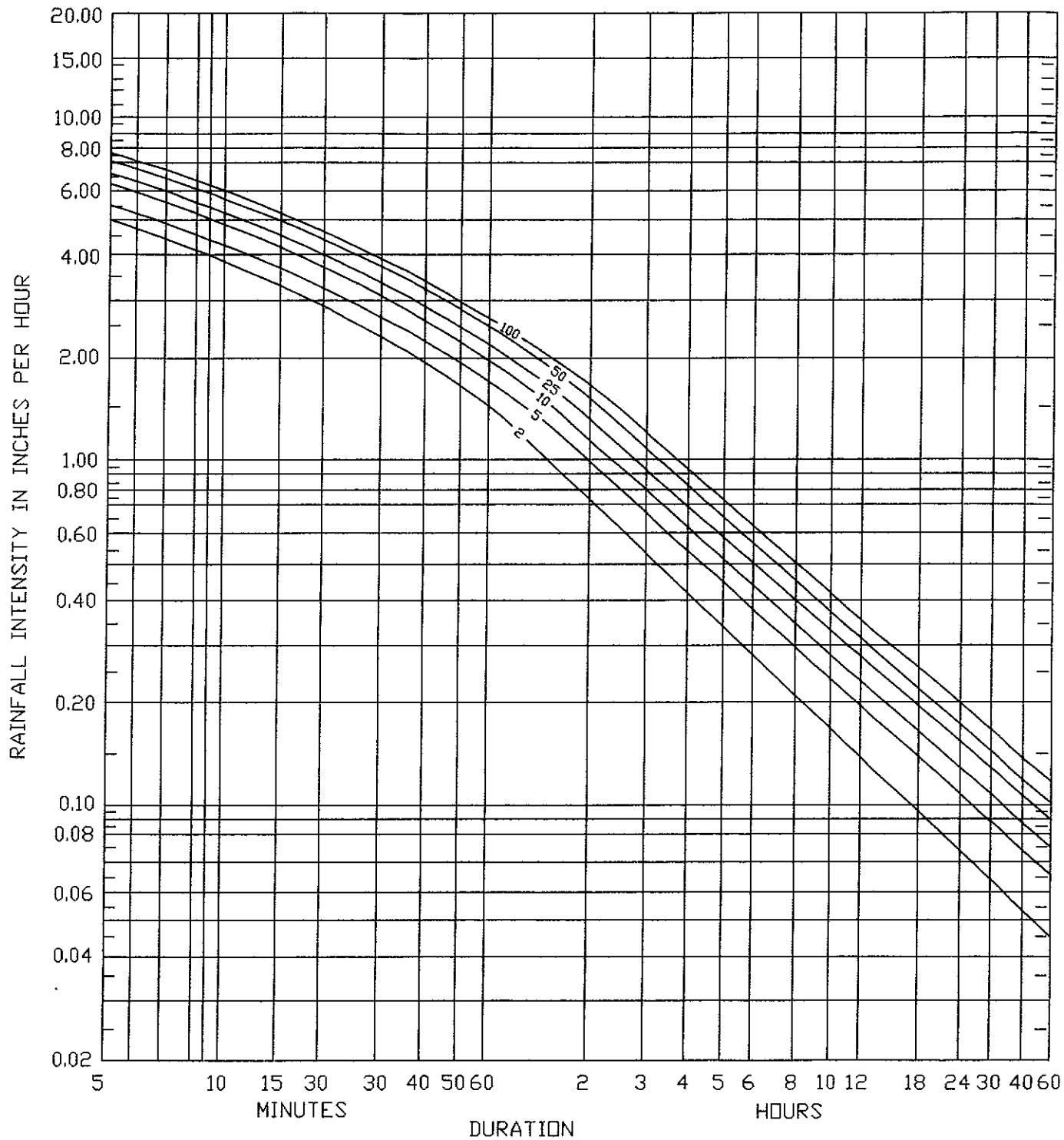
THE DESIGNER SHALL ANALYZE THIS CONDITION AND SUBMIT DATA SUBSTANTIATING HIS CONCLUSIONS. THIS INFORMATION SHALL BE SUBMITTED TO THE DRAIN COMMISSIONER ALONG WITH THE REQUIRED DESIGN FORMS.

