Environmental Impact Assessment

MacKinnon Ravine Pedestrian Bridge (B165) Replacement

City of Edmonton

Project No: 60682118

January 10, 2023

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			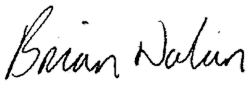
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A	July 27, 2022	DRAFT		Brian Nolan	Project Manager
B	October 21, 2022	DRAFT		Brian Nolan	Project Manager
C	January 10, 2023	FINAL		Brian Nolan	Project Manager

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Table of Contents

Tables

Appendices

1. Introduction

The City of Edmonton (CoE) is planning to replace the MacKinnon Ravine Pedestrian Trestle Bridge (Bridge B165; the Project), located east of the intersection of 149 Street NW and Stony Plain Road within Edmonton, Alberta (Figure 1, Appendix A). The bridge was removed in February 2022 due to safety reasons. The replacement bridge structure will accommodate multi-directional pedestrians and cyclists.

The proposed bridge is located on land subject to the North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188). Therefore, this Environmental Impact Assessment (EIA) was completed following the *North Saskatchewan River Valley Area Redevelopment Plan, A Guide to Completing Environmental Impact Assessments*. This EIA report considers the potential environmental effects of the Project.

2. The Property

2.1 Land Ownership

The land needed for the Project (Project Area) is owned by the City of Edmonton.

2.2 Location of Property

Municipal Address: 14212 Summit Drive NW, Edmonton, Alberta.

Legal Description for Title Lot: Block A, Plan 8722031.

Alberta Township Survey (ATS): SE 02-053-25 W4M.

2.3 Current Zoning

The Project land is zoned Metropolitan Recreation Zone (A), the purpose of which is to preserve natural areas and parkland along the river, creeks, ravines, and other designated areas for active and passive recreational uses and environmental protection.

The Project is also located within the North Saskatchewan River Valley and Ravine System Protection Overlay, which is a development setback from the North Saskatchewan River Valley and Ravine System.

2.4 Description of Existing and Historic Land Uses

Based on a review of historical images, the MacKinnon Ravine was intact and surrounded by agricultural activities prior to 1930. Urban development surrounding the ravine began to occur after 1930. The original MacKinnon Ravine Pedestrian Trestle Bridge was constructed in 1940. Urban development surrounding the ravine increased between 1943 and 1948. Expansion of urban development continued between 1948 and 1952. In 1957, MacKinnon Ravine was surrounded by urban development on either side. The bridge was replaced in 1978. Historical images are found in Appendix A.

Currently, the official name for this section of the ravine is MacKinnon Ravine Park, which is classified as a Natural Area Park by the CoE. There are CoE trails through the MacKinnon Ravine which are part of the larger trail network through the North Saskatchewan River Valley and Ravine System. The ravine is surrounded by urban development. Grovenor neighborhood is to the north of the Project and Crestwood neighborhood is to the south (CoE 2019a).

2.5 Regulatory Requirements

The following table is a summary of federal, provincial, municipal legislation, regulations, and policies that may pertain to the Project.

Table 1: Summary of Regulatory Requirements

Name	Summary	Project Applicability
Federal		
Species at Risk Act	The *Species At Risk Act* (SARA) contains several prohibitions to protect species listed on Schedule 1 of SARA. Under Sections 32 and 33 of SARA, it is an offence to: • kill, harm, harass, capture or take an individual of a species listed as extirpated, endangered or threatened under SARA. • possess, collect, buy, sell or trade an individual (or any part or derivative of such an individual) of a species listed as extirpated, endangered or threatened under SARA. • damage or destroy the residence of one or more individuals of a listed endangered, threatened or extirpated species if a recovery strategy has recommended its reintroduction into the wild in Canada. SARA also contains provisions that prohibit the destruction of any part of the critical habitat of listed aquatic species (Section 58(1)). Critical habitat is: • the habitat necessary for the survival or recovery of the species. • identified and described in the recovery strategy or action plan for that species.	Potential - if species at risk are present.
Migratory Birds Convention Act 1994 and Migratory Birds Regulations	The *Migratory Birds Convention Act, 1994* (MBCA) aims to protect migratory birds, their nests, and their eggs. Birds protected by the MBCA include waterfowl (such as ducks, geese, and swans), insectivorous birds (such as wrens, robins, shrikes, and woodpeckers), and some nongame birds (such as herons and gulls). The MBCA is applicable to all lands and waterbodies in Canada and applies to all activities associated with organizations, industries, and individuals. To protect migratory birds, the MBCA provides general nesting periods based on geographic location. The general nesting period covers the majority of species covered under the MBCA, however, it may not be accurate for species that can breed at any time during optimal conditions (e.g., crossbill species), or species that may nest earlier or later. It is important to note that this period may not include those nesting periods for species not covered under the MBCA but are covered under Alberta's *Wildlife Act* (see below).	Potential - if work occurs within the migratory bird breeding season.
Fisheries Act	The *Fisheries Act* provides a legal basis for conserving and protecting fish and fish habitat. The fish and fish habitat protection provisions of the *Fisheries Act* provide a holistic approach to conserving and protecting fish and fish habitat, supported by policies and programs that provide for the long-term sustainability of freshwater and marine resources. The fish and fish habitat protection provisions of the *Fisheries Act* include: • a prohibition against causing the death of fish, by means other than fishing (Section 34.4). • a prohibition against causing the harmful alteration, disruption or destruction of fish habitat (Section 35). • a framework of considerations to guide the Minister's decision-making functions (Section 34.1). • ministerial powers to ensure the free passage of fish or the protection of fish or fish habitat with respect to existing obstructions (Section 34.3).	No - fish habitat not present.

Name	Summary	Project Applicability
	Fisheries and Oceans Canada (DFO) has developed Measures to Protect Fish and Fish Habitat (Government of Canada 2021a) for compliance with the fish and fish habitat protection provisions of the *Fisheries Act* by incorporating measures to avoid: • causing the death of fish. • harmful alteration, disruption or destruction of fish habitat in the work, undertaking or activity.	
Provincial		
Water Act, Water (Ministerial) Regulation, and Codes of Practice	The *Water Act* manages Alberta's water resources. The Act governs activities affecting waterbodies in Alberta (including wetlands and watercourses). A waterbody is defined as "any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent or occurs only during a flood". The Act is applicable when a shoreline, surface water, and/or groundwater resource may be affected. An approval under the *Water Act* is required to alter flow levels of water; change the location of water; change the direction of water flow, cause the siltation of water; cause erosion of bed or shore of any waterbody; or any effect on the aquatic environment (in drainages, watercourses and wetlands).	No - no waterbodies present and water flow will not be changed.
Public Lands Act	The intent of the *Public Lands Act* is to govern lands that are designated as public land. It does not include privately owned land, National Parks, First Nations reserve, or Provincial Parks. Under the Act, the Crown can claim ownership of the bed and shore of permanent and naturally occurring bodies of water, rivers, stream, watercourses, and lakes.	No – land is owned by the CoE and no waterbodies present.
Historical Resources Act	The intent of the *Historical Resources Act* is to preserve and study historic resources (archaeological, historic and paleontological sites and features) within Alberta.	Yes - a *Historical Resources Act* approval is required as the footings for the bridge will be in a new location.
Weed Control Act and Weed Control Regulation	The *Weed Control Act* protects stakeholders from economic and invasive losses caused by weeds. Some weed species exhibit extreme growth habits, which can have consequences for line of sight at intersections, wildlife control along roadways, culvert and outfall maintenance, agricultural production, livestock forage quality, and many others. The Act prescribes activities that must be undertaken should a noxious or restricted weed be encountered. Each Municipality is responsible for enforcing the Act.	Yes - potential for the spread or introduction of weeds during construction.
Soil Conservation Act	The *Soil Conservation Act* describes the requirement for landholder to prevent soil loss or deterioration from taking place or stop loss or deterioration from continuing.	Yes - potential for soil loss during construction.
Wildlife Act and Wildlife Regulation	AEP administers the *Wildlife Act*, which influences and controls human activities that may have adverse effects on wildlife or wildlife habitats on both Crown and privately-owned land. Section 36(1) of the *Wildlife Act* states that a person shall not willfully molest, disturb or destroy a house, nest or den of prescribed wildlife or beaver dam in prescribed areas and prescribed times. This applies to nests and dens of endangered wildlife, migratory birds, snakes (except prairie rattlesnakes), bats, and prairie rattlesnake hibernacula. Additionally, Section 36(1) also applies to beaver dens on land that is not privately owned as well as houses, nests, and dens of all wildlife in a wildlife sanctuary and nests of game birds in game bird sanctuaries.	Yes - potential for wildlife house, nest or den.
Municipal		
North Saskatchewan River Valley Area Redevelopment	The main goal of the bylaw is to preserve the natural environment and character of the North Saskatchewan River Valley and its ravine system (CoE 2018). The bylaw establishes the North Saskatchewan River Valley and Ravine System as an environmental protection area and outlines the dedication and use of environmental reserves (CoE 2018).	Yes – bridge is located in the North Saskatchewan River Valley and Ravine System.

Name	Summary	Project Applicability
Plan Bylaw 7188 and Amendments		
Edmonton Zoning Bylaw 12800	The zoning bylaw outlines permitted land uses within the CoE. North Saskatchewan River Valley and Ravine System Protection Overlay is part of the zoning bylaw which identifies the NSRVRS and establishes a 7.5m setback from the NSRVRS (CoE 2021a).	Yes - bridge is located in the North Saskatchewan River Valley and Ravine System.
Public Tree Bylaw 18825	No work can be conducted within 5 m of the trunk of a boulevard and open space tree or within 10 metres of a natural stand boundary of the CoE owned trees until a permit has been obtained or a tree preservation plan/tree protection plan has been approved by the CoE (CoE 2021b).	Yes – trees are present in the Project Area.
Municipal Development Plan Bylaw 15100	The Plan provided policy direction for the growth and development of Edmonton. The Plan also outlines the policies to protect, preserve, and enhances the environment within Edmonton, including natural areas, wetlands, and the North Saskatchewan River Valley and Ravine System (CoE 2010).	Yes - bridge is located in the North Saskatchewan River Valley and Ravine System.
Development Setbacks from River Valley/Ravine Crests, Policy C542A	The CoE requires the design of development in all new or redeveloping areas abutting the North Saskatchewan River Valley and Ravine System provide a setback from the river valley a ravine system (CoE 2016a).	No – the bridge location is pre-existing.
Parkland Bylaw C2202	A Parkland Access Permit is required to use parkland for activities that are otherwise regulated, restricted, or prohibited under the bylaw (CoE 2021c).	Yes – for design phase activities. AECOM has gained Parkland Access Permit approval. No - for construction phase activities as construction contracts by Integrated Infrastructure Services do not require a permit.

3. Environmental Context

The Project is located within the MacKinnon Ravine Park which is a part of the North Saskatchewan River Valley and Ravine System Protection Overlay (Overlay; CoE 2020) and the North Saskatchewan River Valley Area Redevelopment Plan (CoE 2018). The purpose of the Overlay and the Area Redevelopment Plan is to protect the North Saskatchewan River Valley and Ravine System by providing guidance on setbacks and developing within or near the River Valley and Ravine System. At the Project location, MacKinnon Ravine is approximately 70 m wide and is bounded by Stony Plain Road on the north and Summit Drive NW on the south. The ravine is dominated by a mixedwood forest. Walking trails, paved paths, and dirt paths are present throughout.

The Ribbon of Green Master Plan (CoE 1992) was published by the CoE to provide guidance for the long-term development, use and care of the river valley and ravine system. The Project is within the Priority 1 of the Ribbon of Green Study Area Boundary. According to the sensitivity maps in the Ribbon of Green, MacKinnon Ravine contains low sensitivity and highly-moderate sensitivities. Low sensitivity contains wildlife habitat consisting of grasses and forbs wither mowed or cleared and contain vegetation habitat of low shrub and grasses, grasses and forbs, shrubs and saplings, mowed and cleared areas. The highly-moderate sensitivities contain vegetation habitat and wildlife habitat consisting of either low shrubs and grasses, shrubs and saplings or coniferous or deciduous trees (CoE 1992). The CoE is undergoing the River Valley Planning Modernization Project to renew the strategic planning of the North Saskatchewan River Valley and Ravine System and the processes and tools for evaluating and regulating development within the system. The River Valley Planning Modernization Project will create an integrated planning and regulatory framework for Edmonton's North Saskatchewan River Valley and Ravine System to ensure that it remains a protected, vibrant and resilient open space network as the city grows (CoE 2022a).

Figures of the environmental features are provided in Appendix A. In addition, a site visit was conducted on July 12, 2022, and photos are provided in Appendix B.

The EIA has been circulated to the necessary CoE departments for review and the comments addressed. The comments and responses are provided in Appendix C.

3.1 Surface Water, Groundwater and Fish Habitat

A review of the Fish and Wildlife Management Information System (FWMIS; GOA 2022a) database within the Fish and Wildlife Internet Mapping Tool (FWIMT) showed an unnamed watercourse through the MacKinnon Ravine into the North Saskatchewan River. Based on site photos and visit, the watercourse does not appear to have bed or banks and does not appear to contain fish habitat; therefore, it is not considered a waterbody.

There is no critical habitat for aquatic species at risk within the MacKinnon Ravine (DFO 2022). The North Saskatchewan River is located 1.5 km from the bridge.

A review of the Alberta Biodiversity Monitoring Institute (ABMI; ABMI 2021) Wetland Inventory did not show any mapped wetlands within the MacKinnon Ravine. The Alberta Merged Wetland Inventory (AMWI; GOA 2020) mapped a fen at the Project Area within MacKinnon Ravine; however, a review of historical aerial imagery and site photos does not indicate a fen is present.

3.1.1 1:100 Year Floodplain

The Project is not within the 1:100 year floodplain of the North Saskatchewan River (Flood Hazard Map, GOA 2022b). The Project is approximately 1.5 km from the larger flood range and the 1:100 directly flood inundation areas (GOA 2022b).

3.1.2 Runoff Characteristics

The general runoff characteristics of the Project Area is through the MacKinnon Ravine towards the North Saskatchewan River. The high point within proximity to the Project is the top of the ravine along Summit Drive NW, Stony Plan Road and 149 Street NW, with the low point at the base of the ravine which slowly decreases in elevation to the North Saskatchewan River.

3.1.3 Depth of Water Table

A geotechnical investigation was conducted for the Project in June of 2022. Three testholes (TH22-01, TH22-02 and TH22-03) were advanced to depths ranging from 14.8 metres below ground surface (mBGS) to 20 mBGS. In addition, one hand auger hole (HA22-01) was advanced to a depth of 3 mBGS (AECOM 2022).

TH22-01 was located adjacent Stony Plain Road, approximately 50 m to the east of the Project Area, adjacent the bus loop. TH22-02 was located along the bridge alignment, in the ravine bottom. TH22-03 was located along the bridge alignment at the top of the ravine on the south side. HA22-01 was located along the bridge alignment, approximately half way down to the ravine bottom on the north slope.

Groundwater was encountered at approximately 7.6 mBGS in TH22-01, 10.4 mBGS in TH22-02, and at approximately 17.1 mBGS in TH22-03 upon drilling completion. No groundwater was encountered in HA22-01.

Standpipe piezometers were installed in TH22-02 and TH22-03 consisting of 50 millimetre (mm) diameter polyvinyl chloride pipes to monitor the groundwater levels. However, at the time of this report, groundwater monitoring levels were not available.

The geotechnical investigation report noted that groundwater levels undergo seasonal fluctuations due to precipitation, snow melting, drainage conditions on site and other factors. Therefore, groundwater conditions at the time of construction may vary from historical observations (AECOM 2022).

3.2 Geology/Geomorphology and Soils

As per the geotechnical investigation report (AECOM 2022; Appendix D), near-surface geology of the Project Area was reviewed based on the *Quaternary Geology, Central Alberta* map (Shetsen 1990) and *Urban Geology of Edmonton* (Kathol C.P. and McPherson R.A 1975). The Project Area is expected to consist of up to 20 m of fluvial deposits comprising of gravel, sand, silt and clay, including local till and bedrock exposures.

The geotechnical investigation report (AECOM 2022; Appendix D) compiled the bedrock geology of the Project Area by reviewing the *Bedrock Geology Map of Alberta* (Prior G.J., *et al*. 2013) and *Urban Geology of Edmonton* (Kathol C.P. and McPherson R.A 1975). The Edmonton is known to have varying thicknesses (ranging from 140 to 190 m, averaging at 170 m) in the Project Area because of the extensive erosion of its upper surface. The Edmonton formation consists primarily of pale grey, fine to very fine grained, feldspathic sandstone interbedded with siltstone, bentonitic mudstone, carbonaceous mudstone, concretionary sideritic layers, and laterally continuous coal seams; the geology includes white, pedogenically altered sandstone and mudstone interval at top (formerly assigned to the Whitemud Formation).

A desktop review of the Agricultural Regions of Alberta Soil Inventory Database (Alberta Agriculture & Forestry 2016) identified miscellaneous undifferentiated disturbed soils within the Project Area. In addition, the Project Area is within the Soil Correlation Area 10, the Thick Black/Dark Gray- Gray Soil Zone of central and east central Alberta (Alberta Soil Information Center 2016).

A review of historical imagery indicates the soils surrounding the ravine have been previously disturbed by agricultural activities since at least 1930 and urban development since at least 1943. The ravine has remained relatively undisturbed since at least 1930.

Results of the geotechnical investigation identified topsoil in TH22-01 and TH22-03 with topsoil thickness of 75 mm and 100 mm, respectively. No topsoil was present at TH22-02. The topsoil was observed to be organic and fibrous containing rootlets, trace silt and clay. The topsoil was moist and black in colour (AECOM 2022).

3.3 Vegetation

A search of the Alberta Conservation Management System (GOA 2017a) within 1 km around the Project did not identify any *Sensitive* or *Non-Sensitive Element Occurrences* of vegetation or vegetation communities, Protected Areas, and/or Crown Reservations/Notations. Additionally, the FWIMT (GOA 2022a) was reviewed for Endangered and Threatened Plant Ranges. The Project does not intersect any Endangered and Threatened Plant Ranges for species listed in Schedule 1 of the Alberta *Wildlife Act* (AEP 2021).

According to the CoE land cover inventory, the urban Primary Land and Vegetation Inventory (uPLVI; CoE 2015), the Project is located within modified non-maintained grass and shrub, and naturally wooded forest (Figure 2-2, Appendix A).

A review of the Alberta's Environmentally Significant Areas of Alberta (Fiera Biological Consulting 2014) did not identify any lands designated as a provincial Environmentally Significant Area. The CoE's Environmental Sensitivity Score Map indicates the Project Area has sensitivity scores of *Moderate Value*, *High Value*, *Very High Value*, and *Extremely High Value* (CoE 2019b; Figure 2-1, Appendix A). The lands with a sensitivity score of *Extremely High* and *Very High Value* are natural areas, CoE protected lands, and important corridors for wildlife connectivity (CoE 2016b). Lands with a *High* sensitivity score are either areas of natural vegetation or contain unique landscape level landforms and are important corridors for wildlife connectivity (CoE 2016b). Lands with a *Moderate* sensitivity score contain non-natural vegetation. All the lands are also associated with the North Saskatchewan River Valley and Ravine System.

According to the Vegetation Areas Map (CoE 2022b), the Project is located in natural tree stand and naturalized un-mowed grass vegetation types. The CoE Tree Map (CoE 2022c) shows there are 18 CoE maintained trees within 25 m of the centre line of the proposed bridge, along Summit Drive NW within the manicured park on the south side of the ravine (Figure 2-1, Appendix A).

During the site visit, it was noted that the ravine vegetation consisted of a mixedwood forest, with a deciduous understory dominated by grasses and forbs.

3.4 Wildlife

The Project is located within the bald eagle (*Haliaeetus leucocephalus*) sensitive raptor range and sharp-tailed grouse (*Tympanuchus phasianellus*) survey range (AEP 2021; Figure 3, Appendix A). Bald eagles are found near large lakes and rivers usually within forested areas (Cornell 2019). Therefore, although there is potential for bald eagles to be nesting near the North Saskatchewan River Valley and Ravine System, there is limited nesting habitat potential for this species near the Project. Sharp-tailed grouse leks are strongly associated with native prairies, but are also found in agricultural pastures, shrublands, and within open areas in woodlands and are sensitive to human activities (AMBI 2020a). The Project Area does not provide suitable lek habitat for the sharp-tailed grouse due to the lack of native grasslands, pastures, shrublands, open areas in woodlands and the surrounding human activities.

3.4.1 Species Observed, Reported, or Expected and the Site Suitability

A search of FWIMT (GOA 2022a) for a 3 km buffer from the Project identified 13 species. Three species are listed on *Species At Risk Act* (SARA) Schedule 1; two considered species at risk. Three species are provincially listed as May be at Risk and seven species that are listed as Sensitive in Alberta (Table 2; Appendix E).

Table 2: Wildlife Species Identified within 3 km of the Project Area

Common Name	Scientific Name	Federal Status[1]	Provincial Status[2]	Habitat	Potential Habitat Present Within or Near Project Area
Alder Flycatcher	*Empidonax alnorum*	Not listed	Secure	Prefers wet shrubby habitats and early seral forests (ABMI 2019).	Yes - within the North Saskatchewan River and Ravine System.
Bald Eagle	*Haliaeetus leucocephalus*	Not at Risk	Sensitive	Breeds in forested areas adjacent to large bodies of water, staying away from heavily developed areas when possible. Nests in large trees (Cornell 2019).	Yes - within the North Saskatchewan River and Ravine System.
Barred Owl	*Strix varia*	Not listed	Sensitive	Prefer unfragmented, old growth mixedwood forests and in Alberta they inhabit mature forest in the mixedwood boreal, foothills, and aspen parkland regions (AEP 2016).	No - preferred habitat of unfragmented forests is present within or near the Project Area.
Bay-breasted Warbler	*Dendroica castanea*	Not listed	Sensitive	Preferred habitat is coniferous trees in mature or old forests and deciduous forests (M.R. Norton 2001a).	Yes - within the North Saskatchewan River and Ravine System.
Canadian Toad	*Anaxyrus hemiophrys*	Not listed	May be at Risk	Breeds in natural ponds, borrow pits, streams, and lake margins with sandy borders. Disperses to upland areas where it overwinters by digging underground in sandy soil (ACA and ASRD 2002).	Yes - breeding habitat along the North Saskatchewan River and Ravine System. However, the potential habitat is limited as soil compaction in the surrounding urban landscape limits overwintering habitat.
Cape May Warbler	*Dendroica tigrina*	Not listed	Sensitive	Preferred habitat is coniferous trees in mature or old forests and deciduous dominated forests (M.R. Norton 2001b).	Yes - within the North Saskatchewan River and Ravine System.
Common Yellowthroat	*Geothlypis trichas*	Not listed	Sensitive	Found in a variety of wet, shrubby habitats including riparian areas, and wetlands (ABMI 2020b).	Yes - within the North Saskatchewan River and Ravine System.
Cougar	*Puma concolor*	Not listed	Secure	Found in a variety of habitats including coniferous forests, wooded swamps, open grasslands, shrublands (GOA 2019).	Yes - within the North Saskatchewan River and Ravine System.
Least Flycatcher	*Empidonax minimus*	Not listed	Secure	Prefer mature deciduous and mixedwood forests but can be found in a variety of habitat including conifer forests, burned areas, swamps, bogs and shrubby areas (ABMI 2020g).	Yes - within the North Saskatchewan River and Ravine System.
Little Brown Bat	*Myotis lucifugus*	Endangered	May be at Risk	Hibernacula habitat are underground openings, caves, abandoned mines, wells, and	Yes - roosting habitat is present surrounding the Project Area and present

Common Name	Scientific Name	Federal Status[1]	Provincial Status[2]	Habitat	Potential Habitat Present Within or Near Project Area
				tunnels. Roosting habitats include buildings and other anthropogenic structures, but will also use tree cavities, foliage, tree bark, crevices on cliffs (Environment Canada 2015).	within the North Saskatchewan River and Ravine System.
Sharp-tailed grouse	*Tympanuchus phasianellus*	Not listed	Sensitive	Sharp-tailed grouse use open prairie, shrubby hills, coulees, and the margins of watercourses and farmlands in grassland regions, and open woodland such as brush and aspen groves in parkland. Sharp-tailed grouse gather on leks (traditional dancing grounds) from mid-February to May and are sensitive to human activities (GOA 2013).	No - the Project Area does not contain grasslands and the surrounding areas have high human activities.
Short-eared owl	*Asio flammeus*	Special Concern	May Be at Risk	Breeds in grasslands, marshes, bogs, and old pasture. Nests in dense grasses (Cornell 2019).	No - the Project Area does not contain grasslands.
Western Tanager	*Piranga ludoviciana*	Not listed	Sensitive	Breeds in open coniferous forests and mixed woodlands and prefers older forests stands (Government of Canada 2015).	Yes - within the North Saskatchewan River and Ravine System.

Source: [1] Government of Canada 2021, [2]AEP 2020

During the site visit, typical urban wildlife species were observed including sparrow species, black-capped chickadees, and small mammals (i.e., squirrels and rabbits).

3.4.2 Wildlife Trees

Within the North Saskatchewan River and Ravine System there is potential for wildlife trees or other features that could provide nesting or den sites.

3.4.3 Significant Wildlife Habitat

The Project is located within a provincial Key Wildlife and Biodiversity Zone (KWBZ; AEP 2021). KWBZ are a combination of key winter ungulate habitat and higher habitat potential for biodiversity (GOA 2015). However, the Project is located near the top of the ravine which is surrounded by urban development; therefore, the wildlife habitat is limited.

The Project Area is also known as Natural Linkage within the CoE's Ecological Network (CoE 2007). Linkages are areas of natural or semi-natural vegetation that provide structural and/or functional connections for species, communities or ecological processes, between core areas to regional areas within CoE's ecological network (CoE 2007).

In the Project Area, the wildlife habitat is expected to be marginal due to the surrounding land use (i.e., roads and urban development), and the associated level of noise disturbance.

3.5 Historical Resources

The Alberta Government's *Historical Resources Shapefile* (GOA 2022) was reviewed to determine the presence of lands designated with Historical Resource Value (HRV) within the Project area (Figure 3, Appendix A). Lands with HRV are known to contain historical, archeological, paleontological, natural, geological, or cultural resources requiring avoidance or additional assessment prior to development (GOA 2021).

The Project is not located on lands assigned with an HRV. However, lands within the E of 35-53-25 W4M, are assigned with an HRV of 5p, lands that have a *high potential to contain a palaeontological historic resource*, which is located 280 m east of the Project (GOA 2022).

4. The Project

The Project is a new pedestrian bridge across MacKinnon Ravine to provide access across the MacKinnon Ravine from Stony Plain Road to Summit Drive NW. The bridge will accommodate multi-directional pedestrian and cyclist traffic. New trail lights are proposed close to the bridge access/exit to replace existing lights.

Preliminary design considered several options including the following:

- Option 1 (the preferred option): a timber bridge structure supported by steel piers with 3 spans for a total of 51 m in length. The piers constructed of steel and the girders, decking, and railing constructed of timber.
- Option 2: a rolled steel super structure bridge with 2 piers for a total of 52 m in length. The piers, girders, and railing constructed of steel and the decking constructed of timber.
- Option 3: a steel pony through truss super structure bridge with 2 piers for a total of 52 m in length. The piers, trusses, and railing constructed of steel and the decking constructed of timber.
- Option 4: a single span steel pony through truss super structure bridge for a total of 45 m in length. The piers, trusses, and railing constructed of steel and the decking constructed of timber.

Each bridge option will utilize concrete pile caps for the pier foundations. In addition, each option will include a conventional cast-in-place concrete abutments with flare wingwalls. The overall footprint of the bridge for each option is similar, with the location of the piers varying between options. The new bridge will follow the alignment of the previous bridge.

Based on an evaluation of the options, Option 1 (i.e., the 3 span bridge) has been selected for detailed design. The preliminary drawings for the preferred option can be found in Appendix F.

4.1 Project Phases

4.1.1 Site Preparation

Due to public safety concerns, the demolition of the previous MacKinnon Ravine Pedestrian Trestle Bridge occurred in February 2022. As part of the demolition, vegetation clearing was completed; however, some understory vegetation removal and tree pruning is anticipated. At the time of EIA preparation, minor tree removal is anticipated (one tree east of the proposed bridge). Tree and vegetation removal will be further assessed with CoE Urban Forestry and Natural Areas representatives to determine if it will be affected by the Project as the design and construction advances. In addition, some tree pruning is anticipated for the access route. Access is expected to utilize the existing paved pathways; however, an existing informal trail along the ravine bottom that connects the paved pathway will also be used.

4.1.2 Construction

Construction of the new bridge is planned for spring/summer 2023. Construction will include the following activities:

- Selective tree pruning for access to the Project Area and pruning for clearance to maneuver overhead equipment to hoist materials.
- Assessment of trees within Project Area for root treatment.
- Drilling and placing cast in place concrete pile foundations at the piers and abutments.
- Constructing concrete pile caps for the pier foundations.
- Install piers.
- Construct abutments.

- Hoist girders into place.
- Construct bridge deck and install railings.
- Pave a new shared-use path connecting the bridge to the existing shared-use path network.
- Install light standards.
- Clean-up and restoration.

4.1.3 Landscaping

Once installation of the new bridge is complete, the Project Area will be restored to pre-existing conditions where possible. The draft landscape and restoration plan is included in Appendix G and will be further developed during detailed design.

4.2 Preliminary Drawings

The preliminary drawings can be found in Appendix F.

5. Project Impacts and Mitigation Measures

5.1 Assessing Impacts

5.1.1 Methods

5.1.1.1 Approach

The impact assessment methodology was developed to meet the CoE's North Saskatchewan River Valley Area Redevelopment Plan, A Guide to Completing Environmental Impact Assessments. The conditions of the existing environment are compared against the Project components and activities to assess potential effects of the Project. The methodology includes the following steps:

1. Determine the scope of the assessment.
2. Describe the existing environment.
3. Identify potential effects, identify mitigation, and predict residual effects.
4. Characterize residual effects and determine their significance.

5.1.1.2 Scoping

Environmental components (ECs) are environmental features that are considered important to regulators and other parties. As per the CoE's North Saskatchewan River Valley Area Redevelopment Plan, A Guide to Completing Environmental Impact Assessments, the following ECs were identified and assessed in relation to the Project:

- Surface Water, Groundwater, and Fish Habitat.
- Geology/Geomorphology and Soils.
- Vegetation.
- Wildlife.
- Historical Resources.

A preliminary identification of potential Project-EC interactions was undertaken to focus the assessment on the issues of key importance. The Project activities were analyzed to determine if there was a plausible mechanism for an effect on each EC during normal Project conditions. The analyses were based on professional judgement and experience of the assessment team. Where the Project is not predicted to interact with an EC, the rationale is provided. The results are presented in Table 3. The identified interactions were used to develop mitigation and for the assessment of potential effects.

Table 3. Potential Project Interactions with Environmental Components

Environmental Component	Potential Interaction with Project
Surface Water	Potential interaction. Although there are no surface waterbodies in vicinity of the Project, there is potential for erosion. Therefore, sedimentation into the North Saskatchewan River Valley and Ravine System could occur.
Groundwater	No potential interaction. The foundations for the bridge piers will be shallow and are not likely to intersect groundwater.
Fish Habitat	No potential interaction. The nearest fish-bearing waterbody is the North Saskatchewan River which is located 1.5 km from the Project.
Geology/Geomorphology	No potential interaction. The foundations for the bridge piers will be shallow and minor work will be needed for construction of the abutments.
Soils	Potential interaction. Soils will be disturbed during construction.
Vegetation	Potential interaction. Vegetation clearing will occur during construction and weeds may be introduced.
Wildlife	Potential interaction. Construction will occur within an area likely used by wildlife.
Historical Resources	Potential interaction. The area affected by the Project is not assigned with an HRV; however, there may be the potential for the land to contain historic resources.

For those ECs which are not predicted to interact with the Project, no further analysis is necessary, and the EC is not taken forward into the effects assessment.

5.1.1.3 Spatial and Temporal Extents

The spatial boundaries of the assessment were based on the area within which Project effects might occur. The spatial boundaries used are:

- Project Area - the area subject to direct disturbance from the Project; the footprint of the Project.
- Local Study Area (LSA) - the area where direct Project effects may occur; the footprint of the Project plus a 50 m radius.
- Regional Study Area (RSA) - the area where indirect Project effects may occur; a 500 m radius from the Project Area.

The temporal boundaries of the assessment were based on the timeframe within which Project effects might occur. The temporal boundaries are construction and the life of the Project.

Construction of the bridge is scheduled to begin in spring/summer 2023 and be complete by the end of the year. Currently, there are no decommissioning plans for the Project.

5.1.1.4 Assessment of Effects

5.1.1.4.1 Prediction of Residual Effects

5.1.1.4.1.1 Identify Potential Effects

Interactions between the Project and the ECs, within the spatial and temporal boundaries, are assessed for the Project. Potential effects of the Project are determined by comparing the existing environmental conditions to the conditions which are expected to result from the Project. An effect is a change in the existing environmental conditions resulting from the Project.

5.1.1.4.1.2 Identify Mitigation

Mitigation is the measures that would avoid, minimize, or compensate for the effects on the environment as a result of the Project. Mitigation includes the implementation of Best Management Practices (BMPs) recommendations from regulators, and industry standards as well as maintaining compliance with

legislation, regulations, and guidelines, and considering changes to the Project design. Mitigation identified for the Project is presented in Section 5.3.

5.1.1.4.1.3 Predict Residual Effects

Residual effects are those effects predicted to remain after the application of mitigation. An effect that is eliminated is not a residual effect and is not considered further.

5.1.1.4.2 Characterization of Residual Effects

The residual effects are characterized using the criteria listed in Table 4. The characterization of residual effects considers the ecological context of where the Project is located (e.g., existing environmental conditions, level of existing disturbance, and regulatory legislation, policy, and recommendations).

Table 4. Criteria used to Characterize Residual Effects

Criteria	Description
Nature of impact	The type of interaction between the Project and the EC: • Direct – a cause-effect relationship between the Project and EC. • Indirect – an interaction occurs because of a change that the Project may cause, often produced away from or as a result of a complex effects pathway and at least one step removed from a Project activity in terms of cause-effect linkages.
Magnitude	The measure of the amount of change to the EC: • Negligible – no detectable change from existing conditions. • Low – change is detectable but well within established criteria/standards or range of natural variability. • Moderate – change approached the limits of established criteria/standards or range of natural variability. • High – change exceeds established criteria/standards or beyond range of natural variability.
Geographic extent	The area within which the change to the EC occurs: • Project Area. • Local Study Area. • Regional Study Area. • Beyond Regional Study Area.
Duration and timing	The amount of time over which the effect will be present: • Short-term – effect is detectable during construction. • Medium-term – effect is detectable up to the end of construction. • Long-term – effect is detectable for a defined period after construction. • Permanent – effect is detectable after construction; decommissioning is not anticipated.
Likelihood	The probability of the effect occurring: • Low – effect not likely to occur. • Moderate – effect may occur. • High – effect is likely to occur.

5.1.1.4.3 Determining Significance of Effects

Significant effects are those which are considered to be of sufficient direction, magnitude, geographic extent, duration, frequency or irreversibility to cause a change in the EC that will alter its condition or state beyond an acceptable level. The determination of significance is based on professional judgement in the context of society's objectives (i.e., land use plans, policies, legislation, regulations, and guidelines). The definitions of significance are:

- Not significant: the effect is not predicted to cause a change in the EC that will alter its condition or state beyond an acceptable level.

- Significant: the effect is predicted to cause a change in the EC that will alter its condition or state beyond an acceptable level.

5.1.2 Effects Assessment

Each EC which is predicted to interact with the Project was assessed for potential effects. Mitigation was developed to avoid, minimize, or compensate for the effects. Any residual effects were predicted and characterized. The assessment is summarized in Table 5 and the residual effects characterization provided in Table 6.

5.1.2.1 Surface Water

5.1.2.1.1 Potential Effects

Construction activities could temporarily change local drainage patterns and the soil stockpiles and disturbed areas will be temporarily susceptible to erosion. Potential effects on surface water are change to local drainage patterns and change to surface water quality.

5.1.2.1.2 Predicted Residual Effects

As drainage will be re-established following construction, local drainage patterns will not be affected, and no residual effect is predicted.

The sedimentation and erosion control measures outlined in Section 5.3 will be used and the North Saskatchewan River is located over 1.5 km away from the Project Area; therefore, no changes to surface water quality are expected and no residual effect is predicted.

5.1.2.2 Soils

5.1.2.2.1 Potential Effects

The Project will involve topsoil stripping and stockpiling, which could result in soil admixing and/or loss of soil. The stockpiles and disturbed areas will be temporarily susceptible to erosion and the use of heavy machinery could cause soil compaction. Soil admixing, erosion, and soil compaction can reduce the quality of the soil. Therefore, potential effects on soils are reduction in soil quality and reduction in soil quantity.

5.1.2.2.2 Predicted Residual Effects

To limit the reduction in soil quality, topsoil will be stripped and stockpiled separately, sedimentation and erosion control measures will be used, and measures to prevent soil compaction will be implemented. Other mitigation measures will be implemented as outlined in Section 5.3; however, it is still possible that some reduction in soil quality will occur.

The predicted residual effect of reduction in soil quality is negligible in magnitude and limited to the Project Area. Overall, the predicted residual effect of reduction in soil quality is not significant.

Topsoil will be reused for restoration if suitable, and sedimentation and erosion control measures will be used to reduce soil loss, as outlined in Section 5.3. However, some erosion may still occur in the period between the end of construction and the establishment of vegetative cover.

The predicted residual effect of reduction in soil quantity is negligible in magnitude as the majority of soil will be reused and the implementation of mitigation will limit soil losses due to erosion. Overall, the predicted residual effect of reduction in soil quantity is not significant.

5.1.2.3 Vegetation

5.1.2.3.1 Potential Effects

Vegetation will be cleared to construct the Project, including areas that contain native vegetation; however, the footprint of the Project is small and no rare plant species were identified in the Project Area. At least one large tree will be removed. Tree pruning will likely be required along the access route and for clearance to maneuver overhead equipment to hoist materials. Areas to be cleared were disturbed during construction and demolition of the previous bridges. The use of construction equipment has the potential to introduce weeds. In addition, exposed soils are susceptible for the establishment of weeds prior to revegetation, which may take several years. Therefore, potential effects on vegetation are loss of vegetation and the introduction or spread of weeds.

5.1.2.3.2 Predicted Residual Effects

To construct the Project, vegetation clearing will be necessary. An appropriate seed mix will be used for restoration to replace the lost of vegetation. Other mitigation measures are outlined in Section 5.3; however, the area beneath the piers will not be reclaimed, and the residual effect to loss of vegetation is predicted.

The predicted residual effect of loss of vegetation is low in magnitude. The loss will be limited to the Project Area. Overall, the predicted residual effect of loss of vegetation is not significant.

Weeds are likely already present within the Project Area. Measures will be implemented to prevent the introduction and spread of weeds and the area will be monitored for weeds as outlined in Section 5.3. Weed control will be implemented as required; however, weeds are expected to establish and possibly spread; therefore, the residual effect of the introduction or spread of weeds is predicted.

The predicted residual effect of the introduction or spread of weeds is low in magnitude. Overall, the predicted residual effect of the introduction or spread of weeds is not significant.

5.1.2.4 Wildlife

5.1.2.4.1 Potential Effects

Given the urban setting of the Project and the proximity to human activity, the habitat quality of the Project Area for wildlife is considered to be low. However, the MacKinnon Ravine is part of the North Saskatchewan River Valley and Ravine System which is considered to be high quality wildlife habitat within Edmonton. Construction of the Project will result in the clearing of vegetation, areas that may provide habitat for wildlife (e.g., nesting, foraging, overwintering, cover, breeding). In addition, construction has the potential for sensory disturbance to wildlife, acting as a barrier to wildlife movements, and wildlife mortality could occur during vegetation clearing and excavation. Therefore, potential effects on wildlife and wildlife habitat are loss of habitat, sensory disturbance, barrier to movement, and mortality.

5.1.2.4.2 Predicted Residual Effects

Given the limited quality of the habitat in the Project Area, the availability of habitat in the surrounding area, the restoration of the Project Area, the availability of the Project Area as habitat for wildlife following construction, and the other mitigation measures outlined in Section 5.3, the loss of wildlife habitat is expected to be minimal. However, some vegetation will be cleared and the residual effect of loss of habitat is predicted.

The predicted residual effect of loss of habitat is negligible in magnitude. The effect is permanent; however, it will be limited to the Project Area. Overall, the predicted residual effect of loss of habitat is not significant.

Given the proximity of the Project to roadways, pathways, and residences, local wildlife are likely habituated to human activity. The use of the mitigation measures outlined in Section 5.3 will limit sensory disturbance; however, some species may be disturbed, and the residual effect of sensory disturbance is predicted.

The predicted residual effect of sensory disturbance is short-term as it is only expected during construction. The magnitude of the effect is expected to be negligible given the desensitization of local wildlife. Overall, the predicted residual effect of sensory disturbance is not significant.

Given the urban setting of the Project and the proximity to human activity, and that the Project is located near the top of the ravine, construction is not expected to be a barrier to wildlife movement. Therefore, no residual effects are predicted.

The use of machinery has the potential for wildlife mortality, especially during vegetation and soil clearing. However, with the use of the mitigation measures outlined in Section 5.3, mortality is not anticipated, and no residual effects are predicted.

5.1.2.5 Historical Resources

5.1.2.5.1 Potential Effects

Although the area affected by the Project is not assigned with an HRV, and some of the Project Area has been previously disturbed for construction of the original bridge, there is the potential to encounter archaeological or palaeontological features (e.g., arrow heads, modified bone, pottery fragments, fossils) during construction and the potential effect on historical resources is disturbance to archaeological or palaeontological features.

5.1.2.5.2 Predicted Residual Effects

An approval under the *Historical Resources Act* was issued by Alberta Culture and the Status of Women on October 20, 2022 (HRA Number: 4715-22-0081-001; Appendix E). There are no further requirements under the *Historical Resource Act*. In addition, the footprint of the Project is small and largely previously disturbed, and mitigation measures outlined in Section 5.3 will be used. Therefore, disturbance to archaeological or palaeontological features is not anticipated, and no residual effects are predicted.

Table 5. Potential Effects, Mitigation, and Prediction of Residual Effects

Environmental Component	Potential Effect	Mitigation	Predicted Residual Effect
Surface Water	Change to local drainage patterns	See Section 5.3	None
	Change to surface water quality	See Section 5.3	None
Soils	Reduction in soil quality	See Section 5.3	Reduction in soil quality
	Reduction in soil quantity	See Section 5.3	Reduction in soil quantity
Vegetation	Loss of vegetation	See Section 5.3	Loss of vegetation
	Introduction or spread of weeds	See Section 5.3	Introduction or spread of weeds
Wildlife	Loss of habitat	See Section 5.3	Loss of habitat
	Sensory disturbance	See Section 5.3	Sensory disturbance
	Barrier to movement	See Section 5.3	None
	Mortality	See Section 5.3	None
Historical Resources	Disturbance to archaeological or palaeontological features	See Section 5.3	None

Table 6. Predicted Residual Effects Characterization and Significance Determination

Environmental Component	Predicted Residual Effect	Nature of Impact	Magnitude	Geographic Extent	Duration and Timing	Likelihood	Significance
Soils	Reduction in soil quality	Direct	Negligible	Project Area	Long-term	Low	Not significant
	Reduction in soil quantity	Direct	Negligible	Project Area	Permanent	Moderate	Not significant
Vegetation	Loss of vegetation	Direct	Low	Project Area	Permanent	High	Not significant
	Introduction or spread of weeds	Direct	Low	Local Study Area	Long-term	Moderate	Not significant
Wildlife	Loss of habitat	Direct	Negligible	Project Area	Permanent	High	Not significant
	Sensory disturbance	Direct	Negligible	Local Study Area	Short-term	Low	Not significant

5.2 Identifying Cumulative Effects

Cumulative effects are changes to an EC caused by the combined effect of past, present and future human activities. Identification of cumulative effects considers changes caused by the Project effects combined with the effects of other past, present and reasonably foreseeable future projects and activities.

A review of past, present, and future projects and activities within the determined spatial boundaries were reviewed for their potential for cumulative effects. Since at least 1930, agricultural or urban development has surrounded the MacKinnon Ravine. As one of the goals of the North Saskatchewan River Valley Area Redevelopment Plan is to protect the North Saskatchewan River Valley, projects and activities within the ravine are limited to the minimum necessary.

Presently, the Valley Line Light Rail Transit (LRT) project, a 27 km rail line that will operate between Mill Woods in the southeast to the Lewis Farms in the west, is being constructed on the north side of the ravine along Stony Plain Road and will take five to six years to construct. In addition, the 99 Avenue NW Sanitary Trunk Rehabilitation Project is underway on the south side of the ravine on Summit Drive NW, which includes tunneling under the ravine from Summit Drive NW to 146 Street NW.

Foreseeable projects within the ravine portion of the RSA are expected to be limited to trail infrastructure maintenance. Outside the ravine portion of the RSA, foreseeable projects are expected to be various road and utility upgrades and residential property improvements.

For soils, the residual effects of reduction in soil quality and reduction in soil quantity were predicted. As the effects were expected to be limited to the Project Area and occur over the long-term and permanently, respectively; therefore, the effects may act cumulatively with the effects from construction of the original bridge.

For vegetation, the residual effects of loss of vegetation and introduction or spread of weeds were predicted. As the effect of loss of vegetation is limited to the Project Area and any loss of vegetation from construction of the original bridge will be reversed, and that no foreseeable future projects and activities are expected within the Project Area, no cumulative effects are predicted. As weeds may have been introduced and spread during demolition of the original bridge and from the surrounding development, the effect of introduction or spread of weeds may act cumulatively with past, present, and future projects and activities.

For wildlife, the residual effects of loss of habitat and sensory disturbance were predicted. As the effect of loss of habitat is limited to the Project Area, the effect may act cumulatively with the effect from construction of the original bridge. As the effect of sensory disturbance is limited to the construction phase, and no future projects and activities are expected to overlap construction of the bridge, no cumulative effects are predicted.

5.3 Mitigation Measures

5.3.1 General

General mitigation measures to avoid and/or reduce effects on the environment include the following:

- An Environmental Construction Operation (ECO) Plan will be prepared by the contractor as per the ECO Plan Framework, Municipal Version (The City of Calgary and CoE 2020) and implemented during construction.
- The contractor responsibilities under Enviso: Edmonton's Environmental Management System will be followed (CoE 2022d).
- Construction equipment will be clean and in good working order (e.g., no oil or hydraulic fluid leaks).
- Vehicles and equipment will be inspected for leaks daily.
- Refueling and spill response procedures will be in place prior to construction.

- Workers will be trained in refueling and spill response procedures.
- Personnel will be present at the transfer point during fueling for the duration of the fueling process.
- Spill kits and/or drip pads will be present at the fueling location during refueling.
- Refueling and maintenance of mobile equipment will not occur within 100 m of a waterbody.
- Appropriate spill response materials will be available onsite during construction.
- All fuel nozzles must be equipped with functional automatic shutoffs and all fuel and service vehicles must carry a minimum 10 kg of commercial grade absorbent, shovels, and an empty fuel barrel.
- All leaks and spills will immediately be contained, cleaned up, and reported to the CoE and appropriate regulatory agencies.

