Z.V. Holdings Corporation

Preliminary Geotechnical Investigation

1881/1883 Merivale and Adjacent Lot, Ottawa

26 September 2023

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1881/ 1883 Merivale and Adjacent Lot, Ottawa, Ontario

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Acronyms and Abbreviations

Arcadis	Arcadis Canada Inc.
AST	Aboveground Storage Tank
BVL	Bureau Veritas Laboratories
COPE	Construction, Occupancy, Protection, Exposure
CSA	Canadian Standards Association
ESA	Environmental Site Assessment
FIP	Fire Insurance Plan
HASP	Health and Safety Plan
LDPE	Low-density polyethylene
masl	metres above sea level
mald	metres above local datum
mbgs	metres below ground surface
MECP	Ontario Ministry of the Environment, Conservation and Parks
PCA	Potentially Contaminating Activity
PHC	Petroleum hydrocarbons
PVC	Polyvinyl chloride
QA/QC	Quality assurance/quality control
RDL	Reportable detection limit
RPD	Relative percent difference
SCS	Site Condition Standards
SLS	Serviceability Limit State
SPMDD	Standard Proctor Maximum Dry Density
TOC	Top of Casing
ULS	Ultimate Limit State
VOCs	Volatile Organic Compound

Executive Summary

Arcadis Canada Inc. (Arcadis) was retained by Z.V. Holdings Corporation to conduct a Preliminary Geotechnical Investingation in conjunction with Phase One and Two Environmental Site Assessment (ESA) updates of the properties at 1881 and 1883 Merivale Road and Adjacent Lot, Ottawa, ON (the Site). The Preliminary Geotechnical Assessment was required to develop preliminary designs and evaluate alternatives for the proposed new construction. The proposed new construction includes two raised, one-storey, office/warehouse space buildings; Building A of 3540m^2 and Building B of 3070m^2, across a total site area of 14,113m^2 under zoning designation IG – General Industrial zone.

It was understood that the objectives of the Preliminary Geotechnical Investigation were to determine the subsoil and groundwater conditions at the property by means of advancing boreholes and taking soil samples for geotechnical testing. The objective of the investigation was to then provide geotechnical recommendations for design of the proposed development, including construction considerations which may affect the design process.

Arcadis carried out the borehole drilling program on 15 and 16 September 2022, with a return visit to the site to measure groundwater levels on 11 October 2022. The investigation consisted of the advancement of boreholes at nine locations to a typical depth of 5m below existing ground surface (mbgs). Three of the boreholes were completed as piezometers to measure static groundwater levels. One borehole (BH22-10) was advanced using a dynamic cone to a maximum depth of 10.9 metres below surface (mbgs). Selected soil samples obtained were analyzed for grain size distribution and corrosivity parameters.

Generally, the subsurface profile encountered at borehole locations consists of a layer of sand fill at surface underlain by native fine sand with silt/silty sand. The surface fill layer along Jamie Avenue consisted of gravel fill while a medium to coarse sand (often characterized as topsoil when organics were noted) was encountered at other locations. No bedrock was encountered at any borehole locations.

SPT values in the overburden at a depth of 1.5 to 2.5mbgs ranged from 9 to 28 per 0.3m with an average SPT of 16 over the nine boreholes reviewed (BH22-2 to BGH22-10); indicative of a compact relative density. Borehole BH22-10 was advanced beyond 5m depth using a dynamic cone to an eventual depth of 10.9mbgs. SPT values from the cone were 15 at 5.6mbgs and increased with depth. No indications of voids or any very soft overburden materials were observed.

Soil samples submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures found no concerns related to potentially aggressive/ corrosive environment and GU cement was considered suitable for use.

Geotechnical recommendations were provided for slab on grade as well as strip or spread shallow footing construction.

It is also recommended that a professional engineering firm be retained during construction to perform a) observation of and verification of all bearing surfaces prior to the placement of foundation concrete; b) sampling and testing of the concrete and fill materials used; c) periodic observation of the condition of unsupported excavation side slopes in excess of 3m in height, if applicable; d) observation of all subgrades prior to backfilling; e) field density tests to determine the level of compaction achieved; f) sampling and testing of the bituminous concrete including mix design reviews.

1 Introduction

Arcadis Canada (Arcadis) was commissioned by the Z.V. Holdings Corporation to conduct a Preliminary Geotechnical Investigation for the properties located at 1881-1883 Merivale Road, in the City of Ottawa, Ontario (the Site, refer to Figure 1 attached to this report). It is understood that two raised, one-storey warehouse buildings are proposed for the Site. The objectives of the investigation were to provide preliminary geotechnical information to guide design and potential construction of the proposed development.

The scope of work for the preliminary geotechnical investigation included:

- Completion of a field investigation consisting of nine borehole advanced across the Site;
- Water level measurements taken from installed monitoring wells;
- Specified laboratory index testing;
- Geotechnical engineering analyses; and
- Preparation of a preliminary geotechnical engineering report.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our preliminary findings and geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report. We note that the recommendations provided in this report are intended solely for the preliminary planning of this development. Geotechnical recommendations may change with proposed design changes. Further investigation will be required before detailed geotechnical parameters can be provided.

This report does not address environmental concerns associated with the Site. Please reference the Arcadis Phase One and Two ESA reports completed for these properties, as provided under separate cover.

1.1 Site Description

Address #1:	1881 and 1883 Merivale Road, Ottawa, Ontario
Location:	The site is surrounded by mixed residential and commercial properties. It is located on the east side of Merivale Road and south side of Jamie Avenue in the City of Ottawa, Ontario. Refer to **Figure 1** following the text.
Latitude and Longitude:	45° 19’ 57.8244" N, 75° 43' 19.7508" W (centroid)
Zoning:	IG- General Industrial Use
Site Area:	14,113 m^2

The subject site is currently occupied by an undeveloped grass field with a graveled school bus parking lot adjacent to the Jamie street property access. Grass covered areas and mature bushes/trees are found on the periphery of the property. The existing ground surface at the site is relatively flat with a gentle downslope towards the west.

1.2 Physical Setting

The subject property is situated in an urban area zoned for institutional land use. The subject area is relatively flat and generally level with surrounding grades having an approximate elevation of 91masl. Based on site observations and topographic maps, both 1881 and 1883 Merivale properties slope from east to west towards Merivale Road. Based on site observations and topographic maps both 1881 and 1883 Merivale slope from east to west towards Merivale Road. Generally, 1883 Merivale Road is at a higher elevation than 1881 Merivale Road, which is at a slightly higher elevation than 6 and 12 Jamie Avenue. Site drainage was not observed, no ditches were observed on either site. The site surface stormwater would be expected to flow from east to west towards Merivale Road. The regional topography is relatively flat. A depiction of the site is shown on **Figure 2**.

1.3 Local Geology and Hydrogeology

Bedrock geology mapping for the Site indicates that local bedrock is described as the Rockcliffe Formation comprising shale with lenses of sandstone (Geological Survey of Canada Map 1058A Generalized Bedrock Geology Ottawa, Ontario and Quebec).

The surficial geology mapping referenced describes surface soils as: Deltaic and Estuarine deposits, medium to fine grained sand, in some place fossiliferous; lying outside abandoned channels; most common deposit is a combined strip delta-sand plain that developed as fluvial water levels fell (Geological Survey of Canada Map 1056A Surficial Geology Ottawa, Ontario and Quebec).

Borehole logs and figures from surrounding properties were also referenced for surficial soil geology from records returned in the ERIS Ecolog search. According to the data contained in logs for wells advanced in close proximity to the property, the soils were generally characterized as sand and/or medium sand from surface to a depth ranging from 10.67 to 15.2 metres below ground surface (mbgs) before encountering bedrock.

Regional shallow groundwater may be directed westwards towards surficial water bodies in the Pinhey Forest but it is expected that deep groundwater flow may be in a northeasterly direction towards the Rideau River, based on a review of local topographical features and drainage patterns. Immediate area groundwater flow may be influenced by local features such as the presence of utilities and site facilities.

1.4 Proposed Development

The specific study area is located at 1881-1883 Merivale Road in Ottawa, Ontario. The proposed new construction includes two raised, one-storey buildings; Building A of 3540m^2 area and Building B of 3070m^2 area office/warehouse space, across a total site area of 14, 113m^2 under zoning designation IG – General Industrial zone.

1.5 Previous Reporting

Arcadis completed previous reporting for this subject property, which included the following reports: *Phase I and II Environmental Site Assessment, Arcadis – dated 17 December 2019.*

2 Scope of Work

The scope of work for the preliminary geotechnical investigation, conducted concurrently with the Phase One and Two ESA Updates for the Site, included the following:

i. Development of a Site Specific Health and Safety Plan governing all site activities;
ii. Performance of Utility OneCall clearances as well as borehole location clearances performed by a private utility locator;
iii. Advancement of nine boreholes to depths ranging from 5.18 to 10.67mbgs (refer to Figure 2 for locations);
iv. Installation of monitoring wells in three of the advanced boreholes;
v. Selection of soil samples obtained for geotechnical analyses and submission to an accredited laboratory for testing;
vi. Return to site and measurement of water levels, where possible;
vii. Survey of all boreholes and monitoring wells to a temporary, local benchmark; and
viii. Preparation of a preliminary geotechnical report summarizing the results of the onsite investigation and providing basic geotechnical recommendations to inform the proposed design and construction.

3 Method of Investigation

3.1 General

The field work for this investigation was carried out on 15 and 16 September (with a subsequent site visit on 11 October) under the supervision of Mr. Lennart DeGroot, B.Sc. of Arcadis. Nine boreholes were drilled on the subject property at the locations shown on **Figure 2**. Borehole locations were selected to correspond with the proposed building footprints as shown on the preliminary site layout drawings provided to Arcadis.

The Site area and all test locations were cleared for buried utilities prior to the start of the field investigation program. Ontario OneCall was contacted to determine the location of public utilities, and USL-1 was contracted to clear private utilities.

Standard field procedures are summarized in the following sections.

3.2 Borehole Drilling

Nine boreholes (BH22-2 through -10) were advanced on 15 and 16 September 2022 as shown on **Figure 2**. Borehole depths ranged from 5.18mbgs to 10.67mbgs. Descriptions of the soil stratigraphy encountered are presented on the borehole logs included as **Appendix A**.

The boreholes were advanced using a truck-mounted CME-55 auger drill rig (with hollow stem augers) operated by a two-person crew from Downing Estate Drilling. All fieldwork was conducted under the full-time supervision of Arcadis personnel, under the direction of a senior engineer. The proposed borehole at location BH22-1 was not able to be advanced due to safety concerns associated with heavy traffic at that location. Boreholes were backilled with bentonite clay chips at the end of site operations, with the exception of three boreholes (BH22-2, -4, and -6) which were outfitted as monitoring wells for purposes of evaluating water table elevation measurement and groundwater sampling.

3.1.2 Soil Sampling and In-Situ Testing

Soil samples were collected from the boreholes using a 51mm diameter, 0.6m long split-spoon (SS) sampler on a continuous basis to 3mbgs, then at intervals of 1.6m thereafter. Standard penetration testing (SPT) was performed, and "N" values were recorded at the time of sample collection to assess soil density conditions.

All soil samples were visually inspected and initially classified on site. The split-spoon samples were placed in sealed plastic bags or jars and logged in the field for soil type, moisture content, colour, structure, and visual evidence of potential contamination, then transferred to the Arcadis laboratory for further evaluation. Borehole logs were prepared on the basis of sample and drilling process observations in the field describing the encountered strata and are presented in **Appendix A**. Site photographs are presented in **Appendix B**. Samples were selected and submitted to ALS in Ottawa, Ontario, for the selected geotechnical testing.

All samples will be stored at the laboratory for a period of one month after the issue date of this report. They will then be discarded unless we are otherwise directed. All excess soil cuttings were used as backfill when reinstating boreholes.

3.3 Groundwater Monitoring Well Installation and Groundwater Elevation Measurement

Three boreholes were finished as groundwater monitoring wells – BH22-2, -4, and -6 – to permit monitoring of the groundwater levels at Site. The monitoring wells comprised 50mm diameter Schedule 40 PVC Triloc riser pipes with a 3.05m long No. 10 slot intake zone (well screen). Silica sand was placed around the piping to a height of at least 300mm above the top of the well screen as filter pack. The remaining annular space was filled with a bentonite clay seal. A protective aluminum flushmount casing was then cemented in place at the top of the well.

In accordance with O.Reg. 903, well records were submitted to the MECP for the monitoring wells installed at the Site. The well tag and well record was submitted by the subcontracted licenced well drillers (Downing) who performed the installation.

A dedicated WaTerra inertial pump was installed in each monitoring well. The well was developed by hand-pumping the WaTerra sampler to ensure that at least three well volumes of water were removed (or until the well ran dry) to reduce the potential effects of foreign material introduced through drilling and to maximize the responsiveness of the surrounding geological materials.

Groundwater table monitoring was completed on 11 October 2022 at all wells within the same time period to ensure that the results are representative of conditions across the Site. Any unusual weather conditions and modifying features were noted on the log.

3.4 Field Survey

The test holes and monitoring wells installed on Site were located and surveyed in the field by Arcadis personnel during the initial fieldwork. Elevations were surveyed using a TopCon laser-level unit to a local datum, where the top of the concrete NE corner of the residential building used as the Diver's Wearhouse was assigned an elevation of 100.00m. The borehole location northing and easting coordinates were determined using a handheld GPS. The borehole locations are presented on **Figure 2** and the ground surface elevations are shown on each borehole log (**Appendix A**).

4 Geotechnical Laboratory Testing Program

Geotechnical laboratory testing was carried out on representative samples recovered from the boreholes, to effectively classify the soil strata observed in the field. This program included:

- Natural moisture content on all recovered samples where feasible;
- Grain size (sieve and hydrometer) testing on two samples;
- Coarse/fine material analyses on four samples; and
- Corrosivity suite testing on three samples.

The results of the testing program have been summarized in tabular format following the text of this report. Samples subjected to geotechnical testing have been identified on the borehole logs presented as **Appendix A**. Where applicable, the results of the index testing have been included on the borehole logs.

Additional soil and groundwater analytical results are reported in the corresponding Phase II ESA report prepared by Arcadis, presented under a separate cover. Environmental results and potential liabilities are not discussed in this report, unless where specifically noted.

The laboratory certificates of analyses are presented in **Appendix C**.

5 Subsurface Conditions

Generally, the subsurface profile encountered at borehole locations consists of a layer of gravel fill or topsoil underlain by native silty sand/sandy silt units. grading to light brown fine sand with depth. The surface fill layer along Jamie Avenue consisted of gravel fill while a medium to coarse sandy topsoil was encountered at other locations. No bedrock was encountered at any borehole location.

Reference should be made to the borehole logs in **Appendix A** for specific details of the soil profiles encountered at each borehole location.

5.1 Fill Soils

Fill soils were encountered at each borehole location onsite.

5.1.1 Gravel/Sand Fill

Gravel or sand fill (parking lot surfacing, at some locations) was encountered at borehole locations BH22-2, -3, -5 and -8 at surface and extended to depths ranging from 0.3 to 1.2mbgs. This unit was generally described as light grey and dry, with some to trace sand. The natural water content was measured at 0-8% - moisture content was not measured at each location if the sample was considered too dry. The SPT values obtained in this strata ranged from 5-18 blows per 300mm, indicating a loose to compact (medium dense) soil.

5.1.2 Topsoil

Topsoil was encountered at borehole locations that were not in areas used as parking space; BH22-4, -6, -7, -9, and -10. This unit was encountered at surface and extended to depths ranging from 0.3 to 0.6mbgs. This stratum was generally described as moist and brown to black organic material and medium to coarse sand, with or without organic lenses, trace roots and grass debris. The natural water content was measured at 10-16%. SPT values in this unit ranged from 2-4, indicating a loose to very loose soil.

5.2 Native Soils

5.2.1 Silty Sand/Silt with Sand

Silty sand/sand with silt was encountered at each borehole location, underlying the surficial fill units. This unit was general described as dry to moist, light to dark brown or grey fine sand with silt. Some lenses of coarser sand material were noted, as well as mottled texture in BH22-9. The natural water content was measured at 2-19%, with an average of 8%. The SPT values in this stratum ranged from 9-33, indicating a loose to dense soil.

5.2.2 Sand

Native sand was encountered in BH22-7 at a depth of 2.4mbgs and continuing to borehole termination at 5.18mbgs. This stratum was described as moist, light brown to light grey fine to coarse sand with some silt. The natural water

content was measured at 5%. SPT values in this unit ranged from 23-38, indicating a compact (medium dense) to dense soil.

5.3 Bedrock

The bedrock surface was not encountered in any of the borehole locations advanced. The cone penetration test performed at BH22-10 was terminated at a depth of 10.67mbgs.

5.4 Groundwater

Groundwater levels were measured at the monitoring wells in the borehole locations on 11 October 2022. The measured groundwater levels in monitoring wells are presented in **Table 2** following the text of this report – of the three wells, only one was observed to have collected liquid. Borehole logs indicated the presence of a wet soil at depths ranging from 2.5 to 4.5mbgs. Capillary action in the silty native soils may tend to wick moisture upwards. Based on these observations, the long-term shallow groundwater table is anticipated to vary seasonally between 3.5 to 5.5m depth below grade. It is anticipated that groundwater elevations may vary between the monitoring time and the time of construction.

The groundwater levels measured in 2019 are noted on **Figure 3**. These are not necessarily considered representative of current conditions but may be used as a reference when discussing construction methodology.

6 Geotechnical Discussion and Recommendations

It is understood that the site is intended to be developed as warehouse space, with two raised, single-storey warehouse buildings occupying the proposed footprints as shown on **Figure 2** at the rear of this report. Further geotechnical engineering analyses and/or investigation work may be required if the design changes beyond what has been proposed.

From a geotechnical perspective, the subject site condition is satisfactory for the construction of the proposed two buildings. It is recommended that the proposed building be founded on conventional shallow foundations placed over competent native silty sands. The geotechnical recommendations provided herein to assist preliminary foundation and building design are general in nature as limited details are available regarding the proposed structures. The recommendations should be reviewed by Arcadis prior to final design and construction to assess their applicability to the proposed structure. Further engineering, analyses and investigation work may be required once the final building parameters and configuration is known.

It is assumed that the proposed buildings would be no more than one raised storey in height. On the basis of the results of the field investigation program carried out during this study, the following geotechnical recommendations are provided.

6.1 Foundation Considerations

6.1.1 Shallow Foundations

The subsurface conditions encountered at the site are considered suitable for support for the proposed warehouse buildings on spread or strip footings, provided that they can be designed using the bearing resistance values provided below. Due to the presence of competent soils at shallow depths, deep foundations involving piles or caissons is not considered necessary or cost-effective. All existing fill, topsoil, organics, humus, reworked fill and any other deleterious material should be excavated and removed and the spread or strip footings founded on the underlying competent native silty sands/sands.

The maximum bearing resistance for spread or strip foundations up to 1.5m in width founded on the undisturbed native silty sands may be designed using a net allowable serviceability limit states (SLS) bearing capacity of 100kPa and a factored bearing resistance value at ultimate limit states (ULS) of 200 kPa. The maximum bearing resistance for pad footings up to 4m in width may be taken as the same.

Exterior wall support structures placed on undisturbed compact silty sand can be designed using a bearing resistance value SLS of 100kPa and a factored bearing resistance at ULS of 200kPa. All founding surfaces must be proof rolled by adequately sized compaction equipment making several passes under dry conditions and above freezing temperatures.

A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

In the proposed warehouse building footprint areas, the surface of undisturbed native silty fine sand stratum is located 0.6 to 1.8 m below grade. Total and differential settlements of properly designed and installed foundations are estimated to not exceed 25mm.

Proof-rolling and geotechnical inspection is required to ensure that founding surfaces are of acceptable undisturbed, native soils prior to placing crushed stone, engineered fill or concrete.

6.1.2 Slabs-on-Grade

It is anticipated that slab-on-grade floor construction may be required for the main floor of the buildings. The surficial topsoil/humus layer is considered unsuitable for support of building floor slabs due to its compressible nature and should be excavated and removed. Any underlying reworked overburden is considered adequate for support of building floor slabs. The underlying native silty sands, if exposed during regrading of the site, are also considered suitable for slab-on-grade floor support. Exposed surfaces of the reworked or undisturbed sandy soil should be proof rolled to identify soft spots, which should be repaired through excavation and backfilled with OPSS Granular B fill material compacted to not less than 95% SPMDD.

Any building floor slabs should typically be constructed to be independent of building foundation walls, or any other part of the structure founded on different soils/foundations to minimize differential settlement.

A minimum 150 mm-thick layer of compacted, free-draining granular or crushed stone material should be placed between the subgrade and the building floor slab to provide proper sub-slab drainage, moisture migration and support. If reworked overburden or native fill options are used, given the variable subgrade soil gradation potentially present it is recommended that a non-woven geotextile layer (Terrafix 270R or equivalent) be placed to separate crushed stone from the subgrade.

Proof-rolling and geotechnical inspection is required to ensure that founding surfaces are of acceptable undisturbed, native soils prior to placing crushed stone, engineered fill or concrete.

6.1.3 Frost Protection

All exterior foundations should be provided with a minimum of 1.5m soil cover, or equivalent, to provide frost protection. Frost protection should also be provided for any slabs exposed to the elements. The silty or fine sand stratum is considered to be frost susceptible. Due to its freezing potential, the silty or fine sand material is not recommended as backfill to exterior building walls.

Trench excavations and pavement construction are difficult activities to complete during freezing conditions without introducing frost in the sub-grade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be carried out during freezing conditions.

6.2 Site Grading and Preparation

6.2.1 Recommendations for Soil Removal

Asphalt, topsoil, and deleterious fill, such as material containing high content of organic materials or construction remnants, should be stripped entirely from under the proposed building footprint and other settlement sensitive structures (e.g. pavement structures). All overburden at the subject property within the proposed building footprints are expected to be removed. Further geotechnical analyses on the stratum will be required if the fill is to be considered for construction use (founding surface, backfill, etc.) on site.

6.2.2 Engineered and Native Fill

Fill used for grading beneath the proposed building should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300mm thick and compacted using suitable compaction equipment for the lift thickness. Load-bearing fill soils placed beneath the building footings and paved areas should be compacted to at least 98% of the material's standard Proctor maximum dry density (SPMDD).

Topsoil and humus excavated throughout the site may be stockpiled for future use on site. Reworked native soils excavated during the course of foundation installation are considered to be frost susceptible and as such are not recommended for use as load-bearing material. The material may be reused on site as general upfill as required for berms or landscaping.

Non-specified existing fill, along with site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If this material is to be used to build up the subgrade level for areas to be paved, it should be compacted in thin lifts to at least 98% of the material's SPMDD (this will require Proctor testing).

Non-specified existing fill and site excavated soils are not suitable for use as backfill against foundation walls unless used in conjunction with a composite drainage membrane. Further geotechnical testing and analyses on this material to confirm consistency and suitability is required before it is approved for construction use such as this.

6.2.3 Excess Soils

The removal of any excess soil from the site should follow the requirements of O.Reg. 406/19- ***On-Site and Excess Soil Management***.

6.3 Seismic Considerations

6.3.1 Seismic Hazard

The Ottawa area falls within the Western Quebec Seismic Zone (WQSZ), according to the Geological Survey of Canada. Based on a review of Ontario Geological Survey maps (map 431A), the project Site is not underlain by any known faults. Under the 2015 Ontario Building Code, a seismic hazard with a 2% probability of exceedance in 50 years has been retained for design of the building structure. The design earthquake magnitude retained for this event is 6.1, and represents the mean magnitude of the de-aggregation of the PGA seismic hazard for Ottawa.

6.3.2 Liquefaction Assessment

Liquefaction is a seismically induced phenomenon that can cause soil densification and excess pore pressures which then can lead to potentially large surface settlements and sudden temporary losses in bearing strength. These then can cause lateral spreading and catastrophic soil failures (or flow slides) which are often observed

alongside rivers or shorelines. The shallow overburden present at the subject site is not considered to be potentially liquifiable.

6.3.3 Seismic Classification

At this preliminary stage, the site class for seismic site response can be taken as **Class D** (stiff soil) for the foundations bearing on soil profile materials with an average N_{60} between 15 to 50.

Seismic classifications should be verified during the subsequent detailed geotechnical investigation(s) using field MASW/ESPAC and seismic refraction methods.

6.4 Pavement Recommendations

Founding soils for pavements structure must be proof-rolled and inspected by qualified personnel prior to pavement structure construction. Where required at the subject site, the recommended pavement structures for parking areas and access lanes are shown below:

Table 6-1: Recommended Pavement Structure-Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course**: HL-3 or Superpave 12.5 Asphaltic Concrete
150	**Base**: OPSS Granular A Crushed Stone base
300	**Subbase**: OPSS Granular B Type II
Subgrade: Either fill, competent in-situ soil or OPSS Granular B Type I or II material placed over competent in-situ soil or fil.	

Table 6-2: Recommended Pavement Structure- Access Lanes and Heavy Truck Parking/Loading Areas

Thickness (mm)	Material Description
40	**Wear Course**: HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course**: HL-8 or Superpave 19.0 Asphaltic Concrete
150	**Base**: OPSS Granular A Crushed Stone base
450	**Subbase**: OPSS Granular B Type II
Subgrade: Either fill, in-situ soil or OPSS Granular B Type I or II material placed over in-situ soil or fil.	

Minimum Performance Graded (PG) 58-34 asphalt cement is recommended for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with compacted OPSS Granular B Type II material. Weak subgrade conditions may be

experienced over service trench fill materials. This may require the use of a geotextile, such as Terrafix 270R or equivalent, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

The pavement granular base and subbase should be placed in maximum 300mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment.

6.5 Retaining Wall Design

As requested, Arcadis Canada Inc,. (Arcadis) completed a Redi-Rock retaining wall design to be located on the eastern side of the truck unloading bay of the proposed development. The Redi- Rock retaining wall system has been designed for the subject site to consider site constraints and grading requirements. The walls have also been designed in accordance with the National Building Code of Canada 2020 (NBCC). Details of the retaining wall are presented below and are depicted in Drawing C-01 attached.

The following grading plan prepared by McIntosh-Perry was reviewed as part of our retaining wall designs:

- Project No. CCO-23-1150, Drawing C101, Grading, Drainage and Erosion & Sediment Control Plan, Revision 1 dated 13 February 2023.

Based on our review, the exposed portions of the subject Redi Rock retaining wall vary in height between 0.3m to 1.9m.

6.5.1 Retaining Wall Fencing

The proposed fencing is recommended to be extended through the top two blocks of the Redi Rock wall and designed by others. Open guide rail, chain link fences and others of a "flow-through" configuration, will not impart significant wind loads on the wall. It should be noted that the fencing should be installed using galvanized steel to protect the railing/fencing system from long- term corrosion. Refer to City of Ottawa fencing standard - Figure 7.9

6.5.2 Global and Internal Stability Analysis

The global stability analysis was modeled using Redi-Rock+ software (part of the Fine suite by Geo 5), a computer program which permits a two-dimensional slope stability analysis calculating several methods including the Bishop's method, which is a widely accepted slope analysis method. The software further allows for the internal review of the design as per various codes including the CHBDC 2019. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to forces favoring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsurface soil and groundwater conditions, a factor of safety greater than 1.0 is generally required for the failure risk to be considered acceptable.

A minimum factor of safety of 1.5 is generally recommended for conditions where the slope failure would comprise permanent structures. Based on the configuration of the Site plans reviewed and the conservative nature of the software/parameters used, a factor of safety of 1.3 was considered acceptable. An analysis considering seismic loading was also completed. A horizontal acceleration of 0.1515 g was considered for the sections for the seismic loading condition. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading. Based on the conservative nature of the software/parameters used, including the fact that the model does not account for the wall being affixed to the adjacent structure, a factor of safety within rounding error is considered acceptable.

The highest retaining wall cross-section was studied as the worst-case scenario. The following parameters were used for the slope stability analysis under static and seismic conditions:

Table 1 - Effective Soil Parameters for Stability Analysis

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
SAND, some silt	18	35	0
Granular B Type II	21	40	0

The total strength parameters for seismic analysis were chosen based on the geotechnical testing results from the subject site and are the same as those used above.

6.5.3 Analysis Results

The factor of safety for the retaining wall section was greater than 1.3 for static conditions. Similarly, the results under seismic loading yielded a factor of safety for this section greater than 1.1.

The internal and structural design reviewed the bearing capacity, overturning resistance, and sliding resistance of the retaining wall units. All analysis were found to be acceptable, the worst case scenarios are presented in attached calculation sheets.

Based on these results, the retaining wall design is considered suitable from a geotechnical perspective.

6.6 Backfill Material

The retaining wall should be backfilled with free-draining granular backfill materials and incorporate longitudinal drains and weep holes to provide positive drainage of the backfill. For the purpose of this report, it is recommended that the wall be backfilled with either OPSS Granular B Type II or Granular A materials. The backfill should be placed within a wedge-shaped zone defined by a line drawn up and back from the back edge of the base block of the wall at an inclination of 1H:1V or a minimum of 1 m behind the back of the blocks. All material should be compacted to a minimum of 98% of the material's SPMDD.

6.6.1 Drainage

A 100 mm diameter perforated drainage pipe wrapped in geotextile and surrounded on all sides by 150 mm of clear crushed stone, should be installed at the heel of the bottom block. The drainage should have positive drainage to a nearby outlet such as a catch basin or an existing ditch. It is recommended that the outlets be spaced evenly along the retaining wall with a minimum spacing of 30m center to center passing through the wall or connected to a nearby catch basin.

6.6.2 Retaining Wall General Recommendations

It is recommended that the following be completed once the retaining wall design and course of action are determined

- Observation of all bearing surfaces prior to backfill;

- Observation of all subgrades prior to placing backfilling materials;
- Observation of the drainage system prior to backfilling;
- Field density tests to ensure the specified level of compaction was achieved;
- Periodic observation of the retaining wall installation, especially during construction of the foundation and first course.

A report confirming that these works have been conducted in general accordance with Arcadis's recommendations should be issued, following the completion of a satisfactory material testing and observation program by the supervisory geotechnical consultant.

7 City of Ottawa comment responses- Geotechnical Review of Drawings/ Plans-

As requested, Arcadis Canada Inc,. (Arcadis) completed a geotechnical review of the existing development plans as recently transmitted to Arcadis via email.

The following drawings were examined as part of our geotechnical review:

- The site plan prepared by McRobie/Arnon: Project No. 19-120, Drawing SP-A01, Site Plan, Revision 7 dated 16 May 2023; and
- The grading plan prepared by McIntosh-Perry: Project No. CCO-23-1150, Drawing C101, Grading, Drainage and Erosion & Sediment Control Plan, Revision 1, distributed 2023.05.24.
- Tree Report and Landscape Plan- JBLA,Drawing L-1; dated Feb. 7, 2023

There are currently no outstanding geotechnical concerns with respect to the drawings/plan presented and as listed above. All drawings provided appear to be in keeping with the geotechnical recommendations provided in this Geotechnical Investigation report, dated 4 August 2023.

