Response Activity Plan for PFAS
3769 Cannonsburg Road, NE
Belmont, Michigan
Site ID: 41000048

Prepared for:
Northeast Gravel Company

Project No. 181258
August 29, 2019




Fishbeck, Thompson, Carr & Huber, Inc.
engineers | scientists | architects | constructors

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List of Abbreviations/Acronyms

BCDC	Boulder Creek Development Company
bgs	below ground surface
CSM	conceptual site model
DWC	Drinking Water Criteria
EGLE	Michigan Department of Environment, Great Lakes, and Energy
GSI	Groundwater/Surface Water Interface
MDEQ	Michigan Department of Environmental Quality
NREPA	Natural Resources and Environmental Protection Act
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
ppt	parts per trillion
RAP	Remedial Action Plan
SOP	Standard Operating Procedure

1.0 Introduction

Fishbeck, Thompson, Carr & Huber, Inc. (Fishbeck) has prepared this response activity plan (RA Plan) for the Northeast Gravel Company Site (formerly known as 4300 Cannonsburg Road), 3769 Cannonsburg Road, NE, Belmont, Kent County, Michigan; Facility ID No. 41000048 (the Site). This RA Plan has been prepared to provide the scope of work for response activities outlined in the Michigan Department of Environment, Great Lakes, and Energy (EGLE) letter dated July 24, 2019. The site location is shown on Figure 1S – Site Plan South, and Figure 1N - Site Plan North.

This RA Plan presents and summarizes existing information related to the site history, site geology, site hydrogeology, and groundwater flow to develop a preliminary conceptual site model (CSM). The preliminary CSM will serve as a guide for site investigation activities and will be continuously updated as additional site investigation data are generated throughout this response activity. This RA Plan presents an initial scope of work to begin to evaluate the Part 201 obligations under the Natural Resources and Environmental Protection Act (NREPA) 1994 PA 451, as amended. The goals of the work described in this RA Plan are to meet all Part 201 requirements related to site characterization and potential response activities. Following the initial scope of work, it is expected that additional sampling, investigation, or other response activities may be required. If an additional scope of work is required, a review of the work completed will be conducted, and approval of work proposed will be obtained in accordance with the EGLE letter dated July 24, 2019.

2.0 Background and Site History

The Site, as it exists today, comprises three separate operation areas. The western area of the Site is an active sand and gravel mine that is operated by the Grand Rapids Gravel Company (see Figure 1S). The eastern area of the Site was previously a sand and gravel mine and landfill area owned and operated by Northeast Gravel Company. The mining and landfill operations in the eastern area of the Site have been completed and the landfill was closed in 1997. In that same year, Boulder Creek Development Company (BCDC) purchased the Site and redeveloped the area into a golf course and residential development (see Figure 1S). BCDC and Grand Rapids Gravel are sister companies. The northern area of the site, north of 7 Mile Road, is also occupied by a residential development and includes seven holes of the golf course. No sand and gravel mining or landfill activities have been conducted on the northern area of the site (see Figure 1N).

Historically, the eastern portion of the Site included a tannery waste landfill, an electroplating waste landfill, and a municipal solid waste landfill. Extensive geologic, hydrogeologic, and environmental investigations were conducted in the eastern area of the Site to meet the applicable regulations under the guidance and review of the MDEQ.

The eastern area of the Site was closed by meeting all applicable MDNR/MDEQ requirements that were in place at the time under Act 307 and Act 451, Part 201. A Remedial Site Investigation Report was completed and submitted to the MDEQ in October 1994. A Remedial Action Plan (RAP) was completed and submitted to the MDEQ in 1995. A RAP Amendment was submitted to the MDEQ on April 1, 1996. The RAP and its amendment were approved by the MDEQ on May 8, 1996. A RAP Certification Report was completed and submitted to the MDEQ in August 1997. All site investigation work, site remedial design work, and all site remedial system construction work was reviewed for compliance based on the regulatory requirements in place at the time of each submittal. All final submittals were approved by the MDEQ as fulfilling or exceeding all applicable regulatory requirements.

Irrigation of the golf course and green spaces uses surface water that was impacted with per- and polyfluoroalkyl substances (PFAS) from the former landfill cell containing tannery sludge generated by Wolverine

Worldwide. Irrigation using potentially impacted surface water was conducted at the site from 1996 to the present.

The currently active sand and gravel mining operation on the western area of the Site has been investigated and is currently operating to meet all EGLE requirements under Rule 323.2221, Part 22 Rules, Part 31, of the NREPA. Additional information for this area is provided below (see Section 2.1).

2.1 Active Mining Area

Grand Rapids Gravel currently operates a gravel and sand mining operation at 7 Mile Road and Brewer Road in Plainfield Township, Kent County, Michigan (see Figure 1S). The mining operation includes discharge of gravel wash-water to the underlying soils. Because the wash-water includes a chemical additive to remove clay minerals from suspension, a full groundwater discharge permit was required rather than a general permit. The full permit required additional information including a hydrogeological study of the Site area pursuant to Rule 323.2221, Part 22 Rules, Part 31, of the NREPA. Since 2003, annual groundwater monitoring has been conducted at the Site as required under the groundwater discharge permit. All sand and gravel mining operations at the Site have continuously met MDEQ requirements and all investigation, monitoring, and reporting has been approved by the MDEQ.

Numerous geologic studies were conducted prior to the start of the mining operation. These studies included the completion of more than 80 borings to various depths, which were drilled at differing stages of the site development. These investigations were completed to assess the sand/gravel resources and include drilling programs conducted during 1968, 1987, and an undated event. All available logs are on file at Fishbeck. The boring logs indicated an aquifer composed almost entirely of coarse-grained sand and gravel materials; very little silt or clay material was encountered.

In 2003, Fishbeck prepared the *Hydrogeologic Investigation Report Grand Rapids Gravel Company Gravel and Sand Mining Operation 7 Mile and Brewer Roads Plainfield Township, Michigan* (May 1, 2003). The 2003 hydrogeologic investigation report containing the extensive geologic and hydrogeologic site characterization was presented to the MDEQ in the "*Per- and Polyfluoroalkyl Substances Investigation Work Plan, 3769 Cannonsburg Road, NE Belmont, Michigan Site ID:41000048 (September 12, 2018).*" The September 12, 2018, Work Plan included figures, tables, and maps illustrating the site conditions, geologic cross-sections, groundwater flow direction, monitoring well construction, laboratory results, etc.

2.2 Historic Landfill Area

The historic landfill area of the Site received and disposed of various wastes from 1966 to 1980. During this time period, three main waste disposal areas were created: (1) a tannery waste area (1966 to 1980); (2) a plating waste area (1966 to 1977); and a (3) domestic refuse area (1966 to 1977). Numerous geologic and hydrogeologic investigations were conducted resulting in the MDEQ-approved closure for all of the former landfill areas. The investigation and remediation work conducted at the Site were extensive and met MDEQ requirements specified by State law. The investigation and remedial actions at the Site were documented in the following reports prepared by Fishbeck:

Remedial Investigation Report for Northeast Gravel Company Act 307 Site Plainfield Township, Michigan (October 1994). This report was provided in Appendix 2 of the September 12, 2018, Work Plan and includes figures, tables, and maps illustrating the site conditions, geologic cross-sections, groundwater flow direction, monitoring well construction, analytical results, etc.

Remedial Action Plan for Northeast Gravel Company Act 307 Site Plainfield Township, Michigan (November 1995). This report documented the basis for selecting appropriate remedial actions for the landfill areas based on all available data. This report is on file at Fishbeck.

The closure of the former landfill areas, as specified in the remedial action plan (November 1995), is documented in the *Remedial Action Plan Certification Report Northeast Gravel Company Act 307 Site Plainfield Township, Michigan* (August 1997). This report was provided to the MDEQ in Appendix 3 of the September 12, 2018, Work Plan and included the full documentation and certification of all response actions required in the RAP. All remedial work at the site was reviewed and approved by the MDEQ.

2.3 Golf Course, Condominiums, and Single-Family Homes

Following the completion of the soil and groundwater investigations at the Site and the closure of all landfill cells with MDEQ approval, a golf course, condominium, and single-family residential development was constructed at the Site. Development of the Site continues at this time. All residents of the Site are served by municipal drinking water and sewer service. See Figure 1N and Figure 1S.

3.0 Conceptual Site Model

3.1 Geologic Conditions in the Area South of 7 Mile Road

Based on the previous investigation work at the Site in the area south of 7 Mile Road, the native soil in the area of the Site is characterized by a mixture of medium sand, to gravelly sand, to gravel. The geology in the area north of 7 Mile Road has not been previously investigated.

The thickness of the coarser grained soils south of 7 Mile Road ranges from approximately 54 to 100 feet. The base of the sand/gravel unit is bounded by a glacial till unit. The till consists primarily of poorly sorted clay and silt with minor amounts of sand and gravel. A regionally extensive unconfined aquifer exists within the sand/gravel unit. The base of this aquifer is the till unit, which acts as an aquitard. In addition to the till unit, thin layers of clay (typically less than 1-foot thick) are also present within the sand and gravel unit. A shallow clay layer is present in the northern portion of the plating waste area that is the likely cause for the perched water pond that resides between the tannery and plating disposal areas. The geologic conditions at the Site are described in more detail and illustrated on maps and cross-sections that were previously submitted to the MDEQ in the September 12, 2018, Work Plan.