5.3.2 Surface Water, Groundwater and Fish Habitat

Mitigation measures to avoid and/or reduce effects on surface water, groundwater and fish habitat include the following:

- Erosion and sediment controls will be implemented to reduce erosion by wind and water.
- An erosion and sediment control plan will be prepared by the construction contractor and approved prior to construction.
- The effectiveness of sediment and erosion controls will be monitored (at least every 7 days), particularly during or within 24 hours of precipitation or snowmelts (greater than 12 mm of rainfall in any 24 hour period or precipitation on wet or partially frozen soils). Implementation of remedial measures and maintenance will occur in a timely manner.
- Remove all temporary erosion and sediment controls when no longer required.
- The area of disturbed ground that is exposed to erosion at any one time will be minimized.
- Topsoil stockpiles will be stabilized with a tackifier or other suitable method (e.g., water applied during windy conditions, covered with tarps, use of mulch) to prevent wind or water erosion.
- Stockpiles and laydown areas will be located away from sensitive environmental features.
- Stockpile slopes will be no steeper than 3H:1V.
- Vegetation clearing will be limited to that required for the Project.
- All disturbed areas will be revegetated.
- All disturbed areas will be temporarily stabilized with a tackifier or other suitable method to prevent wind or water erosion until vegetation has been fully established.
- Surface water drainage patterns will be restored following construction.
- If excavations require dewatering, pump water onto stable, well vegetated areas, tarpaulins, sheeting, rocks, sandbags, or into settling ponds, filter bags, or other appropriate sediment filtering devices. Complete dewatering in a manner that does not cause flooding, erosion, or sediment to enter a watercourse.
- Ensure the pump intake is elevated from the bottom of the trench to minimize the pumping of sediment.
- Ensure hoses and pumps are of sufficient length and capacity to transfer trench water to the desired location.
- Ensure hoses are in good working condition, and hoses with tears or ruptures will be repaired or replaced.
- All water discharged to a waterbody or that may enter a waterbody will meet the Environmental Quality Guidelines for Alberta Surface Waters (GOA 2018).

5.3.3 Geology/Geomorphology and Soils

Mitigation measures to avoid and/or reduce effects on geology/geomorphology and soils include the following:

- Limit the footprint of the Project to the minimum necessary to construct the Project.
- Minimize the size and depth of excavations to the minimum necessary to construct the Project.
- Erosion and sediment controls will be implemented to reduce erosion by wind and water.
- An erosion and sediment control plan will be prepared by the construction contractor and approved prior to construction.
- The effectiveness of sediment and erosion controls will be monitored (at least every 7 days), particularly during or within 24 hours of precipitation or snowmelts (greater than 12 mm of rainfall in any 24-hour period or precipitation on wet or partially frozen soils). Implementation of remedial measures and maintenance will occur in a timely manner.
- Remove all temporary erosion and sediment controls when no longer required.
- The area of disturbed ground that is exposed to erosion at any one time will be minimized.
- Topsoil will be salvaged from the Project footprint and stockpiled.
- Topsoil salvage depth will be to colour change.
- Topsoil must be stored a minimum of 1.0 m distance from all other soil materials.
- Topsoil will be reused if suitable for restoration.
- If topsoil is stripped during frozen conditions, proper equipment (i.e., frozen topsoil cutter, grinder or equivalent) will be used to minimize the mixing of topsoil and subsoil layers.
- Topsoil stockpiles will be stabilized with a tackifier or other suitable method (e.g., water applied during windy conditions, covered with tarps, use of mulch) to prevent wind or water erosion.
- Stockpiles and laydown areas will be located away from sensitive environmental features.
- Stockpile slopes will be no steeper than 3H:1V.
- Limit stockpiles to 3 m in height where possible.
- All vehicles and equipment will avoid driving in wet conditions to avoid unnecessary soil disturbance from rutting.
- Vegetation clearing will be limited to that required for the Project.
- All disturbed areas will be revegetated.
- All disturbed areas will be temporarily stabilized with a tackifier or other suitable method to prevent wind or water erosion until vegetation has been fully established.
- Post construction monitoring of revegetation success will be completed during the establishment and warranty period.

5.3.4 Vegetation

Mitigation measures to avoid and/or reduce effects on vegetation include the following:

- Temporary access into the Project Area will be minimized to the extent practical and will be reclaimed.
- No work can be conducted within 5 m of the trunk of a boulevard and open space tree or within 10 m of a natural stand of CoE owned trees until a permit has been obtained or a tree preservation plan/tree protection plan has been approved by the CoE.
- Vegetation clearing for temporary access will be minimized.

- Vegetation clearing will be limited to that required for the Project.
- Within natural areas, avoid trees and shrubs, where possible.
- All equipment must be cleaned prior to arrival on site to remove soil, weeds, and weed seed.
- Equipment moving from areas with weeds or non-native species into natural areas must be clean and free of weeds and weed seeds.
- If weeds, as identified in the Alberta *Weed Control Regulation*, are encountered, measures will be taken to prevent the spread of weeds (e.g., avoidance of patches, cleaning of vehicles) (GOA 2016). Under the Alberta *Weed Control Act*, Prohibited Noxious weeds are required to be destroyed and Noxious weeds are required to be controlled (GOA 2017b).
- Post construction monitoring of weeds and weed control will be completed during the establishment and warranty period.
- Mechanical methods of weed control will be preferred (e.g., hand picking).
- Herbicide will only be used if approved by the CoE.
- All disturbed areas, if vegetated before construction, will be revegetated.
- Topsoil will be reused if suitable for restoration.
- An appropriate seed mix(es) will be used containing only Certified No. 1 seed.
- Seed will be applied at appropriate rates and using appropriate methods.
- Post construction monitoring of revegetation success will be during the establishment and warranty period.

5.3.5 Wildlife

Mitigation measures to avoid and/or reduce effects on wildlife include the following:

- Schedule construction activities to avoid the migratory bird breeding and nesting period, if possible. The Project is located in Nesting Zone B4 and the migratory bird breeding and nesting period is April 14 to August 28 (Government of Canada 2018).
- If construction must occur during the migratory bird breeding and nesting period (April 14 to August 28), initiate vegetation clearing outside of the period if possible.
- If construction occurs during the migratory bird breeding and nesting period (April 14 to August 28), a wildlife and nest search will be conducted prior to construction activities to ensure compliance with the *Migratory Birds Convention Act, 1994* and the Alberta *Wildlife Act*. Wildlife and nest searches will be conducted within 7 days of commencement of constructed by a qualified wildlife biologist. If these activities do not commence by the survey date plus seven days, or if work is interrupted for seven consecutive days during the migratory bird breeding and nesting period, a follow-up bird nest search is recommended.
- If wildlife features or nests are found, appropriate guidelines for species setback will be followed to minimize disturbance to the species.
- If an active nest is found, qualified personnel will determine an appropriate setback and the setback area will be flagged or marked. Construction will not occur within a setback area until nesting has concluded.
- Active animal dens or bird nests will not be disturbed. If a den or a bird nest is found during construction, mitigation (e.g., an appropriate setback buffer) will be implemented to protect the den/nest based on the recommendations of a qualified biologist following the *Recommended Land Use Guidelines for Protection of Selected Wildlife Species and Habitat within Grassland and Parkland Natural Regions of Alberta* (Government of Alberta 2011); additional consultation with AEP and/or Environment and Climate Change Canada may be required.

- Feeding or harassing of wildlife will be strictly prohibited. If wildlife is encountered on-site, they will not be approached and will be allowed to leave passively.
- Garbage and waste from construction will be stored appropriately as to not attract wildlife.

5.3.6 Historical Resources

Mitigation measures to avoid and/or reduce effects on historical resources include the following:

- An approval under the *Historical Resources Act* was issued by Alberta Culture and the Status of Women on October 20, 2022 (HRA Number: 4715-22-0081-001; Appendix E). There are no further requirements under the *Historical Resource Act*.
- If archaeological or palaeontological features (e.g., arrow heads, modified bone, pottery fragments, fossils) are found, suspend work immediately in the vicinity of the discovery. Work at that location may not resume until the measures below are undertaken. Notify the CoE who will provide an initial review of possible archaeological, palaeontological and historical remains and either allow construction to resume or, in the event of a confirmed or potential discovery, proceed by notifying the applicable regulatory agencies (e.g., Alberta Culture and the Status of Women) as required.

6. Environmental Monitoring

The monitoring requirements during construction will be developed as part of preparation of the ECO Plan, following the ECO Plan Framework, Municipal Version (The City of Calgary and CoE 2020).

Following construction, the restoration monitoring program will include the following:

- Monitoring will meet the current CoE Design and Construction Standards for Landscape until a Final Acceptance Certificate is received from the CoE.
- Restored areas will be monitored by visual inspection during the establishment and maintenance periods.
- Restored areas will be maintained from the time of installation until Construction Completion, and for period of one year from the issuance of a Construction Completion Certificate to the date of Final Acceptance Certificate. After the Final Acceptance Certificate has been approved, the CoE will be responsible for restored areas.
- Maintenance will include repairing slumped or eroded areas, watering, ensuring sufficient germination of seeded areas and removing or controlling weed growth. Maintenance will include all measures necessary to establish and maintain all plants in a vigorous and healthy growing condition. Maintenance activities include the repair and reseed of dead or bare spots, removal or control weeds by mechanical means and watering the seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Sod areas showing deterioration, bare spots or thin areas shall be re-sodded. At the time of final inspection all the sod areas shall be alive and in a healthy satisfactory growing condition and free from weeds. All installed trees found dead or not in a healthy state shall be replaced.
- Prior to the issuance of a Final Acceptance Certificate the Contractor will be responsible for re-seeding bare spots or thin areas. A satisfactory condition of seeded area must be a minimum of 90% turf establishment.
- If seed fails to germinate within four growing months, the Contractor will be responsible to recultivate and re-seed until germination takes place and the above criteria are met.
- The Contractor will be responsible to monitor the Project to achieve the above criteria. Inspections will be as per the CoE Design and Construction Standards for Landscape.

7. Public Consultation

Meetings with Crestwood Community League, Grovenor Community League, and The Summit Village Housing Co-operative have occurred. The purpose of the meetings were to garner feedback on use of the bridge and area, discuss design options, and identify any other considerations. The groups were supportive of the design options presented and keen to see the bridge replaced as quickly as possible. Personal safety in the area of the bridge was a concern, and an emphasis on providing adequate lighting across the bridge was important to provide the users an added level and sense of security.

In addition to the three primary community stakeholders, Paths for People, River Valley Conservation Coalition, River Valley Alliance, Sierra Club, and Bike Edmonton were sent information regarding the Project and were offered the opportunity for a meeting to provide additional feedback. Responses were received from Paths for People, River Valley Conservation Coalition, and Sierra Club. River Valley Conservation Coalition and Sierra Club do not have any concerns with the Project. Paths for People requested information on detours during construction; additional information will be provided as the Project advances and prior to construction.

8. Conclusions and Supporting Information

This EIA identifies the likely effects of the Project on the environment, analyzes the effects, and classifies the predicted effects remaining after implementing mitigation (i.e., residual effects). Residual effects resulting from the Project are predicted on soils, vegetation, and wildlife.

Given that the Project is the replacement of a previously existing structure, and based on the planned mitigation measures, it is anticipated that the residual effects on the environment will be limited and not significant.

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Appendix A
Figures

Legend

- Project Area
- Preferred Access Route
- Alternate Access Route
- Watercourse (AltaLIS) *

Notes:
* Not Considered a Waterbody based on Site Visit.

MACKINNON RAVINE PEDESTRIAN BRIDGE ENVIRONMENTAL IMPACT ASSESSMENT

PROJECT OVERVIEW

0 20 40 60 80
Metres

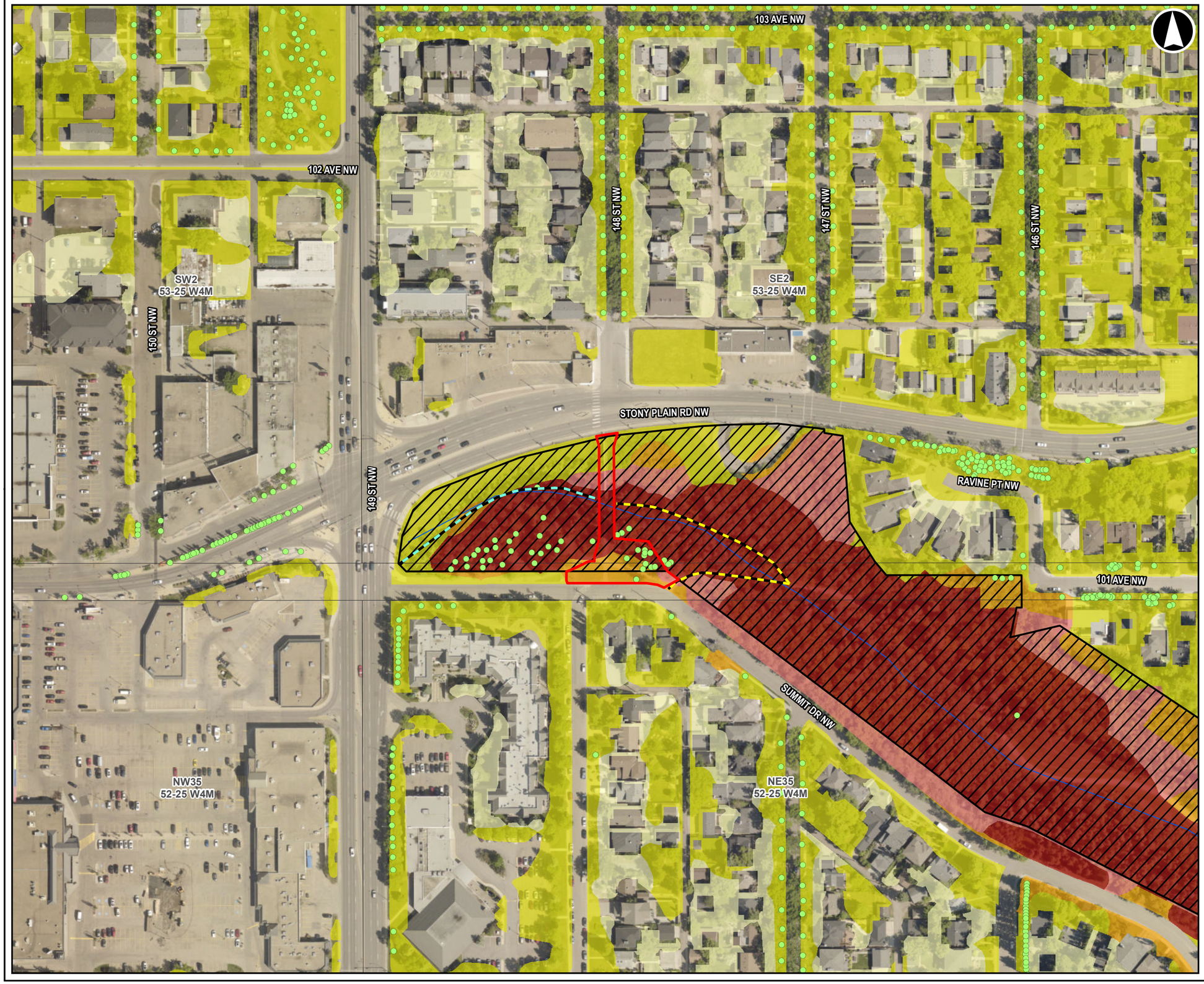
Datum: NAD 1983 UTM Zone 12N

Oct, 2022	PN#: 60682118	1:2,100 * when printed 11"x17"

Figure 1

AECOM

Data Sources: NRCan - Canvec, AltaLIS, AEP, City of Edmonton
Main Map: Esri World Imagery Basemap
Key Map: Esri World Topographic Map



Legend

- Project Area
- Preferred Access Route
- Alternate Access Route
- Watercourse (AltaLIS) *
- City of Edmonton Trees
- North Saskatchewan River Valley and Ravine System Protection Overlay

Environmental Sensitivity Project (2015) Values

- Extremely High Value
- Very High Value
- High Value
- Moderate Value
- Low Value

Notes:

* Not Considered a Waterbody based on Site Visit.

MACKINNON RAVINE PEDESTRIAN BRIDGE ENVIRONMENTAL IMPACT ASSESSMENT

ENVIRONMENTAL OVERVIEW – VEGETATION

0 20 40 60 80

Metres

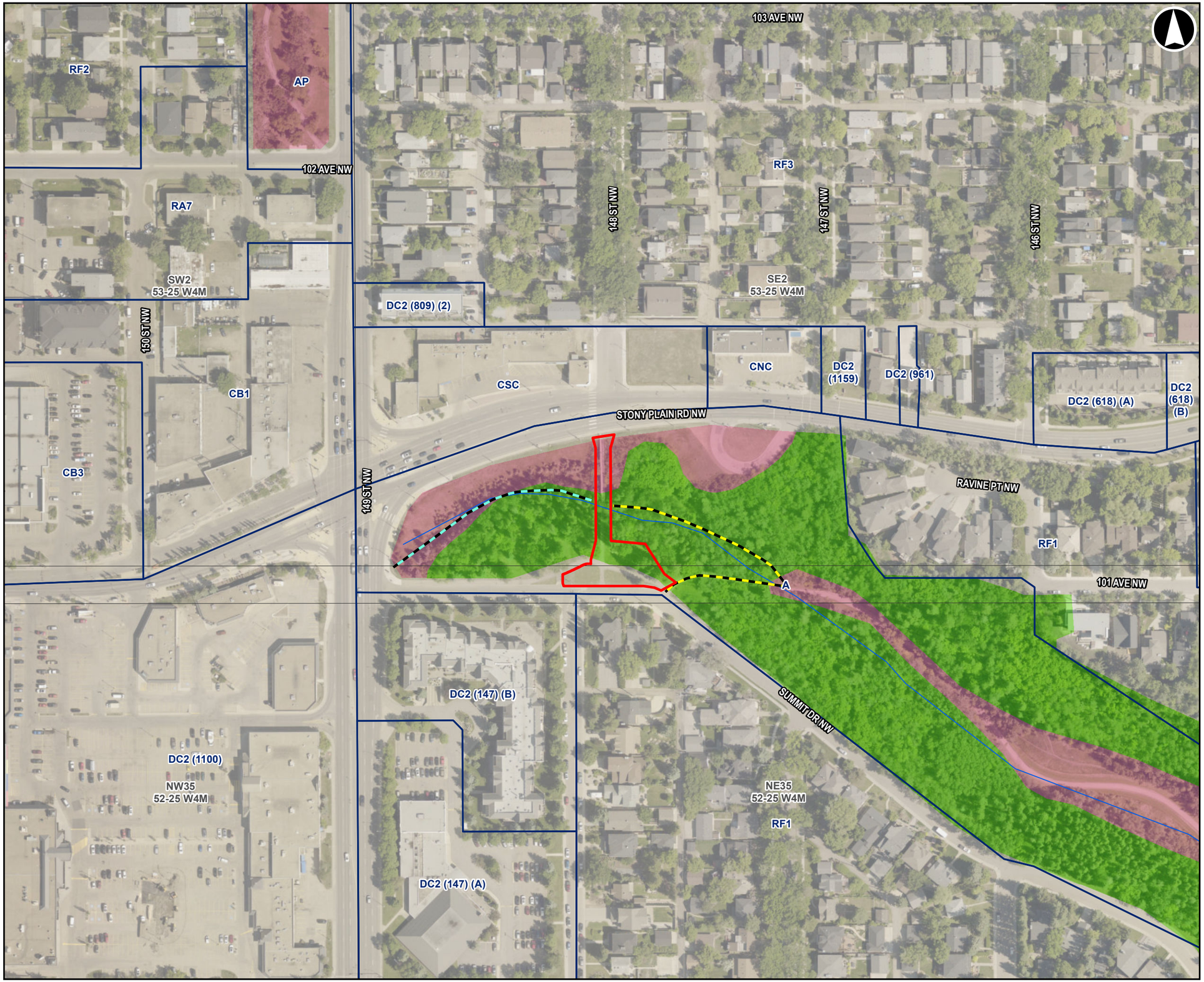
Datum: NAD 1983 UTM Zone 12N

Oct, 2022	PN#: 60682118	1:2,000 * when printed 11"x17"	AECOM

Figure 2-1

Data Sources: NRCan - Canvec, AltaLIS, AEP, City of Edmonton
Main Map: Esri World Imagery Basemap
Key Map: Esri World Topographic Map

Date Saved: 10/21/2022 10:41:10 AM User Name: Stephanie.Clark
Path: S:\Projects\60682118_EIA_EnvironmentalOverview\c_Vegi.mxd



Legend

- Project Area
- Preferred Access Route
- Alternate Access Route
- Watercourse (AltaLIS) *
- City of Edmonton Zoning (See Table)

Urban Primary Land and Vegetation Inventory

- Developed
- Modified
- Naturally Wooded

Zone	Description
A	Metropolitan Recreation Zone
AP	Public Parks Zone
CB1	Low Intensity Business Zone
CB3	Commercial Mixed Business Zone
CNC	Neighbourhood Convenience Commercial Zone
CSC	Shopping Centre Zone
DC2 (1000) (1), DC2 (1100), DC2 (1159), DC2 (147) (A), DC2 (147) (B), DC2 (618) (A), DC2 (618) (B), DC2 (809) (2), DC2 (961)	Site Specific Development Control Provision
RA7	Low Rise Apartment Zone
RF1	Single Detached Residential Zone
RF2	Low Density Infill Zone
RF3	Small Scale Infill Development Zone

Notes:

* Not Considered a Waterbody based on Site Visit.

MACKINNON RAVINE PEDESTRIAN BRIDGE ENVIRONMENTAL IMPACT ASSESSMENT

ENVIRONMENTAL OVERVIEW – VEGETATION

0 20 40 60 80

Metres

Datum: NAD 1983 UTM Zone 12N

Oct, 2022	PN#: 60682118	1:2,000 * when printed 11"x17"

Figure 2-2

AECOM

Data Sources: NRCan - Canvec, AltaLIS, AEP, City of Edmonton
Main Map: Esri World Imagery Basemap
Key Map: Esri World Topographic Map

Legend

- Project Area
- Preferred Access Route
- Alternate Access Route
- Watercourse (AltaLIS) *
- Key Wildlife and Biodiversity Zone

Historic Resources (Spring 2022)

- HRV 5

Notes:

* Not Considered a Waterbody based on Site Visit.
The Sensitive Raptor Range for the Bald Eagle and the Sharp-tailed Grouse Survey Range encompasses the entire Project Area.

MACKINNON RAVINE PEDESTRIAN BRIDGE ENVIRONMENTAL IMPACT ASSESSMENT

ENVIRONMENTAL OVERVIEW – WATER BODIES, WILDLIFE, AND HISTORICAL RESOURCES

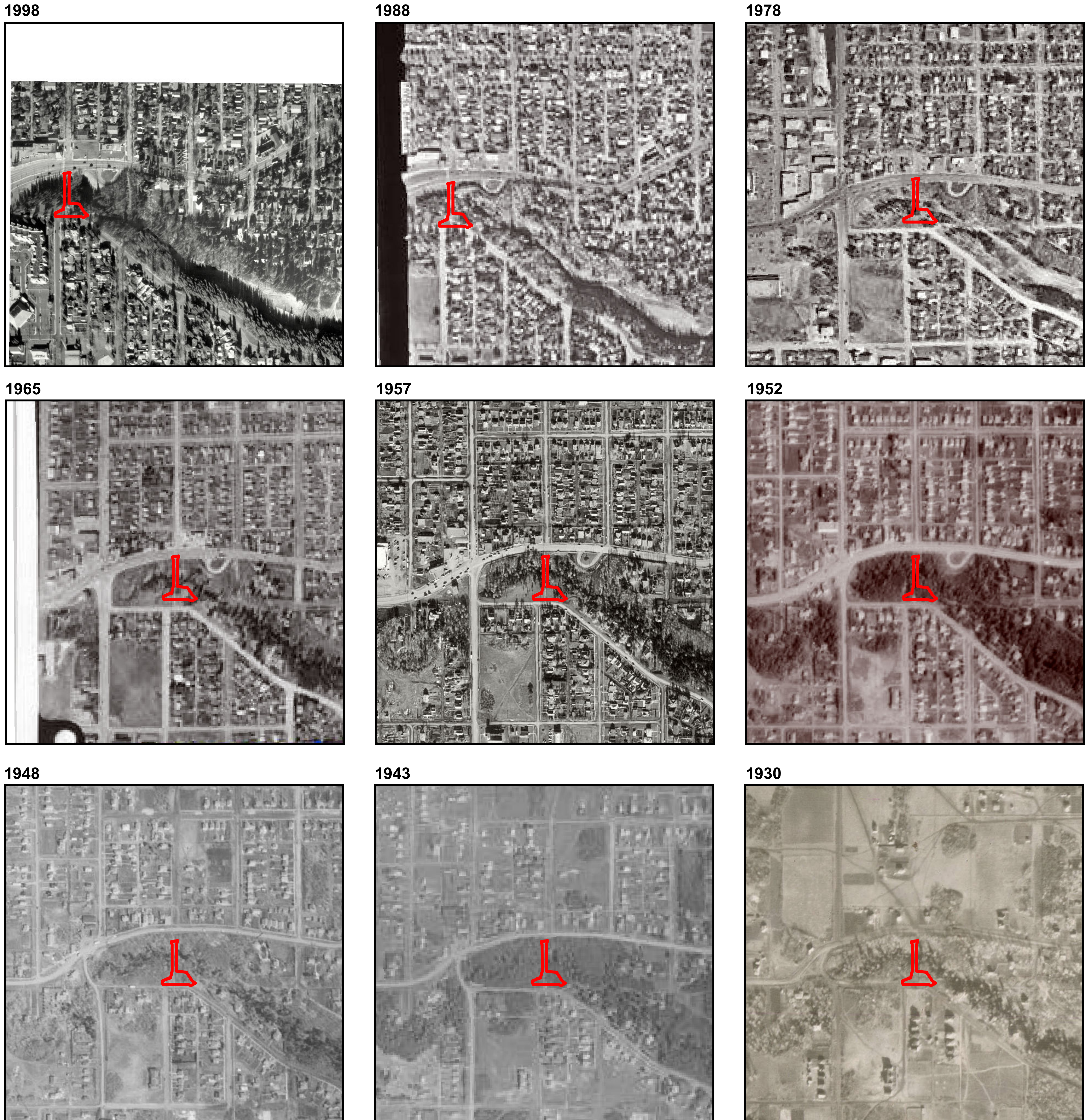
0 20 40 60 80
Metres

Datum: NAD 1983 UTM Zone 12N

Oct, 2022	PN#: 60682118	1:2,000 * when printed 11"x17"	AECOM

Figure 3

Data Sources: NRCan - Canvec, AltaLIS, AEP, City of Edmonton, Alberta Historic Resources Management Branch
Main Map: Esri World Imagery Basemap
Key Map: Esri World Topographic Map



Legend

Project Area

MACKINNON RAVINE PEDESTRIAN BRIDGE ENVIRONMENTAL IMPACT ASSESSMENT

AERIAL IMAGERY

0 80 160 240 320
Metres

Datum: NAD 1983 UTM Zone 12N

Oct, 2022	PN#: 60682118	1:8,000 * when printed 11"x17"

Figure 4

AECOM

Data Sources:
Key Map: Esri World Topographic Map

Map location: \\na.aecomnet.com\LFS\AMER\Calgary-CACGY3\DCS\GIS\Alberta\60682118_MacKinnon Ravine\02_MXDs\Environmental Impact Assessment\H004_60682118_EIA_AerialImagery.mxd
Date Saved: 10/21/2022 10:40:59 AM User Name: Stephanie.Clark

Appendix B
Photographic Log

AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
City of Edmonton	MacKinnon Pedestrian Bridge Replacement	60682118

Photo No.	Date
1	7/12/2022

Direction Photo Taken

North

Description

Access trail off Summit Drive NW.

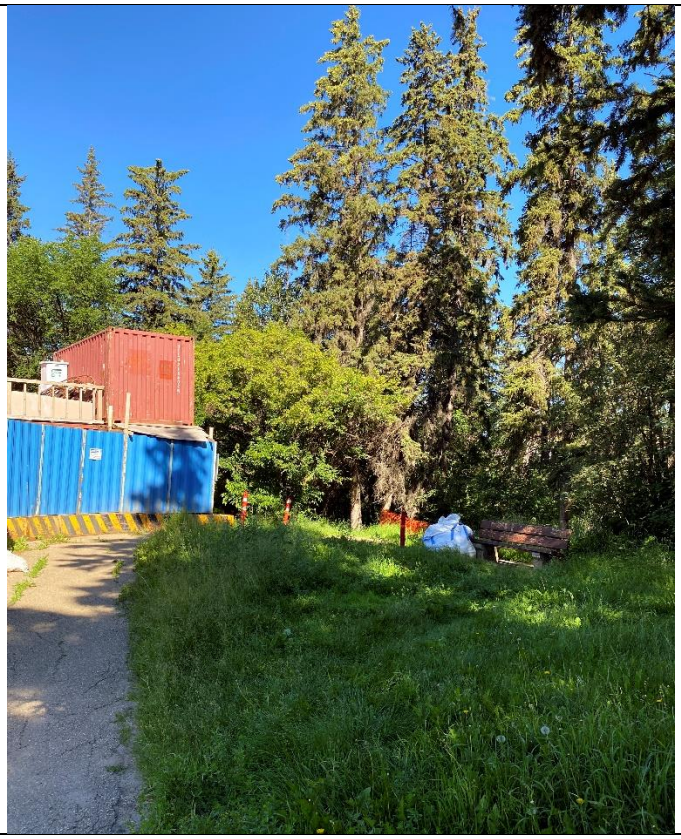


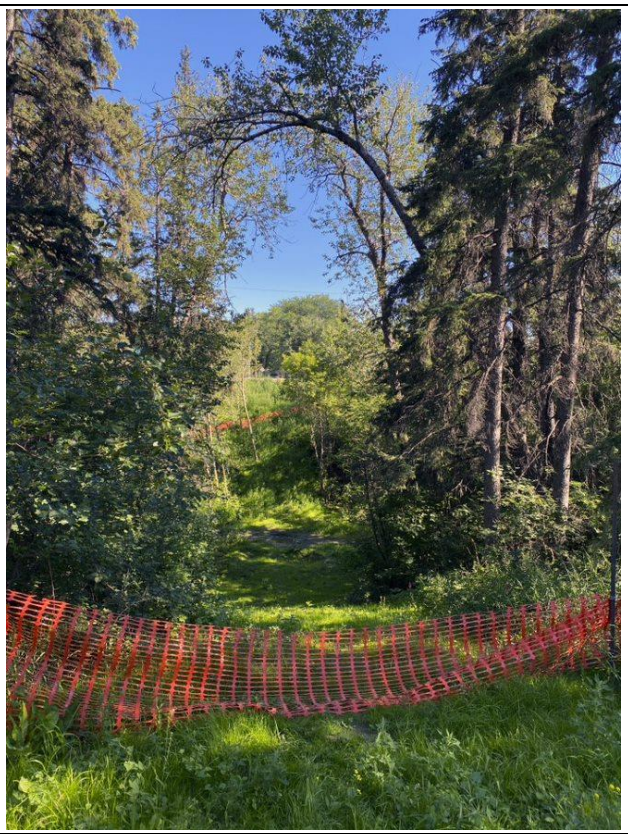
Photo No.	Date
2	7/12/2022

Direction Photo Taken

North

Description

Bridge alignment looking north.



AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
City of Edmonton	MacKinnon Pedestrian Bridge Replacement	60682118

Photo No.	Date
3	7/12/2022

Direction Photo Taken

South

Description

Bridge alignment looking south from the ravine.

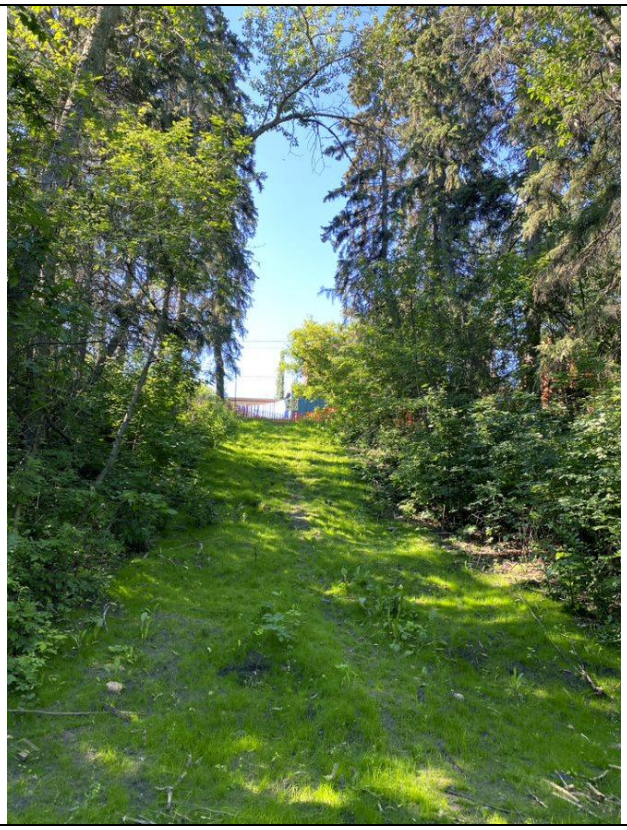


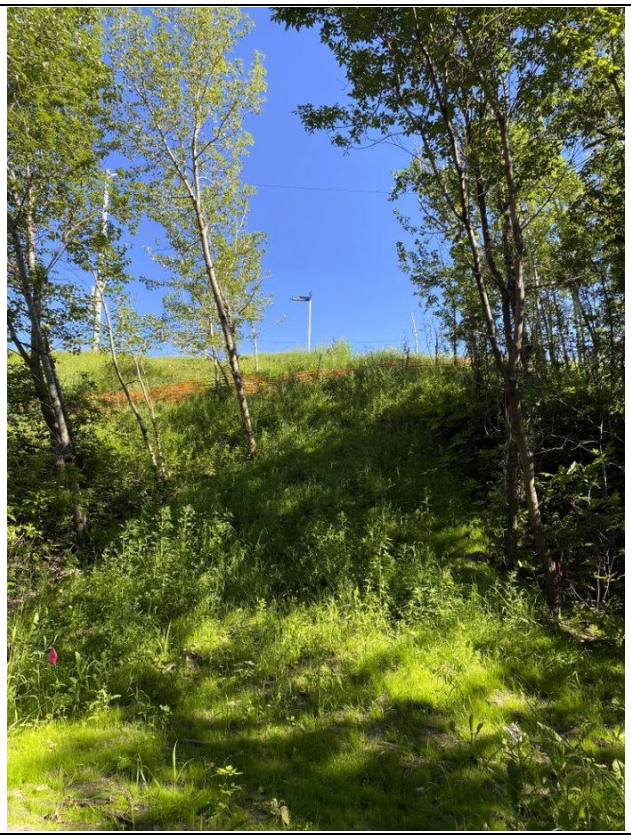
Photo No.	Date
4	7/12/2022

Direction Photo Taken

North

Description

Bridge alignment looking north from the ravine.



AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
City of Edmonton	MacKinnon Pedestrian Bridge Replacement	60682118

Photo No.	Date
5	7/12/2022

Direction Photo Taken

South

Description

Bridge alignment looking south.

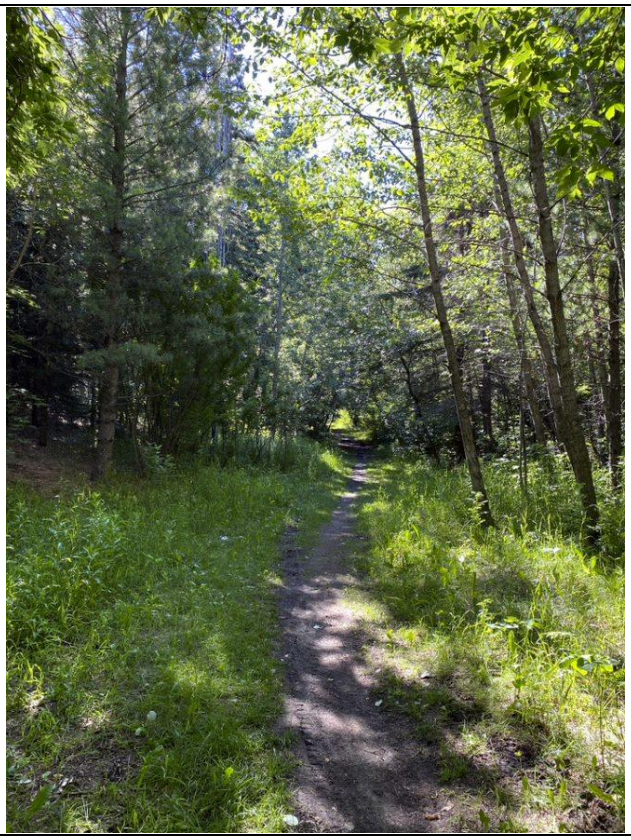
Photo No.	Date
6	7/12/2022

Direction Photo Taken

Southeast

Description

Typical dirt trail within the ravine.



Appendix C
Circulation Comments

Reference No. Posse # 452642888-001
BD22-74 MacKinnon Ravine Pedestrian Bridge Replacement EIA

Comments from City Planning (Growth Planning, Urban Growth and Open Space Strategy):	Response
For Open Space & Ecology comments, please ensure the project omits lighting on the bridge itself. There was one preexisting light post at either side of the bridge entrance, which may be replaced outside of 10m from the trees and on turf, but the lighting should be modified to focus light downward and reduce spill or glare. There is existing lighting along Stony Plain Rd and Summit Dr NW as well which would likely be enough to illuminate either entrance if the proponent wanted to omit lighting entirely.	Thank you for your feedback. The Project Team will advance replacement lights on either end of the bridge.
Comments from Engineering Services (Geotechnical Services):	
I reviewed the document submitted for this file: - Draft Environmental Impact Assessment; MacKinnon Ravine Pedestrian Bridge (B165) Replacement; City of Edmonton; prepared by AECOM Canada Ltd. (AECOM); File Number 60682118; dated October 21, 2022. Based on the information provided, it is understood that the original pedestrian bridge B165 was removed in February 2022 due to poor condition and safety concerns. A replacement bridge crossing is proposed to be constructed in spring/summer 2023. It is understood that the draft Environmental Impact Assessment (EIA) was submitted in support of the proposed replacement of pedestrian bridge B165. The draft EIA included several design options, as well as the preferred option for the replacement bridge. Preliminary schematics for the replacement bridge were included in the draft EIA. The draft EIA also included brief descriptions of the soils present in this area, making reference to a draft geotechnical report prepared by AECOM (MacKinnon Ravine Pedestrian Trestle Bridge Replacement; Geotechnical Report – DRAFT; prepared by AECOM; Project Number 60682118; dated July 28, 2022). However, the referenced draft geotechnical report was not appended to this draft EIA. Engineering Services - Geotechnical previously completed a technical review of the referenced draft geotechnical report (attached for reference) through another city circulation from Transportation Planning and Design (TPD). Comments were provided to TPD in an email dated Aug.18, 2022 (attached for reference). To date we have yet to receive a response to these comments or a revised final authenticated geotechnical report for the project addressing these comments. Of note is that at the time of writing of the draft geotechnical report the design options for the bridge had yet to be finalized and as such the draft report provided generalized information and recommendations to facilitate preliminary design of a multitude of different options. Now that the preferred option appears to be somewhat finalized (as presented in the schematics in the draft EIA), the final geotechnical report can likely be amended to provide information and recommendations specific to the presented preferred option, as well as to address the previously provided comments. The final geotechnical report is to be circulated to our office for review. Once the final report is submitted for our review and accepted by the City for use on this project, we will be able to provide our formal comments for this file.	Thank you for your feedback. Response to previous feedback and final geotechnical report will be provided.
Comments from EPCOR Drainage Services (Water & Sewer Servicing):	
Please find attached the response to the noted circular.	Thank you for your feedback. The Project Team continue to coordinate with EPCOR. A Proximity Agreement has been completed.
Comments from EPCOR Drainage Services (Drainage Planning and Engineering):	
No concerns, however please note that you are working in proximity to EPCOR Drainage infrastructure and agreements may be required.	Thank you for your feedback. The Project Team continue to coordinate with EPCOR. A Proximity Agreement has been completed.
Comments from Parkland Management:	
Please contact Parkland Management at prsparklandmanagement@edmonton.ca to confirm whether this project will require a parkland access permit - please reference the file number with the River Valley Bylaw team (ie: CM22-22). Parkland Access Permits can be applied for prior to receiving River Valley Bylaw approval to ensure timelines for completing permit requirements are addressed as best as possible. Please refer to the Parkland Access Permit application for information on what will be required for completing Parkland Access Permits.	Thank you for your feedback. Parkland Access Permits have been secured for investigations by AECOM. Parkland Access Permit is not required for Integrated Infrastructure Services construction projects.
Comments from Community and Recreation Facilities (Civic Events and Festivals):	
Please include Cheryl Taylor, Festival & Events Liaison (cheryl.taylor@edmonton.ca) for the Central River Valley on further project circulations so that there can be the coordination of multi use trail events in the area over construction. Once the project circulation is made Civic Events & Festivals will be looking to clarify if access across Summit Dr to the MacKinnon Ravine trail will be maintained as this is an access point commonly licenced to events.	Thank you for your feedback. The City Project Manager will follow up with Cheryl Taylor.
Comments from Community and Recreation Facilities (Partnership and Event Attraction Strategy):	
Acknowledged with no feedback.	Thank you for your feedback and support.
Comments from Community and Recreation Facilities (River Valley Parks and Facilities):	
Ensure trail detours and access routes remain open for pedestrian traffic and do not block the entry into trails.	Thank you for your feedback.
Comments from Parks and Roads Services (Natural Area Operations):	
Natural Area's Comments are below: ●The landscape and restoration plan will require review by a Natural Areas Urban Forester ●An approved Tree Preservation Plan will be required prior to construction which must be included in the application for a Public Tree Permit, as per the Public Tree Bylaw 18825. ●Please consider planting shrubs along with seed mix to excelerate reestablishment of understory vegetation near bridge and along access route depending on removals. ●Mitigate reduction in soil quantity by adding 300mm of top soil to disturbed areas as part of restoration. ●A pre- and post-construction inspection will need to be conducted. Please contact parkslandscapeinventory@edmonton.ca to schedule the inspection and include naturalareaoperations@edmonton.ca. ●Please ensure the project coordinates early with NAO regarding trail disruptions and closures, as our crews may need access through the area for trail maintenance. ●All mitigation measures identified in the EIA must be adhered to throughout the length of the project ●It is recommended that educational signage be used in the restoration areas to educate the public and minimize potential disturbance. ●All restoration should follow the City of Edmonton's Design and Construction Standards Volume 5 Landscaping and should be defined by the reference habitat. ●Any public communication for the project should include details on the tree removals required and restoration. ●Please consider conducting Tree work before Feb 15 to avoid owl and migratory bird surveys if possible. ●Will the alternate access only be used in case of emergency? Natural Areas would like to limit access to 1 side of possible. The use of rigmats may be required where equipment is wider than the path or equipment is not on the path so as to not compact tree roots.	Thank you for your feedback. Comments noted and will be considered as the design advances. The Project Team has met on site with Urban Forestry and Natural Areas Representatives on site. The Project Team will continue to coordinate the landscape, tree, and restoration plans. The intent is to access via the east route. The west route has been included as a contingency/back-up as the area has several construction projects in proximity.
Further consultation with a Natural Areas Urban Forester is required to confirm potential tree impacts and removals. To coordinate this and the clearance pruning here are General Conditions Regarding Vegetation Removal and clearance pruning: 1.Upon approval of the plan, a site meeting with Natural Area Operations will be required to review construction plans and tree protection. This meeting will need to be scheduled a minimum of 4 weeks in advance of the construction start date. This is to review access points, placement of all permanent or temporary construction material required for this project, and to determine tree protection requirements for construction within 10 meters of the natural stand. For any vegetation removal, please ensure the area has been clearly staked. Note that the laydown area fencing must be installed 5 meters from any adjacent trees and must be outside of the natural stand boundary. 2.Please be advised that all costs associated with pruning, removal, tree damage, or replacement shall be covered by the Proponent as per the Corporate Tree Management Policy C456C. Natural Area Operations will schedule and carry out all required tree work involved with this project. Please contact naturalareaoperations@edmonton.ca to arrange this meeting. 3.Any soil damage or compaction compromising the tree's root system within the parkland space shall be corrected by and at a cost to the Proponent. Please be advised that all costs associated with soil remediation, watering, and tree protection shall be covered by the Proponent as per the Corporate Tree Management Policy C456C. 4.Please note that the removal of vegetation has the potential to impact birds and bird habitat. Protection of migratory and non-migratory birds is legislated both provincially and federally. The onus is on the individual or company conducting habitat disturbance or construction activities to ensure that due diligence has been exercised to avoid harm to migratory and non-migratory birds. Individuals or companies that do not avoid harm to most wildlife species risk prosecution under the Wildlife Act and, in some cases, the Species at Risk Act. In the case of migratory birds, prosecution under the Migratory Birds Convention Act is also possible.	Thank you for your feedback. Comments noted and will be considered as the design advances. The Project Team has met on site with Urban Forestry and Natural Areas Representatives on site. The Project Team will continue to coordinate the landscape, tree, and restoration plans.
Comments from Parks and Roads Services (Urban Forestry):	
Please see comments below from Urban Forestry regardingBD22-74 MacKinnon Ravine Pedestrian Bridge Replacement EIA: Please be advised that the majority of tree impacts for this project are with Natural Areas Operations. The following comments pertain to any inventoried open spaces or boulevard trees. Urban Forestry requires a Tree Preservation Plan (TPP) for this project which will be completed by an ISA certified arborist, landscape architect or approved designate at the Development Permit stage. These reports shall detail how the long term viability and health of the trees is to be ensured through site specific protection and care, to the satisfaction of the Development Officer in consultation with Urban Forestry. The Tree Preservation Plan must be followed and enforced for the duration of the project. Any required tree work needs to be identified on the tree preservation plan for Urban forestry to review and approve. Prior to construction, all City of Edmonton trees within 5m of a construction site or active haul route require tree protection. A Public Tree Permit is required prior to construction. For more information on City of Edmonton Tree Protection, please visit https://www.edmonton.ca/residential_neighbourhoods/gardens_lawns_trees/trees-construction. If tree damage occurs, remediation or removal will be enforced and shall be covered by the proponent as per the Corporate Tree Management Policy (C456C). This includes compensation for tree value on full or partial tree loss as well as operational and administrative fees. There appear to be conflicts with City of Edmonton Natural Areas Forestry trees. Please contact Natural Areas Forestry Team at naturalareaoperations@edmonton.ca. If upon review and approval of the tree preservation plan there are required tree removals for this project, forestry may approve the removal with the condition that the tree value is paid by the proponent as compensation for the loss of canopy and that the proponent provides proof that the Community League has been notified of the tree removal request. All costs associated with the removal, replacement or transplanting of trees shall be covered by the Proponent as per the Corporate Tree Management Policy (C456C). Forestry will schedule and carry out all required tree work involved with this project. Please contact Urban Forester Laurie Lacey at 780-868-2174 or laurie.lacey@edmonton.ca to arrange this meeting.	Thank you for your feedback. Comments noted and will be considered as the design advances. The Project Team has met on site with Urban Forestry and Natural Areas Representatives on site. The Project Team will continue to coordinate the landscape, tree, and restoration plans.
Comments from Parks and Roads Services (Resource Planning and Land Development):	
Open Space Inspection Services comments. 1.A pre-construction inspection prior to accessing the site and a post-construction inspection once parkland restoration has occurred will be conducted by Open Space Inspection Services. Email: parkslandscapeinventory@edmonton.ca to request inspections. 2.This project will require a Parkland Access Permit. Please contact Parkland Management to obtain a permit prior to scheduling a pre site inspection. Email: prsparklandmanagement@edmonton.ca 3.This project must follow all City Policies and Servicing Agreements 4.A detailed landscape restoration design must be submitted to Natural Area Operations for comment and approval prior to construction. 5.Erosion and Sedimentation Control Measures must be in place prior to any construction activity to prevent any contaminants from entering Infrastructure or Water Bodies. 6.Any damaged ornamental turf areas shall be repaired with sod (not topdress and seed) and all maintenance (watering, mowing, public access control and weed control) of the restored areas will be the responsibility of the proponent until established, inspected and accepted by PARS. 7.All damages to natural areas must be restored to pre-existing conditions with approved (by NAO) natural grasses/vegetation as required and the maintenance (watering, weed control and public access control measures) of restored natural areas will be the responsibility of the proponent until the natural area planting material is established, inspected and accepted by PARS. 8.All other damages to parkland inventory (curbs, roads, trails, paths, furniture, fixtures, signs, trees, shrub beds, etc) must be restored to pre-existing conditions and CoE Construction Standards and PARS inspection and acceptance. 9.Any lay down, staging or haul route area on Parkland must be approved and fenced, with no vehicular or project activity outside of the fenced area. There should be no access to the lay down, staging or haul route area to ensure public safety. The restoration of the entire area must be repaired to the existing conditions. Soil compaction protection, aeration and re-sodding; including the maintenance (eg watering, mowing, weed control and public access control measures) of restored turf areas will be the responsibility of the proponent until the sod is established and accepted by PARS. Email: parkslandscapeinventory@edmonton.ca to request a laydown area pre inspection. 10.There is no unapproved parking on Parkland.	Thank you for your feedback. Comments noted and will be considered as the design advances.

