Carver County Compost Facility Groundwater Monitoring
Quality Assurance Project Plan

Submitted to:
United States Environmental Protection Agency Region 5

JUNE 2017

w-sw11-02

QAPP Signature Page

The following parties have reviewed and approved the Quality Assurance Project Plan (QAPP).

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QAPP Distribution List

The following individuals will be provided a copy of the final, approved version of this document. Any future additions or changes will also be sent to them.

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Acronyms and Abbreviations

AR- Arboretum

ASTM- American Society for Testing and Materials

BTM - Bottom

CC- Carver County

CFR - Code of Federal Regulations

CRL- Central Regional Laboratory -Chicago

D - Field Duplicate

DQO - Data Quality Objective

LOQ - Limit of Quantification

MDL - Method Detection Level

MRL- Minimum Reporting Level

MSL - Mean Sea Level

MPCA - Minnesota Pollution Control Agency

NRMRL- National Risk Management Research Laboratory

QA - Quality Assurance

QAPP - Quality Assurance Project Plan

QC - Quality Control

ORD- Office of Research and Development

R - Field Replicate

SAP - Sampling and Analysis Plan

SFC - Surface

SOP - Standard Operating Procedure

SSO - Source Separated Organics

SSOM- Source Separate Organic Materials

TSI - Trophic Status Index

USDA- United States Department of Agriculture

USEPA or EPA - United States Environmental Protection Agency

VOCs - Volatile Organic Compounds

WA- Watertown

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Section 1 Project Description

1.1 Introduction

The Minnesota Pollution Control Agency (MPCA) requested assistance from the United States Environmental Protection Agency (EPA) in their efforts to evaluate the potential for ground water impacts at composting facilities. The Federal project partners include staff members from the Central Regional Laboratory (CRL-Chicago), the Land and Chemicals Division (Chicago) and the Office of Research and Development (ORD-Cincinnati). The Federal project partner's role is to ensure MPCA and their partner, Carver County, obtain representative ground water samples at the sites they selected for their study and receive appropriate analysis and results from those samples.

The MPCA's proposed project objectives-are to gather information on how the use of a gravel pad at Source Separated Organics Material (SSOM) compost facilities, may impact the ability of contaminants to reach ground water and to compare the environmental impact of an unlined yard waste site with an unlined SSOM site. MPCA stated that the collection of the data will allow them to better balance design and operational practices governing compost facilities to ensure adequate protection of the environment, but not overly onerous to the point they curtail development of new sites. Currently none of Minnesota's approximately 115-yard waste composting facilities or 10 SSOM composting facilities has monitoring wells in place. All of the ten SSOM sites currently operating have Municipal Solid Waste (MSW) permits. The MPCA established new rules for compost facilities; several facilities are pursuing permits under the new SSOM designation and may take on that classification in 2017. The Arboretum SSOM site is unique in that it has a compacted gravel pad and has been operating for several years making it ideally situated to provide useful information through installation and utilization of monitoring wells.

The Arboretum SSOM Demonstration/Research permit expired in December 2015 at which time no additional SSOM has been accepted. The County and site operator are working with the MPCA to obtain a SSOM facility permit, which will allow the site to accept SSOM in the fall of 2017. As of 2016, the site has only received yard waste.

This project involves the use of monitoring wells to sample and analyze groundwater at two compost facilities. One facility will be the SSOM facility located at the University of Minnesota Landscape Arboretum in Carver County, hereafter known as the "Arboretum SSOM". This facility collects food scraps co-mingled with yard waste, compostable paper and compostable plastics. The second site is located in the City of Watertown, hereafter known as "Watertown". This site is regulated under a permit-by-rule and only accepts yard wastes, no food scraps. The Watertown site does accept compostable Kraft bags as well as ASTM certified compostable plastic bags.

Sampling of monitoring wells will take place for an agreed period of time depending on the available budget. The EPA, Central Regional Laboratory (CRL) and Office of Research and Development (ORD) will analyze he results; in addition, ORD will develop a summary of results and provide a narrative of the potential for groundwater impacts from the Arboretum SSO and Watertown sites. The MPCA has funded the installation of eight (8) monitoring wells, four at each facility. The wells were installed in December 2016. Carver County (CC) will ensure the facilities continue to operate during the project. The County will also hire a vendor from the state sampling and analysis contract to collect and submit the samples to the EPA Chicago and ORD Cincinnati laboratories. The project partners (EPA, ORD, MPCA and Carver County) anticipate the first sampling event will take place in June of 2017.

While the project involving the Arboretum SSO site and, the Watertown yard waste site, will provide valuable information, additional data will provide a more comprehensive understanding of how composting operations with unlined pads may impact the groundwater. Project partners may identify additional facilities elsewhere to collect data.

1.2 Background

With a grant from the MPCA, Carver County installed monitoring wells at both the Arboretum and Watertown sites for this project. Samples will be collected quarterly for a period of 2 years to gather information on any potential impacts to groundwater from the composting operations. The EPA's CRL in Chicago and the ORD Cincinnati, both, will provide laboratory bottles and analysis of the samples and will report the findings from that analysis to both Carver County and MPCA, while the ORD will develop a summary of the results and provide a narrative of the potential for groundwater impacts.

The Arboretum SSOM facility, located at the University of Minnesota Landscape Arboretum, in the city of Chanhassen, MN accepts SSOM and yard waste. The other facility, located in the city of Watertown, only accepts yard waste. Both facilities are located in Carver County, Minnesota. Carver County has signed a Joint Powers Agreement (JPA) with the MPCA and is a key partner in this project. The JPA provided funding from the MPCA for the installation of the monitoring wells and some detailed characterizations of the compost sites. The Arboretum SSOM facility accepts SSOM that has been comingled and co-collected with yard waste. Detailed descriptions of both facilities are outlined in sections 1.3 and 1.4 of this document.

The MPCA revised the state rules for compost facilities in 2014. During that process there was substantial public engagement on how to best ensure that compost facilities were protective of the environment especially pertaining to impacts on groundwater. Minnesota has adopted aggressive goals for organics recycling and the rule revision was intended to reduce regulatory barriers to establishing or operating compost facilities to support those goals. While the revisions were intended to expand composting, the agency also prioritized ensuring that facility design and operations remained adequately protective of the environment.

Carver County will work with private partners to ensure the continued operation of the Arboretum compost facility. County staff has been actively involved in the permitting and operations of the Arboretum SSOM facility. Carver County will also contract with a third party approved by MPCA, to gather and ship samples collected from the monitoring wells. The MPCA and Carver County have partnered on research efforts at the Arboretum SSOM facility through three previous grant funded projects. In the prior research as well as the current study, the County will assist in dissemination of the findings.

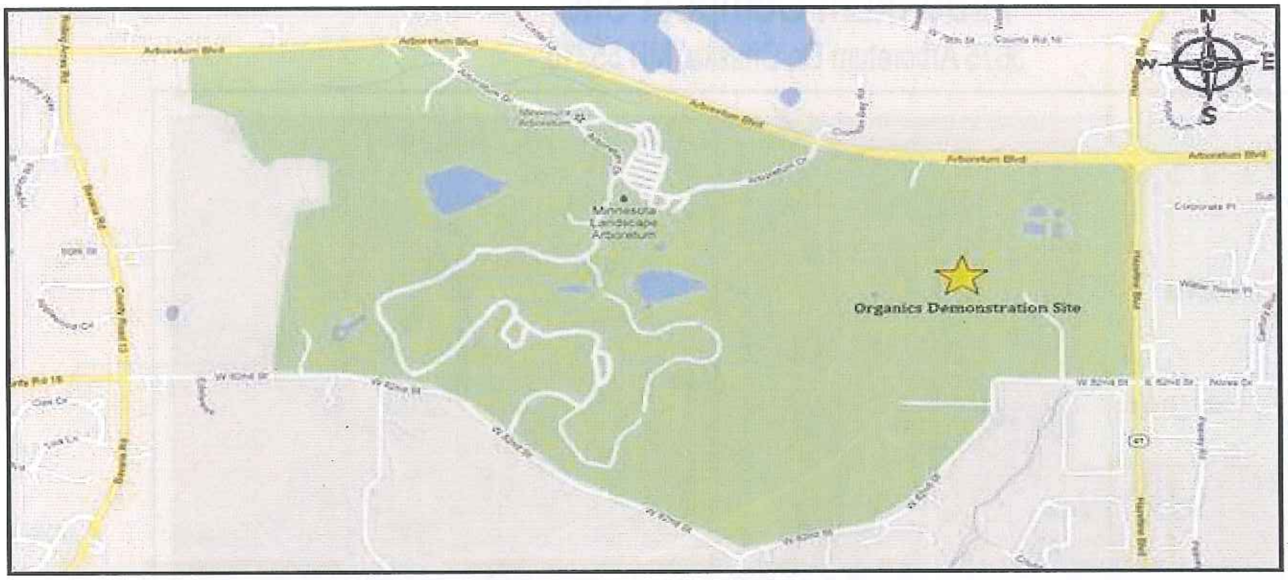
1.3 University of Minnesota Landscape Arboretum, Specialized Environmental Technologies Site

The project site is located at the University of Minnesota Landscape Arboretum and is managed by Specialized Environmental Technology (SET). Carver County who assists with staffing and technical assistance received a Demonstration project permit from the MPCA in 2010. The site began accepting material in September of 2011.

1.3.1 Description

The Carver County/(SET) Arboretum SSOM site, is located at the University of Minnesota Landscape Arboretum in Chanhassen, MN. The University of Minnesota Landscape Arboretum is part of the College of Food, Agricultural and Natural Resource Sciences at the University of Minnesota. The Arboretum SSOM Site occupies two acres of the Minnesota Landscape Arboretum which was previously undeveloped and was utilized as the burn site for brush and wood waste generated from Arboretum operations. Figure A shows the location of the Arboretum SSOM Site on the Arboretum property. The nearest residential home not owned by the University of Minnesota Landscape Arboretum is approximately 1,800 feet away from the site.

Figure A: Organics Demonstration Site Location



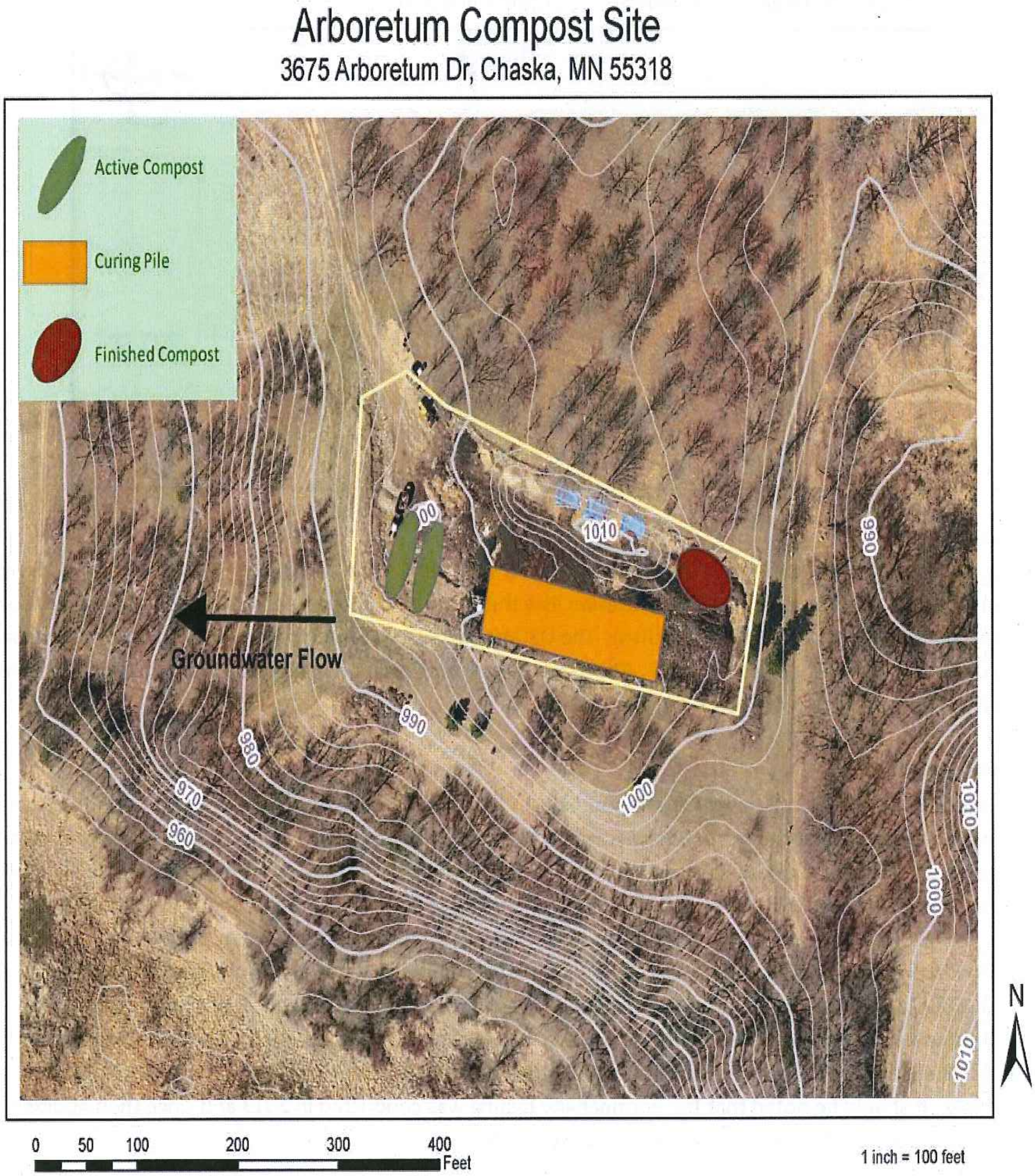
1.3.2 Soils

The site is constructed on Lester-Kilkenny Loam soil that has a 12% - 18% slope and a 25% - 40% slope respectively. The USDA Soil Survey for the Arboretum SSOM Site location lists the depth to the water table and the depth to any soil restrictive layer at >200 centimeters (>78.7 inches). The USDA's Soil Survey refers to the water table as "the saturated zone in the soil that occurs during specified months". The mean annual precipitation in the area is about 28 inches, and the mean annual soil temperature is about 49 degrees Fahrenheit.

1.3.3 Working Pad

The Arboretum SSOM Site naturally slopes to the southwest. The pad is graded to ensure drainage is directed toward water management berms installed at the toe of each aerated static windrow and toward compost socks installed on the site. The pad is constructed of eight inches (8") of compacted rock consisting of one and a half inch minus (1 ½-) limestone under Class 5 gravel. The gravel originally covered the tipping, processing and active composting areas of the facility. The curing and finished compost areas as well as equipment storage consisted of compacted soil when the Organics Composting Demonstration Site was originally constructed. Class 5 gravel was added to these areas to allow for year-round operations in December 2011. Braun Intertec conducted permeability testing of the pad utilizing a double ring infiltrometer, a nuclear density gage as well as laboratory testing in 2013. Testing was performed in accordance with ASTM International D2434-68. Based on these test results Braun estimated that infiltration rate of the working pad to be $1.34X10^{-4}$(cm/sec) which is considered slow. It should be noted that the permeability testing was conducted in 2013 and since then additional gravel was added and compacted. The current pad permeability is unknown.

The Arboretum SSOM Site began accepting materials on September 1, 2011. SET, the site operator, accepts materials on site from private waste haulers and from the University of Minnesota Landscape Arboretum property through prearranged agreements. Waste haulers co-collect organics with yard waste curbside from residential customers and deliver it to the facility for composting. The Arboretum Site also accepts the Arboretum's cafeteria 's SSOM and the Arboretum's yard



waste. No public drop off is allowed at the site. The Arboretum SSOM Site is permitted to process 15,000 cubic yards annually, of which 20% or 3,000 cubic yards may consist of SSOM. The volume of material is recorded by material type,

(SSOM, brush and yard waste), in cubic yards (yd^3) on a ticket by a gate attendant, for all loads entering and leaving the site. There is no scale for recording the weight of materials. The active composting area, curing pile and finish compost storage area are indicated on Figure 1.3.3. A mixer, front-end loader and a screener are used for processing materials.
The Arboretum SSOM Site was originally designed to gather data, through the use of lysimeters, regarding the differing environmental impacts of composting yard waste by itself versus composting SSOM with yard waste. Co-collected SSOM with yard waste is transported to the composting area where it is mixed and then placed into aerated static piles using a front-end loader. Yard waste only loads are placed in a separate pile using a front end loader. Fall leaves are either used or stockpiled for future use so the optimal C/N ratio can be achieved.

Aerated static piles and stockpiles do not exceed twelve feet (12') in height. Composting materials are turned to ensure compliance with the Process to Further Reduce Pathogens (PFRP) requirements.

1.3.4 Hydrogeology

Ice stagnation deposits
Holocene: *pe,* organic debris, clay and silt
Pleistocene: *dth,* loam to clay loam
Ground water flow: surficial aquifer West trend
Depth to Bedrock: 401-450 feet
Estimated water table elevation: 975-1000 feet
Depth to the water table in the wells is approximately 7.5 feet. More information can be found in Appendix D the "Hydrogeologic Investigation and Monitoring Well Installation Report."

1.3.5 Monitoring Well Locations

Four monitoring wells were installed at the Arboretum SSOM site in December of 2016. The well locations and elevations are marked on Figure 1.3.5A below. The wells are designated as: AR-MW1, AR-MW2, AR-MW-3 and AR-MW4.

Monitoring Well	X* (ft)	Y* (ft)	Elevation** (ft)	Well Depth (ft BTOR)
MW-AR-1	543,186.5	180,430.2	1,005.73	26.82
MW-AR-2	543,112.5	180,385.8	995.17	25.45
MW-AR-3	543,112.7	180,266.9	994.28	26.58
MW-AR-4	543,197.7	180,219.0	996.70	26.23

*Locations in Carver County Coordinates

**Elevations are to top of riser and referenced to NAVD88

BTOR = Below top of riser pipe

Potentiometric Surface Elevation Contour (04/17/2017)

Monitoring Wells and Groundwater Elevations (4/17/2017)

* Monitoring Well Not Included in Contours

0 50 Feet

N

Figure 1.3.5A

Carlson McCain
ENVIRONMENTAL · ENGINEERING · SURVEYING

HYDROGEOLOGIC INVESTIGATION AND MONITORING WELL INSTALLATION REPORT

CARVER COUNTY COMPOST SITES
ARBORETUM COMPOST SITE

…RE 6
ARBORETUM
GROUNDWATER
ELEVATIONS
04/17/2017

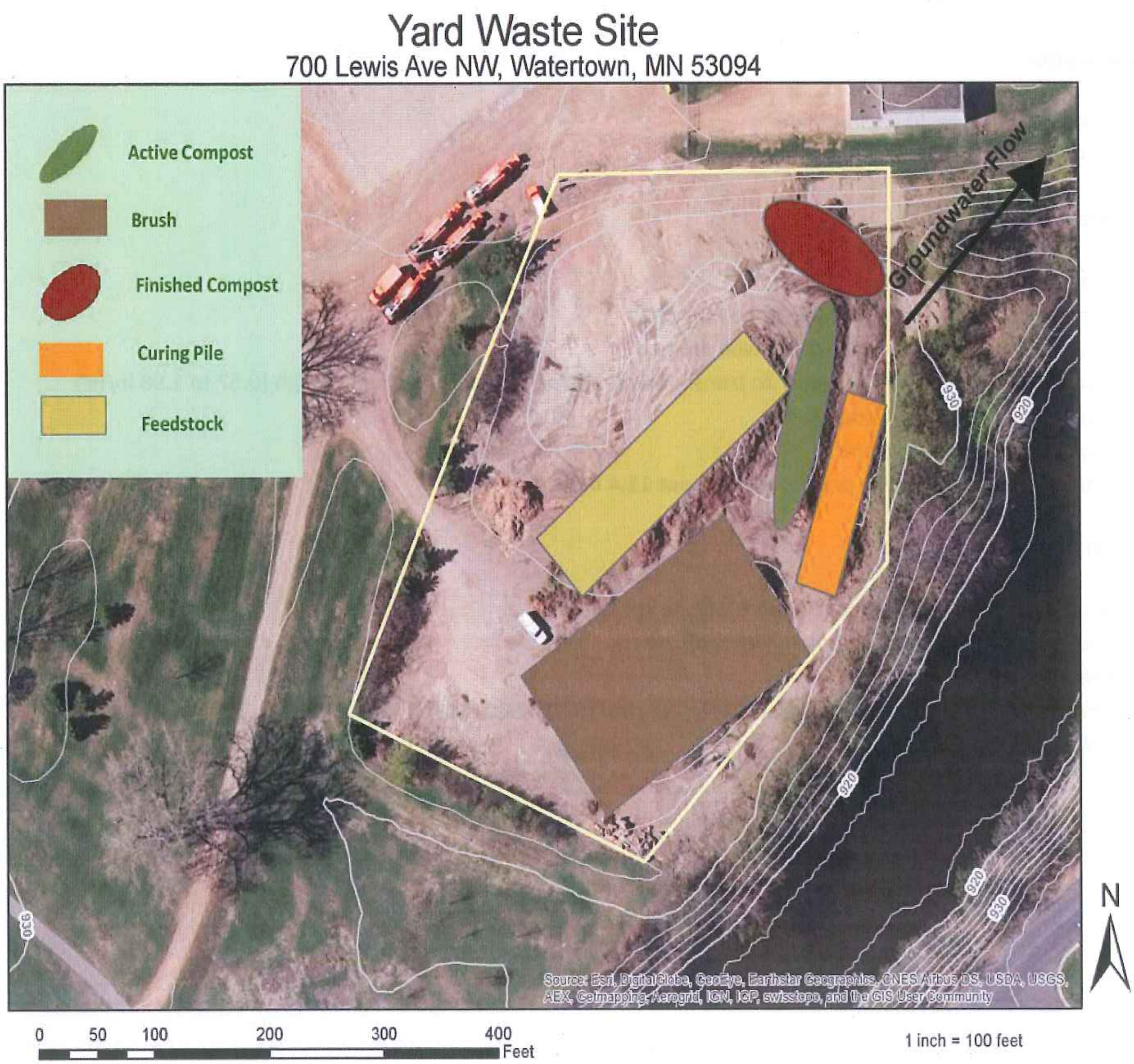
1.4 City of Watertown Yard Waste Site

Watertown is a city located in northwest Carver County along the South Fork of the Crow River and has a population of 4,205.

The City of Watertown coordinates residential yard waste collection services within the City by contracting with Randy's Environmental Services, Inc.. In addition to the weekly curb side yard waste and compost collection the City also offer year-round yard waste drop-off service at their yard waste site located Public Works property.

1.4.1 Description

The Watertown yard waste site, hereafter known as Watertown, is located 700 Lewis Avenue North Watertown. The site is approximately 2.5 acres in size and accepts both lawn waste, including grass clippings and leaves, as well as brush. The City of Watertown's staff, mange the composting of grass and leaves, while a private contract is utilized to manage the brush and stumps.



1.4.2 Soils

The geology encountered at the Watertown Site consists of unconsolidated fluvial deposits typical of a sandy meandering river. The alluvium is comprised of alternating layers of gravel, sand and clay material. It is comprised of thickly bedded, variably textured deposits that classify as a poorly graded gravel with sand (GP), poorly graded sand (SP), fat clay (CH), and lean clay (CL) with lesser amounts of material classifying as poorly graded sand with silt (SP-SM) and sandy silt (ML) under the USCS. The typical sequence of material indicates a massively bedded fining upward characteristic, indicating a change from high flow velocity to low flow velocity which is consistent with floodplain deposits along a meandering river.

SV—Spillville loam,

Setting

- *Landform:* Flood plains
- *Down-slope shape:* Linear
- *Across-slope shape:* Linear
- *Parent material:* Alluvium

Typical profile

- *Ap,A1,A2,A3 - 0 to 40 inches:* loam
- *C - 40 to 60 inches:* loam

Properties and qualities

- *Slope:* 0 to 2 percent
- *Depth to restrictive feature:* More than 80 inches
- *Natural drainage class:* Moderately well drained
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
- *Frequency of flooding:* Occasional
- *Frequency of ponding:* None
- *Available water storage in profile:* High (about 11.4 inches)

Interpretive groups

- *Land capability classification (irrigated):* None specified
- *Land capability classification (nonirrigated):* 2w
- *Hydrologic Soil Group:* B/D
- *Other vegetative classification:* Level Swale, Neutral (G103XS001MN)
- *Hydric soil rating:* No

1.4.3 Hydrogeology

Ice stagnation deposits
Holocene: *al,* silty clay loam to sandy loam
Pleistocene: *dth,* loam to clay loam
Depth to bedrock: 151-200 feet
Ground water flow: surficial aquifer NE trend
Estimated water table elevation: 900-925 feet

Depth to the water table in the wells is approximately 1.5 feet. More information can be found in Appendix D the "Hydrogeologic Investigation and Monitoring Well Installation Report."

1.4.5 Monitoring Well Locations

Four monitoring wells were installed at the Watertown site in December of 2016. The well locations and elevations are marked on Figure 1.4.5A below. The wells are designated as: WA-MW1, WA-MW2, WA-MW3 and WA- MW4.

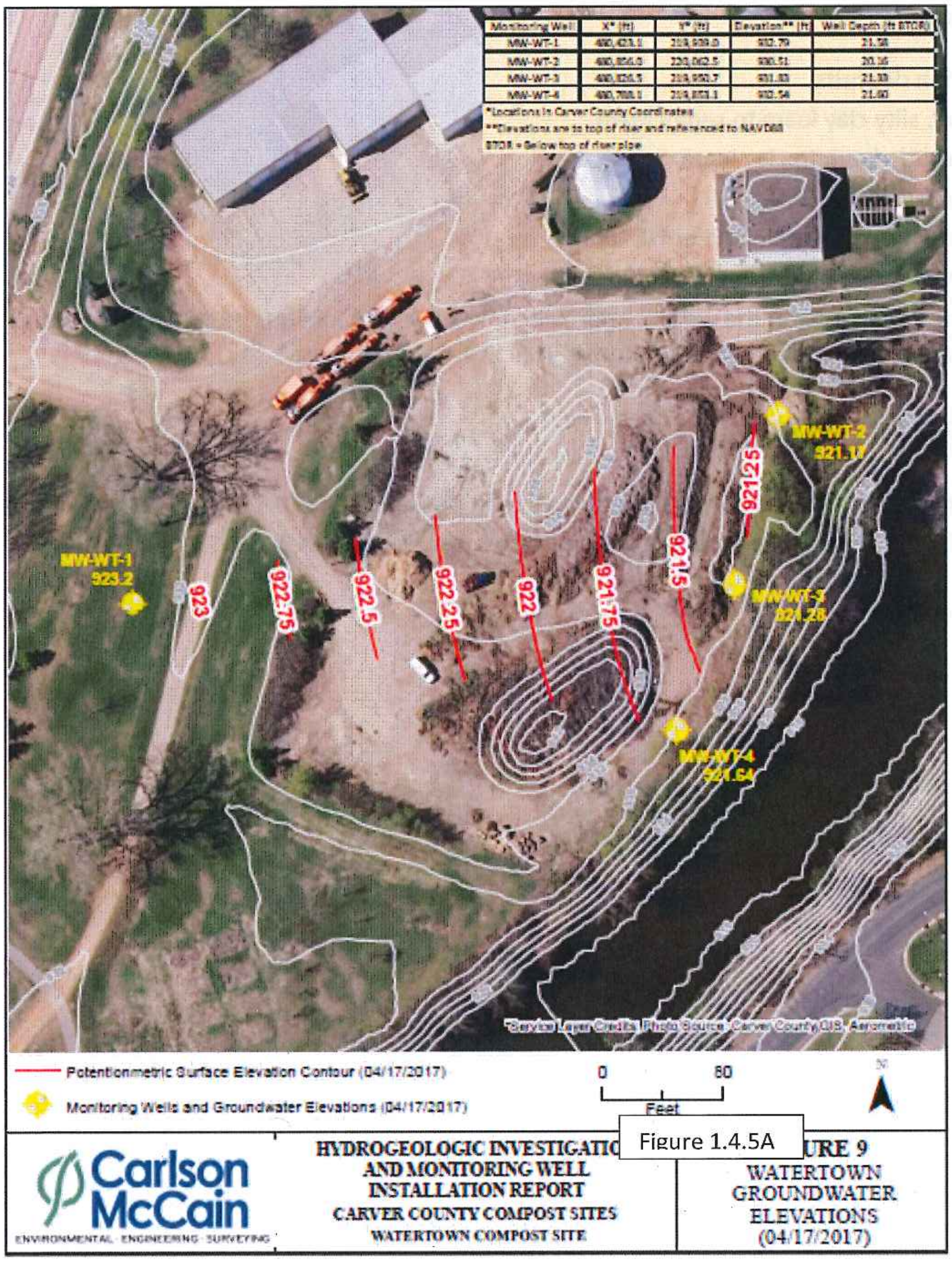


Figure 1.4.5A

1.5 Field, Laboratory and Water Quality Objectives

1.5.1 Field Analysis

This provides rapid on-site analysis for parameters needed to evaluate well stabilization prior to sample collection. The parameters include pH, conductivity, and temperature and require no quality control other than instrument calibration. pH meters are calibrated in the lab once per week, using standard buffer. The calibration of conductivity is conducted once per month in the lab. Thermometers are checked in the lab before transport to the field. Observations are recorded in a field notebook.

1.5.2 Laboratory Analysis

This provides the highest level of data quality and is used for the purpose of evaluating the degree of aquifer contamination. All analysis is conducted using EPA recognized methodology and is evaluated using reagent blanks, duplicates, and matrix spikes. The parameters to be measured are listed in Table 1.

1.5.3 Water Quality Data

The results of all water quality measurements will be compared with applicable standards in order to evaluate the impact of composting activity. These standards are:

- USEPA Safe Drinking Water Act Primary Standards (PDW)
- USEPA Safe Drinking Water Act Secondary Standards (SDW).
- Minnesota Standards (found at this link: http://www.health.state.mn.us/divs/eh/risk/guidance/gw/table.html
- EPA MCLs

Parameters not included in any of these lists will be used to compare water quality trends at each sampling site. That is, new data will be compared with data generated previously to assess changes in water quality.

1.6 Groundwater Contaminants of Concern (COC)

The COCs are generalized by contaminant category; a detailed list of contaminants that will be monitored is included in Table 1. This list may be modified during the course of the filed analysis.

Table 1. Contaminants of Concern

SVOCs:

ANALYTE	MRL	Units
2,4-Dichlorophenol	1	ug/L
1,2,4-Trichlorobenzene	1	ug/L
Naphthalene	1	ug/L
4-Chloroaniline	5	ug/L
Hexachlorobutadiene	1	ug/L
2-Methylnaphthalene	1	ug/L
4-Chloro-3-methylphenol	1	ug/L
2,4,6-Trichlorophenol	1	ug/L
2,4,5-Trichlorophenol	1	ug/L
2-Chloronaphthalene	1	ug/L
2-Nitroaniline	1	ug/L
Acenaphthylene	1	ug/L
Dimethylphthalate	1	ug/L
2,6-Dinitrotoluene	1	ug/L
Acenaphthene	1	ug/L
3-Nitroaniline	5	ug/L
Dibenzofuran	1	ug/L
2,4-Dinitrophenol	5	ug/L
2,4-Dinitrotoluene	1	ug/L

Fluorene	1	ug/L
4-Nitrophenol	5	ug/L
4-Chlorophenylphenyl ether	1	ug/L
Diethylphthalate	1	ug/L
4,6-Dinitro-2-methylphenol	5	ug/L
Pyridine	5	ug/L
2-Picoline	5	ug/L
Bis(1-chloroisopropyl)ether	1	ug/L
3-Methylcholanthrene	5	ug/L
3,3'-Dichlorobenzidine	5	ug/L
2-Acetylaminofluorene	1	ug/L
Chlorobenzilate	1	ug/L
p-Dimethylaminoazobenzene	1	ug/L
Benzidine	5	ug/L
Isodrin	1	ug/L
Pronamide	1	ug/L
Pentachloronitrobenzene	1	ug/L
Diallate (cis or trans)	1	ug/L
Phenacetin	1	ug/L
1,3,5-Trinitrobenzene	5	ug/L
Azobenzene	1	ug/L
5-Nitro-o-toluidine	1	ug/L
2,3,4,6-Tetrachlorophenol	5	ug/L
Pentachlorobenzene	1	ug/L
Acetophenone	1	ug/L
Pentachlorophenol	5	ug/L
Phenanthrene	1	ug/L
Anthracene	1	ug/L
Carbazole	1	ug/L
Di-n-butylphthalate	1	ug/L
Fluoranthene	1	ug/L
Pyrene	1	ug/L
Butylbenzylphthalate	1	ug/L
Chrysene	1	ug/L
Aniline	5	ug/L
o-Toluidine	5	ug/L
3,3'-Dimethylbenzidine	5	ug/L
Ethyl methacrylate	5	ug/L
Caprolactam	5	ug/L
1-Methylnaphthalene	1	ug/L

Biphenyl	1	ug/L
1-Chloronaphthalene	1	ug/L
1,4-Dinitrobenzene	5	ug/L
1,2-Dinitrobenzene	1	ug/L
Diphenyl ether	1	ug/L
2,3,5,6-Tetrachlorophenol	5	ug/L
Dibenz (a,j) acridine	1	ug/L
Diphenylamine	1	ug/L
4-Nitroaniline	1	ug/L
Pentachloroethane	5	ug/L
1,3-Dinitrobenzene	5	ug/L
Isosafrole	1	ug/L
1,2,4,5-Tetrachlorobenzene	1	ug/L
Safrole	1	ug/L
N-Nitrosodi-n-butylamine	1	ug/L
2,6-Dichlorophenol	1	ug/L
N-Nitrosopiperidine	1	ug/L
2-Chlorophenol	1	ug/L
Benzo (a) anthracene	1	ug/L
Bis(2-ethylhexyl)phthalate	1	ug/L
Di-n-octylphthalate	1	ug/L
Benzo(b)fluoranthene	1	ug/L
Benzo(k)fluoranthene	1	ug/L
Benzo(a)pyrene	1	ug/L
Indeno(1,2,3-cd)pyrene	1	ug/L
Dibenz(a,h)anthracene	1	ug/L
Benzo(g,h,i)perylene	1	ug/L
Hexachlorobenzene	1	ug/L
Phenol	1	ug/L
Bis(2-chloroethyl)ether	1	ug/L
1,3-Dichlorobenzene	1	ug/L
4-Bromophenyl phenyl ether	1	ug/L
1,4-Dichlorobenzene	1	ug/L
1,2-Dichlorobenzene	1	ug/L
2-Methylphenol	1	ug/L
N-Nitroso-di-n-propylamine	1	ug/L
3+4-Methylphenol	1	ug/L
Hexachloroethane	5	ug/L
Nitrobenzene	1	ug/L

Isophorone	1	ug/L
2-Nitrophenol	1	ug/L
2,4-Dimethylphenol	1	ug/L
Bis(2-chloroethoxy)methane	1	ug/L

PFCs:

ANALYTE	MRL	Units
perfluorodecanoate	10	ng/L
perfluoroheptanoate	10	ng/L
perfluorohexyl sulfonate	10	ng/L
perfluorohexanoate	10	ng/L
perfluorononanoate	10	ng/L
perfluorooctyl sulfonate	10	ng/L
perfluorooctanoate	10	ng/L
perfluoropentanoate	50	ng/L
perfluorotetradecanoate	10	ng/L
perfluorotridecanoate	10	ng/L
perfluoroundecanoate	10	ng/L
perfluorobutyl sulfonate	10	ng/L
perfluorobutanoate	50	ng/L
perfluorododecanoate	10	ng/L
perfluoro-1-pentanesulfonate (PFPeS)	10	ng/L
perfluoro-1-octanesulfonamide (FOSA)	10	ng/L
perfluoro-1-nonanesulfonate (PFNS)	10	ng/L
perfluoro-1-heptanesulfonate (PFHpS)	10	ng/L
perfluoro-1-decanesulfonate (PFDS)	10	ng/L
N-MeFOSAA	10	ng/L
N-EtFOSAA	10	ng/L
1H,1H,2H,2H-perfluorooctane sulfonate (6:2 FTS)	10	ng/L
1H,1H,2H,2H-perfluorohexane sulfonate (4:2 FTS)	10	ng/L
1H,1H,2H,2H-perfluorodecane sulfonate (8:2 FTS)	10	ng/L

ANALYTE	MRL	Units
2,4-D	250	ng/L

Chlorinated Pesticides:

ANALYTE	MRL	Units
Alpha-BHC	0.05	ug/L
Gamma-BHC	0.05	ug/L
Beta-BHC	0.05	ug/L
Heptachlor	0.05	ug/L
Delta-BHC	0.05	ug/L
Aldrin	0.05	ug/L
Heptachlor epoxide	0.05	ug/L
4,4'-DDE	0.05	ug/L
Dieldrin	0.05	ug/L
Endrin	0.05	ug/L
4,4'-DDD	0.05	ug/L
Endosulfan II	0.05	ug/L
4,4'-DDT	0.05	ug/L
Endrin aldehyde	0.05	ug/L
Endosulfan Sulfate	0.05	ug/L
Methoxychlor	0.05	ug/L
Endrin ketone	0.05	ug/L
gamma-Chlordane	0.05	ug/L
Alpha-Chlordane	0.05	ug/L
Endosulfan I	0.05	ug/L

Metals by ICP:

ANALYTE	MRL	Units
Aluminum	0.2	mg/L
Antimony	0.02	mg/L
Arsenic	0.04	mg/L
Barium	0.003	mg/L
Beryllium	0.002	mg/L
Boron	0.05	mg/L
Cadmium	0.002	mg/L

Calcium	0.2	mg/L
Chromium	0.005	mg/L
Cobalt	0.006	mg/L
Copper	0.02	mg/L
Iron	0.08	mg/L
Lead	0.03	mg/L
Lithium	0.025	mg/L
Magnesium	0.2	mg/L
Manganese	0.008	mg/L
Molybdenum	0.012	mg/L
Nickel	0.012	mg/L
Potassium	0.8	mg/L
Selenium	0.05	mg/L
Silver	0.01	mg/L
Sodium	0.4	mg/L
Strontium	0.003	mg/L
Thallium	0.06	mg/L
Tin	0.02	mg/L
Titanium	0.006	mg/L
Vanadium	0.005	mg/L
Zinc	0.03	mg/L

Metals by ICP-MS:

ANALYTE	MRL	Units
Copper	2	ug/L
Lead	0.5	ug/L
Manganese	1	ug/L
Molybdenum	1	ug/L
Nickel	1	ug/L
Selenium	2	ug/L
Thallium	0.5	ug/L
Uranium	0.5	ug/L
Vanadium	1	ug/L
Zinc	10	ug/L
Thorium	5	ug/L
Antimony	1	ug/L
Arsenic	1	ug/L
Beryllium	1	ug/L
Cadmium	1	ug/L
Chromium	1	ug/L

Cobalt	0.5	ug/L
Silver	1	ug/L
Barium	10	ug/L

Hg by CVAA:

ANALYTE	MRL	Units
Mercury	0.5	ug/L

General Chemistry:

ANALYTE	MRL	Units
Phosphorous	0.15	mg/L
Nitrate as N	0.125	mg/L
TKN	0.5	mg/L
TDS	20	mg/L
TSS	5	mg/L
BOD	2	mg/L

VOCs:

Dichlorodifluoromethane
Ethyl Ether
1,1-Dichloroethene
Dibromofluoromethane
1,2-Dichloroethane-d4
Methylene chloride
Toluene-d8
4-Bromofluorobenzene
1,1,2-Trichlorotrifluoroethane
Allyl Chloride
trans-1,2-Dichloroethene
Methyl-t-butyl ether
Chloromethane
1,1-Dichloroethane
2-Butanone (MEK)
cis-1,2-Dichloroethene
Bromochloromethane
Vinyl chloride
Chloroform
2,2-Dichloropropane
Tetrahydrofuran
1,2-Dichloroethane

1,1,1-Trichloroethane
1,1-Dichloropropene
Carbon Tetrachloride
Benzene
Dibromomethane
1,2-Dichloropropane
Bromomethane
Trichloroethene
Bromodichloromethane
cis-1,3-Dichloropropene
Methyl Isobutyl Ketone
trans-1,3-Dichloropropene
1,1,2-Trichloroethane
Toluene
Chloroethane
1,3-Dichloropropane
Chlorodibromomethane
1,2-Dibromoethane
Tetrachloroethene
1,1,1,2-Tetrachloroethane
Chlorobenzene
Ethylbenzene
m,p-Xylenes
Dichlorofluoromethane
Bromoform
Styrene
1,1,2,2-Tetrachloroethane
o-Xylene
1,2,3-Trichloropropane
Isopropylbenzene
Bromobenzene
n-Propylbenzene
Trichlorofluoromethane
2-Chlorotoluene
4-Chlorotoluene
1,3,5-Trimethylbenzene
tert-Butylbenzene
1,2,4-Trimethylbenzene
sec-Butylbenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene

4-Isopropyltoluene
1,2-Dichlorobenzene
n-Butylbenzene
1,2-Dibromo-3-chloropropane
1,2,4-Trichlorobenzene
Naphthalene
Hexachlorobutadiene
1,2,3-Trichlorobenzene
Acetone

Section 2 Project Organization and Responsibilities

This portion of the QAPP addresses the project organization as it provides for QA/QC coordination and responsibilities.

The key responsibilities of each of the Carver County groundwater monitoring project participants are outlined in the following subsections.

2.1 Program Manager

The Program Manager will serve as the liaison between the MCPA project team and EPA/ORD. The Program Manager will ensure appropriate corporate resources are supplied to the Project Team in the form of technical, financial, regulatory, QA/QC and Health and Safety support. The Program Manager will maintain contact with the Project Manager and other key team members as project tasks deem appropriate, and assure appropriate coordination among all project team staff.

2.2 Project Manager

The Project Manager's responsibilities include review of work plans, schedules, costs, and technical performance, and effective day-to-day management of the project staff. The Project Manager will also be the primary technical reviewer of project deliverables. The Project Manager's responsibilities specific to QA/QC are to ensure proper implementation of the field procedures by the project team. The project manager is experienced in project staff management, as well as development and implementation of appropriate field procedures. The project manager will assist in disseminating results of the research to partner organizations.

2.3 Project QA Officer

The Project QA Officer is responsible for maintaining and overseeing an effective QA/QC organization in the laboratory and field. The Project QA Officer, in conjunction with other appropriately trained and experienced EPA personnel, audits the performance of the laboratory and field team to ensure that the requirements of the QAPP are followed in sampling and analysis activities. The Project QA Officer directs the development of the QAPP facilitates review and approval of any deviations or changes to QA/QC requirements. The QA Officer informs project management of any QAPP nonconformance, and ensures appropriate corrective actions are completed and documented. Portions of reports and other project deliverables are prepared or reviewed by the QA Officer, as appropriate, to ensure that environmental data standards of the project QAPP are appropriately addressed. The QA Officer provides the analytical laboratory and field personnel with current project QA/QC standards and requirements, to ensure that they are adequately prepared for conducting their work tasks in conformance with project requirements.

2.4 Field Team Leader

The Field Team Leader is responsible for provision of accurate field data produced by sampling personnel. The Field Team Leader is responsible for ensuring that QC procedures are followed and documented. He/she will be trained and experienced in the field procedures relevant to the field activities. The Field Team Leader is responsible for contacting the Sample Custodian to ensure that samples have arrived at the laboratory on time and in good condition.

2.5 Analysts and Field Team Members

It is the responsibility of the Laboratory Analysts and Field Team Members to perform the required QA/QC procedures and to document observations and calculations in the proper notebooks or standard forms. It is the responsibility of the analysts to perform preliminary QC checks. The Field Team Member or Analyst must also bring any unusual observation or analytical problem to the immediate attention of his/her supervisor or the Project QA Officer. The Analyst or Field Team Member must ensure that instruments are properly calibrated, with completed calibrations recorded in permanent records. All analysts and field team members on the project will be experienced in their assigned tasks and familiar with the applicable requirements of this QAPP and associated project requirements.

2.6 Sample Custodian/Support Services Coordinator

The Sample Custodian/Support Services Coordinator is responsible for receiving samples from the field and checking to ensure that proper preservation, shipment, and chain-of-custody are maintained. The Sample Custodian also reports any unusual problems (e.g., sample breakage or improper temperature) to the Laboratory Manager. He/she is experienced in sample management and review of procedures relevant to the position. Various personnel fulfill this function, and all are appropriately trained prior to assuming this responsibility. The samples will be shipped to the USEPA Region 5 Chicago Regional Laboratory, 536 S. Clark St. ML-10C. 10th floor, Chicago, Illinois 60605: Attention Robert Synder.

The biological samples will be shipped to the EPA's Cincinnati Lab at:

C/O Laura Boczek
US EPA – ORD
26 W Martin Luther King Dr
MS 681
Cincinnati OH 45268

Before shipment of the biological samples, please contact Ron Herrmann (herrmann.ron@epa.gov, 513-569-7741) or Laura Boczek (boczek.laura@epa.gov, 513-569-7282) to ensure the laboratory is able to receive and analyze the samples in a timely fashion.

Section 3 Quality Assurance Objectives

Data obtained during the investigation of the compost facilities is intended to define the distribution, types, and concentrations of site-related constituents as a supplement to previous site investigations and for long- term monitoring. The QAPP and SAP have been prepared to detail the minimum environmental data standards, particularly for field and analytical data quality. It is anticipated that the EPA Region 5 Analytical Laboratory, located at Chicago, IL, will provide most of the required analytical services for this project except the biological analytical services. Should project-specific objectives or requirements necessitate that laboratory analyses be subcontracted, information regarding the subcontracted laboratory will be provided as an addendum to this QAPP.

It is anticipated that EPA ORD Cincinnati NRMR L will provide the biological analytical services.

Analytical data will be generated by EPA approved methods and QC criteria generated from a laboratory method validation. These procedures will result in analytical data considered generally equivalent to EPA definitive data.

The overall QA objectives are to develop and implement procedures for field sampling; chain-of-custody, laboratory analysis, and reporting that will provide results that are legally defensible in a court of law. Specific procedures for sampling, chain-of-custody, instrument calibration/preventive maintenance, chemical analysis, internal QC, reporting data, audits, and corrective actions are described in other sections of this QAPP. This section addresses the specific objectives for accuracy, precision, completeness, representativeness, and comparability.

Section 4 Sampling Procedures

4.1 Sampling Site Selection

The objective of this monitoring system is to measure the effect on groundwater from an unlined source separated organics material composting facility and an unlined yard waste composting facility. If the groundwater becomes contaminated, there is a potential for the contamination to impact both the environment and the health of the local community. Besides the potential for contaminating drinking water wells, the groundwater may also have an impact on the aquatic life in nearby lakes and streams. Fish from these lakes are a staple food for many of the local residents.

The monitoring wells at each of the two project sites were located to allow observation of the groundwater both up gradient and down gradient of the compost operations.

