Smith Crossing Pedestrian Bridge Replacement

Environmental Impact Assessment Pursuant to Bylaw 7188
Final Report

Prepared for:
City of Edmonton
Integrated Infrastructure Services
Edmonton, Alberta

Project Number EP-860
21 September 2021

Prepared by:
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21 September 2021
File: EP860

Dear Mr. Karim,

Re: Environmental Impact Assessment Pursuant to Bylaw 7188 for the Smith Crossing Pedestrian Bridge Replacement – FINAL REPORT

We are pleased to submit this pdf copy of the above-mentioned final Environmental Impact Assessment (EIA). This report is intended to fulfil Bylaw 7188 environmental review requirements. You will note that this EIA report reflects the City's decision to delay construction until the period July 2022-October 2023. That change to the schedule did not result in any changes to the draft EIA's impact assessment's findings.

As requested, this version of the final EIA includes the Associated Engineering's final hydrotechnical assessment report in Appendix E.

In addition, and as requested, the concordance table documenting the project team's responses to the City's Urban Planning and Economy's draft EIA comments is included in Appendix K of this report. A copy of the concordance table was previously provided under separate cover for your submission to Urban Planning for their review, circulation and approval for the EIA to go forward to City Council for their approval in November 2021.

As previously noted, a Site Location Study is not required for this project because the new bridge will be located in the footprint of the existing bridge.

Please contact the undersigned if you require additional information.

Sincerely,

Spencer Environmental
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1.0 INTRODUCTION

The City of Edmonton proposes to replace the Smith Crossing pedestrian bridge (BF 191) over Whitemud Creek, located immediately south of 23 Avenue and approximately 35 m downstream of the confluence of Whitemud and Blackmud Creeks. It is located in Whitemud Creek Ravine, within the boundaries of the City of Edmonton's North Saskatchewan River Valley Area Redevelopment Plan (NSRV ARP) (Bylaw 7188) (Figure 1, Appendix A). The pedestrian bridge was constructed in approximately 1914 and was historically used as a vehicle bridge over Whitemud Creek before it was repurposed as a pedestrian bridge in 1961 (BPTEC 2018). The bridge has reached the end of its service life and requires replacement to maintain safe operation for pedestrian use.

The existing bridge is a 24.38 m long single-span steel pony truss supported on unreinforced cast-in-place concrete abutments (BPTEC 2018) (Plates 1.1 to 1.5). The north abutment is directly exposed to creek flows (Plates 1.2 and 1.5) while the south abutment is set back on the vegetated creek bank (Plate 1.2). The north creek bank east of the pedestrian bridge comprises vegetated gabions extending approximately 350 m upstream along Blackmud Creek (Plate 1.1). Those gabions are part of previous slope stabilization work carried out between 1990 and 1992 when Blackmud Creek was realigned further to the south and a large toe berm was constructed to buttress the north creek bank and slope (Thurber 2006). EPCOR's Outfall #295 and recently bioengineered north creek bank (2019) is located west and downstream of the pedestrian bridge (Plate 1.6). EPCOR's Outfall #296 and associated riprap bank armouring is located immediately downstream of the south bridge abutment (Plates 1.1, 1.2 and 1.4). The south creek bank was bioengineered in 2019 in front of and upstream of the south bridge abutment as well as downstream of the Outfall #296 and associated riprap (Plates 1.4 and 1.5). The areas of bank bioengineering on the north and south banks are currently fenced.

The pedestrian bridge provides an important connection in the gravel trail system in Whitemud Creek Ravine in the vicinity of 23 Avenue, including access to the MacTaggart and Larch Sanctuaries to the south and to the top-of-bank Shared Use Path (SUP) along the east edge of the Magrath Heights neighbourhood (Figure 1, Appendix A).

The preliminary design phase of the project has been completed and detailed design is underway. Bridge replacement construction is tentatively scheduled to begin in summer 2022 and end in autumn 2023.

Plate 1.1. View to southwest of upstream side of pedestrian bridge crossing Whitemud Creek (prior to bank bioengineering) (19 July 2019).

Plate 1.2. View to south of downstream side of bridge over Whitemud Creek showing proximity of Outfall #296 to south side of bridge (prior to bank bioengineering (19 July 2019).

Plate 1.3. View south across bridge deck towards trailhead for McTaggart Sanctuary and trail to west up hill (19 July 2019).

Plate 1.4. View to southwest (downstream) of bridge crossing Whitemud Creek including fenced bank bioengineering areas at south abutment and downstream of Outfall #296 (30 January 2021).

Plate 1.5. View to west (downstream) of the north pedestrian bridge abutment and bioengineered south bank in distance (30 January 2021).

Plate 1.6. View to south of pedestrian bridge and fenced area of bioengineered bank at Outfall #295 on north creek bank (left); view downstream from bridge of bioengineered north bank at Outfall #295 (right) (30 January 2021).

The pedestrian bridge and adjacent lands needed for replacement activities are wholly located within the boundaries of the NSRV ARP (Bylaw 7188) and, therefore, trigger the need for an environmental review pursuant to that Bylaw. City Planning determined at a project scoping meeting that an Environmental Impact Assessment (EIA) is the appropriate required level of environmental review for compliance with the Bylaw 7188 process. A separate Site Location Study (SLS) is not required for the proposed project because the bridge will be replaced in the same footprint as the existing bridge. The EIA will require City Council approval.

This report comprises the Bylaw 7188 EIA prepared for the Smith Crossing pedestrian bridge replacement project. The EIA format and content follow a project-specific Terms of Reference (ToR)(Appendix B), informed by the NSRV ARP Guide to Completing Environmental Impact Assessments Environmental Reviews ToR and adapted with additional subsections to include all information relating to site plans, the project location and anticipated project activities.

2.0 THE PROPERTY

2.1 Project Area Location, Disposition, Zoning

The proposed pedestrian bridge replacement project assessed by this EIA is located on City-owned lands in Whitemud Creek Ravine (SE 1-52-25-W4M), immediately south of 23 Avenue and approximately 35 m downstream of the confluence of Whitemud and Blackmud Creeks (Figure 1, Appendix A). Figure 1 illustrates the project location in relation to Bylaw 7188 and adjacent lands. The portion of the project area east of the existing bridge is zoned as Metropolitan Recreation Zone (A), and the portion west of the existing bridge is zoned for Agriculture (AG). Figure 3 (Appendix A) illustrates land use zoning in and near the project area. Whitemud and Blackmud Creeks in the proposed project area are not mapped in the City of Edmonton's Flood Protection Overlay area or the Province's flood hazard mapping.

2.2 Historic Conditions

Historical aerial photograph review was limited to the photograph series available on Google Earth (2020) for 1985, 2002 to 2020 and City of Edmonton SLIM Maps pictometry (2007, 2013-2018 and 2020). This series of photographs shows that lands west of Whitemud Creek Ravine comprised agriculture land use until sometime between 2000 and 2002 when the area was developed into residential and commercial land use. The largest change to the tablelands surrounding the ravine occurred to the southwest of the bridge when the Magrath Heights Neighborhood was under development from 2004 to 2014. The Twin Brooks Neighbourhood to the south of the project area was already developed in 2004, and it is difficult to determine when that neighbourhood was developed due to the clarity of the available aerial photographs. Imagery from 2007 shows that a large area of vegetation southwest of the pedestrian bridge was cleared for construction of EPCOR's present-day dry pond associated with EPCOR's Outfall #296. By 2008, Outfall #296 and the associated riprap bank armouring had been installed on the south bank of Whitemud Creek immediately southwest of the bridge. Imagery from 2008 showed that 23 Avenue was twinned, including construction of a second vehicle bridge crossing over Whitemud Creek, expansion of the MacTaggart Sanctuary parking area south of 23 Avenue and addition of a drive in/out parking area north of 23 Avenue. There was little change in the bridge area until 2019, when EPCOR rehabilitated Outfalls #295 and #296 downstream of the bridge on the north and south creek banks, respectively. Extensive riprap bank armouring and bank bioengineering were constructed between Outfall #295 and the pedestrian bridge. Bank bioengineering was also constructed upstream and downstream of the south end of the bridge and Outfall #296.

2.3 Environmental Site Assessment and Soil Quality Assessment

2.3.1 Limited Phase II Environmental Site Assessment

Thurber Engineering Ltd. (Thurber) conducted a Limited Phase II Environmental Site Assessment (ESA) in the bridge project area to assess the environmental condition of soil under the bridge and surrounding area based on the assumption that the existing bridge has been coated with lead paint (Thurber 2019a). Thurber's complete Limited Phase II ESA report may be found in Appendix C. A summary of their scope of work and findings is provided below.

Thurber's scope of work included:

- advancement of a total of 17 test holes comprising an initial 10 test holes (four on each side of Whitemud Creek) on 09 July 2019 to a depth of 0.3 m followed by an additional seven (7) test holes located on the island beneath the bridge on 12 September 2019.
- collection of soil samples from surface to 0.15 m below ground surface and 0.15 m to 0.3 m below ground surface.
- submission of soil samples and one landfill characterization for laboratory lead chemical analyses.

Thurber (2019a) submitted 36 soil samples to the lab for analyses of lead. The soil was classified as fine grained by Thurber. Overall, all soil samples met lead guidelines and the landfill characterization sample met the applied Alberta Environment and Parks (AEP) user guide, therefore, the soil is not considered hazardous waste.

Thurber (2019a) recommended that during construction in the vicinity of the bridge careful attention should be paid to areas of visible lead paint during the excavation if encountered. Where lead paint chips or flecks are evident, in order to assess the extent and degree of soil impact at the location, an environmental sampling program should be conducted.

2.3.2 Soil Quality Assessment

Crimson Environmental Limited (Crimson) (2021) conducted a supplementary Soil Quality Assessment (ESA) of surface soils situated in the areas immediately underlying and/or adjacent to the Smith Crossing pedestrian bridge. The purpose of the investigation was to obtain soil quality data with respect to a select list of Alberta Tier I trace metals and/or salinity related parameters. Five boreholes (one on each side of the north bridge abutment and three adjacent the south abutment) were advanced on 13 May 2021 to depths ranging between 0.5 metres below ground level (mbgl) and 1.0 mbgl. Ten soil samples were collected and sent to an accredited laboratory for chemical testing.

Testing results indicated that no trace metal or salinity parameters exceeded Alberta Tier 1 Guidelines and there was no indication of widespread or severe impairment from road salt. Crimson's full report is provided in Appendix D.

3.0 ENVIRONMENTAL CONTEXT

3.1 Overview of Study Area and Adjacent Lands

The existing Smith Crossing pedestrian bridge crosses Whitemud Creek, approximately 35 m downstream of the confluence between Whitemud and Blackmud Creeks. The site is located in Whitemud Creek Ravine and bounded by 23 Avenue to the north, and Blue Quill Estates, Hodgson and Twin Brooks neighbourhoods to the east, west and south, respectively (Figure 1, Appendix A). MacTaggart Sanctuary, a City of Edmonton natural area, and Larch Sanctuary, an Edmonton and Area Land Trust conservation area, are located south of the pedestrian bridge. A gravel trail connects the unpaved parking lot south of 23 Avenue to the bridge and connects to trails to the north, south and west of the bridge. Extensive natural vegetation comprising mixedwood forest and riparian communities of willows and other moisture-loving species are present in Whitemud Creek Ravine and Blackmud Creek Ravines in undisturbed areas south of the pedestrian bridge and in Whitemud Creek Ravine north of 23 Avenue. Creek banks immediately adjacent the pedestrian bridge have been previously disturbed in support of EPCOR stormwater management infrastructure. Previously disturbed slopes adjacent the parking lot and connecting gravel trail south of 23 Avenue comprise exotic grasses and forbs and typical road right-of-way grasses that is frequently mowed.

The EIA study area was defined at two scales, local and expanded. The local study area (LSA) comprises the lands within and adjacent the project area that have potential to be directly affected by the proposed development, temporarily and permanently [Figures 1 and 2 (Appendix A)]. An expanded study area was established for assessment of some resources, such as environmental sensitivities and wildlife movement, and included adjacent river valley ravine lands that may be indirectly affected, and adjacent residential areas as shown in Figure 1 (Appendix A).

3.2 Environmental Sensitivities

3.2.1 Original (2016) Mapping

Figure 4 (Appendix A) shows the results of the City of Edmonton environmental sensitivities analysis and classification mapping (Solstice 2016) in the project vicinity, overlaid with our LSA. The LSA is predominantly mapped as being high value to the City with some areas around the gravel parking lot and trail and adjacent 23 Avenue being mapped as moderate value. Some small areas along Whitemud Creek and within treed areas were mapped as very high and extremely high value. The City considers high, very high, and extremely high values as lands suitable for protection or conservation.

3.2.2 Refined Mapping

Methods

As requested by the ToR (Appendix B), using the July 2019 site-specific vegetation data and mapping, we re- analyzed City of Edmonton’s Environmental Sensitivities (2016) GIS layer for the LSA. In particular, we updated the input Ecological Asset scores for the Natural Vegetation (‘AVegNat2’ attribute), and for the Non-Native Vegetation

('AVegNoNat1' attribute). Overlay analysis (union function) was used to intersect the 2019 vegetation polygons with the 2016 Environmental Sensitivities polygons. This not only allowed us to update the relevant scores, it also allowed us to break up the larger 2016 mapped polygons to reflect our finer scale 2019 mapped polygons. Scores were updated as shown in Table 3.1.

Table 3.1. Sensitivity Analysis Refinement

Where 2020 Vegetation were observed to be...	…the respective Environmental Sensitivities attribute was updated to:
Deciduous Mixedwood – Mixed Shrubs (DLM.1)	If not originally so, update to: Natural Vegetation ('AVegNat2' attribute) = 2 score; Non-Native Vegetation ('AVegNoNat1' attribute) = 0 score.
Non-Forested Smooth Brome – Level Slopes (NF.7)	If not originally so, update to: Non-Native Vegetation ('AVegNoNat1' attribute) = 1 score; Natural Vegetation ('AVegNat2' attribute) = 0 score.
Riparian (R)	If not originally so, update to: Natural Vegetation ('AVegNat2' attribute) = 2 score; Non-Native Vegetation ('AVegNoNat1' attribute) = 0 score.

With the scores updated, the Environmental Sensitivities analysis – whereby Assets, Threats and Constraints were summed – was re-run using the model formula as originally prescribed by Solstice Canada (2016) to produce the new cumulative Environmental Sensitivities layer for the study site. The original final score categorical classes were used to bin the new scores.

Description

The revised Environmental Sensitivities map (Figure 5, Appendix A) shows some small changes in mapping within the LSA, particularly in the bridge area. The area to the east of the bridge that was formally mapped as extremely high value has expanded slightly to the south. A small area to the west of the bridge is now mapped as extremely high value where it was previously mapped as very high value. Areas of very high value have been extended along the creek's riparian area. The small island under the bridge is now also mapped as very high value. The area mapped as moderate value adjacent to 23 Avenue and the trails was extended slightly to the south to encompass non-native vegetation present along the trails near the bridge. Areas of moderate value have been identified by the City as good candidates for restoration to improve habitat quality.

3.3 Surface Water and Groundwater

3.3.1 Methods

Surface Water

Surface water flows in the proposed project area were described based on examination of topographic maps and field observations. Available literature, relevant environmental assessments prepared by Spencer Environmental and others were also reviewed for additional information.

Associated Engineering Ltd. (2021) conducted a hydrotechnical assessment in support of the proposed project where they updated the flood frequency analysis which was completed during the *Blackmud/Whitemud Surface Water Management Study* in 2016. The updated analysis incorporated the most recent flow data (up to 2018) available from the Water Survey of Canada to estimate the peak stream flows within Blackmud and Whitemud Creeks. Associated Engineering also developed one-dimensional and two-dimensional numerical model for the Smith Crossing Pedestrian Bridge. Model results represent the natural channel flood depths, extents, and velocities (Associated Engineering 2021).

Kingfisher Aquatics' (Kingfisher) (2021) Fisheries Resources Assessment was also reviewed for information describing Whitemud Creek.

Associated Engineering's (2021) full report can be found in Appendix E, and Kingfisher's full report can be found in Appendix F.

Groundwater

Thurber (2019b) installed a standpipe piezometer in test hole TH19-01 to a depth of 13 m on the north side of Whitemud Creek during drilling and site investigations between the period of 10 July 2019 and 13 July 2019. The piezometer was installed flush to the ground surface, backfilled with drill cuttings and capped with bentonite chips near the ground surface. The piezometer was monitored at the time of installation and on 29 July 2019. Thurber's report is provided in Appendix G.

3.3.2 Description

Surface Water

Whitemud and Blackmud Creeks are the most significant natural features in the project area. Whitemud Creek's confluence with Blackmud Creek is located approximately 35 m upstream of the bridge and then meanders in a northerly direction towards the North Saskatchewan River (NSR). Kingfisher (2021) found that Whitemud Creek within the study area was generally confined within a natural channel with an irregular meander pattern and could best be described as a Rosgen Type E channel. The mean wetted width within the study area was 10.6 m, while the mean channel width was 13 m. Water depths varied considerably and averaged approximately 0.4 m at the bridge site (Kingfisher 2021, Appendix F). Whitemud Creek and Blackmud Creek are Class B and C water bodies, respectively, with a Restricted Activity Period (RAP) of 16 April and 30 June (AESRD 2012).

The pedestrian bridge location has an approximate drainage area of 1,050 km^2 (Associated Engineering 2021, Appendix E). The channel reach at the bridge location is generally flat with gentle to steep banks. Simulated average velocity of creek flows at the pedestrian bridge are 0.9 m/s during a 2-year design flood event and 2.8 m/s during a 100-year design flood event. The 100-year design flood water level is 643.7 m (Associated Engineering 2021, Appendix E).

Plate 3.1. Looking upstream from the existing pedestrian bridge at the confluence of Blackmud (left) and Whitemud (right) Creeks (26 June 2019).

Plate 3.2. Looking downstream from the existing pedestrian bridge at Whitemud Creek and 23 Avenue vehicle bridge crossings (26 June 2019).

Groundwater

Upon installation of the standpipe piezometer, groundwater was found at a depth of 4.1 m below ground surface (Thurber 2019b). On 29 July 2019 the groundwater level was observed at 1.5 m (elevation 642.4 m), which corresponded to approximately 3 m above creek level. Groundwater levels can vary in response to seasonal factors and precipitation.

3.4 Fish and Fish Habitat

3.4.1 Methods

Kingfisher (2021) undertook field and desktop investigations to assess fish populations and fish habitat in the study area. Field investigations were conducted following Kingfisher's standard procedures for small to medium crossings. These procedures are consistent with the methods described in the *Alberta Fish Habitat Manual*, which were designed to meet the requirements of the Code of Practice for Watercourse Crossings as well as information requirements of Fisheries and Oceans Canada (DFO). The desktop review comprised a query of the Fish and Wildlife Management Information System (FWMIS; AEP 2021a) to identify historical fish sampling efforts in the Whitemud Creek drainage.