11.Vehicle and equipment travel on the site must not traverse areas adjacent to the identified work space(s) and must stick to specified and planned minimally impactful haul/planting routes. Travel must also be away from low areas where water retention may occur. Travel must also not occur during inclement weather or within a minimum of 48 hours after major inclement weather events.
12.Soil compaction protection (rig matting or other approved) on the site is required prior to any activity (normally where there is a large number of existing trees in close proximity).
13.Site drainage must not be affected by this project. Any overland drainage issue or concern that is a result of this project will be corrected and repaired by the developer/contractor, not the City of Edmonton.
14.Erosion Control Measures must be in place and maintained post construction to prevent overland drainage washout on areas that have been newly landscaped (along the sides of stairs, trails, paths, etc). The project should also consider the installation of fencing and informational signage around areas to discourage disturbance of the area by the public.
15.Public access control measures should be in place and maintained post construction to prevent the public from accessing areas that have been newly landscaped (along the sides of trails, stairs, paths, etc). In order to ensure the success of the restoration areas, the project should also consider the installation of fencing and informational signage around areas to discourage disturbance of the area by the public. Please be aware that native species can take longer to establish than many ornamental landscaping species or traditional turf grasses. It is for this reason that considerations for protection of restoration areas are strongly recommended.
16.Trail closures shall adhere to the City's Trail Closure Procedures. All trail closure activities must be approved through River Valley Operations prior to construction and closure of trails. This shall be done a minimum two weeks in advance of planned construction.
17.Any new trail construction or rehabilitation must meet current City of Edmonton trail construction standards and have a minimum 1M buffer zone, free of vegetation on either side of the trail.
18.All damages to trails and paths must be restored to pre-existing trail surface type conditions and to COE Construction Standards and PARS acceptance.
19.Please note that the disturbance areas will need to be weed free to pass the FAC inspection. Therefore, the contractor should ensure they have an adequate weed control plan in place and that it is adhered to throughout the warranty period.
20.If tree conflicts (work within 5m of a tree) are anticipated, or arise during construction, or a tree is within 3m of the haul route a site meeting with the City of Edmonton Urban and/or Natural Area Forester will be required. Please be advised that all costs associated with the removal, replacement or transplanting of trees shall be covered by the applicant as per the Corporate Tree Management Policy (C456C). The City of Edmonton will schedule and carry out all required tree work involved with this project.
21.Tree protection is required around existing boulevard trees near the site access points. A minimum 2M protection barrier surrounding each tree is required.
22.There is no dumping or stockpiling on the site.
23.Use of this area must be managed carefully to prevent any spills or release of contaminants.
24.The developer/contractor is responsible for all weed control on the construction site, lay down or haul route areas during construction and until the site has been inspected and accepted by PARS.
25.Hard-surface access routes are preferred for large equipment.
26.All holes must be filled immediately to ensure public safety. This includes mitigating settlement that would create a future trip hazard.
27.The site is left in an intended state that meets the City's satisfaction.
28.For projects longer than one day, signage must be posted with an active project contact person and phone number for inquiries.
29.Please follow the City of Edmonton Design and Construction Standards Volume 5 - Landscaping (2022).

Comments from Open Spaces Infrastructure Delivery (Building Great Neighborhoods and Open Spaces):

There are no concerns from OSID/OSPD and this project is supported

Thank you for your feedback and support.

General Conditions:

1)All mitigation measures and commitments outlined by City reviewers must be incorporated into the construction work plan.
2)The proponent is responsible for seeking approval for any other regulatory permits from provincial and federal agencies.
3)Please contact the Neighbourhood Resource Coordinator, Michael Goth, 587-986-5755 in the area to ensure appropriate community notification.
4)For potential impacts to City parks and facilities:
a)Hard surface access/haul routes are preferred.
b)Site drainage must not be affected by this project.
c)Noxious weeds shall be managed and controlled as required within the footprint of the project area and should be the responsibility of the contractor/department during the construction and maintenance period.
5)All trail closures shall adhere to the City's Trail Closure Procedures. All trail closure activities must be approved through River Valley Operations prior to construction and closure of trails. Please contact Braeden Holmstrom (Team Leader, River Valley & Horticulture) at 587-986-2841 or braeden.holmstrom@edmonton.ca to obtain the necessary trail closure approvals. This shall be done a minimum of two weeks in advance of planned construction.
6)Use of this area must be managed carefully to prevent any spills or release of contaminants.
7)Please attach this letter for any further City of Edmonton approvals.
Should you have any questions or concerns, please contact me by e-mail or by phone at 780-423-7407.

Thank you for your feedback. Comments noted. The Project Team will coordinate with identified contacts.

Appendix D
Geotechnical Investigation Report

Please contact the City Project Manager for authenticated version.

AECOM

MacKinnon Ravine Pedestrian Trestle Bridge (B165) Replacement

Geotechnical Report

City of Edmonton

Project reference: CP-0010081
Project number: 60682118

September 28, 2022

Delivering a better world

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The attached Report (the “Report”) has been prepared by AECOM Canada Ltd. (“AECOM”) for the benefit of the Client (“Client”) in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the “Agreement”).

The information, data, recommendations and conclusions contained in the Report (collectively, the “Information”):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the “Limitations”);
- represents AECOM’s professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time..

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AECOM: 2015-04-13

Quality information

Prepared by	Verified by
Imran Shah, M.A.Sc., P.Eng. Geotechnical Engineer	Faris Alobaidy M.Sc., P.Eng. Senior Geotechnical Engineer

Revision History

Revision	Revision date	Details	Authorized
A	July 28, 2022	Imran Shah	Draft for Comment
B	September 28, 2022	Imran Shah	Final

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Table of Contents

Tables

Appendices

1. Introduction

1.1 General

AECOM Canada Ltd. (AECOM) was retained by the City of Edmonton (The City) to provide engineering services required for replacing the MacKinnon Ravine Pedestrian Trestle Bridge located in Edmonton, Alberta. Single and multi-span bridge options are currently being considered for the new pedestrian bridge.

The main objectives of the geotechnical investigation were to determine the site-specific subsurface soil/groundwater conditions at the testhole locations and to provide geotechnical recommendations to support the design and construction of the geotechnical elements of the new bridge including foundations and the bridge head slopes stability.

The analyses and recommendations presented in this report are based on the data obtained from testholes drilled by AECOM at locations shown on **Figure 1** in **Appendix A**. This report does not reflect any variations in subsurface conditions that may occur at locations other than the testhole locations. In the performance of subsurface explorations, specific information is obtained at specific locations at specific times; however, it is well known that variations in soil conditions exist at most sites between testhole locations. The nature and extent of variations may not become evident until construction commences. If variations are then evident, it will be necessary to re-evaluate the recommendations presented in this report after performing on-site observations during the construction period and noting the characteristics of any variations.

This report is subject to the general statement regarding normal variability of subsurface conditions provided in **Appendix B**.

1.2 Background

The MacKinnon Ravine Pedestrian Bridge (B165) site is located east of the intersection of Stony Plain Road and 149 Street NW. The pre-existing structure was a timber trestle bridge with an approximate span length of 59.4 metres (m) and a 1.8 m deck width. The bridge tied into a 1.5 m wide sidewalk along Stony Plain Road at its north end and to a 3.0 m wide shared use path travelling east into MacKinnon Ravine at its south end.

The MacKinnon Ravine bridge was closed in September 2021 due to structural capacity concerns of the superstructure and was demolished earlier this year. The bridge replacement project has been categorized as a high priority and the plan is to begin construction of the proposed pedestrian and cyclist bridge with a minimum clear width of 4.2 m in 2023.

1.2.1 Review of Existing Reports

Several existing reports related to the project site have been reviewed. These reports include the following:

- Environmental Impact Assessment Pursuant to Bylaw 7188 for Valley Line West Light Rail Transit (LRT) Activities Near MacKinnon Ravine – Spencer Environmental Management Services Ltd. (2018)
- Geotechnical Investigation – Proposed Residential Subdivision 146 Street & Stony Plain Road – J.R. Paine & Associates Ltd. (1997)
- Edmonton LRT Valley Line Stage 2 (West) Geotechnical Considerations at MacKinnon Ravine Revision 1 – Thurber Engineering Ltd. (2018)
- Edmonton Valley Line West – Tracks, Retaining Walls, Stops, and Utility Complexes – Geotechnical Breakout Interpretive Report (Area 4 and 5) – Stantec Consulting Ltd. (2022)

Based on the review of the environmental impact assessment carried out by Spencer Environment Management Services Ltd. (Spencer) in 2018, Thurber Engineering Ltd. (Thurber) conducted an overall

appraisal of the geotechnical conditions along the Valley Line West alignment including the northern terminus of MacKinnon Ravine near Stony Plain Road. The geotechnical assessment was based on the findings of a review of available information and a site reconnaissance of the proposed alignment. Site reconnaissance involved visual examination of surface conditions along the proposed route, including the slopes in MacKinnon Ravine. No test holes were advanced as part of this study.

The Spencer (2018) report stated that the slopes of MacKinnon Ravine are generally covered with colluvium material. Colluvium is deposited by gravity because of slumping and erosion of overburden units at higher stratigraphic positions. It is composed of a random mixture of clay, silt, sand and possibly blocks of bedrock. Colluvium material tends to be loose and can be prone to sliding. In the vicinity of the LRT alignment (near the proposed MacKinnon Ravine Pedestrian Bridge Location), the ravine is approximately 5 m deep, and the inclination of ravine slopes ranges between 2H:1V and 3H:1V. No visible signs of active slope movement/instability were identified in this area. However, previously, Thurber (1990) investigated a slope failure on the north bank of MacKinnon Ravine at the bus turnaround near 147 Street (Approx. 50 m east of the MacKinnon Ravine Pedestrian Bridge location). The slide appeared to be shallow within the upper, high plastic glacio-lacustrine clay. The failure mass was excavated, and the slope was reconstructed to a flatter inclination of 3H:1V. Granular drains were also installed at the slope toe. Considering this history, it is possible that portions of the north ravine slope along the Stony Plain Road may be only marginally stable (Thurber 2018). In addition, uncontrolled fills of varying thickness could be present along the stretch of the alignment.

Another report prepared by J.R Paine and Associates Ltd. (1997) for a geotechnical investigation of a residential subdivision development located at the north end of the MacKinnon Ravine and approximately 130 m east of the MacKinnon Ravine Pedestrian Bridge site. Based on the report review, the slope was gentle at the north end and became steeper and irregular towards the south. The upper part of the slope was noted to be inclined approximately between 3H:1V and 4H:1V and the southern slope was steeper (estimated inclination between 1.5 and 2H:1V). The height of the slope was approximately 12 meters. The report states that slope stability analyses were performed using theoretical water tables and the slope was found to be stable.

Stantec (2022) performed the geotechnical investigation for Valley Line West LRT track, retaining wall, stop and utility complex sites along LRT alignment from approximately 138 Street and Stony Plain Road NW to 162 Street and 87 Avenue NW. One testhole BH-MR-02 was drilled close to the north abutment of the proposed MacKinnon Ravine Pedestrian Bridge. No observations regarding any potential slope instability of the north slope of the MacKinnon Ravine were noted in Stantec (2022). However, AECOM reviewed and utilized the testhole BH-MR-02 information from Stantec (2022) in the slope stability assessment for the proposed MacKinnon Ravine Pedestrian Bridge.

1.3 Scope of Work

The geotechnical scope of work includes a desktop study review of the surficial and bedrock geology maps of the proposed development site, a field investigation, and a factual and geotechnical recommendations report. Specific items for the geotechnical work include:

- Desktop review of the existing information
- Site reconnaissance
- Planning and coordination for the field investigation
  - Obtaining utility locations via Utility Safety Partners (Alberta One-Call)
  - Arranging for a private utility locator to visit the site for determining the presence of underground utilities
- Intrusive geotechnical field investigation involving drilling three testholes; one at or near each abutment location and one at the pier location
- Laboratory testing program on selective samples collected during the investigation program

- Preparing a geotechnical report that documents the findings from the site investigation and laboratory testing and provides geotechnical recommendations to support the design and construction of geotechnical elements of the project

2. Methodology

2.1 Planning and Coordination

Permits including a Parkland Access Permit and River Review Form pertaining to Bylaw 7188 for the North Saskatchewan River Valley Area Redevelopment Plan were obtained. Coordination and integration with the Valley Line West Light Rail Transit (LRT) design and construction was carried out in communication with Marigold Infrastructure Partners (MIP).

2.2 Desktop Study

2.2.1 Surficial Geology

Near-surface geology of the project was reviewed based on the "Quaternary Geology, Central Alberta Map" (Shetsen 1990) and "Urban Geology of Edmonton" (Kathol C.P. and McPherson R.A 1975). The project area is expected to consist of up to 20 m of fluvial deposits comprising of gravel, sand, silt and clay, including local till and bedrock exposures.

2.2.2 Bedrock Geology

Bedrock geology of the project was compiled by reviewing the "Bedrock Geology Map of Alberta" (Prior G.J., et al. 2013) and "Urban Geology of Edmonton" (Kathol C.P. and McPherson R.A 1975). The Edmonton formation (also known as the Horseshoe Canyon of Irish, 1970) is known to have varying thicknesses (ranging from 140 to 190 m, averaging at 170 m) in the study area because of the extensive erosion of its upper surface. The Edmonton formation consists primarily of pale grey, fine to very fine grained, feldspathic sandstone interbedded with siltstone, bentonitic mudstone, carbonaceous mudstone, concretionary sideritic layers, and laterally continuous coal seams; the geology includes white, pedogenically altered sandstone and mudstone interval at top (formerly assigned to the Whitemud Formation).

2.3 Field Investigation

Three testholes (TH22-01, TH22-02 and TH22-03) were advanced to depths ranging from 14.8 metres below ground surface (mBGS) to 20 mBGS within the study area using a solid stem auger mounted on a tracked rig provided by All Service Drilling Inc. from June 13, 2022 to July 15, 2022. Two standpipe piezometers were installed in TH22-02 and TH22-03 consisting of 50 millimetres (mm) diameter polyvinyl chloride (PVC) pipes to monitor the groundwater level. Significant delays were faced during the drilling program due to weather and site conditions. In addition to testholes, one hand auger (HA22-01) was advanced at the north abutment as the testhole at the top of the north slope of the ravine, TH22-01, was offset from the proposed abutment location due to site constraints.

AECOM geotechnical personnel visually examined and recorded the subsoils and groundwater conditions encountered in the testholes. Soil was logged according to the Modified Unified Soil Classification (mUSC) System. Standard Penetration Tests (SPT) were performed at regular intervals in all drilled testholes. The SPT blow counts for 300 mm penetration of the split spoon (SPT N-values) were also recorded. Disturbed soil samples were collected at a regular interval for further examination and laboratory testing. Testhole logs and the laboratory test data along with AECOM's Explanation of Field and Laboratory Test Data and the mUSC for soils are included in **Appendix B.**

The locations of testholes and hand auger are presented in **Figure 1** in **Appendix A. Table 2-1** summarizes the field investigation program.

Table 2-1 Field Investigation Summary

Testhole	Depth (mBGS)	Northing (m)	Easting (m)	Elevation (m)	Monitoring Well Installed (Y/N)
TH22-01	15.5	5935650	329362	671.0	N
TH22-02	14.8	5935602	329313	662.26	Y
TH22-03	20.0	5935587	329312	670.0	Y
HA22-01	3.0	5935633	329307	667.0	N

2.4 Laboratory Testing

Soil samples collected during the investigation program were tested in AECOM's material testing laboratory in Calgary, Alberta. The laboratory testing included the determination of moisture contents, Atterberg Limits, grain size distributions and soil chemical properties. Soil chemical analysis tests were carried out in an ALS Environmental laboratory and included testing for pH, soluble sulphates, resistivity, and chloride content. Laboratory tests consisted of the following:

- Water Content – ASTM D2216
- Grain Size Analysis – ASTM D422
- Atterberg Limits – ASTM D4318
- Chemical Testing for pH, sulphate content, chloride content, and resistivity

The test results are shown on the testhole logs in **Appendix B** and in **Appendix C**.

3. Subsurface Conditions

The subsurface stratigraphy encountered at the testholes/hand auger locations generally consisted of topsoil or clay fill at the ground surface, underlain by clay, underlain by clay till.

Detailed descriptions of the subsurface conditions are provided in AECOM testhole/hand auger logs in **Appendix B** and testhole log of the testhole BH-MR-02 from Stantec (2022) in **Appendix B1**. The testhole BH-MR-02 was reviewed and included in the analyses as this testhole was completed near the north abutment of the proposed pedestrian bridge.

3.1.1 Topsoil

Topsoil was encountered in TH22-01 and TH22-03 at ground surface. The topsoil thicknesses ranged from 75 mm to 100 mm. The topsoil was observed to be organic and fibrous containing rootlets, trace silt and clay. The topsoil was moist and black in colour.

3.1.2 Clay Fill

Clay fill was encountered below the topsoil in TH22-01 and at ground surface in HA22-01. The thickness of clay fill varied from 0.6 m to 0.7 m. The clay fill was firm to stiff, brown to dark brown and moist. The clay fill contained trace to some sand, trace silt and trace gravel, trace rootlets, silt laminations, and was oxidized.

Moisture content of clay fill varied from 18.8 % to 21.7 %.

3.1.3 Sand

Sand was encountered in testhole TH22-02 below clay at a depth of 0.4 mBGS and extended 2.5 mBGS. Another thin layer (0.3 m thick) of sand was also encountered at 11.4 mBGS in TH22-02. The sand was silty and contained trace clay, fine grained, loose to compact, damp to wet and brown.

The moisture content of sand varied from 9.2 % to 22.7 %.

3.1.4 Gravel

Gravel was encountered below clay fill in TH22-01 and extended to 3 mBGS. The gravel contained some clay to being clayey, trace to some sand and trace silt. The gravel was poorly graded, subangular, loose to dense, moist, and dark brown in colour.

The moisture content of the gravel ranged from 5.3 % to 9.2 %.

3.1.5 Clay

Clay was encountered below gravel in TH22-01, at ground surface in TH22-02, and below topsoil in TH22-03. The thickness of clay layer varied from 0.4 m to 5 m. The clay contained some silt to being silty, and trace fine sands. Trace to some sand or silt laminations and oxidation were also observed. The clay was low to high plastic, moist to wet and brown to grey. The SPT N-values for the clay ranged from 4 to 17, indicating that the clay is firm to very stiff.

The moisture content of the clay ranged from 16.8 % to 45.8 %. Tests were conducted on the clay samples to determine Atterberg Limits and grain size distribution and are summarized in **Table 3-1**.

Table 3-1 Summary of Laboratory Test Results for Clay

Testhole	Sample	Depth (mBGS)	mUSC	MC (%)	LL (%)	PL (%)	PI (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TH22-01	8	5.35	CH	45.8	61.1	19.5	41.5	0	1.6	40.2	58.2
TH22-03	7	4.55	CI-CH	33.8	49.1	19.5	29.4	0.0	0.6	54.6	44.8

MC = Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index

3.1.6 Clay Till

Clay till was encountered in all testholes and the hand auger hole and was a predominant soil unit. Clay till was encountered at depths ranging from 0.6 mBGS to 6.7 mBGS and all the testholes/hand auger hole terminated in clay till. The clay till contained trace sand to sandy, had trace gravel, and trace silt to silty. The clay till was of low to medium plasticity, stiff to very stiff, moist and brown. Some fine sand/silt laminations as well as trace coal and oxidization were observed.

The moisture content of the clay till ranged from 13.5 % to 21.5 %. The SPT N-values for the clay till varied from 2 to 53 indicating that the clay till is soft to hard. Tests were conducted on the clay till samples to determine Atterberg Limits and grain size distribution and are summarized in **Table 3-2**.

Table 3-2 Summary of Laboratory Test Results for Clay Till

Testhole	Sample	Depth (mBGS)	mUSC	MC (%)	LL (%)	PL (%)	PI (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TH22-01	13	9.05	CI	15.0	38.6	13.4	25.2	–	–	–	–
TH22-02	6	3.85	CI-CL	15.9	30.9	12.0	18.9	3.3	37.8	33.7	25.2
TH22-02	14	9.85	CI-CL	18.0	31.8	12.1	19.7	6.4	32.9	33.5	27.2
TH22-02	20	14.35	CL-CI	21.5	28.6	14.4	14.2	0.9	30.2	45.9	23.0
TH22-03	11	7.55	CI-CL	14.6	30.5	12.1	18.4	4.1	37.4	33.3	25.2

3.2 Groundwater Condition

Groundwater was encountered at approximately 7.6 mBGS in testhole TH22-01, 10.4 mBGS in testhole TH22-02, and 17.1 mBGS in TH22-03 upon drilling completion. The 50 mm standpipe piezometers were installed in TH22-02 and TH22-03. Groundwater was measured at 7.45 mBGS in testhole TH22-02 on July 22, 2022, and at 14.04 mBGS in testhole TH22-03 on July 27, 2022. The groundwater was reported to be at 4.8 mBGS in testhole BH-MR-02 (Stantec, 2022) on June 26, 2021.

It should be noted that groundwater levels undergo seasonal fluctuations due to precipitation, snow melting, drainage conditions on site and other factors. Therefore, groundwater conditions at the time of construction may vary from historical observations.

3.3 Soil Chemical Testing

Chemical testing was conducted on select samples to determine pH, resistivity, soluble chloride and sulphate concentration. The degree of corrosiveness and corrosion potential for sulphate attack are provided in **Table 3-3.**

Table 3-3 Summary of Chemical Testing Results

Testhole	Sample	Depth (mBGS)	mUSC	Resistivity	pH	Sulphate Content		Chloride Content	Degree of Corrosiveness	Potential for Sulphate Attack
		(mBGS)		(Ohm-cm)		(%)	(mg/L)	(mg/L)		
TH22-02	7	4.55	CL-CI	1850	8.27	<0.050	466	<40	Highly Corrosive	Low
TH22-03	9	6.1	CI-CL	1000	7.49	0.714	1720	< 20	Highly Corrosive	Severe

The expected degree of corrosivity presented in **Table 3-3** is based on Roberge (2000) and the potential for sulphate attack presented in **Table 3-3** is based on Canadian Standards Association (CSA – 2014 with Update No. 1 in September 2015 and Update No. 2 in 2018).

3.4 Frost Susceptibility

The surficial soils encountered at the study area consist of topsoil (OR), clay fill (CL), gravel (GC), clay (CI) and clay till (CI-CL). The qualitative frost susceptibility of a soil is typically assessed using guidelines developed by Casagrande (1932) on the basis of the percentage by weight of soil finer than 0.02 mm and the plasticity index. The classification system has been adapted by the U.S. Army Corps of Engineers and the Canadian Foundation Engineering Manual (CFEM, 2006). Soils are classified as F1 through F4 in order of increasing frost susceptibility and loss of strength during thaw events. The soils encountered near ground surface at the site are classified as F3 and are highly frost susceptible.

3.5 Site Seismicity

Seismic loading is required for the design of structures. The level of importance of seismic loading at any site is related to factors such as the subsoil conditions and their behavior during an earthquake, the magnitude, duration and frequency of strong ground motion and the probable intensity and likelihood of the occurrence of an earthquake. The parameters representing seismic hazard in the 2020 National Building Code of Canada (NBCC 2020) for specific geographical locations are the 5% damped horizontal spectral acceleration for periods of 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s and 10.0 s, the horizontal peak ground acceleration (PGA) and the horizontal peak ground velocity (PGV) corresponding to a 2% probability of being exceeded in 50 years.

Based on the requirements set out in the NBCC 2020, a determination of the soil's relative response to the seismic activity is required. The NBCC (2020) deals with the seismic classification of soils based on average properties of the top 30 m of the soil profile. This classification is based on the average standard penetration resistance, shear wave velocity, or undrained shear strength (Table 6.1 A, CFEM 2006).

The average standard penetration resistance in the overburden soils varied from 2 to 53, with an average of 21. Based on the subsurface stratigraphy encountered at the site, the subject site is classified as Site Class D (stiff soil) based on the NBCC (2020) and Canadian Foundation Engineering Manual (CFEM 2006).

The Peak Ground Acceleration (PGA) for this site is 0.123g where g is 9.81 m/s^2 and Peak Ground Velocity (PGV) is 0.103 m/s (NBCC 2020).

4. Analyses, Considerations and Recommendations

4.1 General

The soil stratigraphy at the pedestrian bridge location consists of clay fill and gravel near the ground surface, underlain by clay, underlain by clay till at the north abutment; clay underlain by clay till at the south abutment; and clay underlain by sand, underlain by clay till with interlayered sand at the pier location. Thin sand layers were encountered at approximately 14.3 mBGS and 11.4 mBGS at south abutment and pier locations, respectively. Groundwater was measured at depths of approximately 7.6 mBGS, 7.45 mBGS and 14.04 mBGS in testholes TH22-01 (north abutment), TH22-02 (pier) and TH22-03 (south abutment), respectively. Stantec (2022) reported the groundwater to be at 4.8 mBGS in testhole BH-MR-02 (near north abutment) on June 26, 2021. Seepage and sloughing were also encountered during drilling and should be expected in excavations.

It is understood that driven steel piles, cast-in-place (CIP) concrete piles, micropiles and helical screw piles are being considered for the pedestrian bridge foundations. The driven steel piles are not considered appropriate for the pedestrian bridge as the vibrations caused by pile-driving could potentially be detrimental to adjacent infrastructure including a 2100 mm diameter drainage pipe in the ravine. In addition, the subsurface soils at the site are also highly corrosive which requires sacrificial additional thickness for the pile section to satisfy the long term corrosion requirements.

Straight shaft CIP concrete piles are considered suitable for the pedestrian bridge subject to the precautions and recommendations provided in this report. Seepage and sloughing should be expected within pile holes during construction. Casing will be required to control seepage and sloughing and to maintain clean pile holes.

Sand and silt layers are also common within the clay till and have the potential to slough into pile holes during construction; therefore, casing should be available on-site for all piles. Controlling seepage and sloughing and maintaining clean pile holes is the *Contractor's* responsibility.

Cobbles and occasional boulders are common in clay till; therefore, equipment used for the installation of casing and piles should be capable of handling cobbles and boulders if encountered within the pile holes. Selection of suitable equipment for installation of casing and piles is the *Contractor's* responsibility.

Micropiles can also be considered for the pedestrian bridge foundations. Micropiles are small diameter (generally between 100 mm to 300 mm diameter) piles and may consist of either a solid or hollow reinforcing bar. Performance of micropiles is installation dependent and these piles are typically designed and installed by an experienced *Contractor*.

Helical screw piles can be considered for pedestrian bridge foundations. Screw piles are considered suitable for lightly loaded structures, however; are generally not recommended to support heavily loaded structures or foundations subject to dynamic loading. The lateral capacity of the screw piles is limited due to disturbance of soil next to the shaft and reduction in lateral soil resistance during pile installation. Screw piles typically consist of a steel pipe shaft with one or more helices welded onto the shaft. The piles are rotated into ground with a hydraulic drive to adequate depth to achieve required resistance. Performance of screw piles is installation dependent, and these piles are typically designed and installed by an experienced *Contractor*. Due to limited lateral capacity, the use of helical screw piles is not preferred at this site.

We recommend the use of CIP concrete piles for bridge foundations as they satisfy the axial and lateral capacity requirements, and are less installation dependent as compared to micropiles and screw piles.

4.2 Cast-in-Place Concrete Piles

The axial capacity of straight shaft CIP concrete piles may be estimated using **Equation 4-1** and parameters provided in **Tables 4-1**.

$$Q_u = q_s P_s L + q_t A$$ **Equation 4.1**

where:

Q_u = ultimate load carrying capacity of the pile (kN);
q_s = ultimate skin friction between the pile and soil (kPa);
q_t = ultimate end bearing (kPa);
P_s = perimeter of the pile section (m) = πD, where D is pile shaft diameter;
L = effective pile embedment length; and,
A = cross sectional area of the pile (m^2)

Table 4-1 Recommended Ultimate Axial Design Parameters for CIP Concrete Piles

Location	Soil Type	Elevation (m)	Ultimate Skin Friction (kPa)	Ultimate End Bearing (kPa)
North Abutment	Firm Clay / Clay Fill	670.7 – 668.0	N/A	N/A
	Firm Clay	668.0 – 666.5	30	N/A
	Stiff Clay / Clay Till	666.5 – 663.5	50	N/A
	Hard Clay Till	663.5 – 655.5	85	1500
South Abutment	Firm Clay	670.0 – 667.5	N/A	N/A
	Firm Clay	667.5 – 665.5	40	N/A
	Stiff Clay / Clay Till	665.5 – 663.0	50	N/A
	Very Stiff Clay Till	663.0 – 656.5	70	N/A
	Hard Clay Till	656.5 – 655.0	90	1650
	Very Stiff Clay Till	655.0 – 651.0	70	1050
	Hard Clay Till	651.0 – 650.0	100	1925
Pier	Loose Sand	662.3 – 659.3	N/A	N/A
	Very Stiff Clay Till	659.3 – 656.0	65	N/A
	Stiff Clay Till	656.0 – 654.0	55	N/A
	Very Stiff Clay Till	654.0 – 647.5	65	900

A resistance factor of 0.4 should be applied on the ultimate skin friction and ultimate end bearing values provided in **Table 4-1** to obtain the factored skin friction and end bearing values. The piles should have a minimum diameter of 600 mm and a minimum centre-to-centre spacing of 3 times the pile diameter. General recommendations for conventional CIP concrete piles are provided below:

- The pile base should be free of disturbed and/or softened material or ponded water. The pile base should be cleaned to remove all loose, sloughed or disturbed material. Where significant quantities of water are present and it is not possible, or it is unfeasible to eliminate water from the pile holes, concrete should be poured using tremie mix and tremie technique.
- End-bearing is applicable only if the pile bases are clean and piles are founded in clay till as described above. End-bearing should not be used in sand layers or if pile bases cannot be cleaned and inspected by a qualified geotechnical engineer.
- The concrete should be poured immediately after completion of the pile hole. Any pile hole left open for a significant time period should be subject to review by a qualified geotechnical engineer.
- Concrete should be poured without segregation and carefully vibrated throughout the pile to reduce the risk of voids forming in the pile shaft.

- Group effects should be considered if pile spacing is less than the minimum recommended spacing. Piles spaced closer than 3 times the pile diameter, centre-to-centre, should not be drilled consecutively until the initial pile has been cast and set for at least 24 hours.
- Installation of piles should be monitored by qualified geotechnical personnel to confirm that pile bases are clean and that piles are founded in clay till in accordance with the recommendations in this report.

4.2.1 Tension Loads/Uplift Forces

The piles will be subject to uplift forces due to frost heave, tensile forces due to lateral loading, overturning moments, etc. The piles should be designed to resist all these forces. The resistance to uplift will be provided by pile self-weight, applied dead loads and skin friction. Factors such as seasonal frost depth, heating and insulation and soil type should be taken into account while designing the piles against uplift. The pile embedment should be sufficient to resist the uplift forces.

The resistance to uplift may be calculated using the ultimate skin friction parameters provided in **Table 4-1**. A resistance factor of 0.3 should be applied on the ultimate uplift capacity to obtain the factored uplift capacity in accordance with the CFEM (2006).

4.2.2 Lateral Pile Capacity

Lateral pile performance may be analyzed using a lateral pile computing program (such as LPILE) to determine pile top deflections and bending moments. The soil parameters required for estimating lateral pile capacity in clay are generally the modulus of subgrade reaction (k), the undrained shear strength (S_u), the bulk unit weight (γ), effective unit weight (γ'), and the soil strain parameter (ε_{50}). In sand the parameters used for estimating lateral pile capacity are k, γ, γ', and angle of internal friction (ϕ).

The lateral soil parameters for pile design are provided in **Table 4-2**. These parameters are based on review of published literature, local soil conditions, and our judgement and experience with the similar soils.

Table 4-2 Soil Parameters for Lateral Pile Analysis

Location	Soil Type	Elevation (m)	S_u (kPa)	ϕ (deg)	γ (kN/m^3)	γ' (kN/m^3)	k (MPa/m)	ε_{50} (%)
North Abutment	Firm Clay / Clay Fill	670.7 – 668.0	42	N/A	18.0	18.0	5	1.0
	Firm Clay	668.0 – 666.5	31	N/A	18.0	18.0	5	1.0
	Stiff Clay / Clay Till	666.5 – 663.5	75	N/A	19.0	9.2	15	0.7
	Hard Clay Till	663.5 – 655.5	220	N/A	20.0	10.2	35	0.4
South Abutment	Firm Clay	670.0 – 667.5	42	N/A	18.0	18.0	5	1.0
	Firm Clay	667.5 – 665.5	42	N/A	18.0	18.0	5	1.0
	Stiff Clay / Clay Till	665.5 – 663.0	75	N/A	19.0	19.0	15	0.7
	Very Stiff Clay Till	663.0 – 656.5	160	N/A	19.5	19.5	30	0.5
	Hard Clay Till	656.5 – 655.0	235	N/A	20.0	10.2	35	0.4
	Very Stiff Clay Till	655.0 – 651.0	150	N/A	19.5	9.7	30	0.5
	Hard Clay Till	651.0 – 650.0	275	N/A	20.0	10.2	35	0.4
Pier	Loose Sand	662.3 – 659.3	N/A	28	18.0	18.5	5	N/A
	Very Stiff Clay Till	659.3 – 656.0	140	N/A	19.5	19.5	30	0.5
	Stiff Clay Till	656.0 – 654.0	90	N/A	19.0	9.2	20	0.7
	Very Stiff Clay Till	654.0 – 647.5	130	N/A	19.5	9.7	30	0.5

It should be noted that the design of laterally loaded piles is generally governed by Serviceability Limit States limiting the top of pile movement to tolerable limits.

The lateral capacity of individual piles in a group is primarily affected by the spacing of the piles, measured centre-to-centre along an alignment parallel to the lateral load applied (provided that the pile spacing perpendicular to the applied load is at least 3 times the pile diameters). Group effects diminish at a pile spacing of 6 pile diameters or greater. Similar to axial loading, reduction factors for lateral loading should also be applied. The lateral load reduction factors (pile spacing parallel to applied load) are provided in **Table 4-3**.

Table 4-3 Recommended Lateral Load Reduction Factors for Pile Groups (Mokwa 1999)

Pile Spacing – Measured Centre to Centre (Multiples of pile diameter)	Lateral Load Reduction Factors	
	1st Row (Lead Row)	2nd Row
6 or greater	1.00	1.00
5	0.94	0.88
4	0.88	0.78
3	0.83	0.67

4.3 Micropiles

Micropiles are small diameter (generally between 100 mm and 300 mm diameter) piles and may consist of either a solid or hollow reinforcing bar. The micropiles are generally more expensive as compared to CIP and driven steel piles. Installation of solid bar micropiles includes drilling to the target depth using temporary casing, placing the reinforcement in the borehole and tremie grouting. Permanent casing is generally required in firm clays and loose granular soils to provide additional stiffness. Performance of micropiles is installation dependent and these piles are typically designed and installed by an experienced *Contractor* on design build bases.

Table 4-4 presents the preliminary design parameters (ultimate bond strengths) for solid bar micropiles. The *Contractor* must demonstrate that adopted construction means and methods (solid/hollow bars, drilling and grouting methods etc.) achieve the assumed ultimate bond strengths by testing the micropiles.

Table 4-4 Preliminary Design Parameters for Solid Bar Micropiles

Location	Soil Type	Elevation (m)	γ' (kN/m^3)	Assumed Ultimate Bond Strength (kPa)
North Abutment	Firm Clay / Clay Fill	670.7 – 668.0	18.0	–
	Firm Clay	668.0 – 666.5	18.0	–
	Stiff Clay / Clay Till	666.5 – 663.0	9.2	–
	Hard Clay Till	663.0 – 655.5	10.2	70
South Abutment	Firm Clay	670.0 – 665.5	18.0	–
	Stiff Clay / Clay Till	665.5 – 663.0	19.0	–
	Very Stiff Clay Till	663.0 – 656.5	19.5	50
	Hard Clay Till	656.5 – 655.0	10.2	70
	Very Stiff Clay Till	655.0 – 651.0	9.7	50
	Hard Clay Till	651.0 – 650.0	10.2	70
Pier	Loose Sand	662.3 – 659.3	18.0	–
	Very Stiff Clay Till	659.3 – 656.0	19.5	–
	Stiff Clay Till	656.0 – 654.0	9.2	35
	Very Stiff Clay Till	654.0 – 647.5	9.7	50

Notes:

1. Permanent steel casings are recommended to be installed above very stiff clay till.

2. Ultimate bond strength assumed gravity grouting and are to be verified by Contractor by verification testing.

3. Geotechnical resistance factors of 0.6 and 0.5 should be applied to the ultimate bond strengths to determine the design bond strengths in compression and tension, respectively.
4. The factored design load should not exceed the design bond strength of the micropile.

The ultimate bond strengths provided in **Table 4-4** are based on the assumption that micropiles will be installed using gravity grouting. *Contractor* should perform verification tests on sacrificial piles prior to installation of production piles to verify that the assumed ultimate bond strengths can be achieved by the *Contractor's* selected drilling and grouting methods. A minimum of one verification test should be performed on a sacrificial micropile at each abutment and pier locations. Maximum test load should be based on the ultimate bond strength and the bond length.

In case the verification test indicates that ultimate bond strength could not be achieved, the *Contractor* is responsible for the cost of extending the micropile based on the bond strength achieved or application of pressure grouting or post-grouting method to enhance the bond strength. If new methods of drilling and/or grouting are selected to improve bond strengths, a new verification test should be performed by the *Contractor*.

In addition to the verification test on a sacrificial micropile, all production micropiles should be subjected to proof tests. The maximum test load during proof test should be equal to the factored design load.

Additional design and testing considerations for the micropiles are as follows:

- Micropiles should be spaced at least 3 times their diameter, measured centre to centre.
- Battered piles may be considered to enhance the lateral capacity of micropiles, subject to lateral load tests of the piles.
- Due to small diameter, it is not possible to inspect the pile bases; therefore, end bearing should not be included in the design.
- Permanent casings are recommended for the unbonded portion of the piles. Permanent casings are expected to extend to an elevation of 663 m or deeper at north and south abutments; and to an elevation of 656 m or deeper at pier locations to increase pile stiffness and to resist lateral loads, shear and bending moments.
- During compression load, buckling of micropile should be checked along the unbonded length and bonded length.
- A cone failure mode should be checked for a group of micropiles in uplift loading.
- Corrosion protection should be considered for all steel components based on design life. Corrosion protection may include double corrosion protected reinforcing bars, grout cover, sacrificial thickness, galvanizing, epoxy coating, and sheathing.

4.3.1 Installation Considerations

General installation recommendations for micropiles are provided below:

- The pile hole should be clear of water and debris immediately before installing the reinforcing bar. All pile holes must be checked for sloughing and pre-drilled if required prior to micropile installation and grouting. The grouting should be performed immediately after completion of the pile hole. Any pile hole left open for a significant time period should be subject to review by a qualified geotechnical engineer.
- The reinforcing bars and corrosion protection should be checked to ensure they are free of any damage immediately prior to installation. Micropiles should be installed in clean pile holes and the reinforcing bars should be protected from damage during placement and grouting.
- The micropiles should have an adequate number of centralizers along the reinforcing bar length to keep the bar position at the centre of the hole throughout both cased and uncased portions of the micropile. Centralizers should be securely attached to the reinforcing bar and should be sized to

allow subsequent grouting through a tremie pipe from the bottom of the pile hole, and grout to flow freely through the pile hole for the entire micropile length.

- A post-grout pipe should be provided in each micropile in case post-grouting is required.
- Micropile grout should be neat type HS cement grout. Grouting should be conducted after installation of the reinforcing bar within two hours of completion of drilling by tremie methods. The pile holes should not be left open for significant time period.
- Grouting should start from the bottom of the micropile through a tremie pipe extended to the bottom of the pile hole until clean, dense grout flows from the top of the casing to ensure a continuous grout column in full contact with the in-situ ground for the entire length is formed. Post-grouting, if required should be performed at least 24 hours after the initial tremie grout. Grout cube samples should be collected from the overflowing drill hole during grouting and tested to check that the specified compressive strength is achieved.
- In the event that a pile hole is to be abandoned, it should be backfilled with tremie grout.
- The piles should be spaced at least 3 times the pile diameter, centre-to-centre and should not be drilled consecutively until the initial pile has been grouted and set for at least 48 hours.
- The *Contractor* should maintain installation records for micropiles, including but not limited to all details such as location, drill date, grout date, air temperature, soil profile descriptions, top of bond length, total length installed, hole diameter, hole depth, reinforcement type and size installed, mill certificates, splice locations, grout mix, grout volume, grout pressure, grout cube sample records, and compressive strength of initial grout and post-grout from test results.

4.4 Helical Screw Piles

Screw piles can be used to support lightly loaded structures. Screw piles are generally not recommended to support heavily loaded structures or foundations subject to dynamic loading. Also screw piles should not be founded in fill and soft/wet soils. The lateral capacity of the screw piles is limited due to disturbance of soil next to the shaft and reduction of the lateral soil resistance during pile installation.

Screw piles typically consist of a steel pipe shaft with one or more helices welded onto the shaft. The piles are rotated into ground with a hydraulic drive to adequate depth to achieve required resistance.

Screw piles can be installed in very stiff clay till encountered below an elevation of 663 m at north and south abutments and below an elevation of 656 m at pier location. The depth of penetration and required design of helices (single or multiple) will depend on the soil conditions and design vertical and lateral loads.

Shaft diameters typically vary from about 100 mm (nominal) for lightly loaded piles (no lateral loading) to 150 mm to 200 mm for piles subjected to lateral loading. Pile helix diameters typically vary from 300 mm to 600 mm in diameter. Shaft diameters need to be designed by a structural engineer to meet the required installation stresses considering the ground conditions.

The performance of screw piles is installation dependent; therefore, the design of screw piles is generally provided and warranted by the supplier based on the specific pile geometry, installation procedure and ground conditions. It is recommended to hire/consult an experienced screw piling *Contractor* for design and installation of the piles in accordance with ground conditions provided in this report. It is also recommended that pile load tests (axial and lateral) be performed on select piles to verify the load carrying capacity of the piles. Pile load testing should be carried out prior to commencement of the screw pile construction to confirm the pile capacity, pile length and applied torque.

For design purposes, the capacity of screw piles can be determined using the bearing capacity theory. The major factors that affect the axial capacity are the pile geometry (diameter, depth and spacing of helices), soil and groundwater profile and installation of procedure.

4.4.1 Compression Screw Pile Capacity

The ultimate axial capacity of the screw pile (Q_c) with a single helix founded in clay till at or below elevation of 663 m at north and south abutments and at or below elevation 656 m at pier location may be estimated as follows:

$$Q_c = S_f(\pi D L_c)C_u + A_H C_u N_c + \pi d H_{eff} \alpha C_u \qquad \textbf{Equation 4.2}$$

where:

C_u = undrained shear strength at helix plate depth;
L_c = distance between top and bottom helical plates;
S_f = spacing ratio factor;
A_H = area of helix;
N_c = bearing capacity coefficient;
d = diameter of shaft;
α = adhesion coefficient;
H_{eff} = effective length of pile, H_{eff} = H – D; and
D = helix plate diameter

It is recommended to assume C_u of 150 kPa for the clay till at or below elevation of 663 m at north and south abutments, and C_u of 100 kPa at pier location. Bearing capacity coefficient (N_c) is a function of the pile toe diameter and based on CFEM (2006), following N_c values are recommended.

- Pile diameter smaller than 0.5 m, N_c = 9;
- Pile diameter between 0.5 m and 1.0 m, N_c = 7; and,
- Pile diameter larger than 1.0 m, N_c = 6

The adhesion coefficient (α) is a function of undrained shear strength and can be interpolated from the Figure 18.1 in the CFEM (2006). A resistance factor of 0.4 should be used to determine the factored Ultimate Limit States (ULS) capacity of the screw pile. The shaft friction should be neglected due to small diameters (less than 100 mm) and potential effects of disturbance and loss of shaft adhesion.

Using multi-helixes can increase screw pile capacity. The skin friction of multi-helix screw piles is equal to the sum of the capacity per helix multiplied by the appropriate interaction factor (R_u) for each individual helix. The interaction factor is dependent on the ratio of helix spacing (S) to helix diameter (D) and is provided in **Table 4-5**.

Table 4-5 Interaction Factors for Multi-Helix Screw Piles

S/D	Interaction Factor, R_u
3.0	0.75
3.5	0.85
4.0	0.95
5.0	1.00

Screw piles should not be installed at spacing closer than 3 times the largest helix diameter, centre to centre. The upper helix should be located at or below elevation of 663 m at north and south abutments; and at or below elevation 658 m at pier location.

Note that piles with multiple helical bearing plates, the helical bearing plates should be spaced a minimum of 3 times the diameter of the largest helix, to avoid overlapping of their stress zones.

In cases where the helical plate spacing is less than 3 times the diameter of the largest helix (or multi-helix), the spacing ratio factor (S_f) introduced by Narasimha Rao and Prasad (1993) can be obtained from the following:

- For S/D < 1.5, S_f = 1
- For 1.5 ≤ S/D ≤ 3.5, S_f = 0.863 + 0.069 (3.5 – S/D)
- For 4.6 ≤ S/D ≤ 3.5, S_f = 0.7 + 0.148 (4.6 – S/D)

Designing for cylindrical shaft resistance between helices and resistance along the shaft above the helices requires close consideration to division between cohesive and non-cohesive layers and pile dimensions.

4.4.2 Tension Screw Pile Capacity

Screw piles will be subject to uplift forces due to frost heave, tensile forces due to lateral loading, overturning movements due to water and wind, etc. The piles should be designed to resist these uplift forces. The uplift resistance will be provided by pile self weight, applied dead loads, the effective weight of the soil above the helix, and the shearing resistance of the soil as the pile is lifted. For predicting the ultimate uplift capacity of the multi-helix screw pile, the following equation should be used:

$$Q_t = S_f(\pi D L_c)C_u + A_{HN}(C_u N_u + \Upsilon' H) + \pi d H_{eff}\alpha C_u \qquad \textbf{Equation 4.3}$$

where:

A_{HN} = net area of the helix (area of helix – shaft area);

N_u = uplift bearing capacity factor ($where;\ N_u = 1.2(\frac{H}{D}) \leq 9$);

Υ' = effective unit weight of soil above water table or buoyant weight if below water table;

A resistance factor of 0.3 should be used on the ultimate uplift resistance obtained from above equation to obtain factored uplift resistance.