4.2 Sampling Site Description

Figures 1.3.5A and Figures 1.4.5A show the locations of the monitoring wells.

Section 5 Internal Quality Control

5.1 Field QC Checks

Three types of QC samples will be processed: equipment blanks, trip blanks, and field duplicates. The analytical data derived from these QC samples are useful for assessing field operations: constituent-free sample containers, preserving reagents, and equipment; potential onsite environmental contamination; personnel expertise in sample collection; and problems that may occur in sample storage and transport. Field duplicate samples are collected to ensure precision of the sampling and analytical processes.

5.1.1 Blanks

5.1.1.1 *Equipment Blanks*

Equipment blanks will test for the cleanliness of sampling equipment and effectiveness of field decontamination procedures. Equipment blanks are collected after field and/or laboratory decontamination by rinsing decontaminated sampling equipment (pumps, bailers, soil samplers, etc.) with laboratory-grade deionized water. The rinse water is collected in sample bottles, preserved, and handled in the same manner as the samples. Equipment blanks will be collected and analyzed at a rate of one blank or 10 percent (whichever is greater) of the samples in each analyte group for all matrices.

5.1.1.2 *Trip Blanks*

Trip blanks will be used to evaluate the contamination generated from sample containers and changes occurring during the shipping process. Trip blanks are collected for volatile organics and for biological analyses. Trip blanks consist of sample bottles filled in the laboratory with organic-free water and any applicable preservatives or additives. They are sent to the sampling location with sampling kits and are returned unopened from the sampling location with the samples. One trip blank should be included for shipping and analysis with every cooler containing volatile or biological samples shipped from the field.

5.1.1.3 *Temperature Blanks*

Temperature blanks are used to determine whether the samples have been maintained at an appropriate temperature, and thus properly preserved, during shipping. The temperature blank and trip blank may be the same sample, which is evaluated for temperature upon receipt at the laboratory, then analyzed as a trip blank. Standard temperature is expected to be 6^0 C.

5.1.2 *Field Duplicates*

Field duplicates will be used to monitor sample collection precision. These are duplicate samples collected at the same location and are sent "blind" to the laboratory for analysis as separate samples. During each independent sampling event, at least one sample or 10 percent of the samples (whichever is greater) will be collected in duplicate for analysis.

5.1.3 *QC Checks on Field Measurements*

Field instruments will be calibrated at the beginning of each sampling day, checked with one standard at intervals not to exceed 4 hours of consecutive instrument use, and checked again at the end of sampling day. Instruments will be recalibrated if these QC checks do not meet acceptance criteria. Field checks against knowns will be conducted as part of calibration of field instrumentation in accordance with instrument standard operating procedures. Should field QC checks fall outside the acceptable range, corrective action will be initiated per the operating procedure. QC checks will be recorded in the field notebook.

5.1.4 *Assessment of Field Data Precision and Accuracy*

The Project QA Officer will assess field data. The Project QA Officer will review the field results for compliance with the established QC criteria that are specified in this QAPP and in the site-specific SAP. Accuracy of the field measurements will be assessed using daily instrument calibration and calibration check. Precision will be assessed on the basis of reproducibility by multiple reading of a single sample.

5. 2 Lab QC checks

5.2.1 *Method Blank*

A method blank, or preparation blank, is analyzed with each preparation batch as a check on analytical system contamination. A sample consisting of laboratory reagent water or analyte free laboratory sand, clean is processed through the entire analytical method including all sample preparation procedures such as extraction, digestion, and filtration. As a quality control sample, the results are used in conjunction with other control data to validate overall system performance and data quality. Client samples are associated with the method blank by sharing a common preparation workgroup number. The Laboratory will perform the necessary control, duplicates and matrix spike samples as required in the quality assurance plan.

5.2.2 *Lab duplicates*

Lab duplicates will be used to monitor analytical precision. These are duplicate analysis. During each analytical batch, at least one sample or 10 percent of the samples (whichever is greater) will be analyzed in duplicate. Spiked duplicates may be used if there is the possibility of non-detects in the original sample.

5.2.3 *Lab Spikes*

Depending on the method requirements, either laboratory control samples or matrix spikes will be used to assess analytical accuracy.

Section 6 Preventive Maintenance

To minimize the occurrence of instrument failure and other system malfunction, a preventive maintenance program for field and laboratory instruments has been implemented. The preventive maintenance performed for each major piece of field and analytical equipment is addressed in the following sections.

6.1 Field Instruments

Preventive maintenance of field instruments is performed in accordance with manufacturer's instructions. Field Team Members routinely perform preventive maintenance of field equipment before each sampling event. Manufacturers perform more extensive maintenance on the basis of hours in use. Field Team Members report on the performance of the equipment after each sampling event. Critical spare parts are kept in stock. At times, it is necessary to perform routine maintenance in the field; therefore, each field instrument is provided with an operating manual and tool kit.

The list of field instruments and their maintenance frequency are provided in Field Procedure 3 of Appendix A. Preventative maintenance procedures are recorded in the field logbooks.

6.2 Routine Maintenance Activities

Instruments undergo routine maintenance, cleaning, and inspection on a daily, weekly, or monthly basis, according to the manufacturer's recommendation, and/or the requirements of the standard methods employed. Maintenance logs and instrument maintenance checklists are kept, noting problems and the steps taken to correct them.

APPENDIX A: FIELD PROCEDURES

FIELD PROCEDURE 1	FIELD DOCUMENTATION
FIELD PROCEDURE 2	FIELD INSTRUMENT CALIBRATION
FIELD PROCEDURE 3	GROUNDWATER SAMPLING
FIELD PROCEDURE 4	SAMPLE NUMBERING, LABELS AND CUSTODY
FIELD PROCEDURE 5	MICROBIAL SAMPLING

FIELD PROCEDURE 1

FIELD DOCUMENTATION

Field notes will be recorded, in ink, on bound field notebooks with continuously numbered pages. Any supplementary information will be recorded, in ink, on standard field documentation forms appropriate for the activity involved. The supplementary information forms will be specifically referenced in the bound notebooks by date, time, page number, and content. Each form must provide a place for the Field Team Member to sign and date the entries.

Supplemental field data sheets must be reviewed and approved by the Field Team Leader and documented by his/her signing or initialing each field page. The review must be completed during the field site visit or, shortly following completion of field activities to ensure that timely corrective actions can be implemented, if necessary. At a minimum, documentation and validity of the following items will be reviewed and verified:

1. Correct study area designation and sample numbers,
2. Date and time (24-hour system recordings), and
3. Complete entries on each form (no blank spaces).

Field Logbooks

Data collection activities will be documented in field logbooks and/or on appropriate task-specific field data sheets. Field logbooks will be bound field survey notebooks. Logbooks will be assigned to field personnel and will be stored in the project file when not in use. The front of each logbook will show the person/organization, book number, project name, and start/end dates for the logbook. Field data sheets will be returned to the Project Management office and placed in three-ring binders or otherwise will be appropriately retained and filed. For groundwater sampling, completed field data sheets will be submitted with sample chains of custody. This will ensure field data are included in electronic data deliverables. Field personnel will reference field data sheets in field logbooks to ensure complete records are established and retained.

Entries into the field logbooks and field data sheets will be made in waterproof ink without erasures. If an incorrect entry is made, the erroneous information will be crossed out with a single strike mark and initialed.

Field logbooks and/or field data sheets will be used to record field measurements and other pertinent information necessary to reconstruct all sample collection activities without reliance on memory. Field logbooks and/or field data sheets will contain the following information at a minimum:

- Dates of sample collection;
- Detailed descriptions of sample locations that identify the area of concern;
- Name(s) of sampler(s);
- Weather and site conditions;
- Sampling equipment used, including all information related to the calibration and maintenance of
- field equipment, along with the date and person doing the calibration or maintenance;
- Field ID for each sample and components to be sampled;
- Sample sequence number;
- Time of collection;
- Preservative used;
- Field measurement data;
- Identification and types of QC samples collected;

- The number and subject of all photographs;
- Reference to any field data sheets that may be used and a summary of the field activities recorded on the field data sheets.

Photographic Records

Photographs may be digital or film photographs. Digital photographs will be maintained in digital files. Film photographs will be maintained in the project file. The number and subject of all photographs will be recorded in the field logbooks. Photographs will be identified with the following information:

1. The date, time, and location of the photograph, including direction facing; and
2. The name of the photographer.

Samples and Field Documentation Procedures

Field procedures are designed to minimize sample handling and transfers. During sampling, the field crew will record the following information in the field logbook and/or field data sheet, and on the chain-of-custody, using indelible ink:

1. The unique sample number,
2. Source of sample (including name, location, and sample type),
3. Date and time of sample collection,
4. Preservatives used,
5. Name(s) of collector(s), and
6. Field measurements (PID, pH, temperature, turbidity, specific conductance, or other).

The following data regarding sampling activities will be kept in a bound field notebook and/or field data sheets. These same data will be recorded for other field activities (i.e., storm water management, waste management) as appropriate for the task being conducted.

1. Task area number or location;
2. Date;
3. Time (24-hour system);
4. Static water level [to $\pm$ 0.0l ft., if applicable];
5. Depth of well;
6. Number of bailer volumes removed or pumping rate, if applicable;
7. Time of pumping, if applicable;
8. Total volume of water evacuated from well;
9. Water quality measurements such as pH, specific conductance, and temperature;
10. Other pertinent observations of samples (color, turbidity, odor, depth, evidence of constituents, etc.);
11. Fractions sampled and preservation method;
12. Weather conditions and/or miscellaneous observations;
14. Description of photographs taken at each sampling location, if applicable;
15. Initials of sampler

The vendor for the project was selected and is Interpol Laboratories, 4500 Ball Road NE, Circle Pines, MN 55014 (763) 786-6020.

FIELD PROCEDURE 2

FIELD INSTRUMENT CALIBRATION AND MAINTENANCE

Field Equipment

The field equipment for this project includes sampling devices and instruments used for field measurement of pH, Conductivity, Dissolved Oxygen, Turbidity, Temperature and depth. Preventative maintenance procedures recommended by the equipment manufacturers are followed as closely as possible, unless more stringent or more frequent maintenance is deemed necessary.

When not in use, individual items of field equipment are kept in their cases to protect them from contamination and physical damage during storage and transport. Items that do not have protective cases are stored in manner that minimizes exposure to contaminants. All equipment is stored in areas that inhibit tampering and unauthorized use.

Table 2 lists the maintenance procedures and schedules for field equipment, and includes a listing of critical spare parts that are available to the field crews.

Table 2. Preventative Maintenance of Field Equipment

Equipment	Maintenance Procedure/Schedule	Spare Parts
DO Meter	1. Check battery at beginning of each day. 2. Verify the instrument's calibration on a regular basis although optical sensors hold their calibration for many months. 3. Replace sensor element if damaged, or if stable calibration cannot be achieved. DO optical sensor element will be changed once per year.	1. Battery or battery charger. 2. Sensor element.
pH Meter	1. Check battery at beginning of each day. 2. Calibrate with two buffers at beginning of each day. 3. Replace probe if damaged, if stable calibration cannot be achieved, or if response becomes slow. 4. Probes will also be replaced when their mV readings are above YSI recommendations.	1. Battery or battery charger. 2. pH buffers. 3. Spare probe
Conductivity Meter	1. Check battery at beginning of each day. 2. Check calibration at beginning of each day. 3. Clean probe if calibration is unacceptable. 4. Calibrate conductivity once monthly.	1. Battery or battery charger. 2. Standard 0.01 M KCl
Samplers (bailers, pumps –if applicable -and any sample tubing)	1. Inspect for damage before each use. Repair or replace as necessary. 2. Triple rinse with DI water after use and store in protective case. 3. Avoid Teflon coated sampling material for PFC sampling.	

Water Level Meter/Interface Probe

1. Preventive maintenance of the water level meter consists of cleaning the exterior of the equipment after use with a solution of mild detergent and rising with tap water (daily). Replace probe into the probe holder. If severe staining occurs on the probe, rinsing with a 10% solution of nitric acid (HNO_3) followed by a de-ionized water rinse may be conducted.
2. To prevent damage, utilize the carrying bag.
3. Replacement parts, such as probes and probe tips, must be available.

* See SOP manual for more details.

In general, preventive maintenance of the field instruments is performed in accordance with manufacturer's instructions. ***The manufacturer's calibration instructions must be kept on site or with the field instrument.***

Field Team Members routinely perform preventive maintenance of field equipment before each sampling event. Manufacturers perform more extensive maintenance on the basis of hours in use. Field Team Members report on the performance of the equipment after each sampling event. Critical spare parts are kept in stock. At times, it is necessary to perform routine maintenance in the field; therefore, each field instrument is provided with an operations manual and tool kit. The solutions used for field instrument testing and calibration will be audited by the Field Team Leader for expiration dates. The lot numbers for test solutions will be noted on the calibration sheets or in the instrument logbooks.

The list of field instruments and their maintenance frequency are provided below. The major components of preventive maintenance are described below for each instrument. Each piece of instrumentation will be appropriately calibrated per manufacturer's specifications. Each field instrument shall have a certificate of calibration from the supplier. Records of field equipment maintenance, including calibration, will be retained on site in a readily available location (e.g., dedicated 3-ring binder or designated files). The field equipment maintenance records will include calibration notes and frequencies, any preventive maintenance conducted, and field repairs made to the instrument.

Salinity/Conductivity/Temperature Meter and Probe

1. Preventive maintenance protocol for the salinity/conductivity/temperature meter involves checking the condition of the batteries and electronics for loose connections and cracked leads. These are checked daily before use and are replaced as needed.
2. Probe preventive maintenance involves verification of temperature readings using a calibrated mercury thermometer in an ice bath solution with an approximate temperature of 0 degrees Celsius and verification that the probe does not need cleaning. Replacement probe parts will be available.

pH Meters and Combination pH/ORP Electrodes

Preventive maintenance for the pH meter and electrodes primarily involves the proper care of the electrode. Electrodes are stored in a manufacturer's storage solution or if not available a 200 ml solution of pH7 buffer with 1 gram of potassium chloride for short term storage.

If a pH probe will not be used within a week it should be rinsed completely with distilled water to remove any crystal deposits. The probe should be dried completely and stored with a protective cap. The preventive maintenance frequency is as follows:

1. The instrument batteries and electronics connections and cracks are checked daily during use.
2. Spare parts such as a replacement probe and fresh buffer solutions will be available for the system at all times and replaced as needed.
3. The instrument shall be calibrated daily with fresh buffers prior to use and stored in a pH7 buffer if frequent use is anticipated.

4. If the pH or combination pH/ORP meter has a self- diagnostic check procedure, it should be conducted quarterly to determine any malfunctions with the meter.

Dissolved Oxygen Meter

The maintenance requirements for an optical sensor are less laborious then electrochemical sensors.

To clean the probe and sensing element, rinse it with clean water and a lint free cloth. If necessary, use a mild detergent. Do not use alcohols or other organic solvents that may deteriorate the sensing element.

The sensing element should be replaced about once per year but may last longer. It should also be replaced if it is cracked or damaged. While changing the sensing element, rinse the optics with clean water and then wipe the optics with a lint free cloth or lens tissue. The instruction sheet that is shipped with the replacement sensing element includes calibration coefficients specific to the sensing element. For highest accuracy, these coefficients should be entered by the user into the instrument following the instructions provided. See the instrument specific manual for detailed instruction on how to change a sensing element

Turbidity Meter and Probe

1. Preventive maintenance will consist of cleaning the unit with a damp cloth and rinsing the probe with deionized water following each use.
2. The probe shall be rinsed and dried for storage.

Water Level Meter/Interface Probe

1. Preventive maintenance of the water level meter consists of cleaning the exterior of the equipment after use with a solution of mild detergent and rising with tap water (daily). Replace probe into the probe holder. If severe staining occurs on the probe, rinsing with a 10% solution of nitric acid (HNO_3) followed by a de-ionized water rinse may be conducted.
2. To prevent damage, utilize the carrying bag.
3. Replacement parts, such as probes and probe tips, must be available.

Contingency Plan

In the event of an instrument failure, the Field Team Leader will notify the Project Manager and a decision for a work hold will be ascertained. An additional instrument will be acquired as soon as possible to be able to take readings and/or resume work. After coordination with the Project Manager, the decision will be made for work progression.

Table 3. Preventive Maintenance — Field

Instrument	Activity	Frequency
pH meter	Battery replacement	As needed
	Probe replacement	As needed
ORP meter	Battery replacement	As needed
Salinity/ Conductivity/Temperature meter	Battery replacement	As needed
	Check loose connections	Daily
	Replatinization	As needed
	Calibrate temperature sensor w/ calibrated thermometer	Monthly

FIELD PROCEDURE 3

GROUNDWATER SAMPLING

Groundwater samples will be obtained from monitor wells in accordance with a final Groundwater Monitoring Plan. The following procedures will be used in the collection of groundwater samples:

I. Low-flow Purging and Sampling

The following procedure outlines low-flow purging and sampling methods with the use of a pump. This method is the preferred sampling method and should be used whenever possible, especially during groundwater sampling events. The pumps may be dedicated to each well or non-dedicated with decontamination of the pump between sampling wells. The type of pump(s), if used, to be used has not been determined. Upon pump selection, this procedure will be updated as necessary to address specific procedures based on the equipment.

1. After opening the well, a water level will be taken using a steel water-level tape, electric water-level tape, or acoustic well sounder and recorded in the field notebook or supplemental field sheet~~. The~~ water level must be taken prior to inserting the pump in the well.

2. The pump will be set within mid-point of the screen interval of the well. After setting up the pump and associated equipment (generator, compressor, tubing, etc.) a graduated collection apparatus will be used to measure the flow rate. The flow rate will be set at less than 1 liter per minute (LPM) to achieve minimal drawdown and decreased as needed. When the flow rate is stabilized (typical .1 - .3 L/min), readings of groundwater parameters will be collected every 3-5 minutes until all the parameters have stabilized. Depth to water and flow-rate measurements will be recorded every 3-5 minutes to guarantee the flow rate stays within its range and the well is not being pumped dry.

3. Parameters to be measured and the corresponding stabilization readings are the following:

   - pH ± 0.1 units
   - Conductivity ± 5.0 umhos/cm for values <1000 umhos/cm
   - Temperature ± 0.1°C

   Stabilization of parameters is achieved when 3 consecutive sets of readings are within the acceptable ranges listed above or within ± 10%.

4. After all parameters have stabilized, the sample will be collected. Sampling equipment will be kept off potentially affected soil to prevent sample cross contamination (e.g., equipment will be placed on disposable polyethylene plastic sheeting).

5. Samples will be collected in the order of biological, volatiles, semi-volatiles, conventional, metals, and dissolved metals.

6. Following collection, each sample container will be labeled, preserved as required, unless pre- preserved, and placed in a cooler of wet ice at 6°C. The temperature inside the cooler will be measured and attainment of 6°C documented prior to sealing the cooler for transportation to the laboratory under chain-of-custody documentation.

   The chain-of-custody will be placed in a waterproof container, taped to the inside of the lid of the cooler, and sealed in the cooler along with its samples. The cooler seal or lock will not be opened until the samples arrive in the analytical laboratory and are checked in by the Sample Custodian. The Field Team Leader will alert the laboratory to pertinent shipping information at the end of each sampling day.

7. All purged water will be disposed on the ground next to the well.

8. During the sampling of each monitor well, information regarding the sampling will be kept in a field notebook and transferred onto a Ground Water Sampling Field Data Sheet (an example form is included on the following pages). The following data will be collected:

   - Well number;
   - Date;
   - Time;
   - Static water level [to $\pm$ 0.01 foot];
   - Depth of well;
   - Diameter of well casing;
   - Calculated well volume;
   - Pumping rate;
   - Time (duration) of pumping, if applicable;
   - Total volume of water evacuated from well;

9. Water quality measurements of pH, conductivity, and temperature;
10. Other pertinent observations of water samples (color, turbidity, odor, etc.);
11. Fractions sampled and preservation method;
12. Weather conditions, including ambient air temperature and/or miscellaneous observations and;
13. Signature of sampler(s) and QC person with date

II. Purging four well volumes with a standard pump and sampling with a pump

1. Repeat steps 1 – 2 of low flow method
2. Following measurement of initial flow rate, pump well for desired time to remove the 4 well volumes previously calculated.
3. Upon pumping 4 well volumes, record final purge time, volume removed, and collect samples immediately followed by field parameters.
4. Record total times of purging, flow rate, and any other pertinent information on the field data sheet.

III. Purging and Sampling using a Manual Bailer

The following procedure outlines the use of manual bailers to collect groundwater samples.

1. Immediately prior to collecting a sample, the depth to water below the top of the well casing will be measured with a steel water-level tape, electric water-level tape, or acoustic well sounder and recorded in the field notebook. The point from which water levels are measured (typically the high point of the casing) will be marked by the field geologist as soon as practical after well installation for future water level measurement reference.

2. Whenever feasible, wells expected to be unaffected will be sampled first, followed by wells with increasing levels of constituents.

3. Prior to collecting a groundwater sample, the volume of water in the screen, well casing, and saturated annulus will be purged. Purging is considered complete once four well volumes are removed:

   a. Upon achieving four well volumes, collect the samples and field readings.

b. In the event of a dry purge, the groundwater sample should be collected as soon as an adequate volume of water has entered the well to meet sample requirements or within 24- hours of purging.

Monitor well purge volumes will be calculated using the attached form and information obtained from the site monitor well drilling records. Purging may be accomplished by:

a. Using a decontaminated bailer for manual bailing,
b. Using a decontaminated stainless steel drop pipe with a motor-driven centrifugal lift pump,
c. Using a dedicated PVC drop pipe is allowed on a site-specific basis, or
d. Using a decontaminated submersible pump and appropriately decontaminated tubing.

Purging should begin from just below the top of water level in a well, and the purging device lowered to follow the water level as it falls.

Wells shall be sampled within 6 hours of purging except "slow recovery" wells. "Slow recovery" wells or wells that purge completely dry may be sampled as soon as sufficient recharge water is available or up to 24 hours after purging. Wells that have not recovered sufficiently within 24 hours will not be sampled unless specified by the client and/or regulatory agency.

The amount of fluid purged will be measured and recorded by using a graduated bucket and counting the number of buckets purged, or by using a stopwatch and measuring the flow-rate of the pump versus elapsed times.

4. The standard well sampling technique will be through the use of a separate pre-cleaned Teflon® bailer or a disposable high density polyethylene (HDPE) bailer for each well. A new braided nylon or polypropylene cord is typically used for bailers. A separate piece of cord is used for sampling each well, and is discarded after one use. Since bottom-filling bailers are used, the bailer cord does not contact the sample. Reusable lanyards (monofilament, stainless steel, or Teflon-coated) are not typically used in any well other than as part of a dedicated bailer system. Reusable lanyards are decontaminated using the same methods described herein.

5. HDPE bailers will be constructed with stainless steel screws and a Teflon® check ball, and no glue will be used.

6. Sampling equipment will be kept off potentially affected soil to prevent sample cross contamination (e.g., equipment will be placed on disposable polyethylene plastic sheeting).

7. The bailer, as well as all sample containers (except those for oil and grease, TPH, VOCs, microbiological samples, and any pre-preserved containers), will be rinsed once with well water prior to collecting a sample. When collecting samples from the well, especially for VOC analysis, care should be taken not to drop the bailer into the well allowing it to splash into the water. The bailer should be lowered into the water gently to reduce agitation of the sample.

8. The first samples collected will be those for VOC analysis by decanting an aliquot into the appropriate sample jars. This will be done so as to minimize sample agitation and exposure to the sample for filtered metals should be collected last.
9. The turbidity of the recovered sample should be measured during the well sampling. It is recommended that turbidity be evaluated using a portion of the sample for the metals analysis, preferably the unfiltered sample. Turbidity will be measured in national turbidity units (NTUs) using a portable turbidity meter that will be calibrated at each sampling location.

10. Following collection, each sample container will be labeled, preserved as required, unless pre-removed and wet ice and blue ice will be added. The temperature inside the cooler will be measured and attainment of 4°C $\pm$ 2°C documented prior to sealing the cooler for transportation to the laboratory under chain-of-custody documentation.

    During the sampling of each monitor well, information regarding the sampling will be kept in a field notebook. The following data will be collected:

    - Well number;
    - Date;
    - Time;
    - Static water level [to $\pm$ 0.01 foot];
    - Depth of well and depth of siltation;
    - Radius of well;
    - Radius of borehole;
    - Calculated well volume;
    - Number of bailer volumes removed or pumping rate, if applicable; temperature;
    - Time (duration) of pumping, if applicable;
    - Total volume of water evacuated from well;
    - Water quality measurements of pH, conductivity, turbidity, and temperature;
    - Other pertinent observations of water samples (color, turbidity, odor, etc.);
    - Fractions sampled and preservation method;
    - Weather conditions and/or miscellaneous observations;
    - Signature of sampler and date, and
    - Bailer inventory number, if pre-cleaned bailers are used.

List of COCs to sample is outlined in section 1.6 of this document.

FIELD PROCEDURE 4

FIELD QUALITY CONTROL SAMPLES

Field QC samples will include trip blanks, equipment blanks, and field duplicates. Field QC samples will be collected at the frequencies outlined below. In addition to these QC samples, matrix spike and matrix spike duplicate samples will be collected and submitted for analysis as outlined in table below, unless otherwise specified in the project QAPP.

Table 4. Quality Control Samples

QC Sample	Aqueous
Trip Blank	1 per cooler *
Temperature Blank	1 per cooler
Equipment Blank	10 percent
Field Duplicate	10 percent per event
Matrix Spike/Matrix Spike Duplicate	5 percent per event

Note: NR = not required
All parameters must meet QC sample type and frequency requirements.
Numbers calculated from specification will be rounded up to the nearest whole number(s).
*For volatile organic samples only.

Trip Blank

Trip blanks are collected to demonstrate that no volatile compound exposure occurs during the transport of samples both to and from the sampling site, or during shipment to the laboratory. Trip blanks are required for aqueous volatile organic samples only and consist of sample bottles filled in the laboratory with organic-free water; the sample bottles are then sent to the sampling location with the sampling kits. The trip blanks are returned from the sampling location with every shipment of aqueous samples and analyzed.

Temperature Blank

Temperature blanks are used to determine whether the samples have been maintained at an appropriate temperature, and thus properly preserved, during shipping. The temperature blank and trip blank may be the same sample, which is evaluated for temperature upon receipt at the laboratory, then analyzed as a trip blank. Standard temperature is expected to be 4^0 C, plus or minus 2 degrees.

Equipment Blank

Equipment blanks (rinsate blanks) are a means of proving that non-dedicated sampling equipment is thoroughly decontaminated. This demonstrates that no cross-contamination is occurring. Rinsate samples are processed by rinsing decontaminated sampling equipment (soil samplers, bailers, pumps, etc.) with laboratory grad deionized (DI) water. Equipment blanks collected from non-dedicated pumps should be collected from DI water pumped through the pump.

The rinse water is collected in sample containers, preserved, and handled in the same manner as the samples. Equipment blanks will not be collected if solely dedicated or disposable equipment is employed in a sampling event.

Field Duplicates

Collection and analysis of field duplicate samples provide an overall estimate of precision associated with sample collection and analysis.

The field duplicate samples will be identified on the labels and chain-of-custody forms as "QC DUP," without further information as to the source of the replicate.

The source information will be recorded in the field notes and the chain-of-custody by the Field Team Member at the time of collection. The identity of the duplicates will not be given to the analysts.

Matrix Spike (MS)/Matrix spike Duplicate (MSD)

Collection of a MS/MSD sample is a QC method for laboratory analysis. The MS/MSD samples should be collected for every 20 samples (or 5%) collected as extra samples from a selected well. The MS/MSD samples are collected as a typical sample and are spiked by the laboratory for QC.

FIELD PROCEDURE 5

Sample collection for Microbial Analysis

All individual microbial samples from monitoring well should be taken with sterile or sterile disposable equipment whenever possible and care needs to be taken to make sure that cross contamination between samples does not occur due to the contamination of sampling materials and equipment from one sample site to another.

Sampling Instructions: Wear gloves when collecting samples. Do not rinse the bottles. The bottles are sterile so care must be taken not to contaminate the bottle or cap. Quickly open the bottle (but do not set the cap down), hold the cap by its outside edges only, and fill the sample bottle to leaving a one-inch headspace. The 1-inch headspace is important to ensure proper mixing of entire sample prior to microbial analysis. Cap the bottle immediately and label it with appropriate sample identification, collection time, and sampler initials. Place sample bottle into gallon size Ziploc bag. Place it into a cooler with ice or blue icepacks for delivery or overnight shipment to the laboratory. Samples should be chilled to 10°C or less but should not be frozen. Frozen samples will not be analyzed. Samples should be analyzed within 30hrs of collection. Samples may be shipped to the EPA ORD laboratory in Cincinnati, OH for receipt Monday through Thursday. Because analysis for *E. coli* and total coliforms is a 24hr test no samples will be accepted on Fridays or weekends during the study.

Upon receipt in the laboratory samples will analyzed for E. coli and total coliforms using Colilert™ (Idexx, Westbrook MA) using the Quantitray sealer (Idexx, Westbrook MA) to provide a microbial estimation using Most Probable Number format. Samples will be analyzed using Standard Methods 9223B (APHA, 2014).

Colilert™ simultaneously detects total coliforms and E. coli in water. Commercially prepared media formulations are available in packets for presence-absence and multiple-well procedures. The use of commercially prepared media is required for quality assurance and uniformity. Incubate the sample at 35.0°C+0.5°C for 24 hours. If the response is unclear after the specified incubation period, the sample is incubated for up to an additional 4 hours at 35.0°C+0.5°C. After the appropriate incubation period, compare each bottle/tube/well to the reference color "comparator" provided by the manufacturer. A yellow color greater or equal to the comparator indicates the presence of total coliforms in the sample, and the bottle/tube/well is then checked for fluorescence under long-wavelength UV light (365-nm). The presence of fluorescence greater than or equal to the comparator is a positive result for E. coli. The concentration in MPN/100 mL.

Prior to analysis of samples each lot of Colilert™ will be QA/QC for sterility and performance using sterile Butterfields buffer. Any lot that doesn't pass the QA/QC check will be discarded. Each lot of Quantitray Sealer Trays will also be checked for sterility using sterile Butterfields buffer. Any lot not passing the QA check will be discarded. All samples analyzed will be recorded on Bench sheets maintained by Laura Boczek. All results will be communicated to Ron Herrmann.

Sample Bench Sheet

Coli-lert Carver County Composting Groundwater Monitoring Project Total coliforms / E. coli Bench Sheet

Date/Time samples received, and processed______________________________ Date/Time results_________________

Incubator Temperature___________________ Initials___________

Sample ID	Dilution	Number of Yellow positive wells (Big/small)	Total Coliform MPN/100 mL	Dilution	Number of MUG positive wells (Big/Small)	E. coli MPN/100 mL

APPENDIX B: FORMS

USEPA REGION 5 CHICAGO REGIONAL LABORATORY ANALYTICAL REQUEST FORM

CRL SAMPLE SHIPMENT GUIDELINESCHICAGO REGIONAL LABORATORY (CRL) SAMPLE HOLDING TIME, PRESERVATION, AND CONTAINER REQUIREMENTS

CHAIN OF CUSTODY FORMS

U.S. ENVIRONMENTAL PROTECTION AGENCY—REGION 5
CHICAGO REGIONAL LABORATORY
ANALYTICAL REQUEST FORM

This analytical request form should be completed before sending samples to CRL for analysis. The requester should complete all relevant fields and email the form and electronic copy of the quality assurance project plan (QAPP) and/or sampling plan to the CRL Sample Coordinator Rob Thompson (Thompson.robert@epa.gov).

GENERAL PROJECT INFORMATION

Requester: Carol Staniec	**Request Date:** 04/27/2017
Title: Engineer/Scientist	**Division/Office:** LCD/MMB
Address: 77 Jackson, Chicago IL 60604	
Phone: 61436	**E-mail:** staniec.carol@epa.gov

☐ **One-time** or ☑ **Continuous request** (*check one*)

A continuous request is defined as a standing request for the same analytical service (analyses and sample matrices) that may span several sites/projects/sampling events. Please note that submission of this analytical request form is only required once for a continuous request. However, QAPPs and/or sampling plans should still be submitted for every site/project.

Site Name and Location: Carver County Composting GW Sites

Expected Arrival Date at CRL: June 21, 2017; QUARTERLY SAMPLING EVENT

Turnaround Time Requested (*standard TAT is 45 days*): 45

CRL ANALYTICAL SERVICES

Disclaimer:

The effective versions of all Standard Operating Procedures (SOPs) are available in pdf format on the R5 Intranet. By submitting an analytical request form, the requestor is implying consent for the use of the appropriate effective SOPs. It is the responsibility of the requester to check the intranet for SOP deviations (known at CRL as Pen&Ink changes) and version updates. Should the CRL suspect that an SOP deviation affect the data, the CRL Sample Coordinator will contact the requester via email or phone to obtain a Pen&Ink consent. As defined by CRL, SOP deviations "affect the data" when there is a change in the laboratory's ability to identify or quantify the analytes in the SOP or when there is a deviation in the regulatory method.

Form Instructions:

1. In the table below, select the appropriate checkbox to request an analysis and enter the proposed number of samples of each matrix type. An analysis is not currently available for a matrix where the box is shaded.
2. For other/waste, briefly describe the matrix in the space provided. Additional space for a detailed matrix description is available at the end of the table, if needed.
3. For multi-analyte tests, list specific classes/subsets (e.g., PAHs, RCRA metals, etc.) in the space given at the end of this table, if requested.

General Chemistry

Analysis Request		Sample Matrix and Number		
Analysis	Check to Request	soil/sediment	water/liquid	other/waste*
acidity	☐		___	___
alkalinity	☐		___	___
ammonia-N	☐	___	___	___
anions**	☑	___	8	___
biochemical oxygen demand-5 day (BOD)	☑		8	___
carbonaceous BOD-5 day (CBOD)	☐		___	___
corrosivity by pH	☐		___	___
cyanide, amenable to chlorination	☐		___	___
cyanide, total	☐	___	___	___
dissolved organic carbon (DOC)	☐		___	___
fluoride	☐	___	___	___
grain size	☐	___		___
ignitability by flashpoint	☐		___	___
nitrate-nitrite-N	☐		___	___
paint filter liquid test	☐		___	___
pH	☐	___	___	___
residue, filterable (TDS)	☑		8	___
residue, non-filterable (TSS)	☑		8	___
solvent ID	☐		___	___
total Kjeldahl nitrogen (TKN)	☑	___	8	___
total organic carbon (TOC)	☐	___	___	___
total phosphorus (TP)	☑	___	8	___
total dissolved phosphorus (TDP)	☐		___	___
total solids (TS)	☐		___	___
total volatile solids (TVS)	☐		___	___
turbidity	☐		___	___
water content	☐		___	___

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Metals

Analysis Request		Sample Matrix and Number		
Analysis	**Check to Request**	**soil/sediment**	**water/liquid**	**other/waste***
chromium (VI)	☐	___	___	
dissolved metals** (except Hg & Cr (VI))	✓		8	___
hardness	☐		___	___
mercury (Hg)	✓	___	16	
total metals** (except Hg & Cr (VI))	✓	___	16	___ wipe/filter

Organics

Analysis Request		Sample Matrix and Number		
Analysis	**Check to Request**	**soil/sediment**	**water/liquid**	**other/waste***
air toxics**	☐			___ air
1,4-dioxane, low level	☐		___	___
oil & grease	☐		___	___
polychlorinated biphenyls (PCB) congeners	☐	___		___
perfluorinated compounds** (PFCs)	✓	___	8	___
pesticides, chlorinated**	✓	___	8	___
PCB aroclors**	☐	___	___	___
semi-volatiles** (SVOCs)	✓	___	8	___
total petroleum hydrocarbons (TPH as DRO/ORO)	☐	___	___	___
(tri-n-butyl)-n-tetradecylphosphonium chloride (TTPC)	☐	___	___	___
volatiles** (VOCs)	☐	___	___	___

Toxicity Characteristic Leaching Procedure (TCLP)

Analysis Request		Sample Matrix and Number		
Analysis	**Check to Request**	**soil/sediment**	**water/liquid**	**other/waste***
TCLP Hg	☐	___	___	___
TCLP metals	☐	___	___	___
TCLP pesticides	☐	___	___	___
TCLP SVOCs	☐	___	___	___
TCLP VOCs	☐	___	___	___

*Additional Matrix Description	
Please describe *other/waste* matrix, if not specified above:	

**Specific Analyte Class/Subset Request	
Please list or attach specific class/subset for multi-analyte test, if requested:	TOTAL AND DISSOLVED METALS, 2,4-D (HERBICIDE), NITRATE AS N

NON-STANDARD REQUESTS

For analyses/matrices not listed above or to obtain analyte lists, quality control limits, and/or reporting limits, please contact the CRL Sample Coordinator to discuss. (Thompson.robert@epa.gov, 312-353-9078)

CRL DATA FORMAT

The CRL standard data deliverable includes: 1) a pdf of the work order 2) a pdf of the final Level II report and 3) an electronic data deliverable (EDD) that includes batch quality control sample data. EDD typically refers to an Excel spreadsheet of the data, but EDDs are available in a variety of formats and can be customized upon request. A full data package (Level IV) is also available upon request and will be transmitted electronically via the CRL SharePoint. Contact Sylvia Griffin, CRL Data Coordinator, for additional details. (Griffin.sylvia@epa.gov, 312-353-9073)

CRL SAMPLE DISPOSAL POLICY

Due to space limitations in a controlled temperature environment, samples are relocated to secure room temperature storage six months after the analysis completion of the project. Notification of the intent to relocate the samples is given to the customer with sufficient time for the customer to respond with any objections. Samples remain in secure room temperature storage until the case/project is completed and the samples are no longer needed. Notification is given to the customer with sufficient time for customer response prior to sample disposal.

CRL SAMPLE SHIPMENT REQUIREMENTS

Before collecting samples, please refer to the attached table for sample sizes, containers, and preservatives. Notify the CRL Sample Custodian (312.353.9083, Snyder.robert@epa.gov) and the CRL Sample Coordinator (312.353.9078, Thompson.robert@epa.gov) before shipping any samples and to arrange for sample receipt.

When packing samples for shipment:

- ✓ Seal individual samples in plastic bags, preferably Ziploc bags.
- ✓ The temperature of samples requiring refrigeration during transport MUST be maintained at or below 6°C.
- ✓ Ice in a sealed plastic bag or reusable ice substitute freeze packs are acceptable cooling media.
- ✓ Chain of custody forms MUST be sealed in a large Ziploc bag and taped to the inside of the cooler lid.
- ✓ Include the address to which the cooler should be returned.

After items are packed for shipment, secure the cooler with tape and attach a custody seal across the seam of the cooler lid.

All samples MUST be shipped overnight to arrive Monday thru Friday or hand-delivered. No deliveries are accepted on weekends or Federal holidays. Exceptions may be made on a case by case basis depending on sampling priority/emergency status.

Send all samples to:
Robert Snyder
US EPA Region 5
Chicago Regional Laboratory
536 S. Clark Street, 10th Floor
Chicago, IL 60605

CRL SAMPLE SHIPMENT GUIDELINES

This document provides guidance in the shipment of samples to CRL for chemical analysis.

Before collecting samples, please refer to the attached table for sample sizes, containers, and preservatives.

Before shipping samples, please notify the CRL Sample Coordinator (312.353.0375, wroble.amanda@epa.gov) and/or CRL Sample Custodian (312.353.9083, snyder.robert@epa.gov) to arrange for sample receipt.

When packing samples for shipment:

- ✓ Seal individual samples in plastic bags, preferably Zip-loc bags.
- ✓ The temperature of samples requiring refrigeration during transport MUST be maintained at or below 6°C.
- ✓ Ice in a sealed plastic bag or reusable ice substitute freeze packs are acceptable cooling media.
- ✓ Chain of custody forms MUST be sealed in a large Zip-loc bag and taped to the inside of the cooler lid.
- ✓ Include the address to which the cooler should be returned.

After items are packed for shipment, secure the cooler with tape and attach a custody seal across the seam of the cooler lid.

All samples MUST be shipped overnight to arrive Monday thru Friday or hand-delivered. No deliveries are accepted on weekends or Federal holidays. Exceptions may be made on a case by case basis dependent on sampling priority/emergency status.

Send all samples to:

Robert Snyder
US EPA Region 5
Chicago Regional Laboratory
536 S. Clark Street, 10th Floor
Chicago, IL 60605

CHICAGO REGIONAL LABORATORY

HOLDING TIME AND CONTAINER REQUIREMENTS FOR WATER / AQUEOUS SAMPLES

DISCLAIMER: This table represents The Chicago Regional Laboratory's (CRL) recommended guidelines. Additional containers may be required for laboratory quality control samples (see notes section). There are non-routine analytes (reported upon request) that may require modification to the specifications detailed in this table. It is the client's responsibility to confirm container, preservation, and holding time requirements for a project prior to initiating sampling. This includes any equipment procurements, if applicable.

General Chemistry	CRL SOP(s)	Reference Method	Holding Time (days)	Min. Volume (mLs)[l]	Container[e]		Preservation
Acidity	AIG004A	SM 2310	14	50	500 mL Poly		<6 C
Alkalinity	AIG005	SM 2320 B	14	50	500 mL Poly		<6 C
Ammonia (Nitrogen, NH_3)	AIG029B	SM 4500-NH_3 B/H	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Ammonia (Nitrogen, NH_3) Distilled	AIG029B	SM 4500-NH_3 B/H	28	50	500 mL Poly		pH<2, H_2SO_4, <6 C
Anions (Br, Cl, F, NO_3, NO_2, PO_4[a], SO_4)	AIG045A	EPA 300.0	2[b] or 28	10	250 mL Poly		<6 C
Biochemical Oxygen Demand (BOD) 5-day	AIG006, A	SM 5210 B	2	60	1 L Poly		<6 C
BOD, Carbonaceous (cBOD)	AIG006, A	SM 5210 B	2	60	1 L Poly		<6 C
Corrosivity	AIG003	EPA 9040C	365	20	250 mL Amber		<6 C
Cyanide, Amenable	AIG025A	SM 4500 CN^- G	14	50	500 mL Poly		dechlorinate[c] NaOH, pH>10, <6 C
Cyanide, Total	AIG025C	EPA 335.4	14	50	500 mL Poly		dechlorinate[c] NaOH, pH>10, <6C
Ignitability (Flashpoint)	AIG048A, B	EPA 1010A , 1020B	365	100	250 mL Clear		<6 C
Nitrogen, Nitrate+Nitrite	AIG031B	ASTM D7781-14	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Nitrogen, Total Kjeldahl (TKN)	AIG035B	EPA 351.2	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Organic Carbon, Dissolved (DOC)	AIG021D	EPA 5310B	28	20	500 mL Poly		field filtered[d] pH<2, H_2SO_4, <6 C
Organic Carbon, Total (TOC)	AIG021D	EPA 5310B	28	20	500 mL Poly		H2SO4
Paint Filter Liquid Test	AIG010	EPA 9095B	30	100	250 mL Amber		<6 C
pH	AIG002	SM 4500-H^+ B	15 min	50	250 mL Poly		<6 C
Phosphorus, Total Dissolved (TDP)	AIG034B	EPA 365.4	28	10	500 mL Poly		field filtered[d] pH<2, H_2SO_4, <6 C
Phosphorus, Total (TP)	AIG034B	EPA 365.4	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Solids, Total Dissolved (TDS)	AIG017	SM 2540 C	7	50	500 mL Poly		<6 C
Solids, Total Suspended (TSS)	AIG018	SM 2540 D	7	100	500 mL Poly		<6 C
Turbidity	AIG054	EPA 180.1	2	30	250 mL Clear		<6 C
Water Content	AIG015A	EPA 9000	365	10	250 mL Amber		<6 C
Metals	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Volume (mLs)[l]**	**Container**		**Preservation**
Chromium (VI)	AIG032A	EPA 218.6	28	50	250 mL Poly		pH 9.3-9.7, <6 C NaOH/(NH4)$_2SO_4$
Hardness	Metals026	SM 2340 B	180	50	500 mL Poly		pH<2, HNO_3
Mercury (Hg)	AIG044D, E	EPA 245.1/7470A	28	20	500 mL Poly		pH<2, HNO_3
Metals, Total	Metals001, 003, 003A	EPA 200.7/200.8 EPA 6010D/6020B	180	50	500 mL Poly		pH<2, HNO_3
Metals, Dissolved	Metals001, 003, 003A	EPA 200.7/200.8 EPA 6010D/6020B	180	50	500 mL Poly		field filtered[d] pH<2, HNO_3
Organics	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Volume (mLs)[l]**	**Container**	**MS[m] MSD**	**Preservation**
1,4-Dioxane (low-level)	MS035	EPA 522/8000D	28[g]	250	2 - 250 mL Amber	2	pH<2, Na_2SO_4, <6 C
Chlorothalonil	MS033	EPA 525.3/8270D	7[f]	40	3 - 40 mL Amber VOA	2	<6 C
Oil and Grease	GC030, 32	EPA 1664B	28	1 L	2 - 1L Clear wide-mouth	2	pH<2, H_2SO_4, <6 C
Polychlorinated Biphenyls (PCBs)	GC002, 003	EPA 608/8082A	7[f,k] or 365[f]	1 L	2 - 1L Amber	2	<6 C
PCB Congeners (oil only)	MS034	NA	365	1 gram	4 oz. jar	1	<6 C
Perfluorinated Compounds (PFCs)	OM012	NA	28	10	2 - 15 mL Polypropylene tube (preweighed)	4	<6 C
Pesticides (low level)	OM019	NA	28[f]	10	3 - 40 mL amber VOA	2	<6 C
Pesticides, Chlorinated	GC001	EPA 608/8081B	7[f]	1 L	2 - 1L Amber	2	<6 C
Petroleum Hydrocarbons (TPH as DRO/ORO)	GC034	EPA 8015C	7[f]	1 L	2 - 1L Amber	2	<6 C
Semi-Volatile Organic Compounds (SVOCs)	MS026, 27	EPA 625/8270D	7[f]	1 L	2 - 1L Amber	2	<6 C
Tetradecylphosphonium chloride (TTPC)	OM016	NA	30	10	3 - 40 mL Amber VOA	2	<6 C
Volatile Organic Compounds (VOCs)	MS023, 24	EPA 624/8260C	7 (unpreserved) 14 (Preserved)	40	3 - 40mL VOA no headspace	2	pH<2, HCl,<6 C
Waste Characterization	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Volume (mLs)[l]**	**Container**		**Preservation**
Toxicity Characteristic Leaching Procedure (TCLP)	GEN019	EPA 1311	Varies[i]	Varies[j]	Varies		<6 C

Notes:

[a] Orthophosphate must be field filtered

[b] Nitrite, nitrate, and ortho-phosphate have a 48 hour holding time

[c] Dechlorinate with ascorbic acid

[d] Field filtering should use a 0.45 μm filter

[e] All containers must be filled completely and maintained on ice at ≤ 6 C

[f] 40 day holding time post extraction

[g] 28 day holding time post extraction

[h] Can be requested for metals, Hg, Pesticides, SVOCs and VOCs

[i] Field collection->TCLP ext. (in days): 14 for organics, 28 for Hg, 180 for metals

[j] Contact CRL for additional details and/or options

[k] Applicable to method 608 only

[l] Does not include amount needed for QC samples or excess needed for dilutions/reanalysis

[m] Extra containers needed for MS/MSD location. Frequency = 1/20 field samples

CHICAGO REGIONAL LABORATORY

HOLDING TIME AND CONTAINER REQUIREMENTS FOR SOIL / SOLID SAMPLES

DISCLAIMER: This table represents The Chicago Regional Laboratory's (CRL) recommended guidelines. Additional containers may be required for laboratory quality control samples (see notes section). There are non-routine analytes (reported upon request) that may require modification to the specifications detailed in this table. It is the client's responsibility to confirm container, preservation, and holding time requirements for a project prior to initiating sampling. This includes any equipment procurements, if applicable.

