Hydrogeologic Investigation Report

Parchment, Michigan

TETRA TECH

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PRESENTED BY

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
%R	Percent Recovery
Addendum	Hydrogeologic Investigation Work Plan Addendum, Tetra Tech, January 3, 2019
amsl	Above Mean Sea Level
bgs	Below Ground Surface
CORS	Continuously Operating Reference Station
COC	Constituents of Concern
CSM	Conceptual Site Model
DO	Dissolved Oxygen
EGLE	Michigan Department of Environment, Great Lakes and Energy
EPA	United States Environmental Protection Agency
FEP	Fluorinated Ethylene Propylene
GP	Georgia-Pacific LLC
gpd/ft	Gallons per Day per Foot
GDW	Groundwater to Drinking Water
GSI	Groundwater to Surface Water Interface
HDPE	High Density Polyethylene
IDW	Investigation Derived Waste
Investigation	Hydrogeological Investigation
KVG	Kalamazoo Valley Group
LCS	Laboratory Control Sample
LLC	Limited Liability Corporation
e.g.	Exempli Gratia (for example)
FEP	Fluorinated Ethylene Propylene
GPS	Global Positioning System
Landfills Area	Landfills associated with the former Crown Vantage operations
mg/L	Milligrams per Liter
MDOT	Michigan Department of Transportation
Mill 2	Former Crown Vantage Paper Mill
MS/MSD	Matrix Spike and Matrix Spike Duplicate
mV	Millivolt
NAD	North American Datum
NAVD	North American Vertical Datum
ng/L	Nanogram Per Liter

Acronyms/Abbreviations	Definition
ORP	Oxidation-Reduction Potential
Part 201	Part 201 of the Natural Resources and Environment Protection Act, PA 451, as amended
PCB	Polychlorinated Biphenyl
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances

EXECUTIVE SUMMARY

This report documents a Hydrogeologic Investigation (Investigation) in and near the City of Parchment, Michigan, where the presence of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in groundwater led to the shutdown of a municipal water supply well field in July 2018. The Investigation was completed in accordance with the Michigan Department of Environment, Great Lakes, and Energy (EGLE) approved *Hydrogeologic Investigation Work Plan* dated October 19, 2018 (Work Plan) and *Hydrogeological Investigation Work Plan Addendum* (Addendum), dated January 3, 2019. The Work Plan and Addendum were developed by Tetra Tech on behalf of Georgia-Pacific LLC (GP). The area of Investigation includes portions of Cooper Township, Kalamazoo Township, the City of Kalamazoo, and the City of Parchment (Study Area). The Study Area lies immediately east of the Kalamazoo River. A location map depicting the Study Area is presented as **Figure 1**.

PFAS were detected in groundwater samples collected from the City of Parchment municipal wells, select residential wells, and monitoring wells associated with a former Crown Vantage paper mill. These impacts were identified during sampling events that were completed by EGLE and their contractors from June 2018 through September 2018. The sampling was completed as part of the State of Michigan's proactive statewide testing of drinking water, groundwater, lakes and streams, soils, sediments, and wastewater.

In response to the sampling results, GP retained Tetra Tech to complete a Hydrogeological Investigation (Investigation) to characterize the groundwater flow system in the Study Area and to delineate the extent of PFAS, specifically Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS), impacts in groundwater above Groundwater Residential Generic Cleanup Criteria established in Part 201 of the Natural Resources and Environment Protection Act, PA 451, as amended (Part 201). The Investigation was completed between November 2018 and March 2019. The tasks completed of as part of the Investigation included:

- Installation of twenty-nine monitoring wells at twenty-one locations.
- Minimal drawdown (low-flow) groundwater sampling of the new monitoring wells for PFAS.
- Surface water sampling at ten locations within the Study Area for PFAS.
- Collection of Quality Assurance/Quality Control (QA/QC) samples to monitor for sample integrity.

- Static water level gauging at the new monitoring wells in addition to wells previously installed at the former Crown Vantage Paper Mill (Mill 2) and at Landfills associated with the Former Crown Vantage operations (Landfills Area).
- Establishment of vertical and horizontal locations by survey of the monitoring wells installed as part of this Investigation, as well as, the Mill 2 and Landfills Area monitoring wells.

As a result of this work, PFOA and PFOS impacts in groundwater have been delineated to the Groundwater Residential Generic Cleanup Criteria for the Groundwater to Drinking Water Criteria (GDW Criteria) of 70 Nanograms per Liter (ng/L). The vertical extent of impact above Part 201 GDW Criteria is limited to the uppermost unconfined aquifer except at the former Parchment well field where impacts extend downward to a semi-confined aquifer that is beneath a clay layer (aquitard).

Facilities associated with the former Crown Vantage paper plant appear to be a source of PFAS compounds in groundwater. There appears to be other PFAS source(s) east of the former City of Parchment municipal well field.

1.0 INTRODUCTION

In the summer of 2018, EGLE collected groundwater samples from the City of Parchment municipal wells for laboratory analysis of PFAS. The analytical results of the municipal well sampling, identified concentrations of PFOA and PFOS in the groundwater greater than GDW Criteria established in Part 201. Subsequently, EGLE collected groundwater samples from monitoring wells located at Mill 2 and the Landfills Area, as well as select residential wells within and near the service area of the City of Parchment water distribution system. The analytical results identified PFOA plus PFOS concentrations in the groundwater at some locations greater than Part 201 GDW Criteria. EGLE groundwater sample locations and results are depicted in **Figure 2**. The information obtained from EGLE and evaluated as part of the Investigation, is included in **Appendix A**.

On behalf of GP, Tetra Tech developed a Work Plan and Addendum to characterize the groundwater flow system and determine the nature and extent of PFAS within the Study Area. The Work Plan and Addendum, which were developed in concert with, and approved by EGLE, outlines the scope and methods that were followed during the hydrogeologic Investigation. This report documents the results of the Investigation.

1.1 REPORT ORGANIZATION

This report is organized as follows:

- **Section 1.0 Introduction**: This section provides a description of the Study Area, the objectives and scope of the Investigation and an overview of the methods used to conduct the Investigation.
- **Section 2.0 Methodologies:** This section describes monitoring well siting, access, installation, and construction. Decontamination procedures and Investigation Derived Waste (IDW) management are also covered. Groundwater and surface water sampling is described including static water level measurement, sample collection procedures, and laboratory analysis methods.
- **Section 3.0 Results**: This section presents the analytical results of the surface water and groundwater sampling, data validation results, IDW sampling results and Conceptual Site Model (CSM). The CSM includes regional and local geologic and hydrogeologic information specific to the Study Area. Geologic cross-sections are discussed and local

vertical and horizontal groundwater flow directions are presented. The nature and extent of the Constituents of Concern (COCs) are provided.

- **Section 4.0. References**: This section presents a list of references used in the preparation of this report.

1.2 STUDY AREA DESCRIPTION

The Study Area (**Figures 1 and 2**) covers portions of Cooper Township, Kalamazoo Township, the City of Kalamazoo and the City of Parchment. The Study Area is immediately east of the Kalamazoo River. Residential, commercial and industrial properties are present within this area, as are former Mill and associated Landfills Area. The Landfills area is comprised of closed Type II and Type III landfills. A Type II landfill, or municipal landfill, can accept virtually any non-hazardous solid waste for disposal. A Type III landfill can be a construction and demolition landfill or a special use landfill for a particular waste. The topography of the Study Area includes approximately 100 feet of relief, from approximately 750 feet Above Mean Sea Level (amsl) at the Kalamazoo River to 852 feet on the escarpment along the eastern extent of the Kalamazoo River valley.

1.3 INVESTIGATION OBJECTIVES

The Investigation of the Study Area was completed to evaluate the groundwater flow system and to determine the nature and extent of PFAS that were detected during the sampling events conducted by EGLE in the summer of 2018. Locations of drinking water and groundwater samples tested for PFAS during EGLE sampling events, are presented in **Figure 2** and are color coded based on the measured concentration of PFOA plus PFOS. PFOA and PFOS, are the two PFAS that are regulated by EGLE. The United States Environmental Protection Agency (EPA) has established drinking water health advisory concentration of 70 ng/L for PFOA and PFOS. EGLE has adopted this 70 ng/L in the Part 201 GDW Criteria applicable to groundwater. The Part 201 GDW Criteria are published in Table 1 – Groundwater: Residential and Nonresidential Part 201 Generic Cleanup Criteria and Screening Levels, dated January 10, 2018 and updated June 25, 2018.

The Investigation was completed in two phases. Phase I began on November 12, 2018 and Phase II began on January 7, 2019. The scopes of work for Phase I and Phase II were developed in concert with EGLE and focused on:

- Groundwater quality evaluation of priority areas identified by EGLE. During Phase I, these priority areas were the northern and eastern extents of the PFAS impacts. The southern extent of PFAS impacts was determined during Phase II.
- The evaluation of the depths of the impacts where relatively higher concentrations of PFAS were detected and where well depths at the MDEQ sample collection points (e.g. private wells) were unknown.
- The definition of hydraulic gradients and groundwater flow directions within the Study Area. Nested wells (wells that are installed in the same location but have wells screens at different depths) were used to calculate gradients between multiple aquifers that are present in the Study Area.
- The evaluation of surface water bodies within the Study Area for PFAS.

Based on input from EGLE, the western extent of PFAS impact is the Kalamazoo River as demonstrated by nondetect results in groundwater samples collected by EGLE in 2018 from wells located west of the Kalamazoo River.

The data collected during the Investigation were used to help determine the extent and nature of PFAS impacts within the Study Area, in addition to potential origins and transport pathways of PFAS within the Study Area.

1.4 INVESTIGATION METHODOLOGY OVERVIEW

The field work preparation and field activities completed as part of the Investigation included the following:

- Contracting with a laboratory that could analyze groundwater and surface water samples for EGLE's PFAS Minimum Laboratory Analyte List of compounds using a Modified EPA Method 537.
- Identifying viable well installation locations by performing site reconnaissance to assess the feasibility of the locations proposed in the Work Plan and Addendum.
- Obtaining site access agreements to work on both public and private properties.
- Clearing the drilling locations of utilities by public and private utility locating services.
- Collection of continuous soil cores to a maximum depth of 156 feet for geologic logging.
- Installation and development of monitoring wells.

- Measurement of groundwater levels from the new monitoring wells and from monitoring wells previously installed at Mill 2 and the Landfills Area.
- Collection of groundwater samples using minimal drawdown (low-flow) techniques from the new monitoring wells for PFAS analysis.
- Collection of surface water samples for PFAS analysis.
- Handling and sampling IDW in accordance with local, state and federal regulations.
- Surveying the horizontal and vertical location of monitoring wells installed as part of the Investigation and of existing monitoring wells located at Mill 2 and the Landfills Area.

As part of the Phase I Investigation, fifteen monitoring wells, which includes three nested sets (wells that are installed in the same location but have wells screens at different depths), were installed and developed at ten locations and surface water samples were collected at nine locations. During Phase II, fourteen monitoring wells, which includes two nested sets, were installed at eleven locations and one surface water sample was collected.

2.0 METHODOLOGIES

The following sections describe the methods employed for monitoring well installation and sampling of groundwater and surface water. These methods were described in the Work Plan, Addendum, and standard operating procedures included in the Work Plan.

2.1 SITE ACCESS

Soil borings and monitoring wells were installed within public road Rights of Way (ROWs) and on private properties. Monitoring well locations are presented in **Figure 3**. Prior to working in a ROW, permit applications were submitted. ROW access permits were granted by the Kalamazoo County Road Commission for thirteen locations and by the City of Kalamazoo for one location. The remaining monitoring wells were installed on properties owned by public and private entities. Prior to working on private property, access agreements outlining the terms and conditions of access were signed by the property owner.

2.2 SOIL BORING COMPLETION

Prior to drilling, several precautions were taken to avoid coming into contact with buried utilities. Utility locating was completed by utilizing Michigan Utility Notification Center and a private utility locating service. If buried utilities were identified in a proposed location, an alternative location was chosen and cleared for buried utilities. After a location was cleared by a public and private utility locator, air excavation techniques were used to complete the first 5 to 7 feet of the boring. After the air excavation was completed, soil borings were completed using sonic drilling methods, with the exception of two locations (MW1911A and MW1912A) at which direct push methods were used because the sonic drill rig could not access the locations due to site conditions (ice, snow and saturated ground). Buried utilities were not encountered in any of the locations drilled.

During sonic drilling, a 6-inch core barrel assembly was advanced into the subsurface to obtain continuous soil cores. For the shallow soil borings, the boring was advanced into the first encountered water bearing formation until an underlying clay layer, greater than 1.5 feet in thickness (upper clay) was identified. For soil borings advanced for the nested wells, a temporary, 8-inch surficial casing was installed into the upper clay, prior to advancing tooling further, to prevent vertical migration of groundwater between water bearing units. Soil cores were recovered within plastic sleeves and brought to the surface. The plastic sleeves were placed on a table and cut open to access the recovered soil core. The soil cores were photographed and logged by the

onsite Tetra Tech geologist. Each soil core was described, including sample recovery and lithological description using the Unified Soil Classification System. Moisture content, and other notable observations/information were documented. Photographs were taken of the soil cores in their entirety. This information was used to finalize depths for well installation.

Direct push methods were used for two of the shallow borings, MW1911A and MW1912A, because the locations were inaccessible with the sonic rig at the time they were completed. Continuous soil sampling was completed by direct push techniques with a Geoprobe 6620DT drill rig using 2.25-inch diameter dual tube tooling. Soils recovered by direct push were collected in a 1.75-inch diameter acetate liner. The liners were placed on a table and cut open to access the recovered soil core. The soil cores were photographed and logged as described in the above paragraph.

Soil-boring names were assigned in the format “SBYY##X” where “YY” is the last two numbers of the year the soil boring was completed and “##” is the unique number of the location. The final character “X” in the soil-boring name, was used to distinguish multiple borings at the same location (e.g. for nested wells). The first boring completed at a location ends with “A” and the second boring completed at a location ends with “B”.

In the western portion of the Study Area, within the Kalamazoo River Valley, soil borings were advanced to depths ranging between 15 feet and 96 feet bgs. In the eastern portion of the Study Area, outside of the river valley, soil borings were advanced to depths ranging from 66 feet to 156 feet. Bedrock was not encountered at any of the boring locations. Soil boring logs are provided as **Appendix B**.

2.3 MONITORING WELL INSTALLATION

Monitoring wells were installed in the boreholes discussed in Section 2.2. Special precautions taken to avoid introducing outside sources of PFAS during the well installations included:

- Decontaminating drill rig tooling before and after each use.
- Avoiding equipment constructed of or containing Polytetrafluoroethylene (PTFE, including the DuPont brand name Teflon®) or Fluorinated Ethylene Propylene (FEP).
- Avoiding the use of waterproof field books or paper during sampling activities.
- Avoiding water resistant clothing (e.g., Gore-Tex® or similar material).
- Using rain gear made from polyvinyl chloride, polyurethane or wax-coated materials

The general locations of the monitoring wells were determined in concert with EGLE to delineate the horizontal and vertical extents of the PFAS impacts and to further investigate areas with elevated PFAS concentrations. The final location of each monitoring well was chosen based the feasibility to drill in an area, including drill rig accessibility and the utilities present. The chosen monitoring well depths were based on the review of available well construction data from private wells installed within the Study Area and field observations made during boring installation. **Table 1** provides the planned well installation at each location along with a description of the actual well installation.

At select locations, nested monitoring wells were installed at different depths within the subsurface. to understand vertical distribution of PFAS impacts and vertical hydraulic gradients. Up to two wells were installed in the first boring completed at a location. If a third well was installed at a location, a second boring was completed no less than 5-feet from the first boring.

Monitoring well names were assigned in the format “MWYY##X” where “YY” is the last two numbers of the year the monitoring well was installed and “##” is the unique number of the location. The final character “X’ in the well name, was used to distinguish multiple wells at the same location (e.g. for nested wells). "A" denotes the shallowest, "B" the intermediate, and "C" the deepest well within the nest. An intermediate well was not installed at all well nests because multiple aquifers beneath the upper clay were not always encountered.

Table 2 provides the well descriptions along with each well’s corresponding soil boring name. General well construction diagrams are provided in **Appendix C** and soil boring and monitoring well log are provided in **Appendix B**. Information regarding borehole diameter, well diameter, well material, well-screen length and slot size, and filter-pack description, can be found in these appendices.

2.4 SURVEY

After the monitoring well installations were completed, a survey of the geographic location of each well, including the top of well casing elevation and the adjacent ground elevation was conducted. In addition to surveying the new monitoring wells, a survey of the existing monitoring wells located on the former mill and landfill properties was completed. The horizontal and vertical locations of the monitoring wells were established with a professional survey as follows:

- A Leica Global Positioning System (GPS) receiver was connected to the local Michigan Department of Transportation (MDOT) Continuously Operating Reference Station (CORS) tower to achieve 0.10-foot (or better) accuracy.
- At least two National Geodetic Survey monuments were located and used to verify the datum broadcast from the CORS tower. (Datum is State Plane Coordinates, Michigan South Zone (2113), North American Datum (NAD)83- North American Vertical Datum (NAVD)88, International feet, Geoid 12B).
- Monitoring wells that could not be measured directly by GPS were surveyed with Leica Robotic Total Station from temporary control points established by GPS.
- At each monitoring well, the ground surface, top of well casing/pipe, and top of protective casing was surveyed.

Survey data were used to generate groundwater contour maps and geologic cross sections. Survey data for the all monitoring wells is included in **Table 2**.

2.5 Groundwater Sampling

Groundwater samples were collected from the twenty-nine monitoring wells installed during the Investigation. Surface water samples were collected from ten locations. Low-flow groundwater samples were collected from the Phase I & II monitoring wells in general accordance the Work Plan and using low-flow sampling methods (Barcelona, 1996). At wells where the depth to water was approximately 30-feet or less, groundwater samples were collected using a peristaltic pump with High Density Polyethylene (HDPE) and silicone tubing. At wells where the depth to water was greater than approximately 30-feet, groundwater samples were collected using a Teflon-free submersible stainless-steel pump with HDPE tubing. New tubing was used for each monitoring well to avoid cross-contamination between wells. If practical, the tubing was left in the well for use in future groundwater sampling events.

Prior to sampling, groundwater was purged using low-flow purging techniques. During the purging of each well, water level drawdown, flow rate, and water quality readings were recorded on a groundwater water quality data sheet. Groundwater was pumped through a flow-through cell and water quality parameters of pH, conductivity, temperature, Dissolved Oxygen (DO), Oxidation-Reduction Potential (ORP), and turbidity were measured with a QED MP20DT multi-parameter water quality meter. The instrument was calibrated according to the manufacturer's specifications

prior to sampling. The water quality parameters were collected at 3-minute intervals until all parameters had stabilized for three consecutive readings and were within the following limits:

- Turbidity (10% if greater than 5 Nephelometric Turbidity Units)
- DO (10% for values greater than 2 milligrams per Liter (mg/L); 0.5 mg/L for values less than 2 mg/L)
- Specific conductance (3%)
- Temperature (3%)
- pH (0.1 unit)
- ORP (10 millivolts)

Drawdown was maintained at 0.3 foot or less during purging and sampling. If water quality parameters did stabilize or meet the limits within 1 hour, three well volumes were removed from the well and a groundwater sample was collected. Groundwater monitoring field data are included in **Table 3**.

Groundwater samples were collected in clean, pre-labeled, laboratory supplied HDPE containers. The sample containers were placed in a cooler for shipment to Vista Analytical Laboratory (Vista) where the samples were analyzed for EGLE's PFAS Minimum Laboratory Analyte List of compounds (**Appendix D**) via Modified EPA Method 537. A Level IV data package was ordered for each set of groundwater samples collected. The Level IV data packages were used by Tetra Tech's project chemist to validate the data following US EPA's National Functional Guidelines for Data Review (US EPA, 2017).

Groundwater sample names were assigned in the format "MWYY##X-YYMMDD" where "MWYY##X" corresponds to the well name and "YYMMDD" corresponds to the date that the sample was collected. "YY" is the last two numbers of the year, "MM" is the month and "DD" is the day.

During groundwater monitoring, EGLE was onsite with Tetra Tech personnel. At the time of sample collection by Tetra Tech, EGLE collected split samples for analysis by Test America Laboratories (Test America), except for location MW1915A. EGLE was unable to obtain site access approval from the property owner prior to the scheduled sampling of the well.

2.6 Surface Water Sampling

Surface water samples were collected from ten locations within the Study Area (**Figure 4**). The surface water sample locations were identified by a desktop and onsite review of the Study Area. Surface water sample locations included ponds, municipal drains, creeks and drainage ditches. The locations were selected based on water bodies that have not been sampled to date, by EGLE. Locations that are on private property were sampled after individual owner access agreements were obtained.

Surface water samples were collected in general accordance with the Work Plan when site access and weather conditions allowed. The samples were collected with disposable HDPE dipper samplers. A new dipper sample cup was used at each sample location. To avoid sample dilution, surface water samples were collected at least 72 hours after any rain event. Water collected in the dipper was poured directly into clean, pre-labeled, laboratory-provided bottles. The sample containers were placed in cooler for shipment to Vista where the samples were analyzed for EGLE's PFAS Minimum Laboratory Analyte List of compounds (**Appendix D**) via Modified EPA Method 537. A level IIB data package was ordered for each set of surface water samples collected.

Surface water sample names were assigned in the format "SWYY##-YYMMDD" where "SWYY##" corresponds to the unique name assigned to a location. "YY" is the last two numbers of the year that the surface water body was first sampled. "YYMMDD" corresponds to the date that the sample was collected. "YY" is the last two numbers of the year, "MM" is the month and "DD" is the day.