The published literature for predicting the lateral load capacities of screw piles is limited. The method for calculating the lateral capacity of screw piles would be similar to those for driven or drilled piles if the helix can be installed without shearing the soil. For determining lateral capacity of screw piles, the shaft diameter should be used, not the diameter of the helix. However, as the diameter of helix is larger than the shaft, soil next to the shaft is likely to be disturbed. The soil resistance to lateral pile displacement could be less than in situ undisturbed soils. If vertical screw piles are to be used to resist lateral loads, it is recommended that lateral load tests be undertaken to determine the lateral pile capacity. Preferably, the piles would be battered to resist lateral loads.

Group effects should be considered when centre-to-centre pile spacing is 2 to 3 helix diameters, such that vertical capacity of a group should be reduced by 20 %. With a center-to-center spacing of 3 helix diameters or more, the group capacity may be taken as the sum of the capacities of individual piles. The center-to-center pile spacing should not be less than 2 helix diameters.

The pile installation should be monitored by qualified geotechnical personnel.

4.5 Slope Stability Analyses

Soil profile for the slope stability analyses was developed from HA22-01, TH22-03 and BH-MR-02 (Stantec 2022). Soil parameters used for the analyses were estimated from soil index properties (particle size distribution and Atterberg Limits), SPT N-values, and published literature (Das and Sivakugan 2017, NAVFAC 1986, Look 2007). Estimated soil parameters are provided in **Table 4-6**.

Table 4-6 Estimated Soil Parameters for Slope Stability Analyses

Soil Type	Unit Weight (kN/m^3)	Undrained Shear Strength (kPa)	Effective Cohesion (kPa)	Angle of Friction (Deg)
Clay Fill	19.0	-	5	25
Firm High Plastic Clay	18.0	40	5	23
Granular Fill	21.0	-	-	35
Very Stiff Clay Till	20.0	165	10	27
Concrete Abutment	0.5	-	75	50

The slope stability analyses were performed using Slope/W module of GeoStudio (2019) software suite, the Morgenstern-Price method and circular slip surfaces with a minimum slip surface depth of 0.1 m. The pseudo-static analyses were performed to simulate the seismic conditions using a PGA of 0.123g.

Following assumptions were made for the slope stability analyses:

- The fill is placed on competent bearing strata i.e., any soft soils encountered below the fill will be removed and replaced with general engineered fill compacted to 98 % of SPMDD and within ± 2 % of the OMC. General engineered fill materials should be comprised of inorganic well-graded granular soils or inorganic low to medium plastic clay/clay till. Granular soils used as general engineered fills should conform to The City's Roadways Design Standards, Aggregate Designation 3, Class 25.
- For short term conditions, undrained shear strengths of 40 kPa for firm high plasticity clay and 165 kPa for very stiff clay till were used.
- Granular fill consisting of The City's Roadways Design Standards, Aggregate Designation 3, Class 25 be placed behind the abutment walls as shown on the figures in **Appendix D**.
- The future LRT and vehicle loading along Stony Plain Road has been simulated using a surcharge loading of 65 kPa over a width of 7 m.
- The pedestrian loading has been simulated using a surcharge loading of 4 kPa.

A factor of safety (FS) is generally introduced in the slope stability assessments. Generally, the FS for earthworks against shearing failure is from 1.3 to 1.5; however, the selection of the FS for an earthen structure depends on many factors such as the importance of the structure, potential failure consequences, uncertainties involved in the design loads and soil parameters, the additional cost associated with a higher FS and the risk the owner is willing to accept in case of failure. **Table 4-7** summarizes the slope stability analyses results for north and south abutment head slopes, including the minimum recommended FS.

Table 4-7 Summary of Slope Stability Analyses Results

Abutment	Condition	Minimum Recommended FS	FS (Slope Stability Failures)	Reference Figure
North	During Construction – During Construction	1.3	2.6	Appendix D – Figure D1
	After Construction – Long Term Condition	1.5	1.5	Appendix D – Figure D2
	Long Term Condition – During Seismic event	1.1	1.2	Appendix D – Figure D3
South	During Construction – During Construction	1.3	4.0	Appendix D – Figure D4
	After Construction – Long Term Condition	1.5	1.9	Appendix D – Figure D5
	Long Term Condition – During Seismic event	1.1	1.3	Appendix D – Figure D6

As summarized in **Table 4-7**, both north and south abutment head slopes achieve the target FS requirements. However, the head slope at north abutment will require reinforcements, while the head slope at south abutments will not require reinforcements. The results of the slope stability analysis of the head slopes for the north and south abutments including the reinforcement details at north abutment are presented in **Appendix D**. The reinforcements should have minimum Long Term Design Strength (LTDS) of 65 kN/m.

4.6 Temporary Excavations and Dewatering

The composition and consistency of the soils encountered at the testhole locations were such that conventional hydraulic excavators should be able to excavate these soils, although a ripper may be required to excavate the seasonally frozen soils if encountered in excavations during construction. Construction should be in accordance with good practices and should conform to Alberta's Occupational Health and Safety guidelines. Excavations should be sloped or adequately shored in accordance with Occupational Health and Safety guidelines. The appropriate side slopes for the excavations will depend on the soil type, controlling groundwater flow into the excavations and the time the trench is left open.

Groundwater was encountered at approximately 7.6 mBGS in testhole TH22-01, 10.4 mBGS in testhole TH22-02, and 17.1 mBGS in TH22-03 upon drilling completion. The 50 mm standpipe piezometers were installed in TH22-02 and TH22-03. Groundwater was measured at 7.45 mBGS in testhole TH22-02 on July 22, 2022, and at 14.04 mBGS in testhole TH22-03 on July 27, 2022. Stantec (2022) reported the groundwater to be at 4.8 mBGS in testhole BH-MR-02 (near north abutment) on June 26, 2021. Groundwater may be encountered in excavations during construction; therefore, the *Contractor* should be prepared for dewatering of excavations if required at site. The *Contractor* is responsible for temporary dewatering using suitable means and methods including, but not limited to, sumps/pumps and wells and safe disposal of groundwater in accordance with applicable local regulations. The *Contractor* is also responsible for protecting adjacent infrastructure from any negative impacts of dewatering. Means and methods for temporary dewatering are the *Contractor's* responsibility.

Based on the ground conditions, the subsurface soils at the site are categorized as “Soft, Sandy, or Loose Soils” in accordance with Alberta’s *Health and Safety Act*, 2017 Edition, Part 32 Excavating and Tunnelling. The method of excavation and safe support of excavation/trench sidewalls and protection of the existing infrastructure are the responsibility of the *Contractor* and are subject to the applicable regulations of Alberta’s Health and Safety Act. The *Contractor* is required to employ appropriate mitigation measures to avoid impacts on existing site infrastructure adjacent to excavations considering the soil type characterized in this section. Excavation slopes and temporary shoring, if required at this site, should be in accordance with the site soils characterized in this section. Design and construction of temporary slopes and shoring systems as well as temporary dewatering and disposal are the *Contractor’s* responsibility.

Temporary surcharge loads from construction materials, equipment or excavated soils should not be allowed within a distance equal to the depth of excavation from the unsupported excavated face. Vehicles delivering material should be kept a safe distance away from excavation faces.

The stability of cut slopes will deteriorate with time; therefore, temporary side slopes should be monitored for any signs of deterioration, especially after periods of rain and appropriate measures should be taken to mitigate deterioration of the side slopes. Small earth falls from the side slopes are a potential source of danger to workers and must be guarded against.

4.7 Subgrade Preparation

All vegetation, peat, organics, organic rich soils and topsoil should be stripped from within the footprint of approach fill. Surficial organic material should be stockpiled separately to be used for site erosion and sedimentation control.

Following organic stripping and excavation to achieve design grades, the exposed subgrade should be scarified to a minimum depth of 150 mm, moisture conditioned to within ± 2 % of the Optimum Moisture Content (OMC) and compacted to 98 % of the Standard Proctor Maximum Dry Density (SPMDD). Following moisture conditioning and compaction, the subgrade should be proof-rolled to identify loose or soft areas. Any loose or soft areas should be over-excavated and backfilled with general engineered fill compacted to 98 % of the SPMDD within ± 2 % of the OMC. The prepared subgrade should be proof-rolled again to confirm that the prepared subgrade is stable and does not exhibit rutting and cracking under wheeled loads.

The native clay / clay till is generally medium-to-highly plastic and the highly plastic clay is generally not suitable to be used as fill.

Any surface water or groundwater infiltration into exposed/prepared subgrades should be diverted away from the footprint of the approach fill to avoid softening of the soils. In warm, dry weather, care should also be taken to prevent the prepared soil and bedrock subgrade from drying. The subgrade should be graded to have a minimum gradient of 2 % to drain water away from the site as quickly as possible. Poor drainage and ponding may damage the prepared subgrade.

The prepared subgrade should not be left exposed for extended periods of time to avoid wetting, drying and freezing of the subgrade. The prepared subgrade should be protected from freezing during construction. Structures should not be constructed on frozen subgrade or in frozen conditions. Structures constructed on frozen subgrade or in freezing conditions may result in excessive settlement during/after spring thaw.

Observations of site grading, subgrade preparation and compaction operations should be monitored by qualified geotechnical personnel. The prepared subgrade should be inspected by qualified geotechnical personnel, prior to construction of the structures, to confirm that the subgrade below the structures is suitably prepared and showing no deflections during proof-rolling.

4.8 Backfill Placement and Compaction

Soils used as the fill material may consist of general engineered fill. General engineered fill materials should be comprised of inorganic well-graded granular soils or inorganic low to medium plastic clay/clay till. Granular soils used as general engineered fills should conform to The City's Roadways Design Standards, Aggregate Designation 3, Class 25. Native surficial soils consist of medium-to-high plastic clay soils and have high moisture contents and are therefore not suitable for the embankment construction. The soils used as general engineered fill should be submitted for review and approval by the geotechnical engineer. The fill should be placed in lifts not exceeding 150 mm in compacted thickness. The fill should be compacted to 98 % of the SPMDD density within ± 2 % of the OMC unless otherwise specified.

Fill materials should not be placed in a frozen state or placed on a frozen subgrade. All lumps of materials should be broken down during placement. The maximum particle size in fill material should not exceed half the layer thickness. Fill material should not contain deleterious materials such as debris, organics, coal particles, wood chunks, etc.

Bonding should be provided between backfill lifts if the previous lift has become desiccated. For fine-grained materials the previous lift should be scarified to the base of the desiccated layer, properly moisture conditioned, and re-compacted and bonded thoroughly to the succeeding lift. For granular materials, the surface of the previous lift should be scarified to a depth of about 75 mm followed by proper moisture conditioning and re-compaction.

It should be noted that the ultimate performance of the fill is directly related to the uniformity of the fill compaction. In order to achieve this uniformity, the lift thickness and compaction criteria must be strictly enforced.

4.9 Lateral Earth Pressures

The abutments and wingwalls (if any) should be designed to resist a triangular earth pressure distribution using appropriate lateral earth pressure coefficients. The earth pressure coefficients to be used will depend on the extent and direction of movement of the soil, nature and extent of backfill and groundwater conditions. Lateral earth pressure on the abutments and wing walls can be calculated using **Equation 4.4**.

$$P = K(\gamma H + q) \qquad \textbf{Equation 4.4}$$

where:

P = Lateral earth pressure at rest (kPa);
K = Appropriate coefficient of lateral earth pressure (K_a = active earth pressure coefficient, K_o = at rest earth pressure coefficient; and, K_p = passive earth pressure coefficient);
γ = Bulk unit weight of backfill soil (kN/m^3);
H = Depth of abutment/wing wall below the finished ground elevation; and,
q = Any surcharge pressure at ground level (kPa)

For rigid non-yielding abutment walls, the coefficient of earth pressure at rest (K_o) should be used.

The native soils are frost susceptible and may exert excessive lateral earth pressure on wing walls and abutments when frozen; therefore, we recommend using frost stable and free draining granular fill behind abutments and wing walls in conjunction with a weeping tile system at the toe of the abutments/wing walls to reduce the potential for lateral earth pressure on the abutment and wing walls due to frozen ground and groundwater. The gravel should be wrapped with non-woven geotextile to reduce the potential for migration of fines from the native soils into the gravel and vice versa. The coefficients required for calculation of the lateral earth pressure for granular backfill behind abutment and wing walls are provided in **Table 4-8**.

Table 4-8 Lateral Earth Pressure Parameters – Wing Walls and Abutments

Backfill Type	γ (kN/m^3)	ϕ (deg)	K_a	K_p	K_o
Well Graded Granular Fill – 25 mm minus crush	20	35	0.27	3.7	0.43

A wedge of free draining granular fill consisting of Designation 3, Class 25 (Table 02060.1 – Construction Specifications City of Edmonton), sloped at 1H:1V should be provided immediately behind the abutment walls.

The soil coefficients provided in **Table 4-8** and **Equation 4-4** assume that the backfill material placed behind the abutment and wing walls is compacted to at least 98 % of SPMDD within 2 % of the OMC and that the ground behind the wall is horizontal. If the ground surface slopes away from the wall, the coefficients for the lateral earth pressure and design earth pressure should be re-evaluated.

Where traffic or other live loads are imposed behind the retaining wall, the horizontal pressures due to live load should be superimposed on the earth pressures.

The surcharge loading due to soil compaction should also be considered in accordance with Canadian Highway Bridge Design Code (CHBDC 2019). The surcharge loading will depend on the size of compaction equipment used behind the wall. A minimum lateral soil pressure of 12 kPa should be applied at the top of the wall (Figure 6.8 CHBDC compaction Effects)

Where passive resistance is required, a geotechnical resistance factor of 0.5 should be applied on the ultimate passive resistance to obtain the factored passive resistance. For passive resistance to mobilize, the walls must move slightly; therefore, passive resistance should only be included in the design if slight movement of wing walls and abutments is acceptable.

Backfill behind wing walls and abutments should not commence before the concrete walls have reached a minimum two-thirds of their 28 day strength. Only hand operated compaction equipment should be employed within 600 mm of the concrete walls. Caution should be used during backfill compaction to reduce lateral loads caused by compaction. To avoid differential lateral pressures against walls during construction, the backfill should be brought up evenly around the walls. The difference in backfill elevation between any two points in the perimeter must not exceed 0.5 m.

A subdrain surrounded with washed gravel and enveloped with non-woven geotextile should be provided at the base of the abutment wall to provide drainage and prevent the build up of hydrostatic pressure on the abutment walls.

4.10 Site Grading and Drainage

The entire site should be properly graded to drain surface water away from the structures as quickly as possible without ponding, both during and after construction. Ponding near or below structures may result in subgrade softening, causing foundation failure and settlement.

The finished grade adjacent to structures should be graded such that surface water is drained away by the shortest route, shedding the water away from the structures towards the drainage system (ditches/curb and gutter) for final storage or off-site disposal. The site should have overall grades of no less than 1 % to reduce ponding.

Erosion protection for slopes can be provided through the application of a layer of topsoil and grass seed. Erosion protection mats may be required to reduce ditch erosion in the short term. Silt fences may also be required during construction to reduce silt flow into the water bodies.

4.11 Seasonal Frost and Frost Design Considerations

4.11.1 General

The surficial soils are frost susceptible; therefore, frost heave is a concern and should be considered in the design of foundations and grade supported structures.

The seasonal frost penetration depth was estimated for surficial soils following the procedure described in the CFEM (2006). The seasonal frost penetration depth is estimated to be approximately 2.7 m for clay and 3.5 m for granular fill. The estimated frost depth assumes no snow cover, peat or vegetation on the surface. The presence of snow, vegetation and peat may reduce the seasonal frost penetration depths.

Piles, retaining walls and other structure elements below the finished grade should be protected from frost heave by burial below the seasonal frost zone or by shallow burial accompanied with insulation. The minimum burial depth of un-insulated utility lines, water pipelines and foundations should not be less than the seasonal frost penetration depth. Insulation should be provided if the burial depth is less than the seasonal frost penetration depth.

4.11.2 Pile Foundations

Since different foundation alternatives are being considered for the pedestrian bridge, and therefore, frost action should be considered on pile foundations which include uplift due to frost heave on the underside of pile caps and adhesion freezing forces (adfreeze) along the pile shaft and sides of pile caps within the seasonal frost zone. The adfreeze bond stress on steel screw piles in the seasonal frost zone is 100 kPa. Similarly, the adfreeze bond stress on CIP concrete piles and micropiles in the seasonal frost zone is 65 kPa, respectively. Pile embedment below the seasonal frost zone should be sufficient to resist uplift due to frost heave. The minimum pile embedment to resist frost heave should be calculated using the adfreeze stress on the pile shaft within the seasonal frost zone, dead loads on piles, pile self-weight and skin friction below the seasonal frost zone.

Unheated pile caps can also experience frost heave forces acting on the underside of these structures. These forces can be extremely high in some cases, particularly if drainage is not provided away from the structure. The recommended construction procedure for preventing frost heave under the pile caps and grade beams involves placing a crushable, non-degradable void form under the grade beams and pile caps. The void form should be placed on a bedding sand layer approximately 75 mm thick. The grade beam or pile cap should be designed in accordance with the crushing strength of the void form.

A void form with a minimum thickness of 150 mm is recommended and a potential frost heave of 50 mm should be assumed, resulting in compression of 33 % of the void form. The pile caps/grade beams should consider the uplift forces induced by collapse of the void form by 50 mm which is supplied in the product supplier literature.

It is particularly important that water is not allowed to pond near or under the pile caps and grade beams. Ponding near or adjacent to structures may saturate and damage the void form, resulting in uplift on the underside of the grade beam/pile cap. The finished grade adjacent to grade beams/pile caps should be capped with well-compacted clay and adequately sloped away from the structures.

Another frost effect is adfreeze/uplift pressure acting on the sides of grade beams and pile caps. This can be reduced by placing non-frost susceptible soil around structures, providing good drainage and applying a frost bond breaker to the faces of pile caps and grade beams.

4.11.3 Underground Utilities

Underground utilities (water, storm and sewer) should also be protected from frost heave either by burial below the seasonal frost zone or by shallow burial combined with insulation and/or heat tracing.

The minimum burial depth of un-insulated utility lines, water and sewer pipelines should not be less than the seasonal frost penetration depth. Insulation should be provided if pipelines are buried with soil cover

less than the seasonal frost penetration depth. The insulation should be rigid and of high strength (Styrofoam HI-40, HI-60, or HI-80), with an appropriate design compressive strength. The insulation should be at least 100 mm thick for a minimum insulation burial depth of 1 m. A 600 mm thick compacted clay layer should be placed at surface to reduce infiltration. For pipelines, the width of insulation (W) extending outwards from the pipe centreline on each side may be calculated using the following equation:

$$W = 0.5\big(d + 2(F - I)\big)$$ **Equation 4.5**

where:

d = pipe diameter (m)
F = seasonal frost penetration depth (m)
I = insulation depth below finished grade (m)

The insulation should extend at least 2 m on either side of the centreline of the utility in situations where estimated W from the above equation is less than 2 m.

4.12 Sulphate Attack and Corrosion

The potential of sulphate attack on concrete in contact with subsurface soils or groundwater is low to severe (**Table 3-3**); therefore, consideration should be given to using Type HS (formerly known as Type 50) Sulphate Resistant cement with Exposure Class S-1 for all concrete in contact with subsurface soils and groundwater.

Resistivity and pH values (**Table 3-3**) indicate that the subsoils at the site are highly corrosive. It is, therefore, recommended that all metals in contact with subsurface soils and groundwater should be designed to withstand a corrosive environment.

5. Pavement Structure for Trail and Walkway Systems

The City's Design and Construction Standards provides details for trail systems, walkways, and shared use pathways. The results of this geotechnical investigation indicated that the ground conditions at this site are suitable for the trail structures, provided in The City's design and construction standards to be used at this site. The details of each structure are summarized in **Table 5-1** to **Table 5-3**. It should be noted, that at the time of submission of this geotechnical report, the preferred pavement trail type has not been yet selected (granular surfaced, asphalt, or concrete walkways). Therefore, this report includes the pavement structure for all trail types.

Table 5-1 Concrete Walkways 1.5 m or Greater (The City's Design and Construction Standards, Drawing 5150, Volume 2)

Trail or Walkway Structure	Thickness (mm)
Concrete (Reinforced with 10M Reinforcement)	120
Granular Base Course (Designation 3, Class 20 Aggregate)	150
Prepared Subgrade	150
Total Walkway or Trail Structure Above Prepared Subgrade	270

Table 5-2 Asphalt Pavement, Shared Use Pathways (The City's Design and Construction Standards, Drawing 5160, Volume 2)

Trail or Walkway Structure	Thickness (mm)
Asphalt - 10 mm Low Traffic (LT) Mix	75
Granular Base Course (Designation 3, Class 20 Aggregate)	150
Prepared Subgrade	150
Total Walkway or Trail Structure Above Prepared Subgrade	225

Table 5-3 Granular Walkways (The City's Design and Construction Standards, Drawing 5170, Volume 2)

Trail or Walkway Structure	Thickness (mm)
Granular Base Course (Designation 3, Class 20 Aggregate)	150
Prepared Subgrade	150
Total Walkway or Trail Structure Above Prepared Subgrade	150

The above structures may be modified with the use of woven geotextiles in the absence of prepared subgrade. **Table 5-4** and **Table 5-5** summarize the alternatives structures with the use of these geotextiles.

Table 5-4 Asphalt Pavement, Shared Use Pathways (The City's Design and Construction Standards, Drawing 5160, Volume 2)

Trail or Walkway Structure	Thickness (mm)
Asphalt - 10 mm Low Traffic (LT) Mix	75
Granular Base Course (Designation 3, Class 20 Aggregate)	300
Nilex 2002 or Layfield LP200 or Equivalent on Native Ground	-
Total Walkway or Trail Structure Above Subgrade	375

Table 5-5 Granular Walkway with use of woven Geotextile (The City's Design and Construction Standards, Drawing 5170, Volume 2)

Trail or Walkway Structure	Thickness (mm)
Granular Base Course (Designation 3, Class 20 Aggregate)	300
Nilex 4551 or Layfield LP6 or Equivalent on Native Ground	-
Total Walkway or Trail Structure Subgrade	300

The granular base course (GBC) should consist of well graded gravels with a low percentage of fines. Gravels with a lower percentage of fines generally have better drainage properties, and, when drained, can limit the effects of frost, which is a primary geotechnical concern for the proposed site. **Table 5-6** provides granular base course gradations for the 20 mm crushed gravel which is recommended for the granular base course of the roads.

Table 5-6 Specifications for Granular Base Course (The City's Roadways Design Standards, Aggregate Designation 3, Class 20)

Metric Sieve (mm)	Percentage Passing by Mass
20	100
12.5	60 to 96
5	36 to 75
2	24 to 54
1.25	20 to 43
0.63	14 to 34
0.40	11 to 29
0.315	9 to 26
0.160	6 to 20
0.080	2 to 10

6. Review of Design and Construction

The geotechnical engineer will review the final design drawings to assess whether the geotechnical recommendations provided in this report have been incorporated in the design. The performance of the bridge structure will depend upon the quality of workmanship during construction. This is particularly important in regard to foundation installations where variations in soil conditions could occur. Therefore, it is recommended that inspection be provided by qualified geotechnical personnel during foundation installation to confirm that piles for the bridge are installed in competent bearing material and that the stratigraphy is similar to those that have been assumed for the design. Construction of the head slopes should also be inspected by qualified geotechnical personnel.

7. References

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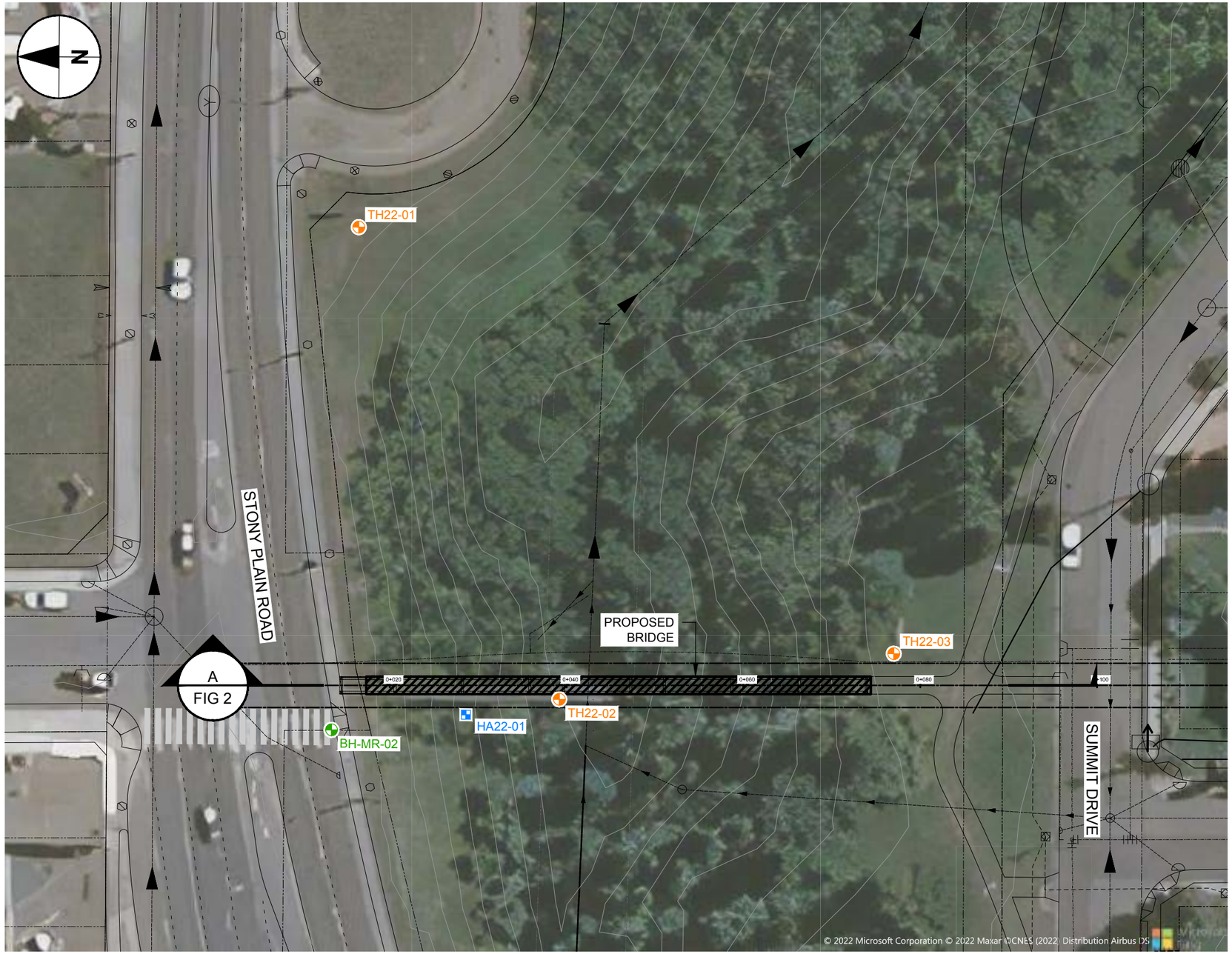
Appendix A

Figures



0 12.5 25 m

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GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES, UNLESS SHOWN OTHERWISE.
2. COORDINATES ARE IN ALBERTA NAD83; 3TM CENTRED AT 114 DEG. WEST.

LEGEND:

- TH22-01 — AECOM TESTHOLE
- HA22-01 — AECOM HAND AUGER
- BH-MR-01 — STANTEC (2022) TESTHOLE

COORDINATE TABLE		
LOCATION	NORTHING	EASTING
TH22-01	5 934 429	28 154
TH22-02	5 934 406	28 101
TH22-03	5 934 368	28 107
HA22-01	5 934 417	28 099
BH-MR-02	5 934 432	28 098

ANSI B 279.4mm x 431.8mm
Approved: ____
Checked: ____
Designer: ____
Project Management Initials:
Last saved by: LES.DOWHALUK (2022-09-27) Last Plotted: 2022-09-27
Filename: L:\LEGACY\CAEDM1FP001\PROD\PROJECTS\60682118\900_CAD_GIS\910_CAD\30-FIGURES\H100\60682118-FIG-00-0000-H-0001.DWG

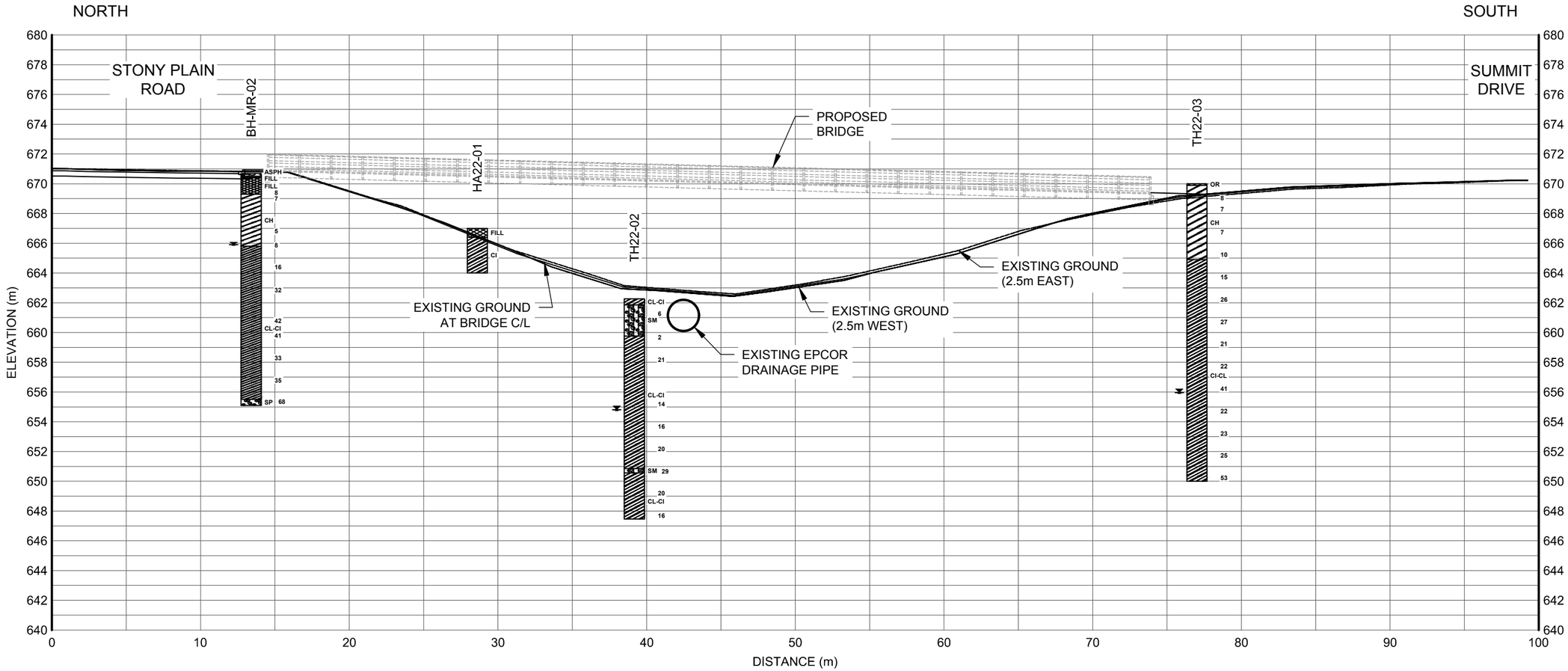
MACKINNON RAVINE PEDESTRIAN BRIDGE

City of Edmonton
Project No.: 60682118 Date: 2022-09-27

Testhole Location Plan

AECOM

Figure 1



A SECTION

FIG 1 — 1:300

0 7.5 15 m H=1:300 V=1:300

MACKINNON RAVINE PEDESTRIAN BRIDGE

Pedestrian Bridge Location Section

City of Edmonton
Project No.: 60682118 Date: 2022-09-27

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Figure 2

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Appendix B

General Statement; Normal Variability of Subsurface Conditions
Explanation of Field and Laboratory Test Data
Modified Unified Soil Classification System
Testhole Logs

AECOM Canada Ltd.
General Statement; Normal Variability Of Subsurface Conditions

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability of the site for the proposed project. This report has been prepared to aid in the general evaluation of the site and to assist the design engineer in the conceptual design for the area. The description of the project presented in this report represents the understanding by the geotechnical engineer of the significant aspects of the project relevant to the design and construction of the subdivision, infrastructure and similar. In the event of any changes in the basic design or location of the structures, as outlined in this report or plan, AECOM should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations represented in this report are based on the data obtained from the test holes drilled at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere on the site are not significantly different from those encountered at the test locations. However, variations in soil conditions may exist between the test holes and, also, general groundwater levels and condition may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions, different from those encountered in the test holes are observed or encountered during construction or appear to be present beneath or beyond the excavation, AECOM should be advised at once so that the conditions can be observed and reviewed and the recommendations reconsidered where necessary.

Since it is possible for conditions to vary from those identified at the test locations and from those assumed in the analysis and preparation of recommendations, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modifications of the design and construction procedures.

EXPLANATION OF FIELD & LABORATORY TEST DATA

The field and laboratory test results, as shown for each hole, are described below.

1. NATURAL MOISTURE CONTENT

The relationship between the natural moisture content and depth is significant in determining the subsurface moisture conditions. The Atterberg Limits for a sample should be compared to its natural moisture content and plotted on the Plasticity Chart in order to determine the soil classification.

2. SOIL PROFILE AND DESCRIPTION

Each soil stratum is classified and described noting any special conditions. The Modified Unified Classification System (MUCS) is used. The soil profile refers to the existing ground level at the time the hole was done. Where available, the ground elevation is shown. The soil symbols used are shown in detail on the soil classification chart.

3. TESTS ON SOIL SAMPLES

Laboratory and field tests are identified by the following and are on the logs:

N - Standard Penetration Test (SPT) Blow Count. The SPT is conducted in the field to assess the in-situ consistency of cohesive soils and the relative density of non-cohesive soils. The N value recorded is the number of blows from a 63.5 kg hammer dropped 760 mm which is required to drive a 51 mm split spoon sampler 300 mm into the soil.

SO_4 - Water Soluble Sulphate Content. Expressed in percent. Conducted primarily to determine requirements for the use of sulphate resistant cement. Further details on the water-soluble sulphate content are given in Section 6.

γ_D - Dry Unit Weight. Usually expressed in kN/m^3.

γ_T - Total Unit Weight. Usually expressed in kN/m^3.

Q_U - Unconfined Compressive Strength. Usually expressed in kPa and may be used in determining allowable bearing capacity of the soil.

C_U - Undrained Shear Strength. Usually expressed in kPa. This value is determined by either a direct shear test or by an unconfined compression test and may also be used in determining the allowable bearing capacity of the soil.

C_{PEN} - Pocket Penetrometer Reading. Usually expressed in kPa. Estimate of the undrained shear strength as determined by a pocket penetrometer.

The following tests may also be performed on selected soil samples and the results are given on separate sheets enclosed with the logs:

- Grain Size Analysis
- Standard or Modified Proctor Compaction Test
- California Bearing Ratio Test
- Direct Shear Test
- Permeability Test
- Consolidation Test
- Triaxial Test

4. SOIL DENSITY AND CONSISTENCY

The SPT test described above may be used to estimate the consistency of cohesive soils and the density of cohesionless soils. These approximate relationships are summarized in the following tables:

Table 1 Cohesive Soils

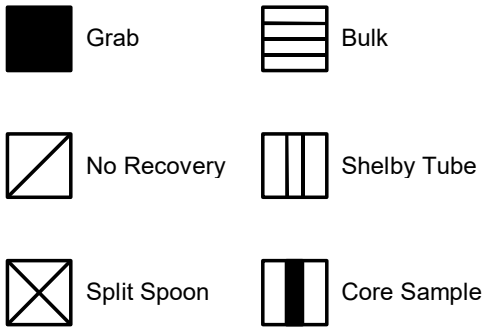
N	Consistency	C_u (kPa) approx.
0 - 1	Very Soft	<10
1 - 4	Soft	10 - 25
4 - 8	Firm	25 - 50
8 - 15	Stiff	50 - 100
15 - 30	Very Stiff	100 - 200
30 - 60	Hard	200 - 300
>60	Very Hard	>300

Table 2 Cohesionless Soils

N	Density
0 - 5	Very Loose
5 - 10	Loose
10 - 30	Compact
30 - 50	Dense
>50	Very Dense

5. SAMPLE CONDITION AND TYPE

The depth, type, and condition of samples are indicated on the logs by the following symbols:



6. WATER SOLUBLE SULPHATE CONCENTRATION

The following table, from CSA Standard A23.1-14, indicates the requirements for concrete subjected to sulphate attack based upon the percentage of water-soluble sulphate as presented on the logs. CSA Standard A23.1-14 should be read in conjunction with the table.

Table 3 Requirements for Concrete Subjected to Sulphate Attack*

Class of exposure	Degree of exposure	Water-soluble sulphate (SO_4)† in soil sample, %	Sulphate (SO_4) in groundwater samples, mg/L‡	Water soluble sulphate (SO_4) in recycled aggregate sample, %	Cementing materials to be used§††	Performance requirements§,§§		
						Maximum expansion when tested using CSA A3004-C8 Procedure A at 23 °C, %		Maximum expansion when tested using CSA A3004-C8 Procedure B at 5 °C, % †††
						At 6 months	At 12 months††	At 18 months‡‡
S-1	Very severe	> 2.0	> 10 000	> 2.0	HS** ,HSb, HSLb*** or HSe	0.05	0.10	0.10
S-2	Severe	0.20–2.0	1500–10 000	0.60–2.0	HS**, HSb, HSLb*** or HSe	0.05	0.10	0.10
S-3	Moderate (including seawater exposure*)	0.10–0.20	150–1500	0.20–0.60	MS, MSb, MSe, MSLb***, LH, LHb, HS**, HSb, HSLb*** or HSe	0.10		0.10

*For sea water exposure, also see Clause 4.1.1.5.
†In accordance with CSA A23.2-3B.
‡In accordance with CSA A23.2-2B.
§Where combinations of supplementary cementing materials and portland or blended hydraulic cements are to be used in the concrete mix design instead of the cementing materials listed, and provided they meet the performance requirements demonstrating equivalent performance against sulphate exposure, they shall be designated as MS equivalent (MSe) or HS equivalent (HSe) in the relevant sulphate exposures (see Clauses 4.1.1.6.2, 4.2.1.1, and 4.2.1.3, and 4.2.1.4).
**Type HS cement shall not be used in reinforced concrete exposed to both chlorides and sulphates, including seawater. See Clause 4.1.1.6.3.
††The requirement for testing at 5 °C does not apply to MS, HS, MSb, HSb, and MSe and HSe combinations made without portland limestone cement.
‡‡ If the increase in expansion between 12 and 18 months exceeds 0.03%, the sulphate expansion at 24 months shall not exceed 0.10% in order for the cement to be deemed to have passed the sulphate resistance requirement.
§§For demonstrating equivalent performance, use the testing frequency in Table 1 of CSA A3004-A1 and see the applicable notes to Table A3 in A3001 with regard to re-establishing compliance if the composition of the cementing materials used to establish compliance changes.

***Where MSLb or HSLb cements are proposed for use, or where MSe or HSe combinations include Portland-limestone cement, they must also contain a minimum of 25% Type F fly ash or 40% slag or 15% metakaolin (meeting Type N pozzolan requirements) or a combination of 5% Type SF silica fume with 25% slag or a combination of 5% Type SF silica fume with 20% Type F fly ash. For some proposed MSLb, HSLb, and MSe or HSe combinations that include Portland-limestone cement, higher SCM replacement levels may be required to meet the A3004-C8 Procedure B expansion limits. Due to the 18-month test period, SCM replacements higher than the identified minimum levels should also be tested. In addition, sulphate resistance testing shall be run on MSLb and HSLb cement and MSe or HSe combinations that include Portland-limestone cement at both 23 °C and 5 °C as specified in the table.
†††If the expansion is greater than 0.05% at 6 months but less than 0.10% at 1 year, the cementing materials combination under test shall be considered to have passed.

7. SOIL CORROSIVITY

The following table, from the Handbook of Corrosion Engineering (Roberge, 1999) indicates the corrosivity rating can be obtained from the soil resistivity, presented on the logs.

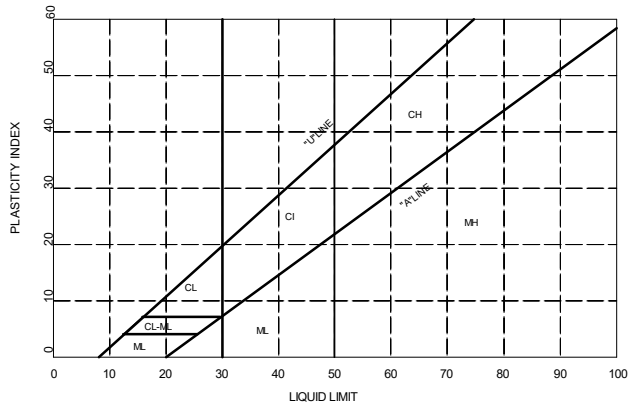
Table 4 Corrosivity Ratings Based on Soil Resistivity

Soil Resistivity (ohm-cm)	Corrosivity Rating
>20,000	Essentially non-corrosive
10,000 – 20,000	Mildly corrosive
5,000 – 10,000	Moderately corrosive
3,000 – 5,000	Corrosive
1,000 – 3,000	Highly corrosive
<1,000	Extremely corrosive

8. GROUNDWATER TABLE

The groundwater table is indicated by the equilibrium level of water in a standpipe installed in a testhole or test pit. This level is generally taken at least 24 hours after installation of the standpipe. The groundwater level is subject to seasonal variations and is usually highest in the spring. The symbol on the logs indicating the groundwater level is an inverted solid triangle (▼).

