# PARKS DRAIN #0471

PART OF SECTIONS 9, 10, 15 & 16, T6N-R5E,
GAINES TOWNSHIP,
GENESEE COUNTY, MICHIGAN

# PRELIMINARY ENGINEERING REPORT (PHASE I)

JUNE 2013
REVISED NOVEMBER 2013

• PREPARED FOR •

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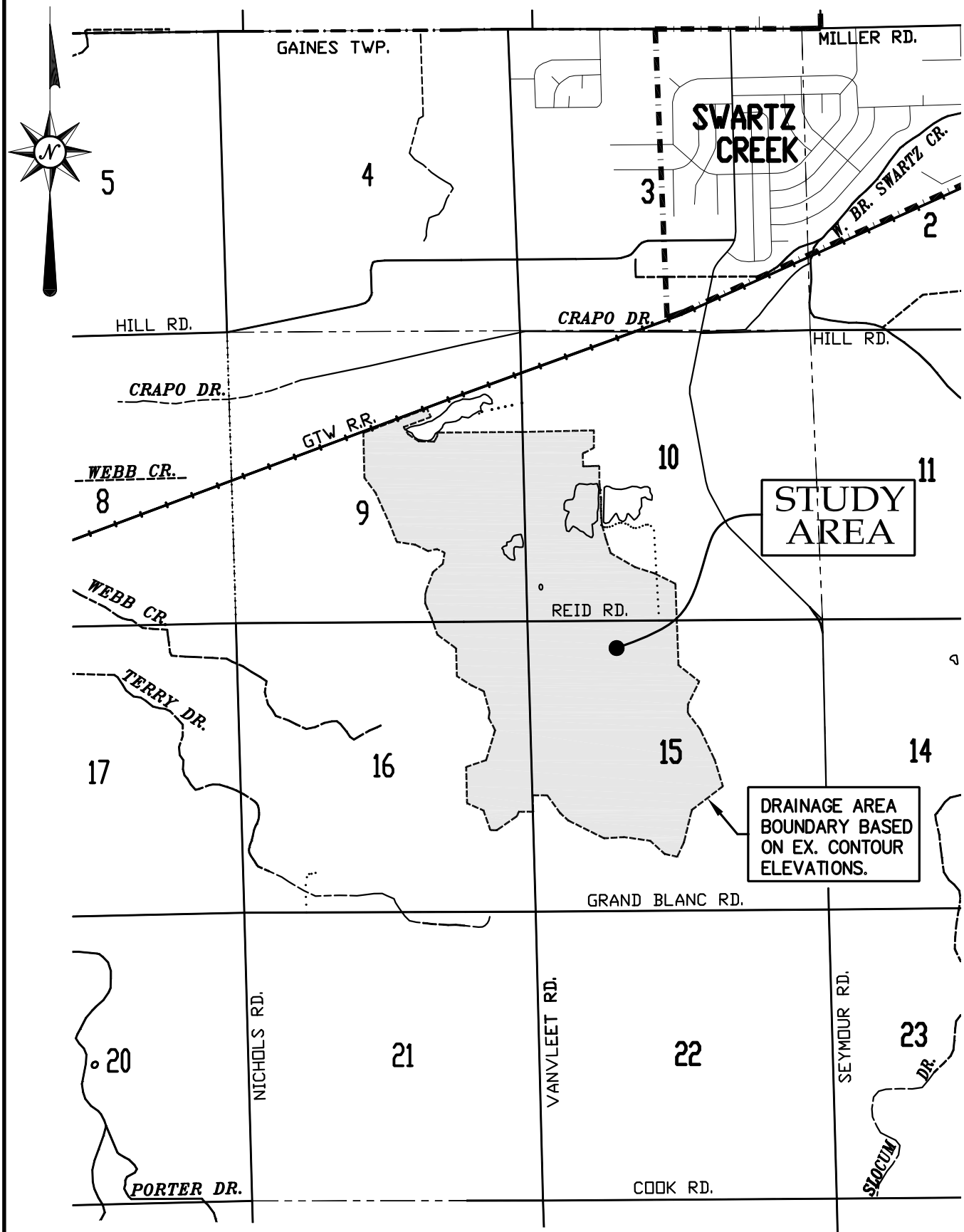


# PARKS DRAIN NO. 0471

## PART OF SECTIONS 9, 10, 15, & 16 OF GAINES TOWNSHIP

## SITE LOCATION MAP

## SUMMARY

The purpose of this report is to identify existing drainage concerns and issues, and to develop solutions to correct drainage problems occurring within the Parks Drain Drainage District. The Parks Drain and Branch Nos. 1, 2, and 3 of the Parks Drain are all public County Drains under the jurisdiction of the Genesee County Drain Commissioner. The study area encompasses land on the east and west sides of Van Vleet Road lying north of Grand Blanc Road and south of Hill Road. This study area is located predominantly within the east halves of Sections 9 and 16 and the west halves of Sections 10 and 15 of Gaines Township. The study area includes approximately six hundred and eighty-three (683) +/- acres of land.[1]

Presently there are drainage problems and concerns within the district where existing residential properties and roads are subject to significant flooding due to the lack of an adequately sized drainage system which is also old and deteriorating. Reports of drainage problems were obtained from the Board of Determination meeting minutes, and from on-site discussion with property owners. The original Parks Drain drainage system was constructed in 1915, which is nearly 100 years old.

Residents of the drainage district have submitted a petition to the Genesee County Drain Commissioner calling for the cleaning, deepening, widening, straightening, extending, tiling, relocating, and/or maintaining of the drain known and designated as the Parks Drain #0471 and its three branches. A Board of Determination meeting was held at the Gaines Township Hall on June 22, 2011. The recorded meeting minutes indicate that many of the residents had concerns about drainage problems and issues within the drainage district for this project. The Board of Determination decided that the Parks Drain project was necessary, which led to the preparation of this Preliminary Engineering Report.

The existing drainage system for the study area consists of a combination of open channel and enclosed storm sewer pipe. The downstream end of the existing Main drain of the Parks Drain system begins at the existing Crapo Drain and runs Southerly approximately 1,070 feet via an open drain to an existing 36” CSP culvert that crosses under the CN/GTW Railroad Right-of-Way at a point approximately 1/2 mile west of Van Vleet Road as measured along the southerly line of the railroad right-of-way. The existing main drain then runs Southeasterly approximately 1,585 feet as an open drain to a point approximately at the southwest property corner of 6214 Van Vleet Road. The existing main drain then runs easterly approximately 715 feet as a 20” tile to its intersection with the lower terminus of Branch No. 3 of the Parks Drain. At this point the main drain is a 16” tile that runs southeasterly traversing the property at 6276, 6310, 6362, and 6392 Van Vleet Road, where it routes through a pond located on the property at 6392 Van Vleet Road. The existing pond is not part of the County Drain. Apparently it was constructed by the property owner. The existing 16” tile main drain continues southeasterly across the property at 6476 Van Vleet Road, and then crosses Van Vleet Road at a point approximately 220 feet south of the northeast corner of the property at 6476 Van Vleet Road which is also approximately 770 feet north of Reid Road. A side inlet drainage structure was observed on the west side of Van Vleet Road at this location. An 8 inch clay pipe was observed exiting the structure to the west. This structure was observed to be in