2.7 Quality Assurance/Quality Control (QA/QC) Samples

QA/QC samples were collected to assure PFAS contamination was not introduced to the Investigation samples from the drilling equipment, sample collection equipment or water used for equipment decontamination. QA/QC samples are also used to assess the accuracy and reliability of concentration results. QA/QC sample collection methodology is provided below:

- Drilling Activities
    - After drilling tooling was decontaminated, an equipment blank was collected. The equipment blank was collected by pouring laboratory-provided water over the deconned drilling tooling and into laboratory supplied containers.
- Sample Collection Events

- Equipment blank samples were collected at a rate of at least one equipment blank sample per ten environmental samples.
- If reusable equipment was used at the equipment blank sample location, the equipment was decontaminated. Following decontamination, laboratory provided reagent-free water was run through (pumps and tubing) and over (water level meter) equipment. The rinseate was collected into laboratory supplied containers.
- If disposable equipment was used at the equipment blank sample location, unused equipment was used. Laboratory provided reagent-free water was run through an unused length of tubing and over equipment (water level meters and dippers). The rinseate was collected into laboratory supplied containers.
- Field duplicate samples were collected at a rate of at least one duplicate sample per ten samples.
- Matrix Spike and Matrix Spike Duplicate (MS/MSD) samples were collected at a rate of at least one MS/MSD sample per twenty samples.

The QA/QC samples collected were analyzed for EGLE's PFAS Minimum Laboratory Analyte List of compounds (**Appendix D**) via modified EPA Method 537. Laboratory reports for the groundwater well QA/QC samples are included in the Level IV data packages. Laboratory reports for the drilling QA/QC samples and surface water samples are included in the level IIB data packages.

2.8 Sample Handling

Due to the nature of PFAS and their prevalence in many consumer products, special precautions and procedures were required for the handling, packaging, and shipment of samples analyzed for PFAS. These precautions and procedure are discussed in detail in the Work Plan (Standard Operating Procedure 1, Sample Acquisition for Polyfluorinated Compounds and Other Polyfluoroalkyl Substance Analysis).

Samples were collected directly into clean, laboratory provided bottles. Sample bottle sets were placed into plastic resealable bags and placed on ice for preservation from the time of collection through shipment to the analytical laboratory. Custody of the samples was maintained and documented through chain-of-custody forms. Chain-of-custody began with the collection of the samples in the field and ended at the analytical laboratory receiving department. The samples were shipped to the analytical laboratory via overnight courier service.

2.9 Decontamination Procedures

All drilling equipment was decontaminated before being brought to the work site and between each of the boring locations. Drilling tooling was decontaminated at each boring location as it was pulled from the ground. A steam pressure washer with clean water was used to decontaminate drilling equipment.

All non-disposable sampling equipment was decontaminated prior to use and after each use (except for dedicated tubing left in monitoring wells). Non-disposable sampling equipment was decontaminated using Alconox detergent and distilled water. All decontamination water was containerized for offsite disposal as described in Section 2.10.

2.10 Investigation Derived Waste

Purge water, decontamination water, and well development water generated during monitoring well installation and groundwater sampling was containerized and stored in 55-gallon drums. Soil cutting IDW generated during well installation was containerized in separate 55-gallon drums. IDW drums were properly labeled identifying their contents. While awaiting disposal, IDW was staged at the Kalamazoo Valley Group (KVG) Landfill in Charleston Township, Kalamazoo County Michigan. The IDW will not be disposed of at KVG Landfill but was staged at this GP facility prior to disposal at an approved facility. IDW was sampled for:

- PFAS
- Toxic Characteristic Leaching Procedure (TCLP) Volatile Organic Compounds (VOCs)
- TCLP Semivolatile Organic Compounds (SVOCs)
- TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver)
- Polychlorinated Biphenyls (PCBs).

Disposable sampling supplies and materials (i.e., nitrile gloves and sample tubing) were bagged and disposed of as general refuse/garbage.

3.0 RESULTS

The hydrogeologic Investigation included the Installation of twenty-nine monitoring wells at twenty-one locations, minimal drawdown (low-flow) groundwater sampling of the new monitoring wells for PFAS, surface water sampling at ten locations within the Study Area for PFAS, collection of QA/QC samples to monitor for sample integrity, static water level gauging at the new monitoring wells in addition to wells previously installed at the Mills 1 and 2 and Landfills Area, and survey of the monitoring wells installed as part of this study as well as the Mill 2 and Landfills Area monitoring wells. Laboratory results and field observations were used to develop a CSM for the Study Area. The laboratory results and CSM are presented in the sections below.

3.1 Laboratory Analytical Results

Low-flow groundwater samples were collected from the twenty-nine monitoring wells installed within the study during the hydrogeologic Investigation. Surface water samples were collected from ten locations within the Study Area. The samples were analyzed for PFAS following the method described in previous sections of this report. The analytical results of the groundwater, surface water, QA/QC samples and IDW samples are detailed in the following paragraphs.

3.1.1 Groundwater

Groundwater analytical results for PFOA and PFOS are presented in **Table 4** where they are compared to Part 201 GDW and Groundwater to Surface Water Interface (GSI) Criteria. **Table 4** provides the sample name and the corresponding well name. Locations, by well name, of the samples are provided in **Figures 5, 6 and 7**. A side-by-side comparison of all PFAS results from Vista (collected by Tetra Tech) and Test America (Collected by EGLE), is provided in **Appendix E. Appendix E** also includes laboratory reports and data validation reports for samples collected by Tetra Tech.

Groundwater analytical results indicate that within the semi-confined and confined aquifers, PFOA and PFOS were only detected at one location, MW1911B. In the upper, unconfined aquifer combined PFOA and PFOS concentrations ranged from nondetect to 3,433 ng/L. The groundwater analytical results for the twenty-nine monitoring wells installed for this study are summarized below:

- The sum of PFOA plus PFOS was detected above the Part 201 GDW Criteria (70 ng/L) in four wells: MW1809A, MW1911A, MW1911B and MW1912A;

- PFOS concentrations were detected greater than the Part 201 GDW Criteria in MW1809A and MW1912A;
- PFOA concentrations were detected greater than the Part 201 GDW Criteria in MW1911B and MW1912A;
- PFOS concentrations were detected greater than the Part 201 GSI Criteria applicable to the Kalamazoo River and tributaries (12 ng/L) in six wells: MW1809A, MW1911A, MW1911B, MW1912A, MW1917A and MW1919A;
- PFOA concentrations were not detected greater than the Part 201 GSI Criteria applicable to the Kalamazoo River and tributaries (12,000 ng/L) in any monitoring well;
- PFOS concentrations were detected greater than the laboratory reporting limits (RLs), but less than the Part 201 Criteria in nine wells;
- PFOA concentrations were detected greater than the laboratory RLs but less than the Part 201 Criteria in thirteen wells; and
- Neither PFOA nor PFOS concentrations were detected greater than the laboratory RLs in eight wells.

Geographical review of the analytical results (**Figures 5, 6 and 7**) indicates that the extent of PFOA and PFOS has been successfully delineated to Part 201 Criteria within the Study Area. The northern delineation of PFOS and PFOS is indicated by the nondetect results at MW1801A and MW1803A, and detections below Part 201 Criteria at MW1802A and MW1918A at 11.2 ng/L and 2.83 ng/L, respectively. The eastern delineation of PFOA and PFOS is indicated by the nondetect result at MW1803A and detections below Part 201 Criteria at MW1804A and MW1808A at 5.9 ng/L and 8.51 ng/L, respectively. The southern delineation is indicated by the detection of 6.58 ng/L at MW1914A. The nondetect results in groundwater samples collected by EGLE in 2018 from wells located west of the Kalamazoo River indicate the western extent of PFAS impact is the Kalamazoo River. In addition, the northwestern flow of groundwater within the Study Area and natural discharge to the Kalamazoo River indicates that additional PFAS detections above Part 201 Criteria farther to the east and south, are unlikely.

3.1.2 Surface Water

Surface water analytical results for PFOA and PFOS are presented in **Table 5** where they are compared to the Michigan Rule 57 Human Noncancer Values (HNV) for non-drinking water sources. **Table 5** provides the sample name and the corresponding surface water name. Locations, by surface water name, of the samples are provided in **Figure 4**. Surface water

analytical results ranged from nondetect to 5,840 ng/L and 17,200 ng/L for PFOA and PFOS, respectively at SW1817. The surface water analytical results are summarized below:

- PFOS concentrations were detected greater than the HNV (12 ng/L) at SW1813, SW1914, SW1817, SW1919 and SW1921;
- PFOA concentrations were not detected greater than the HNV (12,000 ng/L) in any surface water samples;
- PFOS concentration was detected greater than the laboratory RL, but below HNV at SW1812;
- PFOA concentrations were detected greater than the laboratory RLs, but less than the HNV at SW1812, SW1813, SW1817, SW1914, SW1919 and SW1921; and
- Neither PFOA nor PFOS concentrations were detected greater than the laboratory RLs, in SW1811, SW1815, SW1816 or SW1818;

3.1.3 QA/QC SAMPLES

A Tetra Tech chemist conducted a Level IV validation for sample delivery groups containing groundwater samples. The data validation included a review of:

- Data completeness
- Hold times/Sample Preservation
- Mass Calibration
- LC/MS/MS System Tuning and Performance
- Mass Spectral Acquisition Rate
- Instrument Sensitivity Check
- Ion Transition Check
- Initial/Continuing Calibrations
- Laboratory Method/Preparation Blank Results
- Extraction Internal Standard Recoveries
- Injection Internal Standard Recoveries
- Laboratory Control Sample (LCS) Recoveries
- Field Duplicate Precision
- Compound Identification
- Compound Quantitation
- Detection Limits

Comments were provided in the data validation report summaries regarding these quality control criteria (**Appendix E**). All the data collected, have been determined usable and no data were rejected. The following sections include the comments regarding quality control that were listed in the data validation reports. Note that when all QA/QC criteria are met, no comments are listed for the sample(s) and the analytical results are judged to be validated as qualified by the laboratory.

3.1.3.1 PFAS Internal Standards Recovery Results

Internal standards are used to demonstrate laboratory accuracy. The laboratory analyzes a sample of a standard that has a known concentration and determines what percent of the known concentration is recovered (Percent Recovery). The following comments regarding internal standard recovery results were included in the data validation reports:

- The Percent Recovery (%R) for the extraction internal standard compound, 13C3-Perfluorobutanesulfonic acid (13C3-PFBS) in sample EB1815-181129 was below the 60% quality control limit. The non-detected results reported the associated compound, PFBS, was qualified as estimated, (UJ) in this sample.
- The %R for the extraction internal standard compound, 13C2-Perfluoroundecanoic acid (13C2-PFUnA) in sample MS1815-181129 was below the 60% quality control limit. The non-detected results reported the associated compound, PFUNA, was qualified as estimated, (UJ) in this sample.
- The %R for the extraction internal standard compound, 18O2-Perfluorohexanesulfonic acid (18O2-PFHxS), was above the 130% quality control limit in sample MW1802A-181213. No action was taken because the associated PFAS compound, PFHxS, was not detected in this sample.
- The %R for the extraction internal standard compound, 13C8-Perfluorooctane sulfonamide (13C8-PFOSA), was below the lower quality control limit in sample MW1810C-190108. The nondetected result reported for the associated PFAS compound, PFOSA in this sample was qualified as estimated (validation qualification code: UJ).

These results do not impact the usability of the data. No other issues regarding internal standard recovery results were noted in the data validation reports.

3.1.3.2 Duplicate Results

Duplicate sample results are used to evaluate overall laboratory precision. The following comments regarding the duplicate sample results were included in the data validation reports:

- The Relative Percent Differences (RPDs) between the detected results for PFOS in the field duplicate pair DUP02-190218/MW1918A-190218 exceeded the 30% quality control criterion. The detected results reported for this compound in the field duplicate pair were qualified as estimated, (J).
- DUP01-181212/MW1808A-181212 and MS1808A-181212/ MW1808A-181212, were within the 30% quality control limit.
- The calculated RPDs in the field duplicate pair, DUP03-181129/SW1811-181129, were non detect.
- The calculated RPDs in the field duplicate pair, DUP02-190108/MW1810A-190108, were within the 30% quality control limit.
- The calculated RPDs in the field duplicate pair, DUP02-190108/MW1810A-190108, were within the 30% quality control limit.
- The RPDs in field duplicate pairs, DUP01-190218/MW1911B-190218, DUP03-190218/MW1911A-190218, and DUP04-190306/MW1912A190306 were within the 30% quality control limit.
- The RPDs in the field duplicate pair, DUP03-190219/SW1921-190219 were within the 30% quality control limit.
- Sample MS1911A-190218 as listed on the chain of custody record was changed to DUP03-190218. The RPDs in the duplicate pair MS1911A-190218/MW1911A190218 were within the 30% quality control limit.

These results do not impact the usability of the data. No other comments regarding the duplicate samples results were noted in the data validation reports.

3.1.3.3 MS/MSD Sample Results

MS/MSD sample results are used to demonstrate laboratory precision. The laboratory spikes a sample collected during the groundwater sampling event, with a known concentration and determines what percent of the known concentration is recovered (%R). The following comments regarding the MS/MSD sample results were included in the data validation reports:

- A MS analyses was not performed on the sample, MS1808A-181212, designated for this quality control parameter. The chain of custody did not indicate the sample should be spiked. No validation action was required.
- A MS/MSD analyses was performed on sample, MS1809A-190109, designated for this quality control parameter. All %Rs and RPDs were within the quality control limits.

- A MS/MSD analyses was performed on sample, MS1912A-190306. All MS/MSD %Rs and RPDs were within the quality control limits with the exception of the PFOS results. No action was necessary because the concentration of PFOS in the parent sample was greater than four times the amount spiked in the MS/MSD sample.
- MS/MSD analyses were not performed on sample, MS1921-190219, which was designated for quality control analysis. The chain of custody record did not specify that the sample should be spiked. The laboratory analyzed the sample as a unique sample

These results do not impact the usability of the data. No other comments regarding the MS/MSD samples results were noted in the data validation reports.

3.1.3.4 Additional Comments

The following comments apply to all sample delivery groups:

- Samples were received at the proper temperature, extracted within the required14-day holding time and analyzed within the required 28-day holding time.
- All laboratory calibration criteria were met.
- The laboratory method blanks and equipment blanks were free of contamination.
- The LCS %Rs were within the quality control limits.
- Non-detect results were reported to the RLs.

3.1.4 IDW

Waste characterization samples received to date indicate solid and liquid IDW is non-hazardous; non-Resource Conservation and Recovery Act (RCRA) regulated; and, non-PCB containing. Laboratory analytical reports for the waste characterization samples, are provided in **Appendix F**.

3.2 CONCEPTUAL SITE MODEL (CSM)

A CSM was developed based on data collected during the Investigation and review of publicly available resources which included topographical maps, wetland maps, geological maps, and regional hydrogeological studies. Referenced documents are identified in **Section 5.0**. During the Investigation, monitoring wells were installed near the northern, eastern, and southern extents of the Study Area, as well as at select points of interest within the Study Area. In addition to the monitoring wells that were installed as part of this study, information from monitoring wells present at Mill 2 and the Landfills Area were considered. The monitoring wells are depicted on **Figure 3**.

3.2.1 Hydrology

The main surface water feature within the Study Area is the north-flowing Kalamazoo River. Tributaries, including Travis Drain, Spring Brook and lakes present in Spring Valley, flow westward into the Kalamazoo River. Several north flowing drains discharge into Travis Drain. A portion of the eastern extent of the Kalamazoo River valley is present within the Study Area, generally trending southwest to northeast, along Riverview Road. Other surface waters include wetland areas adjacent to the river and relatively small ponds located on residential properties and at Mill 2 and the Landfills Area. According to the United States Fish and Wildlife Service National Wetland Inventory (**Appendix G**), there are Freshwater Forested/Shrub and Emergent Wetlands located in areas adjacent to the Kalamazoo River and in a low-lying area located east of properties located along 20th Ave and west of properties located along Collingwood Drive.

Water levels measured in monitoring wells located within the river valley, ranged from 1.12 feet to 19.50 feet Below Ground Surface (bgs) (**Table 2**) and one monitoring well exhibits flowing conditions (MW1917A). The shallow groundwater depths near surface water features, indicates groundwater is in connection with surface waters. The Kalamazoo River primarily is a gaining stream, recharged by groundwater. Published reports by the Michigan and U.S. Geological Surveys indicate that there may be localized areas where there is flow from surface water features to aquifers during high river flow stage and/or when high yield production wells are operating near surface water features. (Michigan Department of Conservation, 1960; U.S. Geological Survey, 1972; U.S. Geological Survey, 2004).

3.2.2 Geology

The regional geology consists of unconsolidated deposits that consist of glacially derived deposits of Pleistocene age and alluvial deposits of Holocene age. These deposits range in thickness from

less than 50 feet in north-central Kalamazoo County to 600 feet in northwestern Kalamazoo County. Alluvial deposits, which consist of relatively recent sand and gravel, were deposited in the valleys of present-day streams and are interconnected with glacial deposits. Review of a glacial terrain map of Kalamazoo County (**Appendix H**), indicates three glacial deposits are mapped in the Study Area: 1) outwash/flood plain, 2) slope wash alluvium, and 3) elevated terraces. The outwash/flood plain occurs in Copper Township adjacent and east of the Kalamazoo River. It consists of thick deposits of gravel, cobbles, boulders and coarse bedded sand. Slope wash alluvium occurs in Cooper Township east of the outwash/floodplain deposits, and in the City of Parchment, adjacent and east of the Kalamazoo River. It consists of moderate slopes of sorted sand, gravel and occasional cobbles and boulders from the adjacent moraine. Elevated terraces occur east of the slope wash alluvium and are easily recognized by the change in elevation at the escarpment that occurs near Riverview Drive. The change in elevation is mapped as a fluvial incised scarp (**Appendix H**). Elevated terraces are low relief to rolling sediments consisting of bedded sand, gravel and abundant cobbles at surface in some locations. Brown sandy diamicton (glacial till) generally underlies the sand and gravel and may overlie sands and gravels in some places.

Bedrock consisting of the Mississippian-aged Coldwater Shale is expected to occur beneath the Study Area and in other places in Kalamazoo County. The Marshall Formation is also present beneath Kalamazoo County. (U.S. Geological Survey, 1990).

Information regarding the local geology was obtained during the completion of the Investigation. A description of field observations at each soil boring/monitoring well locations is provided in **Table 1.** The geology of the Study Area has been generalized in cross-sections based on geologic data collected from continuous soil cores logged during the installation of the new monitoring wells. The orientation of these cross-sections is illustrated on **Figure 8**, and the cross-sections are included as **Figures 9 through 13**. Soil boring logs are provided in **Appendix B**.

Generally, unconsolidated materials comprised of sand and gravel formations were encountered from surface to a depth of approximately 120 feet in the eastern portion of the Study Area and 15 feet in the western portion of the Study Area (approximate elevation of 745 feet amsl). These sand and gravel formations are poorly sorted and are representative of the glacial/alluvial deposits described in the glacial terrain map (**Appendix H**). The thicker sequences of sand and gravel occur on an elevated terrace in the eastern portion of the Study Area, and the thinner sand and

gravel formations, that are interbedded with silts and clays, occur in the western portion of the Study Area near the Kalamazoo River. The interbedded materials are most likely relatively recent deposits that are in connection with the glacial outwash materials. The sand and gravel formations are generally underlain by clay that was observed to be approximately 50 feet thick in the western portion of the Study Area and 5 feet thick in the eastern portion of the Study Area.

3.2.3 Hydrogeology

The regional hydrogeology in Kalamazoo County, has been described in published hydrogeological studies. Unconsolidated aquifers in Kalamazoo County are grouped into three categories (U.S. Geological Survey, 2004)

- The unconfined upper aquifer ranging in thickness from 0 to 120 feet
- The intermediate aquifer ranging in thickness from 0 to 100 feet
- The lower aquifer ranging in thickness from 0 to 120 feet

Within Kalamazoo County, the unconfined upper aquifer is estimated to have an average transmissivity of approximately 110,000 Gallons per Day per Foot (gpd/ft) (U.S. Geological Survey, 1972). The intermediate and lower aquifers are grouped together and are estimated to have an average transmissivity of 53,000 gpd/ft (U.S. Geological Survey, 1972).

Within the Study Area, limited aquifer information was available for the well field at the former Mill 2 property (State of Michigan Department of Conservation Geological Survey Division, 1960) and the former City of Parchment municipal well field (Consulting Engineering, 1992). At the time of the 1960 report, mill 2 was referred to as the Kalamazoo Vegetable Parchment Co. The aquifer was described as a coarse-grained gravel channel deposit with a depth of 23 to 48 feet, overlain by a 7-foot thick clayey material (aquitard). The transmissivity was estimated to be 230,000 gpd/ft. It was concluded that the aquifer test data at the site showed that the Kalamazoo River was a source of recharge to the well field. In addition, it was noted that water level fluctuations in the aquifer closely correlated to fluctuations at river stage. The aquifer test data and relationship between river and groundwater levels, indicated that the aquitard was breached somewhere along the Kalamazoo River (State of Michigan Department of Conservation Geological Survey Division, 1960).

Aquifer testing was completed at the City of Parchment municipal well field in 1991. The well logs for Well 1, Well 2 and Well 3 indicate the presence of a clay or gravel and clay confining layer,

above the aquifer. Results of the aquifer test indicated an average transmissivity of 180,000 gpd/ft. It was concluded that the aquifer test drawdown curves indicated delayed yield, or recharge. The report states that the confining layer does not extend to the Kalamazoo River.