General Chemistry	CRL SOP(s)	Reference Method	Holding Time (days)	Min. Mass (g)[l]	Container[c]	Preservation[d]
Ammonia (Nitrogen, NH_3)	AIG029B, 22A	SM 4500-NH_3 B/H	28	1	4 oz. jar	<6 C
Anions (Br, Cl, F, NO_3, NO_2, PO_4, SO_4)	AIG039, 45A	EPA 300.0	2[a,b] or 28[b]	10	4 oz. jar	<6 C
Chemical Oxygen Demand (COD)	AIG007A, 22A	410.4	28[b]	10	4 oz. jar	<6 C
Cyanide, Total	AIG025B, C	EPA 335.4	14	1	4 oz. jar	<6 C
Nitrogen, Total Kjeldahl (TKN)	AIG022A, 35B	EPA 351.2	28[b]	1	4 oz. jar	<6 C
Organic Carbon, Total (TOC)	AIG009A	ASA-SSSA	28[b]	1	4 oz. jar	<6 C
Particle Size	AIG038, 38A	ASTM D2487-93	365	100	16 oz. jar	<6 C
pH	AIG008	EPA 9045D	365	20	4 oz. jar	<6 C
Phosphorus, Total (TP)	AIG022A, 34B	EPA 365.4	28[b]	1	4 oz. jar	<6 C
% Solids	AIG019	SM 2540 G	7	10	4 oz. jar	<6 C
Metals	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Mass (g)[l]**	**Container**	**Preservation**
Chromium (VI)	AIG033A	EPA 7199/3060A	30	2.5	4 oz. jar	<6 C
Mercury (Hg)	AIG043C,D,E	EPA 245.5/7471B EPA 7473	28	1	4 oz. jar	<6 C
Metals, Total	Metals001, 003A, 004	EPA 200.7/200.8 EPA 6010C,D/6020B	180	100	4 oz. jar	<6 C
Organics	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Mass (g)[l]**	**Container**	**Preservation**
Pesticides, Chlorinated	GC001	EPA 8081B	14	10	8 oz. jar	<6 C
Polychlorinated Biphenyls (PCBs)	GC002, 003	EPA 8082A	365	10	8 oz. jar	<6 C
PCB Congeners	MS034	NA	365	30	8 oz. jar	<6 C
Perfluorinated Compounds (PFCs)	OM013	NA	28	2	50 mL Polypropylene Tube[k]	<6 C
Petroleum Hydrocarbons (TPH as DRO/ORO)	GC034	EPA 8015C	14	30	8 oz. jar	<6 C
Polycyclic Aromatic Hydrocarbons, Alkylated	MS027	NA	14	30	8 oz. jar	<6 C
Semi-Volatile Organic Compounds (SVOCs)	MS026	EPA 8270D	14	30	8 oz. jar	<6 C
Tetradecylphosphonium chloride (TTPC)	OM017	NA	NA	2	4 oz. jar	<6 C
Volatile Organic Compounds (VOCs)	MS001	EPA 8260C	2	5	3 Encores™[e] or 3 VOA vials w/ stir bar[e,f,j]	<6 C
Waste Characterization	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Mass (g)[l]**	**Container**	**Preservation**
Toxicity Characteristic Leaching Procedure (TCLP)[g]	GEN019	EPA 1311	Varies[h]	Varies[i]	16 oz. jar	<6 C

HOLDING TIME AND CONTAINER REQUIREMENTS FOR FILTERS / WIPE SAMPLES

Organics	CRL SOP(s)	Reference Method	Holding Time (days)	Num. of Wipes	Container	Preservation
Polychlorinated Biphenyls (PCBs)	GC002, 003	EPA 8082A	365	1 wipe w/hexane	4 oz. jar	<6 C
Semi-Volatile Organic Compounds (SVOCs)	MS026	EPA 8270D	14	1 wipe w/ isopropanol	4 oz. jar	<6 C

HOLDING TIME AND CONTAINER REQUIREMENTS FOR AIR / VAPOR SAMPLES

Volatiles	CRL SOP(s)	Reference Method	Holding Time (days)	Pressure	Vessel	Preservation
Air Toxics	MS005	TO-15	30	approx. -7 "Hg	2.7 L Summa[i]	Room Temp

Notes:

[a] Nitrite, nitrate, and ortho-phosphate have a 48 hour holding time

[b] Holding time after extraction

[c] All jars should be wide mouthed and have a teflon lid

[d] All containers must be filled completely and maintained on ice at ≤ 6 C

[e] If no additional organics are requested, a 4 oz. jar must be submitted for % solids. For MS/MSD locations, 3 extra encores/VOA vials are need. Frequency = 1/20 field samples

[f] Dispensed in preweighed 40 mL VOA vials with stir bar. Preferred over Encore™ or similar

[g] Can be requested for metals, Hg, Pesticides, SVOCs and VOCs

[h] Field collection->TCLP ext. (in days): 14 for organics, 28 for Hg, 180 for metals

[i] Contact CRL for additional details and/or options

[j] Collected w/ a 5 gram coring device (e.g. Terracore™ or similar).

k Must be preweighed

[l] Does not include amount needed for QC samples or excess needed for dilutions/reanalysis

CHICAGO REGIONAL LABORATORY
HOLDING TIME AND CONTAINER REQUIREMENTS FOR WATER / AQUEOUS SAMPLES

DISCLAIMER: This table represents The Chicago Regional Laboratory's (CRL) recommended guidelines. Additional containers may be required for laboratory quality control samples (see notes section). There are non-routine analytes (reported upon request) that may require modification to the specifications detailed in this table. It is the client's responsibility to confirm container, preservation, and holding time requirements for a project prior to initiating sampling. This includes any equipment procurements, if applicable.

General Chemistry	CRL SOP(s)	Reference Method	Holding Time (days)	Min. Volume (mLs)[l]	Container[e]		Preservation
Acidity	AIG004A	SM 2310	14	50	500 mL Poly		<6 C
Alkalinity	AIG005	SM 2320 B	14	50	500 mL Poly		<6 C
Ammonia (Nitrogen, NH_3)	AIG029B	SM 4500-NH_3 B/H	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Ammonia (Nitrogen, NH_3) Distilled	AIG029B	SM 4500-NH_3 B/H	28	50	500 mL Poly		pH<2, H_2SO_4, <6 C
Anions (Br, Cl, F, NO_3, NO_2, PO_4[a], SO_4)	AIG045A	EPA 300.0	2[b] or 28	10	250 mL Poly		<6 C
Biochemical Oxygen Demand (BOD) 5-day	AIG006, A	SM 5210 B	2	60	1 L Poly		<6 C
BOD, Carbonaceous (cBOD)	AIG006, A	SM 5210 B	2	60	1 L Poly		<6 C
Corrosivity	AIG003	EPA 9040C	365	20	250 mL Amber		<6 C
Cyanide, Amenable	AIG025A	SM 4500 CN^- G	14	50	500 mL Poly		dechlorinate[c] NaOH, pH>10, <6 C
Cyanide, Total	AIG025C	EPA 335.4	14	50	500 mL Poly		dechlorinate[c] NaOH, pH>10, <6C
Ignitability (Flashpoint)	AIG048A, B	EPA 1010A , 1020B	365	100	250 mL Clear		<6 C
Nitrogen, Nitrate+Nitrite	AIG031B	ASTM D7781-14	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Nitrogen, Total Kjeldahl (TKN)	AIG035B	EPA 351.2	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Organic Carbon, Dissolved (DOC)	AIG021D	EPA 5310B	28	20	500 mL Poly		field filtered[d] pH<2, H_2SO_4, <6 C
Organic Carbon, Total (TOC)	AIG021D	EPA 5310B	28	20	500 mL Poly		H2SO4
Paint Filter Liquid Test	AIG010	EPA 9095B	30	100	250 mL Amber		<6 C
pH	AIG002	SM 4500-H^+ B	15 min	50	250 mL Poly		<6 C
Phosphorus, Total Dissolved (TDP)	AIG034B	EPA 365.4	28	10	500 mL Poly		field filtered[d] pH<2, H_2SO_4, <6 C
Phosphorus, Total (TP)	AIG034B	EPA 365.4	28	10	500 mL Poly		pH<2, H_2SO_4, <6 C
Solids, Total Dissolved (TDS)	AIG017	SM 2540 C	7	50	500 mL Poly		<6 C
Solids, Total Suspended (TSS)	AIG018	SM 2540 D	7	100	500 mL Poly		<6 C
Turbidity	AIG054	EPA 180.1	2	30	250 mL Clear		<6 C
Water Content	AIG015A	EPA 9000	365	10	250 mL Amber		<6 C
Metals	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Volume (mLs)[l]**	**Container**		**Preservation**
Chromium (VI)	AIG032A	EPA 218.6	28	50	250 mL Poly		pH 9.3-9.7, <6 C NaOH/$(NH4)_2SO_4$
Hardness	Metals026	SM 2340 B	180	50	500 mL Poly		pH<2, HNO_3
Mercury (Hg)	AIG044D, E	EPA 245.1/7470A	28	20	500 mL Poly		pH<2, HNO_3
Metals, Total	Metals001, 003, 003A	EPA 200.7/200.8 EPA 6010D/6020B	180	50	500 mL Poly		pH<2, HNO_3
Metals, Dissolved	Metals001, 003, 003A	EPA 200.7/200.8 EPA 6010D/6020B	180	50	500 mL Poly		field filtered[d] pH<2, HNO_3
Organics	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Volume (mLs)[l]**	**Container**	**MS[m] MSD**	**Preservation**
1,4-Dioxane (low-level)	MS035	EPA 522/8000D	28[g]	250	2 - 250 mL Amber	2	pH<2, Na_2SO_4, <6 C
Chlorothalonil	MS033	EPA 525.3/8270D	7[f]	40	3 - 40 mL Amber VOA	2	<6 C
Oil and Grease	GC030, 32	EPA 1664B	28	1 L	2 - 1L Clear wide-mouth	2	pH<2, H_2SO_4, <6 C
Polychlorinated Biphenyls (PCBs)	GC002, 003	EPA 608/8082A	7[f,k] or 365[f]	1 L	2 - 1L Amber	2	<6 C
PCB Congeners (oil only)	MS034	NA	365	1 gram	4 oz. jar	1	<6 C
Perfluorinated Compounds (PFCs)	OM012	NA	28	10	2 - 15 mL Polypropylene tube (preweighed)	4	<6 C
Pesticides (low level)	OM019	NA	28[f]	10	3 - 40 mL amber VOA	2	<6 C
Pesticides, Chlorinated	GC001	EPA 608/8081B	7[f]	1 L	2 - 1L Amber	2	<6 C
Petroleum Hydrocarbons (TPH as DRO/ORO)	GC034	EPA 8015C	7[f]	1 L	2 - 1L Amber	2	<6 C
Semi-Volatile Organic Compounds (SVOCs)	MS026, 27	EPA 625/8270D	7[f]	1 L	2 - 1L Amber	2	<6 C
Tetradecylphosphonium chloride (TTPC)	OM016	NA	30	10	3 - 40 mL Amber VOA	2	<6 C
Volatile Organic Compounds (VOCs)	MS023, 24	EPA 624/8260C	7 (unpreserved) 14 (Preserved)	40	3 - 40mL VOA no headspace	2	pH<2, HCl,<6 C
Waste Characterization	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Volume (mLs)[l]**	**Container**		**Preservation**
Toxicity Characteristic Leaching Procedure (TCLP)	GEN019	EPA 1311	Varies[i]	Varies[j]	Varies		<6 C

Notes:

[a] Orthophosphate must be field filtered

[b] Nitrite, nitrate, and ortho-phosphate have a 48 hour holding time

[c] Dechlorinate with ascorbic acid

[d] Field filtering should use a 0.45 µm filter

[e] All containers must be filled completely and maintained on ice at ≤ 6 C

[f] 40 day holding time post extraction

[g] 28 day holding time post extraction

[h] Can be requested for metals, Hg, Pesticides, SVOCs and VOCs

[i] Field collection->TCLP ext. (in days): 14 for organics, 28 for Hg, 180 for metals

[j] Contact CRL for additional details and/or options

[k] Applicable to method 608 only

[l] Does not include amount needed for QC samples or excess needed for dilutions/reanalysis

[m] Extra containers needed for MS/MSD location. Frequency = 1/20 field samples

CHICAGO REGIONAL LABORATORY

HOLDING TIME AND CONTAINER REQUIREMENTS FOR SOIL / SOLID SAMPLES

DISCLAIMER: This table represents The Chicago Regional Laboratory's (CRL) recommended guidelines. Additional containers may be required for laboratory quality control samples (see notes section). There are non-routine analytes (reported upon request) that may require modification to the specifications detailed in this table. It is the client's responsibility to confirm container, preservation, and holding time requirements for a project prior to initiating sampling. This includes any equipment procurements, if applicable.

General Chemistry	CRL SOP(s)	Reference Method	Holding Time (days)	Min. Mass (g)[l]	Container[c]	Preservation[d]
Ammonia (Nitrogen, NH_3)	AIG029B, 22A	SM 4500-NH_3 B/H	28	1	4 oz. jar	<6 C
Anions (Br, Cl, F, NO_3, NO_2, PO_4, SO_4)	AIG039, 45A	EPA 300.0	2[a,b] or 28[b]	10	4 oz. jar	<6 C
Chemical Oxygen Demand (COD)	AIG007A, 22A	410.4	28[b]	10	4 oz. jar	<6 C
Cyanide, Total	AIG025B, C	EPA 335.4	14	1	4 oz. jar	<6 C
Nitrogen, Total Kjeldahl (TKN)	AIG022A, 35B	EPA 351.2	28[b]	1	4 oz. jar	<6 C
Organic Carbon, Total (TOC)	AIG009A	ASA-SSSA	28[b]	1	4 oz. jar	<6 C
Particle Size	AIG038, 38A	ASTM D2487-93	365	100	16 oz. jar	<6 C
pH	AIG008	EPA 9045D	365	20	4 oz. jar	<6 C
Phosphorus, Total (TP)	AIG022A, 34B	EPA 365.4	28[b]	1	4 oz. jar	<6 C
% Solids	AIG019	SM 2540 G	7	10	4 oz. jar	<6 C
Metals	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Mass (g)[l]**	**Container**	**Preservation**
Chromium (VI)	AIG033A	EPA 7199/3060A	30	2.5	4 oz. jar	<6 C
Mercury (Hg)	AIG043C,D,E	EPA 245.5/7471B EPA 7473	28	1	4 oz. jar	<6 C
Metals, Total	Metals001, 003A, 004	EPA 200.7/200.8 EPA 6010C,D/6020B	180	100	4 oz. jar	<6 C
Organics	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Mass (g)[l]**	**Container**	**Preservation**
Pesticides, Chlorinated	GC001	EPA 8081B	14	10	8 oz. jar	<6 C
Polychlorinated Biphenyls (PCBs)	GC002, 003	EPA 8082A	365	10	8 oz. jar	<6 C
PCB Congeners	MS034	NA	365	30	8 oz. jar	<6 C
Perfluorinated Compounds (PFCs)	OM013	NA	28	2	50 mL Polypropylene Tube[k]	<6 C
Petroleum Hydrocarbons (TPH as DRO/ORO)	GC034	EPA 8015C	14	30	8 oz. jar	<6 C
Polycyclic Aromatic Hydrocarbons, Alkylated	MS027	NA	14	30	8 oz. jar	<6 C
Semi-Volatile Organic Compounds (SVOCs)	MS026	EPA 8270D	14	30	8 oz. jar	<6 C
Tetradecylphosphonium chloride (TTPC)	OM017	NA	NA	2	4 oz. jar	<6 C
Volatile Organic Compounds (VOCs)	MS001	EPA 8260C	2	5	3 Encores™[e] or 3 VOA vials w/ stir bar[e,f,j]	<6 C
Waste Characterization	**CRL SOP(s)**	**Reference Method**	**Holding Time (days)**	**Min. Mass (g)[l]**	**Container**	**Preservation**
Toxicity Characteristic Leaching Procedure (TCLP)[g]	GEN019	EPA 1311	Varies[h]	Varies[i]	16 oz. jar	<6 C

HOLDING TIME AND CONTAINER REQUIREMENTS FOR FILTERS / WIPE SAMPLES

Organics	CRL SOP(s)	Reference Method	Holding Time (days)	Num. of Wipes	Container	Preservation
Polychlorinated Biphenyls (PCBs)	GC002, 003	EPA 8082A	365	1 wipe w/hexane	4 oz. jar	<6 C
Semi-Volatile Organic Compounds (SVOCs)	MS026	EPA 8270D	14	1 wipe w/ isopropanol	4 oz. jar	<6 C

HOLDING TIME AND CONTAINER REQUIREMENTS FOR AIR / VAPOR SAMPLES

Volatiles	CRL SOP(s)	Reference Method	Holding Time (days)	Pressure	Vessel	Preservation
Air Toxics	MS005	TO-15	30	approx. -7 "Hg	2.7 L Summa[i]	Room Temp

Notes:

[a] Nitrite, nitrate, and ortho-phosphate have a 48 hour holding time

[b] Holding time after extraction

[c] All jars should be wide mouthed and have a teflon lid

[d] All containers must be filled completely and maintained on ice at ≤ 6 C

[e] If no additional organics are requested, a 4 oz. jar must be submitted for % solids. For MS/MSD locations, 3 extra encores/VOA vials are need. Frequency = 1/20 field samples

[f] Dispensed in preweighed 40 mL VOA vials with stir bar. Preferred over Encore™ or similar

[g] Can be requested for metals, Hg, Pesticides, SVOCs and VOCs

[h] Field collection->TCLP ext. (in days): 14 for organics, 28 for Hg, 180 for metals

[i] Contact CRL for additional details and/or options

[j] Collected w/ a 5 gram coring device (e.g. Terracore™ or similar).

k Must be preweighed

[l] Does not include amount needed for QC samples or excess needed for dilutions/reanalysis

TCLP Holding Times (days)

Analytes	FROM: Field collection TO: TCLP extraction	FROM: TCLP extraction TO: Preparative extraction	FROM: Preparative extraction TO: Determinative analysis	TOTAL ELAPSED TIME
Volatiles	14	NA	14	28
Semi-volatiles (SVOC/ABN)	14	7	40	61
Pesticides	14	7	40	61
Mercury	28	NA	28	56
Metals (except mercury)	180	NA	180	360

Carver County Compost Site | Field Data Sheet

Location: ______________________ Site: __________ Initial: __________

Date: ______________________ Weather: ______________________

Total Depth: Static Water Level __________ Calc. Vol. __________

Purge Method: [ ] Bailer [ ] Pump: Other: __________

Time	Cum. Vol. Purged	pH	Cond.	Temp	Comments
	START				

Samples With: [ ] Bailer [ ] Pump: __________ [ ] Other:

Containers	No.	mLs	Type	Pres. Check		Ice Check
General Chem:			Plastic	None		
Nutrients			Plastic	H_2SO_4		
Metals, Filt.			Plastic	HNO_3		
Metals, Tot.			Plastic	HNO_3		
VOC vials			Glass	HCL		

Appearance: (N = None, S = Slight, V = Very)

Color: __________ Turb: __________ Odor: __________ Other: __________

Was Stabilization Achieved? [ ]

Comments: ______________________________________

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 5
77 West Jackson Boulevard
Chicago, Illinois 60604

CHAIN OF CUSTODY RECORD

PROJ. NO.:

PROJECT NAME: Carver County Compost Facility

SAMPLERS: (Print Name and Sign)

Activity Code:

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CON-TAINERS	Analyte: TKN, TP, Nitrate as N	TDS, TSS, BOD	Pesticides, Herbicides	Totals dissolved metals + Hg	PFCs	SVOCs + VOCs	TAG NUMBERS
WA-MW1				X	Watertown	18	X	X	X	X	X	X	
WA-MW2				X		18	X	X	X	X	X	X	
WA-MW3				X		18	X	X	X	X	X	X	
WA-MW4				X		18	X	X	X	X	X	X	
WA-FD1				X		18	X	X	X	X	X	X	
WA-EB1				X		17	X	X	X	X	X	X	total Metals only
AR-MW1				X	Arboretum	18	X	X	X	X	X	X	
AR-MW2				X		18	X	X	X	X	X	X	
AR-MW3				X		18	X	X	X	X	X	X	
AR-MW4				X		27	X	X	X	X	X	X	MS/MSD
AR-FD1				X		18	X	X	X	X	X	X	
AR-EB1				X		17	X	X	X	X	X	X	total metals only
TB1				X	trip Blank	3						X	VOCs only

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Ship To:
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	ATTN:
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature) — Date / Time	Airbill Number
			Chain of Custody Seal Numbers

Distribution: White - Accompanies Shipment; Pink - Coordinator Field Files; Yellow - Laboratory File

Printed on Recycled Paper/Printed with Soy-Based Ink

5-32569

Chain of Custody Form

Site Name: **Watertown Yard Waste Site**	Sample Owner/Collector:
Contact Information:	Signature

Sample ID	Collection Date/Time (24 h)	Sample Location	Sample Type (Matrix)	Grab/ Composite	Preservative(s)	No./Type of Bottles	Comments
WA-MW1		**WA-MW1**	**GW**		**Ice**	**1**	
WA-MW2		**WA-MW2**	**GW**		**Ice**	**1**	
WA-MW3		**WA-MW3**	**GW**		**Ice**	**1**	
WA-MW4		**WA-MW4**	**GW**		**Ice**	**1**	
WA-MW4 D		**WA-MW4 D**	**GW**		**Ice**	**1**	
WA-Equip Bl			**Rinse water**		**Ice**	**1**	
WA Trip Bl					**Ice**	**1**	

Matrix: DW = Drinking Water, RW = Reservoir Water, GW=Ground Water, SD = Sediment, SL = Sludge, SO = Soil, SM = Misc. Solid Material

Relinquished By:	Received by:	Date/Time:	
Relinquished By:	Received by:	Date/Time:	
Relinquished By:	Received by:	Date/Time:	
Relinquished By:	Received by:	Date/Time:	
Relinquished By:	Received by:	Date/Time:	
Dispatched by:	Date/Time:	Received by:	Date/Time:
Method of Sample Transport			
Shipper:	Phone No.:	Shipper's Tracking No.:	

Attach additional pages as required.

Sample collection directions

- Don't open bottles until it is to be filled.
- Remove cap, don't place it down on any surface as to make sure not to contaminate the lid.
- Fill bottle up to the blue fill line as labeled on the bottle.
- Take care not to touch the lid, of the bottle or cap with hands or any other materials as to not contaminated the sample container.
- Once water sample is properly taken, replace the lid tightly.
- Place the sample bottle into a ziplock bag, and seal it.
- Place sealed ziplock bag into cooler containing ice or use freezable icepacks to cool samples until they are received in laboratory. Ice should be in bags to prevent leakage of the ice during shipment.
- Ship coolers back to EPA. – over night

EPA - ship to

ATTN: Jill Hoelle 513-569-7911
26 W. Martin Luther King Dr.
MS. 681
Cincinnati, OH 45268

Updated on 4-10-2017

Tests to be performed at the CRL-Chicago EPA Region 5

	Analysis	Reference Method	CRL Method SOP	Holding Time	Bottleware Per Sample	Quantity of Bottles per sample	Preservative	Notes
5	PFCs	ASTM D-7979	OM012	28 days	15 mL polypropylene tube, pre-weighed filled with 5.0 mL sample. **No label on tube!**	4 per well	4C	**On page 16 is the sampling protocol which should be modified and inserted in the field procedure 3 to include specifics in which we discussed today. Ie the tubes preweighed at CRL labs. Drop the whole method in a new Appendix C titled specific test methods.**
7	Total Metals by ICP-MS (As, Ag, Pb, Cd, Se, Mo)	EPA 200.8	Metals 001	180 days	1L Poly	1 per well	HNO3, pH,<2 4C	
7	Total Metals by ICP-AES (rest of metals)	EPA 200.7	Metals 003	180 days	1L Poly	1 per well (Can combine with ICP-MS)	HNO3, pH,<2 4C	
8	Dissolved Metals ICP-MS (As, Ag, Pb, Cd, Se, Mo)	EPA 200.8	Metals 001	180 days	1L Poly	1 per well	HNO3, pH,<2 4C	Insert filtering the sampling into the field procedures

8	Dissolved Metals by ICP-AES (rest of metals)	EPA 200.7	Metals 003	180 days	1L Poly	1 per well (Can combine with ICP-MS)	HNO3, pH,<2 4C	Insert filtering the sampling into the field procedures
7	Hg by CVAA	EPA 24.1/7470A	AIG044E	28 days	1L Poly	1 per well (Can combine with ICP-MS)	HNO3, pH,<2 4C	
8	Dissolved Hg by CVAA	EPA 24.1/7470A	AIG044E	28 days	1L Poly	1 per well (Can combine with dissolved ICP-MS)	HNO3, pH,<2 4C	
	VOCs	EPA 8260C	MS023	14-days	40mL VOA vial	3 per well	HCl,pH<2 4C	Full list
9	SVOCs	EPA 8270D	MS026	7 days	1L Amber	2 per well	4C	CRL to provide the list of all the SVOCs and they will be incorporated into the COCs
10	Pesticides	EPA 8081B	GC001	7 days	1L Amber	2 per well	4C	CRL to provide the suite of parameters and RLs . MPCA will then then include them in Table 1.
3	Herbicides (2,4-D only) Suite	NA	OM019	28 days	40 mL amber VOA Vial	3 per well	4C	~~CRL to provide the suite of parameters and RLs . MPCA will then then include them in Table 1~~.
4	Nitrate as N	EPA 300.0	AIG045A	48 hrs.	500 mL Poly	1 per well	4C	
① combined	TKN	EPA 351.2	AIG035B	28 days	500 mL Poly	1 per well~~, combine with nitrate-nitrite~~	H2SO4, pH<2 4C	
	Total Phosphorous	EPA 365.4	AIG034B	28 days	500 mL Poly	1 per well, combine with	H2SO4, pH<2	

					~~nitrate-nitrite~~TKN	4C	
6 BOD (5-day)	SM 5210B	AIG006A	48 hours	1L Poly	1 per well	4C	
2 TSS	SM 2540D	AIG018	7 days	1L Poly	1 per well	4C	
TDS	SM 2540C	AIG017	7 days	1L Poly	1 per well, combine with TSS	4C	
Tests to be completed at NREL in Cincinnati							
E Coli							**Once this is sent the sampling protocol which should be modified and inserted in the field procedure 3. Drop the whole method in a new Appendix C titled specific test methods.**
Total Coli							As above

Notes: Please add the comments

For wells with locations **with Matrix Spike/Matrix Spike Duplicate** : Triple sample bottle counts for organics only.

Total coliform & E Coli will be done by the National Risk Environmental Laboratory/ESMD-LRR Division in Cincinnati

Interpoll Laboratories, Inc.

4500 Ball Road NE

Circle Pines, MN 55014-1819

Attn: Tim MacDonald/Robin Worlie

Environmental Protection Agency Region 5

Chicago Regional Laboratory

536 South Clark Street, Chicago, IL 60605
Phone:(312)353-8370 Fax:(312)886-2591

BOTTLE ORDER/PACKING LIST

Ship To:

Attn:	Carol Staniec	Date Submitted:	06/08/2017
	MMB, LCD, U.S. EPA Region 5	Date Needed:	06/12/2017
	77 W. Jackson Boulevard	Date Shipped:	01/01/1953
	Chicago, IL 60604		

Phone: (312) 886-1436
Fax:
Email:

Shipping Method:
Tracking Number:
Ship Comments: Ship to:
Interpoll Laboratories, Inc.
4500 Ball Road NE
Circle Pines, MN 55014-1819
Attn: Tim MacDonald/Robin Worlie

Project: Carver County Compost Facility GW Monitoring

Order Comments: Sample counts assumed 8 well locations + 2 FDs + 2 EBs. A TB is needed for PFCs only.
Samples must be shipped daily on ice (6C) and follow CRL shipping and custody protocols.
Additional volume is needed for MS/MSD locations for organics only.

BOTTLE ORDER/PACKING LIST

Ship To:

Attn: Carol Staniec
MMB, LCD, U.S. EPA Region 5
77 W. Jackson Boulevard
Chicago, IL 60604

Phone: (312) 886-1436
Fax:
Email:

Date Submitted: 06/08/2017
Date Needed: 06/12/2017
Date Shipped: 01/01/1953

Shipping Method:
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Interpoll Laboratories, Inc.
4500 Ball Road NE
Circle Pines, MN 55014-1819
Attn: Tim MacDonald/Robin Worlie

Project: Carver County Compost Facility GW Monitoring

Order Comments: Sample counts assumed 8 well locations + 2 FDs + 2 EBs. A TB is needed for PFCs only. Samples must be shipped daily on ice (6C) and follow CRL shipping and custody protocols. Additional volume is needed for MS/MSD locations for organics only.

Container	Qty	Analysis	Matrix	Preservative	Sample Count	Lot Nbr	Comments
Water Samples							
500 mL Poly H2SO4	12	TKN DA, Total Phosphorus DA	Water	Add H2SO4 to pH<2; Store cool at < or equal to 6 C	12		8 wells + 2 FDs + 2 EBs= 12 samples x 500mL poly each. No extra needed for MS/MSD
1 L Poly - Unpres	12	Solids, TDS, Solids, TSS	Water	Store cool at < or equal to 6 C	12		8 wells + 2 FDs + 2 EBs= 12 samples x 1L poly each. No extra needed for MS/MSD
40 mL amber VOA vial	38	Pesticides by LC/MS/MS	Water	Store cool at < or equal to 6 C in Dark	12		8 wells +2 FD + 2 EBs= 12 samples x 3 Vials each=36 + 2 Vials at MS/MSD location=38
500 mL Poly Unpres	12	Anions NO3 as N	Water	Store cool at < or equal to 6 C	12		8 wells + 2 FDs + 2EBs=12 samples x 1 500mL poly each. No extra needed for MS/MSD location
15 mL polypropylene (Pre-weighed)	28	OSRTI PFC	Water	Store cool at < or equal to 6 C in Dark	13		8 wells+2 FDs+2EBs+1TB=13 samples x 2 tubes each. + 2 tubes at MS/MSD location=28
1 L Poly - Unpres	12	BOD	Water	Store cool at < or equal to 6 C	12		8 wells + 2 FDs + 2 EBs= 12 samples x 1L poly each. No extra needed for MS/MSD
7, 8 1 L Poly - HNO3	22	Hg Total CVAA, Metals ICP-AES (w), Metals ICP-MS (w)	Water	Add HNO3 to pH<2	12		8 wells (total+dissolved)+2 FDs (total and dissolved)+2EB (total only)=22. No extra needed for MS/MSD

BOTTLE ORDER/PACKING LIST

Ship To:

Attn: Carol Staniec
MMB, LCD, U.S. EPA Region 5
77 W. Jackson Boulevard
Chicago, IL 60604

Phone: (312) 886-1436
Fax:
Email:

Date Submitted: 06/08/2017
Date Needed: 06/12/2017
Date Shipped: 01/01/1953

Shipping Method:
Tracking Number:
Ship Comments: Ship to:
Interpoll Laboratories, Inc.
4500 Ball Road NE
Circle Pines, MN 55014-1819
Attn: Tim MacDonald/Robin Worlie

Project: Carver County Compost Facility GW Monitoring

Order Comments: Sample counts assumed 8 well locations + 2 FDs + 2 EBs. A TB is needed for PFCs only. Samples must be shipped daily on ice (6C) and follow CRL shipping and custody protocols. Additional volume is needed for MS/MSD locations for organics only.

Container	Qty	Analysis	Matrix	Preservative	Sample Count	Lot Nbr	Comments
Water Samples (Continued)							
1 L Amber- Unpres.	26	SVOA water by SPE (8270 1-pass)	Water	Store cool at < or equal to 6 C	12		8 wells +2FDs+2EBs=12 samples x 2 1L ambers each + 2 1L ambers at MS/MSD location=26
1 L Amber- Unpres.	26	Pesticides by SPE	Water	Store cool at < or equal to 6 C	12		8 wells +2FDs+2EBs=12 samples x 2 1L ambers each + 2 1L ambers at MS/MSD location=26

NO VOA this sampling round.

modification: 40 VOA vials provided for VOCs. 3 VOA vials per sampling location must be collected and preserved with HCL. 5 are needed at MS/MSd location. A trip blank must be submitted with the cooler containing VOCs. Make a trip blank by filling 3 VOA vials with di water and preserve with HCL.

APPENDIX C: TEST METHODS

USEPA REGION 5 CHICAGO REGIONAL LABORATORY PFOS

NREL SAMPLE ECOLI AND FECAL COLIFORM ANAYSES AND SHIPMENT GUIDELINES

Standard Operating Procedure for the Analysis of Polyfluorinated Compounds of Interest to OSRTI in Water, Sludge, Influent, Effluent, and Wastewater by Multiple Reaction Monitoring Liquid Chromatography/Mass Spectrometry (LC/MS/MS)

United States Environmental Protection Agency
Region 5 Chicago Regional Laboratory
536 S. Clark Street (ML-10C)
Chicago IL, 60605

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Tables 10-17 in the Appendix show the performance data for the target analytes and surrogates in various matrices.

1.4. The RL for a specific water sample may differ from that listed depending on the nature of the interferences in the sample matrix. The estimate of minimum laboratory contribution to measure uncertainty of this method for each compound is calculated by LCS mean ±3 SD. These values are derived from CRL historical data from Laboratory Control Samples. The uncertainty will be greater near the reporting limit and much greater near the detection limit. Refer to the Appendix, Table 2 for measured uncertainty. The default control limits, listed in Table 2 of the Appendix, for the analytes and surrogates are preliminary until a full multi-lab study is completed.

2. Summary of Method

2.1. A water sample (5 mL) is spiked with surrogates (all samples) and target PFC compounds (laboratory control and matrix spike samples) and hand-shaken for two minutes after adding 5 mL of methanol. The samples are then filtered through an Acrodisc GxF/0.2μm GHP membrane syringe driven filter unit. Acetic acid (10 μL) is added to all the samples to adjust to pH ~ 3-4 and the sample is analyzed by LC/MS/MS. For sludge samples, the pH is adjusted to ~ 9-10 (adding ~ 20 μl of ammonium hydroxide) before extraction and ~ 50 uL of acetic acid is needed for acidification after filtration.

2.2. The target compounds are identified by comparing the single reaction monitoring (SRM) transitions in the sample to the SRM transitions in the standards (Appendix Table 6). Certain PFC analytes only have a primary SRM transition that is used for identification and quantitation. The retention time (RT) for the analytes of interest must also agree with the RT of the mid-level standard by ±5%. The target compounds are quantitated using the SRM transitions of the target compounds utilizing external calibration. As an additional quality control measure, isotopicallylabeled PFC surrogate (listed in Section 7.2.4-5) recoveries are monitored; the percent recovery of each should fall within the control limits of the method. Compounds from this SOP are reported to the RL, typically in ng/L.

3. Abbreviations and Definitions

3.1. Abbreviations

RTS	Retention Time Shift
SD	Standard Deviation
SDS	Safety Data Sheet
SOP	Standard Operating Procedure
SRM	Single Reaction Monitoring
SS	Surrogate Standard
TC	Target Compound
TCL	Target Compound List
UPLC	Ultra Performance Liquid Chromatography

3.2. Definitions

Method Detection Limit (MDL): The minimum concentration of analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.

Reporting Limit (RL): This is the lowest concentration reported by CRL except in the case of a special request.

Batch QC: All the quality control samples and standards included in an analytical procedure. A batch typically consists of 20 field samples.

Sludge: Sludge in this method is defined as a sewage sample containing approximately □ 2% solids in a sample by weight.

ASTM Type I Water: Shall conform to ASTM Standard D1193 specifications.

Reagent Water: Reagent water is defined as water with no interferants at or near the RL for all reagent compounds. The in-house Milli-Q water has been found acceptable for use. It is tested for each batch of samples by using it as a Method Blank.

SRM Transition: Single Reaction Monitoring transition.

4. Health, Safety and Waste Handling

5.2. Cautions

5.2.1. All reagents and solvents should be of pesticide-residue purity or higher to minimize interference problems, preferably LC/MS grade.

5.2.2. Contaminants have been found in reagents, glassware, tubing, polytetrafluoroethylene (PTFE) LC vial caps, glass disposable pipettes, filters, degassers, and other apparatus that release polyfluorinated compounds. All of these materials are routinely demonstrated to be free from interferences by analyzing laboratory reagent and method blanks under the same conditions as the samples. All the supplies should be checked to determine the release of target analytes of interest. If found, measures should be taken to remove the contamination or data should be qualified.

5.2.3. The Liquid Chromatography system used should have components replaced, when possible, with materials known to not contain fluorinated target analytes of interest.

5.2.4. Polyethylene LC autosampler vial caps or target analyte-free vial caps should be used.

5.2.5. Polyethylene disposable pipettes or target analyte-free pipettes should be used. All disposable pipettes should be checked for release of target analytes of interest.

5.2.6. Degassers are important to continuous LC operation and are most commonly made of fluorinated polymers. To enable use, an isolator column should be placed after the degasser and before the sample injection valve.

5.2.7. The procedure described in the glassware cleaning section (6.4) should be followed to make glassware free from interferences.

6. Equipment and Supplies

The vendors' equipment and/or part numbers are listed for the supplies and reagents below. Any equivalent equipment or supplies from any vendor may be used. Mention of brand names or part numbers is for informational purposes only; no endorsement is

6.3. Glassware and miscellaneous supplies

6.3.1. Vials - 2-mL amber autosampler vials or equivalent (Source – Waters, Part # 186000847C)
6.3.2. Polyethylene autosampler vial caps or equivalent (Source – Waters, Part # 186004169)
6.3.3. Syringe – 10-25 mL filter-adaptable glass syringe with luer lock
6.3.4. 50 mL polypropylene tubes (Source - BD Falcon, Catalog # 352098)
6.3.5. 15 mL polypropylene tubes (Source - BD Falcon, Catalog # 352097)
6.3.6. Gases - ultrapure argon and nitrogen
6.3.7. Class A volumetric glassware
6.3.8. Pipette tips – Polypropylene pipette tips free of release agents or low retention coating of various sizes (Source - Eppendorf, Catalogue # 022491997, 022492080, 022491954, 022491946, and 022491512)
6.3.9. Acrodisc GxF/0.2µm GHP membrane syringe-driven filter unit (Source - PALL Life Sciences, Part # AP-4307T). The Acrodisc filters are washed with at least 10 mL acetonitrile followed by 20 mL methanol prior to use.
6.3.10. Polyethylene disposable pipettes (SEDI-PET™ PIPET, Source – Samco Scientific, Part # 252)

6.4. Glassware cleaning instructions

All glassware is cleaned according to CRL SOP GEN008. All glassware is subsequently rinsed with an organic solvent such as acetone, methanol, and/or acetonitrile prior to use.

7. Reagents and Standards

Items shown are for informational purpose only; equivalent reagents and standards may be used. All reagents and solvents should be of pesticide residue purity or higher to minimize interference problems, preferably LC/MS grade or equivalent. Refer to CRL SOP GEN026 for instructions and analyst responsibilities when purchasing reagents and standards.

NOTE: Standard mixes are available from Wellington Labs and contain each analyte at a given concentration, either at 1 or 2 □g/mL. The target spike mix concentrations can be changed to account for the rigidity in standard sources when using mixes. The

91-4, Source: Wellington Labs, Part # L-PFPeS as the sodium salt)

7.2.1.8. Perfluoro-1-heptanesulfonate (L-PFHpS, $C_7F_{15}SO_3^-$, CAS # 375-92-8, Source: Wellington Labs, Part # L-PFHpS as the sodium salt)

7.2.1.9. Perfluoro-1-nonanesulfonate (L-PFNS, $C_9F_{19}SO_3^-$, CAS # 68259-12-1, Source: Wellington Labs, Part # L-PFNS as the sodium salt)

7.2.1.10. Perfluoro-1-decanesulfonate (L-PFDS, $C_{10}F_{21}SO_3^-$, CAS # 2806-15-7, Source: Wellington Labs, Part # L-PFDS as the sodium salt)

7.2.2. Polyfluoroalkyl carboxylic acids (PFAC)

7.2.2.1. Perfluorobutanoate (PFBA, C4F7O2-, CAS # 375-22-4, Source: Fluka, Part # 52411-5ML-F)

7.2.2.2. Perfluoropentanoate (PFPeA, $C_5F_9O_2^-$, CAS# 2706-90-3, Source: Sigma Aldrich, Part # 396575-5ML)

7.2.2.3. Perfluorohexanoate (PFHxA, $C_6F_{11}O_2^-$, CAS#307-24-4, Source: Sigma Aldrich, Part # 29226-5ML)

7.2.2.4. Perfluoroheptanoate (PFHpA, $C_7F_{13}O_2^-$, CAS# 375-85-9, Source: Sigma Aldrich, Part # 342041-5G)

7.2.2.5. Perfluorooctanoate (PFOA $C_8F_{15}O_2^-$, CAS # 335-67-1, Source: Sigma Aldrich, Part # 171668-5G)

7.2.2.6. Perfluorononanoate (PFNA, $C_9F_{17}O_2^-$, CAS# 375-95-1, Source: Sigma Aldrich, Part # 394459-5G)

7.2.2.7. Perfluorodecanoate (PFDA, $C_{10}F_{19}O_2^-$, CAS# 335-76-2, Source: Sigma Aldrich, Part # 177741-5G)

7.2.2.8. Perfluoroundecanoate (PFUnA, $C_{11}F_{21}O_2^-$, CAS# 2058-94-8, Source: Sigma Aldrich, Part # 446777-5G)

7.2.2.9. Perfluorododecanoate (PFDoA, $C_{12}F_{23}O_2^-$, CAS# 307-55-1, Source: Sigma Aldrich, Part # 406449-1G)

7.2.2.10. Perfluorotridecanoate (PFTriA, $C_{13}F_{25}O_2^-$, CAS# 72629-94-8, Source: Sigma Aldrich, Part # 654973-1G)

7.2.2.11. Perfluorotetradecanoate (PFTreA, $C_{14}F_{27}O_2^-$, CAS# 376-06-7, Source: Sigma Aldrich, Part # 446785-5G)

7.2.3. Polyfluorinated sulfonamides and sulfonamidoacetic acids

7.2.3.1. N-ethylperfluoro-1-octanesulfonamidoacetic acid (N-EtFOSAA, $C_{12}H_8F_{17}NO_4S$, CAS # 2991-50-6, Source: Wellington Labs, Part # N-EtFOSAA)

7.2.3.2. N-methylperfluoro-1-octanesulfonamidoacetic acid (N-

source may be different than the one shown here, this is an evolving area and standards may change.

7.3. Reagent and standard preparation

All standard preparations are recorded in LIMS. If the details of the preparation are omitted from LIMS, a reference to the logbook containing the preparation details is included in LIMS. All standard stock vials and prepared solutions are labeled with the LIMS ID, name, concentration, dates of preparation and expiration, and initials of the creator. All LC or small vials (where surface area is an issue) shall include, at minimum, a LIMS ID which can be referenced back to LIMS or the logbook.

CAUTION: All standards must be kept away from PFC-containing packaging and materials used in preparation and storage. In order to prevent standard solutions from degrading, all standard solutions are stored at < 6° C in the refrigerator.

When standard compound purity is assayed to be 98% or greater, the weight may be used without correction to calculate the concentration of the stock standard. All weights and concentrations less than 98% purity listed in this SOP are corrected to at least 98% purity. Example: A weight of 0.511 g of compound X that is assayed to be 96% pure is recorded as 0.491 g of compound X after correction. If the standard is purchased and listed having a purity of 95+ % or similar designation, the purity is not accurately known and the product may be 95-100% pure. In this case, the product purity is noted in the LIMS database and/or logbook and may be used uncorrected. Expiration time is one year from the time prepared. The spiking standards and surrogates can be used for more than one year if they fall within +/- 20% of the expected concentration from the calibration standard that is less than 1year old.

Traceability of PFC standards is established using the manufacturer's specifications provided at the time of purchase. The Certificates of Analysis may be obtained from the vendor or online at the vendor's website knowing the catalog and lot number of the standard used as recorded in the logbook or LIMS and are stored in the laboratory in a binder.

Procedures for the preparation of QC batch samples and standards are found in Sections 9.1-9.2.

Each MS/MSD or LCS/LCSD sample is spiked with target PFCs (listed in Sections 7.2.1-7.2.3) to achieve a concentration of 800 ng/L for PFBA and PFPeA and 160 ng/L for the remaining 22 PFCs in a 5 mL water sample. This can be done by adding 40 µL of PFC Target Spike Solution I and 40 µL of PFC Target Spike Solution II to each 5 mL QC sample (Refer to Appendix Table 3 for the composition and concentration of each target analyte in the spiking solutions; each spike solution is prepared in 95:5 acetonitrile and water). The target analyte spiking solutions are prepared from intermediate solutions which are prepared from neat standards. Aliquots of the intermediate solutions are combined and diluted using 95:5 acetonitrile and water to prepare the spike standard concentrations in Appendix Table 3.

7.3.3. Reporting limit check spiking solution

The reporting limit check sample is prepared by spiking a 5 mL water sample with target analytes at the reporting limit. Add 25 µL of a PFC reporting limit check spiking solution to the reporting limit check sample to achieve 50 ng/L of PFBA and PFPeA and 10 ng/L for the remaining 22 PFCs (listed in Sections 7.2.1-7.2.3) in a 5 mL water sample. Refer to Table 3 (Appendix) for the concentrations of each target analyte in the reporting limit spike solution. The reporting limit check spiking solution is prepared in 95:5 acetonitrile and water from intermediate standard solutions or target spike solutions.

7.3.4. Calibration standards

A calibration stock standard solution is prepared from the target and surrogate spike solutions directly to ensure consistency. 500 µL of the surrogate spike and 500 µL of each PFC Target Spike Solution (I and II; Refer to Appendix Table 3 for the composition and concentration of each target analyte in the spiking solutions) is added to a 50 mL polypropylene tube and diluted to 50 mL with a 50:50 methanol and water solution containing 0.1 % acetic acid. This stock standard Solution A (Level 9, Appendix Table 4) containing 200 ng/L of all PFCs (except 1000 ng/L for PFBA and PFPeA) is diluted to prepare Levels 1 through 8 as shown in Tables 4 and 5 (Appendix). All calibration standards should contain 50:50 methanol and water with 0.1% acetic acid.