7.1 Proposed Stormwater Management Structure

The grading plan noted above was also considered when reviewing the proposed stormwater management structure design and layout. The proposed structure on Site is a series of Triton S-29 Chambers, aligned and connected as detailed in the attached drawings and specification:

- Area B3 Storage Tank. Project Results
- Triton S-29 Chamber: Standard Details and Specification

Recommendations for the stormwater infrastructure installation proposed include:

a) Cover: It is recommended that backfill around and adjacent the stormwater management structure be Granular A or B Type II materials. The backfill should be placed in lifts no greater than 200mm and material should be compacted to a minimum of 98% of the material's SPMDD. Cover thickness requirements should meet manufacturer specifications, which appears to be a minimum of 301 mm.

b) Separation from bedrock: no bedrock is expected to be encountered during stormwater system installation as bedrock was not found during any geotechnical drilling and was anticipated to be found at depths ranging from 11 to 15 m below ground surface.

c) Groundwater table: the groundwater table across the Site was determined to be found at depths ranging from 2.5 m to 4.5 m below grade. The proposed location of the Triton S-29 install would be expected to have a static water table at deeper than 2.5 mbgs whereas the invert of the proposed Trion S-29 unit is anticipated at an invert depth well above the static water table elevation. No concerns are anticipated with depth to water table for the installation of the proposed S-29 Triton units.

Traffic loading: Manufacturer's specifications need to be followed. S-29 chambers are rated for H-30 loading conditions with 457 mm of cover (no pavement). Minimum cover requirements are 0.301 m in manufacturing documentation. Arcadis suggests a 0.45 m minimum thickness cover (plus pavement) for application in this instance to account for large transport trailer travel on internal service roads at this Site.

7.2 Grade Raise Restrictions

No significant grade raise is anticipated in this development planning. Based on the absence of Clay soils, we do provide any recommendations to restrict potential minor changes or low raising of site grades. No current concerns with site grading were identified, following review of the drawing Grading, Drainage and Erosion & Sediment Control Plan (C101) by McIntosh Perry, distributed 2023.05.24.

7.3 Tree Planting Restrictions

Sensitive Marine Clay (SMC) soils have not been observed on site. No tree planting restrictions are recommended at the current time for this site.

7.4 Geotechnical Laboratory Testing

Atterberg limit testing was not considered to be warranted for soils encountered on site as the majority of soils observed consisted of Sands.

7.5 Clay Dikes

Clay dikes or Trench breaks/plugs are not considered necessary from a geotechnical standpoint. The static ground water table is not anticipated to be above the level of utility trenching.

7.6 Excavation Impacts on Adjacent Properties

Based on anticipated excavations (estimated max depth ~2.0mbgs) and previously measured groundwater levels (ranging from 2.5 to 4.5 mbgs), dewatering is expected to be minimal or non-existent during construction. Groundwater removal from excavations is only anticipated during heavy storm rainfall events and is not expected to impact adjacent properties.

The proposed warehouse structures are to be constructed as slab on grade buildings and we do not expect any impact on adjacent land parcels.

8 Design and Construction Precautions

8.1 Temporary Excavations

Temporary excavations are expected to be shallow and must conform to the stipulations made in O.Reg. 213/91 promulgated under the Occupational Health and Safety Act. Most soils that will be encountered in temporary excavations are anticipated to be Type 3, as defined under the Regulation. Therefore, open cut side slopes would need to be cut back at an inclination of no steeper than 1 horizontal to 1 vertical (1H:1V). For slopes which are unsupported in the longer term, and might experience free-thaw cycles, flatter side slope inclinations could be required. It is not anticipated that excavations would extend below the groundwater table, but any soils below such would be considered Type 4 and require 3H:1V slopes

8.2 Foundation Drainage and Backfill

Based on the amount of silt present in native soils on site, it is recommended that a perimeter foundation drainage system be provided for the proposed structure. The system should consist of a 100 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 100mm of 19mm clear crushed stone which is placed at the footing level around the exterior perimeter of the structure. The perimeter drainage pipe system should direct water to a suitable outlet.

8.3 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications & Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

A minimum of 150mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil subgrade. If the bedding is placed on bedrock, the thickness of the bedding should be increased to 300 mm for sewer pipes. The bedding should extend to the spring line of the pipe. The material should be placed in a maximum 300mm thick loose lifts and compacted to a minimum of 95% of its SPMDD.

The cover material, which should consist of OPSS Granular A, should extend from the springline of the pipe to at least 300mm above the obvert of the pipe. The material should be placed in a maximum 300 mm thick loose lifts and compacted to a minimum of 95% of its SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (to about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in a maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

If required, frost depth protection can be provided to duct banks or similar using an overlay of Styrofoam SM insulation. Insulation overlay design and backfill parameters can be provided by Arcadis once embedment depths have been confirmed.

8.4 Groundwater Control

8.4.1 Groundwater Control for Building Construction

Based on our observations, it is anticipated that groundwater infiltration into the excavations should be negligible given use of shallow spread or strip footings under summer conditions. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations under summer conditions.

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium. Discharged water should be subject to filtering before discharge. A municipal permit will be required if impounded water is pumped into the sewer. Any sewer discharges should be conducted to meet City of Ottawa sewer discharge bylaw standards.

The finished exterior surface grades of the proposed structure should be sloped away from the building to prevent surface ponding and infiltration immediately adjacent to the building exterior walls. Backfill adjacent to all exterior walls should comprise compacted, free-draining granular materials (OPSS Granular B or equivalent).

8.4.2 Permit to Take Water/ EASR

It is unlikely that a Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) is required for this site (typically required if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase). For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for the completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O. Reg. 63/16.

Neither a PTTW or an EASR is expected to be required for this site given the shallow nature of the proposed foundation footings and the inferred depth of water table across the site.

8.5 Winter Construction

The subsoil fill conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions, ice could form within the soil mass. Heaving upon freezing and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters, tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

Any trench excavations should be carried out in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soil which will experience total and differential frost heaving as the work takes place. In addition, the introduction

of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information and recommendations can be provided during the design and construction project phases if requested.

8.6 Corrosion Potential

Three soil samples were submitted for corrosivity testing, from BH22-3, -5, and -6. The results of analytical corrosivity testing on soil are summarized in Table 4 following the text of this report.

The laboratory results on soil indicate that the sulphate content was non-detect in samples submitted, indicating a non-corrosive environment. As The threshold for chloride content requiring amended concrete is 0.2%, while the maximum concentration observed was at 41µg/g (or 0.0041%), which is acceptable. The neutral pH levels (from 7.5 to 6.6) of the three samples analyzed indicate that this is not a contributing factor in creating a corrosive environmental for exposed ferrous metals at this site.

Based on the National Corrugated Steel Pipe Association, a low soil resistivity relates to increased potential corrosion activity and is governed by the content of electrolytes, which consist of moisture, minerals and dissolved salts which can vary throughout the seasons. Typically, the lower the resistivity, the higher will be the soil corrosivity. Corrosive soil environments occur with a resistivity between 30 and 50 Ohm-m while even lower values are highly corrosive. Based on the soil samples tested with a resulting minimum resistivity of 4950 Ohm-cm (or 49.5 Ohm-m), the corrosion rating for the subject property soil classifies it essentially a non-corrosive environment.

Uncontaminated, high quality concrete normally provides excellent corrosion protection for reinforcing steel. The high pH environment of the concrete (greater than 12.5) keeps the reinforcing steel in a non-active corrosion state. Intrusion of chlorides into the concrete through contact with chloride-contaminated soil, water or marine atmosphere, however, may lead to corrosion of the embedded reinforcing steel. Sulphate attack can cause extensive cracking, expansion and loss of bonds between the cement paste and aggregates. Type GU Portland cement should therefore be suitable for use in concrete at this site based on the results as reported by the laboratory.

9 Future Recommendations

9.1 Detailed Geotechnical Investigation

The geotechnical recommendations provided herein are preliminary in nature. It is recommended that a detailed geotechnical investigation be performed once the new building design has been finalized and once proposed footing alignments and depths are known. Recommendations for future geotechnical work on site and in the laboratory to support the building design process should include, but are not limited to:

- Further geotechnical testing (additional grain size analyses, Proctor testing) of any onsite fill/ soil materials proposed for reuse;
- A soil management plan be developed with the aim of handling soils suitable as native fill, as well as excess soils generated during the construction process, in an efficient and cost-effective manner; and
- Confirmatory boreholes to confirm soil types, distributions and depths to bedrock at defined intervals across the proposed building footprint and especially at proposed corners, anticipated footing locations, etc.

9.2 Geotechnical Consultation During Design Process

The preliminary geotechnical recommendations provided herein to assist foundation and building design are general in nature as specifics of the structure have yet to be determined. These recommendations should be reviewed by Arcadis prior to final design and construction to assess their applicability to the proposed structure. Site-specific foundation design recommendations will be required for components of the proposed structure.

9.3 Geotechnical Supervision During Construction

Development of the subject site will require movement of a variety of soil types and potentially specialized foundation installations. It is recommended that a qualified geotechnical engineer be retained to inspect and approve the subgrade prior to placement of utility lines, watermain thrust blocks, pavement structures, building floor slab/foundations or to supervise the installation of foundations. Geotechnical supervision should also be provided to ensure that engineered fill placed beneath floor slabs, roadways and parking areas is properly compacted and that any weak soil layers are properly removed. Geotechnical inspection of the bearing conditions for the proposed foundation system should also be carried out.

Geotechnical site supervision and review is required during future construction activities. It is recommended that the following material testing and observation program be performed by a licensed geotechnical engineering consultant during construction operations:

- Observation of all bearing surfaces prior to the placement of concrete/crushed stone/engineered fill;
- Sampling and testing of the concrete and fill materials used;
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3m in height, if applicable;
- Observation of all subgrades prior to backfilling;

- Field density tests to determine the level of compaction achieved; and
- Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these construction works have been conducted in general accordance with geotechnical recommendations would then be issued following the completion of a satisfactory material testing and observation program by the geotechnical consultant. It is recommended that all footing excavations be inspected by competent geotechnical personnel to ensure that a proper bearing surface has been attained and that foundation designs are suited to site conditions.

9.4 Existing Wells

The groundwater wells installed at this site will require decommissioning at the time of construction in accordance with O.Reg. 461/19 protocols.

10 Closure

The field work and reporting for this investigation was carried out by Mr. Lennart de Groot, B.Sc. and Mr. Justin Cameron, B.Sc., working under the direction and final review of Mr. Troy Austrins, P.Eng., PMP and Mr. Ryan Janzen, P. Eng.

We trust that the contents of this report are sufficient for your present purposes. If you have any questions, please call.

Respectfully submitted,

Arcadis Canada Inc.

Ryan Janzen, P.Eng.
Project Engineer

Troy Austrins, P.Eng., PMP
Team Lead

11 Statement of Limitations

This report, prepared for the Z.V. Holdings Corporation, does not provide certification or warranty, expressed or implied, that the investigation conducted by Arcadis uncovered all potential geotechnical constraints at the site. The conclusions and recommendations presented in this geotechnical investigation report are based on the information determined at the borehole locations. The information contained within this report in no way reflects the environmental aspect of the site or soil, unless specifically reported upon. Subsurface and groundwater conditions between and beyond the test locations may differ from those encountered at the specific locations tested, and conditions may be encountered during construction which were not detected and could not be anticipated at the time of the site investigation. It is recommended that Arcadis be retained during construction to confirm that the subsurface conditions throughout the subject property do not differ materially from those conditions encountered at the test locations. The benchmark and ground surface elevations in this report were used to establish relative elevation differences between the test locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations provided in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not have been available at the time this report was prepared, it is recommended that a qualified engineering consultant be retained during future stages of the design process to verify that the design is consistent with the recommendations of this report, and that the assumptions made in the analyses contained in this report are still valid. The need for additional subsurface investigation work and laboratory testing should be reviewed by the retained qualified engineering consultant during the course of the detailed design work.

The comments given in this report on potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of boreholes/ groundwater wells may not be sufficient to determine all of the factors that may affect construction methods and costs (e.g., the thickness of surficial topsoil and fill layers can vary markedly and unpredictably). Contractors bidding on the project or undertaking the construction should, therefore, make their own interpretations of the factual information in this report and draw their own conclusions as to how the subsurface conditions may affect their bid or work.

Furthermore, this report was prepared by Arcadis for Z.V. Holdings Corporation. The material in it reflects the best judgement of Arcadis based on the information available at the time of preparation, Sept./Oct. 2022. Changes to soil and/or groundwater quality in the areas investigated can occur following the date of testing. Any use which a third party makes of the report, or reliance on, or decisions to be based on it, is the responsibility of such third parties. Arcadis accepts no liability, whether in negligence, contract or arising on any other basis for damages or from indemnification arising from decisions or actions by others based on this report. Please note that the recommendations provided in this report are intended solely for the preliminary planning of this development. Further geotechnical investigation will be required before detailed geotechnical parameters can be established.

Tables

Table 1
Elevations Summary

Borehole Number	Co-ordinates		Ground Surface Elevation (local)	Borehole Depth (mbgs)	Borehole Base Elevation (local)	Depth to Well Screen (mbgs)	Well Screen Elevation (local)	Depth to bedrock (mbgs)	Bedrock Elevation (local)
	N	E							
BH22-2	45°20.011'	075°43.315'	98.98	5.18	93.80	2.13	96.85	--	--
BH22-3	45°19.988'	075°43.303'	98.96	5.18	93.78	--	--	--	--
BH22-4	45°19.976'	075°43.332'	98.97	5.18	93.79	2.13	96.84	--	--
BH22-5	45°19.996'	075°43.338'	98.81	5.18	93.63	--	--	--	--
BH22-6	45°19.968'	075°43.324'	99.04	5.61	93.43	2.56	96.48	--	--
BH22-7	45°19.947'	075°43.306'	99.86	5.18	94.68	--	--	--	--
BH22-8	45°19.934'	075°43.335'	99.48	5.18	94.30	--	--	--	--
BH22-9	45°19.957'	075°43.351'	99.15	5.18	93.97	--	--	--	--
BH22-10	45°19.952'	075°43.306'	99.86	10.67	89.19	--	--	10.67	89.19

Notes: - All screen intervals are 3.05m. Elevation given is the top of the screen.

- Bedrock was not proved during this investigation, depth given is the inferred bedrock surface.

- A local datum was used, with the catchbasin present at the northwestern corner given as 100.00m elevation.

Table 2
Groundwater Levels

Borehole / MW Number	Ground Surface Elevation (m)	Depth to Water (m) 2022.10.11	Water Elevation (m) 2022.10.11
BH22-2	98.98	4.85	94.13
BH22-4	98.97	dry	--
BH22-6	98.04	dry	--

Notes: - Water levels were measured using an oil-water interface probe.

ARCADIS Design & Consultancy for natural and built assets

Table 3

Grain Size Analyses Results

Borehole Number	Sample	Gravel	Sand	Silt	Clay	Classification
BH22-3	2	0%	67%	30%	3%	Silty SAND, fine grained.
BH22-4	2	0%	69%	27%	4%	Silty SAND, fine grained.
BH22-5	2	0%	47%	46%	6%	SAND-SILT, trace clay.
BH22-6	2	0%	78%	18%	4%	SAND, fine-grained, some silt.
BH22-7	5	0%	84%	15%	1%	SAND, fine-grained, some silt.
BH22-10	2	0%	38%	56%	6%	SAND-SILT, trace clay.

Notes: - Grain size analyses were performed by ALS.

- Laboratory certificates are provided in the report appendices.

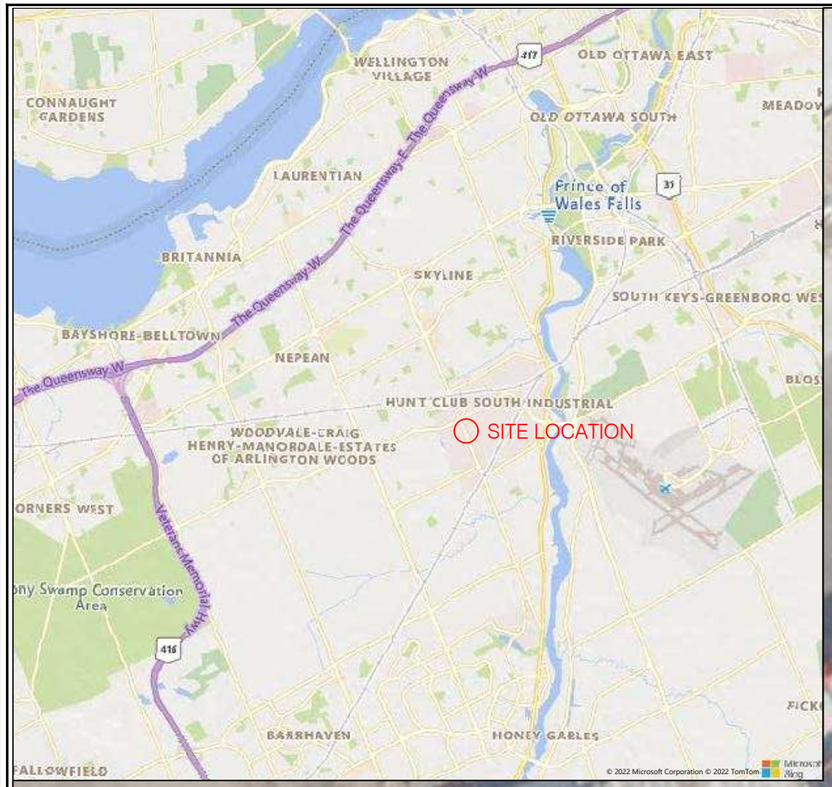
Table 4

Results of Corrosivity Suite Analyses

Borehole Number	Sample	Depth (mbgs)	Sulphide (µg/g)	Chloride (20:1) (µg/g)	Sulphate (20:1) (µg/g)	pH (pH units)	Electrical Conductivity (µS/cm)	Resistivity (ohm.cm)	Redox Potential (mV)
BH22-3	2	1.80	<20	30	<20	7.54	202	4950	486
BH22-5	3	1.80	<20	41	<20	7.52	194	5150	457
BH22-6	3	1.80	<20	<5	<20	6.63	40.2	24900	409

Notes:
- Chloride and Sulphate were determined on the extract obtained from the 20:1 leaching procedure.
- All tests were performed by ALS, a CALA accredited laboratory.
- Laboratory certificates are provided in the report appendices.

Figures



LEGEND

- SITE BOUNDARY
- LOT LINES
- PROPOSED BUILDING FOOTPRINT

Metres

15 0 15 30

1:800

Title:

KEY PLAN

Project:

GEOTECHNICAL INVESTIGATION
1881 & 1883 MERIVALE RD and 6 & 12 JAMIE AVENUE
OTTAWA, ONTARIO

Client:

Z.V.HOLDINGS CORP.

ARCADIS

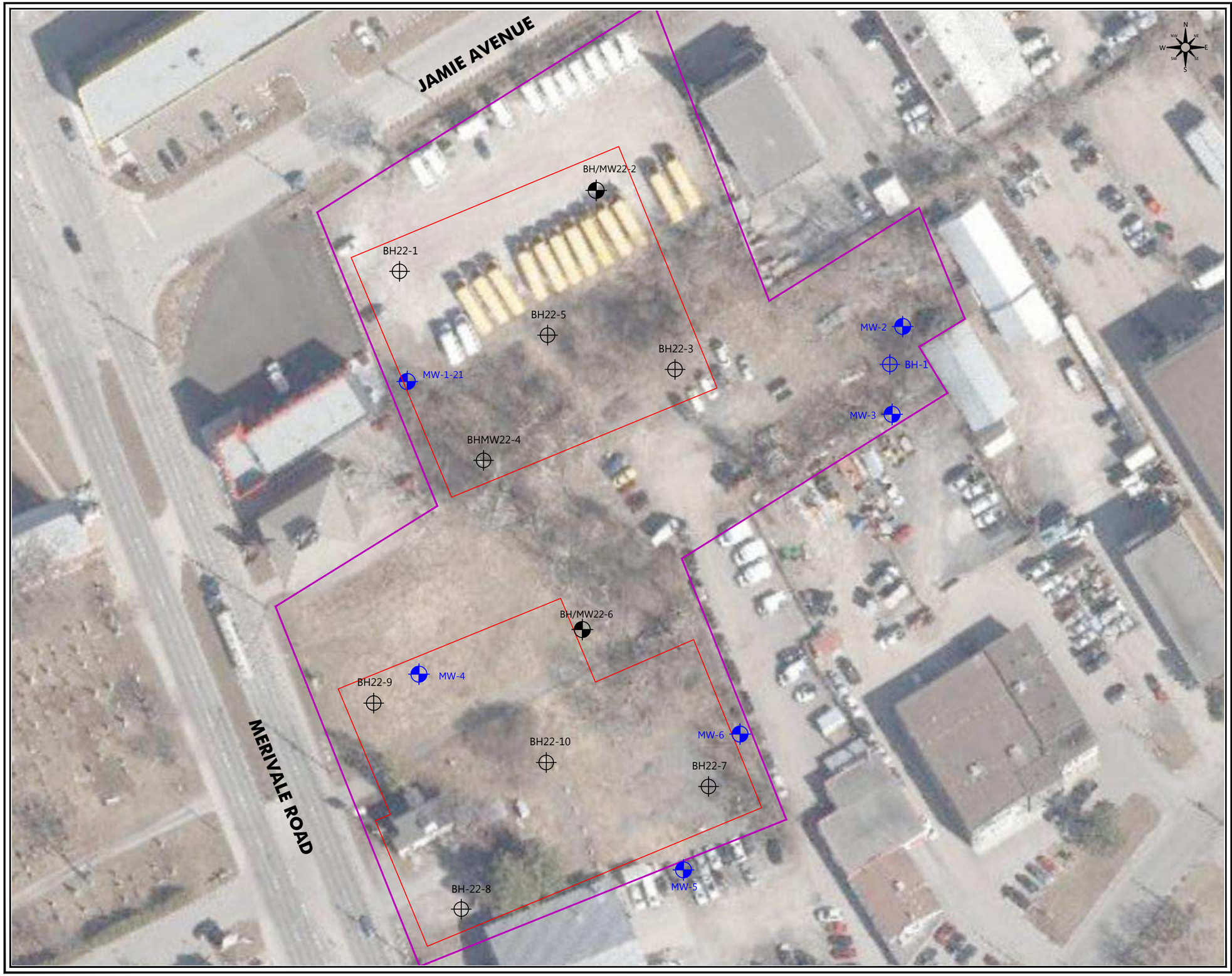
Date:

October 2022

FIGURE 1

last saved 11-Oct-22 by dlogan

C:\Users\dlogan\OneDrive - ARCADIS\Documents\@WFH\30127480 - 1881 Merivale Geotech\30127480 1881 Merivale Geotech.dwg



LEGEND

- SITE BOUNDARY
- LOT LINES
- BOREHOLE LOCATION
- MONITORING WELL LOCATION
- BOREHOLE/MONITORING WELL LOCATION (ARCADIS, 2022)
- BOREHOLE LOCATION (ARCADIS, 2022)

Metres
10 0 10 20
1:750

Title:
BOREHOLE LOCATION PLAN

Project:
GEOTECHNICAL INVESTIGATION
1881 & 1883 MERIVALE RD and 6 & 12 JAMIE AVENUE
OTTAWA, ONTARIO

Client:
Z.V.HOLDINGS CORP.

ARCADIS

Date:
October 2022

FIGURE 2

last saved 11-Oct-22 by dlogan

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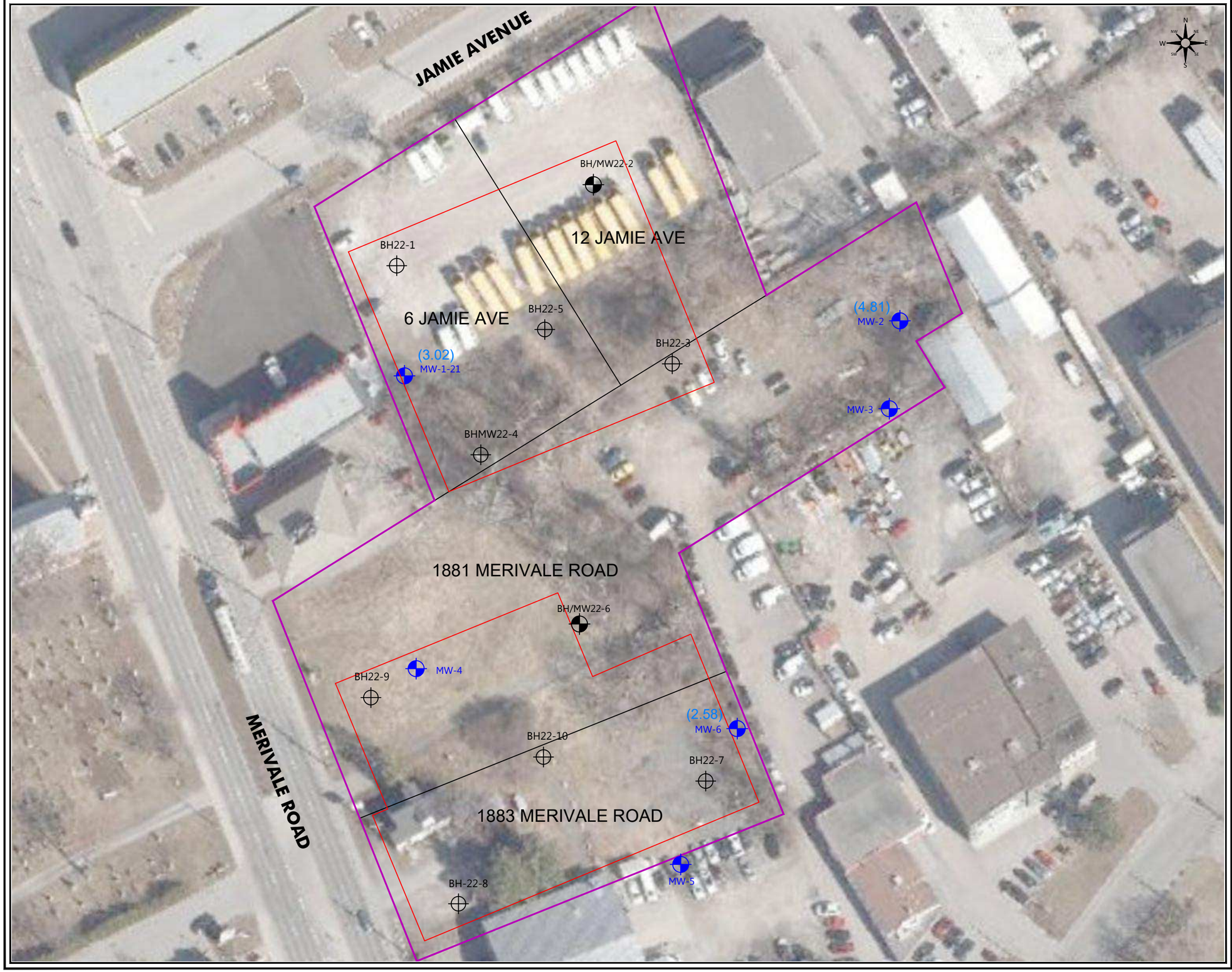

LEGEND

- SITE BOUNDARY
- LOT LINES
- BOREHOLE LOCATION
- MONITORING WELL LOCATION
- (4.81) GROUNDWATER TABLE DEPTH (OCTOBER 2019)

Metres
10 0 10 20
1:750

Title:
GROUNDWATER TABLE DEPTHS (OCTOBER 2019)

Project:
GEOTECHNICAL INVESTIGATION
1881 & 1883 MERIVALE RD and 6 & 12 JAMIE AVENUE
OTTAWA, ONTARIO

Client:
Z.V.HOLDINGS CORP.

ARCADIS

Date:
October 2022

FIGURE 3

last saved 11-Oct-22 by dlogan

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Appendix A

Borehole Logs

Logo
Arcadis Canada Inc.
1050 Morrison Drive, Suite 201
Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-2 (MW22-2)

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-15 **COMPLETED** 22-9-16
GROUND ELEVATION 98.98 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING 4.85 m / Elev 94.13 m

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		WELL GRADED GRAVEL, SANDY, light gray, angular, fine to coarse grained, dry, very dense (GRAVEL FILL)										
		SILTY SAND, light brown, fine grained, moist, loose to medium dense, trace gravel	SS 1	50	35-55-25-12 (80)							
1			SS 2	75	8-8-9-10 (17)			8				
			SS 3	67	4-5-4-50 (9)			3				
2		Sand becomes fine to coarse	SS 4	92	5-5-4-11 (9)			3				
		Colour becomes brown to grey	SS 5	83	6-8-9-9 (17)			8				
3												
4												
		Becomes wet	SS 6	50	3-7-9-12 (16)			6				
5												

Bottom of borehole at 5.20 meters.

Logo
Arcadis Canada Inc.
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Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-2 (MW22-2)

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-15 **COMPLETED** 22-9-16
GROUND ELEVATION 98.98 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING 4.85 m / Elev 94.13 m

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		WELL GRADED GRAVEL, SANDY, light gray, angular, fine to coarse grained, dry, very dense (GRAVEL FILL)										
		SILTY SAND, light brown, fine grained, moist, loose to medium dense, trace gravel	SS 1	50	35-55-25-12 (80)							
1			SS 2	75	8-8-9-10 (17)			8				
			SS 3	67	4-5-4-50 (9)			3				
2		Sand becomes fine to coarse	SS 4	92	5-5-4-11 (9)			3				
		Colour becomes brown to grey	SS 5	83	6-8-9-9 (17)			8				
3												
4												
		Becomes wet	SS 6	50	3-7-9-12 (16)			6				
5												

Bottom of borehole at 5.20 meters.

Logo

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1050 Morrison Drive, Suite 201
Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-3

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-16 **COMPLETED** 22-9-16
GROUND ELEVATION 98.96 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		WELL GRADED GRAVEL, SANDY, light gray, angular, fine to coarse grained, dry, loose to medium dense some dark brown topsoil (GRAVEL FILL)	SS 0	75	18-12-6-2 (18)							
1			SS 1	75	2-2-5-3 (7)			6				
		SILTY SAND, light brown, fine grained, moist, medium dense, trace gravel	SS 2	75	6-8-10-10 (18)			10				33
2		Colour becomes light grey	SS 3	75	4-7-8-6 (15)			8				
			SS 4	75	4-8-8-10 (16)			14				
3												
4												
		Becomes wet	SS 5	75	6-9-6-7 (15)							
5		Bottom of borehole at 5.20 meters.										

Logo

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Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-4 (MW22-4)

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-15 **COMPLETED** 22-9-15
GROUND ELEVATION 98.97 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		ORGANIC SOIL WITH SAND, dark brown, medium to coarse grained, moist, very loose, some organics, and roots (TOPSOIL)	SS 0	50	1-1-1-1 (2)			10				
1		SILTY SAND, light brown, fine grained, moist, medium dense, trace gravel	SS 1	58	5-11-13-16 (24)			5				31
			SS 2	25	5-11-11-11 (22)			5				
2			SS 3	5000	4-7-9-8 (16)			3				
		Becomes wet at 2.5mbgs	SS 4	92	6-8-7-7 (15)			14				
3												
4												
5		Becomes light grey, wet and fine to medium grained	SS 5	83	4-12-13-16 (25)							

Bottom of borehole at 5.20 meters.

Logo

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Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-5

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-16 **COMPLETED** 22-9-16
GROUND ELEVATION 98.81 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		WELL GRADED GRAVEL, SANDY, light gray, angular, fine to coarse grained, dry, medium dense (GRAVEL FILL)	SS 1	50	18-4-7-7 (11)							
1		SILT WITH SAND, dark brown to black, well graded, fine to coarse grained, moist, loose to medium dense, some organics, trace clay pockets of organic material	SS 2	67	7-7-7-7 (14)			14				52
			SS 3	50	5-5-5-5 (10)			17				
2		SILTY SAND, light gray to brown, fine grained, moist, medium dense, trace gravel	SS 4	83	6-12-14-10 (26)			5				
		Colour becomes only grey	SS 5	92	7-10-13-14 (23)			4				
3												
4												
		Becomes wet at 4.5mbgs	SS 6	75	7-12-14-14 (26)			5				
5		Bottom of borehole at 5.20 meters.										