Within the Study Area, groundwater is present in the first sand and gravel and is considered the unconfined aquifer. Depth to water in the unconfined aquifer ranges from 0 feet bgs (surface flow) in the western portion of the Study Area to 60 feet bgs in the eastern portion of the Study Area. The unconfined aquifer is approximately 15 to 60 feet thick within the Study Area. Groundwater is also present in deeper sand and gravel formations that occur beneath and within the first encountered clay layer (intermediate and lower aquifers described above). These formations represent semi-confined to confined aquifers. The aquifer studies at the former Mill 2 (State of Michigan Department of Conservation Geological Survey Division, 1960) and City of Parchment municipal well field (Consulting Engineering, 1992) suggest that there is a connection between the unconfined aquifer and deeper aquifers. Review of cross-section C to C' (**Figure 11**) indicates that the aquifer beneath an observed clay layer at the former municipal well field and MW1911B/C, is in connection with the unconfined aquifer that was observed at MW1912A. MW1912A is located south of the former municipal well field.

Groundwater elevations measured on February 14, 2019 were used to create groundwater elevation maps for the unconfined aquifer and the semi confined/confined aquifer. The groundwater elevation maps are presented in **Figures 14 and 15**. The groundwater flow direction is to the northwest in both the unconfined and the deeper semi-confined/confined aquifer. The horizontal groundwater gradient of the unconfined aquifer is approximately 0.013 feet/feet in the eastern portion of the Study Area and 0.002 feet/feet in the western portion of the Study Area. The horizontal groundwater gradient of the deeper aquifer is 0.011 feet/feet in the eastern portion of the Study Area and 0.004 feet/feet in the western portion of the Study Area. An upward vertical hydraulic gradient was observed in the following nested well pairs:

- MW1806A and MW1806C
- MW1809A and MW1809C
- MW1810A and MW1810B
- MW1810B and MW1810C
- MW1911A and MW1911B
- MW1911B and MW1911C

Clay layers of varying thicknesses were observed in these locations between the shallower monitoring well and the deeper monitoring well. Due to the upward vertical hydraulic gradient observed in these locations, groundwater migration from the unconfined aquifer to the deeper semi-confined/confined aquifers is not expected.

A downward vertical gradient was observed in the following nested well pairs:

- MW1806A and MW1906B
- MW1921A and MW1921C

Monitoring well MW1806A is screened 53 feet to 63 feet, in the first encountered groundwater formation. MW1806B is screened 98 feet to 108 feet, in the same location. A 5-feet thick silt layer is present 63.5 feet to 73.5 feet, between the well screen intervals. There is potential for groundwater to move downward through the observed silt layer. A third well, MW1806C is screened in this location 145 feet to 155 feet. A 35-feet thick clay layer is present 109.5 feet to 148 feet, between the well screen intervals. There is an upward vertical hydraulic gradient between MW1806C and MW1806B.

Monitoring well MW1921A is screened 10 feet to 20 feet, in the first encountered groundwater formation. MW1912C is screened 57 feet to 62 feet, in the same location. A 35.5-feet thick silt and clay layer is present 21.5 feet to 57 feet, between the well screen intervals. There is potential for groundwater to move downward through the observed silt and clay layer.

Groundwater flow velocities were estimated for the unconfined aquifer using Darcy's Law: velocity = hydraulic conductivity (K) * hydraulic gradient (i) / porosity (n). Hydraulic conductivity is the transmissivity of the aquifer divided by the aquifer thickness. Using a transmissivity of 13,000 square feet/day (100,000 gpd/ft) and an average aquifer thickness of 40 feet, the hydraulic conductivity is estimated to be 330 feet/day. The average hydraulic gradient for the unconfined aquifer is 0.007. Assuming a porosity of 30% for sand and gravel, the groundwater velocity for the unconfined aquifer is estimated to be 7.7 ft/day.

3.2.4 Constituents of Concern (COCs) and Extent

The COC in the study are PFAS in groundwater, specifically PFOA and PFOS. The study conducted by EGLE in summer 2018 (**Figure 2**), revealed relatively high concentration of PFOA plus PFOS (greater than 1,000 ng/L) in monitoring wells at the Mill 2 and Landfills Area parcels,

the former municipal well field and a property located along Riverview Rd. Concentrations of PFOA plus PFOS were detected greater than the Part 201 GDW Criteria of 70 ng/L in other residential wells within the Study Area. Limited well construction data were available for the residential wells and Landfills Area monitoring wells. No well construction data were available for the Mill 2 monitoring wells. Without well construction information, there is some uncertainty in establishing the aquifer(s) in which groundwater impacts were detected; however, based on results of the Investigation described in this report, it is likely that the impacted residential wells are installed in the unconfined aquifer.

Groundwater sample results of PFOA plus PFOS that were obtained during residential and monitoring well sampling events, were used to estimate the isoconcentrations lines, areas of equal concentration, depicted on **Figure 16**. The lateral extent of PFOA and PFOS greater than Part 201 GDW Criteria has been delineated. Further, based on non-detections of PFOA and PFOS in the deepest wells at each well nest installed as part of this Investigation, the vertical extent of PFAS has been delineated.

Facilities associated with the former Crown Vantage paper plant are likely a source for PFAS that have been detected in groundwater. There are likely other PFAS source(s) east of the former City of Parchment municipal well field based on the direction of groundwater flow to the west/northwest and the lack of a concentration gradient in groundwater, between the former Crown Vantage facilities and the locations of elevated PFAS detections in the eastern portion of the Study Area.

4.0 REFERENCES

Barcelona, R. W. (1996, April). Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. *EPA Ground Water Issue EPA/540/S-95/50*.

Consulting Engineering. (1992). *City of Parchment Well Head Protection Program Report.*

Laton, W. R. (1997). *Groundwater-Kalamazoo River Interaction Near the Parchment City Wellfield, Parchment, Michigan.* Dissertation.

Michigan Department of Conservation. (1960). *Ground-water Hydrology and Glacial Geology of the Kalamazoo Area, Michigan.* Progress Report Number 23.

State of Michigan Department of Conservation Geological Survey Division. (1960). *Ground-Water Hydrology and Glacial Geollogy of the Kalamazoo Area, Michigan.* State of Michigan Department of Conservation Geological Survey Division.

Tetra Tech (2018), *Hydrogeological Investigation Work Plan*, Parchment Michigan

Tetra Tech (2019), *Hydrogeological Investigation Work Plan Addendum*, Parchment Michigan

U.S. Geological Survey. (1972). *Availability of Water in Kalamazoo County, Southwestern Michigan.* united States Department of the Interior.

U.S. Geological Survey. (1972). *Availability of Water in Kalamazoo County, Southwestern Michigan.* Water-Supply Paper 1973.

U.S. Geological Survey. (1990). *Geohydrology and Water Quality of Kalamazoo County, Michigan, 1986-88.* Water-Resources Investigations Report 90-4028.

U.S. Geological Survey. (2004). *Simulation of the Ground-Water-Flow System in the Kalamazoo County Area, Michigan.* Scientific Investigations Report 2004-5054.

US EPA. (2017, January). National Functional Guidelines for Inorganic Superfund Methods Data Review.

TABLES

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan
TABLE 1
MONITORING WELL DESCRIPTIONS

Soil Boring/ Monitoring Well	Monitoring Well	Soil Boring Depth (feet)	Proposed Monitoring Well Depth (feet)	Monitoring Well Depth (feet)	Location Rationale	Nearest Address to the Monitoring Well Installation	Final Installation Rational
SB1801A	MW1801A	40'	39'	33'	Location was selected by MDEQ. Location may define the northern extent of impacts in the first encountered aquifer. Residential well logs have depths ranging between 30 and 44 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	6259 Polk St.	Sand and gravel layers were noted from the surface to an approximate depth of 33 feet where silt and then clay was observed to the terminus of the soil boring at 40 feet. MW1801A was installed within the water table aquifer with a well screen from 23 to 33 feet below ground surface (bgs).
SB1802A	MW1802A	151'	39'	22'	Location was selected by MDEQ and adjusted to be located in a public road rights-of-way. Location may define the northern extent of impacts in the first encountered aquifer. Residential well logs have depths ranging between 30 and 44 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer and to evaluate vertical hydraulic gradients using data from intermediate and deep wells that are planned for this location.	6340 Riverview Dr.	Monitoring well MW1802A was installed at 6340 N. Riverview Dr., just north of the original planned location. The location was revised due to drill rig accessibility issues at 6304 Riverview Dr. Sand and gravel layers were noted from the surface to an approximate depth of 52 feet where clay was observed to the terminus of the soil boring at 151 feet. MW1802A was installed within the water table aquifer with a well screen from 12 to 22 feet bgs. Due to the vertical extent of the clay in this location, intermediate and deep wells were not installed as planned.
SB1803A	MW1803A	66'	39'	30'	Location was selected by MDEQ. Location may define the northeastern extent of impacts in the first encountered aquifer. Residential well logs have depths ranging between 30 and 44 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	6190 N. Riverview Dr.	Sand and gravel layers were noted from the surface to an approximate depth of 46 feet where clay and silt was observed to an approximate depth of 50 feet where gravel and sand was observed to the the terminus of the soil boring at 50 feet. MW1803A was installed within the water table aquifer with a well screen from 20 to 30 feet bgs.
SB1804A	MW1804A	86'	57'	80'	Location was selected by MDEQ. Location may define the eastern extent of impacts in the first encountered aquifer. Residential well logs have depths ranging between 50 and 75 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	3320 Tibet Avenue	Monitoring well MW1804A was installed at 3320 Tibet Avenue, north of the original planned location. The location was revised due the presence of underground utilities at 5701 Mt. Olivet Rd. Sand and gravel layers were noted from the surface to the terminus of the soil boring at 86 feet. MW1804A was installed within the water table aquifer with a well screen from 70 to 80 feet bgs.
SB1805A	MW1805A	66'	86'	65'	Location was selected by MDEQ. Location may define the eastern extent of impacts in the first encountered aquifer. Residential well logs have depths ranging between 77 and 95 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	5485 Lindenwood St.	Sand and gravel layers were noted from the surface to the terminus of the soil boring at 66 feet. MW1805A was installed within the water table aquifer with a well screen from 55 to 65 feet bgs.
SB1806A	MW1806A	156'	86'	63'	Location was selected by MDEQ. Location may define the eastern extent of impacts in the first encountered aquifer. Residential well logs have depths ranging between 77 and 95 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer and to evaluate vertical hydraulic gradients using data from intermediate and deep wells that are planned for this location.	5363 Lindenwood St.	Sand with intermittent silt layers were noted from the surface to an approximate depth of 109.5 feet where a 38.5 feet thick clay layer was observed. Beneath the clay layer, sand and gravel layers were noted to a depth of 154.5 feet bgs where clay was encountered to the terminus of the soil boring at 156 feet. MW1806A was installed within the water table aquifer with a well screen from 53 to 63 feet bgs.
SB1806B	MW1806B	110'	102'	108'	Location may define the eastern extent of impacts in the intermediate aquifer that underlies a potential clay layer that provides separation from the shallow aquifer. The depth of the intermediate aquifer is reported on residential well logs at depths ranging between 94-122 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be semi-confined and to evaluate vertical hydraulic gradients using data from shallow and deep wells that are planned for this location.	5363 Lindenwood St.	Sand with intermittent silt layers were noted from the surface to the terminus of the soil boring at 110 feet. MW1806B was installed within a semi-confined aquifer with a well screen from 98 to 108 feet bgs.
SB1806A	MW1806C	156'	150'	155'	To evaluate the presence of the deeper aquifer or deeper intervals of the intermediate aquifer and potential impact in the eastern extent of the study area. Depth of the deeper aquifer is unknown at this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer that may be semi-confined and to evaluate vertical hydraulic gradients using data from shallow and intermediate wells that are planned for this location.	5363 Lindenwood St.	Sand with intermittent silt layers was noted from the surface to an approximate depth of 109.5 feet where a 38.5 feet thick clay layer was observed. Beneath the clay layer, sand and gravel layers were noted to a depth of 154.5 feet bgs where clay was encountered to the terminus of the soil boring at 156 feet. MW1806C was installed within a confined aquifer with a well screen from 145 to 155 feet bgs.
SB1807A	MW1807A	115'	86'	104'	Location was selected by MDEQ. Location may define the eastern extent of impacts in the first encountered aquifer. Residential well logs have depths ranging between 75 and 105 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	2881 Summerdale Ave.	Sand and gravel layers were noted from the surface to an approximate depth of 111 feet where clay was observed to the terminus of the soil boring at 115 feet. MW1807A was installed within the water table aquifer with a well screen from 94 to 104 feet bgs.
SB1808A	MW1808A	80'	94'	80'	To evaluate groundwater quality at the southeastern extent of the study area within the first encountered aquifer. Residential well logs that have depths ranging between 80 and 109 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	Vacant Parcel near Mount Olivet Road and Wolverine Dr.	Sand with intermittent clay and silt layers was noted from the surface to the terminus of the soil boring at 80 feet. The clay layers were less than 2 feet in thickness and the sand formations above the clay layers were not saturated. Monitoring well MW1808A was installed within the water table aquifer with a well screen from 70 to 80 feet bgs.

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan
TABLE 1
MONITORING WELL DESCRIPTIONS

Soil Boring/ Monitoring Well	Monitoring Well	Soil Boring Depth (feet)	Proposed Monitoring Well Depth (feet)	Monitoring Well Depth (feet)	Location Rationale	Nearest Address to the Monitoring Well Installation	Final Installation Rational
SB1809A	MW1809A	154'	36'	32'	This location is where a relatively high concentration of impact was detected in a residential well. Well depth for the residential well is unknown; therefore, it is unknown at what depth the impacts were detected. A well will be installed in the first encountered aquifer to evaluate groundwater quality. The first encountered aquifer that is reported on residential well logs that have depths ranging between 34.5 and 44 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer and to evaluate vertical hydraulic gradients using data from intermediate and deep wells that are planned for this location.	5616 N. Riverview Dr.	Monitoring well MW1809A confirmed the relatively high concentration of impact in the water table aquifer at this location. Sand and gravel layers were noted from the surface to an approximate depth of 54 feet where a 25 feet thick clay and silt layer was observed to an approximate depth of 79 feet. Beneath the clay layer, intermittent sand, silt and clay layers were noted to the terminus of the soil boring at 154 feet. MW1809A was installed within the water table aquifer with a well screen from 22 to 32 feet bgs. Due to only one confining unit observed in this location, an intermediate well was not installed at this location as planned.
SB1809A	MW1809C	154'	130'	86'	This location is where a relatively high concentration of impact was detected in a residential well. Well depth for the residential well is unknown; therefore, it is unknown at what depth the impacts were detected. A well will be installed in deeper aquifer(s) or deeper intervals of intermediate aquifers. Depth of deeper aquifers is unknown at this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be semi-confined and to evaluate vertical hydraulic gradients using data from shallow and intermediate wells that are planned for this location.	5616 N. Riverview Dr.	Sand and gravel layers were noted from the surface to an approximate depth of 54 feet where a 25 feet thick clay and silt layer was observed. Beneath the clay layer, intermittent sand, silt and clay layers were noted to the terminus of the soil boring at 154 feet. MW1809C was installed within a confined aquifer with a well screen from 76 to 86 feet bgs. Due to only one confining unit observed in this location, an intermediate well was not installed at this location as planned.
SB1810A	MW1810A	151'	30'	20'	This location is where a relatively high concentration of impact was detected in a residential well. Well depth for the residential well is unknown; therefore, it is unknown at what depth the impacts were detected. A well will be installed in the first encountered aquifer to evaluate groundwater quality. The first encountered aquifer that is reported on residential well logs that have depths ranging between 25 and 42 feet near this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer and to evaluate vertical hydraulic gradients using data from intermediate and deep wells that are planned for this location.	5292 Keyes Dr.	Monitoring well MW1810A was installed at 5292 Keyes Dr., just north of the planned location. The location was revised due the placement of underground utilities at 5280 Keyes Dr. Sand and gravel with intermittent clay and silt layers were noted from the surface to an approximate depth of 93.5 feet where clay was observe to the terminus of the soil boring at 151 feet. An upper confining unit was observed between 45 and 55.5 feet and a lower confining unit was observed between 72 and 75 feet. MW1810A was installed within the water table aquifer with a well screen from 10 to 20 feet bgs.
SB1810B	MW1810B	75'	90'	68'	This location is where a relatively high concentration of impact was detected in a residential well. Well depth for the residential well is unknown; therefore, it is unknown at what depth the impacts were detected. A well will be installed in aquifer(s) that may be present beneath a clay layer that underlies the shallow aquifer. Depth of an intermediate aquifer is unknown at this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be semi-confined and to evaluate vertical hydraulic gradients using data from shallow and deep wells that are planned for this location.	5292 Keyes Dr.	MW1810B was installed at 5292 Keyes Dr., just north of the planned location. The location was revised due the placement of underground utilities at 5280 Keyes Dr. Sand and gravel with intermittent clay and silt layers were noted from the surface to the terminus of the soil boring at 75 feet. An upper confining unit was observed between 45 and 55.5 feet and a lower confining unit was observed between 72 and 75 feet. MW1810B was installed within a confined aquifer with a well screen from 58 to 68 feet bgs.
SB1810A	MW1810C	151'	130'	82'	This location is where a relatively high concentration of impact was detected in a residential well. Well depth for the residential well is unknown; therefore, it is unknown at what depth the impacts were detected. A well will be installed in deeper aquifer(s) or deeper intervals of intermediate aquifers. Depth of deeper aquifers is unknown at this location. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be semi-confined and to evaluate vertical hydraulic gradients using data from shallow and intermediate wells that are planned for this location.	5292 Keyes Dr.	MW1810C was installed at 5292 Keyes Dr., just north of the planned location. The location was revised due the placement of underground utilities at 5280 Keyes Dr. Sand and gravel with intermittent clay and silt layers were noted from the surface to an approximate depth of 93.5 feet where clay was observe to the terminus of the soil boring at 151 feet. An upper confining unit was observed between 45 and 55.5 feet and a lower confining unit was observed between 72 and 75 feet. MW1810C was installed within a confined aquifer with a well screen from 77 to 82 feet bgs.
SB1911B	MW1911A	15'	60'	15'	This location was selected by MDEQ. This location is where a relatively high concentration of impact was detected in the municipal well field. Municipal well logs have depths ranging between 58 and 60 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be present. Vertical hydraulic gradients will be calculated using data from shallow and deep wells that are planned for this location.	Parchment City Sewer Department 5661 N. 20th St.	Sand was noted from the surface to an approximate depth of 14.5 feet where a layer of clay was observed till the terminus of the soil boring at an approximate depth of 15 feet. MW1911A was installed in the water table aquifer with a well screen from 5 to 15 feet bgs.
SB1911A	MW1911B	96'	NA	48'	An intermediate well was not included in the Hydrogeologic Work Plan Addendum. An intermediate well was added once the depth of the originally planned shallow well was observed to be below a confining unit.	Parchment City Sewer Department 5661 N. 20th St.	Monitoring well MW1911B was screened at a similar elevation as the former municipal wells within a semi-confined aquifer. Review of boring logs from this area indicate that the semi-confined aquifer at this location is in connection with the water table aquifer to the south. Sand and gravel with intermittent layers of clay and silt were noted from the surface to an approximate depth of 85 feet. Clay was observed from 85 feet to the terminus of the soil boring at 96 feet. The first significant confining unit was observed 48.5 to 55 feet. MW1911B was installed in a semi-confined aquifer with a well screen from 38 to 48 feet bgs.
SB1911A	MW1911C	96'	100'	85'	This location was selected by MDEQ. This location is where a relatively high concentration of impact was detected in the municipal well field. Municipal well logs have depths ranging between 58 and 60 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be present. Vertical hydraulic gradients will be calculated using data from shallow and deep wells that are planned for this location.	Parchment City Sewer Department 5661 N. 20th St.	Monitoring well MW1911C indicated the absence of PFAS in the deeper aquifer across the study area. Sand and gravel with intermittent layers of clay and silt were noted from the surface to an approximate depth of 85 feet where clay was observe to the terminus of the soil boring at 96 feet. Significant confining units were observed from 48.5 to 55 feet and from 60 to 76.5 feet. MW1911C was installed in a confined aquifer with a well screen from 75 to 85 feet bgs.

