



Memorandum

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Subject: *Geotechnical Field Exploration Program and Environmental Site Assessment
Tobin School Assessment
Cambridge, Massachusetts*

Introduction

This memorandum summarizes the results of CDM Smith's Phase 1 and Phase 2 geotechnical and environmental subsurface exploration and laboratory testing programs, groundwater sampling, and permeability testing conducted from July 2017 to March 2018 for the proposed new Tobin School campus located in Cambridge, Massachusetts. This memorandum includes available subsurface data collected for this project and supplements the previous conceptual geotechnical and environmental assessments included in the following documents: *Summary of Geotechnical Field Exploration Programs and Conceptual Geotechnical Engineering Considerations and Recommendations*, dated November 17, 2017 and *Environmental Site Assessment Summary*, dated October 26, 2017.

Purpose and Scope

The purpose of this memorandum is to summarize the data gathered during the Phase 1 and Phase 2 geotechnical and environmental field programs for the Tobin and Vassal Lane Upper School campus. This data is intended for use by the City of Cambridge (City) to develop a list of alternative options for design and construction of the new school campus. In particular, the scope of work included the following tasks:

- Review existing drawings and available subsurface information;
- Conduct a Phase 1 subsurface exploration program consisting of fifteen (15) test borings (CDM-1 through CDM-15) to depths ranging from 40 to 94 feet below ground surface (bgs) and obtain soil and rock samples for geotechnical and environmental laboratory testing;
- Install five (5) pairs of groundwater monitoring wells for a total of ten (10) wells. Each monitoring well pair included one (1) shallow groundwater monitoring well and one (1) deep groundwater monitoring well for groundwater elevation monitoring and groundwater sampling;
- Install and sample twenty-eight (28) landfill gas probes around the entire property line
- Screen for the presence of landfill gas at the ten (10) groundwater wells as well as existing on-site and off-site utility manholes.
- Conduct a Phase 1 test pit program consisting of two (2) test pits (TP-101 and TP-102) to depths ranging from 12 to 13.5 feet bgs to explore the physical composition of the fill materials;
- Conduct a Phase 2 subsurface exploration program consisting of twenty-two (22) test borings (CDM-101A through CDM-120) to depths ranging from 5 to 36 feet bgs to observe the limits of the waste material and obtain soil samples for geotechnical laboratory testing;
- Conduct a Phase 2 test pit program consisting of three (3) test pits (TP-201, TP-203, and TP 204) to depths ranging from 16 to 22 feet bgs to further explore the physical composition of the fill and waste materials;
- Conduct two rounds of groundwater sampling with environmental laboratory testing;
- Conduct in-situ instantaneous change in head (slug) testing in five (5) shallow monitoring wells and five (5) deep monitoring wells to estimate hydraulic conductivity of the subsurface soils and waste materials; and
- Prepare this memorandum presenting the data gathered from the Phase 1 and Phase 2 subsurface exploration programs.

Existing Site Conditions

The existing Tobin School campus is located at 197 Vassal Lane in Cambridge, Massachusetts. The site is located within a mixed residential and commercial area and is bounded by Vassal Lane to the south, Concord Avenue to the north, residences along Alpine Street to the east, and a gas station, commercial properties and the Cambridge Armory to the west. Fresh Pond water supply reservoir is located approximately 400 feet to the west of the site across Fresh Pond Parkway.

The project site is an approximately 9-acre City of Cambridge property. The existing Tobin School is located on the south side of the site and consists of a three-story concrete structure constructed in the early 1970's with an approximate footprint of 59,000 square feet. The school structure houses pre-K through 8th grade students currently attending the Tobin Montessori School and Vassal Lane Upper School.

The school has three accessible utility rooms (referred to as large crawl spaces on school blueprint plans) located on the first floor at the north, east and west ends of the building. According to available drawings, the existing school structure is supported on a combination of concrete piles and timber piles with the top of pile cap elevations range from approximately elevation (El). 14.0 to El. 29.3. North of the existing school is the Callanan playground and field complex, which extends to Concord Avenue. The site is relatively flat with grades typically ranging from approximately El. 20 to El. 23. A few localized high and low spots exist around landscaped areas, loading dock and patios.

Based on the site history, the area was once used for clay mining. After mining activities ceased, the clay pit was used as an uncontrolled waste pit (1930s through the 1950s) prior to development of the current school and recreational field. Available historical aerial photos and maps dated back to the late 1800's and early 1900's are included in **Attachment A**.

The site is located within an area of known impacts under the Massachusetts Contingency Plan (MCP). Due to the presence of the waste materials beneath the Tobin School property, a sub-slab depressurization and venting system was installed in the early 1990's at the school to prevent the migration of landfill gas and any volatile organic vapors from migrating into the school building indoor air. In addition, the Tobin School property currently has a Response Action Outcome (RAO) Statement with an activity and use limitation (AUL) which was filed by CDM Smith in 1999. The AUL allowed continued normal use of the school building and grounds, but restricted access to the soil and groundwater beneath the site at depths greater than three feet below ground surface. Thus, typical activities of education, recreation, and temporary maintenance were permitted, and it was required that the pavement, school building foundation, and top layer of soil be maintained as a barrier to the potentially contaminated soil beneath. Any activities that require disturbing the soil below three feet deep are not permitted without a soil management plan prepared by a Licensed Site Professional (LSP).

Elevations noted herein are in feet and referenced to Cambridge City Base (CCB).

Subsurface Exploration Programs

Previous Subsurface Exploration Programs

1966 and 1968 Subsurface Exploration Programs (by others)

Previous subsurface investigations were conducted at the Tobin School property by New England Test Boring Corporation during October to November 1966 and January 1968. The investigations included twenty-four (24) test borings to depths ranging from 25.5 to 97 feet bgs. The equipment type and methods used to conduct these test borings are unknown. Groundwater levels were

measured at the conclusion of drilling. Rock coring was performed at five (5) test boring locations, Borings #2, #17, #18, #19, and #20. Monitoring wells were installed at two (2) test boring locations, Borings #3 and #6. It is unknown if any laboratory testing was performed.

The approximate locations of the 1966 and 1968 test borings were scaled from available drawings and are shown on **Figure 1**. Test boring logs from the 1966 and 1968 subsurface exploration programs are included in **Attachment B**.

1997-1998 CDM Investigation Program

Between September 1997 and April 1998, a program of soil sampling and analysis was conducted by CDM to characterize the fill beneath the school grounds and playing fields. Based on the results of the soil sampling and analysis program, two contaminated soil hot spots were identified: (1) a polyaromatic hydrocarbon (PAH) hot spot and (2) a lead hot spot. The PAH hot spot was located within the southeastern quadrant of the playing fields and covered an area of approximately 3,200 square feet. The lead hot spot was located near Concord Avenue between the tot lot and the Armory property boundary and covered an area of approximately 100 square feet. These hot spots were removed and confirmatory samples were collected.

Three groundwater monitoring wells were located within the boundaries of the former clay pit and were sampled three times between August 1997 and June 1998. Among the wells, the depth to groundwater ranged from 3.7 feet to 7.5 feet bgs. Groundwater lead concentrations were found to exceed the MCP GW-3 Groundwater Standard.

The approximate locations of the 1997 and 1998 test borings are presented in a plan included in **Attachment B**.

2000 and 2001 Subsurface Exploration Programs (by others)

Previous subsurface investigations were conducted at the adjacent National Guard Armory property by Clean Harbors Environmental Services, Inc. of Weymouth, MA. The subsurface exploration program included seven (7) direct-push method Geoprobe borings, B-1, B-4, B-6, and CHI-4 through CHI-7 in March 2000 and eleven (11) test borings, B-13 through B-18, and CHI-8 through CHI-12, drilled in February 2001. The direct-push method Geoprobe borings were advanced with 2-inch sleeves to depths ranging from 12.0 and 20.0 feet bgs and the test borings were drilled 4-1/4-inch inside diameter hollow stem augers to depths ranging from 8.0 to 22.0 feet bgs. Soil samples were collected during borehole advancement and were screened using a photoionization detector (PID) for volatile organic compounds (VOCs). Soil samples were collected at select intervals at all Geoprobe and test boring locations for volatile petroleum hydrocarbons (VPH), extractable petroleum hydrocarbons (EPH), polyaromatic hydrocarbons (PAHs) and lead.

Groundwater levels were measured at each test boring and geoprobe boring location. In addition, groundwater monitoring wells were installed at nine (9) locations, CHI-4 through CHI-12, for collection of groundwater samples for environmental characterization.

The approximate locations of the 2000 and 2001 test borings were scaled from available drawings and are shown on **Figure 1**. Geoprobe and test boring logs from the 2000 and 2001 subsurface exploration program are included in **Attachment B**.

Recent Subsurface Exploration Programs

A two-phase subsurface exploration program was conducted at the site to further investigate the subsurface soil, rock and groundwater conditions at the site, identify the extent of waste materials and collect samples for geotechnical and environmental laboratory testing. The as-drilled test boring locations for Phase 1 were located in the field by survey, Phase 2 locations were located in the field by taping and line of sight from existing site features and are shown on **Figure 1**.

2017 Phase 1 Subsurface Exploration Program

The Phase 1 subsurface exploration program included fifteen (15) test borings, CDM-1 through CDM-15. The test borings were drilled by New England Boring Contractors of Derry, NH between July 17 and August 9, 2017 using either an ATV-mounted drill rig or a truck-mounted drill rig.

Test borings were advanced using a 4-inch inside diameter (I.D.) steel casing and drive and wash drilling techniques. The depths of the test borings ranged between 40 and 94 feet bgs.

Continuous split spoon sampling was typically conducted in soils located the upper 30 feet or until naturally deposited soils had been encountered, and then at standard, 5-foot intervals below, in accordance with ASTM D1586 (using a 2-inch outside-diameter (O.D.) sampler, driven 24 inches by blows from a 140-pound hammer falling freely for 30-inches). Split spoon samplers were also occasionally driven with a 300-pound hammer falling freely for 30-inches as noted on the test boring logs. The number of blows required to drive the sampler each 6-inch increment was recorded and the Standard Penetration Test (SPT) resistance (N-Value) was determined as the sum of the blows over the middle 12 inches of penetration. Split spoon refusal was encountered at test boring locations CDM-1, CDM-2, CDM-7, CDM-8, CDM-14, and CDM-15 and is defined as less than 6 inches of penetration for 100 blows from a 140-pound hammer. When a refusal condition was encountered, the number of blows at the corresponding depth of penetration was recorded over the length of penetration.

Upon split spoon sampler retrieval, soils were examined for visual evidence (i.e., staining, discoloration) and olfactory indications (i.e., odors) of contamination. Soil samples collected from test borings were screened using a PID to determine the presence of VOCs. A CDM Smith representative visually classified the soil samples recovered in accordance with the Burmister classification system. Representative soil samples from each split spoon were collected, logged and stored in jars for subsequent review and geotechnical laboratory testing. Environmental samples were also collected at select intervals at all test boring locations and were stored in corresponding jars and vials and were relinquished to Alpha Analytical in Westborough, Massachusetts for laboratory testing. Further details related to the environmental sampling and testing are provided in the Environmental Data Summary below.

Undisturbed tube sampling was conducted at selected locations in fine-grained (cohesive) soils using standard Shelby tube sampler and in general accordance with ASTM D-1587. Shelby tube samples were trimmed at both ends of the tube and were sealed with plastic caps, tape and wax for subsequent review and laboratory testing.

Rock coring was conducted with an NX core barrel in accordance with ASTM D2113 at five (5) test boring locations. Rock core samples were described and logged in the field by a CDM Smith representative. The rock core description included percent recovery, Rock Quality Designation (RQD), orientation and frequency of fractures, observed fracture infilling or coatings, the weathering state of the core, and other characteristics of note. The RQD was determined for each core run by dividing the total length of the rock core segments longer than 4 inches over the total length of the core run. The time to advance each foot of rock core was also recorded during the rock coring process. All geotechnical soil samples and rock cores were transported to the CDM Smith Geotechnical Laboratory in Somerville, MA for review and geotechnical laboratory testing.

When possible, groundwater levels at the test boring locations were estimated from the condition of the samples obtained (observed soil moisture, staining, etc.) and/or by the observed water levels within the borehole at the time of drilling. However, with the drive and wash drilling method, groundwater level readings taken during drilling are not generally considered reliable due to the introduction of the drilling fluids into the borehole.

All test borings were backfilled with cement grout to the ground surface upon completion. All excess drill cuttings and drilling fluids were placed into 55-gallon drums and subsequently removed from the site at the completion of the drilling program.

Daily temperatures ranged from 61°F to 83°F, with an average of 73°F, during the course of the field program.

Test boring logs and rock core logs, prepared by CDM Smith, are included as [Attachment C](#). Photographs of rock cores are included in [Attachment D](#).

2018 Phase 2 Subsurface Exploration Program

The Phase 2 subsurface exploration program included twenty-two (22) test borings, CDM-101A, CDM-101B, CDM-102A, and CDM-102B through CDM-120. The test borings were drilled by New England Boring Contractors of Derry, NH between January 22 and February 2, 2018 using an ATV-mounted drill rig.

Test borings were advanced using a 4-inch inside diameter (I.D.) steel casing and drive and wash drilling techniques. The depths of the test borings ranged between 5 and 36 feet bgs.

Continuous split spoon sampling was conducted generally from ground surface until termination at all test boring locations, in accordance with ASTM D1586 (using a 2-inch outside-diameter (O.D.) sampler, driven 24 inches by blows from a 140-pound hammer falling freely for 30-inches). The number of blows required to drive the sampler each 6-inch increment was recorded and the SPT N-

Value was determined as the sum of the blows over the middle 12 inches of penetration. Split spoon refusal was encountered at test boring locations CDM-102A, CDM-112, and CDM-116 and is defined as less than 6 inches of penetration for 100 blows from a 140-pound hammer. When a refusal condition was encountered, the number of blows at the corresponding depth of penetration was recorded over the length of penetration.

Upon split spoon sampler retrieval, soils were examined for visual evidence (i.e., staining, discoloration) and olfactory indications (i.e., odors) of contamination. All soil samples collected from the test borings were screened using a PID to determine the presence of VOCs. A CDM Smith representative visually classified the soil samples recovered in accordance with the Burmister classification system. Representative soil samples from each split spoon were collected, logged and stored in jars for subsequent review and geotechnical laboratory testing. No additional environmental sampling was conducted during this second Phase of borings.

When possible, groundwater levels at the test boring locations were estimated from the condition of the samples obtained (observed soil moisture, staining, etc.) and/or by the observed water levels within the borehole at the time of drilling. However, with the drive and wash drilling method, groundwater level readings taken during drilling are not generally considered reliable due to the presence of the drilling fluids in the borehole.

All geotechnical soil samples were transported to the CDM Smith Geotechnical Laboratory in Somerville, MA for review and geotechnical laboratory testing.

All test borings were backfilled with cement grout or hydrated bentonite chips to the ground surface upon completion. All excess drill cuttings and drilling fluids were placed into 55-gallon drums and subsequently removed from site at the completion of the drilling program.

Daily temperatures ranged from 24°F to 44°F, with an average of 32°F, during the course of the program. Test boring logs, prepared by CDM Smith, are included as **Attachment E**.

2017 Phase 1 Groundwater Monitoring Well Installation

During Phase 1 of the subsurface exploration field program, a total of 5 groundwater monitoring well couplets (one shallow well and one deep well per location) were installed nearby five (5) test boring locations, CDM-3, CDM-4, CDM-7, CDM-9, CDM-14 to allow for collection of the following information:

- Groundwater quality within and downgradient of the waste/fill deposits.
- Groundwater elevation, groundwater flow direction, flow rates, vertical gradients.
- Landfill gas concentrations in the shallow sub-surface and within deeper waste/fill.

Each groundwater monitoring well couplet consisted of one (1) shallow groundwater monitoring well (designated as MW-S) and one (1) deep groundwater monitoring well (designated as MW-D)

located about 3 to 5 feet apart. The shallow monitoring wells were screened across the water table and generally across the granular fill/waste interface at about 2 to 18 feet bgs. The deeper wells were generally screened within the waste materials at depths ranging from 17 to 30 feet bgs. All monitoring wells are installed in separate boreholes offset from the original test boring locations.

The monitoring wells were constructed using 10 to 15-foot long, 2-inch diameter, schedule 40 polyvinyl chloride (PVC) pipe with 0.01-inch machine slots. The monitoring well riser pipe was constructed of 2-inch diameter, schedule 40 threaded PVC. The annulus around the well screen was backfilled with a filter pack to approximately 2 feet above the well screen. Above the filter pack, the wells annular space were backfilled with a 1-foot minimum bentonite clay seal and the remaining annular space around the PVC backfilled with cement grout. The surface was sealed with approximately 6 inches of concrete and a protective flush-mount road box was installed at each well location. The monitoring well installation/construction logs, prepared by CDM Smith, are included in [Attachment H](#).

Recent Test Pit Programs

To further investigate and identify the limits, physical composition, and extent of subsurface fill and waste materials, a two-phase test pit program was conducted in December 2017 and February 2018. Test pit locations were located in the field by taping and line of sight from existing site features and are shown on [Figure 1](#).

2017 Phase 1 Test Pit Program

The Phase 1 test pit program included two (2) test pits, TP-101 and TP-102. The test pits were excavated by Charter Contracting, LLC. of Boston, MA on December 28, 2017. Each test pit was excavated using a Takeuchi TB-290 mini-excavator to depths between 12 to 13.5 feet bgs. Each of the test pits were approximately 5 feet wide and 12 feet long. A CDM Smith field representative visually classified and logged excavated soil in general accordance with the Burmister classification system. A description of debris encountered during the excavation was recorded. The observed groundwater levels were measured within each test pit at the time of excavation.

During excavation, soils were examined for visual evidence (i.e., staining, discoloration) and olfactory indications (i.e., odors) of contamination. Representative soil samples collected from each test pit were screened using a PID to determine the presence of VOCs. Four (4) multi-gas monitors were placed approximately 20 feet at different directions from each test pit to screen for the presence of hazardous gas in ambient air that might be released during excavation. In addition, the PID was also used to determine the presence of VOCs in ambient air.

All excavated soils were segregated and placed on polyethylene sheeting. Each test pit was backfilled to the ground surface upon completion with soils being placed in the general order in which they were removed, capping the excavation with the excavated upper granular fill material and topsoil. The average daily temperature was 9°F during the test pit program. Phase 1 test pit logs, prepared by CDM Smith, are included as [Attachment F](#).

2018 Phase 2 Test Pit Program

The Phase 2 test pit program included three (3) test pits, TP-201, TP-203, and TP-204. The test pits were excavated by Charter Contracting, LLC. of Boston, MA between February 20 and February 23, 2018. Each test pit was excavated using a Komatsu PC-228 excavator to depths between 16 and 22 feet bgs. The test pits varied from approximately 5 to 8 feet wide and 12 to 14 feet long.

A CDM Smith field representative visually classified and logged excavated soil in general accordance with the Burmister classification system. A description of debris encountered during the excavation was recorded. The observed groundwater levels were measured within each test pit at the time of excavation.

During excavation, soils were examined for visual evidence (i.e., staining, discoloration) and olfactory indications (i.e., odors) of contamination. Representative soil samples collected from each test pit were screened using a PID for VOCs to assess the possible presence of organic vapors. Four (4) multi-gas monitors were placed approximately 20 feet at different locations from each test pit to screen for the presence of hazardous gas in ambient air that may be released during excavation.

All excavated soils were segregated and placed on polyethylene sheeting. Each test pit was backfilled to the ground surface upon completion with soils being placed in the order in which they were removed, capping the excavation with the excavated upper granular fill and topsoil.

Average daily temperatures ranged from 56°F to 57°F during the test pit program. Phase 2 test pit logs, prepared by CDM Smith, are included as **Attachment G**.

Geotechnical Laboratory Testing

Geotechnical laboratory tests were completed on select soil samples obtained from Phase 1 and Phase 2 test borings to characterize the physical and engineering properties. All geotechnical laboratory test was performed at the CDM Smith Geotechnical Testing Laboratory in Somerville, Massachusetts.

2017 Phase 1 Geotechnical Laboratory Testing

Moisture content analyses were performed on sixty-five (65) soil samples in accordance with ASTM D2216. Gradation analyses were performed on twenty-three (23) soil samples in accordance with ASTM D-6913 and ASTM D-7928. Atterberg Limits were performed on forty-two (42) soil samples in accordance with ASTM D-4318. Organic content analyses were performed on two (2) soil samples in accordance with ASTM D-2974. Laboratory Mini Vane Shear analyses were performed on nine (9) soil samples in accordance with ASTM D-4648. Constant Rate of Strain (CRS) consolidation tests were performed on five (5) soil samples in accordance with ASTM D-4186. Isotropically Consolidated Undrained (CIU) triaxial compression tests were performed on three (3) soil samples in accordance with ASTM D-4767.

A summary of the geotechnical index test results is presented in **Table 1**. A summary of the consolidation test results is presented in **Table 2**. A summary of the triaxial compression test results is presented in **Table 3**. The geotechnical laboratory test results are included as **Attachment I**.

2018 Phase 2 Geotechnical Laboratory Testing

Moisture content analyses were performed on twenty-five (25) soil samples in accordance with ASTM D2216. Gradation analyses were performed on fifteen (15) soil samples in accordance with ASTM D-6913 and ASTM D-7928. Atterberg Limits were performed on six (6) soil samples in accordance with ASTM D-4318. Organic content analyses were performed on six (6) soil samples in accordance with ASTM D-2974.

A summary of the geotechnical index test results is presented in **Table 1**. The geotechnical laboratory test results are included as **Attachment J**.

In-Situ Permeability Slug Testing

As part of the Phase 2 geotechnical and environmental investigations, instantaneous change in head (slug) testing was performed at the five (5) shallow monitoring wells and five (5) deep monitoring wells to estimate the hydraulic conductivity of the shallow fill and deeper waste materials. Slug testing was performed and logged in the field by a CDM Smith representative on March 1, 2018.

