4.0 Investigation Results

This section describes the results of the investigation conducted in the spring of 2018 (Phase A). Included in this discussion of results is the description of the different solid media encountered and their distribution across the Site. Additionally, solid media and water quality results are presented in comparison to relevant health-based risk criteria.

4.1 Solid Media Characterization

Unconsolidated materials (including waste material, fill, and native sediments) were described in the field by Barr. Materials were described using methods included in ASTM D-2488, Standard Practice for Description and Identification of Soils. General descriptions of the primary unconsolidated materials encountered at the Site are provided below.

4.1.1 Non-Native Material

4.1.1.1 Fill

Fill material used as cover soil was observed at all investigation locations. This fill material generally consisted of a few inches of root zone material (topsoil with a fine sandy loam texture) underlain by sand to silty sand with varying percentages of coarse-grained sediment. Fill material was also observed directly below the operations building at the Transfer Station.

4.1.1.2 Waste Material

For the purposes of this investigation, waste material was divided into two classifications: (1) municipal solid waste/construction debris (MSW/CD) and (2) ash, as described in the following paragraphs.

MSW/CD stockpile at FD-TT-01

Ash sidewall at FD-TT-03

Municipal Solid Waste/Construction Debris

MSW/CD was encountered across most of the site. Municipal solid waste consisted of paper, plastics, glass, wood, metal, and rubber and was sometimes mixed with fill material. Construction debris varied,

typically including bricks, concrete, wood, shingles, and insulation. The level of decomposition varied as well, with some areas appearing relatively dry and containing readable lines of newspaper, whereas other pockets of waste material were well degraded and had a noticeable odor of decomposition.

Ash

Ash was observed only at investigation locations at the Dump. Ash is generally described as gray, or black, non-plastic, silt to fine grained sand-size material and was differentiated from native sediments by strength and texture comparisons. The ash encountered at the Dump was mostly fine-grained and non-cemented, making it appear as a possible native gray silt except that it often was intermixed with waste material. The ash was generally observed either above and/or below the waste material.

4.1.2 Native Sediments

Native sediments encountered during the investigation included alluvial or glacial sediment deposits. In general, native sediments were encountered below the waste material. The most commonly observed native sediment was a dark brown fibrous peat, but lean to fat clays, organic clays, silts, and sandy soils were also present in some locations.

4.2 Freeway Dump

The subsurface conditions at Dump are based on the soil borings and test excavations that were completed as shown on Figure 4. Boring logs and test excavation field logs are provided in Appendix B and Appendix C, respectively, and the observations are summarized below:

4.2.1 Subsurface Conditions

Subsurface conditions at the Freeway Dump generally consist of non-native fill material overlaying waste material (MSW/CD and ash), which overlay native sediments and/or bedrock. Cross section locations are displayed on Figure 6, and four cross sections of the Dump are included as Figure 6A, Figure 6B, Figure 6C, and Figure 6D.

4.2.1.1 Non-Native Material

Fill

Fill soil was encountered at all thirty-five soil borings and fourteen test excavations at the Dump. The fill soil cover thickness over the waste ranged from 0.5 to 12.5 feet, but generally was observed to be between two to five feet thick. The greatest thicknesses of fill soil were encountered along the west side of the Dump property, where several borings were positioned on top of landscaped berms.

Field screening of the fill soil did not identify evidence of contamination such as staining, odors, discoloration, and/ or sheen. Soil headspace readings ranged between 0.0 and 6.9 parts per million (ppm).

Waste Material

Waste material encountered at the Dump consisted of a combination of MSW/CD and ash.

MSW/CD was encountered at 34 (of 35) soil borings and 11 (of 14) test excavations at the Dump. The top of the MSW/CD was generally observed below the fill soil layer and in some locations, below a layer of ash. MSW/CD was observed at varying thicknesses throughout the Dump, but was generally between 10 and 20 feet thick. The greatest thickness of MSW/CD observed was approximately 30 feet at FD-SB-A3 in the north-central portion of the Dump. The thinnest intervals of MSW/CD were identified at the westernmost borings (FD-SB-A1 through FD-SB-G1), where thicknesses averaged less than 2.5 feet. MSW/CD was sometimes observed intermixed with fill soil or ash. In general, this mixing occurred where the material layers contact.

Test excavations were completed around the perimeter of the Dump to determine the extent of the waste material. MSW/CD were not observed in any of the three test excavations along the west parcel boundary of the Dump. It appears that MSW/CD extends beyond the north, south, and east parcel boundaries, where it was observed in test excavations at thicknesses of up to 8 feet.