Logo

Arcadis Canada Inc.
1050 Morrison Drive, Suite 201
Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-6 (MW22-6)

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-15 **COMPLETED** 22-9-15
GROUND ELEVATION 99.04 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		ORGANIC SOIL WITH SAND, light brown, well graded, fine to coarse grained, moist, very loose, some organics, trace roots and grass debris (TOPSOIL)	SS 1	50	1-1-2-2 (3)			12				
1		POORLY GRADED SAND, light gray, fine grained, moist, loose to medium dense, some silt	SS 2	75	6-10-12-11 (22)			5				
			SS 3	100	4-8-9-8 (17)			6				22
2			SS 4	67	3-5-5-5 (10)			11				
		Becoming wet at 2.8mbgs	SS 5	67	3-3-7-6 (10)			19				
3												
4												
5			SS 6	83	6-15-18-21 (33)							
		Bottom of borehole at 5.61 meters.										

GEOTECH BH COLUMNS 30127480 1881 MERIVAL GEOTECH BH_RVJ (1).GPJ GINT STD CANADA LAB.GDT 22-11-22

Logo

Arcadis Canada Inc.
1050 Morrison Drive, Suite 201
Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-7

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-15 **COMPLETED** 22-9-15
GROUND ELEVATION 99.86 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		ORGANIC SOIL WITH SAND, light brown to black, well graded, fine to coarse grained, moist, loose, some organics, trace gravel (TOPSOIL)	SS 1	50	1-2-2-1 (4)			11				
1		POORLY GRADED SAND, light brown, fine grained, moist, medium dense, some silt	SS 2	75	4-7-10-8 (17)			6				
			SS 3	92	3-7-8-9 (15)			6				
2			SS 4	83	4-8-10-13 (18)			5				
		WELL GRADED SAND, light brown, fine to coarse grained, moist, medium dense to dense, some silt	SS 5	83	7-12-11-10 (23)			5				16
3												
4												
		Colour becomes light grey	SS 6	67	4-17-21-16 (38)							
5		Bottom of borehole at 5.20 meters.										

GEOTECH BH COLUMNS 30127480 1881 MERIVAL GEOTECH BH_RVJ (1).GPJ GINT STD CANADA LAB.GDT 22-11-22

Logo

Arcadis Canada Inc.
1050 Morrison Drive, Suite 201
Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-8

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-16 **COMPLETED** 22-9-16
GROUND ELEVATION 99.48 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		WELL GRADED GRAVEL, SANDY, light gray, angular, fine to coarse grained, dry, loose (GRAVEL FILL)	SS 1	33	11-3-1-2 (4)							
1		WELL GRADED SAND, brown, fine to coarse grained, loose (SAND FILL)	SS 2	92	5-3-2-4 (5)			8				
		SILTY SAND, brown, medium to coarse grained, moist, medium dense	SS 3	83	3-9-11-11 (20)			7				
2		Sand becomes fine, colour becomes grey	SS 4	75	4-8-9-11 (17)			4				
			SS 5	83	5-11-11-10 (22)			9				
3												
4												
		Colour becomes dark grey	SS 6	83	6-12-13-9 (25)							
5		Bottom of borehole at 5.20 meters.										

Logo

Arcadis Canada Inc.
1050 Morrison Drive, Suite 201
Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-9

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-16 **COMPLETED** 22-9-16
GROUND ELEVATION 99.15 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		ORGANIC SOIL WITH SAND, light brown to black, well graded, fine to coarse grained, moist, very loose, some organics, trace gravel (TOPSOIL)	SS 1	83	1-1-2-1 (3)			16				
1		SILTY SAND, dark brown to light gray, fine grained, moist, medium dense	SS 2	92	4-9-12-11 (21)			8				
		Colour become grey	SS 3	92	6-10-15-13 (25)			9				
2		Coarse sand lenses	SS 4	100	5-9-10-9 (19)			8				
			SS 5	100	4-10-12-15 (22)			6				
3												
4												
		Sand becomes fine to coarse	SS 6	75	5-8-11-10 (19)							
5		Bottom of borehole at 5.20 meters.										

GEOTECH BH COLUMNS 30127480 1881 MERIVAL GEOTECH BH_RVJ (1).GPJ GINT STD CANADA LAB.GDT 22-11-22

Logo

Arcadis Canada Inc.
1050 Morrison Drive, Suite 201
Ottawa, ON
Telephone: 613-721-0555

BORING NUMBER BH22-10

CLIENT ZV Holdings
PROJECT NAME 1881-1883 Merivale Geotech
PROJECT NUMBER 30127480
PROJECT LOCATION 1881 Merivale Road, Ottawa, ON
DATE STARTED 22-9-16 **COMPLETED** 22-9-16
GROUND ELEVATION 99.86 m **HOLE SIZE** 15cm
DRILLING CONTRACTOR Downing Estate Drilling
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING ---
LOGGED BY LDeGroot **CHECKED BY** RJanzen
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES (%)
		ORGANIC SOIL WITH SAND, dark brown to black, well graded, fine to coarse grained, moist, very loose, some organics, trace roots (TOPSOIL)	SS 0	33	1-1-1-1 (2)							
		SILT WITH SAND, light gray, fine grained, moist, loose to medium dense	SS 1	67	1-1-8-14 (9)			14				
			SS 2	83	5-10-9-10 (19)			12				
2		Some mottling visible	SS 3	50	9-9-9-11 (18)			15				62
			SS 4	67	5-13-12-12 (25)			2				
4		Trace gravel, mottled texture	SS 5	75	4-7-15-15 (22)							
		SPT cone test begins at 5.18mbgs.	SPT		7-8-18-18 (26)							
6			SPT		17-17-17-18 (34)							
			SPT		18-19-23-23 (42)							
			SPT		22-23-22-23 (45)							
8			SPT		14-15-10-9 (25)							
			SPT		14-13-17-18 (30)							
			SPT		22-23-28-29 (51)							
10			SPT		26-26-27-28 (53)							
		Borehole ends.	SPT		27-27-18-18 (45)							

Bottom of borehole at 10.67 meters.

Appendix B

Photo Log

Project Photographs

Preliminary Geotechnical Investigation – 1881/1883 Merivale and Adjacent Lot, Ottawa, ON

Photo: 1

Date: 16 September 2022

Description:

View of the drilling of borehole location MW22-6 at the northeast portion of the 6/12 Jamie Avenue bus parking lot. Looking northeast.

Photo: 2

Date: 16 September 2022

Description:

View of the drilling of borehole location BH22-5 at the southwest portion the 6/12 Jamie Avenue bus parking lot. Looking northeast.

Project Photographs

Preliminary Geotechnical Investigation – 1881/1883 Merivale and Adjacent Lot, Ottawa, ON

Photo: 3

Date: 16 September 2022

Description:
View of the drilling of borehole location BH22-8 at the southwest portion of 1881 Merivale Road, looking northeast. The scuba divers' warehouse is visible.

Photo: 4

Date: 16 September 2022

Description:
View of the drilling of borehole location MW22-4 at the northern portion of 1881 Merivale Road, looking north.

Project Photographs

Preliminary Geotechnical Investigation – 1881/1883 Merivale and Adjacent Lot, Ottawa, ON

Photo: 5

Date: 16 September 2022

Description:

View of a split spoon containing the typical light brown fine sand observed at most areas on the property.

Appendix C

Laboratory Certificates of Analysis

CERTIFICATE OF ANALYSIS

Work Order	: **WT2214822**	Page	: 1 of 10
Amendment	: **1**		
Client	: **Arcadis Canada Inc.**	Laboratory	: Waterloo - Environmental
Contact	: Lennart DeGroot	Account Manager	: Emily Smith
Address	: 1050 Morrison Drive Suite 201 Ottawa ON Canada K2H 1L1	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: 613 721 0555	Telephone	: +1 519 886 6910
Project	: 30127480	Date Samples Received	: 19-Sep-2022 14:55
PO	: ----	Date Analysis Commenced	: 21-Sep-2022
C-O-C number	: ----	Issue Date	: 31-Oct-2022 10:15
Sampler	: ----		
Site	: ----		
Quote number	: Waterloo 2022 Price List		
No. of samples received	: 42		
No. of samples analysed	: 42		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Ganouri-Lumsden	Department Manager - Microbiology and Prep	Centralized Prep, Waterloo, Ontario
Hedy Lai	Team Leader - Inorganics	Inorganics, Saskatoon, Saskatchewan
Hedy Lai	Team Leader - Inorganics	Sask Soils, Saskatoon, Saskatchewan
Jon Fisher	Department Manager - Inorganics	Inorganics, Waterloo, Ontario
Joseph Scharbach		Centralized Prep, Waterloo, Ontario
Niral Patel		Centralized Prep, Waterloo, Ontario

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances

LOR: Limit of Reporting (detection limit).

Unit	*Description*
-	No Unit
%	percent
µS/cm	Microsiemens per centimetre
mg/kg	milligrams per kilogram
mV	millivolts
ohm cm	ohm centimetre (resistivity)
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Sample Comments

Sample	Client Id	*Comment*
WT2214822-007	BH22-3-2	Sample(s) XXX: Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
WT2214822-020	MW22-4-2	Sample(s) XXX: Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
WT2214822-025	BH22-5-2	Sample(s) XXX: Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
WT2214822-030	MW22-6-2	Sample(s) XXX: Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
WT2214822-038	BH22-7-5	Sample(s) XXX: Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.

WT2214822-040	BH22-10-2	Sample(s) XXX: Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.

Analytical Results

Sub-Matrix: Soil/Solid
(Matrix: Soil/Solid)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MW22-2-1	MW22-2-2	MW22-2-3	MW22-2-4	MW22-2-5
					Client sampling date / time	16-Sep-2022 09:00	16-Sep-2022 09:00	16-Sep-2022 09:00	16-Sep-2022 09:00	16-Sep-2022 09:00
						WT2214822-001	WT2214822-002	WT2214822-003	WT2214822-004	WT2214822-005
						Result	Result	Result	Result	Result
Physical Tests										
moisture	----	E144	0.25	%		8.08	3.28	3.22	8.18	6.09

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Soil/Solid
(Matrix: Soil/Solid)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	BH22-3-1	BH22-3-2	BH22-3-3	BH22-3-4	BH22-8-1
					Client sampling date / time	16-Sep-2022 12:00	16-Sep-2022 12:00	16-Sep-2022 12:00	16-Sep-2022 12:00	16-Sep-2022 14:00
						WT2214822-006	WT2214822-007	WT2214822-008	WT2214822-009	WT2214822-010
						Result	Result	Result	Result	Result
Physical Tests										
conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm		----	202	----	----	----
moisture	----	E144	0.25	%		5.84	9.93	7.95	13.5	8.06
oxidation-reduction potential [ORP]	----	E125	0.10	mV		----	486	----	----	----
pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units		----	7.54	----	----	----
resistivity	----	EC100R	100	ohm cm		----	4950	----	----	----
Particle Size										
passing (9.5 mm)	----	E181	1.0	%		----	100	----	----	----
passing (4.75 mm)	----	E181	1.0	%		----	100	----	----	----
passing (19 mm)	----	E181	1.0	%		----	100	----	----	----
passing (25.4 mm)	----	E181	1.0	%		----	100	----	----	----
passing (38.1 mm)	----	E181	1.0	%		----	100	----	----	----
passing (50.8 mm)	----	E181	1.0	%		----	100	----	----	----
passing (76.2 mm)	----	E181	1.0	%		----	100	----	----	----
passing (1.0 mm)	----	E182	1.0	%		----	100	----	----	----
passing (0.841 mm)	----	E182	1.0	%		----	100	----	----	----
passing (0.50 mm)	----	E182	1.0	%		----	99.8	----	----	----
passing (0.420 mm)	----	E182	1.0	%		----	99.7	----	----	----

Analytical Results

Sub-Matrix: **Soil/Solid**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	BH22-3-1	BH22-3-2	BH22-3-3	BH22-3-4	BH22-8-1
					Client sampling date / time	16-Sep-2022 12:00	16-Sep-2022 12:00	16-Sep-2022 12:00	16-Sep-2022 12:00	16-Sep-2022 14:00
						WT2214822-006	WT2214822-007	WT2214822-008	WT2214822-009	WT2214822-010
						Result	Result	Result	Result	Result
Particle Size										
passing (0.250 mm)	----	E182	1.0	%		----	95.9	----	----	----
passing (0.149 mm)	----	E182	1.0	%		----	75.6	----	----	----
passing (0.125 mm)	----	E182	1.0	%		----	61.8	----	----	----
passing (0.075 mm)	----	E182	1.0	%		----	33.1	----	----	----
passing (0.063 mm)	----	E182	1.0	%		----	22.7	----	----	----
passing (0.05 mm)	----	E182	1.0	%		----	13.4	----	----	----
passing (0.0312 mm)	----	E183	1.0	%		----	7.8	----	----	----
passing (0.020 mm)	----	E183	1.0	%		----	4.5	----	----	----
passing (0.005 mm)	----	E183	1.0	%		----	3.4	----	----	----
passing (0.004 mm)	----	E183	1.0	%		----	3.0	----	----	----
passing (0.002 mm)	----	E183	1.0	%		----	2.2	----	----	----
grain size curve	----	E185	-	-		----	See Attached	----	----	----
passing (2.0 mm)	----	E181	1.0	%		----	100	----	----	----
Inorganic Parameters										
sulfides, acid volatile	----	E396-L	0.20	mg/kg		----	<0.20	----	----	----
Leachable Anions & Nutrients										
chloride, soluble ion content	16887-00-6	E236.Cl	5.0	mg/kg		----	29.8	----	----	----
sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg		----	<20	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Soil/Solid (Matrix: Soil/Solid)					Client sample ID	BH22-8-2	BH22-8-3	BH22-8-4	BH22-9-1	BH22-9-2
					Client sampling date / time	16-Sep-2022 14:00	16-Sep-2022 14:00	16-Sep-2022 14:00	16-Sep-2022 13:00	16-Sep-2022 13:00
Analyte	CAS Number	Method	LOR	Unit		WT2214822-011	WT2214822-012	WT2214822-013	WT2214822-014	WT2214822-015
						Result	Result	Result	Result	Result
Physical Tests										
moisture	----	E144	0.25	%		7.19	4.09	8.75	15.9	7.82

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Soil/Solid (Matrix: Soil/Solid)					Client sample ID	BH22-9-3	BH22-9-4	BH22-9-5	MW22-4-1	MW22-4-2
					Client sampling date / time	16-Sep-2022 13:00	16-Sep-2022 13:00	16-Sep-2022 13:00	15-Sep-2022 15:45	15-Sep-2022 15:45
Analyte	CAS Number	Method	LOR	Unit		WT2214822-016	WT2214822-017	WT2214822-018	WT2214822-019	WT2214822-020
						Result	Result	Result	Result	Result
Physical Tests										
moisture	----	E144	0.25	%		9.34	7.60	6.48	10.1	4.59
Particle Size										
sand (>0.075mm)	----	E178	1.0	%		----	----	----	----	69.3
fines (<0.075mm)	----	E178	1.0	%		----	----	----	----	30.6
texture class	----	E178	-	-		----	----	----	----	Coarse

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: **Soil/Solid**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MW22-4-3	MW22-4-4	MW22-4-5	BH22-5-1	BH22-5-2
					Client sampling date / time	15-Sep-2022 15:45	15-Sep-2022 15:45	15-Sep-2022 15:45	16-Sep-2022 08:50	16-Sep-2022 08:50
						WT2214822-021	WT2214822-022	WT2214822-023	WT2214822-024	WT2214822-025
						Result	Result	Result	Result	Result
Physical Tests										
moisture	----	E144	0.25	%		5.44	2.88	13.8	14.3	16.9
Particle Size										
passing (9.5 mm)	----	E181	1.0	%		----	----	----	----	100
passing (4.75 mm)	----	E181	1.0	%		----	----	----	----	100
passing (19 mm)	----	E181	1.0	%		----	----	----	----	100
passing (25.4 mm)	----	E181	1.0	%		----	----	----	----	100
passing (38.1 mm)	----	E181	1.0	%		----	----	----	----	100
passing (50.8 mm)	----	E181	1.0	%		----	----	----	----	100
passing (76.2 mm)	----	E181	1.0	%		----	----	----	----	100
passing (1.0 mm)	----	E182	1.0	%		----	----	----	----	94.3
passing (0.841 mm)	----	E182	1.0	%		----	----	----	----	93.2
passing (0.50 mm)	----	E182	1.0	%		----	----	----	----	80.7
passing (0.420 mm)	----	E182	1.0	%		----	----	----	----	77.9
passing (0.250 mm)	----	E182	1.0	%		----	----	----	----	74.3
passing (0.149 mm)	----	E182	1.0	%		----	----	----	----	66.6
passing (0.125 mm)	----	E182	1.0	%		----	----	----	----	61.9
passing (0.075 mm)	----	E182	1.0	%		----	----	----	----	52.2
passing (0.063 mm)	----	E182	1.0	%		----	----	----	----	43.4
passing (0.05 mm)	----	E182	1.0	%		----	----	----	----	33.8
passing (0.0312 mm)	----	E183	1.0	%		----	----	----	----	21.5
passing (0.020 mm)	----	E183	1.0	%		----	----	----	----	14.9
passing (0.005 mm)	----	E183	1.0	%		----	----	----	----	6.4
passing (0.004 mm)	----	E183	1.0	%		----	----	----	----	5.7
passing (0.002 mm)	----	E183	1.0	%		----	----	----	----	4.8
grain size curve	----	E185	-	-		----	----	----	----	See Attached
passing (2.0 mm)	----	E181	1.0	%		----	----	----	----	99.4

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Soil/Solid (Matrix: Soil/Solid)					Client sample ID	BH22-5-3	BH22-5-4	BH22-5-5	MW22-6-1	MW22-6-2
					Client sampling date / time	16-Sep-2022 08:50	16-Sep-2022 08:50	16-Sep-2022 08:50	15-Sep-2022 11:15	15-Sep-2022 11:15
Analyte	CAS Number	Method	LOR	Unit		WT2214822-026	WT2214822-027	WT2214822-028	WT2214822-029	WT2214822-030
						Result	Result	Result	Result	Result
Physical Tests										
conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm		194	----	----	----	----
moisture	----	E144	0.25	%		4.82	4.42	5.22	11.9	5.34
oxidation-reduction potential [ORP]	----	E125	0.10	mV		457	----	----	----	----
pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units		7.52	----	----	----	----
resistivity	----	EC100R	100	ohm cm		5150	----	----	----	----
Particle Size										
sand (>0.075mm)	----	E178	1.0	%		----	----	----	----	78.5
fines (<0.075mm)	----	E178	1.0	%		----	----	----	----	21.5
texture class	----	E178	-	-		----	----	----	----	Coarse
Inorganic Parameters										
sulfides, acid volatile	----	E396-L	0.20	mg/kg		<0.20	----	----	----	----
Leachable Anions & Nutrients										
chloride, soluble ion content	16887-00-6	E236.Cl	5.0	mg/kg		40.5	----	----	----	----
sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg		<20	----	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: **Soil/Solid**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MW22-6-3	MW22-6-4	MW22-6-5	BH22-7-1	BH22-7-2
					Client sampling date / time	15-Sep-2022 11:15	15-Sep-2022 11:15	15-Sep-2022 11:15	15-Sep-2022 13:00	15-Sep-2022 13:00
						WT2214822-031	WT2214822-032	WT2214822-033	WT2214822-034	WT2214822-035
						Result	Result	Result	Result	Result
Physical Tests										
conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm		40.2	----	----	----	----
moisture	----	E144	0.25	%		5.90	10.6	19.4	10.6	5.59
oxidation-reduction potential [ORP]	----	E125	0.10	mV		409	----	----	----	----
pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units		6.63	----	----	----	----
resistivity	----	EC100R	100	ohm cm		24900	----	----	----	----
Inorganic Parameters										
sulfides, acid volatile	----	E396-L	0.20	mg/kg		<0.20	----	----	----	----
Leachable Anions & Nutrients										
chloride, soluble ion content	16887-00-6	E236.Cl	5.0	mg/kg		<5.0	----	----	----	----
sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg		<20	----	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: **Soil/Solid**
(Matrix: **Soil/Solid**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	BH22-7-3	BH22-7-4	BH22-7-5	BH22-10-1	BH22-10-2
					Client sampling date / time	15-Sep-2022 13:00	15-Sep-2022 13:00	15-Sep-2022 13:00	15-Sep-2022 14:10	15-Sep-2022 14:10
						WT2214822-036	WT2214822-037	WT2214822-038	WT2214822-039	WT2214822-040
						Result	Result	Result	Result	Result
Physical Tests										
moisture	----	E144	0.25	%		6.03	4.98	4.63	14.4	12.0
Particle Size										
sand (>0.075mm)	----	E178	1.0	%		----	----	83.9	----	38.1
fines (<0.075mm)	----	E178	1.0	%		----	----	16.1	----	61.9
texture class	----	E178	-	-		----	----	Coarse	----	Fine

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Soil/Solid (Matrix: Soil/Solid)					Client sample ID	BH22-10-3	BH22-10-4	----	----	----
					Client sampling date / time	15-Sep-2022 14:10	15-Sep-2022 14:10	----	----	----
Analyte	CAS Number	Method	LOR	Unit		WT2214822-041	WT2214822-042	--------	--------	--------
						Result	Result	----	----	----
Physical Tests										
moisture	----	E144	0.25	%		14.6	1.99	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

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QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WT2214822**	Page	: 1 of 15
Amendment	: 1		
Client	: **Arcadis Canada Inc.**	Laboratory	: Waterloo - Environmental
Contact	: Lennart DeGroot	Account Manager	: Emily Smith
Address	: 1050 Morrison Drive Suite 201 Ottawa ON Canada K2H 1L1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: 613 721 0555	Telephone	: +1 519 886 6910
Project	: 30127480	Date Samples Received	: 19-Sep-2022 14:55
PO	: ----	Issue Date	: 31-Oct-2022 10:15
C-O-C number	: ----		
Sampler	: ----		
Site	: ----		
Quote number	: Waterloo 2022 Price List		
No. of samples received	: 42		
No. of samples analysed	: 42		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap										
BH22-3-2	E396-L	16-Sep-2022	21-Sep-2022	14 days	5 days	✓	21-Sep-2022	7 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap										
BH22-5-3	E396-L	16-Sep-2022	21-Sep-2022	14 days	5 days	✓	21-Sep-2022	7 days	0 days	✓
Inorganic Parameters : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap										
MW22-6-3	E396-L	15-Sep-2022	21-Sep-2022	14 days	6 days	✓	21-Sep-2022	7 days	0 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap										
BH22-3-2	E236.Cl	16-Sep-2022	26-Sep-2022	30 days	10 days	✓	28-Sep-2022	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap										
BH22-5-3	E236.Cl	16-Sep-2022	26-Sep-2022	30 days	10 days	✓	28-Sep-2022	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap										
MW22-6-3	E236.Cl	15-Sep-2022	26-Sep-2022	30 days	11 days	✓	28-Sep-2022	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap										
BH22-3-2	E236.SO4	16-Sep-2022	26-Sep-2022	30 days	10 days	✓	28-Sep-2022	28 days	2 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap										
BH22-5-3	E236.SO4	16-Sep-2022	26-Sep-2022	30 days	10 days	✓	28-Sep-2022	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap										
MW22-6-3	E236.SO4	15-Sep-2022	26-Sep-2022	30 days	11 days	✓	28-Sep-2022	28 days	2 days	✓
Particle Size : CCME fine/coarse Particle Size Analysis by wet sieve										
Glass soil jar/Teflon lined cap										
BH22-10-2	E178	15-Sep-2022	----	----	----		30-Sep-2022	180 days	15 days	✓
Particle Size : CCME fine/coarse Particle Size Analysis by wet sieve										
Glass soil jar/Teflon lined cap										
BH22-7-5	E178	15-Sep-2022	----	----	----		30-Sep-2022	180 days	15 days	✓
Particle Size : CCME fine/coarse Particle Size Analysis by wet sieve										
Glass soil jar/Teflon lined cap										
MW22-4-2	E178	15-Sep-2022	----	----	----		30-Sep-2022	180 days	15 days	✓
Particle Size : CCME fine/coarse Particle Size Analysis by wet sieve										
Glass soil jar/Teflon lined cap										
MW22-6-2	E178	15-Sep-2022	----	----	----		30-Sep-2022	180 days	15 days	✓
Particle Size : Grain Size Report (Attachment) Hydrometer/Sieve Method										
Glass soil jar/Teflon lined cap										
BH22-3-2	E185	16-Sep-2022	----	----	----		29-Sep-2022	----	----	
Particle Size : Grain Size Report (Attachment) Hydrometer/Sieve Method										
Glass soil jar/Teflon lined cap										
BH22-5-2	E185	16-Sep-2022	----	----	----		29-Sep-2022	----	----	
Particle Size : Particle Size Analysis - Hydrometer										
Glass soil jar/Teflon lined cap										
BH22-3-2	E183	16-Sep-2022	23-Sep-2022	----	----		23-Sep-2022	365 days	7 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Particle Size : Particle Size Analysis - Hydrometer										
Glass soil jar/Teflon lined cap										
BH22-5-2	E183	16-Sep-2022	23-Sep-2022	----	----		23-Sep-2022	365 days	7 days	✓
Particle Size : Particle Size Analysis - Sieve <2mm										
Glass soil jar/Teflon lined cap										
BH22-3-2	E182	16-Sep-2022	23-Sep-2022	----	----		23-Sep-2022	365 days	7 days	✓
Particle Size : Particle Size Analysis - Sieve <2mm										
Glass soil jar/Teflon lined cap										
BH22-5-2	E182	16-Sep-2022	23-Sep-2022	----	----		23-Sep-2022	365 days	7 days	✓
Particle Size : Particle Size Analysis - Sieve >2mm										
Glass soil jar/Teflon lined cap										
BH22-3-2	E181	16-Sep-2022	23-Sep-2022	----	----		23-Sep-2022	365 days	7 days	✓
Particle Size : Particle Size Analysis - Sieve >2mm										
Glass soil jar/Teflon lined cap										
BH22-5-2	E181	16-Sep-2022	23-Sep-2022	----	----		23-Sep-2022	365 days	7 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap										
BH22-3-2	E100-L	16-Sep-2022	28-Sep-2022	----	----		28-Sep-2022	30 days	12 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap										
BH22-5-3	E100-L	16-Sep-2022	28-Sep-2022	----	----		28-Sep-2022	30 days	12 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap										
MW22-6-3	E100-L	15-Sep-2022	28-Sep-2022	----	----		28-Sep-2022	30 days	13 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-10-1	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-10-2	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-10-3	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-10-4	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-3-1	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-3-2	E144	16-Sep-2022	----	----	----		21-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-3-3	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-3-4	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-5-1	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-5-2	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-5-3	E144	16-Sep-2022	----	----	----		21-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-5-4	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-5-5	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-7-1	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-7-2	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-7-3	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-7-4	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-7-5	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-8-1	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-8-2	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-8-3	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-8-4	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-9-1	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-9-2	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-9-3	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-9-4	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
BH22-9-5	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-2-1	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-2-2	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-2-3	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-2-4	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-2-5	E144	16-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-4-1	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-4-2	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-4-3	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-4-4	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-4-5	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-6-1	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-6-2	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-6-3	E144	15-Sep-2022	----	----	----		21-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-6-4	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap										
MW22-6-5	E144	15-Sep-2022	----	----	----		22-Sep-2022	----	----	
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap										
BH22-3-2	E125	16-Sep-2022	22-Sep-2022	----	----		22-Sep-2022	180 days	6 days	✓
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap										
BH22-5-3	E125	16-Sep-2022	22-Sep-2022	----	----		22-Sep-2022	180 days	6 days	✓
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap										
MW22-6-3	E125	15-Sep-2022	22-Sep-2022	----	----		22-Sep-2022	180 days	7 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap										
BH22-3-2	E108A	16-Sep-2022	22-Sep-2022	----	----		22-Sep-2022	30 days	6 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap										
BH22-5-3	E108A	16-Sep-2022	22-Sep-2022	----	----		22-Sep-2022	30 days	6 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap										
MW22-6-3	E108A	15-Sep-2022	22-Sep-2022	----	----		22-Sep-2022	30 days	7 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	657907	1	4	25.0	4.7	✓
CCME fine/coarse Particle Size Analysis by wet sieve	E178	674236	1	8	12.5	5.0	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	659587	1	19	5.2	5.0	✓
Moisture Content by Gravimetry	E144	659122	4	70	5.7	5.0	✓
ORP by Electrode	E125	659317	1	3	33.3	5.0	✓
Particle Size Analysis - Hydrometer	E183	663154	1	5	20.0	5.0	✓
Particle Size Analysis - Sieve <2mm	E182	663153	1	5	20.0	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	659219	1	20	5.0	5.0	✓
Water Extractable Chloride by IC	E236.Cl	659594	1	3	33.3	5.0	✓
Water Extractable Sulfate by IC	E236.SO4	659593	1	3	33.3	5.0	✓
Laboratory Control Samples (LCS)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	657907	1	4	25.0	4.7	✓
CCME fine/coarse Particle Size Analysis by wet sieve	E178	674236	1	8	12.5	5.0	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	659587	2	19	10.5	10.0	✓
Moisture Content by Gravimetry	E144	659122	4	70	5.7	5.0	✓
ORP by Electrode	E125	659317	1	3	33.3	5.0	✓
Particle Size Analysis - Hydrometer	E183	663154	1	5	20.0	5.0	✓
Particle Size Analysis - Sieve <2mm	E182	663153	1	5	20.0	5.0	✓
Particle Size Analysis - Sieve >2mm	E181	663152	1	5	20.0	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	659219	1	20	5.0	5.0	✓
Water Extractable Chloride by IC	E236.Cl	659594	2	3	66.6	10.0	✓
Water Extractable Sulfate by IC	E236.SO4	659593	2	3	66.6	10.0	✓
Method Blanks (MB)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	657907	1	4	25.0	4.7	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	659587	1	19	5.2	5.0	✓
Moisture Content by Gravimetry	E144	659122	4	70	5.7	5.0	✓
Water Extractable Chloride by IC	E236.Cl	659594	1	3	33.3	5.0	✓
Water Extractable Sulfate by IC	E236.SO4	659593	1	3	33.3	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L Waterloo - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Conductance is measured in the fluid that is observed in the upper layer.
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A Waterloo - Environmental	Soil/Solid	MOEE E3137A	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) and is carried out in accordance with procedures described in the Analytical Protocol (prescriptive method). A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling, or decanting and then analyzed using a pH meter and electrode.
ORP by Electrode	E125 Waterloo - Environmental	Soil/Solid	APHA 2580 (mod)	Oxidation Redution Potential (ORP) is reported as the oxidation-reduction potential of the platinum metal-reference electrode employed in the analysis, measured in mV.
Moisture Content by Gravimetry	E144 Waterloo - Environmental	Soil/Solid	CCME PHC in Soil - Tier 1	Moisture is measured gravimetrically by drying the sample at 105°C. Moisture content is calculated as the weight loss (due to water) divided by the wet weight of the sample, expressed as a percentage.
CCME fine/coarse Particle Size Analysis by wet sieve	E178 Saskatoon - Environmental	Soil/Solid	CCME Vol 4 Analytical Methods	An air-dried sample is reduced to < 2 mm size and mixed with a dispersing agent (sodium hexametaphosphate). The sample is washed through a 200 mesh (0.075 mm) sieve. The retained mass of sample is used to determine % sand fraction. If the percentage of sand is >50%, the soil is considered to be coarse textured soil. If the percentage of sand is <50%, the soil is considered to be fine textured.
Particle Size Analysis - Sieve >2mm	E181 Saskatoon - Environmental	Soil/Solid	ASTM D6913-17 (mod)	Soil samples are disaggregated and sieved through a 2mm sieve. Material retained on the sieve is then further sieved through a series of sieves. The amount passing through the sieves is measured gravimetrically.
Particle Size Analysis - Sieve <2mm	E182 Saskatoon - Environmental	Soil/Solid	ASTM D6913-17 (mod)	Soil samples are disaggregated and sieved through a 2mm sieve. Material passed through the sieve is then further disaggregated using calgon solution and passed through a series of sieves. The amount passing through the sieves is measured gravimetrically.
Particle Size Analysis - Hydrometer	E183 Saskatoon - Environmental	Soil/Solid	ASTM D7928-21 (mod)	Soil material is separated from coarse material (>2mm). A specimen is then disaggregated through mixing with Calgon solution. The material is then suspended in solution wherein regular hydrometer readings are taken at specific time intervals. The principles of Stokes' Law are applied to determine the amount of material remaining in solution as well as the maximum particle size remaining in solution at the specified time.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Grain Size Report (Attachment) Hydrometer/Sieve Method	E185 Saskatoon - Environmental	Soil/Solid	ASTM D6913/D7928	A grain size curve is a graphical representation of the particle sizing of a sample representing the percent passing against the effective particle size.
Water Extractable Chloride by IC	E236.Cl Waterloo - Environmental	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Water Extractable Sulfate by IC	E236.SO4 Waterloo - Environmental	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L Waterloo - Environmental	Soil/Solid	APHA 4500S2J	This analysis is carried out in accordance with the method described in APHA 4500 S2-J. After extraction the Acid Volatile Sulphide is determined colourimetrically.
Resistivity Calculation for Soil Using E100-L	EC100R Waterloo - Environmental	Soil/Solid	APHA 2510 B	Soil Resistivity (calculated) is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil:Water for pH/EC	EP108 Waterloo - Environmental	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Leach 1:2 Soil : 0.01CaCl2 - As Received for pH	EP108A Waterloo - Environmental	Soil/Solid	MOEE E3137A	A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling or decanting and then analyzed using a pH meter and electrode.
Preparation of ORP by Electrode	EP125 Waterloo - Environmental	Soil/Solid	APHA 2580 (mod)	Field-moist sample is extracted in a 1:2 ratio with DI water and then analyzed by ORP meter.
Anions Leach 1:10 Soil:Water (Dry)	EP236 Waterloo - Environmental	Soil/Solid	EPA 300.1	5 grams of dried soil is mixed with 50 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.
Distillation for Acid Volatile Sulfide in Soil	EP396-L Waterloo - Environmental	Soil/Solid	APHA 4500S2J	Acid Volatile Sulfide is determined by colourimetric measurement on a sediment sample that has been treated with hydrochloric acid within a purge and trap system, where the evolved hydrogen sulfide gas is carried into a basic solution by argon gas for analysis.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dry and Grind in Soil/Solid <60°C	EPP442 Waterloo - Environmental	Soil/Solid	Soil Sampling and Methods of Analysis, Carter 2008	After removal of any coarse fragments and reservation of wet subsamples a portion of homogenized sample is set in a tray and dried at less than 60°C until dry. The sample is then particle size reduced with an automated crusher or mortar and pestle, typically to <2 mm. Further size reduction may be needed for particular tests.