[1] See Page 1 “Site Location Map”

poor condition and has no drainage structure cover. There is also a 71" x 47" CSP culvert crossing under Van Vleet Road running east and west at this location. The 16" tile main drain then continues on a southeasterly course traversing the property at 6451, 6477, and 6505 Van Vleet Road, and also across the property at 9506 Reid Road to the north side of Reid Road. There are three beehive drainage structures located near the northerly right-of-way line of Reid Road approximately 370 feet east of the intersection of Reid and Van Vleet Roads. These structures, along with a 42" concrete storm sewer pipe that crosses Reid Road to the south, were constructed in 2002 as part of the Reid Road paving project by the Genesee County Road Commission. The existing 42" concrete pipe has adequate capacity and can be re-used as part of the new county drain system. The westerly two beehive structures had existing 12 inch clay tiles exiting to the north, and they were also connected to the third catch basin to the east by a 15 inch concrete pipe. This easterly catch basin has an existing 16 inch tile running northwesterly and the 42 inch concrete pipe crossing under Reid Road to the south. The structure in the south ditch line of Reid Road contains the 42 inch concrete pipe to the north, with an existing 14" tile running to the southeast. The existing 14" tile main drain then runs in a Southeasterly direction, a distance of approximately 570 feet, traversing the property at 7021 Van Vleet Road, and then South along the east property lines of 7071, 7083, and 7101 Van Vleet Road to a point approximately 55 feet south of the north line of 7101 Van Vleet Road, where it takes a Southeasterly course for approximately 55 feet, at which point it intercepts the lower terminus of Branch No. 2 of the Parks Drain. The main drain then continues Southeasterly for approximately 3,100 feet along the back part of the properties at 9365 and 9295 Van Vleet Road, and 7275 Van Vleet Road as a 10" and 8" clay tile to its intersection with the lower terminus of Branch No. 1 of the Parks Drain. The main drain then continues to the East as an 8" clay tile for approximately 250 feet to its upper terminus at a point located approximately 500 feet east and 300 feet south of the Northwest corner of the property at 7290 Seymour Road.

Branch No. 1 of the Parks Drain is located in the southeast quadrant of the drainage district and it runs northeasterly approximately 290 feet from the main drain as a 6" clay tile to its upper terminus at a point on the north line of 7290 Seymour Road which is located approximately 440 feet east of the northwest corner of said property. Branch No. 2 of the Parks Drain is located in the southwest quadrant of the drainage district and it runs southwesterly approximately 1,600 feet from the main drain as a 8" clay tile to its upper terminus at a point on the east side of Van Vleet Road approximately 2,500 feet south of Reid Road. Branch No. 3 of the Parks Drain is located in the northeast quadrant of the drainage district and it runs easterly approximately 2,000 feet from the main drain as a 10" clay tile crossing Van Vleet Road to its upper terminus at a point approximately 1,300 feet east of the northwest corner of the property owned by Consumers Energy. At the Van Vleet Road crossing a side inlet drainage structure was observed on the west side of the road and a 10 inch clay tile was observed exiting to the south. There is also a 12" CSP culvert crossing Van Vleet Road running east and west at this location. In addition, an open drain was observed running east and west at the same location as the tile drain on the east side of Van Vleet Road. This open drain was observed to be blocked at the eastern edge of Consumer Energy's property.

Refer to Exhibit No. 1 for a drainage map that shows the existing drainage system and drainage areas, and other relevant existing features within the study area.

The Parks Drain and its three branches has an existing easement width of 50 feet in those areas where tile was installed, and a width of 100 feet along the route where open channel was constructed.

We have determined from the meeting minutes, and from our direct observation and analysis of the study area that there are two main issues relating to the drainage problems in this study area. The main issues to be addressed by this study therefore are as follows:

1. The current drainage system is not adequately sized for the drainage area it is currently serving. The existing undersized tiles cannot accept the volume of stormwater runoff that is occurring. As a result, the stormwater backs up and floods areas at various locations in the drainage area. Property owners have also indicated that there is significant flooding in the study area which is related to the lack of adequate capacity in the existing drainage systems. There was testimony at the Board of Determination Meeting of soil erosion problems, gravel accumulating from washouts at Van Vleet Road, fish swimming in flooded yards, knee deep rapids running across yards, standing water that provides a breeding ground for mosquitoes, and additional stormwater runoff that is occurring as a result of the Reid Road paving improvements in 2002.

2. There is evidence indicating that the current drainage system and the existing tile drain is damaged, blocked, broken, structurally unsound, and deteriorating. Since the existing tile is nearly 100 years old, it is most likely past its useful life and in need of replacement. The existing pipe is also susceptible to blockages from broken pipes, debris and tree roots.

   From our observations and analysis, the current drainage system and tile drain is outdated, undersized and has structural damage at various locations that requires significant improvements and replacement along its entire length with new pipe and/or open drain to provide a proper drainage system for the current conditions and land use.

## POTENTIAL SOLUTIONS

Three alternative solutions have been developed to address the existing drainage problem and deficiencies in the Parks Drain drainage area. Potential solutions to be examined and defined as a result of this study are summarized below:

1. **Alternative No. 1**: Replace the existing drainage system in kind (replace existing pipe with new pipe, and replace existing open drain with new open drain), and place the new drainage system at the same location as the existing system. This alternative includes modifications to the existing pond located on the north side of the property at 9426 Reid Road (also east of Van Vleet Road), raising the bank elevation to 783.00 to allow for stormwater detention. This will allow for the outlet drain (Branch No. 3) to be constructed with a smaller size and at a lower cost. This outlet drain begins at the northeasterly corner of the pond approximately 1,320 feet east of Van Vleet Road (Point 7b).

2. **Alternative No. 2:** Replace the existing drainage system with either open drain or pipe based on its location. Pipe would be placed in the vicinity of homes or yards, and open drain would be placed when the drain is further away from developed homes and yards. In addition, the location of the proposed drains would be moved to a different location than the existing location if it is determined to be more practical and cost effective.

3. **Alternative No. 3**: Replace the existing drainage system with either open drain or pipe using the same reasoning mentioned in the Alternative No. 2 discussion above. In addition, a significant portion of the drainage area would be re-routed to a new stormwater detention basin located north of the existing pond at the northeast quadrant of the drainage area. This alternative was explored to see if a larger stormwater detention system could reduce new pipe sizes enough to be more practical and cost effective than the other alternatives.

All three alternative solutions would provide a new drainage system that would provide a proper drainage outlet for the entire drainage and study area that conforms with current design criteria and standards of the Genesee County Drain Commissioner – Division of Surface Water Management. The alternative solutions mentioned above are discussed and described in more detail later in this report.

## DRAINAGE AREAS

For the hydrologic analysis and preliminary design, a drainage area map was prepared showing the tributary areas.[2] This map is based upon aerial photogrammetry from the Genesee County Drain Commission, ca. 2002, current tax parcel and zoning information from Genesee County Equalization, existing as-built drawings of public record, satellite imagery from the National Map, dated March 27, 1999, and current survey data obtained for this report by Kraft Engineering and Surveying, Inc. surveyors.

The drainage basin, and sub-basin areas were delineated on the Drainage Area Maps, and the drainage areas were determined using CADD. From the map, it has been determined that approximately six-hundred and eighty-three (683) acres will be served by the proposed enclosed storm sewer and/or open drain system for the Parks Drain and its three branches.

## LAND USE:

The existing land use within the drainage area consists of single family residential homes, agricultural fields and vacant land. The zoning classifications within the drainage district are AG-1 Prime Agriculture, AG-2 Agricultural Estate, and RR Rural Residential.