Field investigations were conducted on 05 September 2019, and included:

- habitat inventory of a 673 m section of Whitemud Creek at and adjacent to the project site;
- characterization of the channel profile at seven transects that were established on Whitemud Creek in the vicinity of the proposed works; and
- in-situ sampling of select water chemistry variables (pH, temperature, dissolved oxygen, conductivity and turbidity) at one location within Whitemud Creek.

Kingfisher's full report is provided in Appendix F.

3.4.2 Description

A query of the FWMIS database identified 20 different fish species that are known to inhabit Whitemud Creek (Kingfisher 2021, Appendix F). Species previously captured in Whitemud Creek include sport fish species, large-bodied non-sport species and forage fish. None of the fish species previously found within the creek are listed as special status species. AEP has designated three of the sportfish species, burbot, northern pike and walleye, as higher management priority according to fisheries management objectives set out for the NSR (Kingfisher 2021, Appendix F).

Fish habitat within the study area consisted primarily of shallow (<0.5 m deep) run habitat. Moderate depth (0.5 m to 1.0 m deep) run habitat and riffle habitat were present in modest quantities, while deep (>1 m deep) run habitat and pools were relatively rare (Kingfisher 2021, Appendix E). Fines and coarse substrates were present in similar quantities overall, with the coarse fraction composed of comparable proportions of gravel, cobbles and boulders. The streambanks were composed almost entirely of fine materials. In general, the riparian area was well vegetated with a mixture of grasses, shrubs and trees; however, some erosion and a lack of vegetation was noted along the outside of several channel meanders. Cover for fish was relatively sparse within the study area. Overhanging vegetation, woody debris, and overhanging banks were the most prevalent forms of cover while boulders and aquatic vegetation afforded limited cover opportunities. There was minimal cover for large-bodied fish due to the lack of deep water habitat (Kingfisher 2021, Appendix F).

Results from in-situ water quality and stream discharge measured at one location within the study area can be found in Table 3.2.

Table 3.2. In-situ water chemistry and stream discharge for Whitemud Creek.

Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)	Temperature (°C)	Specific Conductivity (µS/cm)	Discharge (m^3/s)
9.62	8.17	12.78	17.1@13:20	917	0.235

Overall, the capability of the fish habitat within the study section was judged to be moderate.

Watercourse Class and Restricted Activity Period

Whitemud Creek and Blackmud Creek are Class B and C water bodies, respectively, with a Restricted Activity Period (RAP) of 16 April and 30 June (AESRD 2012).

3.5 Geology/Geomorphology/Soils

3.5.1 Methods

Thurber conducted a geotechnical investigation in support of the proposed bridge replacement project in summer 2019 comprising a drilling program and laboratory testing of soil samples (Thurber 2019b, Appendix G).

Two test holes were drilled on the north and south sides of the creek at abutment locations between 10 July 2019 and 13 July 2019. Test hole TH19-01 was drilled to a depth of 13.4 m (elevation 630.5 m) and test hole TH19-02 was drilled to a depth of 15.5 m (elevation 628.1 m) below the ground surface. Both holes terminated in competent bedrock.

Soil samples were obtained during drilling and Standard Penetration Tests (SPTs) were carried out at selected depths in each test hole. The undrained shear strength of cohesive soil samples was estimated at select locations using a pocket penetrometer (Thurber 2019b).

Following collection of soil samples, laboratory tests included visual classification and determination of natural moisture content of all recovered soil samples. Atterberg limits, grain size analysis and soluble sulphate tests were performed for selected soil samples. In addition, an undrained shear strength test was also conducted on a select undisturbed sample from TH19-01 (Thurber 2019b, Appendix G).

Thurber (2019b, Appendix G) undertook a slope stability analysis for both north and south abutments in their current configuration using the program SLOPE-W. In 2021, Thurber undertook a second slope stability analysis for the proposed new bridge design (Appendix G).

Thurber's complete reports are provided in Appendix G of this document.

3.5.2 Description

Site Geology

Thurber (2019b, Appendix G) noted that the site geology is expected to be underlain by fluvial deposits derived from the Blackmud and Whitemud Creeks overlying Upper Cretaceous bedrock comprised of clay shales and sandstones of the Horseshoe Canyon Formations of the Edmonton Group. The clay shale and sandstone bedrock contain scattered coal and bentonitic beds. Bedrock materials were weakly cemented, often resembling hard over-consolidated clay, and exhibit many of the properties associated with soils such as softening and swelling on exposure to weathering. Bedrock is present at the approximate elevations of 635 m to 640 m at the bottom of the Whitemud Creek valley (Thurber 2019b, Appendix G).

Surface Conditions

The north bridge abutment is located on the edge of the creek and is directly exposed to creek flows (Thurber 2019b, Appendix G). The northeast riverbank upstream of the bridge is protected with gabion baskets, which are overgrown with vegetation. The southwest riverbank downstream of the bridge is protected by heavy riprap where a storm water outlet (Outfall #296) discharges into the creek. The bridge is relatively level, with ground surface elevations at about 643.5 m. The creek bed elevation at the project site is about 639 m, with the bridge deck located approximately 4 m above the creek bed.

Subsurface Conditions

Clay fill was encountered under the surficial layers in both test holes, extending to depths between about 3.0 m and 3.5 m below the ground surface (Thurber 2019b). Gravel was encountered underlying the clay fill in test hole TH19-02 at about 3 m below grade and was about 0.8 m thick. Silty clay was encountered underlying the gravel in test hole TH19-02 and extended to a maximum depth of 3.8 m below ground surface. Clay shale and sandstone bedrock was encountered underlying the clay fill or silty clay layers in both test holes. The depth to bedrock in the test holes ranged from 3.8 (elevation 640 m) m to 6.1 m (elevation 637 m) (Thurber 2019b, Appendix G).

Slope Stability

Thurber (2019b, Appendix G) did not observe any signs of riverbank instability, as slopes were generally well vegetated. The heavy rock riprap on the southwest bank and the gabion basket slope protection on the northeast bank both appeared to be functioning as intended (Thurber 2019b, Appendix G).

The northeast abutment is founded below the creek bed and no head slope currently exists (Thurber 2019b, Appendix G). The northeast bank appeared to be relatively stable and no evidence of bank erosion was observed during Thurber's (2019b) site visits. Thurber (2019b) recommends that the creek bank erosion protection be reviewed by a hydrotechnical consultant to evaluate the adequacy and determine if additional creek bank erosion protection is warranted.

Thurber (2019b, Appendix G) undertook slope stability analyses for the south abutment using two different cases: geometries based on a cross-section of the existing surveyed slope profiles with soil conditions based on available test hole logs, and a 2:1 slope was assumed to have been constructed of common fill materials and placed above the existing soils. A target factor of safety of 1.5 was desired for head slope stability. In both the present and proposed cases, the south head slope under the bridge appears to be in a stable condition, with a long-term factor of safety of at least 1.5 (Thurber 2019b, Appendix G).

Thurber's (2021) additional slope stability analysis found that the north head slope meets the target factor of safety for the design slope angle of 1.5H:1V; increasing the slope to 1.4H:1V (or steeper) does not meet the target factor of safety of 1.5. The south head slope meets the target factor of safety for the design slope angle of 2H:1V. The embankment side slopes meet the target factor of safety for the design slope angle of 2H:1V (Thurber 2021).

3.6 Vegetation

3.6.1 Methods

Vegetation in the LSA was characterized by undertaking the following tasks:

- Preliminary desktop delineation of plant communities using high-resolution remote imagery.
- Classification of plant communities following the Urban Ecological Field Guide for the City of Edmonton, Alberta, Canada (City of Edmonton 2015). Riparian plant communities were described as such, as no plant communities within the Urban Ecological Field Guide fit the community observed.
- Search of the Alberta Conservation Information Management System (ACIMS) (AEP 2021b) for all records of special status plant species within the project area on 12 February 2021. The area searched consisted of legal section 01-52-25-W4M.
- Plant community inventory and rare plant vegetation survey on 19 July 2019 to characterize communities and identify occurrences of rare plants. Results are located in Appendix H.
- Species nomenclature follows the ACIMS' *List of all Vascular Plant Elements recorded for Alberta in the ACIMS Database - March 2018* (AEP 2018).

3.6.2 Description

The following natural plant communities were mapped in the study area (Figure 6, Appendix A):

- Deciduous Mixedwood – Mixed Shrubs (DLM.1)

- Non-Forested Smooth Brome – Level Slopes (slopes <60%) (NF.7)
- Riparian (R)

3.6.2.1 Deciduous Mixedwood – Mixed Shrubs (DLM.1)

In general, this community type is characterized in City of Edmonton (2015) as having considerable tree cover comprising predominantly balsam poplar and white spruce, moderate but diverse shrub cover and relatively low forb and grass cover. It tends to occur on rich sites.

Within the study area, the deciduous mixedwood – mixed shrub community was present upslope of Whitemud Creek on the west side of the existing bridge, adjacent to the MacTaggart Sanctuary access trail (Figure 6, Appendix A). In the study area, this community generally conformed to the description provided above, comprising dominant balsam poplar and abundant white spruce, with occasional Manitoba maple (Plate 3.3). Abundant and frequently occurring shrubs included buckbrush, prickly rose, red-osier dogwood, wild red raspberry and an escaped horticultural variety of lilac. The forb and graminoid layer was relatively open compared to the dense shrub layer, with abundant or frequent occurrences of star-flowered Solomon's-seal, common fireweed, wild sarsaparilla, and woodland horsetail. The forest margins supported abundant exotics, including white-sweet clover, alfalfa and alsike clover.

Plate 3.3. Interior of the deciduous mixedwood – mixed shrub community, demonstrating a diverse shrub layer and relatively open herbaceous layer (19 July 2019).

Overall 30 species were observed in the deciduous-leading mixedwood – mixed shrub community. Of these, 20 (67%) were native, while the remaining 10 (33%) were exotic or noxious. Two species of noxious weeds were observed in this community: common tansy and creeping thistle. No prohibited noxious weeds were observed in this community.

3.6.2.1 Non-Forested Smooth Brome – Level Slopes (slopes <60%) (NF.7)

This community is characterized in City of Edmonton (2015) as being anthropogenic in origin and dominated by species of grasses, particularly the exotic species smooth brome. It tends to occur on nutrient-rich soils.

In the study area, the non-forested smooth brome community was present on the east side of Whitemud Creek, and south of the existing parking area (Figure 6, Appendix A)(Plate 3.4). In the study area, this community generally conformed to the description provided above and was characterized by exotic grass species, such as smooth brome, quackgrass, crested wheatgrass and timothy forming the dominant cover. Abundant forbs included cicer milkvetch, alsike clover, alfalfa and yellow lucerne. Shrubs were relatively infrequent, with sandbar willow and buckbrush observed occasionally. A few planted trees and shrubs were observed adjacent to the existing parking area and included aspen, balsam poplar and Peking cotoneaster.

Plate 3.4. Non-forested smooth brome community, looking west toward Whitemud Creek (19 July 2019).

Overall 35 species were observed in the non-forested – smooth brome community. Of these, nine (26%) were native, while the remaining 26 (74%) were exotic or noxious. Six species of noxious weeds were observed in this community: common tansy, common toadflax, creeping thistle, leafy spurge, scentless chamomile, and white cockle. No prohibited noxious weeds were observed in this community.

3.6.2.1 Riparian (R)

Riparian communities are not characterized as part of City of Edmonton (2015). Riparian communities are situated on the banks of watercourses and generally comprise moisture-loving vegetation and moist soils (Figure 6, Appendix A). Within the study area, riparian communities were situated on the banks of Whitemud Creek and were characterized by wetland-associated species lower on the slopes and moist forest vegetation farther upslope (Plate 3.5). In particular, the lower portion of the bank supported dominant or abundant reed canary grass, awned sedge, wolf willow and shining willow, with frequent occurrences of bulrush, pale persicaria, common horsetail, and yellow avens. Farther upslope, river alder, red-osier dogwood and wild red raspberry were abundant shrubs, with abundant to frequent forbs including woodland horsetail, common horsetail and wild sarsaparilla.

Plate 3.5. Riparian community on the east bank of Whitemud Creek (19 July 2019)

Overall, 51 species were observed in the riparian community. Of these, 34 (67%) were native, while the remaining 17 (33%) were exotic or noxious. Seven species of noxious weeds were observed in this community: common tansy, common toadflax, creeping thistle, leafy spurge, perennial sow-thistle, scentless chamomile, and white cockle. No prohibited noxious weeds were observed in this community.

3.6.2.2 Special Status Species

In the City of Edmonton, rare plant species are considered as those having an ACIMS conservation rank of S1, S2 or S3. S1 species are known from five or fewer locations in the province. S2 species are known from 6-20 occurrences, and S3 species are known from 21-100 occurrences in the province. A rare plant survey was required by City Planning and was undertaken on 19 July 2019; no rare plant species were detected during that survey. A search of ACIMS data conducted on 12 February 2021 returned no records of special status vascular plant species in the immediate project area.

3.6.2.3 Weeds

The Alberta *Weed Control Act* defines two categories of weeds: noxious and prohibited noxious. Noxious weeds are generally those that are currently widespread in the province and are considered difficult to eradicate. Provincial legislation requires those species to be *controlled*. Prohibited noxious weeds are those that are currently uncommon or absent in the province but have been identified as noxious due to their potential to invade and damage natural and cultivated systems. Alberta law requires that prohibited noxious weeds be *destroyed* where they are found.

Prohibited Noxious Species

No prohibited noxious weed species were observed in the study area.

Noxious Species

Noxious weeds found in the study area included common tansy, common toadflax, creeping thistle, leafy spurge, perennial sow-thistle, scentless chamomile and white cockle. All these species are common on disturbed lands in the Edmonton area. Noxious weeds were widespread and relatively abundant in the non-forested – smooth brome and riparian communities; all seven species were observed in the riparian community, and all but perennial sow-thistle were observed in the non-forested smooth brome community. Only two noxious weed species (common tansy and creeping thistle) were observed in the deciduous-mixedwood forest and both had relatively low occurrences in that community.

3.7 Wildlife

3.7.1 Methods

Wildlife resources in the study area were characterized by undertaking the following tasks:

- Conducting one breeding bird survey in representative habitats in the project area on 26 June 2019, at 0440 hours, by a professional biologist experienced in breeding bird surveys. Five, 50 m radius point count stations (Figure 7, Appendix A) were surveyed. All birds seen or heard within an 8-minute period were recorded and estimated bird locations were mapped within the survey area.
- Visually surveying the LSA on 26 June 2019 and 30 April 2021 for the presence of wildlife trees.
- Conducting two snake hibernaculum surveys of the LSA were completed by two qualified professional biologists on each of 30 April 2021 and 13 May 2021 due to the potential presence of a historical garter snake (*Thamnophis spp.*) den site in the project vicinity (AEP 2021 and Kendell 2020).
    - The purpose of the survey was to determine whether there was evidence of snake habitat use in the LSA indicating the potential presence of an occupied hibernaculum. Spencer Environmental's search protocol was based on provincial survey methods (Government of Alberta 2013) and communications with provincial experts.

  - The two surveyors conducted meandering transects throughout the LSA during appropriate ambient conditions (light or calm wind, clear or partly cloudy skies, and mean air temperature of around 18°C) to meet the province's guidelines (Government of Alberta 2013) and recent Alberta Conservation Association snake hibernaculum survey data (Kendell 2020).
  - On the advice of K. Kendell (*pers. comm.*), the surveys focussed on suitable snake habitat including land surface features or human structures that may suggest the creation or formation of favourable belowground conditions for snakes and where good sun exposure occurs. Specifically, features surveyed in the project area included south-facing slopes, the pedestrian bridge abutments and 23 Avenue bridge abutments, adjacent outfall infrastructure and riprap and in and around the gabion baskets along the north bank of Blackmud Creek for evidence of snake presence (e.g., dead or alive snakes, skin shedding). If snakes and/or a hibernaculum were observed, the surveyors noted location, species and behaviour.
- Documenting all incidental wildlife and wildlife sign observations during site visits.
- Documenting incidental wildlife and wildlife sign observations in the ravine during site visits.
- Characterizing available habitat type, condition and quality through field observations and examination of City of Edmonton vegetation datasets and maps.
- Searching Fish and Wildlife Management Information System (FWMIS) for all wildlife records for lands within a one km radius centered on the bridge. FWMIS was accessed on 12 February 2021 (AEP 2021).
- Searching eBird for verified species observation records.
- Preparing a list of potential wildlife species present, including special status species, by considering all of the above and our knowledge of Edmonton wildlife communities and occurrences (Appendix I).
- Qualitatively assessing wildlife movement corridors/habitat connectivity in the expanded study area.
- Common species names are used throughout the text; scientific names are provided in Appendix I.

Wildlife nomenclature in this report follows the Cornell Lab of Ornithology's 2018 Clements Checklist (birds), the Government of Alberta's 2015 Wild Species Status List (mammals, amphibians, reptiles) and Alberta eBat (bats).

3.7.2 Description

3.7.2.1 Available Habitat, Observed and Potential Wildlife

The LSA was dominated by open grassy areas in previously disturbed areas to the north and east of the bridge along the 23 Avenue roadway embankment and south of the bridge on the west side (Figure 6 in Appendix A). Riparian habitat was located along the banks of Whitemud Creek at the time of our survey in July 2019, however, the banks were re-engineered in fall 2019 in association with EPCOR outfall rehabilitation activities. Disturbed areas from those activities currently have snow fencing around them on the west side of the bridge to the north and south of Whitemud Creek. At the time of our survey in 2019 there were some areas of deciduous mixedwood trees and shrubs located on the south side of the bridge to the east and west of the trail. No wildlife trees (i.e., trees with visible nests or large trees with cavities) were observed in the LSA. Overall, the structural and spatial diversity of these habitat types provided low- to medium quality wildlife habitat in the LSA for some urban-adapted avian and mammal species. Better and higher quality habitat is located in the expanded study area in Whitemud and Blackmud Creek Ravines to the north, south and east.

McTaggart and Larch Sanctuaries are well known birding locations, which is reflected in the fact that there are eBird Field Checklists available for each area. The Edmonton Area and Land Trust has documented 34 species for the Larch Sanctuary. The general birding public has documented 116 species in the MacTaggart Sanctuary. Documented bird species include a range of resident, short-distance and long-distance migratory species over the past several years, some of which could use suitable habitat in the LSA.