MAJOR DIVISION			LOG SYMBOLS	UCS	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS	GRAVELS (MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm)	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
				GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
	SANDS (MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm)	CLEAN SANDS (LITTLE R NO FINES)		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
				SP	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		SANDS WITH FINES		SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
FINE GRAINED SOILS	SILTS (BELOW 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 50$		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50$		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS		
	CLAYS (ABOVE 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 30$		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER 'F'. E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$30 < W_L < 50$		CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50$		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS (BELOW 'A' LINE)	$W_L < 50$		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50$		OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS				Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE	
BEDROCK				BR	SEE REPORT DESCRIPTION		
FILL				FILL	SEE REPORT DESCRIPTION		



NOTE:
1. BOUNDARY CLASSIFICATION POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%

SOIL COMPONENTS

FRACTION		SIEVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		PASSING	RETAINED	PERCENT	IDENTIFIER
GRAVEL	COARSE	75	19	50 – 35	AND
	FINE	19	4.75		
SAND	COARSE	4.75	2.00	35 – 20	_____Y
	MEDIUM	2.00	0.425		
	FINE	0.425	0.080	20 – 10	SOME
SILT (non-plastic) or CLAY (plastic)		0.080		10 – 1	TRACE
OVERSIZE MATERIALS					
ROUNDED OR SUB-ROUNDED COBBLES 75 mm TO 300 mm BOULDERS >300 mm		ANGULAR ROCK FRAGMENTS ROCKS > 0.75 m3 IN VOLUME			

MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

February 2021

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **HA22-01**
LOCATION: North Abutment	COORDINATES: N 5935633 E 329307	PROJECT NO.: 60682118
CONTRACTOR: AECOM	METHOD: Hand Auger	ELEVATION (m): 667

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ◧ CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	PLASTIC / M.C. / LIQUID (25 50 75)	COMMENTS	ELEVATION (m)
0	FILL		FILL - CLAY: trace to some sand, trace silt, trace gravel, trace to some rootlets, some black layering (topsoil), trace fine sand/silt laminations, medium plastic, firm to sitff, oxidized, moist and brown					
			CLAY TILL: trace to some sand, trace silt, trace gravel, trace fine sand/silt laminations, trace coal, medium plastic, stiff to very stiff, oxidized, moist and brown	■	1	21.7		
1				■	2	17.1		666
	CI			■	3	15.4		
2				■	4	16.1		665
				■	5	16.6		
3			END OF HOLE AT 3mBGS. NO FREE WATER OR SLOUGHING UPON COMPLETION. HOLE BACKFILLED WITH HAND AUGER CUTTINGS.					664
4								663
5								662
6								661
7								660
8								659
9								658
10								

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 3.00 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 7/18/2022
PROJECT MANAGER: Brian Nolan	Page 1 of 1

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **TH22-01**
LOCATION: North Abutment	COORDINATES: N 5935650 E 329362	PROJECT NO.: 60682118
CONTRACTOR: All Service Drilling Ltd.	METHOD: Solid Stem Augers	ELEVATION (m): 671

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ⊠ SPLIT SPOON ▤ BULK ⊘ NO RECOVERY ◧ CORE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION (m)
0	OR	TOPSOIL (75 mm thick): organic, fibrous, rootlets, trace silt and clay, moist, black					
	CL	FILL - CLAY: some sand, trace silt, trace gravel, medium plastic, stiff, moist, some black layering / laminations and rootlets, some fine sand / silt laminations, oxidized, dark brown,	■	1			
		- gravel content increase					
1		GRAVEL: some clay to clayey, trace to some sand, trace silt, poorly graded, sub angular, loose to dense, moist, dark brown	⊠	2	40		670
	GC		⊠	3	39		
2		- clay content increase	■	4			669
3		CLAY: some silt, trace fine sand, high plastic, firm to very stiff, moist to saturated, trace silt laminations, oxidized, brown	⊠	5	7		668
4		- some very silty layers, wet, trace free water	■	6			667
	CH		⊠	7	4		
5							666
			■	8		LL: 61.1% PL: 19.5% PI: 41.5% Gravel: 0% Sand: 1.6% Silt: 40.2% Clay: 58.2%	
6			⊠	9	17		665
7		CLAY (TILL): some sand, trace silt, trace gravel, medium plastic, very stiff, moist, coal inclusions, some fine sand / silt laminations, oxidized, dark brown	■	10			664
			⊠	11	23		
8	CI		■	12			663
9			⊠	13	24	LL: 38.6% PL: 13.4% PI: 25.2%	662
10			■	14			

SPT (Standard Pen Test) (Blows/300mm) 25 50 75

PLASTIC M.C. LIQUID 25 50 75

18.8, 5.3, 6.7, 9.2, 16.8, 35.2, 43.1, 45.8, 20.7, 18.9, 18.1, 13.5, 15, 14.9

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 15.50 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 6/24/2022
PROJECT MANAGER: Brian Nolan	Page 1 of 2

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **TH22-01**
LOCATION: North Abutment	COORDINATES: N 5935650 E 329362	PROJECT NO.: 60682118
CONTRACTOR: All Service Drilling Ltd.	METHOD: Solid Stem Augers	ELEVATION (m): 671

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ▩ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ◧ CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75	COMMENTS	ELEVATION (m)
10							PLASTIC M.C. LIQUID 25 50 75		
11	CI		- hard	▩	15	44	14.6		660
				■	16		14.4		
12				▩	17	27	14.8		659
13				■	18		15.7		658
				▩	19	22	15		
14				■	20		15.2		657
15				▩	21	28	16.5		656
16			END OF TEST HOLE AT 15.5mBGS. WATER MEASURED AT 7.6mBGS UPON DRILLING COMPLETION. HOLE BACKFILLED WITH DRILL CUTTING / BENTONITE CHIP MIXTURE, SEALED WITH 0.6m BENTONITE CHIPS AT SURFACE.						655
17									654
18									653
19									652
20									

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 15.50 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 6/24/2022
PROJECT MANAGER: Brian Nolan	Page 2 of 2

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **TH22-02**
LOCATION: Pier	COORDINATES: N 5935602 E 329313	PROJECT NO.: 60682118
CONTRACTOR: All Service	METHOD: Solid Stem	ELEVATION (m): 662.26

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75	PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
0	CL-CI		CLAY: some silt, trace fine sand, numerous black layers, rootlets, low to medium plastic, firm, moist and dark grey/black							662
			SAND: fine grained, silty, trace clay, loose, damp and brown		1		28.9			
1		SM			2	6	9.2			661
					3		22.7			
2										660
			CLAY TILL: trace sand, some silt, trace gravel, low to medium plastic, trace to some organics, very soft, wet and dark grey/black		4	2	21.2			
3			- trace coal, trace fine sand/silty laminations, stiff to very stiff, moist and dark grey		5		15.8			659
4			- trace free water		6	21	15.9		LL: 30.9% PL: 12.0% PI: 18.9% Gravel: 3.3% Sand: 37.8% Silt: 33.7% Clay: 25.2%	658
			- pH = 8.27, resistivity = 1850 ohm-cm, sulphate content <0.05% / 466 mg/L, chloride content < 40 mg/L		7		16.6			
5					8					657
6	CL-CI				9		16.7			656
7					10	14	18		LL: 31.8% PL: 12.1% PI: 19.7% Gravel:6.4% Sand: 32.9% Silt: 33.5% Clay: 27.2%	655
					11		19.3			
8										654
9					12	16	17			
					13		13.5			653
10										

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 14.80 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 7/15/2022
PROJECT MANAGER: Brian Nolan	Page 1 of 2

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **TH22-02**
LOCATION: Pier	COORDINATES: N 5935602 E 329313	PROJECT NO.: 60682118
CONTRACTOR: All Service	METHOD: Solid Stem	ELEVATION (m): 662.26

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75 PLASTIC M.C. LIQUID	COMMENTS	ELEVATION (m)
10					14	20	16.6		652
	CL-CI				15		17.4		
11									651
	SM		SAND: fine grained, sitly, trace clay, compact, wet and grey		16	29	20.1		
			CLAY TILL: some sand, some silt, trace gravel, low to medium plastic, very stiff, trace fine sand/silt laminations, moist and grey						
12					17		17.4		650
13					18	20	18.9		
	CL-CI								649
			silty, moist to wet		19		15.9		
14									648
					20	16	21.5	LL: 28.6% PL: 14.4% PI: 14.2% Gravel: 0.9% Sand: 30.2% Silt: 45.9% Clay: 23.0%	
15			END OF TEST HOLE AT 14.8 mBGS. WATER MEASURED AT 7.45 mBGS ON JULY 22, 2022. WATER MEASURED AT 10.4 mBGS UPON DRILLING COMPLETION. SLOUGH AT 12m BGS UPON DRILLING COMPLETION. 50 mm STANDPIPE INSTALLED AT 12m WITH 3m SLOTTED LENGTH.						647
16									646
17									645
18									644
19									643
20									

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 14.80 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 7/15/2022
PROJECT MANAGER: Brian Nolan	Page 2 of 2

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **TH22-03**
LOCATION: South Abutment	COORDINATES: N 5935587 E 329312	PROJECT NO.: 60682118
CONTRACTOR: All Service Drilling Ltd.	METHOD: Solid Stem Augers	ELEVATION (m): 670

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75 PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
0	OR		TOPSOIL (100 mm thick): organic, fibrous, rootlets, trace silt and clay, moist, black						
			CLAY: silty, trace fine sand, firm to stiff, high plastic, some fine sand / silt laminations, oxidized, moist to saturated, brown		1		25.8		
1					2	8	29		669
					3	7	32.2		
2									668
					4		32.5		
	CH								
3					5	7	36.4	LL: 49.1% PL: 19.5% PI: 29.6% Gravel: 0% Sand: 0.6% Silt: 54.6% Clay: 44.8%	667
					6		40.9		
4									666
					7	10	33.8		
5			CLAY (TILL): trace sand to sandy, trace gravel, trace silt to silty, low to medium plastic, stiff to hard, some fine sand / silt lainations, trace coal, oxidized, moist, brown		8		18.9		665
6			- pH = 7.49, resistivity = 1000 ohm-cm, sulphate content 0.714% / 1720 mg/L, chloride content < 20 mg/L		9	15	19		664
					10		17		
7			- very stiff						663
	CI-CL				11	26	14.6	LL: 30.5% PL: 12.1% PI: 18.3% Gravel: 4.1% Sand: 37.4% Silt: 33.3% Clay: 25.2%	
8									662
					12		16.4		
9			- minor seepage, grey		13	27	15.8		661
10					14		15.2		

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 20.00 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 6/13/2022
PROJECT MANAGER: Brian Nolan	Page 1 of 3

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **TH22-03**
LOCATION: South Abutment	COORDINATES: N 5935587 E 329312	PROJECT NO.: 60682118
CONTRACTOR: All Service Drilling Ltd.	METHOD: Solid Stem Augers	ELEVATION (m): 670

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 25 50 75	PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
10										
11					15	21	14.4			659
					16		15.1			
12					17	22	16.3			658
13					18		16.4			657
14 ▼			- hard		19	41	16.6			656 ▼
			- sand layer		20		16.6			
15	CI-CL		- some wet sand laminations / layers		21	22	16.7			655
16					22		16.3			654
17					23	23	15.9			653
					24		16			
18					25	25	16			652
19			- some silt layering		26		18.3			651
20					27	53	16.2			

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 20.00 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 6/13/2022
PROJECT MANAGER: Brian Nolan	Page 2 of 3

PROJECT: McKinnon Ravine	CLIENT: City of Edmonton	TESTHOLE NO.: **TH22-03**
LOCATION: South Abutment	COORDINATES: N 5935587 E 329312	PROJECT NO.: 60682118
CONTRACTOR: All Service Drilling Ltd.	METHOD: Solid Stem Augers	ELEVATION (m): 670

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	◆SPT (Standard Pen Test)◆ (Blows/300mm) 25 50 75 PLASTIC M.C. LIQUID 25 50 75	COMMENTS	ELEVATION (m)
20			END OF TEST HOLE AT 20.0mBGS. WATER MEASURED AT 14.04 mBGS ON JULY 27, 2022. WATER MEASURED AT 17.1mBGS UPON DRILLING COMPLETION. 50mm MONITORING WELL INSTALLED TO 20.0m, BOTTOM 3.0m SLOTTED.						
21									649
22									648
23									647
24									646
25									645
26									644
27									643
28									642
29									641
30									

AECOM

LOGGED BY: Pat Eckel	COMPLETION DEPTH: 20.00 m
REVIEWED BY: Usman Raja	COMPLETION DATE: 6/13/2022
PROJECT MANAGER: Brian Nolan	Page 3 of 3

LOG OF TESTHOLE MACKINNON_JULY 25, 2022.GPJ UMA_COC.GDT PRINT: 7/27/22 By:

Appendix B1

Testhole Log (Stantec 2022)

BOREHOLE RECORD

BH-MR-02

CLIENT: **Marigold Infrastructure Partners (MIP)**
PROJECT: **Valley Line West LRT**
LOCATION: **Tracks, Retaining Walls, Stops, and Utility Complexes**
DATE BORED: **1/26/2021**

BH COORDINATES [3TM114W] 5934431.9N 28097.5E
WATER LEVEL: **4.8 m on 6/26/2021**

PROJECT NO. : **1135510096**
BH ELEVATION: **670.7m**
DATUM: **Geodetic**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (MUSCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS
0	670.7							
	670.5	ASPHALT 0.2 m thickness						
	670.4	SAND AND GRAVEL (FILL) - trace silt, well graded, gravel size up to 40 mm, moist						
1		CLAY (FILL) - some silt, some sand, trace gravel, black, trace organics, trace rootlets, moist to wet		BS	1			
	669.3	- low to medium plastic, firm below 1.1 m		SS	2	450	8	frozen to 1.1 m
2		CLAY (CH) - silty, some sand, high plastic, firm, brown, trace rootlets, moist		SS	3	450	7	
				BS	4			
3				ST	5	430		UCS test at 3.4 m: Qu = 130.8 kPa at 3.0% strain
4		- trace oxides below 3.7 m		SS	6	450	5	
				BS	7			
	665.8			SS	8	450	8	
5		CLAY TILL (CL/CI) - silty, sandy, trace gravel, low to medium plastic, stiff, grey, trace oxides, trace coal, moist		BS	9			
6		- very stiff below 6.1 m		SS	10		16	
7				BS	11			
		- hard, brownish grey, below 7.6 m		SS	12	450	32	pp > 215 kPa
8		- 300 mm thick fine sand layer, some clay, some silt, poorly graded, grey, moist to wet from 8.0 m to 8.3 m		BS	13			
9				ST	14	460		0.1 m of slough at borehole bottom at 9.1 m UCS test at 9.4 m: Qu = 267.8 kPa at 4.8% strain
				SS	15	450	42	pp > 215 kPa pp > 215 kPa
10								

UNDRAINED SHEAR STRENGTH, Cu (kPa)
LABORATORY TEST ▲ FIELD VANE TEST ◆
POCKET PEN. ★ POCKET SHEAR VANE ◘
50 kPa 100 kPa 150 kPa 200 kPa

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N-value) BLOWS/0.3m
Water Content (%) and Blow Count
10 20 30 40 50 60 70 80

BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m): 670 669 668 667 666 665 664 663 662 661

▽ Water Level Observed During Drilling
▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: All Service Drilling Inc.
Drilling Method: Solid Stem Auger
Completion Depth: 15.6 m

Logged By: MF
Reviewed By: DM
Page 1 of 2

Printed Jul 6 2021 7:23 STANTEC GEO 2016 BHLOGS_MACKINNON_RAVINE.GPJ MASTER1.GDT 7/6/21

Stantec

BOREHOLE RECORD

BH-MR-02

CLIENT: **Marigold Infrastructure Partners (MIP)**
BH COORDINATES
PROJECT NO. : **1135510096**

PROJECT: **Valley Line West LRT**
[3TM114W]
BH ELEVATION: **670.7m**

LOCATION: **Tracks, Retaining Walls, Stops, and Utility Complexes**
5934431.9N 28097.5E
DATUM: **Geodetic**

DATE BORED: **1/26/2021**
WATER LEVEL: **4.8 m on 6/26/2021**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (MUSCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS
10		- grey below 10.0 m		BS	16			
11				SS	17	410	41	pp > 215 kPa
				BS	18			
12				SS	19	430	33	
13				BS	20			
14				SS	21	450	35	
				BS	22			
15	655.5							
	655.1	SAND (SP) - trace silt, fine, poorly graded, very dense, brownish grey, moist - medium to coarse, trace fine angular gravel below 15.4 m		SS	23	450	68	
16		End of Borehole at 15.6 m - slough to 15.2 m - water at 14.0 m upon completion - water at 5.2 m on February 27, 2021 - standpipe piezometer installed with slotted section from 7.6 m to 9.1 m - water at 4.8 m on June 26, 2021 - concrete and flush mounted cover - borehole backfilled with soil cuttings, sand, and bentonite						
17								
18								
19								
20								

UNDRAINED SHEAR STRENGTH, Cu (kPa)
LABORATORY TEST ▲ FIELD VANE TEST ◆
POCKET PEN. ★ POCKET SHEAR VANE ◘
50 kPa 100 kPa 150 kPa 200 kPa

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N-value) BLOWS/0.3m
Water Content (%) and Blow Count
10 20 30 40 50 60 70 80

BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m): 660, 659, 658, 657, 656, 655, 654, 653, 652, 651

▽ Water Level Observed During Drilling
▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: All Service Drilling Inc.
Logged By: MF
Drilling Method: Solid Stem Auger
Reviewed By: DM
Completion Depth: 15.6 m
Page 2 of 2

Printed Jul 6 2021 7:2:3 STANTEC GEO 2016 BHLOGS_MACKINNON_RAVINE.GPJ MASTER1.GDT 7/6/21

Appendix C

Laboratory Test Results

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

WATER CONTENT (ASTM D2216)

CLIENT:	City of Edmonton							
PROJECT:	MacKinnon Bridge							
JOB No.:	60682118							
DATE :	June 29, 2022					TECHNICAN :	GU	
HOLE No.	22-01							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	643.2	553.5	708.0	675.5	566.6	610.7	626.3	663.6
WT. SAMPLE DRY + TARE	543.4	526.4	664.5	619.8	487.0	455.0	441.6	459.2
WT. TARE	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
WATER CONTENT W%	**18.8%**	**5.3%**	**6.7%**	**9.2%**	**16.8%**	**35.2%**	**43.1%**	**45.8%**
HOLE No.	22-01							
DEPTH								
SAMPLE No.	9	10	11	12	13	14	15	16
TARE No.								
WT. SAMPLE WET + TARE	482.7	682.1	680.7	656.4	160.5	632.6	710.3	671.5
WT. SAMPLE DRY + TARE	402.2	575.9	578.3	579.9	141.3	552.3	621.7	588.7
WT. TARE	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
WATER CONTENT W%	**20.7%**	**18.9%**	**18.1%**	**13.5%**	**15.0%**	**14.9%**	**14.6%**	**14.4%**
HOLE No.	22-01							
DEPTH								
SAMPLE No.	17	18	19	20	21			
TARE No.								
WT. SAMPLE WET + TARE	672.2	676.3	626.6	684.4	609.7			
WT. SAMPLE DRY + TARE	587.0	586.3	546.6	595.7	525.3			
WT. TARE	13.2	13.2	13.2	13.2	13.2			
WATER CONTENT W%	**14.8%**	**15.7%**	**15.0%**	**15.2%**	**16.5%**			
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

WATER CONTENT (ASTM D2216)

CLIENT:	City of Edmonton							
PROJECT:	MacKinnon Bridge							
JOB No.:	60682118							
DATE :	July 19, 2022					TECHNICAN :	GU	
HOLE No.	22-02							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	9
TARE No.								
WT. SAMPLE WET + TARE	599.1	278.7	670.8	246.3	635.8	817.0	554.4	656.4
WT. SAMPLE DRY + TARE	467.7	256.3	549.2	205.5	551.0	706.9	477.8	564.2
WT. TARE	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
WATER CONTENT W%	**28.9%**	**9.2%**	**22.7%**	**21.2%**	**15.8%**	**15.9%**	**16.5%**	**16.7%**
HOLE No.	22-02							
DEPTH								
SAMPLE No.	10	11	12	13	14	15	16	17
TARE No.								
WT. SAMPLE WET + TARE	734.2	644.5	679.1	744.0	830.8	709.6	793.6	691.3
WT. SAMPLE DRY + TARE	624.3	542.5	582.5	630.0	714.4	606.3	663.2	590.6
WT. TARE	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
WATER CONTENT W%	**18.0%**	**19.3%**	**17.0%**	**18.5%**	**16.6%**	**17.4%**	**20.1%**	**17.4%**
HOLE No.	22-02							
DEPTH								
SAMPLE No.	18	19	20					
TARE No.								
WT. SAMPLE WET + TARE	589.4	659.3	711.0					
WT. SAMPLE DRY + TARE	497.7	565.7	587.5					
WT. TARE	13.2	13.2	13.2					
WATER CONTENT W%	**18.9%**	**16.9%**	**21.5%**					
HOLE No.								
DEPTH								
SAMPLE No.								
TARE No.								
WT. SAMPLE WET + TARE								
WT. SAMPLE DRY + TARE								
WT. TARE								
WATER CONTENT W%								

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

WATER CONTENT (ASTM D2216)

CLIENT:	City of Edmonton							
PROJECT:	MacKinnon Bridge							
JOB No.:	60682118							
DATE :	June 17, 2022					TECHNICAN :	GU	
HOLE No.	22-03							
DEPTH								
SAMPLE No.	1	2	3	4	5	6	7	8
TARE No.								
WT. SAMPLE WET + TARE	684.6	581.9	613.7	686.8	627.4	827.1	569.0	712.7
WT. SAMPLE DRY + TARE	546.7	454.1	467.6	521.6	463.4	591.0	428.7	601.7
WT. TARE	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
WATER CONTENT W%	**25.8%**	**29.0%**	**32.2%**	**32.5%**	**36.4%**	**40.9%**	**33.8%**	**18.9%**
HOLE No.	22-03							
DEPTH								
SAMPLE No.	9	10	11	12	13	14	15	16
TARE No.								
WT. SAMPLE WET + TARE	777.3	646.0	660.4	800.9	721.7	719.4	805.7	752.9
WT. SAMPLE DRY + TARE	655.3	553.9	578.1	689.9	624.9	626.0	706.2	656.1
WT. TARE	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
WATER CONTENT W%	**19.0%**	**17.0%**	**14.6%**	**16.4%**	**15.8%**	**15.2%**	**14.4%**	**15.1%**
HOLE No.	22-03							
DEPTH								
SAMPLE No.	17	18	19	20	21	22	23	24
TARE No.								
WT. SAMPLE WET + TARE	784.4	787.3	702.8	734.8	712.5	671.9	732.0	740.5
WT. SAMPLE DRY + TARE	676.2	678.3	604.5	631.9	612.3	579.7	633.5	640.1
WT. TARE	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
WATER CONTENT W%	**16.3%**	**16.4%**	**16.6%**	**16.6%**	**16.7%**	**16.3%**	**15.9%**	**16.0%**
HOLE No.	22-03							
DEPTH								
SAMPLE No.	25	26	27					
TARE No.								
WT. SAMPLE WET + TARE	781.9	808.9	674.6					
WT. SAMPLE DRY + TARE	675.9	686.0	582.6					
WT. TARE	13.2	13.2	13.2					
WATER CONTENT W%	**16.0%**	**18.3%**	**16.2%**					

FORM : MacKinnon Moisture Contents .xls
DATE: 7/20/2022

ATTERBERG LIMITS (ASTM D4318)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	8
TESTHOLE:	22-01	DEPTH:	
DATE :	July 12, 2022	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	29					
Container Number						
Wt. Sample (wet+tare)(g)	50.78					
Wt. Sample (dry+tare)(g)	37.79					
Wt. Tare (g)	16.13					
Wt. Dry Soil (g)	21.7					
Wt. Water (g)	13.0					
Water Content (%)	60.0%					

AVERAGE VALUES

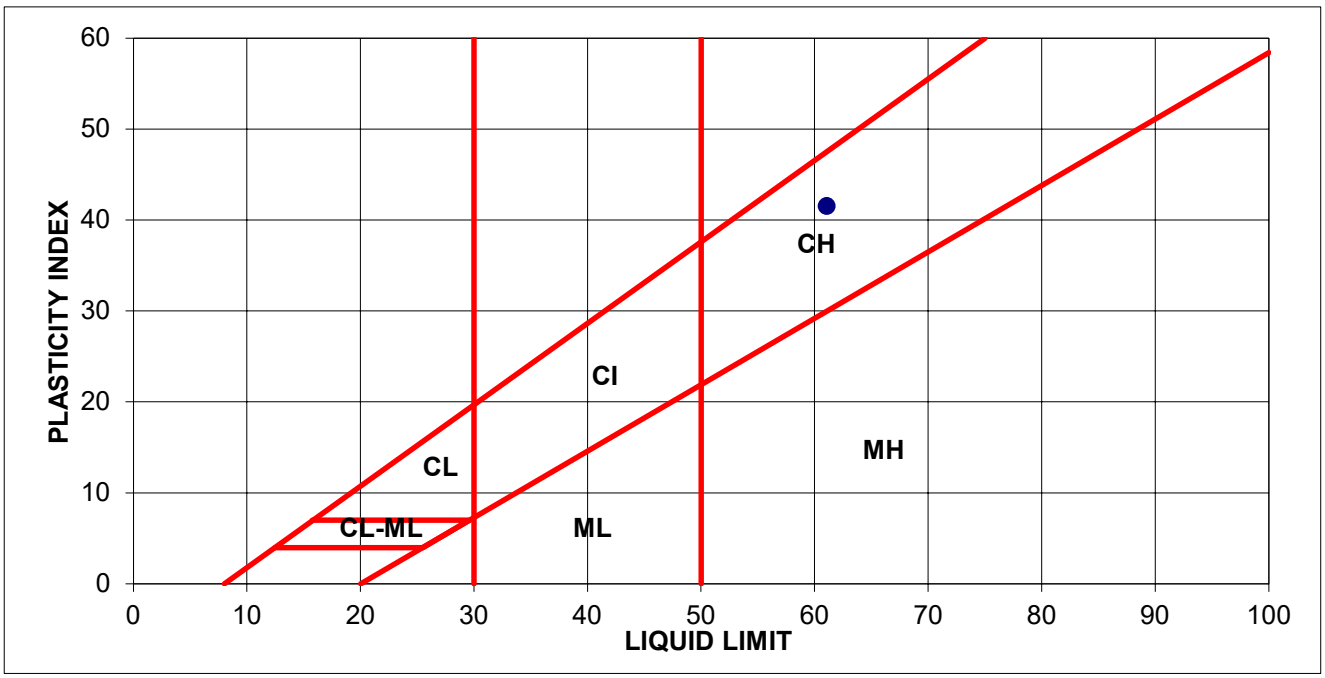
Liquid Limit	61.1
Plastic Limit	19.5
Plasticity Index	41.5

SAMPLE DESCRIPTION

Classification: **CH**

PLASTIC LIMIT

Trial No.	1				
Container Number					
Wt. Sample (wet+tare)(g)	28.73				
Wt. Sample (dry+tare)(g)	25.92				
Wt. Tare (g)	11.53				
Wt. Dry Soil (g)	14.4				
Wt. Water (g)	2.8				
Water Content (%)	19.5%				



FORM: MacKinnon TH22-01 #8 Atterberg.xls
DATE: 7/13/2022

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	8
TESTHOLE:	22-01	DEPTH :	
DATE :	July 11, 2022	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	558.5	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	458.5	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0		0%	100%	
MC (%)		5,000	0.185	5.0		0%	100%	
	Passing							
After Washing		2,000	0.0937	2.0		0%	100%	
Wt. Dry+Tare		1,250	0.0469	1.25	0.9	0%	99.8%	
Tare		630	0.0234	0.63	1.8	0%	99.6%	
Wt. Dry		315	0.0116	0.315	3.7	1%	99.2%	
Tare No.		160	0.0059	0.160	6.4	1%	98.6%	
		75	0.00295	0.075	7.3	2%	98.4%	
		PAN						

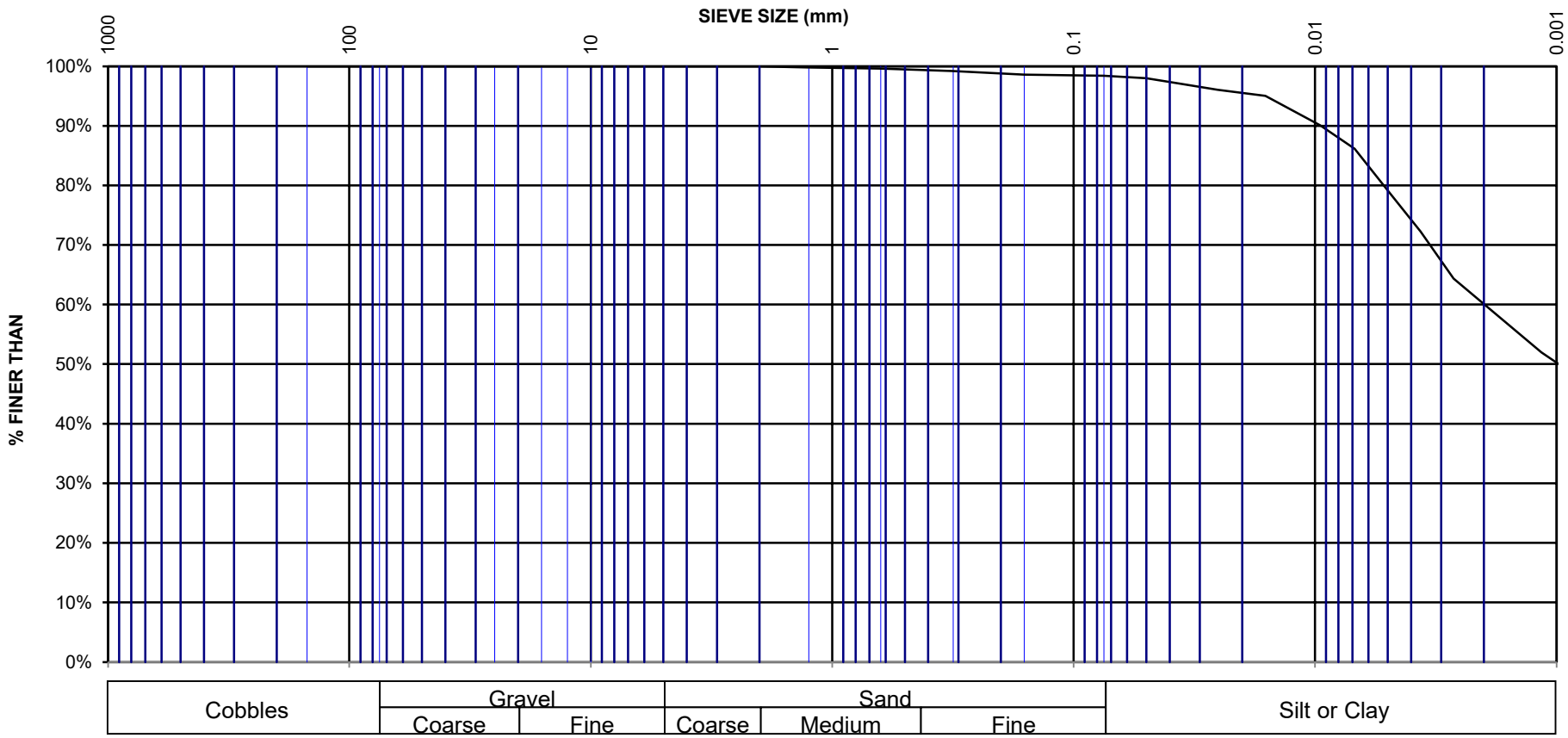
HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	558.5	53	0.5	0.050	24	50	98.0%	
Wt Tare	100.0	53	1	0.036	24	49	97.0%	
Wt Dry	458.5	52	2	0.025	24	49	96.0%	
Sample Size :	50	52	5	0.016	24	48	95.0%	
Wt Retained 2 mm:	0.0	49	15	0.010	24	46	90.1%	
% Passing 2 mm:	100.0%	47	30	0.007	24	44	86.1%	
Specific Gravity :	2.70	44	60	0.005	24	40	79.2%	
Hydrometer No.:	43-9856	40	120	0.004	24	37	72.3%	
Solution (g/L) :	40	36	240	0.003	24	33	64.4%	
		30	1440	0.001	23	26	52.0%	
		28	2880	0.001	23	24	48.0%	

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	8
TESTHOLE:	22-01	DEPTH :	
DATE :	July 11, 2022	TECHNICIAN :	GU

Gravel = 0.0% **Sand = 1.6%** **Silt = 40.2%** **Clay = 58.2%**



FORM: MacKinnon TH22-01 #8 Hydro.xls
DATE: 7/13/2022

ATTERBERG LIMITS (ASTM D4318)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	13
TESTHOLE:	22-01	DEPTH:	
DATE :	July 12, 2022	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	19					
Container Number						
Wt. Sample (wet+tare)(g)	54.36					
Wt. Sample (dry+tare)(g)	43.64					
Wt. Tare (g)	16.76					
Wt. Dry Soil (g)	26.9					
Wt. Water (g)	10.7					
Water Content (%)	39.9%					

AVERAGE VALUES

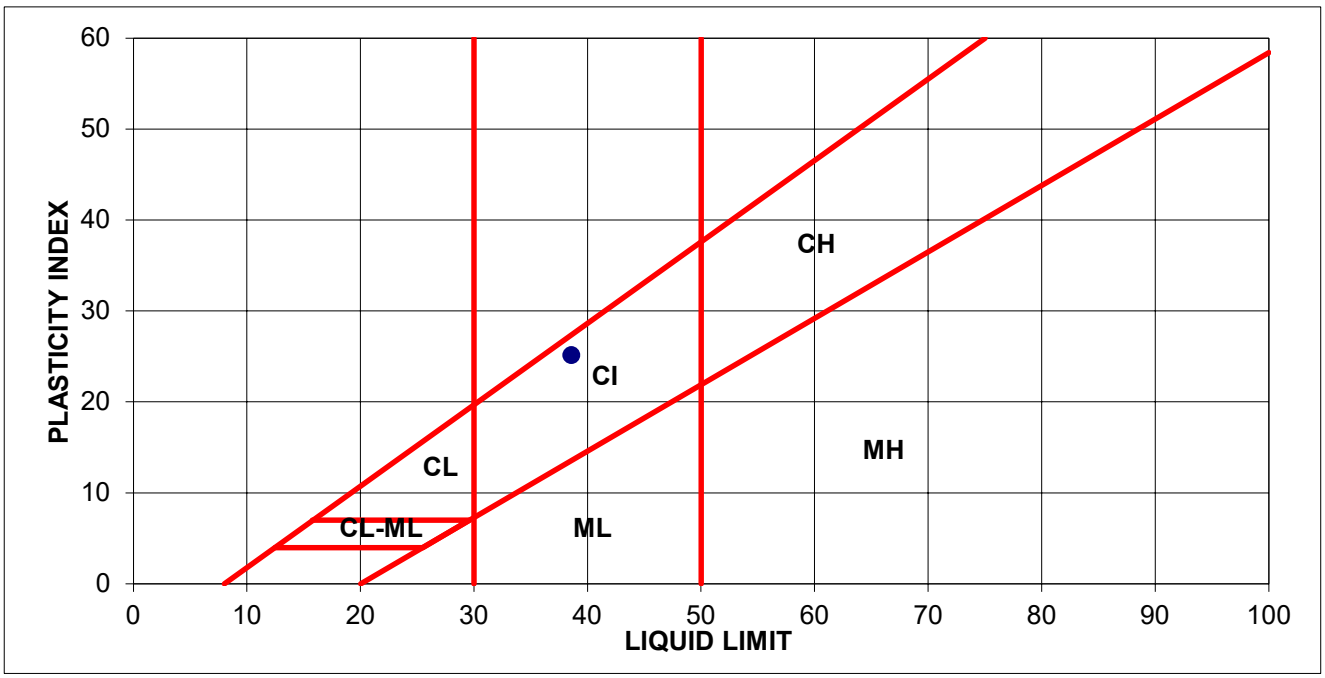
Liquid Limit	38.6
Plastic Limit	13.4
Plasticity Index	25.2

SAMPLE DESCRIPTION

Classification: **CI**

PLASTIC LIMIT

Trial No.	1		
Container Number			
Wt. Sample (wet+tare)(g)	32.37		
Wt. Sample (dry+tare)(g)	29.97		
Wt. Tare (g)	12.09		
Wt. Dry Soil (g)	17.9		
Wt. Water (g)	2.4		
Water Content (%)	13.4%		



FORM: MacKinnon TH22-01 #13 Atterberg.xls
DATE: 7/13/2022

ATTERBERG LIMITS (ASTM D4318)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	6
TESTHOLE:	22-02	DEPTH:	
DATE :	July 21, 2022	TECHNICIAN :	GU

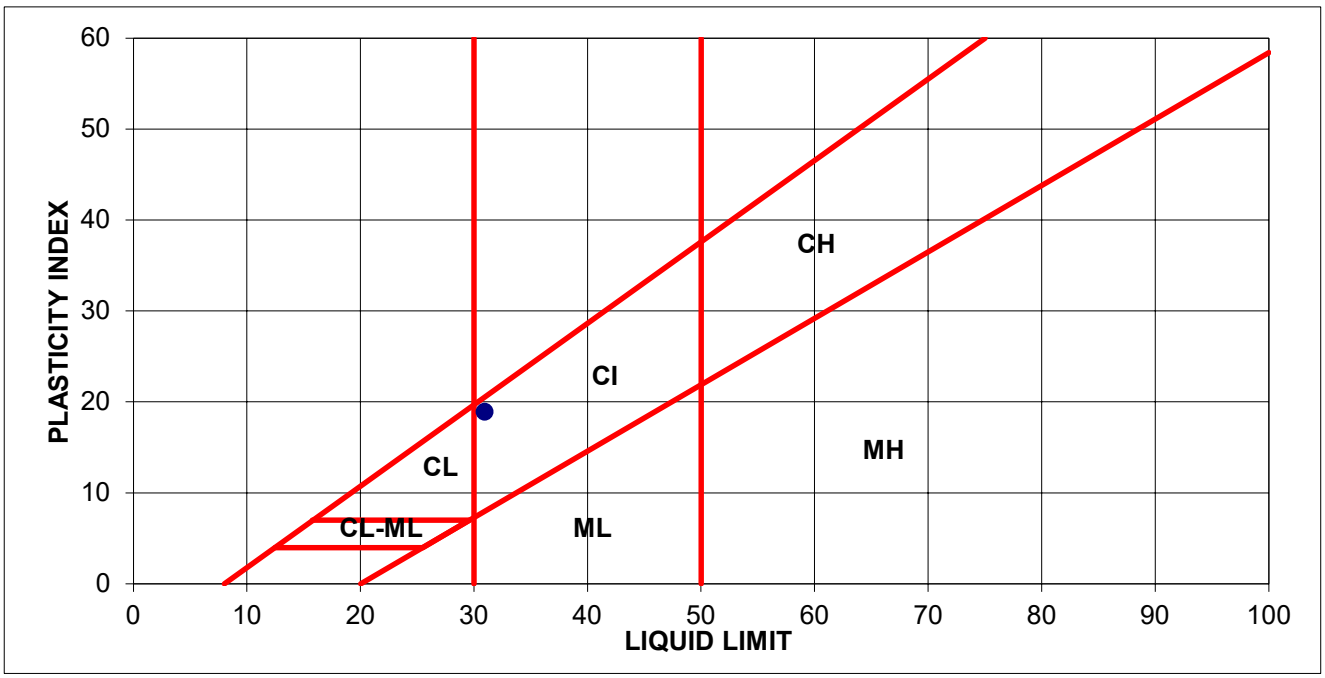
LIQUID LIMIT						
Trial No.	1					
Number of Blows	30					
Container Number						
Wt. Sample (wet+tare)(g)	60.57					
Wt. Sample (dry+tare)(g)	50.12					
Wt. Tare (g)	15.57					
Wt. Dry Soil (g)	34.6					
Wt. Water (g)	10.5					
Water Content (%)	30.2%					

AVERAGE VALUES	
Liquid Limit	30.9
Plastic Limit	12.0
Plasticity Index	18.9

SAMPLE DESCRIPTION

Classification: **CI-CL**

PLASTIC LIMIT				
Trial No.	1			
Container Number				
Wt. Sample (wet+tare)(g)	31.73			
Wt. Sample (dry+tare)(g)	29.59			
Wt. Tare (g)	11.76			
Wt. Dry Soil (g)	17.8			
Wt. Water (g)	2.1			
Water Content (%)	12.0%			



FORM: MacKinnon TH22-02 #6 Atterberg.xls
DATE: 7/22/2022

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	6
TESTHOLE:	22-02	DEPTH :	
DATE :	July 20, 2022	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	635.5	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	535.5	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0	17.6	3%	96.7%	
Wet + Tare		16,000	5/8	16.0	17.6	3%	96.7%	
Dry+Tare		12,500	1/2	12.5	17.6	3%	96.7%	
Tare		10,000	3/8	10.0	17.6	3%	96.7%	
MC (%)		5,000	0.185	5.0	17.6	3%	96.7%	
	Passing							
After Washing		2,000	0.0937	2.0	20.2	4%	96.2%	
Wt. Dry+Tare		1,250	0.0469	1.25	29.5	6%	94.5%	
Tare		630	0.0234	0.63	46.0	9%	91.4%	
Wt. Dry		315	0.0116	0.315	85.1	16%	84.1%	
Tare No.		160	0.0059	0.160	149.0	28%	72.2%	
		75	0.00295	0.075	220.1	41%	58.9%	
		PAN						

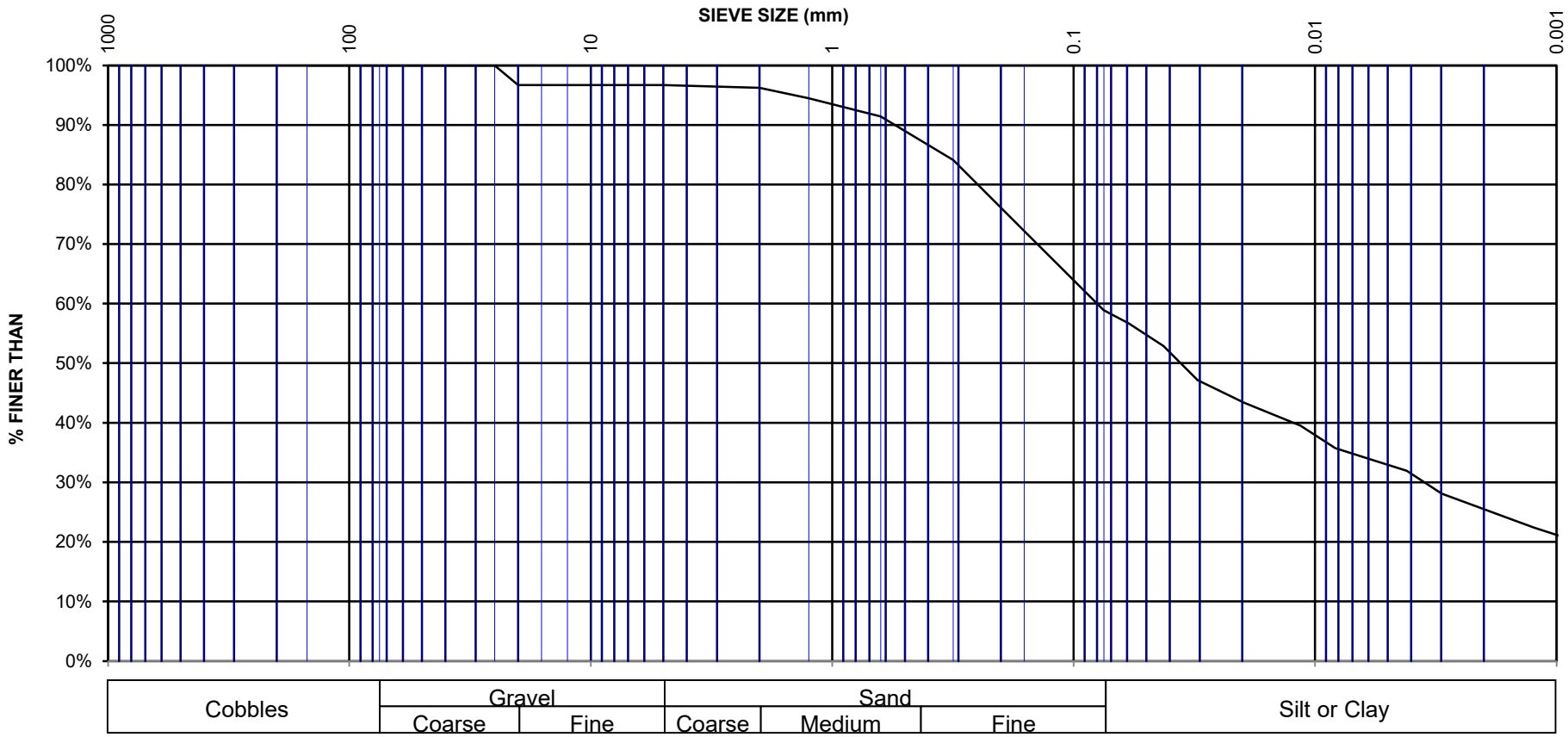
HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	635.5	33	0.5	0.059	25	30	56.7%	
Wt Tare	100.0	31	1	0.042	25	28	52.9%	
Wt Dry	535.5	28	2	0.031	25	25	47.2%	
Sample Size :	50	26	5	0.020	25	23	43.3%	
Wt Retained 2 mm:	20.2	24	15	0.012	25	21	39.5%	
% Passing 2 mm:	96.2%	22	30	0.008	25	19	35.7%	
Specific Gravity :	2.70	21	60	0.006	25	18	33.8%	
Hydrometer No.:	43-9856	20	120	0.004	25	17	31.9%	
Solution (g/L) :	40	18	240	0.003	25	15	28.1%	
		15	1440	0.001	25	12	22.4%	
		14	2880	0.001	25	11	20.5%	

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	6
TESTHOLE:	22-02	DEPTH :	
DATE :	July 20, 2022	TECHNICIAN :	GU

Gravel = 3.3% **Sand = 37.8%** **Silt = 33.7%** **Clay = 25.2%**



FORM: MacKinnon TH22-02 #6 Hydro.xls
DATE: 7/22/2022

ATTERBERG LIMITS (ASTM D4318)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	10
TESTHOLE:	22-02	DEPTH:	
DATE :	July 21, 2022	TECHNICIAN :	GU

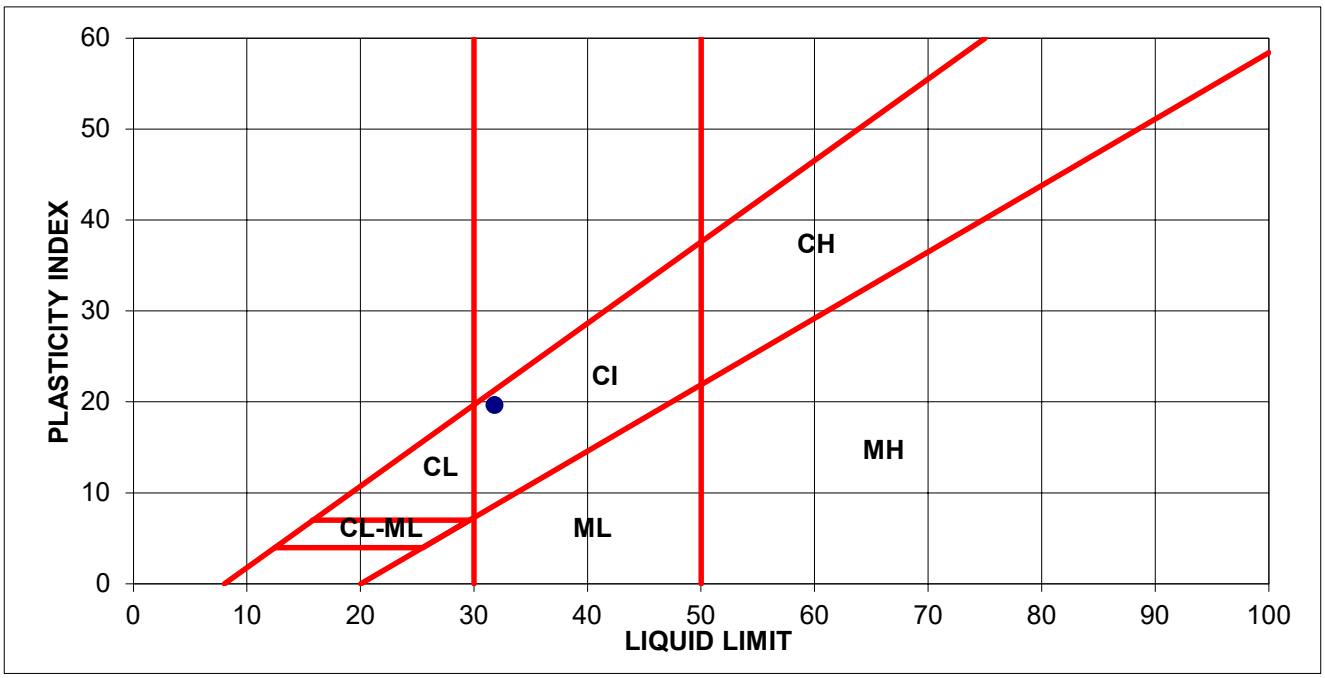
LIQUID LIMIT						
Trial No.	1					
Number of Blows	29					
Container Number						
Wt. Sample (wet+tare)(g)	56.67					
Wt. Sample (dry+tare)(g)	47.04					
Wt. Tare (g)	16.22					
Wt. Dry Soil (g)	30.8					
Wt. Water (g)	9.6					
Water Content (%)	31.2%					

AVERAGE VALUES	
Liquid Limit	31.8
Plastic Limit	12.1
Plasticity Index	19.7

SAMPLE DESCRIPTION

Classification: **CI-CL**

PLASTIC LIMIT				
Trial No.	1			
Container Number				
Wt. Sample (wet+tare)(g)	31.43			
Wt. Sample (dry+tare)(g)	29.29			
Wt. Tare (g)	11.66			
Wt. Dry Soil (g)	17.6			
Wt. Water (g)	2.1			
Water Content (%)	12.1%			



FORM: MacKinnon TH22-02 #10 Atterberg.xls
DATE: 7/22/2022

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	10
TESTHOLE:	22-02	DEPTH :	
DATE :	July 20, 2022	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	710.3	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	610.3	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0	28.0	5%	95.4%	
Wet + Tare		16,000	5/8	16.0	36.7	6%	94.0%	
Dry+Tare		12,500	1/2	12.5	36.7	6%	94.0%	
Tare		10,000	3/8	10.0	37.9	6%	93.8%	
MC (%)		5,000	0.185	5.0	38.9	6%	93.6%	
	Passing							
After Washing		2,000	0.0937	2.0	41.5	7%	93.2%	
Wt. Dry+Tare		1,250	0.0469	1.25	49.5	8%	91.9%	
Tare		630	0.0234	0.63	63.1	10%	89.7%	
Wt. Dry		315	0.0116	0.315	101.8	17%	83.3%	
Tare No.		160	0.0059	0.160	166.6	27%	72.7%	
		75	0.00295	0.075	239.4	39%	60.8%	
		PAN						