QC sample must be collected in its own container, including matrix spike, matrix spike duplicate, and duplicate samples.

Since surface binding of target compounds may bias data, it is best to collect a 5.0 mL sample in a graduated 15 mL polypropylene BD Falcon tube in the field so that the whole sample is processed in the lab.

CAUTION: Taking a sub-sample is not recommended in this SOP, whether in the field during sample collection, or in the lab at the bench.

In order to have accurate volumes, the weight of the 15 mL polypropylene BD Falcon tube should be taken before and after sampling in order to calculate an exact volume. The density of water is assumed to be 1.0 g/mL unless otherwise instructed by the client/sampler. The laboratory analysts will likely weigh the tubes before/after field sampling. If the clients/samplers pre-weigh their own sampling containers they shall provide those weights to CRL. The use of sample tags or removable labels should be used in order to weigh the vial without the additional weight of the label or its fragments.

If a larger sample is collected in the field, a 5.0 mL aliquot of that sample will be processed, not taking into account any PFCs that may adhere to the surface of the original container. This practice is not recommended. This section is in this SOP in the event that field samples are taken in large containers or for another project where the customer may be interested to "screen" for PFCs. This shall be stated in the case narrative accompanying the data and the data shall be qualified as estimated ('J') as this will affect the quantitative accuracy of many of the PFCs, potentially producing very low-biased results.

Conventional laboratory practices involving chain of custody, field sampling, lab custody beginning with receipt and transfer custody, and sampling protocols should be followed.

8.2. Sample preservation and storage

All samples are iced or refrigerated at < 6°C from the time of collection until sample analysis. At the laboratory, prepared samples (diluted and filtered) are stored in the refrigerator at < 6°C at all times while not being analyzed. Holding times have not yet been established for these analytes in various matrices. A preliminary holding time of

The method blank is prepared by measuring 5 mL of ASTM type I water in a 15 mL polypropylene tube, spiking with 40 L of the surrogate spike solution (Section 7.3.1), and then taking it through the sample preparation step II in Section 9.2.

9.1.3. Laboratory control sample/laboratory control sample duplicate

Add 5 mL of ASTM type I water to each of two 15 mL polypropylene centrifuge tubes. The samples are spiked with 40 L of surrogate spiking solution (Section 7.3.1), 40 µL of Target Spike Solution I, and 40 µL of Target Spike Solution II (Section 7.3.2, Appendix Table 3), and then taken through the sample preparation step II in Section 9.2.

9.1.4. Reporting limit check

Add 5 mL of ASTM type I water to a 15 mL polypropylene centrifuge tube. The sample is spiked with 40 L of surrogate spiking solution (Section 7.3.1) and 25 µL of Reporting Limit Check solution (Section 7.3.3, Appendix Table 3) and then taken through the sample preparation step II in Section 9.2.

9.1.5. Sample and sample duplicate

The 5.0 mL sample collected in a 15 mL polypropylene centrifuge tube is allowed to warm to room temperature before spiking and sample processing (if sludge samples are requested to be analyzed by dry weight, see Section 9.2.3). If another sample size is collected, a 5.0 mL aliquot is used as the sample and indicated in the data package narrative (see Section 8.1). Each sample is spiked with 40 L of surrogate spiking solution (Section 7.3.1) and then taken through the sample preparation step II in Section 9.2.

9.1.6. Matrix spike/matrix spike duplicate

Additional field-collected 5.0 mL samples in each of two 15 mL polypropylene centrifuge tubes are used for the MS and MSD (if sludge samples are requested to be analyzed by dry weight, see Section 9.2.3). If another sample size is collected, a 5.0 mL aliquot is used as the sample and indicated in the data

solids. In that case, dry weights must be determined for sludge samples according to CRL SOP AIG019. The sample is then initially weighed (~ 5 g to the hundredth of a gram) instead of taken by volume, dependent upon the percent moisture.

9.3. Analytical procedure

9.3.1. Sample analysis procedure

Instrument conditions for LC/MS/MS are described in Section 9.4.3. The target compounds are identified by comparing the single reaction monitoring (SRM) transitions in the sample to the SRM transitions in the standards. A confirmatory transition is available for most of the analytes (Appendix Table 6). The retention time (RT) for the analytes of interest must also agree with the RT of the mid-level standard by ±5%. The target compounds are quantitated using the primary SRM transitions of the target compounds utilizing external calibration. As an additional quality control measure, fourteen isotopicallylabeled surrogate (listed in Section 7.2.4-7.2.5) recoveries are monitored; the percent recovery of each should fall within the control limits of the method (Appendix Table 2). Compounds from this SOP are reported to the RL, typically in ng/L.

If the absolute amount of a target compound in a sample exceeds the working calibration range (see Level 9 in Appendix Table 4), the sample must be diluted and re-analyzed. This should be done by diluting the sample with 50:50 methanol and water solution containing 0.1 % acetic acid.

9.3.2. Qualitative and quantitative analysis

9.3.2.1. The quantitation of the target analytes and surrogates is accomplished with QuanLynx™ or TargetLynx™ software. An external calibration is used along with fourteen isotopically-labeled surrogates (listed in Section 7.2.4-7.2.5). Refer to Appendix Table 6 for the MRM transitions and expected retention times. The quantitation method is set as an external calibration using the peak areas in ppt units (ng/L).

mixtures may be observed with analytes that have the possibility of containing isomeric mixtures. The complete isomer grouping shall be quantitated consistently for all samples. These differences for PFHxS and PFOS were found in groundwater samples and may either be the cause of different compositions used, weathering, degradation, or the affinity of the branched isomers to be more soluble than the linear in water and leach into the water from the soil at a higher rate than the linear.

9.3.2.4. Regression fits should exclude the point of origin (X=0, Y= 0) and be weighted by 1/concentration in order to increase the accuracy of the curve at the lower concentrations. For linear regression to be used, the coefficient of determination, r^2, should be > 0.98 for each analyte, and for quadratic regression, the r^2 should be > 0.99. Upon inspection of the calibration curves, if one of the calibration standard injections, other than the high or low, skews the curve such that the r^2 is unacceptable, this point must be re-injected and replaced in the calibration curve, or a new calibration curve must be made or the data may be reported estimated, "J", and explained in the narrative. If the low and/or high points are excluded, a sixpoint curve is acceptable for quadratic fit and five point for a linear fit, but the calibration range and reporting limits must be modified to reflect this change. Points can be dropped from both the high and/or the low end of the curve as long as the reporting range is adjusted accordingly. The calculated calibration level concentrations used to generate the curve should be < ±30% deviation from the concentration of the generated curve; if this is exceeded, a new calibration curve must be generated or the data reported must be qualified estimated, "J", with an explanation in the narrative accompanying the data.

9.3.2.5. The retention time window of the SRM transitions must be within 5% of the retention time of the analyte in a Level 4-6 calibration standard. If this is not true, the calibration curve needs to be reanalyzed to see if there was a shift in retention time during the analysis and the sample needs to be re-injected. If the retention time is still incorrect in the sample, the analyte is referred to as an unknown.

instrument to obtain a width of about 0.75 Da at half height for each peak. This can be done with low mass and high mass resolution settings for each quadrupole. The ion energies also need to be set in order to obtain adequate movement or sensitivity without affecting peak shape or increasing baseline. In order to obtain optimal results, all adjustable tune page settings will need to be optimized for the calibration solution at the infusion flow rate chosen by the analyst, usually a low flow rate < 20 L/min. The following guidelines for calibrating shall be followed:

9.4.2.1. There should be no missed reference peaks. If there are missed reference peaks, something is wrong and the instrument either requires optimization of the tuning parameters, maintenance, or a new/different calibration solution.

9.4.2.2. The Maximum Mean of Absolute Residuals shall be ≤ 0.1. If above this value, something is wrong and the instrument either requires optimization of the tuning parameters, maintenance, or a new/different calibration solution.

9.4.2.3. 'Apply span correction' and 'Check Acquisition calibration ranges' should both be checked.

9.4.2.4. Peak Match Parameters should set the Peak Window at 1 Da, Initial Error of 2 Da, Intensity Threshold of 0.1, Curve fit using a 3rd or 4th order polynomial over the calibration range, and the display shall be calibrated.

9.4.2.5. In regards to Mass Measure, 'background subtract' should be selected with a polynomial order of 1 and 33% Below Curve. Smoothing should be enabled with a Peak Width of 0.75 Da and the number of smooths set at 2; either the Mean or Savitzky Golay data smoothing filters may be selected. Mean is usually chosen. The minimum peak width at half height (channels) should be set at 4 based upon the top of the peak and height.

9.4.2.6. The Acquisition parameters should be set over the calibration range and at scan speeds the instrument is specified to achieve. The

is wise to analyze a blank after a concentrated sample and before a dilute sample to minimize carry-over of analytes from injection to injection. However, there should not be carry-over between samples; The H-Class UPLC® has a flow through LC needle design. The gradient conditions for liquid chromatography are shown in Table 7 (Appendix).

The sample compartment temperature is set at 15°C and the needle wash solvent is 60% acetonitrile/40% 2-propanol. Other needle wash solvents may be used, but it must be demonstrated that they adequately wash the needle between injections.

9.4.3.2. Mass spectrometer conditions

Variable parameters depending on analytes are shown in Table 8 (Appendix). The instrument is set in the Electrospray (-) negative source setting. The values for the following parameters are shown here for information purposes only. These conditions should be checked and optimized when required.

Capillary voltage: 0.65 kV
Cone: Variable depending on analyte
Source temperature: 150 °C
Desolvation gas temperature: 425°C
Desolvation gas flow: 800 L/hr
Cone gas flow: 200 L/hr
Collision gas flow: 0.15 mL/min
Low mass resolution 1: 3.0
High mass resolution 1: 14.9
Ion energy 1: 1
Entrance energy: 1
Collision energy: Variable, see Table 8 (Appendix)
Exit energy: 1
Low mass resolution 2: 3.0
High mass resolution 2: 14.7
Ion energy 2: 2.3
Gain: 1.0

are qualified as estimated ('J'). A new calibration must be generated every 24 hours regardless of a passing CCC.

CAUTION: The CCC end calibration check must be prepared in a separate vial since the concentrations of some analytes have been observed to change once the LC vial cap is pierced.

9.4.5. Autosampler schedule/analytical sequence

Prepare a sequence that includes all calibration standards, QC samples, and field samples. The first sample to be analyzed is a reagent blank sample. The calibration standards levels are analyzed next along with the second source calibration check standard. The next samples to be analyzed should be in the following recommended sequence: reagent blank, method blanks, reporting limit checks, LCS/LCSD, diluted field samples, field samples, duplicates, MS/MSD, and CCC.

10. Quality Control

10.1. Demonstration of capability

10.1.1. An analyst must have an approved Analyst Demonstration of Capability (ADOC) prior to reporting data. See the CRL QMP for guidance and requirements regarding ADOCs.

10.1.2. MDL with P&A studies must be performed before an analytical SOP may be used and repeated for any major SOP revisions. See the CRL QMP for guidance and requirements regarding IDOCs. MDLs for this method are shown in Tables 1 and 9 (Appendix). No data is reported below the reporting limit for this SOP unless the customer requests.

10.1.3. Quality control acceptance criteria for P&As are shown in Table 2 (Appendix, preliminary until a validation study is completed). These limits will be updated as more data is generated. For a precision and accuracy (P&A) study, at least 4 samples containing all the PFCs and surrogates at or near the level 6 concentration in Table 4 (Appendix) must be analyzed as replicates. These samples are then analyzed according to the method described in Section 9.

Refer to Section 9.4.4.3 for continuing calibration check QC criteria and qualification guidelines.

10.3.4. Surrogates

All samples are spiked with a surrogate standard spiking solution as described in Section 9.1. The percent recovery limits for each surrogate compound will be updated regularly based on historical laboratory control sample recovery data and will be based on a 99.7% confidence interval from X±3□. The current acceptance criteria are shown in Table 2 (Appendix, preliminary until a validation study is completed).

There are fourteen surrogates for this analysis that monitor method performance in each sample. The isotopically-labeled surrogates represent the unlabeled native analytes. In addition, PFTreA and PFTriA are represented by MPFDoA, PFHpA is represented by MPFHxA, PFBS, PFPeS, and PFHpS are represented by MPFHxS, PFDS and PFNS are represented by MPFOS, PFPeA is represented by MPFBA, and FOSA is represented by MNMeFOSAA. The number of surrogates used may be determined by customer request and may be different than what is stated in this method.

For qualification guidelines concerning surrogate recovery, see CRL SOP GEN028.

10.3.5. Method blank and reagent blank samples

For every 20 field samples, at least two method blanks will be prepared in reagent water to investigate for contamination throughout sample preparation, extraction, and analysis. A reagent blank is prepared each day with a 50:50 methanol and water solution containing 0.1 % acetic acid for every 30 samples (or a batch) to investigate for system/laboratory contamination.

The concentration of target analytes in the blank shall be less than half the reporting limit or the associated data shall be qualified "K" for high bias due to blank contamination. Alternatively, the reporting limit in the associated field sample(s) can be raised to three times the blank contamination concentration. Since a quadratic fit is often used, the concentrations below the reporting limit

9.1 to monitor spike accuracy and method performance in a sample matrix. The percent recovery limits for each target compound will be updated regularly based on historical LCS recovery data and will be based on a 99.7% confidence interval (X ± 3□). Historical LCS recovery data will be used in order to keep the limits more restrictive. The current acceptance criteria are shown in Table 2 (Appendix).

If the laboratory has not received MS/MSD samples for site-specific matrix evaluation, this QC check is excluded.

For qualification guidelines concerning MS/MSD recovery, see CRL SOP GEN028.

Calculate the percent recovery of the spike (P) using Equation 2..

Equation 2

$$P\square 100\square \frac{SSR\square SR}{SA}$$

Where:
SSR = MS/MSD Spiked Sample Result
SR = Unspiked Sample Result
SA = Spike Concentration
P =Percent Recovery

10.3.9. Duplicate samples

For every 20 field samples, a duplicate sample will be prepared using a field sample matrix in order to evaluate reproducibility of the sample preparation and analysis procedure. The percent difference in the duplicate must be < 30%. If not, the native sample is qualified estimated, "J".

Calculate the percent difference (%D) using Equation 3.

Equation 3

$$\%D = \frac{calculated\ concentration - expected\ concentration}{expected\ concentration} \times 100$$

11.2.3. Verify that all analytes have been properly identified and quantified in the chromatogram. Using software programs, manually integrate as necessary. The integration is recorded before and after in the MassLynx™ software, clearly showing the before and after integration.

11.2.4. Review the calibration report for calibration outliers and make area corrections for any peaks that are improperly integrated. If corrections have been made, update the calibration file and regenerate a calibration report. Alternatively, re-analyze "nonconforming" calibration level(s) and repeat the above procedures.

NOTE: A valid calibration curve must be generated before field samples or batch QC can be analyzed.

11.2.5. If the initial calibration data are acceptable, generate the calibration report. Samples may be analyzed during the 24-hour period after the last calibration standard injection, ending with an injection at or near the midpoint of the calibration curve (CCC). After that 24-hour period is expired, a new calibration curve must be generated to continue analysis or the low, middle, and high points of the previous curve must be checked with newly prepared calibration standards and all three points must be within ±10% of the previous calibration curve's concentration in order to be utilized.

11.2.6. Generate quantitation reports for all samples. Generate the final report. If manual integrations were made, the QuanLynx Audit Report can be consulted showing the details of how, when, and why the peak was changed. The entire quantitation method is saved and archived.

11.2.7. Review the quantitation reports for all samples making sure all surrogate and target compounds have been properly quantitated. Check for integration errors. Delete any false positives. Be sure the blank sample data have been properly reviewed.

11.2.8. Verify that all spike compounds were present in the MS/MSD and LCS/LCSD sample quantitation reports. Investigate any differences in spike concentrations that are more than 30% different.

11.4.2.1. Once the batch is called up in Data Entry/Review, click **Create** to create a Data Entry table. If data is to be entered manually, click **Save** and proceed to Section 11.4.3. To merge data automatically, click **DataTool**.

11.4.2.2. Once in DataTool, click **Browse** and select the .xml file created earlier (see Section 11.2.9). If unneeded sample entries remain in the lower left-hand box, click **Clear**. Double-click on the desired .xml file and either **Auto Select** or highlight individual samples and click **Include**. Ensure that the File Type is set to 'Waters MassLynx HRMS (*.xml)'.

11.4.2.3. Once the samples and quality control samples are selected, click **Done** and it will return to the main DataTool page. Ensure that the appropriate cross table is loaded.

11.4.2.4. Click **Merge Files**. If either Unmatched Analytes or Unmatched Units appear in red, repair the cross table with the assistance, if necessary, of the Group Leader. Verify that the results in **Initial Result** are correct and click **Save**. Once saved, the data entry table will be populated with the instrument data. Proceed to Section 11.4.4.

11.4.3. When performing manual data entry, enter the results in the column **IResult**. Include the response in the **Response** column and the retention time in the **RT** column. For each result, enter the date of analysis in the column **Analyzed**. This column has a calendar feature as do other date fields in LIMS. If dilutions were necessary for the analysis, enter the dilution factor in the column **Diln**. The sample result should be the one measured and not corrected for the dilution factor. Verify that the correct information is present in the **Analyst** field and the **Instrument** field.

11.4.4. Once all data are entered, click the **Save** button to save the entered data to the LIMS database. After saving, proceed to the Review page and click **Query**. Lock the data. Verify that all conversions to reporting units and dilutions have been calculated correctly. Verify that reporting limits have been correctly

12.2.1. High "background" levels of undesired substances (contamination from earlier sample injections) which contribute additional abundance at the isotope mass. Bake out the ion source assembly and condition the column.

12.2.2. Resolution of adjacent masses set improperly/higher than normal ratios due to poor resolution (peaks too wide) or lower ratios due to over resolution (narrow peaks).

12.3. Symptom: poor reproducibility

Probable Causes:

12.3.1. Loose or intermittent connection either to a printed circuit or to one or more ion source or quadrupole elements inside the analyzer assembly.

12.4. Symptom: high background

Probable Causes:

12.4.1. Dirty or contaminated ion source, electron multiplier, or quadrupole rod surfaces.

12.4.2. "Yesterday's" samples - There is the possibility that some previously injected sample can still be present in the vacuum system long after it was thought to be evacuated. This phenomenon depends on sample volatility, temperature, etc.

12.4.3. Contamination in a recently cleaned vacuum system - After any venting of a vacuum system for maintenance, there is the potential for introducing new substances into the vacuum system. Some substances are normal and can be pumped out, while others require more cleaning or baking.

12.4.3.1. Solvents used in the cleaning process - These will be present for a while but should be pumped out as heat is applied to the vacuum system.

12.4.3.2. Water absorbed on the metal surfaces while vented - This will pump out with heat.

12.4.3.3. "Fingerprints" - Heavy organic substances from inadequate clean room procedures may not be pumped out and may require source cleaning.

12.5. Symptom: mass spectrometer does not respond

15. Revision History

Description of changes only summarize significant changes. Minor changes not recorded in the revision history include, but are not limited to, addition of general information, correcting grammar, spelling, formatting, section changes, or re-wording for clarity that does not affect the meaning.

Version	Status	Location and Description of Significant Modifications
1	I	This document is first version of SOP for analysis of Expanded PFCs of Interest to OSRTI.

I = Initial

APPENDIX

Item	Title	Revision #	Date Revised
Table 1	Method Parameters	1	August 2016
Table 2	Quality Control Acceptance Criteria and Uncertainty	1	August 2016
Table 3	Target Analyte Spiking Solutions	1	August 2016
Table 4	Concentrations of Calibration Standards	1	August 2016
Table 5	Preparation of Calibration Standards	1	August 2016
Table 6	Retention Times and MRM Ions	1	August 2016
Table 7	Gradient Conditions for Liquid Chromatography	1	August 2016
Table 8	Variable Mass Spectrometer Parameters Depending on Analyte	1	August 2016
Table 9	MDL Study	1	August 2016
Tables 10a-d	P&A Study in Sewage Treatment Plant I Effluent	1	August 2016

PFNS	1.4	10 - 400
PFOA	1.7	10 - 400
PFHpS	2.5	10 - 400
PFHxS	1.2	10 - 400
PFHpA	1.0	10 - 400
PFHxA	2.0	10 - 400
PFBS	0.8	10 - 400
PFPeS	1.3	10 - 400
PFPeA	4.6	50 - 2000
PFBA	4.6	50 - 2000
FOSA	1.6	10 - 400
4:2 FTS	1.5	10 - 400
6:2 FTS	1.6	10 - 400
8:2 FTS	2.7	10 - 400
NEtFOSAA	1.1	10 - 400
NMeFOSAA	1.9	10 - 400

MDLs and RLs were determined from the IDOC performed on LC/MS/MS #3 analyzed in August 2016 (LIMS work order # 1701020, Qualtrax workflow ID #9595). This SOP is for use with LC/MS/MS #2 and #3.

Table 2. Quality Control Acceptance Criteria and Uncertainty

Analyte	Average Recovery (%)	Standard Deviation (%)	# of Replicates (n)	Lower Control Limit (LCL) %	Upper Control Limit (UCL) %
PFTreA	100	15.6	102	70	130
PFTriA	103	8.4	102	70	130
PFDoA	100	9.9	102	70	130
PFUnA	99.8	6.6	102	70	130
PFDA	97.7	5.6	102	70	130
PFDS*	101.4	2.7	6	70	130
PFOS	97.3	6.4	102	70	130
PFNA	96.4	5.0	102	70	130

M8:2 FTS*	107.3	7.8	17	70	130
MNEtFOSAA*	111	3.8	17	70	130
MNMeFOSAA*	103.9	2.1	17	70	130

Laboratory control sample recovery statistics were calculated in August 2016 from historical LCS QC samples analyzed between July 2014 and August 2016, unless otherwise noted. This SOP is for use with LC/MS/MS #2 and #3.

*Laboratory control sample recovery statistics for these analytes were calculated in August 2016 from LCS QC samples analyzed in August 2016 as part of the IDOC performed on LC/MS/MS #3 (LIMS work order # 1701020, Qualtrax workflow ID #9595).

Table 3. Target Analyte Spiking Solutions

Analyte	Concentration of Analyte in PFC Target Spike Solutions		
	PFC High Target Spike Solutions		PFC Reporting Limit Spike Solution
	Target Spike I	Target Spike II	
PFTreA, PFTriA, PFDoA, PFUnA, PFDA, PFOS, PFNA, PFHxA, PFHpA, PFBS, PFOA, PFHxS	20 µg/L	-	2 µg/L
PFBA, PFPeA	100 µg/L	-	10 µg/L
4:2 FTS, 6:2 FTS, 8:2 FTS, PFDS, PFNS, PFPeS, PFHpS, FOSA, N-MeFOSAA, NEtFOSAA	-	20 µg/L	2 µg/L

Table 4. Concentrations of Calibration Standards*

Analyte (Concentrations in ppt)	LV1	LV2	LV3	LV4	LV5	LV6	LV7	LV8	LV9
PFPeA, PFBA	25	50	100	200	300	400	500	750	1000

	Confirmatory	512.9□219		
PFDS	Primary	□□□□□□□□□□□□	9.8	1.2
	Confirmatory	□□□□□□□□□□□□		
PFOS	Primary	498.9□80.1	8.78	1.3
	Confirmatory	498.9□99.1		
PFNA	Primary	462.9□418.9	7.78	4.9
	Confirmatory	462.9□219		
PFNS	Primary	□□□□□□□□□□□□□	9.2	1.2
	Confirmatory	□□□□□□□□□□□□□		
PFOA	Primary	412.9□369	7.11	3.6
	Confirmatory	412.9□169		
PFHpS	Primary	□□□□□□□□□□□□□	7.95	1.3
	Confirmatory	□□□□□□□□□□□□□		
PFHxS	Primary	398.9□80.1	7.39	1
	Confirmatory	398.9□99.1		
PFHpA	Primary	362.9□319	6.35	4.1
	Confirmatory	362.9□169		
PFHxA	Primary	312.9□269	5.54	24.1
	Confirmatory	312.9□119.1		
PFBS	Primary	298.9□80.1	5.66	1.6
	Confirmatory	298.9□99.1		
Analyte	**Primary/Confirmatory**	**MRM Transition**	**Retention Time (Minutes)**	**Primary/ Confirmatory SRM Area Ratio**
PFPeA	Primary	263□219	4.68	NA
PFPeS	Primary	□□□□□□□□□□□□□	6.4	1.4
	Confirmatory	□□□□□□□□□□□□		
PFBA	Primary	212.9□169	3.67	NA

		% Solvent Line A	**% Solvent Line B**	**% Solvent Line C**
Time (min)	**Flow (mL/min)**	**95% Water : 5% Acetonitrile**	**Acetonitrile**	**400mM Ammonium Acetate (95% Water : 5% Acetonitrile)**
0	0.3	95	0	5
1	0.3	75	20	5
6	0.3	50	45	5
13	0.3	15	80	5
14	0.4	0	95	5
17	0.4	0	95	5
18	0.4	95	0	5
21	0.4	95	0	5

PFHpA	Primary	362.9□319	15	10
	Confirmatory	362.9□169	15	15
PFHxA	Primary	312.9□269	15	8
	Confirmatory	312.9□119.1	15	18
PFBS	Primary	298.9□80.1	10	30
	Confirmatory	298.9□99.1	10	25
PFPeA	Primary	263□219	10	8
Analyte	**Primary/Confirmatory**	**MRM Transition**	**Cone (V)**	**Collision Energy (eV)**
PFPeS	Primary	□□□□□□□□□□□□□	15	34
	Confirmatory	□□□□□□□□□□□□	15	30
PFBA	Primary	212.9□169	10	8
4:2 FTS	Primary	□□□□□□□□□□□	10	20
	Confirmatory	□□□□□□□□□□□	10	24
6:2 FTS	Primary	□□□□□□□□□□□□	10	22
	Confirmatory	□□□□□□□□□□□	10	30
8:2 FTS	Primary	□□□□□□□□□□□□□	10	26
	Confirmatory	□□□□□□□□□□□□	10	34
N-MeFOSAA	Primary	□□□□□□□□□□□	15	20
	Confirmatory	□□□□□□□□□□□□□	15	16
N-EtFOSAA	Primary	□□□□□□□□□□□	15	20
	Confirmatory	□□□□□□□□□□□□□	15	16
FOSA	Primary	□□□□□□□□□□□□	15	28
MPFBA	Primary	217□172.1	10	7
MPFHxA	Primary	315□270	15	8
MPFHxS	Primary	402.9□84.1	15	34
MPFOA	Primary	417□372	15	10

PFHpA	6	6.28	90.3	6.28	0.34	1.0
PFHxA	6	5.22	87	13.4	0.70	2.0
PFBS	6	6.50	108	4.16	0.27	0.8
PFPeS	6	6.83	114	6.34	0.43	1.3
PFPeA	30	31.60	105	5.07	1.61	4.6
PFBA	30	34.60	115	4.58	1.59	4.6
FOSA	6	7.17	119	7.73	0.55	1.6
4:2 FTS	6	6.35	106	8.21	0.52	1.5
6:2 FTS	6	5.89	98.2	9.6	0.57	1.6
8:2 FTS	6	5.70	94.9	16.6	0.95	2.7
NEtFOSAA	6	7.54	126	4.98	0.38	1.1
NMeFOSAA	6	6.93	116	9.39	0.64	1.9

*MDL values are reported below the reporting limit and lowest point of the calibration curve; they are estimated concentrations because they are not bracketed by calibration points.

MDLs were determined from the IDOC performed on LC/MS/MS #3 analyzed in August 2016 (LIMS work order # 1701020, Qualtrax workflow ID #9595). This SOP is for use with LC/MS/MS #2 and #3.

Tables 10a-d. P&A Study in Sewage Treatment Plant I Effluent

Table 10a. Precision and accuracy study for PFACs in Sewage Treatment Plant I (Effluent Sample)

Sample	Treatment Plant I (Effluent Sample) Measured ng/L from 160 ng/L spike for all PFCAs except PFBA and PFPeA (800 ng/L)										
	PFTreA	**PFTriA**	**PFDoA**	**PFUnA**	**PFDA**	**PFNA**	**PFOA**	**PFHpA**	**PFHxA**	**PFPeA**	**PFBA**
Unspiked 1	<RL	11.62	<RL	<RL	<RL	<RL	11.48	<RL	<RL	<RL	<RL
Unspiked 2	<RL	<RL	<RL	<RL	<RL	<RL	11.16	<RL	<RL	<RL	<RL
P&A1	175.7	139.5	147.7	145.4	143.8	142.5	139.4	98.8	96.7	673.3	510.8
P&A2	177.6	143.5	149.1	145.4	144.7	138.6	136.0	99.8	99.6	680.8	549.8
P&A3	169.2	141.9	142.1	143.2	138.0	138.8	134.3	98.4	96.4	672.5	517.3
P&A4	158.1	137.3	147.4	141.8	138.9	134.9	134.7	97.7	95.4	668.0	501.0
Average Conc. (ng/L)	170.2	140.5	146.6	143.9	141.3	138.7	136.1	98.7	97.0	673.6	519.7
% Average Recovery	106.4	87.8	91.6	90.0	88.3	86.7	85.1	61.7	60.6	84.2	65.0

Table 10d. Precision and accuracy study for PFCs in Sewage Treatment Plant IV (Effluent Sample)

Sample	Stickney, IL POTW (Effluent Sample) Measured ng/L from 160 ng/L spike												
	PFBS	PFHxS	PFOS	PFDS	PFNS	PFHpS	PFPeS	FOSA	4:2 FTS	6:2 FTS	8:2 FTS	N-ET FOSAA	N-MeFOSAA
Unspiked 1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Unspiked 2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Spiked 1	138	147	146	151	148	142	143	150	141	147	159	158	153
Spiked 2	127	134	140	144	146	142	139	146	133	141	148	150	143
Spiked 3	134	142	148	143	144	143	135	143	134	139	151	151	148
Spiked 4	140	143	150	151	153	148	144	152	146	149	155	159	151
Spiked 5	136	146	147	151	149	146	140	151	139	141	154	154	150
Spiked 6	140	142	149	149	151	151	141	148	140	145	167	148	158
Average Recovery (ng/L)	136	142	147	148	148	145	140	148	139	144	156	153	150
% Average Recovery	84.7	88.8	91.7	92.7	92.8	90.8	87.5	92.7	86.8	89.8	97.2	95.8	94.0
Standard Deviation	4.98	4.74	3.76	3.59	3.30	3.51	3.81	3.41	4.78	3.96	6.48	4.75	4.93
RSD (%)	3.67	3.33	2.56	2.42	2.22	2.42	2.72	2.30	3.44	2.76	4.17	3.10	3.28

Tables 11a-d. P&A Study in Sewage Treatment Plant I Influent

Table 11a. Precision and accuracy study for PFACs in Sewage Treatment Plant I (Influent Sample)

Sample	Treatment Plant I (Influent Sample) P&A Data (160 ng/L spike for all PFCAs except PFBA and PFPeA (800 ng/L)										
	PFTreA	PFTriA	PFDoA	PFUnA	PFDA	PFNA	PFOA	PFHpA	PFHxA	PFPeA	PFBA
Unspiked 1	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Unspiked 2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
P&A1	180.4	156.4	146.6	146.7	144.0	143.3	144.6	98.0	93.9	648.6	511.2
P&A2	167.2	153.4	140.8	141.0	141.8	139.0	142.2	96.8	91.4	629.6	497.7
P&A3	186.3	157.3	148.7	146.6	143.1	143.6	144.8	97.4	93.8	639.9	509.4
P&A4	166.9	156.5	145.3	148.6	144.4	146.8	144.9	97.7	93.7	651.1	516.8
Average Conc. (ng/L)	175.2	155.9	145.4	145.7	143.3	143.2	144.1	97.5	93.2	642.3	508.8
% Average Recovery	109.5	97.4	90.8	91.1	89.6	89.5	90.1	60.9	58.3	80.3	63.6
Sample	Treatment Plant I (Influent Sample) P&A Data (160 ng/L spike for all PFCAs except PFBA and PFPeA (800 ng/L)										
	PFTreA	PFTriA	PFDoA	PFUnA	PFDA	PFNA	PFOA	PFHpA	PFHxA	PFPeA	PFBA
Standard Deviation	9.7	1.7	3.3	3.3	1.2	3.2	1.3	0.5	1.2	9.8	8.0
RSD (%)	5.5	1.1	2.3	2.2	0.8	2.2	0.9	0.5	1.3	1.5	1.6

Table 11b. Precision and accuracy study for PFAS in Sewage Treatment Plant I (Influent Sample)

	PFBS	PFHxS	PFOS	PFDS	PFNS	PFHpS	PFPeS	FOSA	4:2 FTS	6:2 FTS	8:2 FTS	N-ET FOSAA	N-MeFOSAA
Unspiked 1	ND	ND	ND	ND	ND	ND	ND	ND	ND	17.8	ND	ND	ND
Unspiked 2	ND	ND	ND	ND	ND	ND	ND	ND	ND	18.2	ND	ND	ND
Spiked 1	139	146	150	144	143	140	140	128	153	146	149	154	153
Spiked 2	144	141	152	143	150	142	143	128	151	145	162	153	157
Spiked 3	152	153	158	139	148	149	145	130	156	146	164	156	155
Spiked 4	138	143	141	146	142	145	136	127	150	143	155	145	155
Spiked 5	156	153	158	149	151	151	151	132	167	158	163	163	163
Spiked 6	140	148	154	146	147	145	143	126	148	142	151	152	159
Average Recovery (ng/L)	145	147	152	144	147	145	143	129	154	146	157	154	157
% Average Recovery	90.5	92.1	95.1	90.3	91.8	90.8	89.4	80.4	96.4	91.5	98.4	96.2	98.0
Standard Deviation	7.30	4.86	6.13	3.59	3.63	4.03	4.80	2.10	6.82	5.87	6.42	5.71	3.57
RSD (%)	5.05	3.30	4.03	2.48	2.47	2.78	3.35	1.63	4.42	4.01	4.08	3.71	2.28

Tables 12a-d. P&A Study in Chicago River Water

Table 12a. Precision and accuracy study for PFACs in Chicago River Water

Sample	Chicago River Water Measured ng/L from 160 ng/L spike for all PFCAs except PFBA and PFPeA (800 ng/L)										
	PFTreA	PFTriA	PFDoA	PFUnA	PFDA	PFNA	PFOA	PFHpA	PFHxA	PFPeA	PFBA
Unspiked 1	<RL	<RL	<RL	<RL	<RL	<RL	11.44	<RL	9.54*	<RL	<RL
Unspiked 2	<RL	<RL	<RL	<RL	<RL	<RL	11.4	<RL	9.5*	<RL	<RL
P&A1	142.0	146.4	149.1	145.7	142.5	146.9	145.4	96.5	89.5	691.1	517.4
P&A2	143.8	149.7	157.5	150.6	153.0	154.9	147.5	100.5	91.4	708.4	530.4
P&A3	138.0	144.6	147.9	147.8	150.0	152.8	136.4	99.1	90.7	697.7	551.9
P&A4	147.7	143.4	152.6	149.3	150.9	147.5	137.4	98.7	89.4	681.7	535.4
P&A5	160.7	160.7	153.7	149.1	145.7	153.2	145.8	102.3	90.7	706.3	547.8
P&A6	150.6	144.7	148.5	142.2	139.5	144.4	135.4	97.1	87.8	695.1	529.1
Average Conc. (ng/L)	147.1	148.3	151.6	147.5	146.9	150.0	141.3	99.0	89.9	696.7	535.3
% Average Recovery	92.0	92.7	94.7	92.2	91.8	93.7	88.3	61.9	56.2	87.1	66.9
Standard Deviation	8.0	6.5	3.7	3.1	5.3	4.2	5.5	2.2	1.3	9.9	12.7
RSD (%)	5.4	4.4	2.5	2.1	3.6	2.8	3.9	2.2	1.4	1.4	2.4

NOTE: P&A concentration for each analyte are values after subtracting average of the Unspiked samples if □ RL.
*Slightly below Reporting Limit

Table 12b. Precision and accuracy study for PFAS in Chicago River Water

Sample	Chicago River Water Measured ng/L from 160 ng/L spike		
	PFBS	PFHxS	PFOS
Unspiked 1	<RL	<RL	10.34

	Measured ng/L from 160 ng/L spike												
	PFBS	PFHxS	PFOS	PFDS	PFNS	PFHpS	PFPeS	FOSA	4:2 FTS	6:2 FTS	8:2 FTS	N-ET FOSAA	N-MeFOSAA
Unspiked 1	ND	ND	13.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Unspiked 2	ND	ND	16.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Spiked 1	143	165	157	172	164	166	160	150	155	150	172	167	157
Spiked 2	152	170	162	177	176	167	162	150	158	170	172	179	163
Spiked 3	155	165	163	178	172	170	163	151	160	165	172	163	158
Spiked 4	150	167	169	175	172	170	165	148	153	160	170	163	156
Spiked 5	146	161	162	172	168	165	160	147	153	164	172	171	157
Spiked 6	150	163	169	176	170	165	161	153	154	167	175	173	157
Average Recovery (ng/L)	149	165	163	175	170	167	162	150	156	163	172	169	158
% Average Recovery	93.4	103	102	109	106	104	101	93.6	97.2	102	108	106	98.6
Standard Deviation	4.09	3.25	4.56	2.28	3.97	2.39	1.86	2.13	2.85	7.17	1.76	6.32	2.62
RSD (%)	2.74	1.97	2.79	1.30	2.35	1.43	1.15	1.42	1.83	4.40	1.02	3.73	1.66

Tables 13a-b. P&A Study in Sewage Treatment Plant II (Effluent with Supplemental Sewage)

Table 13a. Precision and accuracy study for PFCs in Sewage Treatment Plant II (Effluent with Supplemental Sewage)

Sample	Treatment Plant II (Effluent with Supplemental Sewage) Measured ng/L from 160 ng/L spike for all PFCAs except PFBA and PFPeA (800 ng/L)										
	PFTreA	PFTriA	PFDoA	PFUnA	PFDA	PFNA	PFOA	PFHpA	PFHxA	PFPeA	PFBA
Unspiked 1	13.1	9.7*	40.1	26.6	60.6	26.2	30.8	<RL	9.3*	<RL	<RL
Unspiked 2	12.8	10.6	39.7	24.8	55.9	27.7	33.5	<RL	10.6	<RL	<RL
P&A1	181.9	160.0	165.5	156.3	140.2	139.3	136.1	98.7	85.0	668.9	552.8
P&A2	171.8	154.3	165.8	149.1	132.3	139.1	136.5	100.8	88.2	657.7	537.3
P&A3	155.0	149.3	153.0	144.8	137.1	136.9	133.9	95.6	85.1	646.3	543.9
P&A4	144.1	147.8	154.0	144.0	143.0	138.1	136.2	98.4	85.7	644.0	540.1
P&A5	153.7	146.0	150.9	142.8	133.0	134.4	123.2	94.2	82.3	623.4	533.9
P&A6	160.6	164.8	171.2	161.8	157.0	151.7	149.2	107.6	94.2	695.5	579.4
Average Conc. (ng/L)	161.2	153.7	160.1	149.8	140.4	139.9	135.8	99.2	86.7	656.0	547.9
% Average Recovery	100.7	96.1	100.0	93.6	87.8	87.5	84.9	62.0	54.2	82.0	68.5
Standard Deviation	13.7	7.4	8.5	7.7	9.1	6.0	8.3	4.7	4.1	24.6	16.7
RSD (%)	8.5	4.8	5.3	5.1	6.5	4.3	6.1	4.8	4.7	3.8	3.1

NOTE: P&A concentration for each analyte are values after subtracting average of the Unspiked samples if □ RL. The samples were extracted under basic conditions.
*Slightly below Reporting Limit

Table 13b. Precision and accuracy study for PFAS in Sewage Treatment Plant II (Effluent with

P&A4	142.8	142.0	153.8	144.7	142.8	145.2	137.1	102.0	86.6	636.2	874.3
P&A5	151.8	141.3	149.3	151.7	144.6	150.5	151.6	104.3	95.2	675.2	1155.3
P&A6	163.5	149.3	152.8	148.2	137.4	141.1	139.5	101.5	88.8	658.8	1243.5
Average Conc. (ng/L)	141.9	140.7	147.4	146.2	135.8	141.8	140.8	100.7	88.9	651.8	1037.2
% Average Recovery	88.7	87.9	92.1	91.4	84.9	88.6	88.0	62.9	55.6	81.5	129.6
Standard Deviation	14.2	5.5	10.5	3.6	13.6	5.9	5.4	3.6	5.0	22.0	285.0
RSD (%)	10.0	3.9	7.1	2.4	10.0	4.1	3.9	3.6	5.6	3.4	27.5

NOTE: P&A concentration for each analyte are values after subtracting average of the Unspiked samples if □ RL. The samples were extracted under basic conditions.

Table 14b. Precision and accuracy study for PFAS in Sewage Treatment Plant III (Effluent with Supplemental Sewage)

Sample	**Treatment Plant III (Effluent with Supplemental Sewage) Measured ng/L from 160 ng/L spike**		
	PFBS	**PFHxS**	**PFOS**
Unspiked 1	20.7	<RL	222.3
Unsoiked 2	24.1	<RL	175.6
P&A1	140.0	147.3	130.7
Sample	**Treatment Plant III (Effluent with Supplemental Sewage) Measured ng/L from 160 ng/L spike**		
	PFBS	**PFHxS**	**PFOS**
P&A2	138.0	138.2	145.2
P&A3	149.5	151.2	107.9
P&A4	138.9	154.5	127.1
P&A5	153.5	157.5	147.5
P&A6	143.8	156.0	150.9
Average Conc. (ng/L)	143.9	150.8	134.9
% Average Recovery	90.0	94.2	84.3
Standard Deviation	6.3	7.2	16.3
RSD (%)	4.4	4.8	12.1

NOTE: P&A concentration for each analyte are values after subtracting average of the Unspiked samples if □ RL. The samples were extracted under basic conditions.