[2] See Exhibit Nos. 1, 4, 7, and 10 - "Drainage Maps"

SOIL TYPES

Soil types have been determined from the "Soil Survey of Genesee County, Michigan", Map Sheet #34, April 1972, USDA. The predominant soil classifications in the Parks Drain study area are Del Rey Silt Loam, Brookston Loam, Morley Silt Loam, Conover Loam, Lenawee Silty Clay Loam, Gilford Sandy Loam, Celina-Conover Loams, Selfridge Loamy Sand, and Miami Loam.

The hydrologic soil groups for the above soils and their specific characteristics, as defined by the Soil Conservation Services, are as follows:

**Map Unit Legend**

| Genesee County, Michigan (MI049) | | | |
|---|---|---|---|
| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
| DrA/DrB | Del Rey silt loam, 0 to 6 percent slopes | 288.2 | 42.2% |
| Bw | Brookston Loam | 84.1 | 12.3% |
| MvB/MvC | Morley silt loam, 2 to 12 percent slopes | 71.5 | 10.5% |
| CvA/CvB | Conover loam, 0 to 6 percent slopes | 48.8 | 7.1% |
| Le | Lenawee silty clay loam | 40.2 | 5.9% |
| Gd | Gilford sandy loam | 27.8 | 4.1% |
| CIB | Celina – Conover Loams, 2 to 6 percent slopes | 27.1 | 4.0% |
| SdB | Selfridge loamy sand, 2 to 6 percent slopes | 18.0 | 2.6% |
| MoB | Miami Loam, 2 to 6 percent slopes | 13.7 | 2.0% |
| | Other miscellaneous soils (<2% each) | 38.2 | 5.6% |
| W | Water | 25.4 | 3.7% |
| **Totals for Area of Interest** | | **683.0** | **100.0%** |


83° 52' 58"
83° 51' 25"
42° 56' 24"
42° 56' 27"
264900
265200
265500
265800
266100
266400
266700
4758000
4757700
4757400
4757100
4756800
4756500
4756200
4755900
4755600
Seymour Rd
Reid Rd
Van Vleet Rd
Bw
EtmaaE
Bv
W
CvB
MoB
ClB
Gd
MIA
Ed
Se
CvA
DrA
MvB
DrB
Lm
MvC
Le
SdB
MnB
42° 54' 52"
42° 54' 55"
83° 52' 54"
83° 51' 21"
Map Scale: 1:13,600 if printed on A size (8.5" x 11") sheet.
N
Meters
0 100 200 400 600
Feet
0 500 1,000 2,000 3,000

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Units

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

**Special Line Features**
- Gully
- Short Steep Slope
- Other

**Political Features**
- Cities

**Water Features**
- Streams and Canals

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

## MAP INFORMATION

Map Scale: 1:13,600 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

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

Soil Survey Area: Genesee County, Michigan
Survey Area Data: Version 7, Oct 2, 2012

Date(s) aerial images were photographed: 7/10/2005

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

# Map Unit Legend

| Genesee County, Michigan (MI049) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| Bv | Brevort loamy sand | 0.9 | 0.2% |
| Bw | Brookston loam | 76.4 | 12.3% |
| ClB | Celina-Conover loams, 2 to 6 percent slopes | 24.5 | 4.0% |
| CvA | Conover loam, 0 to 2 percent slopes | 18.7 | 3.0% |
| CvB | Conover loam, 2 to 6 percent slopes | 25.5 | 4.1% |
| DrA | Del Rey silt loam, 0 to 2 percent slopes | 3.5 | 0.6% |
| DrB | Del Rey silt loam, 2 to 6 percent slopes | 257.8 | 41.6% |
| Ed | Edwards muck | 5.6 | 0.9% |
| EtmaaE | Udorthents and Udipsamments, nearly level to hilly | 4.9 | 0.8% |
| Gd | Gilford sandy loam | 25.2 | 4.1% |
| Le | Lenawee silty clay loam | 36.4 | 5.9% |
| Lm | Linwood muck | 3.9 | 0.6% |
| MlA | Metamora sandy loam, 0 to 2 percent slopes | 8.6 | 1.4% |
| MnB | Metea loamy sand, 2 to 6 percent slopes | 0.6 | 0.1% |
| MoB | Miami loam, 2 to 6 percent slopes | 12.5 | 2.0% |
| MvB | Morley silt loam, 2 to 6 percent slopes | 48.0 | 7.7% |
| MvC | Morley silt loam, 6 to 12 percent slopes | 16.8 | 2.7% |
| SdB | Selfridge loamy sand, 2 to 6 percent slopes | 16.4 | 2.6% |
| Se | Sebewa loam | 10.4 | 1.7% |
| W | Water | 23.0 | 3.7% |
| **Totals for Area of Interest** | | **619.7** | **100.0%** |

## HYDROLOGY

For this report, and for purposes of estimating pipe sizes and costs, the Rational Method has been used to determine peak runoff at various points of concentration in this watershed.

The proposed drainage system is designed for the 10-year flood flows when the drainage area is less than 300 acres in size, and for the 25-year flood flows when the drainage area is greater than 300 acres, but less than 2 square miles in size.

The standard form of the rational formula is:

Qp = ciA | where Qp is the peak flow in cubic feet per second; 'c' is a dimensionless coefficient of runoff determined by surface conditions; 'i' is the rainfall intensity in inches per hour; and 'A' is the watershed area in acres.

For the Rational Method, many factors such as: land usage, land form, land area, impervious surface area, rainfall, soils, slopes and conveyances are taken into account in the determination of the three required factors by using published standards and experienced engineering judgment.

The value for c is generally determined either by weighted averaging for the area under consideration, or by the Engineer's estimation and judgment, or by consulting the Genesee County Drain Commissioner's regulatory chart based upon standard land usage patterns. For this report, both the Engineer's judgment and the Genesee County Drain Commissioner's regulatory chart based upon standard land usage patterns was used to determine 'C'.

The rainfall intensity "i" may be determined from tabulated values, or from I.D.F. (Intensity, Duration, Frequency) curves for Genesee County, or from the following formulas:

i (10-yr) = 166.37 / (tc + 23.305) for 10 year storms, or i (25-yr) = 191.76/(tc + 25.93) for 25 year storms, where 'tc' is the time of concentration in minutes for the drainage basin under consideration. For this report, the formula method was used to calculate the rainfall intensity.

Areas for 'A' were determined by drawing the drainage zone boundaries on the composite drainage area map, and then measuring those areas with computer aided programming.

## ESTIMATED PEAK FLOWS

The mapped drainage areas were analyzed and peak flows were determined using the Rational Method as described above. A runoff coefficient of 0.30 was used for the entire drainage district due to its agricultural and rural large lot residential zoning and land use.

To determine the rainfall intensity, the following information was used:

- Flow lengths were determined from the drainage area maps.
- The types of ground cover in the drainage district were generally determined to be 'Grass Fields, Farm Fields, Lawns, Wooded Areas, and Roadways.'
- Time of Concentration for sheet and waterway flows was determined using engineering judgment and formulas acceptable to the Genesee County Drain Commissioner and Michigan Department of Transportation.
- A minimum initial time of concentration of 30 minutes was selected for this rural drainage basin. Land flow, open channel flow, and/or pipeline transmission times were added to the initial time to determine the downstream time of concentrations for each specific segment of drain.
- The Genesee County Drain Commissioner's Intensity-Duration-Frequency (IDF) chart and formulas was used to determine the rainfall intensity for each drainage area based on the design storm frequency (10 year or 25 year) and the time of concentration.