At each groundwater monitoring well location, a 5 foot long weighted PVC cylinder (slug) was introduced to the well to displace the water as a data logger (pressure transducer) recorded the water level response. Initially, a falling head test was performed by quickly lowering the slug into the well to temporarily elevate the water level while the time for water level recovery to static condition was recorded. Subsequently, a rising head test was performed by quickly removing the slug from the well to temporarily lower the water level while the time for water level recovery to static condition was recorded. The rate at which the water level rises or falls is used to estimate the horizontal hydraulic conductivity. The water level response data measured by a pressure transducer was analyzed using a software package for aquifer test data plotting and evaluation (AQTESOLV™), which applied the Bouwer and Rice (1976) and Springer-Gelhar (1991) methods to calculate horizontal hydraulic conductivity.

A summary of the hydraulic conductivity test results is presented in **Table 4**. The slug test logs and results are included as **Attachment K**.

Geotechnical Site Assessment

Subsurface Conditions

In general, subsurface conditions encountered during the recent test boring program conducted within the proposed project site are consistent with those encountered during previous subsurface investigations. The subsurface condition generally consisted of Pavement or Topsoil, Granular Fill, Waste Fill, Organic Soils, Clay & Silt, Glacial Till, Weathered Rock, and Bedrock.

Pavement

Pavement consisting of asphalt or concrete was encountered at the ground surface at five (5) Phase 1 test boring locations (CDM-7, CDM-8, CDM-9, CDM-10 and CDM-12), and ten (10) Phase 2 test boring locations (CDM-101A through CDM-103, CDM-108 through CDM-110, CDM-117, and CDM-120). Where encountered, the pavement layer ranged in thickness of approximately 4 to 6 inches.

Topsoil

Topsoil was encountered at the ground surface at eight (8) Phase 1 test boring locations (CDM-1 through CDM-6, CDM-13, and CDM-15), nine (9) Phase 2 test boring locations (CDM-104 through CDM-106, CDM-111 through CDM-113, CDM-115, CDM-116, CDM-118, and CDM-119), one previous test boring (Boring #15), and at all recent test pit locations. Where encountered, the topsoil layer ranged in thickness of approximately 3 to 12 inches at recent test boring and test pit locations and 1.5 feet in previous test boring locations. This layer typically consisted of light to dark brown, fine SAND and SILT, trace to no fine gravel.

Granular Fill

Granular Fill was encountered at all recent test boring and test pit locations, and at sixteen (16) previous test borings (Boring #2, Boring # 8 through Boring #12, Boring #14 and Boring #16, B-13 through B-15, B-17, CHI-8, CHI-9, CHI-11, CHI-12). Granular Fill was encountered at the ground surface or just below pavement or topsoil. The Granular Fill layer ranged between 1.2 and 11.5 feet thick at recent test boring locations and 2.5 to 7.0 feet thick at the previous test boring locations. This layer typically consisted of very loose to very dense, dark to light brown, gray, tan, or black, fine to coarse SAND with varying amounts of gravel and silt. SPT N-values ranges from 3 blows/foot (bl/ft) to 127 bl/ft, with an average of 38 bl/ft at recent test boring locations.

Waste Fill

Waste Fill was encountered at nine (9) of the Phase 1 test boring locations (CDM-1, CDM-3 through CDM-5, CDM-7 through CDM-9, CDM-11, and CDM-14), fifteen (15) of the Phase 2 test boring locations (CDM-101B, CDM-102A, CDM-103, CDM-104, CDM-106, CDM-108 through CDM-113, CDM-116, CDM-118 through CDM-120), thirty-two (22) of the previous test boring locations (Boring #1, Boring #2A, Boring #3 through Boring #7, Boring #9 through Boring #15A, and Boring #17 through Boring #24, B-13, B-14, B-15 through B-18, CHI-8 through CHI-12), seven (7) of the previous Geoprobe locations (B-1, B-4, B-6, CHI-4 through CHI-7), and at all of the recent test pit locations. **Figure 2** shows the approximate extent of the waste fill material based on the soil borings and test pits conducted to date.

Waste Fill was encountered just below the Granular Fill at all locations with the exception of the previous 2000 Geoprobe locations and at three (3) previous 2001 test boring locations (B-16, B-18, and CHI-10) where Waste Fill was encountered at the ground surface. This layer ranged between 2.3 and 30 feet thick at test boring locations, and 6 to 25 feet thick at previous test boring locations. This layer typically consisted of very loose to very dense, dark brown to brown, light gray to gray, or black, fine to coarse SAND, with varying amounts of gravel, silt, brick, concrete, coal, ash, cinders,

slag, metal, glass, wood, leaves, granite blocks, and other miscellaneous and deleterious material. A white substance was encountered at test boring CDM 101A, which was tested and found to be negative for asbestos. SPT N-values of this layer ranges from Weight of Hammer (WOH) to over 100 bl/ft, with an average of 20 bl/ft, at the recent test boring locations. Strong VOC and landfill gas odors were noted by CDM Smith personnel while advancing through the Waste Fill layer during test pit excavation. In addition, sheen was observed on the water table in the test pits excavated in the center of the recreational fields (TP-202 and TP-203).

Of note, a 4.5 ft x 2 ft x 0.5 ft granite block and concrete debris between 12-14 in x 2-4 in in size were encountered at 5 feet bgs in the Waste Fill layer during excavation at test pit TP-102. A 0.25 ft x 0.5 ft x 5 ft suspected metal car frame rail was encountered at 11 feet bgs during excavation at test pit TP-203.

Organic Soils

Organic Soils were encountered at one (1) Phase 1 test boring location (CDM-2), five (5) Phase 2 test boring locations (CDM-102B, CDM-105, CDM-108 through CDM-110), and at four (4) previous test boring location (Boring #13, CHI-8 through CHI-10). Organic Soils was typical encountered just below the Waste Fill and above the Clay and Silt stratum. This layer ranged between 0.3 and 1.7 feet thick at recent test boring locations and ranged between 0.5 and 5.2 feet thick at the previous test boring locations. This layer typically consisted of moist to wet, loose to medium dense or stiff, black, slightly Organic to Organic, fine to medium SAND and SILT or CLAY & SILT, trace fine sand. SPT N-value of this layer ranges from 8 bl/ft to 12 bl/ft at the recent test boring locations.

Clay and Silt

Clay and Silt, commonly referred to as Boston Blue Clay, was encountered at all Phase 1 test boring locations, twenty (20) Phase 2 test boring locations (CDM-101B, CDM-102B through CDM-120), thirty-two (32) of the previous test boring locations (Boring #1 through Boring #24, B-13, B-16, B-17, CHI-8 through CHI-12), two (2) of the previous Geoprobe locations (CHI-5, CHI-7), and at one (1) recent test pit location (TP-204). Clay and Silt was encountered below the Granular Fill, Waste Fill or Organic Soils. The Clay and Silt layer ranged between 10.7 and 75.3 feet thick at the recent test boring locations and between 6.5 and 61 feet thick at the previous test boring locations where fully penetrated. This layer typically consisted of very soft to hard, dark to light brown, or light gray to olive gray to greenish gray, CLAY & SILT with varying amounts of sand and gravel. Some miscellaneous fill materials, including glass, metals, woods, cinders and bricks were encountered in the upper 2 to 4 feet of the clay and silt layer at some test boring locations. Sand lenses consisting of fine sand to fine to coarse sand, little to trace silt or fine sand and silt were encountered at varies depths throughout the stratum and varied in thickness ranging from 0.25 to 6.0 feet. SPT N-values of this layer ranges from Weight of Rods (WOR) to 101 bl/ft, with an average of 19.7 bl/ft, at the recent test boring locations.

Glacial Till

Glacial Till was encountered at eleven (11) of the recent test boring locations (CDM-1 through CDM-10, and CDM-13) and at sixteen (16) of the previous test boring locations (Boring #1 through Boring #4, Boring #9 through Boring #14, Boring #15A, Boring #16, Boring #18, Boring #20, Boring #22, and Boring #24). Glacial Till was encountered below the Clay and Silt stratum. This layer ranged between 1.2 and 12.5 feet thick at recent test boring locations where fully penetrated, and between 0.5 and 9.0 feet thick at previous test boring locations where fully penetrated. This layer typically consisted of medium dense to very dense, light gray to greenish gray, fine to coarse SAND with varying amounts of gravel and silt. SPT N-values of this layer ranged from 22 bl/ft to more than 125 bl/ft, with an average of 66 bl/ft, at the recent test boring locations.

Weathered Rock

Weathered Rock was encountered at two (2) of the recent test boring locations (CDM-6 and CDM-14) and at one (1) previous test boring location (Boring #15A). Weathered Rock was encountered below the Clay and Silt or Glacial Till stratum. This layer ranged between greater than 2.5 and 3.0 feet thick in the recent test boring locations, and greater than 2.0 feet thick in the previous test boring location. This layer typically consisted of moist, gray, fine to coarse GRAVEL and fine to coarse SAND, some silt, with gravel inclusions resembling broken Argillite. SPT N-values of this layer ranged from 79 bl/ft to more than 100 bl/ft, with an average of 90 bl/ft, at the recent test boring locations.

Bedrock

Bedrock was encountered at ten (10) of the recent test boring locations (CDM-1 through CDM-4, CDM-7 through CDM-10, CDM-13, and CDM-15) and at five (5) of the previous test boring locations (Boring #2A, and Boring #17 through Boring #21). Bedrock coring was conducted at recent test boring locations CDM-1, CDM-2, CDM-4, CDM-9, and CDM-10, and previous test boring locations Boring #2A, Boring #17, Boring #18, Boring #19, and Boring #20. The top of bedrock at the remaining recent test borings was inferred by split spoon or roller bit refusal and observation of drill fluid return. The depth to top of bedrock at recent and previous test boring locations ranged from 29.6 to 92.5 feet bgs. Bedrock encountered at the recent test boring locations generally consisted of hard, extremely fractured to sound, moderately weathered to fresh, gray, ARGILLITE. The primary joint set was horizontal to moderately dipping, rough to smooth, fresh discolored, open to tight. RQD of the collected rock cores from recent test borings ranged from 0% to 81.4%, with an average of 30.9%.

A summary of the subsurface conditions encountered at all previous and recent test boring locations is presented in [Table 5](#).

Groundwater Conditions

Groundwater levels were observed after completion of drilling in seven (7) of the Phase 1 test boring locations (CDM-1, CDM-2, CDM-7, CDM-9, CDM-10, CDM-12, and CDM-15), seventeen (17) of the Phase 2 test boring locations (CDM-102B through CDM-109, CDM-112 through CDM-120), and

at all previous test boring locations. The groundwater level recorded at the time of drilling at recent test borings ranges from approximately 4.5 to 12.0 feet bgs (approximately El. 11.3 to El. 16.9). Groundwater levels recorded at time of drilling at previous test boring locations ranges from 3.0 to 9.5 feet bgs (approximately El. 12.6 to El. 17.9).

Groundwater levels were observed after the completion of excavation at all recent test pit locations. Groundwater levels measured in the test pits generally ranged about 7.5 to 12.5 feet bgs (approximately El. 10.0 to El. 13.5). A summary of groundwater levels measured in each boring location and test pit are presented in **Table 5**.

Groundwater levels were also measured in August 2017, October 2017 and March 2018 at the ten groundwater monitoring wells installed. Groundwater levels measured in the monitoring wells generally ranged about 6.1 to 9.4 feet bgs (approximately El. 12.8 to El. 14.9). A summary of the groundwater levels measured in each monitoring well are presented in **Table 6**.

Variation in Subsurface Conditions

Interpretation of general subsurface conditions presented herein is based on soil, bedrock and groundwater conditions observed in the previous and recent test boring programs. However, subsurface conditions may vary between exploration locations.

Water levels measured during exploration activities should not necessarily be considered to represent stabilized groundwater levels. In addition, water levels are expected to fluctuate with season, temperature, climate, construction in the area, and other factors. Therefore, groundwater conditions at the time of construction may be different from those observed at the time of the explorations.

Geotechnical Implications for Design and Construction

Primary Geotechnical Considerations

The primary factors related to geotechnical engineering considerations of the design and construction of the proposed structure at the Tobin School project site include:

- There is a significant thickness of Waste Fill materials throughout the project site. Based on the subsurface investigations, the Waste Fill, where encountered, ranges from approximately 2 to 30 feet thick and extends to depths between approximately 5 and 32 ft below existing grade within the project area. Specifically, the depth to bottom of waste fill along the boundary between the existing school structure and recreational field extends to about 18 to 22 feet bgs; whereas the depth to bottom of waste fill along the property lines with the Cambridge Armory ranges from about 18 to 32 feet bgs.
- There is significant variability in the content and consistency of the Waste Fill layer, which also contains a high amount of deleterious materials and debris at some locations and is generally not considered suitable for foundation support.

- There is significant variation of thickness and stiffness of the Clay & Silt stratum. The thickness of the Clay & Silt stratum varies from approximately 7 to 76 feet at test boring locations where fully penetrated, with the thinner stratum located around the middle of the site and thicker stratum located along the south and west side of the site. The Clay & Silt layer is also generally softer at test borings conducted in the southern and western part of the site.
- There is significant variation in the elevation of top of bedrock across the site. Bedrock was encountered approximately 79 to 93 feet bgs along the south side of the site along Vassal Lane and sloped up to approximately 32 feet bgs in the middle of the site, and down again to approximately 47 to 75 feet bgs along the north side of the site along Concord Avenue.
- Relatively shallow groundwater was encountered at the site, at depths between approximately 4.5 and 12 feet bgs, which is generally well above the bottom of the waste fill layer.

Based on these factors, below are the primary geotechnical considerations related to the design and construction of the proposed structure at the Tobin School project site.

Structure Foundation

- Due to the thickness and compressibility of the Clay & Silt stratum located towards the southern and western side of the site, it is anticipated that if the new school structure is to be located on the southern side of the site (same as the existing school structure), the structure is more likely to be supported on a deep foundation system, similar to the existing school structure.
- If the proposed new school building is located on the center to northern part of the site over the existing recreational field where the Clay & Silt stratum is thinner and stiffer, and all of the existing waste fill were removed and replaced with compacted fill materials, it may be possible for the new school structure to be supported on shallow foundation system.
- If the proposed new school building is located over the existing recreational field, but some of the waste fill were to remain in place below the school structure, the new structure may either have to be supported on deep foundation system or ground modification of the remaining waste fill would be needed to stabilize and improve the engineering properties of the materials left in place for the new structure to bear on top. Other environmental mitigation measures would also be needed as part of this option. The new structure should not be supported on shallow foundations over untreated waste fill.
- The use of a shallow foundation system for the new structure would also depend on the level of structural loading and whether the new structure would have a basement or below grade parking, which can be evaluated upon further development on the proposed school structure.

Excavation and Excavation Support

- Based on the depths and thickness of Waste Fill encountered, excavation to remove all Waste Fill will create a deep excavation that is well below the groundwater level. The total volume of the Waste Fill is expected to be substantial. The excavation would also be over 30 feet deep and would require excavation support. Installation of excavation support through waste fill containing obstructions will likely require some level of pre-excavation to remove large obstructions prior to installation.
- Based on the depth and thickness of the Waste Fill between the existing school and recreational fill, if the existing school is to remain in place during construction, an excavation support system would be required to protect the existing school structure.
- Given the shallower bedrock encountered at the central-east part of the site, support for the excavation system may encounter or even be installed into bedrock. The excavation support system type selection and design would need to take into account shallow rock.
- The location and geometry of the proposed construction and excavation limits will have a significant impact on the type, complexity and cost of the excavation support system required for this project.

Ground Improvement for Waste Stabilization

- Ground improvement methods (i.e., deep soil mixing, jet grouting, etc.) may be used as a method of waste stabilization in lieu of waste removal, to improve the engineering properties of any waste left in place for foundation support of the new structure, as a groundwater cut-off where existing waste/contaminated groundwater at adjacent sites will not be removed (e.g., the Armory), and as a means of excavation support.
- Suitability of various ground improvement methods will depend on the composition of the waste to be treated, landfill gas potential, site access, costs, etc. The depth of waste (~32 ft bgs) is within the range of many improvement methods. The general composition of the waste which is primarily sand and gravel with various amounts of debris is generally treatable with several methods. However, obstructions can inhibit effective treatment and may require pre-excavation prior to treatment.

Construction Dewatering

- Due to the depth of the Waste Fill layer, excavation for full removal of waste will extend well below the water table. A dewatering system would be required for the removal. A significant treatment process is also anticipated as part of the dewatering system to treat the effluent prior to discharge.
- Given the relatively thin Clay & Silt layer encountered underlying the Waste Fill in some areas, the hydraulic conductivity of the Glacial Till layer may affect the amount of

groundwater flow into the excavation. To limit the flow, care would need to be taken to not over-excavate the less permeable Clay & Silt at the excavation subgrade level.

Environmental Site Assessment

The objective of the environmental site assessment investigations was to evaluate the nature and extent of contamination within subsurface fill and waste materials, shallow and deep groundwater, and subsurface landfill gas at the Tobin School property in support of the proposed excavation of existing fill and waste materials and construction of the new school and recreational fields. In addition, supplemental investigations were also conducted to evaluate whether the presence of waste materials underlying the school and recreational fields are currently impacting indoor air in the school and the surrounding utilities at the property. This information will be documented in a separate technical memorandum.

Soil Sampling

The Phase 1 (July-September 2017) and Phase 2 (January-February 2018) environmental field investigations were conducted to evaluate the overall extent of waste/fill materials and to determine the concentrations of contaminants in subsurface soils and fill and waste materials.

During the Phase 1 subsurface exploration program, environmental soil samples were collected at select intervals at all Phase 1 test boring locations (CDM-1 through CDM-15) and relinquished to Alpha Analytical in Westborough, Massachusetts for laboratory testing. No analytical soil samples were collected during the Phase 2 subsurface exploration program. During the Phase 1 drilling program, laboratory analytical samples were collected at all fifteen soil boring locations in the shallow soil (0-8 feet bgs, fill/waste materials (8-30 feet bgs) and from the shallow clay directly beneath the waste materials. All soil samples were analyzed for the following parameters:

- VOCs (including 1,4-dioxane) using Environmental Protection Agency (EPA) Method 8260C,
- Semi-volatile organic compounds (SVOCs) using EPA Method 8270D,
- (MCP) 14 Metals using EPA Method 6010C/7471B,
- Polychlorinated biphenyls (PCBs) using EPA Method 8082A, and
- Massachusetts Department of Environmental Protection (MassDEP) Extractable Petroleum Hydrocarbon (EPH) Method carbon ranges.

Duplicate samples were collected for quality assurance/quality control purposes. Excess soil generated during drilling and drilling fluids were containerized into 55-gallon drums and temporarily stored on-site. Based on the results of soil samples submitted for analytical testing, the waste was profiled and transported off site by Clean Harbors, Inc. Phase 1 drums were transported off site between August and September 2017 and Phase 2 drums were transported off site in February 2018. The drum disposal manifest for both phases are included in **Attachment L**.

The subsurface soils at the Tobin School are categorized as S-1 (from 0-15 ft-BGS), S-1/S-2 (3-15 ft-BGS) and S-3 (>15 feet-bgs). Several metals were detected above their respective soil standards as shown in the soil analytical table (**Table 7**). Arsenic was detected in sample CDM-9 (14-16 feet bgs) at a concentration of 64.4 mg/kg exceeding the S-2 standard (20 mg/kg) and S-3 standard (50 mg/kg). Zinc was detected in sample CDM-7 (6-8 feet bgs) at a concentration of 18,500 mg/kg exceeding the S-1 standard (1,000 mg/kg) and S-2 standard (3,000 mg/kg). Zinc was detected in sample CDM-9 (14-16 feet bgs) at a concentration of 1,590 mg/kg exceeding the S-1 standard of 1,000 mg/kg. Zinc was also detected in sample CDM-14 (20-22 feet bgs) at a concentration of 18,500 mg/kg exceeding the S-3 standard of 5,000 mg/kg.

Lead was detected in sample CDM-1 (8-10 feet bgs) at a concentration of 417 mg/kg and was also detected in sample CDM-11 (2-4 feet bgs) at a concentration of 550 mg/kg, exceeding the S-1 standard of 200 mg/kg. Lead was detected in sample CDM-1 (24-28 feet bgs), CDM-7 (6-8 ft BGS), CDM-7 (16-18 feet bgs), CDM-8 (6-8 feet bgs), CDM-9 (14-16 feet bgs), CDM-13 (8-12 feet bgs) and CDM-14 (8-10 feet bgs) with concentrations ranging from 816 to 5200 mg/kg, exceeding the applicable S-2 and S-3 standard of 800 mg/kg. Due to the elevated concentrations of lead, toxicity characteristic leaching procedure (TCLP) analysis was completed at locations where the analysis criteria were triggered. At soil sample locations CDM-1 (24-28 feet bgs), CDM-7 (6-8 feet bgs), CDM-8 (8-10 feet bgs), CDM-9 (14-16 feet bgs), and CDM-11 (2-4 feet bgs), leachable lead was detected with concentrations ranging from 7.62 mg/L (CDM-11) to 138 mg/L (CDM-1), exceeding the TCLP Environmental Protection Agency (EPA) hazardous waste limit of 5 mg/L.