3.2 Geologic Conditions in the Area North of 7 Mile Road

Based on a limited review of Welllogic Well Logs available at www.geowebface.com, the area east of the golf course and north of 7 Mile Road is made up of a sequence of granular and cohesive soils typical of glacial moraine or ice contact glacial deposits. The residential water supply wells in this area are constructed in the glacial drift and are generally set in the depth interval between 55 and 182 feet below ground surface (bgs).

Based on a limited review of Welllogic Well Logs available at www.geowebface.com, the area west of the golf course and north of 7 Mile Road (the Bittersweet neighborhood) is made up of a sequence of granular and cohesive soils typical of glacial outwash or ice contact glacial deposits. The residential water supply wells in this area are constructed in either the glacial drift aquifer or underlying bedrock aquifer. Wells constructed in the glacial drift aquifer are generally set in the depth interval 33 to 97 feet bgs, while wells set in the bedrock aquifer are generally set in the depth interval 160 to 201 feet bgs.

3.3 Groundwater Flow Conditions

Groundwater flow in the area south of 7 Mile Road is predominantly south-southwest toward the Grand River (Figure 6 of Appendix 2 from the September 2018, Work Plan). Groundwater is commonly encountered between 28 and 33 feet bgs in the disposal areas. Groundwater occurs as an unconfined, water table aquifer. The surface

of the unconfined aquifer ranges from 1 to 9 feet below the bottom of the waste material. The saturated thickness of the shallow aquifer ranges from 47 to 90 feet depending on the underlying elevation of the clay aquitard. The calculated linear velocity of the groundwater flow ranges from 0.24 to 2.45 feet per day or 88 to 894 feet per year; accordingly, the groundwater travel time from the disposal areas would reach the Grand River in approximately 3.5 years.

Groundwater flow in the area north of 7 Mile Road has not previously been investigated. It is expected that the area north of 7 Mile Road overlies a largely glacial till sequence with a surface slope of the clay layer that is generally downward to the south and southwest. A shallow water table aquifer zone appears to be present in the Bittersweet neighborhood that is sufficient to support the use of the aquifer for residential water supply wells. The deeper water bearing zone in the Bittersweet neighborhood may be hydraulically connected or hydraulically isolated from the perched groundwater zone(s).

It is not currently known if a direct hydraulic connection exists between the irrigated area of the golf course north of 7 Mile Road to the surface water of Secluded Lake, or if one or more aquifer(s) might be present in the area east of the Site.

4.0 Scope of Work for Response Activity

Proposed response activities will include the following:

- Changing the existing irrigation system at the Site to first reduce the use of potentially PFAS-impacted water for irrigation and ultimately eliminate the use of potentially PFAS-impacted water for irrigation.
- Sampling residential water wells at homes located along or north of 7 Mile Road that are potentially vulnerable to PFAS impact from the past irrigation practices at the Site.
- Conducting groundwater investigation activities to fulfill the applicable Part 201 requirements.
- Providing alternate water supply or filter equipment to any groundwater-use locations that are found to exceed applicable Part 201 criteria that are directly attributed to past irrigation practices at the golf course.

The scope of work for these response activities anticipates the likely location of residential wells to sample, monitoring wells to be installed, groundwater samples to be collected and analyzed, staff gauges to be installed, and surface water samples to be collected and analyzed. As the geologic conditions in the area north of 7 Mile Road are somewhat unknown at this time, the actual scope of work for this investigation is expected to adjust based on the ongoing findings during the investigation. Adjustments to this anticipated scope of work will be coordinated with EGLE. If adjustments to the scope of work are required, EGLE will be contacted for approval prior to performance of the work.

The goal of this scope of work is to meet the Part 201 requirements to identify if groundwater impact exceeding applicable Part 201 criteria is present and to define the horizontal and vertical extent of that impact and the factors controlling it. If unacceptable human exposure through the drinking water pathway are identified that are directly attributed to the past irrigation practices, alternate drinking water supplies (bottled water) will be provided until a filter system or suitable alternative can be arranged.

4.1 Irrigation Areas

Irrigation at the Site has been conducted for the past 24 years (1996 to present) using surface water obtained from the gravel pit pond located south of Cannonsburg Road as the source water. The irrigation water is pumped from the south pond to the irrigation holding ponds located near the southeast corner of the intersection of Brewer Road and 7 Mile Road. The irrigation holding ponds are constructed with an impermeable

bottom liner to hold the irrigation water and to prevent it from infiltrating into the sand and gravel soils that are present at that location.

Irrigation water held in the irrigation holding pond is pumped throughout the entire irrigation area of the golf course using below ground piping. Automatic valves, timers, and similar equipment control the movement of the water to all golf course tee areas, fairways, putting greens, driving range, and landscaped areas. Irrigation is not conducted every day. Irrigation is only conducted when needed to augment the natural precipitation at the Site.

The location of the irrigation system components is shown on the irrigation system schematic drawings contained in Appendix 1.

4.2 Irrigation Practices

4.2.1 Current Irrigation Practices

The golf course irrigation areas described in Section 4.1 above are irrigated between approximately May 1 and October 15 of each year. The irrigation system is operated during the evening/night-time hours when golfers are not present. The irrigation system is operated to augment the natural rainfall, to maintain soil moisture, and to provide healthy growing conditions needed to support the turf grass of the golf course and landscaped areas.

The past irrigation operation applied approximately 500,000 gallons of water to the entire golf course area during each cycle of operation. The irrigation system does not operate every night, as it is only operated to augment the natural rainfall. Typically, depending on the weather, the irrigation system operates 2 to 4 nights per week.

After October 15 of each year, the irrigation system is shut down and the below ground piping is “blown out” to prevent possible freezing conditions during the winter.

As of August 2019, BCDC has implemented irrigation conservation measures to reduce the quantity of irrigation water applied to the golf course. BCDC has greatly reduced the amount of irrigation water applied to the driving range area, which is also the majority location of the former Wolverine Worldwide Tannery waste landfill. Additionally, BCDC has implemented water conservation measures to reduce the application of irrigation water over the remainder of golf course areas. These water conservation measures, enacted in August 2019, have reduced the water application rates to approximately 250,000 gallons per irrigation cycle. These conservation/reduction methods have already reduced the use of PFAS-impacted irrigation water by approximately one-half of the previous rate.

4.2.2 Future Irrigation Practices

In addition to the irrigation water conservation measures that BCDC has already implemented, BCDC will make further short-term and long-term changes to the irrigation practices as follows:

4.2.2.1 Short-Term Changes to Irrigation Practices

BCDC will further change the operation of the irrigation system on a short-term basis (September – October 2019). The irrigation system currently extracts all of the irrigation water from the gravel pit pond south of Cannonsburg Road (“South Pond” on Figure 1S). This water has been shown to contain elevated concentrations of PFAS compounds. BCDC proposes to immediately modify the irrigation system, which is currently operating at approximately 250,000 gallons per irrigation cycle, by accessing the Plainfield Township water supply main along 7 Mile Road. Plainfield Township has indicated that 100,000 gallons of water can be obtained from that water main each irrigation cycle. The Plainfield Township Municipal water will be added to the irrigation holding pond near the southeast corner of 7 Mile Road and Brewer Road before each irrigation cycle so that the use of PFAS-impacted irrigation water can be reduced to approximately 150,000 gallons per

irrigation cycle. This proposed change to the short-term irrigation practices will result in a 70% reduction of the former use of PFAS-impacted irrigation water.

This proposed short-term change to the irrigation practices will continue until the long-term replacement of the source of irrigation water can be completed. The long-term change to the irrigation source water will be completed by May 1, 2020.

4.2.2.2 Long-Term Changes to Irrigation Practices

To fully stop the potential impact to the groundwater in the area of the golf course both north of 7 Mile Road and south of 7 Mile Road from irrigation practices, BCDC will eliminate the use of the south pond for the source of irrigation water. Instead, BCDC will move the pump intake structure and pump to the current mine pond located in the bottom of the active gravel mining area near the western-most side of the site (Figure 1S). The size of the lake in the current gravel mine area will be approximately 15 acres.

Fishbeck has conducted a preliminary analytical groundwater flow model to evaluate this proposed change of the irrigation water intake. The analytical groundwater flow model supports the conclusion that the proposed water intake is not expected to pull in the existing groundwater impact that originates from the former Wolverine Worldwide tannery waste landfill. The proposed long-term replacement of the source of irrigation water is expected to provide a water supply that meets both the current Part 201 drinking water criteria and groundwater-surface water interface (GSI) criteria for perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).

To ensure the water quality objectives will be met, samples of the current gravel mine pond water will be sampled and analyzed for PFAS. The long-term change to the irrigation source water will be completed by May 1, 2020.

4.3 Drinking Water Well Sampling, Analysis, and Alternate Water Supply

Private water wells may be present at land parcels shown on Figure 2. Due to the potential concern for drinking water exposure, it is recommended that residential drinking water wells be sampled in a progressive sequence. Because it is unknown if PFAS-impacted groundwater might be migrating offsite from the golf course area in any specific direction, multiple neighborhoods will be sampled at the same time. Samples will be collected from existing residential water supply wells in areas north, south, east, and west of the golf course area located north of 7 Mile Road. Initially, 13 residential well samples will be collected, plus one duplicate sample and one field blank sample for quality assurance/quality control (QA/QC) purposes. The recommended locations for the initial round of residential water supply well sampling is shown on Figure 3. After receiving the analytical results for the first round of samples, additional locations will be recommended based on the results of the first round.