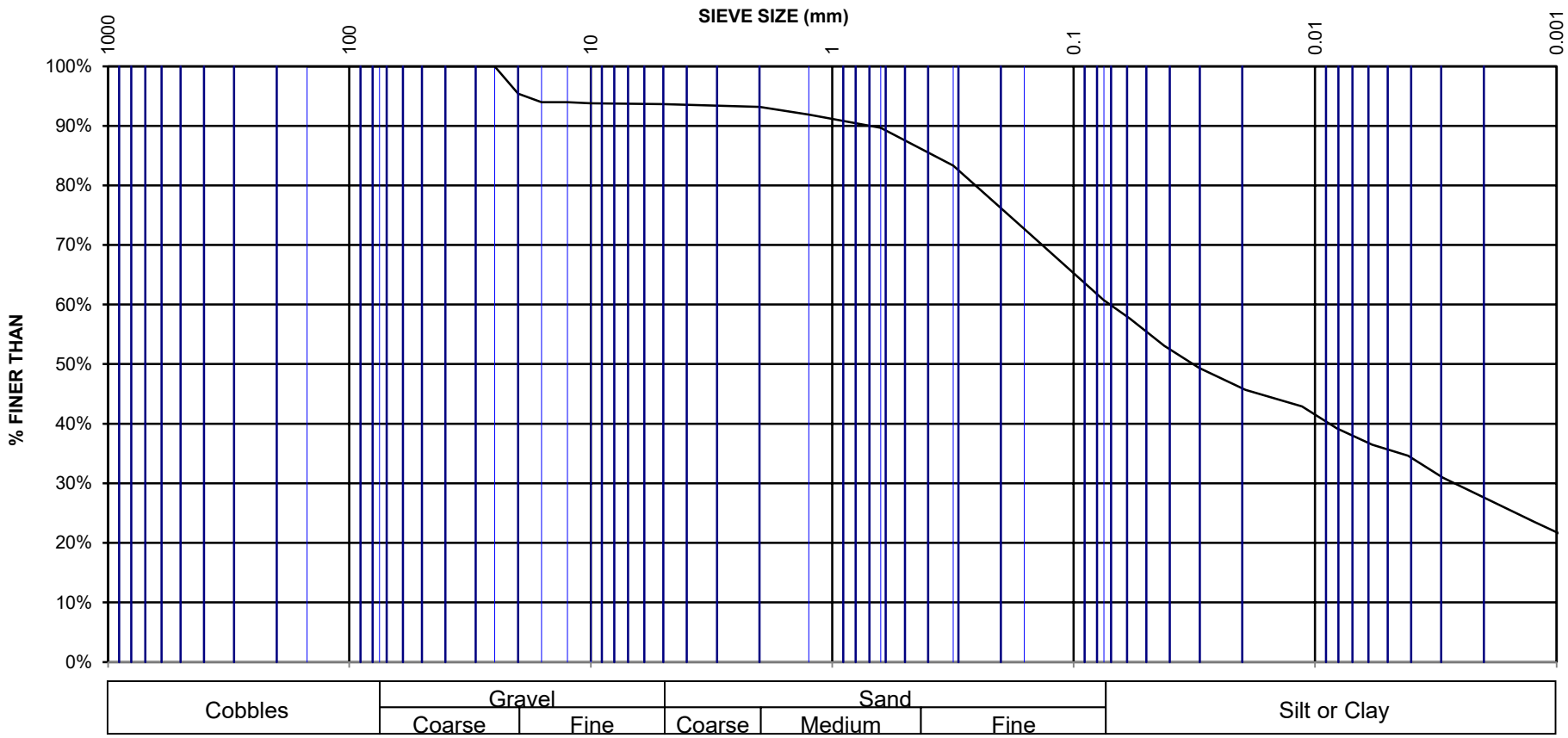
HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	710.3	35	0.5	0.058	25	31	57.7%	
Wt Tare	100.0	32	1	0.042	25	29	53.1%	
Wt Dry	610.3	30	2	0.030	25	27	49.4%	
Sample Size :	50	28	5	0.019	25	25	45.7%	
Wt Retained 2 mm:	41.5	27	15	0.011	25	23	42.9%	
% Passing 2 mm:	93.2%	25	30	0.008	25	21	39.2%	
Specific Gravity :	2.70	23	60	0.006	25	20	36.4%	
Hydrometer No.:	43-9856	22	120	0.004	25	19	34.6%	
Solution (g/L) :	40	20	240	0.003	25	17	30.9%	
		16	1440	0.001	25	13	23.5%	
		15	2880	0.001	25	11	20.8%	

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	10
TESTHOLE:	22-02	DEPTH :	
DATE :	July 20, 2022	TECHNICIAN :	GU

Gravel = 6.4% **Sand = 32.9%** **Silt = 33.5%** **Clay = 27.2%**



FORM: MacKinnon TH22-02 #10 Hydro.xls
DATE: 7/22/2022

ATTERBERG LIMITS (ASTM D4318)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	20
TESTHOLE:	22-02	DEPTH:	
DATE :	July 21, 2022	TECHNICIAN :	GU

LIQUID LIMIT

Trial No.	1					
Number of Blows	24					
Container Number						
Wt. Sample (wet+tare)(g)	59.07					
Wt. Sample (dry+tare)(g)	49.46					
Wt. Tare (g)	16.03					
Wt. Dry Soil (g)	33.4					
Wt. Water (g)	9.6					
Water Content (%)	28.7%					

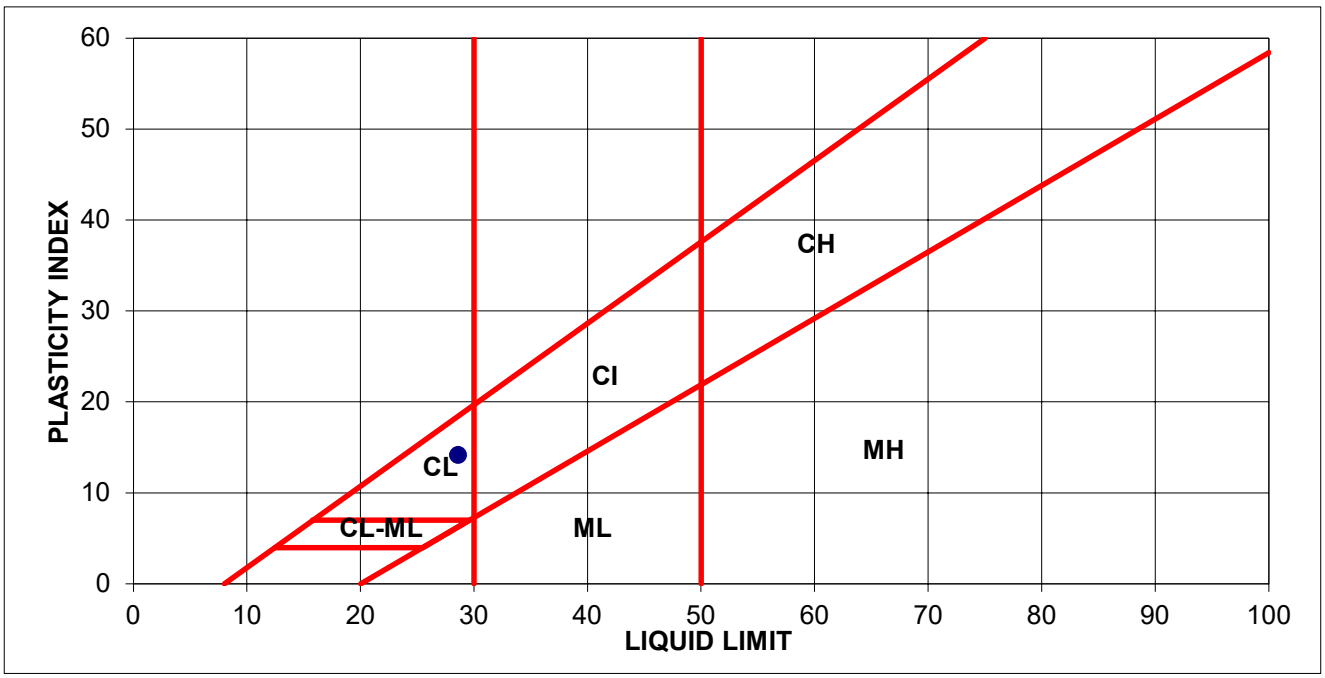
AVERAGE VALUES	
Liquid Limit	28.6
Plastic Limit	14.4
Plasticity Index	14.2

SAMPLE DESCRIPTION

Classification: **CL-CI**

PLASTIC LIMIT

Trial No.	1				
Container Number					
Wt. Sample (wet+tare)(g)	34.08				
Wt. Sample (dry+tare)(g)	31.29				
Wt. Tare (g)	11.94				
Wt. Dry Soil (g)	19.4				
Wt. Water (g)	2.8				
Water Content (%)	14.4%				



FORM: MacKinnon TH22-02 #20 Atterberg.xls
DATE: 7/22/2022

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	20
TESTHOLE:	22-02	DEPTH :	
DATE :	July 20, 2022	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	673.7	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	573.7	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0	1.7	0%	99.7%	
MC (%)		5,000	0.185	5.0	5.4	1%	99.1%	
	Passing							
After Washing		2,000	0.0937	2.0	7.6	1%	98.7%	
Wt. Dry+Tare		1,250	0.0469	1.25	12.1	2%	97.9%	
Tare		630	0.0234	0.63	20.1	3%	96.5%	
Wt. Dry		315	0.0116	0.315	42.7	7%	92.6%	
Tare No.		160	0.0059	0.160	103.8	18%	81.9%	
		75	0.00295	0.075	178.6	31%	68.9%	
		PAN						

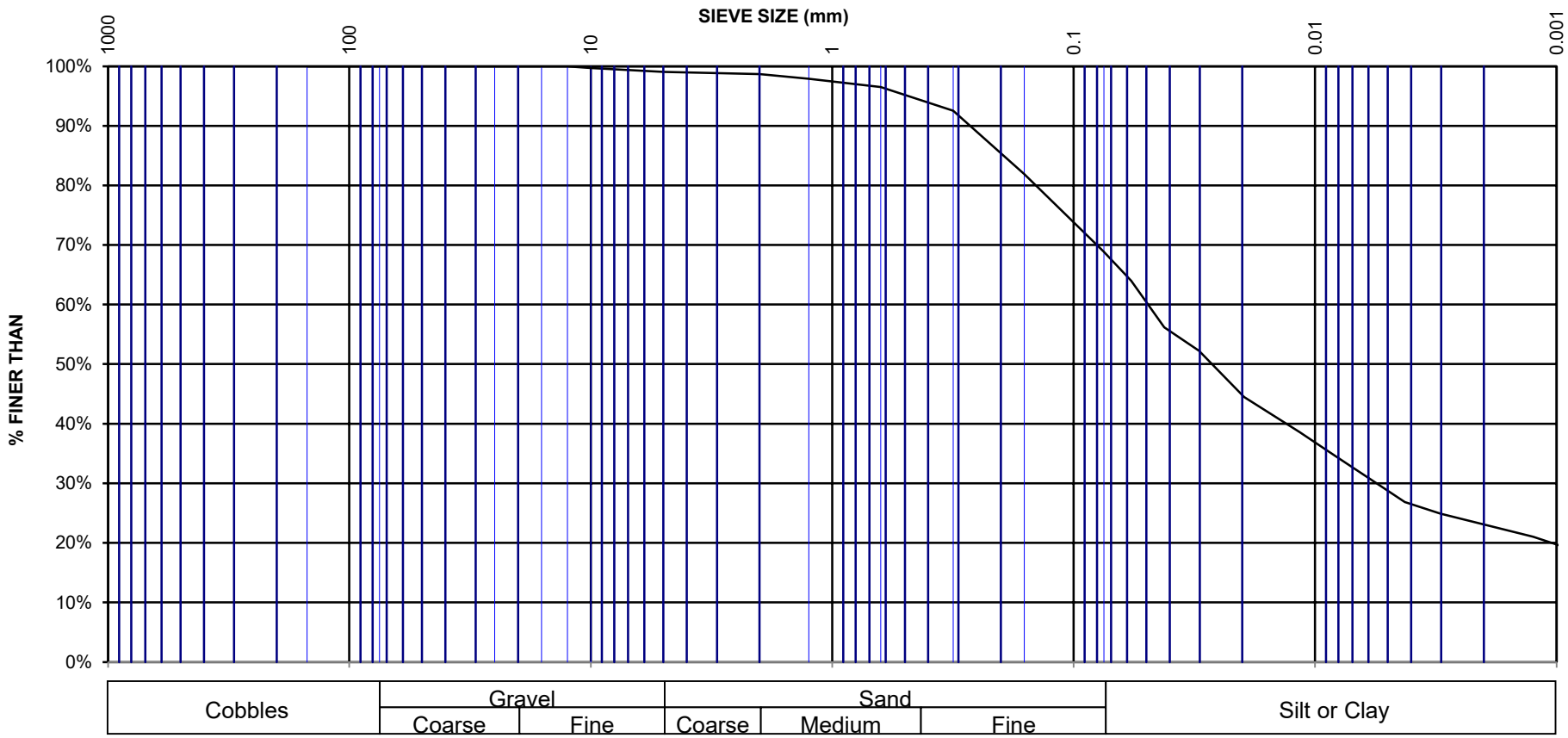
HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	673.7	36	0.5	0.058	25	33	64.0%	
Wt Tare	100.0	32	1	0.042	25	29	56.2%	
Wt Dry	573.7	30	2	0.030	25	27	52.3%	
Sample Size :	50	26	5	0.020	25	23	44.4%	
Wt Retained 2 mm:	7.6	23	15	0.012	25	20	38.6%	
% Passing 2 mm:	98.7%	21	30	0.008	25	18	34.7%	
Specific Gravity :	2.70	19	60	0.006	25	16	30.8%	
Hydrometer No.:	43-9856	17	120	0.004	25	14	26.9%	
Solution (g/L) :	40	16	240	0.003	25	13	24.9%	
		14	1440	0.001	25	11	21.0%	
		13	2880	0.001	25	10	19.0%	

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	20
TESTHOLE:	22-02	DEPTH :	
DATE :	July 20, 2022	TECHNICIAN :	GU

Gravel = 0.9% **Sand = 30.2%** **Silt = 45.9%** **Clay = 23.0%**



FORM: MacKinnon TH22-02 #20 Hydro.xls
DATE: 7/22/2022

ATTERBERG LIMITS (ASTM D4318)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

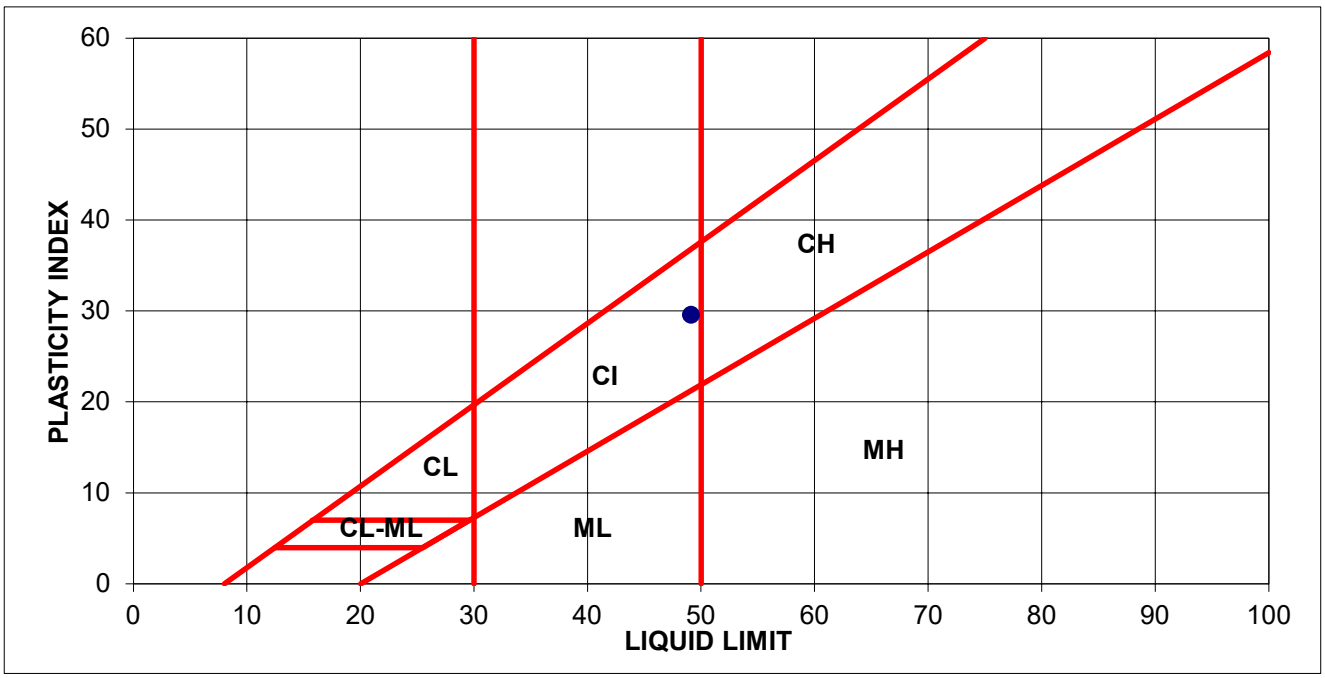
CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	5
TESTHOLE:	22-03	DEPTH:	
DATE :	June 23, 2022	TECHNICIAN :	GU

LIQUID LIMIT						
Trial No.	1					
Number of Blows	20					
Container Number						
Wt. Sample (wet+tare)(g)	55.87					
Wt. Sample (dry+tare)(g)	42.54					
Wt. Tare (g)	16.12					
Wt. Dry Soil (g)	26.4					
Wt. Water (g)	13.3					
Water Content (%)	50.5%					

AVERAGE VALUES	
Liquid Limit	49.1
Plastic Limit	19.5
Plasticity Index	29.6

SAMPLE DESCRIPTION	
Classification:	**CI**

PLASTIC LIMIT				
Trial No.	1			
Container Number				
Wt. Sample (wet+tare)(g)	28.49			
Wt. Sample (dry+tare)(g)	25.76			
Wt. Tare (g)	11.77			
Wt. Dry Soil (g)	14.0			
Wt. Water (g)	2.7			
Water Content (%)	19.5%			



FORM: MacKinnon TH22-03 #5 Atterberg.xls
DATE: 6/24/2022

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	5
TESTHOLE:	22-03	DEPTH :	
DATE :	May 20, 2022	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	562.3	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	462.3	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0		0%	100%	
Wet + Tare		16,000	5/8	16.0		0%	100%	
Dry+Tare		12,500	1/2	12.5		0%	100%	
Tare		10,000	3/8	10.0		0%	100%	
MC (%)		5,000	0.185	5.0		0%	100%	
	Passing							
After Washing		2,000	0.0937	2.0		0%	100%	
Wt. Dry+Tare		1,250	0.0469	1.25		0%	100%	
Tare		630	0.0234	0.63		0%	100%	
Wt. Dry		315	0.0116	0.315	0.9	0%	99.8%	
Tare No.		160	0.0059	0.160	1.8	0%	99.6%	
		75	0.00295	0.075	2.8	1%	99.4%	
		PAN						

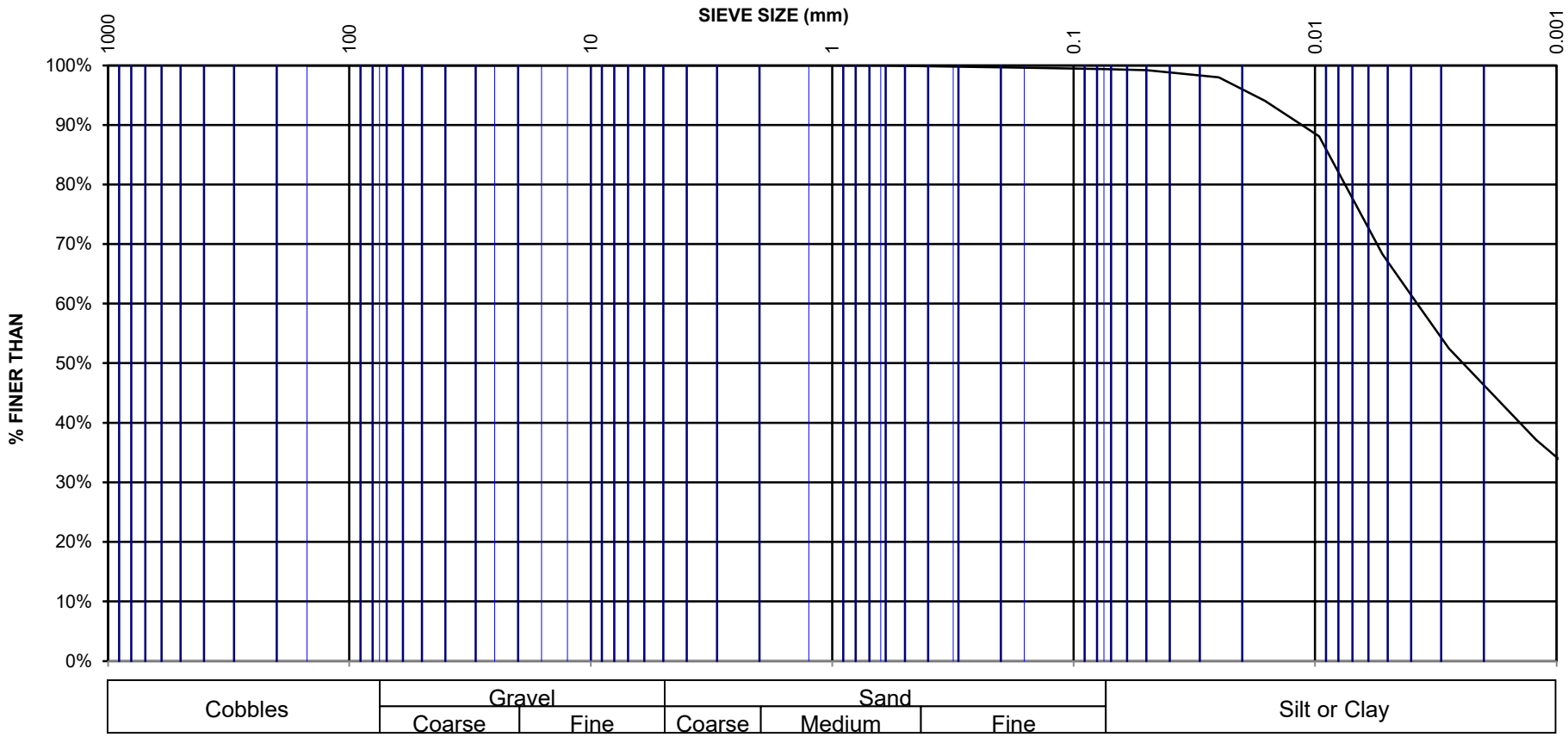
HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	562.3	54	0.5	0.050	24	50	99.2%	
Wt Tare	100.0	53	1	0.035	24	50	98.6%	
Wt Dry	462.3	53	2	0.025	24	50	98.0%	
Sample Size :	50	51	5	0.016	24	48	94.1%	
Wt Retained 2 mm:	0.0	48	15	0.010	24	45	88.1%	
% Passing 2 mm:	100.0%	43	30	0.007	24	40	78.2%	
Specific Gravity :	2.70	38	60	0.005	24	35	68.3%	
Hydrometer No.:	43-9856	34	120	0.004	24	31	60.4%	
Solution (g/L) :	40	30	240	0.003	24	27	52.5%	
		23	1440	0.001	23	19	37.1%	
		20	2880	0.001	23	16	32.2%	

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	5
TESTHOLE:	22-03	DEPTH :	
DATE :	May 20, 2022	TECHNICIAN :	GU

Gravel = 0.0% **Sand = 0.6%** **Silt = 54.6%** **Clay = 44.8%**



FORM: MacKinnon TH22-03 #5 Hydro.xls
DATE: 6/24/2022

ATTERBERG LIMITS (ASTM D4318)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	11
TESTHOLE:	22-03	DEPTH:	
DATE :	June 23, 2022	TECHNICIAN :	GU

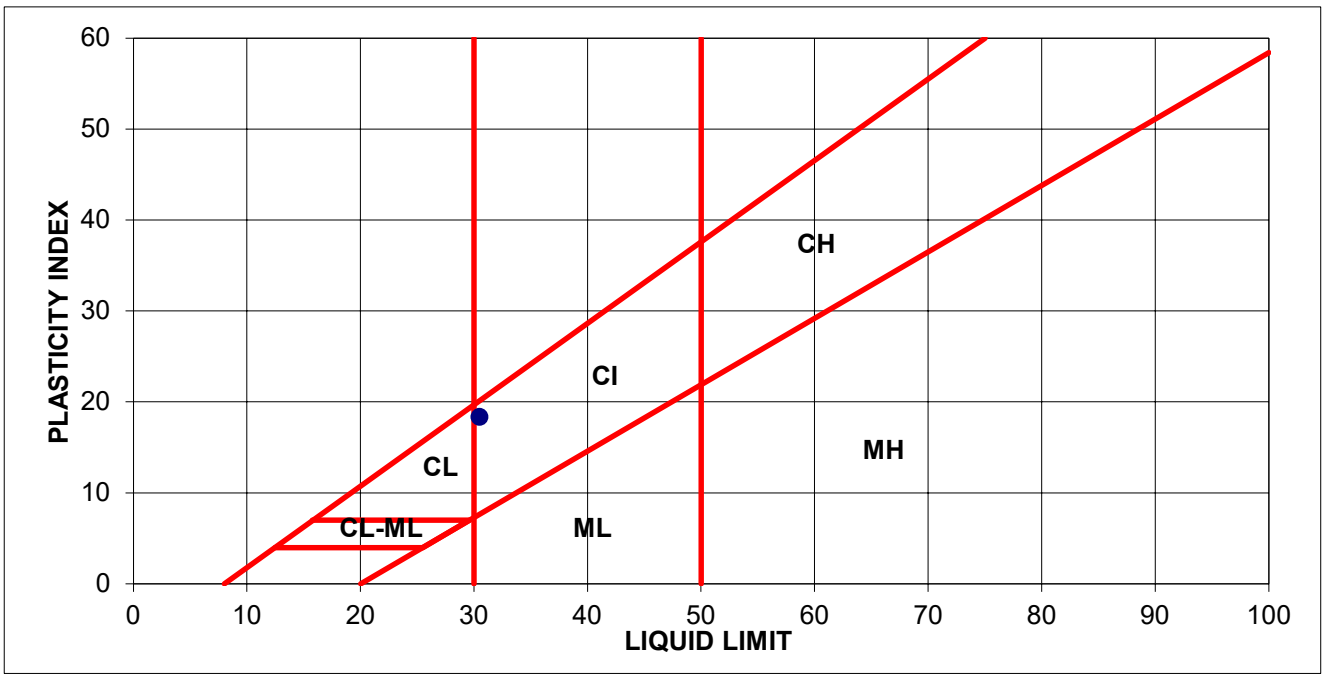
LIQUID LIMIT						
Trial No.	1					
Number of Blows	27					
Container Number						
Wt. Sample (wet+tare)(g)	62.49					
Wt. Sample (dry+tare)(g)	51.76					
Wt. Tare (g)	16.23					
Wt. Dry Soil (g)	35.5					
Wt. Water (g)	10.7					
Water Content (%)	30.2%					

AVERAGE VALUES	
Liquid Limit	30.5
Plastic Limit	12.1
Plasticity Index	18.3

SAMPLE DESCRIPTION

Classification: **CI-CL**

PLASTIC LIMIT				
Trial No.	1			
Container Number				
Wt. Sample (wet+tare)(g)	31.53			
Wt. Sample (dry+tare)(g)	29.38			
Wt. Tare (g)	11.67			
Wt. Dry Soil (g)	17.7			
Wt. Water (g)	2.2			
Water Content (%)	12.1%			



FORM: MacKinnon TH22-03 #11 Atterberg.xls
DATE: 6/24/2022

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	11
TESTHOLE:	22-03	DEPTH :	
DATE :	May 20, 2022	TECHNICIAN :	GU

TOTAL DRY WEIGHT OF SAMPLE		SIEVE NO. (μm)	SIZE OF OPENING APPROX. INCHES	SIZE OF OPENING mm	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT FINER THAN	REMARKS
Before Washing		150,000	6	150.0		0%	100%	
Wet + Tare		75,000	3	75.0		0%	100%	
Dry+Tare	672.9	50,000	2	50.0		0%	100%	
Tare	100.0	40,000	1 1/2	40.0		0%	100%	
Wt. Dry	572.9	25,000	1	25.0		0%	100%	
Moisture Content		20,000	3/4	20.0	20.3	4%	96.5%	
Wet + Tare		16,000	5/8	16.0	20.3	4%	96.5%	
Dry+Tare		12,500	1/2	12.5	20.3	4%	96.5%	
Tare		10,000	3/8	10.0	22.5	4%	96.1%	
MC (%)		5,000	0.185	5.0	23.7	4%	95.9%	
	Passing							
After Washing		2,000	0.0937	2.0	27.1	5%	95.3%	
Wt. Dry+Tare		1,250	0.0469	1.25	35.8	6%	93.7%	
Tare		630	0.0234	0.63	53.3	9%	90.7%	
Wt. Dry		315	0.0116	0.315	98.1	17%	82.9%	
Tare No.		160	0.0059	0.160	166.8	29%	70.9%	
		75	0.00295	0.075	237.8	42%	58.5%	
		PAN						

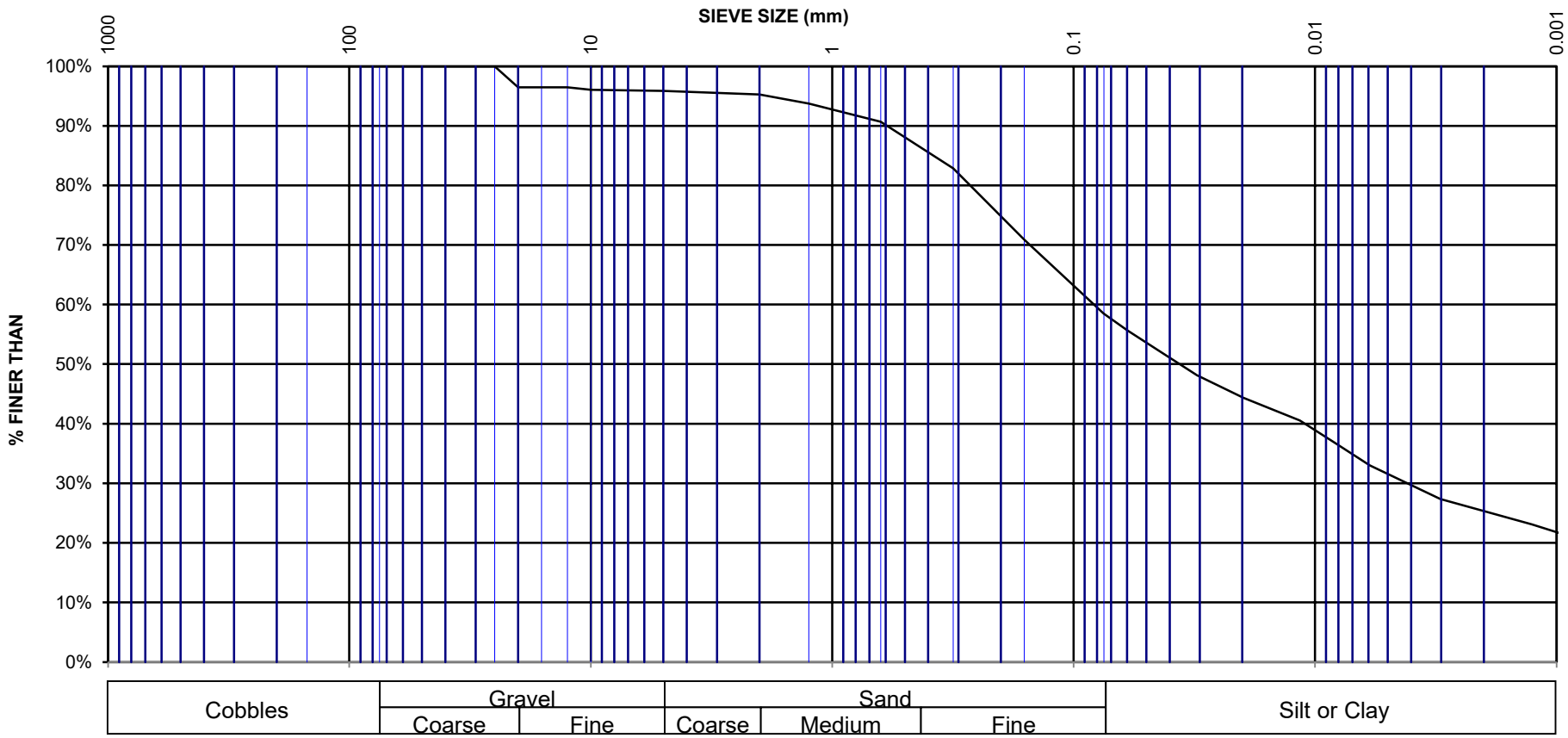
HYDROMETER DATA		READING	TIME (min)	DIAMETER (mm)	TEMP. (°C)	CORR. READING	PERCENT FINER THAN	REMARKS
Wt Dry+Tare	672.9	33	0.5	0.060	24	30	55.6%	
Wt Tare	100.0	31	1	0.043	24	28	51.9%	
Wt Dry	572.9	29	2	0.031	24	26	48.1%	
Sample Size :	50	27	5	0.020	24	24	44.3%	
Wt Retained 2 mm:	27.1	25	15	0.012	24	22	40.6%	
% Passing 2 mm:	95.3%	23	30	0.008	24	20	36.8%	
Specific Gravity :	2.70	21	60	0.006	24	18	33.0%	
Hydrometer No.:	43-9856	20	120	0.004	24	16	30.2%	
Solution (g/L) :	40	18	240	0.003	24	15	27.4%	
		16	1440	0.001	23	12	23.1%	
		15	2880	0.001	23	11	21.2%	

GRAIN SIZE ANALYSIS (ASTM D422)

AECOM
AECOM Canada Ltd.
Materials Testing Lab
Bay#14-1511 Highfield Cres.SE
Calgary, Alberta T2G 5M4

CLIENT :	City of Edmonton		
PROJECT :	MacKinnon Bridge		
JOB No. :	60682118		
LOCATION :		SAMPLE:	11
TESTHOLE:	22-03	DEPTH :	
DATE :	May 20, 2022	TECHNICIAN :	GU

Gravel = 4.1% **Sand = 37.4%** **Silt = 33.3%** **Clay = 25.2%**



FORM: MacKinnon TH22-03 #11 Hydro.xls
DATE: 6/24/2022

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **CG2209439**	Page	: 1 of 3
Client	: **AECOM Canada Ltd.**	Laboratory	: Calgary - Environmental
Contact	: Chris Keeley	Account Manager	: Kiazitako Muanza
Address	: Suite 300,. 48 Quarry Park Blvd. SE Calgary AB Canada T2C 5P2	Address	: 2559 29th Street NE Calgary AB Canada T1Y 7B5
Telephone	: 403 254 3301	Telephone	: +1 403 407 1800
Project	: CITY OF EDMONTON - MACKINNON BRIDGE	Date Samples Received	: 19-Jul-2022 15:00
PO	: 60682118	Date Analysis Commenced	: 22-Jul-2022
C-O-C number	: ----	Issue Date	: 25-Jul-2022 17:15
Sampler	: ----		
Site	:		
Quote number	: 2022 Price List - Prairies		
No. of samples received	: 1		
No. of samples analysed	: 1		

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*
Alex Drake	Lab Analyst	Inorganics, Edmonton, Alberta
Anthony Calero	Team Leader - Inorganics	Inorganics, Calgary, Alberta
Anthony Calero	Team Leader - Inorganics	Metals, Calgary, Alberta
Harneet Kaur	Lab Assistant	Inorganics, Calgary, Alberta
Ruifang Zheng	Analyst	Inorganics, Calgary, Alberta
Shirley Li		Metals, Calgary, Alberta
Vishnu Patel		Inorganics, Calgary, Alberta

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
dS/m	decisiemens per metre
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
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.

Analytical Results

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

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	----	----	----	----
					Client sampling date / time	19-Jul-2022	----	----	----	----
						CG2209439-001	--------	--------	--------	--------
						Result	----	----	----	----
Physical Tests										
pH (1:2 soil:CaCl2-aq)	----	E108B	0.10	pH units		7.99	----	----	----	----
pH, saturated paste	----	E114	0.10	pH units		8.27	----	----	----	----
Inorganic Parameters										
sulfate, total, ion content	14808-79-8	E246.SO4	0.050	%		<0.050	----	----	----	----
sulfate, soluble ion content	14808-79-8	E246A.SO4	0.05	%		NR	----	----	----	----
Saturated Paste Extractables										
conductivity, saturated paste	----	E102	0.010	dS/m		1.22	----	----	----	----
resistivity	----	E131	1.0	ohm cm		1850	----	----	----	----
sodium adsorption ratio [SAR]	----	EC102	0.10	-		1.69	----	----	----	----
sulfate, soluble ion content	14808-79-8	E239.SO4	5.0	mg/L		466	----	----	----	----
% saturation	----	E141	1.0	%		48.7	----	----	----	----
chloride, soluble ion content	16887-00-6	E239.Cl	20	mg/L		<40	----	----	----	----
calcium, soluble ion content	7440-70-2	EC485	5.0	mg/kg		56.5	----	----	----	----
calcium, soluble ion content	7440-70-2	E485	5.0	mg/L		116	----	----	----	----
magnesium, soluble ion content	7439-95-4	EC485	5.0	mg/kg		12.3	----	----	----	----
magnesium, soluble ion content	7439-95-4	E485	5.0	mg/L		25.3	----	----	----	----
potassium, soluble ion content	7440-09-7	EC485	5.0	mg/kg		9.6	----	----	----	----
potassium, soluble ion content	7440-09-7	E485	5.0	mg/L		19.7	----	----	----	----
sodium, soluble ion content	17341-25-2	EC485	5.0	mg/kg		37.6	----	----	----	----
sodium, soluble ion content	17341-25-2	E485	5.0	mg/L		77.2	----	----	----	----
chloride, soluble ion content	16887-00-6	EC266A.Cl	10	mg/kg		14	----	----	----	----
chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L		28	----	----	----	----
sulfur (as SO4), soluble ion content	14808-79-8	EC485	8.0	mg/kg		226	----	----	----	----
sulfur (as SO4), soluble ion content	14808-79-8	E485	6.0	mg/L		464	----	----	----	----

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

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **CG2209439**	Page	: 1 of 7
Client	: **AECOM Canada Ltd.**	Laboratory	: Calgary - Environmental
Contact	: Chris Keeley	Account Manager	: Kiazitako Muanza
Address	: Suite 300,. 48 Quarry Park Blvd. SE Calgary AB Canada T2C 5P2	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 254 3301	Telephone	: +1 403 407 1800
Project	: CITY OF EDMONTON - MACKINNON BRIDGE	Date Samples Received	: 19-Jul-2022 15:00
PO	: 60682118	Issue Date	: 25-Jul-2022 17:15
C-O-C number	: ----		
Sampler	: ----		
Site	:		
Quote number	: 2022 Price List - Prairies		
No. of samples received	: 1		
No. of samples analysed	: 1		

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 Matrix Spike 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

- Quality Control Sample Frequency Outliers occur - please see following pages for full details.

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 : Soluble Sulfate ion in soil by boiling water extraction, IC.										
LDPE bag COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E246A.SO4	19-Jul-2022	25-Jul-2022	180 days	7 days	✓	25-Jul-2022	28 days	0 days	✓
Inorganic Parameters : Total Sulfate ion in soil by acidic boiling water extraction, IC										
LDPE bag COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E246.SO4	19-Jul-2022	25-Jul-2022	180 days	7 days	✓	25-Jul-2022	28 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)										
LDPE bag COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E108B	19-Jul-2022	22-Jul-2022	----	----		22-Jul-2022	30 days	0 days	✓
Physical Tests : pH by Meter (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E114	19-Jul-2022	----	----	----		22-Jul-2022	365 days	4 days	✓
Saturated Paste Extractables : Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E485	19-Jul-2022	----	----	----		22-Jul-2022	180 days	4 days	✓
Saturated Paste Extractables : Chloride by Colourimetry (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E266.Cl	19-Jul-2022	----	----	----		22-Jul-2022	365 days	4 days	✓
Saturated Paste Extractables : Chloride by IC (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E239.Cl	19-Jul-2022	----	----	----		22-Jul-2022	365 days	3 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
Saturated Paste Extractables : Conductivity in Soil (Saturated Paste)										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E102	19-Jul-2022	----	----	----		22-Jul-2022	365 days	4 days	✓
Saturated Paste Extractables : Resistivity by Electrode (Saturated Paste)										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E131	19-Jul-2022	----	----	----		22-Jul-2022	----	----	
Saturated Paste Extractables : Saturation Percentage										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E141	19-Jul-2022	----	----	----		22-Jul-2022	----	0 days	
Saturated Paste Extractables : Sulfate by IC (Saturated Paste)										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	E239.SO4	19-Jul-2022	----	----	----		22-Jul-2022	365 days	3 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)							
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485	573215	1	1	100.0	5.0	✓
Chloride by Colourimetry (Saturated Paste)	E266.Cl	573217	1	1	100.0	5.0	✓
Chloride by IC (Saturated Paste)	E239.Cl	573214	1	5	20.0	5.0	✓
Conductivity in Soil (Saturated Paste)	E102	573216	1	1	100.0	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)	E108B	573384	1	2	50.0	5.0	✓
pH by Meter (Saturated Paste)	E114	573213	1	5	20.0	5.0	✓
Resistivity by Electrode (Saturated Paste)	E131	573208	1	5	20.0	5.0	✓
Saturation Percentage	E141	573211	1	5	20.0	5.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	576099	0	1	0.0	5.0	✗
Sulfate by IC (Saturated Paste)	E239.SO4	573212	1	5	20.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	575968	1	1	100.0	5.0	✓
Laboratory Control Samples (LCS)							
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485	573215	2	1	200.0	10.0	✓
Chloride by Colourimetry (Saturated Paste)	E266.Cl	573217	2	1	200.0	10.0	✓
Chloride by IC (Saturated Paste)	E239.Cl	573214	1	5	20.0	5.0	✓
Conductivity in Soil (Saturated Paste)	E102	573216	2	1	200.0	10.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)	E108B	573384	2	2	100.0	10.0	✓
pH by Meter (Saturated Paste)	E114	573213	2	5	40.0	10.0	✓
Resistivity by Electrode (Saturated Paste)	E131	573208	2	5	40.0	10.0	✓
Saturation Percentage	E141	573211	2	5	40.0	10.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	576099	2	1	200.0	10.0	✓
Sulfate by IC (Saturated Paste)	E239.SO4	573212	1	5	20.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	575968	2	1	200.0	10.0	✓
Method Blanks (MB)							
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485	573215	1	1	100.0	5.0	✓
Chloride by Colourimetry (Saturated Paste)	E266.Cl	573217	1	1	100.0	5.0	✓
Chloride by IC (Saturated Paste)	E239.Cl	573214	1	5	20.0	5.0	✓
Conductivity in Soil (Saturated Paste)	E102	573216	1	1	100.0	5.0	✓
Saturation Percentage	E141	573211	1	5	20.0	5.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	576099	1	1	100.0	5.0	✓
Sulfate by IC (Saturated Paste)	E239.SO4	573212	1	5	20.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	575968	1	1	100.0	5.0	✓
Matrix Spikes (MS)							
Chloride by IC (Saturated Paste)	E239.Cl	573214	1	5	20.0	5.0	✓
Sulfate by IC (Saturated Paste)	E239.SO4	573212	1	5	20.0	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 (Saturated Paste)	E102 Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)/AER D50	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a filtered extract from a soil sample prepared using the saturated paste procedure. Conductivity measurements are temperature-compensated to 25°C.
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)	E108B Calgary - Environmental	Soil/Solid	CSSS (2008) 16.3	A 10g portion of dried (<60°C) and ground (10 mesh/2 mm) sample 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.
pH by Meter (Saturated Paste)	E114 Calgary - Environmental	Soil/Solid	Carter-CSSS / APHA 4500 H	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) on a soil produced by the saturated paste extraction procedure.
Resistivity by Electrode (Saturated Paste)	E131 Calgary - Environmental	Soil/Solid	ASTM G57-95A (mod)	Resistivity is determined on a soil sample that has been mixed with deionized water to create a saturated paste, which is then placed directly into a four electrode resistivity soil box and measured for resistivity using a resistivity meter.
Saturation Percentage	E141 Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/AER D50	Saturation Percentage (SP) is determined as the total volume of water present in a saturated paste (in mL) divided by the dry weight of the sample (in grams), expressed as a percentage.
Chloride by IC (Saturated Paste)	E239.Cl Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/EPA 300.1 (mod)	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by Ion Chromatography with conductivity and/or UV detection.
Sulfate by IC (Saturated Paste)	E239.SO4 Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/EPA 300.1 (mod)	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by Ion Chromatography with conductivity and/or UV detection.
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4 Edmonton - Environmental	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis by IC with conductivity detector.
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4 Edmonton - Environmental	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water at a specified ratio then heated. After filtration the liquid is ready for analysis by IC with conductivity detector. A result of "NR" indicates that the total sulfate analysis was <0.2% and based on CSA-A23.2-3B no analysis for soluble sulfate is required.
Chloride by Colourimetry (Saturated Paste)	E266.Cl Calgary - Environmental	Soil/Solid	CSSS Ch. 15/APHA 4500-CL E (mod)/AER D50	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by colourimetry using a discrete analyzer.
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485 Calgary - Environmental	Soil/Solid	CSSS CH15/EPA 6010B/AER D50	A soil extract produced by the saturated paste extraction procedure is analyzed for Calcium, Magnesium, Potassium, Sodium, Boron, and Sulfur (as SO4) by ICPOES.
Sodium Adsorption Ratio (SAR) Saturated Paste	EC102 Calgary - Environmental	Soil/Solid	CCME Sodium Adsorption Ratio (SAR)	The Sodium Adsorption Ratio (SAR) for a sample is calculated from the Sodium, Calcium, and Magnesium concentrations from sediment paste extract.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Chloride by Colourimetry (Saturated Paste) (mg/kg)	EC266A.Cl Calgary - Environmental	Soil/Solid	CSSS Ch. 15/APHA 4500-CL E (mod)	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by colourimetry using a discrete analyzer.
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste) (mg/kg)	EC485 Calgary - Environmental	Soil/Solid	CSSS CH15/EPA 6010B	A soil extract produced by the saturated paste extraction procedure is analyzed for Calcium, Magnesium, Potassium, Sodium, Boron, and Sulfur (as SO4) by ICPOES. Results are calculated in mg/kg using Saturation Percentage.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil : 0.01CaCl2	EP108B Calgary - Environmental	Soil/Solid	CSSS (2008) 16.3	A 10g portion of dried (<60°C) and ground (10 mesh/2 mm) sample 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.
Soluble ion Sulfate in soil or concrete preparation.	EP246.S Edmonton - Environmental	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water then heated. After filtration the liquid is ready for analysis.
Total ion Sulfate in soil or concrete preparation	EP246.T Edmonton - Environmental	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis.