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 1
MONITORING WELL DESCRIPTIONS

Soil Boring/ Monitoring Well	Monitoring Well	Soil Boring Depth (feet)	Proposed Monitoring Well Depth (feet)	Monitoring Well Depth (feet)	Location Rationale	Nearest Address to the Monitoring Well Installation	Final Installation Rational
SB1912A	MW1912A	50'	60'	39'	This location will be used to evaluate groundwater quality south of the municipal wells. Municipal well logs have depths ranging between 58 and 60 feet. A nearby residential well is installed at a depth of 82 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	West of 5535 N.20th Street on Consumers Energy property.	Monitoring well MW1912A was installed on Consumers Energy property west of the original planned location. The location was revised due to drill rig accessibility issues at 5535 N. 20th St. Gravel and sand was noted from the surface to an approximate depth of 48.5 feet where clay was observed to the terminus of the soil boring at 50 feet bgs. MW1912A was installed within the water table aquifer with a well screen from 29 to 39 feet bgs.
SB1913A	MW1913A	81'	80'	61'	This location will be used to evaluate groundwater quality at the southeastern extent of the study area within the first encountered aquifer and semi-confined aquifers if present. Residential well logs are not available in the area. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	3419 Courtland Ave.	Sand and gravel intervals were noted from the surface to the soil boring terminus at a depth of 81 feet bgs. MW1913A was installed in the water table aquifer with a well screen from 51 to 61 feet bgs.
SB1914A	MW1914A	36'	50'	25'	This location was selected by MDEQ. This location will be used to evaluate groundwater quality in the southern extent of the study area. Residential well logs are not available in the area. This location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	Parchment City Hall 650 S. Riverview Dr.	Sand and gravel intervals were noted from the surface to an approximate depth of 25 feet bgs. Silt and clay was observed from 25 to 34.5 feet and sand was observed from 34.5 feet to the terminus of the boring at 36 feet bgs. MW1914A was installed in the water table aquifer with a well screen from 15 to 25 feet bgs.
SB1915A	MW1915A	45'	50'	30'	This location was selected to evaluate groundwater quality in the central portion of the study area, hydraulically upgradient of the municipal well field, where MDEQ has identified a potential source of PFAS. Residential well logs indicate that wells are installed between 30 and 53 feet in the first encountered aquifer and at 93 to 125 feet in a confined aquifer beneath a clay layer that is noted as 63 and 99 feet thick in nearby well logs. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be present. Vertical hydraulic gradients will be calculated using data from shallow and deep wells that are planned for this location.	Sapa Extrusions North America LLC, a.k.a. Hydro Aluminum North America 5575 N. Riverview Dr.	Gravel and sand was noted from the surface to an approximate depth of 35 feet. Silt and clay was observed from 35 feet to the terminus of the soil boring at 45 feet. MW1915A was installed in the water table aquifer with a well screen from 20 to 30 feet bgs. A deep well originally planned for this location was installed at SB1921A instead.
SB1916A	MW1916A	62'	50'	28'	This location was selected by MDEQ to evaluate groundwater quality east of the municipal well field. Residential well logs have depths ranging from 28 and 44 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	5831 N. 20th St.	Sand was noted from the surface to an approximate depth of 27 feet with interval of silt and clay observed from 17.5 to 24 feet. Clay was observed from 27 feet to the terminus of the soil boring at 62 feet. MW1916A was installed within the water table aquifer with a well screen from 23 to 28 feet bgs.
SB1917A	MW1917A	56'	50'	32'	This location was selected by MDEQ to evaluate groundwater quality southeast of the municipal well field. A nearby residential well log has a depth of 28 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	5433 N. 20th St.	Sand and gravel layers were noted from the surface to an approximate depth of 32.5 feet. Silt and clay was observed from 32.5 feet to the terminus of the soil boring at 56 feet. MW1917A was installed within the water table aquifer with a well screen from 22 to 32 feet bgs.
SB1918A	MW1918A	35'	50'	19'	This location was selected to evaluate groundwater quality north of where MDEQ has identified a potential source of PFAS. Residential well logs indicated that wells are installed between 26 to 125 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	WKZO Radio 2254 McKinley St	Sand and gravel layers were noted from the surface to an approximate depth of 28 feet, with a interval of silt and clay observed from 20 to 25 feet. Clay was observed from 28 feet to the terminus of the soil boring at 35 feet. MW1918A was installed within the water table aquifer with a well screen from 9 to 19 feet bgs.
SB1919A	MW1919A	66'	50'	50'	This location will be used to evaluate groundwater quality east of where MDEQ has identified a potential source of PFAS. Residential well logs have depths ranging from 42 to 46 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	Harding's Friendly Market 612 N. Riverview Dr.	Sand was note from the surface to the terminus of the soil boring at 66 feet. One layer of silt observed from 29.5 to 32.5 feet. MW1919A was installed within the water table aquifer with a well screen from 40 to 50 feet bgs.
SB1920A	MW1920A	46'	40'	30'	This location was selected by MDEQ to evaluate groundwater quality in the central portion of the study area where MDEQ has identified a potential source of PFAS. Residential well logs have depths ranging from 34.5 to 44 feet. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the first encountered aquifer.	5468 Keyes Dr.	Intervals of sand and gravel were noted to 30.5 feet, followed by sand and silt to 36 feet. Silt and clay were observed from 36 feet to the terminus of the soil boring at 46 feet. MW1920A was installed within the water table aquifer with a well screen from 20 to 30 feet bgs.
SB1921A	MW1921A	80'	NA	20'	This location was not included in the Hydrogeologic Work Plan Addendum. This location was selected to evaluate groundwater quality in the western portion of the study area, hydraulically upgradient of the municipal well field where MDEQ has identified a potential source of PFAS, and hydraulically downgradient from other potential sources of PFAS. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be present. Vertical hydraulic gradients will be calculated using data from shallow and deep wells that are planned for this location.	5718 N. 20th St.	Sand and gravel was noted from the surface to 21.5 feet. Silt and clay was observed from 21.5 feet to the soil boring terminus at 80 feet, with layers of sand present at 57 feet and 59 feet, and a sand and silt layer from 60 to 62 feet. MW1921A was installed within the water table aquifer with a well screen from 10 to 20 feet bgs.

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 1
MONITORING WELL DESCRIPTIONS

Soil Boring/ Monitoring Well	Monitoring Well	Soil Boring Depth (feet)	Proposed Monitoring Well Depth (feet)	Monitoring Well Depth (feet)	Location Rationale	Nearest Address to the Monitoring Well Installation	Final Installation Rational
SB1921A	MW1921C	80'	NA	62'	This location was not included in the Hydrogeologic Work Plan Addendum. This location was selected to evaluate groundwater quality in the western portion of the study area, hydraulically upgradient of the municipal well field where MDEQ has identified a potential source of PFAS, and hydraulically downgradient from other potential sources of PFAS. In addition to water quality data, this location will provide groundwater elevation data for the purpose of calculating groundwater flow direction in the aquifer(s) that may be present. Vertical hydraulic gradients will be calculated using data from shallow and deep wells that are planned for this location.	5718 N. 20th St.	Sand and gravel was noted from the surface to 21.5 feet. Silt and clay was observed from 21.5 feet to the soil boring terminus at 80 feet, with layers of sand present at 57 feet and 59 feet, and sand and silt layer from 60 to 62 feet. MW1921C was installed within a confined aquifer with a well screen from 57 to 62 feet bgs.

1. Nomenclature definitions for SB1801A or B
"SB" = soil boring
"18" = year of installation
"01" = location number
"A" = first soil boring drilled at location
"B" = second soil boring drilled at location

2. Nomenclature definitions for MW1801A, B or C
"MW" = monitoring well
"18" = year of installation
"01" = location number
"A" = shallowest well at location
"B" = intermediate well at location (between shallow and deep)
"C" = deepest well at location

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 2
WELL CONSTRUCTION AND WATER LEVELS

Well Name Current	Well Name Previous*	Soil Boring Name	Date Installed	Northing (y)	Easting (x)	TOC Elevation (feet amsl)	Surface Elevation (feet amsl)	Screen Length (feet)	Screen Slot Size	Screen Interval (bgs feet)		Screen Elevation (feet amsl)		Well Casing Diameter (inches)	Well Casing Material	Stickup or Flush Mount (S/F)	Depth to Water 2/14/2019	Groundwater Elevation 2/14/2019
										Top	Bottom	Top	Bottom					
MW1801A	--	SB1801A	11/30/2018	312627.81	12801870.81	776.93	777.27	10	10	23	33	752.93	742.93	2	PVC	F	10.04	766.89
MW1802A	--	SB1802A	12/6/2018	312991.59	12803249.14	772.05	772.40	10	10	12	22	760.05	750.05	2	PVC	F	2.88	769.17
MW1803A	--	SB1803A	12/3/2018	311924.87	12803251.82	785.12	785.43	10	10	20	30	765.12	755.12	2	PVC	F	16.25	768.87
MW1804A	--	SB1804A	12/7/2018	309858.57	12803469.42	838.60	838.95	10	10	70	80	767.60	757.60	2	PVC	F	62.27	776.33
MW1805A	--	SB1805A	11/29/2018	308253.71	12803011.01	837.68	837.90	10	10	55	65	781.68	771.68	2	PVC	F	52.14	785.54
MW1806A	--	SB1806A	11/15/2018	307591.48	12803015.64	839.56	839.95	10	10	53	63	785.56	775.56	2	PVC	F	48.85	790.71
MW1806B	--	SB1806B	11/19/2018	307583.96	12803015.70	839.78	840.08	10	10	98	108	739.78	729.78	2	PVC	F	49.11	790.67
MW1806C	--	SB1806A	11/15/2018	307591.49	12803015.67	839.50	839.93	10	10	145	155	691.50	681.50	2	PVC	F	39.99	799.51
MW1807A	--	SB1807A	11/13/2018	307021.08	12802276.03	843.10	843.42	10	10	94	104	748.10	738.10	2	PVC	F	55.03	788.07
MW1808A	--	SB1808A	11/27/2018	306050.62	12804487.58	852.02	852.40	10	10	70	80	782.02	772.02	2	PVC	F	38.59	813.43
MW1809A	--	SB1809A	12/11/2018	308798.04	12801615.70	787.24	787.50	10	10	22	32	765.24	755.24	2	PVC	F	20.25	766.99
MW1809C	--	SB1809A	12/11/2018	308798.05	12801615.66	787.22	787.51	10	10	76	86	709.22	699.22	2	PVC	F	12.51	774.71
MW1810A	--	SB1810A	12/14/2018	307290.75	12799907.06	772.89	773.20	10	10	10	20	763.89	753.89	2	PVC	F	8.21	764.68
MW1810B	--	SB1810B	12/18/2018	307295.27	12799910.14	772.68	773.11	10	10	58	68	714.68	704.68	2	PVC	F	6.01	766.67
MW1810C	--	SB1810A	12/14/2018	307290.81	12799907.04	772.81	773.29	10	10	77	82	699.81	689.81	2	PVC	F	3.72	769.09
MW1911A	--	SB1911A	3/4/2019	309542.088	12797012.27	752.03	752.39	10	10	4.3	14.3	747.74	737.74	2	PVC	F	NM	NA
MW1911B	--	SB1911B	1/10/2019	309542.24	12797006.64	751.94	752.39	10	10	38	48	713.94	703.94	2	PVC	F	1.32	750.62
MW1911C	--	SB1911B	1/10/2019	309542.12	12797006.63	751.90	752.38	10	10	75	85	676.90	666.90	2	PVC	F	0.83	751.07
MW1912A	--	SB1912A	2/28/2019	308893.516	12796680.03	756.53	756.95	10	10	29.2	39.2	727.33	717.33	2	PVC	F	NM	NA
MW1913A	--	SB1913A	1/16/2019	302924.68	12801152.35	846.34	846.78	10	10	51	61	795.34	785.34	2	PVC	F	50.02	796.32
MW1914A	--	SB19114A	1/14/2019	301092.09	12797681.05	774.31	774.63	10	10	15	25	759.31	749.31	2	PVC	F	19.18	755.13
MW1915A	--	SB1915A	2/7/2019	309599.55	12799898.20	774.89	775.40	10	10	20	30	754.89	744.89	2	PVC	F	11.80	763.09
MW1916A	--	SB1916A	1/17/2019	310264.16	12797916.12	753.34	753.63	5	10	23	28	730.34	725.34	2	PVC	F	1.35	751.99
MW1917A	--	SB1917A	1/22/2019	308005.59	12797900.66	756.24	756.58	10	10	22	32	734.24	724.24	2	PVC	F	0.00	756.24
MW1918A	--	SB1918A	2/5/2019	311940.38	12799955.54	763.39	763.76	10	10	9	19	754.39	744.39	2	PVC	F	0.75	762.64
MW1919A	--	SB1919A	1/11/2019	305687.33	12799504.61	800.60	800.98	10	10	40	50	760.60	750.60	2	PVC	F	28.84	771.76
MW1920A	--	SB1920A	1/23/2019	308208.70	12800619.24	773.13	773.51	10	10	20	30	753.13	743.13	2	PVC	F	7.75	765.38
MW1921A	--	SB1921A	2/12/2019	309569.70	12798609.18	757.00	757.17	10	10	10	20	747.00	737.00	2	PVC	F	1.00	756.00
MW1921C	--	SB1921A	2/12/2019	309569.69	12798609.17	756.93	757.25	5	10	57	62	699.93	694.93	2	PVC	F	2.83	754.10
LFMW-1	**MW-1 (19.15 ft)**	NA	NA	306517.79	12794787.10	758.85	756.77	NA	10	NA	19.19	NA	739.66	2	Stainless Steel	S	NM	NA
LFMW-2	**MW-2 (24.95 ft)**	NA	NA	307039.34	12794685.71	762.98	760.07	NA	10	NA	24.43	NA	738.55	2	Stainless Steel	S	NM	NA
LFMW-2A	**MW-2a (40.75 ft)**	NA	NA	307037.61	12794693.72	762.37	759.63	NA	10	NA	40.91	NA	721.46	2	Stainless Steel	S	NM	NA
LFMW-3	**MW-3 (13.63 ft)**	NA	NA	307420.04	12795037.99	755.25	751.29	NA	10	NA	13.55	NA	741.70	2	Stainless Steel	S	4.13	751.12
LFMW-4	**MW-4 (13.82 ft)**	NA	NA	307657.21	12795141.31	753.10	750.39	NA	10	NA	13.88	NA	739.22	2	Stainless Steel	S	NM	NA
LFMW-5	**MW-5 (19.51 ft)**	NA	NA	308137.42	12795470.99	760.51	758.00	NA	10	NA	19.54	NA	740.97	2	Stainless Steel	S	10.71	749.80
LFMW-6N	**MW-6 North (19.90 ft)**	NA	NA	306514.65	12795669.71	757.19	755.39	NA	10	NA	19.94	NA	737.25	2	Stainless Steel	S	3.99	753.20
LFMW-6S	**MW-6 South (35.75 ft)**	NA	NA	306506.78	12795670.89	757.35	755.14	NA	10	NA	35.81	NA	721.54	2	Stainless Steel	S	4.15	753.20
LFMW-7E	**MW-7 East (40.40 ft)**	NA	NA	307688.44	12796429.00	758.65	756.03	NA	10	NA	40.44	C	718.21	2	Stainless Steel	S	3.87	754.78
LFMW-7W	**MW-West (24.31 ft)**	NA	NA	307689.04	12796424.17	757.70	755.97	NA	10	NA	24.33	NA	733.37	2	Stainless Steel	S	3.81	753.89
LFMW-8	**MW-8 (12.31 ft)**	NA	NA	308413.45	12795993.08	753.16	751.41	NA	10	NA	12.33	NA	740.83	2	Stainless Steel	S	3.45	749.71
LFMW-9	**MW-9 (14.50 ft)**	NA	NA	306213.48	12796333.74	757.67	755.88	NA	10	NA	13.94	NA	743.73	2	Stainless Steel	S	2.63	755.04
LFMW-11	**MW-11 (35.79 ft)**	NA	NA	308204.18	12796252.58	755.66	753.11	NA	10	NA	35.79	NA	719.87	2	Stainless Steel	S	3.00	752.66
LFMW-12	**MW-12 (17.24 ft)**	NA	NA	307149.91	12795438.01	759.48	757.08	NA	10	NA	17.44	NA	742.04	2	Stainless Steel	S	6.65	752.83
LFMW-UNK-A	**MW-UNK (24.85)**	NA	NA	308379.36	12795701.15	761.96	759.06	NA	NA	NA	NA	NA	761.96	NA	NA	NA	11.95	750.01
LFMW-UNK-B	**MW-UNK (24.85)**	NA	NA	307140.48	12794605.72	757.60	755.33	NA	NA	NA	NA	NA	757.60	NA	NA	NA	NM	NA
LFMW-UNK-C	**MW-UNK (24.85)**	NA	NA	307041.79	12794697.09	761.32	759.32	NA	NA	NA	NA	NA	761.32	NA	NA	NA	NM	NA
PMMW-1	**MW1**	NA	NA	304695.44	12797391.44	769.68	766.59	NA	10	NA	16.05	NA	753.63	1	PVC	S	14.78	754.90
PMMW-2	**MW2**	NA	NA	304659.79	12797392.40	767.03	767.06	NA	10	NA	16.35	NA	750.68	1	PVC	F	13.12	753.91
PMMW-3	**MW3**	NA	NA	305003.68	12797465.00	769.85	768.87	NA	10	NA	19.81	NA	750.04	1	PVC	S	14.65	755.20

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 2
WELL CONSTRUCTION AND WATER LEVELS

Well Name Current	Well Name Previous*	Soil Boring Name	Date Installed	Northing (y)	Easting (x)	TOC Elevation (feet amsl)	Surface Elevation (feet amsl)	Screen Length (feet)	Screen Slot Size	Screen Interval (bgs feet)		Screen Elevation (feet amsl)		Well Casing Diameter (inches)	Well Casing Material	Stickup or Flush Mount (S/F)	Depth to Water 2/14/2019	Groundwater Elevation 2/14/2019
										Top	Bottom	Top	Bottom					
PMMW-4	**MW4**	NA	NA	304951.95	12797461.36	771.00	768.11	NA	10	NA	18.9	NA	752.10	1	PVC	S	14.58	756.42
PMMW-6	**MW6**	NA	NA	305173.23	12797575.68	766.00	763.25	NA	10	NA	13.67	NA	752.33	1	PVC	S	10.59	755.41
PMMW-7	**MW7**	NA	NA	305005.29	12796945.04	767.61	765.24	NA	10	NA	19.1	NA	748.51	1	PVC	S	NM	NA
PMMW-8	**MW8**	NA	NA	305698.30	12796815.87	763.05	760.95	NA	10	NA	13.6	NA	749.45	1	PVC	S	7.43	755.62
PMMW-9	**MW9**	NA	NA	305395.39	12796564.04	761.95	760.15	NA	10	NA	12.96	NA	748.99	1	PVC	S	NM	NA
PMMW-10	**MW10**	NA	NA	304588.97	12796825.41	768.14	765.53	NA	10	NA	19.51	NA	748.63	1	PVC	S	NM	NA

Notes:
Y-Coordinate = Northing in State Plane, Michigan South, feet
X-Coordinate = Easting in State Plane, Michigan South, feet
TOC = Top of Casing
NM = Not Measured
NA = Not Available
amsl = Above Mean Sea Level
bgs = Below Ground Surface
PVC =Polyvinyl chloride
-- = Not Applicable
* The well was renamed from previous well names documented in reports completed by others, for the purpose of distinguishing the same numbered wells from each other.

Hydrogeologic Investigation Report
Georgia-Pacific LLC
Parchment, Michigan

TABLE 3
GROUNDWATER MONITORING FIELD DATA

Well Name	Sample Name	Sample Date	pH (S.U.)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Approximate Pumping Rate (mL/min)
MW1801A	**MW1801A-181213**	12/13/2018	8.03	0.508	0.20	12.01	-250	0	500
MW1802A	**MW1802A-181213**	12/13/2018	8.14	0.378	0.13	12.75	-170	14.1	500
MW1803A	**MW1803A-181213**	12/13/2018	7.94	0.526	3.71	12.15	26	0	320
MW1804A	**MW1804A-181212**	12/12/2018	7.86	0.71	6.76	12.47	45	11.5	400
MW1805A	**MW1805A-181211**	12/11/2018	7.82	0.726	8.08	13.14	154	37.1	700
MW1806A	**MW1806A-181211**	12/11/2018	7.80	0.769	5.94	12.68	-3	23.3	600
MW1806B	**MW1806B-181211**	12/11/2018	7.74	0.685	1.89	11.67	-29	58.8	400
MW1806C	**MW1806C-181213**	12/13/2018	8.45	0.487	0.23	11.11	-236	21.4	500
MW1807A	**MW1807A-181212**	12/12/2018	8.02	0.755	0.35	11.46	-184	22.4	200
MW1808A	**MW1808A-181212**	12/12/2018	7.74	1.302	3.44	11.59	-19	10.8	420
MW-1809A	**MW1809A-190109**	1/9/2019	7.66	0.622	4.61	6.43	145	0	150
MW-1809C	**MW1809C-190109**	1/9/2019	7.79	0.546	0.14	9.01	-177	13.3	400
MW-1810A	**MW1810A-190108**	1/8/2019	7.46	0.823	3.13	8.58	63	92.3	200
MW-1810B	**MW1810B-190108**	1/8/2019	7.96	0.753	0.17	10.51	-501	49.1	800
MW-1810C	**MW1810C-190108**	1/8/2019	8.06	0.807	0.12	10.39	-520	39.3	480
MW1911A	**MW1911A-190306**	3/6/2019	7.15	0.674	2.17	6.15	-134	50.3	400
MW1911B	**MW1911B-190218**	2/18/2019	7.75	0.72	0.11	9.49	-171	15.5	320
MW1911C	**MW1911C-190218**	2/18/2019	7.55	5.18	0.13	9.30	-117	114	200
MW1912A	**MW1912A-190306**	3/6/2019	7.31	0.799	2.09	8.31	-161	140	400

Hydrogeologic Investigation Report
Georgia-Pacific LLC
Parchment, Michigan

TABLE 3
GROUNDWATER MONITORING FIELD DATA

Well Name	Sample Name	Sample Date	pH (S.U.)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	Temperature (°C)	ORP (mV)	Turbidity (NTU)	Approximate Pumping Rate (mL/min)
MW1913A	**MW1913A-190215**	2/15/2019	7.41	0.794	2.98	10.42	-98	82.7	500
MW1914A	**MW1914A-190215**	2/15/2019	7.17	1.15	1.85	4.81	-25	32.5	100
MW1915A	**MW1915A-190213**	2/13/2019	7.42	0.715	5.82	5.94	67	21.1	200
MW1916A	**MW1916A-190218**	2/18/2019	7.64	0.846	0.18	8.81	-158	56.3	300
MW1917A	**MW1917A-190218**	2/18/2019	7.25	0.904	0.13	9.78	-85	0	400
MW1918A	**MW1918A-190218**	2/18/2019	7.59	0.545	0.25	4.61	-96	0	300
MW1919A	**MW1919A-190215**	2/15/2019	7.31	0.81	7.72	10.49	21	102	400
MW1920A	**MW1920A-190219**	2/19/2019	7.33	0.868	3.93	10.04	56	0	400
MW1921A	**MW1921A-190219**	2/19/2019	7.37	0.899	0.13	8.66	-116	0	300
MW1921C	**MW1921C-190219**	2/19/2019	7.68	0.735	0.14	7.79	-183	0	220