Ten-year and twenty-five year flood flows were calculated for each map point, based on the area of the drainage basin, utilizing the overall drainage maps which can be found in Exhibit Nos. 4, 7, and 10, and as summarized on the storm sewer design spreadsheets which can be found in Exhibit Nos. 3, 6, and 9 at the back of this report. The estimated ten-year or twenty-five year flood flows are summarized as follows:

#0471 PARKS DRAIN IMPROVEMENTS

| | | Estimated Peak Flows (cfs) | | | |
|---|---|---|---|---|---|
| Location/Point No. | Description | Alt. No. 1 | Alt. No. 2 | Alt. No. 3 | Design Storm |
| 1a-1c Branch No. 1 | 12" Storm Sewer | 3.34 | NA | NA | 10 Year |
| 1b-1c Main Drain | 12" Storm Sewer | 1.95 | NA | NA | 10 Year |
| 1b-1c Main Drain | Open Drain | NA | 1.25 | 1.25 | 10 Year |
| 1c-1d Main Drain | 18"/30" Storm Sewer | 5.07 | NA | NA | 10 Year |
| 1c-1d Main Drain | Open Drain | NA | 3.61 | 3.61 | 10 Year |
| 1d-1e-2b Main Drain | 30" Storm Sewer | 21.32 | NA | NA | 10 Year |
| 1d-1e-2b Main Drain | Open Drain | NA | 21.25 | 21.24 | 10 Year |
| 2a-1e-2b Branch No. 2 | 24"/30" Storm Sewer | 21.85 | 21.85 | 21.85 | 10 Year |
| 1e-2b-4 Main Drain | 36"/42" Storm Sewer | 59.58 | NA | NA | 10 Year |
| 1e-4 Main Drain | Open Drain | NA | 58.11 | 58.08 | 10 Year |
| 4-5a Reid Rd/Main Drain | Ex. 42" Storm Sewer | 78.18 | 74.87 | NA | 10 Year |
| 4b-7b New Main Drain | Open Drain | NA | NA | 87.26 | 25 Year |
| 5a-5b Main Drain | 48" Storm Sewer | 88.85 | 85.13 | NA | 25 Year |
| 5b-6 Main Drain | 48"/54" Storm Sewer | 107.42 | 89.41 | NA | 25 Year |
| 6-8b Main Drain | 48"/54" Storm Sewer | 112.70 | 107.25 | NA | 25 Year |
| 7b-7c Branch No. 3 | 18"/30" Storm Sewer | 6.73 | 18.80 | NA | 10 Year |
| 7b-7c Branch No. 3 | Open Drain | NA | 22.01 | NA | 25 Year |

| | | Estimated Peak Flows (cfs) | | | |
|---|---|---|---|---|---|
| Location/Point No. | Description | Alt. No. 1 | Alt. No. 2 | Alt. No. 3 | Design Storm |
| 7c-7d Branch No. 3/Main Drain | 27”/42” Storm Sewer | 13.69 | NA | 77.40 | 10 Year |
| 7c-7d Branch No. 3/Main Drain | 36”/48”Open Drain | NA | 22.01 | NA | 10 Year |
| 7d-8a Branch No. 3/Main Drain | 30”/48”Storm Sewer | 17.18 | 32.46 | 86.64 | 10 Year |
| 8a-8b Branch No. 3/Main Drain | 30”/48” Storm Sewer | 18.32 | 33.43 | 96.74 | 10 Year |
| 8b-9a Main Drain | 60” Storm Sewer | 172.84 | 127.34 | 163.59 | 25 Year |
| 9a-9b Main Drain | Open Drain | 178.87 | 133.98 | 113.35 | 25 Year |
| 9b-9c Main Drain | 36”/48” Storm Sewer | 190.89 | 144.85 | 126.80 | 25 Year |
| 9c-Crapo Drain-Main Drain | Open Drain | 171.9 | 144.68 | 126.61 | 25 Year |

## HYDRAULICS

To estimate both pipe sizes and slopes, and open channel configurations and slopes for this report, standard formulas approved by the Genesee County Drain Commissioner have been used. [3]

Hydraulic computations for both open channel flow and for enclosed pipe flow have been computed using “Manning’s Equation”, with standard Manning’s friction coefficients specified by the Genesee County Drain Commissioner.

Manning’s Equation is derived from the empirical Chezy-Manning relationship used to study the relationship of channel or pipe velocity to the parameters of slope, and channel bed condition and shape, or pipe type, size and shape. Its general form is:

V = 1.486 x R^(2/3) x S0^(1/2) / n | where ‘V’ is average velocity in feet per second; ‘S0’ is the slope in feet per feet; ‘n’ is the Manning’s dimensionless friction coefficient; 1.486 is a conversion factor to English Customary units; and ‘R’ is the hydraulic radius of the conveyance in feet, determined from its geometry using the following equation:

R = A / P | where ‘A’ is the cross-sectional area of flow in square feet, and ‘P’ is the wetted perimeter in feet.

By substitution of V (average velocity) = Q (discharge) / A (area of cross-section), the equation may be solved for Q and placed in its common form (U.S. customary units) as shown below:

Q = 1.486 x A x R^(2/3) x S0^(1/2) / n

Values for ‘n’ were chosen from the Genesee County Drain Commissioner’s standard tabulated values.

[3] See Exhibit Nos. 3, 6, and 9 - Storm Sewer System Design (spreadsheets)

## ALTERNATIVES, DISCUSSION, AND ESTIMATED COSTS

There are three alternatives that have been developed to establish and provide a new drainage system that would address the drainage problems and issues within the Parks Drain Drainage District. All three alternatives would provide a new drainage system for the Parks Drain and for Branch Nos. 1, 2, and 3 of the Parks Drain to address drainage issues throughout the entire study area. The Parks Drain and all three of its branches are all public County Drains under the jurisdiction of the Genesee County Drain Commissioner. It is our determination that the full length of existing pipe for the main drain and all three branches must be replaced due to its age and poor condition, and also because it is too small. All of these factors contribute to flooding at various places throughout the drainage district. The only exception to the complete removal would be the existing 42" concrete storm sewer under Reid Road, which would remain in place. The existing open drain section of the main drain (lower end) would have to be widened and deepened to provide additional depth and capacity.

Alternative No. 1 would replace the existing drainage system in kind (replace existing pipe with new pipe, and replace existing open drain with new open drain), and place the new drainage system at the same location as the existing system. Alternative No. 2 would replace the existing drainage system with either open drain or pipe based on its location. Pipe would be placed in the vicinity of homes or yards, and open drain would be placed when the drain is further away from developed homes and yards. In addition, the location of the proposed drains for Alternative No. 2 would be moved to a different location than the existing location if it is determined to be more practical and cost effective. Alternative No. 3 would replace the existing drainage system with either open drain or pipe using the same reasoning mentioned in the Alternative No. 2 discussion above. In addition, a significant portion of the drainage area southerly of Reid Road would be re-routed to a new stormwater detention basin located near the northeast quadrant of the drainage area, as part of Alternative No. 3. This alternative was explored to see if stormwater detention could reduce new pipe sizes enough to be more practical and cost effective than the other alternatives.