Field screening results varied greatly throughout the MSW/CD in the Dump. Decomposition, chemical-like, and/or petroleum odors were observed in varying degrees in the MSW/CD. Sheens were also encountered, ranging from trace to heavy rainbow sheen. PID soil headspace readings were generally elevated (above 10 ppm), and ranged from 0.0 to 343 ppm. Headspace readings above 100 ppm were observed at seven borings and two test excavations, all of which were generally located in the eastern portion of the Dump. Maximum headspace readings from investigation locations are displayed on Figure 7. Field screening results are presented in the boring logs and test excavation field logs included as Appendices B and C.

Ash was identified in 25 (of 35) borings and 13 (of 14) test excavations at the Dump. Ash was observed both above and below the MSW/CD, and its thickness ranged between 0 and 13 feet. In general, ash is more commonly observed above the MSW/CD on the east half of the property and below the MSW/CD on the west half of the property. Ash was occasionally encountered mixed with a minor amount of debris/plastic sheeting.

Field screening in the ash did not identify evidence of contamination such as staining, discoloration, odor, and/ or sheen. PID headspace readings ranged between 0.0 to 4.5 ppm.

4.2.1.2 Native Sediments / Bedrock

Native soil was identified beneath the waste and above bedrock in 22 (of 35) borings completed at the Dump. Native soil generally consists of alluvial deposits of peat overlaying a thin layer of organic silt/fat clay. Peat was present in 21 of the 22 soil borings at the Dump where native soil was observed above bedrock. Organic silt and/ or clay was present beneath the peat in 11 out of the 22 borings. Peat thickness ranged from 1 to 10 feet, but generally, peat layers were observed to be between two and five feet thick. The silts and clays underlying the peat were generally no thicker than one foot.

Poorly graded sand and clayey sand is present beneath the waste material at two boring locations in the northeast portion of the Dump (FD-SB-B5 and FD-SB-C5). Native sand was not observed in any of the other borings or test excavations completed at the Dump during this investigation.

Waste material was observed in direct contact with bedrock at 13 (of 35) boring locations. The uppermost bedrock beneath the Dump Site is a sandy dolostone of the Prairie du Chien Group. The depth to bedrock encountered during the investigation varied from 14 to 40 feet bgs. Bedrock was encountered at higher elevation (approximately 716 feet above MSL) in the southern portion of the site, and generally slopes downward to the north edge of the property (approximately 684 feet above MSL) towards the Minnesota River.

4.2.1.3 Groundwater

Water was observed at 2 (of 14) test excavations and in the temporary wells of 18 (of 35) soil borings and was most commonly observed on the eastern portion of the site (Figure 4). Although water was present at 18 of the temporary wells, the water level was just above the bottom of the screen and there was insufficient recharge to collect any sample at 8 of those 18 locations. Water samples were collected from the remaining 10 temporary wells and the 2 test excavations.

Groundwater observations generally align with previous investigations that describe the unconfined water table at the Dump as existing above and below the interface of the unconsolidated material and bedrock (MPCA, 1992). The variability of measurable groundwater observed during this investigation is likely due to low permeability soils that restrict the recharge of water to the temporary wells. For these reasons, true groundwater elevations and flow directions could not be ascertained during this investigation.

4.2.1.4 Soil Gas

Measurements made with the multi-gas meter indicated methane concentrations ranged from 0.0% to 36.9% across the Dump site. Carbon dioxide concentrations ranged from 0.0% to 28.6% and oxygen concentrations ranged from 0.0% to 21.6%. As would be expected, the concentrations of methane and carbon dioxide generally had an inverse relationship compared with the concentration of oxygen. Landfill gas concentrations are shown on Figure 7 and in Table 4.

4.2.2 Analytical Results

Analytical results for samples collected at the Dump are presented in Appendix D and laboratory reports are included in Appendix E. Key analytical results are summarized in the subsequent sections.

Solid media were compared to the MPCA's soil reference values (SRVs) and soil leaching values (SLVs). The SRVs are conservative, risk-based criteria that are dependent on land use scenarios. Concentrations from solid media samples collected from the Dump were compared to both Recreational and Industrial SRVs. The SLVs provide a conservative estimate of the potential for contaminants detected in soil to leach to the groundwater. A summary of concentrations in soil samples at the Dump that exceeded the above mentioned values is provided as Table 5.