To obtain permission to sample the proposed residential wells, request for sampling access letters will be sent for each location. Access will be requested first using written US Mail requests, followed-up by door-to-door requests for residences that do not reply to the mailed request.

Residential wells that are granted access for sampling will be sampled and analyzed to evaluate the potential presence of PFAS. The samples will be analyzed using USEPA Method 537 REV 1.1 for analysis of drinking water for 24 PFAS compounds. The wells will be sampled following the methods described in the Fishbeck Standard Operating Procedure (SOP) for *Residential Sampling Procedure for Per and Polyfluoroalkyl (PFAs)* presented in Appendix 2. The PFAS drinking water sample analyses will be conducted using an analytical laboratory providing Level 4 Data Quality Control. It is expected that PFAS analytical services will be provided by Pace Analytical, ALS, Test America, or Merrit Laboratories. The selection of the PFAS analytical laboratory will strongly consider the available turnaround times for each laboratory.

Results of each residential drinking water well analysis will be forwarded to EGLE and the Michigan Department of Health and Human Services within 3-days of receiving the analytical results. If necessary, households with PFAS sample results that exceed Part 201 drinking water criteria that are attributed to past irrigation practices will be offered bottled water until an appropriate PFAS removal filter can be provided.

Following the initial round of 13 residential drinking water well samples, recommendations for additional residential drinking water well sampling will be proposed to EGLE for review, comment, and approval. Residential drinking water well sampling will be continued until the Part 201 requirements are fulfilled.

4.4 Evaluating the Extent of PFAS Contamination Including the Area North of 7 Mile Road

To investigate the potential presence and extent of PFAS compounds in the groundwater on or originating from the BCDC property north of 7 Mile Road, new monitoring wells will be installed and sampled. The number and location of monitoring wells to be installed will be selected after receiving analytical results for residential wells that are sampled as described in Section 4.3, above. Following the receipt of residential well analytical results, representatives of BCDC will meet with representatives of EGLE to discuss and select monitoring well locations. Because the site geology and hydrogeology north of 7 Mile Road are not defined, the exact location and depth of each monitoring well will be determined as the investigation proceeds. The current CSM indicates a potential source of groundwater impacted with PFAS compounds in the area north of 7 Mile Road may be from surface application of irrigation water. Following the receipt of analytical results for each monitoring well, and the results of any subsequent residential water supply well testing, vertical profile monitoring wells may be required. Additionally, following the installation of on-site monitoring wells, off-site monitoring wells may be necessary. The potential location of off-site monitoring wells will be based on the analytical results of on-site monitoring wells, residential monitoring wells analytical results, and the groundwater flow direction evaluation that will be based on surveyed and measured water elevations in monitoring wells and surface waters. The need for additional monitoring wells and their locations will be discussed with EGLE, and approval from EGLE will be obtained before proceeding. The groundwater investigation will continue until the requirements of Part 201 are fulfilled.

4.4.1 Monitoring Well Installation and Sampling Methods

At each proposed monitoring well location, a two-inch diameter, five-foot long, polyvinyl chloride monitoring well will be installed using standard 4.25-inch hollow stem auger drilling methods and split spoon sampling. Each monitoring well will be logged by a Fishbeck geologist, following the methods and procedures outlined in the Fishbeck SOP *Soil Samples Description*. The initial monitoring wells will be installed with the top of screen placed approximately five feet below the water table surface to provide monitoring locations expected to best represent potential groundwater impacted by PFAS-impacted irrigation water from the adjacent golf course. Each monitoring well will be developed and sampled within seven days after installation, following the methods described in the Fishbeck SOP *Groundwater Sampling Procedure for Per and Polyfluoroalkyl (PFAs)* and related information presented in Appendix 2. During drilling and sampling, equipment blank samples and decontamination water samples will be collected and analyzed to evaluate the potential for trace contributions to the PFAS concentration from the decontamination/wash water process, the well materials, and the sampling equipment. Groundwater and blank samples will be analyzed using USEPA Method 537 Modified using isotope dilution for analysis of drinking water for 24 PFAS compounds. Level 2 data packages will be provided of the analyses of groundwater samples.

4.4.2 Surface Water Elevation and Sampling Locations

A creek is present that flows southward along the east side of Northland Drive that crosses 7 Mile Road onto the gravel mining area of the Site (Figure 1N). A second creek drains Secluded Lake and flows southward across 7

Mile Road into the area north of the tannery waste landfill area (Figure 1S). A pond (Hole 2 Pond) and overflow drainage are located near the northeast corner of 7 Mile Road and Brewer Road that receives surface water drainage from the clay rich soil areas of the site. The Hole 2 Pond and surface water overflow drains to the south under 7 Mile Road and discharges into the pond and creek system that is located immediately south of the tannery waste landfill. A pond is located in the active gravel mining area that will be used for the future irrigation water supply. These creeks and ponds will be sampled to evaluate if impacted groundwater is present in the surface water that might indicate a GSI discharge into the creeks. The location of these creeks and the proposed pond water sampling locations are shown on Figure 4.

At each surface water sample location, a staff gauge will be established and surveyed to provide surface water elevation data for use in interpreting the groundwater flow direction(s) at the site. Each surface water sampling location, shown on Figure 4, will be sampled following the methods described in the Fishbeck SOP *Groundwater Sampling Procedure for Per and Polyfluoroalkyl (PFAs)* and related information presented in Appendix 2. Surface water samples will be analyzed using USEPA Method 537 Modified using isotope dilution for analysis of drinking water for 24 PFAS compounds. Level 2 data packages will be provided for the surface water analyses.

4.5 Hydrogeologic Data Evaluation

Following the residential water well sampling and analysis, the installation of new staff gauges, and surface water sampling and analyses, Fishbeck will prepare maps and tables to illustrate the investigation results. These results will be prepared in an investigation progress update and presented to EGLE to discuss the next steps for site investigation. The investigation progress update will include recommendations for additional monitoring well installation, additional residential well sampling, or supplemental response actions to protect public health as appropriate.

5.0 Schedule

The investigation work specified in this work plan will begin immediately upon receiving approval for all or part of this investigation scope of work. Fishbeck currently possesses PFAS sampling bottle kits from qualified laboratories. Residential well sampling will begin as soon as access is approved via the initial round of access request mailings or during the follow-up, door-to-door contacts. Residential water well sampling is expected to require three days following the agreement for site access. Current quotes for PFAS lab analyses are currently projecting results approximately 3 to 5 weeks following sample submission.

Progress updates will be given to EGLE throughout the investigation process. BCDC expects that all work specified in this work plan will be completed and an investigation progress update will be presented to EGLE as soon as the data is available.

Figures

SITE PLAN-NORTH

NORTH

0 300 600 FEET

LEGEND

- Soil Boring Location
- Test Pit
- Proposed Surface Water Sample Location
- Surface Water Sample Location
- Monitoring Well
- Residential Well
- Non-Potable Well
- Irrigation Well
- Approximate Boundary of Tannery Waste Disposal Area
- Approximate Boundary of Domestic Refuse Disposal Area
- Approximate Boundary of Plating Waste Disposal Area
- Parcel Boundary

Zverts St NE
Northland Dr NE
Livingood St NE
Bodie St NE
Millis St NE
Checkerberry Ln NE
Thimbleweed Ln NE
Wolverine Blvd NE
M-44
Cemetary Pond
Courtland Dr NE
Skyhawk Dr NE
Secluded Lake Dr NE
Secluded Lake Ct NE
Secluded Lake
Blythefield Memorial Gardens
Kurts Hill Dr NE
Archer St NE
Senna Dr NE
Bianca Dr NE
Pine Meadows Dr NE
Mesa Dr NE
Mesa Ct NE
M-44 E
Bittersweet Dr NE
Brewer Ave NE
Boulder Ridge NE
Boulder Mews NE
Hole 2 Pond
Boulder Creek Golf Club
7 Mile Rd NE
Creek 1N
SF-6
Creek 2N
SF-5
MW-5S
MW-5D
Mine Pond
Tom Morris Dr NE
Chauncey Dr NE
TWSS-02

fishbeck
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scientists
architects
constructors

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Grand Rapids Gravel Company Site
Kent County, Michigan