Notes:

1. S.U. = standard units
2. µS/cm = microsiemens per centimeter
3. mg/L = milligrams per liter
4. ORP = Oxidation-reduction potential
5. mV = millivolts
6. NTU = nephelometric turbidity units
7. mL/min = milliliters per minute
8. ft amsl = feet above mean sea level
9. ft below TOC = feet below the top of well casing

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 4
GROUNDWATER MONITORING DETECTIONS OF PFOA AND PFOS

Sample Location and Date	Sample ID	CAS Number	Parameter	Reporting Limit (ng/L)	Result (ng/L)		Residential & Nonresidential Drinking Water Criteria	Groundwater Surface Water interface (GSI)
					Value	VQL		
MW1801A 12/13/2018	**MW1801A-181213**	335-67-1	PFOA	2.01	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.01	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1802A 12/13/2018	**MW1802A-181213**	335-67-1	PFOA	2.1	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.1	2.83		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	2.83		70	--
MW1803A 12/13/2018	**MW1803A-181213**	335-67-1	PFOA	2.09	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.09	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1804A 12/12/2018	**MW1804A-181212**	335-67-1	PFOA	2.04	3.50		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.04	ND		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	3.50		70	--
MW1805A 12/11/2018	**MW1805A-181211**	335-67-1	PFOA	2.01	7.58		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.01	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	7.58		70	--
MW1806A 12/11/2018	**MW1806A-181211**	335-67-1	PFOA	2.1	6.51		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.1	6.25		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	12.76		70	--

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 4
GROUNDWATER MONITORING DETECTIONS OF PFOA AND PFOS

Sample Location and Date	Sample ID	CAS Number	Parameter	Reporting Limit (ng/L)	Result (ng/L)		Residential & Nonresidential Drinking Water Criteria	Groundwater Surface Water interface (GSI)
					Value	VQL		
MW1806B 12/11/2018	**MW1806B-181211**	335-67-1	PFOA	2.16	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.16	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1806C 12/13/2018	**MW1806C-181213**	335-67-1	PFOA	2.04	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.04	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1807A 12/12/2018	**MW1807A-181212**	335-67-1	PFOA	2.02	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.02	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1808A 12/12/2018	**MW1808A-181212**	335-67-1	PFOA	2.06	8.51		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.06	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	8.51		70	--
MW1808A DUP01 (Duplicate of Sample at MW1808A) 12/12/2018	**DUP01-181212**	335-67-1	PFOA	2.03	8.65		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.03	ND		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	8.65		70	--
MW1809A 1/9/2019	**MW1809A-190109**	335-67-1	PFOA	2.04	22.9		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	10.2	***3,410***		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	**3,432.9**		70	--

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 4
GROUNDWATER MONITORING DETECTIONS OF PFOA AND PFOS

Sample Location and Date	Sample ID	CAS Number	Parameter	Reporting Limit (ng/L)	Result (ng/L)		Residential & Nonresidential Drinking Water Criteria	Groundwater Surface Water interface (GSI)
					Value	VQL		
MW1809C 1/9/2019	**MW1809C-190109**	335-67-1	PFOA	2.05	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.05	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1810A 1/8/2019	**MW1810A-190108**	335-67-1	PFOA	2.03	23.9		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.03	11.5		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	35.4		70	--
MW1810A DUP02 (Duplicate of Sample at MW1810A) 1/8/2019	**DUP02-190108**	335-67-1	PFOA	2.05	24.1		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.05	*12.0*		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1810B 1/8/2019	**MW1810B-190108**	335-67-1	PFOA	2.00	ND		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.00	ND		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1810C 1/8/2019	**MW1810C-190108**	335-67-1	PFOA	1.99	ND		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.99	ND		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1911A 3/6/2019	**MW1911A-190306**	335-67-1	PFOA	2.1	55.8		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.1	*51.6*		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	**107.4**		70	--
MW1911B 2/18/2019	**MW1911B-190218**	335-67-1	PFOA	2.0	**112**		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.0	*48.4*		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	**160.4**		70	--

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 4
GROUNDWATER MONITORING DETECTIONS OF PFOA AND PFOS

Sample Location and Date	Sample ID	CAS Number	Parameter	Reporting Limit (ng/L)	Result (ng/L)		Residential & Nonresidential Drinking Water Criteria	Groundwater Surface Water interface (GSI)
					Value	VQL		
MW1911B DUP01 (Duplicate of Sample at MW1911B) 2/18/2019	**DUP01-190218**	335-67-1	PFOA	2.01	**129**		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.01	*57.6*		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	**186.8**		70	--
MW1911B DUP03 2/18/2019	**DUP03-190218**	335-67-1	PFOA	1.95	**132**		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.95	*56.6*		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	**188.8**		70	--
MW1911C 2/18/2019	**MW1911C-190218**	335-67-1	PFOA	2.06	ND		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.06	ND		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--
MW1912A 3/6/2019	**MW1912A-190306**	335-67-1	PFOA	2.05	**493**		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.05	***467***		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	**960**		70	--
MW1912A DUP04 (Duplicate of Sample at MW1912A) 3/6/2019	**MW1912A-190306**	335-67-1	PFOA	2.1	**507**		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.1	***429***		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	**936**		70	--
MW1913A 2/15/2019	**MW1913A-190215**	335-67-1	PFOA	1.94	5.71		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.94	8.15		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	13.86		70	--
MW1914A 2/15/2019	**MW1914A-190215**	335-67-1	PFOA	1.89	2.41		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.89	4.17		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	6.58		70	--
MW1915A 2/13/2019	**MW1915A-190213**	335-67-1	PFOA	1.95	5.83		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.95	4.89		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	10.72		70	--

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 4
GROUNDWATER MONITORING DETECTIONS OF PFOA AND PFOS

Sample Location and Date	Sample ID	CAS Number	Parameter	Reporting Limit (ng/L)	Result (ng/L)		Residential & Nonresidential Drinking Water Criteria	Groundwater Surface Water interface (GSI)
					Value	VQL		
MW1916A 2/18/2019	**MW1916A-190218**	335-67-1	PFOA	1.98	7.08		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.98	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	7.08		70	--
MW1917A 2/18/2019	**MW1917A-190218**	335-67-1	PFOA	1.95	46.9		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.95	*22.9*		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	69.8		70	--
MW1918A 2/18/2019	**MW1918A-190218**	335-67-1	PFOA	2.0	5.17		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.0	6.03	J	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	11.2		70	--
MW1918A DUP02 (Duplicate of Sample at MW1918A) 2/18/2018	**DUP02-190218**	335-67-1	PFOA	2.0	5.52		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.0	4.26	J	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	9.78		70	--
MW1919A 2/15/2019	**MW1919A-190215**	335-67-1	PFOA	1.95	21.1		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.95	*26.3*		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	47.4		70	--
MW1920A 2/19/2018	**MW1920A-190219**	335-67-1	PFOA	1.98	7.61		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	1.98	9.19		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	16.8		70	--
MW1921A 2/19/2018	**MW1921A-190219**	335-67-1	PFOA	2.02	15		70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.02	2.7		70 (JJ)	12 (X)
		--	PFOA + PFOS	--	17.7		70	--

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

TABLE 4
GROUNDWATER MONITORING DETECTIONS OF PFOA AND PFOS

Sample Location and Date	Sample ID	CAS Number	Parameter	Reporting Limit (ng/L)	Result (ng/L)		Residential & Nonresidential Drinking Water Criteria	Groundwater Surface Water interface (GSI)
					Value	VQL		
MW1921C 2/19/2018	**MW1921C-190219**	335-67-1	PFOA	2.02	ND	U	70 (JJ)	12,000 (X)
		1763-23-1	PFOS	2.02	ND	U	70 (JJ)	12 (X)
		--	PFOA + PFOS	--	--		70	--

Notes:

Table reflects analytical data comparison to Michigan Department of Environment, Great Lakes, and Energy Table 1. Groundwater: Residential and Nonresidential Part 201 Generic Cleanup Criteria and Screening Levels, June 25, 2018.

All criteria units and analytical results are in ng/L.

Yellow highlighting indicates that result is above Drinking Water or GSI Criteria.

Bold text indicates that the results is above Drinking Water Criteria.

Italicized text indicates that the result is above GSI Criteria.

ng/L = nanogram per liter

VQL = Validation Qualifier

PFOA = Perfluorooctanoic acid

PFOS = Perfluorooctane sulfonic acid

ND = Not Detected above the reporting limit

CAS = Chemical Abstract Service

MW = Monitoring Well

DUP = Laboratory blind duplicate sample collected in the field simultaneously with the groundwater sample for laboratory quality assurance purposes.

Sample ID = MW1801A-181213: Sample collected from location MW1801A on 12/13/2018

U = Not Detected

J = The Result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample (due either to the quality of the data generated because certain quality control criteria were not met, or the concentration of the analyte was below the reporting limit).

X = The GSI criterion shown in the generic cleanup criteria tables is not protective for surface water that is used as a drinking water source. For a groundwater discharge to the Great Lakes and their connecting waters or discharge in close proximity to a water supply intake in inland surface waters, the generic GSI criterion shall be the surface water human drinking water value (HDV) listed in the table in this footnote, except for those HDV indicated with an asterisk. For HDV with an asterisk, the generic GSI criterion shall be the lowest of the HDV, the WV, and the calculated FCV. See formulas in footnote (G). Soil protection criteria based on the HDV shall be as listed in the table in this footnote, except for those values with an asterisk. Soil GSI protection criteria based on the HDV shall be as listed in the table in this footnote, except for those values with an asterisk. Soil GSI protection criteria for compounds with an asterisk shall be the greater of 20 times the GSI criterion or the GSI soil-water partition values using the GSI criteria developed with the procedure described in this footnote.

JJ = The residential and nonresidential drinking water criteria for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) are not calculated using the equations of R 299.10 or the toxicological, chemical-specific, or chemical-physical input values as shown in the tables of R 299.50. The PFOA drinking water criteria are the health advisory value as presented in the United States Environmental Protection Agency Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA), EPA 822-R-16-005, May 2016. The PFOS drinking water criteria are the health advisory value as presented in the United States Environmental Protection Agency Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS), EPA 822-R-16-004, May 2016. Compliance with the drinking water criteria shall require comparing the sum of the PFOA and PFOS groundwater concentrations to the drinking water criterion of 0.07 µg/L. The drinking water criteria for PFOA and PFOS protect for both short-term developmental and chronic exposure.

Hydrogeologic Investigation Report
Georgia-Pacific
Parchment, Michigan

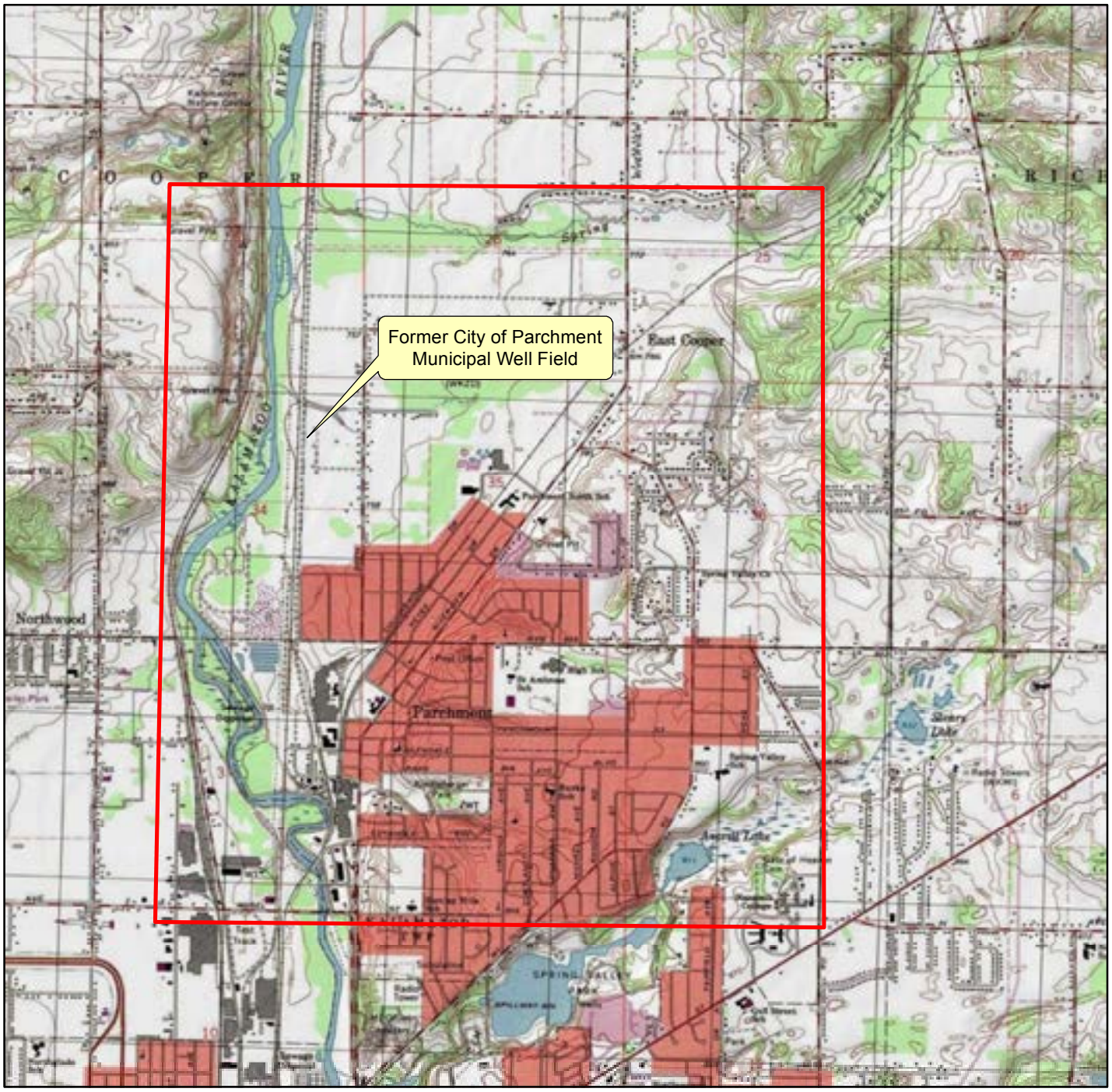
TABLE 5

SURFACE WATER MONITORING DETECTIONS OF PFOA AND PFOS

Sample Location	Sample ID	CAS Number	Parameter	Reporting Limit	Result (ng/L)		HNV (Nondrinking)
					Value	VQL	
SW1811 11/29/2018	**SW1811-181129**	335-67-1	PFOA	2.04	ND	U	12,000
		1763-23-1	PFOS	2.04	ND	U	12
SW1811 DUP03 (Duplicate of Sample at SW1811) 11/29/2018	**DUP03-181129**	335-67-1	PFOA	2.05	ND	U	12,000
		1763-23-1	PFOS	2.05	ND	U	12
SW1812 11/29/2018	**SW1812-181129**	335-67-1	PFOA	2.16	3.52		12,000
		1763-23-1	PFOS	2.16	2.88		12
SW1813 11/29/2018	**SW1813-181129**	335-67-1	PFOA	2.21	28.4		12,000
		1763-23-1	PFOS	2.21	19.9		12
SW1815 11/29/2018	**SW1815-181129**	335-67-1	PFOA	2.19	ND	U	12,000
		1763-23-1	PFOS	2.19	ND	U	12
MS1815 (Duplicate of Sample at SW1815) 11/29/2018	**MS1815-181129**	335-67-1	PFOA	2.33	ND	U	12,000
		1763-23-1	PFOS	2.33	ND	U	12
SW1816 11/29/2018	**SW1816-181129**	335-67-1	PFOA	2.04	ND	U	12,000
		1763-23-1	PFOS	2.04	ND	U	12
SW1817 11/29/2018	**SW1817-181129**	335-67-1	PFOA	22.0	5,840		12,000
		1763-23-1	PFOS	22.0	17,200		12
SW1914 3/27/2019	**SW1914-190327**	335-67-1	PFOA	2.18	98.2		12,000
		1763-23-1	PFOS	2.18	79.5		12
SW1914 DUP05 (Duplicate of Sample at SW1914) 3/27/2019	**DUP05-190327**	335-67-1	PFOA	2.19	102		12,000
		1763-23-1	PFOS	2.19	78.1		12
SW1918 2/19/2019	**SW1918-190219**	335-67-1	PFOA	2.00	ND	U	12,000
		1763-23-1	PFOS	2.00	ND	U	12
SW1919 **3/27**/2019	**SW1919-190327**	335-67-1	PFOA	2.23	18.7		12,000
		1763-23-1	PFOS	2.23	18.2		12
SW1921 2/19/2019	**SW1921-190219**	335-67-1	PFOA	1.97	387		12,000
		1763-23-1	PFOS	1.97	1,540		12
SW1921 DUP03 (Duplicate of Sample at SW1921) 2/19/2019	**DUP03-190219**	335-67-1	PFOA	1.94	400		12,000
		1763-23-1	PFOS	1.94	1,270		12

Notes:
Table reflects analytical data comparison to Michigan Department of Environmental Quality Environment, Great Lakes, and Energy, Rule 57 Water Quality Values Surface Water Assessment Section, June 2, 2011.
All criteria and analytical results units are in ng/L.
Shading indicates a detection above the HNV (Nondrinkingwater source) Criteria.
ng/L = nanogram per liter
HNV = Human Noncancer Values
VQL = Validation Qualifier
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonic acid
CAS = Chemical Abstract Service
ND = Not Detected
U= Not Detected
SW = Surface Water
DUP = Laboratory blind duplicate sample collected in the field simultaneously with the groundwater sample for laboratory quality assurance purposes.
Sample ID = SW1811-181129: Sample collected from Surface Water location SW1811 on 11/29/2018

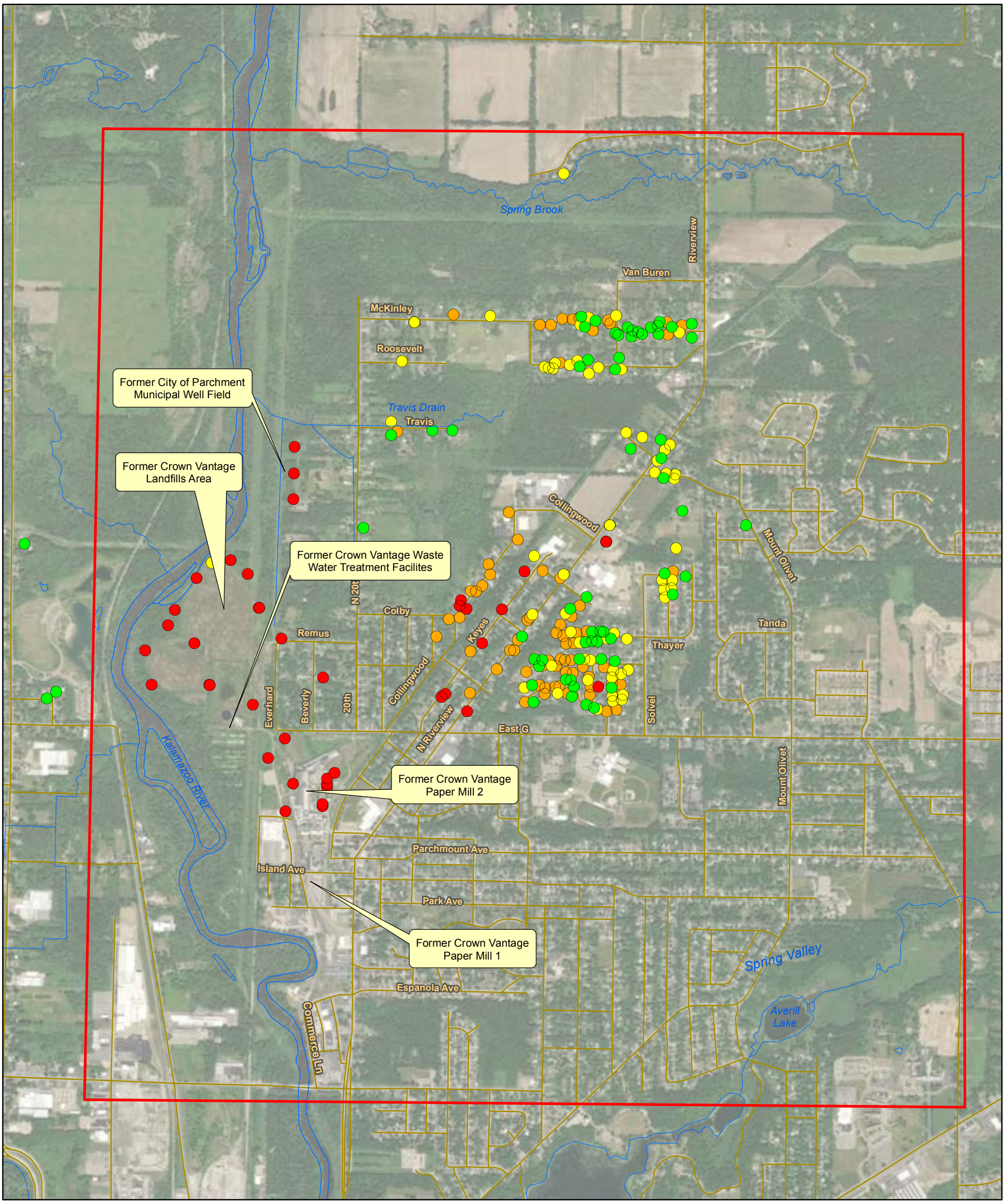
FIGURES



P:\Projects\Georgia-Pacific\Parchment, MI\GIS\Figures\Hydrogeologic Investigation\Figure 1 - Location Map_v1.mxd