These three alternatives are discussed in more detail as follows:

**Alternative No. 1**: Replace the existing drainage system in kind (replace existing pipe with new pipe, and replace existing open drain with new open drain), and place the new drainage system at the same location as the existing system. Refer to Exhibit No. 4 for a drainage map that shows the proposed drainage system and drainage areas, and other relevant existing features within the study area. Refer to Exhibit No. 3 for a storm sewer design spreadsheet showing the proposed drainage system design information. Refer to Exhibit No. 4a for the existing pond storage calculations. The current existing drainage system would be replaced with a new drainage system along its entire length, including the Parks Drain main drain and all three of its existing branches. The new main drain would begin as an open drain where the existing main drain outlets into the Crapo Drain, at a point located approximately one half (1/2) mile west of Van Vleet Road, and approximately 1,100 feet north of the CN/GTW Railroad. The main drain then proceeds southerly 1,070 feet along the existing open drain to an existing 36" CSP culvert running under the CN/GTW Railroad and to point 9b. This existing open drain north of point 9b would

be cleaned out and widened to provide the required flow capacity. A new 48" concrete culvert would be bored under the railroad tracks next to the existing 36" culvert. The new 48" culvert, together with the existing 36" culvert, would provide the required capacity. The new main drain would then proceed southeasterly 1,585 feet along the existing open drain to Point 9a, which is located approximately one fourth (1/4) mile west of Van Vleet Road and one-half (1/2) mile north of Reid Road. This existing open drain northwesterly of point 9a would also be cleaned out and widened to provide the required flow capacity. The new main drain would then proceed East 715 feet along the route of the existing 20" tile drain to point 8b. At point 8b, Branch No. 3 intersects the main drain from the east, and the main drain proceeds southeasterly from this point. The existing 20" tile west of point 8b would be removed and replaced with a new 60" concrete pipe storm sewer to provide the required flow capacity. The main drain then continues southeasterly approximately 2,030 feet along the route of the existing 16" tile drain to point 5b and Van Vleet Road, at a point located approximately 750 feet north of Reid Road. The existing 16" tile northwesterly of point 5b would be removed and replaced with a new 48" and 54" concrete pipe storm sewer to provide the required capacity. There is an existing 3 acre +/- pond on the west side of Van Vleet Road located approximately 500 feet northwesterly of point 5b that was apparently dug out by the property owner on the same alignment as the existing 16" tile drain. It appears that the property owner also did some work to re-route the main drain around the pond. For now we have assumed that the new 48" pipe main drain could flow into the south side of the pond, and a new 54" pipe main drain would outlet the upstream drainage area flow on the north side of the pond along with an outlet weir to control the pond level. This plan may not be acceptable to both the Drain Commissioner and/or the property owners, and something different might need to be done as determined during the final design phase. If the pond were to be utilized an easement would have to be obtained for the pond as determined by the Drain Commissioner. It is intended that the Van Vleet Road ditches would be connected into the new 48" pipe storm sewer, and the existing 71" x 47" CSP culvert under Van Vleet Road would be removed. The new main drain would then continue southeasterly 930 feet from point 5b along the route of the existing 16" tile drain to point 4 and Reid Road, at a point located approximately 370 feet east of Van Vleet Road. The existing 16" tile northwesterly of point 4 would be removed and replaced with a new 48" concrete pipe storm sewer to provide the required flow capacity. The existing 42" concrete pipe storm sewer under Reid Road that was constructed with the Reid Road paving project in the year 2002 has adequate flow capacity for proposed conditions and it would remain in place. The Reid Road ditches are already connected into the existing 42" concrete storm sewer under Reid Road. At point 4 on the south side of Reid Road, the new main drain then continues southeasterly 570 feet and south 690 feet from point 4 along the route of the existing 14" tile drain to point 1e, which is located approximately 1,130 feet south of Reid Road and 700 feet east of Van Vleet Road. At point 1e, Branch No. 2 intersects the main drain from the southwest, and the main drain proceeds southeasterly from this point. The existing 14" tile north of point 1e would be removed and replaced with a new 36" and 42" concrete pipe storm sewer to provide the required flow capacity. The new main drain would then continue southeasterly 3,130 feet from point 1e along the route of the existing 10" and 8" tile drain to point 1c, which is located approximately 2,900 feet south of Reid Road and 3,020 feet east of Van Vleet Road. At point 1c, Branch No. 1 intersects the main

drain from the northeast, and the main drain continues easterly from this point. The existing 8” and 10” tile northwesterly of point 1c would be removed and replaced with a new 18” and 30” concrete pipe storm sewer to provide the required flow capacity. The new main drain would then continue Easterly 280 feet from point 1c along the route of the existing 8” tile drain to point 1b and the upper terminus of the main drain of the Parks Drain. The existing 8” tile westerly of point 1b would be removed and replaced with a new 12” concrete pipe storm sewer to provide the required capacity.

At point 1c, Branch No. 1 of the Parks Drain would proceed Northerly 290 feet along the route of the existing 6” tile drain to point 1a and the upper terminus of Branch No. 1. The existing 6” tile would be removed and replaced with a new 12” concrete pipe storm sewer to provide the required capacity. At point 1e, Branch No. 2 of the Parks Drain would proceed Southwesterly 1,605 feet along the route of the existing 8” tile drain to point 2a and the upper terminus of Branch No. 2, at a point on the east side of Van Vleet Road which is approximately 2,500 feet south of Reid Road. The existing 8” tile northwesterly of point 2a would be removed and replaced with a new 24” and 30” concrete pipe storm sewer to provide the required capacity. The Van Vleet Road ditches would drain into the new 24” storm sewer. An existing 24” CSP culvert under Van Vleet Road would transport the ditch flow from the west side of the road to the east side. At point 8b, Branch No. 3 of the Parks Drain would proceed East 1,970 feet along the route of the existing 10” tile drain and across Van Vleet Road to point 7b and the upper terminus of Branch No. 3, at a point located approximately 1,320 feet east of Van Vleet Road. The existing 10” tile drain west of the point 7b would be removed and replaced with a new 18”, 27”, and 30” concrete pipe storm sewer to provide the required capacity. The upper end of Branch No. 3 would be the outlet for the existing 11.5 acre +/- pond and the upstream drainage area. The existing pond is located approximately 1,100 feet east of Van Vleet Road and approximately 2,000 feet north of Reid Road. A weir along with adding approximately 1,800 lineal feet of berm to elevation 783.0+/- would be constructed on the north side of the pond to provide stormwater detention and to control the water level outflow into the Branch No. 3 drain. This detention would also reduce the outlet pipe size (Branch No. 3), and reduce the cost. An easement would be required to complete this berm construction, and also to use the existing pond for stormwater detention as determined by the Drain Commissioner. The Van Vleet Road ditches would drain into the new 30” storm sewer on both sides of the road.

At point 7a there is an existing low point on Reid Road. A significant portion of the drainage area outside of the road right-of-way flows to this low point. The existing low point currently flows to the north across private land without any existing easements to the existing pond at the upstream end of Branch No. 3. It was determined by the Drain Commissioner’s Office that this existing condition would be left in place as is with no changes.

It is proposed that the new open drain and storm sewer pipe will be constructed within the existing 100 foot easement for open drain, existing 50 foot easement for storm sewer pipe, and within the existing road right-of-way when the proposed drain crosses or parallels the existing road right-of-way. A new easement would be required for the existing pond on the west side of Van Vleet Road where the proposed drainage flows into and out from the existing pond, if the condition is left in

place. In addition a new easement would also be required to utilize the existing pond at the northeast corner of the drainage district at the upper terminus of Branch No. 3.