PROJECT NO.
181258

FIGURE NO.
1N

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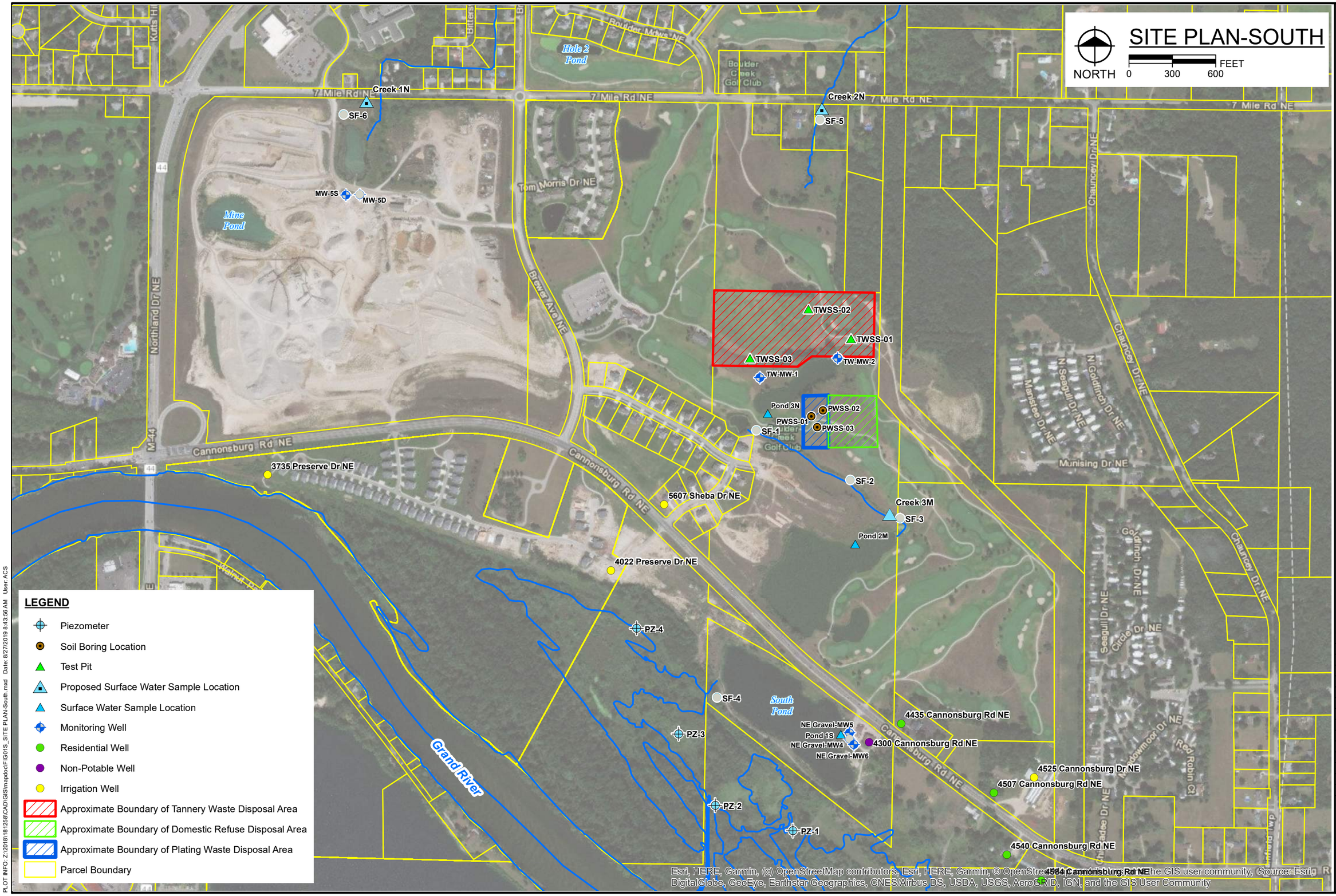
SITE PLAN-SOUTH

NORTH

0 300 600 FEET



LEGEND

- Piezometer
- Soil Boring Location
- Test Pit
- Proposed Surface Water Sample Location
- Surface Water Sample Location
- Monitoring Well
- Residential Well
- Non-Potable Well
- Irrigation Well
- Approximate Boundary of Tannery Waste Disposal Area
- Approximate Boundary of Domestic Refuse Disposal Area
- Approximate Boundary of Plating Waste Disposal Area
- Parcel Boundary

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Grand Rapids Gravel Company Site
Kent County, Michigan

PROJECT NO.
181258

FIGURE NO.
1S

POTENTIAL RESIDENTIAL WELLS

NORTH

0 300 600 FEET

LEGEND

- Soil Boring Location
- Test Pit
- Proposed Surface Water Sample Location
- Surface Water Sample Location
- Monitoring Well
- Residential Well
- Non-Potable Well
- Irrigation Well
- Approximate Boundary of Tannery Waste Disposal Area
- Approximate Boundary of Domestic Refuse Disposal Area
- Approximate Boundary of Plating Waste Disposal Area
- Parcel Boundary
- Sampling Area

Creek 1N
SF-6
Creek 2N
SF-5
MW-5S
MW-5D
TWSS-02
Cemetary Pond
Hole 2 Pond
Mine Pond
Secluded Lake
Blythefield Memorial Gardens
Boulder Creek Golf Club
Zverts St NE
Northland Dr NE
Livingood St NE
Bodie St NE
Millis St NE
Checkerberry Ln NE
Thimbleweed Ln NE
Wolverine Blvd NE
M-44 E
Skyhawk Dr NE
Courtland Dr NE
Secluded Lake Dr NE
Secluded Lake Ct NE
Kutts Hill Dr NE
Archer St NE
Senna Dr NE
Bianca Dr NE
Pine Meadows Dr NE
Mesa Ct NE
Mesa Dr NE
Brittlesweet Dr NE
Brewer Ave NE
Boulder Rdg NE
Boulder Mdws NE
7 Mile Rd NE
Tom Morris Dr NE
Chauncey Dr NE

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Grand Rapids Gravel Company Site
Kent County, Michigan

PROJECT NO.
181258

FIGURE NO.
2

PLOT INFO: Z:\2018\181258\CAD\GIS\mapdoc\FIG02_Potential Residential Wells.mxd Date: 8/27/2019 8:58:55 AM User: ACS

INITIAL RESIDENTIAL WELL SAMPLING LOCATIONS

NORTH

0 300 600 FEET

LEGEND

- Initial Residential Well Sampling Location
- Soil Boring Location
- Test Pit
- Proposed Surface Water Sample Location
- Surface Water Sample Location
- Monitoring Well
- Residential Well
- Non-Potable Well
- Irrigation Well
- Approximate Boundary of Tannery Waste Disposal Area
- Approximate Boundary of Domestic Refuse Disposal Area
- Approximate Boundary of Plating Waste Disposal Area
- Parcel Boundary
- Sampling Area

Creek 1N
SF-6
Creek 2N
SF-5
MW-5S
MW-5D
TWSS-02
Cemetary Pond
Hole 2 Pond
Secluded Lake
Mine Pond
Blythefield Memorial Gardens
Boulder Creek Golf Club
Zverts St NE
Northland Dr NE
Livingood St NE
Bodie St NE
Millis St NE
Checkerberry Ln NE
Thimbleweed Ln NE
Skyhawk Dr NE
Courtland Dr NE
Wolverine Blvd NE
M-44
M-44 E
Senna Dr NE
Bianca Dr NE
Pine Meadows Dr NE
Mesa Dr NE
Mesa Ct NE
Archer St NE
Kuts Hill Dr NE
Butterweed Dr NE
Brewer Ave NE
Boulder Ridge NE
Boulder Mews NE
7 Mile Rd NE
Tom Morris Dr NE
Secluded Lake Ct NE
Secluded Lake Dr NE
Chauncey Dr NE

fricch
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

Grand Rapids Gravel Company Site
Kent County, Michigan

PROJECT NO.
181258

FIGURE NO.
3

PLOT INFO: Z:\2018\181258\CAD\GIS\mapdoc\FIG03_Initial Residential Well Sampling Locations.mxd Date: 9/27/2019 8:51:35 AM User: ACS

PROPOSED MONITORING WELL/ SURFACE WATER SAMPLING LOCATIONS

NORTH

0 300 600 FEET

LEGEND

- Proposed Piezometer/Surface Water Sampling Location
- Soil Boring Location
- Test Pit
- Proposed Surface Water Sample Location
- Surface Water Sample Location
- Monitoring Well
- Residential Well
- Non-Potable Well
- Irrigation Well
- Approximate Boundary of Tannery Waste Disposal Area
- Approximate Boundary of Domestic Refuse Disposal Area
- Approximate Boundary of Plating Waste Disposal Area
- Parcel Boundary
- Sampling Area

Zivers St NE
Northland Dr NE
Checkerberry Ln NE
Livingood St NE
Bodie St NE
Millis St NE
Wolverine Blvd NE
M-44
Cemetary Pond
Skyhawk Dr NE
Courtland Dr NE
Secluded Lake Dr NE
Secluded Lake Ct NE
Secluded Lake
Blythefield Memorial Gardens
Senna Dr NE
Bianca Dr NE
Pine Meadows Dr NE
Mesa Ct NE
Mesa Dr NE
Archer St NE
Kutts Hill Dr NE
Brittlesweet Dr NE
Brewer Ave NE
Boulder Rdg NE
Boulder Mdws NE
Hole 2 Pond
Boulder Creek Golf Club
7 Mile Rd NE
Creek 1N
SF-6
Creek 2N
SF-5
MW-5S
MW-5D
Mine Pond
Tom Morris Dr NE
Chauncey Dr NE
TWSS-02

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Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

Grand Rapids Gravel Company Site
Kent County, Michigan

PROJECT NO.
181258

FIGURE NO.
4

PLOT INFO: Z:\2018\181258\CAD\GIS\mapdoc\FIG04_Proposed Monitoring Well-Surface Water Sampling Locations.mxd Date: 8/27/2019 12:19:47 PM User: ACS

Appendix 1

MATCHLINE A

MATCHLINE A

POND

PUMP STATION

IRRIGATION POND

ROAD CROSSING

TUNNEL

PUTTING COURSE

PARKING

CLUBHOUSE

CENTRAL AREA

CONSUMERS POWER CO. - R.O.W.