QUALITY CONTROL REPORT

Work Order	: **WT2214822**	Page	: 1 of 7
Amendment	: **1**		
Client	: Arcadis Canada Inc.	Laboratory	: Waterloo - Environmental
Contact	: Lennart DeGroot	Account Manager	: Emily Smith
Address	: 1050 Morrison Drive Suite 201 Ottawa ON Canada K2H 1L1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	:	Telephone	: +1 519 886 6910
Project	: 30127480	Date Samples Received	: 19-Sep-2022 14:55
PO	: ----	Date Analysis Commenced	: 21-Sep-2022
C-O-C number	: ----	Issue Date	: 31-Oct-2022 10:15
Sampler	: ---- 613 721 0555		
Site	: ----		
Quote number	: Waterloo 2022 Price List		
No. of samples received	: 42		
No. of samples analysed	: 42		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Ganouri-Lumsden	Department Manager - Microbiology and Prep	Waterloo Centralized Prep, Waterloo, Ontario
Hedy Lai	Team Leader - Inorganics	Saskatoon Inorganics, Saskatoon, Saskatchewan
Hedy Lai	Team Leader - Inorganics	Saskatoon Sask Soils, Saskatoon, Saskatchewan
Jon Fisher	Department Manager - Inorganics	Waterloo Inorganics, Waterloo, Ontario
Joseph Scharbach		Waterloo Centralized Prep, Waterloo, Ontario
Niral Patel		Waterloo Centralized Prep, Waterloo, Ontario

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Physical Tests (QC Lot: 659122)											
WT2214822-001	MW22-2-1	moisture	----	E144	0.25	%	8.08	7.88	2.55%	20%	----
Physical Tests (QC Lot: 659123)											
WT2214822-010	BH22-8-1	moisture	----	E144	0.25	%	8.06	8.07	0.109%	20%	----
Physical Tests (QC Lot: 659219)											
TY2201744-003	Anonymous	pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units	7.56	7.69	1.70%	5%	----
Physical Tests (QC Lot: 659220)											
WT2214822-032	MW22-6-4	moisture	----	E144	0.25	%	10.6	10.2	3.74%	20%	----
Physical Tests (QC Lot: 659317)											
WT2214822-007	BH22-3-2	oxidation-reduction potential [ORP]	----	E125	0.10	mV	486	472	2.92%	25%	----
Physical Tests (QC Lot: 659587)											
WT2214860-003	Anonymous	conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm	0.492 mS/cm	510	3.59%	20%	----
Physical Tests (QC Lot: 660485)											
WT2214804-001	Anonymous	moisture	----	E144	0.25	%	78.4	78.1	0.386%	20%	----
Particle Size (QC Lot: 663153)											
WT2214849-001	Anonymous	passing (0.05 mm)	----	E182	1.0	%	84.1	83.3	0.977%	15%	----
		passing (0.063 mm)	----	E182	1.0	%	90.4	90.1	0.353%	15%	----
		passing (0.075 mm)	----	E182	1.0	%	96.3	96.4	0.146%	15%	----
		passing (0.125 mm)	----	E182	1.0	%	96.9	97.0	0.137%	15%	----
		passing (0.149 mm)	----	E182	1.0	%	97.2	97.3	0.133%	15%	----
		passing (0.250 mm)	----	E182	1.0	%	97.6	97.7	0.0742%	15%	----
		passing (0.420 mm)	----	E182	1.0	%	98.0	98.0	0.0182%	15%	----
		passing (0.50 mm)	----	E182	1.0	%	98.1	98.1	0.00625%	15%	----
		passing (0.841 mm)	----	E182	1.0	%	98.5	98.4	0.0404%	15%	----
		passing (1.0 mm)	----	E182	1.0	%	98.5	98.5	0.0361%	15%	----
Particle Size (QC Lot: 663154)											
WT2214849-001	Anonymous	passing (0.002 mm)	----	E183	1.0	%	27.4	28.4	3.70%	20%	----
		passing (0.004 mm)	----	E183	1.0	%	45.0	47.2	4.84%	20%	----
		passing (0.005 mm)	----	E183	1.0	%	51.9	53.8	3.66%	20%	----
		passing (0.020 mm)	----	E183	1.0	%	75.0	74.1	1.19%	20%	----
		passing (0.0312 mm)	----	E183	1.0	%	77.6	76.6	1.35%	20%	----

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Particle Size (QC Lot: 674236)											
SK2205375-027	Anonymous	sand (>0.075mm)	----	E178	1.0	%	<1.0	<1.0	0	Diff <2x LOR	----
Inorganic Parameters (QC Lot: 657907)											
WT2214267-003	Anonymous	sulfides, acid volatile	----	E396-L	0.20	mg/kg	0.24	0.33	0.09	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 659593)											
WT2214822-007	BH22-3-2	sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	<20	<20	0	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 659594)											
WT2214822-007	BH22-3-2	chloride, soluble ion content	16887-00-6	E236.Cl	5.0	mg/kg	29.8	28.8	1.0	Diff <2x LOR	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Soil/Solid**

Analyte	*CAS Number*	*Method*	*LOR*	*Unit*	*Result*	*Qualifier*
Physical Tests (QCLot: 659122)						
moisture	----	E144	0.25	%	<0.25	----
Physical Tests (QCLot: 659123)						
moisture	----	E144	0.25	%	<0.25	----
Physical Tests (QCLot: 659220)						
moisture	----	E144	0.25	%	<0.25	----
Physical Tests (QCLot: 659587)						
conductivity (1:2 leachate)	----	E100-L	5	µS/cm	<5.00	----
Physical Tests (QCLot: 660485)						
moisture	----	E144	0.25	%	<0.25	----
Inorganic Parameters (QCLot: 657907)						
sulfides, acid volatile	----	E396-L	0.2	mg/kg	<0.20	----
Leachable Anions & Nutrients (QCLot: 659593)						
sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	<20	----
Leachable Anions & Nutrients (QCLot: 659594)						
chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	<5.0	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 659122)									
moisture	----	E144	0.25	%	50 %	100	90.0	110	----
Physical Tests (QCLot: 659123)									
moisture	----	E144	0.25	%	50 %	100	90.0	110	----
Physical Tests (QCLot: 659219)									
pH (1:2 soil:CaCl2-aq)	----	E108A	----	pH units	7 pH units	101	98.0	102	----
Physical Tests (QCLot: 659220)									
moisture	----	E144	0.25	%	50 %	101	90.0	110	----
Physical Tests (QCLot: 659587)									
conductivity (1:2 leachate)	----	E100-L	5	µS/cm	1409 µS/cm	105	90.0	110	----
Physical Tests (QCLot: 660485)									
moisture	----	E144	0.25	%	50 %	101	90.0	110	----
Inorganic Parameters (QCLot: 657907)									
sulfides, acid volatile	----	E396-L	0.2	mg/kg	2.536 mg/kg	99.4	70.0	130	----
Leachable Anions & Nutrients (QCLot: 659593)									
sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	5000 mg/kg	102	70.0	130	----
Leachable Anions & Nutrients (QCLot: 659594)									
chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	5000 mg/kg	101	80.0	120	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 659317)									
	RM	oxidation-reduction potential [ORP]	----	E125	475 mV	102	80.0	120	----
Physical Tests (QCLot: 659587)									
	RM	conductivity (1:2 leachate)	----	E100-L	1031.5 µS/cm	111	70.0	130	----
Particle Size (QCLot: 663152)									
	RM	passing (19 mm)	----	E181	100 %	100	90.0	110	----
	RM	passing (2.0 mm)	----	E181	100 %	100	90.0	110	----
	RM	passing (25.4 mm)	----	E181	100 %	100	90.0	110	----
	RM	passing (38.1 mm)	----	E181	100 %	100	90.0	110	----
	RM	passing (4.75 mm)	----	E181	100 %	100	90.0	110	----
	RM	passing (50.8 mm)	----	E181	100 %	100	90.0	110	----
	RM	passing (76.2 mm)	----	E181	100 %	100	90.0	110	----
	RM	passing (9.5 mm)	----	E181	100 %	100	90.0	110	----
Particle Size (QCLot: 663153)									
	RM	passing (0.05 mm)	----	E182	49.81 %	99.2	90.0	110	----
	RM	passing (0.063 mm)	----	E182	54.27 %	98.6	90.8	109	----
	RM	passing (0.075 mm)	----	E182	58.38 %	98.2	91.4	109	----
	RM	passing (0.125 mm)	----	E182	68.06 %	99.3	92.7	107	----
	RM	passing (0.149 mm)	----	E182	72.71 %	99.7	93.1	107	----
	RM	passing (0.250 mm)	----	E182	85.38 %	99.2	94.1	106	----
	RM	passing (0.420 mm)	----	E182	92.78 %	99.7	94.6	105	----
	RM	passing (0.50 mm)	----	E182	93.78 %	99.7	94.7	105	----
	RM	passing (0.841 mm)	----	E182	97.34 %	99.8	94.9	105	----
	RM	passing (1.0 mm)	----	E182	97.77 %	99.8	94.9	105	----
Particle Size (QCLot: 663154)									
	RM	passing (0.002 mm)	----	E183	21.14 %	89.0	76.0	124	----
	RM	passing (0.004 mm)	----	E183	24.64 %	93.7	80.0	120	----
	RM	passing (0.005 mm)	----	E183	25.91 %	96.3	82.0	118	----
	RM	passing (0.020 mm)	----	E183	37.12 %	96.9	87.0	113	----

Sub-Matrix:

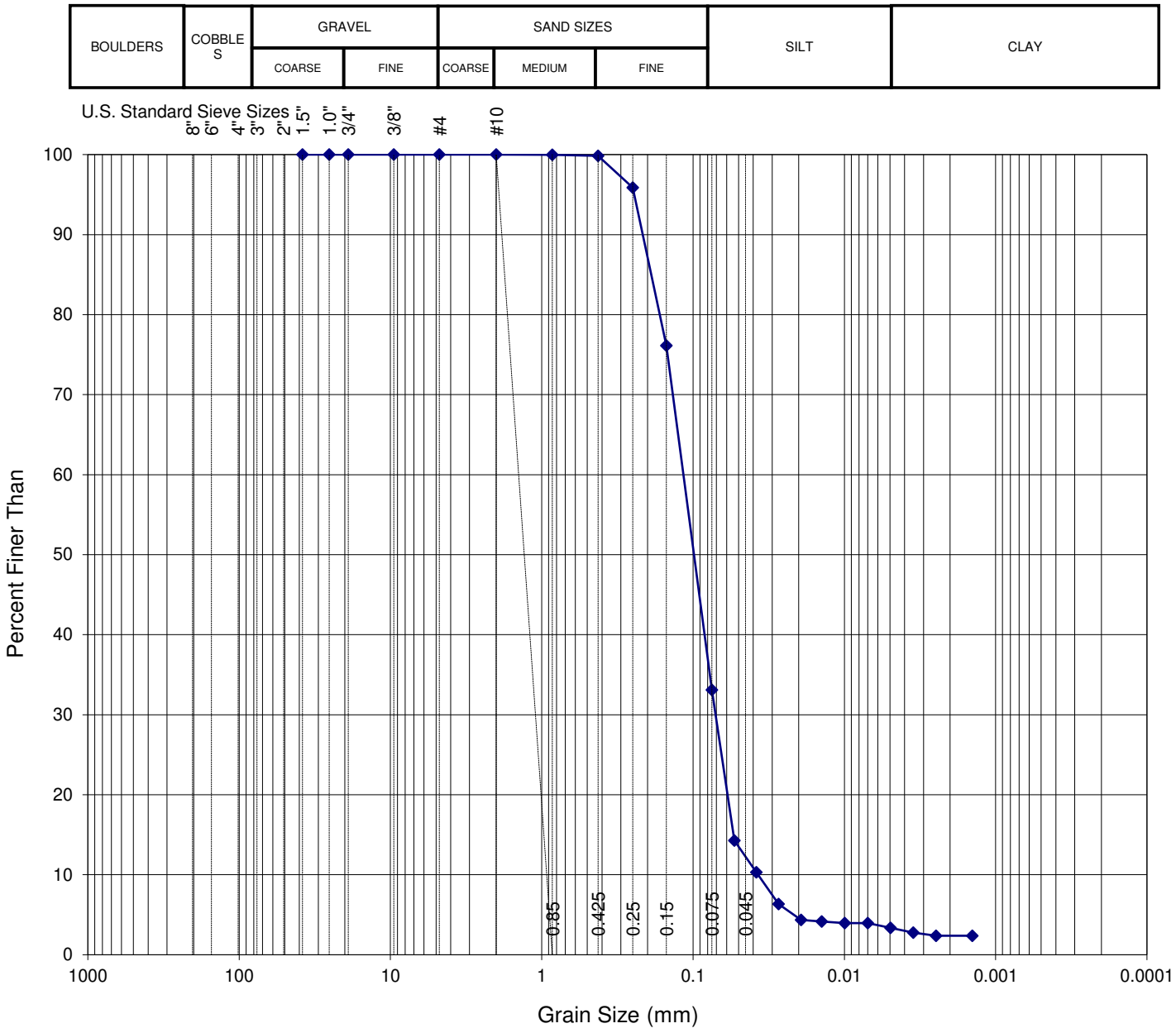
					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Particle Size (QCLot: 663154) - continued									
	RM	passing (0.0312 mm)	----	E183	42.58 %	98.7	88.0	112	----
Particle Size (QCLot: 674236)									
	RM	sand (>0.075mm)	----	E178	42.85 %	93.6	88.0	112	----
Leachable Anions & Nutrients (QCLot: 659593)									
	RM	sulfate, soluble ion content	14808-79-8	E236.SO4	217 mg/kg	107	60.0	140	----
Leachable Anions & Nutrients (QCLot: 659594)									
	RM	chloride, soluble ion content	16887-00-6	E236.Cl	673 mg/kg	99.4	70.0	130	----

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	WT2214822007
Project Number:	
Client Sample ID	BH22-3-2
Lab Sample ID	WT2214822007
Date Sample Received	00-Jan-00
Test Completion Date:	28-Sep-22
Analyst:	SIH



METHOD DESCRIPTION

Method Reference: ASTM D6913 & D7928

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

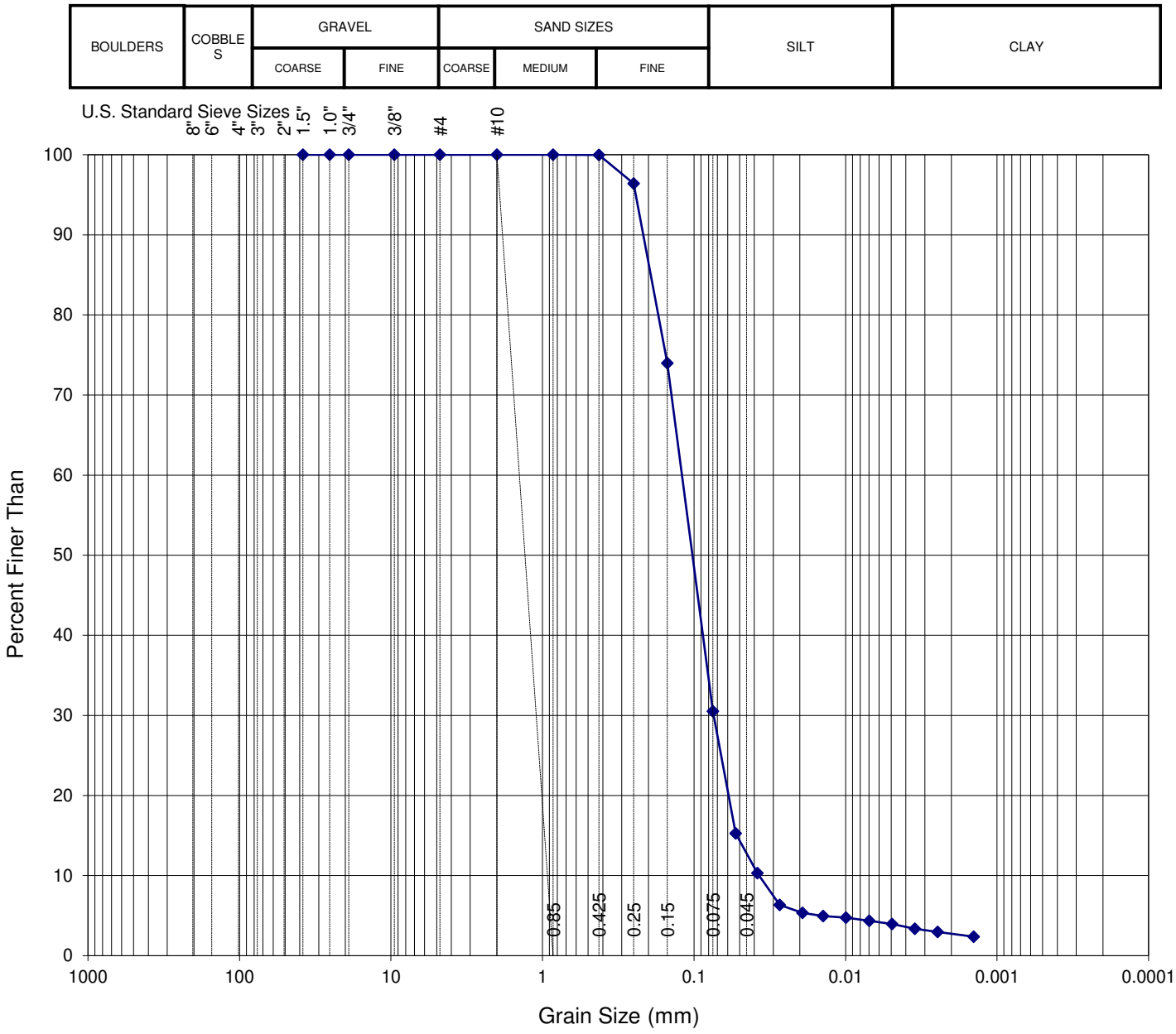
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	<1	0.425 - 2.0
% FINE SAND :	66.73	0.075 - 0.425
% SILT :	29.71	0.075 - 0.005
% CLAY :	3.39	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name: WT2214822020
Project Number:
Client Sample ID MW22-4-2
Lab Sample ID WT2214822020
Date Sample Received 00-Jan-00
Test Completion Date: 28-Sep-22
Analyst: SIH



METHOD DESCRIPTION
Method Reference: ASTM D6913 & D7928
Dispersion method: Mechanical
Dispesion period: 1 minute cm/s

DESCRIPTION OF SAND AND GRAVEL PARTICLES
Shape: Angular
Hardness: Hard

SUMMARY OF RESULTS

GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	<1	0.425 - 2.0
% FINE SAND :	69.44	0.075 - 0.425
% SILT :	26.55	0.075 - 0.005
% CLAY :	3.98	< 0.005

ALS Laboratory Group

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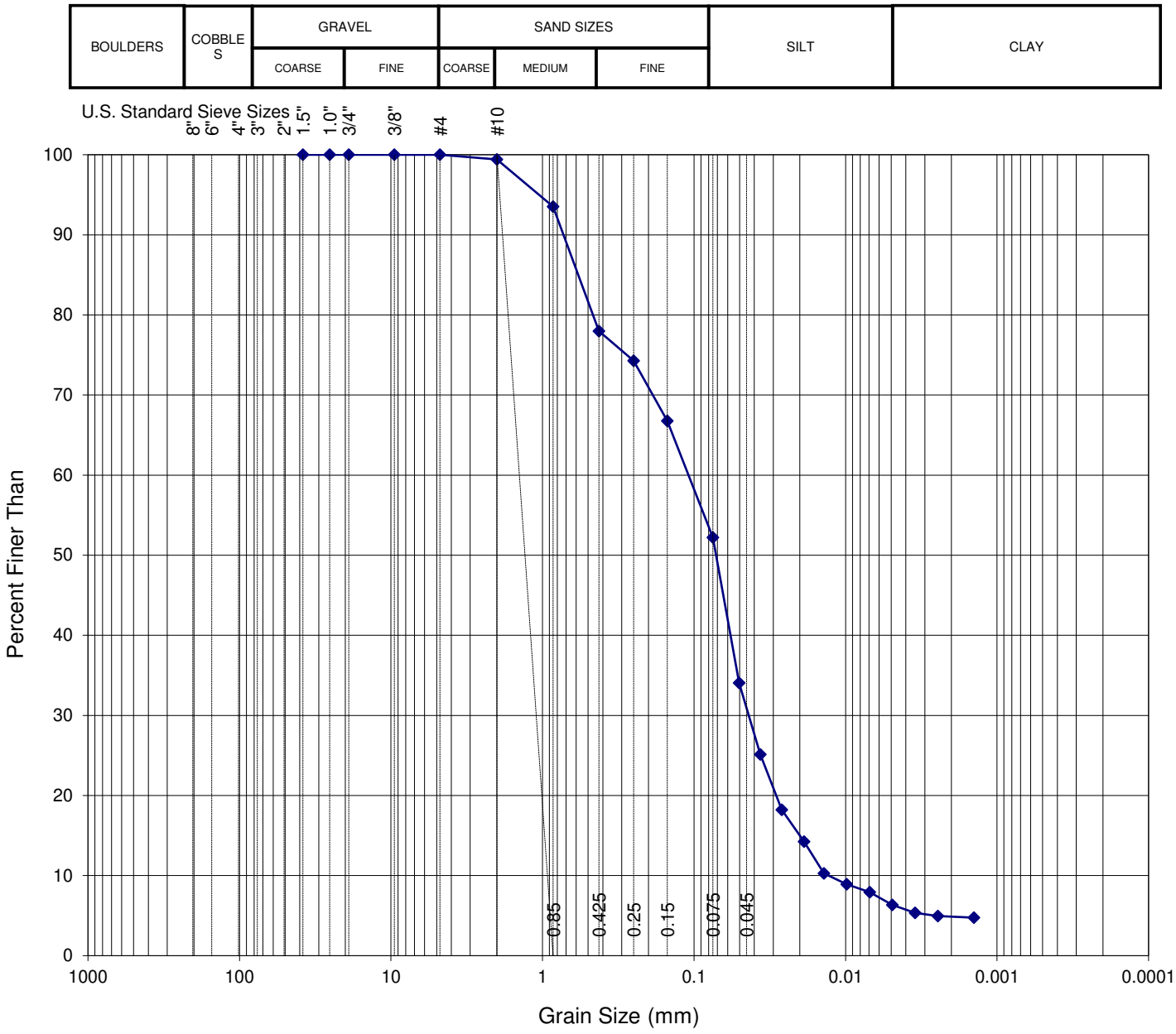
PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	WT2214822025
Project Number:	
Client Sample ID	BH22-5-2
Lab Sample ID	WT2214822025
Date Sample Received	00-Jan-00
Test Completion Date:	28-Sep-22
Analyst:	SIH



METHOD DESCRIPTION

Method Reference: ASTM D6913 & D7928

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	21.40	0.425 - 2.0
% FINE SAND :	25.78	0.075 - 0.425
% SILT :	45.80	0.075 - 0.005
% CLAY :	6.42	< 0.005

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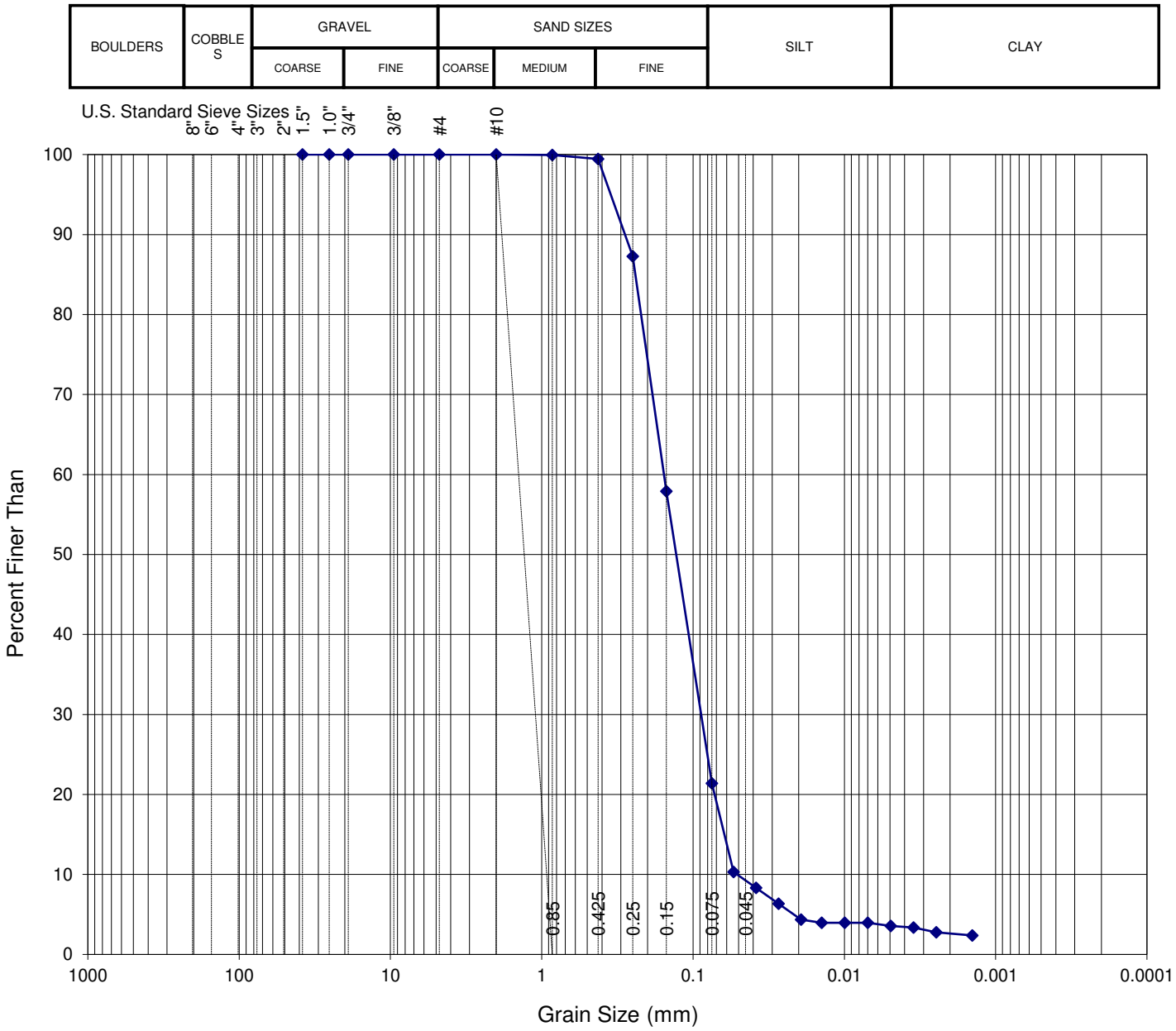
PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	WT2214822030
Project Number:	
Client Sample ID	MW22-6-2
Lab Sample ID	WT2214822030
Date Sample Received	00-Jan-00
Test Completion Date:	28-Sep-22
Analyst:	SIH