SVOCs were also measured above applicable soil standards in several samples. Benzo(a)pyrene was detected in sample CDM-1 (8-10 feet bgs) at a concentration of 2.5 mg/kg, exceeding the S-1 standard of 2 mg/kg. Benzo(a)pyrene was detected in sample CDM-4 (8-10 feet bgs), CDM-8 (8-10 feet bgs), CDM-9 (14-16 feet bgs) and CDM-14 (8-10 feet bgs) with concentrations ranging from 13 to 17 mg/kg, exceeding the applicable S-2 standard of 7 mg/kg. Benzo(a)anthracene was detected in sample CDM-4 (8-10 feet bgs) at a concentration of 28 mg/kg and was also detected in sample CDM-8 (8-10 feet bgs) at a concentration of 17 mg/kg, exceeding the S-1 standard of 7 mg/kg. Dibenzo(a,h)anthracene was detected in sample CDM-8 (8-10 feet bgs) at a concentration of 1.5 mg/kg and was also detected in sample CDM-9 (14-16 feet bgs) at a concentration of 1.7 mg/kg, exceeding the S-1 standard of 0.7 mg/kg. Ideno(1,2,3-cd)perylene was detected in sample CDM-4 (8-10 feet bgs) at a concentration of 8.5 mg/kg, exceeding the S-1 standard of 7.0 mg/kg. EPH compound C11-C22 aromatic was detected in sample CDM-7 (6-8 feet bgs) at a concentration of 1,060 mg/kg, exceeding the S-2/GW-1 standard of 1,000 mg/kg. EPH compound C19-C36 aliphatic was detected in sample CDM-7 (6-8 feet bgs) at a concentration of 3,060 mg/kg, exceeding the S-1 standard of 3,000 mg/kg.

Overall, fill and waste materials contain elevated concentrations of heavy metals (lead, zinc, arsenic), EPH compounds and SVOCs. Some samples exceeded the regulatory limit for TCLP lead indicating that without treatment, this material would be considered a hazardous waste. This material could be treated and disposed of as a non-hazardous waste. Other heavy metals, VOC,

SVOC and EPH compounds were detected, however, all detections were below applicable standards. PCB compounds were reported below the laboratory method detection limit at all sampling locations below applicable standards.

Groundwater Sampling

Groundwater sampling was conducted in August 2017 and March 2018 at the five well couplets (MW-3S/3D, MW-4S/4D, MW-7S/7D, MW-9S/9D, & MW-14S/14D) to determine the chemical quality of the groundwater at the site with respect to MassDEP groundwater standards and to evaluate potential discharge options associated with dewatering of the site during excavation/construction. Sampling and testing occurred in two phases to evaluate seasonal variability of concentrations. Groundwater sampling was performed by CDM Smith representatives between August 16 and August 17, 2018 for Phase 1 and on March 1, 2018 for Phase 2. A summary of the August 2017 and March 2018 groundwater analytical data is presented in **Table 8** and **Table 9**, respectively and the laboratory reports are included in **Attachment M**.

Groundwater sampling was conducted using low flow groundwater sampling procedures in accordance with U.S Environmental Protection Agency's (EPA) low flow guidance document (Revised September 19, 2017). The static depth to water and depth to the well bottom were recorded prior to sampling. An adjustable rate peristaltic pump was used to purge each well and collect the samples. While purging, field parameters including conductivity, specific conductance, pH, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP) were measured and recorded. Analytical samples for were collected after field parameter stabilization and preserved in the field prior to relinquishment to Alpha Analytical in Westborough, Massachusetts for laboratory analysis.

Groundwater samples were analyzed for the following parameters:

- Volatile Organic Compounds (VOCs) (8260/5053);
- Semivolatile Organics (SVOCs) (8270D/SIM);
- Polychlorinated Biphenyls (PBCs) (8082);
- MCP Extractable Petroleum Hydrocarbons (EPHs), Carbon-ranges only (EPH-04-1.1);
- MCP 14 Total Metals (6010C/7471B) – Phase 1;
- MCP 14 Dissolved Metals (6010C/7471B) - Phase 2.

Groundwater at the site is categorized as GW-1 only in the far western portion of the site (area of MW-7S/7D) due to the Zone A surface water protection zone for the Fresh Pond Reservoir. Groundwater is categorized as GW-2 for any location within 30 feet of the school building where the water table depth is less than 15 feet bgs (MW-9S/9D and MW-14S/14D). Groundwater at the entire site is categorized as GW-3 due to the potential for discharge to the Fresh Pond Reservoir,

located to the west and downgradient of the Tobin School property. Due to the total metal exceedances at select well locations during Phase 1, samples were collected for dissolved metals during Phase 2. A well location plan identifying the surface water protection zones are presented on **Figure 3**. During the August 2017 monitoring round, total barium was detected at a concentration of 3,660 ug/L and 2,060 ug/L in the samples collected from MW-7S and MW-7D, respectively, exceeding the applicable GW-1 standard of 2,000 ug/L. In March 2018, dissolved barium was detected greater than the GW-1 standard in the sample collected from MW-7D (2,140 ug/L) and was below the GW-1 standard of 2,000 ug/L in the sample collected from MW-7S (526 ug/L). The total and dissolved barium concentrations at MW-7D are consistent (2,060 ug/L vs 2,140 ug/L, respectively) suggesting that the elevated barium concentrations are not related to the presence of suspended solids from the groundwater sample. The dissolved barium concentration at MW-7S is one-order of magnitude lower than the total barium concentration from August 2017 suggesting that suspended solids from the August 2017 groundwater sample may have contributed to elevated total barium concentration and GW-1 exceedance (August 2017). Dissolved barium was also detected at the remaining groundwater monitoring well sampling locations with concentrations ranging from 49 to 1,150 ug/L which is consistent or slightly lower than the August 2017 total barium results.

During the August 2017 monitoring round, total lead was detected greater than the GW-3 standard of 10 ug/L in samples collected from MW-3D (67 ug/L), MW-4D (31 ug/L), MW-9S (26 ug/L), MW-9D (11 ug/L) and MW-14S (65 ug/L). In March 2018, dissolved lead was detected greater than the GW-3 standard of 10 ug/L in the samples collected from MW-4D (77 ug/L) and MW-9S (54 ug/L). Lead was reported below the laboratory method detection limit of 10 ug/L at the remaining groundwater monitoring well sample locations which suggests that these previous detections and GW-3 exceedances appear to have been related to the presence of suspended solids in the groundwater sample. The dissolved lead concentrations and associated GW-3 exceedances at MW-4D and MW-7D are slightly lower than the total lead concentrations from the August 2017 monitoring round but do not appear to be related to the presence of suspended solids from the groundwater sample.

During the August 2017 monitoring round, total arsenic was detected at groundwater monitoring wells MW-3S, MW-4S/4D, MW-9S/9D and MW-14S with concentrations ranging 6-28 ug/L, all below the applicable GW-3 standard of 900 ug/L. During the March 2018 monitoring round, dissolved arsenic was detected in the groundwater samples collected from MW-3D (6.6 ug/L), MW-9D (40.2 ug/L) and MW-14S (5.5 ug/L), all below the applicable GW-3 standard of 900 ug/L. The March 2018 dissolved arsenic detections are consistent with August 2017 total arsenic concentrations at MW-3D, MW-9D and MW-14S. During the August 2017 monitoring, total zinc was detected in the groundwater samples collected from MW-3D (54 ug/L) and MW-14S (234 ug/L), below the applicable GW-3 standard of 900 ug/L. During the March 2018 round, dissolved zinc was reported below the laboratory method detection limit of 50 ug/L at MW-3D and MW-14S. Dissolved zinc was detected in the sample collected from MW-7S (60 ug/L) below the GW-1 standard of 5,000 ug/L and GW-3 standard of 900 ug/L. Dissolved zinc was also detected in the sample collected

from MW-9S at a concentration of 224 ug/L which is below the GW-3 standard. The presence of elevated concentrations of heavy metals in soil and groundwater such as barium and lead appears to be attributed to the interaction of buried waste material and groundwater at the site.

In both the August 2017 and March 2018 monitoring rounds, other VOCs and SVOC compounds were detected at all groundwater well locations, however, the concentrations were reported below applicable standards. In the sample collected from MW-9D during the March 2018 round, methyl-tert-butyl-ether and tertiary-amyl methyl ether were detected consistent with the August 2017 concentrations and well below applicable GW-2 and GW-3 standards. Benzene was detected in the sample collected from MW-14D (6.7 ug/l), however the concentration is well below GW-2 and GW-3 standards. Numerous SVOCs compounds, primarily PAHs, were detected at all groundwater monitoring wells but were below the applicable standards in both sampling rounds. During both the August 2017 and March 2018 round, 1,4-dioxane was detected in the sample collected from MW-9D (0.198 ug/L and 0.158 ug/L, respectively), however, the detected concentrations are well below the applicable GW-2 and GW-3 standard. PCBs were below the laboratory method detection limit in samples collected from all groundwater monitoring wells. In August 2017 and March 2018, select VOC, SVOC compounds were detected in groundwater samples collected from the two well couplets as noted above (MW-7S/7D and MW-9S/9D) located approximately within 30 feet of the building, however, none of the detections exceeded applicable GW-2 standards.

Hydrogeology Interpretation

Depth to water level measurements were recorded at the ten (10) groundwater monitoring wells in August 2017, October 2017 and in March 2018. Overall, water table depth from ground surface ranged from approximately 6 to 9 feet bgs. Water table and groundwater elevations were calculated using the field data and well location survey data (see **Table 6**). Based on the calculated groundwater elevations, groundwater flows to the west/southwest towards Fresh Pond Reservoir (City of Cambridge public water supply) and the average hydraulic gradient across the site is equal to 0.0003. As shown on **Table 4**, the estimated horizontal hydraulic conductivity values from the testing at the shallow wells screened across the waste/fill interface (shallow waste materials) ranged from 0.21 to 27.0 feet/day ($7.24\text{E-}5$ to $9.54\text{E-}3$ cm/sec) and the estimated horizontal hydraulic conductivity values measured from the testing of the deeper wells screened to the bottom of the waste materials ranged from 2.35 to 18.6 feet per day ($8.28\text{E-}4$ to $6.56\text{E-}3$ cm/sec). The range of hydraulic conductivity values appear to be consistent across the site with the exception of MW-14S which had lower values.

Using the recent hydraulic conductivity data, the geometric mean of the hydraulic conductivity values for the wells screened across the fill/waste interface is equal to 5.34 feet/day and the geometric mean of the hydraulic conductivity values for the wells screened to the bottom of the waste materials is equal to 8.60 feet/day. Based on the average hydraulic gradient, geometric mean of the shallow and deep well hydraulic conductivity values and porosity of the waste materials, the average linear groundwater velocity across the site is equal to 0.0040 ft/day (1.5 feet/year) within

the fill/waste materials. Despite the groundwater flow direction towards Fresh Pond Reservoir, the City of Cambridge Water Department keeps the surface water elevation higher than the adjacent ambient water table to prevent local groundwater discharge into the Reservoir, therefore, it is unlikely that impacted groundwater from the Tobin school property is discharging into the Reservoir.

Landfill Gas Monitoring

On August 16-17, 2017, CDM Smith installed/sampled a total of 28 landfill gas probe locations and screened the 10 newly installed groundwater wells for the presence of landfill gas (see **Figure 4**). For all landfill gas sampling locations, concentrations of methane (CH₄), carbon dioxide (CO₂), oxygen (O₂), Lower Explosive Limit (LEL) and atmospheric pressure were obtained using a Landtec GEM 2000 Gas Analyzer. VOC concentrations were obtained using a PID. Hydrogen sulfide (H₂S) concentrations were obtained using an Interscan Gas Analyzer. Landfill gas sampling locations were purged for 10 minutes with the Landtec Gas Analyzer prior to collection of final readings. Due to the elevated concentrations of methane observed at SGP-27, SGP-28 and groundwater monitoring wells MW-3S/3D and MW-4S/4D during the August 2017 sampling event (see **Table 10**), CDM Smith returned to the Tobin School on October 2, 2017 to screen on-site utilities adjacent the recreational fields (see **Figure 5**) and to complete sub-slab and indoor air sampling at the Tobin School.

Due to the history of the landfilling operations at the Tobin School property, landfill gas migration investigations were completed to determine the nature and extent of landfill gas in the shallow and deeper sub-surface and to confirm there was no gas migration off-site beyond the property boundary. A total of 28 landfill gas probes were installed in August 2017 with a majority of the gas probes installed around the perimeter of the site at the property boundary. Methane was not detected at any of the perimeter landfill gas probes except at SGP-27 which is located at the Armory property boundary, where the initial methane (as an indicator of landfill gas) concentration was detected at 2.9 % (58% LEL) and the final methane concentration was detected at 2.8% (56% LEL). This is not an unexpected finding since it is believed that the waste material extends underneath the Armory property. One landfill gas probe was installed in the center of the recreational fields (SGP-28) to evaluate shallow sub-surface landfill gas conditions in the center of the recreational field. At landfill gas probe, SGP-28, methane was initially detected at 63.8 % (1,276 % LEL) and the final concentration was detected at 50.2 % (1,004 % LEL). These LEL readings are considered very high and comparable to what may be observed at a municipal solid waste landfill. Carbon dioxide was detected at all landfill gas probes with concentrations ranging from 0.5 to 5.4%. Oxygen concentrations ranged from 0.9 to 20.3% at all landfill gas probe locations. VOC concentrations were non-detect (0.0 ppm) at all landfill gas probe locations except SGP-26 where the initial VOC concentration was detected at 111.7 ppmv and the final VOC concentration was detected at 58.8 ppmv. Hydrogen sulfide was not detected at any landfill gas probe location.

The ten (10) groundwater monitoring wells installed during Phase 1 were also screened for the presence of landfill gas during the August 2017 landfill gas sampling event. Methane was detected at groundwater monitoring wells MW-3S, MW-3D, MW-4S, MW-4D, MW-7S and MW-14D. Methane

was initially detected at MW-3S at a concentration of 13.5 % (270% LEL) and the final methane concentration was detected at 13.4 (268 % LEL). Methane was initially detected at MW-3D at a concentration of 1.9 % (38 % LEL) and the final methane concentration was detected at 0.8 % (16% LEL). Methane was initially detected at MW-4S at a concentration of 73 % (1,460% LEL) and the final methane concentration was detected at 71.6 % (1,432 % LEL). Methane was initially detected at MW-4D at a concentration of 0.6 % (12% LEL) and the final methane concentration was detected at 0.3 % (6% LEL). Methane was initially detected at MW-7S at a concentration of 2.4% (48 % LEL) and the final concentration was detected 2.3 % (46% LEL). Methane was initially detected at MW-14D at a concentration of 0.4% (8 % LEL) and the final methane concentration was detected at 0.3 % (6% LEL).

Due to the elevated landfill gas readings across the site, a supplemental gas investigation was completed by CDM Smith on October 2, 2017. During the October 2, 2017 sampling, CDM Smith re-screened the 10 groundwater monitoring wells for the presence of landfill gas. Results were similar to the August 2017 monitoring (see [Table 11](#) for August and October 2017 gas results). The most significant difference between the two rounds was that methane was detected at MW-9S with elevated concentrations in October 2017, whereas, it was not detected in August 2017. Methane was detected at MW-9S at an initial concentration of 22.8 % (456 % LEL) and the final methane concentration was detected at 23.9% (478 % LEL). Simultaneously on October 2, 2017, CDM Smith collected sub-slab and indoor air samples inside the Tobin School to confirm there was no indoor air quality problems inside the school. The conclusion of the Tobin School assessment was that the sub-slab monitoring results showed low levels of contaminants below MassDEP thresholds. The indoor air (within the crawl spaces) did show some commonly found constituents in indoor air, however, they do not appear to be attributed to the underlying waste material. A summary of the results of the Tobin School sub-slab and air sampling in October 2017 and the recent round completed in February 2018 will be included in a separate memorandum.

In addition to the screening of the groundwater monitoring wells for landfill gas, 30-minute grab soil vapor samples were collected from groundwater monitoring well MW-4S and MW-9S where the highest concentrations of methane were observed and were analyzed for VOCs, fixed gases (methane, carbon dioxide, carbon monoxide, nitrogen and oxygen), sulfide analysis and mercaptans. Overall, there were some VOC detections, however, none of the concentrations exceeded MassDEP sub-slab soil gas screening criteria (see [Table 12](#)). Fixed gas concentrations were consistent with concentrations observed when collecting field analyzed gas samples using the Landtec GEM 2000. Sulfide and mercaptan compounds including hydrogen sulfide, methyl mercaptans, dimethyl sulfate and carbon disulfide were detected in the soil vapor samples collected from MW-4S and 9S with concentrations ranging from 4.43 to 6.38 ug/m³.

Due to the elevated methane concentrations within the subsurface of the recreational fields, deeper landfill gas probes were attempted along the eastern property line to confirm there was no gas migration beyond the eastern property line, however, due to subsurface conditions, continuous refusal was encountered at multiple locations and the gas probes could not be installed below 5 feet

bgs. Due to the clean corridor of no waste between the recreational fields and the eastern property line and no observed gas detections from the August 2017 gas sampling, it does not appear gas is migrating towards the eastern property line.

A total of twenty-six (26) utility locations on the Tobin School property and adjacent to the Tobin School property boundary (catch basins, manholes, electrical boxes) as shown on **Figure 5** were screened for the presence of landfill gas on October 2, 2017. The results of the screening are summarized in **Table 13**. Methane was only detected in the water meter pit manhole located directly north of recreational fields. Methane was detected in the water meter pit manhole initially at 296 % LEL of methane and at 16% LEL of methane after venting with the manhole cover off. Under the MCP, an LEL reading greater than 10% LEL in a utility is a 2-hour reporting condition. Since the LEL of methane results were greater than 10% LEL in the Water Meter Pit Manhole, the results were reported to MassDEP Bureau of Waste Site Cleanup (BWSC) by Kathleen Murphy (LSP), (CDM Smith). A release tracking number (RTN) was assigned by MassDEP (RTN 3-34521). As a mitigation measure, the City of Cambridge determined that the water vault was no longer in use and backfilled the manhole with flowable fill on October 18, 2017 and re-screened the manhole with a 4-gas meter which resulted with an LEL of reading of 0.0%.

CDM Smith completed confirmation methane screening of utilities adjacent to the abandoned water meter pit and on Concord Ave on November 30, 2017. During the supplemental screening event, methane was not detected at any of the utility locations. Since the water meter pit was abandoned and methane was not detected during the supplemental screening, CDM Smith submitted an Immediate Response Action (IRA) Completion Report to MassDEP on December 7, 2017 closing out RTN 3-34521 linking it to the overall RTN for the Tobin School property (3-01658).

During the Phase 1 and Phase 2 Test Pit programs, multi-gas monitors were placed approximately 20 feet at different directions from each test pit to monitor ambient air for oxygen, carbon monoxide, hydrogen sulfide and lower explosive limit (LEL). During both phases of test pits, there were no detections of any gases and oxygen concentration remained at approximately 20.9%. A PID was also used during test pitting to determine the presence of VOCs in ambient air, and values ranged from non-detectable to 8.2 parts per million (ppm).

Environmental Implications for Design and Construction

Removal and Disposal of Soil/Waste Materials

Based on the results of the soil/waste fill concentrations, the fill/waste material would need to go either to an out-of-state facility or to an in-state landfill. In order to obtain a clean closure with no deed restrictions, i.e., AUL, on the school property, the entire limits of the waste material would need to be removed. Complete removal of the waste material on the school property may not be possible given the depth of the waste at the property line with the abutting Armory facility and the potential to impact the existing Armory structure. In addition, removal of waste along the remaining property lines may impact abutting properties. Measures such as excavation support

may be considered to allow for removal of as much waste material as possible along the property boundaries.

Removal of the waste material will present considerable challenges including the depth of material requiring removal (up to 32 feet bgs), dewatering during removal, control of landfill gases during removal, proximity of nearby residents and occupied school (if the school is kept open during construction). If it is not feasible or cost effective to remove all of the waste material, mitigation measures will need to be considered regarding potential indoor air issues, e.g., sub-slab depressurization system or a barrier between waste material and buildings or overlying soil. These options for leaving some waste material in place would require an AUL and potential capping of waste with permanent active landfill gas controls as part of the closure of the site.

Dewatering, Groundwater Treatment and Discharge

The water table depth from ground surface ranged from approximately 6 to 9 feet bgs based on the August and October 2017 and March 2018 water level gauging data. The maximum depth of waste encountered within the footprint of the recreational fields is 32 feet bgs, therefore, dewatering for removal of the waste would require an extensive effort due to the shallow water table and depth of waste.

Based on the August 2017 and March 2018 groundwater sampling results, an active remediation system for groundwater collected as part of a dewatering program would be required prior to discharge to the local stormwater system or the local stormwater combined sewer system. If local stormwater discharge is feasible, then an EPA National Pollutant Discharge Elimination System (NPDES) Remediation General Permit would be required. If local stormwater/combined sewer overflow discharge is feasible, then a Massachusetts Water Resource Authority (MWRA) Construction Dewatering Permit would be required.

Landfill Gas Control

Elevated concentrations of landfill gas exist beneath the Tobin School property. Landfill gas concentrations were detected in excess of 1000% LEL of methane at some locations. Due to the elevated concentrations of landfill gas in the shallow and deeper sub-surface strata, active landfill gas controls would be required to ensure the safety of the contractors and nearby residents, minimize gas migration during excavation, and to suppress excessive landfill gas odors.

Based on the soil vapor sample results (sulfide and VOC detections) and observations during drilling and test pit excavations, there is potential for excessive odors migrating in the ambient air during construction/excavation. Landfill gas migration controls required to control landfill gas and odors could consist of an active gas trench system (under vacuum) installed into the shallow waste across the recreational fields. The active gas trench system could utilize a temporary gas flare to burn off the methane and to control landfill gas odors.

Potential Risks for Safety, Human Health, and the Environment

The greatest potential risk for safety, human health and the environmental is primarily due to the elevated concentrations of landfill gases beneath the Tobin School property. Due to the methane concentrations, there exists the potential for an explosion hazard due to the generation of any sparks given that the explosive range of methane exists from 5 to 15%. This hazard would need to be mitigated during the construction activities.