MAINTENANCE AREA

MATCHLINE B

MATCHLINE B

BOULDER CREEK GOLF COURSE

PRELIMINARY ASBUILT / AUGUST 4, 1997

PRELIMINARY ASBUILT / MARCH 23, 1998

IRRIGATION KEY

- ○ RAIN BIRD EAGLE 900 V-I-H ROTOR W/#30 NOZZLE
- ● RAIN BIRD EAGLE 700 V-I-H ROTOR W/#18 NOZZLE
- ◓ RAIN BIRD EAGLE 700 V-I-H ROTOR W/#14 NOZZLE
- • RAIN BIRD FALCON POP UP ROTOR
- RAIN BIRD EFB-CP-PRS CONTROL VALVE
- RAIN BIRD #5 QUICK COUPLING VALVE
- PVC CL 200 LATERAL LINE 2"
- PVC CL 200 LATERAL LINE 2 1/2"
- PVC CL 200 LATERAL LINE 3"
- PVC CL 200 MAINLINE 3" TO 10"

NORTH AREA

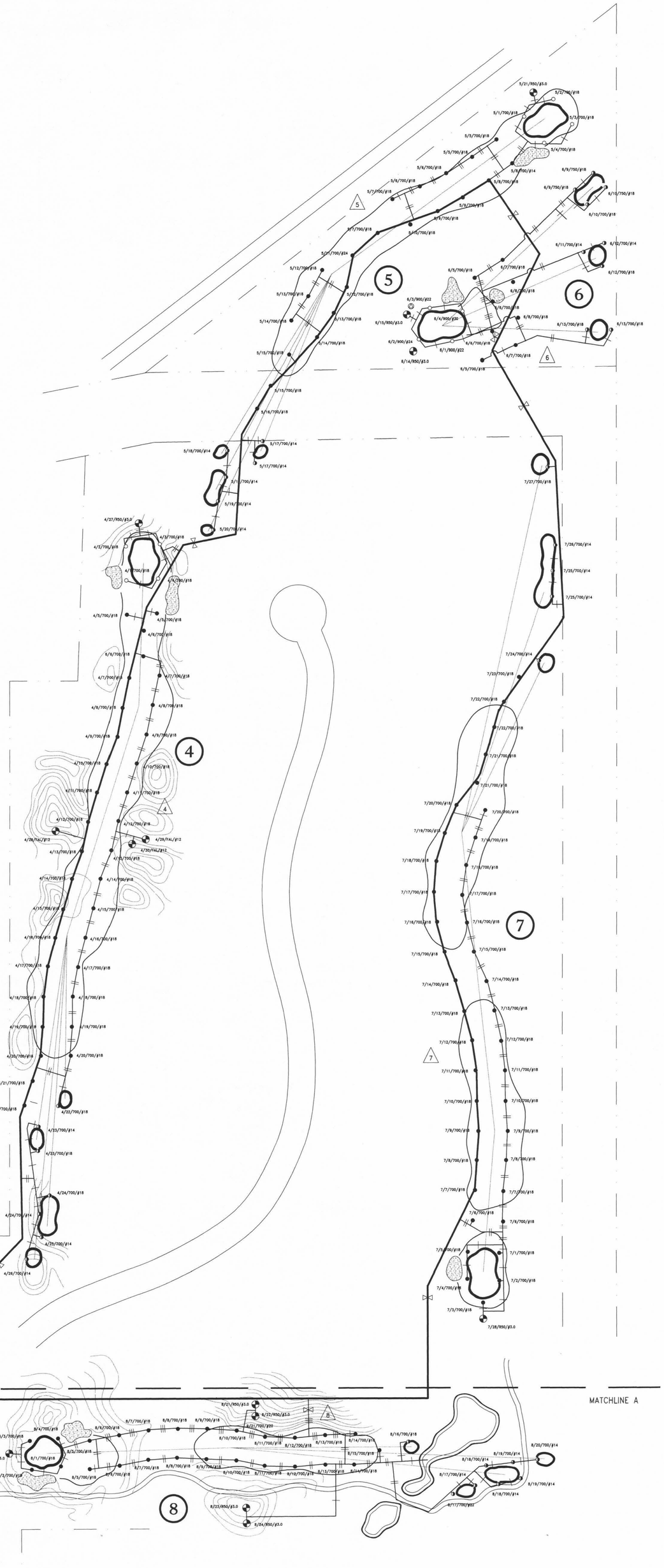
BOULDER CREEK GOLF COURSE

PRELIMINARY ASBUILT / AUGUST 4, 1997

PRELIMINARY ASBUILT / MARCH 23, 1998

IRRIGATION KEY

○	RAIN BIRD EAGLE 900 V-I-H ROTOR W/#30 NOZZLE
●	RAIN BIRD EAGLE 700 V-I-H ROTOR W/#18 NOZZLE
◓	RAIN BIRD EAGLE 700 V-I-H ROTOR W/#14 NOZZLE
•	RAIN BIRD FALCON POP UP ROTOR
◔	RAIN BIRD EFB-CP-PRS CONTROL VALVE
◉	RAIN BIRD #5 QUICK COUPLING VALVE
———	PVC CL 200 LATERAL LINE 2"
———	PVC CL 200 LATERAL LINE 2 1/2"
———	PVC CL 200 LATERAL LINE 3"
———	PVC CL 200 MAINLINE 3" TO 10"



SOUTH AREA

BOULDER CREEK GOLF COURSE

PRELIMINARY ASBUILT / AUGUST 4, 1997

PRELIMINARY ASBUILT / MARCH 23, 1998

IRRIGATION KEY

- ○ RAIN BIRD EAGLE 900 V-I-H ROTOR W/#30 NOZZLE
- ● RAIN BIRD EAGLE 700 V-I-H ROTOR W/#18 NOZZLE
- ◓ RAIN BIRD EAGLE 700 V-I-H ROTOR W/#14 NOZZLE
- • RAIN BIRD FALCON POP UP ROTOR
- ◓ RAIN BIRD EFB-CP-PRS CONTROL VALVE
- ◉ RAIN BIRD #5 QUICK COUPLING VALVE
- PVC CL 200 LATERAL LINE 2"
- PVC CL 200 LATERAL LINE 2 1/2"
- PVC CL 200 LATERAL LINE 3"
- PVC CL 200 MAINLINE 3" TO 10"

MATCHLINE B

MATCHLINE B

MAINTENANCE AREA

MAINTENANCE AREA

CONSUMERS POWER CO. - R.O.W.

POND

STREAM

RESIDENTIAL AREA

LAKE

CANNONSBURG ROAD

18

17

16

15

14

13

12

11

Appendix 2

Residential Sampling Procedure for Per and Polyfluoroalkyl (PFAs)

10/24/2017; revised 10/31/2017

Scope: The procedures outlined in this SOP are intended to provide instructions for water sampling activities at residential locations where PFAs contamination is suspected and is to be evaluated at a screening level. While USEPA Method 537 provides basic guidelines for PFAs in drinking water, precautionary procedures have been added to this document to avoid cross contamination when collecting groundwater or drinking water samples. Field personnel should carefully follow the steps described here and use the provided checklists to avoid cross contamination of the samples. Field personnel should also consult the project work plan for additional information.

Discussion: Per and Polyfluoroalkyl (PFAs) are a large group of synthetic fluorine-containing chemicals with unique properties. Perfluorooctane sulfonate (PFOS) and Perfluorooctanoic acid (PFOA) are the most common PFAs used in a wide variety of industrial and commercial products such as textiles, leathers, aqueous film forming foams (AFFF), metal plating, semi-conductors, paper and food packaging, coating additives, cleaning products and pesticides. Well-known PFAs products are Teflon™, which is used in non-stick cookware, Gore-Tex® textiles, Stainmaster® carpets, and Scotchgard™. Further, PFOA and PFOS can also be created by the biotransformation of some fluorinated telomers (i.e., precursor compounds) used in firefighting foams and other surface protection products.

PFAS are very resistant to breakdown, migrate easily, and accumulate in the food chain. As a result, they may be found throughout the environment in groundwater, surface water, soil, and air, as well as in food, breast milk, and human blood serum. While PFAs persistence, bioaccumulation, and ecological toxicity have been proved, their human toxicity is still uncertain.

Sampling for PFAs should be considered at locations where the following activities may have occurred: facilities where PFAs have been manufactured or used; metal coating and plating facilities; former or current DoD sites; facilities storing firefighting foams and firefighting training areas; landfills where leaching of PFAs resulted in contamination to soil and groundwater; and large rail yards. The need to sample soil, groundwater, surface water, sediment, or drinking water for PFAS will depend on case-specific conditions and the disposal site Conceptual Site Model.

Because of the potential presence of PFAs in common consumer products and in equipment typically used to collect soil, groundwater, surface water, sediment, and drinking water samples as well as the need for very low reporting limits, special handling and care must be taken when collecting samples for PFAs analysis to avoid sample contamination.