METHOD DESCRIPTION

Method Reference: ASTM D6913 & D7928

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

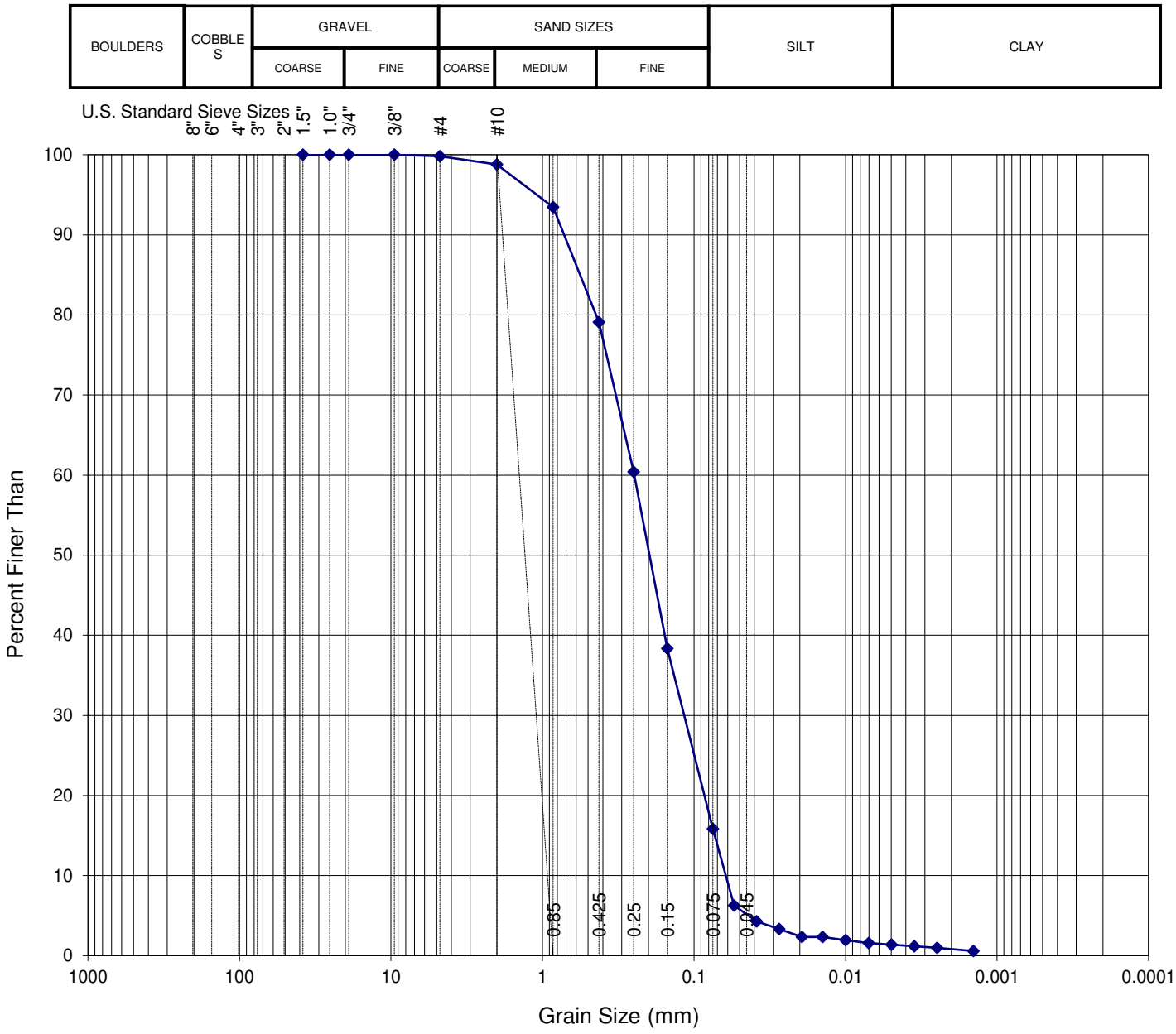
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	<1	0.425 - 2.0
% FINE SAND :	78.05	0.075 - 0.425
% SILT :	17.81	0.075 - 0.005
% CLAY :	3.58	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	WT2214822038
Project Number:	
Client Sample ID	BH22-7-5
Lab Sample ID	WT2214822038
Date Sample Received	00-Jan-00
Test Completion Date:	28-Sep-22
Analyst:	SIH



METHOD DESCRIPTION

Method Reference: ASTM D6913 & D7928

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

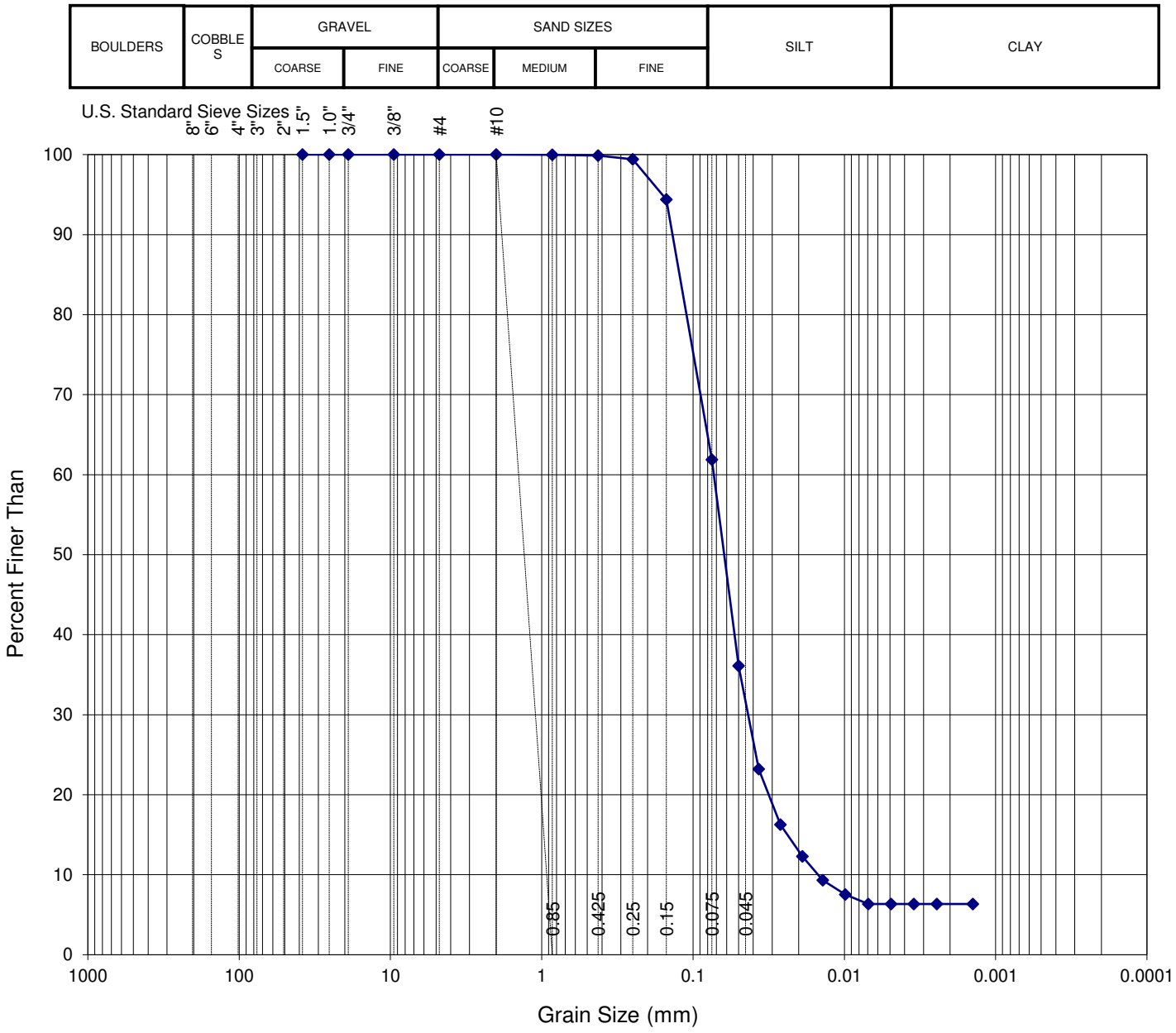
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	1.02	2.0 - 4.75
% MEDIUM SAND :	19.69	0.425 - 2.0
% FINE SAND :	63.24	0.075 - 0.425
% SILT :	14.47	0.075 - 0.005
% CLAY :	1.37	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	WT2214822040
Project Number:	
Client Sample ID	BH22-10-2
Lab Sample ID	WT2214822040
Date Sample Received	00-Jan-00
Test Completion Date:	28-Sep-22
Analyst:	SIH



METHOD DESCRIPTION

Method Reference: ASTM D6913 & D7928

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	<1	0.425 - 2.0
% FINE SAND :	38.00	0.075 - 0.425
% SILT :	55.52	0.075 - 0.005
% CLAY :	6.35	< 0.005

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 17 -

Page 1 of 5

Report To	Contact and company name below will appear on the final report
Company:	ARCADIS Canada Inc.
Contact:	Lennart de Groot
Phone:	613-809-2379
	Company address below will appear on the final report
Street:	1050 Morrison Drive
City/Province:	Ottawa, ON
Postal Code:	K2H 8K7
Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	AccountsPayable.canada@arcadis.com

Report Format / Distribution	
Select Report Format:	☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report	☐ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	Lennart.deGroot@arcadis.com
Email 2	
Email 3	

Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	Lennart.deGroot@arcadis.com
Email 2	AccountsPayable.canada@arcadis.com

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q88485 (2022 SOA)	AFE/Cost Center:	PO#
Job #:	30127480	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	

ALS Lab Work Order # (lab use only): **ALS Contact:** Emily Smith **Sampler:**

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☐ | 3 day [P3-25%] ☐ | 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E - 100%] ☐ | Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	moisture content	Hydrometer Analysis	Full Grain Size Plot	Corrosivity	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	MW22-2-1	16-09-2022	9:00	Soil	1	R					
	MW22-2-2	16-09-2022	9:00	Soil	1	R					
	MW22-2-3	16-09-2022	9:00	Soil	1	R					
	MW22-2-4	16-09-2022	9:00	Soil	1	R					
	MW22-2-5	16-09-2022	9:00	Soil	1	R					
	BH22-3-1	16-09-2022	12:00	Soil	1	R					
	BH22-3-2	16-09-2022	12:00	Soil	3	R	R		R		
	BH22-3-3	16-09-2022	12:00	Soil	1	R					
	BH22-3-4	16-09-2022	12:00	Soil	1	R					

Am13

Environmental Division
Waterloo
Work Order Reference
WT2214822

Telephone : +1 519 886 6910

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human consumption/ use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No	☐
Ice Packs	☒ Ice Cubes ☐	Custody seal intact	Yes ☐	No	☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
14.9				0.2			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Lennart de Groot	Date: 19-09-2022	Time:	Received by: CUTAT F	Date: 9/19/22	Time: 14:55	Received by:	Date: 20 Sep 22	Time: 7:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY NOV 2018 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 17 -

Report To	Contact and company name below will appear on the final report
Company:	ARCADIS Canada Inc.
Contact:	Lennart de Groot
Phone:	613-809-2379
	Company address below will appear on the final report
Street:	1050 Morrison Drive
City/Province:	Ottawa, ON
Postal Code:	K2H 8K7
Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	AccountsPayable.canada@arcadis.com

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: Lennart.deGroot@arcadis.com

Email 2:

Email 3:

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: Lennart.deGroot@arcadis.com

Email 2: AccountsPayable.canada@arcadis.com

Project Information

ALS Account # / Quote #:	Q88485 (2022 SOA)
Job #:	30127480
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only):

ALS Contact: Emily Smith **Sampler:**

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☐ | 3 day [P3-25%] ☐ | 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E - 100%] ☐ | Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	moisture content	Hydrometer Analysis	Full Grain Size Plot	Corrosivity	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	BH22-8-1	16-09-2022	14:00	Soil	1	R					
	BH22-8-2	16-09-2022	14:00	Soil	1	R					
	BH22-8-3	16-09-2022	14:00	Soil	1	R					
	BH22-8-4	16-09-2022	14:00	Soil	1	R					
	BH22-9-1	16-09-2022	13:00	Soil	1	R					
	BH22-9-2	16-09-2022	13:00	Soil	1	R					
	BH22-9-3	16-09-2022	13:00	Soil	1	R					
	BH22-9-4	16-09-2022	13:00	Soil	1	R					
	BH22-9-5	16-09-2022	13:00	Soil	1	R					

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human consumption/ use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ | Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
14.9				10.2			

SHIPMENT RELEASE (client use)

Released by: Lennart de Groot | Date: 19-09-2022 | Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: [illegible] | Date: 9/19/22 | Time: 14:55

FINAL SHIPMENT RECEPTION (lab use only)

Received by: [illegible] | Date: 20-Sep-22 | Time: 9:00

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1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 17 -

Page 3 of 5

Report To	Contact and company name below will appear on the final report
Company:	ARCADIS Canada Inc.
Contact:	Lennart de Groot
Phone:	613-809-2379
	Company address below will appear on the final report
Street:	1050 Morrison Drive
City/Province:	Ottawa, ON
Postal Code:	K2H 8K7
Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	AccountsPayable.canada@arcadis.com

Report Format / Distribution	
Select Report Format:	☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report	☐ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	Lennart.deGroot@arcadis.com
Email 2	
Email 3	

Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	Lennart.deGroot@arcadis.com
Email 2	AccountsPayable.canada@arcadis.com

Project Information	
ALS Account # / Quote #:	Q88485 (2022 SOA)
Job #:	30127480
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only):

ALS Contact: Emily Smith

Sampler:

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4-20%] ☐ | 3 day [P3-25%] ☐ | 2 day [P2-50%] ☐

EMERGENCY: 1 Business day [E - 100%] ☐ | Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	moisture content	Hydrometer Analysis	Full Grain Size Plot	Corrosivity	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	MW22-4-1	15-09-2022	15:45	Soil	1	R					
	MW22-4-2	15-09-2022	15:45	Soil	2	R		R			
	MW22-4-3	15-09-2022	15:45	Soil	1	R					
	MW22-4-4	15-09-2022	15:45	Soil	1	R					
	MW22-4-5	15-09-2022	15:45	Soil	1	R					
	BH22-5-1	16-09-2022	8:50	Soil	1	R					
	BH22-5-2	16-09-2022	8:50	Soil	2	R	R				
	BH22-5-3	16-09-2022	8:50	Soil	1	R			R		
	BH22-5-4	16-09-2022	8:50	Soil	1	R					
	BH22-5-5	16-09-2022	8:50	Soil	1	R					

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human consumption/ use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations Yes ☐ No ☐

Ice Packs ☒ Ice Cubes ☐ | Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
14.9				10.2			

SHIPMENT RELEASE (client use)		
Released by: Lennart de Groot	Date: 19-09-2022	Time:

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by: COLTAF	Date: 9/19/22	Time: 14:55

FINAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: 20Sep22	Time: 9:00

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Canada Toll Free: 1 800 668 9878

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Report To	Contact and company name below will appear on the final report
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Contact:	Lennart de Groot
Phone:	613-809-2379
	Company address below will appear on the final report
Street:	1050 Morrison Drive
City/Province:	Ottawa, ON
Postal Code:	K2H 8K7

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: Lennart.deGroot@arcadis.com

Email 2:

Email 3:

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

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Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

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Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	AccountsPayable.canada@arcadis.com

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: Lennart.deGroot@arcadis.com

Email 2: AccountsPayable.canada@arcadis.com

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q88485 (2022 SOA)	AFE/Cost Center:	PO#:
Job #:	30127480	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	

ALS Lab Work Order # (lab use only):

ALS Contact: Emily Smith

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	moisture content	Hydrometer Analysis	Full Grain Size Plot	Corrosivity	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	MW22-6-1	15-09-2022	11:15	Soil	1	R					
	MW22-6-2	15-09-2022	11:15	Soil	1	R		R			
	MW22-6-3	15-09-2022	11:15	Soil	1	R			R		
	MW22-6-4	15-09-2022	11:15	Soil	1	R					
	MW22-6-5	15-09-2022	11:15	Soil	1	R					
	BH22-7-1	15-09-2022	13:00	Soil	1	R					
	BH22-7-2	15-09-2022	13:00	Soil	1	R					
	BH22-7-3	15-09-2022	13:00	Soil	1	R					
	BH22-7-4	15-09-2022	13:00	Soil	1	R					
	BH22-7-5	15-09-2022	13:00	Soil	2	R		R			

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human consumption/ use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ | Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
14.9				10.2			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Lennart de Groot	Date: 19-09-2022	Time:	Received by:	Date: 9/19/22	Time: 14:55	Received by:	Date: 20-Sep-22	Time: 9:00

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www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 17 -

Page 5 of 5

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Contact:	Lennart de Groot
Phone:	613-809-2379
	Company address below will appear on the final report
Street:	1050 Morrison Drive
City/Province:	Ottawa, ON
Postal Code:	K2H 8K7
Invoice To	Same as Report To ☐ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	AccountsPayable.canada@arcadis.com

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: Lennart.deGroot@arcadis.com

Email 2:

Email 3:

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: Lennart.deGroot@arcadis.com

Email 2: AccountsPayable.canada@arcadis.com

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Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:	Q88485 (2022 SOA)
Job #:	30127480
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#:
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only):

ALS Contact: Emily Smith

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

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	BH22-10-1	15-09-2022	14:10	Soil	1	R					
	BH22-10-2	15-09-2022	14:10	Soil	1	R		R			
	BH22-10-3	15-09-2022	14:10	Soil	1	R					
	BH22-10-4	15-09-2022	14:10	Soil	1	R					

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human consumption/ use? ☐ YES ☐ NO

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Ice Packs ☒ Ice Cubes ☐ | Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

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14.9				10.2			

SHIPMENT RELEASE (client use)

Released by: Lennart de Groot	Date: 19-09-2022	Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: [illegible]	Date: 9/19/22	Time: 14:55

FINAL SHIPMENT RECEPTION (lab use only)

Received by: AP	Date: 20 Sep 22	Time: 9:00

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Appendix D

Triton S-29 Chamber:Standard Details

AREA B3 STORAGE TANK

Parameters

Units: Metric

Storage Volume: 10 Cu m

Chamber Selection: S-29

Header Row Position: Left

Fill Over Embedment Stone: 300 mm

Controlled By: width 5 m

Embedment Stone mm:

Over: 150 Under: 150 Porosity: 0.4

Min 150mm over and under

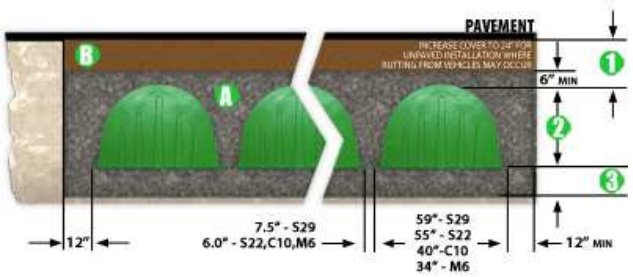
Double Stacked

Double Stacked?: No

Stone Between:

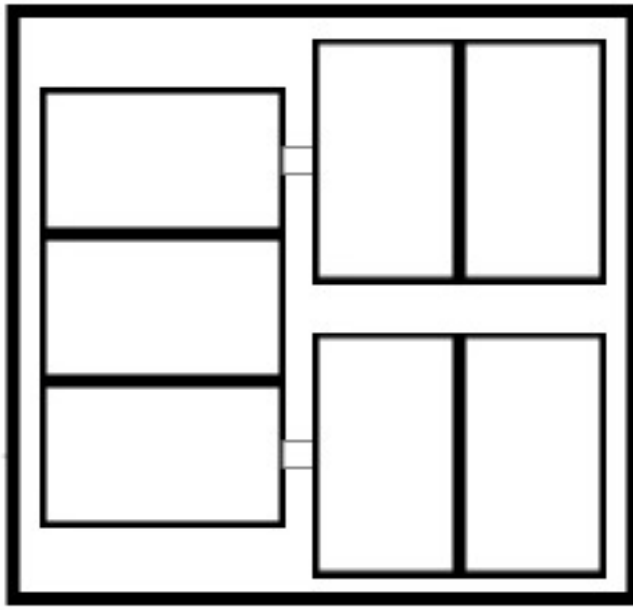
Note: After making an input change you must hit calculate to update the Field Diagram and Project Results.
* The image generation will not save if using MicroSoft Edge

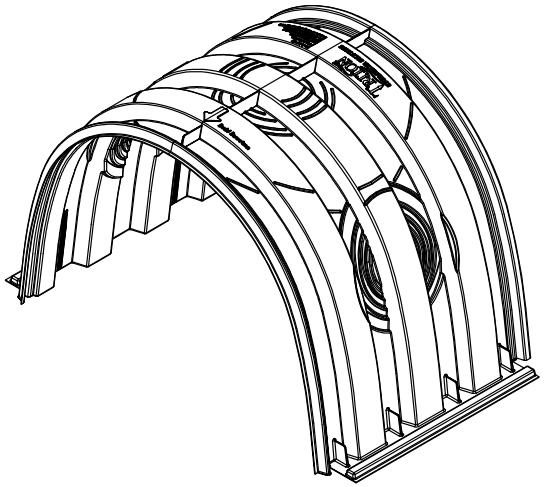
Project Results



1	Total Cover Over Chambers: 301 mm
2	Height Of Chamber: 915 mm
3	Embedment Stone Under Chambers: 151 mm
A	Volume of Embedment Stone Required: 15 Cu. m
B	Volume of Fill Material Required: 6 Cu. m
	Total Storage Provided: 12 Cu. m
	Type Of Chambers: S-29
	# Of Chambers Required: 7
	# Of End Caps Required: 6
	Required Bed Size: 17 Sq. m
	Volume of Excavation: 21 Cu. m
	* Area of Filter Fabric: 37 Sq. m
	# of Chambers Long: 2
	# of rows: 2
	Actual Trench Length: 4.39 m
	Actual Trench Width: 3.80 m

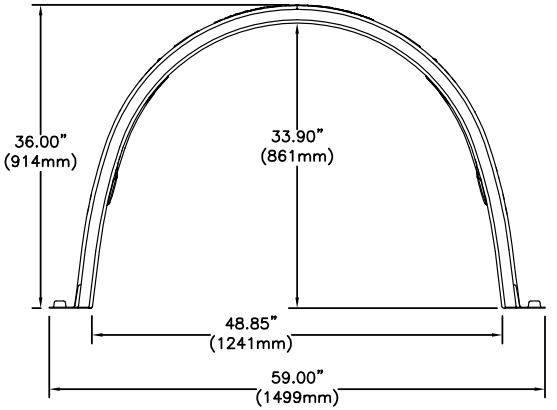
* Filter Fabric quantity for Fabric on Top and Sides of System Only, does not include overlap

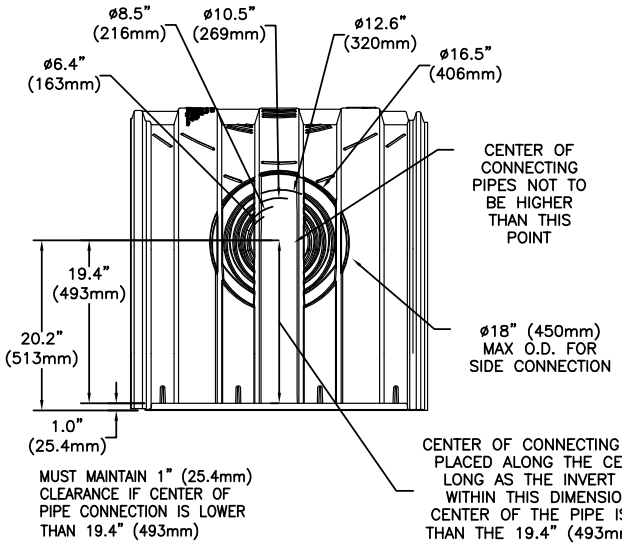


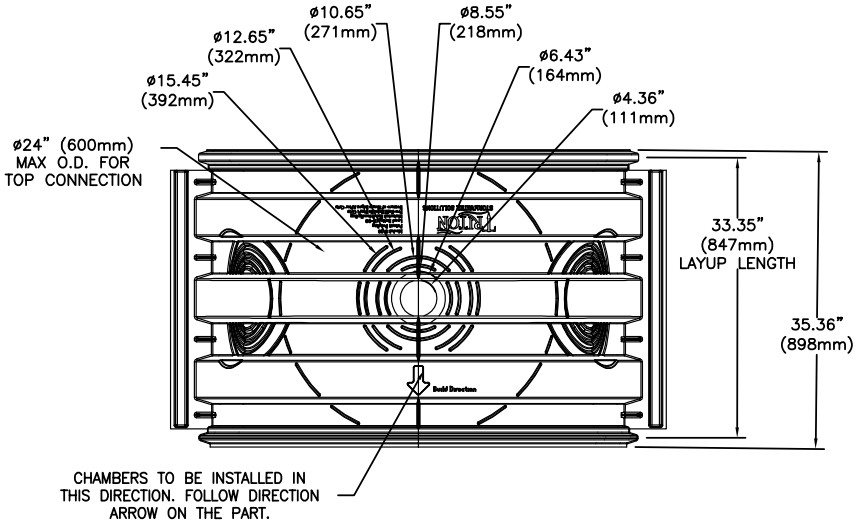


S-29 CHAMBER SPECS	
NOMINAL DIMENSIONS (LAYUP LENGTH X WIDTH X HEIGHT)	33.35" X 59.00" X 36.00" (847mm X 1499mm X 914mm)
BARE CHAMBER STORAGE	27.35 CUBIC FEET (0.774 CUBIC METERS)
*MIN INSTALLED STORAGE	41.05 CUBIC FEET (1.162 CUBIC METERS)
CHAMBER WEIGHT	32 lbs (14.515 kg)
STORAGE PER LINEAR FOOT WITHOUT STONE	9.84 CUBIC FEET (0.279 CUBIC METERS)
STORAGE PER LINEAR FOOT WITH STONE	14.77 CUBIC FEET (0.418 CUBIC METERS)
*ASSUMING A MIN OF 6" (152mm) STONE ABOVE AND BELOW AND 7.5" (191mm) BETWEEN ROWS WITH 40% STONE POROSITY (DOES NOT INCLUDE 12" (305mm) PERIMETER STONE VOLUME)	

NOTE: S-29 CHAMBER DETAILS TESTED AND RATED FOR H-30 LOAD CONDITIONS WITH 18" (457mm) OF COVER AND NO PAVEMENT.







CONCEPTUAL PLAN DISCLAIMER

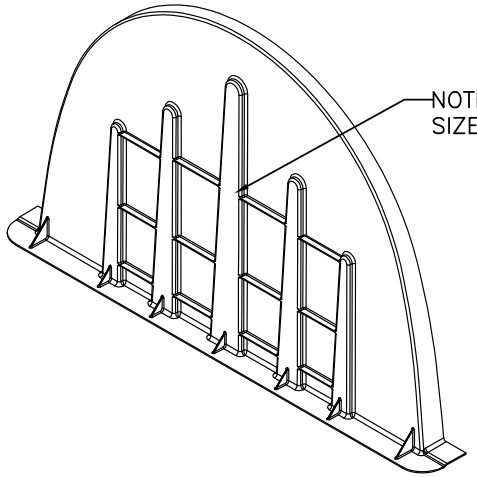
THIS GENERIC DETAIL DOES NOT ENCOMPASS THE SIZING, FIT, AND APPLICABILITY OF THE TRITON CHAMBER SYSTEM FOR THIS SPECIFIC PROJECT. IT IS THE ULTIMATE RESPONSIBILITY OF THE DESIGN ENGINEER TO ASSURE THAT THE STORMWATER SYSTEM DESIGN IS IN FULL COMPLIANCE WITH ALL APPLICABLE LAWS AND REGUALTIONS. TRITON PRODUCTS MUST BE DESIGNED AND INSTALLED IN ACCORDANCE WITH TRITON'S MINIMUM REQUIREMENTS. TRITON STORMWATER SOLUTIONS DOES NOT APPROVE PLANS, SIZING, OR SYSTEM DESIGNS. THE DESIGN ENGINEER IS RESPONSIBLE FOR ALL DESIGN DECISIONS.

TRITON STORMWATER SOLUTIONS
7600 EAST GRAND RIVER, STE.195
BRIGHTON, MI 48114
PHONE: (810) 222-7652 ● FAX: (810) 222-1769
WWW.TRITONSWS.COM

S-29 CHAMBER DETAIL

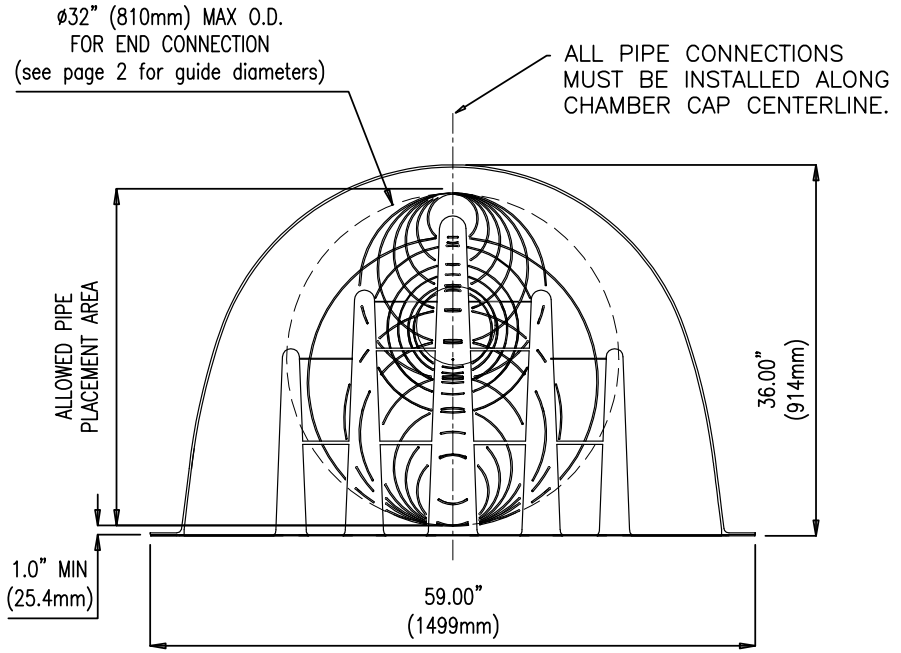
TRITON - STANDARD DETAILS

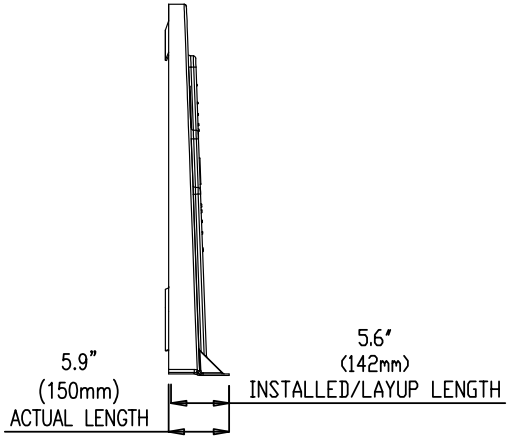
REVISED:
02-26-16 JWM



NOTE: REFER TO PAGE 2 FOR SIZES OF DIAMETER CUT GUIDES.

S-29 END CAP SPECS	
NOMINAL DIMENSIONS (LAYUP LENGTH X WIDTH X HEIGHT)	5.90" X 59.00" X 36.00" (150mm X 1499mm X 914mm)
BARE END CAP STORAGE	1.031 CUBIC FEET (0.029 CUBIC METERS)
*MIN INSTALLED STORAGE	4.98 CUBIC FEET (0.141 CUBIC METERS)
*ASSUMING A MIN OF 6" (152mm) STONE ABOVE AND BELOW AND 7.5" (191mm) BETWEEN ROWS WITH 40% STONE POROSITY (DOES NOT INCLUDE 12" (305mm) PERIMETER STONE VOLUME)	





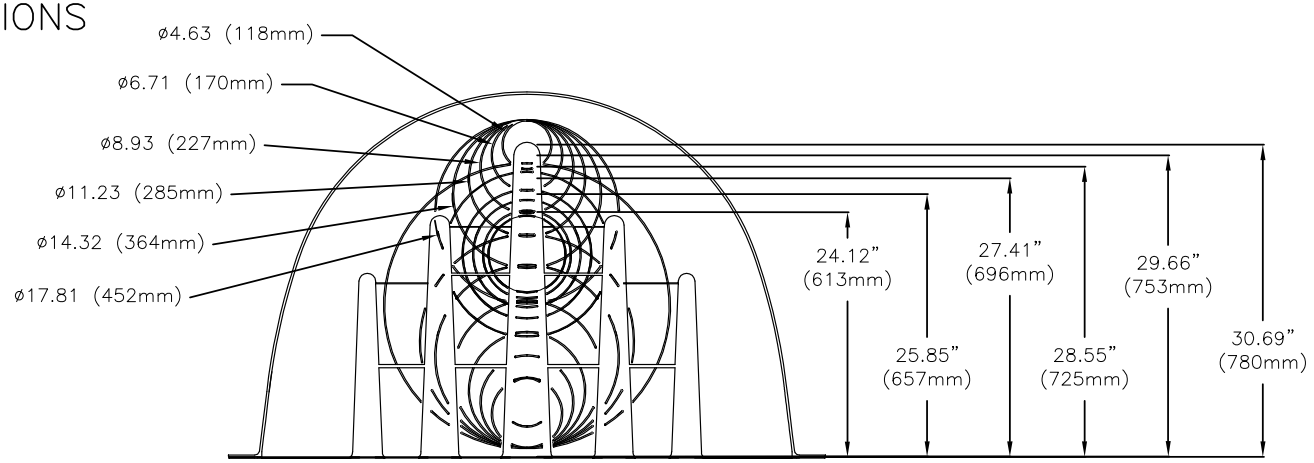
THE END CAP FITS UP ON THE OUTSIDE OF THE S-29 CHAMBER. REFER TO INSTALLATION MANUAL FOR FURTHER DETAIL.