IN THE EVENT THE DESIGNER DOES NOT HAVE SUFFICIENT CAPACITY IN THE OUTLET THE FOLLOWING CRITERIA SHALL APPLY:

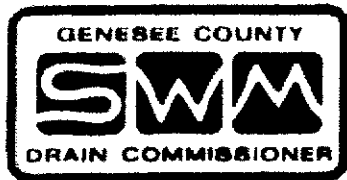
1. THE SYSTEM SHALL BE DESIGNED TO OUTLET ONLY EXISTING RUNOFF. EXISTING RUNOFF SHALL CONSIST OF ALL WATER

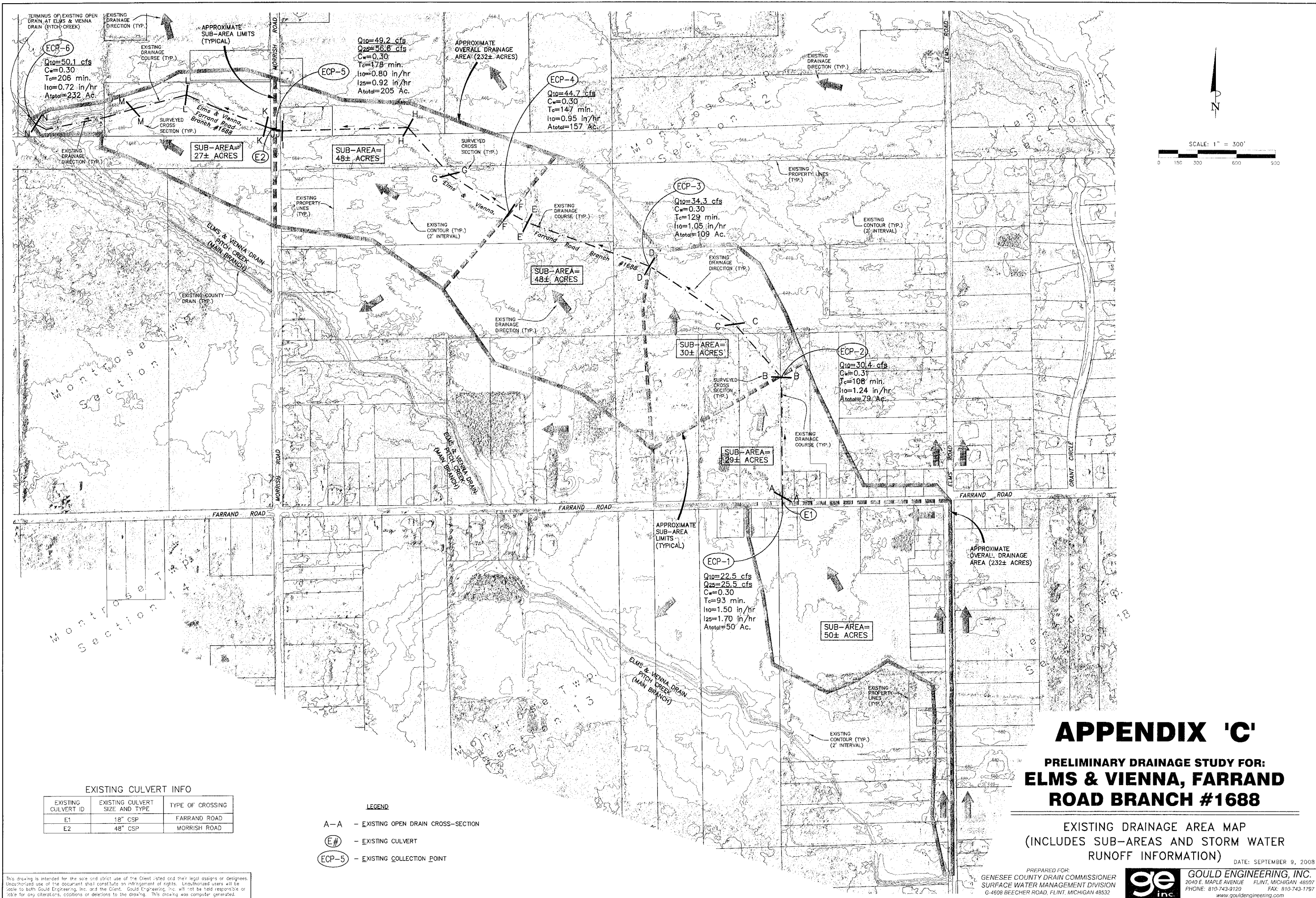
PRESENTLY CONTRIBUTED TO THE DRAINAGE DISTRICT. THIS SHALL MEAN THE 2-YEAR STORM UNDER EXISTING CONDITIONS USING AGRICULTURAL LAND. ($C = 0.25$) ALL EXCESS SHALL BE RETAINED ON SITE FOR DURATION OF TIME NECESSARY TO PASS THE DESIGN STORM WITH DOWNSTREAM FLOODING. THE OUTLET DISCHARGE SHALL NOT EXCEED 0.2 CFS/ ACRE UNDER ANY EVENT.