Tables 15a-b. P&A Study in Lake Water

Table 15a. Precision and accuracy study for PFCs in Lake Water

Sample	**Lake Michicgan Water**

Spiked 3	146	153	154	148	147	155	149	148	152	737	537
Spiked 4	147	153	152	146	145	152	140	143	153	735	466
Spiked 5	149	154	156	149	150	154	148	148	153	742	531
Spiked 6	153	161	158	151	149	156	144	148	157	797	553
Average Recovery (ng/L)	150	157	156	150	149	155	145	148	154	755	527
% Average Recovery	93.6	98.0	97.3	93.8	93.3	96.6	90.8	92.5	96.5	94.4	65.8
Standard Deviation	3.46	4.96	3.29	3.53	4.63	1.93	3.80	2.50	3.45	24.7	30.7
RSD (%)	2.31	3.16	2.12	2.35	3.10	1.25	2.62	1.69	2.24	3.27	5.83

Table 16b. Precision and accuracy study for PFCs in Ground Water

Sample	**Homer Glen, IL Ground Water**												
	Measured ng/L from 160 ng/L spike												
	PFBS	**PFHxS**	**PFOS**	**PFDS**	**PFNS**	**PFHpS**	**PFPeS**	**FOSA**	**4:2 FTS**	**6:2 FTS**	**8:2 FTS**	**N-ET FOSAA**	**N-MeFOSAA**
Unspiked 1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Unspiked 2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Spiked 1	163	160	168	171	165	165	160	150	160	163	175	170	161
Spiked 2	157	161	159	166	168	161	158	148	150	162	163	170	158
Spiked 3	157	157	162	162	165	160	152	144	150	152	162	164	151
Spiked 4	156	160	164	156	162	158	149	149	149	147	163	158	151
Spiked 5	158	161	163	165	166	169	155	148	154	157	168	171	160
Spiked 6	159	164	163	168	164	164	152	146	149	153	163	167	154
Average Recovery (ng/L)	158	160	163	165	165	163	155	148	152	156	166	167	156
% Average Recovery	98.9	100	102	103	103	102	96.6	92.3	95.0	97.3	104	104	97.4
Standard Deviation	2.61	2.27	2.84	5.11	2.02	4.06	4.18	2.12	4.44	6.07	4.88	4.85	4.45
RSD (%)	1.65	1.42	1.74	3.10	1.22	2.49	2.70	1.43	2.92	3.90	2.95	2.91	2.85

Tables 17a-j. <u>Surrogate Recoveries for P&A Study</u>

Table 17a. Surrogate recoveries for precision and accuracy study in Treatment Plant I (Effluent Sample)

Sample	**Treatment Plant I (Effluent Sample – 160 ng/L spike)**								
	MPFBA	MPFHxA	MPFHxS	MPFOA	MPFNA	MPFOS	MPFDA	MPFUnA	MPFDoA
Unspiked 1	151.6	152.7	154.8	150.6	147.5	158.1	158.1	157.2	161.9
Unspiked 2	139.0	147.4	145.7	143.4	148.8	152.3	149.3	154.5	157.0
P&A1	133.9	152.4	155.1	148.8	150.2	151.4	151.2	154.7	155.2
P&A2	142.8	152.4	152.5	144.7	153.7	149.4	153.8	151.5	158.1
P&A3	136.3	149.2	149.5	147.0	149.4	148.5	145.5	151.4	153.6
P&A4	137.4	149.9	152.9	146.4	149.4	149.1	150.6	155.6	155.3
Average Conc. (ng/L)	140.1	150.7	151.8	146.8	149.8	151.5	151.4	154.2	156.8
Sample	**Treatment Plant I (Effluent Sample – 160 ng/L spike)**								

P&A 6	151.6	167.4	168.7	165.0	163.2	165.8	164.6	168.6	168.2
Average Conc. (ng/L)	146.0	161.6	162.3	158.5	158.3	159.6	159.8	162.9	162.8
% Average Recovery	91.3	101.0	101.4	99.0	98.9	99.8	99.9	101.8	101.7
Sample	**Chicago River Water - 160 ng/L spike**								
	MPFBA	MPFHxA	MPFHxS	MPFOA	MPFNA	MPFOS	MPFDA	MPFUnA	MPFDoA
Standard Deviation	5.3	5.5	7.7	6.0	5.6	8.8	5.5	5.1	6.5
RSD (%)	3.6	3.4	4.7	3.8	3.5	5.5	3.4	3.1	4.0

Table 17d. Surrogate recoveries for precision and accuracy study in Sewage Treatment Plant II (Effluent with Supplemental Sewage)

Sample	**Treatment Plant II (Effluent with Supplemental Sewage – 160 ng/L spike)**								
	MPFBA	MPFHxA	MPFHxS	MPFOA	MPFNA	MPFOS	MPFDA	MPFUnA	MPFDoA
Unspiked 1	143.0	148.9	153.1	149.5	156.7	161.5	157.2	165.8	176.2
Unspiked 2	149.5	152.8	160.7	159.1	161.0	163.7	160.6	166.2	175.0
P&A1	138.7	145.5	150.3	148.6	151.1	158.8	151.2	158.3	175.2
P&A2	132.4	142.3	151.9	144.4	152.0	152.1	148.7	156.4	167.7
P&A3	127.3	137.4	150.4	141.6	144.8	146.5	150.4	150.1	163.5
P&A4	131.1	142.3	143.6	139.1	145.3	147.2	144.3	155.0	167.0
P&A5	128.4	136.3	148.5	140.7	143.7	145.5	144.9	152.7	165.2
P&A6	141.5	145.4	157.8	150.5	158.2	159.8	155.5	166.5	170.8
Average Conc. (ng/L)	136.5	143.9	152.1	146.7	151.6	154.4	151.6	158.9	170.1
% Average Recovery	85.3	89.9	95.0	91.7	94.7	96.5	94.8	99.3	106.3
Standard Deviation	7.9	5.5	5.3	6.6	6.6	7.4	5.8	6.5	4.9
RSD (%)	5.8	3.8	3.5	4.5	4.4	4.8	3.8	4.1	2.9

Table 17e. Surrogate recoveries for precision and accuracy study in Sewage Treatment Plant III (Effluent with Supplemental Sewage)

Sample	**Treatment Plant III (Effluent with Supplemental Sewage – 160 ng/L spike)**								
	MPFBA	MPFHxA	MPFHxS	MPFOA	MPFNA	MPFOS	MPFDA	MPFUnA	MPFDoA
Unspiked 1	136.1	144.9	147.7	149.4	151.2	152.6	150.8	162.4	170.5
Unspiked 2	142.5	146.6	150.2	144.6	150.1	155.9	149.1	150.6	163.7

Standard Deviation	5.29	6.59	5.54	6.03	4.32	4.65	4.09	5.54	3.34	8.19	5.91	7.02	6.16	4.62
RSD (%)	7.22	4.38	3.67	4.01	2.88	3.19	2.67	3.76	2.27	5.59	3.95	4.55	3.94	2.92

Table 17h. Surrogate recoveries for precision and accuracy study in Ground Water

Sample	Surrogates - Homer Glen, IL Ground Water (Ground Water Sample – 160 ng/L spike)													
	MPFBA	MPFHxA	MPFHxS	MPFOA	MPFNA	MPFOS	MPFDA	MPFUnA	MPFDoA	M4:2 FTS	M6:2 FTS	M8:2 FTS	MN-ET FOSAA	MN-MeFOSAA
Unspiked 1	119	156	163	155	156	171	154	159	155	156	153	160	176	166
Unspiked 2	113	155	164	154	154	170	160	158	158	158	164	172	171	170
Spiked 1	107	152	161	151	154	167	157	154	157	156	161	163	176	161
Spiked 2	116	152	167	154	153	172	157	158	158	162	161	185	177	167
Spiked 3	114	152	161	151	153	166	152	154	153	158	158	167	170	159
Spiked 4	104	147	158	151	147	164	150	151	151	156	153	167	165	155
Spiked 5	113	156	169	156	158	176	156	159	158	158	157	176	176	163
Spiked 6	113	154	159	158	156	173	156	154	157	160	158	170	180	166
Average Recovery (ng/L)	112	153	163	154	154	170	155	156	156	158	158	170	174	163
% Average Recovery	70.1	95.7	102	96.1	96.1	106	97.0	97.5	97.4	98.7	98.8	106	109	102
Standard Deviation	4.76	2.78	3.80	2.69	3.17	3.96	3.10	2.97	2.63	2.03	3.81	7.81	4.87	4.77
RSD (%)	4.24	1.82	2.33	1.75	2.06	2.33	2.00	1.90	1.69	1.28	2.41	4.59	2.80	2.92

Table 17i. Surrogate recoveries for precision and accuracy study in Lake Water

Sample	Surrogates - Lake Michigan Water (Lake Water Sample – 160 ng/L spike)													
	MPFBA	MPFHxA	MPFHxS	MPFOA	MPFNA	MPFOS	MPFDA	MPFUnA	MPFDoA	M4:2 FTS	M6:2 FTS	M8:2 FTS	MN-ET FOSAA	MN-MeFOSAA
Unspiked 1	107	148	158	150	152	169	157	154	158	150	155	168	182	167
Unspiked 2	112	158	173	161	162	183	164	163	165	155	163	167	192	175
Spiked 1	112	154	163	155	159	172	157	161	160	166	168	178	173	168
Spiked 2	81.3	151	162	154	156	171	160	158	159	155	166	171	176	169
Spiked 3	102	152	164	155	155	171	156	155	158	160	162	180	173	167
Spiked 4	106	148	164	156	156	174	157	160	163	159	164	179	179	164
Spiked 5	112	153	163	156	152	169	154	154	156	160	163	172	168	162
Spiked 6	71.1	137	155	149	148	167	145	150	155	148	154	164	182	165
Average Recovery (ng/L)	100	150	163	155	155	172	156	157	159	157	162	172	178	167
% Average Recovery	62.8	93.8	102	96.6	96.9	107	97.7	97.9	99.5	97.8	101	108	111	104
Standard Deviation	15.6	6.19	5.04	3.73	4.31	4.96	5.44	4.41	3.27	5.80	4.77	6.05	7.33	4.04
RSD (%)	15.6	4.13	3.10	2.41	2.78	2.89	3.48	2.82	2.05	3.71	2.95	3.51	4.12	2.42

Table 17j. Surrogate recoveries for precision and accuracy study in River Water

Sample	Surrogates - Chicago River Water (River Water Sample – 160 ng/L spike)													
	MPFBA	MPFHxA	MPFHxS	MPFOA	MPFNA	MPFOS	MPFDA	MPFUnA	MPFDoA	M4:2 FTS	M6:2 FTS	M8:2 FTS	MN-ET FOSAA	MN-MeFOSAA
Unspiked 1	121	153	164	161	158	174	157	157	161	160	156	167	175	167
Unspiked 2	115	157	167	155	157	177	161	158	157	158	152	168	173	168
Spiked 1	117	149	165	153	153	171	153	154	158	157	155	167	167	165
Spiked 2	121	154	169	157	160	177	156	161	159	165	172	178	177	162
Spiked 3	118	153	164	156	155	169	155	157	159	163	166	181	171	161
Spiked 4	107	152	158	154	149	168	155	160	157	154	156	173	166	164
Spiked 5	116	153	163	156	153	170	158	161	163	157	156	168	171	162
Spiked 6	119	156	165	154	155	173	162	160	161	164	159	182	173	169
Average Recovery (ng/L)	117	153	164	156	155	172	157	158	160	160	159	173	172	165
% Average Recovery	72.9	95.8	103	97.3	96.9	108	98.2	99.0	99.7	99.8	99.4	108	107	103
Standard Deviation	4.59	2.38	3.15	2.65	3.32	3.38	3.32	2.38	2.21	4.18	6.72	6.31	3.50	3.01
RSD (%)	3.93	1.56	1.91	1.70	2.14	1.96	2.11	1.50	1.38	2.62	4.22	3.65	2.04	1.83

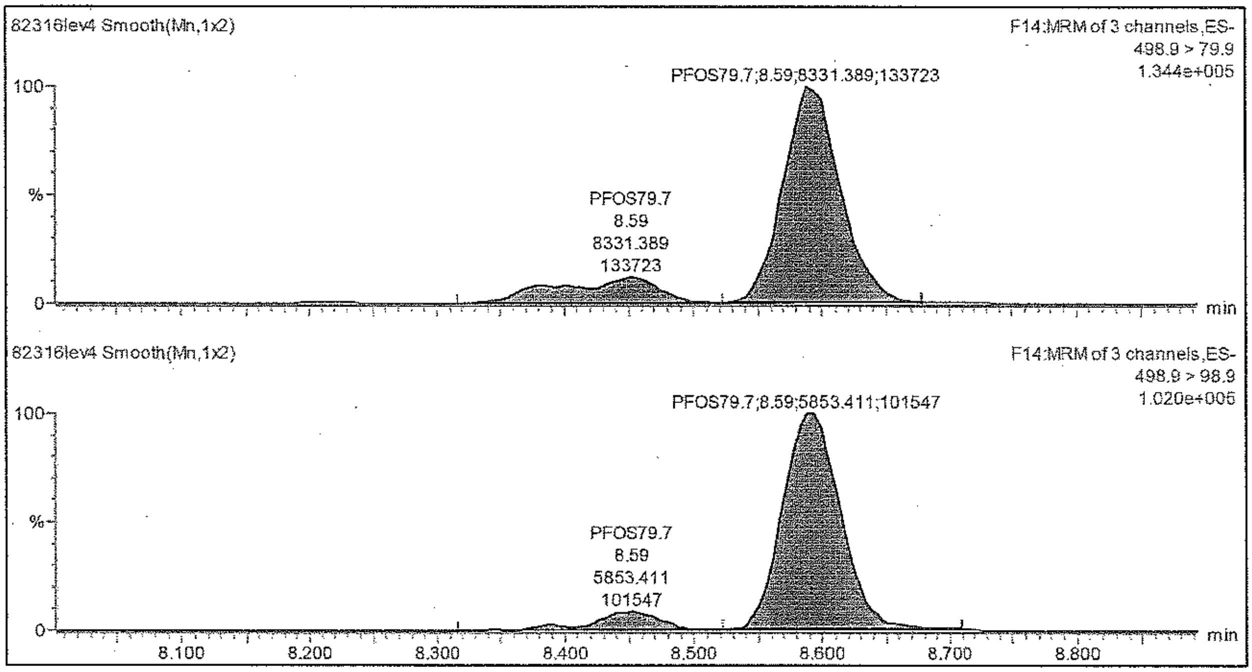
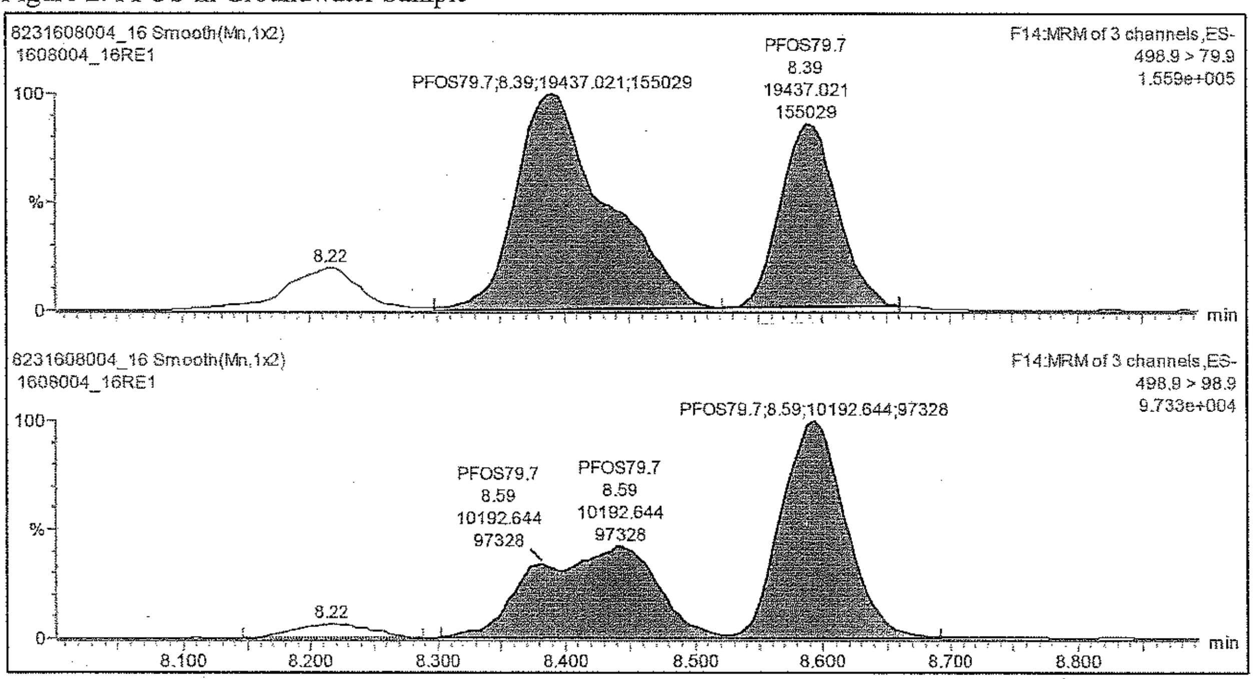


Figure 2. PFOS in Groundwater Sample



The peak at 8.22 minutes is probably another isomer group of PFOS, but it's not included in the quantitation of the calibration standard so it can't be included in the quantitation of the groundwater sample.

Figure 3. PFHxS in Calibration Standard

FIELD PROCEDURE 5

Sample collection for Microbial Analysis
All individual microbial samples from monitoring well should be taken with sterile or sterile disposable equipment whenever possible and care needs to be taken to make sure that cross contamination between samples does not occur due to the contamination of sampling materials and equipment from one sample site to another.

Sampling Instructions: Wear gloves when collecting samples. Do not rinse the bottles. The bottles are sterile so care must be taken not to contaminate the bottle or cap. Quickly open the bottle (but do not set the cap down), hold the cap by its outside edges only, and fill the sample bottle to leaving a one-inch headspace. The 1-inch headspace is important to ensure proper mixing of entire sample prior to microbial analysis. Cap the bottle immediately and label it with appropriate sample identification, collection time, and sampler initials. Place sample bottle into gallon size Ziploc bag. Place it into a cooler with ice or blue icepacks for delivery or overnight shipment to the laboratory. Samples should be chilled to 10°C or less but should not be frozen. Frozen samples will not be analyzed. Samples should be analyzed within 30hrs of collection. Samples may be shipped to the EPA ORD laboratory in Cincinnati, OH for receipt Monday through Thursday. Because analysis for *E. coli* and total coliforms is a 24hr test no samples will be accepted on Fridays or weekends during the study.

Upon receipt in the laboratory samples will analyzed for E. coli and total coliforms using Colilert™ (Idexx, Westbrook MA) using the Quantitray sealer (Idexx, Westbrook MA) to provide a microbial estimation using Most Probable Number format. Samples will be analyzed using Standard Methods 9223B (APHA, 2014).

Colilert™ simultaneously detects total coliforms and E. coli in water. Commercially prepared media formulations are available in packets for presence-absence and multiple-well procedures. The use of commercially prepared media is required for quality assurance and uniformity. Incubate the sample at 35.0°C+0.5°C for 24 hours. If the response is unclear after the specified incubation period, the sample is incubated for up to an additional 4 hours at 35.0°C+0.5°C. After the appropriate incubation period, compare each bottle/tube/well to the reference color "comparator" provided by the manufacturer. A yellow color greater or equal to the comparator indicates the presence of total coliforms in the sample, and the bottle/tube/well is then checked for fluorescence under long-wavelength UV light (365-nm). The presence of fluorescence greater than or equal to the comparator is a positive result for E. coli. The concentration in MPN/100 mL.

Prior to analysis of samples each lot of Colilert™ will be QA/QC for sterility and performance using sterile Butterfields buffer. Any lot that doesn't pass the QA/QC check will be discarded. Each lot of Quantitray Sealer Trays will also be checked for sterility using sterile Butterfields buffer. Any lot not passing the QA check will be discarded. All samples analyzed will be recorded on Bench sheets maintained by Laura Boczek. All results will be communicated to Ron Herrmann.

Sample Bench Sheet

Coli-lert Carver County Composting Groundwater Monitoring Project Total coliforms / E. coli Bench Sheet

Date/Time samples received, and processed_____________________________ Date/Time results_________________

Incubator Temperature___________________ Initials___________

Sample ID	Dilution	Number of Yellow positive wells (Big/small)	Total Coliform MPN/100 mL	Dilution	Number of MUG positive wells (Big/Small)	E. coli MPN/100 mL

APPENDIX D: REPORTS

Hydrogeologic Investigation and Monitoring Well Installation Report

HYDROGEOLOGIC INVESTIGATION AND MONITORING WELL INSTALLATION REPORT

Carver County Compost Facilities
Chanhassen and Watertown, Minnesota
Project No. 6320-01

Prepared for:

Carver County Environmental Services
600 4th Street East
Chaska, Minnesota 55319

March 22, 2017
Revised: April 27, 2017

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ENVIRONMENTAL • ENGINEERING • LAND SURVEYING

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APPENDICES

1.0 INTRODUCTION

1.1 Purpose and Scope

This report describes the work completed for the drilling of soil borings and installation of groundwater monitoring wells at the Arboretum Source Separated Organic Material (SSOM) Compost Site (Arboretum Site) and the Watertown Yard Waste Composting Site (Watertown Site). The purpose of the project was to install four vertical monitoring wells surrounding the active composting area at the Yard Waste Site; and drill six soil borings and install four monitoring wells surrounding the active composting area at the Arboretum Site. The wells will be used in conjunction with a demonstration research project to evaluate potential impacts of SSOM composting and yard waste composting on groundwater at the Arboretum and Watertown Sites, respectively. Soil boring information collected from the Arboretum Site will be used to determine the Site's compliance with Minnesota Pollution Control Agency (MPCA) SSOM composting rules and subsurface information will be used for determining the need for a lined compost pad at the Arboretum Site. Evaluation of the Arboretum Site for SSOM site compatibility will be provided under a separate cover.

1.2 Site Background Information

The information provided below has been adapted from background information provided in the Hydrogeologic Investigation Work Plan (Work Plan) (Carlson McCain, 2016).

1.2.1 Arboretum Site Location and Hydrogeologic Setting

The Arboretum Site is located in the northeast ¼ of the northeast ¼ of Section 17, Township 116 North, Range 27 West in the eastern portion of Carver County, Minnesota. A Site location map is presented in Figure 1. The Site is located within the University of Minnesota Landscape Arboretum property boundary, and consists of a compacted Class 5 compost pad and SSOM composting operations. The site occupies approximately 0.6 acres.

Topography of the Site consists of rolling hills interspersed with low-lying surface water depressions. Subsurface material consists of unconsolidated glacial till deposits overlying bedrock. Surficial deposits are reported to be associated with the Des Moines lob glaciation and consist of an unsorted mix of sand, silt, clay, and rocks. Regional groundwater is typically obtained from a buried quaternary sand and gravel aquifer at depths in excess of 200 feet below ground surface, and groundwater flow in the vicinity of the Site is southeast toward the Minnesota River. However, the surficial water table in the vicinity of the Site, in general, follows the local topography, and is recharged by low-lying surface water depressions.

1.2.2 Watertown Site Setting and Geology

The Watertown Site is located in the northeast ¼ of the southwest ¼ of Section 4, Township 117 North, Range 25 West in the northwest portion of Carver County, Minnesota. A Site location map is provided in Figure 2. The Watertown Site occupies approximately 2 acres and consists of a compacted compost pad and yard waste processing and composting operations.

The Watertown Site slopes gradually northeast, with all surface water draining toward the northeast portion of the Site and discharging into the adjacent Crow River. Geology at the Site consists of alluvial clay, silt, sand, and gravel deposited by the adjacent Crow River. Regional groundwater flow for the Watertown Site is to the southeast, toward the regional groundwater discharge of the Minnesota River. Local groundwater flow in the vicinity of the Site is to the east-northeast, toward the local groundwater discharge of the Crow River.

2.0 FIELD INVESTIGATION ACTIVITIES RESULTS AND DISCUSSION

The following sections discuss the field tasks associated with the soil boring advancement and monitoring well installation. Drilling and monitoring well installation services were provided by Cascade Drilling, L.P., of Little Falls, Minnesota, a licensed and registered well contractor in the State of Minnesota. Drilling and well construction was conducted in accordance with Minnesota Administrative Rules (Rules), Chapter 4725, *Wells and Borings.*

2.1 Arboretum Site Investigation Activities

2.1.1 Soil Borings

A total of six soil borings were advanced at the Arboretum Site, with two borings occurring within the compost pad footprint and four surrounding the active compost area. A map showing the boring locations is presented in Figure 3, and boring construction information is provided in Table 1. The two borings located on the pad, B16-5 and B16-6, were advanced to a depth of 15 feet below ground surface (bgs), and three of the four borings surrounding the pad, B16-1, B16-2, and B16-4, were advanced to a minimum of twelve feet below the observed water table with depths of 30 feet bgs, 40 feet bgs, and 30 feet bgs, respectively. The fourth boring, B16-3, was advanced to 70 feet bgs. Field boring logs are provided in Appendix A.

Borings were completed using rotasonic drilling methods in general accordance with American Society for Testing and Materials (ASTM) D6914-04 "Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices" (ASTM, 2010). Soil samples were collected continuously by advancing a four-inch diameter core barrel and extruding the soil from the core into a polyethylene bag. A six-inch diameter casing was advanced as needed to keep the borehole open during drilling, and to accommodate the installation of the wells.

Core runs were either 5-foot or 10-foot intervals depending on sample recovery and expected depth of the borehole. Extruded soil samples were placed on the ground for logging and stratigraphic characterization. Samples were logged, classified, and geologically interpreted in the field in general accordance with the procedure outlined in ASTM D2488 "Standard Practice for Description and Identification of Soils" (ASTM, 2009). Soil descriptions included consistency, matrix color, material classification, field moisture, plasticity, and dispositional interpretation. Soil textural classifications were assigned according to the United Soil Classification System (USCS). Due to the use of rotasonic drilling methods, standard penetration testing was not performed, and therefore density descriptions do not conform to ASTM D1586. However, pocket penetrometers were used to test core specimens of fine-grained soils. Penetrometer readings were converted to density descriptions using the equivalency values listed in the *Field Guide for Soil and Stratigraphic Analysis, v. 2* (Midwest GeoSciences Group, 2008).

Boreholes that were not completed as monitoring wells were abandoned in accordance with Minnesota Rules. The boreholes were grouted using Portland cement, and filled to the ground surface.

2.1.2 Geology and Soils

The following section describes the geologic conditions encountered during the field investigation and also provides an interpretation of the geology of the Site. The information and discussion presented below are based on observations recorded on soil boring logs completed during the investigation, along with information provided in the Work Plan. Copies of the boring logs are included in Appendix A, and boring construction information is summarized in Table 1.

2.1.2.1 Unconsolidated Till (Des Moines Lobe Glaciation)

The main geologic materials at the Site consist of undifferentiated glacial till associated with the northwest source, Des Moines Ice Lobe glaciation. The till is comprised of an upper oxidized and lower unoxidized portion (Minnesota Geologic Survey, 2009).

The upper portion of the till is primarily comprised of a medium plasticity, sandy lean clay with varying amounts of very fine to coarse-grained sand and fine gravel. Soils classified as CL under USCS. Color was typically described as brown or yellowish-brown; with reference to the Munsell color chart, hue was reported as YR. Areas of mottling were observed at various depths within the upper till and were typically one to two feet thick. For example, mottling was observed in boring B16-4 at depths of 4'-5', 8'-10', and 15.5'-17'. The upper portion of the till unit was observed to be 26 feet thick in B16-1, 34 feet thick in B16-2, 26 feet thick in B16-3, and 18.5 feet thick in B16-4. Borings B16-5 and B16-6 were terminated prior to advancing through the upper portion of the till.

The lower, unoxidized portion of the till consists of sandy lean clay with silt, and varying amounts of very fine to fine-grained sand and trace fine gravel. Soils classified as CL under USCS. Color was described as dark gray; with reference to the Munsell soil color chart, hue was reported as Y. The lower portion of the till was observed to be 36 feet thick at boring B16-3. All other borings were terminated prior to reaching the bottom of the till.

2.1.2.2 Geotechnical Soil Samples

A total of six soil samples were collected from the borings located on the active compost pad and submitted to Soil Engineering Testing, Inc. of Bloomington, Minnesota for grain size analysis and classification in accordance with the United States Department of Agriculture (USDA) Soil Textural Classification. Three samples were collected at B16-5 from depths of 1.5-2.5 feet, 5-7 feet, and 10-11 feet deep, and three samples were collected at B16-6 from depths of 3-5 feet, 8-10 feet, and 12-13 feet deep. The six soil samples contained a combined average of 18 percent sand, 48 percent silt, 29 percent clay, and 5 percent coarse material, which corresponds to a USDA classification of silty clay loam. The top 5 to 7 feet below ground surface contained the most clayey material, however all samples had greater than 20% percent clay, except for B16-6 from 10-11'. Laboratory results are summarized in Table 2 and hard copies of the report are provided in Appendix B.

2.1.3 Monitoring Well Installation and Site Hydrogeology

Four monitoring wells were installed within the soil borings discussed in Section 2.1 and were constructed in accordance with Minnesota Department of Health (MDH) well code (i.e. Minnesota Rules, Chapter 4725). Monitoring well MW-AR-1 was installed within boring B16-4, well MW-AR-2 was installed within boring B16-1, well MW-AR-3 was installed within B16-2, and well MW-AR-4 was installed within boring B16-3. Construction data for the new wells are summarized in Table 1 and well locations are shown on Figure 4.

Due to the fine grained nature of the soils, static water levels in each hole were not easily discernable during drilling. Recharge to the boreholes was observed to be slow and only at B16-2 was a water level measurement able to be obtained prior to installing the monitoring well. The water level measurement of 7.5 feet below ground surface at B16-2 was collected approximately 10 hours after drilling and was thought to have been higher than normal based on the abnormally high amount of precipitation received during the fall of 2016, and the presence of mottled and oxidized zones deeper in the borehole. The well at B16-2 was therefore installed lower than two feet below the observed water table, and the screened elevation at B16-2 was used as the basis for setting the well screens within the other soil borings located onsite. Consequently, the wells were completed at depths of approximately 22 to 25 feet below existing ground surface.

Water levels were not stabilized immediately after the completion of well installation on 12/10/16, so the monitoring wells were bailed dry and allowed to recharge until 12/28/16 before the next round of water levels was collected. Ultimately, three of the four monitoring wells were installed such that the bottom of the well was at least twelve feet below the static water elevation measured on 12/28/16. The one exception is MW-AR-4, where the well bottom was 10.63 feet below static water level.

The wells were installed using factory-new, two-inch diameter stainless steel, No. 7 slot screens. The screens were connected via couplers to schedule 40 low-carbon steel riser pipe which extended to approximately two-feet above ground surface. A clean, uniform sand filter pack was placed around each well screen and extended approximately three feet above the top of the screen. An approximately 1-foot thick hydrated bentonite seal was placed above the filter pack, followed by Portland cement placed to at or above ground surface. A concrete collar was placed around the well at the ground surface and sloped away from the well to divert surface drainage. Well protection consisted of a 7-foot long, 6-inch diameter, locking, steel protective casing (pro-top) imbedded within the concrete and three bumper posts surrounding the well.

All well installation activities were supervised by a Carlson McCain field geologist. Well construction details were entered onto well construction diagrams, which are included in Appendix A. In addition, MDH well construction records have also been included in Appendix D.

2.1.3.1 Site Hydrogeology

The uppermost groundwater observed at the Arboretum site occurs within the fine grained glacial till. Water levels from each of the four monitoring wells were collected on December 28th, 2016, January 10th, 2017, and April 17th, 2017. Groundwater elevations referenced to the North American Vertical Datum of 1988 (NAVD88) are summarized in Table 3, and a groundwater hydrograph is presented in Figure 4. During the initial measurements in December, groundwater elevations ranged from approximately 981 feet in MW-AR-4 to 1,001 feet in MW-AR-1, and were similar during the April event, ranging from approximately 978 feet in MW-AR-4 to 1,000 feet in MW-AR-1. During the January event water levels decreased by approximately three feet in all wells except for MW-4. Depth to water in monitoring wells MW-AR-1, MW-AR-2, and MW-AR-3 was less than five feet below the ground surface during both the January and April measurements. Water levels in MW-AR-4 have ranged from to 13.8 feet to 16.6 feet below ground surface.

Figures 5 and 6 illustrate groundwater elevation contours at the Site based on water level data collected on January 10th, 2017 and April 17th, 2017, respectively. The contours indicate that groundwater flow beneath the Site is generally south-southwest towards a low-lying marsh area, which is presumed to act as the local groundwater discharge for shallow groundwater in the surrounding upland areas. Using the contours shown in Figure 5, the horizontal gradient of the water table in below the Site is approximately 0.06 (unitless: vertical feet/horizontal foot). Calculations for determining the horizontal gradient are provided in Appendix C.

A notable feature of Figure 6 is that well MW-AR-4 is not used in generating the groundwater elevation contours. This was done in response to an apparent hydraulic disconnect between MW-AR-4 and the other three wells. The hydrograph in Figure 4 illustrates how water levels in MW-AR-4 do not track similarly with the other three wells. This dissimilarity, combined with the fact that the original borehole for MW-AR-4 was initially dry to a depth of 70 feet when first drilled, indicates a poor hydraulic connection between MW-AR-4 and the other three wells. Because this well has the lowest groundwater elevation, including it in the contouring would result in a contour map showing flow directly to the well, which is inconsistent with field observations that this location is not a preferential flow pathway.

The water level information collected to date is indicative of a variably saturated condition in the oxidized portion of the till, with water elevations varying both spatially and temporally. This is characteristic of clay till in that there can be discontinuous perched saturated zones within the overall fine-grained matrix. Generally speaking, the glacial till upon which the Site sits is considered an aquitard, or confining unit, and the borehole data shows that the first significant sand lens is nearly 70 feet below the ground surface, indicating that the Site presents low potential for influencing underlying drinking water aquifers. This is consistent with the Minnesota Department of Natural Resources pollution sensitivity map for Carver County, which reports a "Low" pollution sensitivity for near-surface materials at the Site location (DNR, 2014).

2.2 Watertown Site Investigation Activities

2.2.1 Soil Borings

A total of four soil borings were advanced at the Watertown Site surrounding the active compost area. A map showing the boring locations is presented in Figure 7, and boring construction information is provided in Table 1. All four borings were advanced to a minimum depth of twelve feet below the observed water table. Boring B16-7 was advanced to a depth of 19 feet bgs, B16-8 was advanced to a depth of 18 feet bgs, B16-9 was advanced to a depth of 20 feet bgs, and B16-10 was advanced to 19 feet bgs. Field boring logs are provided in Appendix A.

Borings were completed using rotasonic drilling methods in general accordance with American Society for Testing and Materials (ASTM) D6914-04 "Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices" (ASTM, 2010). Soil samples were collected continuously by advancing a four-inch diameter core barrel and extruding the soil from the core into a polyethylene bag. A six-inch diameter casing was advanced as needed to keep the borehole open during drilling, and to accommodate the installation of the wells.

Core runs were either 5-foot or 10-foot interval depending on sample recovery and expected depth of the borehole. Extruded soil samples were placed on the ground for logging and stratigraphic characterization. Samples were logged, classified, and geologically interpreted in the field in general accordance with the procedure outlined in ASTM D2488 "Standard Practice for Description and Identification of Soils" (ASTM, 2009). Soil descriptions included consistency, matrix color, material classification, field moisture, plasticity, and depositional interpretation. Soil textural classifications were assigned according to the United Soil Classification System (USCS). Due to the use of rotasonic drilling methods, standard penetration testing was not performed, and therefore density descriptions do not conform to ASTM D1586. However, pocket penetrometers were used to test core specimens of fine-grained soils. Penetrometer readings were converted to density descriptions using the equivalency values listed in the *Field Guide for Soil and Stratigraphic Analysis, v. 2* (Midwest GeoSciences Group, 2008).

2.2.2 Geology and Soils

The following section describes the geologic conditions encountered during the field investigation and also provides an interpretation of the geology of the Site. The information and discussion presented below are based on observations recorded on soil boring logs completed during the investigation, along with information provided in the Work Plan. Copies of the boring logs are included in Appendix A, and boring construction information is summarized in Table 1.

2.2.2.1 Alluvium

The geology encountered at the Watertown Site consists of unconsolidated fluvial deposits typical of a sandy meandering river (Boggs, 2006). The alluvium is comprised of alternating layers of gravel, sand,

and clay material. It is comprised of thickly bedded, variably textured deposits that classify as a poorly graded gravel with sand (GP), poorly graded sand (SP), fat clay (CH), and lean clay (CL) with lesser amounts of material classifying as poorly graded sand with silt (SP-SM) and sandy silt (ML) under the USCS. The typical sequence of material indicates a massively bedded fining upward characteristic, indicating a change from high flow velocity to low flow velocity which is consistent with floodplain deposits along a meandering river. Episodes of channel shifting and intensity of flooding affect the lateral variation and thickness of the deposits seen in the borings. In borings closer to the river, (B16-8, B16-9, and B16-10), coarser material is more prevalent at shallow depths, indicating that the finer suspended load material has either been removed or reworked by subsequent river channel shifting and flooding events. In general, the boring descriptions match well with fluvial deposition of horizontally stratified sands overlain by laminated mud.

The color of the alluvium varies; however the coarser deposits were typically described as very dark to yellowish brown with finer materials classifying as gray to black. With respect to the Munsell color chart, hue was typically reported at YR for the coarser material and Y for the fine grained material. Due to the proximity of the borings to the river and the shallow nature of the borings, it is assumed that none of the borings were advanced completely through the fluvial deposits.

2.2.3 Monitoring Well Installation and Site Hydrogeology

Four monitoring wells were installed within the soil borings discussed in Section 2.2 and constructed in accordance with MDH well code (i.e. Minnesota Rules, Chapter 4725). Monitoring well MW-WT-1 was installed within boring B16-7, well MW-WT-2 was installed within boring B16-8, well MW-WT-3 was installed within B16-9, and well MW-WT-4 was installed within boring B16-10. Construction data for the new wells are summarized in Table 1 and well locations are shown on Figure 8.

The wells were installed using factory-new, two-inch diameter stainless steel, No. 10 slot (0.01 inch) screens. The screens were connected via couplers to schedule 40 low-carbon steel riser pipe which extended to approximately two-feet above ground surface. A clean, uniform sand filter pack was placed around each well screen and extended approximately two feet above the top of the screen. An approximately 1-foot thick hydrated bentonite seal was placed above the filter pack, followed by Portland cement placed to at or above ground surface. A concrete collar was placed around the well at the ground surface and sloped away from the well to divert surface drainage. Well protection consisted of a 7-foot long, 6-inch diameter, locking, steel protective casing (pro-top) imbedded within the concrete and three bumper posts surrounding the well. The wells were fitted with two waterproof threaded caps; one within the riser pipe and a locking one fitting in the top of the pro-top.

All well installation activities were supervised by a Carlson McCain field geologist. Well construction details were entered onto well construction diagrams, which are included in Appendix A. In addition, MDH well construction records have also been included in Appendix D.

2.2.3.1 Site Hydrogeology

All four monitoring wells were set so that the top of the screen was approximately two feet below the observed water table. With the exception of B16-7, the wells at the Watertown Site have primarily been set within saturated fat clay deposits. However, all monitoring wells screen at least two feet of sandy, coarse-grained material with B16-7 set to screen all sandy, coarse-grained material. Due to the wells screening at least a portion of loose, coarse-grained material, it is expected that groundwater recharge to the wells at the Watertown Site will be good.

Figures 8 and 9 illustrates groundwater elevation contours at the Watertown Site based on water level data collected on January 10^{th}, 2017 and April 17^{th}, 2017, respectively. The contours indicate that groundwater flow beneath the Site is generally to the east-northeast towards the Crow River, which is the local groundwater discharge. Using the contours shown in Figure 8, the horizontal gradient of the water table beneath the Site is approximately 0.005 (unit less: vertical feet/horizontal foot). Calculations for determining the horizontal gradient are provided in Appendix C.

2.3 Well Development

Monitoring wells at both the Arboretum and Watertown Sites were developed by using either a plastic bailer or a 12-volt submersible Hurricane® pump to remove water and sediment, and flush out fines from the filter pack and well screen. Development was conducted on January 10 and January 11, 2017. Development consisted of pumping at least three well annulus volumes of water from each well. During development, field measurements of pH, temperature, conductivity, turbidity, dissolved oxygen (DO), and oxidation-reduction potential (eH) were obtained using a Horiba® U-50 Series water quality meter equipped with a flow-through cell. In addition, color and odor were noted. Well development was considered complete when the following criteria were met:

- Water temperature was stabilized to $\pm$ 0.5 degrees Celsius;
- pH was stabilized to $\pm$ standard units; and,
- Specific conductance was stabilized to $\pm$ 10% µS/cm;

Well development was conducted by Carlson McCain personnel and measurements were recorded on well development forms which are included in Appendix E. All well development criteria were met for each well at the Watertown Site. At the Arboretum Site, the wells were bailed or pumped dry and allowed to recharge three times in an attempt to remove the three well annulus volumes of water from each well. After bailing or pumping dry and allowing recharge, wells MW-AR-1 and MW-AR-3 had approximately 2.5 well annulus volumes removed. For MW-AR-2 and MW-AR-4, well recharge was much slower, and bailing the well dry three times resulted in the removal of approximately nine gallons of water from MW-AR-2 and five gallons from MW-AR-4 which is approximately one well annulus volume removed from each well. Due to time constraints, well development at the Arboretum Site was terminated prior to meeting the aforementioned stabilization criteria. All water removed during well development was disposed of at the surface, away from each well.

Decontamination of the submersible pump used for well development consisted of decontaminating both the interior and exterior of the equipment. The exterior portion of the pump was decontaminated by using deionized (DI) water and paper toweling. The interior was decontaminated using an Alconox® wash, followed by a tap-water rinse, and completed with a rinse using DI water. Disposable tubing was used in conjunction with the pump at each well location. All disposable supplies (i.e. gloves, paper towels, etc.) were disposed of as solid waste.

2.4 Water Level Monitoring Data

Groundwater level measurements were collected using an electronic water level indicator and were measured to the nearest 0.01 foot. These measurements were taken from the top of riser (TOR) for each well. Measurements taken while drilling were made to the nearest 0.1 foot and referenced to the ground surface. A summary of groundwater elevation data is presented in Table 3.

2.5 Surveying

All well locations were surveyed to the nearest 0.01 foot horizontally and vertically using Real-Time Kinematic GPS survey methods. Horizontal coordinates were based on Carver County coordinates and Universal Transverse Mercator (UTM), Zone 15N. Elevations were measured in reference to NAVD88.

3.0 CONCLUSION

The 2016 hydrogeologic investigation and monitoring well installation activities were successfully completed in general accordance with the procedures outlined in the Work Plan.

Four monitoring wells (MW-AR-1, MW-AR-2, MW-AR-3, and MW-AR-4) were installed, developed, and surveyed at the Arboretum Site. These wells will be used as to assess groundwater levels and potential impacts from SSOM composting operations. In addition, two soil borings, B16-5 and B16-6, located on the active compost pad, were advanced to depths of 15 feet bgs at the Arboretum. Six soil samples were collected from these two borings and submitted for grain size analysis and USDA soil classification in accordance with the MPCA site suitability checklist. Results of the geotechnical analyses indicate that five feet of clayey soils occur within the top 15 feet bgs, and overall, the top 15 feet bgs classify as a Silty Clay Loam (with respect to USDA soil classification).

Based on requirements for siting a SSOM composting facility (Minnesota Rules 7035.2836, subp. 8) without a liner, the Site meets the requirement of five feet of clay soils. In regards to the requirement of the water table being greater than five feet from the ground surface: initial groundwater elevation measurements have thus far indicated that depth to water varies from less than five feet to greater than five feet depending on the timing of the measurement and the location of the measurement. This spatial and temporal variability is characteristic of the clayey soils in which the uppermost groundwater is observed. Additional water level measurements could help assess the degree of variability expected at the site over time. Considering there is a nearly 70 foot thickness of glacial till at the site, the potential for migration from the shallow saturated zone to the deeper regional aquifer is very low.

Well development stabilization criteria were not met for wells at the Arboretum Site. It is recommended that prior to sampling these monitoring wells, the wells should be bailed dry and allowed to fully recharge with clean, formation water.

Four monitoring wells (MW-WT-1, MW-WT-2, MW-WT-3, MW-WT-4) were installed, developed, and surveyed at the Watertown Site. These wells will be used as to assess potential impacts from yard waste composting.

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5.0 CERTIFICATION

Carlson McCain has prepared this Hydrogeologic Investigation and Monitoring Well Installation Report for the exclusive use of Carver County, and its agents for specific application to the Watertown Yard Waste Site in Watertown, Minnesota and the Arboretum Site in Chaska, Minnesota. The services performed by Carlson McCain for this project have been conducted in a manner consistent with the level of skill and care ordinarily exercised by other members of the profession currently practicing in this area. No other warranty, expressed or implied, is made.

I certify that this document and all appendices were prepared under my direction or supervision under a system designed to assure that qualified personnel gathered and evaluated the information submitted. Based on my inquiry of the persons or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. Furthermore, I certify that I am knowledgeable in the field of hydrogeology.

Name and Title:	Signature:	Date Signed:
Megan Lindstrom, GIT– Staff Engineer/Geologist	Megan Lindstrom	04/27/17
Nick Bonow, P.E., P.G. – Senior Engineer/Geologist	Nick Bonow	04/27/17
Company Mailing Address:	Carlson McCain, Inc.	
	15650 36th Ave N, Suite 110	
	Plymouth, MN 55446	
Phone:	(952) 346-3859	

Tables

TABLE 1
SOIL BORING AND MONITORING WELL CONSTRUCTION INFORMATION
Carver County Compost Sites

ue er	Location - Carver County Coordinates (feet)		Location - UTM Zone 15E (meters)		TOR Elevation [feet above NAVD88]	GSE Elevation* [feet above NAVD88]	Well Diameter [inches]	Screen Length [feet]	Screen Slot Size	Screen Type	Well Depth[1] [feet BTOR]	Approx. Screen Elevation[2] [feet above NAVD88]
	Northing	Easting	Northing	Easting								
Arboretum Site Well Information												
	180386	542113	16297818	1483784	995.17	992.5	2	10	No. 7	SS	25.45	980-970
	180267	542113	16297700	1483783	994.28	991.5	2	10	No. 7	SS	26.58	978-968
	180219	542198	16297651	1483868	996.7	994.9	2	10	No. 7	SS	26.23	980-970
	180430	542386	16297860	1484058	1005.73	1003.6	2	10	No. 7	SS	26.82	989-979
Watertown Site Well Information												
	219939	480423	16337937	1422496	932.79	930.3	2	10	No. 10	SS	21.58	921-911
	220062	480856	16338056	1422930	930.51	927	2	10	No. 10	SS	20.16	920-910
	219951	480827	16337944	1422899	931.83	932	2	10	No. 10	SS	21.33	920-910
	219853	480788	16337847	1422860	932.34	931	2	10	No. 10	SS	21.60	921-911

f 1988

ed boring locations. Ground
'atertown Site

.on and reflect well depth
/ell. These measurements
ams and well development
›tentially silted in well

g the measured well depth

TABLE 2
GEOTECHNICAL SOIL SAMPLE RESULTS
Carver County Compost Sites

Boring Number	Interval Collected [ft bgs]	Percent Sand	Percent Silt	Percent Clay	USDA Classification
B16-6	1.5-2.5	8.9	48	42	Silty Clay
B16-5	3-5	1.6	56	42	Silty Clay
B16-6	5-7	29.4	42	23	Loam w/ a little gravel
B16-5	8-10	9.5	61	29	Silty Clay Loam
B16-6	10-11	36.6	39	18	Loam w/ a little gravel
B16-5	12-13	21.2	41	20	Silty Loam w/ a little gravel
Average Grain Size Percentages		18	48	29	Silty Clay Loam

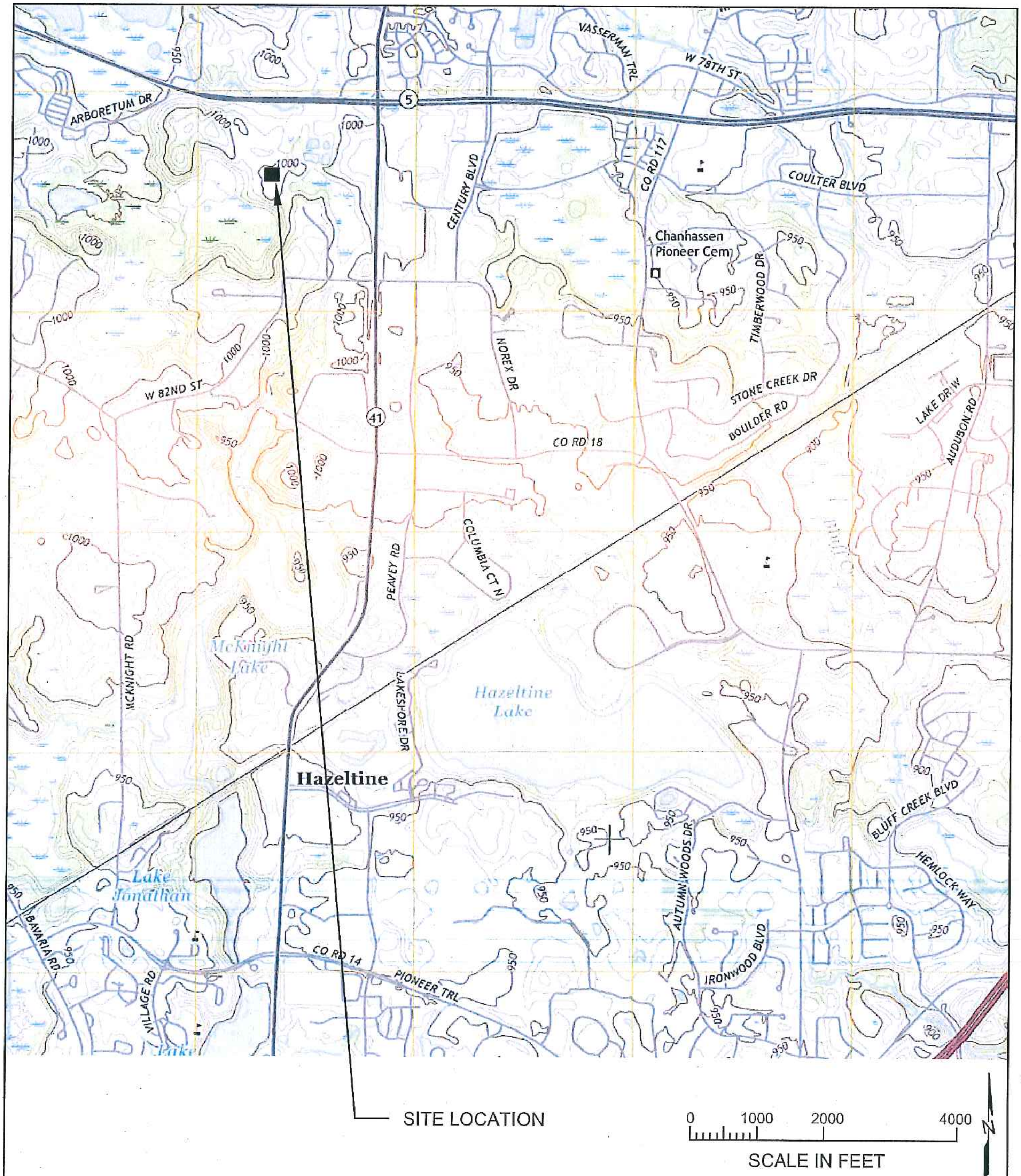
Note: Percentages of sand, silt, and clay are based on ASTM D422. USDA soil classification uses relative percentages of sand, silt, and clay only.