Avifauna

Breeding Bird Survey

The EIA's breeding bird survey provides a snapshot of passerine use of the area. The survey recorded 29 individuals of 12 species across the five, point count stations (station) surveyed (Table 3.3; Figure 7, Appendix A). All species observed are known to commonly breed in Edmonton. Most of these species were singing territorially and were likely nesting in the area. Species abundance within the surveyed area ranged from 1 to 9 individuals, with the yellow warbler being the most abundant (9). This species was detected at every survey station, whereas every other species was found at 1 to 3 of the 5 survey stations. The high abundance of yellow warbler and the occurrence of cedar waxwing, gray catbird and song sparrow indicated that the tall dense shrubs in the surveyed area were a valuable component of the available habitat. The mature mixedwood forest provided suitable nesting habitat for vireos and white-throated sparrow. The presence of cavity nesting species, e.g., black-capped chickadee and downy woodpecker, indicated there was suitable mature trees and/or snags in the expanded study area to support nesting. No nests were observed on the bridge during the breeding bird survey in 2019 or during site visits in spring 2021.

Table 3.3. Summary of Bird Species Observed in the Project Area During the Breeding Bird Survey (26 June 2019)

Species Common Name	Point Count Station (50 m radius)*					Total Individuals
	1	2	4	5	6	
American crow			2			2
Black-capped chickadee			1			1
Cedar waxwing	1		1		2	4
Clay-colored sparrow	1	1				2
Downy woodpecker					1	1
Eastern phoebe	1					1
Gray catbird	1					1
Red-eyed vireo			2	1		3
Song sparrow	1	1				2

Species Common Name	**Point Count Station (50 m radius)***					**Total Individuals**
	1	**2**	**4**	**5**	**6**	
Warbling vireo		1	1			2
White-throated sparrow			1			1
Yellow warbler	2	1	4	1	1	9
Total (abundance)	**7**	**4**	**12**	**2**	**4**	**29**
Total (species richness)	**6**	**4**	**7**	**2**	**3**	

*Point count station #3 was not surveyed due to inability to hear birds over the loud sound of rushing water from Whitemud Creek flowing under the bridge.

Mammals

Incidental mammal observations recorded during the breeding bird survey on 26 June 2019 included red squirrel, coyote, and beaver. As noted above, a coyote was observed crossing 23 Avenue to the LSA and crossing over Whitemud Creek using the pedestrian bridge (A. Bismanis, *pers. comm.*). In addition, beavers were observed in Whitemud Creek during the breeding bird survey and during a site visit in spring 2021.

Other undocumented species may use the area as breeding, foraging or year-round habitat. A list of wildlife species potentially occurring in the LSA is provided in Appendix I.

Reptiles

All terrestrial reptiles in Alberta, including snakes, congregate in winter dens or hibernacula. Any subterranean cavity of enough depth to allow snakes access below the frostline can serve as a den (e.g., burrows, crevices in rocks, cracks in the soil, etc.) (Kendell 2020). Dens are difficult to locate because of the complex and cryptic subsurface needs of snakes and suitable dens may be limited or absent in some areas despite the appearance of abundant suitable habitat (Kendell 2020). Dens are also ephemeral in that if they collapse or otherwise become unsuitable, snakes will move to a new den. There is a historical record of a snake hibernaculum in the project area (Kendell 2020), the exact location of which is unknown. Kendell (2020) considered the hibernaculum in the general area to be active based on the observation of one snake sunning itself on the rocks along Whitemud Creek in May 2018.

No evidence of garter snakes (*Thamnophis* spp.) was observed by the surveyors in the LSA during the hibernaculum surveys conducted for the proposed project in April and May 2021. No snakes were overserved around south-facing slopes, the pedestrian bridge abutments, the 23 Avenue bridge abutments, outfall and riprap areas or in and around the gabion baskets along the north bank of Blackmud Creek. A member of the public, however, did note the presence of one garter snake in the grass on the slope east of the parking lot coincident with the second hibernaculum survey on 13 May 2021. Based on that information, Spencer Environmental conducted additional survey effort in that area to attempt to find more evidence of snake use, however, no additional observations were made. The observation of one snake on that grassy, south-facing slope suggests there may be a hibernaculum in the vicinity because snakes would be expected to be just emerging from their dens on warm spring days at that time of year and would not be expected to travel far from the den until later in the season. If there is a hibernaculum in the area east of the parking lot, it would be located outside of the bridge project's LSA.

Snakes appear to be commonly observed by the public in the project area based on comments collected during stakeholder and public engagement events held in support of the project, however, the locations and time of year of those observations are unknown.

3.7.2.2 Wildlife Movement/Connectivity

Large-, medium- and small-sized urban-adapted wildlife species, such as moose, deer, coyote, beavers, and weasels are known to utilize Whitemud and Blackmud Creek Ravines as major movement corridors. This is owing to the relatively undisturbed nature of the ravines, the relatively high level of ecological connectivity, the availability of a diversity of habitat types and the relative lack of barriers to movement. Specific to the expanded and LSAs, animals can move unimpeded under the elevated 23 Avenue bridges along Whitemud Creek northwest of the pedestrian bridge and to the east, west and south of the pedestrian bridge. Some wildlife pass under the existing pedestrian bridge along the creek banks under low water and frozen conditions if they can navigate around the north pedestrian bridge abutment, adjacent bioengineered banks and outfall-related riprap. A few deer tracks were observed crossing the frozen creek under the pedestrian bridge on 30 January 2021 (A. Bismanis, *pers. comm.*). In addition, in January 2021 extensive deer and coyote tracks were observed scattered across the open grassy area to the north and east of the pedestrian bridge as well as extensive trails along the creek banks leading to and from the frozen creeks. On the south side of the bridge there were extensive deer trails extending from the east creek bank up to and across the pedestrian trail to the west side of the trail. That trail continued along the south Whitemud Creek bank along the edge of the fenced bioengineered area before descending down to the frozen creek. No deer tracks were observed in the snow crossing over the pedestrian bridge. Moose tracks were observed coming off the frozen creek and onto the gravel trail under 23 Avenue on 20 February 2021. A coyote was observed during the breeding bird survey on 26 June 2019 crossing 23 Avenue and then moving down the gravel trail from the parking area to and over the pedestrian bridge towards MacTaggart Sanctuary.

According to the City of Edmonton's Wildlife Passage Engineering Design Guidelines (WPEDG)(City of Edmonton 2010), all ecological design groups (EDG's) are expected to be able to successfully cross a recreational trail. The gravel trails in the LSA, therefore, are not considered a barrier to wildlife movement for urban-adapted wildlife species. Based on the existing clearance under the pedestrian bridge, the above-noted wildlife movement observations, and the creek habitat present under the bridge, most EDG's [large terrestrial (LT), medium terrestrial (MT), small terrestrial (ST), Aerial mammal (AM), aquatic (AQ), amphibian (AMP), waterbirds (WB) and Other birds (OB)] are expected to successfully pass under the pedestrian bridge under suitable conditions.

3.7.2.3 Special Status Species

Based on species habitat requirements, an understanding of the available habitat in the project area, provincial species distributions and species records in the FWMIS database, several special status species were identified as having at least some potential to occur in the LSA (Appendix I). The following section discusses the potential occurrence of species that are ranked by the Province that are *At Risk* or *May Be At Risk*, or, have been federally assessed by the Committee on the Status of Endangered Wildlife in Canada (COSWIC) as either *Endangered, Threatened*, or *Special Concern*, and were rated in this study as having at least a moderate likelihood of occurrence within the LSA. In addition, all species on Schedule 1 of the *Species at Risk Act* (SARA) with ranges that include Edmonton and for which suitable habitat is available in the project area are included for discussion. Species having a provincial status of *Sensitive*, but no federal status, hold no potential to trigger project considerations beyond those applicable to wildlife in general, and, thus, are not discussed, even if their potential for occurrence was considered moderate or high.

The FWMIS search returned records of one special status species observed within one km of the project area: long-tailed weasel. In addition, we identified little brown bat and northern myotis, both on Schedule 1 of SARA, as potentially occurring in the bridge area. Table 3.6 includes an overview of each species status, likelihood of occurrence and potential habitat use in the study area.

Table 3.6. Special Status Wildlife Species with Moderate or High Potential to Occur in the Study Area

Common Name	Provincial Status (General Status of AB Wild Species 2015)	Wildlife Act Designation*	COSEWIC Designation	SARA Designation (Schedule 1)	Likelihood of Occurrence	Potential Habitat Use
Little Brown Myotis	May Be At Risk	None given	Endangered	Endangered	Moderate	Roosting, foraging
Northern Myotis	May Be At Risk	Data Deficient	Endangered	Endangered	Low	Roosting, foraging
Long-tailed weasel	May Be At Risk	None given	Not At Risk		Moderate	Breeding, foraging

* Under the *Wildlife Act*, select species carry a designation of Threatened or Endangered; additional species assessed by the Endangered Species Conservation Committee (ESCC) also have these designations.

Little Brown Bat and Northern Myotis

Little brown bat utilizes tree crevices (especially old, dead or dying trees in mature deciduous forests) for day roosting in spring and summer and for maternity roosting during the breeding season. They may also roost in buildings or bridges or in man-made bat boxes. While no observations of this species have been recorded in the project area in FWMIS, the presence of suitable mature forest in the project area, particularly south of the bridge and adjacent Blackmud and Whitemud Creeks – important water source and hunting areas – suggests a high probability of occurrence in the project area during summer months. A rocket bat box on a pole, recently installed by the Edmonton Area and Land Trust, is located in a clearing on the southwest boundary of the LSA and could be used as a roost. While there are few mature trees in the LSA and the metal structure of the bridge is likely unsuitable for day or maternity roosting, there is high potential for little brown bat to occur in the LSA while it forages in the open areas along the creeks in summer.

Northern myotis are generally dependent on trees for day roosting and for maternity roosting, utilizing a wide range of tree species (deciduous trees preferred) in primarily intact forests (AESRD 2009 and Alberta Community Bat Program 2018). Northern myotis, less common in Edmonton, is assessed as having a low likelihood of occurrence in the LSA. Neither species is known to overwinter in the Edmonton area. Legal protection currently extends only to overwintering hibernacula and does not cover individual bats. The protection of individual bats and important/high quality roost sites is an emerging beneficial management practice in line with emerging bat conservation efforts.

Long-tailed Weasel

Long-tailed weasels live in a wide-variety of habitats including open agricultural areas, grassy slopes and aspen parklands where it preys on small mammals such as voles and mice (Pattie and Fisher 1999). Although suitable long-tailed weasel habitat is available in the LSA, this is a wide-ranging species and, if present, the proposed project area may comprise only part of its territory. Considering the above, we have rated their likelihood of occurrence in the LSA as moderate.

3.8 Historical Resources

Circle CRM Group Inc. (Circle CRM) conducted a desktop assessment that determined that the pedestrian bridge is located on lands designated as Historic Resource Value (HRV) 5 (high potential to contain a historic resource) for archaeological and palaeontological resources. There are two known HRV 0 (limited or no historical significance) sites within 100 m of the proposed project at the confluence of Whitemud and Blackmud Creeks and countless more sites in the adjacent ravines. One known site was situated adjacent the northeastern extent of the proposed project area and comprised a scatter of two quartzite flakes. The second known site was located approximately 50 m southwest of the bridge site and contained one bipolar core. While the project area has been previously disturbed from previous bridge and outfall construction as well as realignment of Blackmud Creek, there are known previously recorded sites in the area.

To that end, *Historical Resources Act* (HRA) approval was required prior to proceeding with any development activities that include ground excavation. Circle CRM submitted an application on 01 March 2021 to Alberta Culture, Multiculturalism and Status of Women (ACMSW) for their review and determination of HRA requirements for the proposed bridge replacement project. ACMSW granted project approval pursuant to the HRA on 08 April 2021 (Appendix J).

3.9 Recreation

The existing pedestrian bridge connects gravel trails and the unpaved parking lot north of the bridge to gravel and informal trails south of the bridge leading to MacTaggart and Larch Sanctuaries and upslope to the west to connect with a Shared Use Path (SUP) in the Magrath Heights neighbourhood. The bridge also provides a connection to a short section of gravel trail that passes under the 23 Avenue vehicle bridges to the north and beyond to informal trails in Whitemud Creek Ravine. Results of the City's Public Engagement program showed that the public uses the bridge and adjacent areas in Whitemud Creek Ravine for a wide variety of activities including photography [professional (e.g., wedding photography, especially in the autumn when the leaves are turning colour) and casual], walking, cycling, fishing, family gatherings, and paddling during high spring flows.

4.0 THE PROJECT

4.1 Project Description

Based on existing hydrotechnical/geotechnical/environmental site conditions, the proposed new bridge design incorporates the following design elements (Morrison Hershfield 2021; design drawings are provided in Appendix K):

- Increase in overall span length, with new abutments located behind the location of the existing abutments (Appendix K).
- Increase in bridge soffit elevation by 1.0 m, to meet a 1:100 peak flood event. No freeboard will be provided.
- Improve headslope slope stability and erosion improvement with provision of Class 2 riprap and toe thickening at the north abutment.
- The proposed bridge will have a 75-year design life.

EPCOR does not currently cross the historic bridge to access the south creek bank and stormwater management facilities. To maintain the status quo and to stay within the City's bridge replacement budget, the proposed new bridge has not been designed to accommodate vehicles, including heavy maintenance vehicles, and will not be used by EPCOR for access.

The scope of work includes:

- Excavation and backfilling;
- Demolition and removal of existing bridge;
- Bridge abutment installation including foundations, riprap armouring of upstream and downstream creek banks;
- Bridge superstructure erection;
- Gravel trail bridge approach regrading only.
- Miscellaneous trail amenities modifications (e.g., public information panels, seating areas), and landscape restoration.

Design drawings are provided in Appendix K. Conceptual renderings are shown in Plates 4.1 and 4.2.

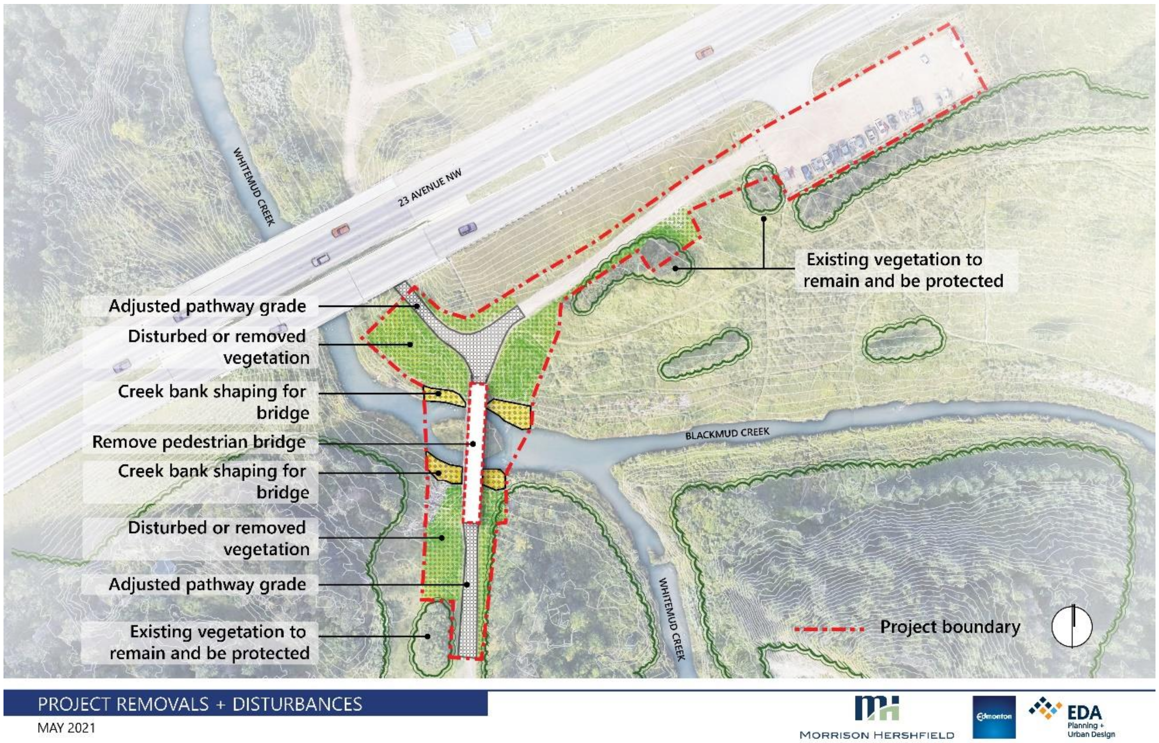

Plate 4.1. Conceptual Overview of Project Removals and Disturbances

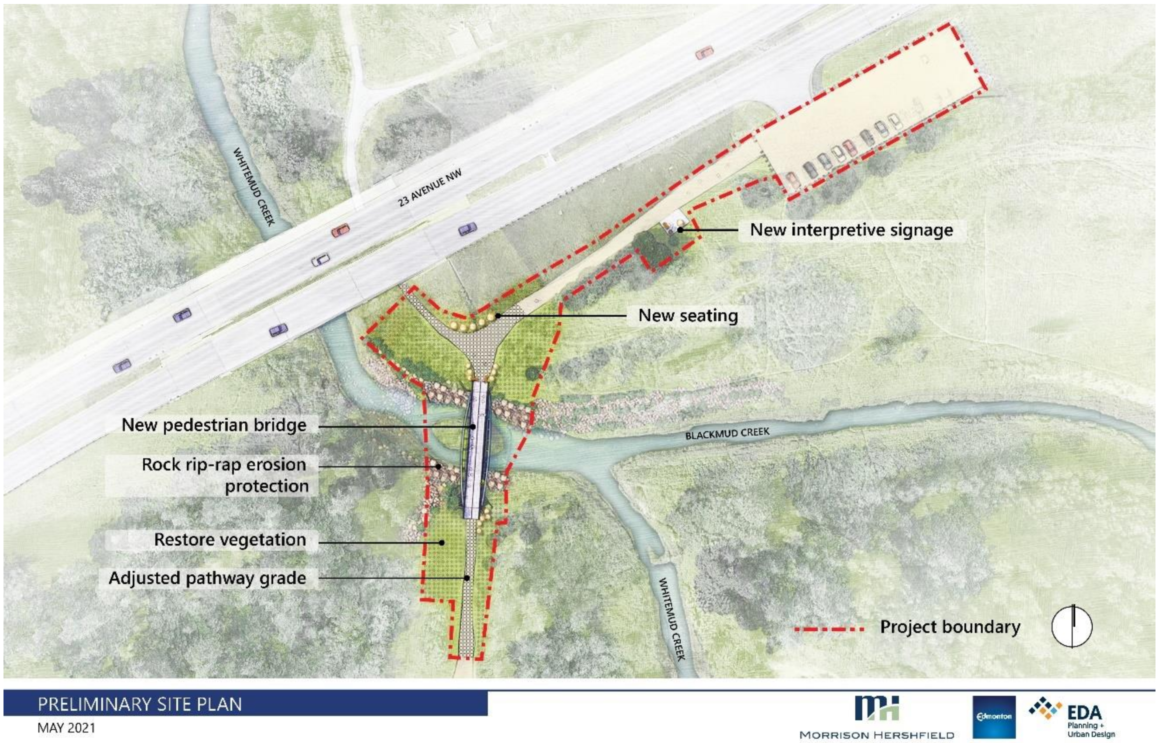

Plate 4.2. Conceptual Preliminary Site Plan

The gravel trails in the project area are maintained as passable by the City and currently there is no winter snow clearing on the bridge along this section of trail in the winter. This will continue to be the case with the new bridge and overall trail upgrades in the project area are not included in the scope of this bridge replacement project.