Due to nature of waste material, low oxygen conditions also exist in the sub-surface, therefore, excavation contractors could potentially be exposed to low oxygen conditions. Another concern with excavating waste is the potential for landfill gas/odors to migrate in the sub-surface to sensitive receptors such as residential homes on the eastern property line, utilities located on-site and directly adjacent to the site and towards the Tobin School which would potentially be operating during construction.

MCP Requirements

The site has an existing AUL and Permanent Solution which would need to be retracted and revised following completion of the construction of the school. Prior to any excavation activities, a Release Abatement Measure (RAM) Plan would need to be submitted to MassDEP summarizing proposed excavation work, soil management, engineering controls and safety measures to protect human health and the environment. As part of the soil management for off-site disposal, additional sampling will be required to meet the requirements of the disposal facilities.

Closing

These considerations and presented data has been prepared for the proposed Tobin School project located in Cambridge, Massachusetts as understood at this time and described in this memorandum. The presented data has been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made. In the event that changes in the design or location of the proposed development occur, the interpretation of data and considerations contained herein should not be considered valid unless verified in writing by CDM Smith.

Attachments:

- FIGURE 1** – Test Boring Location Plan
- FIGURE 2** – Extent of Waste
- FIGURE 3** – Surface Water Protection Zones
- FIGURE 4** – Landfill Gas Probe and Well Monitoring Locations
- FIGURE 5** – Landfill Gas Utility Screening Locations

TABLE 1 – Summary of Geotechnical Index Test Results








TABLE 2 – Summary of Consolidation Test Results

TABLE 3 – Summary of Triaxial Compression Test Results
TABLE 4 – Summary Hydraulic Conductivity Test Results
TABLE 5 – Summary of Subsurface Exploration Programs
TABLE 6 – Summary of Monitoring Well Readings
TABLE 7 – Soil Sampling Results – July-August 2017
TABLE 8 – Groundwater Sampling Results – August 2017
TABLE 9 – Groundwater Sampling Results – March 2018
TABLE 10 – Soil Gas Probe and Groundwater Well Landfill Gas Monitoring Results – August 16-17, 2017
TABLE 11 – Groundwater Well Landfill Gas Monitoring Results – August and October 2017
TABLE 12 – Soil Vapor Sampling Results (VOCs, Sulfides, Mercaptans) – October 2, 2017
TABLE 13 – Utility Landfill Gas Monitoring Results – October 2, 2017

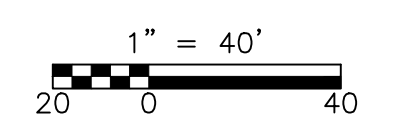
ATTACHMENT A – Historical Aerial Photos, Topographic Maps, and Sanborn Maps
ATTACHMENT B – Previous Test Boring Logs
ATTACHMENT C – Phase 1 - Test Boring Logs
ATTACHMENT D – Phase 1 - Rock Core Photographs
ATTACHMENT E – Phase 2 – Test Boring Logs
ATTACHMENT F – Phase 1 – Test Pit Logs
ATTACHMENT G – Phase 2 – Test Pit Logs
ATTACHMENT H – Phase 1 - Monitoring Well Logs
ATTACHMENT I – Phase 1 - Geotechnical Laboratory Test Results
ATTACHMENT J – Phase 2 - Geotechnical Laboratory Test Results
ATTACHMENT K – Slug Testing Results
ATTACHMENT L – Drum Disposal Manifest
ATTACHMENT M – Soil and Groundwater Analytical Laboratory Data

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REUSE OF DOCUMENTS: THESE DOCUMENTS AND DESIGNS PROVIDED BY PROFESSIONAL SERVICE, INCORPORATED HEREIN, ARE THE PROPERTY OF CDM SMITH AND ARE NOT TO BE USED, IN WHOLE OR PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF CDM SMITH.



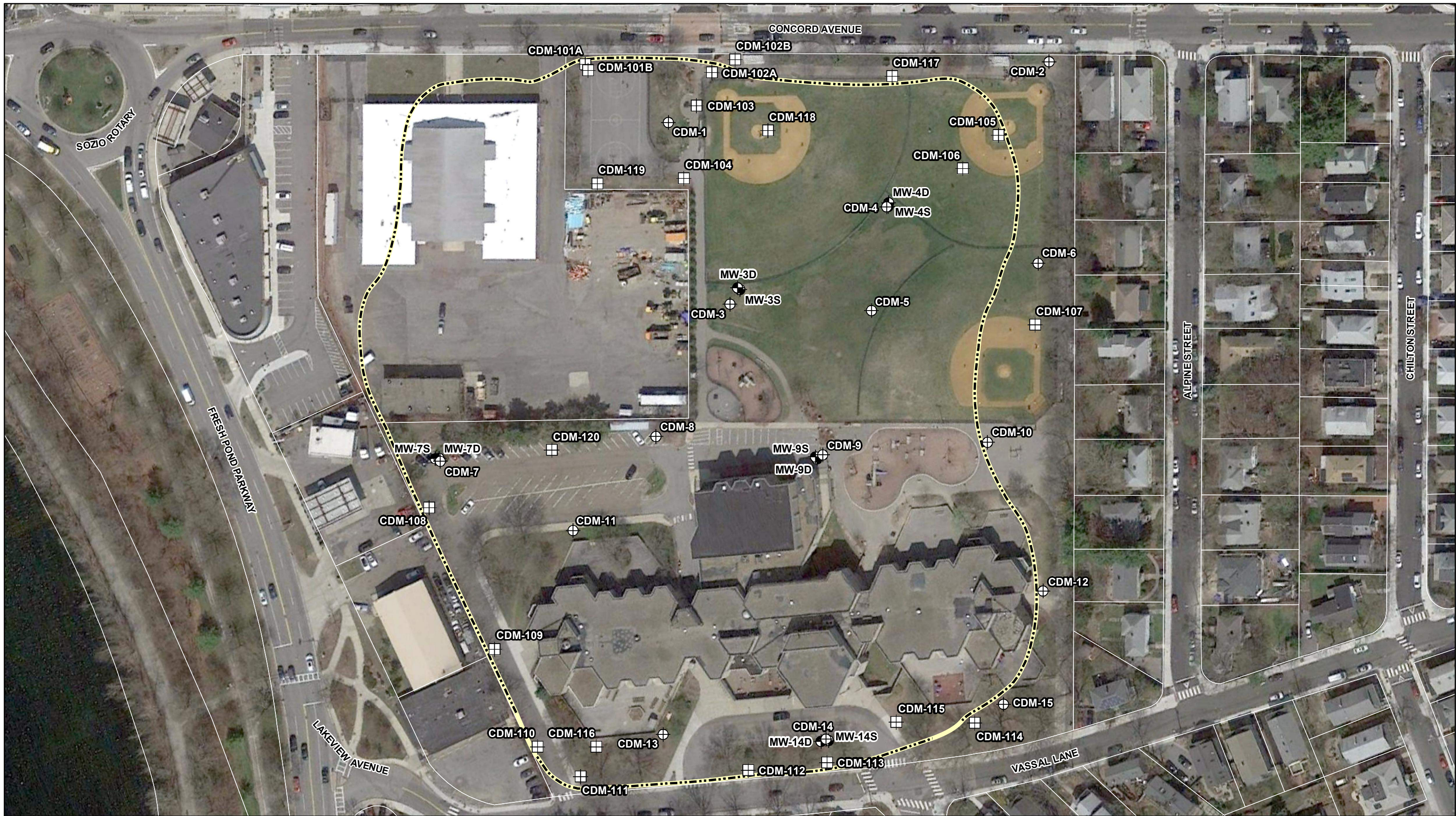
- LEGEND:**
-  **BORING #1** DESIGNATION AND APPROXIMATE LOCATION OF TEST BORINGS CONDUCTED BY NEW ENGLAND TEST BORING CORPORATION DATED OCTOBER-NOVEMBER 1966 AND JANUARY 1968.
 -  **CDM-1** DESIGNATION AND APPROXIMATE LOCATION OF PHASE I TEST BORINGS CONDUCTED BY NEW ENGLAND BORING CONTRACTORS, INC. OF DERRY, NH BETWEEN JULY 17 AND AUGUST 9, 2017.
 -  **MW-3D** DESIGNATION AND APPROXIMATE LOCATION OF MONITORING WELLS CONDUCTED BY NEW ENGLAND BORING CONTRACTORS, INC. OF DERRY, NH BETWEEN JULY 17 AND AUGUST 9, 2017.
 -  **CDM-101** DESIGNATION AND APPROXIMATE LOCATION OF PHASE II TEST BORINGS CONDUCTED BY NEW ENGLAND BORING CONTRACTORS, INC. OF DERRY, NH BETWEEN JANUARY 22 AND FEBRUARY 2, 2018.
 -  **TP-101** DESIGNATION AND APPROXIMATE LOCATION OF PHASE I TEST PIT CONDUCTED BY CHARTER CONTRACTING COMPANY, LLC. OF BOSTON, MA ON DECEMBER 28, 2017.
 -  **TP-201** DESIGNATION AND APPROXIMATE LOCATION OF PHASE II TEST PIT CONDUCTED BY CHARTER CONTRACTING COMPANY, LLC. OF BOSTON, MA BETWEEN FEBRUARY 20 AND FEBRUARY 21, 2017.
 -  **B-1/CHI-1** DESIGNATION AND APPROXIMATE LOCATION OF TEST BORINGS CONDUCTED BY CLEAN HARBORS ENVIRONMENTAL SERVICES, INC. OF WEYMOUTH, MA DATED MARCH 2000 AND FEBRUARY 2001.

- NOTES:**
1. BASE PLAN PREPARED FROM A DRAWING ENTITLED "EXISTING CONDITIONS SURVEY", PREPARED BY SURVEYING AND MAPPING CONSULTANTS, SCALE 1"=20', DATED OCTOBER 2, 2017.
 2. COORDINATES NOTED ARE IN FEET AND REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD83).
 3. ELEVATIONS AND CONTOUR LINES NOTED ARE IN FEET AND REFERENCED TO CAMBRIDGE CITY BASE (CCB) DATUM.
 4. TEST BORINGS CDM-1 THROUGH CDM-15, TEST BORINGS CDM-101A THROUGH CDM-120, TEST PITS TP-101, TP-102, TP-201, TP-203, TP-204, AND MONITORING WELLS MW-3D THROUGH MW-14S WERE OBSERVED AND LOGGED ON A FULL-TIME BASIS BY A CDM SMITH GEOTECHNICAL ENGINEER OR GEOLOGIST.
 5. TEST BORINGS BORING #1 THROUGH BORING #24 WERE LOCATED BASED ON A DRAWING TITLED "EXISTING CONDITIONS" FROM 1969.
 6. TEST BORINGS B-1, B-4, B-6, B-13 THROUGH B-18, AND CHI-4 THROUGH CHI-12 WERE LOCATED BASED ON A DRAWING TITLED "MASSACHUSETTS ARMY NATIONAL GUARD ARMORY - SITE PLAN" FROM 2002.







CITY OF CAMBRIDGE, MASSACHUSETTS
TOBIN SCHOOL
CAMBRIDGE, MASSACHUSETTS

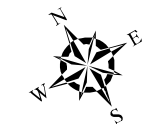
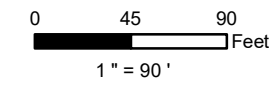
FIGURE 1
TEST BORING LOCATION PLAN
APRIL 2018



Legend

-  Geotechnical/Environmental Borings (Completed Jan-Feb 2018)
-  Geotechnical/Environmental Boring Location (July-August 2017)
-  Groundwater Monitoring Well Couplet Installation Location (July-August 2017)
-  Approximate Boundary of Former Clay Pit/Edge of Waste (updated April 2018 for Tobin School Property Only)

**Tobin School
197 Vassal Lane
Cambridge, MA**

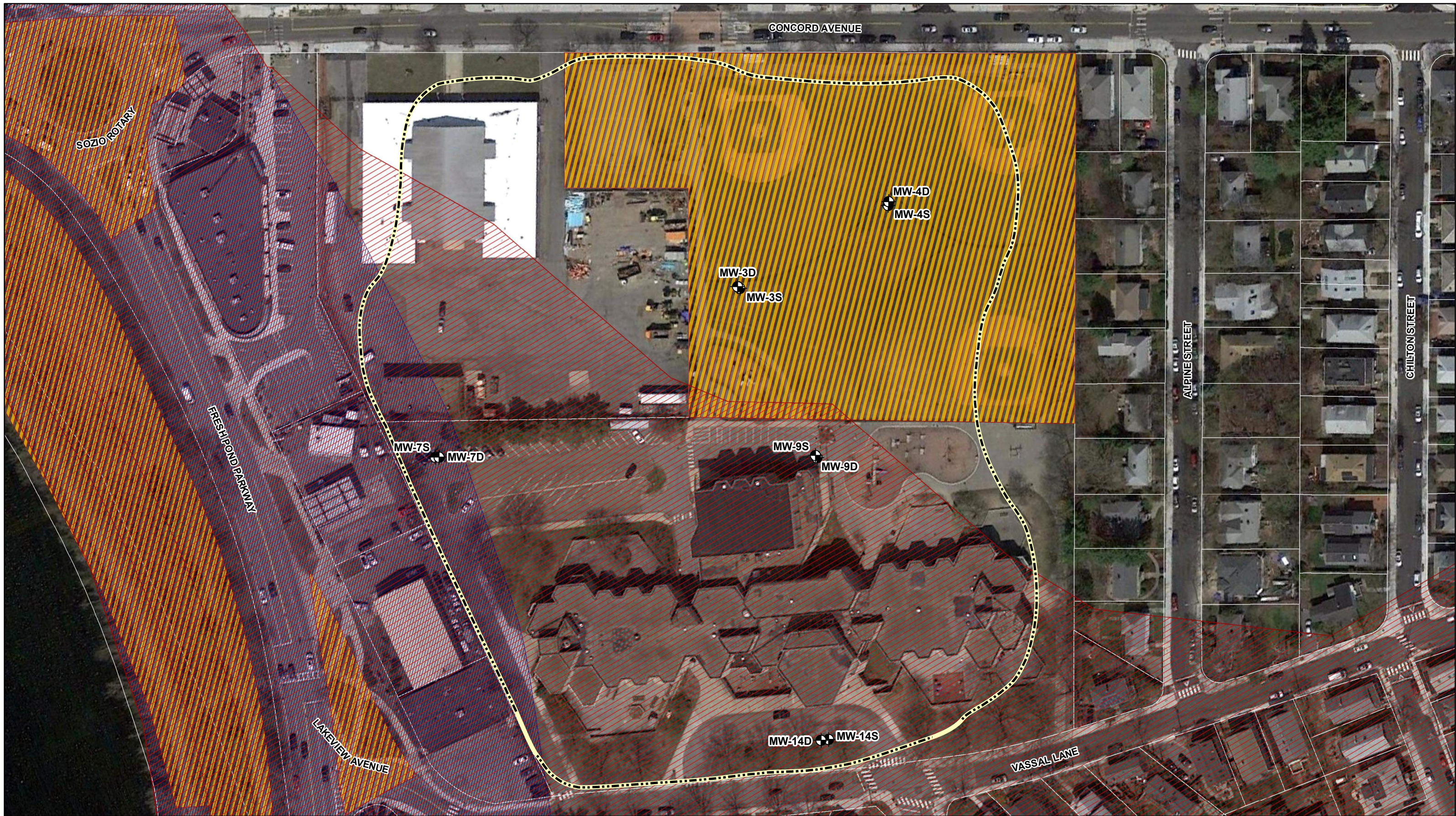


Basemap: Google Earth Pro Imagery (April 2017)
Source: Google, MassGIS, and ESRI ArcGIS Online
Coordinate Sys: NAD83 Mass. State Plane Mainland (feet)

FIGURE 2
Horizontal Edge of Waste
April 2018



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Legend

- Groundwater Monitoring Well Couplets Installation Location
- Approximate Boundary of Former Clay Pit/Edge of Waste (updated April 2018)

Surface Water Protection Areas

- Zone A
- Zone B
- Zone C
- Protected & Recreational Open Space

**Tobin School
197 Vassal Lane
Cambridge, MA**

0 45 90
Feet



Basemap: Google Earth Pro Imagery (April 2017)
Source: Google, MassGIS and ESRI ArcGIS Online
Coordinate Sys: NAD83 Mass. State Plane Mainland (feet)

**FIGURE 3
Surface Water Protection Zones
Fresh Pond Reservoir**

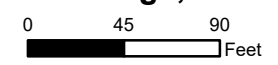


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- Legend**
- Gas Probe Location
 - Groundwater Monitoring Well Couplet Installation Location
 - Approximate Boundary of Former Clay Pit/Edge of Waste (updated April 2018)

Tobin School
197 Vassal Lane
Cambridge, MA

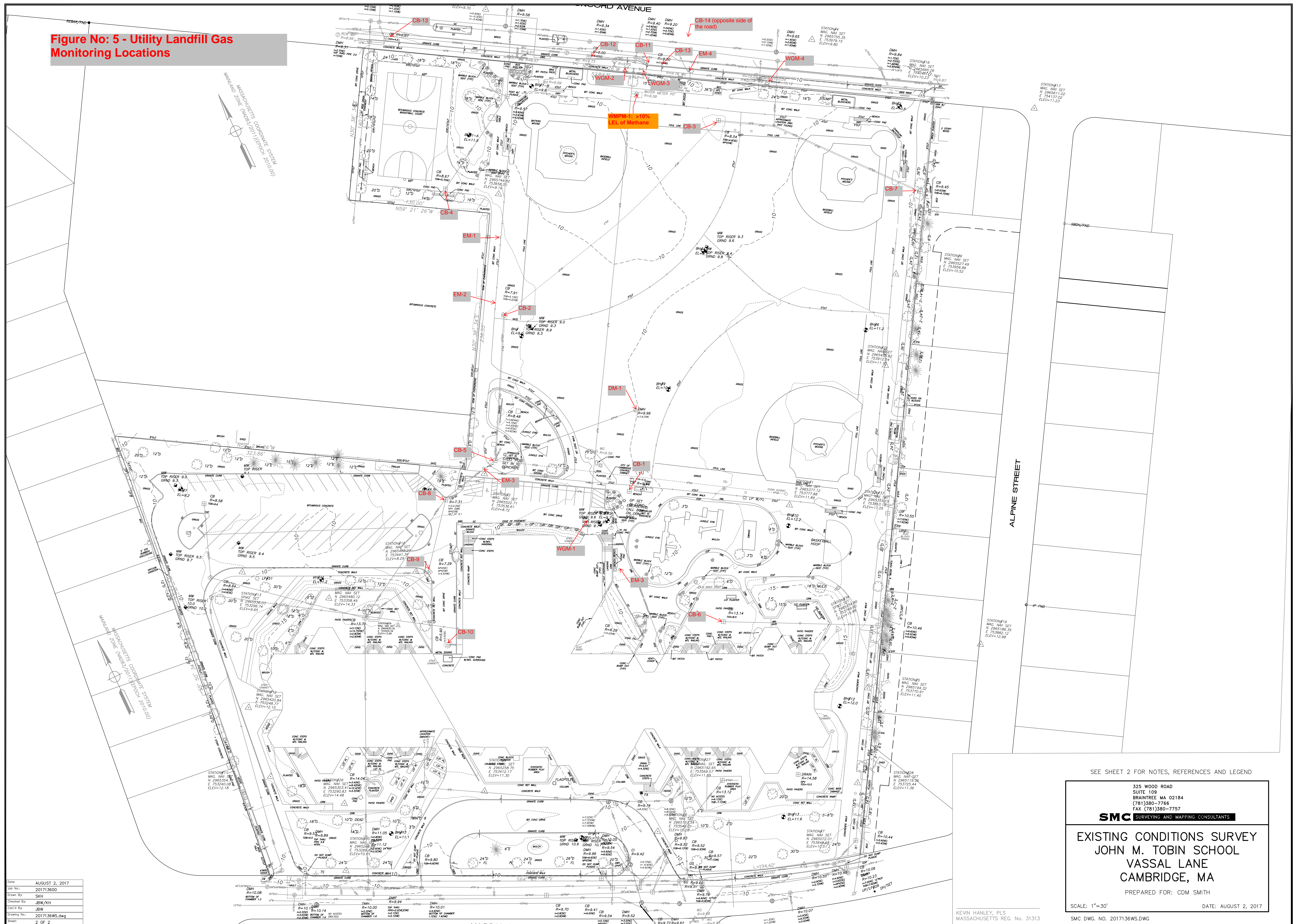


Basemap: Google Earth Pro Imagery (April 2017)
 Source: Google, MassGIS and ESRI ArcGIS Online
 Coordinate Sys: NAD83 Mass. State Plane Mainland (feet)

FIGURE 4
Landfill Gas Probe Monitoring Locations
July-August 2017



Figure No: 5 - Utility Landfill Gas Monitoring Locations



Date: AUGUST 2, 2017
 Job No.: 201713600
 Drawn By: SKH
 Checked By: JEW/KH
 Date: 08/02/17
 Drawing No.: 2017136WS.dwg
 Sheet: 2 OF 2

SEE SHEET 2 FOR NOTES, REFERENCES AND LEGEND

325 WOOD ROAD
 SUITE 109
 BRAintree MA 02184
 (781)380-7766
 FAX (781)380-7757
SMC SURVEYING AND MAPPING CONSULTANTS

EXISTING CONDITIONS SURVEY
JOHN M. TOBIN SCHOOL
VASSAL LANE
CAMBRIDGE, MA

PREPARED FOR: CDM SMITH

SCALE: 1"=30'