2. THE TOWNSHIP SHALL PETITION THE DRAIN COMMISSIONER TO IMPROVE THE OUTLET TO THE REQUIRED SIZE TO PASS THE ADDITIONAL WATER AT THE DESIGN STORM. IN THE EVENT THIS PETITION IS NOT SUCCESSFUL CRITERIA #1 ABOVE SHALL APPLY.



RAINFALL INTENSITY - DURATION - FREQUENCY CURVES FOR FLINT, MI





APPENDIX 'C'

PRELIMINARY DRAINAGE STUDY FOR: ELMS & VIENNA, FARRAND ROAD BRANCH #1688

EXISTING DRAINAGE AREA MAP
(INCLUDES SUB-AREAS AND STORM WATER
RUNOFF INFORMATION)

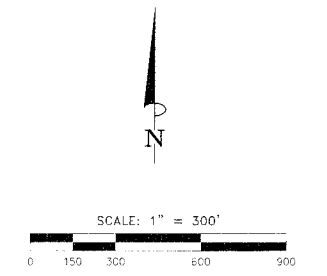
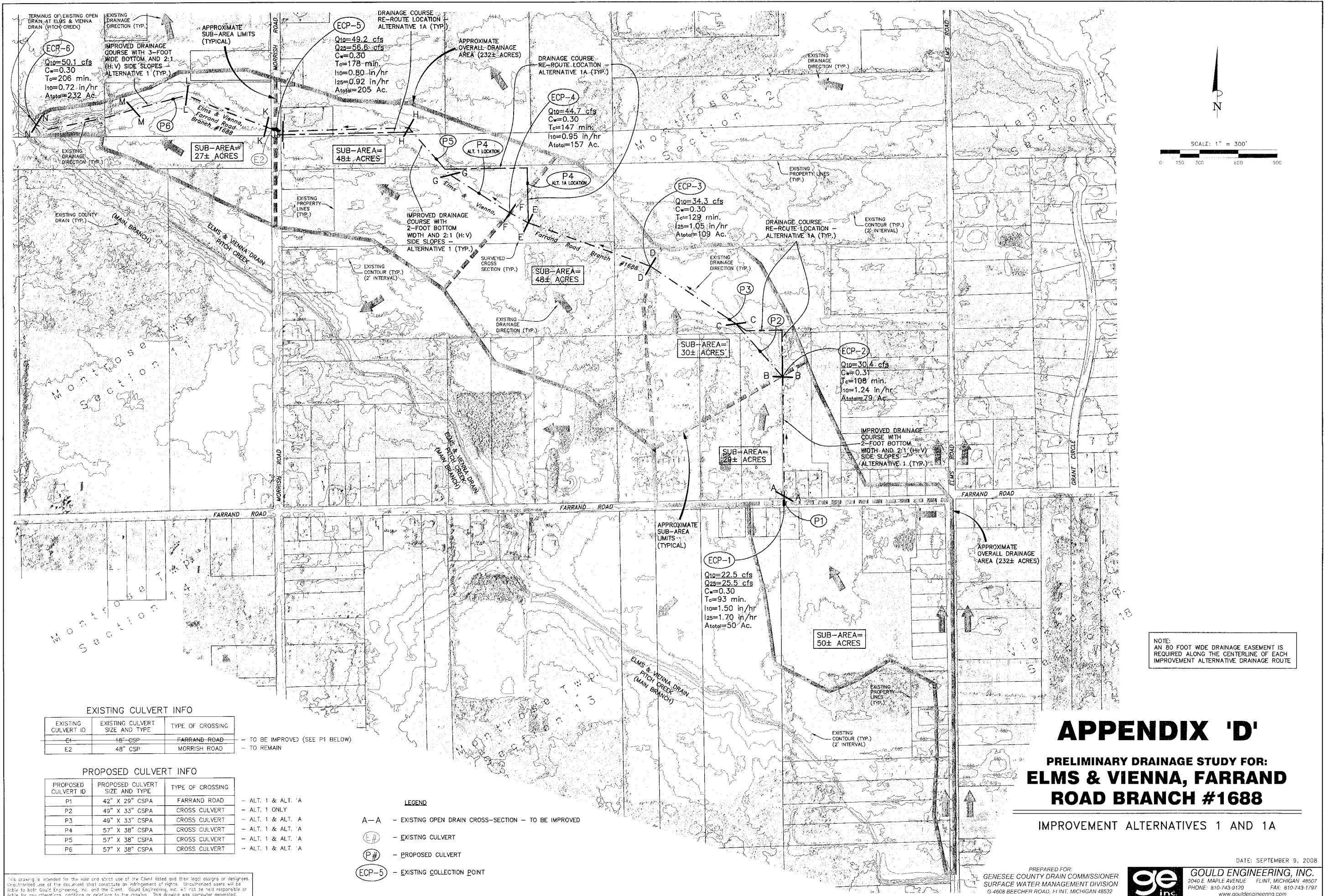
DATE: SEPTEMBER 9, 2008