4.1.1 Superstructure Alternatives Considered

Five superstructures type options were considered for pedestrian bridge replacement: 1) tilted tied arch; 2) pony truss; 3) slab-on-girder; 4) steel tub girder; and 5) FRP bridge. Evaluation criteria included life-cycle cost/maintenance, sustainable urban integration/aesthetics, hydraulic clearance improvements, design risk, and constructability/schedule (with respect to supply chains, ease of fabrication and erection feasibility). Project stakeholders also identified bridge aesthetics as an important consideration in bridge design considering the natural environment in the project area. Based on these criteria, the City selected Option 1- tilted tied arch as the preferred option to advance to detailed design. Conceptual renderings of the proposed new bridge are provided below in Plates 4.3 and 4.4.

Plate 4.3. Conceptual Plan View of Proposed Steel Tied-Arch Bridge Design at Smith Crossing (Provided by: Morrison Hershfield, City of Edmonton and EDA Planning + Urban Design 2021)

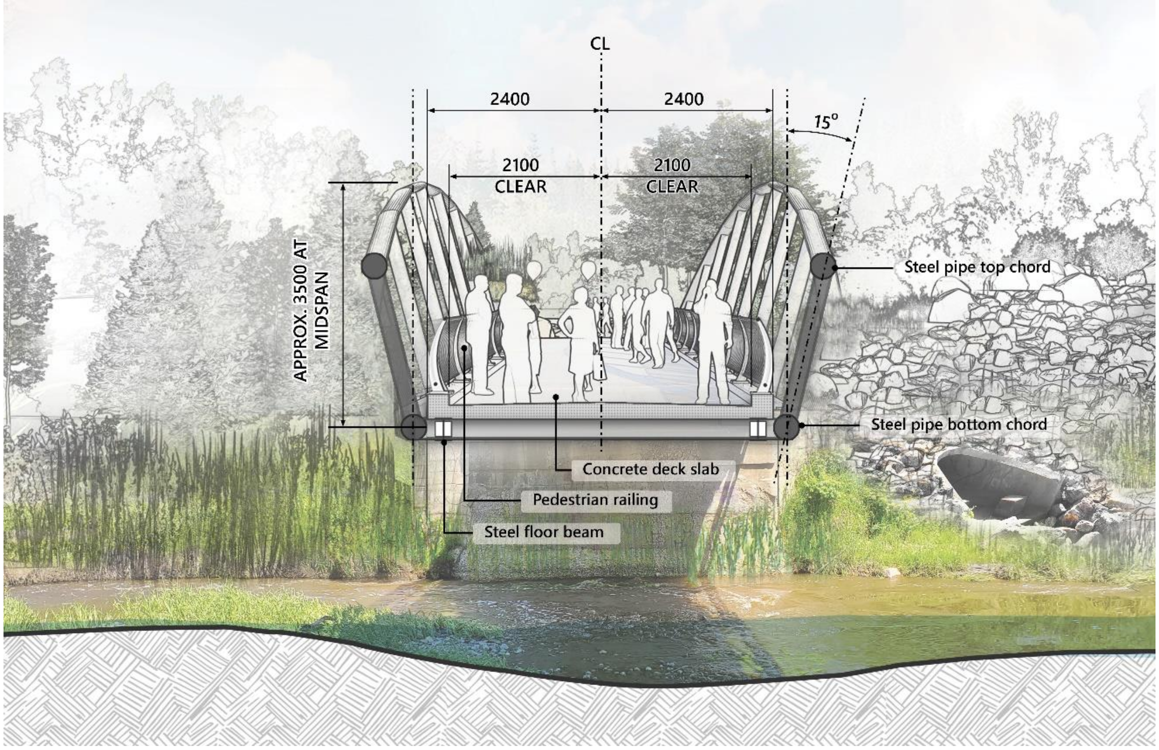

Plate 4.4. Conceptual Cross-Section View of Proposed Steel Tied-Arch Bridge Design at Smith Crossing (Provided by: Morrison Hershfield, City of Edmonton and EDA Planning + Urban Design 2021)

4.2 Landscaping

A landscaping restoration plan will be prepared for the project during detailed design. All disturbed areas will be reclaimed with site-specific appropriate native plant species and seed mixes. Riprap areas will be bioengineered with willow cuttings. Plantings will be selected based on appropriate natural species for the site, as well as in consideration of sightlines, Crime Prevention Through Environmental Design (CPTED), and other design influences.

4.3 Construction Schedule

Construction is tentatively scheduled to occur between July 2022 and October 2023. Instream works will occur outside the fisheries Restricted Activity Period (RAP) of April 16-June 30.

4.4 Construction Laydown Area and Access

The primary project laydown area will be located in the gravel parking lot south of 23 Avenue (Figure 2, Appendix A; Plate 4.5). Two additional potential laydown areas are located to the west and east of the north end of the bridge. Construction access to the laydown area will be along existing roads and access from laydown to the north side of the bridge crossing will be by way of the existing gravel trail. The existing historic bridge does not accommodate vehicles so it is expected that some construction access also will be from the south of the bridge using EPCOR's maintenance access road/gravel trail from the top of the hill at 23 Avenue at Magrath Heights.

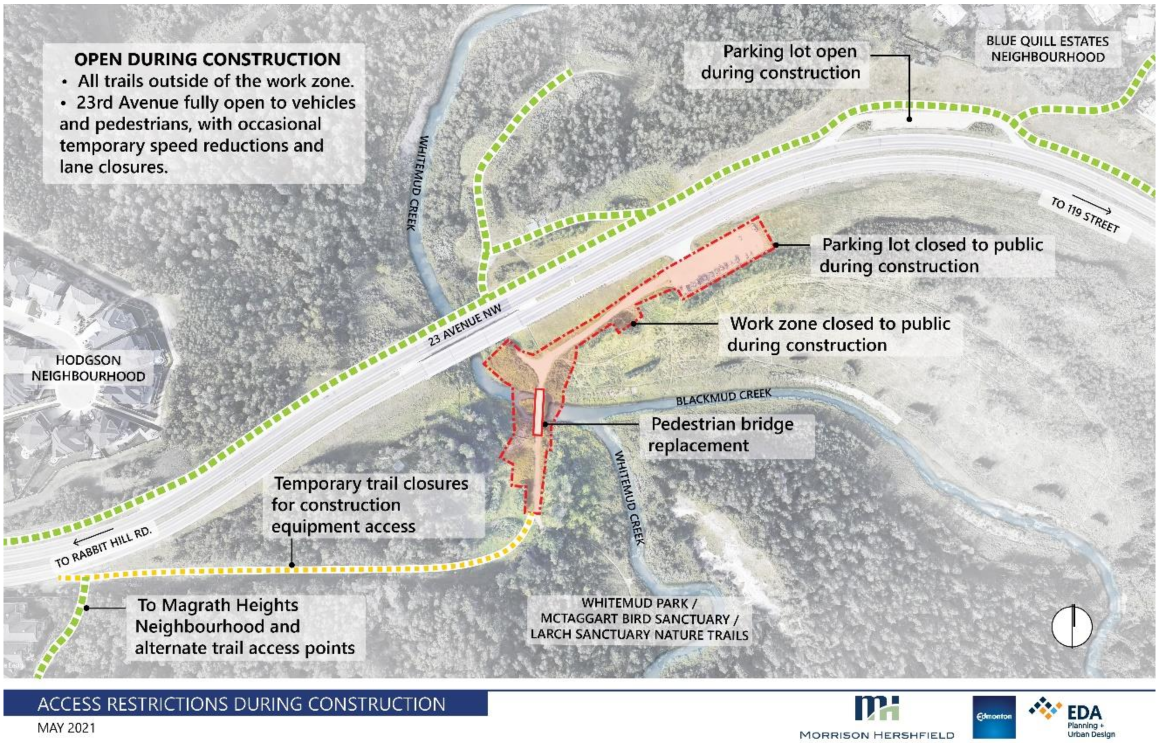

Plate 4.5. Access and Restrictions During Construction

4.5 Project Phases and Associated Key Activities

4.5.1 Site Preparation

- Notification of local residents, businesses and institutions of the proposed construction schedule, temporary road and trail closures and detours.
- Coordinate access for project equipment and site security.
- Closure of the parking area and gravel approach trail to the public and install appropriate warning and detour signage.
- Establishment of construction staging areas.
- Removal of existing vegetation within the established disturbance boundaries.
- Remove and stockpile all topsoil prior to any disturbance for reuse.
- Install temporary silt fencing as required around any stockpiles or exposed soil to prevent siltation of the watercourse.
- Place construction warning signs upstream and downstream related to navigation.
- Isolate in-stream work and conduct fish capture and release as required.
- Tree protection in the form of physical barriers shall be provided for any tree within 5 m of the work zone.

4.5.2 Bridge Demolition

- The existing steel and timber bridge superstructure will be removed and disposed of.
- Demolished components will not enter the creek.
- The existing steel superstructure is coated in lead-based paint. Any paint removal required to facilitate demolition will be fully contained. Lead painted components will be removed and disposed of in accordance with provincial guidelines.
- Careful attention will be paid to areas of visible lead paint encountered during excavation. Where lead paint chips or flecks are evident, an environmental sampling program will be conducted to assess extent and degree of soil impact at encountered locations.
- Existing concrete abutments will be removed and disposed of to the extents shown in the drawings in Appendix K, with remaining components buried in-place beneath riprap embankment armouring.
- Excavated material will be removed and disposed of off-site, in accordance with provincial guidelines.

4.5.3 New Bridge Construction

- Superstructure – detailed design of the single-span pedestrian bridge superstructure is underway and will be composed of modern materials such as steel, reinforced concrete, timber, fibre-reinforced polymer, or similar.
- Foundation type – drilled cast-in-place reinforced concrete piles
- Abutment – cast-in-place reinforced concrete abutment
- Headslope protection – Class II riprap (nominal diameter 500 mm)
- Embankment protection – Class II riprap on non-woven geotextile extending vertically to the 1:100 year HWL, extending upstream and downstream of bridge headslopes.
- Riprap will tie into existing gabion riverbank protection (riverbank NE of bridge), existing riprap riverbank protection (riverbank SW of bridge), and existing riprap and/or bioengineered riverbank protection (riverbanks NW and SE of bridge).
- Bank disturbance areas outside riprap footprint will be revegetated with dense willow stakes.
- The single-span superstructure will be erected / installed by lifting into place, launching, or similar conventional construction methods for single-span pedestrian bridges.
- There will be no disturbance to the streambed outside the limits of the temporary cofferdams / stream isolation required for bank armouring, as shown in the drawings in Appendix K.
- Project-specific erosion and sediment control measures will be required at all areas of disturbed ground, around stockpiles, and around laydown areas.

4.5.4 Restoration

As previously noted, a landscaping restoration plan will be prepared during detailed design addressing all disturbed areas. Please see Section 4.2 above.

4.6 Summary of Environmental Regulatory Approvals

All typically relevant federal, provincial and municipal environmental legislation, bylaws and policies were reviewed for application to the project described above. Bylaw 7188 is the only trigger for an environmental assessment. Instream work associated with bridge construction will trigger provincial and federal environmental approval processes. As is often the case, several other provincial and federal statutes prohibiting harm to select resources are also relevant to project construction. Table 4.1 describes environmental and historical resource legislation and bylaws identified as applicable to this project. Table 4.1 does not consider any non-environmental municipal permits that may be required to undertake the work.

Table 4.1. Summary of Applicable Legislation and Bylaws

Legislation, Bylaw or Policy	Regulatory Agency	Authorization/ Approval/Permit Required	Responsibility, Approval Timeline or Potential Schedule Impact
<u>Municipal</u>			
***North Saskatchewan River Valley Area Redevelopment Plan* (Bylaw 7188)**	City Planning	EIA required. EIA to be approved by City Council.	Approval anticipated in autumn 2021.
***Corporate Tree Management Policy* (C456C)**	City Forestry	Proponent to collaborate with City Forestry regarding unavoidable impact to City owned trees and shrubs in the project area, valuation of and compensation for affected trees/shrubs and protection of nearby trees.	Continued consultation between City and Forestry suggested to ensure full compliance.
City of Edmonton (Bylaw 18100) - EPCOR Drainage Services Bylaw	EPCOR	Permit to discharge into storm sewer system may be required (e.g., at staging areas).	City or Contractor to obtain permit once construction dates are known.
***City of Edmonton Parkland* (Bylaw 2202)**	City of Edmonton	Laydown areas required in Whitemud Creek Ravine. Permit required to use for construction staging.	City or Contractor to obtain permit once construction dates are known.
<u>Provincial</u>			
Public Lands Act	Alberta Environment and Parks (Land Management Branch)	Temporary and permanent works within the bed and shore of Whitemud Creek, a crown claimed watercourse, outside the road plan right-of-way will require a *Public Lands Act* disposition/authorization	City has initiated application process (in progress) ~ 6 months for DLO approval ~4 months for Temporary Field Authorization, if required
Water Act	Alberta Environment and Parks (Water	Based on the described project work, a Code of Practice (CoP) Notification will be	City has undertaken the required QAES assessment and will submit a Water Act CoP Notification to AEP at

Legislation, Bylaw or Policy	Regulatory Agency	Authorization/ Approval/Permit Required	Responsibility, Approval Timeline or Potential Schedule Impact
	Approvals Branch)	required for instream work during bridge replacement.	least 14 days prior to construction commencement.
Wildlife Act	Alberta Environment and Parks	No permitting triggers; however, the Act prohibits disturbing prescribed breeding wildlife such as northern flying squirrels and owls. In this case, this requires either avoiding vegetation removal in the breeding season or undertaking a nest sweep before vegetation removal. Also, snakes are protected as a non-game animal under this Act, which makes it illegal to kill, possess, buy or sell snakes native to Alberta. Snake hibernacula, underground chambers where snakes gather for the winter, and birthing dens, are also protected under this Act year-round year-round. There is a provincial historical record of a hibernaculum in the general Smith Crossing area, but the exact location is unknown.	City to schedule vegetation removal. Any vegetation clearing/tree removal between 15 February and 20 August, would require a nest sweep and may result in findings that delay clearing. Contractor to collaborate with AEP for further direction regarding confirming location of hibernaculum if construction commences in fall and/or if winter excavation activities disturb/destroy a snake hibernaculum in the bridge project area, which could result in project delays.
Historical Resources Act	Alberta Culture, Multiculturalism and Status of Women (ACMSW)	Approval required.	HRA Approval was granted to the City on 08 April 2021.
Federal			
Fisheries Act	Fisheries and Oceans Canada (DFO)	The project will involve work in fish-bearing Whitemud Creek. Submission of a Request for Review to DFO is recommended to remain compliant with the *Fisheries Act* and DFO protocols.	DFO issued a Letter of Advice for the project on 13 May 2021.
Canadian Navigable Waters Act	Transport Canada	Approval required for bridge replacement	Project approval under the CNWA received on 07 September 2021.

Legislation, Bylaw or Policy	Regulatory Agency	Authorization/ Approval/Permit Required	Responsibility, Approval Timeline or Potential Schedule Impact
Migratory Birds Convention Act	Environment and Climate Change Canada	No permitting triggers; however, violation of the MBCA can result in penalties	City to schedule vegetation removal. Any vegetation clearing/tree removal between 20 April and 20 August would require a nest sweep and may result in nest sweep findings that delay clearing.
Species At Risk Act	Environment and Climate Change Canada	This Act prohibits disturbance to species listed on Schedule 1 of the SARA as endangered, threatened or extirpated and, in some instances, prohibits disturbance to listed species' habitat, **on federal lands**. On non-federal lands, the Act applies only to disturbance of listed endangered, threatened or extirpated *aquatic species* and *migratory birds*.	There is some potential for listed endangered bats to roost in the project area but SARA does not extend protection to those species on these lands. Endangered, threatened or extirpated migratory birds or aquatic species are not expected on project lands.

5.0 PROJECT IMPACTS AND MITIGATION MEASURES

5.1 Assessing Impacts

5.1.1 Potential Impact Identification and Analysis

Based on the environmental context described in Section 3, the following Valued Ecosystem Components (VECs) were identified for impact assessment: surface water quality, channel hydraulics, fish and fish habitat, creek bank slope stability, vegetation, wildlife, historical resources and recreation. For each VEC, potential impacts to be examined were identified by overlaying the project drawings on mapped resources, reviewing project activities, conferring with multidisciplinary project team members, reviewing project reports and applying our professional experience with impact assessment and construction performance auditing in other, similar, projects. This process resulted in identification of specific potential impacts that warranted assessment.

In addition, we separately examined the potential for the following select project incidents to occur and impact natural resources:

- Release of hazardous/deleterious substances in or outside of the project area and potential for mitigation off-site.

5.1.2 Impact Characterization

Identified impacts were characterized according to guidance received from the EIA Terms of Reference (Table 5.1). Potential impacts were characterized with respect to nature (positive or negative, direct or indirect), magnitude (negligible, minor, or major), duration and timing (temporary, permanent or seasonal), geographic extent and likelihood. These criteria were defined as shown in Table 5.1:

Table 5.1: Impact Descriptor Definitions.

Nature of Impact	
Positive Impact	An interaction that enhances the quality or abundance of physical features, natural or historical resources.
Negative Impact	An interaction that diminishes the abundance or quality of physical features, natural resources or historical resources.
Direct	An interaction that results in the loss or reduction of a resource/feature.
Indirect	An interaction that results in off-site impacts, such as sedimentation off-site.
Magnitude	
Negligible Impact	An interaction that is determined to have essentially no effect on the resource. (Such impacts are not characterized with respect to direction duration or confidence.)

Minor Impact	An interaction that has a noticeable effect but does not eliminate a local or regional population, physical feature or affect it beyond a defined critical threshold (where that exists).
Major Impact	An interaction that affects a local or regional population, resource, or physical features beyond a defined critical threshold (where that exists) or beyond the normal limits of natural perturbation.
Duration and Timing	
Temporary Impact	A change that does not persist indefinitely.
Permanent Impact	A change that persists indefinitely.
Seasonal Impact	A change that will terminate or diminish significantly after one season.
Geographic Extent	Extent of area affected. Quantify where feasible.
Likelihood	What is the probability that the impact will occur? Is it likely or unlikely?