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **CG2209439**	Page	: 1 of 7
Client	: AECOM Canada Ltd.	Laboratory	: Calgary - Environmental
Contact	: Chris Keeley	Account Manager	: Kiazitako Muanza
Address	: Suite 300,. 48 Quarry Park Blvd. SE Calgary AB Canada T2C 5P2	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 254 3301	Telephone	: +1 403 407 1800
Project	: CITY OF EDMONTON - MACKINNON BRIDGE	Date Samples Received	: 19-Jul-2022 15:00
PO	: 60682118	Date Analysis Commenced	: 22-Jul-2022
C-O-C number	: ----	Issue Date	: 25-Jul-2022 17:15
Sampler	: ----		
Site	:		
Quote number	: 2022 Price List - Prairies		
No. of samples received	: 1		
No. of samples analysed	: 1		

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
- Matrix Spike (MS) Report; Recovery 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*
Alex Drake	Lab Analyst	Edmonton Inorganics, Edmonton, Alberta
Anthony Calero	Team Leader - Inorganics	Calgary Inorganics, Calgary, Alberta
Anthony Calero	Team Leader - Inorganics	Calgary Metals, Calgary, Alberta
Harneet Kaur	Lab Assistant	Calgary Inorganics, Calgary, Alberta
Ruifang Zheng	Analyst	Calgary Inorganics, Calgary, Alberta
Shirley Li		Calgary Metals, Calgary, Alberta
Vishnu Patel		Calgary Inorganics, Calgary, Alberta

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: 573384)											
CG2209439-001	COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	pH (1:2 soil:CaCl2-aq)	----	E108B	0.10	pH units	7.99	8.01	0.250%	5%	----
Inorganic Parameters (QC Lot: 575968)											
CG2209439-001	COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	<0.050 %	<500	0	Diff <2x LOR	----
Saturated Paste Extractables (QC Lot: 573208)											
CG2209326-001	Anonymous	resistivity	----	E131	1.0	ohm cm	7500	7590	1.19%	20%	----
Saturated Paste Extractables (QC Lot: 573211)											
CG2209326-001	Anonymous	% saturation	----	E141	1.0	%	54.0	49.5	8.56%	20%	----
Saturated Paste Extractables (QC Lot: 573212)											
CG2209326-001	Anonymous	sulfate, soluble ion content	14808-79-8	E239.SO4	5.0	mg/L	57.2	52.2	9.28%	30%	----
Saturated Paste Extractables (QC Lot: 573213)											
CG2209326-001	Anonymous	pH, saturated paste	----	E114	0.10	pH units	8.44	8.46	0.237%	5%	----
Saturated Paste Extractables (QC Lot: 573214)											
CG2209326-001	Anonymous	chloride, soluble ion content	16887-00-6	E239.Cl	20	mg/L	<20	<20	0	Diff <2x LOR	----
Saturated Paste Extractables (QC Lot: 573215)											
CG2209439-001	COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	calcium, soluble ion content	7440-70-2	E485	5.0	mg/L	116	127	9.22%	30%	----
		magnesium, soluble ion content	7439-95-4	E485	5.0	mg/L	25.3	27.7	2.3	Diff <2x LOR	----
		potassium, soluble ion content	7440-09-7	E485	5.0	mg/L	19.7	21.8	2.1	Diff <2x LOR	----
		sodium, soluble ion content	17341-25-2	E485	5.0	mg/L	77.2	84.6	9.15%	30%	----
		sulfur (as SO4), soluble ion content	14808-79-8	E485	6	mg/L	464	491	5.64%	30%	----
Saturated Paste Extractables (QC Lot: 573216)											
CG2209439-001	COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	conductivity, saturated paste	----	E102	10	µS/cm	1.22 dS/m	1230	0.898%	20%	----
Saturated Paste Extractables (QC Lot: 573217)											
CG2209439-001	COE - MACKINNON BRIDGE - TH22-02 #7 @ 4.55m	chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L	28	28	0.04	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
Inorganic Parameters (QCLot: 575968)						
sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	<500	----
Inorganic Parameters (QCLot: 576099)						
sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	NR	----
Saturated Paste Extractables (QCLot: 573211)						
% saturation	----	E141	1	%	<1.0	----
Saturated Paste Extractables (QCLot: 573212)						
sulfate, soluble ion content	14808-79-8	E239.SO4	5	mg/L	<5.0	----
Saturated Paste Extractables (QCLot: 573214)						
chloride, soluble ion content	16887-00-6	E239.Cl	20	mg/L	<20	----
Saturated Paste Extractables (QCLot: 573215)						
calcium, soluble ion content	7440-70-2	E485	5	mg/L	<5.0	----
magnesium, soluble ion content	7439-95-4	E485	5	mg/L	<5.0	----
potassium, soluble ion content	7440-09-7	E485	5	mg/L	<5.0	----
sodium, soluble ion content	17341-25-2	E485	5	mg/L	<5.0	----
sulfur (as SO4), soluble ion content	14808-79-8	E485	6	mg/L	<6.0	----
Saturated Paste Extractables (QCLot: 573216)						
conductivity, saturated paste	----	E102	10	µS/cm	<10	----
Saturated Paste Extractables (QCLot: 573217)						
chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L	<20	----

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: 573384)									
pH (1:2 soil:CaCl2-aq)	----	E108B	----	pH units	7 pH units	100	97.0	103	----
Inorganic Parameters (QCLot: 575968)									
sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	10000 mg/kg	95.1	70.0	130	----
Saturated Paste Extractables (QCLot: 573208)									
resistivity	----	E131	----	ohm cm	9674 ohm cm	114	70.0	130	----
Saturated Paste Extractables (QCLot: 573211)									
% saturation	----	E141	1	%	100 %	105	90.0	110	----
Saturated Paste Extractables (QCLot: 573212)									
sulfate, soluble ion content	14808-79-8	E239.SO4	5	mg/L	100 mg/L	97.8	80.0	120	----
Saturated Paste Extractables (QCLot: 573213)									
pH, saturated paste	----	E114	----	pH units	7 pH units	100	97.0	103	----
Saturated Paste Extractables (QCLot: 573214)									
chloride, soluble ion content	16887-00-6	E239.Cl	20	mg/L	100 mg/L	99.4	80.0	120	----
Saturated Paste Extractables (QCLot: 573215)									
calcium, soluble ion content	7440-70-2	E485	5	mg/L	50 mg/L	100	80.0	120	----
magnesium, soluble ion content	7439-95-4	E485	5	mg/L	50 mg/L	100	80.0	120	----
potassium, soluble ion content	7440-09-7	E485	5	mg/L	50 mg/L	105	80.0	120	----
sodium, soluble ion content	17341-25-2	E485	5	mg/L	50 mg/L	103	80.0	120	----
sulfur (as SO4), soluble ion content	14808-79-8	E485	6	mg/L	150 mg/L	93.9	80.0	120	----
Saturated Paste Extractables (QCLot: 573216)									
conductivity, saturated paste	----	E102	10	µS/cm	146.9 µS/cm	102	80.0	120	----
Saturated Paste Extractables (QCLot: 573217)									
chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L	100 mg/L	91.8	70.0	130	----

Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: **Soil/Solid**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Saturated Paste Extractables (QCLot: 573212)										
CG2209326-002	Anonymous	sulfate, soluble ion content	14808-79-8	E239.SO4	9210 mg/L	10000 mg/L	92.1	60.0	140	----
Saturated Paste Extractables (QCLot: 573214)										
CG2209326-002	Anonymous	chloride, soluble ion content	16887-00-6	E239.Cl	9590 mg/L	10000 mg/L	95.9	60.0	140	----

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: 573384)									
	RM	pH (1:2 soil:CaCl2-aq)	----	E108B	7.74 pH units	98.4	96.0	104	----
Inorganic Parameters (QCLot: 575968)									
	RM	sulfate, total, ion content	14808-79-8	E246.SO4	33400 mg/kg	86.4	80.0	120	----
Saturated Paste Extractables (QCLot: 573208)									
	RM	resistivity	----	E131	600 ohm cm	108	70.0	130	----
Saturated Paste Extractables (QCLot: 573211)									
	RM	% saturation	----	E141	48.3 %	110	80.0	120	----
Saturated Paste Extractables (QCLot: 573213)									
	RM	pH, saturated paste	----	E114	7.59 pH units	100	96.0	104	----
Saturated Paste Extractables (QCLot: 573215)									
	RM	calcium, soluble ion content	7440-70-2	E485	776 mg/L	96.2	70.0	130	----
	RM	magnesium, soluble ion content	7439-95-4	E485	261 mg/L	96.2	70.0	130	----
	RM	potassium, soluble ion content	7440-09-7	E485	111 mg/L	103	70.0	130	----
	RM	sodium, soluble ion content	17341-25-2	E485	330 mg/L	102	70.0	130	----
	RM	sulfur (as SO4), soluble ion content	14808-79-8	E485	1841 mg/L	95.2	70.0	130	----
Saturated Paste Extractables (QCLot: 573216)									
	RM	conductivity, saturated paste	----	E102	5970 µS/cm	102	80.0	120	----
Saturated Paste Extractables (QCLot: 573217)									
	RM	chloride, soluble ion content	16887-00-6	E266.Cl	1237 mg/L	95.0	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number: 14 -

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	AECOM Canada Ltd. (acct# 10482)	Select Report Format:	☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)	R ☐ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Chris Keeley	Quality Control (QC) Report with Report	☑ Yes ☐ No	P ☑ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	48 Quarry Park Blvd. SE, Suite 300 Calgary, AB T2C 5P2	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
Phone:	403.254.3301	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
		Email 1 or Fax	Chris.Keeley@aecom.com	Specify Date Required for E2,E or P:
		Email 2	usman.raja@aecom.com	

Invoice To		Invoice Distribution	
	Same as Report To ☐ Yes ☑ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☐ Yes ☑ No	Email 1 or Fax	Kristen.Tackney@aecom.com
Company:	AECOM Canada Ltd.	Email 2	canssc.e-billing@aecom.com
Contact:	Kristen.Tackney@aecom.com		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	AECO100	Approver ID:	Cost Center:
Job #:	City of Edmonton - MacKinnon Bridge	GL Account:	Routing Code:
PO / AFE:	60682118	Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Lovepreet Kaur **Sampler:** N/A

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	CL-PASTE-COL-CL	PH-PASTE-CL	RESISTIVITY-PASTE-CL	SAL-MG/KG-CALC-CL	SAT-PCNT-CL	SO4-PASTE-ICP-CL	SO4-S-CSA-A23-ED	SO4-T-CSA-A23-ED	Number of Containers
	COE - MacKinnon Bridge - TH22-02 #7 @4.55m	19-Jul-22	-	Soil	R	R	R	R	R	R	R	R	1

Environmental Division
Calgary
Work Order Reference
CG2209439

Telephone : +1 403 407 1800

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No Are samples for human drinking water use? ☐ Yes ☐ No	Analysis requested - pH, Chlorine Content, Resistivity and Sulphate Content. Please report sulphate results in % for SO4-T/S CSA method and results in mg/L for SO4 via paste, salinity package. Please report resistivity in ohm-cm. Please report chlorides in mg/kg & mg/L.

SAMPLE CON

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice packs Yes ☐ No ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Keeley	Date: Jul 19/22	Time: 14:30	Received by:	Date:	Time:	Received by:	Date: 02 Feb	Time: 3:00PM

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

ALS Form 0126-606 Front/04 January 2014

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**.

28°C

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **CG2207927**	Page	: 1 of 3
Client	: **AECOM Canada Ltd.**	Laboratory	: Calgary - Environmental
Contact	: Chris Keeley	Account Manager	: Kiazitako Muanza
Address	: Suite 300,. 48 Quarry Park Blvd. SE Calgary AB Canada T2C 5P2	Address	: 2559 29th Street NE Calgary AB Canada T1Y 7B5
Telephone	: 403 254 3301	Telephone	: +1 403 407 1800
Project	: CITY OF EDMONTON - MACKINNON BRIDGE	Date Samples Received	: 21-Jun-2022 12:30
PO	: 60682118	Date Analysis Commenced	: 23-Jun-2022
C-O-C number	: ----	Issue Date	: 17-Jul-2022 11:32
Sampler	: ----		
Site	: 2022 Price List - Prairies		
Quote number	: 2022 Price List - Prairies		
No. of samples received	: 1		
No. of samples analysed	: 1		

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*
Kuljeet Chawla		Inorganics, Calgary, Alberta
Ping Yeung	Team Leader - Inorganics	Inorganics, Edmonton, Alberta
Ruifang Zheng	Analyst	Inorganics, Calgary, Alberta
Sara Niroomand		Inorganics, Calgary, Alberta
Sara Niroomand		Metals, Calgary, Alberta
Shirley Li		Metals, Calgary, Alberta
Vishnu Patel		Inorganics, Calgary, Alberta

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
dS/m	decisiemens per metre
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
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.

Qualifiers

Qualifier	*Description*
DLDS	*Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.*
RRV	*Reported result verified by repeat analysis.*

Analytical Results

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

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	COE - MACKINNON BRIDGE - TH22-03 #9	----	----	----	----
					Client sampling date / time	21-Jun-2022	----	----	----	----
						CG2207927-001	--------	--------	--------	--------
						Result	----	----	----	----
Physical Tests										
pH (1:2 soil:CaCl2-aq)	----	E108B	0.10	pH units		7.61	----	----	----	----
pH, saturated paste	----	E114	0.10	pH units		7.49	----	----	----	----
Inorganic Parameters										
sulfate, total, ion content	14808-79-8	E246.SO4	0.050	%		0.482	----	----	----	----
sulfate, soluble ion content	14808-79-8	E246A.SO4	0.050	%		0.714 RRV	----	----	----	----
Saturated Paste Extractables										
conductivity, saturated paste	----	E102	0.010	dS/m		2.52	----	----	----	----
resistivity	----	E131	1.0	ohm cm		1000	----	----	----	----
sodium adsorption ratio [SAR]	----	EC102	0.10	-		0.36	----	----	----	----
sulfate, soluble ion content	14808-79-8	E239.SO4	5.0	mg/L		1820	----	----	----	----
% saturation	----	E141	1.0	%		52.4	----	----	----	----
chloride, soluble ion content	16887-00-6	E239.Cl	20	mg/L		<40 DLDS	----	----	----	----
calcium, soluble ion content	7440-70-2	EC485	5.0	mg/kg		245	----	----	----	----
calcium, soluble ion content	7440-70-2	E485	5.0	mg/L		468	----	----	----	----
magnesium, soluble ion content	7439-95-4	EC485	5.0	mg/kg		65.5	----	----	----	----
magnesium, soluble ion content	7439-95-4	E485	5.0	mg/L		125	----	----	----	----
potassium, soluble ion content	7440-09-7	EC485	5.0	mg/kg		10.8	----	----	----	----
potassium, soluble ion content	7440-09-7	E485	5.0	mg/L		20.6	----	----	----	----
sodium, soluble ion content	17341-25-2	EC485	5.0	mg/kg		17.9	----	----	----	----
sodium, soluble ion content	17341-25-2	E485	5.0	mg/L		34.1	----	----	----	----
chloride, soluble ion content	16887-00-6	EC266A.Cl	10	mg/kg		<10	----	----	----	----
chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L		<20	----	----	----	----
sulfur (as SO4), soluble ion content	14808-79-8	EC485	8.0	mg/kg		901	----	----	----	----
sulfur (as SO4), soluble ion content	14808-79-8	E485	6.0	mg/L		1720	----	----	----	----

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

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **CG2207927**	Page	: 1 of 7
Client	: **AECOM Canada Ltd.**	Laboratory	: Calgary - Environmental
Contact	: Chris Keeley	Account Manager	: Kiazitako Muanza
Address	: Suite 300,. 48 Quarry Park Blvd. SE Calgary AB Canada T2C 5P2	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 254 3301	Telephone	: +1 403 407 1800
Project	: CITY OF EDMONTON - MACKINNON BRIDGE	Date Samples Received	: 21-Jun-2022 12:30
PO	: 60682118	Issue Date	: 17-Jul-2022 11:32
C-O-C number	: ----		
Sampler	: ----		
Site	: 2022 Price List - Prairies		
Quote number	: 2022 Price List - Prairies		
No. of samples received	: 1		
No. of samples analysed	: 1		

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

- Quality Control Sample Frequency Outliers occur - please see following pages for full details.

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 : Soluble Sulfate ion in soil by boiling water extraction, IC.										
LDPE bag COE - MACKINNON BRIDGE - TH22-03 #9	E246A.SO4	21-Jun-2022	14-Jul-2022	180 days	24 days	✓	14-Jul-2022	28 days	0 days	✓
Inorganic Parameters : Total Sulfate ion in soil by acidic boiling water extraction, IC										
LDPE bag COE - MACKINNON BRIDGE - TH22-03 #9	E246.SO4	21-Jun-2022	11-Jul-2022	180 days	20 days	✓	11-Jul-2022	28 days	0 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)										
LDPE bag COE - MACKINNON BRIDGE - TH22-03 #9	E108B	21-Jun-2022	23-Jun-2022	----	----		23-Jun-2022	30 days	0 days	✓
Physical Tests : pH by Meter (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-03 #9	E114	21-Jun-2022	----	----	----		23-Jun-2022	365 days	2 days	✓
Saturated Paste Extractables : Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-03 #9	E485	21-Jun-2022	----	----	----		23-Jun-2022	180 days	3 days	✓
Saturated Paste Extractables : Chloride by Colourimetry (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-03 #9	E266.Cl	21-Jun-2022	----	----	----		23-Jun-2022	365 days	3 days	✓
Saturated Paste Extractables : Chloride by IC (Saturated Paste)										
LDPE bag COE - MACKINNON BRIDGE - TH22-03 #9	E239.Cl	21-Jun-2022	----	----	----		23-Jun-2022	365 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
Saturated Paste Extractables : Conductivity in Soil (Saturated Paste)										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-03 #9	E102	21-Jun-2022	----	----	----		23-Jun-2022	365 days	2 days	✓
Saturated Paste Extractables : Resistivity by Electrode (Saturated Paste)										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-03 #9	E131	21-Jun-2022	----	----	----		23-Jun-2022	----	----	
Saturated Paste Extractables : Saturation Percentage										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-03 #9	E141	21-Jun-2022	----	----	----		23-Jun-2022	----	0 days	
Saturated Paste Extractables : Sulfate by IC (Saturated Paste)										
LDPE bag										
COE - MACKINNON BRIDGE - TH22-03 #9	E239.SO4	21-Jun-2022	----	----	----		23-Jun-2022	365 days	2 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)							
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485	535318	1	3	33.3	5.0	✓
Chloride by Colourimetry (Saturated Paste)	E266.Cl	535317	1	3	33.3	5.0	✓
Chloride by IC (Saturated Paste)	E239.Cl	535319	1	1	100.0	5.0	✓
Conductivity in Soil (Saturated Paste)	E102	535316	1	3	33.3	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)	E108B	536037	1	20	5.0	5.0	✓
pH by Meter (Saturated Paste)	E114	535315	1	1	100.0	5.0	✓
Resistivity by Electrode (Saturated Paste)	E131	535712	1	1	100.0	5.0	✓
Saturation Percentage	E141	535313	1	3	33.3	5.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	562469	1	13	7.6	5.0	✓
Sulfate by IC (Saturated Paste)	E239.SO4	535314	1	1	100.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	557242	1	20	5.0	5.0	✓
Laboratory Control Samples (LCS)							
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485	535318	2	3	66.6	10.0	✓
Chloride by Colourimetry (Saturated Paste)	E266.Cl	535317	2	3	66.6	10.0	✓
Chloride by IC (Saturated Paste)	E239.Cl	535319	1	1	100.0	5.0	✓
Conductivity in Soil (Saturated Paste)	E102	535316	2	3	66.6	10.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)	E108B	536037	2	20	10.0	10.0	✓
pH by Meter (Saturated Paste)	E114	535315	2	1	200.0	10.0	✓
Resistivity by Electrode (Saturated Paste)	E131	535712	2	1	200.0	10.0	✓
Saturation Percentage	E141	535313	2	3	66.6	10.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	562469	2	13	15.3	10.0	✓
Sulfate by IC (Saturated Paste)	E239.SO4	535314	1	1	100.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	557242	2	20	10.0	10.0	✓
Method Blanks (MB)							
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485	535318	1	3	33.3	5.0	✓
Chloride by Colourimetry (Saturated Paste)	E266.Cl	535317	1	3	33.3	5.0	✓
Chloride by IC (Saturated Paste)	E239.Cl	535319	1	1	100.0	5.0	✓
Conductivity in Soil (Saturated Paste)	E102	535316	1	3	33.3	5.0	✓
Saturation Percentage	E141	535313	1	3	33.3	5.0	✓
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	562469	1	13	7.6	5.0	✓
Sulfate by IC (Saturated Paste)	E239.SO4	535314	1	1	100.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	557242	1	20	5.0	5.0	✓
Matrix Spikes (MS)							
Chloride by IC (Saturated Paste)	E239.Cl	535319	0	1	0.0	5.0	✗
Sulfate by IC (Saturated Paste)	E239.SO4	535314	0	1	0.0	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 (Saturated Paste)	E102 Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)/AER D50	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a filtered extract from a soil sample prepared using the saturated paste procedure. Conductivity measurements are temperature-compensated to 25°C.
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction)	E108B Calgary - Environmental	Soil/Solid	CSSS (2008) 16.3	A 10g portion of dried (<60°C) and ground (10 mesh/2 mm) sample 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.
pH by Meter (Saturated Paste)	E114 Calgary - Environmental	Soil/Solid	Carter-CSSS / APHA 4500 H	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) on a soil produced by the saturated paste extraction procedure.
Resistivity by Electrode (Saturated Paste)	E131 Calgary - Environmental	Soil/Solid	ASTM G57-95A (mod)	Resistivity is determined on a soil sample that has been mixed with deionized water to create a saturated paste, which is then placed directly into a four electrode resistivity soil box and measured for resistivity using a resistivity meter.
Saturation Percentage	E141 Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/AER D50	Saturation Percentage (SP) is determined as the total volume of water present in a saturated paste (in mL) divided by the dry weight of the sample (in grams), expressed as a percentage.
Chloride by IC (Saturated Paste)	E239.Cl Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/EPA 300.1 (mod)	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by Ion Chromatography with conductivity and/or UV detection.
Sulfate by IC (Saturated Paste)	E239.SO4 Calgary - Environmental	Soil/Solid	CSSS Ch. 15 (mod)/EPA 300.1 (mod)	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by Ion Chromatography with conductivity and/or UV detection.
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4 Edmonton - Environmental	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis by IC with conductivity detector.
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4 Edmonton - Environmental	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water at a specified ratio then heated. After filtration the liquid is ready for analysis by IC with conductivity detector. A result of "NR" indicates that the total sulfate analysis was <0.2% and based on CSA-A23.2-3B no analysis for soluble sulfate is required.
Chloride by Colourimetry (Saturated Paste)	E266.Cl Calgary - Environmental	Soil/Solid	CSSS Ch. 15/APHA 4500-CL E (mod)/AER D50	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by colourimetry using a discrete analyzer.
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste)	E485 Calgary - Environmental	Soil/Solid	CSSS CH15/EPA 6010B/AER D50	A soil extract produced by the saturated paste extraction procedure is analyzed for Calcium, Magnesium, Potassium, Sodium, Boron, and Sulfur (as SO4) by ICPOES.
Sodium Adsorption Ratio (SAR) Saturated Paste	EC102 Calgary - Environmental	Soil/Solid	CCME Sodium Adsorption Ratio (SAR)	The Sodium Adsorption Ratio (SAR) for a sample is calculated from the Sodium, Calcium, and Magnesium concentrations from sediment paste extract.

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Chloride by Colourimetry (Saturated Paste) (mg/kg)	EC266A.Cl Calgary - Environmental	Soil/Solid	CSSS Ch. 15/APHA 4500-CL E (mod)	Inorganic anions are analyzed by obtaining a soil extract produced by the saturated paste extraction procedure which is then analyzed by colourimetry using a discrete analyzer.
Ca, K, Mg, Na, B and S by ICPOES (Saturated Paste) (mg/kg)	EC485 Calgary - Environmental	Soil/Solid	CSSS CH15/EPA 6010B	A soil extract produced by the saturated paste extraction procedure is analyzed for Calcium, Magnesium, Potassium, Sodium, Boron, and Sulfur (as SO4) by ICPOES. Results are calculated in mg/kg using Saturation Percentage.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil : 0.01CaCl2	EP108B Calgary - Environmental	Soil/Solid	CSSS (2008) 16.3	A 10g portion of dried (<60°C) and ground (10 mesh/2 mm) sample 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.
Soluble ion Sulfate in soil or concrete preparation.	EP246.S Edmonton - Environmental	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water then heated. After filtration the liquid is ready for analysis.
Total ion Sulfate in soil or concrete preparation	EP246.T Edmonton - Environmental	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis.

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **CG2207927**	Page	: 1 of 7
Client	: AECOM Canada Ltd.	Laboratory	: Calgary - Environmental
Contact	: Chris Keeley	Account Manager	: Kiazitako Muanza
Address	: Suite 300,. 48 Quarry Park Blvd. SE Calgary AB Canada T2C 5P2	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 254 3301	Telephone	: +1 403 407 1800
Project	: CITY OF EDMONTON - MACKINNON BRIDGE	Date Samples Received	: 21-Jun-2022 12:30
PO	: 60682118	Date Analysis Commenced	: 23-Jun-2022
C-O-C number	: ----	Issue Date	: 17-Jul-2022 11:32
Sampler	: ----		
Site	: 2022 Price List - Prairies		
Quote number	: 2022 Price List - Prairies		
No. of samples received	: 1		
No. of samples analysed	: 1		

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*
Kuljeet Chawla		Calgary Inorganics, Calgary, Alberta
Ping Yeung	Team Leader - Inorganics	Edmonton Inorganics, Edmonton, Alberta
Ruifang Zheng	Analyst	Calgary Inorganics, Calgary, Alberta
Sara Niroomand		Calgary Inorganics, Calgary, Alberta
Sara Niroomand		Calgary Metals, Calgary, Alberta
Shirley Li		Calgary Metals, Calgary, Alberta
Vishnu Patel		Calgary Inorganics, Calgary, Alberta

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: 536037)											
CG2207806-001	Anonymous	pH (1:2 soil:CaCl2-aq)	----	E108B	0.10	pH units	7.47	7.50	0.401%	5%	----
Inorganic Parameters (QC Lot: 557242)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	0.482 %	4910	1.74%	30%	----
Inorganic Parameters (QC Lot: 562469)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	0.714 %	6900	3.54%	30%	----
Saturated Paste Extractables (QC Lot: 535313)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	% saturation	----	E141	1.0	%	52.4	51.7	1.37%	20%	----
Saturated Paste Extractables (QC Lot: 535314)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	sulfate, soluble ion content	14808-79-8	E239.SO4	10.0	mg/L	1820	1790	1.83%	30%	----
Saturated Paste Extractables (QC Lot: 535315)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	pH, saturated paste	----	E114	0.10	pH units	7.49	7.42	0.939%	5%	----
Saturated Paste Extractables (QC Lot: 535316)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	conductivity, saturated paste	----	E102	10	µS/cm	2.52 dS/m	2520	0.00%	20%	----
Saturated Paste Extractables (QC Lot: 535317)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L	<20	<20	0	Diff <2x LOR	----
Saturated Paste Extractables (QC Lot: 535318)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	calcium, soluble ion content	7440-70-2	E485	5.0	mg/L	468	463	1.10%	30%	----
		magnesium, soluble ion content	7439-95-4	E485	5.0	mg/L	125	125	0.400%	30%	----
		potassium, soluble ion content	7440-09-7	E485	5.0	mg/L	20.6	20.5	0.1	Diff <2x LOR	----
		sodium, soluble ion content	17341-25-2	E485	5.0	mg/L	34.1	34.4	1.05%	30%	----
		sulfur (as SO4), soluble ion content	14808-79-8	E485	6	mg/L	1720	1710	1.05%	30%	----
Saturated Paste Extractables (QC Lot: 535319)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	chloride, soluble ion content	16887-00-6	E239.Cl	40	mg/L	<40	<40	0	Diff <2x LOR	----
Saturated Paste Extractables (QC Lot: 535712)											
CG2207927-001	COE - MACKINNON BRIDGE - TH22-03 #9	resistivity	----	E131	1.0	ohm cm	1000	1100	9.52%	20%	----

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
Inorganic Parameters (QCLot: 557242)						
sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	<500	----
Inorganic Parameters (QCLot: 562469)						
sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	<500	----
Saturated Paste Extractables (QCLot: 535313)						
% saturation	----	E141	1	%	<1.0	----
Saturated Paste Extractables (QCLot: 535314)						
sulfate, soluble ion content	14808-79-8	E239.SO4	5	mg/L	<5.0	----
Saturated Paste Extractables (QCLot: 535316)						
conductivity, saturated paste	----	E102	10	µS/cm	<10	----
Saturated Paste Extractables (QCLot: 535317)						
chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L	<20	----
Saturated Paste Extractables (QCLot: 535318)						
calcium, soluble ion content	7440-70-2	E485	5	mg/L	<5.0	----
magnesium, soluble ion content	7439-95-4	E485	5	mg/L	<5.0	----
potassium, soluble ion content	7440-09-7	E485	5	mg/L	<5.0	----
sodium, soluble ion content	17341-25-2	E485	5	mg/L	<5.0	----
sulfur (as SO4), soluble ion content	14808-79-8	E485	6	mg/L	<6.0	----
Saturated Paste Extractables (QCLot: 535319)						
chloride, soluble ion content	16887-00-6	E239.Cl	20	mg/L	<20	----

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: 536037)									
pH (1:2 soil:CaCl2-aq)	----	E108B	----	pH units	7 pH units	100	97.0	103	----
Inorganic Parameters (QCLot: 557242)									
sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	10000 mg/kg	109	70.0	130	----
Inorganic Parameters (QCLot: 562469)									
sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	200 mg/kg	98.7	60.0	140	----
Saturated Paste Extractables (QCLot: 535313)									
% saturation	----	E141	1	%	100 %	102	90.0	110	----
Saturated Paste Extractables (QCLot: 535314)									
sulfate, soluble ion content	14808-79-8	E239.SO4	5	mg/L	100 mg/L	100	80.0	120	----
Saturated Paste Extractables (QCLot: 535315)									
pH, saturated paste	----	E114	----	pH units	7 pH units	101	97.0	103	----
Saturated Paste Extractables (QCLot: 535316)									
conductivity, saturated paste	----	E102	10	µS/cm	146.9 µS/cm	98.7	80.0	120	----
Saturated Paste Extractables (QCLot: 535317)									
chloride, soluble ion content	16887-00-6	E266.Cl	20	mg/L	100 mg/L	95.0	70.0	130	----
Saturated Paste Extractables (QCLot: 535318)									
calcium, soluble ion content	7440-70-2	E485	5	mg/L	50 mg/L	94.9	80.0	120	----
magnesium, soluble ion content	7439-95-4	E485	5	mg/L	50 mg/L	95.4	80.0	120	----
potassium, soluble ion content	7440-09-7	E485	5	mg/L	50 mg/L	109	80.0	120	----
sodium, soluble ion content	17341-25-2	E485	5	mg/L	50 mg/L	107	80.0	120	----
sulfur (as SO4), soluble ion content	14808-79-8	E485	6	mg/L	150 mg/L	101	80.0	120	----
Saturated Paste Extractables (QCLot: 535319)									
chloride, soluble ion content	16887-00-6	E239.Cl	20	mg/L	100 mg/L	99.4	80.0	120	----
Saturated Paste Extractables (QCLot: 535712)									
resistivity	----	E131	----	ohm cm	9674 ohm cm	105	70.0	130	----

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: 536037)									
	RM	pH (1:2 soil:CaCl2-aq)	----	E108B	7.74 pH units	98.2	96.0	104	----
Inorganic Parameters (QCLot: 557242)									
	RM	sulfate, total, ion content	14808-79-8	E246.SO4	33400 mg/kg	91.0	80.0	120	----
Inorganic Parameters (QCLot: 562469)									
	RM	sulfate, soluble ion content	14808-79-8	E246A.SO4	2600 mg/kg	112	80.0	120	----
Saturated Paste Extractables (QCLot: 535313)									
	RM	% saturation	----	E141	48.3 %	89.2	80.0	120	----
Saturated Paste Extractables (QCLot: 535315)									
	RM	pH, saturated paste	----	E114	7.59 pH units	99.2	96.0	104	----
Saturated Paste Extractables (QCLot: 535316)									
	RM	conductivity, saturated paste	----	E102	5970 µS/cm	92.1	80.0	120	----
Saturated Paste Extractables (QCLot: 535317)									
	RM	chloride, soluble ion content	16887-00-6	E266.Cl	1237 mg/L	100	70.0	130	----
Saturated Paste Extractables (QCLot: 535318)									
	RM	calcium, soluble ion content	7440-70-2	E485	776 mg/L	85.3	70.0	130	----
	RM	magnesium, soluble ion content	7439-95-4	E485	261 mg/L	80.6	70.0	130	----
	RM	potassium, soluble ion content	7440-09-7	E485	111 mg/L	84.0	70.0	130	----
	RM	sodium, soluble ion content	17341-25-2	E485	330 mg/L	96.0	70.0	130	----
	RM	sulfur (as SO4), soluble ion content	14808-79-8	E485	1841 mg/L	91.1	70.0	130	----
Saturated Paste Extractables (QCLot: 535712)									
	RM	resistivity	----	E131	600 ohm cm	96.7	70.0	130	----

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number: 14 -

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	AECOM Canada Ltd. (acct# 10482)	Select Report Format:	☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Chris Keeley	Quality Control (QC) Report with Report	☑ Yes ☐ No	P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	48 Quarry Park Blvd. SE, Suite 300 Calgary, AB T2C 5P2	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	403.254.3301	Email 1 or Fax	Chris.Keeley@aecom.com	Specify Date Required for E2,E or P:
		Email 2	usman.raja@aecom.com	

Invoice To		Invoice Distribution	
	Same as Report To ☐ Yes ☑ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☐ Yes ☑ No		
Company:	AECOM Canada Ltd.	Email 1 or Fax	Kristen.Tackney@aecom.com
Contact:	Kristen.Tackney@aecom.com	Email 2	canssc.e-billing@aecom.com

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	AECO100	Approver ID:	Cost Center:
Job #:	City of Edmonton - MacKinnon Bridge	GL Account:	Routing Code:
PO / AFE:	60682118	Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only)	ALS Contact: Lovepreet Kaur	Sampler: N/A

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	CL-PASTE-COL-CL	PH-PASTE-CL	RESISTIVITY-PASTE-CL	SAL-MG/KG-CALC-CL	SAT-PCNT-CL	SO4-PASTE-ICP-CL	SO4-S-CSA-A23-ED	SO4-T-CSA-A23-ED	Number of Containers
	COE - MacKinnon Bridge - TH22-03 #9	21-Jun-22	-	Soil	R	R	R	R	R	R	R	R	1

Environmental Division
Calgary
Work Order Reference
CG2207927

Telephone : +1 403 407 1800

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No Are samples for human drinking water use? ☐ Yes ☐ No	Analysis requested - pH, Chlorine Content, Resistivity and Sulphate Content. Please report sulphate results in % for SO4-T/S CSA method and results in mg/L for SO4 via paste, salinity package. Please report resistivity in ohm-cm. Please report chlorides in mg/kg & mg/L.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☐	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
LS					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Keeley	Date: June 21/22	Time: 13:40	Received by: Amber M.	Date: June 21	Time: 2:30	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

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.

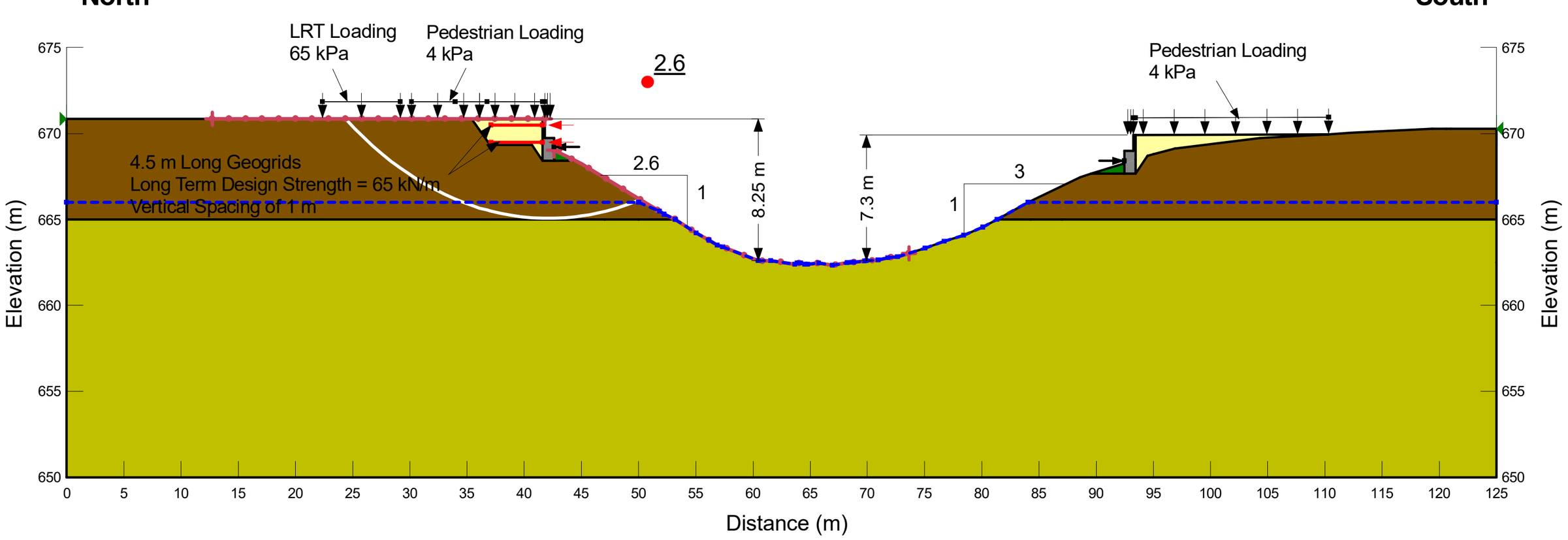
1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Appendix D

Slope Stability Analyses

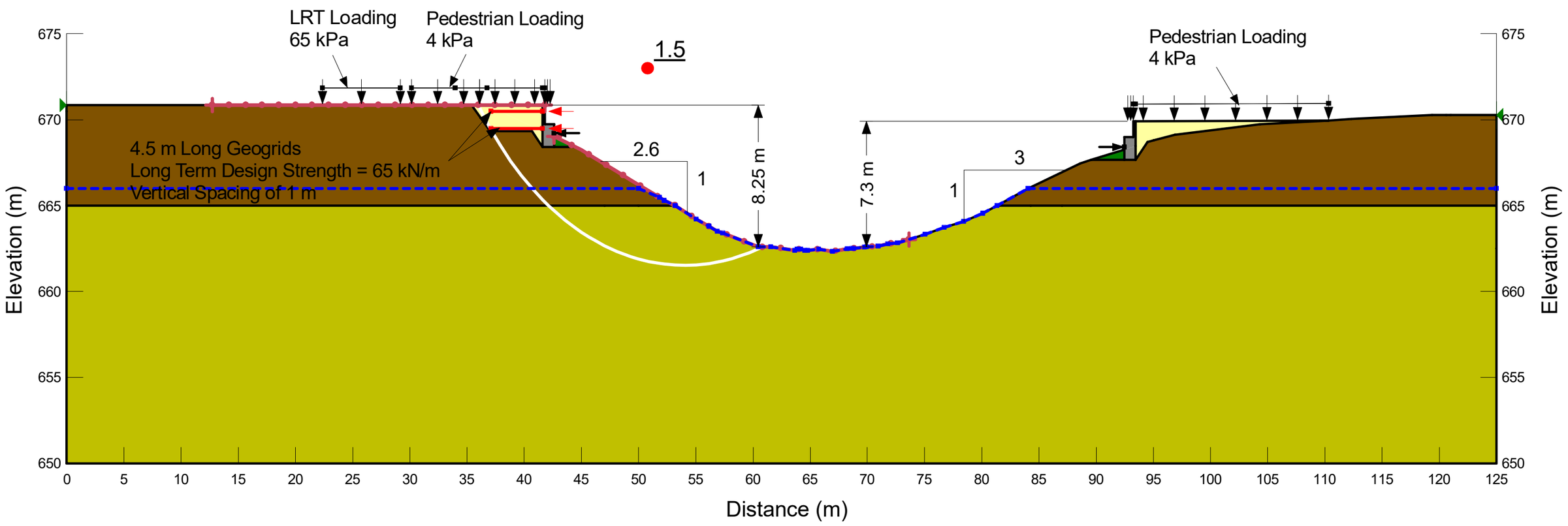
Mackinnon Ravine Pedestrian Bridge
Figure D1 - North Abutment
Short Term Conditions - During Construction

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay Fill	Mohr-Coulomb	19		5	25
	Concrete Abutment	Mohr-Coulomb	0.5		75	50
	Firm High Plastic Clay (Short Term)	Undrained (Phi=0)	18	40		
	Granular Fill	Mohr-Coulomb	21		0	35
	V. Stiff Clay Till (Short Term)	Undrained (Phi=0)	20	165		



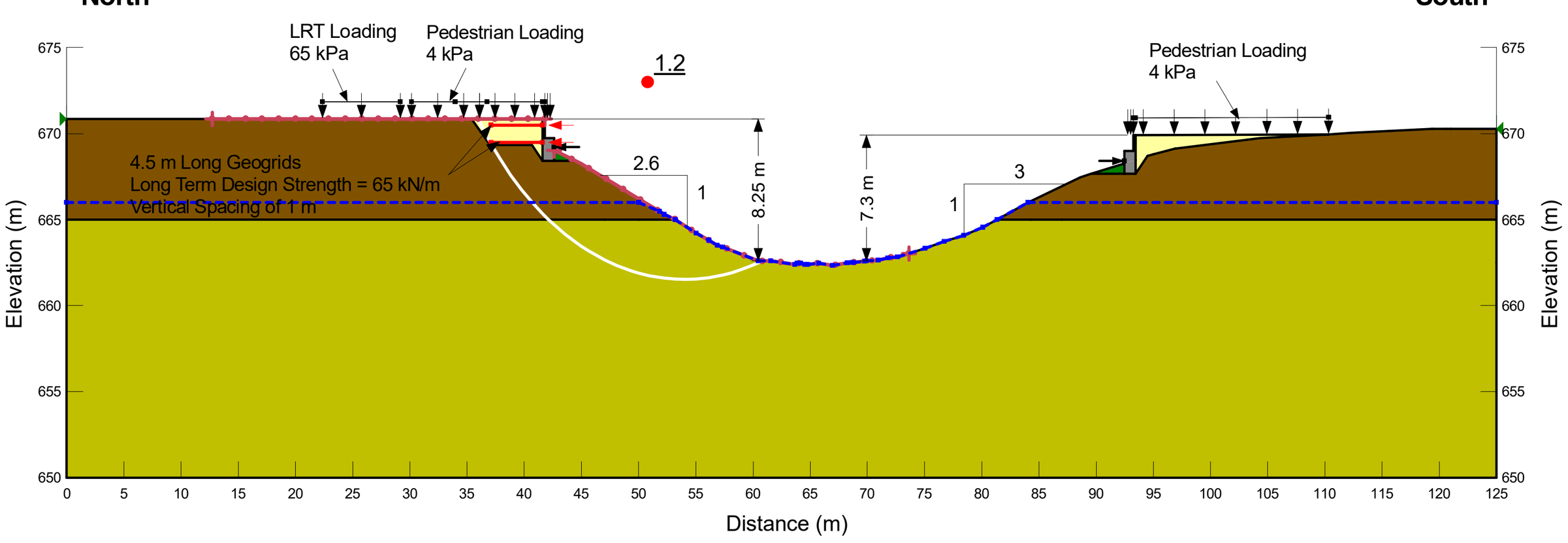
Mackinnon Ravine Pedestrian Bridge
Figure D2 - North Abutment
Long Term Conditions - After Construction

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay Fill	Mohr-Coulomb	19	5	25
	Concrete Abutment	Mohr-Coulomb	0.5	75	50
	Firm High Plastic Clay (Long Term)	Mohr-Coulomb	18	5	23
	Granular Fill	Mohr-Coulomb	21	0	35
	V. Stiff Clay Till (Long Term)	Mohr-Coulomb	20	10	27



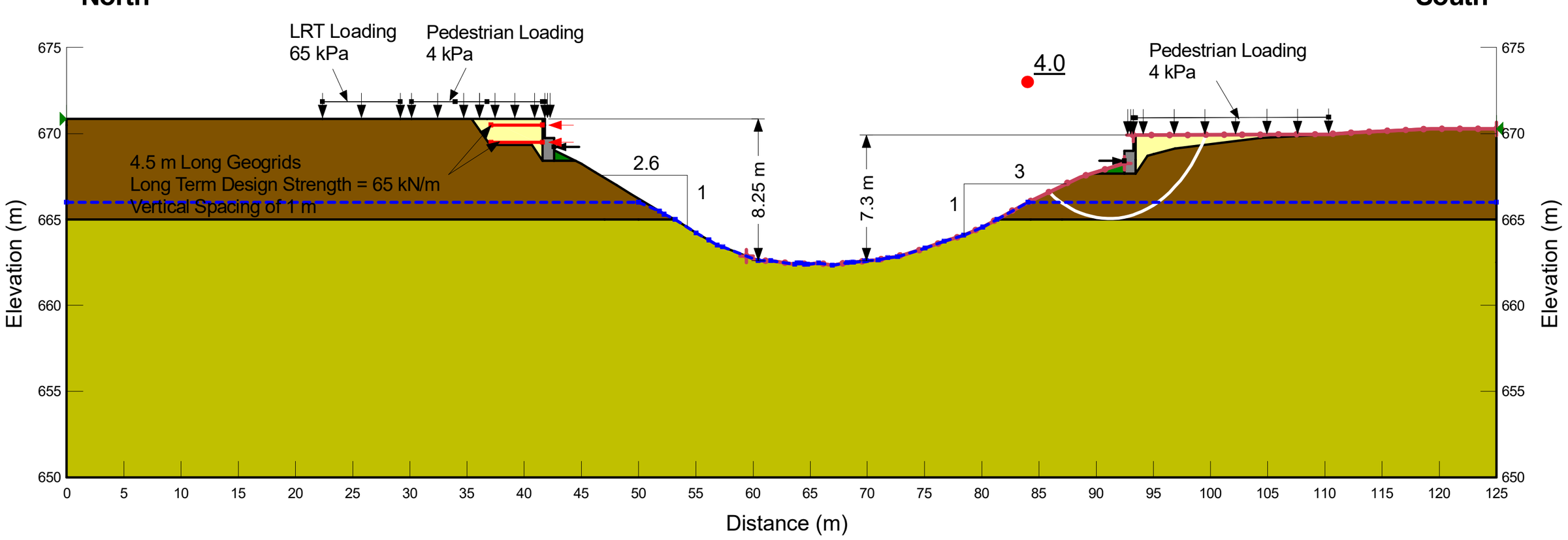
Mackinnon Ravine Pedestrian Bridge
Figure D3 - North Abutment
Long Term Conditions - During Seismic Event

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay Fill	Mohr-Coulomb	19	5	25
	Concrete Abutment	Mohr-Coulomb	0.5	75	50
	Firm High Plastic Clay (Long Term)	Mohr-Coulomb	18	5	23
	Granular Fill	Mohr-Coulomb	21	0	35
	V. Stiff Clay Till (Long Term)	Mohr-Coulomb	20	10	27



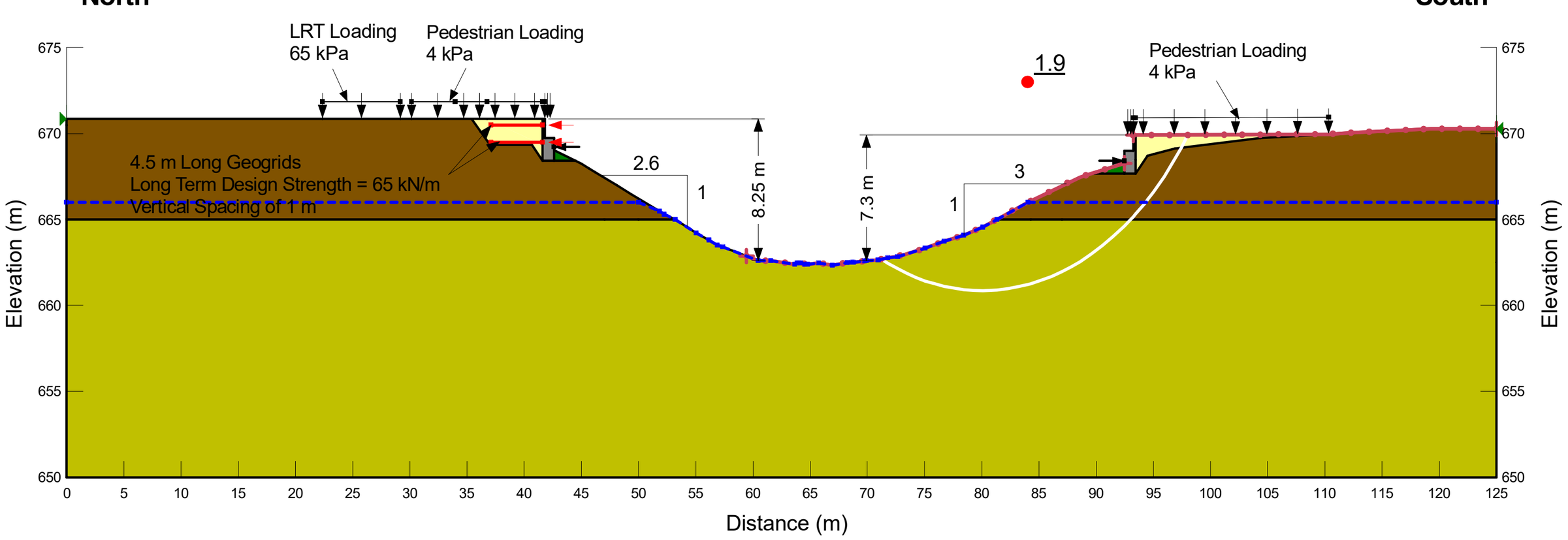
Mackinnon Ravine Pedestrian Bridge
Figure D4 - South Abutment
Short Term Conditions - During Construction