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NOTE:
AN 80 FOOT WIDE DRAINAGE EASEMENT IS
REQUIRED ALONG THE CENTERLINE OF EACH
IMPROVEMENT ALTERNATIVE DRAINAGE ROUTE

APPENDIX 'D'

PRELIMINARY DRAINAGE STUDY FOR: ELMS & VIENNA, FARRAND ROAD BRANCH #1688

IMPROVEMENT ALTERNATIVES 1 AND 1A

EXISTING CULVERT INFO

EXISTING CULVERT ID	EXISTING CULVERT SIZE AND TYPE	TYPE OF CROSSING
E1	18" CSP	FARRAND ROAD
E2	48" CSP	MORRISH ROAD

- TO BE IMPROVED (SEE P1 BELOW)
- TO REMAIN

PROPOSED CULVERT INFO

PROPOSED CULVERT ID	PROPOSED CULVERT SIZE AND TYPE	TYPE OF CROSSING
P1	42" X 29" CSPA	FARRAND ROAD
P2	49" X 33" CSPA	CROSS CULVERT
P3	49" X 33" CSPA	CROSS CULVERT
P4	57" X 38" CSPA	CROSS CULVERT
P5	57" X 38" CSPA	CROSS CULVERT
P6	57" X 38" CSPA	CROSS CULVERT

- ALT. 1 & ALT. 'A'
- ALT. 1 ONLY
- ALT. 1 & ALT. 'A'
- ALT. 1 & ALT. 'A'
- ALT. 1 & ALT. 'A'
- ALT. 1 & ALT. 'A'