When applying these descriptors, we considered the project described in Section 4. No additional mitigation measures were applied at the time of potential impact characterization.

5.1.3 Mitigation Development and Residual Impact Assessment

Mitigation measures were developed for all identified negative impacts. Any impact anticipated to remain following mitigation implementation was termed a residual impact. As with potential impacts, residual impacts were characterized with respect to: nature, magnitude, duration and timing, geographic extent and likelihood.

5.2 Impact Assessment Results and Mitigation Measures

5.2.1 Surface Water Quality

Instream and near stream works associated with demolition of the existing pedestrian bridge and construction of the new bridge and associated disturbances to the adjacent riparian areas have potential to create sediments that could enter Whitemud Creek and travel downstream. There is also potential for accidental releases into the creek. Any spills or mobilized sediment on site could enter Whitemud Creek and travel downstream and ultimately to the NSR. These types of impacts are assessed below in Section 5.2.10.

5.2.2 Whitemud Creek Channel Hydraulics

Impacts

The existing bridge opening over Whitemud Creek is wider than the natural channel, however the existing north abutment is located on the creek bank at the edge of the creek. Bridge replacement with a longer truss will create an even wider opening. In addition, the existing north abutment will be removed from the creek bank, improving flow through the hydraulic opening, and slowing the flow velocity (Associated Engineering 2021). The underside of the new bridge truss will be approximately 1 m higher than the existing bridge to improve the existing freeboard (Morrison Hershfield 2021). Based on this information, the new bridge is expected to result in improved creek hydraulics at the bridge crossing location compared to existing conditions and is, therefore, rated as a positive, direct, minor, permanent and likely impact to creek hydraulics.

Mitigation and Residual Impacts

No mitigation measures required. Residual impacts will remain positive, direct, minor, permanent and likely.

5.2.3 Fish and Fish Habitat

Kingfisher (2021) identified the following potential impacts to fish and fish habitat as needing examination:

- Release of sediment
- Release of deleterious substances
- Invasive species/disease
- Entrapment, impingement, entrainment of fish
- At Risk Species
- Change in access to fish habitat
- Alteration or destruction of potential habitat

See Kingfisher's (2021) full report in Appendix F for comprehensive impacts and mitigation measures for fish and fish habitat. A summary of their identified impacts and mitigation measures are provided in Table 5.2 below.

Table 5.2. Analysis of potential effects to fisheries resources associated with the project.

Impact Pathway		Potential Effect	
Category	**Potential Source**	**Description**	**Analysis**
Release of sediment	➢ Clearing of riparian area(s) ➢ Installation/removal of isolation works ➢ General earthworks	➢ Alteration of potential fish habitat due to deposition of sediment ➢ Decreased food production due to deposition of sediment ➢ Reduced fish health and/or increased fish mortality due to suspended sediment	Possible negative effects due to: ➢ Instream works associated with the in channel placement of material ➢ Instream works associated with installation/removal of isolation works Possible positive effects due to: ➢ Stabilization and revegetation of the eroded bank
Release of deleterious substances	➢ Operation of heavy equipment near water	➢ Reduced fish health and/or increased fish mortality	Possible negative effect due to: ➢ Instream and riparian works will

Impact Pathway		Potential Effect	
Category	**Potential Source**	**Description**	**Analysis**
	➢ Construction processes (i.e. pouring concrete)		require heavy equipment to be in close proximity to the watercourse
Invasive Species/Disease	➢ In-water construction activities using contaminated equipment	The spread of invasive species and/or disease can result from: ➢ Bringing contaminated machinery or materials on site ➢ Not disposing of contaminated materials appropriately	Possible negative effect due to: ➢ Instream and riparian works will require equipment to be in close proximity to the watercourse
Entrapment, impingement, entrainment of fish	➢ Installation of isolation works ➢ Dewatering/water management with pumps	➢ Fish mortality can occur when fish become stranded in isolation areas ➢ Fish mortality can occur when fish become impinged on screens or entrained in pumps when isolated areas are dewatered	Possible negative effect due to: ➢ Installation of isolation works to facilitate placement of bank material and riprap ➢ Dewatering and flow management operations that may be required to complete the Project
At Risk Species	➢ In-water construction activities	➢ Instream work can adversely affect species that are *At Risk* or *Threatened* under Provincial and/or Federal legislation	Not expected: ➢ No *At Risk* or *Threatened* species are found in Whitemud Creek
Change in access to fish habitat	➢ Installation of isolation works	➢ Isolation works can temporarily impede fish movements if structures completely block or excessively constrict the channel width	Possible negative effect due to: ➢ Installation of isolation works to facilitate in-channel activities
Alteration or destruction of potential habitat	➢ Bank stabilization works ➢ Temporary isolation works	➢ The amount and/or quality of available habitat can be permanently reduced if the bank stabilization and armouring results in a physical habitat footprint	Neutral effect due to: ➢ Upslope riprap under the bridge will be confined to areas that have limited riparian value (i.e. lack vegetation and/or are denuded). ➢ Upslope riprap adjacent to the bridge will be covered with fill and revegetated as part of the bioengineered riverbank protection. ➢ In-water (below 1:2 year high water mark) riprap placed along the RUB (for 10 m) and LUB (for 15 m) will result in a change in substrate composition (from being dominated by fines to being dominated by large cobbles and boulders)

Mitigation and Residual Impacts

Potential fisheries impacts can be mitigated through best management practices and specific management/protection plans as itemized in Section 7.2 of Kingfishers’s (2021) report (Appendix F). With these measures in place the project is not expected to result in the death of fish or the HADD of fish habitat, and residual impacts are anticipated to be negligible (Kingfisher 2021, Appendix F). In compliance with DFO protocols pursuant to the *Fisheries Act* for fish-bearing watercourses, Kingfisher submitted a Request for Review to Fisheries and Oceans Canada (DFO) for their review. DFO issued a Letter of Advice for the project on 13 May 2021.

5.2.4 Creek Bank Slope Stability

Impacts

Removal of the existing pedestrian bridge and construction of the new bridge could affect slope stability of the creek banks. Thurber (2019b; Appendix G) observed no recent signs of instability at either the north or south creekbanks at the existing bridge site. The heavy rock riprap on the south creek bank and gabion baskets along the north creek bank both appeared to be functioning well (Thurber 2019b; Appendix G). If appropriate measures are not taken to avoid slope destabilization, impacts to slope stability are anticipated to be negative, direct, minor, permanent, local and likely.

Mitigation and Residual Impacts

Thurber (2019b; Appendix G) recommended the current erosion protection (riprap and gabion baskets) should be reviewed by a hydrotechnical consultant to evaluate the adequacy and determine if additional riverbank erosion protection is warranted. Thurber (2021) recommended that during construction, subgrade should be inspected by qualified geotechnical personnel prior to the placement of any additional fill required for site grading, to confirm that all deleterious material and organic soil has been removed. They also recommend that any soft areas detected during proof rolling should be excavated and replaced with compacted low to medium plastic clay or granular soils. Until there is confirmation that a hydrotechnical consultant has evaluated the current erosion protection measures and there are no slope stability concerns during construction, residual impacts to slope stability remain negative, direct, minor, permanent, local and likely.

5.2.5 Vegetation

The following potential impacts to vegetation were identified as needing examination:

- Loss or alteration to native plant communities
- Loss of special status plant species
- Establishment of invasive or weedy species
- Incidental tree damage

5.2.5.1 Loss or Alteration to Plant Communities

Impact

The proposed project will require the clearing of some portions of native riparian (43.6 m^2) and deciduous mixedwood - mixed shrub (147.7 m^2) communities to accommodate the demolition of the existing bridge and construction of the new bridge (Figure 6, Appendix A). Clearing of approximately 506.5 m^2 of the non-native non-forested smooth brome level slopes community will also be required. All areas disturbed during construction will be revegetated, with the exception of some very small areas of the riparian community that will be permanently loss for the placement of riprap. Removal of native vegetation is rated as a negative, direct, minor, temporary to permanent, local and likely impact.

Mitigation and Residual Impact

Prior to construction, marking the project clearing limits with highly visible flagging will minimize the extent of vegetation loss. Efforts will be made to minimize tree and shrub removal in work sites to the minimum necessary. In accordance with the *City of Edmonton Corporate Tree Management Policy C456*, all forested areas on city-owned (public) lands in the project area will be assessed for value by the City of Edmonton Forestry department prior to removal and compensation applied as required. With the landscaping planned, and the maturation of planted trees and shrubs, and compliance with the *Corporate Tree Management Policy*, the residual impact to vegetation will be reduced to negligible, over time.

5.2.5.2 Loss of Special Status Plant Species

As no rare plants have been recorded on-site, there is no anticipated impact on rare plants. Additional surveys are not warranted and mitigation is not required.

5.2.5.3 Establishment of Invasive or Weedy Species

Impact

Surface disturbance from construction could create ideal conditions for the establishment and spread of noxious weed species. Weeds could become established following construction through the movement of seeds and rhizomes carried on equipment as well as by colonization by seeds transported naturally from adjacent weed populations. Weed establishment in the project area is undesirable, as weeds may then spread to surrounding native plant communities along Whitemud Creek and Blackmud Creek. Preventing weed establishment in the first place may be the best and most economical opportunity for weed management. In the absence of mitigation, the spread of weedy species within reclaimed areas will likely occur and will have a negative, direct, minor, local, permanent and likely impact.

Mitigation and Residual Impact

Precautions such as cleaning equipment before moving into the project area will help reduce the potential transfer and spread of weedy species. Cleared areas will be revegetated with topsoil and an appropriate seed mix approved by the City of Edmonton Facility and landscape Infrastructure Branch as soon as possible following construction. Some level of weed control will likely be required until desired vegetation becomes established, but the need for such measures can be assessed through monitoring. All short-term weed control measures will be outlined in the contractor’s Environmental Construction Operations (ECO) Plan. With proper implementation of these measures, the residual impact will be reduced to negligible.

5.2.5.4 Incidental Tree Damage

Impact

The proposed project will require clearing of native plant communities, leaving adjacent trees and shrubs vulnerable to limb, trunk and root damage during clearing or construction activity. The potential for additional tree loss as a result is rated as a negative, indirect, minor, permanent, local and likely impact.

Mitigation and Residual Impact

The successful contractor will be required to prepare a Tree Protection Plan pursuant to the City’s *Corporate Tree Management Policy* and the *City of Edmonton Tree Preservation Guidelines*. That plan will include measures to physically protect individual open space trees within 5 m of the laydown areas and natural tree stands within 10 m of the project area. The plan will be reviewed by City Forestry to ensure protection measures are sufficient and City Forestry will likely meet with the contractor on site to discuss protection measures. The contractor will be required to monitor the effectiveness of their protection program and record any incidental damage. To reduce potential for impact on native plant communities during proposed construction, equipment storage, maintenance and refueling anywhere other than the parking lot staging area will be prohibited. With these measures in place, the residual impact is expected to be negligible.

5.2.6 Wildlife and Wildlife Habitat

The following potential impacts to wildlife were identified as needing examination:

- Loss of terrestrial habitat due to clearing activities
- Habitat alienation during construction
- Breeding wildlife mortality
- Snake hibernaculum disturbance during construction
- Mortality or disturbance of special status species

5.2.6.1 Loss of Terrestrial Habitat Due to Clearing Activities

Impacts

Any loss of natural vegetation in the project area represents an associated loss of natural habitat. It is expected that relatively small, localized areas of natural deciduous mixedwood-mixed shrubs and riparian habitat will be cleared adjacent the existing bridge prior to demolition. Some disturbance is also expected to be in the anthropogenic non-forested smooth brome plant community, which does provide some wildlife habitat value for nesting, cover and forage. The habitat value of areas to be cleared is moderate to very high, however, as noted in the vegetation discussion, the majority of habitat loss will be temporary. As a result, the anticipated temporary habitat loss is rated as a negative, direct, minor, local in scale, and likely impact.

Mitigation and Residual Impacts

Applying all mitigation measures outlined in the vegetation section will result in establishment of a native riparian plant community with a reduced exotic/weedy component and additional smaller naturalized areas supporting native trees and shrubs adjacent the new bridge. This is considered to fully mitigate for the loss, over time. The residual impact is rated as negligible.

5.2.6.2 Habitat Alienation During Construction

Impacts

Activities and noise associated with construction have potential to disrupt wildlife species using adjacent habitat, leading to habitat alienation in those areas. This effectively reduces the amount of usable habitat available to individuals. However, in this case, this potential impact is rated as minor for the following reasons:

- Most wildlife species in the area are likely already adapted to human disturbance.
- Construction disturbance will be periodic over the construction period, and location specific within the project area.
- Construction will typically occur during daylight or early evening hours, leaving adjacent areas relatively undisturbed for nocturnal species.

Considering all the above, the impact of habitat alienation during construction activities is rated as negative, indirect, minor, temporary, local and likely.

Mitigation and Residual Impacts

Few mitigation measures are available. Work crews will be instructed not to harass wildlife and the contractor's ECO plan will include worker/wildlife encounter protocols. The residual impact of habitat alienation during construction activities is, therefore, also rated as negative, indirect, minor, long-term, temporary, local and likely.

5.2.6.3 Disturbance of Breeding Wildlife

Impacts

Any project involving vegetation removal must consider the potential for vegetation clearing or pruning to affect wildlife, particularly from the perspective of legislation compliance. Many species of wildlife are protected by federal and provincial law. The *Migratory Birds Convention Act, 1994* protects migratory birds (as populations and individuals), their nests and eggs anywhere they are found in Canada. The *Wildlife Act* (Alberta) provides for the protection and conservation of wild animals in Alberta and prohibits the wilful molesting, disturbing or destroying of a house, nest or den of prescribed wildlife. Clearing of vegetation during the wildlife breeding season has potential to destroy nests/dens and to disturb or kill wildlife because otherwise mobile adults remain close to nest sites, and young are either restricted to nests, dependent on nests or not yet mobile enough to avoid sudden disturbance.

To protect nests and nesting birds, Environment and Climate Change Canada (ECCC) recommends avoiding vegetation clearing during the period when there is a high probability of nesting activity (i.e., high risk period). In this region (nesting zone B4), ECCC identifies the high probability period (approximately 95%) as 20 April to 20 August. The provincial government concurs with this recommendation for migratory and other birds but recognizes that the period does not adequately cover nesting owls, which are also protected by the *Wildlife Act.* In the Edmonton region, owls may begin nesting as early as mid-February and may remain on nests into the ECCC-defined high probability period.

There is some potential for owls and other bird species to nest in/near the project site. Therefore, in the absence of appropriate measures (e.g., temporal clearing restrictions or effective nest sweeps), vegetation clearing/tree removal has potential to result in disturbance of active nests or nesting individuals. The current project schedule calls for clearing/selective removal of trees and shrubs after 20 August, followed by construction initiation and bridge demolition in fall 2021. This schedule will avoid vegetation clearing in the breeding season and the potential for related impacts to breeding wildlife. It will also preclude the need to conduct a nest sweep of the bridge prior to demolition. As currently scheduled, there is little potential for the project to disturb breeding wildlife and the potential impact is rated as negligible.

Mitigation and Residual Impacts

If the current project schedule is implemented, mitigation is not warranted; however, if project scheduling changes such that any vegetation clearing/tree removal or other activities requiring vegetation manipulation and/or bridge demolitions must occur during the period 15 February to 20 August, this would create potential for impacts to wildlife, and mitigation should be implemented. Specifically, if vegetation clearing/removal/pruning and/or bridge demolition must occur during the period 20 April to 20 August, the City shall ensure that the work is preceded by a nest sweep of the work site and buffering adjacent habitat, conducted by a qualified biologist, to a standard compliant with federal and provincial law. If active nests are identified they will be appropriately buffered from disturbance until the nest is no longer active. Similarly, if mature tree removal is required during the period 15 February to 20 April, the City shall ensure that the work is preceded by an owl nest sweep of the work site and a buffer of adjacent habitat, conducted by a qualified biologist to a standard compliant with provincial law. Identified active nests will be appropriately buffered from disturbance until the nest is no longer active. With these measures in place, breeding wildlife disturbance should be avoided, and the residual impact should be reduced to negligible.

5.2.6.4 Disturbance to a Snake Hibernaculum

The province holds a historical record of a garter snake hibernaculum (winter den) somewhere in the Smith Crossing area and Alberta Conservation Association (Kendell 2020) determined the hibernacula to be occupied based on observation of one snake in the area in May 2018. Snake hibernacula are known to occur in areas where land surface features or human structures occur that may suggest the creation or formation of favourable belowground conditions for snakes (K. Kendall, *pers. comm.*). Since 2018, extensive outfall rehabilitation and bank bioengineering was undertaken in the LSA by EPCOR in 2019 potentially creating suitable hibernacula conditions. Hibernacula are known to be ephemeral features that can become unusable by snakes and new dens can form over time. The Smith Crossing LSA contains suitable potential hibernacula habitat particularly around south-facing slopes and bridge abutment areas as well as adjacent outfall infrastructure and Blackmud Creek slope stability features (gabion baskets, underground drains, etc.). While no snakes were observed in the LSA during the hibernaculum survey in April and May 2021, snakes are known to occur in the area. Snakes congregate in hibernacula to overwinter so there is potential for winter construction and excavation activities to inadvertently disturb and/or destroy a snake hiberculum and the snakes within it, potentially having a significant impact on local garter snake populations. Snakes and their hibernacula are protected by the *Wildlife Act* year-round so disturbance to a hibernaculum and resulting snake mortality would result in contravention of this Act. The impact to disturbing a snake hibernaculum during winter construction is, therefore, rated as negative, major, permanent, local to regional, and unknown likelihood because the hibernaculum location is unknown.

Mitigation and Residual Impacts

Because the exact location of the hibernaculum is unknown, the contractor will collaborate with Alberta Environment and Parks to develop a mitigation plan with respect to attempting to confirm the presence of a hibernaculum in the LSA if construction commences in the fall when snakes return to their hibernacula and/or develop a mitigation plan for winter construction in the event an occupied hibernaculum is discovered. That plan should include immediately suspending all work and contact Alberta Environment and Parks. Appropriate follow-up measures would then be implemented as required, including potentially constructing an alternative denning site. Considering these measures, the residual impact to potential snake hibernaculum disturbance during construction is reduced to negligible.

Mitigation Measures and Residual Impacts

In accordance with ACMSW approval requirements, all work will be immediately suspended and ACMSW contacted should potential historical resources be discovered during construction (Appendix J). Appropriate follow-up measures would then be implemented. Considering this, the residual impact to historical resources is rated as negligible.