DATE: AUGUST 2, 2017

KEVIN HANLEY, PLS
 MASSACHUSETTS REG. NO. 31313

SMC DWG. NO. 2017136WS.DWG

**City of Cambridge
Tobin School
Cambridge, Massachusetts**

**Table 1
Summary of Geotechnical Index Test Results**

Exploration No.	Sample No.	Sample Depth (ft)	Stratum	USCS Classification ⁽¹⁾	Grain Size Analysis ⁽²⁾						Atterberg Limits ⁽³⁾			Moisture Content (%) ⁽⁴⁾	Mini-Vane Shear Test ⁽⁵⁾		Organic Content (%) ⁽⁶⁾	
					Gravel (%)		Sand (%)			Fines (%)		LL (%)	PL (%)		PI (%)	Initial Shear Strength (psf)		Remolded Shear Strength (psf)
					Coarse	Fine	Coarse	Medium	Fine	Silt	Clay							
Phase 1 - Subsurface Exploration Program (CDM Smith, Jul-Aug 2017)																		
CDM-1	S-3	4-6	Granular Fill	SM	4.6	24.9	8.9	19.8	20.8	21.0	--	--	--	9.1	--	--	--	
CDM-1	S-7	12-14	Waste Fill	SM	0.0	38.2	17.4	18.1	13.3	13.0	--	--	--	23.8	--	--	--	
CDM-1	S-20	44-46	Clay & Silt	CL	--	--	--	--	--	--	39	19	20	29.9	--	--	--	
CDM-1	ST-1	46-48	Clay & Silt	CL	--	--	--	--	--	--	38	19	19	27.5	1450	478	--	
CDM-1	S-23	59-61	Clay & Silt	CL	--	--	--	--	--	--	40	21	19	34.9	--	--	--	
CDM-1	S-25	69-71	Glacial Till	SM	0.0	15.4	12.4	11.4	14.4	23.4	23.0	--	--	--	14.5	--	--	--
CDM-2	S-3B	4-6	Granular Fill	CL	--	--	--	--	--	--	40	21	19	23.0	--	--	--	
CDM-2	S-4A	6-8	Granular Fill	SM	0.0	13.9	8.5	16.8	30.1	16.2	14.5	--	--	--	23.0	--	--	--
CDM-2	S-4B	6-8	Organic Soils	OL	--	--	--	--	--	--	--	--	--	90.0	--	--	17.7	
CDM-2	S-5A	8-10	Organic Soils	OL	--	--	--	--	--	--	--	--	--	90.9	--	--	14.0	
CDM-2	S-8	14-16	Clay & Silt	CL	--	--	--	--	--	--	41	20	21	25.9	--	--	--	
CDM-2	S-15	34-36	Clay & Silt	CL	--	--	--	--	--	--	33	18	15	28.2	--	--	--	
CDM-2	ST-1	41-43	Clay & Silt	CL	--	--	--	--	--	--	45	20	25	34.3	2869	1558	--	
CDM-2	S-18	49-51	Glacial Till	GM	7.4	34.1	10.0	10.3	11.7	12.9	13.6	--	--	--	10.3	--	--	--
CDM-2	S-19	54-55	Glacial Till	CL-ML	--	--	--	--	--	--	16	12	4	10.8	--	--	--	
CDM-3	S-15	35-37	Clay & Silt	CL	--	--	--	--	--	--	41	19	22	28.3	--	--	--	
CDM-4	S-2	2-4	Granular Fill	SM	6.2	18.0	9.3	23.3	27.5	15.7	--	--	--	10.6	--	--	--	
CDM-4	S-10	18-20	Waste Fill	SP	0.0	34.0	12.1	27.7	22.2	4.0	--	--	--	38.5	--	--	--	
CDM-4	ST-1	36-38	Clay & Silt	CL	--	--	--	--	--	--	45	21	24	30.7	2306	1643	--	
CDM-4	S-20	44-46	Clay & Silt	CL	--	--	--	--	--	--	45	21	24	36.0	--	--	--	
CDM-4	ST-2	48-50	Clay & Silt	CL	--	--	--	--	--	--	30	19	11	25.8	1604	1381	--	
CDM-5	S-2	2-4	Granular Fill	SM	0.0	7.2	8.0	34.0	36.8	14.0	--	--	--	8.6	--	--	--	
CDM-5	S-4	6-8	Waste Fill	SM	8.4	27.1	10.4	23.6	16.6	13.9	--	--	--	32.5	--	--	--	
CDM-5	ST-1	30-32	Clay & Silt	CH	--	--	--	--	--	--	52	21	31	45.0	401	247	--	
CDM-5	S-17	44-46	Clay & Silt	CL	--	--	--	--	--	--	41	20	21	43.9	--	--	--	
CDM-6	S-6	9-11	Clay & Silt	CL	--	--	--	--	--	--	39	20	19	25.2	--	--	--	
CDM-6	S-12B	35-37	Clay & Silt	ML	0.0	0.0	0.0	0.4	29.8	65.4	4.4	--	--	--	22.3	--	--	--
CDM-7	S-2	2-4	Granular Fill	SM	0.0	25.6	7.7	29.9	23.0	13.8	--	--	--	15.2	--	--	--	
CDM-7	S-15	39-41	Clay & Silt	CL	--	--	--	--	--	--	36	20	16	28.6	--	--	--	
CDM-7	S-19	59-61	Clay & Silt	CL	--	--	--	--	--	--	33	18	15	31.6	--	--	--	
CDM-7	S-21A	69-71	Clay & Silt	CL	0.0	0.0	0.0	0.3	20.4	56.3	23.0	--	--	--	32.2	--	--	--
CDM-7	S-21B	69-71	Clay & Silt	ML	--	--	--	--	--	--	37	21	16	33.3	--	--	--	
CDM-7	S-23	79-81	Glacial Till	GM	22.4	27.9	11.9	16.0	8.8	13.0	--	--	--	8.2	--	--	--	

**City of Cambridge
Tobin School
Cambridge, Massachusetts**

**Table 1
Summary of Geotechnical Index Test Results**

Exploration No.	Sample No.	Sample Depth (ft)	Stratum	USCS Classification ⁽¹⁾	Grain Size Analysis ⁽²⁾						Atterberg Limits ⁽³⁾			Moisture Content (%) ⁽⁴⁾	Mini-Vane Shear Test ⁽⁵⁾		Organic Content (%) ⁽⁶⁾	
					Gravel (%)		Sand (%)			Fines (%)		LL (%)	PL (%)		PI (%)	Initial Shear Strength (psf)		Remolded Shear Strength (psf)
					Coarse	Fine	Coarse	Medium	Fine	Silt	Clay							
CDM-8	S-3	4-6	Granular Fill	SM	0.0	9.4	6.4	18.3	42.3	23.6	--	--	--	14.8	--	--	--	
CDM-8	S-14	30-32	Clay & Silt	CL	--	--	--	--	--	--	49	24	25	35.3	--	--	--	
CDM-8	ST-1	40-42	Clay & Silt	CL	--	--	--	--	--	--	30	18	12	26.2	1820	748	--	
CDM-8	S-17	50-52	Glacial Till	SM	0.0	31.3	13.3	17.0	16.3	13.1	9.0	--	--	--	11.2	--	--	--
CDM-8	S-18	55-57	Glacial Till	CL-ML	--	--	--	--	--	--	20	16	4	9.4	--	--	--	
CDM-9	S-2	2-4	Granular Fill	SP-SM	5.6	20.0	9.6	31.5	22.4	10.9	--	--	--	10.9	--	--	--	
CDM-9	S-12	22-24	Clay & Silt	CL	--	--	--	--	--	--	34	18	16	28.4	--	--	--	
CDM-9	S-14	26-28	Clay & Silt	CL	--	--	--	--	--	--	31	16	15	25.1	--	--	--	
CDM-10	S-1	0.5-2	Granular Fill	SP-SM	0.0	19.9	10.7	35.5	23.8	10.1	--	--	--	5.1	--	--	--	
CDM-10	S-4	6-8	Granular Fill	SM	0.0	15.1	24.2	26.8	7.8	13.7	12.4	--	--	--	16.8	--	--	--
CDM-10	S-6	10-12	Clay & Silt	CL	--	--	--	--	--	--	41	18	23	24.9	--	--	--	
CDM-10	ST-1	20-22	Clay & Silt	CL	--	--	--	--	--	--	40	21	19	35.5	1234	370	--	
CDM-11	S-10	18-20	Clay & Silt	CL	--	--	--	--	--	--	41	21	20	28.2	--	--	--	
CDM-12	S-2	2-4	Granular Fill	SM	0.0	25.8	10.7	22.7	16.6	24.2	--	--	--	16.2	--	--	--	
CDM-12	S-6	14-16	Clay & Silt	CL	--	--	--	--	--	--	42	21	21	27.8	--	--	--	
CDM-12	S-13	48-50	Clay & Silt	CL-ML	0.0	0.0	0.0	0.3	22.4	55.4	21.9	21	16	5	28.8	--	--	--
CDM-13	S-2	2-4	Granular Fill	SM	0.0	25.7	8.4	20.1	23.1	22.7	--	--	--	6.7	--	--	--	
CDM-13	S-17	44-46	Clay & Silt	CL	--	--	--	--	--	--	30	15	15	22.4	--	--	--	
CDM-13	S-20	59-61	Clay & Silt	CL	--	--	--	--	--	--	41	20	21	38.7	--	--	--	
CDM-13	S-22	69-71	Clay & Silt	CL	--	--	--	--	--	--	42	19	23	38.1	--	--	--	
CDM-13	S-23	74-76	Clay & Silt	CL-ML	--	--	--	--	--	--	24	19	5	24.1	--	--	--	
CDM-13	S-24	84-86	Clay & Silt	CL-ML	6.3	23.0	11.0	14.0	12.8	15.6	17.3	--	--	--	10.6	--	--	--
CDM-14	S-18	55-57	Clay & Silt	CL	--	--	--	--	--	--	38	17	21	37.8	--	--	--	
CDM-14	S-19B	65-67	Clay & Silt	ML	--	--	--	--	--	--	NP	NP	NP	22.6	--	--	--	
CDM-14	S-20	75-77	Clay & Silt	CL	--	--	--	--	--	--	28	17	11	22.5	--	--	--	
CDM-15	S-3	6-8	Clay & Silt	CL	0.0	0.0	0.0	0.4	4.7	46.2	48.7	39	18	21	17.6	--	--	--
CDM-15	S-5	10-12	Clay & Silt	CL	--	--	--	--	--	--	49	21	28	29.6	--	--	--	
CDM-15	ST-1	18-20	Clay & Silt	CL	--	--	--	--	--	--	38	22	16	28.6	2561	725	--	
CDM-15	ST-2	31-33	Clay & Silt	CL	--	--	--	--	--	--	34	19	15	30.7	1311	1088	--	
CDM-15	S-17	54-56	Clay & Silt	CL	--	--	--	--	--	--	49	20	29	43.2	--	--	--	
CDM-15	S-19	69-71	Clay & Silt	CH	--	--	--	--	--	--	56	16	40	48.1	--	--	--	
CDM-15	S-20B	74-76	Clay & Silt	ML	--	--	--	--	--	--	NV	NP	NP	28.8	--	--	--	

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**Table 1
Summary of Geotechnical Index Test Results**

Exploration No.	Sample No.	Sample Depth (ft)	Stratum	USCS Classification ⁽¹⁾	Grain Size Analysis ⁽²⁾						Atterberg Limits ⁽³⁾			Moisture Content (%) ⁽⁴⁾	Mini-Vane Shear Test ⁽⁵⁾		Organic Content (%) ⁽⁶⁾	
					Gravel (%)		Sand (%)			Fines (%)		LL (%)	PL (%)		PI (%)	Initial Shear Strength (psf)		Remolded Shear Strength (psf)
					Coarse	Fine	Coarse	Medium	Fine	Silt	Clay							
Phase 2 - Subsurface Exploration Program (CDM Smith, Jan-Feb 2018)																		
CDM-101B	S-4	7-9	Waste Fill	OL	--	--	--	--	--	--	--	--	--	82.4	--	--	17.0	
CDM-102B	S-4B	7-9	Organic Soils	OL	--	--	--	--	--	--	--	--	--	74.2	--	--	18.8	
CDM-103	S-8	15-17	Waste Fill	SM	0.0	40.8	19.9	14.5	10.3	9.9	4.6	--	--	45.4	--	--	--	
CDM-103	S-11	21-23	Clay & Silt	ML	--	--	--	--	--	--	--	NV	NP	NP	25.1	--	--	
CDM-104	S-7	12-14	Waste Fill	GW-GM	17.7	32.2	11.9	17.0	11.7	9.5	--	--	--	29.8	--	--	--	
CDM-104	S-15	28-30	Waste Fill	GP-GM	1.6	52.1	16.8	13.8	6.0	9.7	--	--	--	28.2	--	--	--	
CDM-104	S-17	32-34	Clay & Silt	CL	--	--	--	--	--	--	--	40	21	19	32.3	--	--	
CDM-105	S-4B	6-8	Organic Soils	CL	--	--	--	--	--	--	--	--	--	22.9	--	--	2.4	
CDM-106	S-6	10-12	Waste Fill	GP	14.0	54.6	21.4	5.5	2.7	1.8	--	--	--	22.1	--	--	--	
CDM-106	S-9	16-18	Clay & Silt	CL	--	--	--	--	--	--	--	44	22	22	29.9	--	--	
CDM-108	S-4B	7-9	Organic Soils	OL	--	--	--	--	--	--	--	--	--	71.1	--	--	17.5	
CDM-109	S-2B	3-5	Waste Fill	SM	9.1	19.3	8.6	21.4	19.8	21.8	--	--	--	32.5	--	--	--	
CDM-109	S-4A	7-9	Organic Soils	OL	--	--	--	--	--	--	--	--	--	48.9	--	--	10.6	
CDM-109	S-4B	7-9	Clay & Silt	ML	0.0	0.0	0.0	5.5	41.8	45.7	7.0	NV	NP	NP	24.6	--	--	
CDM-109	S-5B	9-11	Clay & Silt	SM	0.0	0.5	2.9	21.8	62.7	12.1	--	--	--	18.9	--	--	--	
CDM-110	S-3	5-7	Waste Fill	SM	0.0	10.3	7.6	34.7	34.1	13.3	--	--	--	29.7	--	--	--	
CDM-110	S-4A	7-9	Organic Soils	SM	--	--	--	--	--	--	--	--	--	24.4	--	--	9.4	
CDM-112	S-3	4-6	Waste Fill	SM	0.0	17.5	11.1	23.7	22.5	25.2	--	--	--	10.1	--	--	--	
CDM-115	S-4	6-8	Sand & Silt	SM	0.0	0.0	0.1	2.8	56.7	17.2	23.2	--	--	--	18.1	--	--	
CDM-115	S-7	12-14	Clay & Silt	CL	0.0	0.0	0.5	2.4	16.5	29.8	50.8	27	15	12	28.0	--	--	
CDM-118	S-4	6-8	Waste Fill	SM	20.3	6.7	6.8	28.9	23.6	13.7	--	--	--	16.4	--	--	--	
CDM-118	S-10A	18-20	Waste Fill	SM	0.0	35.2	20.0	22.4	10.3	12.1	--	--	--	55.3	--	--	--	
CDM-119	S-11	20-22	Waste Fill	SW-SM	0.0	27.8	17.6	31.3	14.2	9.1	--	--	--	54.1	--	--	--	
CDM-119	S-18	34-36	Clay & Silt	CL	--	--	--	--	--	--	--	39	20	19	28.4	--	--	
CDM-120	S-5	9-11	Waste Fill	SM	0.0	23.2	11.7	19.7	17.6	27.8	--	--	--	77.6	--	--	--	

Notes:

- USCS classifications were performed in accordance with ASTM D-2487.
- Grain size analysis tests performed in accordance with ASTM D-7928 & D-6913 and ASTM D-1140
- Atterberg limit tests performed in accordance with ASTM D-4318.
- Moisture content analysis performed in accordance with ASTM D-2216.
- Miniature Vane Shear Test performed in accordance with ASTM D-4648.
- Organic content tests performed in accordance with ASTM D-2974.

Abbreviations:

--	Test Not Performed	CL-ML	Lean, silty clay	GW-GM	Well-Graded Gravel with Silt
SM	Silty Sand	CH	Fat Clay	GP-GM	Poorly-Graded Gravel with Silt
SP	Poorly-Graded Sand	CL	Lean Clay	GP	Poorly-Graded Gravel
SW-SM	Well-Graded Sand with Silt	ML	Silt	GM	Silty Gravel
SP-SM	Poorly-Graded Sand with Silt	NV	No Value		
OL	Organic Sand or Silt	NP	Non Plastic		

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**Table 2
Summary of Consolidation Test Results**

Exploration No.	Sample No.	Sample Depth (ft)	Stratum	Initial Dry Density, V_d (pcf)	Moisture Content (%)		Void Ratio		Estimated Effective Vertical Stress, σ'_{vo} (psf)	Interpreted Pre-consolidation Pressure, σ'_p (psf)	OCR ⁽¹⁾	Compression Ratio C_{ce} ⁽²⁾	Recompression Ratio C_{re} ⁽³⁾	Coefficient of Consolidation, C_v (ft ² /yr)	
					Initial, w_o	Final, w_f	Initial, e_o	Final, e_f						Min (Typical)	Max (Typical)
Subsurface Exploration Program (CDM Smith, Jul-Aug 2017)															
CDM-1	ST-1	47	Clay & Silt	96.0	27.5	24.4	0.76	0.61	3,168	5,000	1.58	0.110	0.018	--	--
CDM-4	ST-1	37	Clay & Silt	100.2	24.5	22.8	0.68	0.52	2,575	6,000	2.33	0.131	0.015	80	1040
CDM-4	ST-2	49	Clay & Silt	99.8	26.6	24.9	0.69	0.57	3,205	5,500	1.72	0.080	0.018	42	3323
CDM-8	ST-1	41	Clay & Silt	93.0	28.9	28.8	0.81	0.76	2,448	6,000	2.45	0.117	0.011	8	245
CDM-15	ST-2	32	Clay & Silt	95.9	27.5	23.8	0.76	0.59	2,160	3,500	1.62	0.107	0.017	3	100

Notes:

1. OCR = Overconsolidation Ratio, σ'_p / σ'_{vo}
2. C_{ce} = Virgin compression ratio
3. C_{re} = Recompression ratio
4. Constant Rate of Strain (CRS) tests were performed in accordance with ASTM D4186.

Abbreviations:

- ST indicates Shelby Tube sample
-- indicates data not recorded

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**Table 3
Summary of Triaxial Compression Test Results**

Exploration Number	Sample Number	Sample Depth (ft)	Stratum	Initial Conditions			Effective Confining Stress, σ_c' (psf)	Failure at $R_{max}^{(2)}$		Failure at $q_{max}^{(3)}$		$E_i^{(4)}$ (psf)	$E_{50}^{(5)}$ (psf)
				Initial Moisture Content (%)	Initial Void Ratio	Initial Dry Unit Weight (pcf)		p' (psf)	q (psf)	p' (psf)	q (psf)		
Subsurface Exploration Program (CDM Smith, Jul-Aug 2017)													
CDM-1	ST-1	47	Clay & Silt	29.9	0.820	94.3	3,168	2,932	1,688	3,204	1,793	422,754	526,867
CDM-8	ST-1	41	Clay & Silt	25.6	0.704	100.7	2,448	3,077	1,925	5,754	3,323	382,142	451,376
CDM-15	ST-2	32	Clay & Silt	28.9	0.781	96.4	2,160	2,554	1,565	3,234	1,833	371,336	491,744

Notes:

1. USCS classifications were performed in accordance with ASTM D-2487.
2. R_{max} maximum principal stress ratio, σ_1' / σ_3'
3. q_{max} maximum principal difference, $(\sigma_1' - \sigma_3') / 2$
4. Initial secant modulus, E_i , taken at 0.5% strain.
5. Young's secant modulus, E_{50} , taken at 50% of q at failure at R_{max} .
6. Isotropically Consolidated Undrained Triaxial compression tests were performed in accordance with ASTM D-4767.