TRITON STORMWATER SOLUTIONS

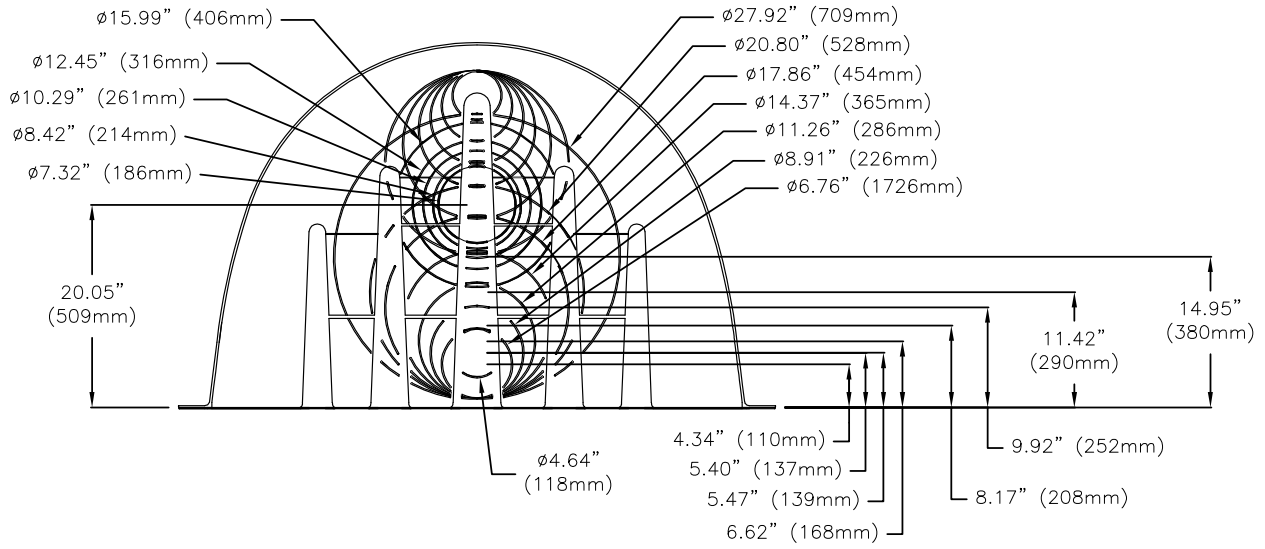
7600 EAST GRAND RIVER, STE.195
BRIGHTON, MI 48114
PHONE: (810) 222-7652 • FAX: (810) 222-1769
WWW.TRITONSWS.COM

S-29 CHAMBER END CAP DETAIL

S-29 END CAP:
TOP HOLE DIMENSIONS



S-29 END CAP:
CENTER AND BOTTOM HOLE DIMENSIONS



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BRIGHTON, MI 48114
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WWW.TRITONSWS.COM

S-29 CHAMBER END CAP DETAIL

TRITON S-29 PRODUCT SPECIFICATIONS

1.0 General

1.1 Triton chambers are designed to control stormwater runoff. As a subsurface retention or detention system, Triton chambers retain and allow effective infiltration of water into the soil. As a subsurface detention system, Triton chambers detain and allow for the metered flow of water to an outfall.

2.0 Chamber Parameters

2.1 The chamber shall be injection compression molded of a structural grade 1010 green soy resin composite to be inherently resistant to environmental stress cracking (ESCR), creep, and to maintain proper stiffness through temperature ranges of -40 degrees F to 180 degrees F.

2.2 The material property for the chamber and end cap must meet or exceed the following:
Tensile Strength- Ultimate: 21,755 PSI
Tensile Strength-Yield: 17,404 PSI
Tensile Modulus: 1,750-2,240 PSI
Flex Modulus: 1,600 KSI
Flex Yield Strength: 33,100 PSI
Compressive Strength: 30,457,000 PSI
Shear Strength: 11,500 PSI

2.3 The nominal chamber dimensions of the Triton S-29 shall be 36.0 inches tall, 59.0 inches wide and 35.0 inches long. Lay-up length is 33.35”

2.4 The chamber shall have an elliptical curved section profile.

2.5 The chamber shall be open-bottomed.

2.6 The chamber shall incorporate an overlapping corrugation joint system to allow chamber rows to be constructed.

2.7 The nominal storage volume of a Triton S-29 chamber shall be 41.06 cubic feet per chamber when installed per Triton’s typical details. This equates to 2.67 cubic feet of storage/square foot of bed. This does not include perimeter stone.

2.8 The chamber shall have both of its ends open to allow for unimpeded hydraulic flows and visual inspections down a row’s entire length.

2.9 The chamber shall have five corrugations to achieve strengths defined above.

2.10 The chamber shall have five circular and elliptical, indented and raised, surfaces on the top to the chamber for a maximum of 33 inch diameter optional top feed inlets, inspection ports and or clean-out access ports.

2.11 The chamber shall have 5 elliptical, indented, surfaces on either side of the chamber for optional feed inlets, outlets. Capable of accepting pipe O.D. up to 18 inches.

2.12 The chamber shall be analyzed, designed and field tested using AASHTO LRFD bridge design specifications 1. Design live load shall meet or exceed the AASHTO HS30 or a rear axle load of 48,000 pounds. Design shall consider earth and live loads without pavement as appropriate for the minimum of 18” of total cover to a maximum total cover of 50’.

2.13 The chamber shall be manufactured in an ISO 9001:2008 certified facility

2.14 The service life of the product is over 60 years under a constant sustained load of 10,000 PSI which is equal to the H-20 loading condition. Under typical loading conditions the Chamber and End Cap has a useful lifespan of 120 years from date of when manufactured.

2.15 Designed to exceed ASTM F2418, F2787, F2922 standard and AASHTO LRFD Bridge specifications. Validated through independent third party performance testing.

3.0 End Cap Parameters

3.1 The end cap shall be Injection Compression molded of 1010 green soy resin to be inherently resistant to environmental stress cracking (ESCR), creep and to maintain proper stiffness through temperature ranges of -40 degrees F to 180 degrees F.

3.2 The end cap shall be designed to fit over the last corrugation of a chamber, which allows: the capping of each end of the chamber row.

3.3 The end cap shall have six upper saw guides capable of accepting pipe O.D. up to 18.2” Six middle saw guides and eight lower saw guides capable of accepting pipe O.D. up to 28.2” to allow easy cutting for various diameters of pipe that may be used to inlet or outlet the system.

3.4 The end cap shall have excess structural adequacies to allow cutting an orifice of any size at any invert elevation.

3.5 The primary face of an end cap shall have 5 corrugations and be angled outward to resist horizontal loads generated near the edges of beds.

3.6 The end cap shall be manufactured in an ISO 9001:2008 certified facility.

3.7 The service life of the product to be over 60 years under a sustained load of 10,000 PSI which is equal to the H-20 loading condition.

4.0 Installation

4.1 Installation shall be in accordance with the latest Triton Installation manual that can be downloaded from the Triton website:
www.tritonsws.com/support/downloads

TRITON STORMWATER SOLUTIONS
7600 EAST GRAND RIVER, STE.195
BRIGHTON, MI 48114
PHONE: (810) 222-7652 • FAX: (810) 222-1769
WWW.TRITONSWS.COM

S-29 PRODUCT SPECIFICATIONS

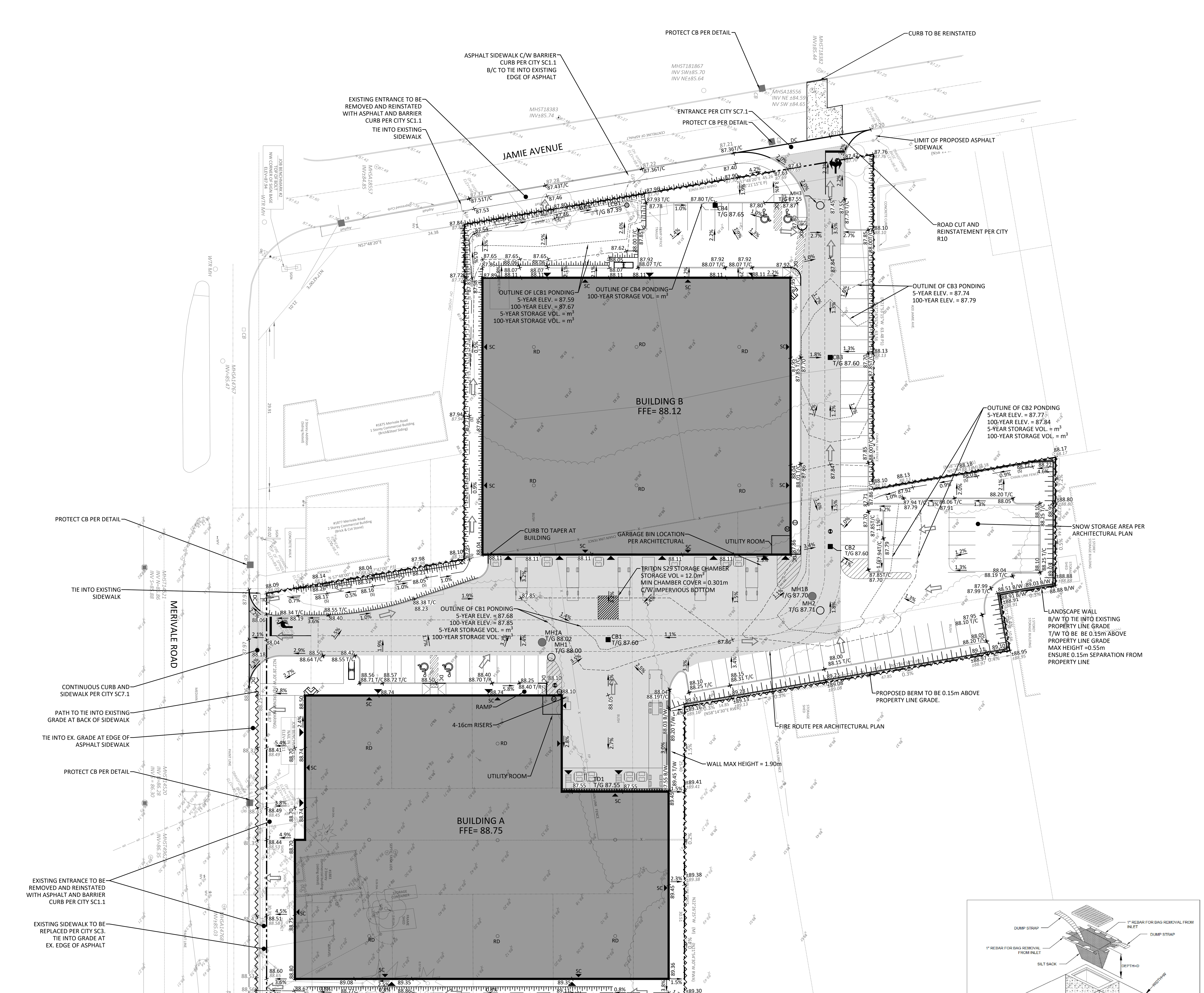
TRITON - STANDARD DETAILS

REVISED:
05-25-17 JWM

Appendix E

Drawing C101: Grading, Drainage and Erosion & Sediment and

Erosion Control Plan

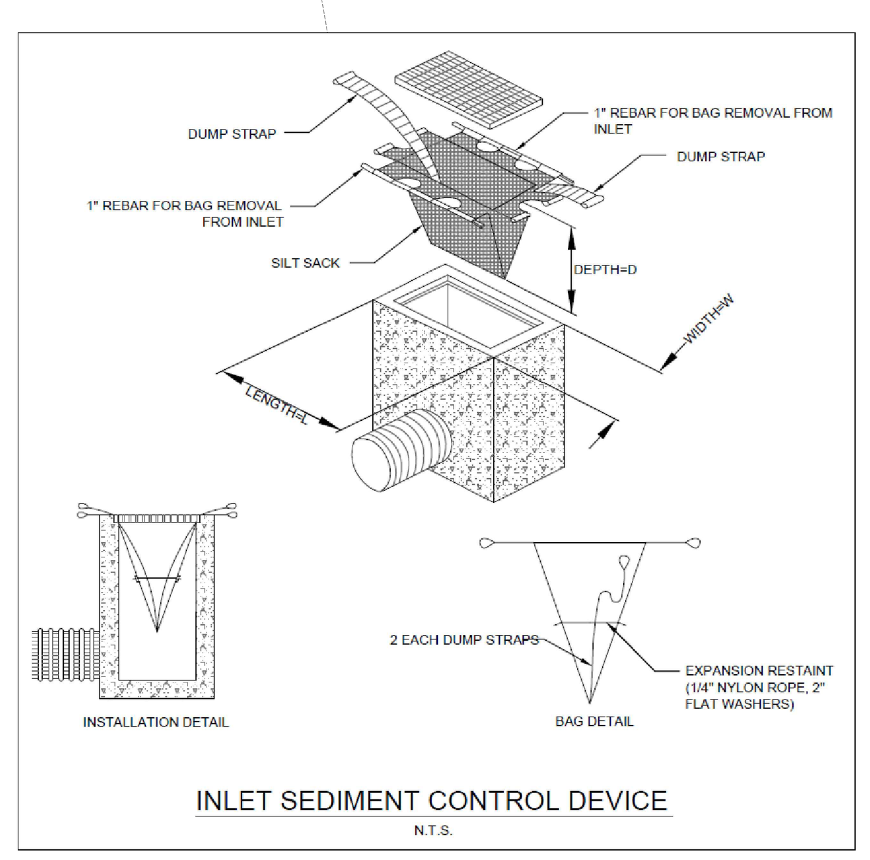


GENERAL NOTES

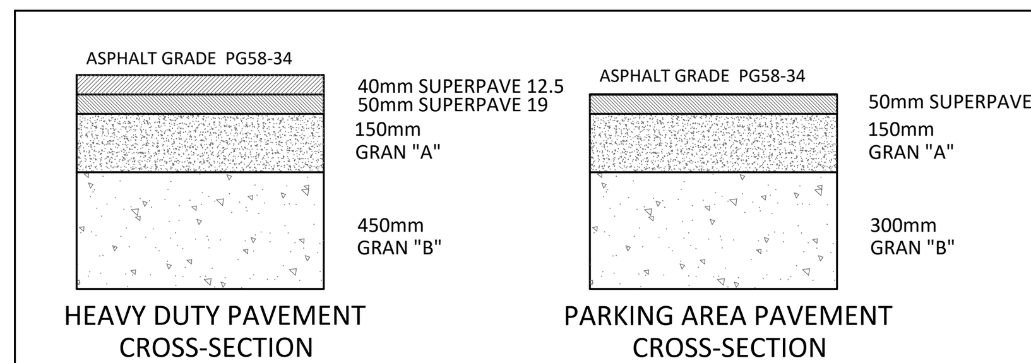
1. THE ORIGINAL TOPOGRAPHY, GROUND ELEVATION AND SURVEY DATA SHOWN ARE SUPPLIED FOR INFORMATION PURPOSES ONLY, AND IMPLY NO GUARANTEE OF ACCURACY. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL INFORMATION SHOWN.
2. THIS PLAN IS NOT A CADASTRAL SURVEY SHOWING LEGAL PROPERTY BOUNDARIES AND EASEMENTS. THE PROPERTY BOUNDARIES SHOWN HEREON HAVE BEEN DERIVED INFORMATION SUPPLIED BY FAIRHALL MOFFATT & WOODLAND LTD. (JOB NO. AC21300) AND CANNOT BE RELIED UPON TO BE ACCURATE OR COMPLETE. THE PRECISE LOCATION OF THE CURRENT PROPERTY BOUNDARIES AND EASEMENTS CAN ONLY BE DETERMINED BY AN UP-TO-DATE LAND TITLES SEARCH AND A SUBSEQUENT CADASTRAL SURVEY PERFORMED AND CERTIFIED BY AN ONTARIO LAND SURVEYOR.
3. THE CONTRACTOR IS TO OBTAIN AND PAY FOR ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY BEFORE COMMENCING CONSTRUCTION.
4. THE CONTRACTOR IS RESPONSIBLE FOR ALL LAYOUT.
5. THE CONTRACTOR IS TO DETERMINE THE EXACT LOCATION, SIZE, MATERIAL AND ELEVATION OF ALL EXISTING UTILITIES PRIOR TO COMMENCING CONSTRUCTION. PROTECT AND ASSUME ALL RESPONSIBILITY FOR EXISTING UTILITIES WHETHER OR NOT SHOWN ON THESE DRAWINGS. IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
6. RESTORE ALL TRENCHES AND SURFACES OF PUBLIC ROAD ALLOWANCES TO CONDITION EQUAL OR BETTER THAN ORIGINAL CONDITION AND TO THE SATISFACTION OF THE CITY AUTHORITIES.
7. EXCAVATE AND DISPOSE OF ALL EXCESS EXCAVATED MATERIAL, SUCH AS ASPHALT, CURBING AND DEBRIS, OFF SITE AS DIRECTED BY THE ENGINEER AND THE CITY.
8. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER UNLESS OTHERWISE SPECIFIED.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC CONTROL AND SAFETY MEASURES DURING THE CONSTRUCTION PERIOD, INCLUDING THE SUPPLY, INSTALLATION, AND REMOVAL OF ALL NECESSARY SIGNAGE, DELINEATORS, MARKERS AND BARRIERS.
10. DO NOT ALTER GRADING OF THE SITE WITHOUT PRIOR APPROVAL OF THE ENGINEER/CITY.
11. ALL ROADWAY, PARKING LOT, AND GRADING WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH CITY STANDARDS AND SPECIFICATIONS. THE CONTRACTOR IS TO PROVIDE POSITIVE DRAINAGE AWAY FROM THE BUILDING.
12. CONTACT THE CITY FOR INSPECTION OF ROUGH GRADING OF PARKING LOTS, ROADWAYS AND LANDSCAPED AREAS PRIOR TO PLACEMENT OF ASPHALT AND TOPSOIL. ALL DEFICIENCIES NOTED SHALL BE RECTIFIED TO THE CITY'S SATISFACTION PRIOR TO PLACEMENT OF ANY ASPHALT, TOPSOIL, SEED & MULCH AND/OR SOD.
13. ALL DIMENSIONS AND INVERTS MUST BE VERIFIED PRIOR TO CONSTRUCTION, IF THERE IS ANY DISCREPANCY THE CONTRACTOR IS TO NOTIFY THE ENGINEER PROMPTLY.
14. ELECTRICAL, GAS, TELEPHONE AND TELEVISION SERVICE LOCATIONS ARE SUBJECT TO THE INDIVIDUAL AGENCY:
    - ELECTRICAL SERVICE - HYDRO OTTAWA,
    - GAS SERVICE - ENBRIDGE,
    - TELEPHONE SERVICE - BELL CANADA,
    - TELEVISION SERVICE - ROGERS.
16. INSTALLATION TO BE IN ACCORDANCE WITH CURRENT CODES AND STANDARDS OF APPROVAL AGENCIES HYDRO OTTAWA, BELL AND THE CITY.
17. CONTRACTOR TO ENSURE ALL APPLICABLE OPS SPECIFICATIONS ARE FOLLOWED DURING CONSTRUCTION
18. ALL PROPOSED CURB TO BE CONCRETE BARRIER CURB UNLESS OTHERWISE SPECIFIED.
19. THIS PLAN MUST BE READ IN CONJUNCTION WITH THE GEOTECHNICAL INVESTIGATION COMPLETED BY ARCADIS, DATED JANUARY 29, 2023

EROSION AND SEDIMENT CONTROL

1. THE CONTRACTOR SHALL IMPLEMENT BEST MANAGEMENT PRACTICES, TO PROVIDE FOR PROTECTION OF THE AREA DRAINAGE SYSTEM AND THE RECEIVING WATERCOURSE, DURING CONSTRUCTION ACTIVITIES. THIS INCLUDES LIMITING THE AMOUNT OF EXPOSED SOIL, TEMPORARY SEDIMENT CONTROL (GEOSOCK INSERTS WITH AN OVERFLOW UNDER GRATE OR COVER) TO BE IMPLEMENTED DURING CONSTRUCTION ON ALL PROPOSED ROAD CATCHBASINS, REARYARD CATCHBASINS AND CATCHBASIN MANHOLES AND OTHER SEDIMENT TRAPS. NO RECYCLED GEOSOCK MATERIAL SHALL BE PERMITTED FOR USE ON SITE.
2. AT THE DISCRETION OF THE PROJECT MANAGER OR MUNICIPAL STAFF, ADDITIONAL SILT CONTROL DEVICES SHALL BE INSTALLED AT DESIGNATED LOCATIONS.
3. FOR SILT FENCE BARRIER, USE OPSD 219.110. GEOTEXTILE FOR SILT FENCE AS PER OPSS 1860, TABLE 3.
4. EXCEPT AS PROVIDED IN PARAGRAPHS 4.1., and 4.2. BELOW, STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS FEASIBLE IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, BUT IN NO CASE MORE THAN 14 DAYS AFTER THE CONSTRUCTION ACTIVITY HAS TEMPORARILY OR PERMANENTLY CEASED.
   - 4.1. WHERE THE INITIATION OF STABILIZATION MEASURES BY THE 14TH DAY AFTER CONSTRUCTION ACTIVITY TEMPORARILY OR PERMANENTLY CEASE IS PRECLUDED BY SNOW COVER, STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS FEASIBLE.
   - 4.2. WHERE CONSTRUCTION ACTIVITY WILL RESUME ON A PORTION OF THE SITE WITHIN 21 DAYS FROM WHEN ACTIVITIES CEASED, (E.G. THE TOTAL TIME PERIOD THAT CONSTRUCTION ACTIVITY IS TEMPORARILY CEASED IS LESS THAN 21 DAYS) THEN STABILIZATION MEASURES DO NOT HAVE TO BE INITIATED ON THAT PORTION OF SITE BY THE 14TH DAY AFTER CONSTRUCTION ACTIVITY TEMPORARILY CEASED.
5. SEDIMENT THAT IS ACCUMULATED BY THE TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES SHALL BE REMOVED IN A MANNER THAT AVOIDS ESCAPE OF THE SEDIMENT TO THE DOWNSTREAM SIDE OF THE CONTROL MEASURE AND AVOIDS DAMAGE TO THE CONTROL MEASURE. SEDIMENT SHALL BE REMOVED TO THE LEVEL OF THE GRADE EXISTING AT THE TIME THE CONTROL MEASURE WAS CONSTRUCTED AND BE ACCORDING TO THE FOLLOWING:
   - 5.1. FOR LIGHT-DUTY SEDIMENT BARRIERS, ACCUMULATED SEDIMENT SHALL BE REMOVED ONCE IT REACHES THE LESSER OF THE FOLLOWING:
     - 5.1.1. A DEPTH OF ONE-HALF THE EFFECTIVE HEIGHT OF THE CONTROL MEASURE.
     - 5.1.2. A DEPTH OF 300 MM IMMEDIATELY UPSTREAM OF THE CONTROL MEASURE.
   - 5.2. FOR ALL CONTROL MEASURES, ACCUMULATED SEDIMENT SHALL BE REMOVED AS NECESSARY TO PERFORM MAINTENANCE REPAIRS.
   - 5.3. ACCUMULATED SEDIMENT SHALL BE REMOVED PRIOR TO THE REMOVAL OF THE CONTROL MEASURE.
   - 5.4. ACCUMULATED SEDIMENT IS TO BE REMOVED AND DISPOSED OF AS PER OPSS 180.
6. ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES SHALL BE MONITORED TO ENSURE THEY ARE IN EFFECTIVE WORKING ORDER. THE CONDITION OF THE CONTROL MEASURES SHALL BE MONITORED PRIOR TO ANY FORECAST STORM EVENT AND FOLLOWING A STORM EVENT.
7. DUST CONTROL MEASURES SHOULD BE CONSIDERED PRIOR TO CLEARING AND GRADING. THE USE OF WATER, CALCIUM CHLORIDE FLAKES/SOLUTION OR MAGNESIUM CHLORIDE FLAKES/SOLUTION SHALL BE USED AS DUST SUPPRESSANTS AS PER OPSS 506. THIS IS TO LIMIT WIND EROSION OF SOILS WHICH MAY TRANSPORT SEDIMENTS OFFSITE, WHERE THEY MAY BE WASHED INTO THE RECEIVING WATER BY THE NEXT RAINSTORM.
8. ALL 'GREEN AREAS' TO BE TREATED WITH 150mm TOPSOIL AND HYDROSEEDING AS SOON AS FEASIBLE, AS PER OPSS 570.
9. TOPSOIL TO BE STRIPPED. CLEAN FILL TO BE PLACED IN FILL AREAS AND COMPACTED TO 95% STANDARD PROCTOR DENSITY.
10. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER UNLESS OTHERWISE SPECIFIED.
11. STOCKPILED MATERIAL IS TO BE STORED AWAY FROM POTENTIAL RECEIVERS (E.G. STORM CATCHBASINS, MANHOLES), AND BE SURROUNDED BY EROSION CONTROL MEASURES WHERE MATERIAL IS LEFT IN PLACE IN EXCESS OF 14 DAYS.
12. IF REQUIRED, DEWATERING/SETTLING BASINS SHALL BE CONSTRUCTED AS PER OPSD 219.240 AND LOCATED ON FLAT GRADE UPSTREAM OF OTHER EXISTING MITIGATION MEASURES. WATERCOURSES SHALL NOT BE DIVERTED, OR BLOCKED, AND TEMPORARY WATERCOURSES CROSSINGS SHALL NOT BE CONSTRUCTED OR UTILIZED, UNLESS OTHERWISE SPECIFIED IN THE CONTRACT. IF CLOSURE OF ANY PERMANENT WATER PASSAGE IS NECESSARY, THE CONTRACTOR SHALL RELEASE ANY STRANDED FISH TO THE OPEN PORTION OF THE WATERCOURSE WITHOUT HARM.
13. ALL EROSION AND SEDIMENT CONTROL MEASURES SHALL CONFORM TO OPSS 577
14. WHERE DEWATERING IS REQUIRED, THE DISCHARGED WATER SHALL BE CONTROLLED IN ACCORDANCE WITH OPSS 518.
15. ALL SETTLING/FILTRATION BASINS SHALL BE EQUIPPED WITH TERRAFIX 270R GEOTEXTILE (OR APPROVED EQUIVALENT) AND SHALL BE CLEANED AND REPLACED AS REQUIRED



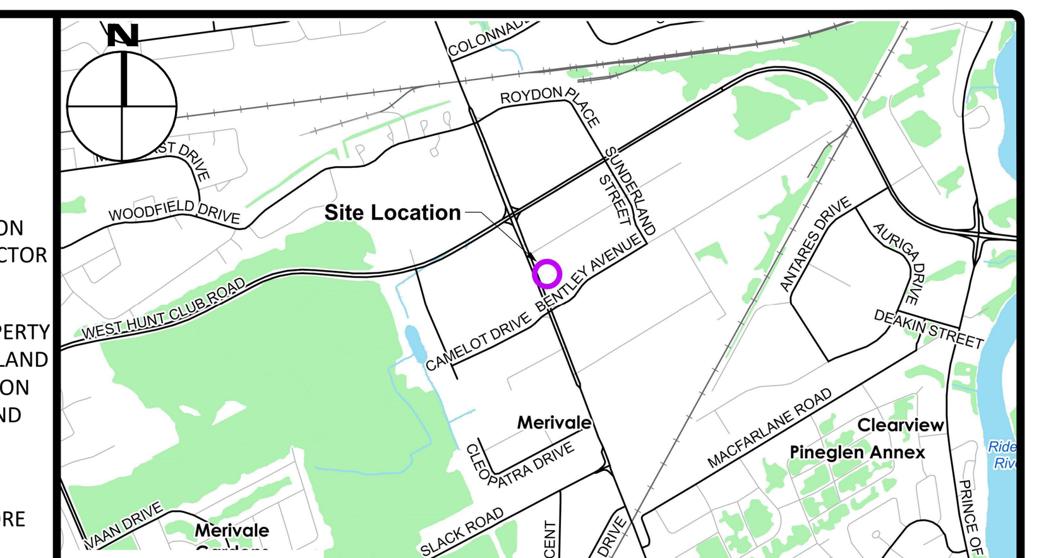
INLET SEDIMENT CONTROL DEVICE
N.T.S.



HEAVY DUTY PAVEMENT CROSS-SECTION
NOT TO SCALE

PARKING AREA PAVEMENT CROSS-SECTION
NOT TO SCALE

ASPHALT CROSS-SECTIONS TO CONFORM TO GEOTECHNICAL REPORT COMPLETED BY ARCADIS, DATED JANUARY 29, 2023



LOCATION PLAN

LEGEND

PROPERTY LINE	CENTRELINE OF SWALE
BARRIER CURB & CURB DEPRESSION (DC)	CENTRELINE OF DITCH
PROPOSED HEAVY DUTY ASPHALT	SLOPING AT 3:1 UNLESS SPECIFIED
PROPOSED CONCRETE WALKWAY	95.94 / 93.20 PROPOSED ELEVATION / EXISTING ELEVATION
MH# STORM MANHOLE	95.94 (S) SWALE ELEVATION
CB / CICB / DI CATCHBASIN, CURB INLET OR DITCH INLET	T/W100.50 / B/W90.50 TOP/BOTTOM WALL FACE ELEVATIONS
	EMERGENCY OVERLAND FLOW ROUTE
MH#A SANITARY MANHOLE	SILT FENCE BARRIER PER OPSD 219.110
PERFORATED PIPE	O/H BUILDING ENTRANCE OVERHEAD DOOR
WATER VALVE/CHAMBER	REDUCER
FIRE HYDRANT	
PROPOSED WALL	LOCATION OF TWSI PER ARCHITECTURAL
SEDIMENT CONTROL DEVICE PER DETAIL	LOCATION OF SIAMESE CONNECTION
ROADCUT AND REINSTATEMENT PER CITY R10	RD LOCATION OF ROOF DRAIN
SERVICE/WATERMAIN BEND	SC LOCATION OF SCUPPER
① SERVICE/SEWER CROSSING LOCATION	LOCATION OF PROPOSED ASPHALT SIDEWALK C/W BARRIER CURB PER SC1.1

FOR REVIEW ONLY
NOT FOR CONSTRUCTION

No.	Revisions	Date
1	ISSUED FOR SITE PLAN CONTROL	FEB 13, 2023

Check and verify all dimensions before proceeding with the work — Do not scale drawings

SCALE 1 : 400
0 10 20 30 40 Metres

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A 1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

Stamp:

Client:
Z.V. HOLDINGS CORP.
1801 WOODWARD DRIVE
OTTAWA, ON K2C 0R3

Project:
WAREHOUSE DEVELOPMENT
1881 MERIVALE ROAD
OTTAWA ON

Drawing Title:
GRADING, DRAINAGE AND EROSION & SEDIMENT CONTROL PLAN

Scale: 1:400	Project Number: CCO-23-1150
Drawn By: R.R.R.	
Checked By: R.D.F.	Drawing Number: C101
Designed By: R.R.R.	