5.2.6.5 Mortality or Disturbance to Special Status Wildlife Species

Impacts

Three special status wildlife species have the potential to occur in suitable habitat in the project area including little brown myotis, northern myotis and long-tailed weasel.

Clearing of mature trees during the period May to September does have some potential to result in individual bat mortality, if day or maternity roost trees are cleared. The potential for mortality of individual, solitary bats that are roosting during daylight hours is of limited concern to bat conservation. Disturbance of maternity colonies is of more concern. That said, the probability of disturbance from this project is rated as low for the following reasons: the area to be cleared is small; the trees anticipated to be cleared are primarily smaller deciduous trees and mature conifers, rather than the larger and decaying deciduous trees preferred as roosts; and the nearby rocket bat box is located outside of the construction limits. Therefore, regardless of when clearing occurs, the project is not anticipated to adversely affect local, bat populations. In addition, disturbance/mortality of individual bats would not contravene the law as this project is not on federal lands and individual day roosts (and maternity roosts) for these species are not currently identified by SARA as critical habitats and are not protected by the provincial *Wildlife Act*. Direct impacts to these species from the proposed project are, therefore, ranked as negligible.

Long-tailed weasels are wide-ranging species and are not expected to be adversely impacted by the proposed project. Direct impact to this species from the proposed project is ranked as negligible.

Mitigation and Residual Impacts

Bat-specific mitigation measures are not warranted but we note that the current vegetation clearing schedule that protects breeding birds also significantly reduces risk to roosting individual bats. The residual impact to little brown myotis and northern myotis from the proposed project is rated as negligible.

The residual impact to long-tailed weasel remains negligible.

5.2.7 Ecological Connectivity/Wildlife Movement

The potential for the project to change ecological connectivity/wildlife movement patterns was examined.

Impacts

A separate wildlife passage assessment report was not completed for this bridge replacement project, however, the City’s Wildlife Passage Engineering Design Guidelines (WPEDG) (City of Edmonton 2010) were considered in support of pedestrian bridge replacement. The proposed replacement bridge will maintain similar conditions for wildlife passage compared to existing conditions (i.e., most EDG’s, including LT (moose and deeer) and MT (coyote) animals, can move unimpeded under the bridge under suitable conditions (e.g. low water and frozen conditions)]. The opening under the bridge will be larger compared to existing conditions with an increase of 1.0 m in bridge clearance to better accommodate 1:100 year flood events. In addition, the new bridge will be longer than the existing bridge, increasing the opening under the bridge. The granular approach trails will be maintained and designated for pedestrian use only, with fencing limited to the immediate ends of the bridge structure where required for pedestrian safety. Riprap armouring will be placed on the creek banks for improved flood resilience and will be similar to existing rock already present at the bridge crossing and at the nearby EPCOR stormwater outfall facilities, thereby not creating any new barriers to wildlife movement in the area. The riprap armouring will be naturalized with willow cuttings or similar. The existing bridge is not lit at night and the proposed project does not include introducing new bridge lighting, thereby maintaining the status quo.

Impacts to ecological connectivity/wildlife movement as a result of bridge replacement are rated as positive, direct, minor, permanent, local and likely. This applies to LT, MT, ST, AM, AQ, AMP, WB and OB animals.

Mitigation and Residual Impacts

No additional mitigation measures are required for the proposed pedestrian bridge replacement at this location and residual impacts remain positive, direct, minor, permanent, local and likely.

5.2.8 Historical Resources

The following potential impacts to historical resources were identified as needing examination:

- Disturbance to known and undiscovered historical resources

5.2.8.1 Disturbance to Historical Resources

Impacts

Alberta Culture, Multiculturalism and Status of Women (ACMSW) has granted approval pursuant to the *Historical Resources Act* for the proposed project with the understanding that all ground disturbance activities will be confined to the identified project footprint. If final project planning requires the expansion of development activities (including temporary workspace, temporary storage and new access) outside of the approved boundary, then these final plans must be submitted in a new Historic Resources Application prior to the onset of development activities. Impacts to known historical resources are, therefore, expected to be negligible and there is some low potential to encounter unknown archaeological resources. The potential for adverse impact is reduced to an acceptable level by the Province's requirement to comply with Standard Requirements under the "*Historical Resources Act*: Reporting the Discovery of Historic Resources". This includes immediately suspending work and contacting ACMSW should potential historical/archaeological resources be discovered during construction. The potential for the project to adversely affect historical resources is, therefore, rated as negligible.

Mitigation Measures and Residual Impacts

In accordance with ACMSW approval requirements, all work will be immediately suspended and ACMSW contacted should potential historical resources be discovered during construction (Appendix J). Appropriate follow-up measures would then be implemented. Considering this, the residual impact to historical resources is rated as negligible.

5.2.9 Recreation

The following potential impacts to recreation were identified as needing examination:

- Disturbance to existing recreational use from construction activities

5.2.9.1 Disturbance to Existing Recreational Use from Construction Activities

Impacts

Replacement of the pedestrian bridge will require temporary closures of the parking lot and granular trails in the project area. Recreationalists using the trails will be temporarily inconvenienced by detours during construction. Deliveries of materials and equipment as well as construction activities also may cause temporary trail closures, potentially diminishing recreational use in nearby areas. Temporary navigation closures through the construction site during superstructure removal and installation may be required.

Signage throughout the area will provide recreationalists with adequate notification of the timing and duration of construction activities. Temporary fencing will be installed to prevent public access into active construction areas. The potential impacts to recreational use from construction activities are rated as a negative, direct, minor, temporary, local and likely impact.

Mitigation and Residual Impacts

Temporary fencing will be installed around the active construction area. Signage must be clearly posted indicating a project contact person and prime contractor, and shall include project information, duration and phone number for inquiries. In addition, construction warning signs will be placed upstream and downstream of the site to alert potential creek users to potential navigation interference. Signage shall be removed within two weeks of construction completion. With these measures in place, residual impacts should be negligible.

5.2.10 Project Incidents

5.2.10.1 Release of Hazardous/Deleterious Substances On- or Off-Site

Impact

Fuels, lubricants and other hazardous materials are anticipated on-site. Spills or releases can occur during refuelling, as a result of equipment failure (e.g., leaking hose), accidents or improper storage/containment and sites. While large spills are generally preventable during construction of projects such as this one, incidental, small spills typically occur at most construction sites. Small spills, if uncontrolled, can spread over larger areas. In this case, even localized spills could contaminate soils and plant communities on- and off-site. Due to proximity of construction work to Whitemud Creek, there is a risk of spill material being released into Whitemud Creek, with potential to spread downstream into the NSR.

If appropriate plans and practices are not put into place, there is potential for a hazardous or deleterious substance spill to result in a negative, direct, minor, permanent, local and likely impact on local resources such as plants, soils and water quality.

Mitigation and Residual Impact

The contractor will be required to comply with City of Edmonton’s Enviso system. In addition, for the construction period, the contractor will be required to prepare and implement a spill prevention and emergency response plan and a care of water plan. Those plans will include specific measures related to protecting Whitemud and Blackmud Creeks, including securely protecting all catch basins in the project area. The plans must also include construction monitoring protocols and frequency. With these measures in place, the residual impact should be negligible.

5.2.10.2 Release of Sediment or Other Debris On- or Off-Site

Impact

Site preparation during construction activities will result in exposure of bare soil surfaces, likely for extended periods of time. Construction activities on exposed soils can result in erosion and introduction of sediments to Whitemud Creek and downstream to the NSR. In cleared areas, exposed soils are susceptible to fluvial (surface water) erosion in wet conditions, and, to a lesser extend, aeolian (wind) erosion in dry conditions.

If erosion control mitigation measures are not put into practice, the impact related to sedimentation of Whitemud Creek would be negative, direct, minor, permanent, local and likely.

Mitigation and Residual Impact

The contractor will be required to comply with City of Edmonton's Enviso system. In addition, for the construction period, the contractor will be required to prepare and implement a temporary ESC Plan and a care of water plan, to City of Edmonton specifications. These plans will also include monitoring protocols and frequency. With these plans in place, the residual impact of sediment or other debris release off-site or into Whitemud or Blackmud Creeks should be negligible.

5.3 Cumulative Effects

5.3.1 Past Projects

EPCOR completed rehabilitation works at nearby Outfalls #295 (north bank) and #296 (south bank), including bioengineered creek bank areas, in 2019. The bioengineering works were installed to stabilize the Whitemud Creek bank slopes and to protect the outfalls from sedimentation (N. Kushka, *pers. comm.*). The existing snow fenced area southwest of the bridge was the outfall contractor's laydown area in 2019 and was fenced to allow for revegetation. The 2019 outfall works construction warranty period will expire in fall 2021 allowing for removal of the snow fencing prior to bridge construction.

5.3.2 Present Projects

There are no known current projects taking place in this area.

5.3.3 Future Planned Projects

EPCOR does not have any plans for capital projects/scheduled or planned work proximate to this bridge replacement for the foreseeable future (N. Kushka, *pers.comm.*). No other known future planned projects in the project area have been identified.

5.3.4 Conclusion

Since the proposed pedestrian bridge project comprises replacement of existing infrastructure, it is not expected to act as a catalyst for additional future development in this area. The proposed project, therefore, has no potential to add to the cumulative impact of past projects, including previous adjacent EPCOR outfall rehabilitation works, nor contribute to cumulative impacts of future projects, because all proposed works will occur in existing infrastructure disturbance footprints.

6.0 ENVIRONMENTAL MONITORING

At present, there are no project monitoring conditions linked to regulatory approvals. However, this EIA makes several specific monitoring recommendations throughout construction and reclamation.

Pursuant to the City of Edmonton's Enviso program, Environmental Construction Operations (ECO) Plan and Erosion and Sediment Control (ESC) plan requirements (e.g., monitoring of temporary ESC measures) will be monitored to ensure mitigation measures have been effectively implemented and are performing well.

All specific monitoring requirements included as mitigation measures in Section 5 of this EIA will be included in the construction contract. In addition, many of the environmental protection measures required of the contractor have associated monitoring components. Key construction monitoring requirements specified in Section 5, summarized by VEC include:

- Vegetation
    - Monitor performance of Tree Protection Plan.
    - Monitor weeds/exotic species on site.
    - Monitor landscaping/reclamation performance.

- Project Incidents
    - Monitor performance of all temporary ESC measures, including at catch basins
    - Monitor project area margins to ensure there is no migration of deleterious substances or other debris off site.
    - Monitor all spill clean up efforts.

7.0 PUBLIC CONSULTATION

Stakeholder and public engagement has been ongoing since the beginning of the project (City of Edmonton 2021, Appendix L). To-date, engagement has comprised the following:

- Identified external stakeholders, including environmental groups, community groups, recreation groups and immediately impacted landowners, were contacted via email, or mail, for one-on one virtual meeting with the project team to capture information regarding the bridge experience, local knowledge about the site, preferred bridge experience, and comments about the environmental pursuant to Bylaw 7188.
- In addition, an online survey open to all residents of Edmonton was used to capture additional information on the same topics. The 13 question survey was available on the City's website (Edmonton Insight) from 12 December 2020 to midnight, 04 January 2021..
    - Signs advertising the survey were placed near the site, at two bus stops on 23 Avenue (one eastbound and one westbound) and one in the parking lot used to access the site and the MacTaggart and Larch Sanctuaries.
    - External stakeholder groups were emailed on 12 December 2020 to inform them about the survey and provided them with information for posting on their respective websites, if desired.
    - The survey had 85 respondents, 81 of which used the pedestrian bridge. Survey respondents represented 36 communities out of 388 in Edmonton.

The stakeholder meetings and online survey sought information about bridge use, access to the site, important elements of the existing bridge, wildlife sightings and knowledge about potential sensitive environmental sites within the immediate area. Key themes about the bridge and site brought up by responders included :

- Keep the bridge in the same location.
- The bridge must fit into the site (size, location, aesthetics), compliment the natural site and be narrower.
- The historic character of the bridge is important.
- Construction impacts to the natural environment must be minimized.
- Connections to adjacent neighbourhoods are important.
- Access to the creek is important (e.g., kayaking, canoeing).
- Some additional amenities, such as interpretive signage and seating, was identified.
- Many wildlife sightings occur around the bridge.
- Photography for weddings, family gatherings and graduations were identified as the most frequently seen activities on the bridge.

Respondents identified a wide variety of wildlife observations in the project area including, but not limited to beaver, coyote, rabbit/hare, deer, moose, squirrel, muskrat, bats, fox, chipmunk, small rodents, skunk, porcupine, wolf, raccoon, gray jay, woodpeckers, ducks, geese, water birds, owl, birds, garter snake, insects and fish.

Specific to the request to provide information regarding the environment within, or adjacent to, the project boundaries related to Bylaw 7188 and preparation of this EIA, 19 respondents provided the following summarized information related to the environment (City of Edmonton 2021).

Environment:

- There is a weed infestation - require access for weed removal by volunteers during construction.
- Adequate clearance for animal passage below the bridge, and boating clearance during high water.
- Minimize disturbance to creek banks and wildlife during construction.

Weed management, wildlife passage and construction impacts to the creek banks and wildlife are addressed in this EIA in Section 5.2.

More recently, an online information session was held on Thursday 20 May 2021 to provide details about preliminary design of the pedestrian bridge replacement. Topics discussed included: project scope and timeline, preferred bridge design, environmental impact assessment information, anticipated construction activities, and how the design incorporates What We Heard from the January 2021 online survey. The presentation recording and questions and answers from the event have been posted on the City's project website.

8.0 CONCLUSIONS

8.1 Impact and Sensitivities

This EIA has shown that with the described mitigation measures applied, all but two impacts related to the construction phase of the bridge replacement project can be mitigated such that adverse residual impacts are reduced to negligible.

The key sensitivities identified for the proposed project, therefore, are:

- creek bank slope stability, and
- habitat alienation during construction.

The project has the potential to result in a negative impact to creek bank slope stability. If no appropriate measures are put in place, slope destabilization could occur during construction and operation of the new bridge. Thurber (2019b; Appendix D) observed no recent signs of instability at either the north or south creekbanks at the existing bridge site. The heavy rock riprap on the south creek bank and gabion baskets along the north creek bank both appeared to be functioning well (Thurber 2019b; Appendix D). Thurber (2019b; Appendix D) recommended the current erosion protection (riprap and gabion baskets) should be reviewed by a hydrotechnical consultant to evaluate the adequacy and determine if additional riverbank erosion protection is warranted. Thurber (2021) recommended that during construction, the subgrade should be inspected by qualified geotechnical personnel prior to the placement of any additional fill required for site grading, to confirm that all deleterious material and organic soil has been removed. They also recommend that any soft areas detected during proof rolling should be excavated and replaced with compacted low to medium plastic clay or granular soils. Until there is confirmation that there are no slope stability concerns with new bridge design or during construction, residual impacts remain negative, direct, minor, permanent, local and likely.

The project is anticipated to result in one temporary negative residual impact related to wildlife during construction. Construction activities and related noise have the potential to result in wildlife habitat alienation in adjacent areas. Activities and noise associated with construction phases have potential to disrupt wildlife species using adjacent habitat, leading to habitat alienation in those areas. This effectively reduces the amount of usable habitat available to individuals. Few mitigation measures are available, however, work crews will be instructed not to harass wildlife and the contractor’s ECO plan will include worker/wildlife encounter protocols.

Considering the above, and that communication with City stakeholders remains open during project development, we are of the opinion that the proposed project does not require additional modifications to proceed responsibly.

8.2 EIA Limitations

This EIA was founded on Issued for Permitting Design Drawings and supporting project preliminary design information, including anticipated construction methodology information. The EIA was predicated on the knowledge that the City's construction contractor will develop environmental controls intended to induce excellent environmental performance during construction.

8.3 Summary of Key Mitigation Measures for Future Project Phases

The following represents a list of key mitigation measures selected to itemize important action items for future project phases for the City and/or the successful contractor.

8.3.1 Detailed Design Phase

- The City will ensure a landscaping restoration plan is prepared for the project during detailed design.

8.3.2 Construction Phase

All mitigation measures should be included in the Contractor's ECO Plan.

- The City must ensure that the construction contractor adheres to all the mitigation measures listed in Section 5.2.1 and 5.2.3 and distilled here to mitigate potential impacts to surface water and fish and fish habitat and ensure compliance with Provincial and Federal Acts pertaining to water and fish.
    - Prepare a detailed ESC Plan
    - Turbidity monitoring is recommended
    - Follow instream isolation BMPs
    - Construction is to take place outside the RAP
    - Follow decontamination protocols for whirling disease

- The City must ensure that the construction contractor adheres to all the mitigation measures listed in Section 5.2.5 and distilled here to address vegetation loss and ensure compliance with the *Corporate Tree Management Policy*:
    - Prepare a Tree Protection Plan
    - Revegetate exposed soils promptly
    - Discourage weed establishment
    - Implement weed control and monitoring

- The City must ensure that the construction contractor adheres to all mitigation measures listed in section 5.2.6 to mitigate potential wildlife impacts and ensure compliance with all Provincial and Federal Acts pertaining to wildlife. Note that vegetation clearing and bridge demolition timing are critical issues as is the potential presence of a snake hibernaculum in the LSA.

- The City must ensure that the construction contractor adheres to all mitigation measures listed in section 5.2.8. to mitigate potential historical (archaeological and palaeontological) impacts and ensure compliance with the *Historical Resources Act*.

- The City must ensure that the construction contractor adheres to all mitigation measures listed in section 5.2.9 to mitigate potential impacts to recreation and maintain recreationalist safety.

- The City must ensure that the construction contractor adheres to all mitigation measures listed in Section 5.2.10 and distilled here to mitigate impacts to project incidents.
    - Prepare a detailed spill prevention and emergency response plan
    - Care of Water Plan

8.4 Summary of Outstanding City Environmental Permitting Requirements

The following environmental permitting requirements remain the responsibility of the City and must be completed prior to construction start:

- North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188) - EIA approval - anticipated in autumn 2021

- City of Edmonton Parkland Bylaw (Bylaw 2202) – City (or contractor) to undertake

- Alberta *Public Lands Act* – Disposition License of Occupation (DLO) for work areas in the bed and shore outside the roadway ROW – pending AEP's review; anticipated autumn 2021.

- *Water Act* Code of Practice (CoP) Notification for instream works - to be submitted to AEP at least 14 days prior to construction initiation.

8.5 Draft EIA Comments and Conditions

As part of the Bylaw 7188 environmental review process, comments on the draft EIA and conditions moving forward were issued by City of Edmonton Urban Planning and Economy on 15 July 2021. In response, we prepared a concordance table documenting those comments and conditions, the project team's responses and relevant EIA section references, if applicable. That concordance table is being submitted to Urban Planning under separate cover for circulation, review and approval. Once approved by Administration, this final EIA will be advanced to City Council for their approval pursuant to Bylaw 7188 in November 2021. A copy of the concordance table is provided for reference in Appendix K.