Abbreviations:

- p' Mean Effective Stress
 q Undrained Shear Stress

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**Table 4
Summary of Hydraulic Conductivity Test Results**

Well Identification	Screened Interval		Hydraulic Conductivity (ft/day)		Hydraulic Conductivity (cm/sec)	
	Depth (bgs)	Strata	Falling	Rising	Falling	Rising
MW-3S	3-13	FILL/WASTE	13.60	27.05	4.80E-03	9.54E-03
MW-3D	14-24	WASTE	7.57	18.59	2.67E-03	6.56E-03
MW-4S	3-18	Fill/WASTE	6.27	6.53	2.21E-03	2.31E-03
MW-4D	20-30	WASTE	14.05	10.02	4.96E-03	3.53E-03
MW-7S	3-13	FILL/WASTE	8.78	22.85	3.10E-03	8.06E-03
MW-7D	7-17	WASTE	8.85	11.40	3.12E-03	4.02E-03
MW-9S	2-12	FILL/WASTE	2.50	8.38	8.82E-04	2.96E-03
MW-9D	12-22	WASTE	6.47	4.57	2.28E-03	1.61E-03
MW-14S	2-12	FILL/WASTE	0.21	1.45	7.24E-05	5.12E-04
MW-14D	12-22	WASTE	2.35	15.90	8.28E-04	5.61E-03

Notes:

1. All wells constructed using 2 " Schedule 40 PVC Riser and 2" (.01") Slot Schedule 40 PVC Screen
2. Slug Testing completed on 3/1/2018

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**Table 5
Summary of Subsurface Exploration Programs**

Exploration Number	Approximate Ground Surface Elevation (ft) ⁽¹⁾	Exploration Depth (ft)	Stratum Thickness (ft)								Depth to Top of Bedrock (ft)	Depth to Groundwater (ft) ⁽²⁾	Approximate Groundwater Elevation (ft)	
			Topsoil	Pavement	Granular Fill	Waste Fill	Organic Soils	Clay & Silt	Glacial Till	Weathered Rock				Bedrock
Previous Subsurface Exploration Program (New England Test Boring Corporation, Oct-Nov 1966)														
Boring #1	22.6	66.5	--	--	--	6.5	--	52.5	>7.5	--	--	--	--	
Boring #2	22.7	11.0	--	--	5.5	--	--	>5.5	--	--	--	--	--	
Boring #2A	22.7	39.5	--	--	--	6.0	--	23.0	0.5	--	>10.0	29.6	--	
Boring #3	21.1	46.3	--	--	--	25.0	--	13.5	>7.8	--	--	8.1	13.0	
Boring #4	21.6	52.5	--	--	--	18.0	--	26.5	>8	--	--	5.8	15.8	
Boring #5	21.6	33.0	--	--	--	19.0	--	>14.0	--	--	--	8.5	13.1	
Boring #6	21.7	25.5	--	--	--	21.5	--	>4.0	--	--	--	5.5	16.2	
Boring #7	21.8	41.0	--	--	--	21.0	--	>20.0	--	--	--	5.5	16.3	
Boring #8	22.6	30.0	--	--	2.5	--	--	>27.5	--	--	--	7.5	15.1	
Boring #9	21.8	41.5	--	--	5.5	15.5	--	19.5	>1.0	--	--	5.5	16.3	
Boring #10	21.6	27.0	--	--	6.5	13.0	--	6.5	>1.0	--	--	5.5	16.1	
Boring #11	21.3	33.0	--	--	6.0	15.0	--	10.0	>2.0	--	--	5.0	16.3	
Boring #12	22.0	32.0	--	--	5.0	9.0	--	16.0	>2.0	--	--	6.6	15.4	
Boring #13	21.4	50.0	--	--	--	25.0	1.5	17.5	>6.0	--	--	5.5	15.9	
Boring #14	22.7	51.0	--	--	5.0	8.0	--	34.5	>3.5	--	--	9.0	13.7	
Boring #15	21.2	10.0	--	--	--	10.0	--	--	--	--	--	6.0	15.2	
Boring #15A	21.2	66.0	1.5	--	--	18.5	--	42.0	2.0	>2.0	NE	6.0	15.2	
Boring #16	22.0	58.0	--	--	7.0	--	--	42.0	>9.0	--	--	6.5	15.5	
Previous Subsurface Exploration Program (New England Test Boring Corporation, Jan 1968)														
Boring #17	21.9	87.0	--	--	--	16.0	--	61.0	--	--	>10.0	77.0	6.5	15.4
Boring #18	21.6	88.0	--	--	--	16.5	--	52.5	9.0	--	>10.0	78.0	6.8	14.8
Boring #19	21.3	49.0	--	--	--	14.5	--	24.5	--	--	>10.0	39.0	7.3	14.0
Boring #20	21.8	97.0	--	--	--	15.5	--	65.5	6.0	--	>10.0	87.0	7.8	14.0
Boring #21	21.7	66.0	--	--	--	14.0	--	>52.0	--	--	--	--	4.5	17.2
Boring #22	21.5	69.5	--	--	--	14.5	--	49.0	>6.0	--	--	--	5.8	15.7
Boring #23	22.3	75.5	--	--	--	18.5	--	>57.0	NE	--	--	--	8.5	13.8
Boring #24	22.1	73.5	--	--	--	13.0	--	52.5	>8.0	--	--	--	9.5	12.6
Previous Subsurface Exploration Program (Clean Harbors Environmental Services, Inc., Mar 2000)														
B-1	20.7	16.0	--	--	--	>16.0	--	--	--	--	--	--	--	
B-4	20.6	16.0	--	--	--	>16.0	--	--	--	--	--	5.0	15.6	
B-6	21	20.0	--	--	--	>20.0	--	--	--	--	--	5.0	16.0	
CHI-4	20.3	16.0	--	--	--	>16.0	--	--	--	--	--	5.0	15.3	
CHI-5	20.5	16.0	--	--	--	14.0	--	>2.0	--	--	--	5.0	15.5	
CHI-6	20.4	16.0	--	--	--	>16.0	--	--	--	--	--	5.0	15.4	
CHI-7	21.8	12.0	--	--	--	10.0	--	>2.0	--	--	--	5.0	16.8	

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**Table 5
Summary of Subsurface Exploration Programs**

Exploration Number	Approximate Ground Surface Elevation (ft) ⁽¹⁾	Exploration Depth (ft)	Stratum Thickness (ft)									Depth to Top of Bedrock (ft)	Depth to Groundwater (ft) ⁽²⁾	Approximate Groundwater Elevation (ft)
			Topsoil	Pavement	Granular Fill	Waste Fill	Organic Soils	Clay & Silt	Glacial Till	Weathered Rock	Bedrock			
Previous Subsurface Exploration Program (Clean Harbors Environmental Services, Inc., Feb 2001)														
B-13	20.4	22.0	--	--	10.0	8.0	--	>4.0	--	--	--	--	4.5	15.9
B-14	20.5	8.0	--	--	6.0	>2.0	--	--	--	--	--	--	3.0	17.5
B-15	20.5	8.0	--	--	>8.0		--	--	--	--	--	--	3.0	17.5
B-16	20.5	22.0	--	--	--	20.3	--	>1.8	--	--	--	--	4.8	15.8
B-17	20.5	22.0	--	--	3.0	17.1	--	>1.9	--	--	--	--	4.8	15.8
B-18	20.7	16.0	--	--	--	>16.0	--	--	--	--	--	--	3.8	17.0
CHI-8	21.6	17.0	--	--	5.0	3.0	0.5	>8.5	--	--	--	--	5.0	16.6
CHI-9	21.8	17.0	--	--	0.8	4.3	2.0	>10.0	--	--	--	--	4.8	17.1
CHI-10	21.4	17.0	--	--	--	10.0	5.2	>2.8	--	--	--	--	4.8	16.7
CHI-11	21.1	22.0	--	--	10.0	9.5	--	>2.5	--	--	--	--	7.0	14.1
CHI-12	22.6	17.0	--	--	3.0	7.0	--	>7.0	--	--	--	--	4.8	17.9
Phase 1 - Subsurface Exploration Program (CDM Smith, Jul-Aug 2017)														
CDM-1	21.5	83.0	0.3	--	7.7	22.4	--	32.1	12.2	--	>8.3	74.7	7.7	13.8
CDM-2	22.2	62.5	0.2	--	7.3	--	1.5	38.5	7.5	--	>7.5	55.0	5.3	16.9
CDM-3	20.7	55.0	0.8	--	1.2	26.0	--	20.5	3.5	--	>3.0	52.0	NR	--
CDM-4	21.4	63.5	0.8	--	5.2	24.0	--	23.0	5.5	--	>5.0	58.5	NR	--
CDM-5	22.0	50.0	0.7	--	3.3	24.0	--	19.0	>3.0	--	--	--	NR	--
CDM-6	22.9	50.0	0.5	--	2.5	--	--	40.5	4.0	>2.5	--	--	NR	--
CDM-7	20.8	81.5	--	0.4	5.6	10.2	--	58.3	7.0	--	0.0	81.5	4.5	16.3
CDM-8	19.4	59.1	--	0.5	7.5	10.0	--	29.0	11.0	--	>1.1	58.0	NR	--
CDM-9	21.3	40.0	--	0.5	3.5	14.0	--	10.7	2.8	--	>8.5	31.5	7.0	14.3
CDM-10	23.9	41.0	--	0.4	7.6	--	--	22.8	1.2	--	>9.0	32.0	8.5	15.4
CDM-11	22.9	52.0	--	--	3.0	5.2	--	>43.8	--	--	--	--	NR	--
CDM-12	23.6	50.0	--	0.5	11.5	--	--	38.0	--	--	--	--	7.0	16.6
CDM-13	22.8	94.0	0.3	--	5.7	8.0	--	66.0	12.5	--	>1.5	92.5	NR	--
CDM-14	22.3	85.5	--	--	2.0	18.0	--	62.5	--	>3.0	--	--	NR	--
CDM-15	23.3	80.5	0.3	--	3.7	--	--	75.3	--	--	>1.2	79.3	6.5	16.8
Phase 1 - Test Pit Program (CDM Smith, Dec 2017)														
TP-101	21.0	13.5	1.0	--	6.0	>6.5	--	--	--	--	--	--	11.0	10.0
TP-102	21.0	12.0	1.0	--	2.5	>8.5	--	--	--	--	--	--	9.5	11.5
Phase 2 - Test Pit Program (CDM Smith, Feb 2018)														
TP-201	23.5	22.0	1.0	--	3.0	>18.0	--	--	--	--	--	--	12.5	11.0
TP-203	21.0	18.0	0.5	--	5.5	>12.0	--	--	--	--	--	--	9.0	12.0
TP-204	21.0	16.0	0.5	--	5.5	9.0	--	>1.0	--	--	--	--	7.5	13.5

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**Table 5
Summary of Subsurface Exploration Programs**

Exploration Number	Approximate Ground Surface Elevation (ft) ⁽¹⁾	Exploration Depth (ft)	Stratum Thickness (ft)									Depth to Top of Bedrock (ft)	Depth to Groundwater (ft) ⁽²⁾	Approximate Groundwater Elevation (ft)
			Topsoil	Pavement	Granular Fill	Waste Fill	Organic Soils	Clay & Silt	Glacial Till	Weathered Rock	Bedrock			
Phase 2 - Subsurface Exploration Program (CDM Smith, Jan-Feb 2018)														
CDM-101A	21.5	5.0	--	0.3	4.2	>0.5	--	--	--	--	--	--	NE	--
CDM-101B	21.5	15.0	--	0.3	2.7	7.7	--	>4.3	--	--	--	--	NR	--
CDM-102A	21.2	9.0	--	0.4	2.6	>4.8	--	--	--	--	--	--	NE	--
CDM-102B	21.2	15.0	--	0.4	8.1	--	0.5	>6.0	--	--	--	--	8.5	12.7
CDM-103	21.5	23.0	--	0.3	2.7	16.2	--	>3.8	--	--	--	--	6.5	15.0
CDM-104	20.2	34.0	0.5	--	7.2	24.1	--	>2.2	--	--	--	--	6.5	13.7
CDM-105 ⁽³⁾	22.5	12.0	0.3	--	3.7	--	0.3	>7.8	--	--	--	--	7.0	15.5
CDM-106	21.3	18.0	0.5	--	2.5	11.3	--	>3.7	--	--	--	--	7.3	14.1
CDM-107	23.2	12.0	--	--	4.0	--	--	>8.0	--	--	--	--	6.5	16.7
CDM-108	21.2	15.0	--	0.4	2.3	6.1	0.3	>6.0	--	--	--	--	7.2	14.0
CDM-109	22.7	15.0	--	0.4	4.3	2.3	1.0	>7.0	--	--	--	--	8.1	14.6
CDM-110	22.5	13.0	--	0.4	2.1	4.5	1.7	>4.3	--	--	--	--	NR	--
CDM-111	21.8	12.0	0.5	--	2.8	3.7	--	>5.0	--	--	--	--	NE	--
CDM-112	21.8	18.0	0.5	--	1.5	10.8	--	>5.2	--	--	--	--	9.8	12.0
CDM-113	22.0	18.0	0.5	--	1.5	9.5	--	>6.5	--	--	--	--	6.8	15.2
CDM-114	22.5	20.0	--	--	6.0	--	--	>14.0	--	--	--	--	8.0	14.5
CDM-115	22.2	16.0	0.5	--	3.5	--	--	>12.0	--	--	--	--	8.8	13.4
CDM-116	24.0	14.0	0.5	--	3.5	5.8	--	>4.3	--	--	--	--	12.0	12.0
CDM-117	20.8	19.0	--	0.3	4.7	--	--	>14.0	--	--	--	--	9.5	11.3
CDM-118	22.3	24.0	0.5	--	2.8	16.2	--	>4.5	--	--	--	--	9.8	12.5
CDM-119	21.2	36.0	0.3	--	2.3	30.0	--	>3.3	--	--	--	--	8.5	12.7
CDM-120	21.2	21.0	--	0.3	2.7	15.6	--	>2.4	--	--	--	--	6.8	14.4

Notes:

- Elevations are referenced to the Cambridge City Base (CCB). Elevations from previous borings from 1966 and 1968 are estimated based on a historical plan entitled "Existing Conditions", dated 01/20/1969. Elevations for borings from Phase 1 Subsurface Exploration Program were surveyed. Elevations for all other borings are estimated based on a site plan entitled "Existing Conditions Survey" by Surveying and Mapping Consultants, dated 10/02/2017.
- Groundwater depths were measured inside borehole or test pit at completion of test borings or excavation and may not necessarily represent stabilized levels.
- Clay & Silt encountered above and below Organic Soils. Layer thickness indicates total thickness of both upper and lower Clay & Silt.

Abbreviations:

- indicates no value
- NR indicates not recorded
- > indicates strata not fully penetrated
- NE indicates not encountered

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**Table 6
Summary of Monitoring Well Readings**

Exploration No. ⁽¹⁾	Approximate Ground Surface El. (ft) ⁽²⁾	Screen Depth Interval (ft bgs)	Date of Reading	Groundwater Depth Below Ground Surface (ft)	Groundwater El. (ft)
Subsurface Exploration Program (CDM Smith, Jul-Aug 2017)					
CDM-3 (MW-S)	21.0	3 - 13	8/17/2017	6.6	14.4
			10/2/2017	7.0	14.0
			3/1/2018	6.1	14.9
CDM-3 (MW-D)	21.0	14 - 24	8/17/2017	6.8	14.2
			10/2/2017	7.2	13.8
			3/1/2018	6.3	14.7
CDM-4 (MW-S)	21.5	3 -18	8/17/2017	7.1	14.4
			10/2/2017	7.6	13.9
			3/1/2018	6.7	14.8
CDM-4 (MW-D)	21.3	20 -30	8/17/2017	7.0	14.3
			10/2/2017	6.6	14.7
			3/1/2018	6.6	14.7
CDM-7 (MW-S)	21.0	3 - 13	8/16/2017	6.7	14.3
			10/2/2017	7.2	13.8
			3/1/2018	6.3	14.7
CDM-7 (MW-D)	21.0	7 - 17	8/16/2017	6.7	14.3
			10/2/2017	7.2	13.8
			3/1/2018	6.5	14.5
CDM-9 (MW-S)	21.3	2 - 12	8/16/2017	6.7	14.6
			10/2/2017	7.4	13.9
			3/1/2018	6.5	14.9
CDM-9 (MW-D)	21.4	12 - 22	8/16/2017	6.9	14.5
			10/2/2017	7.5	14.0
			3/1/2018	6.5	14.9
CDM-14 (MW-S)	22.4	2 - 12	8/16/2017	8.1	14.3
			10/2/2017	8.5	13.9
			3/1/2018	7.6	14.8
CDM-14 (MW-D)	22.2	12 - 22	8/16/2017	9.0	13.3
			10/2/2017	9.4	12.8
			3/1/2018	8.6	13.7

Notes:

1. See Figure 1 for Monitoring Well locations.
2. Elevations are referenced to the Cambridge City Base (CCB).
3. MW-S is abbreviated for Monitoring Well-Shallow and represents the monitoring well with the shallower screen interval at the specified boring location.
4. MW-D is abbreviated for Monitoring Well-Deep and represents the monitoring well the deeper screen interval at the specified boring location.

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Table 7
Soil Sampling Results July-August 2017

CDM-5 (9-11')	CDM-5 (9-13')	CDM-5 (24-26')	CDM-5 (24-28')	CDM-6 (0-2')	CDM-6 (20-22')	CDM-7 (6-8')	CDM-7 (16-18')	CDM-8 (8-10')	CDM-8 (16-18')	CDM-8 (22-24')	CDM-9 (10-12')	CDM-9 (14-16')	CDM-9 (14-16')	CDM-9 (20-22')	CDM-10 (2-4')		
8/4/2017	8/4/2017	8/4/2017	8/4/2017	7/26/2017	7/26/2017	7/17/2017	7/17/2017	7/18/2017	7/18/2017	7/18/2017	7/27/2017	7/27/2017	7/27/2017	7/27/2017	7/31/2017		
L1727138-01	L1727138-02	L1727138-03	L1727138-04	L1725718-04	L1725718-05	L1724532-01	L1724532-02	L1724532-05	L1724532-06	L1724532-07	L1726151-06	L1726151-07	L1726151-07 R1	L1726151-08	L1726486-01		
Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results		
-	-	2140	-	613	17.1	8.46 U	1060	-	1050	294	8.25 U	67.9	854	-	9.38	25.7	
-	-	2080	-	59.8	16	8.46 U	1060	-	774	226	8.25 U	50.7	727	-	9.38	25.7	
-	-	1590	-	96.3	7.37 U	8.46 U	3070	-	414	299	8.25 U	67.2	1630	-	19.4	28.2	
-	-	431	-	13.5	7.37 U	8.46 U	92.1	-	80	33.5	8.25 U	7.65 U	299	-	8.66 U	7.42 U	
70.8	70.8	80.7	80.7	89.3	75.4	84.1	75	67.7	70.5	79.1	86.9	34.7	-	73.4	87.3		
-	-	0.3	-	0.38	0.22 U	0.26 U	2.4 U	-	2.9 U	0.8	0.25 U	0.28	1.1	-	0.26 U	0.22 U	
-	-	0.47	-	0.29 U	0.26 U	0.31 U	2.8 U	-	3.5 U	0.34 U	0.27 U	0.67 U	-	-	0.22 U	0.27 U	
-	-	0.57	-	0.97	0.15 U	0.17 U	1.6 U	-	9	1.6	0.17 U	0.58	3.3	-	0.18 U	0.15 U	
-	-	0.19 U	-	0.37	0.15 U	0.17 U	1.6 U	-	1.9 U	0.2	0.17 U	0.15 U	0.72	-	0.18 U	0.15 U	
-	-	1.6	-	1.5	0.15 U	0.13 U	1.2 U	-	17	2.8	0.13 U	1.4	7.3	-	0.13 U	0.11 U	
-	-	1.8	-	1.8	0.33	0.13 U	1.2 U	-	17	4.3	0.13 U	1.4	13	-	0.13 U	0.11 U	
-	-	1.1	-	1.4	0.36	0.17 U	1.6 U	-	16	2.9	0.17 U	1.2	18	-	0.18 U	0.15 U	
-	-	1.5	-	1.7	0.43	0.13 U	1.2 U	-	19	3.8	0.13 U	1.4	18	-	0.13 U	0.13 U	
-	-	0.58	-	0.61	0.31	0.17 U	1.6 U	-	5.6	1.9	0.17 U	0.66	7	-	0.18 U	0.15 U	
-	-	0.5	-	0.61	0.12	0.13 U	1.2 U	-	6.6	1.3	0.13 U	0.5	5.3	-	0.13 U	0.11 U	
-	-	0.23 U	-	0.2 U	0.18	0.22 U	2 U	-	2.4 U	0.23 U	0.21 U	0.19 U	0.46 U	-	0.22 U	0.19 U	
-	-	2	-	1.6	0.33	0.13 U	1.2 U	-	15	3.7	0.13 U	1.2	13	-	0.13 U	0.11 U	
-	-	0.2	-	0.2	0.11 U	0.13 U	1.2 U	-	1.5	0.57	0.13 U	0.16 U	1.7	-	0.13 U	0.11 U	
-	-	0.41	-	0.73	0.18 U	0.22 U	2 U	-	3.8	1.1	0.21 U	0.56 U	2.1	-	0.22 U	0.19 U	
-	-	0.23 U	-	0.2 U	0.18 U	0.22 U	2 U	-	2.4 U	0.23 U	0.21 U	0.19 U	0.46 U	-	0.22 U	0.19 U	
-	-	0.23 U	-	0.2 U	0.18 U	0.22 U	2 U	-	2.4 U	0.23 U	0.21 U	0.19 U	0.46 U	-	0.22 U	0.19 U	
-	-	3.9	-	3.8	0.76	0.13 U	1.2 U	-	40	8	0.13 U	3.7	35	E	34	0.24	0.17
-	-	1.2	-	1.7	0.18 U	0.22 U	2 U	-	7.5	1.7	0.21 U	0.9	4.3	-	0.22 U	0.19 U	
-	-	0.7	-	0.73	0.31	0.17 U	1.6 U	-	6.4	2.1	0.17 U	0.72	7.8	-	0.18 U	0.15 U	
-	-	0.55	-	0.2 U	0.18 U	0.22 U	2 U	-	2.4 U	3.2	0.21 U	0.34	1.8	-	0.22 U	0.19 U	
-	-	4.8	-	5.9	0.57	0.13 U	1.2 U	-	47	8.1	0.13 U	4.3	33	E	34	0.23	0.11 U
-	-	3.4	-	3.1	0.64	0.13 U	1.2 U	-	31	6.3	0.13 U	3	31	E	31	0.2	0.16
-	-	2.76 U	-	24.3 U	2.16 U	2.6 U	7.3	4.84	13.5	4.84	2.53 U	3.26	15.8	-	2.6 U	2.19 U	
-	-	6.54	-	8.55	8.75	7.96	8.51	12.5	8.55	8.46	9.7	10.4	64.4	-	7.47	5.13	
-	-	85.5	-	270	27.9	76.4	502	226	531	523	78.5	89.6	548	-	96.2	19.2	
-	-	0.282	-	2.43 U	0.216 U	0.74	0.232 U	0.257 U	0.354	0.286	0.698	0.222 U	0.651	-	0.734	0.298	
-	-	1.45	-	8.99	0.432 U	0.724	8.06	0.514 U	0.59 U	0.562 U	0.506 U	0.444 U	1.12 U	-	0.52 U	0.438 U	
-	-	18.7	-	25.4	12.6	52.2	19.8	39	35.8	36.2	38.3	27.6	45.9	-	39.1	15.4	
-	-	199	-	200	32.9	9.23	3950	888	915	596	8.8	97.3	1620	-	24.7	30.6	
-	-	0.384	-	0.152	0.07 U	0.087 U	0.122	0.098	1.55	16.7	0.083 U	0.072 U	1.07	-	0.085 U	0.075	
-	-	15.7	-	22.2	9.97	32.7	32.3	38.7	14.2	19.8	26	30.4	30.6	-	25.5	8.74	
-	-	2.76 U	-	24.3 U	2.16 U	2.6 U	4.72	2.69	2.95 U	2.81 U	2.53 U	2.22 U	5.62 U	-	2.6 U	2.19 U	
-	-	0.552 U	-	4.86 U	0.432 U	0.521 U	2.35	0.514 U	0.696	0.562 U	0.506 U	0.444 U	11.3	-	0.52 U	0.438 U	
-	-	33.7	-	16.9	11.4	48.9	17.4	9.66	17.8	17.2	45	15.6	23.8	-	45.3	12.1	
-	-	571	-	636	43.4	59.7	18500	815	749	545	59.1	181	1590	-	66.1	37.1	
-	-	4.99	-	0.5 U	-	-	8.48	0.5 U	14.5	1.03	-	-	17.1	-	-	-	
3.3 U	-	-	2.1 U	-	0.067 U	0.057 U	0.051 U	6.9 U	8.5 U	0.065 U	0.062 U	0.049 U	0.54	-	0.15	0.053 U	
0.11	-	-	0.14	-	0.0019 U	0.0016 U	0.0014 U	0.29 U	0.24 U	0.0018 U	0.0017 U	0.0014 U	0.0053 U	-	0.0016 U	0.0015 U	
0.14 U	-	-	0.086 U	-	0.0028 U	0.0024 U	0.0021 U	0.29 U	0.36 U	0.0049 U	0.0026 U	0.002 U	0.008 U	-	0.0024 U	0.0022 U	
0.091 U	-	-	0.058 U	-	0.0019 U	0.0016 U	0.0014 U	0.19 U	0.24 U	0.0018 U	0.0017 U	0.0014 U	0.017	-	0.0016 U	0.0015 U	
0.91 U	-	-	0.58 U	-	0.019 U	0.016 U	0.014 U	1.9 U	2.4 U	0.018 U	0.017 U	0.014 U	0.053 U	-	0.016 U	0.015 U	
0.18 U	-	-	0.12 U	-	0.0037 U	0.0032 U	0.0028 U	0.38 U	0.47 U	0.0036 U	0.0034 U	0.0027 U	0.011 U	-	0.0034 U	0.0029 U	
0.26	-	-	0.058 U	-	0.0019 U	0.0016 U	0.0014 U	0.19 U	0.24 U	0.0018 U	0.0017 U	0.0014 U	0.1	-	0.0016 U	0.0015 U	
0.091 U	-	-	0.058 U	-	0.0019 U	0.0016 U	0.0014 U	0.19 U	0.24 U	0.0018 U	0.0017 U	0.0014 U	0.018	-	0.0016 U	0.0015 U	
0.59	-	-	0.23 U	-	0.0075 U	0.0063 U	0.0057 U	15	0.95 U	0.027	0.0068 U	0.0055 U	0.043	-	0.0065 U	0.0059 U	
0.091 U	-	-	0.79	-	0.0019 U	0.0016 U	0.0014 U	0.19 U	0.24 U	0.009	0.0017 U	0.0014 U	0.0053 U	-	0.0016 U	0.0015 U	
0.15	-	-	0.058 U	-	0.0019 U	0.0016 U	0.0014 U	0.19 U	0.24 U	0.0018 U	0.0017 U	0.0014 U	0.086	-	0.0016 U	0.0015 U	
0.091 U	-	-	0.058 U	-	0.0019 U	0.0016 U	0.0014 U	0.19 U	0.24 U	0.0018 U	0.0025 U	0.0014 U	0.0053 U	-	0.0016 U	0.0015 U	