D07-12-XX-XXXX

#XXXXX

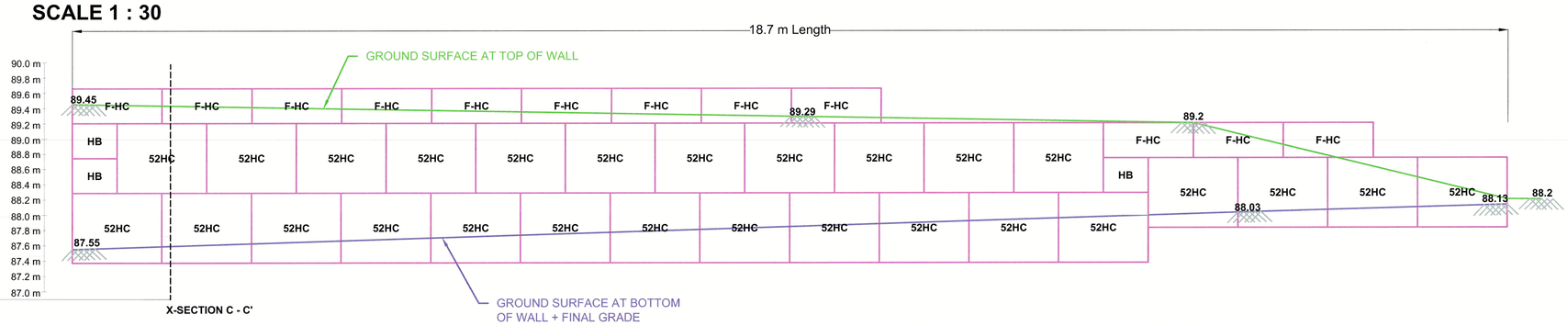
FILENAME: U:\Infrastructure\2023\CCO-23-1150 Amon Dev 1881 Merivale Road\12 - Drawings\CCO-23-1150_PRESENTATION.dwg
LAST SAVED: Thursday, February 16, 2023 LAST SAVED BY: rrobineau
LAST PLOTTED: Thursday, May 18, 2023 CTB FILE USED: ----

Appendix F

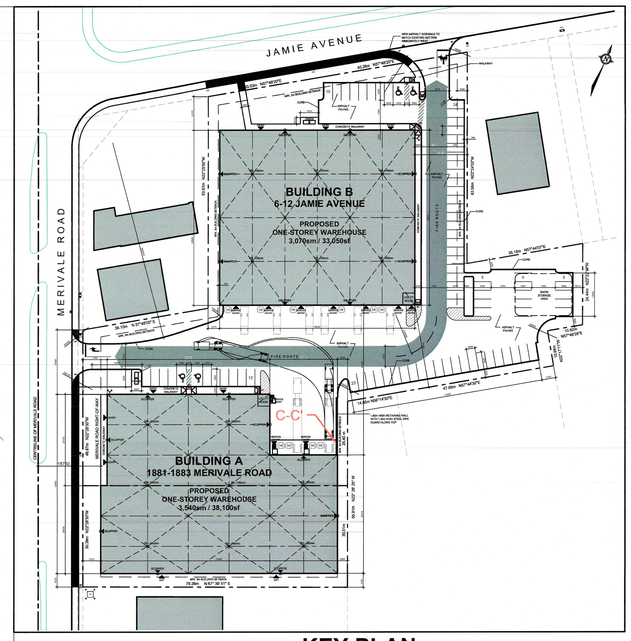
Drawing C-01: Retaining Wall -1

NOT FOR CONSTRUCTION - ISSUED FOR REVIEW

PROFILE VIEW
SCALE 1 : 30

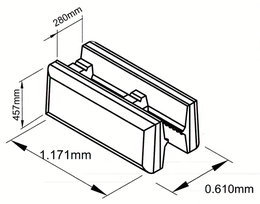


X-SECTION C - C'



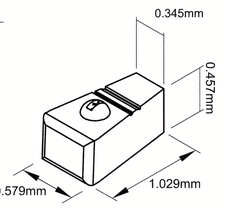
KEY PLAN
SCALE 1 : 750

Free-Standing Hollow Core (F-HC)



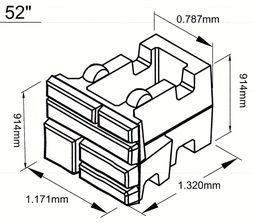
12 UNITS

Half Bottom - 41" (HB)



3 UNITS

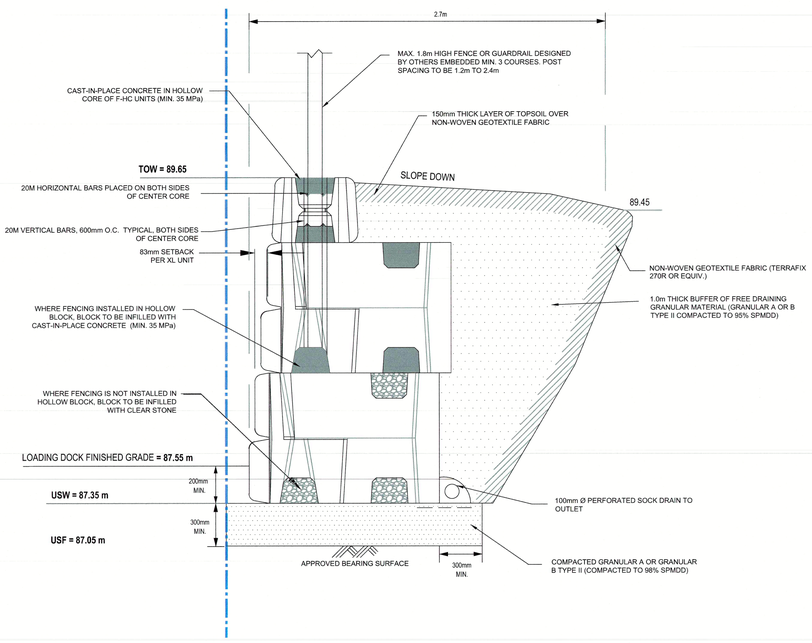
XL Hollow Core - 52" (52 HC)



27 UNITS

CROSS SECTION C-C:
SCALE 1:35

LOADING DOCK
EAST SIDE



NOTES:

1. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR UTILITY CLEARANCES AND CONSTRUCTION SITE SAFETY. ARCADIS SHALL NOT BE RESPONSIBLE FOR MEANS OR METHODS OF CONSTRUCTION OR FOR SAFETY OF WORKERS OR OF THE PUBLIC.
2. THIS DESIGN IS BASED ON THE FOLLOWING SOIL PROPERTIES:

PROPERTY	RETAINED FILL	FOUNDATION MEDIUM (1)
FRICTION ANGLE - ϕ	40°	33°
UNIT WEIGHT - γ	21 kN/m^3	18 kN/m^3
COHESION - C	0 kPa	0 kPa
SOIL TYPE	OPSS GRANULAR B TYPE II	POORLY GRADED SAND, FINE GRAINED, LIGHT GREY, MEDIUM DENSITY, SOME SILT (SPT=10)

MATERIAL PROPERTIES ARE BASED ON SITE EVALUATION BY ARCADIS AND DISCUSSIONS WITH CONTRACTOR. SEISMIC LOADIN GWAS EVALUATED ACCORDING TO THE CURRENT NBCC WITH A PEAK GROUND ACCELERATION VALUE OF 0.303.

3. DESIGN ELEVATIONS WERE BASED ON GRADING PLAN PROVIDED BY MCROBIE ARCHITECTS, DATED 9 MAY 2023. WALL BASE DESIGN ASSUMES A BEARING RESISTANCE AT SLS OF 100 KPA ON MEDIUM DENSITY SAND. ARCADIS ENGINEER SHOULD OBSERVE THE BEARING CONDITIONS AND ADJUST THE THICKNESS OF THE GRANULAR BASE TO ACCOMMODATE THE SITE CONDITIONS, IF NECESSARY.
4. THE DESIGN HAS BEEN REVIEWED FOR THE STABILITY OF THE PRECAST MODULAR RETAINING WALL SYSTEM AND GLOBAL STABILITY WITH A FACTOR OF SAFETY OF 1.3 FOR STATIC CONDITIONS AND 1.1 UNDER SEISMIC CONDITIONS. WALL GEOMETRY AND GRADE ELEVATIONS ABOVE AND BELOW THE WALL SHOULD CONFORM WITH THE GRADING PLAN PROVIDED HEREIN. IF ACTUAL SITE GRADES VARY SIGNIFICANTLY FROM THOSE SHOWN OR IF THE BACK SLOPE DOES NOT CONFORM, INSTALLATION SHALL NOT PROCEED UNTIL THE DESIGN IS VERIFIED OR MODIFIED IN THE APPLICABLE AREA.
5. PRECAST UNITS SHALL BE REDI-ROCK RETAINING WALL UNITS MANUFACTURED UNDER LICENSE FROM REDI-ROCK.
6. THE WALL BASE FOR THE WALL SHALL CONSIST OF A MIN. 300mm THICK OPSS GRANULAR A COMPACTED TO MIN. 98% OF THE MATERIALS SPMDD AND TESTED BY ARCADIS GEOTECHNICAL PERSONNEL AT THE TIME OF CONSTRUCTION. SURFACE OF GRANULAR BASE MAY BE DRESSED WITH FINER AGGREGATE TO AID LEVELING. ENSURE GRADATION OF DRESSING MATERIAL IS SUCH AS TO PRECLUDE LOSS OF FINES INTO BASE. THE THICKNESS OF DRESSING LAYER SHOULD NOT EXCEED 3 TIMES THE MAXIMUM PARTICLE SIZE USED.
7. WALL IS DESIGNED WITH A MIN. 200mm TOE EMBEDMENT WITH A MIN. HORIZONTAL LEDGE WITH A GRANULAR BEDDING LAYER EXTENDING A MIN. 300mm BEYOND HEEL OF THE BASE BLOCK
8. INSTALL 100mm DIAMETER PERFORATED PIPE WRAPPED WITH A GEOSOCK DRAIN BEHIND HEEL OR UNDER THE WALL. PROVIDE CLEAR STONE SURROUND TO PROTECT PIPE FROM CLOGGING AND DAMAGE. PROVIDE OUTLETS THROUGH WALL, NO FURTHER APART THAN 10.0m ON CENTRES. THE DRAINAGE PIPE SHOULD BE CONNECTED TO A POSITIVE OUTLET ON BOTH ENDS OF THE RETAINING WALL SUCH AS AN EXISTING DITCH OR CATCH BASIN.
9. THE CONDITIONS WILL BE EVALUATED BY THE GEOTECHNICAL ENGINEER DURING PREPARATION FOR WALL CONSTRUCTION IN EACH AREA. WHERE GRANULAR BEDDING WILL NOT BE SUFFICIENT THE USE OF CONCRETE BEDDING MAY BE REQUIRED.
10. ALIGNMENT OF THE BOTTOM WALL UNIT COURSE SHOULD BE PLANNED TO CONSIDER THAT A NOMINAL 41mm AUTOMATIC SETBACK WILL OCCUR WITH EACH 0.46m INCREMENT OF HEIGHT.
11. BACKFILL MATERIAL SHALL BE APPROVED BY THE SITE GEOTECHNICAL ENGINEER PRIOR TO USE AND SHOULD CONSIST OF OPSS GRANULAR A OR B TYPE II FOLLOWED BY SUITABLE BACKFILL MATERIAL. ALL FILL WITHIN A 1H:1V ZONE UP AND BACK FROM THE HEEL SHOULD ALSO BE COMPACTED. BACKFILL SHALL BE PLACED IN MAXIMUM 300mm LOOSE LIFTS AND COMPACTED TO A MINIMUM OF 95% OF SPMDD. MOISTURE CONTENT SHOULD BE CONTROLLED AND MAINTAINED WITHIN -3 TO +4 PERCENT OF OPTIMUM.
12. MAINTAIN TEMPORARY GRADES TO DIVERT SURFACE WATER AWAY FROM THE RETAINING WALL EXCAVATION. SLOPE FINAL BACKFILL TO PROVIDE POSITIVE DRAINAGE AND TO ELIMINATE PONDING.
13. BACKSLOPE SHOULD BE CUT BACK TO A MINIMUM OF 2H:1V TO 3H:1V TO MAINTAIN A LONG TERM SAFE SLOPE BEHIND THE RETAINING WALL. IT SHOULD BE NOTED THAT WHERE TREES ARE PRESENT WITHIN THE TOP OF SLOPE. A MINIMUM 1.0m SET BACK IS REQUIRED FOR EXCAVATION FROM THE EDGE OF THE TREE LINE WHERE PRESENT.
14. EXCAVATION SIDE SLOPES SHOULD BE PROTECTED TEMPORARILY DURING CONSTRUCTION FROM PRECIPITATION EVENTS BY PLACEMENT OF TARPS.
15. ALL RETAINING WALL RELATED INSPECTIONS (BEARING SURFACE, COMPACTION, BLOCK INSTALLATION, ETC.) MUST BE COMPLETED BY ARCADIS ONCE THE WALL CONSTRUCTION IS COMPLETED AND REVIEWED BY ARCADIS DURING CONSTRUCTION, A CERTIFICATE LETTER WILL BE ISSUED BY ARCADIS.
16. ANY CUTTING OF BLOCKS TO SUIT SITE CONDITIONS OR WALL DESIGN WILL BE RESPONSIBILITY OF THE CONTRACTOR.
17. IF WINTER CONSTRUCTION IS CONSIDERED, HEAT MUST BE MAINTAINED WHEN THE BASE IS EXPOSED. THE WALL BASE MUST COVERED WITH HIGH GRADE INSULATION TARPS TO MAINTAIN HEAT AND PROTECT THE BASE FROM POTENTIAL FROST HEAVE. ONCE THE BASE IS BACKFILLED, THE TOP OF THE WALL MUST BE COVERED WITH INSULATION TARPS OVERNIGHT UNTIL THE WALL CONSTRUCTION IS COMPLETED. ADDITIONAL INSPECTIONS WILL BE REQUIRED DURING WINTER CONSTRUCTION TO ENSURE THE WALL CONSTRUCTION IS IN GENERAL CONFORMANCE WITH ARCADIS RECOMMENDATIONS.
18. THE CONTRACTOR SHOULD REFER TO THE INSTALLATION MANUAL PROVIDED FOR THE RETAINING WALL BLOCK TYPE PROVIDED HEREIN FOR ADDITIONAL DETAILS ON ACCEPTABLE INSTALLATION PRACTICES.

SCALE(S) AS INDICATED

THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING: _____ USE TO VERIFY FIGURE REPRODUCTION SCALE

No.	Date	Revisions	By	Ckd

Professional Engineer's Name: Ryan V. Janzen
Professional Engineer's No.: 100209056

Province	Date Signed	Project Mgr.
ON	7 June 2023	RVJ
Designed by	Drawn by	Checked by
RVJ	BYR	TA

LICENSED PROFESSIONAL ENGINEER 2023.06.07 R. V. JANZEN 100209056 PROVINCE OF ONTARIO

ARCADIS CANADA, INC.

HP URBAN/ ZV HOLDINGS CORPORATION. ● 1881/1883 MERIVALE ROAD, OTTAWA
RETAINING WALL DESIGN

RETAINING WALL - 1

ARCADIS Project No. 30127480

Date 31 MAY 2023

Arcadis Canada Inc.
Suite 500, 333 Preston Street
Ottawa ON K1S 5N4 Canada
TEL. 613-703-3035

C-01

Appendix G

Redi Rock Retaining Wall Design - Global Stability Section

Analysis of Redi Rock wall

Input data (Stage of construction 1)

Task : Global Stability
Part : 1881 Merivale Development_Geotech
Description : Truck Bay Retaining Wall
Customer : ZV Holdings Corp.
Author : Ryan Janzen, P.Eng.
Date : 2023-05-17
Project ID : Merivale Geotech Consult
Project number : 30127480

Settings

USA - LRFD

Wall analysis

Verification methodology : according to LRFD
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Load factors					
Design situation - Service I					
		Minimum		Maximum	
Dead load of structural components :	DC =	1.00	[–]	1.00	[–]
Dead load of wearing surfaces :	DW =	1.00	[–]	1.00	[–]
Earth pressure - active :	EH_A =	1.00	[–]	1.00	[–]
Earth pressure - at rest :	EH_R =	1.00	[–]	1.00	[–]
Earth surcharge load (permanent) :	ES =	1.00	[–]	1.00	[–]
Vertical pressure of earth fill :	EV =	1.00	[–]	1.00	[–]
Live load surcharge :	LL =	0.00	[–]	1.00	[–]
Water load :	WA =	1.00	[–]	1.00	[–]

Resistance factors			
Design situation - Service I			
Resistance factor on overturning :	ϕ_o =	1.00	[–]
Resistance factor on sliding :	ϕ_t =	1.00	[–]
Resistance factor on bearing capacity :	ϕ_b =	1.00	[–]
Resistance factor on passive pressure :	ϕ_{VE} =	1.00	[–]

Blocks

No.	Description	Height h [mm]	Width w [mm]	Unit weight γ [kN/m³]
1	Block 28	457.2	711.2	18.85
2	Block 41	457.2	1028.7	18.85
3	Block 60	457.2	1524.0	20.42
4	Top block 24 straight	457.2	609.6	16.97
5	Planter 41	457.2	1028.7	18.85
6	Planter 60	457.2	1524.0	17.59

No.	Description	Height h [mm]	Width w [mm]	Unit weight γ [kN/m³]
7	Top block 28	457.2	711.2	18.85
8	Top block 41	457.2	1028.7	18.85
9	Top block 24 straight garden	457.2	609.6	12.57
10	Block R-5236 HC	914.4	1320.8	17.28
11	Block R-7236 HC	914.4	1828.8	17.28
12	Block R-9636 HC	914.4	2438.4	17.28
13	Block R-41 HC	457.2	1028.7	17.28

No.	Description	Min. shear strength F_{min} [kN/m]	Max. shear strength F_{max} [kN/m]	Friction f [°]
1	Block 28	88.45	164.56	44.00
2	Block 41	88.45	164.56	44.00
3	Block 60	88.45	164.56	44.00
4	Top block 24 straight	88.45	164.56	44.00
5	Planter 41	88.45	164.56	44.00
6	Planter 60	88.45	164.56	44.00
7	Top block 28	88.45	164.56	44.00
8	Top block 41	88.45	164.56	44.00
9	Top block 24 straight garden	88.45	164.56	44.00
10	Block R-5236 HC	66.40	175.13	44.00
11	Block R-7236 HC	66.40	175.13	44.00
12	Block R-9636 HC	66.40	175.13	44.00
13	Block R-41 HC	78.19	188.35	37.00

Setbacks

No.	Setback s [mm]
1	0.254
2	9.525
3	41.275
4	238.125
5	422.275

Geometry

No. group	Description	Count	Setback s [mm]
1	Block R-5236 HC	2	82.6
2	Top block 24 straight	1	-

Base

Geometry

Upper setback a_1 = 0.15 m
Lower setback a_2 = 0.30 m
Height h = 0.30 m
Width b = 1.90 m

Material

Soil creating foundation - Granular

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	SAND, some silt, trace clay		35.00	0.00	18.00	9.00	25.00
2	Granular		40.00	0.00	21.00	12.00	30.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

SAND, some silt, trace clay

Unit weight : γ = 18.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : δ = 25.00 °
Saturated unit weight : γ_{sat} = 19.00 kN/m³

Granular

Unit weight : γ = 21.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : δ = 30.00 °
Saturated unit weight : γ_{sat} = 22.00 kN/m³

Backfill

Assigned soil : Granular
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2.29	0.00 .. 2.29	SAND, some silt, trace clay	
2	-	2.29 .. ∞	SAND, some silt, trace clay	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	5.00		1.00	0.30	on terrain

No.	Name
1	Pedestrians

Resistance on front face of the structure

Resistance on front face of the structure: not considered
Soil on front face of the structure - Granular

Soil thickness in front of structure h = 0.50 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force edit	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	Yes		Fence Load	permanent	0.00	3.00	0.00	-0.30	0.00

Settings of the stage of construction

Design situation : Service I
Reduction of soil/soil friction angle : do not reduce

Verification No. 1 (Stage of construction 1)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.07	57.40	0.98	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.48	1.60	1.72	1.000	1.000	1.000
Weight - earth wedge	0.00	-2.35	5.14	1.33	1.000	1.000	1.000
Active pressure	13.69	-0.80	15.86	1.76	1.000	1.000	1.000
Pedestrians	0.47	-1.64	0.25	1.68	1.000	1.000	1.000
Fence Load	0.00	-2.59	3.00	0.77	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 96.30 kNm/m
Overturning moment M_{ovr} = 11.75 kNm/m

Capacity demand ratio CDR = 8.19
Wall for overturning is SATISFACTORY

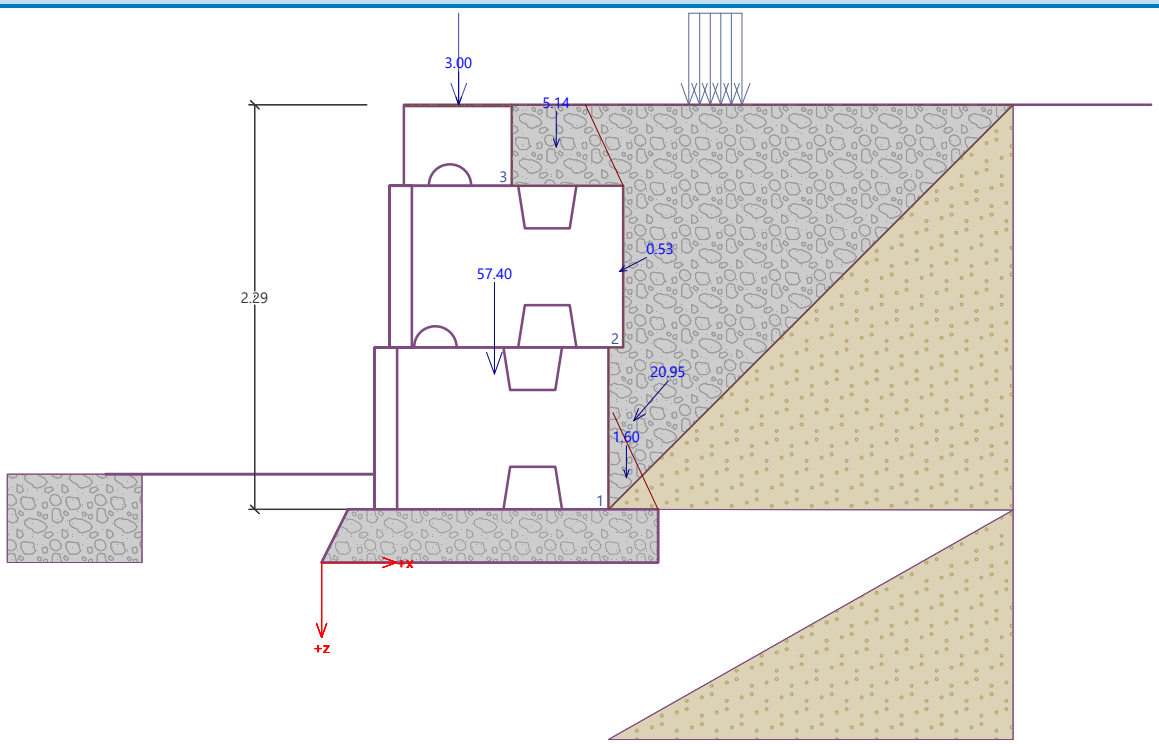
Check for slip

Resisting horizontal force H_{res} = 58.29 kN/m
Active horizontal force H_{act} = 14.17 kN/m

Capacity demand ratio CDR = 4.11
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Name : Verification | **Stage - analysis : 1 - 1**
Description : Initial



Dimensioning No. 1 (Stage of construction 1)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.01	45.43	0.68	1.000	1.000	1.000
Weight - earth wedge	0.00	-2.05	5.14	1.03	1.000	1.000	1.000
Active pressure	9.07	-0.78	5.48	1.35	1.000	1.000	1.000
Pedestrians	0.47	-1.34	0.25	1.38	1.000	1.000	1.000
Fence Load	0.00	-2.29	3.00	0.47	1.000	1.000	1.000

Verification of block No. 1

Check for overturning stability
Resisting moment M_{res} = 45.45 kNm/m
Overturning moment M_{ovr} = 7.69 kNm/m

Capacity demand ratio CDR = 5.91
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 49.75 kN/m
Active horizontal force H_{act} = 9.54 kN/m

Capacity demand ratio CDR = 5.21
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 1)

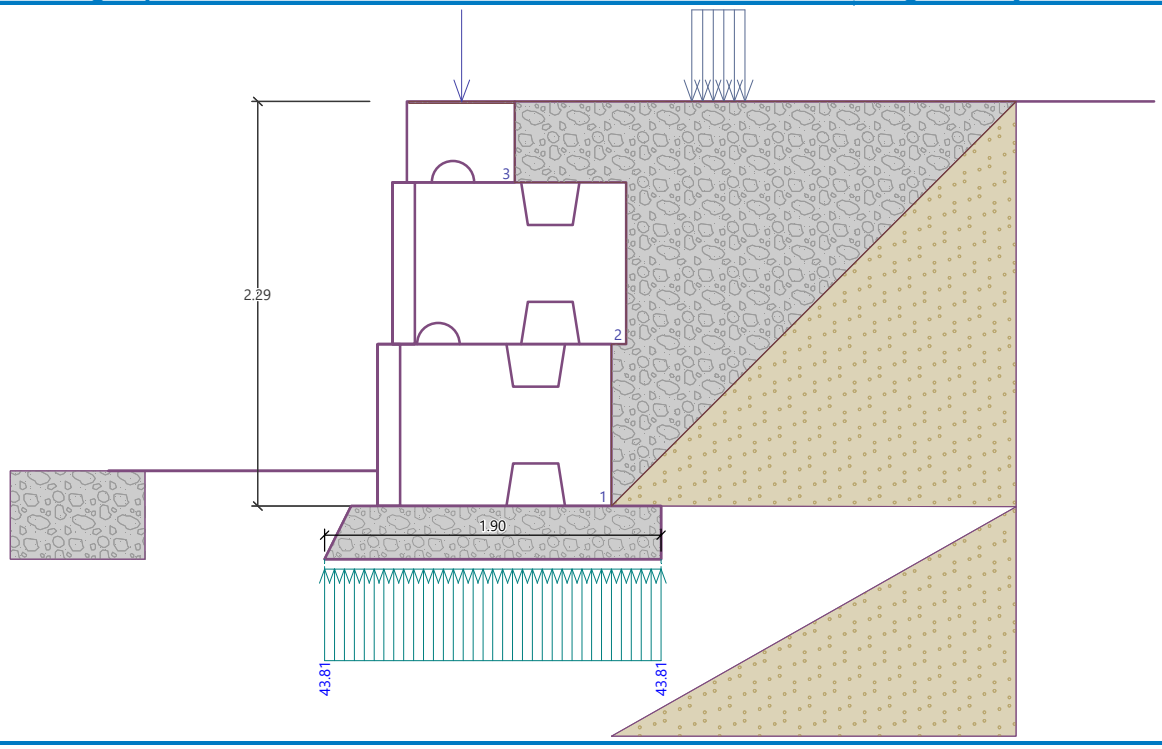
Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	-5.46	83.25	14.17	0.000	43.81

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-5.46	83.25	14.17

Name : Bearing cap. | **Stage - analysis : 1 - -1**



Slope stability analysis

Input data (Construction stage 1)

Settings

USA - LRFD

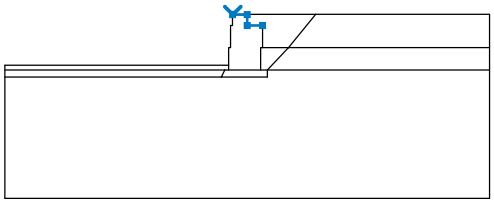
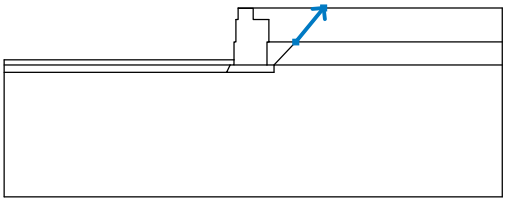
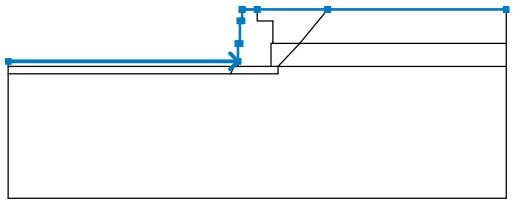
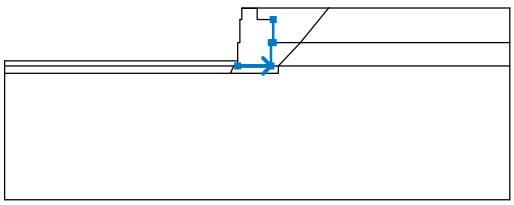
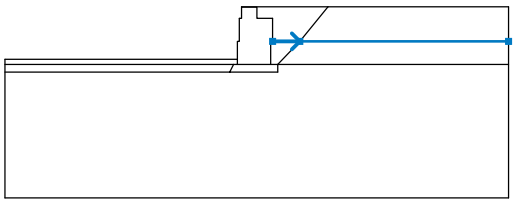
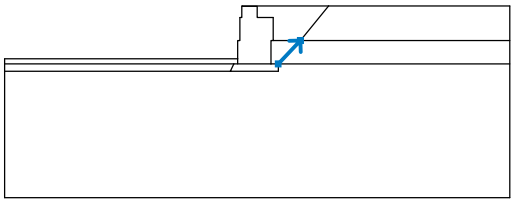
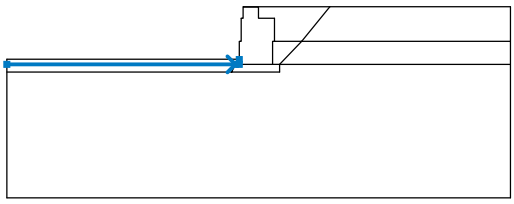
Stability analysis

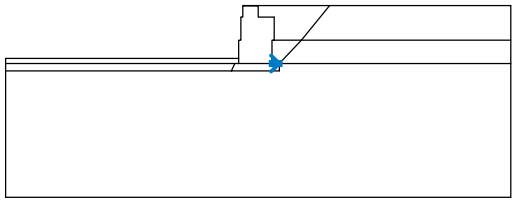
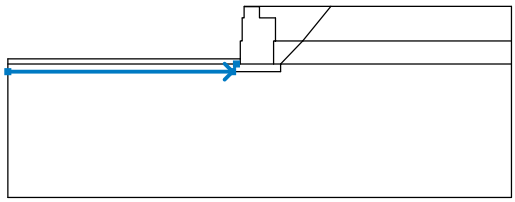
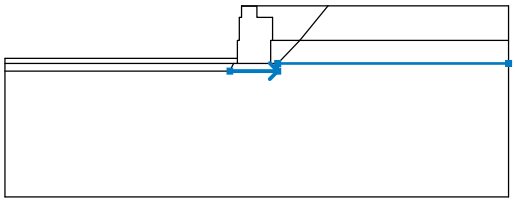
Verification methodology : according to LRFD
Earthquake analysis : Standard