For the purpose of results discussion in the subsequent sections, diesel range organics (DRO) and gasoline range organics (GRO) concentrations were compared to the criteria (100 mg/kg) included in the MPCA's Best Management Practice for Off-Site Reuse of Unregulated Fill (Unregulated Fill: MPCA, 2012). The applicability of these criteria have yet be determined and will depend on future land use decisions.

Concentrations detected in water samples were compared to drinking water (EPA maximum contaminant levels and MDH health-based guidance) and surface water (Class 2B) criteria. A summary of concentrations in water samples at the Dump that exceeded the above mentioned criteria is provided as Table 6.

Background Concentrations of Select Metals

Previous investigations of the surrounding area have concluded that the background concentrations of arsenic, iron, manganese, and vanadium often exceed SRVs and SLVs. Therefore the range of background concentrations will be taken into account when discussing exceedances in the following sections. A comparison of criteria to background concentrations is provided in the following table:

Parameter	Criteria (mg/kg)			Dakota County Background Range*			
	SLV	Industrial SRV	Recreational SRV	Soil (0.2 – 0.5 m)		Soil Parent Material (1 – 2 m)	
Arsenic	5.8	20	11	7	12	12	17
Iron	NA	75,000	12,000	17,000	30,000	34,000	90,000
Manganese	130	8,100	5,000	498	1,284	NA	NA
Vanadium	4	250	40	72	93	93	115

*Data range from summary maps: OFR09-02, Minnesota Soil, Till, and Ground-Water Geochemical Data. Lively, R.S.; Thorleifson, L.Harvey (Minnesota Geological Survey, 2009) http://conservancy.umn.edu/handle/11299/117364

4.2.2.1 Non-Native Material

Fill

One sample of fill soil was collected from location FD-SB-G1 in the southwest corner of the Dump. Arsenic was detected above the recreational SRV and the SLV at this location and manganese and vanadium were detected above the SLV, however these metals were detected below or within their background range as discussed in Section 4.1.2. DRO was detected at a concentration of 68.1 mg/kg, which is below the MPCA's Best Management Practice for Off-Site Reuse of Unregulated Fill (Unregulated Fill: MPCA, 2012).

Ash

Seven samples of ash were collected for chemical analysis from the Dump. Samples were collected from ash encountered both below and above the MSW/CD, as well as in some locations where MSW/CD were not present.

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances		
		MPCA Tier 2 Recreational SRV	MPCA Tier 2 Industrial SRV	MPCA Screening SLV
Metals	7	7	5	7
B(a)P equivalent	7	1	1	1
Pentachlorophenol (SVOC)	7	0	0	1

Concentrations of vanadium were detected above the recreational SRV at all locations and above industrial SRVs at one sample location. Concentrations of vanadium were detected above background concentrations in five of the seven samples. Industrial SRVs as well as background concentrations were exceeded for arsenic in five of the seven samples. Manganese concentrations were detected above SLVs at all locations, but were below or within the background range at all locations. Iron concentrations were detected above recreational SRV at all locations, but were also below or within the background range at all locations. DRO was detected at a concentration of 33.7 mg/kg in one sample.

MSW and Construction Debris

Thirty-six samples of MSW/CD were collected for chemical analysis from the Dump. Samples were collected from locations where field screening results showed evidence of contamination. A summary of the constituents that exceeded SRVs or SLVs is provided below:

Parameter	Samples Analyzed	Number of Sample Locations with SRV Exceedances		
		MPCA Tier 2 Recreational SRV	MPCA Tier 2 Industrial SRV	MPCA Screening SLV
Metals	36	34	11	36
VOCs	36	2	1	18
PCBs	36	18	7	30
B(a)P equivalent	36	12	10	15
SVOCs	36	1	1	13

Metal constituents that exceeded SRV criteria most frequently were iron (36 locations, 4 above background), arsenic (27 locations, 9 above background), vanadium (24 locations, 5 above background), mercury (15 locations), lead (14 locations), and copper (11 locations). Antimony exceeded SRV criteria at two locations. Barium, cadmium, nickel, and zinc exceeded SRV criteria at only one location each. Manganese concentrations were detected above SLVs at all locations, but were below or within the background range at all but two locations.