BASE MAP: Copyright:© 2013 National Geographic Society, i-cubed

	ORIGINAL BY: JMM DATE: 10/12/2018 REVISED BY: JMM DATE: 4/25/2019	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN LOCATION MAP	FIGURE 1



Base MapSource: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Area

Surface Water

Sample Locations with PFOA plus PFOS Results

- ND above RL
- RL-10 ng/L
- >10 - 70 ng/L
- >70 ng/L

Abbreviations:
ng/L = nanograms per liter
ND - Not detected
RL = Reporting Limit
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

N

0 625 1,250 2,500

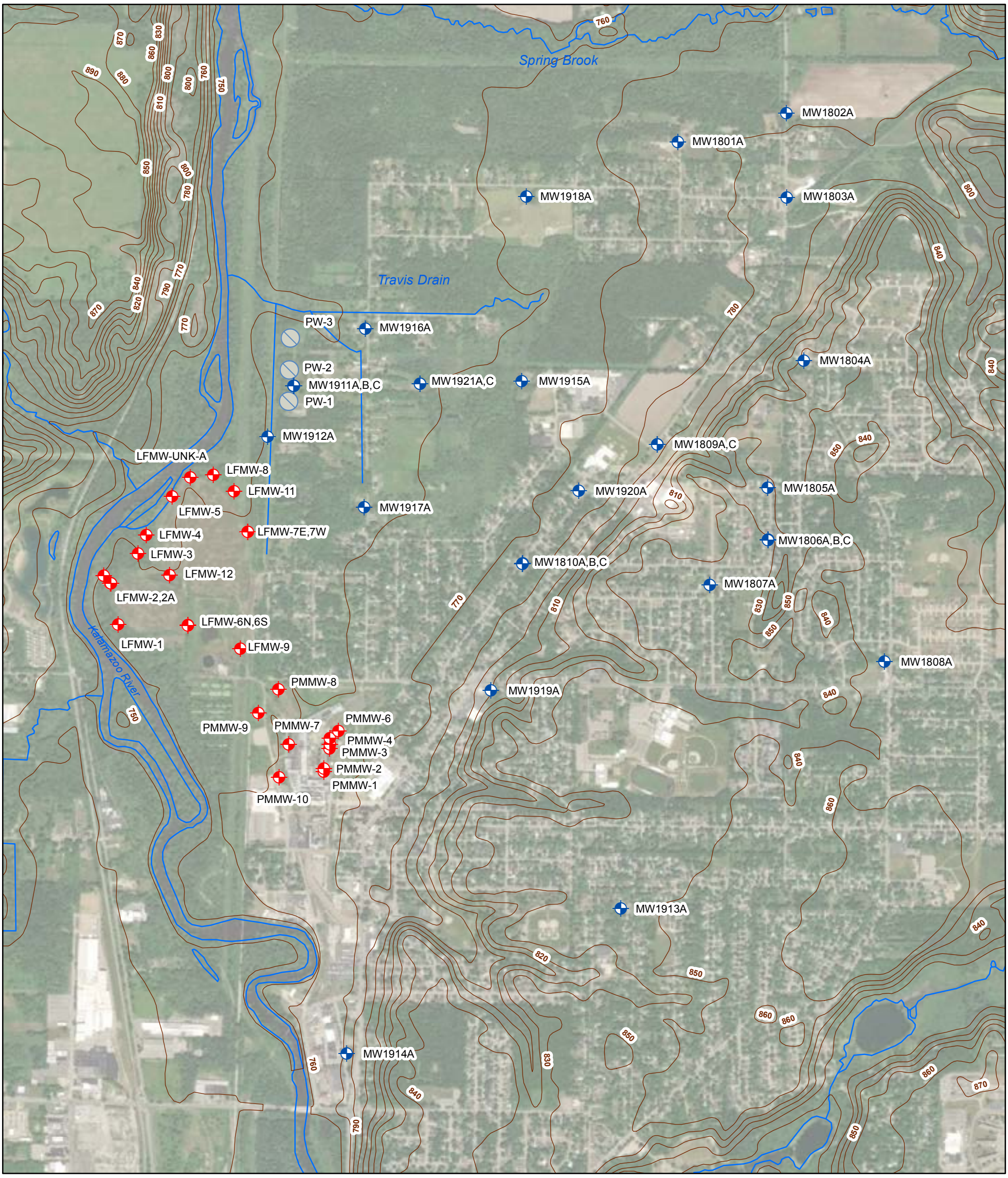
Feet

Notes

1. PFOA and PFOS results obtained by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) July to August 2018. (Refer to Appendix A)
2. 70 nanograms per Liter (ng/L) for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1(June 25, 2018).

ORIGINAL BY: MC	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 1/17/2019	
REVISED BY: LAS	**STUDY AREA AND EGLE SAMPLE RESULTS**
DATE: 6/4/2019	FIGURE 2

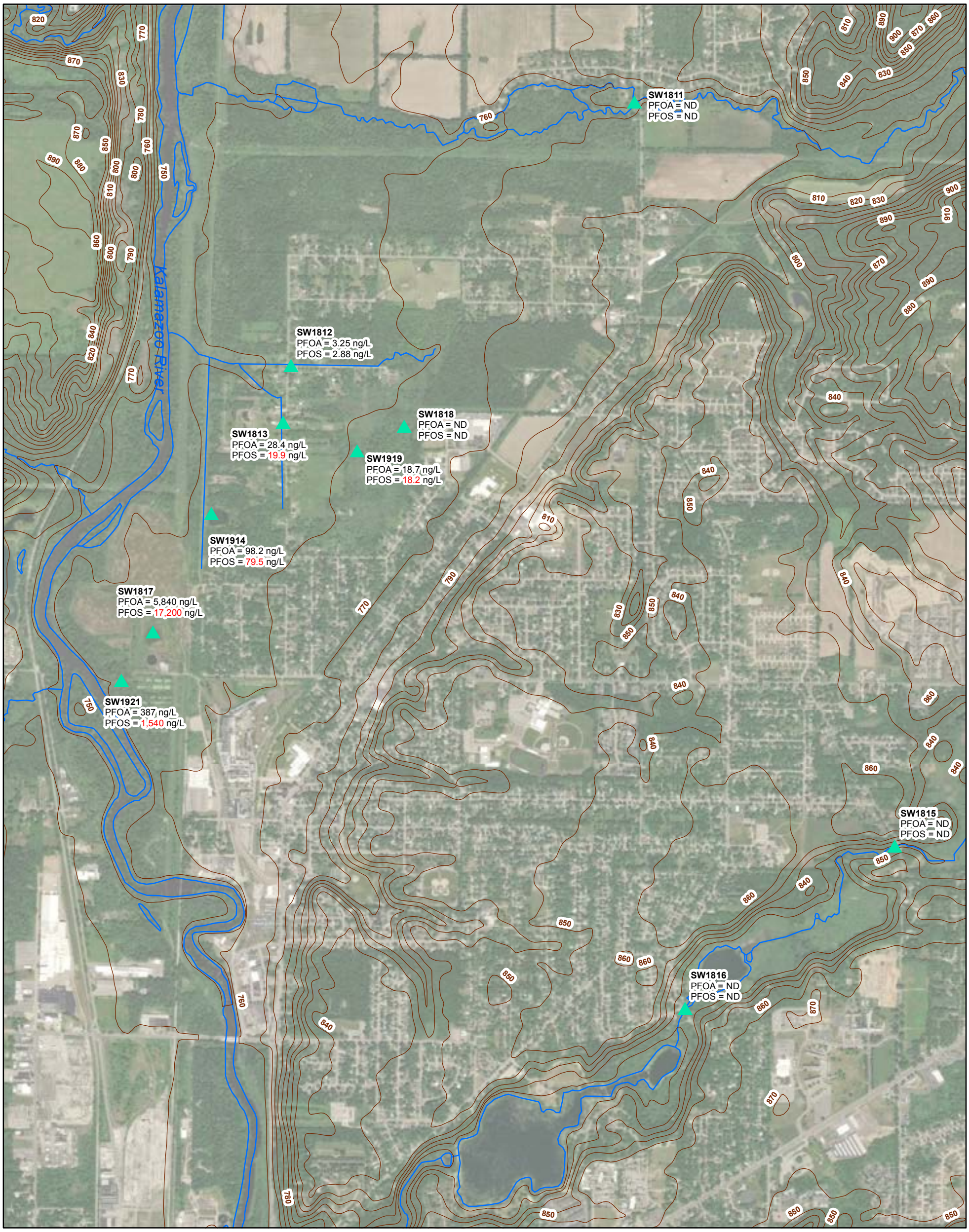
P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 2 - Study Area and MDEQ SRes_rev3.mxd



Notes:
1. Refer to Table 1 for explanation of the naming convention for the Landfill and Mill Wells. These wells were renamed from previous reports by others, for the purpose of distinguishing the same numbered wells from each other.
2. Monitoring wells (names begin with MW) were installed as a part of the Hydrogeologic Investigation conducted by Tetra Tech. Monitoring well locations were established by survey (refer to Table 1).
3. Landfill and Mill monitoring wells were installed as a part of previous investigations conducted by others. Landfill and Mill monitoring well locations were established by survey (refer to Table 1).
4. Nested monitoring wells (example MW1809A,C) were installed in one or more soil borings and have well screens at different depths within the subsurface (refer to Appendix D). "A" denotes the shallowest, "B" the intermediate, and "C" the deepest well within the nest. An intermediate well was not installed at all well nests (refer to Table 2).

ORIGINAL BY: MC	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 1/17/2019	**MONITORING WELL LOCATION MAP**
REVISED BY:LAS	FIGURE 3
DATE: 6/3/2019	

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 3 - Monitoring Well Location.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Surface Water Sample Location

Surface Water

Topopgraphic Contour (10 ft interval)

Notes:
1. 12 ng/L for PFOS and 12,000 ng/L for PFOA, are the Michigan Department of Environment, Great Lakes, and Energy, Rule 57 Nondrinking Water Human Health, Human Noncancer Valve. (HNV nondrinking)
2. Red text indicates the result is greater than the HNV Criteria.

Abbreviations:
ng/L = nanograms per liter
ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

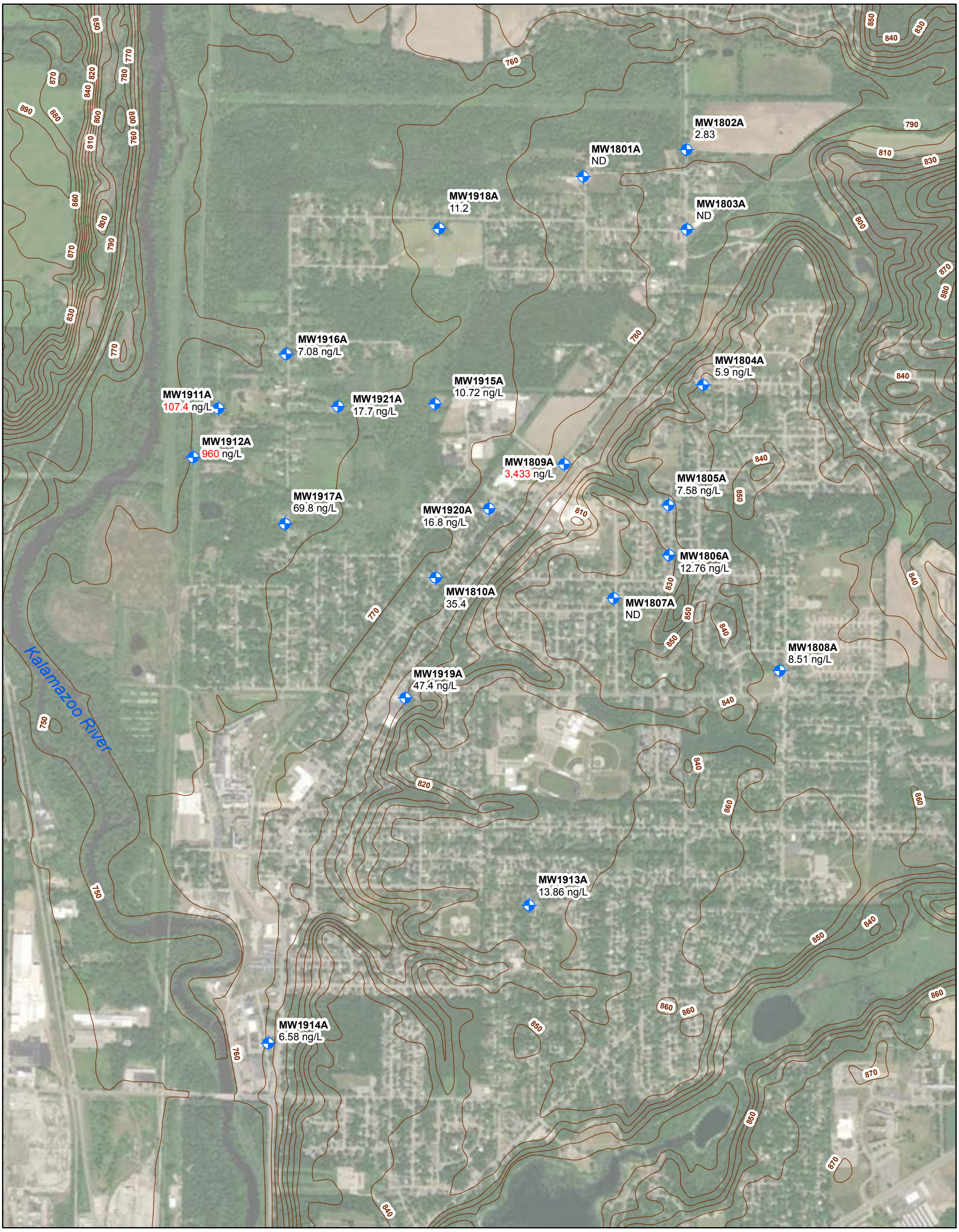
N

0 625 1,250 2,500

Feet

ORIGINAL BY: MC	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 1/17/2019	**PFOA AND PFOS ANALYTICAL RESULTS - SURFACE WATER**
REVISED BY: LAS	FIGURE 4
DATE: 6/3/2019	

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 4 - PFOA + PFOS Surface Water Analytical Results_GSI.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Monitoring Well - Unconfined Aquifer

Topopgraphic Contour (10 ft interval)

N

0 625 1,250 2,500

Feet

Notes:
1. Analytical results reflect the sum of PFOA and PFOS.
2. 70 nanograms per Liter (ng/L) for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018)
3. Red text indicates the result is greater than the Drinking Water Criteria.
4. Refer to notes on Figure 3 regarding monitoring well names and locations.

Abbreviations:
ng/L = nanograms per liter
ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

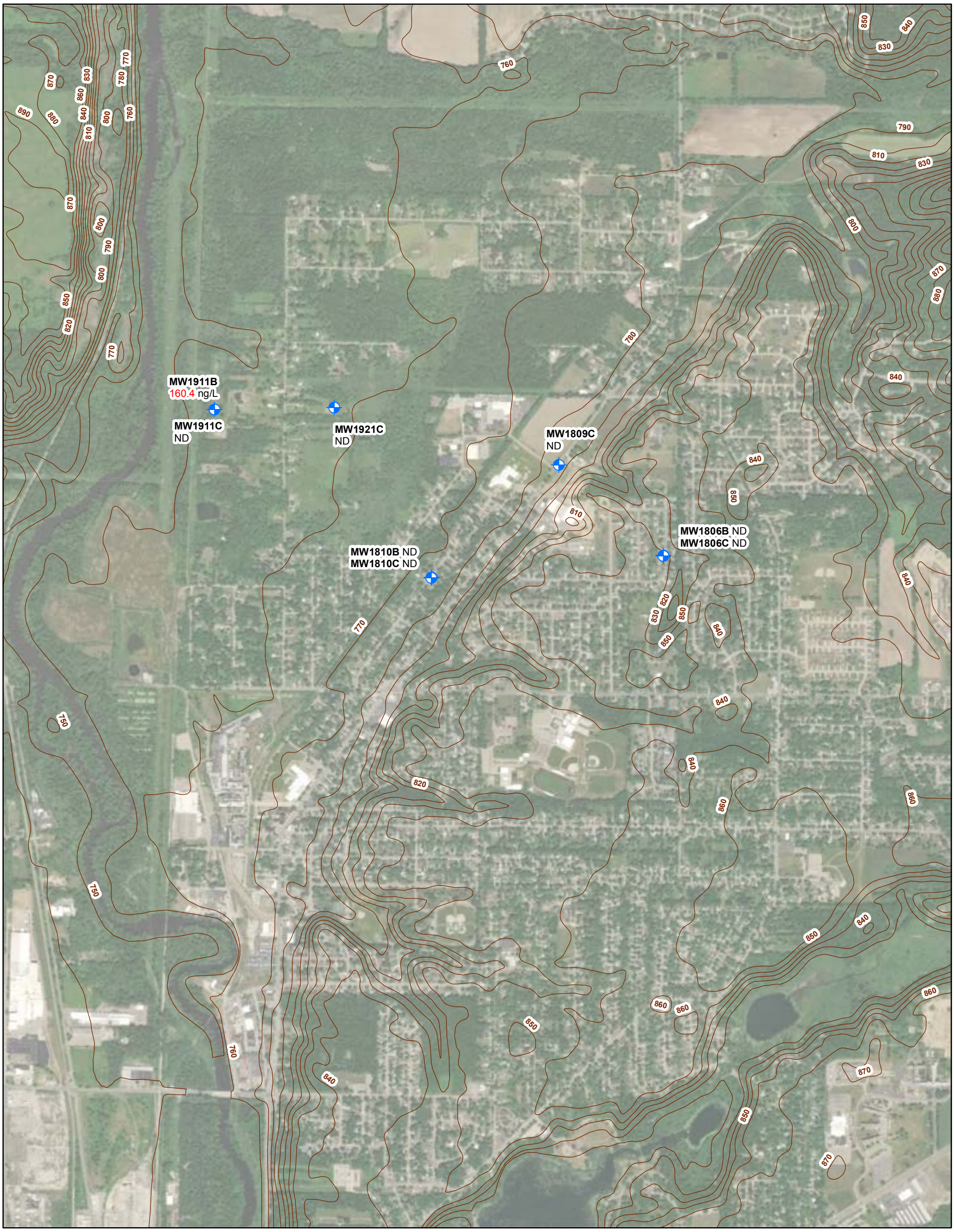
ORIGINAL BY:	MC
DATE:	1/17/2019
REVISED BY:	JMM
DATE:	5/31/2019

HYDROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

PFOA PLUS PFOS ANALYTICAL RESULTS - UNCONFINED AQUIFER

FIGURE
5

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 5 - PFOA + PFOS Analytical Results_WT_rev1.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Monitoring Well - Semi-confined/Confined Aquifer

Topopgraphic Contour (10 ft interval)

N

0 625 1,250 2,500

Feet

Abbreviations:
ng/L = nanograms per liter
ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

Notes:
1. Analytical results reflect the combined total of PFOA and PFOS.
2. 70 nanograms per Liter (ng/L) for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018)
3. Red text indicates the result is greater than the Drinking Water Criteria.
4. Refer to notes on Figure 3 regarding monitoring well names and locations.