TABLE 3
GROUNDWATER ELEVATIONS
Carver County Compost Sites

Well ID	TOR Elevation (ft NAVD88)	12/28/2016 Water Depth Below TOR (ft)	12/28/2016 Water Elevation (ft NAVD88)	1/10/2017 Water Depth Below TOR (ft)	1/10/2017 Water Elevation (ft NAVD88)	4/17/2017 Water Depth Below TOR (ft)	4/17/2017 Water Elevation (ft NAVD88)
Arboretum Site Water Levels							
MW-AR-1	1005.73	4.60	1001.13	7.56	998.17	5.88	999.85
MW-AR-2	995.17	3.90	991.27	7.48	987.69	3.29	991.88
MW-AR-3	994.28	7.55	986.73	10.67	983.61	5.24	989.04
MW-AR-4	996.7	15.60	981.10	15.41	981.29	18.42	978.28
Watertown Site Water Levels							
MW-WT-1	932.79	8.30	924.49	8.82	923.97	9.59	923.20
MW-WT-2	930.51	7.45	923.06	8.61	921.90	9.34	921.17
MW-WT-3	931.83	8.60	923.23	9.65	922.18	10.55	921.28
MW-WT-4	932.54	9.05	923.49	10.26	922.28	10.9	921.64

NAVD88= North American Vertical Datum of 1988
TOR - Top of riser.

Figures



SOURCE: USGS QUAD (SHAKOPEE, 2016)

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HYDROGEOLOGIC INVESTIGATION AND MONITORING WELL INSTALLATION REPORT
CARVER COUNTY COMPOST SITES
ARBORETUM COMPOST SITE

FIGURE 1
ARBORETUM SITE LOCATION MAP

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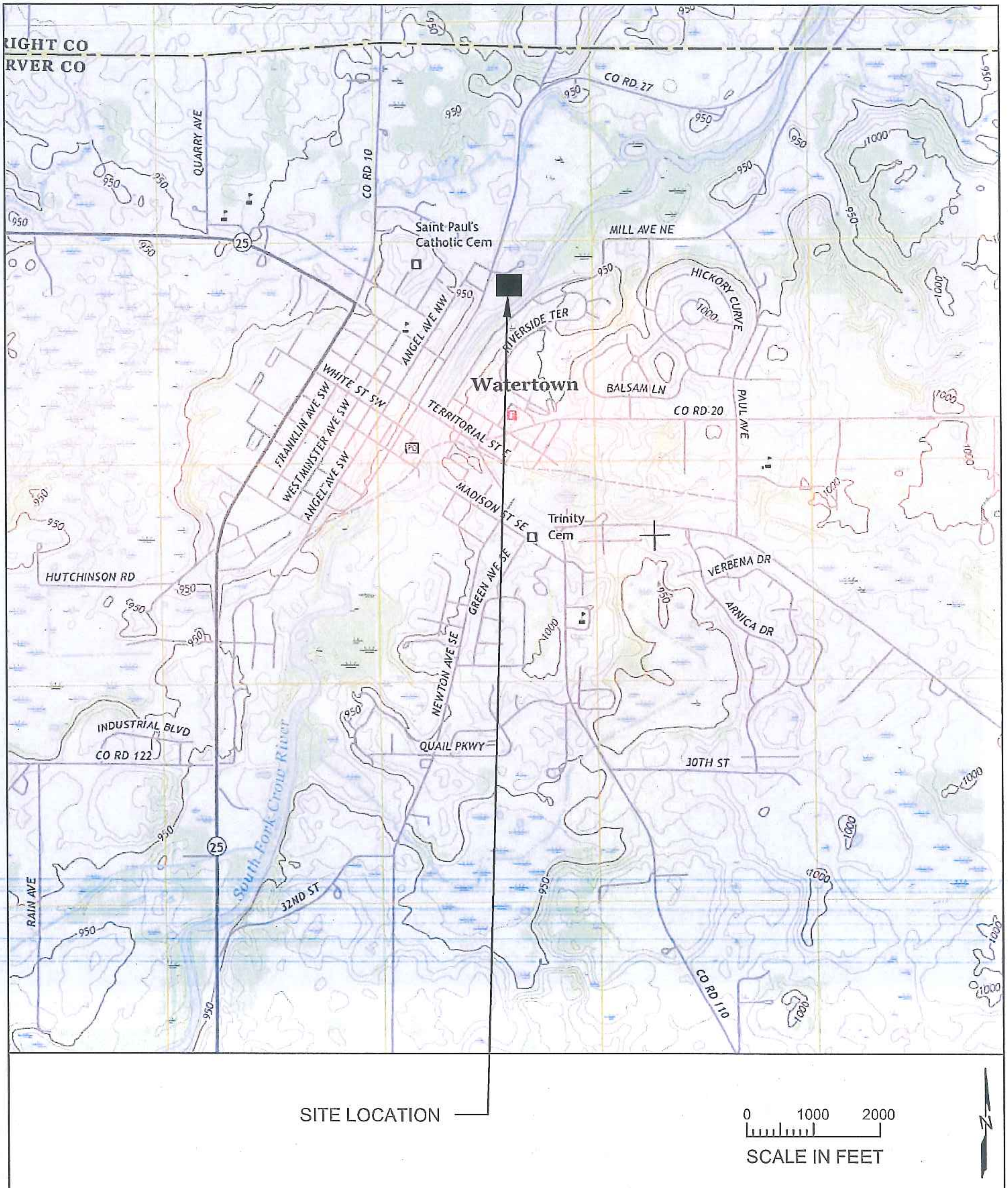

SOURCE: USGS QUAD (WATERTOWN, 2016)

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CARVER COUNTY COMPOST SITES
WATERTOWN COMPOST SITE

FIGURE 2
WATERTOWN SITE LOCATION MAP

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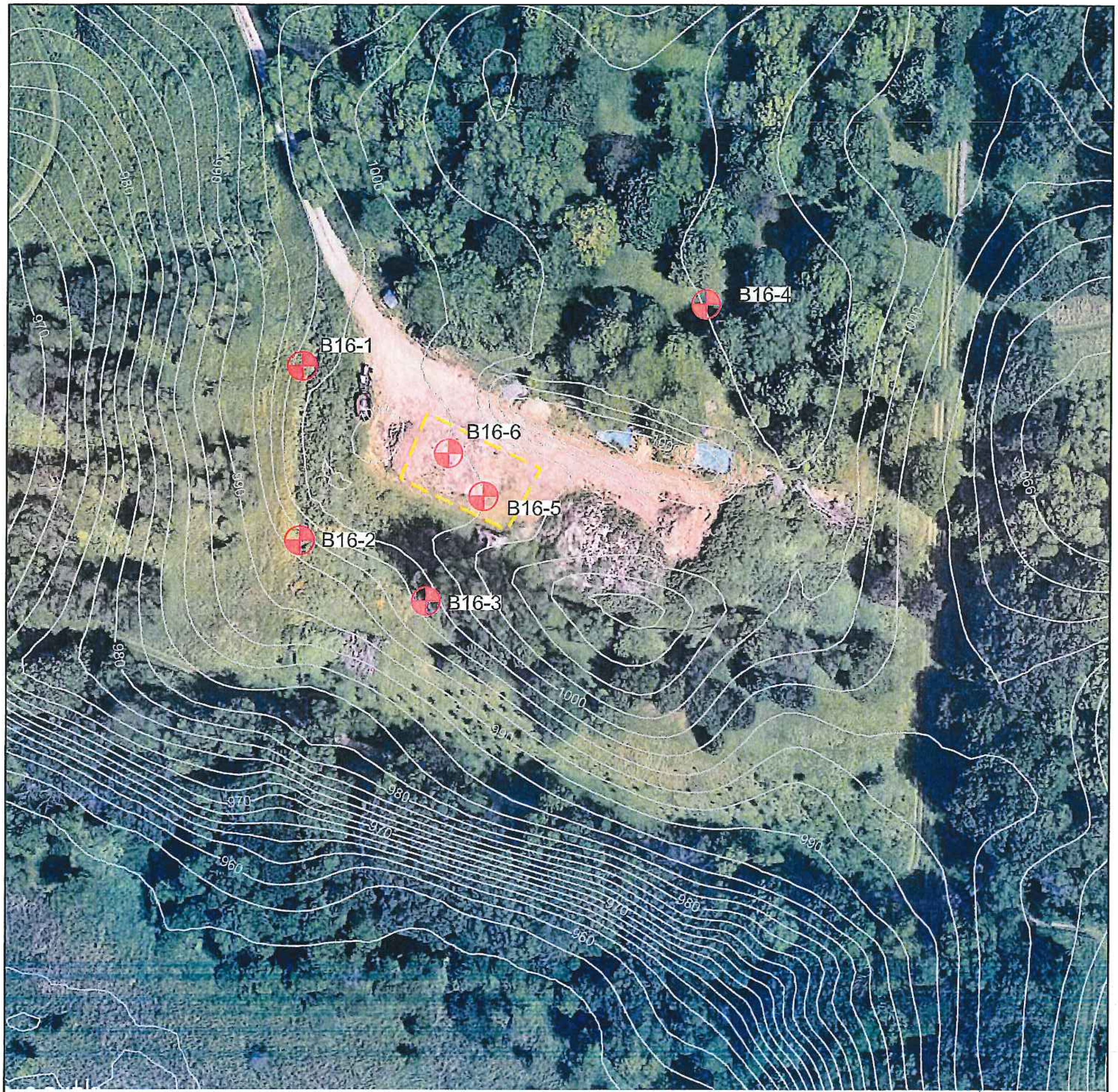

(SOURCE: GOOGLE EARTH)

Boring Location

Active Composting Area
(Approximate Limit)

1000 2012 Topography Contours (LiDAR)

0 100 200
SCALE IN FEET

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CARVER COUNTY COMPOST SITES
ARBORETUM COMPOST SITE

FIGURE 3
ARBORETUM BORING LOCATION MAP

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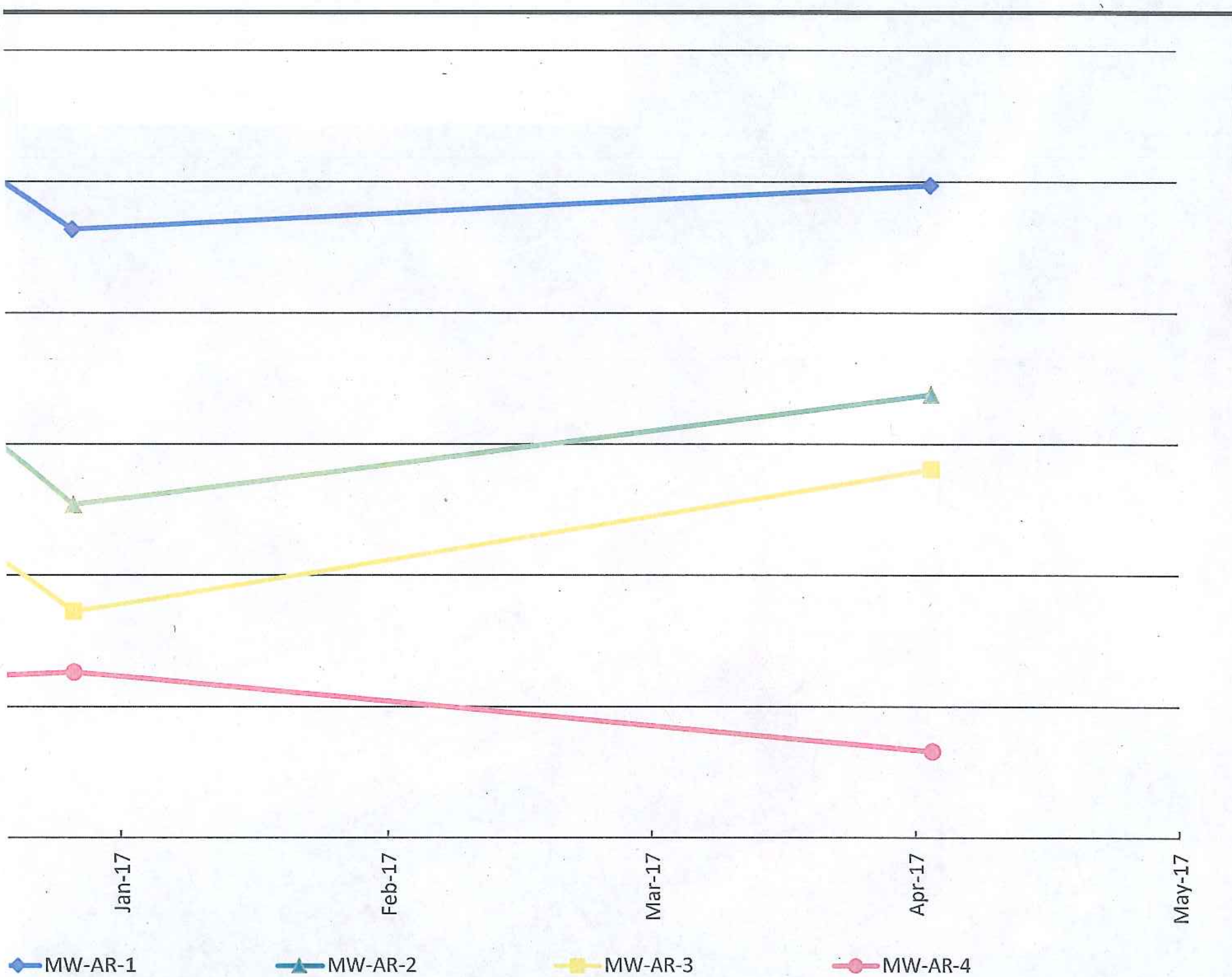

HYDROGEOLOGIC INVESTIGATION AND MONITORING WELL INSTALLATION REPORT
CARVER COUNTY COMPOST SITES
ARBORETUM COMPOST SITE

FIGURE 4
ARBORETUM WATER TABLE HYDROGRAPH

Monitoring Well	X* (ft)	Y* (ft)	Elevation** (ft)	Well Depth (ft BTOR)
MW-1	542,386.5	180,430.2	1,005.73	26.82
MW-2	542,112.5	180,385.8	995.17	25.45
MW-3	542,112.7	180,266.9	994.28	26.58
MW-4	542,197.7	180,219.0	996.70	26.23

*Locations in Carver County Coordinates

**Elevations are to top of riser and referenced to NAVD88

BTOR = Below top of riser pipe

Monitoring Wells and Groundwater Elevations (1/10/2017)

Potentiometric Surface Elevation Contour

0 50 Feet

N

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CARVER COUNTY COMPOST SITES
ARBORETUM COMPOST SITE

FIGURE 5
ARBORETUM GROUNDWATER ELEVATIONS
01/10/2017

Monitoring Well	X* (ft)	Y* (ft)	Elevation** (ft)	Well Depth (ft BTOR)
MW-AR-1	542,386.5	180,430.2	1,005.73	26.82
MW-AR-2	542,112.5	180,385.8	995.17	25.45
MW-AR-3	542,112.7	180,266.9	994.28	26.58
MW-AR-4	542,197.7	180,219.0	996.70	26.23

*Locations in Carver County Coordinates
**Elevations are to top of riser and referenced to NAVD88
BTOR = Below top of riser pipe

Potentiometric Surface Elevation Contour (04/17/2017)

Monitoring Wells and Groundwater Elevations (4/17/2017)

* Monitoring Well Not Included in Contours

0 50
Feet

N

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CARVER COUNTY COMPOST SITES
ARBORETUM COMPOST SITE

FIGURE 6
ARBORETUM GROUNDWATER ELEVATIONS
04/17/2017

Proposed Boring Location

Active Composting Area
(Approximate Limit)

1000 2012 Topography Contours, 2 ft (LiDAR)

(SOURCE: GOOGLE EARTH)

0 100 200
SCALE IN FEET

N

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CARVER COUNTY COMPOST SITES
WATERTOWN COMPOST SITE

FIGURE 7
WATERTOWN BORING LOCATION MAP

Monitoring Well	X* (ft)	Y* (ft)	Elevation** (ft)	Well Depth (ft BTOR)
MW-1	480,423.1	219,939.0	932.79	21.58
MW-2	480,856.0	220,062.5	930.51	20.16
MW-3	480,826.5	219,950.7	931.83	21.33
MW-4	480,788.1	219,853.1	932.54	21.60

*Locations in Carver County Coordinates

**Elevations are to top of riser and referenced to NAVD88

BTOR = Below top of riser pipe

Monitoring Wells and Groundwater Elevations (1/10/2017)

Potentiometric Surface Elevation Contour

0 75
Feet

N

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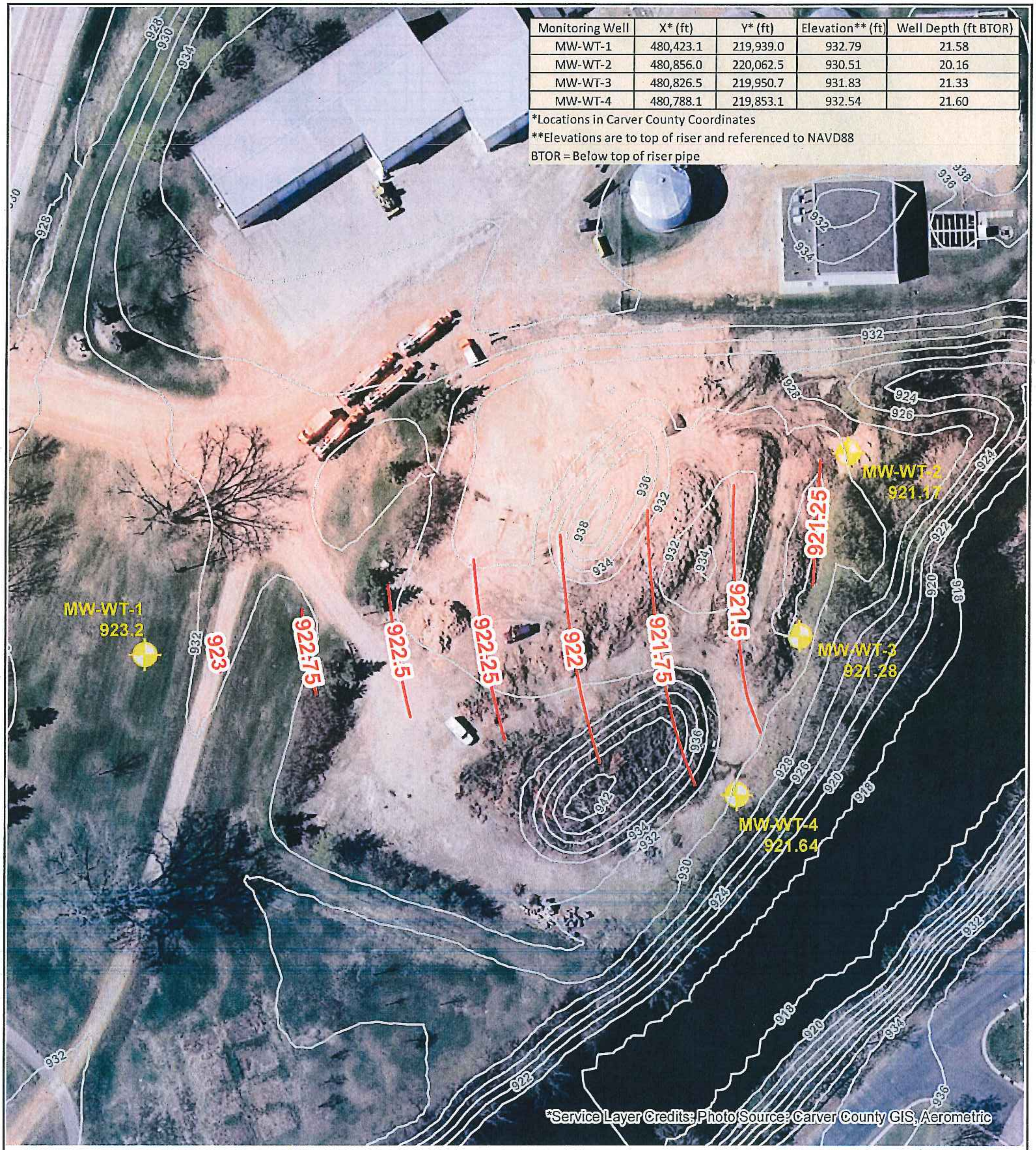
CARVER COUNTY COMPOST SITES
WATERTOWN COMPOST SITE

FIGURE 8
WATERTOWN GROUNDWATER ELEVATIONS (01/10/2017)



Monitoring Well	X* (ft)	Y* (ft)	Elevation** (ft)	Well Depth (ft BTOR)
MW-WT-1	480,423.1	219,939.0	932.79	21.58
MW-WT-2	480,856.0	220,062.5	930.51	20.16
MW-WT-3	480,826.5	219,950.7	931.83	21.33
MW-WT-4	480,788.1	219,853.1	932.54	21.60

*Locations in Carver County Coordinates
**Elevations are to top of riser and referenced to NAVD88
BTOR = Below top of riser pipe

Potentionmetric Surface Elevation Contour (04/17/2017)

Monitoring Wells and Groundwater Elevations (04/17/2017)

0 80
Feet

N

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CARVER COUNTY COMPOST SITES
WATERTOWN COMPOST SITE

FIGURE 9
WATERTOWN GROUNDWATER ELEVATIONS (04/17/2017)

Appendix A
Boring Logs and Monitoring Well Construction Diagrams

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BORING NUMBER 16-1

CLIENT Carver County Environmental Services
PROJECT NAME Carver County Compost Sites
PROJECT NUMBER 6320-00
PROJECT LOCATION Chaska, Minnesota
DATE STARTED 12/9/16 COMPLETED 12/9/16
GROUND ELEVATION 992.5 ft HOLE SIZE 6 inch
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotasonic
AT TIME OF DRILLING ---
LOGGED BY M. Lindstrom CHECKED BY N. Bonow
AT END OF DRILLING ---
NOTES Downgradient of Compost Pad.
▽ 0.75hrs AFTER DRILLING 22.0 ft / Elev 970.5 ft

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0			PP = 1.8 tsf PP = 0.8 tsf	CL		2.0	Dark grayish brown (10YR 4/2) SANDY LEAN CLAY, cohesive, medium plasticity, sand is very fine to fine-grained with trace coarse sand, coarse-grained material is subrounded to angular, trace to few rootlets, moist.
	5	RS 1	70	PP = 2.0 tsf PP = 1.5 tsf PP = 3.0 tsf PP = 1.5 tsf PP = 2.0 tsf PP = 1.5 tsf PP = 1.8 tsf PP = 2.5 tsf				Approximately 1" thick poorly graded sand with silt layer at 2' bgs. Medium to coarse-grained, angular, wet. Yellowish brown (10YR 5/4) SANDY LEAN CLAY, cohesive, medium plasticity, massive, uniform, stiff to hard, sand is fine to medium-grained with few to some coarse sand, coarse-grained material is subrounded to angular, few fine gravel, moist to wet. Gravel is subrounded. Heavily mottled with white and gray observed from 4.5-6' bgs. Sandy silt lense at 9'bgs, approximately 2" thick, very fine to fine-grained.
	10 15	RS 2	100	PP = 1.0 tsf PP = 1.5 tsf PP = 1.3 tsf PP = 0.3 tsf PP = 0.3 tsf PP = 3.3 tsf PP = 2.0 tsf PP = 3.3 tsf PP = 4.0 tsf PP = 4.5 tsf	CL			Wet from 10-16' bgs, soft. Oxidization observed from 15-18' bgs. Oxidization is primarily observed to be surrounding coarse sand and gravel grains.
	20 25	RS 3	41	PP = 3.0 tsf PP = 4.0 tsf PP = 4.0 tsf PP = 4.5 tsf PP = 3.5 tsf			▽ 28.5	Highly oxidized layer at 25' bgs, approximately 3" thick.
	30			PP = 2.0 tsf	CL		30.0	Dark gray (5Y 4/1) SANDY LEAN CLAY, cohesive, medium plasticity, massive, uniform, stiff to very stiff, some silt present, sand is fine to medium-grained with few coarse sand, coarse-grained material is angular to rounded, moist. Some slight oxidization at 29.5' bgs.

Water was used to extrude the sample runs from the core barrel.
Installed monitoring well MW-AR-2 in soil boring.
End of boring at 30.0 feet.

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BORING NUMBER 16-2

CLIENT Carver County Environmental Services	**PROJECT NAME** Carver County Compost Sites
PROJECT NUMBER 6320-00	**PROJECT LOCATION** Chaska, Minnesota
DATE STARTED 12/8/16 **COMPLETED** 12/8/16	**GROUND ELEVATION** 991.5 ft **HOLE SIZE** 6 inch
DRILLING CONTRACTOR Cascade Drilling	**GROUND WATER LEVELS:**
DRILLING METHOD Rotasonic	**AT TIME OF DRILLING** ---
LOGGED BY M. Lindstrom **CHECKED BY** N. Bonow	**AT END OF DRILLING** ---
NOTES Downgradient of Compost Pad.	▽ **10hrs AFTER DRILLING** 7.5 ft / Elev 984.0 ft

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
	0–2.0	RS 1	52	PP = 0.8 tsf	CL		Very dark grayish brown (10YR 3/2) SANDY LEAN CLAY, cohesive, medium to high plasticity, sand is very fine to fine-grained and angular, some roots, soft, moist.
	2.0–10			PP = 1.5 tsf PP = 1.8 tsf PP = 2.5 tsf PP = 1.0 tsf PP = 2.0 tsf PP = 2.3 tsf PP = 2.0 tsf PP = 2.0 tsf PP = 2.5 tsf	CL		2.0 Light yellowish brown (10YR 6/4) SANDY LEAN CLAY, cohesive, medium plasticity, massive, uniform, sand is very fine to fine-grained with some coarse sand and subangular, trace to few fine gravel, trace coarse gravel, few to some rootlets in the upper 3', slight 1M HCL reaction, moist. Coarse gravel is subrounded to rounded. ▽ (7.5 ft)
	10–20	RS 2	90	PP = 0.3 tsf PP = 0.3 tsf PP = 2.5 tsf PP = 3.0 tsf PP = 0.3 tsf PP = 3.3 tsf PP = 3.0 tsf PP = 3.3 tsf PP = 3.5 tsf PP = 4.0 tsf			For attempt #2, low pentrometer readings may be due to use of water to remove sample from core barrel. Thin oxidized layer at 19' bgs, approximately 0.1 inches thick. Thin oxidized layer at 19.5' bgs, approximately 0.1 inches thick.
	20–30	RS 3	70	PP = 4.0 tsf PP = 3.5 tsf PP = 3.5 tsf PP = 4.0 tsf PP = 4.0 tsf PP = 3.5 tsf PP = 4.0 tsf PP = 3.5 tsf PP = 3.5 tsf PP = 4.0 tsf			Mottled with white and gray observed from 24-25.5' bgs. Becomes siltier with very fine to medium-grained sand from 25-28' bgs. Sand is subangular to rounded. Poorly graded sand layer at 26' bgs, approximately 4" thick.

(Continued Next Page)

Carlson McCain

CLIENT Carver County Environmental Services **PROJECT NAME** Carver County Compost Sites
PROJECT NUMBER 6320-00 **PROJECT LOCATION** Chaska, Minnesota

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	30–36.0	RS 4	95	PP = 2.3 tsf PP = 2.3 tsf PP = 2.5 tsf PP = 2.5 tsf PP = 2.3 tsf PP = 2.0 tsf	CL		36.0	Light yellowish brown (10YR 6/4) SANDY LEAN CLAY, cohesive, medium plasticity, massive, uniform, sand is very fine to fine-grained with some coarse sand and subangular, trace to few fine gravel, trace coarse gravel, few to some rootlets in the upper 3', slight 1M HCL reaction, moist. Coarse gravel is subrounded to rounded. *(continued)*
	36.0–40			PP = 3.3 tsf PP = 3.3 tsf PP = 3.3 tsf PP = 3.5 tsf	CL		40.0	Dark gray (5Y 4/1) SANDY LEAN CLAY, cohesive, low to medium plasticity, massive, uniform, sand is very fine to coarse-grained with trace coarse sand, sand is angular to rounded, trace to few fine gravel (approximately 0.25" diameter), very stiff, moist.

Borehole was left open overnight to attempt to obtain a waterlevel.
Borehole collapsed to 25' with casing in the ground to 20' bgs.
Water was used to extrude sample runs from the core barrel.
Installed monitoring well MW-AR-3 in soil boring.
End of boring at 40.0 feet.

BORING NUMBER 16-3

Carlson McCain

CLIENT: Carver County Environmental Services
PROJECT NAME: Carver County Compost Sites
PROJECT NUMBER: 6320-00
PROJECT LOCATION: Chaska, Minnesota
DATE STARTED: 12/7/16   COMPLETED: 12/8/16
GROUND ELEVATION: 994.9 ft   HOLE SIZE: 6 inch
DRILLING CONTRACTOR: Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD: Rotasonic
AT TIME OF DRILLING: ---
LOGGED BY: M. Lindstrom   CHECKED BY: N. Bonow
AT END OF DRILLING: ---
NOTES: Downgradient of Compost Pad.
AFTER DRILLING: ---

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
	0						
	0–5	RS 1	84	PP = 2.3 tsf PP = 1.8 tsf PP = 1.0 tsf PP = 3.5 tsf PP = 2.0 tsf	CL CL		Very dark grayish brown (10YR 3/2) SANDY LEAN CLAY, cohesive, medium to high plasticity, sand is very fine-grained and angular, much roots throughout, soft, moist. 1.0 Light yellowish brown (10YR 6/4) SANDY LEAN CLAY, cohesive, medium plasticity, massive, uniform, sand is fine to very fine-grained and subangular, few coarse sand and fine gravel, few roots in upper 2', some oxidation throughout, slight 1M HCL reaction, very stiff to hard, moist. Gravel is approximately 0.25-0.5" diameter granitic in origin, and angular.
	5–10	RS 2	76	PP = 4.0 tsf PP = 3.3 tsf PP = 3.8 tsf PP = 3.0 tsf PP = 3.5 tsf			
	10–15	RS 3	90	PP = 3.3 tsf PP = 3.0 tsf PP = 2.8 tsf PP = 1.0 tsf PP = 2.3 tsf			Trace roots throughout between 10-15' bgs. Stopped drilling on 12/7/16 at 10' bgs due to drill rig mechanical issues. Resumed drilling on 12/8/16. Attempted to collect a water level at 15' bgs on 12/8/16, borehole was dry. Becomes siltier at approximately 12' bgs. Mottled with gray and white and heavy oxidation observed between 14.54-15' bgs.
	15–20	RS 4	100	PP = 4.0 tsf PP = 3.3 tsf PP = 3.5 tsf PP = 4.5 tsf PP = 3.3 tsf			Cobble at 16.5' bgs. Few to some, medium to coarse-grained angular sand at approximately 17' bgs.
	20–25	RS 5	100	PP = 3.5 tsf PP = 4.0 tsf PP = 3.3 tsf PP = 4.0 tsf PP = 3.3 tsf			Attempted water level after sampling to 20'. Water level probe tip slightly muddy. Oxidization observed between 22-24' bgs. Cobble at 23' bgs.
	25–30	RS 6	100	PP = 3.3 tsf PP = 3.3 tsf PP = 3.0 tsf PP = 4.0 tsf PP = 4.5 tsf	SC		27.0 Brown (10YR 5/3) CLAYEY SAND WITH GRAVEL, cohesive, low plasticity, sand is very fine to medium-grained with few coarse sand and fine gravel, coarse-grained material is rounded to subangular, massive, uniform, hard, moist.
	30						

(Continued Next Page)

Carlson McCain

BORING NUMBER 16-3

CLIENT Carver County Environmental Services
PROJECT NAME Carver County Compost Sites
PROJECT NUMBER 6320-00
PROJECT LOCATION Chaska, Minnesota

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	30	RS 7	100	PP = 3.3 tsf PP = 1.8 tsf PP = 3.3 tsf PP = 40.0 tsf PP = 3.5 tsf	SC			Cobble, approximately 3" diameter, at 29.75' bgs. Brown (10YR 5/3) CLAYEY SAND WITH GRAVEL, cohesive, low plasticity, sand is very fine to medium-grained with few coarse sand and fine gravel, coarse-grained material is rounded to subangular, massive, uniform, hard, moist. *(continued)*
							33.0	~~Attempted water level after sampling to 30', borehole was dry.~~
	35				CL			Dark gray (5Y 4/1) SANDY LEAN CLAY, cohesive, medium plasticity, very uniform, massive, some silt, sand is very fine to coarse-grained with trace to few fine gravel and trace coarse gravel, coarse-grained material is angular to rounded, very stiff, moist. Cobble at 34' bgs.
		RS 8	100	PP = 3.3 tsf PP = 3.3 tsf PP = 3.8 tsf PP = 3.8 tsf PP = 3.5 tsf				Poorly graded sand layer at 38' bgs, approximately 0.5" thick. Oxidized.
	40	RS 9	100	PP = 2.5 tsf PP = 3.3 tsf PP = 3.0 tsf PP = 2.5 tsf PP = 3.0 tsf				Poorly graded sand layer at 42' bgs, approximately 0.3' thick, oxidized, wet. Gravel amount increases below 42', and silt content decreases to a sandy lean clay with gravel, no "gritty" feel.
	45	RS 10	100	PP = 3.3 tsf PP = 4.0 tsf PP = 3.3 tsf PP = 4.5 tsf PP = 4.5 tsf	CL			Soil becomes siltier with very fine sand at 48' bgs.
	50	RS 11	98	PP = 3.5 tsf PP = 4.5 tsf PP = 3.3 tsf PP = 3.5 tsf PP = 4.0 tsf				Began using water to advance casing at 50' bgs.
	55	RS 12	90	PP = 4.5 tsf PP = 4.5 tsf PP = 4.0 tsf PP = 4.5 tsf PP = 4.5 tsf				Cobble at 56.5' bgs, approximately 2" diameter, does not react with 1M HCL, subangular, chert.
	60	RS 13	100	PP = 4.5 tsf PP = 4.5 tsf PP = 4.0 tsf PP = 2.0 tsf PP = 2.5 tsf				Chert cobble at 62', approximately 3" diameter, rounded.
					ML		63.5	

(Continued Next Page)

CLIENT Carver County Environmental Services | **PROJECT NAME** Carver County Compost Sites

PROJECT NUMBER 6320-00 | **PROJECT LOCATION** Chaska, Minnesota

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	65	RS 14	100	PP = 3.5 tsf PP = 3.0 tsf PP = 3.5 tsf PP = 2.5 tsf	ML		69.0	Soil becomes SANDY SILT, cohesive, non-plastic, sand is very fine to fine-grained and subangular, trace coarse sand and fine gravel, moist. Gravel is rounded. *(continued)* Cobble at 66.5' bgs, approximately 3" diameter, rounded. Large cobble/boulder at 69' bgs. Granitic in origin, quartz and biotite grains are visible.
	70				SP-SM		70.0	Yellowish brown (10YR 5/4) POORLY GRADED SAND WITH SILT, very fine-grained with trace medium-grained sand, angular to subrounded, trace fine gravel, moist. Oxidization observed in bottom of sample bag at 70'.

Abandoned original borehole with 7 bags of portland cement (100 lbs. bags). Moved eight feet south of original borehole and drilled B16-3R to 30' bgs. Installed monitoring well MW-AR-4 in borehole B16-3R.

End of boring at 70.0 feet.

Carlson McCain

BORING NUMBER 16-4

CLIENT Carver County Environmental Services

PROJECT NAME Carver County Compost Sites

PROJECT NUMBER 6320-00

PROJECT LOCATION Chaska, Minnesota

DATE STARTED 12/10/16 **COMPLETED** 12/10/16

GROUND ELEVATION 1003.6 ft **HOLE SIZE** 6 inch

DRILLING CONTRACTOR Cascade Drilling

GROUND WATER LEVELS:

DRILLING METHOD Rotasonic

AT TIME OF DRILLING ---

LOGGED BY M. Lindstrom **CHECKED BY** N. Bonow

AT END OF DRILLING ---

NOTES Upgradient of Compost Pad.

AFTER DRILLING ---

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0				SC		1.5	Very dark gray (7.5YR 3/1) CLAYEY SAND, cohesive, low plasticity, sand is very fine to fine-grained and angular to subrounded, some roots throughout, moist. Upper 4" are frozen.
		RS 1	40	PP = 2.0 tsf PP = 0.8 tsf PP = 0.3 tsf	CL			Brown (10YR 5/3) SANDY LEAN CLAY, cohesive, medium to high plasticity, massive, uniform, sand is very fine to medium-grained with some coarse sand and subangular to subrounded, trace to few fine gravel, trace coarse gravel, very soft to very stiff, moist. Coarse gravel is approximately 1-2" diameter. Mottled with white and gray observed from 4-5' bgs.
	5	RS 2	76	PP = 0.3 tsf PP = 1.5 tsf PP = 0.3 tsf PP = 1.5 tsf PP = 1.5 tsf				Chert cobble at 5' bgs, subangular, approximately 3" diameter. Very dark gray (7.5YR 3/1) clayey sand layer from 5.3-6' bgs, cohesive, medium to high plasticity, wet. Poorly graded sand layer from 7-7.5' bgs, medium to coarse-grained, subangular to rounded, wet. Strong brown (7.5 YR 5/6) lean clay with silty sand from 8-10' bgs. Sand is very fine to coarse-grained, angular, wet. Heavily mottled with white and gray observed.
	10	RS 3	100	PP = 0.3 tsf PP = 0.8 tsf PP = 1.5 tsf PP = 2.0 tsf PP = 0.3 tsf PP = 2.5 tsf PP = 3.0 tsf PP = 3.5 tsf PP = 3.3 tsf PP = 3.5 tsf	CL			Mottled with white and gray, and oxidization observed from 15.5-17' bgs. From 17-20' bgs: soil is not overall wet, but moisture is visible on gravel and coarse sand grains.
	15							
	20	RS 4	100	PP = 4.0 tsf PP = 4.5 tsf PP = 4.0 tsf PP = 4.0 tsf PP = 4.0 tsf PP = 4.5 tsf PP = 3.5 tsf PP = 3.5 tsf PP = 3.5 tsf PP = 3.5 tsf	CL		20.0	Dark gray (5Y 4/1) SANDY LEAN CLAY, cohesive, low to medium plasticity, massive, uniform, sand is very fine to fine-grained with trace coarse sand, fine gravel and coarse gravel, sand is angular, very stiff to hard, moist. Gravel is rounded, less than 2" diameter, and granitic in origin. Steam was observed rising from the sample collected in attempt #4. Soil is more silty from 22-23.5' bgs. Oxidized layer observed at 26' bgs, approximatly 0.1 inches thick. Chert cobble observed at 28' bgs, approximately 4" diameter.
	25							
	30						30.0	

(Continued Next Page)

Carlson McCain

CLIENT Carver County Environmental Services

PROJECT NUMBER 6320-00

PROJECT NAME Carver County Compost Sites

PROJECT LOCATION Chaska, Minnesota

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
							Water was used to extrude sample from the core barrel. Installed monitoring well MW-AR-1 in soil boring. End of boring at 30.0 feet.

BORING NUMBER 16-5

Carlson McCain

CLIENT Carver County Environmental Services		**PROJECT NAME** Carver County Compost Sites	
PROJECT NUMBER 6320-00		**PROJECT LOCATION** Chaska, Minnesota	
DATE STARTED 12/10/16	**COMPLETED** 12/10/16	**GROUND ELEVATION** 999.4 ft	**HOLE SIZE** 6 inch
DRILLING CONTRACTOR Cascade Drilling		**GROUND WATER LEVELS:**	
DRILLING METHOD Rotasonic		**AT TIME OF DRILLING** ---	
LOGGED BY M. Lindstrom	**CHECKED BY** N. Bonow	**AT END OF DRILLING** ---	
NOTES Within Compost Pad Footprint.		**AFTER DRILLING** ---	

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0	RS 1	100	PP = 3.5 tsf PP = 3.0 tsf	SW-SM		1.5	Yellowish red (5YR 5/6) WELL GRADED SAND WITH SILT AND GRAVEL, very fine to coarse-grained, angular to subrounded, trace compost mixed in, trace roots, moist. Gravel is less than 1" diameter and round.
				PP = 3.0 tsf	CL		3.0	Dark gray (7.5YR 4/1) LEAN CLAY with trace sand, cohesive, high plasticity, heavily mottled with dark gray, oxidized, sand is fine to medium-grained and rounded to angular, trace roots, compost/organic soil layering, very stiff, moist.
	5			PP = 3.5 tsf	CL		5.0	Transitional mixed mottled zone of dark gray (7.5YR 4/1) LEAN CLAY and brown (10YR 5/3) SANDY LEAN CLAY, heavily mottled with white and gray, oxidized, laminated, sand is very fine to medium-grained and angular to rounded, trace roots, very stiff, moist.
	10	RS 2	90	PP = 3.5 tsf PP = 3.5 tsf PP = 3.5 tsf PP = 3.0 tsf PP = 2.5 tsf	CL			Brown (10YR 5/3) SANDY LEAN CLAY, cohesive, medium plasticity, sand is very fine to medium-grained with some silt, few coarse sand, trace fine gravel, coarse material is subangular to subrounded, stiff to very stiff, moist. Heavily mottled with white, red, and gray, and oxidization observed from 5-11' bgs.
	15	RS 3	90	PP = 3.0 tsf PP = 3.5 tsf PP = 1.5 tsf PP = 2.5 tsf PP = 2.0 tsf			15.0	Trace oxidization from 11-15' bgs. Cobble at 12.5' bgs, approximately 2.5" diameter, angular, rusty/oxidized. Sand lense observed at 13' bgs, fine to medium-grained, oxidized, less than 0.25" thick. Black, pulverized rock observed at 14.75'.

Abandoned borehole with approximately 1.75 bags of portland cement (100 lbs. bags).

End of boring at 15.0 feet.

Carlson McCain

BORING NUMBER 16-6

CLIENT	Carver County Environmental Services	PROJECT NAME	Carver County Compost Sites
PROJECT NUMBER	6320-00	PROJECT LOCATION	Chaska, Minnesota
DATE STARTED	12/10/16 COMPLETED 12/10/16	GROUND ELEVATION	998.3 ft HOLE SIZE 6 inch
DRILLING CONTRACTOR	Cascade Drilling	GROUND WATER LEVELS:	
DRILLING METHOD	Rotasonic	AT TIME OF DRILLING	---
LOGGED BY	M. Lindstrom CHECKED BY N. Bonow	AT END OF DRILLING	---
NOTES	Within Compost Pad Footprint.	AFTER DRILLING	---

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0				SW-SM		1.5	Yellowish red (5YR 5/6) WELL GRADED SAND WITH SILT AND GRAVEL, very fine to coarse-grained, angular to subrounded, trace compost/organic material, trace roots, moist. Gravel is less than 1" diameter and rounded.
		RS 1	100	PP = 4.0 tsf PP = 4.5 tsf	CL		2.5	Dark gray (7.5YR 4/1) LEAN CLAY, cohesive, high plasticity, heavily mottled with with and gray, heavily oxidized, trace sand, sand is fine to medium-grained and rounded to angular, layers of compost mixed in, trace roots, hard, moist.
				PP = 3.0 tsf PP = 2.5 tsf	CL		4.0	Transitional, mixed, mottled zone of dark gray (7.5YR 4/1) LEAN CLAY and brown (10YR 5/3) SANDY LEAN CLAY, cohesive, medium plasticity, heavily mottled with white and gray, oxidized, laminated, sand is very fine to medium-grained, trace roots, very stiff, moist.
	5	RS 2	100	PP = 1.7 tsf PP = 2.0 tsf PP = 1.8 tsf PP = 2.0 tsf PP = 3.0 tsf	CL			Brown (10YR 5/3) SANDY LEAN CLAY, very fine to medium-grain with some silt, few coarse sand, trace fine gravel, subangular to subrounded, cohesive, medium plasticity, trace roots, stiff to hard, uniform, massive, moist. Heavy mottling and oxidization observed from 4-7' bgs. Heavy mottling and oxidization layer observed at 7' bgs, approximately 0.25' thick.
	10	RS 3	100	PP = 4.0 tsf PP = 4.0 tsf PP = 4.0 tsf PP = 4.5 tsf PP = 4.5 tsf				Sample from attempt #3 came out very straight from core barrel. Oxidized layer at 12' bgs, approximately 0.1" thick.
	15						15.0	Abandoned borehole with 1.75 bags of portland cement (100 lbs. bags). End of boring at 15.0 feet.

BORING NUMBER 16-7

Carlson McCain

CLIENT Carver County Environmental Services
PROJECT NAME Carver County Compost Sites
PROJECT NUMBER 6320-00
PROJECT LOCATION Watertown, Minnesota
DATE STARTED 12/6/16 **COMPLETED** 12/6/16
GROUND ELEVATION 930.3 ft **HOLE SIZE** 6 inch
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotasonic
∇ **AT TIME OF DRILLING** 7.0 ft / Elev 923.3 ft
LOGGED BY M. Lindstrom **CHECKED BY** N. Bonow
AT END OF DRILLING ---
NOTES Upgradient of Compost Pad.
AFTER DRILLING ---

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0	RS 1	90	PP = 0.5 tsf	SM		2.0	Dark grayish brown (10YR 4/2) SILTY SAND, fine-grained, subangular, cohesive, non-plastic, much roots throughout, soft, moist.
	5			PP = 2.5 tsf PP = 0.3 tsf PP = 1.5 tsf PP = 1.5 tsf	CL		∇ 7.0	Mixture of very dark gray (10YR 3/1) and yellowish brown (10YR 5/4) SANDY LEAN CLAY, cohesive, low to medium plasticity, some slight mottling with gray, sand is very fine to fine-grained with trace coarse sand and fine gravel, sand is angular to rounded, few rootlets, stiff to very stiff, moist. Fine gravel layer at 3' bgs, approximately 0.1' thick. At 5' bgs: Color becomes all yellowish brown (10YR 5/4). Poor recovery in attempt #2 may be due to sampler pushing away sand.
		RS 2	60	PP = 1.0 tsf PP = 1.3 tsf PP = 1.0 tsf PP = 1.5 tsf	CH		9.0	Black (5Y 2.5/2) FAT CLAY WITH SAND, cohesive, high plasticity, sand is very fine-grained and subangular, stiff, wet.
	10	RS 3	96		SP		13.0	Dark grayish brown (10YR 4/2) POORLY GRADED SAND, very fine to fine-grained, subrounded,massive, uniform, loose, wet. At 12.5' bgs: Sand grain size becomes medium to coarse-grained, angular.
	15				SP		15.0	Gray (5Y 5/1) POORLY GRADED SAND WITH GRAVEL, medium to coarse-grained, subangular to angular, losse, massive, wet. Gravel is approximately 0.5" diameter. Cobble at 14.5'.
		RS 4	100		SP		19.0	Gray (5Y 5/1) POORLY GRADED SAND, very fine to fine-grained with trace fine gravel, subrounded to rounded, loose, massive, wet. Gravel is approximately 0.5" diameter. Coarse sand layer at 17' bgs, approximately 0.3' thick.