DRO was detected at all 36 samples locations with concentrations ranging from 23.3 mg/kg to 6,590 mg/kg, with 13 locations exceeding 1,000 mg/kg. GRO was detected at 21 locations with concentrations ranging from 14.6 mg/kg to 854 mg/kg, with 9 locations exceeding 100 mg/kg. Although DRO and GRO do not have an SRV, elevated GRO/DRO concentrations typically indicate the presence of petroleum impacts.

4.2.2.2 Native Sediments

Four samples of native sediments were collected for chemical analysis from the Dump.

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances		
		MPCA Tier 2 Recreational SRV	MPCA Tier 2 Industrial SRV	MPCA Screening SLV
Metals	4	2	0	4
B(a)P equivalent	4	1	0	1
Benzene	4	0	0	3
Bis(2-ethylhexyl)phthalate	4	0	0	1
PCBs	4	0	0	1

Arsenic, iron, manganese, and vanadium were detected above SLVs or SRVs at all locations, but reported the concentrations were below or within their background ranges as discussed in Section 4.1.2. Boron was detected above SLVs at all locations. Lead was detected above the recreational SRV at one location (Table 5). DRO concentrations were detected at three locations ranging from 71.0 mg/kg to 409 mg/kg.

4.2.2.3 Groundwater

Twelve groundwater samples were collected for chemical analysis from soil borings and test excavations at the Freeway Dump. Five samples were analyzed for a full list of parameters, and seven were analyzed for a partial list, as noted in Table 3. A summary of samples that exceeded criteria is provided in the table below:

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances			
		EPA Maximum Contaminant Levels	MDH Human Health-Based Water Guidance	MN Surface Water 2Bd (Chronic)	MN Surface Water 2Bd (Acute)
Metals	10	2	10	7	3
VOCs	12	6	9	7	0
1,4 Dioxane	11	*NA*	10	*NA*	*NA*
PFOA	11	*NA*	10	*NA*	*NA*
PFOS	11	*NA*	9	*NA*	*NA*
Chlorine Dioxide	5	3	NA	*NA*	*NA*
Nitrogen, ammonia, as N	10	*NA*	*NA*	10	*NA*
Cyanide	10	0	*NA*	9	1
Gross Beta (radiation)	6	4	*NA*	*NA*	*NA*

NA – not applicable, no criteria available

Metal detections above criteria were widespread, but the specific metals were generally sporadic, with the exception of the test excavation samples, though this is like due to the high concentration of sediments in the samples (Table 6). Boron was the metal most commonly detected above drinking water standards, and exceeded standards at ten sample locations. Manganese was detected above drinking water standards at nine sample locations. As noted in Section 3.2.3, the hexavalent chromium results did not meet QA/QC criteria and were deemed unusable.

Benzene was detected above drinking water standards at seven sample locations and was detected above surface water standards at a total of six sample locations. Vinyl chloride was detected above drinking water standards at four sample locations and was detected above surface water standards at three sample locations. Other than benzene and vinyl chloride, VOCs did not exceed drinking water standards from samples collected at any location at the Dump, except for FD-SB-B3 where nine VOCs were detected above drinking water standards and six VOCs were detected above surface water standards.

4.3 Freeway Landfill

Nine test excavations were completed at the Landfill to verify the subsurface conditions at the north and southeast property boundaries. Test excavation field logs are provided in Appendix C. Investigation locations are shown on Figure 5, and observations are summarized below:

4.3.1 Subsurface Conditions

The test excavation investigation conducted at the Landfill identified fill soil and waste material as well as native silt, sand, and clay. A description of each type of material encountered is provided in the following subsections.

4.3.1.1 Non-Native Material

Fill

Fill soil covering the waste materials ranged from one to five feet thick, with an average thickness of two feet. The fill soil typically included a top soil cover. Gray silty sand fill was identified below the cover soil at the three western-most excavations (FL-TT-01, FL-TT-02, and FL-TT-02a). The gray silty sand fill was one foot thick at all three locations and was mixed with small amounts of concrete, bricks, glass, plastic, and wood.

Field screening in the fill material did not identify evidence of contamination such as staining, odors, discoloration, and/or sheen. PID soil headspace readings ranged between 0.1 and 5.4 ppm.

Waste Material

Waste material encountered at the Freeway Landfill consisted of a combination of MSW/CD and was generally consistent with that observed at the Dump, with the exception that no ash was encountered. Waste material was encountered in seven of the nine borings completed at the Landfill. The top of the waste material was observed below fill soil between one and five feet bgs. Waste material was observed to be between six and twelve feet thick, with an average thickness of 8.5 feet. Waste material was not encountered in FL-TT-06 and FL-TT-07 in the northeast portion of the Landfill site.