The estimated cost of Alternative No. 1, not including any cost for land or right-of-way is summarized as follows:

**Alternative No. 1**

| | | | |
|---|---|---|---|
| 1) | Estimated Construction Cost | = | $1,166,890.00 |
| 2) | Estimated Cost for Design Contingencies | = | $58,345.00 |
| 3) | Estimated Cost for Construction Contingencies | = | $122,524.00 |
| 4) | Estimated Cost for Design and Construction Engineering | = | $282,241.00 |
| | **Total Estimated Cost** | **=** | **$1,630,000.00** |

See Exhibit No. 2 for the detailed Engineer's Opinion of Costs for Alternative No. 1.

**Alternative No. 2**: Replace the existing drainage system with either open drain or pipe based on its location. Pipe would be placed in the vicinity of homes or yards, and open drain would be placed when the drain is further away from developed homes and yards. In addition, the location of the proposed drains would be moved to a different location than the existing location if it is determined to be more practical and cost effective.

Refer to Exhibit No. 7 for a drainage map that shows the proposed drainage system and drainage areas, and other relevant existing features within the study area. Refer to Exhibit No. 6 for a storm sewer design spreadsheet showing the proposed drainage system design information. The current existing drainage system would be replaced with a new drainage system along its entire length, including the Parks Drain main drain and all three of its existing branches. The new main drain would begin as an open drain where the existing main drain outlets into the Crapo Drain, at a point located approximately one half (1/2) mile west of Van Vleet Road, and approximately 1,100 feet north of the CN/GTW Railroad. The main drain would then proceed southerly 1,070 feet along the existing open drain to an existing 36" CSP culvert running under the CN/GTW Railroad and to point 9b. This existing open drain north of point 9b would be cleaned out and widened to provide the required flow capacity. A new 48" concrete culvert would be bored under the railroad tracks next to the existing 36" culvert. The new 48" culvert, together with the existing 36" culvert, would provide the required capacity. The new main drain would then proceed southeasterly 1,585 feet along the existing open drain to Point 9a, which is located approximately one fourth (1/4) mile west of Van Vleet Road and one-half (1/2) mile north of Reid Road. This existing open drain northwesterly of point 9a would also be cleaned out and widened to provide the required flow capacity. The new main drain would then proceed East 715 feet along the route of the existing 20" tile drain to point 8b. At point 8b, Branch No. 3 intersects the main drain from the

east, and the main drain proceeds southeasterly from this point. The existing 20" tile west of point 8b would be removed and replaced with 615 feet of new open drain and 100 feet of 60" concrete pipe storm sewer (instead of the entire length being 60" pipe) to provide the required flow capacity. The main drain then continues southeasterly 1,035 feet along the route of the existing 16" tile drain to a point located 430 feet west of Van Vleet Road and 1,640 feet north of Reid Road. The existing 16" tile northwesterly of this point would be removed and replaced with a new 48" and 54" concrete pipe storm sewer to provide the required flow capacity. There is an existing 3 acre +/- pond on the west side of Van Vleet Road located approximately 1,400 feet north of Reid Road that was apparently dug out by the property owner on the same alignment as the existing 16" main drain tile drain. It appears that the property owner also did some work to re-route the main drain around the pond. At this time for this alternative we have assumed that the new main drain will have to flow around the existing 3 acre +/- pond. The main drain would continue East 430 feet to Van Vleet Road and south 890 feet along Van Vleet Road to point 5b in order to route the new main drain around the pond. This plan may not be acceptable to both the Drain Commissioner and/or the property owners, and something different might need to be done as determined during the final design phase. It is intended that the Van Vleet Road ditches would be connected into the new 48" pipe storm sewer at point 5b, and the existing 71" x 47" CSP culvert under Van Vleet Road would be removed. The new main drain would then continue southeasterly 930 feet from point 5b along the route of the existing 16" tile drain to point 5a and the north side of Reid Road, at a point located approximately 370 feet east of Van Vleet Road. The existing 16" tile northwesterly of point 5a would be removed and replaced with a new 48" concrete pipe storm sewer to provide the required flow capacity. The existing 42" concrete pipe storm sewer under Reid Road that was constructed with the Reid Road paving project in the year 2002 has adequate flow capacity for proposed conditions and it would remain in place. The Reid Road ditches are already connected into the existing 42" concrete storm sewer under Reid Road. At point 4 on the south side of Reid Road, the new main drain then would continue southeasterly 570 feet and south 690 feet from point 4 along the route of the existing 14" tile drain to point 1e, which is located approximately 1,130 feet south of Reid Road and 700 feet east of Van Vleet Road. At point 1e, Branch No. 2 intersects the main drain from the southwest, and the main drain proceeds southeasterly from this point. The existing 14" tile north of point 1e would be removed and replaced with a new open drain (instead of 36" and 42" concrete pipe storm sewer) to provide the required flow capacity. The new main drain would then continue East 660 feet and South 370 feet along property lines, Southeasterly 730 feet along the route of the existing 8" tile drain, and South 710 feet and East 1,200 feet along property lines to point 1a and the proposed upper terminus of the main drain for Alternative No. 2, at a point which is located approximately 2,640 feet south of Reid Road and 3,100 feet east of Van Vleet Road. At point 1a, Branch No. 1 would intersect the main drain from the southwest. The existing 8" and 10" tile westerly of point 1a would be removed or abandoned (if the existing tile is at a different location than the proposed open drain), and replaced with a new open drain (instead of 18" and 30" concrete pipe storm sewer) to provide the required flow capacity.

At point 1a, the proposed new Branch No. 1 of the Parks Drain would proceed Southwesterly 300 feet along the route of the existing 6" tile drain to point 1c and the proposed upper terminus of Branch No. 1. The existing 6" tile would be removed and replaced with a new open drain (instead of 12" concrete pipe storm sewer) to provide the required capacity. At point 1e, Branch No. 2 of the Parks Drain would proceed Southwesterly 1,605 feet along the route of the existing 8" tile drain to point 2a and the upper terminus of Branch No. 2, at a point on the east side of Van Vleet Road which is approximately 2,500 feet south of Reid Road. The existing 8" tile northwesterly of point 2a would be removed and replaced with a new 24" and 30" concrete pipe storm sewer to provide the required flow capacity. The Van Vleet Road ditches would drain into the new 24" storm sewer. An existing 24" CSP culvert under Van Vleet Road would transport the ditch flow from the west side of the road to the east side. At point 8b, Branch No. 3 of the Parks Drain would proceed East 1,995 feet along the route of the existing 10" tile drain and across Van Vleet Road to point 7b and the upper terminus of Branch No. 3, at a point located approximately 1,320 feet east of Van Vleet Road. The existing 10" tile drain west of the point 7b would be removed and replaced with 1,100 feet of new open drain and 895 feet of new 30" and 36" concrete pipe storm sewer to provide the required capacity. The upper end of Branch No. 3 would be the outlet for the existing 11.5 acre +/- pond and the upstream drainage area. The existing pond is located approximately 1,100 feet east of Van Vleet Road and approximately 2,000 feet north of Reid Road. A weir would be constructed on the north side of the pond to control the water level outflow into the Branch No. 3 drain. The Van Vleet Road ditches would drain into the new 36" storm sewer on both sides of the road.