LEGEND

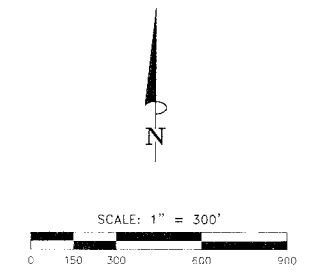
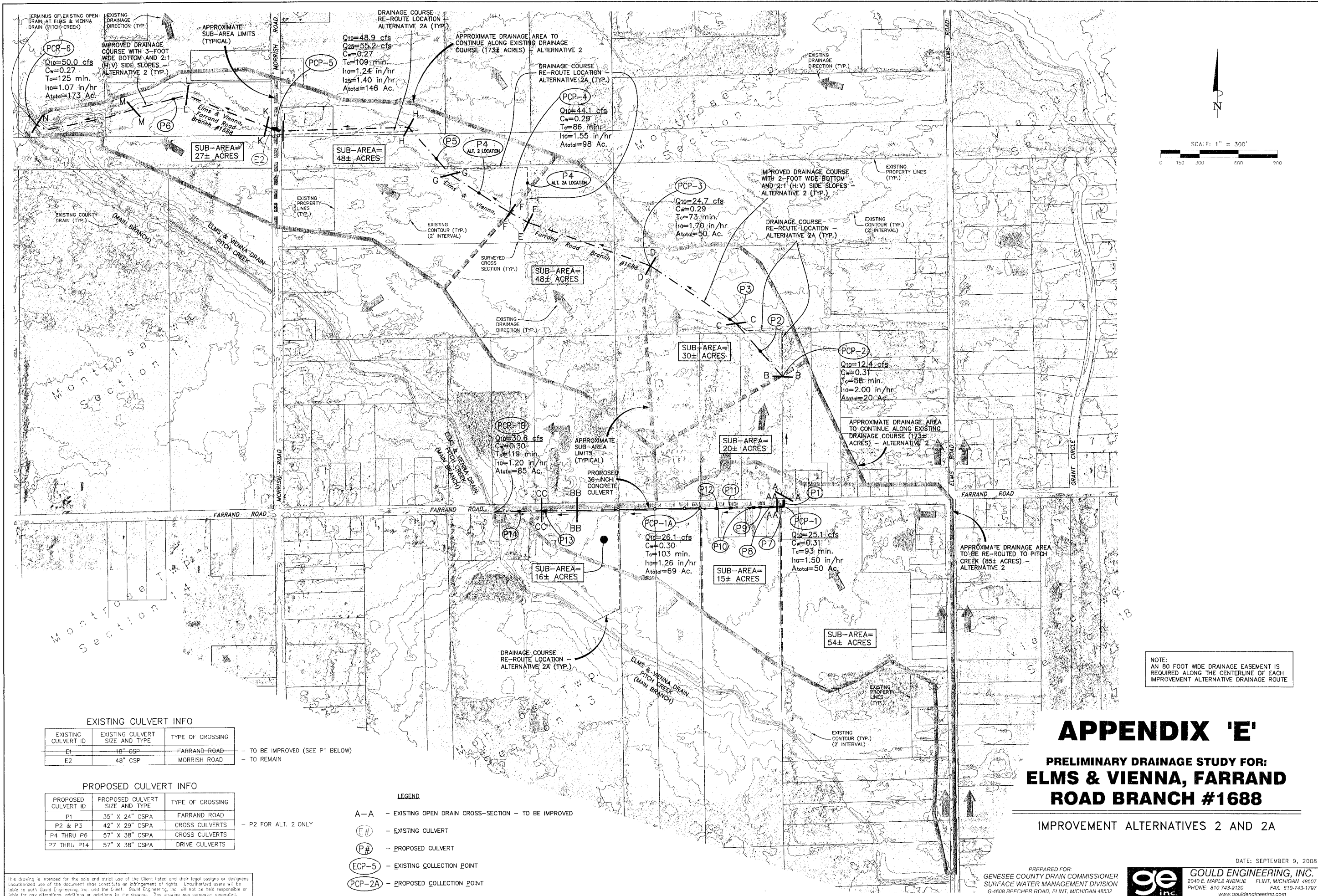
- A-A - EXISTING OPEN DRAIN CROSS-SECTION - TO BE IMPROVED
- E# - EXISTING CULVERT
- P# - PROPOSED CULVERT
- ECP-# - EXISTING COLLECTION POINT

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NOTE:
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REQUIRED ALONG THE CENTERLINE OF EACH
IMPROVEMENT ALTERNATIVE DRAINAGE ROUTE

APPENDIX 'E'

PRELIMINARY DRAINAGE STUDY FOR: ELMS & VIENNA, FARRAND ROAD BRANCH #1688

IMPROVEMENT ALTERNATIVES 2 AND 2A

EXISTING CULVERT INFO

EXISTING CULVERT ID	EXISTING CULVERT SIZE AND TYPE	TYPE OF CROSSING
E1	18" CSP	FARRAND ROAD
E2	48" CSP	MORRISH ROAD

- TO BE IMPROVED (SEE P1 BELOW)
- TO REMAIN

PROPOSED CULVERT INFO

PROPOSED CULVERT ID	PROPOSED CULVERT SIZE AND TYPE	TYPE OF CROSSING
P1	35" X 24" CSPA	FARRAND ROAD
P2 & P3	42" X 29" CSPA	CROSS CULVERTS
P4 THRU P6	57" X 38" CSPA	CROSS CULVERTS
P7 THRU P14	57" X 38" CSPA	DRIVE CULVERTS

- P2 FOR ALT. 2 ONLY

LEGEND

- A-A - EXISTING OPEN DRAIN CROSS-SECTION - TO BE IMPROVED
- ⊕# - EXISTING CULVERT
- ⊕# - PROPOSED CULVERT
- ECP-5 - EXISTING COLLECTION POINT
- PCP-2A - PROPOSED COLLECTION POINT

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