Decomposition, chemical, and petroleum odors were observed throughout the waste material. Sheens were also encountered, ranging from trace to heavy rainbow. PID headspace readings in the waste material were generally below 10 ppm, with the exception of FL-TT-02 (20.5 ppm, 2-10 feet bgs) and FL-T-05 (29.2 ppm, 5-15 feet bgs). Maximum headspace readings from investigation locations are displayed on Figure 8. Field screening results are presented in the test excavation field logs included as Appendix C.

4.3.1.2 Native Sediments

Native sediment beneath the waste material at the Landfill consisted of gray silt with sand to silty sand. The top of this layer was present between 10 and 15 feet bgs at 5 out of the 9 excavations. Several of the excavations were terminated within the waste material and therefore the presence of underlying native sediments could not be assessed. No field screening impacts were observed in this layer, and PID headspace readings were below 1.1 ppm.

Alluvial deposits of silty sand, clayey sand, silt, and clay were identified at the two locations in the northeast portion of the site where no waste material was encountered (FL-TT-06 and FL-TT-07). No field screening impacts were observed at these locations, and PID headspace readings were below 0.5 ppm.

4.3.1.3 Groundwater

Measurable groundwater was observed in six of the eight test excavations completed at the Landfill (Figure 5). Depth to groundwater was measured from the ground surface of the excavation to the surface of the standing water at the base of the excavation. Groundwater depths are variable across the site, and were observed between 5 and 11 feet bgs. The variability of measurable groundwater observed during this investigation is likely due to low permeability soils that restrict the recharge of water within the test excavations

4.3.2 Analytical Results

Analytical results for samples collected at the Landfill are presented as a table in Appendix D and laboratory reports are included in Appendix E. Key analytical results are summarized in the subsequent sections.

Results from solid media and groundwater samples were compared to criteria as described in Section 4.1.2. A summary of concentrations in soil samples from the Landfill that exceeded the above mentioned criteria is provided as Table 7. A summary of concentrations in groundwater samples at the Landfill that exceeded the above mentioned criteria is provided as Table 8.

4.3.2.1 Waste Material

Waste samples were collected for chemical analysis from six test excavation locations at the Freeway Landfill. A summary of the constituents that exceeded SRVs and SLVs is provided below:

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances		
		MPCA Tier 2 Recreational SRV	MPCA Tier 2 Industrial SRV	MPCA Screening SLV
Metals	6	5	2	6
B(a)P equivalent	6	1	1	1
Butyl benzyl phthalate	6	1	1	1
1,4-Dichlorobenzene	6	0	0	4
Benzene	6	0	0	1
Tetrachloroethylene	6	0	0	1
PCBs	6	2	1	4

Manganese and vanadium were detected above SLVs or SRVs at all locations, but their concentrations were below background ranges as discussed in Section 4.1.2. Arsenic was detected above industrial SRVs and its background range at one location. Iron was detected above industrial SRVs and its background range at two sample locations. Cadmium was detected above recreational SRVs at one location. Copper was detected above recreational SRVs at four sample locations. Lead was detected above recreational SRVs at two sample locations.

DRO was detected at all six sample locations with concentrations ranging from 171 mg/kg to 3,370 mg/kg, with samples from two locations exceeding 1,000 mg/kg. GRO was detected in samples from two locations at concentrations of 40.2 mg/kg and 74.1 mg/kg (Appendix D). Although DRO and GRO do not have an SRV they can be indicators of petroleum impacts.

4.3.2.2 Native Sediments

Two samples of native soil were collected from the Landfill test excavations (FL-TT-06 and FL-TT-07).

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances		
		MPCA Tier 2 Recreational SRV	MPCA Tier 2 Industrial SRV	MPCA Screening SLV
Metals	2	1	0	2

Arsenic, iron, manganese, and vanadium were detected above SLVs or SRVs at both locations, but their concentrations were below or within their background ranges as discussed in Section 4.1.2.