Installed monitoring well MW-WT-1 in soil boring.
End of boring at 19.0 feet.

BORING NUMBER 16-8

Carlson McCain

CLIENT Carver County Environmental Services
PROJECT NAME Carver County Compost Sites
PROJECT NUMBER 6320-00
PROJECT LOCATION Watertown, Minnesota
DATE STARTED 12/5/16 COMPLETED 12/5/16
GROUND ELEVATION 927 ft HOLE SIZE 6 inch
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotasonic
AT TIME OF DRILLING 6.1 ft / Elev 920.9 ft
LOGGED BY M. Lindstrom CHECKED BY N. Bonow
AT END OF DRILLING ---
NOTES Downgradient of Compost Pad.
16hrs AFTER DRILLING 4.6 ft / Elev 922.4 ft

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0	RS 1	60	PP = 2.5 tsf	CL		2.0	Yellowish brown (10YR 5/4) LEAN CLAY, cohesive, high plasticity, oxidized, trace medium-grained sand, sand is subangular, much roots and rootlets throughout, stiff to very stiff, moist.
	5			PP = 2.0 tsf PP = 2.0 tsf PP = 2.5 tsf PP = 1.5 tsf	SP-SM		5.5	Black (10YR 2/1) POORLY GRADED SAND WITH SILT, very fine to medium-grained with trace angular coarse sand, subrounded to rounded, somewhat cohesive, earthy odor, massive, trace leaf fragments, moist. Wet at 5' bgs.
	10	RS 2	100		SP		11.0	Light brownish gray (2.5Y 6/2) POORLY GRADED SAND, medium-grained with some coarse sand, angular, massive, loose, wet. Slight oxidization at 6' bgs. Coarse sand layer at 8' bgs, rounded to subrounded, shell fragments present, approximately 0.1' thick. Dark gray (10YR 4/1) FAT CLAY layer at approximately 8.1' bgs, 0.3' thick, contains shell fragments, very fine-grained, soft. At 9': 0.2' thick shell layer, much roots present. From 9.2-9.5': Dark gray (10YR 4/1) POORLY GRADED SAND , very fine-grained, varved, reacts moderatly with 1M HCL.
	15	RS 3	100	PP = 3.3 tsf PP = 2.0 tsf PP = 3.3 tsf PP = 4.5 tsf	CH			Very dark gray (2.5Y 3/1) FAT CLAY WITH SAND, cohesive, medium to high plasticity, laminated, sand is fine to medium-grained with trace coarse sand, coarse-grained material is rounded, stiff to hard, wet.
		RS 4	100	PP = 3.5 tsf PP = 4.0 tsf PP = 3.5 tsf			18.0	Good recovery in attempt #4 may be due to sand slough at top of sample bag and stretching of clay as it's removed from the core barrel.

During drilling, driller reported heaving sands.
After drilling completion, water level rose to top of casing.
Installed monitoring well MW-WT-2 in borehole.
End of boring at 18.0 feet.

BORING NUMBER 16-9

Carlson McCain

CLIENT Carver County Environmental Services

PROJECT NAME Carver County Compost Sites

PROJECT NUMBER 6320-00

PROJECT LOCATION Watertown, Minnesota

DATE STARTED 12/6/16 COMPLETED 12/6/16

GROUND ELEVATION 932 ft HOLE SIZE 6 inch

DRILLING CONTRACTOR Cascade Drilling

GROUND WATER LEVELS:

DRILLING METHOD Rotasonic

AT TIME OF DRILLING 7.3 ft / Elev 924.7 ft

LOGGED BY M. Lindstrom CHECKED BY N. Bonow

AT END OF DRILLING ---

NOTES Downgradient of Compost Pad.

AFTER DRILLING ---

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0				SM		0.5	Very dark grayish brown (10YR 3/2) SILTY SAND, very fine to medium-grained with trace coarse sand, subangular, non-cohesive, massive, moist. Coarse sand is subrounded.
		RS 1	70		ML		4.0	Light yellowish brown (10YR 6/4) SANDY SILT, very fine to fine-grained with few medium to coarse-grained sand, non-cohesive, massive, mottled, trace gravel, hard, moist. Gravel is approximately 0.25" diameter.
	5	RS 2	40	PP = 0.5 tsf	SP-SM		9.5	Very dark gray (10YR 3/1) POORLY GRADED SAND WITH SILT, fine to very fine-grained, angular, non-cohesive, trace very small shells, some clay, few roots, moist to wet. Wet at 8' bgs. Some slough at the top of attempt #2 due to hole collapse. Oxidized FAT CLAY layer observed from approximately 9.2-9.5' bgs, cohesive, soft.
	10				SP		11.0	Grayish brown (10YR 5/2) POORLY GRADED SAND, medium to coarse-grained with some silt, rounded to subrounded, massive, loose, trace shells, wet. Unit becomes more silty with depth.
		RS 3	96	PP = 3.0 tsf	GP		13.0	Gray (5Y 5/1) POORLY GRADED GRAVEL WITH SAND, very coarse-grained sand with fine gravel, subangular to rounded, massive, loose, slight reaction with 1M HCL, wet. Gravel is approximately 0.25-0.5" diameter. Oxidization at 11.5' bgs. Color change to gray (5Y 5/1) observed at 12.5' bgs.
	15			PP = 4.0 tsf	CH			Gray (5Y 5/1) FAT CLAY, cohesive, high plasticity, laminated, trace to some medium to coarse-grained sand, trace fine gravel, coarse-grained material is subrounded, very stiff to hard, wet.
		RS 4	100	PP = 4.5 tsf PP = 4.0 tsf PP = 4.5 tsf PP = 4.5 tsf PP = 4.0 tsf				
	20						20.0	

Installed monitoring well MW-WT-3 in soil boring.
End of boring at 20.0 feet.

Carlson McCain

BORING NUMBER 16-10

CLIENT Carver County Environmental Services
PROJECT NAME Carver County Compost Sites
PROJECT NUMBER 6320-00
PROJECT LOCATION Watertown, Minnesota
DATE STARTED 12/6/16 **COMPLETED** 12/6/16
GROUND ELEVATION 931 ft **HOLE SIZE** 6 inch
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotasonic
∇ **AT TIME OF DRILLING** 7.2 ft / Elev 923.8 ft
LOGGED BY M. Lindstrom **CHECKED BY** N. Bonow
AT END OF DRILLING ---
NOTES Downgradient of Compost Pad.
AFTER DRILLING ---

FORMATION	DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
	0	RS 1	64	PP = 3.5 tsf PP = 3.5 tsf PP = 2.5 tsf PP = 4.0 tsf	ML		2.5	Dark grayish brown (10YR 4/2) SILT WITH SAND, cohesive, non-plastic, sand is medium-grained with few coarse-grained sand and some fine gravel, coarse-grained material is subangular, few roots, very stiff, moist. Gravel is approximately 1" diameter.
					SM		4.0	Very dark gray (10YR 3/10) SILTY SAND, fine-grained with few medium to coarse-grained sand, cohesive, massive, slightly mottled with gray, trace fine gravel, coarse-grained material is rounded, few root and leaf fragments, stiff to hard, moist.
	5				SP-SM		5.0	Dark gray (10YR 4/1) POORLY GRADED SAND WITH SILT, medium to coarse-grained with trace very coarse-grained sand, subangular, loose, wood fragments throughout, moist. Plastic bag/liner observed at 5' bgs.
	10	RS 2	100	PP = 0.5 tsf PP = 0.8 tsf PP = 0.5 tsf PP = 0.3 tsf PP = 1.5 tsf	CH		∇	Very dark gray (2.5Y 3/1) FAT CLAY, cohesive, high plasticity, massive, some very fine-grained sand, trace medium-grained sand, coarse-grained material is rounded, roots and wood fragments throughout, soft, slight reaction with 1M HCL, wet. Roots range in size from very small to approximately 1" diameter. Some mottling with dark gray in the upper 5'. Attempted to collect at water level measurement after attempt #2, water level probe tip was muddy, but no measureable water in borehole at that time.
		RS 3	100	PP = 0.5 tsf PP = 0.5 tsf PP = 0.5 tsf			13.0	
	15				SP		15.0	Gray (5Y 5/1) POORLY GRADED SAND, coarse-grained, rounded to subrounded, trace fine gravel, wet. Gravel content increases towards 15' bgs.
		RS 4	100	PP = 4.5 tsf PP = 4.5 tsf PP = 4.5 tsf	CL		19.0	Gray (5Y 5/1) SANDY LEAN CLAY, cohesive, medium plasticity, thinly laminated, sand is medium-grained, trace fine gravel, hard, wet.
								Installed monitoring well MW-WT-4 in soil boring. End of boring at 19.0 feet.

Carlson McCain

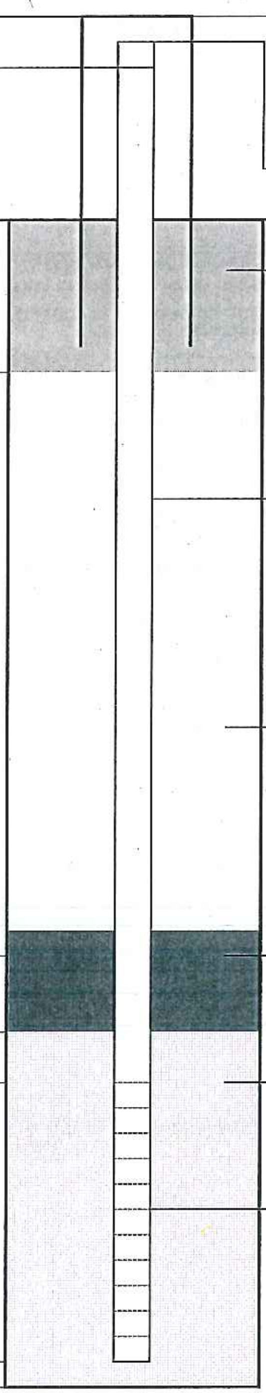
Monitoring Well Diagram
Above Grade Completion

MW-AR-1

PROJECT NAME: Carver County Compost Sites
LOCATION: Chaska, MN

Drilling Method: 4" x 6" Rota-sonic	Ground Surface Elevation: 1003.6
Company: Cascade Drilling	MDH Unique Well No.: 822180
Foreman: Eric Sather	Date/Time Started: 12/10/16 858
Rig Model: mini-Sonic ATV	Date/Time Completed: 12/10/2016 1013
Geol/Engr: M. Lindstrom	Coordinates: N 180430.2, E 542386.5

Protective Casing Stick Up: -3'
Riser Stick Up: -2.5'
Ground Surface
Top of Grout



Top of Seal: 10'
Top of Filter Pack: 11'
Top of Screen: 14'
Bottom of Screen: 24'
Bottom of Filter Pack: 25'
Borehole Diameter: 6"
Total Depth of Boring: 30'
Total Length of Well: 26.5'

PROTECTIVE CASING
Type: Stainless Steel — Bumper Posts: 3 around well
Diameter: 6" — Casing Elevation: 1005.73
Length: 7'
Locked: yes — Key Number: 2121

CAP OR PLUG
Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL
Type: Portland Cement
Total Volume:
Manufacturer: TCC Materials

RISER PIPE
Type: Schedule 40 Low-Carbon Steel
Inner Diameter: 2"
Joint Type: Threaded Coupler
Total Length: 16.5 — No./Length of Sections: 1.65/10 ft
Manufacturer: EXLTUBE

GROUT
Type: Portland Cement
Total Volume: 1 bag — Mix Ratio: 6 gallons of water/1 bag
Manufacturer: TCC Materials

SEAL
Type/Size: 3/8" Bentonite Chips
Total Volume: 1/4 bag
Manufacturer: Halliburton "Hole Plug"

FILTER PACK
Type/Size: #10 Red Flint Sand
Total Volume: 2 bags
Manufacturer: Red Flint Sand and Gravel

WELL SCREEN
Type: Stainless Steel
Inner Diameter: 2"
Length: 10' — Effective Length: 14'
Slot Size: No. 7
Manufacturer: Johnson

WATER SOURCE: Arboretum Site water supply

NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

Carlson McCain

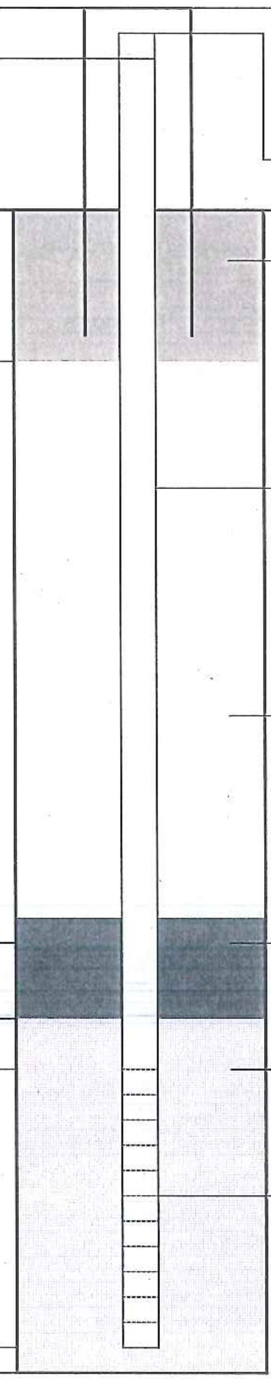
Monitoring Well Diagram
Above Grade Completion

MW-AR-2

PROJECT NAME: Carver County Compost Sites
LOCATION: Chaska, MN

Drilling Method: 4" x 6" Rota-sonic	Ground Surface Elevation: 992.5
Company: Cascade Drilling	MDH Unique Well No.: 822177
Foreman: Eric Sather	Date/Time Started: 12/09/16 1230
Rig Model: mini-Sonic ATV	Date/Time Completed: 12/09/2016 1420
Geol/Engr: M. Lindstrom	Coordinates: N 180385.8, E 542112.5

Protective Casing Stick Up: -3'
Riser Stick Up: -2.5'
Ground Surface
Top of Grout



Top of Seal: 9'
Top of Filter Pack: 10'
Top of Screen: 13'
Bottom of Screen: 23'
Bottom of Filter Pack: 24'

Borehole Diameter: 6"

Total Depth of Boring: 30'
Total Length of Well: 25.5'

PROTECTIVE CASING
Type: Stainless Steel — Bumper Posts: 3 around well
Diameter: 6" — Casing Elevation: 995.17
Length: 7'
Locked: yes — Key Number: 2121

CAP OR PLUG
Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL
Type: Portland Cement
Total Volume:
Manufacturer: TCC Materials

RISER PIPE
Type: Schedule 40 Low-Carbon Steel
Inner Diameter: 2"
Joint Type: Threaded Coupler
Total Length: 15.5 — No./Length of Sections: 1.55/10 ft
Manufacturer: EXLTUBE

GROUT
Type: Portland Cement
Total Volume: 2 bags — Mix Ratio: 6 gallons of water/1 bag
Manufacturer: TCC Materials

SEAL
Type/Size: 3/8" Bentonite Chips
Total Volume: 1/4 bag
Manufacturer: Halliburton "Hole Plug"

FILTER PACK
Type/Size: #10 Red Flint Sand
Total Volume: 2 bags
Manufacturer: Red Flint Sand and Gravel

WELL SCREEN
Type: Stainless Steel
Inner Diameter: 2"
Length: 10' — Effective Length: 14'
Slot Size: No. 7
Manufacturer: Johnson

WATER SOURCE: Arboretum Site water supply

NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

Monitoring Well Diagram
Above Grade Completion

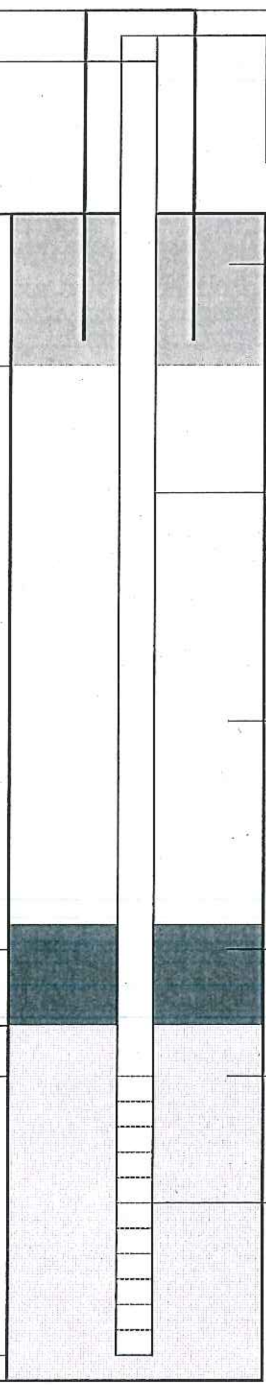
MW-AR-3

PROJECT NAME: Carver County Compost Sites
LOCATION: Chaska, MN

Drilling Method: 4" x 6" Rota-sonic
Company: Cascade Drilling
Foreman: Eric Sather
Rig Model: mini-Sonic ATV
Geol/Engr: M. Lindstrom

Ground Surface Elevation: 991.5
MDH Unique Well No.: 822178
Date/Time Started: 12/09/16 844
Date/Time Completed: 12/09/2016 1008
Coordinates: N 180266.9, E 542112.7

Protective Casing Stick Up: -3'
Riser Stick Up: -2.5'
Ground Surface
Top of Grout
Top of Seal: 10'
Top of Filter Pack: 11'
Top of Screen: 14'
Bottom of Screen: 24'
Bottom of Filter Pack: 25'



Borehole Diameter: 6"

Total Depth of Boring: 40'
Total Length of Well: 26.5'

PROTECTIVE CASING
Type: Stainless Steel — Bumper Posts: 3 around well
Diameter: 6" — Casing Elevation: 994.28
Length: 7'
Locked: yes — Key Number: 2121

CAP OR PLUG
Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL
Type: Portland Cement
Total Volume:
Manufacturer: TCC Materials

RISER PIPE
Type: Schedule 40 Low-Carbon Steel
Inner Diameter: 2"
Joint Type: Threaded Coupler
Total Length: 16.5 — No./Length of Sections: 1.65/10 ft
Manufacturer: EXLTUBE

GROUT
Type: Portland Cement
Total Volume: 2 bags — Mix Ratio: 6 gallons of water/1 bag
Manufacturer: TCC Materials

SEAL
Type/Size: 3/8" Bentonite Chips
Total Volume: 1/4 bag
Manufacturer: Halliburton "Hole Plug"

FILTER PACK
Type/Size: #10 Red Flint Sand
Total Volume: 2 bags
Manufacturer: Red Flint Sand and Gravel

WELL SCREEN
Type: Stainless Steel
Inner Diameter: 2"
Length: 10' — Effective Length: 14'
Slot Size: No. 7
Manufacturer: Johnson

WATER SOURCE: Arboretum site supply

NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

Carlson McCain

Monitoring Well Diagram
Above Grade Completion

MW-AR-4

PROJECT NAME: Carver County Compost Sites
LOCATION: Chaska, MN

Drilling Method: 4" x 6" Rota-sonic	Ground Surface Elevation: 994.9
Company: Cascade Drilling	MDH Unique Well No.: 822179
Foreman: Eric Sather	Date/Time Started: 12/09/16 1523
Rig Model: mini-Sonic ATV	Date/Time Completed: 12/09/2016 1627
Geol/Engr: M. Lindstrom	Coordinates: N 180219, E 542197.7

Protective Casing Stick Up -2.5'

Riser Stick Up -2'

Ground Surface

Top of Grout

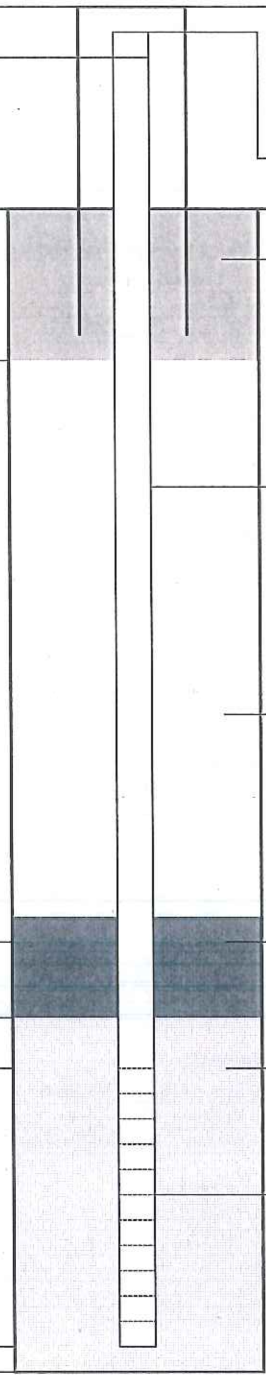
Top of Seal 10'

Top of Filter Pack 11'

Top of Screen 14.5'

Bottom of Screen 24.5'

Bottom of Filter Pack 25'



Borehole Diameter: 6"

Total Depth of Boring 30'

Total Length of Well 26.5'

PROTECTIVE CASING
Type: Stainless Steel — Bumper Posts: 3 around well
Diameter: 6" — Casing Elevation: 996.7
Length: 7'
Locked: yes — Key Number: 2121

CAP OR PLUG
Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL
Type: Portland Cement
Total Volume:
Manufacturer: TCC Materials

RISER PIPE
Type: Schedule 40 Low-Carbon Steel
Inner Diameter: 2"
Joint Type: Threaded Coupler
Total Length: 16.5 — No./Length of Sections: 1.65/10 ft
Manufacturer: EXLTUBE

GROUT
Type: Portland Cement
Total Volume: 1 bag — Mix Ratio: 6 gallons of water/1 bag
Manufacturer: TCC Materials

SEAL
Type/Size: 3/8" Bentonite Chips
Total Volume: 1/4 bag
Manufacturer: Halliburton "Hole Plug"

FILTER PACK
Type/Size: #10 Red Flint Sand
Total Volume: 2 bags
Manufacturer: Red Flint Sand and Gravel

WELL SCREEN
Type: Stainless Steel
Inner Diameter: 2"
Length: 10' — Effective Length: 14'
Slot Size: No. 7
Manufacturer: Johnson

WATER SOURCE: Arboretum Site water supply

NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

Carlson McCain

Monitoring Well Diagram
Above Grade Completion

MW-WT-1

PROJECT NAME: Carver County Compost Sites

LOCATION: Watertown, MN

Drilling Method: 4" x 6" Rota-sonic	Ground Surface Elevation: 930.3
Company: Cascade Drilling	MDH Unique Well No.: 822176
Foreman: Eric Sather	Date/Time Started: 12/06/14 1513
Rig Model: mini-Sonic ATV	Date/Time Completed: 12/06/2016 1604
Geol/Engr: M. Lindstrom	Coordinates: N 219939, E 480483.7

Protective Casing Stick Up: -3'

Riser Stick Up: -2.5'

Ground Surface

Top of Grout

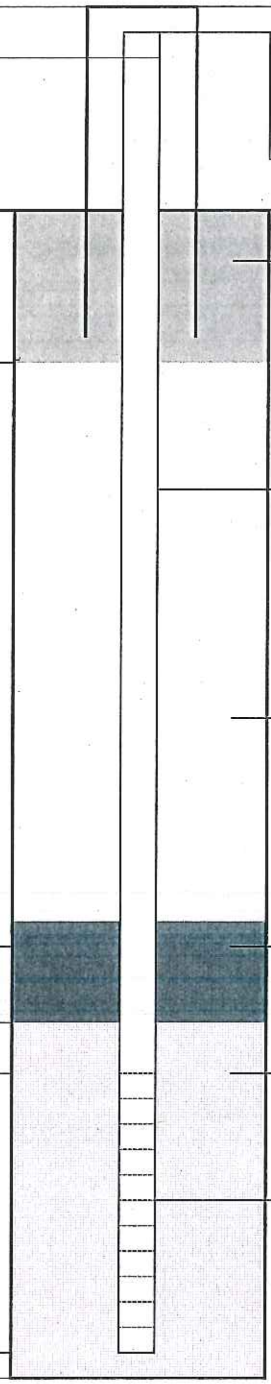
Top of Seal: 6'

Top of Filter Pack: 7'

Top of Screen: 9'

Bottom of Screen: 19'

Bottom of Filter Pack: 19'



Borehole Diameter: 6"

Total Depth of Boring: 19"

Total Length of Well: 21.5"

PROTECTIVE CASING

Type: Stainless Steel — Bumper Posts: 3 around well

Diameter: 6" — Casing Elevation: 932.79

Length: 7'

Locked: yes — Key Number: 2121

CAP OR PLUG

Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL

Type: Portland Cement

Total Volume:

Manufacturer: TCC Materials

RISER PIPE

Type: Schedule 40 Low-Carbon Steel

Inner Diameter: 2"

Joint Type: Threaded Coupler

Total Length: 11.5 — No./Length of Sections: 1.15/10 ft

Manufacturer: EXLTUBE

GROUT

Type: Portland Cement

Total Volume: 1/2 bag — Mix Ratio: 6 gallons of water/1 bag

Manufacturer: TCC Materials

SEAL

Type/Size: 3/8" Bentonite Chips

Total Volume: 1/4 bag

Manufacturer: Halliburton "Hole Plug"

FILTER PACK

Type/Size: #10 Red Flint Sand

Total Volume: 1 bag

Manufacturer: Red Flint Sand and Gravel

WELL SCREEN

Type: Stainless Steel

Inner Diameter: 2"

Length: 10' — Effective Length: 12'

Slot Size: No. 10

Manufacturer: Johnson

WATER SOURCE: Watertown city garage

NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

Monitoring Well Diagram
Above Grade Completion

MW-WT-2

PROJECT NAME: Carver County Compost Sites

LOCATION: Watertown, MN

Drilling Method: 4" x 6" Rota-sonic	Ground Surface Elevation: 927
Company: Cascade Drilling	MDH Unique Well No.: 822173
Foreman: Eric Sather	Date/Time Started: 12/05/16 1610
Rig Model: mini-Sonic ATV	Date/Time Completed: 12/06/2016 825
Geol/Engr: M. Lindstrom	Coordinates: N 220062.5, E 480856

Protective Casing Stick Up: -3'

Riser Stick Up: -2.25'

Ground Surface

Top of Grout

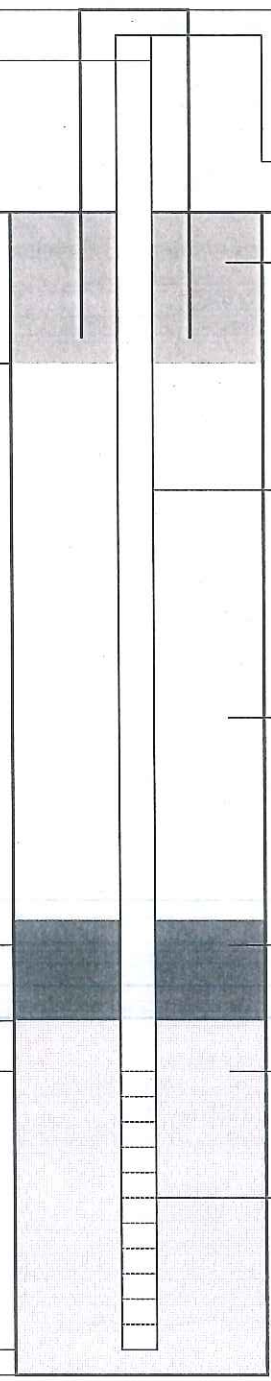
Top of Seal: 5'

Top of Filter Pack: 6.3'

Top of Screen: 8'

Bottom of Screen: 18'

Bottom of Filter Pack: 18'



Borehole Diameter: 6"

Total Depth of Boring: 18'

Total Length of Well: 20.25'

PROTECTIVE CASING
Type: Stainless Steel — Bumper Posts: 3 around well
Diameter: 6" — Casing Elevation: 930.51
Length: 7'
Locked: yes — Key Number: 2121

CAP OR PLUG
Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL
Type: Portland Cement
Total Volume:
Manufacturer: TCC Materials

RISER PIPE
Type: Schedule 40 Low-Carbon Steel
Inner Diameter: 2"
Joint Type: Threaded Coupler
Total Length: 10.25 — No./Length of Sections: 1.1/10 ft
Manufacturer: EXLTUBE

GROUT
Type: Portland Cement
Total Volume: 1/2 bag — Mix Ratio: 6 gallons of water/1 bag
Manufacturer: TCC Materials

SEAL
Type/Size: 3/8" Bentonite Chips
Total Volume: 1/4 bag
Manufacturer: Halliburton "Hole Plug"

FILTER PACK
Type/Size: #10 Red Flint Sand
Total Volume: 2 bags
Manufacturer: Red Flint Sand and Gravel

WELL SCREEN
Type: Stainless Steel
Inner Diameter: 2"
Length: 10' — Effective Length: 11.7'
Slot Size: No. 10
Manufacturer: Johnson

WATER SOURCE: Watertown city garage

NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

Carlson McCain

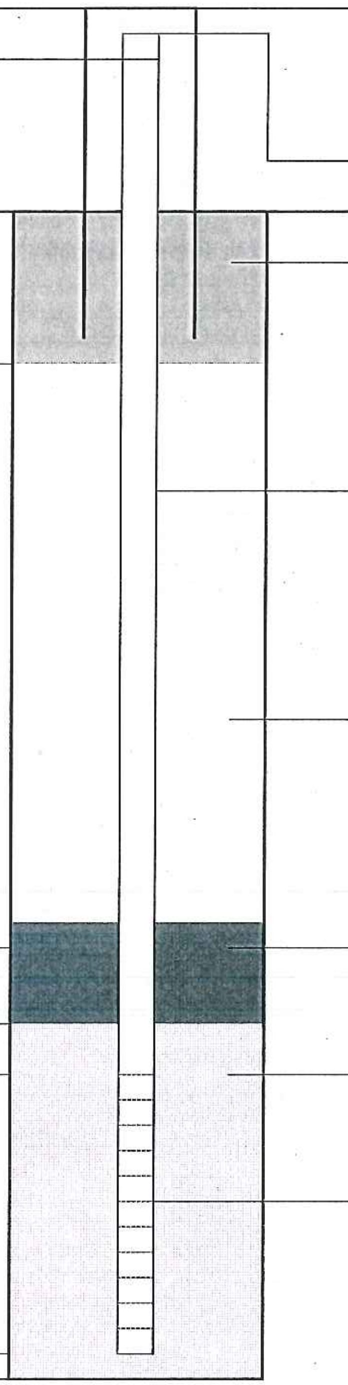
Monitoring Well Diagram
Above Grade Completion

MW-WT-3

PROJECT NAME: Carver County Compost Sites

LOCATION: Watertown, MN

Drilling Method: 4" x 6" Rota-sonic	Ground Surface Elevation: 932
Company: Cascade Drilling	MDH Unique Well No.: 822174
Foreman: Eric Sather	Date/Time Started: 12/06/16 1034
Rig Model: mini-Sonic ATV	Date/Time Completed: 12/06/2016 1122
Geol/Engr: M. Lindstrom	Coordinates: N 219950.7, E 480826.5



Protective Casing Stick Up	-2.5'
Riser Stick Up	-1.75'
Ground Surface	
Top of Grout	
Top of Seal	6'
Top of Filter Pack	7'
Top of Screen	9'
Bottom of Screen	19'
Bottom of Filter Pack	19'
Borehole Diameter:	6"
Total Depth of Boring	20'
Total Length of Well	20.75'

PROTECTIVE CASING

Type: Stainless Steel — Bumper Posts: 3 around well

Diameter: 6" — Casing Elevation: 931.83

Length: 7'

Locked: yes — Key Number: 2121

CAP OR PLUG

Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL

Type: Portland Cement

Total Volume:

Manufacturer: TCC Materials

RISER PIPE

Type: Schedule 40 Low-Carbon Steel

Inner Diameter: 2"

Joint Type: Threaded Coupler

Total Length: 10.5 — No./Length of Sections: 1.1/10 ft

Manufacturer: EXLTUBE

GROUT

Type: Portland Cement

Total Volume: 1/2 bag — Mix Ratio: 6 gallons of water/1 bag

Manufacturer: TCC Materials

SEAL

Type/Size: 3/8" Bentonite Chips

Total Volume: 1/4 bag

Manufacturer: Halliburton "Hole Plug"

FILTER PACK

Type/Size: #10 Red Flint Sand

Total Volume: 1 bag

Manufacturer: Red Flint Sand and Gravel

WELL SCREEN

Type: Stainless Steel

Inner Diameter: 2"

Length: 10' — Effective Length: 12'

Slot Size: No. 10

Manufacturer: Johnson

WATER SOURCE: Watertown city garage

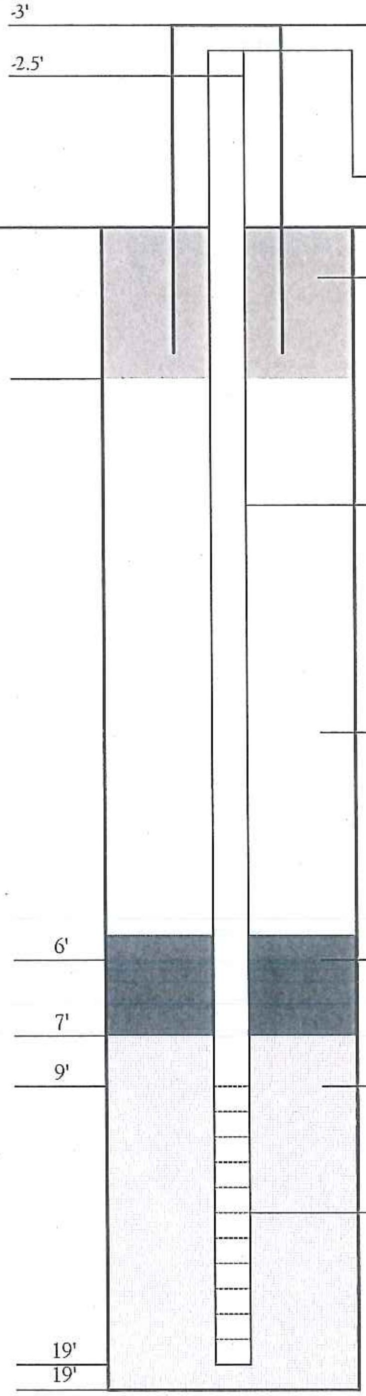
NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

Monitoring Well Diagram
Above Grade Completion

MW-WT-4

PROJECT NAME: Carver County Compost Sites
LOCATION: Watertown, MN

Drilling Method: 4" x 6" Rota-sonic	Ground Surface Elevation: 931
Company: Cascade Drilling	MDH Unique Well No.: 822175
Foreman: Eric Sather	Date/Time Started: 12/06/16 1230
Rig Model: mini-Sonic ATV	Date/Time Completed: 12/06/2016 1318
Geol/Engr: M. Lindstrom	Coordinates: N 219853.1, E 480788.1



Protective Casing Stick Up: -3'
Riser Stick Up: -2.5'
Ground Surface
Top of Grout
Top of Seal: 6'
Top of Filter Pack: 7'
Top of Screen: 9'
Bottom of Screen: 19'
Bottom of Filter Pack: 19'
Borehole Diameter: 6"
Total Depth of Boring: 19'
Total Length of Well: 21.5'

PROTECTIVE CASING
Type: Stainless Steel — Bumper Posts: 3 around well
Diameter: 6" — Casing Elevation: 932.54
Length: 7'
Locked: yes — Key Number: 2121

CAP OR PLUG
Type: Expansion Plug — Vented: No

SURFACE BACKFILL MATERIAL
Type: Portland Cement
Total Volume:
Manufacturer: TCC Materials

RISER PIPE
Type: Schedule 40 Low-Carbon Steel
Inner Diameter: 2"
Joint Type: Threaded Coupler
Total Length: 11.5 — No./Length of Sections: 1.2/10 ft
Manufacturer: EXLTUBE

GROUT
Type: Portland Cement
Total Volume: 1/2 bag — Mix Ratio: 6 gallons of water/1 bag
Manufacturer: TCC Materials

SEAL
Type/Size: 3/8" Bentonite Chips
Total Volume: 1/4 bag
Manufacturer: Halliburton "Hole Plug"

FILTER PACK
Type/Size: #10 Red Flint Sand
Total Volume: 1 bag
Manufacturer: Red Flint Sand and Gravel

WELL SCREEN
Type: Stainless Steel
Inner Diameter: 2"
Length: 10' — Effective Length: 12'
Slot Size: No. 10
Manufacturer: Johnson

WATER SOURCE: Watertown city garage

NOTES: grout was placed to ground surface, and pro-top was installed in grout at time of well installation. Grout height was verified to be at or above ground surface after allowing grout to settle a minimum of 12 hours.

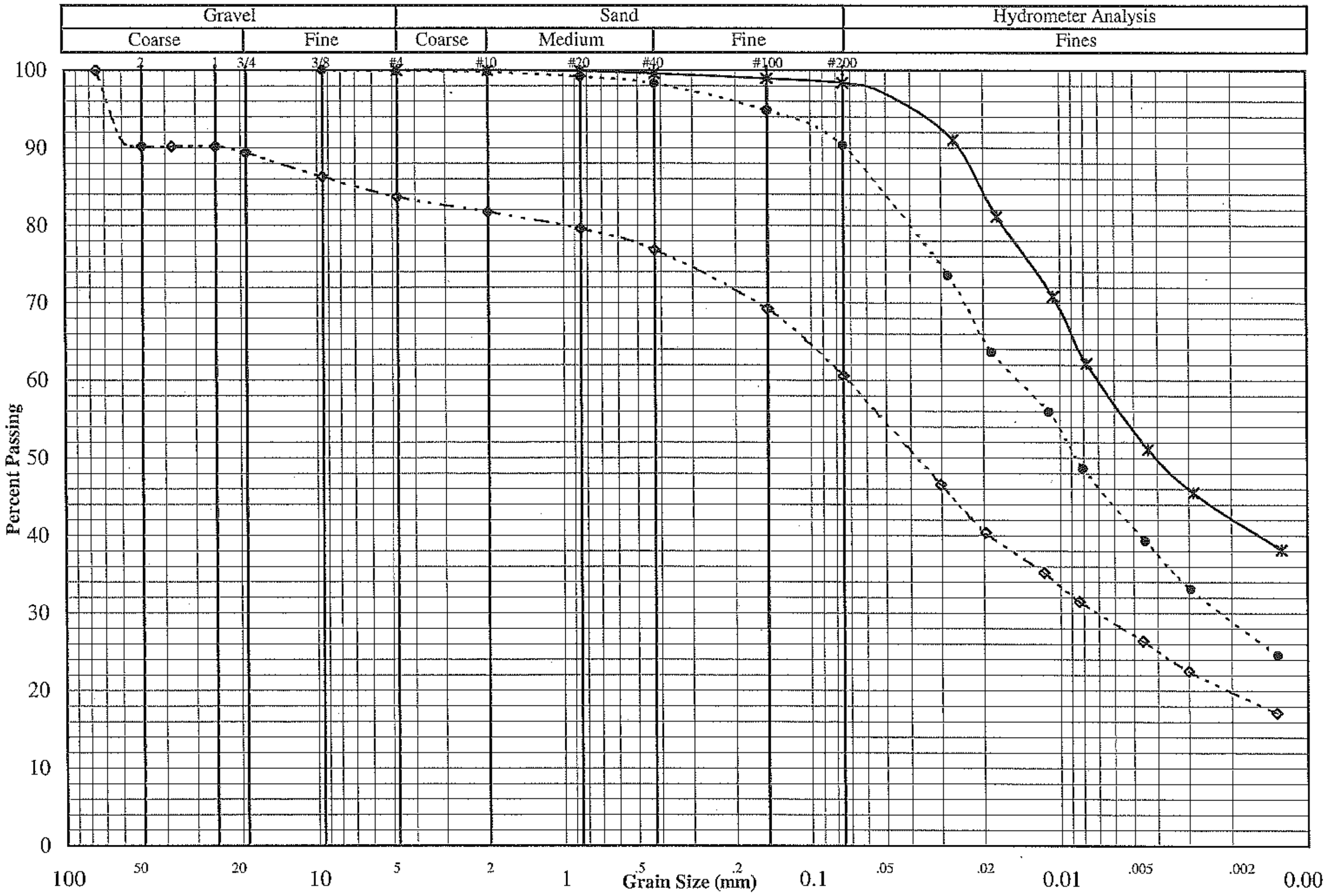
Appendix B
Geotechnical Soil Sample Results

Grain Size Distribution ASTM D422

Job No. : **10714**

Project:	Carver County Compost Sites	Test Date:	1/10/17
Reported To:	Carlson McCain	Report Date:	1/17/17

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	B16-5		3-5	Bag	Silty Clay
●	B16-5		8-10	Bag	Silty Clay Loam
◇	B16-5		12-13	Bag	Silt Loam w/gravel



Other Tests

	*	●	◇
Sand (%)	1.6	9.5	21.2
Silt (%)	56.4	61.3	41.1
Clay (%)	42.0	29.0	19.5
Water Content			
Dry Density (pcf)			
Specific Gravity	2.68*	2.68*	2.68*
Porosity			
Organic Content			
pH			
Shrinkage Limit			
Penetrometer			
Qu (psf)			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	1665.2	2841.5	2910.7
2"			90.2
1.5"			90.2
1"			90.2
3/4"			89.4
3/8"		100.0	86.3
#4	100.0	99.9	83.7
#10	100.0	99.8	81.8
#20	99.9	99.2	79.6
#40	99.6	98.3	76.8
#100	98.9	94.8	69.2
#200	98.4	90.3	60.6

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

B16-5 @ 12'-13' has 100% passing the 3" sieve

9530 James Ave South
SOIL ENGINEERING TESTING, INC.
Bloomington, MN 55431

Grain Size Distribution ASTM D422

Job No. : **10714**

Project:	Carver County Compost Sites	Test Date:	1/10/17
Reported To:	Carlson McCain	Report Date:	1/17/17

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	B16-5		3-5	Bag	Silty Clay
Spec 2	B16-5		8-10	Bag	Silty Clay Loam
Spec 3	B16-5		12-13	Bag	Silt Loam w/gravel

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
2"		2"		2"	90.2
1.5"		1.5"		1.5"	90.2
1"		1"		1"	90.2
3/4"		3/4"		3/4"	89.4
3/8"		3/8"	100.0	3/8"	86.3
#4	100.0	#4	99.9	#4	83.7
#10	100.0	#10	99.8	#10	81.8
#20	99.9	#20	99.2	#20	79.6
#40	99.6	#40	98.3	#40	76.8
#100	98.9	#100	94.8	#100	69.2
#200	98.4	#200	90.3	#200	60.6

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.027	91.0	0.028	73.6	0.030	46.6
0.018	81.1	0.019	63.6	0.020	40.4
0.011	70.8	0.011	55.9	0.012	35.2
0.008	62.2	0.008	48.7	0.008	31.5
0.004	51.1	0.004	39.3	0.005	26.4
0.003	45.5	0.003	33.1	0.003	22.5
0.001	38.1	0.001	24.6	0.001	17.1

Remarks

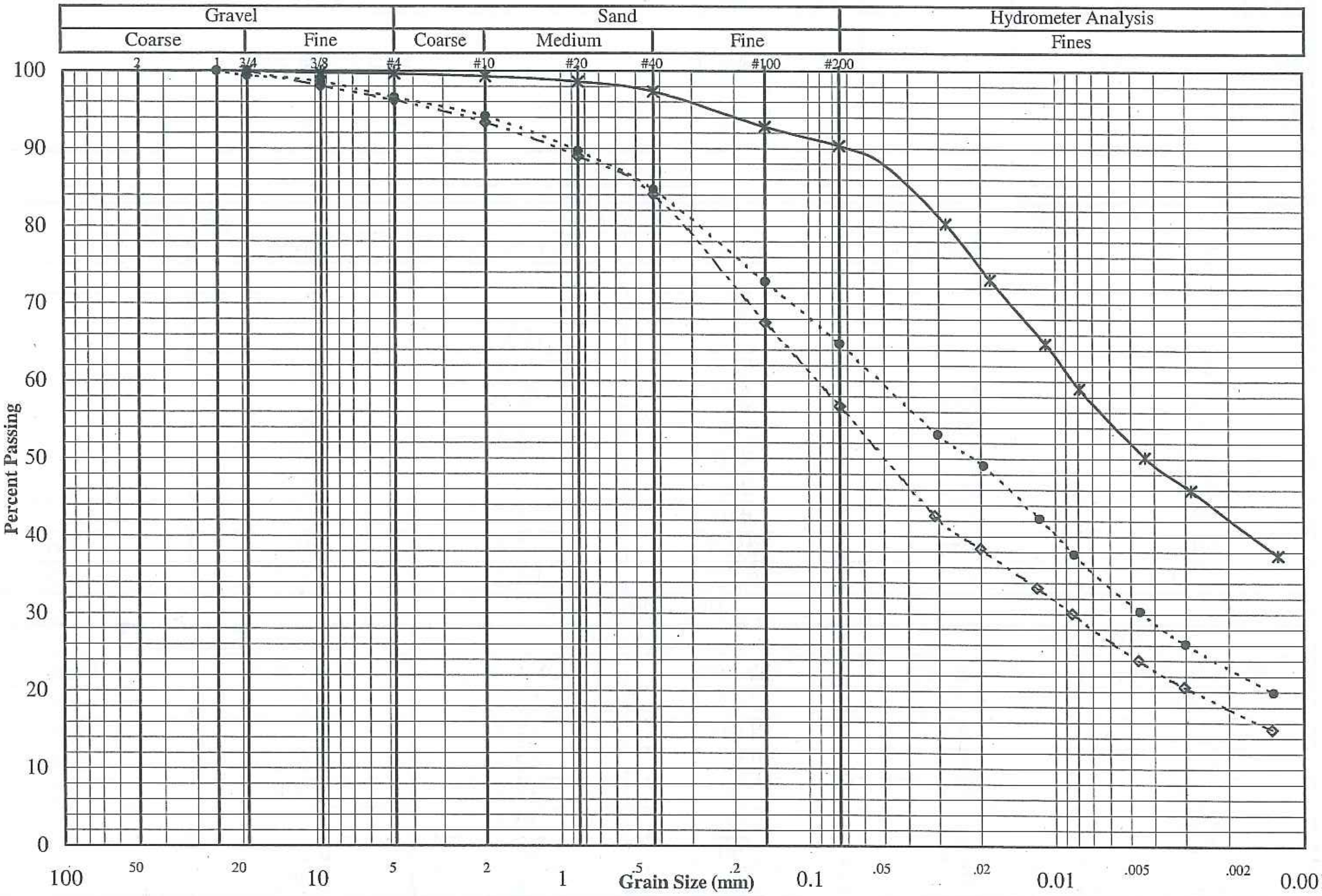
Specimen 1	Specimen 2	Specimen 3

Grain Size Distribution ASTM D422

Job No.: **10714**

Project:	Carver County Compost Sites	Test Date:	1/10/17
Reported To:	Carlson McCain	Report Date:	1/17/17

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	B16-6		1.5-2.5	Bag	Clay
●	B16-6		5-7	Bag	Loam w/a little gravel
◇	B16-6		10-11	Bag	Loam w/a little gravel



Other Tests

	*	●	◇
Sand (%)	8.9	29.4	36.6
Silt (%)	48.4	41.8	38.8
Clay (%)	42.0	23.0	18.0
Water Content			
Dry Density (pcf)			
Specific Gravity	2.68*	2.68*	2.68*
Porosity			
Organic Content			
pH			
Shrinkage Limit			
Penetrometer			
Qu (psf)			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	2104.8	2400.8	2313.3
2"			
1.5"			
1"		100.0	
3/4"	100.0	99.4	100.0
3/8"	99.8	98.6	98.1
#4	99.6	96.6	96.2
#10	99.3	94.2	93.4
#20	98.6	89.7	89.0
#40	97.3	84.7	84.1
#100	92.8	72.8	67.6
#200	90.4	64.8	56.8

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431

Grain Size Distribution ASTM D422

Job No. : **10714**

Project:	Carver County Compost Sites	Test Date:	1/10/17
Reported To:	Carlson McCain	Report Date:	1/17/17

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	B16-6		1.5-2.5	Bag	Clay
Spec 2	B16-6		5-7	Bag	Loam w/a little gravel
Spec 3	B16-6		10-11	Bag	Loam w/a little gravel

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
2"		2"		2"	
1.5"		1.5"		1.5"	
1"		1"	100.0	1"	
3/4"	100.0	3/4"	99.4	3/4"	100.0
3/8"	99.8	3/8"	98.6	3/8"	98.1
#4	99.6	#4	96.6	#4	96.2
#10	99.3	#10	94.2	#10	93.4
#20	98.6	#20	89.7	#20	89.0
#40	97.3	#40	84.7	#40	84.1
#100	92.8	#100	72.8	#100	67.6
#200	90.4	#200	64.8	#200	56.8

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.028	80.3	0.030	53.1	0.031	42.6
0.018	73.1	0.019	49.2	0.020	38.4
0.011	64.9	0.012	42.3	0.012	33.4
0.008	59.1	0.008	37.7	0.008	30.0
0.004	50.2	0.005	30.3	0.005	24.1
0.003	45.9	0.003	26.2	0.003	20.6
0.001	37.6	0.001	19.9	0.001	15.1

Remarks

Specimen 1	Specimen 2	Specimen 3

Appendix C
Gradient Calculations

APPENDIX C: GRADIENT CALCULATIONS

ARBORETUM SITE:

<u>Horizontal Gradient Calculation:</u>

Governing Equation:

$$Horizontal\ Gradient = \frac{Change\ in\ Elevation}{Distance}$$

Given the perpendicular horizontal distance between contours 995 and 900 is approximately 85 ft:

$$Change\ in\ elevation = 995ft - 900\ ft = 5\ ft$$

Calculate the horizontal gradient:

$$Horizontal\ Gradient = \frac{5ft}{85ft} = 0.06ft/ft$$

WATERTOWN SITE:

<u>Horizontal Gradient Calculation:</u>

Governing Equation:

$$Horizontal\ Gradient = \frac{Change\ in\ Elevation}{Distance}$$

Given the perpendicular horizontal distance between contours 923.5 and 923 is approximately 100 ft:

$$Change\ in\ elevation = 923.5ft - 923\ ft = 0.5\ ft$$

Calculate the horizontal gradient:

$$Horizontal\ Gradient = \frac{0.5ft}{100\ ft} = 0.005\ ft/ft$$

Appendix D
MDH Well Records

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING CONSTRUCTION RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL AND BORING NO. 822177

WELL OR BORING LOCATION
County Name: CARVER

Township Name	Township No.	Range No.	Section No.	Fraction
Chanhassen	116	23	17	SE ¼ NE ¼ NE ¼

GPS LOCATION — decimal degrees (to four decimal places).
Latitude ______ Longitude ______

House Number, Street Name, City, and ZIP Code of Well Location: 3675 Arboretum DR, Chaska 55318

Show exact location of well/boring in section grid with "X."
Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

N / W / E / S — ½ Mile — 1 Mile

SEE MAP

PROPERTY OWNER'S NAME/COMPANY NAME: U of M Landscape Arboretum

Property owner's mailing address if different than well location address indicated above.
3675 Arboretum DR
Chaska, MN 55318

WELL OWNER'S NAME/COMPANY NAME: CARVER County

Well/boring owner's mailing address if different than property owner's address indicated above.
600 EAST 4th St
Chaska, MN 55318

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Clay	TAN	M	0	23

Use a second sheet, if needed.