Equipment:
Flowcell for field parameter measurements
Turbidimeter and calibration kit
Spigot adapter and high-density polyethylene (HPDE) food-grade tubing
Stop watch
Graduated cylinder
Polyethylene bucket, 5-gallon
Decontamination supplies
PFA-free sampling bottles

Sample labels and bags (for bagging samples bottles and collect sampling waste)
Cooler containing PFAs-free ice packs
Field notebook

Field gear: Clothing: natural fibers (preferably cotton), laundered without the use of fabric softener (a minimum of 6 times from time of purchase).
Footwear: steel-toed boots made with polyurethane and polyvinyl chloride (PVC).
Disposable nitrile gloves

Field equipment, clothing and personal protective equipment

Field Equipment	
Prohibited	**Acceptable**
Teflon® containing materials	HDPE materials
Low density polyethylene (LDPE) materials	Acetate Liners
	Silicon Tubing
Waterproof field books	Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
Sharpies®	Pens
Post-It Notes®	
Chemical (blue) ice packs	Regular ice or certified PFA
Equipment Decontamination	
Prohibited	**Acceptable**
Decon 90®	Alconox® and/or Liquinox®
Sample Containers	
Prohibited	**Acceptable**
LDPE or glass containers	HDPE or polypropylene
Teflon-lined caps	Unlined polypropylene caps
Field Clothing and PPE	
Prohibited	**Acceptable**
New cotton clothing or synthetic water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing made of natural fibers (preferably cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™	Boots made with polyurethane and PVC
Tyvek®	Cotton clothing
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	Sunscreens - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Insect Repellents - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics Sunscreen and insect repellant - Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion

Rain Events	
Prohibited	**Acceptable**
Waterproof or resistant rain gear	Gazebo tent that is only touched or moved prior to and following sampling activities
Food Considerations	
Prohibited	**Acceptable**
All food and drink, with exceptions noted on right	Bottled water and hydration fluids (i.e, Gatorade® and Powerade®) to be brought and consumed only in the staging areas
Fast food wrappers and containers and pre-wrapped foods and snacks (chocolate bars, energy bars, granola bars, potato chips, etc.)	Use rigid plastic container or bags or stainless steel containers for all food brought to site

Reference: USEPA Method 537 (https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=525468)

Navy Field Sampling Protocols for PFASs (http://www.secnav.navy.mil/eie/Documents/15-12-24-BUMED-PFAS-Memo-Signed-w-Enclosures.pdf)

Interim Guideline on the Assessment and Management of Perfluoroalkyl and, Polyfluoroalkyl Substances (PFAS), Department of Environment Regulation, Western Australia, 2016. (https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/guidelines/Guideline-on-Assessment-and-Management-of-PFAS-.pdf)

Standard Operating Procedure (SOP) for Household and Community Water Sampling (Baseline and Follow-up Study) (https://data.lib.vt.edu/downloads/j67313767)

FTCH Standard Operating Procedure SOP 10-02

FTCH Standard Operating Procedure SOP 11-10

Procedure:

1. Introduce yourself to the resident and briefly explain the purpose for collecting the water sample. Ask the property owner for permission to proceed with sampling. If resident agrees, confirm that agreement has been read, signed, and returned to FTCH via email, and that payment has occurred (or receive form of payment from resident - check nominated to FTCH). If the resident refuses, or payment is not made, express your apologies and leave the residence.
2. Locate the outside spigot(s) indicated on the authorization form and confirm with the resident that they are okay with the selected sampling location. Confirm that the spigot provides cold, untreated water. Complete as much of the paperwork (labels, water collection form and chain of custody) as possible before initiating any sampling activities.
3. Wash and dry hands (use di water and Liquinox solution for this purpose). Don nitrile gloves. Disposable nitrile gloves must be worn at all times. A new pair of nitrile gloves should be donned prior to

decontamination of re-usable sampling equipment, contact with sample bottles, completion of well purging, prior to sample collection, after handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.

4. Install the spigot adapter and sample tubing on the spigot.
5. Connect tubing from the spigot adapter to the flow cell. Adjust flow from the spigot to not more than 0.5 liters per minute. Record values for pH, Eh, dissolved oxygen temperature and turbidity at approximately 3 minute intervals until parameter values indicate stability. While pH, Eh, dissolved oxygen, and turbidity are recorded for the purpose of monitoring stability, temperature is only recorded but not used as an indicator for formation water. See FTCH SOP 10-02 and 11-10 for stabilization parameters and flow cell operation. A minimum of 5 liters of water should be purged from the sample point prior to sampling. Complete and sign the groundwater collection sheet.
6. Remove the spigot adapter. Purge water can be disposed of on the ground.
7. Change nitrile gloves. For each sample location, two 60-milliliter bottles of well water shall be collected. Decrease the flow rate if necessary to prevent overfilling. Fill the sample bottle to the shoulder. Cap the sample bottle when full.
8. Place sample bottle labels on the sample bottles. Time/date and initial the sample bottle labels. Sample bottle labels will be completed using pen (no markers) after caps have been placed and tightened on each bottle.
9. Sealed labeled bottes should be double bagged and placed in cooler containing PFAs-free ice packs. The samples must be kept sealed and double bagged from time of collection and shipment until extraction.
10. Complete the chain of custody.
11. Remove nitrile gloves and wash hands (use di water and Liquinox solution for this purpose). Place gloves and associated solid wastes in a zip lock bag for disposal at FTCH. It is important not leave any sampling supplies behind in the household.
12. Thank the resident.
13. Transport samples back to FTCH for packing and shipment to the appropriate analytical laboratory.

Sample shipment and storage:

Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. All samples must be sent for priority next day delivery, and cannot be shipped on Fridays.

Soil Samples Description

07/14/1996; revised 02/16/2000

Scope: The following SOP presents soil description guidelines for logging soil samples collected during field activities. The guidance provided in this SOP is an adaptation of the USCS classification system and the ASTM (Visual-Manual) classification system, *ASTM Standard Method D 2488-93.*

Equipment: Geotechnical Gauge, manuf. By W.F. McCollough, Beltsville, MD

Procedure:

1. Record the following general information where applicable:
   a. Project name and number
   b. Site location
   c. Contractor
   d. Rig type
   e. Borehole purpose
   f. Total depth drilled
   g. Borehole diameter
   h. Drilling method
   i. Abandonment method
   j. Screening instrument
   k. Boring/well number
   l. Start date and time
   m. End date and time
   n. Ground elevation

2. Soil classifications should be documented in the field by the geologist at the time of sampling and should include the following:
   a. Formation breaks and depths.
      If depths are estimated, note on form. Typically, depths/heights should be recorded in feet or fractions thereof (tenths or hundredths). Use of metric measurements may be required for certain projects. Refer to the project work plan.
   b. Length of sampled interval and percentage of sample recovery for each driven (split spoon), thin wall (Shelby), or cored sample.
      Include the sampler type and size (diameter and length). Blow counts should be recorded for driven samplers; ease of penetration for push samplers.
   c. If bedrock is encountered, describe the lithology, mineralogy, degree of weathering and fracturing, and color of the rock. In addition, identify the formation, if known (e.g., Saginaw Formation, Parma Sandstone).
   d. Grain Size.
      Use the grain size gauge on the Geotechnical Gauge to determine grain size classification of sample.
   e. Percentage Composition.
      Refer to comparison chart on the Geotechnical Gauge to determine relative percentages of the different grain size classifications in sample.
   f. Roundness.
      Four categories are considered adequate: angular, sub-angular, sub-rounded or rounded. Refer to the comparison chart on the Geotechnical Gauge for classification.

g. Sorting
Three categories are considered adequate:

Well sorted	90% in 1 or 2 size classes
Moderately sorted	90% in 3 or 4 size classes
Poorly sorted	90% in 5 or more size classes

h. Density.
The density of the soil is based on the ease of penetration. In the case of a driven sampler, the blow counts are used to estimate the soil density.

Very loose	<5 blows per foot
Medium dense	11 to 30 blows per foot
Dense	31 to 50 blows per foot
Very dense	>51 blows per foot

i. Color.
For most projects, a qualitative description of color is all that is required. To maintain consistency in color designations, the standard colors shown on the Geotechnical Gauge should be used.

j. Water/Fluid Content.
The fluid content of a soil should be described and should include a description of the fluid (e.g., water, water with oily sheen, gasoline).

Dry	No wetness on hand when held
Moist	Slight wetness on hand when held
Saturated	Sample drips water or fluid

k. Other Constituents.
Soil samples may contain material other than clay, silt, sand or gravel. Organic matter or debris such as concrete, buried waste or other non-native material may be present. This material should be described in as much detail as possible.

l. Field Screening.
Any odor, staining, and/or PID measurements should be included in the sample description.

Soil Description Guidelines

1. The principal component of the sample should be described first, followed by other components in decreasing order of importance. For the first component, list the particle size (e.g., sand) in capital letters, and percentage rounded to the nearest 5%. This is followed by a modifier denoting grain size, a description of the color, and angularity/roundness. After a description of the principal component of the sample is completed, a description of the second most important constituent is given in a similar manner.
2. After all constituents have been described, the properties describing the sample as a whole are given. These include: sorting, moisture content, odor, staining, unusual color or sheen. Other possible descriptive properties may be sample density, bedding, cementation, mottles, oxidation, voids, plasticity, cohesiveness, other items (roots) and structure.