4.3.3 Groundwater

Six groundwater samples were collected for chemical analysis from test excavations at the landfill. Five samples were analyzed for a full list of parameters, and one was analyzed for a partial list, as indicated in Table 3. A summary of samples that exceeded criteria is provided in the table below:

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances			
		EPA Maximum Contaminant Levels	MDH Human Health-Based Water Guidance	MN Surface Water 2Bd (Chronic)	MN Surface Water 2Bd (Acute)
Metals	6	0	6	5	2
PFOA	6	*NA*	6	*NA*	*NA*
PFOS	6	*NA*	5	*NA*	*NA*
Benzene	6	0	1	0	0
1,4 Dioxane	6	*NA*	1	*NA*	*NA*
Chlorine Dioxide	5	3	NA	*NA*	*NA*
Nitrogen, ammonia, as N	6	*NA*	*NA*	6	*NA*
Cyanide	6	0	*NA*	2	0
Bis(2-ethylhexyl)phthalate	6	0	0	2	*NA*

NA – not applicable, no exceedance criteria available

Metal detections above criteria were generally sporadic, with the exception of the test excavation samples, though this is like due to the high concentration of sediments in the samples. Aluminum, boron, and manganese were the metal constituents detected above drinking water standards at one or more test excavations. Aluminum, arsenic, cobalt, lead, and zinc were the metal constituents detected above surface water standards at one or more test excavations.

4.4 Freeway Transfer Station

Eight soil borings were completed at the Transfer Station to assess the subsurface conditions beneath and adjacent to the operations building. All eight soil borings were advanced to the top of bedrock. Soil samples were screened in the field using methods described in Section 3.2.1. Investigation locations are shown on Figure 5, and observations are summarized below:

4.4.1 Subsurface Materials

Subsurface materials at the Transfer Station generally consist of non-native fill material overlaying waste material, which overlay native sediments and/or bedrock. Waste material was not present at the two borings completed within the operations building (SB-TS-02 and SB-TS-07). Cross section locations are displayed on Figure 6. Two geologic cross sections of the Transfer Station site are presented as Figure 6E and Figure 6F.

4.4.1.1 Non-Native Material

Fill material

Cover soil at boring locations not completed within the operations building ranged from 2.5 to 7 feet thick. At soil borings completed within the operations building (SB-TS-02 and SB-TS-07), fill material was observed from below the building floor slab to bedrock at approximately 25 feet bgs (Figure 6E).

Trace sheen and moderate odor were observed in borings TS-SB-02 and TS-SB-05. No field screening impacts were identified in the fill material at any other boring locations at the Transfer Station.

Waste Material

Waste material consisting of MSW/CD was encountered beneath the surficial fill at all six borings completed outside of the operations building at the Transfer Station. The top of the waste material was identified between 2.5 and 7 feet bgs and extended to depths of up to 28 feet bgs. Waste material was observed to be between 6.4 and 25 feet thick, with an average thickness of 11 feet. The greatest waste thickness was observed at boring SB-TS-08 where the ground surface is approximately 14 feet higher than the rest of the soil borings.

Light to strong decomposition odors were identified throughout the waste material. Strong petroleum odor and moderate sheen were identified in the waste material at TS-SB-01. PID headspace readings in the waste material were generally elevated, and ranged from 0.5 to 36.7 ppm.

4.4.1.2 Native Sediments / Bedrock

Native soil was observed above the bedrock at 4 out of 8 borings completed at the Transfer Station. The primary native soil observed above bedrock at the Transfer Station was an alluvial deposit of high-plasticity organic clay, which was present at all 4 of the soil borings where native soil was observed. A thin layer of peat was observed above the organic clay at one soil boring location (TS-SB-01), and silty sand was present at one boring beneath the organic clay and above the bedrock (FD-SB-05). Waste material was observed in direct contact with bedrock at TS-SB-04 and TS-SB-08.

The uppermost bedrock beneath the Transfer Station is a sandy dolostone of the Prairie du Chien Group. The depth to bedrock encountered at the Transfer Station during the investigation varied from 16 to 28 feet bgs, and bedrock elevations vary from approximately 686 feet above MSL to 698 feet MSL.

4.4.1.3 Groundwater

Groundwater level data were collected from the temporary monitoring wells after groundwater stabilized and before groundwater sampling began. Measurable groundwater was observed in four of the eight soil borings at the Transfer Station (Figure 5). Groundwater elevations are variable across the site, and range from approximately 706 feet MSL to 690 feet MSL.

The variability of measurable groundwater observed during this investigation is likely due to low permeability soils that restrict the recharge of water within the temporary wells. Further, groundwater that was encountered during the investigation may be perched on top of bedrock or within the low permeability waste materials.