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay Fill	Mohr-Coulomb	19		5	25
	Concrete Abutment	Mohr-Coulomb	0.5		75	50
	Firm High Plastic Clay (Short Term)	Undrained (Phi=0)	18	40		
	Granular Fill	Mohr-Coulomb	21		0	35
	V. Stiff Clay Till (Short Term)	Undrained (Phi=0)	20	165		



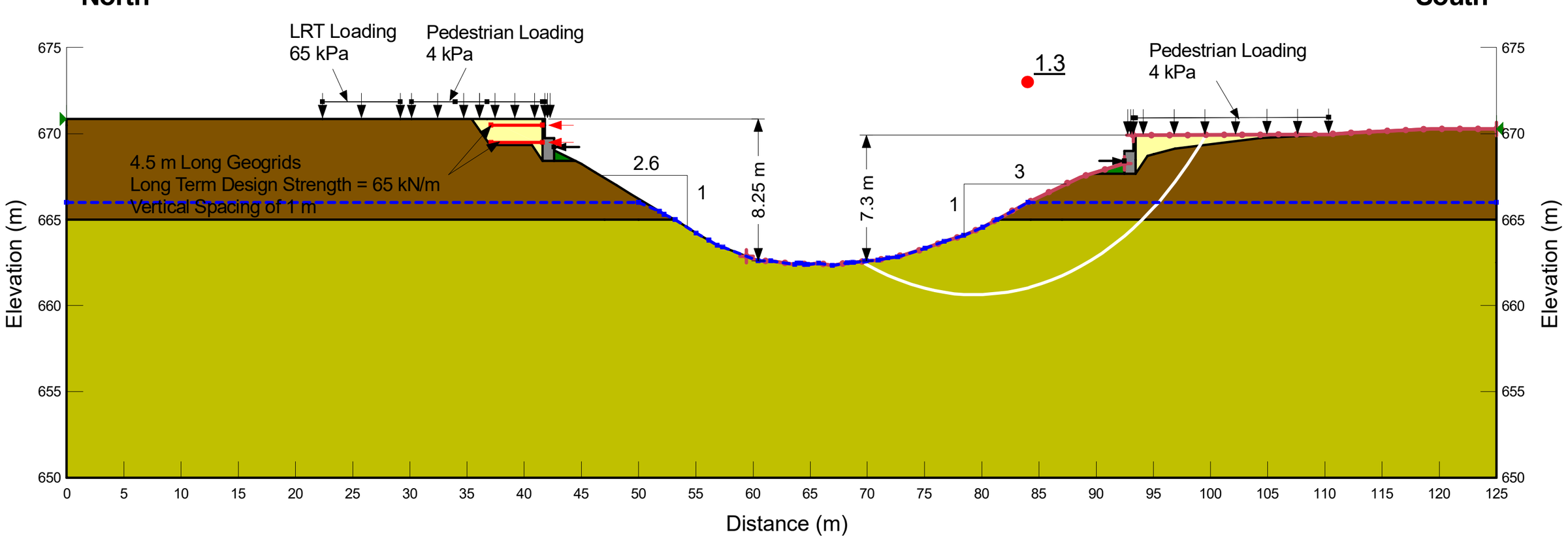
Mackinnon Ravine Pedestrian Bridge
Figure D5 - South Abutment
Long Term Conditions - After Construction

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay Fill	Mohr-Coulomb	19	5	25
	Concrete Abutment	Mohr-Coulomb	0.5	75	50
	Firm High Plastic Clay (Long Term)	Mohr-Coulomb	18	5	23
	Granular Fill	Mohr-Coulomb	21	0	35
	V. Stiff Clay Till (Long Term)	Mohr-Coulomb	20	10	27



Mackinnon Ravine Pedestrian Bridge
Figure D6 - South Abutment
Long Term Conditions - During Seismic Event

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay Fill	Mohr-Coulomb	19	5	25
	Concrete Abutment	Mohr-Coulomb	0.5	75	50
	Firm High Plastic Clay (Long Term)	Mohr-Coulomb	18	5	23
	Granular Fill	Mohr-Coulomb	21	0	35
	V. Stiff Clay Till (Long Term)	Mohr-Coulomb	20	10	27



Appendix E
Supporting Documents

Fish and Wildlife Internet Mapping Tool (FWIMT)

(source database: Fish and Wildlife Management Information System (FWMIS))

Species Summary Report

Report Date: 06-May-2022 15:59

Species present within the current extent

Fish Inventory

- CICHLID
- EMERALD SHINER
- GOLDEYE
- LAKE CHUB
- LONGNOSE DACE
- LONGNOSE SUCKER
- MINNOW FAMILY
- MOONEYE
- MOUNTAIN WHITEFISH
- NORTHERN PIKE
- QUILLBACK
- RIVER SHINER
- SAUGER
- SHORTHEAD REDHORSE
- SILVER REDHORSE
- SUCKER FAMILY
- TROUT-PERCH
- WALLEYE
- WHITE SUCKER

Wildlife Inventory

- ALDER FLYCATCHER
- BALD EAGLE
- BARRED OWL
- BAY-BREASTED WARBLER
- CANADIAN TOAD
- CAPE MAY WARBLER
- COMMON YELLOWTHROAT
- COUGAR
- LEAST FLYCATCHER
- LITTLE BROWN BAT
- SHARP-TAILED GROUSE
- SHORT-EARED OWL
- WESTERN TANAGER

Stocked Inventory

- RAINBOW TROUT
- YELLOW PERCH

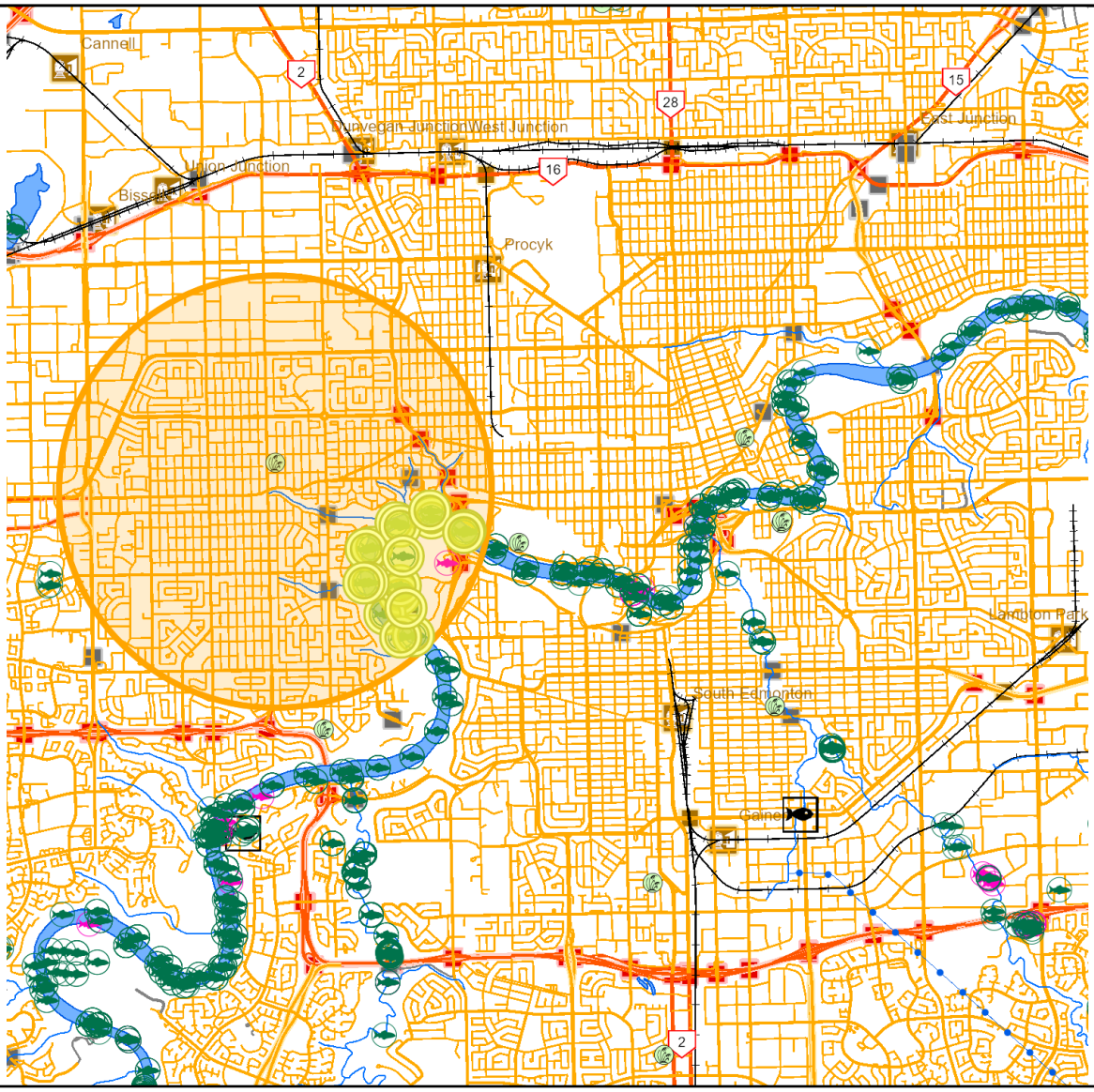
Buffer Extent

Centroid (X,Y)	Projection	Centroid (Qtr Sec Twp Rng Mer)	Radius or Dimensions
594294, 5931097	10-TM AEP Forest	SE 2 53 25 4	3 kilometers

Contact Information

For contact information, please visit:
https://www.alberta.ca/fisheries-and-wildlife-management-contacts.aspx

06-May-2022 15:59 **Map Results**



Display may contain: Base Map Data provided by the Government of Alberta under the Alberta Open Government Licence. Cadastral and Dispositions Data provided by Alberta Data Partnerships. (c)GeoEye, all rights reserved. Information as depicted is subject to change, therefore the Government of Alberta assumes no responsibility for discrepancies at time of use

HRA Number: 4715-22-0081-001
October 20, 2022

Historical Resources Act Approval

Proponent: City of Edmonton
10111-104 Avenue NW, Edmonton, AB T5J 0J4
Contact: Christopher Wintle

Agent: AECOM Canada Ltd.
Contact: Chris LaFleur

Project Name: **MacKinnon Ravine Bridge Replacement**

Project Components: Bridge

Application Purpose: Requesting HRA Approval / Requirements

Historical Resources Act approval is granted for the activities described in this application and its attached plan(s)/sketch(es) subject to Section 31, "a person who discovers an historic resource in the course of making an excavation for a purpose other than for the purpose of seeking historic resources shall forthwith notify the Minister of the discovery." The chance discovery of historical resources is to be reported to the contacts identified within Standard Requirements under the *Historical Resources Act*: Reporting the Discovery of Historic Resources.

Martina Purdon
Manager, Regulatory Approvals and Information Management
Historic Resources Management Branch
Alberta Culture and Status of Women

Lands Affected: All New Lands

Proposed Development Area:

MER	RGE	TWP	SEC	LSD List
4	25	53	2	2

Documents Attached:

Document Name	Document Type
Drawings	Illustrative Material

Alberta

STANDARD REQUIREMENTS UNDER THE *HISTORICAL RESOURCES ACT*: REPORTING THE DISCOVERY OF HISTORIC RESOURCES

If development proponents and/or their agents become aware of historic resources during the course of development activities, they are required, under Section 31 of the *Historical Resources Act*, to report these discoveries to the Heritage Division of Alberta Culture and Status of Women. This requirement applies to all activities in the Province of Alberta.

1.0 REPORTING THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

The discovery of archaeological resources is to be reported to Darryl Bereziuk, Director, Archaeological Survey, at 780-431-2316 (toll-free by first dialing 310-0000) or darryl.bereziuk@gov.ab.ca.

2.0 REPORTING THE DISCOVERY OF PALAEONTOLOGICAL RESOURCES

The discovery of palaeontological resources is to be reported to Dan Spivak, Head, Resource Management, Royal Tyrrell Museum of Palaeontology, at 403-820-6210 (toll-free by first dialing 310-0000) or dan.spivak@gov.ab.ca.

3.0 REPORTING THE DISCOVERY OF HISTORIC PERIOD SITES

The discovery of historic structures to be reported to Rebecca Goodenough, Manager, Historic Places Research and Designation Program, at 780-431-2309 (toll-free by first dialing 310-0000) or rebecca.goodenough@gov.ab.ca. Please note that some historic structure sites may also be considered Aboriginal traditional use sites.

4.0 REPORTING THE DISCOVERY OF ABORIGINAL TRADITIONAL USE SITES

The discovery of any Aboriginal traditional use site that is of a type listed below is to be reported to Valerie Knaga, Director, Aboriginal Heritage Section, at 780-431-2371 (toll-free by first dialing 310-0000) or valerie.k.knaga@gov.ab.ca.

Aboriginal Traditional Use sites considered by Alberta Culture and Status of Women to be historic resources under the *Historical Resources Act* include:

Historic cabin remains;
Historic cabins (unoccupied);
Cultural or historical community camp sites;

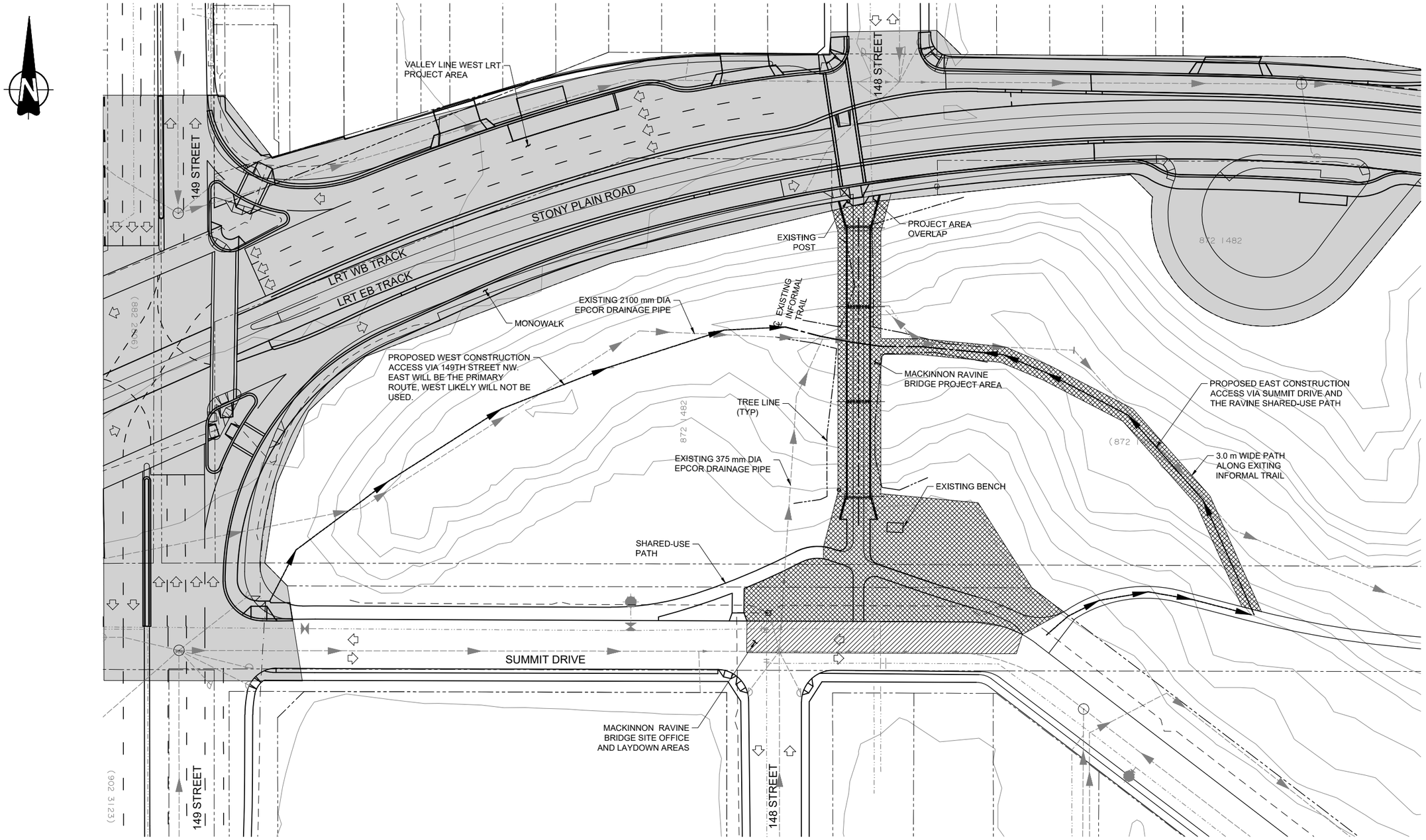
Ceremonial sites/Spiritual sites;
Gravesites;
Historic settlements/Homesteads;
Historic sites;
Oral history sites;
Ceremonial plant or mineral gathering sites;
Historical Trail Features; and,
Sweat/Thirst/Fasting Lodge sites

5.0 FURTHER SALVAGE, PRESERVATIVE OR PROTECTIVE MEASURES

If previously unrecorded historic resources are discovered, proponents may be ordered to undertake further salvage, preservative or protective measures or take any other actions that the Minister of Culture considers necessary.

Appendix F
Preliminary Drawings

Please contact the City Project Manager for authenticated version.



SITE PLAN

0 7.5 15.0 22.5 m SCALE 1:750

NOTES:

- SELECTIVE TREE PRUNING REQUIRED ALONG ACCESS ROUTE FOR CONSTRUCTION VEHICLE HEIGHT CLEARANCE. UNDERSTORY VEGETATION CLEARING REQUIRED IN PROJECT AREA.
- MACKINNON RAVINE BRIDGE SITE OFFICE AND LAYDOWN AREA ARE SIMILAR TO THE SITE LIMITS OF THE CURRENT EPCOR 99 AVENUE SANITARY TRUNK REHABILITATION PROJECT. THIS RESULTS IN THE SIMILAR TRAFFIC CLOSURES.
- MACKINNON RAVINE PROJECT TEAM ARE WORKING WITH MARIGOLD INFRASTRUCTURE PARTNERS AND EPCOR TO ADDRESS THE OVERLAPPING PROJECT AREAS.
- EXTENT OF HARDSCAPE AND LANDSCAPE RESTORATION WILL BE COORDINATED WITH THE 99 AVENUE SANITARY TRUNK REHABILITATION PROJECT.

LEGEND:

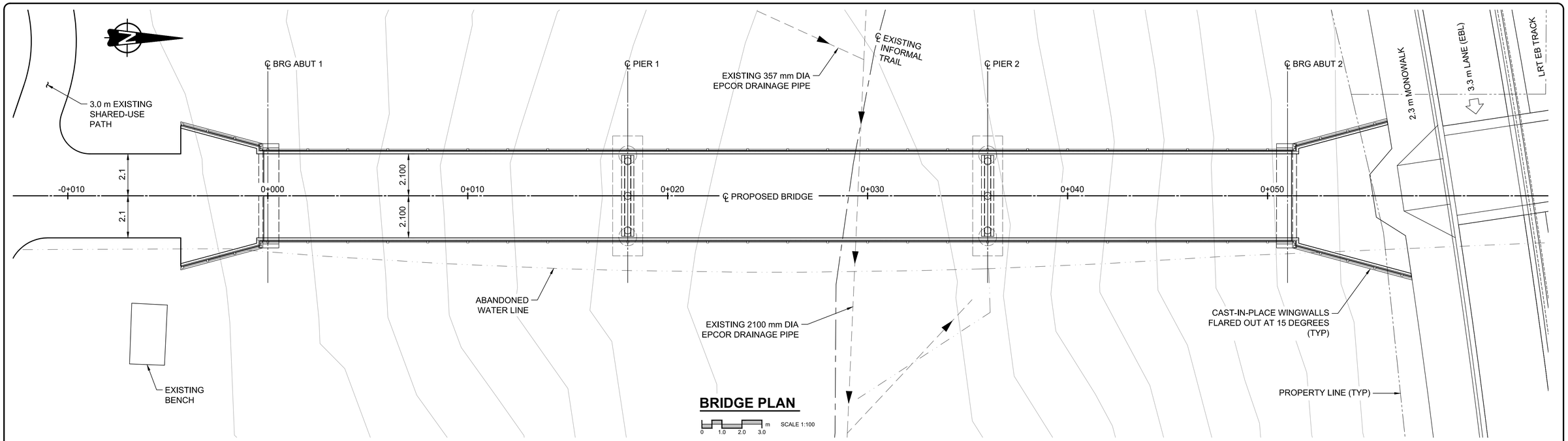
- MACKINNON RAVINE BRIDGE SITE OFFICE AND LAYDOWN AREAS
- MACKINNON RAVINE BRIDGE PROJECT AREA
- VALLEY LINE WEST LRT PROJECT AREA
- PROPERTY LINES

AECOM

CITY OF EDMONTON

MACKINNON RAVINE BRIDGE

PROPOSED PROJECT AREA, ACCESS ROUTE, SITE OFFICE AND LAYDOWN SITE



NOT FOR CONSTRUCTION

AECOM

LAST SAVED: Alex.Kouremenos 9/26/2022 12:09 PM
PATH: C:\Users\alex.kouremenos\AECOM\60682118 MacKinnon Bridge - Documents\General\900_CAD_GIS\910_CAD\20_SHEETS\ST\CADS\148 P221 D01.dwg

NO.	REVISIONS	BY	DATE	APPD
7				
6				
5				
4				
3				
2				
1				

PROGRAM NO.
CONTRACT NO.

NO.	ISSUE	BY	DATE
1	PRELIM DESIGN	DK	220923

CONSTRUCTION RETURN
CONTRACTOR
SURVEYOR
DATE
FILE NUMBER
CONSTRUCTION ENGINEER DATE
GENERAL SUPERVISOR DATE

APPROVED FOR CONSTRUCTION
DATE

DEPARTMENT / BRANCH	APPROVAL	DATE

SUPERVISOR, TRANSPORTATION INFRASTRUCTURE DELIVERY DATE

SURVEY
JOB NO. 60682118
SCALE AS SHOWN
HOR
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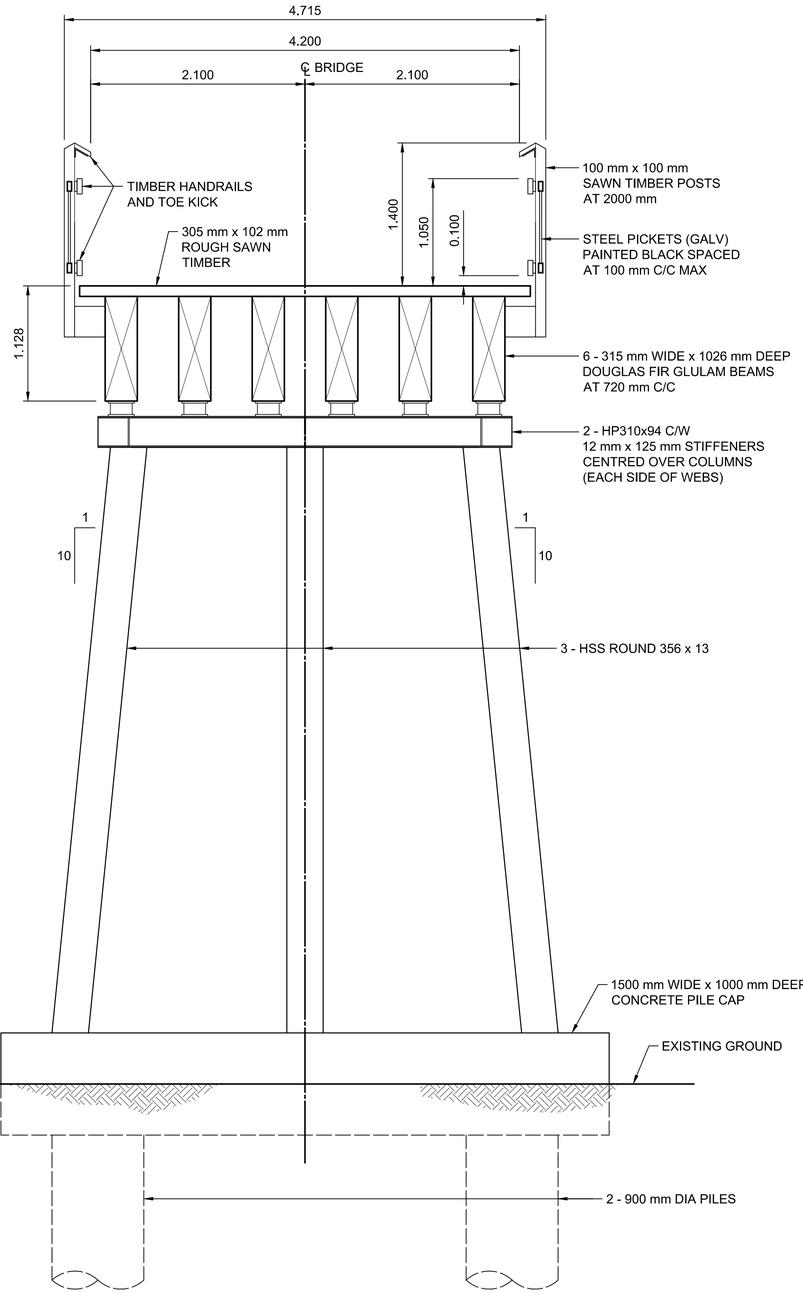
DRAWN CASHMERE C. DATE 26, SEPT. 2022
DESIGNED DEREK K. DATE 26, SEPT. 2022
CHECKED PETER L. DATE 26, SEPT. 2022

THE CITY OF Edmonton
INTEGRATED INFRASTRUCTURE SERVICES
INFRASTRUCTURE PLANNING AND DESIGN

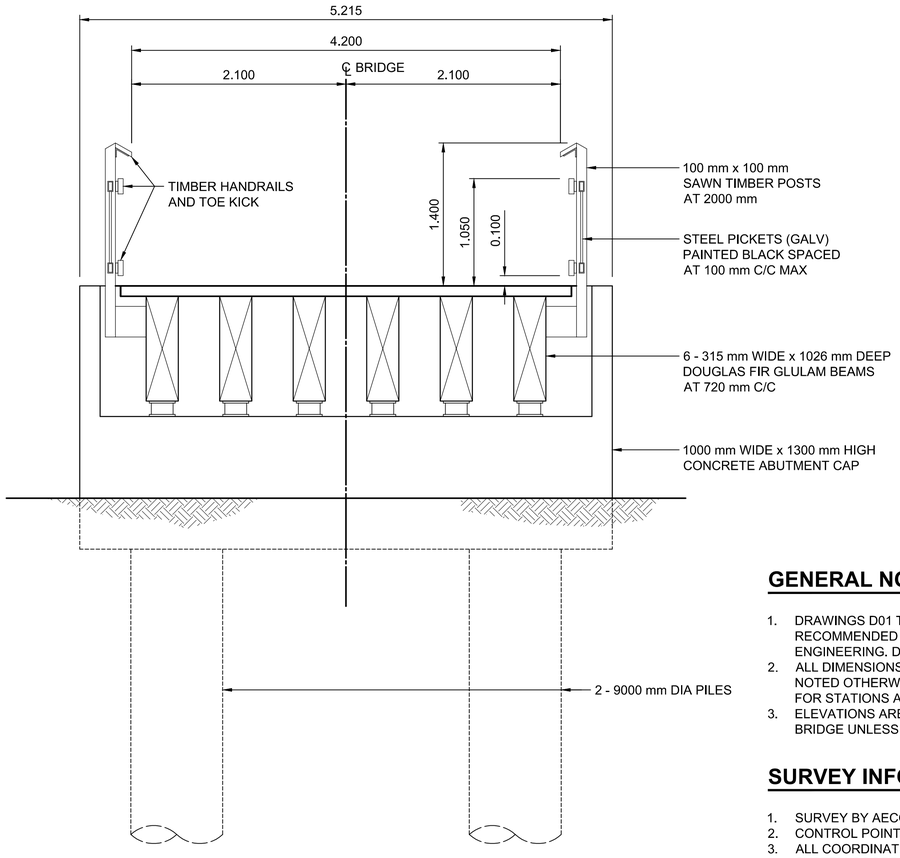
PROJECT
MACKINNON RAVINE PEDESTRIAN BRIDGE (B165)
BRIDGE REPLACEMENT
BRIDGE PLAN AND ELEVATION

DRAWING
S148 P221 D01



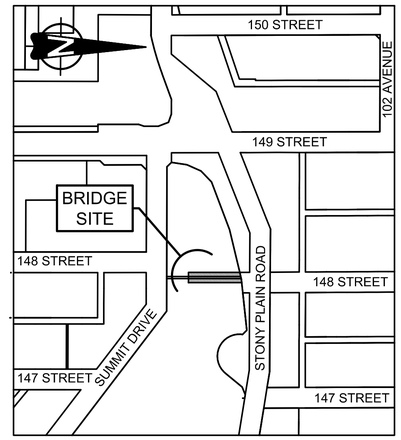
TYPICAL BRIDGE SECTION

0 0.3 0.6 0.9 m SCALE 1:30



TYPICAL ABUTMENT CROSS SECTION

0 0.3 0.6 0.9 m SCALE 1:30



SITE MAP

0 30.0 60.0 90.0 m SCALE 1:3000

GENERAL NOTES

1. DRAWINGS D01 TO D03 ARE FOR A 3-SPAN TIMBER GIRDER BRIDGE WHICH IS THE RECOMMENDED BRIDGE ALTERNATIVE BASED ON THE FINDINGS OF PRELIMINARY ENGINEERING. DRAWINGS ARE NOT TO BE USED FOR CONSTRUCTION.
2. ALL DIMENSIONS SHOWN ON DRAWINGS D01 THROUGH D03 ARE GIVEN IN METRES, UNLESS NOTED OTHERWISE. ALL OTHER DRAWINGS ARE DIMENSIONED IN MILLIMETERS EXCEPT FOR STATIONS AND ELEVATIONS, WHICH ARE GIVEN IN METRES.
3. ELEVATIONS ARE GIVEN TO THE TOP OF FINISHED GRADE AT THE CENTRELINE OF THE BRIDGE UNLESS NOTED OTHERWISE.

SURVEY INFORMATION

1. SURVEY BY AECOM, MAY 2022
2. CONTROL POINTS: ACM 32631, N 5934346.555, E 28122.050
3. ALL COORDINATES AND STATIONS ARE BASED ON 3TM (NAD 83) GRID COORDINATE SYSTEM COORDINATES AND STATIONS ARE AT SEA LEVEL. ALL DIMENSIONS FOR BRIDGE STRUCTRUE ELEMENTS AR GROUND DIMENSIONS
4. COMBINED SCALE FACTOR (CSF) = 0.999808
5. GRID DISTANCE = GROUND DISTANCE x (CSF)

DESIGN NOTES

1. CSA S6-19
2. LIVE LOADS:
   1. PEDESTRIAN LOAD: 4 kPa
   2. CSA MAINTENANCE VEHICLE

NOT FOR CONSTRUCTION

AECOM

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PROGRAM NO.
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INFRASTRUCTURE PLANNING AND DESIGN

PROJECT
MACKINNON RAVINE PEDESTRIAN BRIDGE (B165)
BRIDGE REPLACEMENT
GENERAL NOTES AND BRIDGE SECTIONS

DRAWING
S148 P221 D02

PROPERTY LINES
3.0 SHARED-USE PATH
SUMMIT DRIVE
EXISTING 375 mm DIA EPCOR DRAINAGE PIPE
℄ EXISTING INFORMAL TRAIL
PROPERTY LINE
EB LANE
WB LANE
WB LEFT TURN LANE
WB LEFT TURN LANE
RE-SOD AREA
℄ BRG ABUT 1
51 m
℄ BRG ABUT 2
℄ PIER 1
℄ PIER 2
18 m
18 m
15 m
TIE INTO EXISTING SHARED-USE PATH
RELOCATED WAYFINDING SIGN
CROSSWALK TYPE 4
REMOVE AND REPLACE EXISTING SHARED-USE PATH INSTALL NEW CONCRETE RAMP
PROPOSED NEW WAYFINDING SIGN
-0+020
0+000
℄ PROPOSED BRIDGE
0+020
4.20 m CLEARANCE
0+040
0+060
EXISTING WAYFINDING SIGN TO BE RELOCATED
PROPOSED PEDESTRIAN BRIDGE
UNIAXAIL GEOGRID 4.5 m LONG AT 1 m VERTICAL SPACING
ABANDONED WATER LINE
TREE LINE (TYP)
PROPOSED HISTORICAL JASPER FREEWAY PROJECT INTERPRETIVE PANEL LOCATION
2.30 MONOWALK
LRT EB TRACK
STONY PLAIN ROAD
LRT WB TRACK
RE-SOD AREA
EXISTING BENCH
3.0 SHARED-USE PATH
REMOVE AND REPLACE EXISTING SHARED-USE PATH
RE-SOD AREA
EXISTING 2100 mm DIA EPCOR DRAINAGE PIPE
TIE INTO EXISTING SHARED-USE PATH
C6
R-SMCG

SITE PLAN

0 1.5 3.0 4.5 m SCALE 1:300

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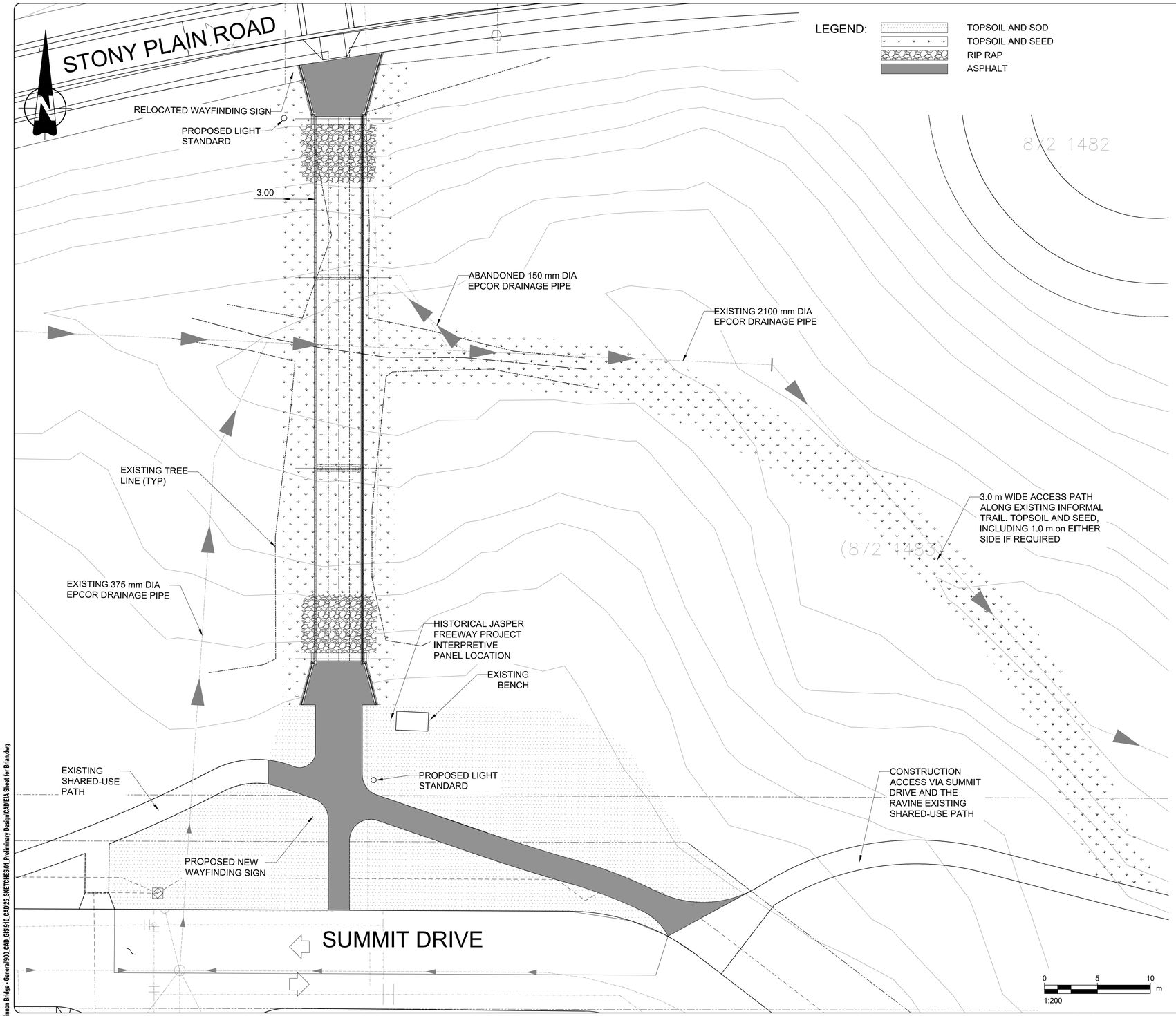
PROJECT
MACKINNON RAVINE PEDESTRIAN BRIDGE (B165)
BRIDGE REPLACEMENT
SITE PLAN

DRAWING
S148 P221 D03

Appendix G
Draft Landscape and Restoration Plan



GENERAL:

1. A PRE-CONSTRUCTION INSPECTION PRIOR TO ACCESSING THE SITE AND A POST-CONSTRUCTION INSPECTION ONCE RESTORATION HAS OCCURRED WILL BE CONDUCTED BY LAND DEVELOPMENT. EMAIL: PARKSLANDSCAPEINVENTORY@EDMONTON.CA TO REQUEST INSPECTIONS.
2. ON-SITE LAYOUT IS TO BE APPROVED BY THE CITY OF EDMONTON REPRESENTATIVE PRIOR TO START OF CONSTRUCTION.
3. CONTRACTOR TO ALLOW FOR WILDLIFE PASSAGE DURING CONSTRUCTION. IF A WILDLIFE HOUSE, NEST OR DEN, ETC IS FOUND IN THE CONSTRUCTION AREA, CONTRACTOR TO IMMEDIATELY STOP WORK. MITIGATION WILL BE REQUIRED TO PROTECT THE HOUSE, DEN, OR NEST BASED ON THE RECOMMENDATIONS OF A QUALIFIED BIOLOGIST AND APPROVAL OF THE CITY OF EDMONTON REPRESENTATIVE.
4. CONTRACTOR TO MINIMIZE THE DISTURBANCE TO EXISTING PLANT MATERIAL AND IS RESPONSIBLE FOR THE HOARDING OF ALL TREES WITHIN OR ADJACENT TO CONSTRUCTION AREAS, TO THE SATISFACTION OF THE CITY OF EDMONTON REPRESENTATIVE. "TREE" GRAPHICS DEPICT APPROXIMATE TREE CANOPY LOCATIONS ONLY.
5. CONTRACTOR TO PROVIDE 'DETOUR' AND 'ROAD CLOSED' SIGNAGE, AS WELL AS CONSTRUCTION FENCE AS REQUIRED BY THE CITY OF EDMONTON. LOCATION OF SIGNS TO BE CONFIRMED ON SITE WITH THE CITY OF EDMONTON REPRESENTATIVE. ROAD CLOSURES SHALL ADHERE TO THE CITY OF EDMONTON ROAD CLOSURE PROCEDURE.
6. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING EXISTING DRAINAGE PATTERNS AND REQUIREMENTS OF THE CITY OF EDMONTON EROSION AND SEDIMENTATION GUIDELINES AND FIELD MANUAL. WATER SHALL MOVE EFFICIENTLY AND QUICKLY AND SHALL NOT POND POST RAIN EVENT.
7. CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE AND MUST MAKE ALL NECESSARY RESTORATIONS AND REPAIRS, TO THE SATISFACTION OF THE CITY OF EDMONTON REPRESENTATIVE.
8. THE FINISHED SURFACE OF HARD SURFACES SHALL BE LEVEL WITH THE TURF GRADE LEVEL.

TREE PROTECTION:

1. THE CONTRACTOR MUST NOTIFY THE CITY OF EDMONTON FORESTRY SECTION A MINIMUM OF 20 BUSINESS DAYS PRIOR TO ANY WORK COMMENCING. THE DISTRICT FORESTER WILL NEED TO REVIEW AND APPROVE ADEQUATE TREE PROTECTION METHODS PRIOR TO WORK STARTING.
2. NO NEW ABOVE-GROUND PERMANENT STRUCTURE SHALL BE PLACED IN SUCH A WAY TO LIMIT A TREE'S STRUCTURAL ROOT PLATE OR THE STRUCTURAL INTEGRITY OF ANY TREE THAT IS EXISTING WITHIN THE INTENDED CONSTRUCTION WORK ZONE. A MINIMUM DISTANCE OF 3.0 m SHALL BE INITIATED AND MAINTAINED FROM ANY EXISTING TREE IN RELATION TO THE PLACEMENT OF ANY PERMANENT STRUCTURE OR UTILITY. IF FIELD ADJUSTMENTS TO THIS DESIRED DISTANCE OF 3.0 m ARE NOT FEASIBLE, PLEASE CONTACT A CITY OF EDMONTON URBAN FORESTER.
3. PRIOR TO CONSTRUCTION, ALL CITY OF EDMONTON TREES WITHIN 5.0 m OF THE CONSTRUCTION AREA SHALL BE PROTECTED IN ACCORDANCE WITH THE PROTECTIVE ZONE REQUIREMENTS. AS WELL AS TO DESIGNATE THE TREES OUTSIDE THE APPOINTED CONSTRUCTION WORK ZONE. IF A TREE CANNOT BE DESIGNATED OUTSIDE THIS ZONE, PROTECTIVE REQUIREMENTS STILL APPLY AND A CITY OF EDMONTON URBAN FORESTER MUST BE CONTACTED PRIOR TO OCCUPYING THIS SPACE FOR CONSTRUCTION. IF TREE DAMAGE OCCURS, COMPENSATION OR VALUE WILL BE ENFORCED AS PER THE CORPORATE TREE MANAGEMENT POLICY (C456C).
4. DURING CONSTRUCTION AND/ OR INSTALLATION, NO VEHICLES, EQUIPMENT, CONSTRUCTION SUPPLIES, OR DEBRIS SHALL BE PLACED WITHIN 5.0 m OF ANY TREE SITUATED ON THE CITY OF EDMONTON RIGHT-OF-WAY, BOULEVARD, GREEN SPACE/ BUFFER OR PARKLAND AREA WITHOUT THE APPROVAL OF A CITY OF EDMONTON URBAN FORESTER. ANY SOIL DAMAGE OR COMPACTION THAT TREES CRITICAL AND STRUCTURAL ROOT SYSTEM SHALL BE CORRECTED BY AND AT COST AS PER THE CORPORATE TREE MANAGEMENT POLICY (C456C).
5. CITY OF EDMONTON FORESTRY WILL SCHEDULE AND CARRY OUT ANY AND ALL REQUIRED TREE WORK (REMOVAL, PRUNING, TRANSPLANTING) INVOLVED WITH THIS PROJECT OR LAY-DOWN REQUEST. PLEASE CONTACT URBAN FORESTRY TO ARRANGE THIS MEETING (780-944-7831) THIS MEETING MUST BE SCHEDULED A MINIMUM OF 4 WEEKS IN ADVANCE OF THE CONSTRUCTION START DATE OR USE OF THE LAY-DOWN AREA.
6. TREE ROOTS OVER 50 mm (2") WILL REQUIRE FORESTRY REVIEW. FORESTRY CONTRACTOR WILL BE RESPONSIBLE FOR ROOT TREATMENT OVER 50 mm (2").

PLANTING:

1. THE CITY OF EDMONTON REPRESENTATIVE MAY REQUEST RANDOM SOIL TESTS FOR ANY AND/ OR ALL SOIL TYPES AND MIXES INSTALLED WITHIN THE PROJECT. THIS MAY BE REQUESTED AT ANY TIME DURING THE PROJECT UNTIL CONSTRUCTION COMPLETION CERTIFICATE IS RECEIVED FROM THE APPROVING AUTHORITY. SOIL SAMPLE LOCATIONS TO BE SELECTED BY THE CITY OF EDMONTON REPRESENTATIVE. THE CONTRACTOR WILL BE REQUIRED TO REPLACE OR AMEND DEFICIENT SOILS/SOIL MIXES TO MEET SPECIFICATIONS SHOULD THE TEST RESULTS INDICATE DEFICIENCIES. THE CITY OF EDMONTON REPRESENTATIVE TO SELECT SOIL SAMPLE LOCATIONS AFTER REPLACEMENT/AMENDMENTS OCCUR AND CONTRACTOR TO PROVIDE SOIL TESTING TO CONFIRM SPECIFICATIONS HAVE BEEN MET. ALL SOIL TESTING COSTS TO BE BORNE BY THE CONTRACTOR. TESTING AND INSPECTION OF IMPORTED TOPSOIL FROM NON-APPROVED CITY SOURCES PER JUNE 2016 SECTION 02910 TOPSOIL SPECIFICATION PER CITY OF EDMONTON DESIGN AND CONSTRUCTION STANDARDS.
2. CONTRACTOR RESPONSIBLE FOR VERIFYING ALL QUANTITIES AND NOTIFYING THE CITY OF EDMONTON REPRESENTATIVE OF ANY OMISSIONS.
3. REHABILITATION TO USE TOPSOIL FROM WEED FREE SOURCE AS PER THE CITY OF EDMONTON STANDARDS.
4. REFER TO CITY OF EDMONTON DESIGN AND CONSTRUCTION STANDARDS (CURRENT EDITION) FOR TREE SETBACKS FROM UTILITIES AND PROPERTY LINE, TREE SETBACKS FROM WALKWAYS AND ROADS, TREE AND SHRUB PLANTING.
5. SEED MIX:

NATIVE SEED MIX - CENTRAL PARKLAND

15%	AWNED WHEATGRASS	AGRYOPYRON TRACHYCAULUM VAR. UNILATERALE
15%	SLENDER WHEATGRASS	AGRYOPYRON TRACHYCAULUM VAR. TRACHYCAULUM
15%	WESTERN WHEATGRASS	AGRYOPYRON SMITHII
5%	SLOUGHGRASS	BECKMANNIA SYZIGACHNE
5%	IDAHO FESCUE	FESTUCA IDAHOENSIS
5%	ALKALI BLUEGRASS	POA SECUNDA SSP. JUNCIFOLIA
5%	JUNEGRASS	KOELERIA MACRANTHA
5%	SANDBERG BLUEGRASS	POA SECUNDA
20%	GREEN NEEDLEGRASS	STIPA VIRIDULA
10%	ROCKY MOUNTAIN FESCUE	FESTUCA SAXIMONTANA

6. CONTRACTOR TO ENSURE ADEQUATE SEED GERMINATION FOR CONSTRUCTION COMPLETION CERTIFICATE AND NATURALIZED TURF SHOULD BE ESTABLISHED BY FINAL ACCEPTANCE CERTIFICATE INSPECTIONS WITH THE CITY OF EDMONTON.
7. LANDSCAPE MAINTENANCE TO INCLUDE 1 YEAR WARRANTY AND MAINTENANCE PERIOD ON REHABILITATION.

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INFRASTRUCTURE PLANNING AND DESIGN

PROJECT

MACKINNON RAVINE PEDESTRIAN BRIDGE (B165)

BRIDGE REPLACEMENT

LANDSCAPING/RESTORATION AND SIGNAGE PLANS

DRAWING

S148 221 H02

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