3. Examples of acceptable soil descriptions are given below:

   Example: SAND: coarse grained (15%), medium grained (80%), red, well sorted, sub-angular, very loose; Traces of gray, silty clay (5%). Moist, hydrocarbon odor, oil sheen.

   Example: CLAYEY SILT: Silt (50%); Clay (25%); Gravel (20%), medium to fine grained, sub-rounded; Sand (5%), coarse grained, rounded. Reddish-brown, very moist, very dense, slightly cohesive, no odor.

   In instances where fill material is encountered, first note that the material is fill, then describe the individual constituents.

   Example: FILL; Sand, coarse grained (50%), medium grained (20%), fine grained (20%), reddish-brown, sub-rounded, loose, moderately sorted, no cohesiveness, dry, no odor. Broken red bricks at 5'-6.5', approx. 2" in diameter.

4. Note that semicolons are used to separate constituents, and commas are used to separate descriptive elements of each constituent. Where applicable, optional descriptors or modifiers may be added (e.g., fossil contents, density, consistency).
5. Color should be indicated after each constituent, assuming that the colors are different for each constituent. However, when the sediment is best described with one overall color or where all constituents have the same color, then the color shall be indicated before the sorting and not after each constituent.
6. Avoid using nonstandard terms or abbreviations. Refer to ASTM Standard Method D 2488-93 or AGI Data Sheets for standard terms and abbreviations.
7. Certain federal and state environmental agencies or projects may require that descriptions strictly adhere to formal classification systems, such as the Unified Soil Classification System.
8. Classifications may be subject to change based upon laboratory tests and/or subsequent review. Any changes in reports and/or boring logs should be made by the project manager or project geologist.

Groundwater Sampling Procedure for Per and Polyfluoroalkyl (PFAs)

1/4/2019

Scope: The procedures outlined in this SOP are intended to provide instructions for groundwater sampling activities at monitoring well locations where PFAs contamination is suspected and is to be evaluated at a screening level. While USEPA Method 537 provides basic guidelines for PFAs in drinking water, precautionary procedures have been added to this document to avoid cross contamination when collecting groundwater or drinking water samples. Field personnel should carefully follow the steps described here and use the provided checklists to avoid cross contamination of the samples. Field personnel should also consult the project work plan for additional information.

Discussion: Per and Polyfluoroalkyl (PFAs) are a large group of synthetic fluorine-containing chemicals with unique properties. Perfluorooctane sulfonate (PFOS) and Perfluorooctanoic acid (PFOA) are the only PFAS currently regulated by U.S. EPA and MDEQ and in the past they were used in a wide variety of industrial and commercial products such as textiles, leathers, aqueous film forming foams (AFFF) (which may still be used in emergency scenarios), metal plating, semi-conductors, paper and food packaging, coating additives, cleaning products and pesticides. Well-known PFAs products are Teflon™, which is used in non-stick cookware, Gore-Tex® textiles, Stainmaster® carpets, and Scotchgard™. Further, PFOA and PFOS can also be created by the biotransformation of some fluorinated telomers (i.e., precursor compounds) used in firefighting foams and other surface protection products.

PFAS are very resistant to breakdown, migrate easily, and accumulate in the food chain. As a result, they may be found throughout the environment in groundwater, surface water, soil, and air, as well as in food, breast milk, and human blood serum. While PFAs persistence, bioaccumulation, and ecological toxicity have been proved, their human toxicity is still uncertain.

Sampling for PFAs should be considered at locations where the following activities may have occurred: facilities where PFAs have been manufactured or used; metal coating and plating facilities; former or current DoD sites; facilities storing firefighting foams and firefighting training areas; landfills where leaching of PFAs resulted in contamination to soil and groundwater; and large rail yards. The need to sample soil, groundwater, surface water, sediment, or drinking water for PFAS will depend on case-specific conditions and the disposal site Conceptual Site Model.

Because of the potential presence of PFAs in common consumer products and in equipment typically used to collect soil, groundwater, surface water, sediment, and drinking water samples as well as the need for very low reporting limits, special handling and care must be taken when collecting samples for PFAs analysis to avoid sample contamination.

Equipment:
Pump (Bladder or Peristaltic)
Portable Bladder Pump (Bladder Sampling Only)
Bladder Controller (Bladder Sampling Only)
Nitrogen Gas Cylinder (Bladder Sampling Only)
Flowcell for field parameter measurements
Turbidimeter and calibration kit
Electric water level meter

New High-Density Polyethylene (HPDE) tubing (if location not previously sampled for PFAs)
New Masterflex® silicone tubing (if location not previously sampled for PFAs)
Stop watch
Graduated cylinder
Polyethylene bucket, 5-gallon
Decontamination supplies
PFA-free sampling bottles
Powderless nitrile gloves
Sample labels and bags (for bagging samples bottles and collect sampling waste)
Ink pen for sample labels (no permanent markers)
Cooler containing PFAs-free ice packs
Field notebook

Field gear: Clothing: natural fibers (preferably cotton), laundered without the use of fabric softener (a minimum of 6 times from time of purchase).
Footwear: steel-toed boots made with polyurethane and polyvinyl chloride (PVC).
Disposable nitrile gloves

Field equipment, clothing and personal protective equipment

Field Equipment	
Prohibited	**Acceptable**
Teflon® containing materials	HDPE materials
Low density polyethylene (LDPE) materials	Acetate Liners
	Silicon Tubing
Waterproof field books	Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
Sharpies®	Pens
Post-It Notes®	
Chemical (blue) ice packs	Regular ice or certified PFA
Equipment Decontamination	
Prohibited	**Acceptable**
Decon 90®	Alconox® and/or Liquinox®
Sample Containers	
Prohibited	**Acceptable**
LDPE or glass containers	HDPE or polypropylene
Teflon-lined caps	Unlined polypropylene caps
Field Clothing and PPE	
Prohibited	**Acceptable**
New cotton clothing or synthetic water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing made of natural fibers (preferably cotton)
Clothing laundered using fabric softener	No fabric softener

Boots containing Gore-Tex™	Boots made with polyurethane and PVC
Tyvek®	Cotton clothing
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	Sunscreens - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Insect Repellents - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics Sunscreen and insect repellant - Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion
Rain Events	
Prohibited	**Acceptable**
Waterproof or resistant rain gear	Gazebo tent that is only touched or moved prior to and following sampling activities
Food Considerations	
Prohibited	**Acceptable**
All food and drink, with exceptions noted on right	Bottled water and hydration fluids (i.e, Gatorade® and Powerade®) to be brought and consumed only in the staging areas
Fast food wrappers and containers and pre-wrapped foods and snacks (chocolate bars, energy bars, granola bars, potato chips, etc.)	Use rigid plastic container or bags or stainless-steel containers for all food brought to site

Reference: USEPA Method 537
(https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=525468)

Navy Field Sampling Protocols for PFASs
(http://www.secnav.navy.mil/eie/Documents/15-12-24-BUMED-PFAS-Memo-Signed-w-Enclosures.pdf)

Interim Guideline on the Assessment and Management of Perfluoroalkyl and, Polyfluoroalkyl Substances (PFAS), Department of Environment Regulation, Western Australia, 2016.
(https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/guidelines/Guideline-on-Assessment-and-Management-of-PFAS-.pdf)

FTCH Standard Operating Procedure SOP 10-01

FTCH Standard Operating Procedure SOP 10-03

FTCH Standard Operating Procedure SOP 10-02

FTCH Standard Operating Procedure SOP 10-06

FTCH Standard Operating Procedure SOP 10-07

FTCH Standard Operating Procedure SOP 10-09

FTCH Standard Operating Procedure SOP 10-11

FTCH Standard Operating Procedure SOP 11-08

FTCH Standard Operating Procedure SOP 11-10

Procedure:

1. Determine the order in which the wells should be sampled. Typically, sampling order should proceed from the cleanest well to the most contaminated. When no historical water quality data are available, sample background wells first, followed by the farthest downgradient wells. The wells expected to be most significantly contaminated should be sampled last. Sampling order is not as critical when a peristaltic pump is used as the pump tubing may be dedicated to the well location or replaced after each use.
2. Wash and dry hands (use PFAS-free deionized water and Liquinox solution for this purpose). Don powderless nitrile gloves. Disposable nitrile gloves must be worn at all times. A new pair of nitrile gloves should be donned prior to decontamination of re-usable sampling equipment, contact with sample bottles, completion of well purging, prior to sample collection, after handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.
3. Calibrate field measurement equipment as required by the project work plan.
4. Record the condition of the monitoring well in the field notes. Additional information may be required for documentation before, during, and after groundwater sampling. Refer to the project-specific work plan and SOP 10-03 for additional information.
5. Determine static water level using SOP 18-04 and record data in the field notebook. Every effort should be made to minimize disturbances of the stagnant water column during water level measurement.

   Water levels are measured prior to and during a groundwater sampling event for the following reasons:

   a. To assess whether the static water elevation is sufficient to allow purging and sampling after groundwater drawdown has stabilized.

   b. To select the depth to which the pump intake or other purging or sampling device should be lowered.

   c. To monitor the water level during purging and sampling and determine the optimum pumping rate to minimize drawdown.

   d. To determine groundwater flow direction.
6. Check condition of tubing before proceeding. If uncertain tubing is HDPE, then replace. If tubing appears to be old, friable, heavily stained, then replace.
7. If using a peristaltic pump, connect designated tubing to pump and adjust down hole tubing to desired screen depth using the steps described on FTCH SOP 10-02.