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Table 7
Soil Sampling Results July-August 2017

CDM-11 (2-4')	CDM-11 (8-10')	CDM-12 (6-8')	CDM-12 (14-16')	CDM-13 (4-6')	CDM-13 (8-12')	CDM-13 (16-18')	CDM-14 (4-6')	CDM-14 (6-8')	CDM-14 (8-10')	CDM-14 (8-10')	CDM-14 (20-22')	CDM-15 (0-2')	CDM-15 (12-14')	TRIP BLANK
7/17/2017	7/17/2017	8/9/2017	8/9/2017	7/25/2017	7/25/2017	7/25/2017	7/19/2017	7/19/2017	7/19/2017	7/19/2017	7/20/2017	7/20/2017	7/20/2017	7/13/2017
L1724532-03	L1724532-04	L1727972-01	L1727972-02	L1725718-01	L1725718-02	L1725718-03	L1724979-01	L1724979-02	L1724979-03	L1724979-03 R1	L1724979-06	L1724979-04	L1724979-05	L1724532-08
Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
69.2	8.16 U	8.55 U	8.21 U	36.3	100	8.05 U	72.6	182	709	--	9.8	34.5	9.19 U	--
69.2	8.16 U	8.55 U	8.21 U	29.6	92.7	8.05 U	44.2	110	502	--	9.8	29.2	9.19 U	--
177	8.16 U	8.55 U	8.21 U	8.1	69.8	8.05 U	20	52.2	132	--	8.58 U	6.66 U	9.19 U	--
27.3	8.16 U	8.55 U	8.21 U	7.78 U	12.4	8.05 U	7.49 U	7.59 U	19.1 U	--	8.58 U	6.66 U	9.19 U	--
87.6	80.1	76	80	83.3	72.8	78.5	87.9	85.3	67.9	--	75.2	94.7	71.1	--
1.1 U	0.24 U	0.26 U	0.25 U	0.24 U	0.27 U	0.25 U	0.44	0.71	0.53	--	0.26 U	0.21 U	0.27 U	--
1.3 U	0.29 U	0.31 U	0.3 U	0.28 U	0.33 U	0.3 U	0.27 U	0.28 U	0.35 U	--	0.32 U	0.25 U	0.33 U	--
0.74 U	0.16 U	0.17 U	0.16 U	0.16 U	0.16 U	0.18 U	0.17 U	0.55	0.86	--	0.18 U	0.14 U	0.18 U	--
0.74 U	0.16 U	0.17 U	0.16 U	0.16 U	0.18 U	0.17 U	0.15 U	0.22	0.75	--	0.18 U	0.14 U	0.18 U	--
0.56 U	0.12 U	0.13 U	0.12 U	0.17 U	0.33 U	0.13 U	1.2	2	6.2	--	0.13 U	0.15 U	0.14 U	--
0.56 U	0.12 U	0.13 U	0.12 U	0.37	0.69	0.13 U	1.5	2.6	17	E	16	0.13 U	0.52	0.14 U
0.74 U	0.16 U	0.17 U	0.16 U	0.37	0.62	0.17 U	1.4	2.3	16	E	16	0.18 U	0.5	0.18 U
0.56 U	0.12 U	0.13 U	0.12 U	0.43	0.84	0.13 U	1.5	2.7	23	E	21	0.13 U	0.63	0.14 U
0.74 U	0.16 U	0.17 U	0.16 U	0.21	0.34	0.17 U	0.89	1.4	12	E	9.5	0.18 U	0.35	0.18 U
0.56 U	0.12 U	0.13 U	0.12 U	0.16	0.27	0.13 U	0.64	0.91	5.7	--	--	0.13 U	0.23	0.14 U
0.93 U	0.2 U	0.22 U	0.2 U	0.2 U	0.2 U	0.21 U	0.19 U	0.19 U	0.24 U	--	--	0.22 U	0.17 U	0.23 U
0.56 U	0.12 U	0.13 U	0.12 U	0.34	0.72	0.13 U	1.5	2.4	17	E	16	0.13 U	0.52	0.14 U
0.56 U	0.12 U	0.13 U	0.12 U	0.12 U	0.14 U	0.13 U	0.21	0.32	3	--	--	0.13 U	0.1 U	0.14 U
0.93 U	0.2 U	0.22 U	0.2 U	0.2 U	0.23 U	0.21 U	0.61	0.91	0.9	--	--	0.22 U	0.17 U	0.23 U
0.93 U	0.2 U	0.22 U	0.2 U	0.2 U	0.23 U	0.21 U	0.19 U	0.19 U	0.24 U	--	--	0.22 U	0.17 U	0.23 U
0.93 U	0.2 U	0.22 U	0.2 U	0.2 U	0.23 U	0.21 U	0.19 U	0.19 U	0.24 U	--	--	0.22 U	0.17 U	0.23 U
0.56 U	0.12 U	0.13 U	0.12 U	0.78	1.6	0.13 U	3.9	6	24	E	36	0.13 U	1	0.14 U
0.93 U	0.2 U	0.22 U	0.2 U	0.2 U	0.24 U	0.21 U	0.8	1.2	1.5	--	--	0.22 U	0.17 U	0.23 U
0.74 U	0.16 U	0.17 U	0.16 U	0.24	0.39	0.17 U	0.94	1.5	13	E	10	0.18 U	0.38	0.18 U
0.93 U	0.2 U	0.22 U	0.2 U	0.2 U	0.23 U	0.21 U	0.97	1.6	1.3	--	--	0.22 U	0.17 U	0.23 U
0.56 U	0.12 U	0.13 U	0.12 U	0.55	1.3	0.13 U	4.3	6.4	10	E	10	0.13 U	0.63	0.14 U
0.56 U	0.12 U	0.13 U	0.12 U	0.67	1.3	0.13 U	3.3	5.2	24	E	30	0.13 U	0.93	0.14 U
2.2 U	2.42 U	2.5 U	2.4 U	2.3 U	2.71 U	2.46 U	2.17 U	2.3 U	2.9 U	--	2.55 U	2.1 U	2.74 U	--
6.96	6.7	6.7	8.92	6.39	8.42	7.96	7.2	7.32	6.95	--	17.9	4.2	8.49	--
150	186	53.5	75.3	54.9	119	66.5	58.6	104	116	--	77.4	37.4	71.3	--
0.22 U	0.275	0.48	0.644	0.469	0.271 U	0.599	0.23	0.23 U	0.29 U	--	0.28	0.214	0.445	--
0.44 U	0.483 U	0.5 U	0.514	0.584	0.694	0.624	1.04	0.726	0.766	--	39.5	0.504	0.763	--
9.71	41.8	25	33.7	23.8	9.09	35.7	15.8	21.1	10.9	--	30.2	13.6	32.6	--
550	519	7.87	8.34	39.8	816	8.55	443	188	1410	--	193	38	9.38	--
0.954	0.082	0.085 U	0.078 U	0.078 U	0.165	0.081 U	0.248	0.37	1.14	--	0.084	0.076	0.091 U	--
7.15	28.4	18.3	22.5	16.6	8.42	26.1	23.9	12	8.48	--	22	10	23.4	--
4.26	2.42 U	2.5 U	2.4 U	2.3 U	2.71 U	2.46 U	2.17 U	2.3 U	2.9 U	--	2.55 U	2.1 U	2.74 U	--
0.44 U	0.483 U	0.5 U	0.481 U	0.46 U	0.542 U	0.491 U	0.434 U	0.46 U	0.581 U	--	0.51 U	0.42 U	0.549 U	--
19.6	16.7	30.3	37.6	30.8	12.6	43.2	21.1	18.2	15.4	--	35.5	20.1	38.4	--
322	648	37.9	52	72.7	283	57.2	458	144	996	--	8460	54	48.7	--
7.62	0.5 U	--	--	--	0.5 U	--	0.664	0.5 U	2.06	--	0.5 U	--	--	--
0.098 U	0.075 U	0.12 U	0.11 U	0.048	0.12	0.043 U	0.35	0.13	0.39	--	0.052 U	0.043 U	0.14 U	0.23
0.0027 U	0.0021 U	0.0033 U	0.003 U	0.00092 U	0.0016 U	0.0012 U	0.0024 U	0.0029 U	0.0074 U	--	0.0014 U	0.0012 U	0.0039 U	0.001 U
0.0041 U	0.0031 U	0.0049 U	0.0045 U	0.0014 U	0.0024 U	0.0018 U	0.0036 U	0.0044 U	0.011 U	--	0.0022 U	0.0018 U	0.0059 U	0.0015 U
0.0027 U	0.0021 U	0.0033 U	0.003 U	0.00092 U	0.0016 U	0.0012 U	0.0024 U	0.0029 U	0.0074 U	--	0.0014 U	0.0012 U	0.0039 U	0.001 U
0.027 U	0.021 U	0.033 U	0.03 U	0.0092 U	0.021 U	0.012 U	0.085	0.029 U	0.11	--	0.014 U	0.012 U	0.039 U	0.01 U
0.0054 U	0.0042 U	0.0066 U	0.006 U	0.0018 U	0.0033 U	0.0024 U	0.0047 U	0.0059 U	0.015 U	--	0.0029 U	0.0024 U	0.0078 U	0.002 U
0.0027 U	0.0021 U	0.0033 U	0.003 U	0.00092 U	0.0016 U	0.0012 U	0.0024 U	0.0029 U	0.0074 U	--	0.0014 U	0.0012 U	0.0039 U	0.001 U
0.0027 U	0.0021 U	0.0033 U	0.003 U	0.00092 U	0.0016 U	0.0012 U	0.0024 U	0.0029 U	0.0074 U	--	0.0014 U	0.0012 U	0.0039 U	0.001 U
0.011 U	0.0083 U	0.013 U	0.012 U	0.0037 U	0.0065 U	0.0048 U	0.12	1.2 E	0.033	--	0.0058 U	0.0048 U	0.016 U	0.004 U
0.0027 U	0.0021 U	0.0033 U	0.003 U	0.00092 U	0.0016 U	0.0012 U	0.0024 U	0.0029 U	0.0074 U	--	0.0014 U	0.0012 U	0.0039 U	0.001 U
0.0027 U	0.0021 U	0.0033 U	0.003 U	0.00092 U	0.0016 U	0.0012 U	0.0024 U	0.0029 U	0.0074 U	--	0.0014 U	0.0012 U	0.0039 U	0.001 U
0.0037	0.0022	0.0033	0.003 U	0.00092 U	0.0016 U	0.0012 U	0.0024 U	0.0029 U	0.0074 U	--	0.0014 U	0.0012 U	0.0039 U	0.001 U
--	--	--	--	--	--	--	6	--	--	--	--	--	--	0.2 U

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Table 8
Groundwater Sampling Results August 2017

Sample ID					MW-3S	MW-3D	MW-4S	MW-4D	DUP-1 (MW-4D)	MW-7S	MW-7D	MW-9S	MW-9D	MW-14S	MW-14D
Sample Collection Date					16-AUG-17	17-AUG-17	17-AUG-17	17-AUG-17	17-AUG-17	16-AUG-17	16-AUG-17	16-AUG-17	16-AUG-17	16-AUG-17	16-AUG-17
Laboratory Order Number					L1728873-01	L1728873-04	L1728873-06	L1728873-05	L1728873-07	L1728684-01	L1728684-02	L1728873-02	L1728873-01	L1728684-03	L1728684-04
Parameter	Reporting Units	GW-1	GW-2	GW-3											
EPH															
C11-C22 Aromatics	ug/l	NA	NA	NA	< 100	< 100	173	140	109	127	< 100	< 100	< 100	NA	< 100
C11-C22 Aromatics, Adjusted	ug/l	200	50000	5000	< 100	< 100	149	140	109	105	< 100	< 100	< 100	NA	< 100
C19-C36 Aliphatics	ug/l	14000	NA	50000	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	NA	< 100
C9-C18 Aliphatics	ug/l	700	5000	50000	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	NA	< 100
GC Volatiles by MAVPH															
Acetone	ug/l	6300	50000	50000	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 10	21	< 5
Methyl tert-butyl ether	ug/l	70	50000	50000	< 2	< 2	< 2	< 2	< 2	< 2	2.7	< 2	400	< 2	< 2
Naphthalene	ug/l	140	700	20000	< 2	< 2	4.5	9.4	9.9	26	< 2	< 2	< 4	< 2	< 2
Tertiary-Amyl Methyl Ether	ug/l	NA	NA	NA	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	25	< 2	< 2
Tetrachloroethene	ug/l	5	50	30000	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	4.4	< 1	< 1
MCP Semivolatile Organics															
3-Methylphenol/4-Methylphenol	ug/l				< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	19	< 5
Dibenzofuran	ug/l				< 2	< 2	< 2	< 2	< 2	2.6	< 2	< 2	< 2	< 2	< 2
MCP Semivolatile Organics by SIM															
Acenaphthene	ug/l	20	NA	10000	3.8	0.42	11	4.5	4.8	5.7	1.6	1.0	0.57	2.0	3.0
Acenaphthylene	ug/l	30	10000	40	0.10	< 0.1	0.20	0.34	0.34	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.13
Anthracene	ug/l	60	NA	30	0.78	< 0.1	1.5	0.94	1.1	2	0.23	0.21	< 0.1	0.78	0.55
Benzo[a]anthracene	ug/l	1	NA	1000	< 0.1	< 0.1	< 0.1	0.12	0.18	0.11	< 0.1	< 0.1	< 0.1	0.32	0.33
Benzo[a]pyrene	ug/l	0.2	NA	500	< 0.1	< 0.1	< 0.1	< 0.1	0.12	< 0.1	< 0.1	< 0.1	< 0.1	0.25	0.28
Benzo[b]fluoranthene	ug/l	1	NA	400	< 0.1	< 0.1	< 0.1	0.10	0.16	< 0.1	< 0.1	< 0.1	< 0.1	0.32	0.40
Benzo[g,h,i]perylene	ug/l	50	NA	20	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.16	0.27
Benzo[k]fluoranthene	ug/l	1	NA	100	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.13	0.16
Chrysene	ug/l	2	NA	70	< 0.1	< 0.1	< 0.1	0.14	0.21	0.13	< 0.1	< 0.1	< 0.1	0.36	0.37
Dibenz(a,h)anthracene	ug/l	0.5	NA	40	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	ug/l	90	NA	200	1.0	< 0.1	0.84	0.93	1.1	1.8	0.27	0.32	0.15	1.3	0.91
Fluorene	ug/l	30	NA	40	3.2	0.15	6.6	3.3	3.4	4.1	0.80	0.64	0.17	2.6	1.4
Indeno[1,2,3-cd]pyrene	ug/l	0.5	NA	100	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.18	0.26
Naphthalene	ug/l	140	700	20000	1.3	0.14	2.8	5.8	6.1	10	0.39	0.69	0.13	0.96	0.26
Phenanthrene	ug/l	40	NA	10000	3.4	0.34	9.3	5.4	6.0	9.9	1.1	0.42	0.50	4.2	1.9
Pyrene	ug/l	60	NA	20	0.75	< 0.1	0.56	0.63	0.75	1.3	0.21	0.22	0.11	0.90	0.66
MCP 1,4 Dioxane by 8270D-SIM															
1,4-Dioxane	ug/l	0.3	6000	50000	< 0.142	< 0.142	< 0.147	< 0.142	< 0.144	< 0.147	< 0.144	< 0.147	0.198	< 0.144	< 0.144
Metals by 6010 (Total)															
Arsenic	ug/l	10	NA	900	< 5	8	9	6	6	< 5	< 5	6	28	11	< 5
Barium	ug/l	2000	NA	50000	170	303	716	608	600	3660	2060	114	70	492	795
Lead	ug/l	15	NA	10	< 10	67	< 10	31	29	< 10	14	26	11	65	< 10
Zinc	ug/l	5000	NA	900	< 50	54	< 50	< 50	< 50	< 50	< 50	< 50	< 50	234	< 50

Notes:
 All wells compared to GW-1 and GW-3
 Wells MW-9S/9D and MW-14S/14D are also compared to GW-2
 Shaded Values: Exceed GW-1 Standards
 Underlined Values: Exceed GW-2 Standards
 Bolded Value: Exceeds GW-3 Standards
 < #: Not detected to the limit indicated
Italicized Value : Reporting limits greater than applicable MassDEP standards
 ug/l - micrograms/liter
 NA - Not Applicable
 GW1 - Concentrations based on the use of groundwater as drinking water, either currently or in the foreseeable future.
 GW2 - Concentrations based on the potential for volatile material to migrate into indoor air.
 GW3 - Concentrations based on the potential environmental effects resulting from contaminated groundwater discharging to surface water.