At point 7a there is an existing low point on Reid Road. A significant portion of the drainage area outside of the road right-of-way flows to this low point. The existing low point currently flows to the north across private land without any existing easements to the existing pond at the upstream end of Branch No. 3. It was determined by the Drain Commissioner's Office that this existing condition would be left in place as is with no changes.

It is proposed that the new open drain and storm sewer pipe will be constructed within the existing 100 foot easement for open drain, and existing 50 foot easement for storm sewer pipe when the proposed drain is at the same location as the existing drain, and within the existing road right-of-way when the proposed drain crosses or parallels the existing road right-of-way. Alternative No. 2 would require new drain easements when the proposed drain is at a different location than the existing drain, and when new open drain replaces an existing easement for tile drain (i.e., the existing easement width of 50 feet for tile drain is not wide enough for open drain, and open drain might not be allowed in an existing easement for tile).

The estimated cost of Alternative No. 2, not including any cost for land or right-of-way is as follows:

**Alternative No. 2**

| | | | |
|---|---|---|---|
| 1) | Estimated Construction Cost | = | $935,020.00 |
| 2) | Estimated Cost for Design Contingencies | = | $46,750.00 |
| 3) | Estimated Cost for Construction Contingencies | = | $98,180.00 |
| 4) | Estimated Cost for Design and Construction Engineering | = | $231,050.00 |
| | **Total Estimated Cost** | **=** | **$1,311,000.00** |

See Exhibit No. 5 for the detailed Engineer's Opinion of Costs for Alternative No. 2.

**Alternative No. 3**: Replace the existing drainage system with either open drain or pipe using the same reasoning mentioned in the Alternative No. 2 discussion above. In addition, a significant portion of the drainage area south of Reid Road would be re-routed to a new stormwater detention basin located near the northeast quadrant of the drainage area. This alternative was explored to see if stormwater detention could reduce new pipe sizes enough to be more practical and cost effective than the other alternatives.

Refer to Exhibit No. 10 for a drainage map that shows the proposed drainage system and drainage areas, and other relevant existing features within the study area. Refer to Exhibit No. 9 for a storm sewer design spreadsheet showing the proposed drainage system design information. Refer to Exhibit No. 9a for the stormwater detention basin volume calculations for a 100 year storm event. The current existing drainage system would be replaced with a new drainage system along its entire length, including the Parks Drain main drain and all three of its existing branches. The new main drain would begin as an open drain where the existing main drain outlets into the Crapo Drain, at a point located approximately one half (1/2) mile west of Van Vleet Road, and approximately 1,100 feet north of the CN/GTW Railroad. The main drain would then proceed southerly 1,070 feet along the existing open drain to an existing 36" CSP culvert running under the CN/GTW Railroad and to point 9b. This existing open drain north of point 9b would be cleaned out and widened to provide the required flow capacity. A new 48" concrete culvert would be bored under the railroad tracks next to the existing 36" culvert. The new 48" culvert, together with the existing 36" culvert, would provide the required capacity. The new main drain would then proceed southeasterly 1,585 feet along the existing open drain to Point 9a, which is located approximately one fourth (1/4) mile west of Van Vleet Road and one-half (1/2) mile north of Reid Road. This existing open drain northwesterly of point 9a would also be cleaned out and widened to provide the required flow capacity. The new main drain would then proceed East 715 feet along the route of the existing 20" tile drain to point 8b. At point 8b, the existing Branch No. 3 intersects the main drain from the east, and the existing main drain proceeds southeasterly from this point. The existing 20" tile west of point 8b would be removed and replaced with 615 feet of new open drain and 100 feet of 60"

concrete pipe storm sewer (instead of the entire length being 60” pipe) to provide the required flow capacity.

It is assumed that the existing main drain to the southeast would become a branch with Alternative No. 3 because a major portion of the drainage district (south of Reid Road) will be re-routed to Branch No. 3 from the proposed detention basin located in the Northeast quadrant of the drainage district. As a result, it is assumed that the existing Branch No. 3 will become the main drain with Alternative No. 3.

The existing main drain (assumed to become a branch drain) would then continue southeasterly from point 8b approximately 2,030 feet along the route of the existing 16” tile drain to point 5b and Van Vleet Road, at a point located approximately 750 feet north of Reid Road. The existing 16” tile northwesterly of point 5b would be removed and replaced with a new 36” concrete pipe storm sewer to provide the required capacity. There is an existing 3 acre +/- pond on the west side of Van Vleet Road located approximately 500 feet northwesterly of point 5b that was apparently dug out by the property owner on the same alignment as the existing 16” tile drain. It appears that the property owner also did some work to re-route the main drain around the pond. For now we have assumed that the new 36” pipe drain could flow into the south side of the pond, and a new 36” pipe drain would outlet the upstream drainage area flow on the north side of the pond along with an outlet weir to control the pond level. This plan may not be acceptable to both the Drain Commissioner and/or the property owners, and something different might need to be done as determined during the final design phase. It is intended that the Van Vleet Road ditches would be connected into the new 36” pipe storm sewer, and the existing 71” x 47” CSP culvert under Van Vleet Road would be removed. The new drain would then continue southeasterly 930 feet from point 5b along the route of the existing 16” tile drain to point 5a and Reid Road, at a point located approximately 370 feet east of Van Vleet Road. The existing 16” tile northwesterly of point 5a would be removed and replaced with a new 30” concrete pipe storm sewer to provide the required flow capacity. The existing 42” concrete pipe storm sewer under Reid Road that was constructed with the Reid Road paving project in the year 2002 has adequate flow capacity for proposed conditions and it would remain in place. The Reid Road ditches are already connected into the existing 42” concrete storm sewer under Reid Road. At point 4c the existing main drain continues southeasterly approximately 450 feet to the proposed upper terminus of the existing main drain (assumed to become a branch drain). This low area southeasterly of Reid Road will continue to flow into the existing 42” storm sewer under Reid Road. The remainder of the majority of the drainage area south of Reid Road will be re-routed to the proposed detention basin through a new relocated main drain as described below.

It is assumed that the relocated new main drain will run east from point 8b along the existing route of Branch No. 3. At point 8b the new main drain would then continue East 1,395 feet along the route of the existing 10” tile drain and across Van Vleet Road to point 7c and the proposed detention basin at a point located approximately 735 feet east of Van Vleet Road. The existing 10” tile drain west of point 7c would be removed and replaced with 1,395 feet of 42” and 48” concrete pipe storm sewer to provide the required outlet flow capacity from the proposed detention basin. A weir would be constructed on the west side of the proposed detention basin to

control the water level outflow into the proposed 42” outlet drain. The Van Vleet Road ditches would drain into the new 48” storm sewer on both sides of the road.

The proposed detention basin would have a surface area of approximately six (6) acres and a storage volume of approximately 871,000 cubic feet. The total site area for the proposed detention basin is estimated to be approximately seven (7) acres. The required storage volume for a 100 year storm event is approximately 911,000 cubic feet. It is proposed that the required remaining storage volume of at least 40,000 cubic feet will be obtained in the existing 11.5 acre +/- pond located immediately to the south of the proposed detention basin. It is estimated that the total available storage volume between the proposed basin and the existing pond will be in excess of 1,000,000 cubic feet, which is greater than the required minimum storage volume of 911,000 cubic feet.