4.4.1.4 Soil Gas

Measurements made with the multi-gas meter indicated methane concentrations ranged from 0.0% to 65.6% across the Transfer Station. Carbon dioxide concentrations ranged from 0.0% to 35.9% and oxygen concentrations ranged from 0.9% to 21.6%. As observed at the Dump, and as would be expected, the

concentration of methane and carbon dioxide appeared to have an inverse relationship with the concentration of oxygen. Landfill gas concentrations are shown on Figure 8 and in Table 4.

4.4.2 Analytical Results

Analytical results for the Transfer Station are presented as a table in Appendix D and laboratory reports are included in Appendix E. Results from solid media and water samples were compared to criteria as described in Section 4.1.2. A summary of concentrations in soil samples at the Transfer Station that exceeded the above mentioned criteria is provided as Table 7. A summary of concentrations in water samples at the Transfer Station that exceeded the above mentioned criteria is provided as Table 8.

4.4.2.1 Non-Native Material

Fill material

Two samples of fill soil were collected from under the operations building at the Freeway Transfer Station.

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances		
		MPCA Tier 2 Recreational SRV	MPCA Tier 2 Industrial SRV	MPCA Screening SLV
Metals	2	0	0	2

Manganese and vanadium were detected above SLVs at both locations, but the concentrations were below or within their background ranges as discussed in Section 4.1.2. DRO was detected at location TS-SB-02 at a concentration of 12.4 mg/kg.

Waste material

Samples of waste material were collected from six locations at the Transfer Station. A summary of the constituents that exceeded the SRVs and SLVs provided below:

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances		
		MPCA Tier 2 Recreational SRV	MPCA Tier 2 Industrial SRV	MPCA Screening SLV
Metals	6	3	0	5
B(a)P equivalent	6	2	1	3
Bis(2-ethylhexyl)phthalate	6	0	0	1
1,1,2,2-Tetrachloroethane	6	0	0	1
Benzene	6	0	0	1
1,4-Dichlorobenzene	6	0	0	1
Naphthalene	6	0	0	1
PCBs	6	0	0	1

Manganese and vanadium were detected above SLVs or SRVs at all locations, but the reported concentrations were below or within their background ranges as discussed in Section 4.1.2. Iron was detected above the recreational SRV but below or within its background range at two locations. Arsenic

was detected above the recreational SRV but below or within its background range at one location. Lead was detected above its recreational SRV two locations and copper was detected above its recreational SRV one location. DRO was detected at all six locations at concentrations ranging from 371 mg/kg to 3,820 mg/kg. GRO was detected at locations TS-SB-01, TS-SB-05, and TS-SB-08 at concentrations of 53.6 mg/kg, 38.9 mg/kg, and 47.7 mg.kg, respectively.

4.4.2.2 Water

Four groundwater samples were collected for chemical analysis from the eight soil borings completed at the Transfer Station. One sample was analyzed for the full list of parameters, and three were analyzed for a partial list of parameters (Table 3). A summary of samples that exceeded health based criteria is provided in the table below:

Parameter	Samples Analyzed	Number of Sample Locations with Exceedances			
		EPA Maximum Contaminant Levels	MDH Human Health-Based Water Guidance	MN Surface Water 2Bd (Chronic)	MN Surface Water 2Bd (Acute)
Metals	4	2	4	4	2
PFOA	4	*NA*	4	*NA*	*NA*
PFOS	4	*NA*	4	*NA*	*NA*
Benzene	4	0	1	0	0
1,4 Dioxane	4	*NA*	4	*NA*	*NA*
3,4-Methylphenol	4	*NA*	1	*NA*	*NA*
Nitrogen, ammonia, as N	4	*NA*	*NA*	1	*NA*
Cyanide	4	0	*NA*	1	0
Chloride	4	*NA*	*NA*	1	0

NA – not applicable, no exceedance criteria available

Twelve metal constituents were detected above surface water standards at one or more soil boring location. All twelve of these metal constituents were observed above surface water standards at TS-SB-07, seven were detected above surface water standards at TS-SB-05, four were detected above surface water standards in TS-SB-08, and one was detected above surface water standards in TS-SB-02 (arsenic).

Thirteen metal constituents were detected above drinking water standards at one or more soil boring location. All thirteen constituents were detected above drinking water standards at TS-SB-07, six were detected above drinking water standards at TS-SB-05, and two were detected above drinking water standards at TS-SB-02 and TS-SB-08.