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Table 9
Groundwater Sampling Results March 2018

Sample ID		MW-3S	MW-3D	MW-4S	MW-4D	MW-7S	MW-7D	MW-9S	MW-9D	MW-14S	MW-14D			
Sample Collection Date		01-MAR-18	01-MAR-18	01-MAR-18	01-MAR-18	01-MAR-18	01-MAR-18	01-MAR-18	01-MAR-18	01-MAR-18	01-MAR-18			
Laboratory Order Number		L1807193-01	L1807193-02	L1807193-03	L1807193-04	L1807193-06	L1807193-05	L1807193-08	L1807193-07	L1807264-02	L1807264-01			
Parameter	Reporting Units	GW-1	GW-2	GW-3										
MCP Volatile Organics														
Acetone	ug/l	6300	50000	50000	<5	<5	<5	<5	<5	<5	6.7			
Methyl tert-butyl ether	ug/l	70	50000	50000	<2	<2	<2	2.2	3.3	<2	400			
Naphthalene	ug/l	140	700	20000	<2	<2	<2	4.7	<2	<2	<2			
Tertiary-Amyl Methyl Ether	ug/l	NA	NA	NA	<2	<2	<2	<2	<2	22	<2			
MCP Semivolatile Organics														
Phenol	ug/l	1000	50000	2000	<5	<5	<5	<5	<5	<5	8.9			
MCP Semivolatile Organics by SIM														
2-Methylnaphthalene	ug/l	10	2000	20000	0.11	<0.1	0.26	0.69	0.4	<0.1	<0.1	<0.1	<0.1	
Acenaphthene	ug/l	20	NA	10000	1.3	0.41	5.2	2.8	2.2	0.38	<0.1	0.4	1.1	2.2
Acenaphthylene	ug/l	30	10000	40	<0.1	0.1	0.12	0.29	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	ug/l	60	NA	30	0.2	<0.1	0.63	1.1	0.49	<0.1	<0.1	<0.1	0.26	0.36
Benzo(a)anthracene	ug/l	1	NA	1000	0.12	<0.1	0.23	0.97	<0.1	<0.1	<0.1	<0.1	<0.1	0.18
Benzo(a)pyrene	ug/l	0.2	NA	500	0.12	<0.1	0.22	0.97	<0.1	<0.1	<0.1	<0.1	<0.1	0.17
Benzo(b)fluoranthene	ug/l	1	NA	400	0.16	<0.1	0.31	1.30	<0.1	<0.1	<0.1	<0.1	<0.1	0.24
Benzo(ghi)perylene	ug/l	50	NA	20	<0.1	0.13	0.16	0.76	<0.1	<0.1	<0.1	<0.1	<0.1	0.13
Benzo(k)fluoranthene	ug/l	1	NA	100	<0.1	<0.1	0.1	0.45	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	ug/l	2	NA	70	0.11	<0.1	0.21	0.96	<0.1	<0.1	<0.1	<0.1	<0.1	0.18
Fluoranthene	ug/l	90	NA	200	0.5	0.12	0.76	2.9	0.54	<0.1	<0.1	<0.1	0.39	0.68
Fluorene	ug/l	30	NA	40	0.94	<0.1	3.5	2.6	1.7	0.22	<0.1	<0.1	1.8	1.2
Indeno(1,2,3-cd)pyrene	ug/l	0.5	NA	100	<0.1	<0.1	0.15	0.68	<0.1	<0.1	<0.1	<0.1	<0.1	0.12
Naphthalene	ug/l	140	700	20000	<2	<2	<2	<2	4.7	<2	<2	<2	0.24	0.26
Phenanthrene	ug/l	40	NA	10000	0.4	0.16	3.2	5.5	2.2	0.24	<0.1	<0.1	0.14	1.1
Pyrene	ug/l	60	NA	20	0.49	0.11	0.6	2.2	0.46	<0.1	<0.1	<0.1	0.25	0.49
MCP 1,4 Dioxane by 8270D-SIM														
1,4-Dioxane	ug/l	0.3	6000	50000	<0.15	<0.142	<0.142	<0.144	<0.144	<0.15	<0.147	0.158	<0.147	<0.147
MCP Dissolved Metals														
Arsenic, Dissolved	ug/l	10	NA	900	<5	6.6	<5	<5	<5	<5	40.2	5.5	<5	<5
Barium, Dissolved	ug/l	2000	NA	50000	49	262	646	729	526	2140	113	134	833	1150
Lead, Dissolved	ug/l	15	NA	10	<10	<10	<10	77	<10	<10	54	<10	<10	<10
Zinc, Dissolved	ug/l	5000	NA	900	<50	<50	<50	<50	60	<50	224	<50	<50	<50

Notes:

All wells compared to GW-1 and GW-3

Wells MW-9S/9D and MW-14S/14D are also compared to GW-2

Shaded Values: Exceed GW-1 Standards

Underlined Values: Exceed GW-2 Standards

Bolded Value: Exceeds GW-3 Standards

< #: Not detected to the limit indicated

Italicized Value : Reporting limits greater than applicable MassDEP standards

ug/l - micrograms/liter

NA - Not Applicable

GW1 - Concentrations based on the use of groundwater as drinking water, either currently or in the foreseeable future.

GW2 - Concentrations based on the potential for volatile material to migrate into indoor air.

GW3 - Concentrations based on the potential environmental effects resulting from contaminated groundwater discharging to surface water.

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Table 10
Soil Gas Probe and Groundwater Well Landfill Gas Monitoring Results - August 16-17, 2017

Sample Location	Sample Date	Methane (% vol.)		LEL (% vol.)		Carbon Dioxide (% vol.)		Oxygen (% vol.)		PID Reading (ppm _v)		Hydrogen Sulfide (ppm _v)		Atmospheric Pressure (in Hg)	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Landfill Gas Probes															
SGP-1	8/16/2017	0.0	0.0	0.0	0.0	1.2	0.9	19.8	20.3	0.0	0.0	0.0	0.0	29.84	29.84
SGP-2	8/16/2017	0.0	0.0	0.0	0.0	3.5	3.3	17.6	18.0	0.0	0.0	0.0	0.0	29.78	29.78
SGP-3	8/16/2017	0.0	0.0	0.0	0.0	2.2	2.3	19.1	19.2	0.0	0.0	0.0	0.0	29.77	29.77
SGP-4	8/16/2017	0.0	0.0	0.0	0.0	2.5	2.6	18.9	19.0	0.0	0.0	0.0	0.0	29.77	29.77
SGP-5	8/16/2017	0.0	0.0	0.0	0.0	4.7	4.8	16.3	16.2	0.0	0.0	0.0	0.0	29.78	29.78
SGP-6	8/16/2017	0.0	0.0	0.0	0.0	2.9	3.2	18.6	18.4	0.0	0.0	0.0	0.0	29.76	29.76
SGP-7	8/16/2017	0.0	0.0	0.0	0.0	5.9	6.0	15.1	14.9	0.0	0.0	0.0	0.0	29.76	29.76
SGP-8	8/16/2017	0.0	0.0	0.0	0.0	3.8	3.6	17.4	17.0	0.0	0.0	0.0	0.0	29.76	29.76
SGP-9	8/17/2017	0.0	0.0	0.0	0.0	3.7	3.9	18.6	18.1	0.0	0.0	0.0	0.0	30.00	30.00
SGP-10	8/17/2017	0.0	0.0	0.0	0.0	1.3	1.7	19.6	19.2	0.0	0.0	0.0	0.0	30.00	30.00
SGP-11	8/17/2017	0.0	0.0	0.0	0.0	2.6	4.1	18.8	17.9	0.0	0.0	0.0	0.0	30.15	30.15
SGP-12	8/17/2017	0.0	0.0	0.0	0.0	3.0	2.7	18.6	18.8	0.0	0.0	0.0	0.0	30.15	30.15
SGP-13	8/17/2017	0.0	0.0	0.0	0.0	2.7	3.6	18.6	18.1	0.0	0.0	0.0	0.0	30.15	30.15
SGP-14	8/17/2017	0.0	0.0	0.0	0.0	2.6	2.8	18.1	18.5	0.0	0.0	0.0	0.0	30.15	30.15
SGP-15	8/17/2017	0.0	0.0	0.0	0.0	1.7	1.6	19.6	19.7	0.0	0.0	0.0	0.0	30.15	30.15
SGP-16	8/17/2017	0.0	0.0	0.0	0.0	2.0	2.0	19.4	19.4	0.0	0.0	0.0	0.0	30.13	30.13
SGP-17	8/17/2017	0.0	0.0	0.0	0.0	1.7	1.3	19.3	19.6	0.0	0.0	0.0	0.0	30.13	30.13
SGP-18	8/17/2017	0.0	0.0	0.0	0.0	0.5	0.8	19.2	19.5	0.0	0.0	0.0	0.0	30.13	30.13
SGP-19	8/17/2017	0.0	0.0	0.0	0.0	1.2	1.4	19.4	19.3	0.0	0.0	0.0	0.0	30.13	30.13
SGP-20	8/17/2017	0.0	0.0	0.0	0.0	0.7	0.9	19.8	19.7	0.0	0.0	0.0	0.0	30.13	30.13
SGP-21	8/17/2017	0.0	0.0	0.0	0.0	2.2	2.3	18.4	18.3	0.0	0.0	0.0	0.0	30.13	30.13
SGP-22	8/17/2017	0.0	0.0	0.0	0.0	0.6	0.5	19.5	19.9	0.0	0.0	0.0	0.0	30.13	30.13
SGP-23	8/17/2017	0.0	0.0	0.0	0.0	3.3	1.4	17.4	19.1	0.0	0.0	0.0	0.0	29.91	29.91
SGP-24	8/17/2017	2.9	2.8	58	56	0.8	0.7	19.1	19.1	0.0	0.0	0.0	0.0	29.91	29.91
SGP-25	8/17/2017	0.0	0.0	0.0	0.0	1.8	1.8	19.3	19.4	0.0	0.0	0.0	0.0	29.84	29.84
SGP-26	8/17/2017	0.0	0.0	0.0	0.0	1.2	0.5	19.2	19.8	117.7	58.8	0.0	0.0	29.84	29.84
SGP-27	8/17/2017	0.0	0.0	0.0	0.0	2.1	2.3	17.9	17.7	0.0	0.0	0.0	0.0	29.84	29.84
SGP-28	8/17/2017	63.8	50.2	1276	1004	5.4	4.9	0.9	4.0	0.2	0.2	0.0	0.0	29.78	29.78
Monitoring Wells															
MW-3S	8/16/2017	13.5	13.4	270	268	8.4	8.4	0.3	0.3	0.0	0.0	0.0	0.0	29.73	29.73
MW-3D	8/16/2017	1.9	0.8	38	16	1.8	0.7	17.4	19.6	0.0	0.0	0.0	0.0	29.73	29.73
MW-4S	8/16/2017	73.0	71.6	1460	1432	4.3	4.1	2.1	2.2	0.0	0.0	0.0	0.0	29.74	29.74
MW-4D	8/16/2017	0.6	0.3	12	6	0.0	0.0	20.3	20.4	0.0	0.0	0.0	0.0	29.76	29.76
MW-7S	8/16/2017	2.4	2.3	48	46	6.5	7.0	0.4	0.0	3.7	4.0	0.0	0.0	29.84	29.84
MW-7D	8/16/2017	0.0	0.0	0.0	0.0	1.5	0.2	16.7	20.0	0.0	0.0	0.0	0.0	29.84	29.84
MW-9S	8/16/2017	0.0	0.0	0.0	0.0	1.1	0.4	12.1	17.6	0.0	0.0	0.0	0.0	29.77	29.77
MW-9D	8/16/2017	0.0	0.0	0.0	0.0	0.4	0.3	19.3	20.5	0.2	0.0	0.3	0.0	29.77	29.77
MW-14S	8/16/2017	0.0	0.0	0.0	0.0	2.1	2.4	19.0	18.6	0.0	0.0	0.0	0.0	29.78	29.78
MW-14D	8/16/2017	0.4	0.3	8	6	0.0	0.0	19.8	19.9	0.0	0.0	0.0	0.0	29.78	29.78

Notes:

1. PID= Photoionization Detector, which measures concentrations of volatile organic compounds
2. LEL = Lower explosive limit

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**Table 11
Groundwater Well Landfill Gas Monitoring Results - August and October 2017**

Sample Location	Sample Date	PID Reading (ppm _v)		Hydrogen Sulfide (ppm _v)		Methane (% vol.)		Carbon Dioxide (% vol.)		Oxygen (% vol.)		LEL (% vol.)		Atmospheric Pressure (in Hg)	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Groundwater Monitoring Wells															
MW-3S	8/16/2017	0.0	0.0	0.0	0.0	13.5	13.4	8.4	8.4	0.3	0.3	270	268	29.73	29.73
	10/2/2017	4.1	3.0	0.0	0.0	5.8	6.7	7.8	8.3	2.9	1.7	116	134	30.46	30.46
MW-3D	8/16/2017	0.0	0.0	0.0	0.0	1.9	0.8	1.8	0.7	17.4	19.6	38	16	29.73	29.73
	10/2/2017	2.9	2.8	0.0	0.0	10.7	6.5	0.8	0.6	17.6	18.8	214	130	30.46	30.46
MW-4S	8/16/2017	0.0	0.0	0.0	0.0	73.0	71.6	4.3	4.1	2.1	2.2	1460	1432	29.74	29.74
	10/2/2017	0.4	0.3	0.0	0.0	72.9	78.0	6.0	6.0	1.8	0.5	1458	1560	30.46	30.46
MW-4D	8/16/2017	0.0	0.0	0.0	0.0	0.6	0.3	0.0	0.0	20.3	20.4	12	6	29.76	29.76
	*10/2/2017	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7S	8/16/2017	3.7	4.0	0.0	0.0	2.4	2.3	6.5	7.0	0.4	0.0	48	46	29.84	29.84
	10/2/2017	2.0	2.3	0.0	0.0	0.9	1.0	7.1	7.2	0.6	0.1	18	20	30.46	30.46
MW-7D	8/16/2017	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.2	16.7	20.0	0	0	29.84	29.84
	10/2/2017	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.8	17.9	19.4	0	0	30.46	30.46
MW-9S	8/16/2017	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.4	12.1	17.6	0	0	29.77	29.77
	10/2/2017	0.3	0.4	0.0	0.0	22.8	23.9	4.7	4.7	2.6	1.2	456	478	30.46	30.46
MW-9D	8/16/2017	0.2	0.0	0.3	0.0	0.0	0.0	0.4	0.3	19.3	20.5	0	0	29.77	29.77
	10/2/2017	0.9	0.4	0.0	0.0	0.0	0.0	0.2	0.1	20.7	20.8	0	0	30.46	30.46
MW-14S	8/16/2017	0.0	0.0	0.0	0.0	0.0	0.0	2.1	2.4	19.0	18.6	0	0	29.78	29.78
	10/2/2017	0.0	0.0	0.0	0.0	0.0	0.0	3.0	8.9	17.2	9.3	0	0	30.46	30.46
MW-14D	8/16/2017	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.0	19.8	19.9	8	6	29.78	29.78
	10/2/2017	0.2	0.4	0.0	0.0	0.0	0.0	0.2	0.2	20.7	20.7	0	0	30.46	30.46

Notes:

1. PID= Photoionization Detector, which measures concentrations of volatile organic compounds
 2. LEL = Lower Explosive Limit
- * Not Sampled - Roadbox Under Shallow Water

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**Table 12
Soil Vapor Sampling Results (VOCs, Sulfides, Mercaptans) - October 2, 2017**

	Sample ID		MW-9S SOIL VAPOR		MW-4S SOIL VAPOR	
	Sample Collection Date		10/2/2017		10/2/2017	
	Laboratory Order Number		L1735464-14		L1735464-15	
Parameter	MA-VIG-RSSGV	Reporting Units	Results		Results	
MCP Volatile Organics in Air by SIM						
Vinyl chloride	19	ug/m3	2.56	U	5.11	U
Bromomethane	42	ug/m3	3.88	U	7.77	U
Acetone	6400	ug/m3	11.9	U	23.8	U
1,1-Dichloroethene	56	ug/m3	3.96	U	7.93	U
Methylene chloride	770	ug/m3	8.69	U	17.4	U
trans-1,2-Dichloroethene	56	ug/m3	3.96	U	7.93	U
1,1-Dichloroethane	56	ug/m3	4.05	U	8.09	U
Methyl tert butyl ether	2700	ug/m3	3.61	U	7.21	U
2-Butanone	850	ug/m3	7.37	U	14.7	U
cis-1,2-Dichloroethene	56	ug/m3	3.96	U	7.93	U
Chloroform	130	ug/m3	29.5		9.77	U
1,2-Dichloroethane	6.3	ug/m3	4.05	U	8.09	U
1,1,1-Trichloroethane	210	ug/m3	5.46	U	10.9	U
Benzene	160	ug/m3	4.03		6.39	U
Carbon tetrachloride	38	ug/m3	6.29	U	12.6	U
1,2-Dichloropropane	8.6	ug/m3	4.62	U	9.24	U
Bromodichloromethane	9.2	ug/m3	6.7	U	13.4	U
1,4-Dioxane	33	ug/m3	3.6	U	7.21	U
Trichloroethene	28	ug/m3	5.37	U	10.7	U
cis-1,3-Dichloropropene	41	ug/m3	4.54	U	9.08	U
4-Methyl-2-pentanone	150	ug/m3	10.2	U	20.5	U
trans-1,3-Dichloropropene	41	ug/m3	4.54	U	9.08	U
1,1,2-Trichloroethane	10	ug/m3	5.46	U	10.9	U
Toluene	3800	ug/m3	20.6		17.3	
Dibromochloromethane	6.8	ug/m3	8.52	U	17	U
1,2-Dibromoethane	0.54	ug/m3	7.69	U	15.4	U
Tetrachloroethene	98	ug/m3	18.7		13.6	U
Chlorobenzene	160	ug/m3	4.61	U	9.21	U
Ethylbenzene	520	ug/m3	4.34	U	8.69	U
p/m-Xylene		ug/m3	13.6		17.4	U
Bromoform	150	ug/m3	10.3	U	20.7	U
Styrene	95	ug/m3	4.26	U	8.52	U
1,1,2,2-Tetrachloroethane	2.8	ug/m3	6.87	U	13.7	U
o-Xylene		ug/m3	5.65		8.69	U
1,3-Dichlorobenzene	42	ug/m3	6.01	U	12	U
1,4-Dichlorobenzene	35	ug/m3	6.01	U	12	U
1,2-Dichlorobenzene	50	ug/m3	6.01	U	12	U
1,2,4-Trichlorobenzene	28	ug/m3	7.42	U	14.8	U
Naphthalene	42	ug/m3	5.24	U	10.5	U
Hexachlorobutadiene	7.4	ug/m3	10.7	U	21.3	U
Mercaptans & Sulfides in Air						
Hydrogen Sulfide	NA	ug/m3	2.79	U	4.43	
Carbonyl sulfide	NA	ug/m3	4.91	U	4.91	U
Methyl mercaptan	NA	ug/m3	3.94	U	6.38	
Ethyl mercaptan	NA	ug/m3	1.27	U	1.27	U
Dimethyl sulfide	NA	ug/m3	1.27	U	5.24	
Carbon disulfide	NA	ug/m3	4.73		5.79	
Isopropyl Mercaptan	NA	ug/m3	1.56	U	1.56	U
tert-Butyl Mercaptan	NA	ug/m3	1.84	U	1.84	U
N-Propyl Mercaptan	NA	ug/m3	1.56	U	1.56	U
Ethyl Methyl Sulfide	NA	ug/m3	1.56	U	1.56	U
Thiophene	NA	ug/m3	1.72	U	1.72	U
Isobutyl Mercaptan	NA	ug/m3	1.84	U	1.84	U
Diethyl Sulfide	NA	ug/m3	1.84	U	1.84	U
n-Butyl Mercaptan	NA	ug/m3	7.38	U	7.38	U
Dimethyl Disulfide	NA	ug/m3	1.93	U	1.93	U
3-Methylthiophene	NA	ug/m3	2.01	U	2.01	U
Tetrahydrothiophene	NA	ug/m3	1.8	U	1.8	U
2-Ethylthiophene	NA	ug/m3	2.29	U	2.29	U
2,5-Dimethylthiophene	NA	ug/m3	2.29	U	2.29	U
Diethyl disulfide	NA	ug/m3	2.5	U	2.5	U

Notes:

*MA-VIG-RSSGV: Vapor Intrusion Guidance: Residential Sub-slab Soil Gas Screening Values (2016) Criteria per MassDEP Vapor Intrusion Guidance, Policy #WSC-16-435, October 14, 2016.

All units are ug/m3

U = compound was not detected above stated laboratory method detection limit

Italicized Values = < Reporting Limits are greater than applicable standards

NA - Not Applicable

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Table 13
Utility Landfill Gas Monitoring Results - October 2, 2017

Sample Location	Sample Date	Methane (% vol.)	Carbon Dioxide (% vol.)	Oxygen (% vol.)	LEL (% vol.)	Atmospheric Pressure (in Hg)
		Initial	Initial	Initial	Initial	Initial
Utility Screening Locations						
WGM-1	10/2/2017	0.0	0.2	20.7	0	30.46
CB-1	10/2/2017	0.0	0.0	20.9	0	30.46
DM-1	10/2/2017	0.0	0.2	20.6	0	30.46
CB-2	10/2/2017	0.0	0.0	20.9	0	30.47
CB-3	10/2/2017	0.0	0.0	20.9	0	30.47
WMPM-1	10/2/2017	14.8	9.2	2.6	296	30.47
*WMPM-1	10/2/2017	0.8	0.5	19.9	16	30.47
CB-4	10/2/2017	0.0	0.0	20.9	0	30.47
EM-1	10/2/2017	0.0	1.1	19.8	0	30.47
EM-2	10/2/2017	0.0	1.1	19.8	0	30.47
CB-5	10/2/2017	0.0	0.0	20.9	0	30.47
EM-3	10/2/2017	0.0	0.2	20.7	0	30.47
EM-4	10/2/2017	0.0	0.0	20.9	0	30.47
CB-6	10/2/2017	0.0	0.0	20.9	0	30.47
CB-7	10/2/2017	0.0	0.0	20.9	0	30.47
CB-8	10/2/2017	0.0	0.0	20.9	0	30.47
CB-9	10/2/2017	0.0	0.0	20.9	0	30.47
CB-10	10/2/2017	0.0	0.0	20.9	0	30.47
CB-11	10/2/2017	0.0	0.0	20.8	0	30.50
CB-12	10/2/2017	0.0	0.0	20.9	0	30.50
DM-2	10/2/2017	0.0	0.1	20.8	0	30.50
WGM-2	10/2/2017	0.0	1.3	19.3	0	30.50
WGM-3	10/2/2017	0.0	0.9	19.4	0	30.50
WGM-4	10/2/2017	0.0	0.0	20.9	0	--
CB-13	10/2/2017	0.0	0.0	20.9	0	--
EM-4	10/2/2017	0.0	0.0	20.9	0	--
CB-14	10/2/2017	0.0	0.0	20.9	0	--

Notes:

1. PID= Photoionization Detector, which measures concentrations of volatile organic compounds
2. LEL = Lower Explosive Limit
3. NS = Not Sampled

Shaded Values Exceed MassDEP Limit of 10% LEL of Methane Within a Utility

* = Water Meter Pit Manhole Results With Manhole Cover Removed

-- = Not Measured

WGM - Water Gate Manhole

CB- Catch Basin

DM - Drain Manhole

EM - Electrical Manhole

WMPM - Water Meter Pit Manhole