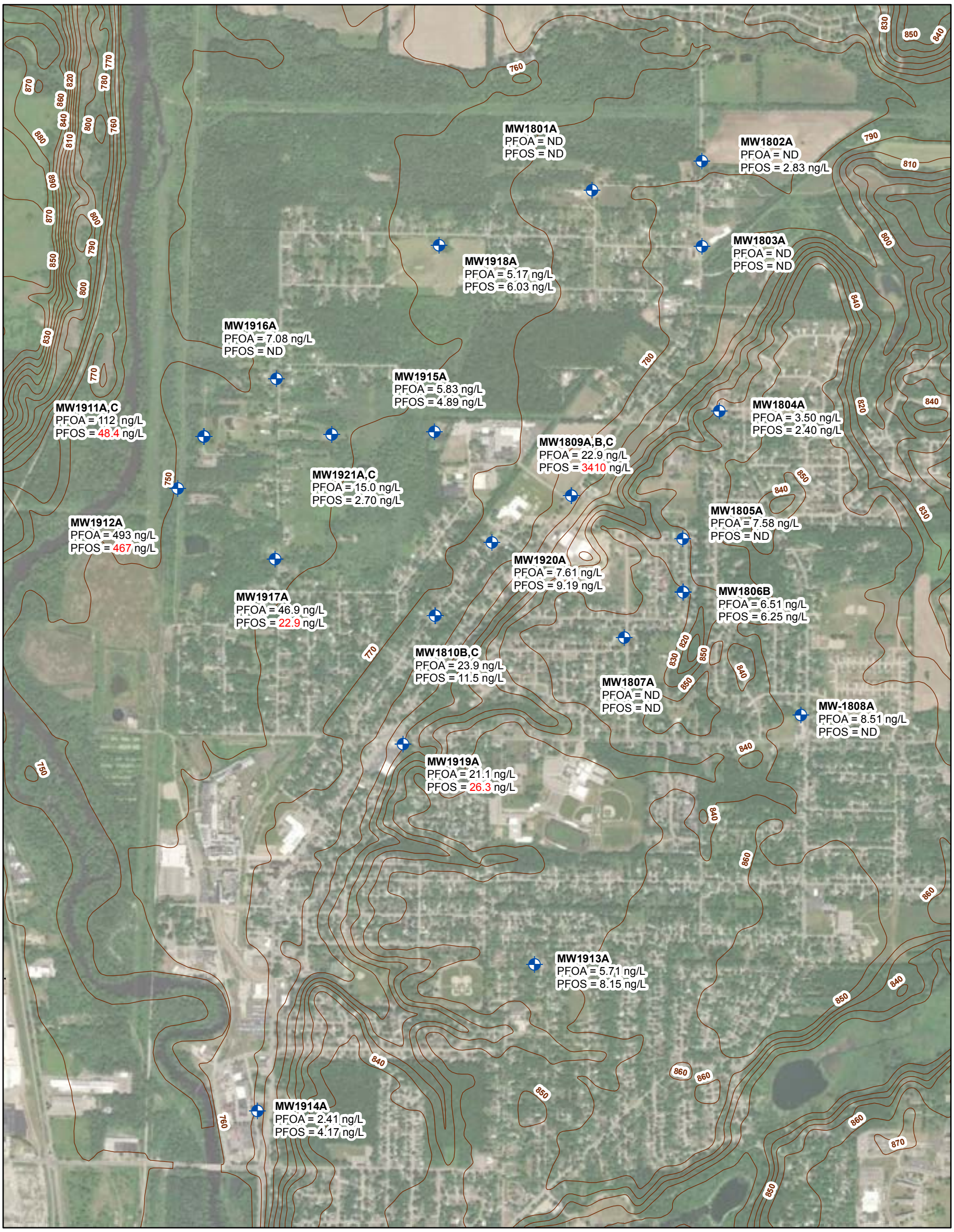
ORIGINAL BY:	MC
DATE:	1/17/2019
REVISED BY:	JMM
DATE:	5/31/2019

HYDROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

PFOA PLUS PFOS ANALYTICAL RESULTS - SEMI-CONFINED/CONFINED AQUIFER

FIGURE
6

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 6 - PFOA + PFOS Analytical Results_SC-C Aquifer.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Monitoring Well

Topopgraphic Contour (10 ft interval)

N

0 625 1,250 2,500

Feet

Notes:
1. 12 ng/L for PFOS and 12,000 ng/L for PFAS, are the Michigan Department of Environment, Great Lakes, and Energy Groundwater to Surface Water Interface (GSI) Criteria per Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, ant the Part 201 Administrative Rules, Table 1. (June 25, 2018)
2. Red text indicates the result is greater than the GSI Criteria.
3. Refer to notes on Figure 3 regarding monitoring well names and locations.

Abbreviations:
ng/L = nanograms per liter
ND = Not detected
PFOA = Perfluorooctanioic acid
PFOS = Perfluorooctane sulfonate

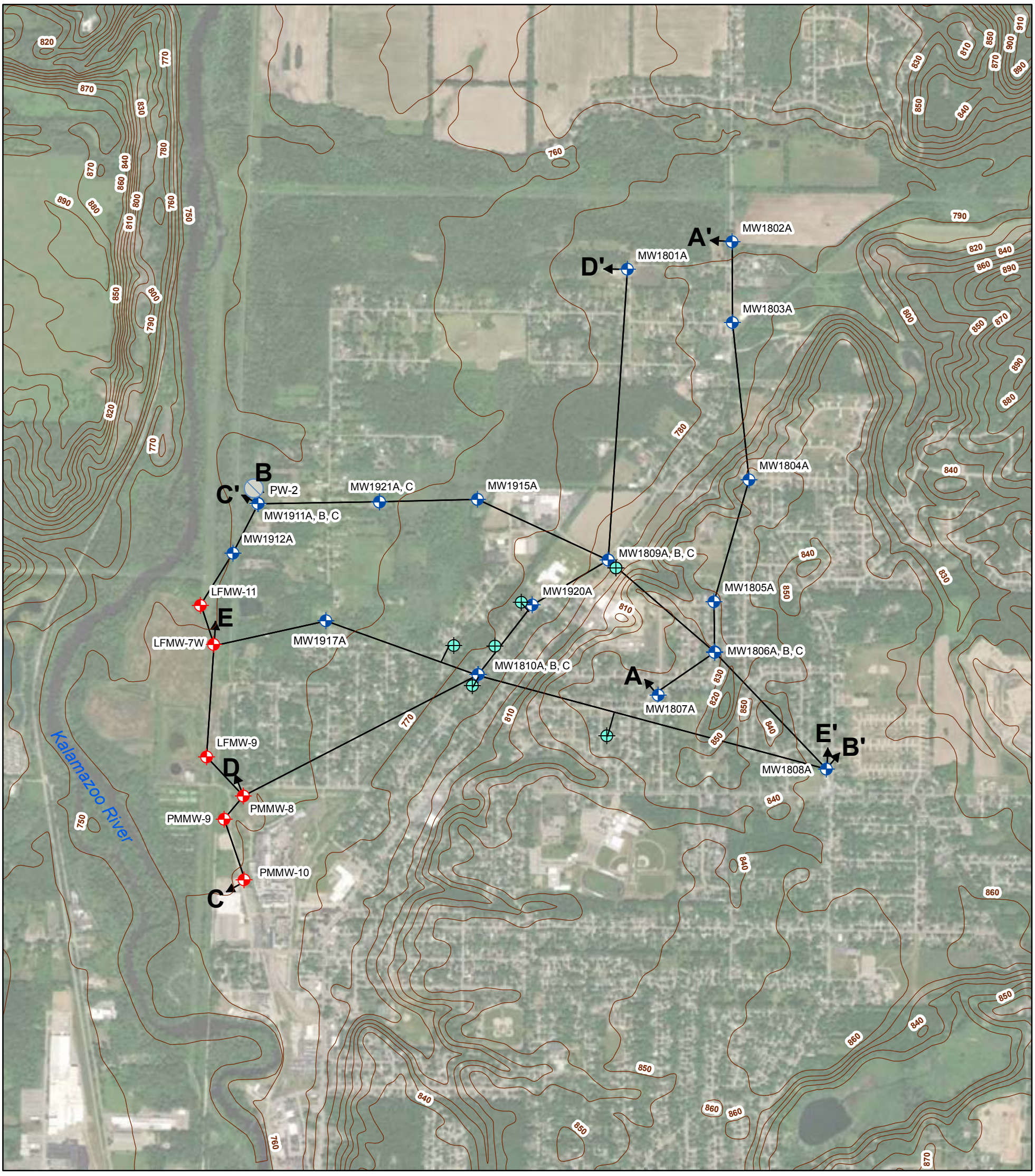
ORIGINAL BY:	LAS
DATE:	4/10/2019
REVISED BY:	JMM
DATE:	5/31/2019

HYGROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

GSI EVALUATION - GROUNDWATER

FIGURE
7

Document Path: P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 7 - GSI Evaluation - Groundwater_rev1.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

- Residential Well
- Study Monitoring Well
- Landfill / Mill Monitoring Well
- Former City of Parchment Municipal Well
- Topographic Contour (10 ft interval)
- Cross Section Orientation Line
  Arrows Denote Direction of View

N

0 625 1,250 2,500 Feet

Notes:
1. Refer to Table 1 for explanation of the naming convention for the Landfill and Mill Wells. These wells were renamed from previous reports by others, for the purpose of distinguishing the same numbered wells from each other.
2. Monitoring wells (names begin with MW) were installed as a part of the Hydrogeologic Investigation conducted by Tetra Tech. Monitoring well locations were established by survey (refer to Table 1).
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ORIGINAL BY:	MC
DATE:	1/17/2019
REVISED BY:	LAS
DATE:	5/31/2019

HYDROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

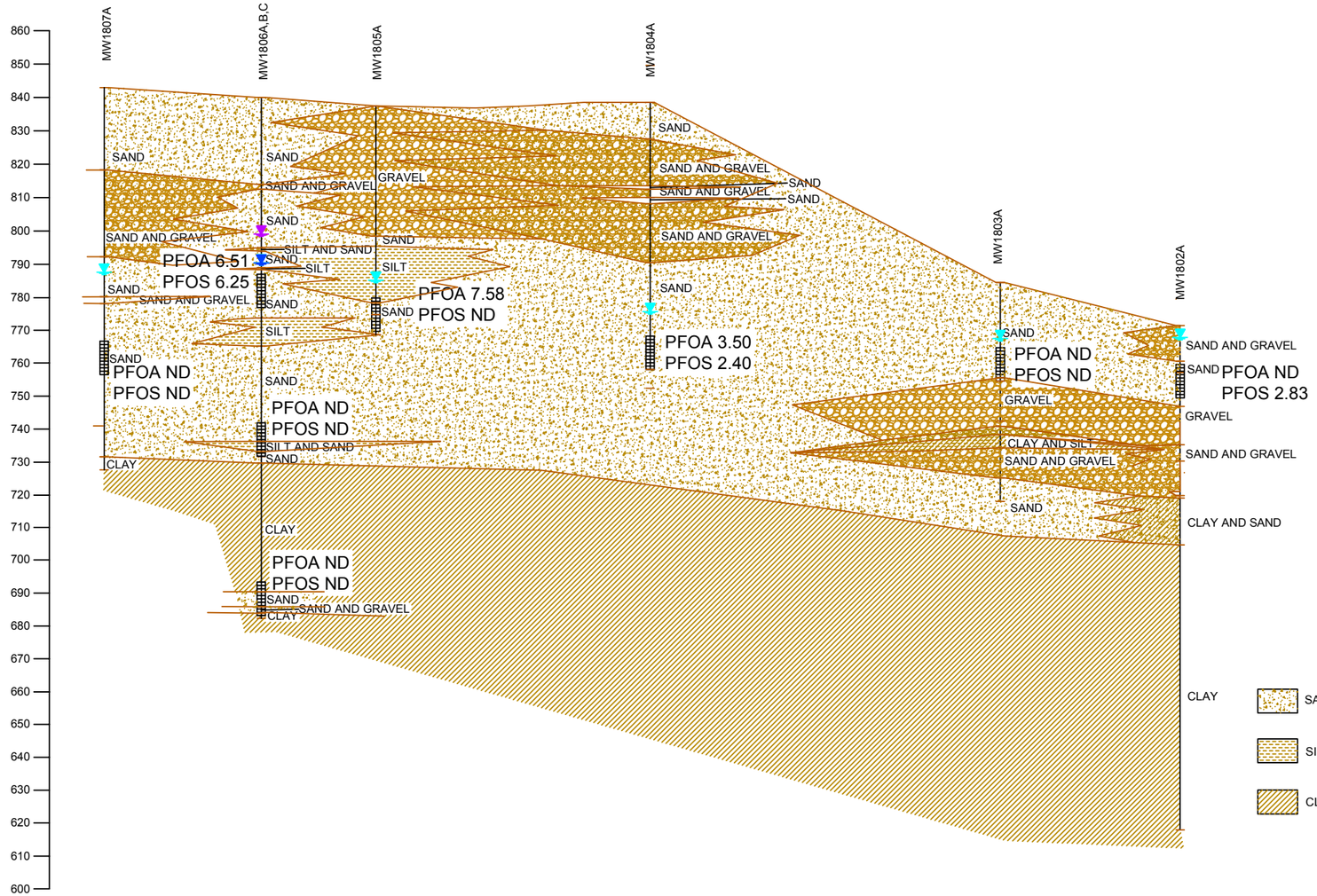
GENERALIZED GEOLOGIC CROSS SECTION ORIENTATION MAP

FIGURE
8

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 8 - Generalized Geo X Section Orientation Map.mxd

A
SOUTH

A'
NORTH



NOTES

1. Geology is generalized from soil boring logs for monitoring wells installed by Tetra Tech (name starts with MW). Please refer to soil boring logs for specific geology and well construction at each location.
2. Up to two monitoring wells were installed in the same soil boring. In some locations a third well was installed in a second boring. This map depicts all wells installed at the same location in a single pictorial. Table 1 and soil boring logs, provide the monitoring wells and their corresponding soil boring locations.
3. Sampling of landfill monitoring wells, mill monitoring wells, and residential wells was completed by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) in July and August 2018.
4. Sampling of monitoring wells installed by Tetra Tech was completed in December 2018, January, February, and March 2019.
5. Results are presented in nanograms per Liter (ng/L).
6. 70 ng/L for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018).
7. Red text indicates the result is greater than the Drinking Water Criteria.
8. 12 ng/L for PFOS and 12,000 ng/L for PFOA, are the EGLE Groundwater to Surface Water Interface (GSI) Criteria per Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules, Table 1. (June 25, 2018).
9. Italicized text indicates the result is greater than the GSI Criteria.
10. Where information on soil type is absent, no information is provided.

ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

HORIZONTAL SCALE
800’ 400’ 0 800’ 1600’

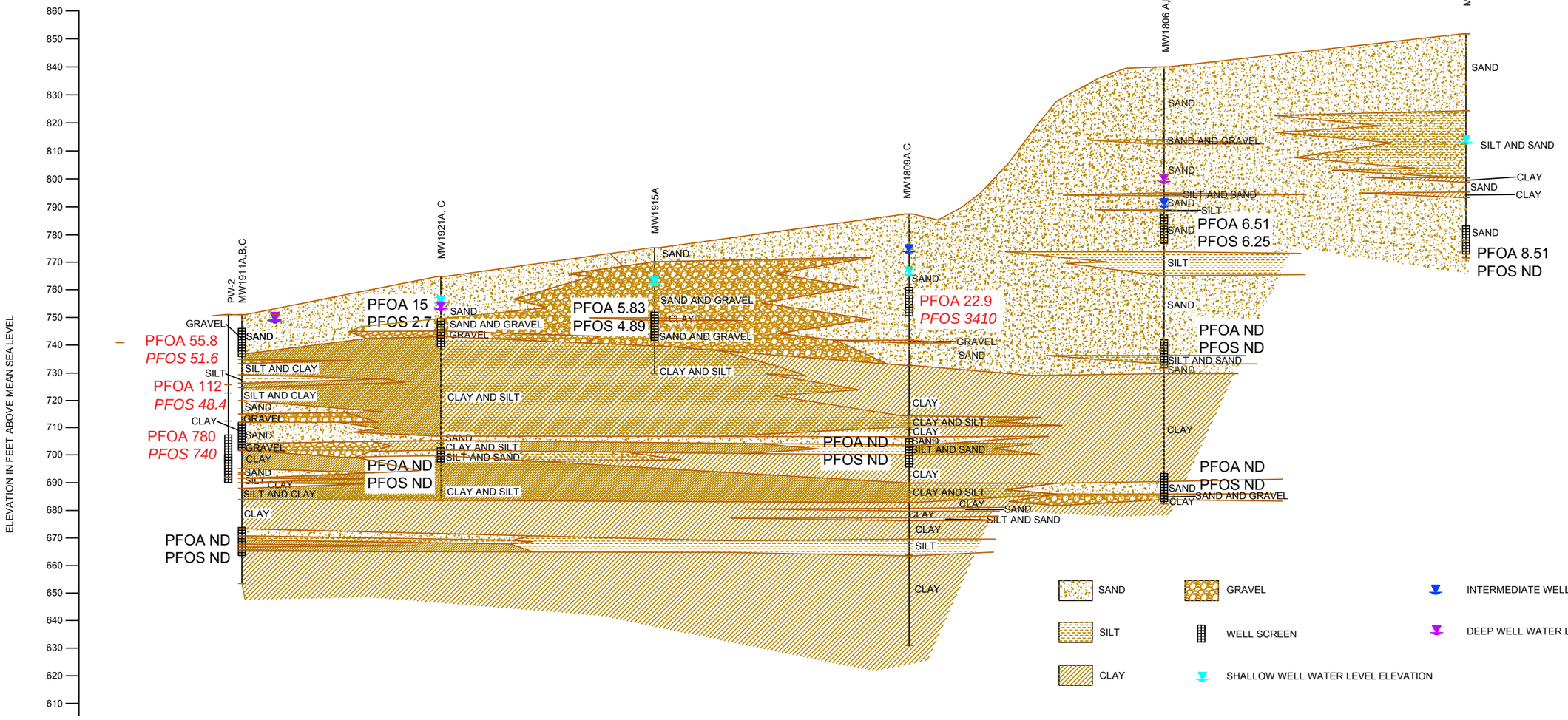
SCALE: 1” = 800’

(20 TIMES TIMES VERTICAL EXAGGERATION)

ORIGINAL: JDW	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN GENERALIZED GEOLOGIC CROSS SECTION A - A'
DATE: 2/28/2019	
EDITED: JMM	
DATE: 5/31/2019	FIGURE 9

B
WEST

B'
EAST



NOTES

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3. Sampling of landfill monitoring wells, mill monitoring wells, and residential wells was completed by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) in July and August 2018.
4. Sampling of monitoring wells installed by Tetra Tech was completed in December 2018, January, February, and March 2019.
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6. 70 ng/L for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018).
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8. 12 ng/L for PFOS and 12,000 ng/L for PFOA, are the EGLE Groundwater to Surface Water Interface (GSI) Criteria per Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules, Table 1. (June 25, 2018).
9. Italicized text indicates the result is greater than the GSI Criteria.
10. Where information on soil type is absent, no information is provided.

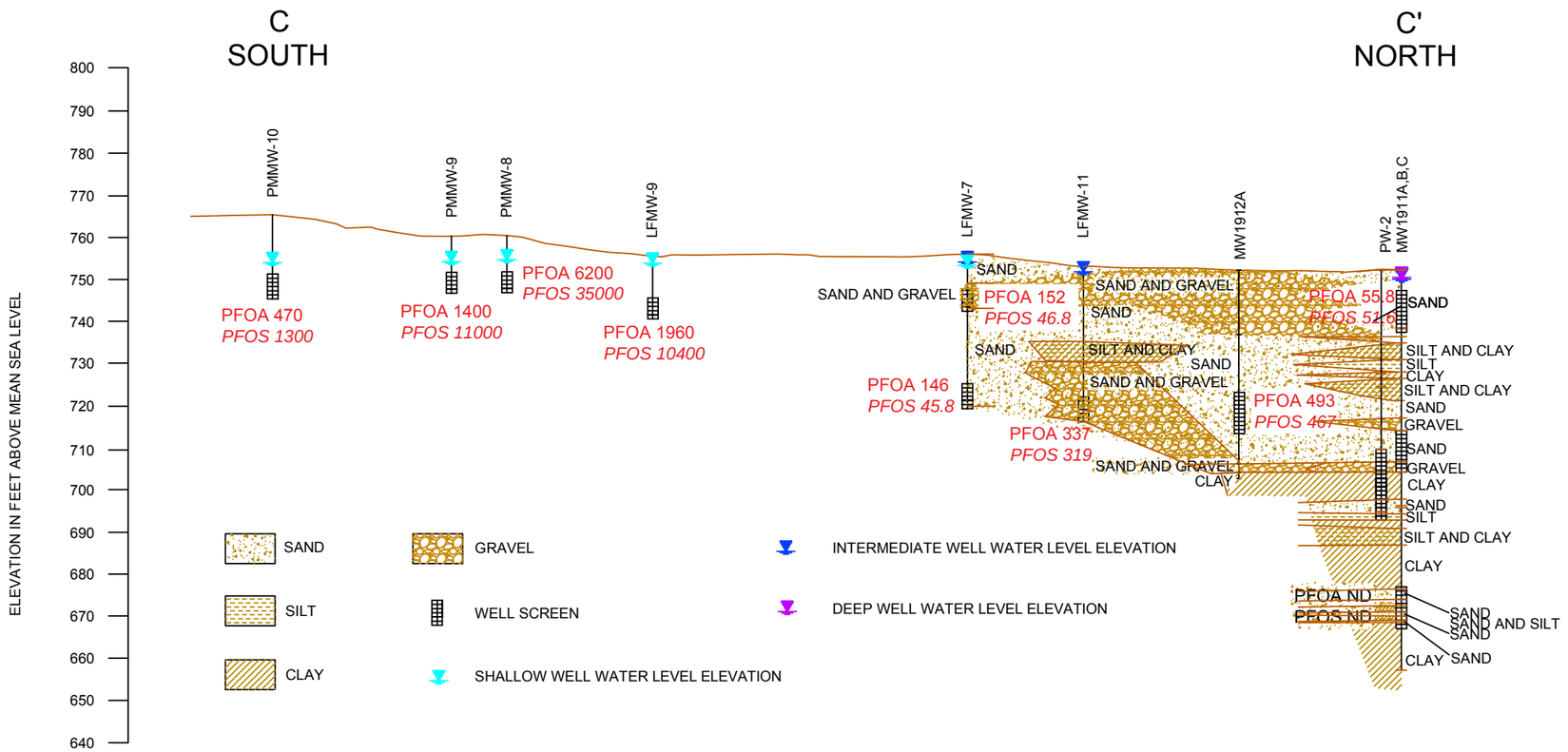
ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

HORIZONTAL SCALE
800’ 400’ 0 800’ 1600’

SCALE: 1” = 800’

(20 TIMES TIMES VERTICAL EXAGGERATION)

ORIGINAL: JDW	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 2/28/2019	GENERALIZED GEOLOGIC CROSS SECTION B - B'
EDITED: JMM	FIGURE 10
DATE: 5/31/2019	



NOTES

1. Geology is generalized from soil boring logs for monitoring wells installed by Tetra Tech (name starts with MW). Please refer to soil boring logs for specific geology and well construction at each location.
2. Up to two monitoring wells were installed in the same soil boring. In some locations a third well was installed in a second boring. This map depicts all wells installed at the same location in a single pictorial. Table 1 and soil boring logs, provide the monitoring wells and their corresponding soil boring locations.
3. Soil boring logs were not available for mill monitoring wells (name begins with PM) and some landfill monitoring wells(name begins with LF).
4. Sampling of landfill monitoring wells, mill monitoring wells, and residential wells was completed by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) in July and August 2018.
5. Sampling of monitoring wells installed by Tetra Tech was completed in December 2018, January, February, and March 2019.
6. Results are presented in nanograms per Liter (ng/L).
7. 70 ng/L for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018).
8. Red text indicates the result is greater than the Drinking Water Criteria.
9. 12 ng/L for PFOS and 12,000 ng/L for PFOA, are the EGLE Groundwater to Surface Water Interface (GSI) Criteria per Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules, Table 1. (June 25, 2018).
10. Italicized text indicates the result is greater than the GSI Criteria.
11. Where information on soil type is absent, no information is provided.

ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

HORIZONTAL SCALE
800’ 400’ 0 800’ 1600’
SCALE: 1” = 800’

(20 TIMES TIMES VERTICAL EXAGGERATION)

ORIGINAL: JDW
DATE: 2/28/2019
EDITED: JMM
DATE: 5/31/2019

HYDROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

GENERALIZED GEOLOGIC CROSS SECTION C - C'

FIGURE
11

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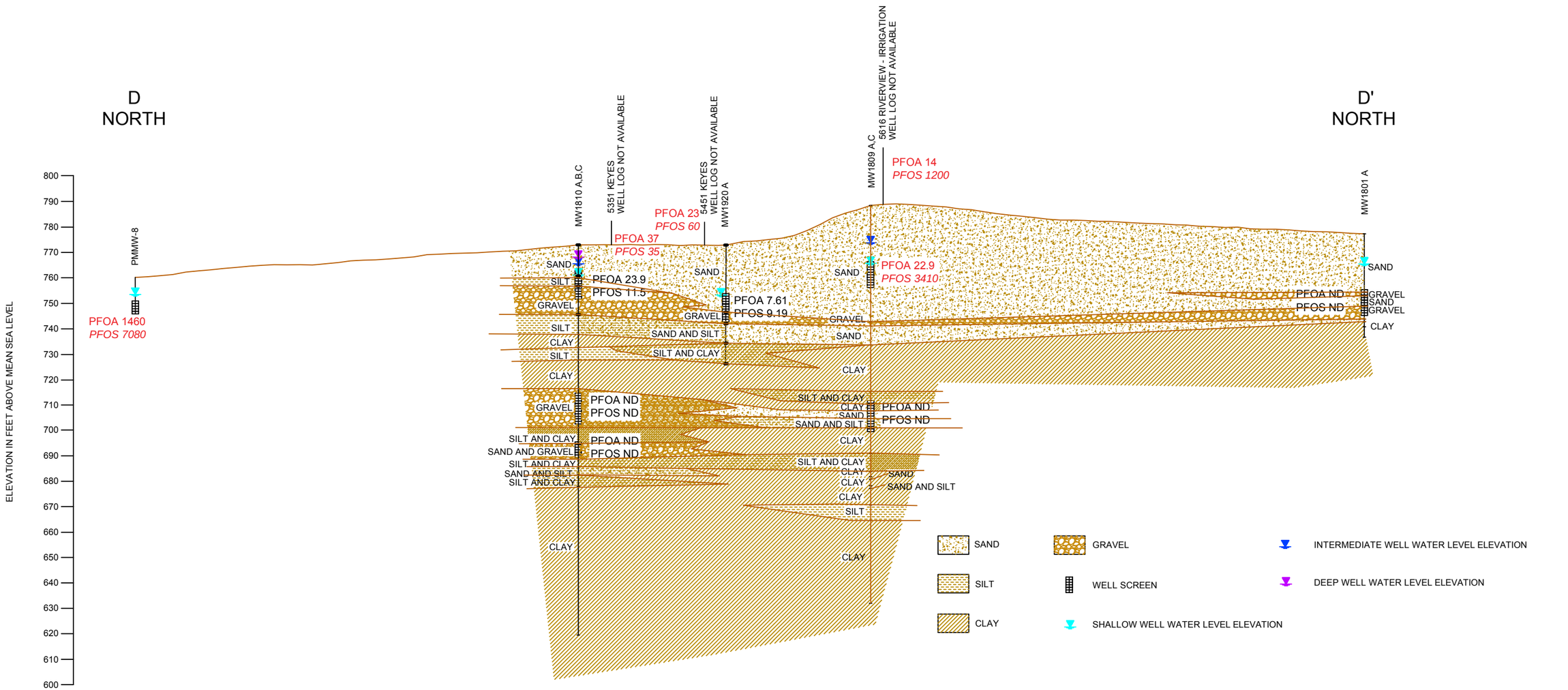

NOTES

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2. Up to two monitoring wells were installed in the same soil boring. In some locations a third well was installed in a second boring. This map depicts all wells installed at the same location in a single pictorial. Table 1 and soil boring logs, provide the monitoring wells and their corresponding soil boring locations.
3. Soil boring logs were not available for mill monitoring wells (name begins with PM).
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5. Sampling of monitoring wells installed by Tetra Tech was completed in December 2018, January, February, and March 2019.
6. Results are presented in nanograms per Liter (ng/L).
7. 70 ng/L for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018).
8. Red text indicates the result is greater than the Drinking Water Criteria.
9. 12 ng/L for PFOS and 12,000 ng/L for PFOA, are the EGLE Groundwater to Surface Water Interface (GSI) Criteria per Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules, Table 1. (June 25, 2018).
10. Italicized text indicates the result is greater than the GSI Criteria.
11. Where information on soil type is absent, no information is provided.

ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

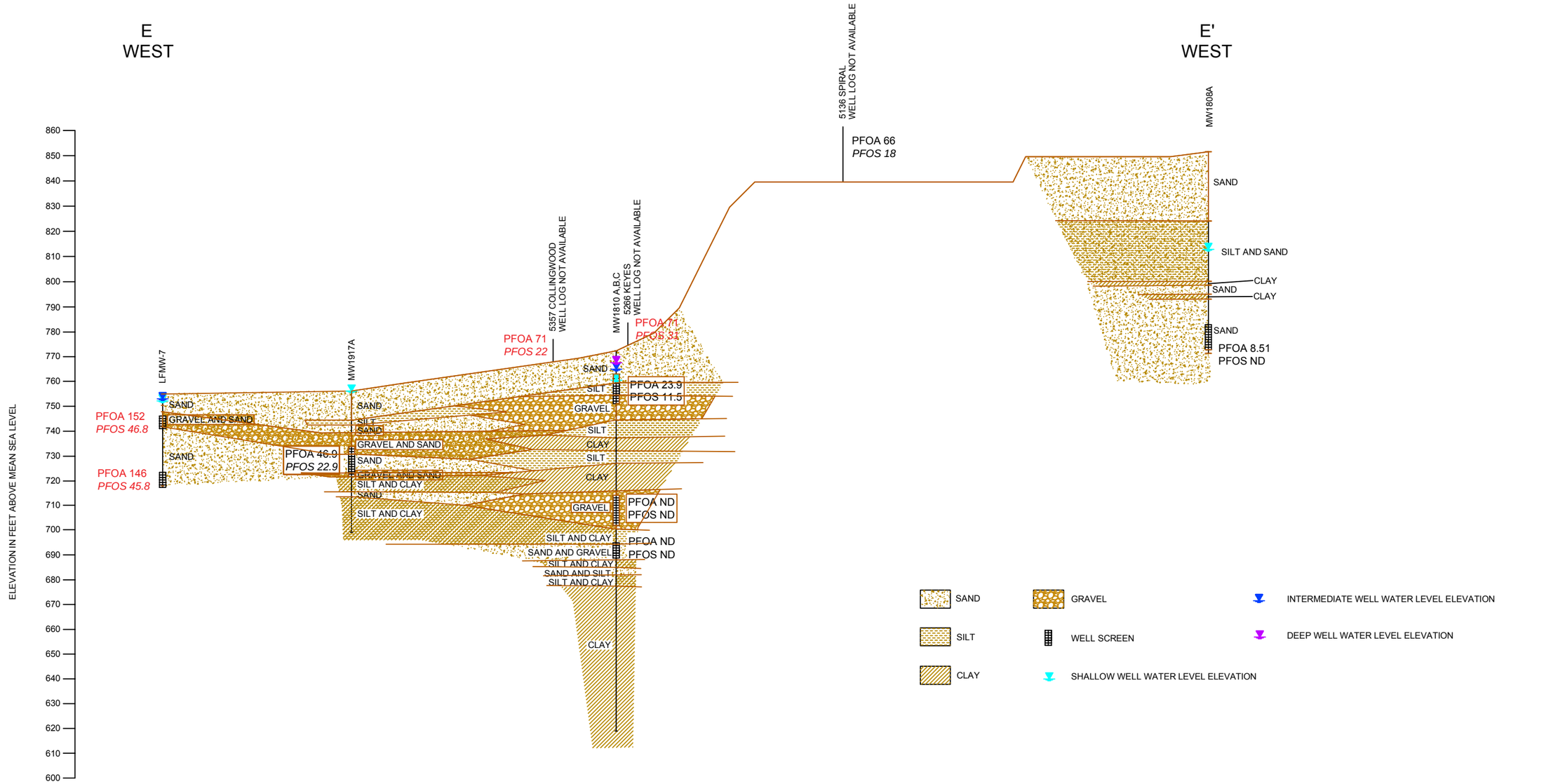
HORIZONTAL SCALE
800’ 400’ 0 800’ 1600’
SCALE: 1” = 800’

(20 TIMES TIMES VERTICAL EXAGGERATION)

ORIGINAL: JDW	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 2/28/2019	GENERALIZED GEOLOGIC CROSS SECTION D - D'
EDITED: JMM	FIGURE 12
DATE: 5/31/2019	

E
WEST

E'
WEST



NOTES

1. Geology is generalized from soil boring logs for monitoring wells installed by Tetra Tech (name starts with MW). Please refer to soil boring logs for specific geology and well construction at each location.
2. Up to two monitoring wells were installed in the same soil boring. In some locations a third well was installed in a second boring. This map depicts all wells installed at the same location in a single pictorial. Table 1 and soil boring logs, provide the monitoring wells and their corresponding soil boring locations.
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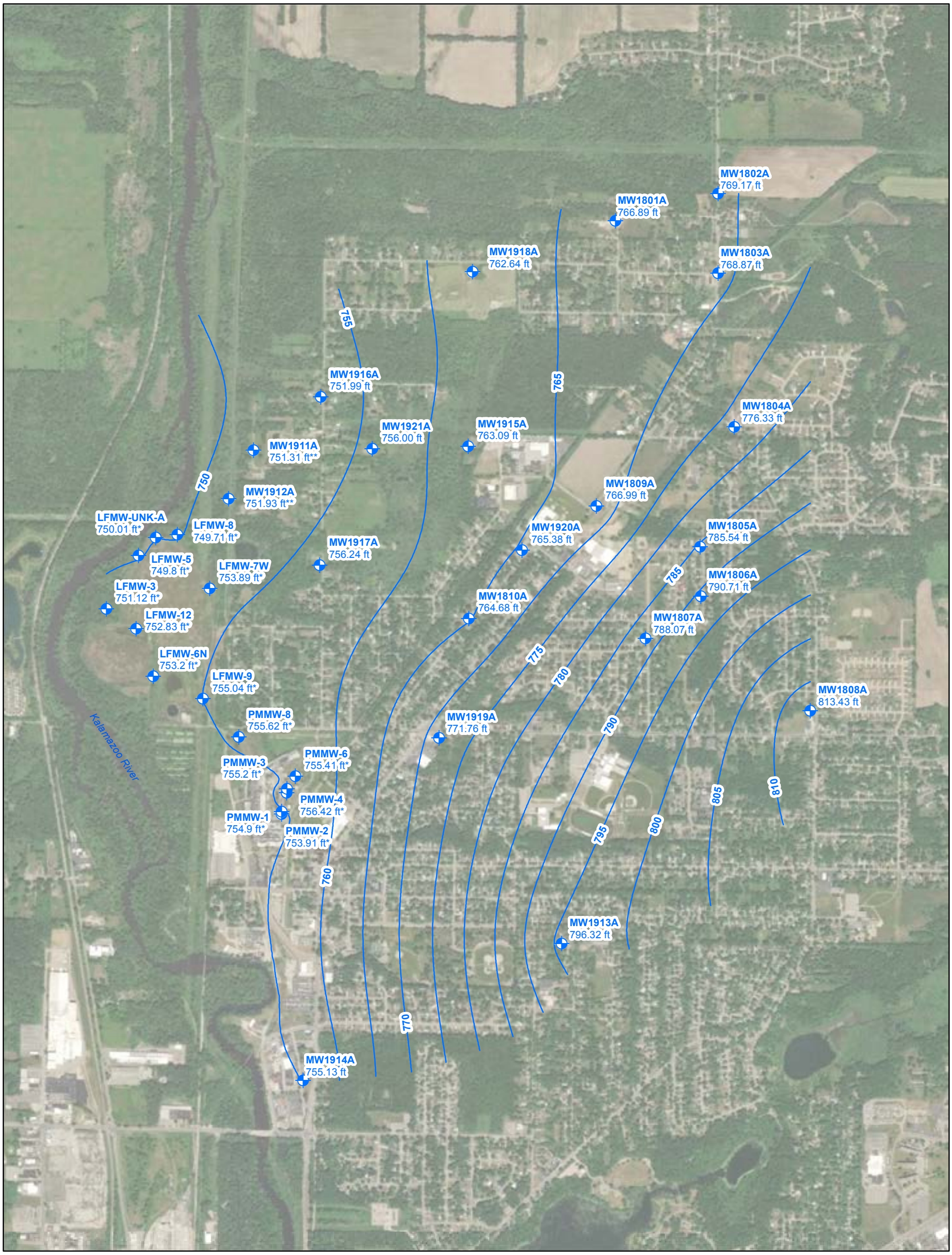
10. Italicized text indicates the result is greater than the GSI Criteria.
11. Where information on soil type is absent, no information is provided.

ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

HORIZONTAL SCALE
800’ 400’ 0 800’ 1600’
SCALE: 1” = 800’

(20 TIMES TIMES VERTICAL EXAGGERATION)

ORIGINAL: JDW	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 2/28/2019	GENERALIZED GEOLOGIC CROSS SECTION E - E'
EDITED: JMM	FIGURE 13
DATE: 5/31/2019	



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Monitoring Well - Unconfined Aquifer

Groundwater Elevation Contour - Unconfined Aquifer

N

0 625 1,250 2,500

Feet

Notes:
1. Contours generated with Surfer 15 software using default settings.
2. Contour interval = 5 feet.
3. Groundwater elevation in feet above mean sea level.
4. Water Table Aquifer data collected on February 14, 2019.
5. *Well log not available. Estimated to be in the Unconfined Aquifer based on well depth.
6. ** Water Table Aquifer data collected on March 6, 2019.
7. Refer to notes on Figure 3 regarding monitoring well names and locations

ORIGINAL BY: MC	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 1/17/2019	
REVISED BY: JMM	**GROUNDWATER ELEVATION CONTOUR MAP - UNCONFINED AQUIFER**
DATE: 5/31/2019	FIGURE 14

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 14 - GW Elevation Contour-WT.mxd

Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Montioring Well - Semi-confined / Confined Aquifer

Groundwater Elevation Contour - Semi-Confined / Confined Aquifer

0 625 1,250 2,500 Feet

N

Notes:
1. Contours generated with Surfer 15 software using default settings.
2. Contour interval = 2 feet.
3. Semi-Confined / Confined Aquifer elevation in feet above mean sea level.
4. Semi-Confined / Confined Aquifer data collected on February 14, 2019.
5. *Well log not available. Estimated to be in the Semi-Confined / Confined Aquifer based on well depth.
6. Refer to notes on Figure 3 regarding monitoring well names and locations.

ORIGINAL BY:	MC
DATE:	1/17/2019
REVISED BY:	JMM
DATE:	4/29/2019

HYDROGEOLOGIC INVESTIGATION REPORT
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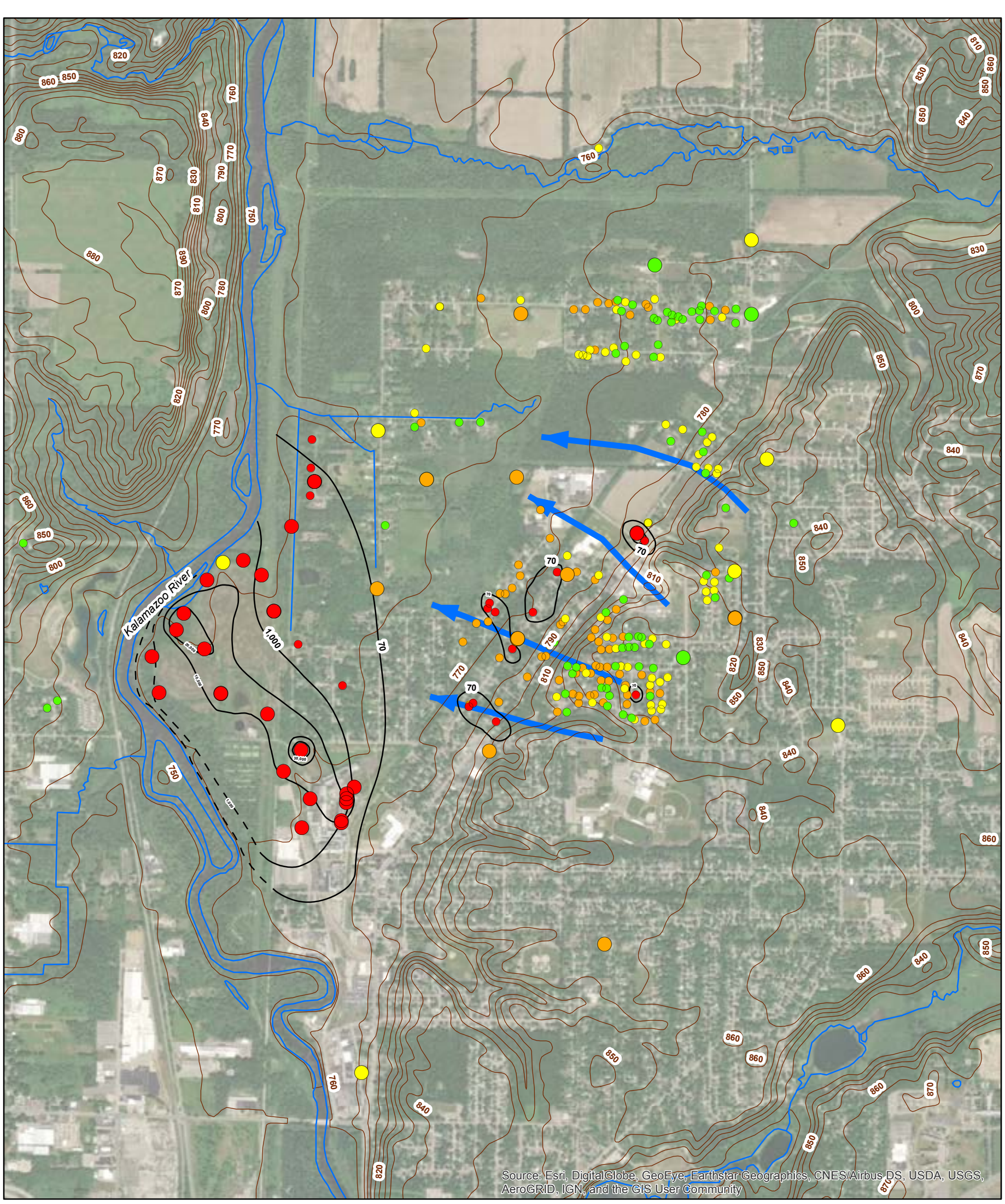
GROUNDWATER ELEVATION CONTOUR MAP - SEMI-CONFINED/CONFINED AQUIFER

FIGURE
15

Document Path: P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 15 - GW Elevation Contour-SC_C Aquifer.mxd



PFOA plus PFOS - Monitoring Well*

- ND above RL
- RL - 10 ng/L
- >10 ng/L - 70 ng/L
- >70 ng/L

PFOA plus PFOS - Residential or Municipal Well**

- ND above RL
- RL - 10 ng/L
- >10 ng/L - 70 ng/L
- >70 ng/L

- PFOA plus PFOS Isocontour
- Inferred PFOA plus PFOS Isocontour
- Surface Water
- Topopgraphic Contour (10 ft interval)
- Groundwater Flow Direction - Unconfined Aquifer

*Larger symbol represtents Monitoring Well location.
**Smaller symbol represents Residential or Municipal Well location.

N

0 625 1,250 2,500

Feet

Notes:

1. PFOA plus PFOS isocontours were estimated based on the lateral distribution of concentrations.
2. Isocontours estimate lateral distributipon of the same concentration of PFOA plus PFOS.
3. Sampling of landfill monitoring wells, mill monitoring wells, municipal and residential wells was completed by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) in July and August 2018. (Appendix A)
4. Sampling of wells installed by Tetra Tech was completed in December 2018, January, February and March 2019.
5. Refer to notes on Figure 3 regarding monitoring well names and locations.

Abbreviations:
ng/L = nanograms per liter
ND = Not detected
RL = Reporting Limit
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

ORIGINAL BY:	LAS
DATE:	11/29/2018
REVISED BY:	LAS
DATE:	6/4/2019

HYDROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

PFOA PLUS PFOS ISOCONCENTRATIONS AND GROUNDWATER FLOW DIRECTION

FIGURE
16

Document Path: P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 16 - PFOA + PFOS Isoconcentrations _Shallow Aquifer.mxd