Load factors					
Design situation - Service I					
		Minimum		Maximum	
Earth surcharge load (permanent) :	ES =	1.00	[–]	1.00	[–]
Live load surcharge :	LL =	0.00	[–]	1.00	[–]

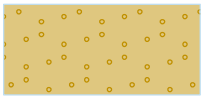
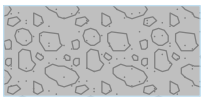
Resistance factors			
Design situation - Service I			
Resistance factor on stability :	ϕ_{SS} =	0.65	[–]

Interface

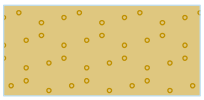
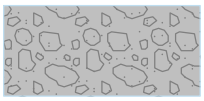
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-0.60	0.00	-0.60	-0.01	0.00	-0.01
		0.00	-0.46	0.63	-0.46		
2		1.71	-1.37	2.83	0.00		
3		-10.00	-2.09	-0.77	-2.09	-0.77	-1.37
		-0.69	-1.37	-0.69	-0.46	-0.61	-0.46
		-0.61	0.00	-0.60	0.00	0.00	0.00
		2.83	0.00	10.00	0.00		
4		-0.77	-2.29	0.55	-2.29	0.55	-1.37
		0.63	-1.37	0.63	-0.46		
5		0.63	-1.37	1.71	-1.37	10.00	-1.37
6		0.83	-2.29	1.71	-1.37		
7		-10.00	-2.29	-0.92	-2.29	-0.77	-2.29
		-0.77	-2.09				

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
8		0.55	-2.29	0.83	-2.29		
9		-10.00	-2.59	-1.07	-2.59	-0.92	-2.29
10		-1.07	-2.59	0.83	-2.59	0.83	-2.29
		10.00	-2.29				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	SAND, some silt, trace clay		35.00	0.00	18.00
2	Granular		40.00	0.00	21.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	SAND, some silt, trace clay		19.00		
2	Granular		22.00		

Soil parameters

SAND, some silt, trace clay

Unit weight :	γ = 18.00 kN/m^3
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 35.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Saturated unit weight :	γ_{sat} = 19.00 kN/m^3

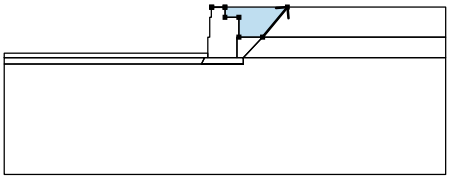
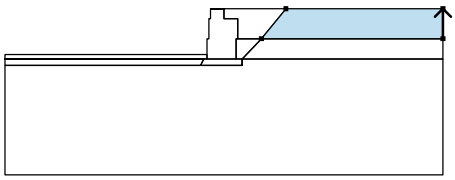
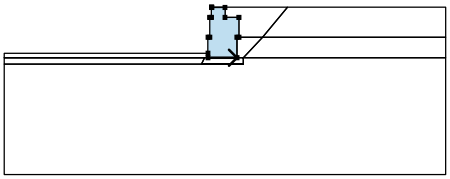
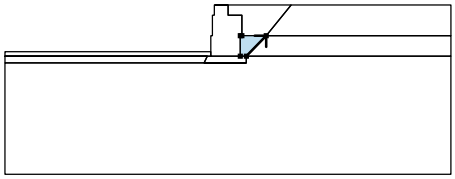
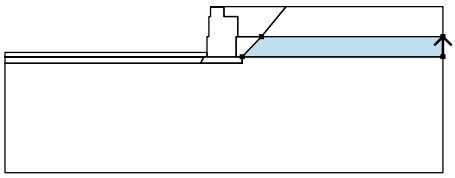
Granular

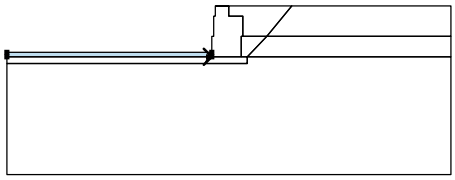
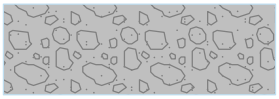
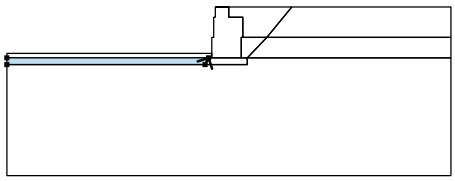
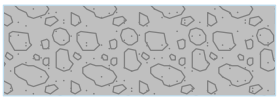
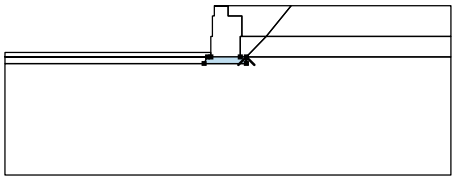
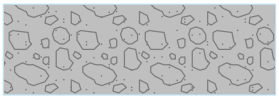
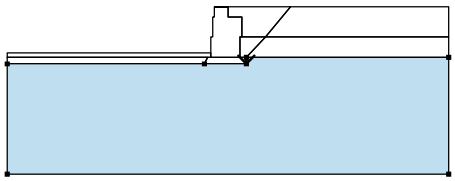
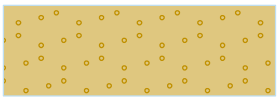
Unit weight :	γ =	21.00 kN/m^3
Stress-state :		effective
Shear strength :		Mohr-Coulomb
Angle of internal friction :	φ_{ef} =	40.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	22.00 kN/m^3

Rigid Bodies

No.	Name	Sample	γ [kN/m^3]
1	Material of structure		18.85

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		1.71	-1.37	2.83	0.00	Granular
		0.00	0.00	-0.60	0.00	
		-0.60	-0.01	0.00	-0.01	
		0.00	-0.46	0.63	-0.46	
		0.63	-1.37			
2		10.00	-1.37	10.00	0.00	SAND, some silt, trace clay
		2.83	0.00	1.71	-1.37	
3		-0.77	-2.29	0.55	-2.29	Material of structure
		0.55	-1.37	0.63	-1.37	
		0.63	-0.46	0.00	-0.46	
		0.00	-0.01	-0.60	-0.01	
		-0.60	0.00	-0.61	0.00	
		-0.61	-0.46	-0.69	-0.46	
		-0.69	-1.37	-0.77	-1.37	
		-0.77	-2.09			
4		0.83	-2.29	1.71	-1.37	Granular
		0.63	-1.37	0.55	-1.37	
		0.55	-2.29			
5		10.00	-2.29	10.00	-1.37	SAND, some silt, trace clay
		1.71	-1.37	0.83	-2.29	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
6		-0.92	-2.29	-0.77	-2.29	Granular
		-0.77	-2.09	-10.00	-2.09	
		-10.00	-2.29			
7		-1.07	-2.59	-0.92	-2.29	Granular
		-10.00	-2.29	-10.00	-2.59	
						
8		0.83	-2.59	0.83	-2.29	Granular
		0.55	-2.29	-0.77	-2.29	
		-0.92	-2.29	-1.07	-2.59	
						
9		0.83	-2.29	0.83	-2.59	SAND, some silt, trace clay
		-1.07	-2.59	-10.00	-2.59	
		-10.00	-7.59	10.00	-7.59	
		10.00	-2.29			

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	variable	on terrain	x = 1.00	l = 0.30		0.00	5.00		kN/m²

Surcharges

No.	Name
1	Pedestrians

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : Service I

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.03	[m]	Angles :	α_1 =	-35.12	[°]
	z =	0.83	[m]		α_2 =	76.56	[°]
Radius :	R =	3.57	[m]				
The slip surface after optimization.							

Total weight of soil above the slip surface: 145.52 kN/m

Slope stability verification (Bishop)

Sum of active forces : F_a = 52.63 kN/m

Sum of passive forces : F_p = 113.14 kN/m

Sliding moment : M_a = 187.91 kNm/m

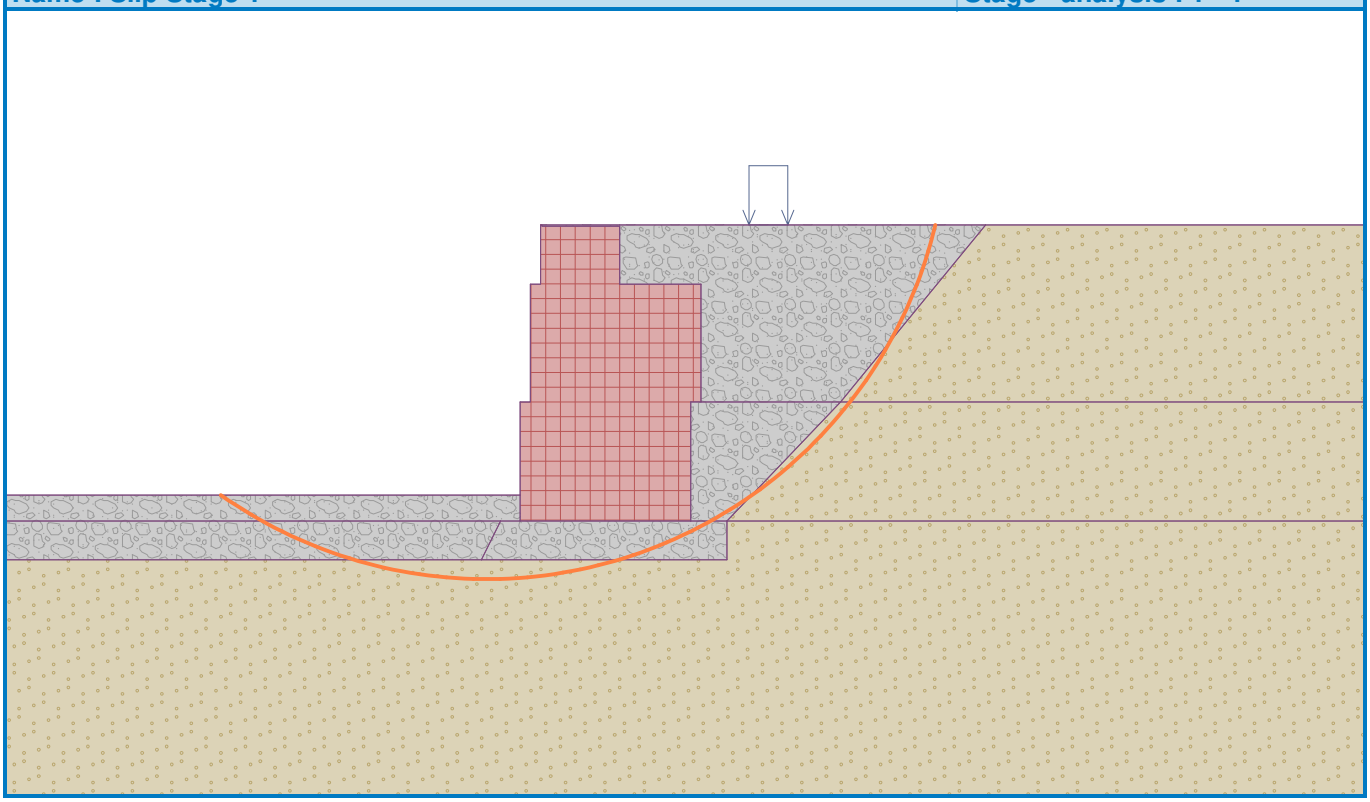
Resisting moment : M_p = 262.53 kNm/m

Utilization : 71.6 %

Capacity demand ratio CDR: 1.397

Slope stability ACCEPTABLE

Name : Slip Stage 1	Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2.29	0.00 .. 2.29	SAND, some silt, trace clay	
2	-	2.29 .. ∞	SAND, some silt, trace clay	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Granular
Soil thickness in front of structure $h = 0.50$ m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force edit	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	No	No	Fence Load	permanent	0.00	3.00	0.00	-0.30	0.00

Earthquake

Factor of horizontal acceleration $K_h = 0.1515$
Factor of vertical acceleration $K_v = 0.0000$

Water below the GWT is restricted.
Combination 1 - Seismic load reduction factor $p_{1,ir} = 0.50$
Combination 1 - Earth pressure reduction factor $p_{1,ae} = 1.00$
Combination 2 - Seismic load reduction factor $p_{2,ir} = 1.00$
Combination 2 - Earth pressure reduction factor $p_{2,ae} = 0.50$

Settings of the stage of construction

Design situation : Service I
Reduction of soil/soil friction angle : do not reduce

Verification No. 1 (Stage of construction 2)

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.07	57.40	0.98	1.000	1.000	1.000
Earthq.- constr.	8.84	-1.12	0.00	0.97	0.500	0.500	0.500
FF resistance	-0.94	-0.17	0.01	-0.15	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.48	1.60	1.72	1.000	1.000	1.000
Earthquake - soil wedge	0.24	-0.48	0.00	1.72	0.500	0.500	0.500
Weight - earth wedge	0.00	-2.35	5.14	1.33	1.000	1.000	1.000
Earthquake - soil wedge	0.78	-2.35	0.00	1.33	0.500	0.500	0.500
Active pressure	13.69	-0.80	15.86	1.76	1.000	1.000	1.000
Earthq.- act.pressure	5.82	-1.75	7.37	1.64	1.000	1.000	1.000
Fence Load	0.00	-2.59	3.00	0.77	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability
Resisting moment $M_{res} = 107.96$ kNm/m
Overturning moment $M_{ovr} = 26.94$ kNm/m

Capacity demand ratio CDR = 4.01
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force $H_{res} = 63.28$ kN/m
Active horizontal force $H_{act} = 23.50$ kN/m

Capacity demand ratio CDR = 2.69
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.07	57.40	0.98	1.000	1.000	1.000
Earthq.- constr.	8.84	-1.12	0.00	0.97	1.000	1.000	1.000
FF resistance	-0.94	-0.17	0.01	-0.15	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.48	1.60	1.72	1.000	1.000	1.000
Earthquake - soil wedge	0.24	-0.48	0.00	1.72	1.000	1.000	1.000
Weight - earth wedge	0.00	-2.35	5.14	1.33	1.000	1.000	1.000
Earthquake - soil wedge	0.78	-2.35	0.00	1.33	1.000	1.000	1.000
Active pressure	13.69	-0.80	15.86	1.76	0.500	0.500	0.500
Earthq.- act.pressure	5.82	-1.75	7.37	1.64	0.500	0.500	0.500
Fence Load	0.00	-2.59	3.00	0.77	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 87.94 kNm/m
Overturning moment M_{ovr} = 22.27 kNm/m

Capacity demand ratio CDR = 3.95
Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 55.15 kN/m
Active horizontal force H_{act} = 18.68 kN/m

Capacity demand ratio CDR = 2.95
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.01	45.43	0.68	1.000	1.000	1.000
Earthq.- constr.	7.29	-1.03	0.00	0.68	0.500	0.500	0.500
FF resistance	-0.15	-0.07	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-2.05	5.14	1.03	1.000	1.000	1.000
Earthquake - soil wedge	0.78	-2.05	0.00	1.03	0.500	0.500	0.500
Active pressure	9.07	-0.78	5.48	1.35	1.000	1.000	1.000
Earthq.- act.pressure	4.64	-1.56	5.44	1.31	1.000	1.000	1.000
Fence Load	0.00	-2.29	3.00	0.47	1.000	1.000	1.000

Verification of block No. 1

Check for overturning stability

Resisting moment M_{res} = 52.26 kNm/m
Overturning moment M_{ovr} = 18.82 kNm/m

Capacity demand ratio CDR = 2.78
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 54.12 kN/m
Active horizontal force H_{act} = 17.59 kN/m

Capacity demand ratio CDR = 3.08
Joint for verification is SATISFACTORY

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.01	45.43	0.68	1.000	1.000	1.000
Earthq.- constr.	7.29	-1.03	0.00	0.68	1.000	1.000	1.000
FF resistance	-0.15	-0.07	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-2.05	5.14	1.03	1.000	1.000	1.000
Earthquake - soil wedge	0.78	-2.05	0.00	1.03	1.000	1.000	1.000
Active pressure	9.07	-0.78	5.48	1.35	0.500	0.500	0.500
Earthq.- act.pressure	4.64	-1.56	5.44	1.31	0.500	0.500	0.500
Fence Load	0.00	-2.29	3.00	0.47	1.000	1.000	1.000

Verification of block No. 1

Check for overturning stability
Resisting moment M_{res} = 44.99 kNm/m
Overturning moment M_{ovr} = 16.21 kNm/m

Capacity demand ratio CDR = 2.78
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 49.53 kN/m
Active horizontal force H_{act} = 14.77 kN/m

Capacity demand ratio CDR = 3.35
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	4.83	90.37	23.50	0.028	50.40
2	9.15	78.76	18.68	0.061	47.23
3	9.15	78.76	18.68	0.061	47.23

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	10.75	90.37	28.43

Slope stability analysis

Input data (Construction stage 1)

Settings

USA - LRFD

Stability analysis

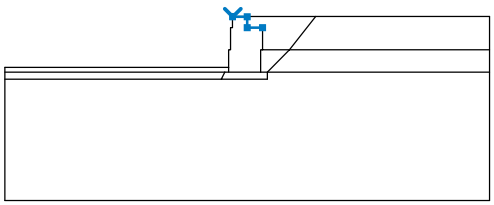
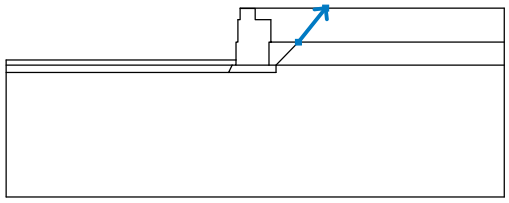
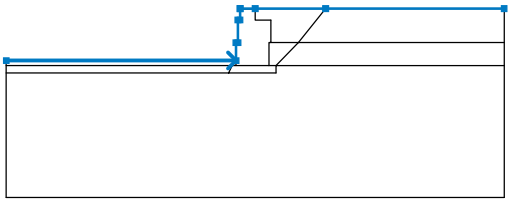
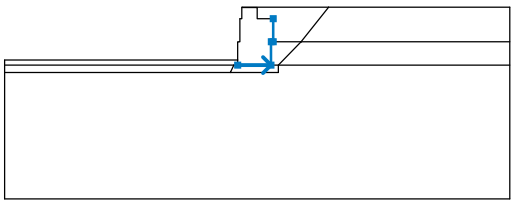
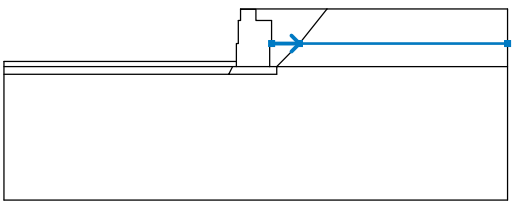
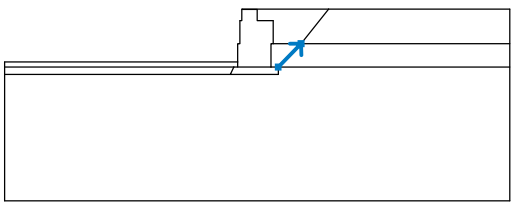
Verification methodology : according to LRFD

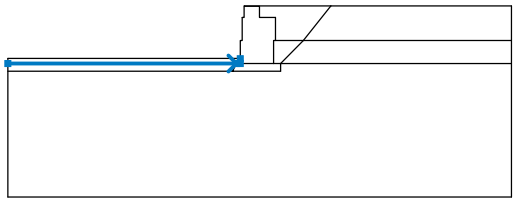
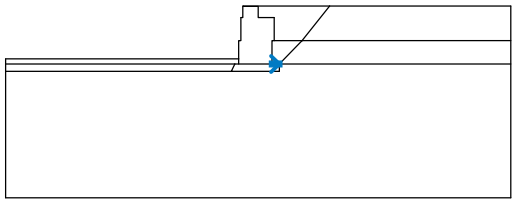
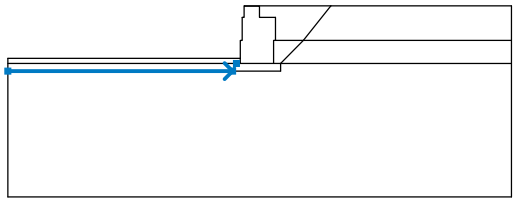
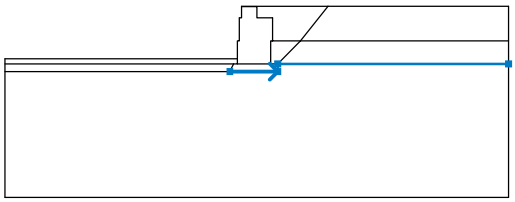
Earthquake analysis : Standard

Load factors					
Design situation - Service I					
		Minimum		Maximum	
Earth surcharge load (permanent) :	ES =	1.00	[–]	1.00	[–]
Live load surcharge :	LL =	0.00	[–]	1.00	[–]

Resistance factors			
Design situation - Service I			
Resistance factor on stability :	ϕ_{SS} =	0.65	[–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-0.60	0.00	-0.60	-0.01	0.00	-0.01
		0.00	-0.46	0.63	-0.46		
2		1.74	-1.37	2.83	0.00		
3		-10.00	-2.09	-0.77	-2.09	-0.77	-1.37
		-0.69	-1.37	-0.69	-0.46	-0.61	-0.46
		-0.61	0.00	-0.60	0.00	0.00	0.00
		2.83	0.00	10.00	0.00		
4		-0.77	-2.29	0.55	-2.29	0.55	-1.37
		0.63	-1.37	0.63	-0.46		
5		0.63	-1.37	1.74	-1.37	10.00	-1.37
6		0.83	-2.29	1.74	-1.37		

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
7		-10.00	-2.29	-0.92	-2.29	-0.77	-2.29
		-0.77	-2.09				
8		0.55	-2.29	0.83	-2.29		
9		-10.00	-2.59	-1.07	-2.59	-0.92	-2.29
10		-1.07	-2.59	0.83	-2.59	0.83	-2.29
		10.00	-2.29				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	SAND, some silt, trace clay		35.00	0.00	18.00
2	Granular		40.00	0.00	21.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	SAND, some silt, trace clay		19.00		
2	Granular		22.00		

Soil parameters

SAND, some silt, trace clay

Unit weight :	γ =	18.00 kN/m^3
Stress-state :		effective
Shear strength :		Mohr-Coulomb
Angle of internal friction :	φ_{ef} =	35.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	19.00 kN/m^3

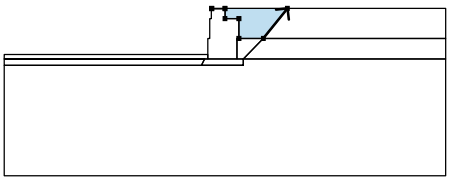
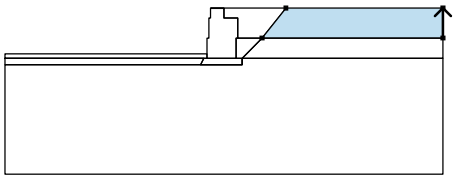
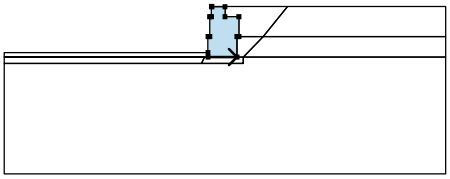
Granular

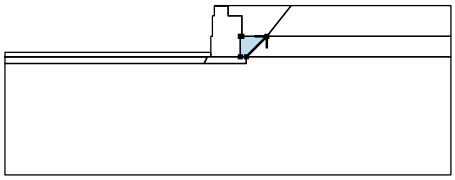
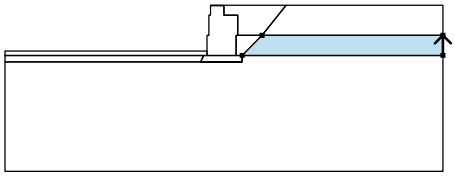
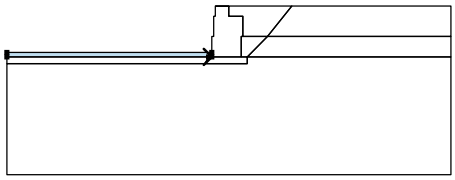
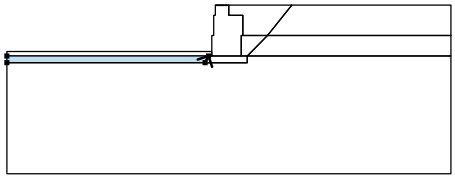
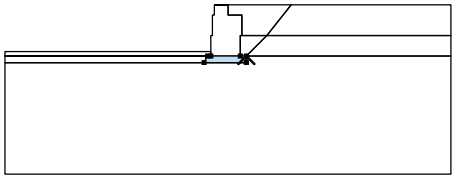
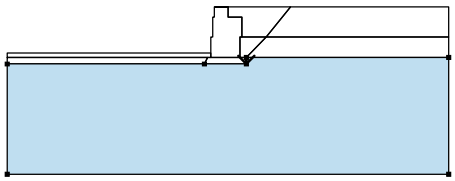
Unit weight :	γ =	21.00 kN/m^3
Stress-state :		effective
Shear strength :		Mohr-Coulomb
Angle of internal friction :	φ_{ef} =	40.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	22.00 kN/m^3

Rigid Bodies

No.	Name	Sample	γ [kN/m^3]
1	Material of structure		18.85

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		1.74	-1.37	2.83	0.00	Granular
		0.00	0.00	-0.60	0.00	
		-0.60	-0.01	0.00	-0.01	
		0.00	-0.46	0.63	-0.46	
		0.63	-1.37			
2		10.00	-1.37	10.00	0.00	SAND, some silt, trace clay
		2.83	0.00	1.74	-1.37	
3		-0.77	-2.29	0.55	-2.29	Material of structure
		0.55	-1.37	0.63	-1.37	
		0.63	-0.46	0.00	-0.46	
		0.00	-0.01	-0.60	-0.01	
		-0.60	0.00	-0.61	0.00	
		-0.61	-0.46	-0.69	-0.46	
		-0.69	-1.37	-0.77	-1.37	
		-0.77	-2.09			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		0.83	-2.29	1.74	-1.37	Granular
		0.63	-1.37	0.55	-1.37	
		0.55	-2.29			
5		10.00	-2.29	10.00	-1.37	SAND, some silt, trace clay
		1.74	-1.37	0.83	-2.29	
6		-0.92	-2.29	-0.77	-2.29	Granular
		-0.77	-2.09	-10.00	-2.09	
		-10.00	-2.29			
7		-1.07	-2.59	-0.92	-2.29	Granular
		-10.00	-2.29	-10.00	-2.59	
8		0.83	-2.59	0.83	-2.29	Granular
		0.55	-2.29	-0.77	-2.29	
		-0.92	-2.29	-1.07	-2.59	
9		0.83	-2.29	0.83	-2.59	SAND, some silt, trace clay
		-1.07	-2.59	-10.00	-2.59	
		-10.00	-7.59	10.00	-7.59	
		10.00	-2.29			

Earthquake

Horizontal seismic coefficient : K_h = 0.1515
Vertical seismic coefficient : K_v = 0.0000

Settings of the stage of construction

Design situation : Service I

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.24	[m]	Angles :	α_1 =	-32.07	[°]
	z =	1.52	[m]		α_2 =	69.10	[°]
Radius :	R =	4.26	[m]				
The slip surface after optimization.							

Total weight of soil above the slip surface: 154.93 kN/m

Slope stability verification (Bishop)

Sum of active forces : F_a = 69.39 kN/m

Sum of passive forces : F_p = 113.67 kN/m

Sliding moment : M_a = 295.59 kNm/m

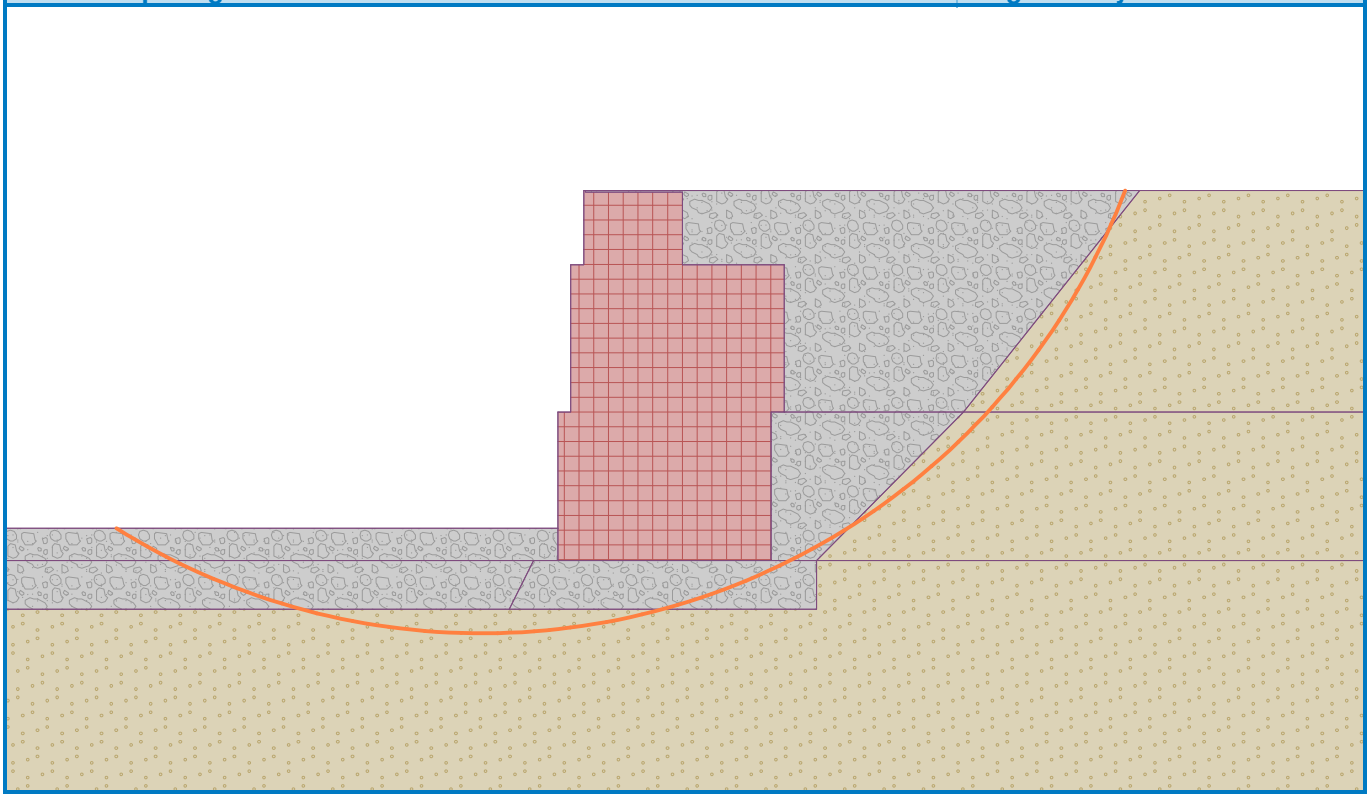
Resisting moment : M_p = 314.75 kNm/m

Utilization : 93.9 %

Capacity demand ratio CDR: 1.065

Slope stability ACCEPTABLE

Name : Slip Stage 2	Stage - analysis : 1 - 1



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