9.0 REFERENCES

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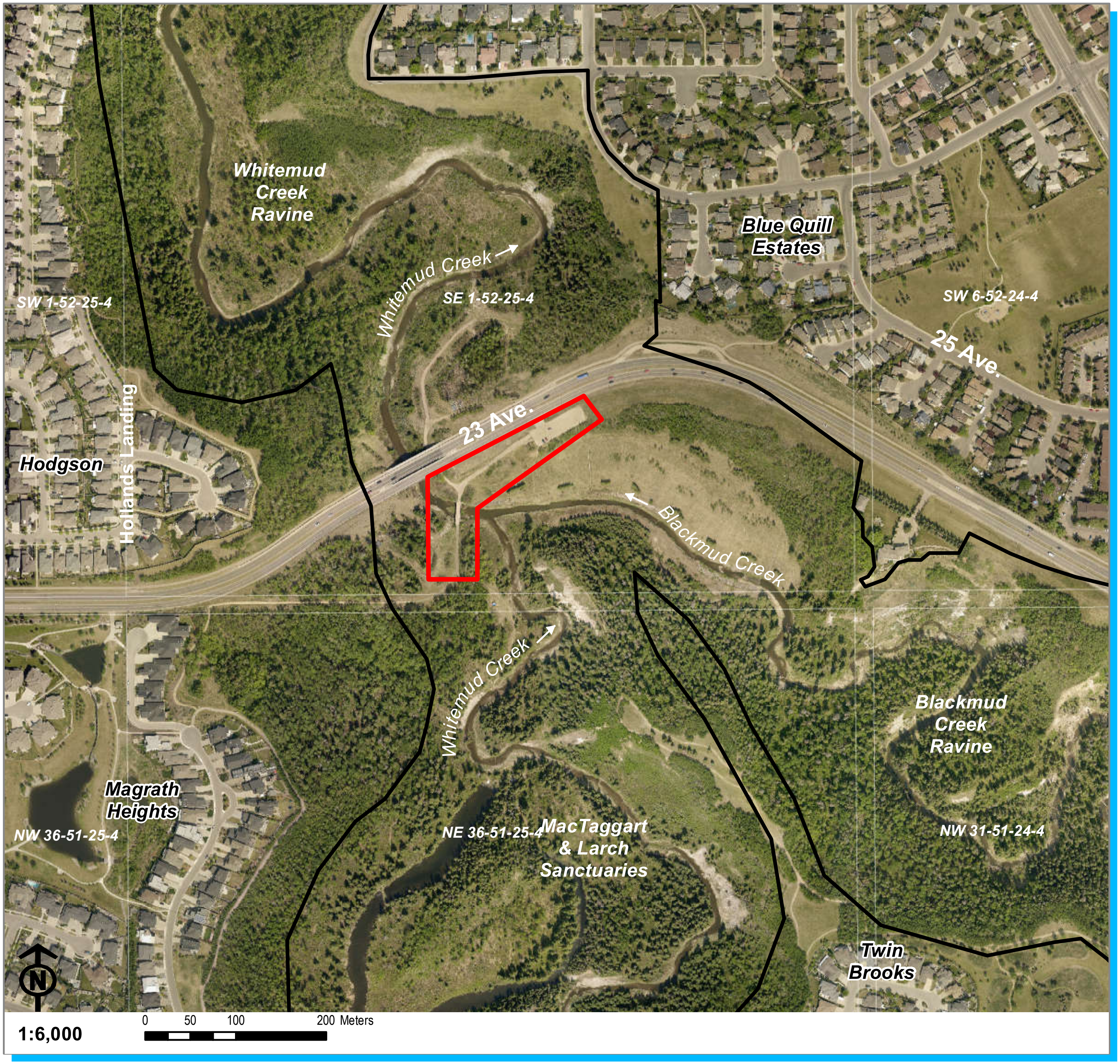
9.1 Personal Communications

A. Bismanis. Environmental Scientist. Spencer Environmental Management Services Ltd. Edmonton, Alberta.

N. Kushka. P.Eng. EPCOR Drainage Engineer, Edmonton, Alberta

Appendix A: Figures

Figure 1.
Project Location
Smith Crossing
Pedestrian Bridge
Replacement

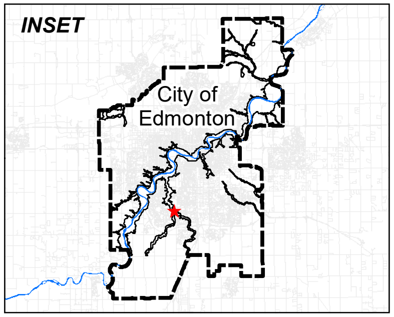


Legend

🟥 Local Study Area

⬛ Bylaw 7188 Boundary (COE, 2008)

*Map extent reflects the Expanded Study Area.

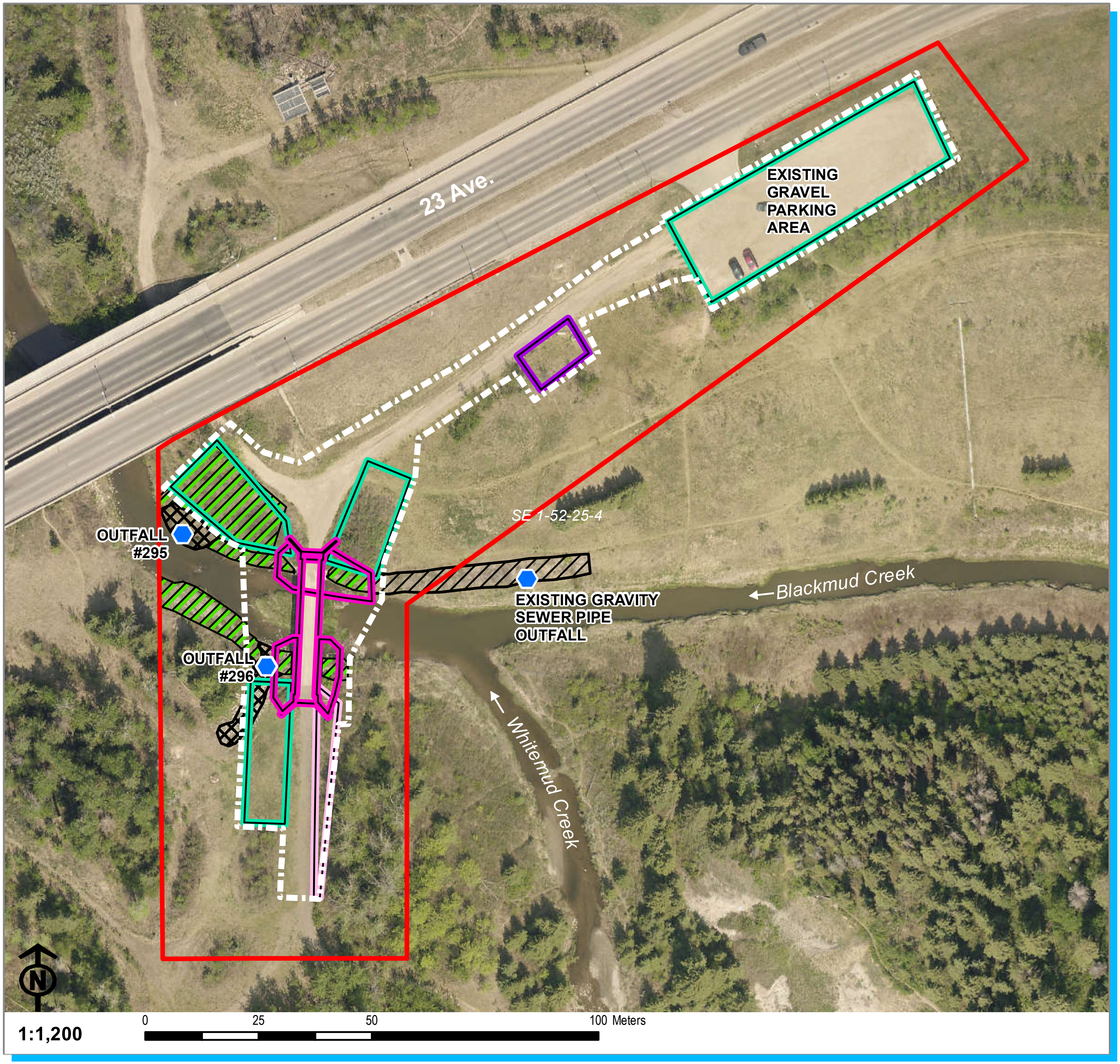


Map Date: 04 June 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

Figure 2.
Site Context and Bridge Project Components

Smith Crossing Pedestrian Bridge Replacement



Map Date: 04 June 2021
Imagery Mosaic: May-July 2019 (COE)

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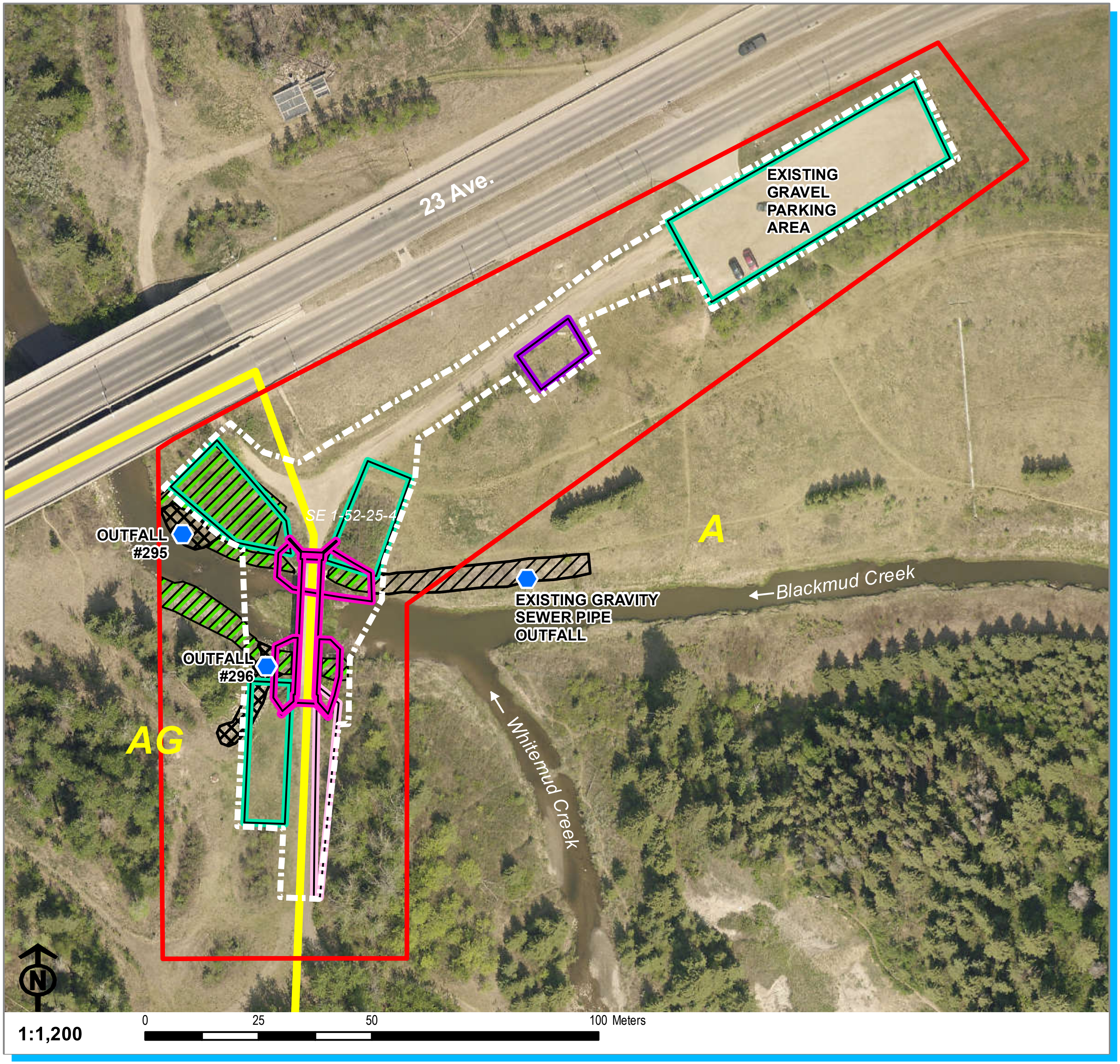
**Issued for Permitting Design Drawings provided by Morrison Hershfield (2021).*
***Location of existing bioengineered bank protection supplemented with review of current City of Edmonton Pictometry imagery and field observation.*

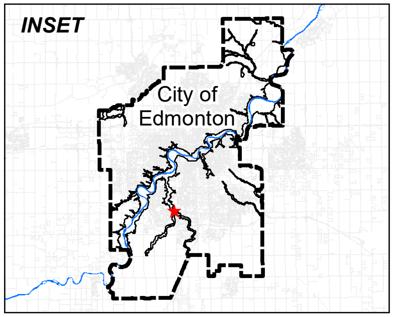
Figure 3.
Land Use Zoning

Smith Crossing
Pedestrian Bridge
Replacement



Legend

- ⬢ Outfall*
- 🟥 Local Study Area
- ▭ Project Construction Limits*
- ▭ Replacement Bridge Footprint*
- ▭ Vegetation Removal for Embankment Works*
- ▭ Proposed Enhancements to Trail Amenities*
- 🟩 Potential Construction Laydown Areas*
- ▩ Existing Riprap*
- ▨ Existing Gabion*
- ▨ Existing Bioengineered Bank Protection**
- A Zoning (COE, 2020)



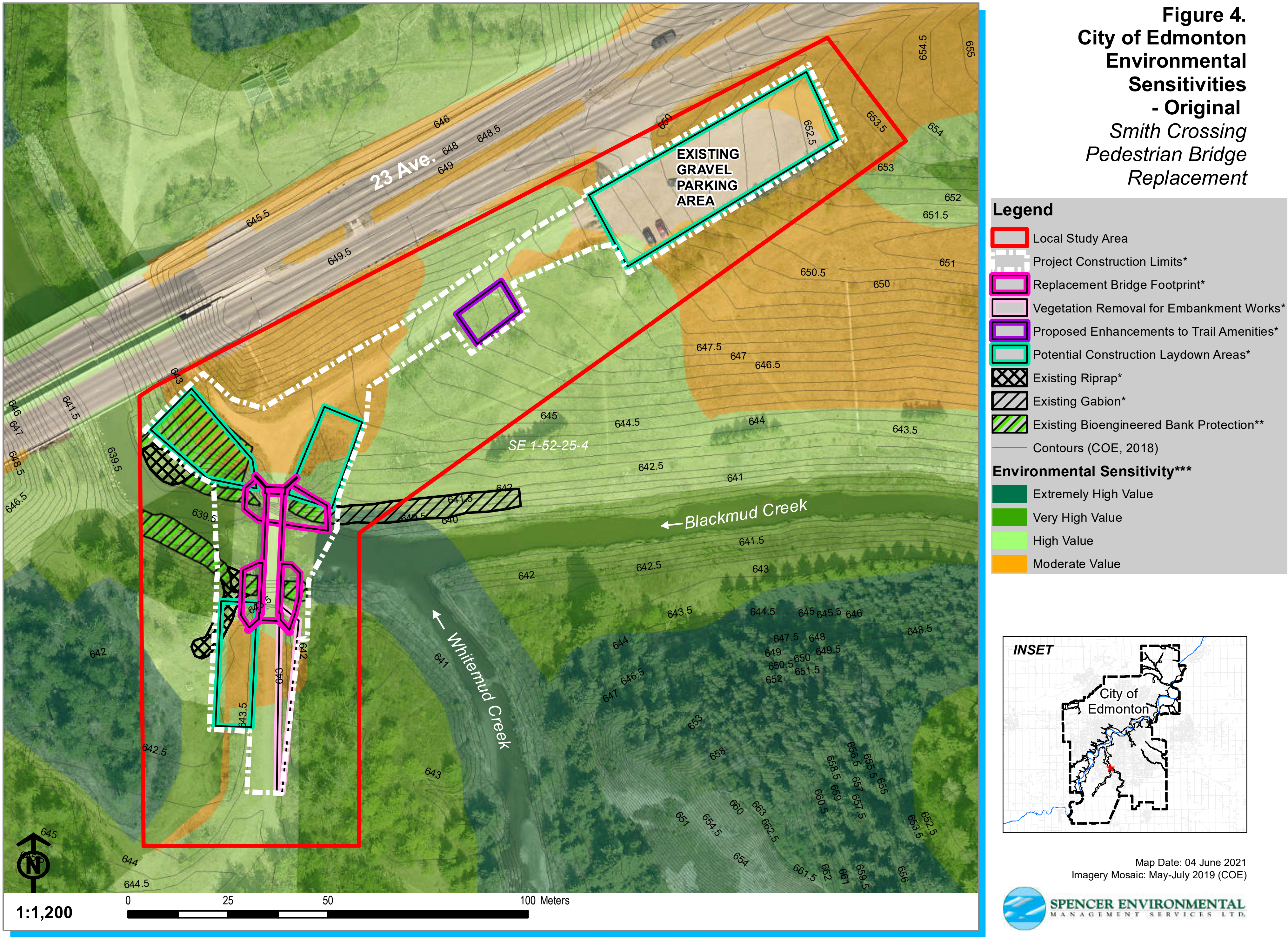
Map Date: 04 June 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Issued for Permitting Design Drawings provided by Morrison Hershfield (2021).
**Location of existing bioengineered bank protection supplemented with review of current City of Edmonton Pictometry imagery and field observation.