If using a bladder pump, remove existing tubing carefully and coil to prevent contact with ground (dirt, grass, debris, etc.). Connect tubing to pump and lower carefully into well to desired screen depth using SOP 10-02.

8. When purging wells screened in low-permeability formations (<0.1 L/min recharge), be cautious to not draw the water column below top of well screen. Introducing atmospheric conditions to the screened area has in some situations had adverse effects on water chemistry, biological activity, and even filter pack properties. Select a purging rate that results in minimum drawdown while allowing the well to be purged in a reasonable length of time. Refer to historical field sampling notes if available.

   Record purge start time in the field notebook. Monitor and record the water level and pumping rate every 3 – 5 minutes (or as appropriate) during purging. Use a plastic graduated cylinder or beaker to monitor the pumping rate and a 5-gallon bucket to monitor the volume of water purged. Dispose of purge water in accordance with the project work plan. Record any pumping rate adjustments on the sample collection form.

   During pump start-up, drawdown may exceed the 0.3 ft. target and then recover as the pump flow adjustments are made. Purge volume calculations should utilize the stabilized drawdown value, not the initial drawdown.

9. Pending clarity/aesthetics of water initially purged, connect tubing discharge end to the flow cell. Adjust flow from the spigot to not more than 0.5 liters per minute. Record values for pH, Eh, dissolved oxygen temperature and turbidity at approximately 3-minute intervals until parameter values indicate stability. While pH, Eh, dissolved oxygen, and turbidity are recorded for monitoring stability, temperature is only recorded but not used as an indicator for formation water. See FTCH SOP 10-02 and 11-10 for stabilization parameters and flow cell operation. If allowed, a minimum of 5 liters of water should be purged from the sample point prior to sampling. Complete and sign the groundwater collection sheet.
10. Once field parameters have stabilized or 45 minutes has lapsed from purge start. Disconnect tubing discharge end from flowcell. Collect all other water samples prior to PFAs samples following FTCH SOP 10-01, 10-10, 10-11.
11. Change nitrile gloves. For each sample location, typically two bottles of well water shall be collected. Volume collected may vary among laboratories. Fill the sample bottle to the shoulder. Cap the sample bottle when full.
12. Place sample bottle labels on the sample bottles. Time/date and initial the sample bottle labels. Sample bottle labels will be completed using pen (no markers) after caps have been placed and tightened on each bottle.
13. Sealed labeled bottles should be double bagged and placed in cooler containing ice. The samples must be kept sealed, double bagged, and on ice from time of collection and shipment until extraction.
14. Complete the chain of custody.
15. Disconnect tubing from peristaltic pump. Remove electric water level meter probe from well and re-insert tubing as initially found. Lock/Bolt down well cover.

    If using bladder pump, disconnect nitrogen line from bladder tubing. Remove electric water level meter probe from well. Remove bladder tubing/bladder pump from well to disconnect pump. Re-insert tubing as

initially found and lock/Bolt down well cover. Decontaminate bladder pump and other equipment in accordance to FTCH SOP 10-01.

16. Remove nitrile gloves and wash hands (use di water and Liquinox solution for this purpose). Place gloves and associated solid wastes in a zip lock bag for disposal at FTCH.
17. Transport samples back to FTCH for packing and shipment to the appropriate analytical laboratory.

Sample shipment and storage:

Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. All samples must be sent for priority next day delivery and cannot be shipped on Fridays.

INDUSTRIAL PRETREATMENT PROGRAM PFAS INITIATIVE

PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCES (PFAS) MINIMUM LABORATORY ANALYTE LIST

Below is the minimum laboratory PFAS analyte list for analysis of deer, drinking water, groundwater, surface water, soil, wastewater effluent, and landfill leachate collected by Michigan's Departments of Environmental Quality (MDEQ), Health and Human Services (MDHHS), Agriculture and Rural Development, and Natural Resources.

This minimum analyte list was developed based on the potential for these chemicals to be found in Michigan, the availability of the chemical standards used for testing, and the ability of available laboratories to test for these PFAS. This list includes PFAS that can be tested for in drinking water using United States Environmental Protection Agency (USEPA) Method 537 Rev.1.1, which is the only method that should be used when analyzing drinking water samples. Other testing methodology may be used to test for PFAS in other media (**not** drinking water). This list is not exhaustive of PFAS in Michigan's environment.

A fish icon (🐟) precedes those compounds that are also currently being tested for in fish tissue.

Analyte Name	Acronym	Fluorinated Carbon Chain Length	Molecular Formula	CAS Number	USEPA Method 537 Rev. 1.1
🐟 Perfluorotetradecanoic acid	PFTeA	C_{14}	$C_{13}F_{27}COOH$	376-06-7	X
🐟 Perfluorotridecanoic acid	PFTriA	C_{13}	$C_{12}F_{25}COOH$	72629-94-8	X
🐟 Perfluorododecanoic acid	PFDoA	C_{12}	$C_{11}F_{23}COOH$	307-55-1	X
🐟 Perfluoroundecanoic acid	PFUnA	C_{11}	$C_{10}F_{21}COOH$	2058-94-8	X
🐟 Perfluorodecanoic acid	PFDA	C_{10}	$C_9F_{19}COOH$	335-76-2	X
🐟 Perfluorononanoic acid	PFNA	C_9	$C_8F_{17}COOH$	375-95-1	X
🐟 Perfluorooctanoic acid	PFOA	C_8	$C_7F_{15}COOH$	335-67-1	X
🐟 Perfluoroheptanoic acid	PFHpA	C_7	$C_6F_{13}COOH$	375-85-9	X
🐟 Perfluorohexanoic acid	PFHxA	C_6	$C_5F_{11}COOH$	307-24-4	X
🐟 Perfluoropentanoic acid	PFPeA	C_5	C_4F_9COOH	2706-90-3	
🐟 Perfluorobutanoic acid	PFBA	C_4	C_3F_7COOH	375-22-4	
🐟 Perfluorodecanesulfonic acid	PFDS	C_{10}	$C_{10}F_{21}SO_3H$	335-77-3	
Perfluorononanesulfonic acid	PFNS	C_9	$C_9F_{19}SO_3H$	68259-12-1	
🐟 Perfluorooctanesulfonic acid	PFOS	C_8	$C_8F_{17}SO_3H$	1763-23-1	X
Perfluoroheptanesulfonic acid	PFHpS	C_7	$C_7F_{15}SO_3H$	375-92-8	
🐟 Perfluorohexanesulfonic acid	PFHxS	C_6	$C_6F_{13}SO_3H$	355-46-4	X
Perfluoropentanesulfonic acid	PFPeS	C_5	$C_5F_{11}SO_3H$	2706-91-4	

Analyte Name	Acronym	Fluorinated Carbon Chain Length	Molecular Formula	CAS Number	USEPA Method 537 Rev. 1.1
Perfluorobutanesulfonic acid	PFBS	C_{4OMG}	$C_4F_9SO_3H$	375-73-5	X
Perfluorooctanesulfonamide	PFOSA	C_8	$C_8F_{17}SO_2NH_2$	754-91-6	
Fluorotelomer sulphonic acid 8:2	FtS 8:2	C_8	$C_8F_{17}CH_2CH_2SO_3$	39108-34-4	
Fluorotelomer sulphonic acid 6:2	FtS 6:2	C_6	$C_6F_{13}CH_2CH_2SO_3$	27619-97-2	
Fluorotelomer sulphonic acid 4:2	FtS 4:2	C_4	$C_4F_9CH_2CH_2SO_3$	757124-72-4	
2-(N-Ethylperfluorooctanesulfonamido) acetic acid	N-EtFOSAA	C_8	$C_8F_{17}SO_2N(C_2H_5)CH_2COOH$	2991-50-6	X
2-(N-Methylperfluorooctanesulfonamido) acetic acid	N-MeFOSAA	C_8	$C_8F_{17}SO_2N(CH_3)CHCOOH$	2355-31-9	X

Laboratories Providing PFAS Analytical Services

(*The provision of the following links does not constitute an endorsement of the firms that may be identified by those links, nor is it a statement against any firm not on the lists generated. Additionally, the capacity of any identified laboratories to provide services consistent with the MDEQ recommendations above has not been verified and these details should be addressed prior to contracting with any laboratory.*)

- The **U.S. Environmental Protection Agency (US EPA)** has a list of laboratories approved under the UCMR3 program using US EPA Method 537 Rev. 1.1 for PFAS in drinking water: www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule
- The **U.S. Department of Defense, Environmental Laboratory Accreditation Program (US DoD ELAP)** maintains a list of labs for the determination of PFAS in various environmental media other than drinking water on the Defense Environmental Network Information Exchange (DENIX) server: www.denix.osd.mil/edqw/accreditation/accreditedlabs/

Contact Information

Questions regarding PFAS in general, contact:

- **MDHHS General Information**
  517-373-3740
- MDEQ Environmental Assistance Center
  800-662-9278

Questions regarding laboratory information, contact:

- **MDHHS Chemistry & Toxicology Division**
  517-335-9490
- **MDEQ Drinking Water Analysis Laboratory**
  517-335-8184