The 7 acres of land required for the proposed detention basin will have to be acquired or donated by the land owner. The existing 11.5 acre +/- pond would be connected into the proposed detention basin at the southeast corner of the proposed basin (point 7b). An outlet weir will be required to control the pond water level and the outflow from the pond into the basin. An easement would also be required thru the existing pond as required to obtain the proposed storage volume of 130,000 cubic feet, and to connect the pond inlet at the southwest corner of the pond to the pond outlet at the northeast corner of the pond.

The proposed main drain would then proceed southerly 1,550 feet from the southwest corner of the existing pond to the north side of Reid Road and point 4b. The proposed drain between the north side of Reid Road and the existing pond would consist of 350 feet of new open drain and 1,200 feet of new 42” concrete pipe storm sewer to provide the required capacity. At point 4b the new main drain would proceed South 50 feet across Reid Road as a new 36” concrete pipe storm sewer. The new main drain would then continue South 1,305 feet as a new open drain to point 1e which is located approximately 1,130 feet south of Reid Road and 700 feet east of Van Vleet Road.

At point 1e, Branch No. 2 intersects the new main drain from the southwest, and the main drain proceeds southeasterly from this point. The new main drain would then continue East 660 feet and South 370 feet along property lines, Southeasterly 730 feet along the route of the existing 8” tile drain, and South 710 feet and East 1,200 feet along property lines to point 1a and the proposed upper terminus of the main drain for Alternative No. 3, at a point which is located approximately 2,640 feet south of Reid Road and 3,100 feet east of Van Vleet Road. At point 1a, Branch No. 1 would intersect the main drain from the southwest. The existing 8” and 10” tile westerly of point 1a would be removed or abandoned (if the existing tile is at a different location than the proposed open drain), and replaced with a new open drain (instead of 18” and 30” concrete pipe storm sewer) to provide the required flow capacity.

At point 1a, the proposed new Branch No. 1 of the Parks Drain would proceed Southwesterly 300 feet along the route of the existing 6" tile drain to point 1c and the proposed upper terminus of Branch No. 1. The existing 6" tile would be removed and replaced with a new open drain (instead of 12" concrete pipe storm sewer) to provide the required capacity. At point 1e, Branch No. 2 of the Parks Drain would proceed Southwesterly 1,605 feet along the route of the existing 8" tile drain to point 2a and the upper terminus of Branch No. 2, at a point on the east side of Van Vleet Road which is approximately 2,500 feet south of Reid Road. The existing 8" tile northwesterly of point 2a would be removed and replaced with a new 24" and 30" concrete pipe storm sewer to provide the required flow capacity. The Van Vleet Road ditches would drain into the new 24" storm sewer. An existing 24" CSP culvert under Van Vleet Road would transport the ditch flow from the west side of the road to the east side.

At point 7a there is an existing low point on Reid Road. A significant portion of the drainage area outside of the road right-of-way flows to this low point. The existing low point currently flows to the north across private land without any existing easements to the existing pond at the upstream end of Branch No. 3. It was determined by the Drain Commissioner's Office that this existing condition would be left in place as is with no changes.

It is proposed that the new open drain and storm sewer pipe will be constructed within the existing 100 foot easement for open drain, and existing 50 foot easement for storm sewer pipe when the proposed drain is at the same location as the existing drain, and within the existing road right-of-way when the proposed drain crosses or parallels the existing road right-of-way. Alternative No. 3 would require new drain easements when the proposed drain is at a different location than the existing drain, and when new open drain replaces an existing easement for tile drain (i.e., the existing easement width of 50 feet for tile drain is not wide enough for open drain, and open drain might not be allowed in an existing easement for tile). In addition, an easement and/or land acquisition will be required for the proposed stormwater detention basin and for use of the existing 11.5 acre +/- pond south of the new basin.

The estimated cost of Alternative No. 3, not including any cost for land or right-of-way is summarized as follows:

**Alternative No. 3**

| | | | |
|---|---|---|---|
| 1) | Estimated Construction Cost | = | $1,134,540.00 |
| 2) | Estimated Cost for Design Contingencies | = | $56,730.00 |
| 3) | Estimated Cost for Construction Contingencies | = | $119,130.00 |
| 4) | Estimated Cost for Design and Construction Engineering | = | $274,600.00 |
| | **Total Estimated Cost** | **=** | **$1,585,000.00** |

See Exhibit No. 8 for the detailed Engineer's Opinion of Costs for Alternative No. 3.

## CONCLUSIONS AND RECOMMENDATION

Alternative No. 1 would basically replace the existing drain in kind (i.e., replace existing pipe with new larger pipe, and replace the existing open drain with a new widened and deepened open drain). In addition, the proposed drain would be located at the same basic location as the existing drain. The majority of the existing Parks Drain and its Branches are currently tile (pipe) drains. The cost of pipe is significantly higher than the cost of open drain. Due to these factors, Alternative No. 1 is the most costly of the three alternatives. The existing county drain easements would be re-used with Alternative No. 1, and we do not anticipate a significant amount of any additional right-of-way being required, if any. The total estimated cost of Alternative No. 1 is $1,630,000.00, not including any cost for land or right-of-way acquisition.

Alternative No. 2 was developed in an attempt to reduce the cost of the proposed drainage system. In order to attain this objective, we replaced the existing tile drain with open drain instead of pipe wherever possible. The existing open drain sections were left in place, and they were widened and deepened in order to provide the required flow capacity. Existing tile drains were replaced with new storm sewer pipe in the vicinity of homes and yards. Existing tile drains further away from developed homes and yards were replaced with new open drain with the proper depth and width to provide the required flow capacity. This action resulted in a lower cost for the entire proposed drainage system, since the cost of open drain is significantly less than the cost of pipe. In addition to changing sections of the drain from tile to open drain, we have also relocated the new drain where it was practical and cost effective to do so. The relocated sections of drain and the sections that were changed from tile to open drain are based on the judgment of the Engineer. These decisions are subject to change after input is received through the review process from the Drain Commissioner's Office and/or the residents within the drainage district. The existing easements will be re-used when possible, however, it is anticipated that a significant number of easements will be required for Alternative No. 2, because of the drain relocations and the proposed replacement of tile drain with open drain. The total estimated cost of Alternative No. 2 is $1,311,000.00, not including the cost of any land or right-of-way acquisition.

Alternative No. 3 would replace the existing drainage system with either open drain or pipe using the same strategy and reasoning mentioned for Alternative No. 2. In addition, a significant portion of the drainage area south of Reid Road would be relocated to a proposed stormwater detention basin located at the northeast corner of the drainage district. A new main drain outlet would be required north of Reid Road to re-route the drainage area south of Reid Road to the proposed basin. The proposed basin would reduce the size of the original main drain, however, the cost of the new basin and inlet drain into the basin more or less offsets the cost savings associated with the reduction in pipe sizes. Also, a significant amount of right-of-way would be required for Alternative No. 3. The right-of-way required for the pipe and open drain is similar to what is required for Alternative No. 2. In addition, a significant amount of right-of-way will be required for the proposed detention basin. The total estimated cost of Alternative No. 3 is $1,585,000.00 which is almost as costly as Alternative No.1 ($1,630,000.00).

The least costly alternative is Alternative No. 2 at a total estimated cost of $1,311,000.00. It is the recommendation of the Engineer that Alternative No. 2 be constructed to alleviate the drainage problems and issues within the Parks Drain drainage district. Alternative No. 2 is the least costly and most cost effective alternative, and the most practical in terms of replacing existing tile drains with open drain whenever possible.