REMARKS, ELEVATION, SOURCE OF DATA, etc.
117-16-3108
B16-1

WELL/BORING DEPTH (completed): 23 ft.
DATE WORK COMPLETED: 12-9-16

DRILLING METHOD
☐ Cable Tool ☐ Driven
☐ Auger ☐ Rotary
☒ Other SONIC

DRILLING FLUID: N/A

WELL HYDROFRACTURED? ☐ Yes ☒ No
From ______ ft. To ______ ft.

USE
☐ Domestic ☒ Monitoring ☐ Heating/Cooling
☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial
☐ Community PWS ☐ Irrigation ☐ Remedial
☐ Elevator ☐ Dewatering ☐ ______

CASING MATERIAL
☒ Steel ☐ Plastic ☐ ______
Drive Shoe? ☐ Yes ☒ No
☒ Threaded ☐ Welded

HOLE DIAM.

CASING Diameter	To	Weight	Specifications	HOLE DIAM.
2 in.	.13 ft.	3.65 lbs./ft.	SCH 40	6 in. To 23 ft.
in.	ft.	lbs./ft.		in. To ft.
in.	ft.	lbs./ft.		in. To ft.

SCREEN: YES
Make: Johnson
Type: SS
Slot/Gauze: .007
Set between 23 ft. and 13 ft.

OPEN HOLE
From 2' ft. To ______ ft.
Diam. 2'
Length 10'
FITTINGS T&C

STATIC WATER LEVEL
10 ft. ☒ Below ☐ Above land surface
Measured from Ground
Date measured 12-9-16

PUMPING LEVEL (below land surface)
N/A ft. after ______ hrs. pumping ______ g.p.m.

WELLHEAD COMPLETION
☐ Pitless/adapter manufacturer ______ Model ______
☒ Casing protection 6" Protop ☒ 12 in. above grade
☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)
Material NEAT Cement From 9 To 0 ft. 1.5 ☐ Yds. ☒ Bags
Material ______ From ______ To ______ ft. ______ ☐ Yds. ☐ Bags
Material ______ From ______ To ______ ft. ______ ☐ Yds. ☐ Bags
Driven casing seal From ______ To ______ ______ Bags

NEAREST KNOWN SOURCE OF CONTAMINATION
______ feet ______ direction ______ type

Well disinfected upon completion? ☐ Yes ☒ No

PUMP
☒ Not installed Date installed ______
Manufacturer's name ______
Model Number ______ HP ______ Volts ______
Length of drop pipe ______ ft. Capacity ______ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ______

ABANDONED WELLS
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ______

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

CASCADE Drilling — Licensee Business Name
3267 — Lic. or Reg. No.

Dale [signature] — Certified Representative Signature
2856 — Certified Rep. No.
12-13-16 — Date

ERIC SATHER — Name of Driller

MINN DEPT. OF HEALTH COPY 822177

ID #52603

HE-01205-15 (Rev. 8/13)

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING CONSTRUCTION RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL AND BORING NO. 822178

WELL OR BORING LOCATION

County Name: CARVER

Township Name	Township No.	Range No.	Section No.	Fraction
Chanhassen	116	23	17	SE ¼ NE ¼ NE ¼

GPS LOCATION — decimal degrees (to four decimal places). Latitude ______ Longitude ______

House Number, Street Name, City, and ZIP Code of Well Location: 3675 Arboretum DR, Chaska 55318

Show exact location of well/boring in section grid with "X." Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

N / W / E / S ½ Mile — 1 Mile

SEE MAP

PROPERTY OWNER'S NAME/COMPANY NAME: U of M Landscape Arboretum

Property owner's mailing address if different than well location address indicated above.
3675 Arboretum DR
Chaska, MN 55318

WELL OWNER'S NAME/COMPANY NAME: CARVER County

Well/boring owner's mailing address if different than property owner's address indicated above.
660 EAST 4th St
Chaska, MN 55318

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Clay	TAN	M	0	24

Use a second sheet, if needed.

REMARKS, ELEVATION, SOURCE OF DATA, etc.
117-16-3108
B16-2

WELL/BORING DEPTH (completed): 24 ft.

DATE WORK COMPLETED: 12-9-16

DRILLING METHOD: ☐ Cable Tool ☐ Driven ☐ Auger ☐ Rotary ☒ Other SONIC

DRILLING FLUID: N/A

WELL HYDROFRACTURED? ☐ Yes ☒ No From ____ ft. To ____ ft.

USE: ☐ Domestic ☒ Monitoring ☐ Heating/Cooling ☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial ☐ Community PWS ☐ Irrigation ☐ Remedial ☐ Elevator ☐ Dewatering ☐ ______

CASING MATERIAL: ☒ Steel ☐ Plastic — Drive Shoe? ☐ Yes ☒ No — ☒ Threaded ☐ Welded ☐ ______

CASING Diameter	To	Weight	Specifications	HOLE DIAM.
2 in.	14 ft.	3.65 lbs./ft.	SCH 40	6 in. To 24 ft.
in.	ft.	lbs./ft.		in. To ft.
in.	ft.	lbs./ft.		in. To ft.

SCREEN: YES — Make: Johnson — Type: SS — Slot/Gauze: .007 — Length: 10' — Diam. 2 — Set between 24 ft. and 14 ft. FITTINGS: T&C

OPEN HOLE: From 2" ft. To ____ ft.

STATIC WATER LEVEL: 10 ft. ☒ Below ☐ Above land surface. Measured from: Ground. Date measured: 12-9-16

PUMPING LEVEL (below land surface): N/A ft. after ____ hrs. pumping ____ g.p.m.

WELLHEAD COMPLETION: ☐ Pitless/adapter manufacturer ____ Model ____ ☒ Casing protection 6" protop ☒ 12 in. above grade ☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)

Material	From	To		Yds. / Bags
NEAT Cement	10	0 ft.	1.5	☐ Yds. ☒ Bags
		ft.		☐ Yds. ☐ Bags
		ft.		☐ Yds. ☐ Bags
Driven casing seal				Bags

NEAREST KNOWN SOURCE OF CONTAMINATION: N/A feet ____ direction ____ type

Well disinfected upon completion? ☐ Yes ☒ No

PUMP: ☒ Not installed Date installed ____ Manufacturer's name ____ Model Number ____ HP ____ Volts ____ Length of drop pipe ____ ft. Capacity ____ g.p.m. Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ____

ABANDONED WELLS: Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE: Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ____

WELL CONTRACTOR CERTIFICATION: This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

CASCADE DRILLING — Licensee Business Name — 3267 Lic. or Reg. No.

Dale [signature] — Certified Representative Signature — 2856 Certified Rep. No. — 12-13-16 Date

ERIC SATHER — Name of Driller

MINN DEPT. OF HEALTH COPY 822178

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING CONSTRUCTION RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL AND BORING NO. 822179

WELL OR BORING LOCATION

County Name: Carver

Township Name	Township No.	Range No.	Section No.	Fraction
Chanhassen	116	23	17	SE ¼ NE ¼ NE ¼

WELL/BORING DEPTH (completed): 24 ft.

DATE WORK COMPLETED: 12-9-16

GPS LOCATION — decimal degrees (to four decimal places).
Latitude ______ Longitude ______

DRILLING METHOD: ☐ Cable Tool ☐ Driven ☐ Auger ☐ Rotary ☒ Other Sonic

House Number, Street Name, City, and ZIP Code of Well Location: 3675 Arboretum Dr Chaska 55318

DRILLING FLUID: N/A

WELL HYDROFRACTURED? ☐ Yes ☒ No From ____ ft. To ____ ft.

Show exact location of well/boring in section grid with "X." Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

N / W / E / S — ½ Mile — 1 Mile

SEE MAP

USE: ☐ Domestic ☒ Monitoring ☐ Heating/Cooling ☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial ☐ Community PWS ☐ Irrigation ☐ Remedial ☐ Elevator ☐ Dewatering ☐ ______

CASING MATERIAL: ☒ Steel ☐ Plastic — Drive Shoe? ☐ Yes ☒ No — ☒ Threaded ☐ Welded ☐ ______

HOLE DIAM.

CASING Diameter	To	Weight	Specifications	Hole Diam.
2 in.	14 ft.	3.65 lbs./ft.	SCH 40	6 in. To 24 ft.
in.	ft.	lbs./ft.		in. To ft.
in.	ft.	lbs./ft.		in. To ft.

PROPERTY OWNER'S NAME/COMPANY NAME: U of M Landscape Arboretum

Property owner's mailing address if different than well location address indicated above.

3675 Arboretum DR
Chaska, MN 55318

SCREEN: YES
Make: Johnson
Type: SS
Slot/Gauze: .007
Set between 24 ft. and 14 ft.

OPEN HOLE: From 2" ft. To ____ ft.
Diam. 2"
Length 10'
FITTINGS: T+C

STATIC WATER LEVEL: 10 ft. ☒ Below ☐ Above land surface
Measured from: Ground
Date measured: 12-9-16

WELL OWNER'S NAME/COMPANY NAME: Carver County

PUMPING LEVEL (below land surface): N/A ft. after ____ hrs. pumping ____ g.p.m.

Well/boring owner's mailing address if different than property owner's address indicated above.

600 East 4th St
Chaska, MN 55318

WELLHEAD COMPLETION
☐ Pitless/adapter manufacturer ______ Model ______
☒ Casing protection 6" protop ☒ 12 in. above grade
☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)

Material	From	To		Amount	
NEAT CEMENT	10	0	ft.	1	☐ Yds. ☒ Bags
			ft.		☐ Yds. ☐ Bags
			ft.		☐ Yds. ☐ Bags
Driven casing seal					Bags

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Clay	TAN	M	0	24

Use a second sheet, if needed.

NEAREST KNOWN SOURCE OF CONTAMINATION: N/A feet ____ direction ____ type

Well disinfected upon completion? ☐ Yes ☒ No

PUMP
☒ Not installed Date installed ______
Manufacturer's name ______
Model Number ______ HP ______ Volts ______
Length of drop pipe ______ ft. Capacity ______ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ______

ABANDONED WELLS
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ______

REMARKS, ELEVATION, SOURCE OF DATA, etc.

117-16-3808
B16-3-R

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Cascade Drilling — Licensee Business Name
3267 — Lic. or Reg. No.

[signature] — Certified Representative Signature
2856 — Certified Rep. No.
12-13-16 — Date

Eric Sather — Name of Driller

MINN DEPT. OF HEALTH COPY 822179

ID #52603 HE-01205-15 (Rev. 8/13)

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING CONSTRUCTION RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL AND BORING NO. 822180

WELL OR BORING LOCATION

County Name: CARVER

Township Name	Township No.	Range No.	Section No.	Fraction
Chanhassen	116	23	17	SE NE NE

GPS LOCATION — decimal degrees (to four decimal places). Latitude ______ Longitude ______

House Number, Street Name, City, and ZIP Code of Well Location: 3675 Arboretum Dr Chaska 55318

Show exact location of well/boring in section grid with "X." Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

N / W / E / S — ½ Mile — 1 Mile

SEE MAP

WELL/BORING DEPTH (completed): 24 ft.

DATE WORK COMPLETED: 12-10-16

DRILLING METHOD: ☐ Cable Tool ☐ Driven ☐ Auger ☐ Rotary ☒ Other SONIC

DRILLING FLUID: N/A

WELL HYDROFRACTURED? ☐ Yes ☒ No From ______ ft. To ______ ft.

USE: ☐ Domestic ☒ Monitoring ☐ Heating/Cooling ☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial ☐ Community PWS ☐ Irrigation ☐ Remedial ☐ Elevator ☐ Dewatering ☐ ______

CASING MATERIAL: ☒ Steel ☐ Plastic — Drive Shoe? ☐ Yes ☒ No — ☒ Threaded ☐ Welded ☐ ______

HOLE DIAM.

CASING Diameter	To	Weight	Specifications	HOLE DIAM.
2 in.	14 ft.	3.65 lbs./ft.	SCH 40	6 in. To 24 ft.
in.	ft.	lbs./ft.		in. To ft.
in.	ft.	lbs./ft.		in. To ft.

PROPERTY OWNER'S NAME/COMPANY NAME: U of M Landscape Arboretum

Property owner's mailing address if different than well location address indicated above:
3675 Arboretum DR
CHASKA, MN 55318

SCREEN: YES
Make: Johnson
Type: SS
Slot/Gauze: .007
Set between 24 ft. and 14 ft.

OPEN HOLE: From ______ ft. To ______ ft.
Diam. 2"
Length 10'
FITTINGS T+C

STATIC WATER LEVEL: 10 ft. ☒ Below ☐ Above land surface
Measured from Ground
Date measured 12-10-16

WELL OWNER'S NAME/COMPANY NAME: CARVER County

Well/boring owner's mailing address if different than property owner's address indicated above:
600 EAST 4th St
ChasKA, MN 55318

PUMPING LEVEL (below land surface): N/A ft. after ______ hrs. pumping ______ g.p.m.

WELLHEAD COMPLETION: ☐ Pitless/adapter manufacturer ______ Model ______ ☒ Casing protection 6" Proto P ☐ 12 in. above grade ☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)

Material	From	To	Amount
NEAT Cement	10	0 ft.	1.5 ☐ Yds. ☒ Bags
		ft.	☐ Yds. ☐ Bags
		ft.	☐ Yds. ☐ Bags
Driven casing seal			Bags

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Clay	BR	M	0	20
Clay	GR	M	20	24

Use a second sheet, if needed.

NEAREST KNOWN SOURCE OF CONTAMINATION: N/A feet ______ direction ______ type ______

Well disinfected upon completion? ☐ Yes ☒ No

PUMP: ☒ Not installed Date installed ______
Manufacturer's name ______
Model Number ______ HP ______ Volts ______
Length of drop pipe ______ ft. Capacity ______ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ______

ABANDONED WELLS: Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE: Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ______

REMARKS, ELEVATION, SOURCE OF DATA, etc.
117-16-3108
B16-4

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Licensee Business Name: CASCADE DRILLING — Lic. or Reg. No. 3267

Certified Representative Signature: [signature] — Certified Rep. No. 2856 — Date 12-13-16

Name of Driller: ERIC SATHER

MINN DEPT. OF HEALTH COPY 822180

ID #52603 HE-01205-15 (Rev. 8/13)

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING CONSTRUCTION RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL AND BORING NO. 822173

WELL OR BORING LOCATION

County Name: CARVER

Township Name	Township No.	Range No.	Section No.	Fraction
WATERTOWN	117	25	4	NE ¼ NE ¼ SW ¼

WELL/BORING DEPTH (completed): 18 ft.

DATE WORK COMPLETED: 12-5-16

GPS LOCATION — decimal degrees (to four decimal places).
Latitude ______ Longitude ______

House Number, Street Name, City, and ZIP Code of Well Location: 700 LEWIS AVE NW, WATERTOWN 53094

Show exact location of well/boring in section grid with "X."

Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

N / W / E / S — ½ Mile — 1 Mile

SEE MAP

DRILLING METHOD
☐ Cable Tool ☐ Driven
☐ Auger ☐ Rotary
☒ Other SONIC

DRILLING FLUID: N/A

WELL HYDROFRACTURED? ☐ Yes ☒ No
From ______ ft. To ______ ft.

USE
☐ Domestic ☒ Monitoring ☐ Heating/Cooling
☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial
☐ Community PWS ☐ Irrigation ☐ Remedial
☐ Elevator ☐ Dewatering ☐ ______

CASING MATERIAL
Drive Shoe? ☐ Yes ☒ No
☒ Steel ☒ Threaded ☐ Welded
☐ Plastic ☐ ______

HOLE DIAM.

CASING Diameter	To	Weight	Specifications	HOLE DIAM.
2 in.	8 ft.	3.65 lbs./ft.	SCH 40	6 in. To 18 ft.
in.	ft.	lbs./ft.		in. To ft.
in.	ft.	lbs./ft.		in. To ft.

SCREEN: YES
Make: Johnson
Type: SS
Slot/Gauze: .010
Set between 18 ft. and 8 ft.

OPEN HOLE
From 2'' ft. To ______ ft.
Diam. 2
Length 10'
FITTINGS T + C

PROPERTY OWNER'S NAME/COMPANY NAME: CITY OF WATERTOWN

Property owner's mailing address if different than well location address indicated above.
309 LEWIS AVE S
(PO BOX 279)
WATERTOWN, MN 55388

STATIC WATER LEVEL
5 ft. ☒ Below ☐ Above land surface
Measured from Ground
Date measured 12-5-16

PUMPING LEVEL (below land surface)
N/A ft. after ______ hrs. pumping ______ g.p.m.

WELL OWNER'S NAME/COMPANY NAME: CARVER COUNTY

Well/boring owner's mailing address if different than property owner's address indicated above.
600 EAST 4th St
Chaska, MN 55318

WELLHEAD COMPLETION
☐ Pitless/adapter manufacturer ______ Model ______
☒ Casing protection 6" Protop ☒ 12 in. above grade
☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)
Material NEAT CEMENT From 4 To 0 ft. 1 ☐ Yds. ☒ Bags
Material ______ From ______ To ______ ft. ______ ☐ Yds. ☐ Bags
Material ______ From ______ To ______ ft. ______ ☐ Yds. ☐ Bags
Driven casing seal From ______ To ______ ______ Bags

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Clay	BR	S	0	2
Sand	BR	S	2	11
Clay	BR	S	11	18

Use a second sheet, if needed.

NEAREST KNOWN SOURCE OF CONTAMINATION
N/A feet ______ direction ______ type

Well disinfected upon completion? ☐ Yes ☒ No

PUMP
☒ Not installed Date installed ______
Manufacturer's name ______
Model Number ______ HP ______ Volts ______
Length of drop pipe ______ ft. Capacity ______ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ______

ABANDONED WELLS
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ______

REMARKS, ELEVATION, SOURCE OF DATA, etc.
117-16-3108
B16-8

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

CASCADE DRILLING — Licensee Business Name
3267 — Lic. or Reg. No.

[signature] — Certified Representative Signature
2856 — Certified Rep. No.
12-13-16 — Date

ERIC SATHER — Name of Driller

MINN DEPT. OF HEALTH COPY 822173

ID #52603

HE-01205-15 (Rev. 8/13)

MINNESOTA UNIQUE WELL AND BORING NO. 822174

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING CONSTRUCTION RECORD
Minnesota Statutes, Chapter 103I

WELL OR BORING LOCATION

County Name: CARVER

Township Name	Township No.	Range No.	Section No.	Fraction
WATERTOWN	117	25	4	SE ¼ NE ¼ SW ¼

GPS LOCATION — decimal degrees (to four decimal places). Latitude ______ Longitude ______

House Number, Street Name, City, and ZIP Code of Well Location: 700 LEWIS AVE NW, WATERTOWN 55094

Show exact location of well/boring in section grid with "X." Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

SEE MAP

PROPERTY OWNER'S NAME/COMPANY NAME: CITY OF WATERTOWN

Property owner's mailing address if different than well location address indicated above:
309 LEWIS AVE S
(PO BOX 279)
WATERTOWN, MN 55388

WELL OWNER'S NAME/COMPANY NAME: CARVER COUNTY

Well/boring owner's mailing address if different than property owner's address indicated above:
600 EAST 4th St
Chaska, MN 55318

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
SAND	BR	S	0	13
Clay	GR	S	13	19

Use a second sheet, if needed.

REMARKS, ELEVATION, SOURCE OF DATA, etc.
117-16-3108
B16-9

WELL/BORING DEPTH (completed): 19 ft.
DATE WORK COMPLETED: 12-6-16

DRILLING METHOD: ☐ Cable Tool ☐ Driven ☐ Auger ☐ Rotary ☒ Other SONIC

DRILLING FLUID: N/A
WELL HYDROFRACTURED? ☐ Yes ☒ No From ____ ft. To ____ ft.

USE: ☐ Domestic ☐ Noncommunity PWS ☐ Community PWS ☐ Elevator ☒ Monitoring ☐ Environ. Bore Hole ☐ Irrigation ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☐

CASING MATERIAL: ☒ Steel ☐ Plastic ☐
Drive Shoe? ☐ Yes ☒ No ☒ Threaded ☐ Welded

CASING Diameter	To	Weight	Specifications	HOLE DIAM.
2 in.	9 ft.	3.65 lbs./ft.	SCH 40	6 in. To 19 ft.
in.	ft.	lbs./ft.		in. To ft.
in.	ft.	lbs./ft.		in. To ft.

SCREEN: YES
Make: Johnson
Type: SS
Slot/Gauze: .010
Set between 19 ft. and 9 ft.

OPEN HOLE: From 2" ft. To ____ ft.
Diam. 2"
Length 10'
FITTINGS T&C

STATIC WATER LEVEL: 7 ft. ☒ Below ☐ Above land surface. Measured from Ground. Date measured 12-6-16

PUMPING LEVEL (below land surface): N/A ft. after ____ hrs. pumping ____ g.p.m.

WELLHEAD COMPLETION
☐ Pitless/adapter manufacturer ______ Model ______
☒ Casing protection 6" Protop ☒ 12 in. above grade
☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)

Material	From	To	Amount	
NEAT CEMENT	6	0 ft.	1	☐ Yds. ☒ Bags
		ft.		☐ Yds. ☐ Bags
		ft.		☐ Yds. ☐ Bags

Driven casing seal From ____ To ____ ____ Bags

NEAREST KNOWN SOURCE OF CONTAMINATION: N/A feet ____ direction ____ type

Well disinfected upon completion? ☐ Yes ☒ No

PUMP
☒ Not installed Date installed ______
Manufacturer's name ______
Model Number ______ HP ______ Volts ______
Length of drop pipe ______ ft. Capacity ______ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ____

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

CASCADE DRILLING — Licensee Business Name; 3267 — Lic. or Reg. No.

Dale [signature] — Certified Representative Signature; 2856 — Certified Rep. No.; 12-13-16 — Date

ERIC SATHER — Name of Driller

MINN DEPT. OF HEALTH COPY 822174

ID #52603 HE-01205-15 (Rev. 8/13)

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING CONSTRUCTION RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL AND BORING NO. 822175

WELL OR BORING LOCATION

County Name: CARVER

Township Name	Township No.	Range No.	Section No.	Fraction
WATERTOWN	117	25	4	SE ¼ NE ¼ SW ¼

WELL/BORING DEPTH (completed): 19 ft.

DATE WORK COMPLETED: 12-6-16

GPS LOCATION — decimal degrees (to four decimal places). Latitude ____ Longitude ____

DRILLING METHOD: ☐ Cable Tool ☐ Driven ☐ Auger ☐ Rotary ☒ Other SONIC

House Number, Street Name, City, and ZIP Code of Well Location: 700 LEWIS AVE NW, WATERTOWN 53094

DRILLING FLUID: N/A

WELL HYDROFRACTURED? ☐ Yes ☒ No From ____ ft. To ____ ft.

Show exact location of well/boring in section grid with "X." (N, S, E, W; ½ Mile; 1 Mile)

Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

SEE MAP

USE: ☐ Domestic ☒ Monitoring ☐ Heating/Cooling ☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial ☐ Community PWS ☐ Irrigation ☐ Remedial ☐ Elevator ☐ Dewatering ☐ ____

CASING MATERIAL: ☒ Steel ☐ Plastic

Drive Shoe? ☐ Yes ☒ No ☒ Threaded ☐ Welded ☐ ____

HOLE DIAM.: 6 in. To 19 ft.

CASING Diameter: 2 in. To 9 ft. Weight 3.65 lbs./ft. Specifications SCH 40

____ in. To ____ ft. ____ lbs./ft.

____ in. To ____ ft. ____ lbs./ft.

PROPERTY OWNER'S NAME/COMPANY NAME: CITY OF WATERTOWN

Property owner's mailing address if different than well location address indicated above.

309 LEWIS AVE S
(PO BOX 279)
WATERTOWN, MN 55388

SCREEN: YES
Make: JOHNSON
Type: SS
Slot/Gauze: .010
Length: 10'
Set between 19 ft. and 9 ft.
FITTINGS: T+C

OPEN HOLE: From 2" ft. To ____ ft. Diam. 2"

STATIC WATER LEVEL: 7 ft. ☒ Below ☐ Above land surface. Measured from GROUND. Date measured 12-6-16

WELL OWNER'S NAME/COMPANY NAME: CARVER COUNTY

PUMPING LEVEL (below land surface): N/A ft. after ____ hrs. pumping ____ g.p.m.

Well/boring owner's mailing address if different than property owner's address indicated above.

600 EAST 4th St
Chaska, MN 55318

WELLHEAD COMPLETION: ☐ Pitless/adapter manufacturer ____ Model ____ ☒ Casing protection 6" Protop ☒ 12 in. above grade ☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)

Material NEAT CEMENT From 6 To 0 ft. 1 ☐ Yds. ☒ Bags
Material ____ From ____ To ____ ft. ____ ☐ Yds. ☐ Bags
Material ____ From ____ To ____ ft. ____ ☐ Yds. ☐ Bags
Driven casing seal From ____ To ____ ____ Bags

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
SAND	GR	S	0	5
Clay	GR	S	5	13
SAND	GR	S	13	15
Clay	GR	S	15	19

Use a second sheet, if needed.

NEAREST KNOWN SOURCE OF CONTAMINATION: N/A feet ____ direction ____ type

Well disinfected upon completion? ☐ Yes ☒ No

PUMP: ☒ Not installed Date installed ____
Manufacturer's name ____
Model Number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ____

ABANDONED WELLS: Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE: Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ____

REMARKS, ELEVATION, SOURCE OF DATA, etc.

117-16-3108
316-10

WELL CONTRACTOR CERTIFICATION

This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

CASCADE DRILLING — Licensee Business Name; 3267 — Lic. or Reg. No.

Dale [signature] — Certified Representative Signature; 2856 — Certified Rep. No.; 12-13-16 — Date

ERIC SATHER — Name of Driller

MINN DEPT. OF HEALTH COPY 822175

ID #52603 HE-01205-15 (Rev. 8/13)

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING CONSTRUCTION RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL AND BORING NO. 822176

WELL OR BORING LOCATION

County Name: CARVER

Township Name	Township No.	Range No.	Section No.	Fraction
WATERTOWN	117	25	4	SW ¼ NE ¼ SW ¼

GPS LOCATION — decimal degrees (to four decimal places).
Latitude ______ Longitude ______

House Number, Street Name, City, and ZIP Code of Well Location: 700 LEWIS AVE NW, WATERTOWN 53094

Show exact location of well/boring in section grid with "X." Sketch map of well/boring location. Showing property lines, roads, buildings, and direction.

N / W / E / S — ½ Mile — 1 Mile

SEE MAP

PROPERTY OWNER'S NAME/COMPANY NAME: CITY OF WATERTOWN

Property owner's mailing address if different than well location address indicated above.
309 LEWIS AVE S
(PO BOX 279)
WATERTOWN, MN 55388

WELL OWNER'S NAME/COMPANY NAME: CARVER COUNTY

Well/boring owner's mailing address if different than property owner's address indicated above.
600 EAST 4th St
CHASKA, MN 55318

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
CLAY	GR	S	0	9
SAND	GR	S	9	19

Use a second sheet, if needed.

REMARKS, ELEVATION, SOURCE OF DATA, etc.
117-16-3108
B16-7

WELL/BORING DEPTH (completed): 19 ft.
DATE WORK COMPLETED: 12-6-16

DRILLING METHOD
☐ Cable Tool ☐ Driven ☐ Auger ☐ Rotary ☒ Other SONIC

DRILLING FLUID ______
WELL HYDROFRACTURED? ☐ Yes ☒ No
From ____ ft. To ____ ft.

USE
☐ Domestic ☒ Monitoring ☐ Heating/Cooling
☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial
☐ Community PWS ☐ Irrigation ☐ Remedial
☐ Elevator ☐ Dewatering ☐ ______

CASING MATERIAL
☒ Steel ☐ Plastic
Drive Shoe? ☐ Yes ☒ No
☒ Threaded ☐ Welded

CASING Diameter / Weight / Specifications / HOLE DIAM.
2" in. To 9 ft. 3.65 lbs./ft. SCH 40 — 6 in. To 19 ft.
____ in. To ____ ft. ____ lbs./ft. — ____ in. To ____ ft.
____ in. To ____ ft. ____ lbs./ft. — ____ in. To ____ ft.

SCREEN YES
Make Johnson
Type SS
Slot/Gauze .010
Set between 19 ft. and 9 ft.

OPEN HOLE
From 2" ft. To ____ ft.
Diam. 2
Length 10'
FITTINGS T+C

STATIC WATER LEVEL
7 ft. ☒ Below ☐ Above land surface
Measured from Ground
Date measured 12-6-16

PUMPING LEVEL (below land surface)
N/A ft. after ____ hrs. pumping ____ g.p.m.

WELLHEAD COMPLETION
☐ Pitless/adapter manufacturer ______ Model ______
☒ Casing protection 6" Protop ☒ 12 in. above grade
☐ At-grade ☐ Well House ☐ Hand Pump

GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)
Material NEAT CEMENT From 6 To 0 ft. 1 ☐ Yds. ☒ Bags
Material ____ From ____ To ____ ft. ____ ☐ Yds. ☐ Bags
Material ____ From ____ To ____ ft. ____ ☐ Yds. ☐ Bags
Driven casing seal From ____ To ____ ____ Bags

NEAREST KNOWN SOURCE OF CONTAMINATION
N/A feet ____ direction ____ type
Well disinfected upon completion? ☐ Yes ☒ No

PUMP
☒ Not installed Date installed ______
Manufacturer's name ______
Model Number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ______

ABANDONED WELLS
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ______

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

CASCADE DRILLING — Licensee Business Name
3267 — Lic. or Reg. No.

Dale [signature] — Certified Representative Signature
2856 — Certified Rep. No.
12-13-16 — Date

ERIC SATHER — Name of Driller

MINN DEPT. OF HEALTH COPY 822176

ID #52603 HE-01205-15 (Rev. 8/13)

Appendix E
Well Development Logs

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-1

Project Name/Location: Watertown Project No.:

Date: 1-10-17 Weather: 27°F, Snowing

Pumping Method ☒ Pumped ☐ Other

Pump Type: Hurricane Bailer Type:

Depth to Water (D.T.W.) 8.82 Depth to Bottom (D.T.B.) 21.50

Volume Calculation: $(12.68 \times 0.163) + (0.3 \times 12 \times (1.469 - 0.163)) = 2.07 + 4.7 = 6.77$

{[H x Vw] + [N x H x (Vbh – Vw)]} = Total Well Volume **see below for variable definitions**

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1003	Initial	6.92	1.18	9.80	-187	1.04	1000	N	Dark brown
1011	6	6.90	1.21	10.20	-200	0	1000	N	light brown
1021	12	6.86	1.19	10.08	-178	13.38	141	N	clear
1032	18	6.78	1.19	10.67	-173	0	166	N	clear
1044	24	6.75	1.19	10.64	-177	0	76.4	N	clear
1056	30	6.71	1.18	10.69	-176	0	38.6	N	clear
1107	36	6.65	1.19	10.69	-174	0	29.6	N	clear

Comments: * Washed out flow through cell

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-2

Project Name/Location: Watertown

Project No.:

Date: 1-10-17

Weather:

Pumping Method ☒ Pumped ☐ Other

Pump Type: Hurrican

Bailer Type:

Depth to Water (D.T.W.) 8.61

Depth to Bottom (D.T.B.) 20.00

Volume Calculation: (11.39 x 0.163) + (0.3 x 11.7 x (1.469 - 0.163)) = 1.86 + 4.58 = 6.44

{[H x Vw] + [N x H x (Vbh – Vw)]} = Total Well Volume ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1400	Initial	6.77	1.36	11.70	-29	2.84	1000	N	dark gray
1406	6	6.74	1.36	11.64	-20	2.26	222	N	slight gray
1414	12	6.75	1.36	11.63	-21	0.96	160	N	clear
1425	18	6.75	1.37	11.60	-46	0.07	62.7	N	Clear
1435	24	6.76	1.37	11.61	-56	0	31.8	N	Clear
1444	30	6.75	1.37	11.60	-55	0	23.6	N	Clear
1455	36	6.77	1.37	11.61	-39	0	14.2	N	clear
1501	39	6.78	1.38	11.61	-40	0	8.2	N	Clear

Flow rate adjusted

Comments: WL: 1425 = 13.1

Well pumped dry after 2.5 gallons. Pumping rate reduced.

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-3

Project Name/Location: Watertown Project No.:

Date: 1-10-17 Weather: Snowing, 22°F, windy

Pumping Method ☒ Pumped ☐ Other

Pump Type: Hurricane Bailer Type:

Depth to Water (D.T.W.) 9.65 Depth to Bottom (D.T.B.) 21.20

Volume Calculation: [(21.2 - 9.65) x 0.163] + [0.3 x [12] [1.469 - 0.163] = 1.88 + 4.7

{[H x Vw] + [N x H x (Vbh – Vw)]} = Total Well Volume ***see below for variable definitions*** 6.58 gallons

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1200	Initial	6.55	1.41	11.81	-167	0	1000	N	dark gray
1205	6	6.55	1.41	11.81	-107	0	—	N	slight gray
1210	12	6.60	1.41	11.89	-118	0	880	N	faint gray
1216	18	6.81	1.41	11.97	-130	0	529	N	clear
1222	24	6.84	1.41	11.91	-136	0	308	N	clear
1230	30	6.76	1.41	11.88	-134	0	137	N	clear
1236	36	6.72	1.41	11.91	-133	0	93.9	N	clear
1244	42	6.91	1.41	11.43	-146	0	47.4	N	clear
1301	48	6.89	1.41	10.93	-144	0	20.0	N	clear
1314	51	6.89	1.41	10.73	-145	0	16.5	N	clear

cleaned outflow cell

lower pump rate

Comments:

WLs: 1205 = 11.84; 1208 = 12.04; 1230 = 12.23

1301 = 10.18

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

3890 Pheasant Ridge Dr., Suite 100 • Blaine, MN 55449 • Tel 763-489-7900 • Fax 763-489-7959 • www.carlsonmccain.com

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-4

Project Name/Location: Watertown | Project No.:

Date: 1-10-17 | Weather: Clear, 17°F, wind from north

Pumping Method ☒ Pumped ☐ Other

Pump Type: Hurricane | Bailer Type:

Depth to Water (D.T.W.) 10.26 | Depth to Bottom (D.T.B.) 20.4

Volume Calculation: $(10.14 \times 0.163) + (0.3 \times 12 \times (1.469 - 0.163)) = 1.65 + 4.7 = 6.35$

{[H x Vw] + [N x H x (Vbh – Vw)]} = Total Well Volume ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1531	Initial	6.91	1.81	12.20	-169	0	1000	Y (organics, eggs)	dark gray
1538	6	6.90	1.81	12.19	-172	0	952	Y " "	light gray
1545	12	6.89	1.81	12.19	-175	0	690	Y " "	light gray
1555	18	6.96	1.83	12.12	-188	0	207	Y " "	light gray
1607	24	6.97	1.83	11.87	-192	0	102	Y, eggs	very slight gray
1618	30	6.89	1.83	11.85	-192	0	36.4	Y, eggs	very slight gray
1630	36	6.90	1.83	11.84	-190	0	17.2	Y " "	" "
1636	40	6.89	1.83	11.86	-189	0	9.44	Y " "	" "

reduce flow rate

reduce flow rate

Comments: - Very sediment th[illegible] at start. Smells of decomposing organics, eggs
- As groundwater clears up in color, smells less like dec. organics + more like eggs.

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-1

Project Name/Location: Arboretum Project No.:

Date: 1-11-17 Weather: Snowing, 7°

Pumping Method ☒ Pumped ☒ Other

Pump Type: Hurricane Bailer Type: Plastic

Depth to Water (D.T.W.) 7.56 Depth to Bottom (D.T.B.) 26

Volume Calculation: (18.44 x 0.163) + (0.3 x 13 x (1.469 - 0.163)) = 3 + 5.09 = 8.09

{[H x Vw] + [N x H x (Vbh – Vw)]} = Total Well Volume ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1031	5	7.58	0.869	6.41	-126	4.17	1000	Slight organic odor	Brown
1044	8	7.48	0.912	6.42	-17	4.43	1000	" "	Brown
	Bailed dry. Waited 10 minutes and bailed dry again.								
1545	10.5	7.11	0.795	8.57	-110	0	—	N	clear
1604	14	6.97	0.920	9.40	-27	0	—	N	Clear
	Returned @ 1524. Almost full recovery & pumped w/ Hurricane. Dried up after 6 gallons								

Comments: Surged before bailing
WL @ 1524 = 7.82

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

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WELL DEVELOPMENT LOG SHEET

Well No. MW-2

Project Name/Location: Arboretum Project No.:

Date: 1-11-17 Weather: Overcast, 5°

Pumping Method ☐ Pumped ☒ Other

Pump Type: Bailer Type: plastic

Depth to Water (D.T.W.) 7.48 Depth to Bottom (D.T.B.) 25.5

Volume Calculation: $(18.02 \times 0.163) + (0.3 \times 13 \times (1.469 - 0.163)) = 2.94 + 5.09 = 8.03$

{[H x Vw] + [N x H x (Vbh – Vw)]} = Total Well Volume ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
11:18	5	7.40	0.907	8.05	-147	6.18	1000	Slight organic odor	Brown
1142	7.6	7.36	0.954	8.53	-36	6.07	1000	" "	Brown
	Bailed dry. Waited 15 minutes. Bailed dry again.								
1500	9.1	7.40	1.02	7.03	48	8.65	1000	" "	Brown
	Returned and bailed dry.								

Comments: Surged then bailed
1300 WL before bailing = 19.1'

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-3

Project Name/Location: Arboretum   Project No.:

Date: 1-11-17   Weather: Overcast, 7°

Pumping Method ☒ Pumped ☒ Other

Pump Type: Hurricane   Bailer Type: Plastic

Depth to Water (D.T.W.) 10.67   Depth to Bottom (D.T.B.) 26.6

Volume Calculation: (15.93×0.163) + (0.3×13× (1.469-0.163)) = 2.6 + 5.09 = 7.69

{[H x Vw] + [N x H x (Vbh – Vw)]} = Total Well Volume   ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1211	6	7.39	1.34	9.37	-109	5.72	1000	N	slight reddish brown
1228	10	7.38	1.34	9.31	1	4.84	1000	N	" "
	Bailed dry. Waited 10 minutes and bailed dry again. Returned @ 1350 to pump dry.								
1358	12	6.92	1.34	9.14	-67	1.39	297	N	clear
1411	14	6.90	1.34	8.86	-38	0	119	N	clear
1445	20	6.80	1.35	9.28	26	0	47.2	N	clear
	Went dry/trickle after 20 gal removed								

Comments: Surged + bailed
1423 WL @ 20.5 and decreasing @ 0.1/15 seconds

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3   H=D.T.B – D.T.W

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Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-4

Project Name/Location: Arboretum Project No.:

Date: 1-11-17 Weather:

Pumping Method ☐ Pumped ☒ Other

Pump Type: Bailer Type: Plastic

Depth to Water (D.T.W.) 15.41 Depth to Bottom (D.T.B.) 26.25

Volume Calculation: $(10.84 \times 0.163) + (0.3 \times 13.9 \times (1.469 - 0.163)) = 1.77 + 5.29 = 7.06$

$\{[H \times Vw] + [N \times H \times (Vbh - Vw)]\}$ = Total Well Volume ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1303	3	7.80	0.906	9.82	-130	7.50	1000	N	Brown
1309	1	7.84	0.910	9.75	-127	7.22	1000	N	Brown
	Bailed dry. Waited + bailed dry again.								
1330	Bailed 1 more gallon before well went dry.								
	Returned @ 1627 and bailed dry. (about 0.2 gallons)								

Comments: Surged + bailed

WL @ 1627 = 24.33'

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-4

Project Name/Location: Arboretum Project No.:

Date: 1-11-17 Weather:

Pumping Method ☐ Pumped ☒ Other

Pump Type: Bailer Type: Plastic

Depth to Water (D.T.W.) 15.41 Depth to Bottom (D.T.B.) 26.25

Volume Calculation: $(10.84 \times 0.163) + (0.3 \times 13.5 \times (1.469 - 0.163)) = 1.77 + 5.29 = 7.06$

$\{[H \times Vw] + [N \times H \times (Vbh - Vw)]\}$ = Total Well Volume ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1303	3	7.80	0.906	9.82	-130	7.50	1000	N	Brown
1309	1	7.84	0.910	9.75	-127	7.22	1000	N	Brown
	Bailed dry. Waited + bailed dry again.								
1330	Bailed 1 more gallon before well went dry.								
	Returned @ 1627 and bailed dry. (about 0.2 gallons)								

Comments: Surged + bailed
WL @ 1627 = 24.33'

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B – D.T.W

Carlson McCain

WELL DEVELOPMENT LOG SHEET

Well No. MW-3

Project Name/Location: Arboretum Project No.:

Date: 1-11-17 Weather: Overcast, 7°

Pumping Method ☒ Pumped ☒ Other

Pump Type: Hurricane Bailer Type: Plastic

Depth to Water (D.T.W.) 10.67 Depth to Bottom (D.T.B.) 26.6

Volume Calculation: (15.93 x 0.163) + (0.3 x 13 x (1.469 - 0.163)) = 2.6 + 5.09 = 7.69

{[H x Vw] + [N x H x (Vbh − Vw)]} = Total Well Volume ***see below for variable definitions***

Time	Volume Removed (gal.)	pH	Cond. (uS/cm)	Temp. (°C)	ORP (mv)	DO (ppm)	Turbidity (ntu)	Odor Y/N	Color
1211	6	7.39	1.34	9.37	-109	5.72	1000	N	slight reddish brown
1228	10	7.38	1.34	9.31	1	4.84	1820	N	" "
	Bailed dry. Waited 10 minutes and bailed dry again. Returned @ 1350 to pump dry.								
1358	12	6.92	1.34	9.14	-67	1.39	297	N	clear
1411	14	6.90	1.34	8.86	-38	0	119	N	clear
1445	20	6.80	1.35	9.28	26	0	47.2	N	clear
	Went dry/trickle after 20 gal removed								

Comments: Surged + bailed
1423 WL @ 20.5 and decreasing @ 0.1/15 seconds

Borehole Dia.	Borehole gal./ft. (Vbh)	Inside Well Diameter	Well gal./ft. (Vw)
6.5"	1.723	1"	0.041
8"	2.611	2"	0.163
10"	4.080	4"	0.653
12"	5.875	6"	1.469

N=Porosity = 0.3 H=D.T.B − D.T.W