Figure 4.
City of Edmonton Environmental Sensitivities - Original

Smith Crossing Pedestrian Bridge Replacement



Legend

- 🟥 Local Study Area
- ▭ Project Construction Limits*
- 🟪 Replacement Bridge Footprint*
- ▭ Vegetation Removal for Embankment Works*
- 🟪 Proposed Enhancements to Trail Amenities*
- 🟩 Potential Construction Laydown Areas*
- ▩ Existing Riprap*
- ▨ Existing Gabion*
- ▨ Existing Bioengineered Bank Protection**
- — Contours (COE, 2018)

Environmental Sensitivity***

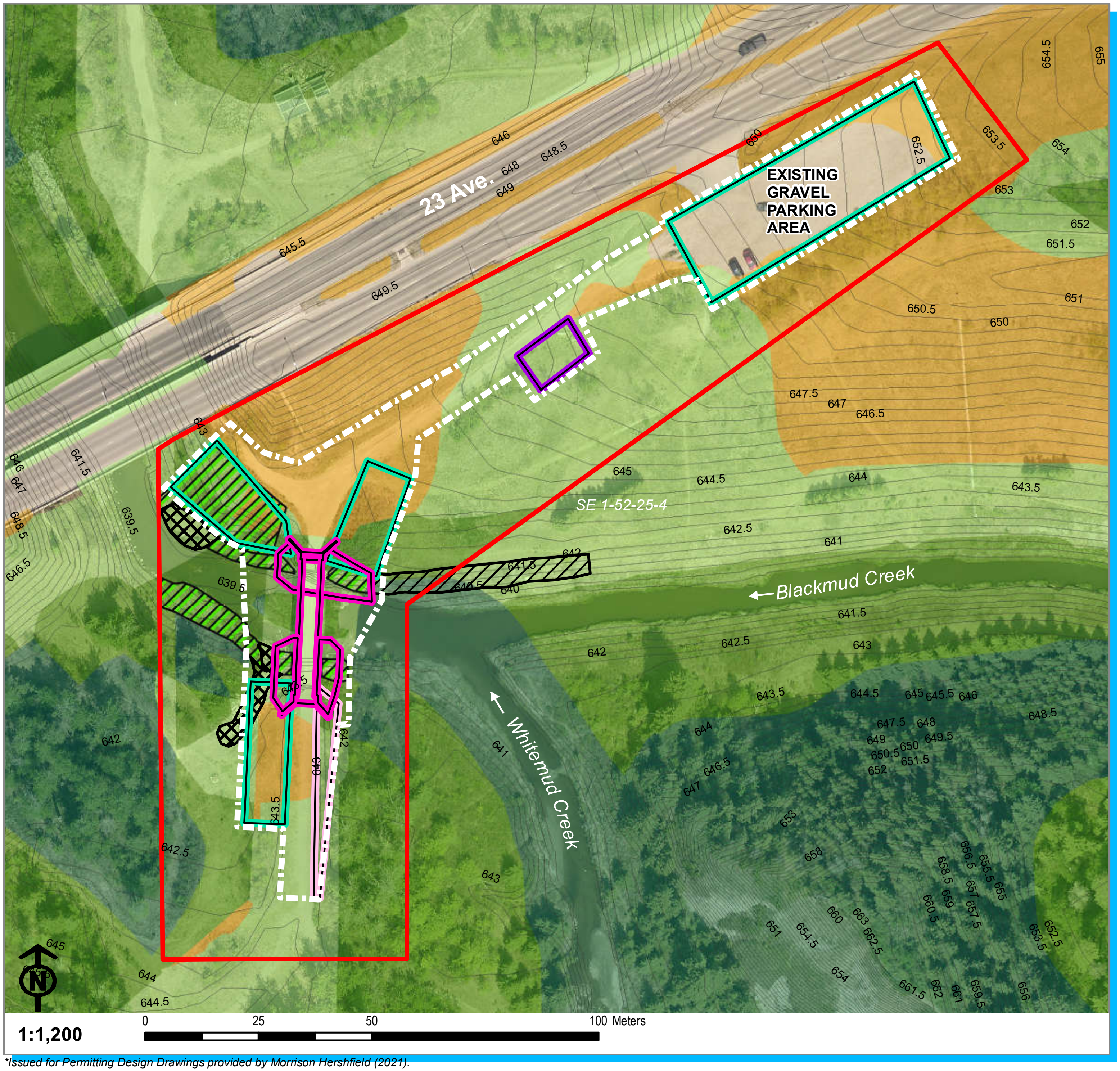
- 🟩 Extremely High Value
- 🟩 Very High Value
- 🟩 High Value
- 🟧 Moderate Value

Map Date: 04 June 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

*Issued for Permitting Design Drawings provided by Morrison Hershfield (2021).
**Location of existing bioengineered bank protection supplemented with review of current City of Edmonton Pictometry imagery and field observation.
***City of Edmonton Environmental Sensitivity Project (Solstice Canada, 2016).

Figure 5.
City of Edmonton Environmental Sensitivities - Updated (2021)
Smith Crossing Pedestrian Bridge Replacement

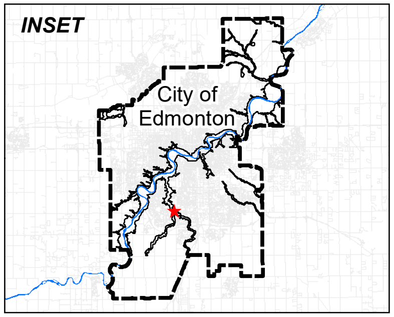


Legend

- 🟥 Local Study Area
- ▭ Project Construction Limits*
- 🟪 Replacement Bridge Footprint*
- ▭ Vegetation Removal for Embankment Works*
- 🟪 Proposed Enhancements to Trail Amenities*
- 🟩 Potential Construction Laydown Areas*
- ▩ Existing Riprap*
- ▨ Existing Gabion*
- ▨ Existing Bioengineered Bank Protection**
- — Contours (COE, 2018)

Environmental Sensitivity***

- 🟩 Extremely High Value
- 🟩 Very High Value
- 🟩 High Value
- 🟧 Moderate Value



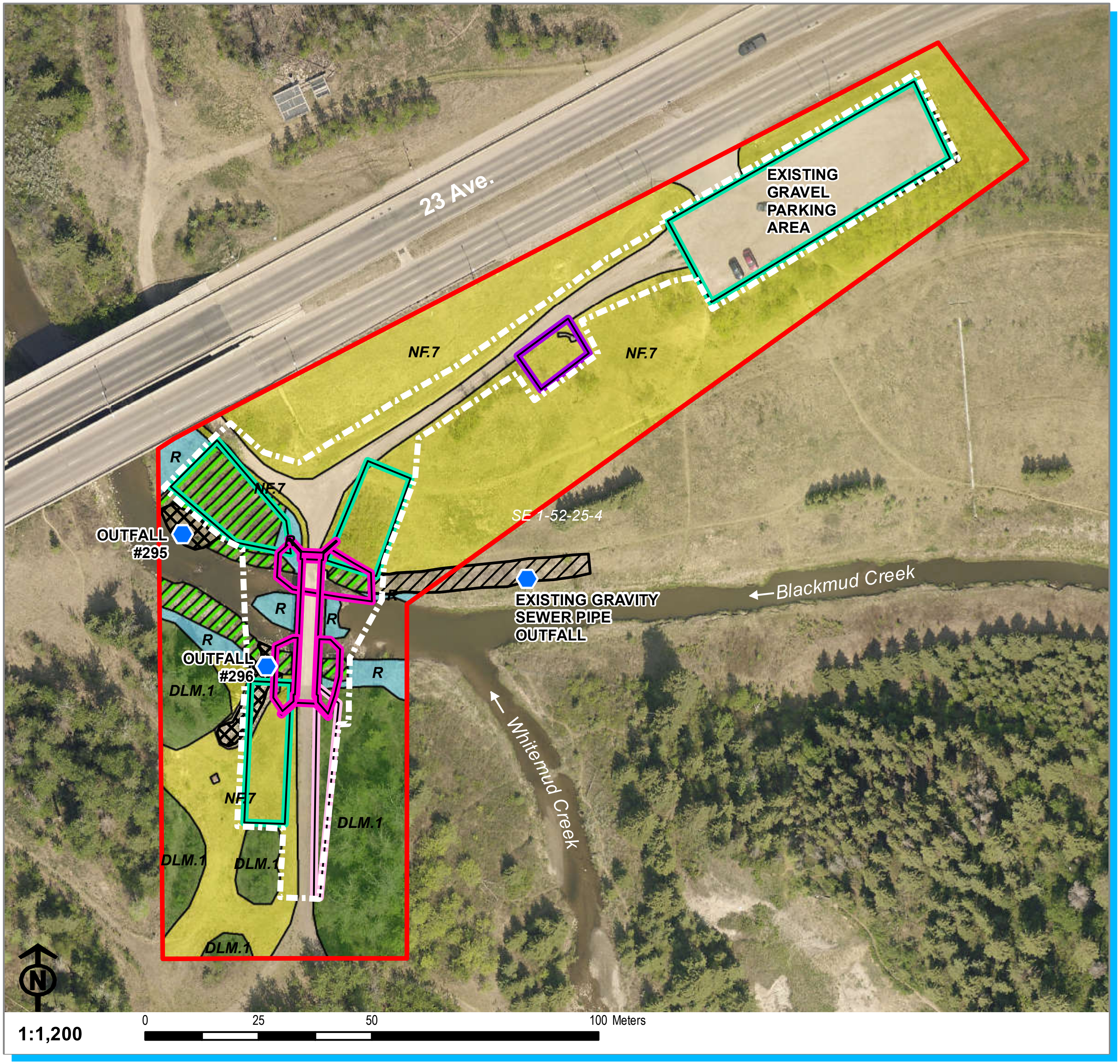
Map Date: 04 June 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

*Issued for Permitting Design Drawings provided by Morrison Hershfield (2021).
**Location of existing bioengineered bank protection supplemented with review of current City of Edmonton Pictometry imagery and field observation.
***Update of City of Edmonton Environmental Sensitivity Project (Solstice Canada, 2016) data based on site-specific survey data conducted by Spencer Environmental (2019).
Note – existing bioengineered bank protection areas constructed in 2019 after our site survey were not used as part of this analysis.

Figure 6. Existing Plant Communities and Impact Areas

Smith Crossing Pedestrian Bridge Replacement

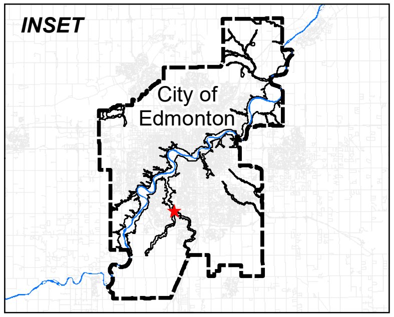


Legend

- ⬢ Outfall*
- 🟥 Local Study Area
- ▭ Project Construction Limits*
- ▭ Replacement Bridge Footprint*
- ▭ Vegetation Removal for Embankment Works*
- ▭ Proposed Enhancements to Trail Amenities*
- 🟩 Potential Construction Laydown Areas*
- ▩ Existing Riprap*
- ▨ Existing Gabion*
- ▨ Existing Bioengineered Bank Protection**

Plant Communities* (2019)**

- 🟩 Deciduous Mixedwood – Mixed Shrubs (DLM.1)
- 🟨 Non-Forested Smooth Brome – Level Slopes (NF.7)
- 🟦 Riparian (R)



Map Date: 04 June 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

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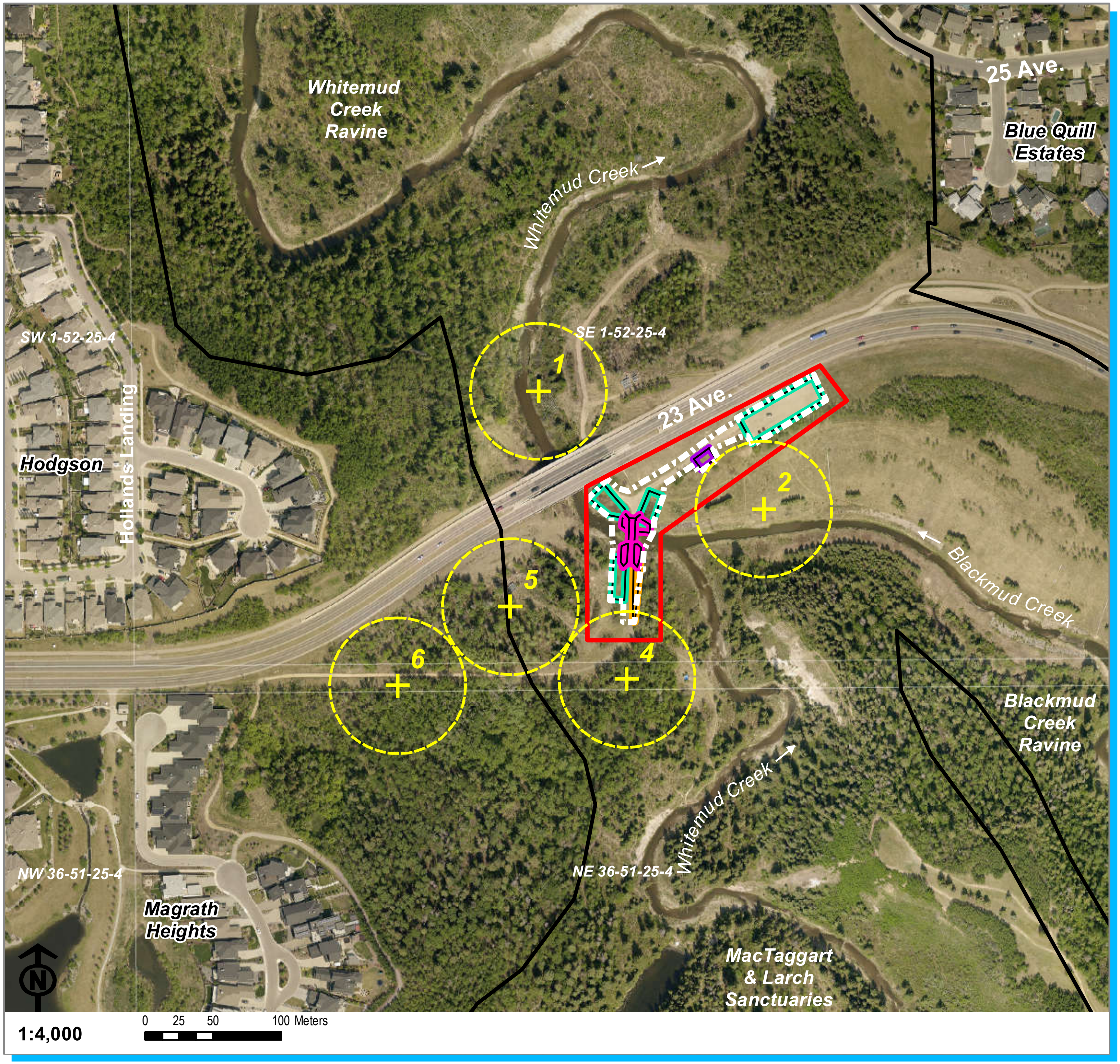
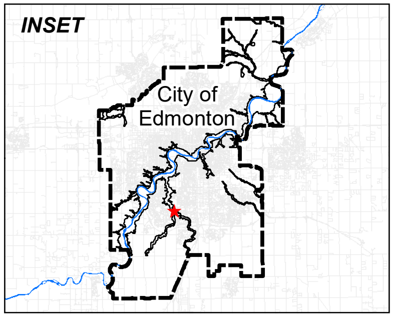
*Issued for Permitting Design Drawings provided by Morrison Hershfield (2021).
**Location of existing bioengineered bank protection supplemented with review of current City of Edmonton Pictometry imagery and field observation.
***Plant community classification follows the Urban Ecological Field Guide for the City of Edmonton, Alberta, Canada (City of Edmonton 2015).

Figure 7.
Breeding Bird Survey Locations
Smith Crossing Pedestrian Bridge Replacement



Legend

- 🟥 Local Study Area
- ⬛ Bylaw 7188 Boundary (COE, 2008)
- ▭ Project Construction Limits*
- 🟪 Replacement Bridge Footprint*
- 🟧 Vegetation Removal for Embankment Works*
- 🟪 Proposed Enhancements to Trail Amenities*
- 🟩 Potential Construction Laydown Areas*
- 🟨 Breeding Bird Survey Location (50m radius)



Map Date: 04 June 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL
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*Issued for Permitting Design Drawings provided by Morrison Hershfield (2021).

Appendix B: EIA Terms of Reference

North Saskatchewan River Valley Area Redevelopment Plan

A Guide to Completing Environmental Impact Assessments

Table of Contents

-

Introduction

The North Saskatchewan River Valley Area Redevelopment Plan, Bylaw 7188, protects, preserves, and enhances the North Saskatchewan River Valley and Ravine System as Edmonton's greatest asset and mitigates the impacts of development upon the natural functions and character of the river valley and ravine system.

The following guide has been developed to outline the process and content required for completing environmental impact assessments under Section 3.3.3 of the North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188). The aim is to provide a consistent approach to assessing impacts, to increase efficiency in report preparation and review, and to improve communication between the agencies and individuals involved.

This Guide is general in nature applying to a range of projects including park master plans, park and facility development projects and utility and infrastructure projects. Proponents are advised that under Section 3.5.3 of the the North Saskatchewan River Valley Area Redevelopment Plan a site location study in addition to an environmental impact assessment that details costs, and social, environmental and institutional constraints which make a River Valley location essential must be prepared for City Council approval. The terms of reference and reporting requirements for the Site Location Study are included as Appendix A (Guide to undertaking a Site Location Study). The environmental impact assessment and site location study should be undertaken prior to Council committing funds for capital expenditure related to any project.

Environmental Impact Assessment Guide

These guidelines provide a general framework in completing an environmental impact assessment in accordance with the requirements outlined in the North Saskatchewan River Valley Area Redevelopment Plan. Emphasis is placed on early consultation with the City of Edmonton and other review agencies (e.g. Province of Alberta). This helps to improve communication, identify issues and constraints at an early stage, avoid costly delays, and make efficient use of time and resources. On-going dialogue and reporting is expected throughout the process.

Prior to commencing work on the environmental impact screening assessment report a pre-consultation, scoping and project review with the Parks and Biodiversity Section of Sustainable Development is strongly advised to:

- Screen proposed projects to determine the type of environmental review required and
- Identify preliminary ecological constraints and other issues requiring assessment.

A pre-consultation meeting for an environmental impact screening assessment will include staff from the City's Parks and Biodiversity section of the Sustainable Development Department, other review agency staff where appropriate, and the applicant. If the applicant has already retained a consultant to complete the environmental report, then the consultant should be included in this meeting. The preliminary scope of the environmental report will depend on the following:

- The scale of the nature of the proposed development or site alteration;
- The character of the natural environment and its associated ecological functions;
- The site's setting within the landscape and/or watershed; and,
- The availability of previous studies and information.

Some specific study requirements for the environmental report, such as breeding bird surveys or field investigations of potential species at risk and their habitats, may be identified and agreed upon during pre-consultation, based upon the known natural features and ecological functions that could be affected by the proposed project.

Once the preliminary scope of the environmental impact assessment has been determined, the assessor (report writer) can proceed to gather information from available background sources and/or original field studies, confirm the scope of the report with the City, conduct the impact assessment and report on the study findings.

Specifications for field investigations are provided in Section Two. In general, however, applicants and their consultants should be aware that at least one site visit is required for every environmental impact assessment report regardless of scope. An environmental impact assessment without direct, personal observations of the site will be considered incomplete. Site visit(s) will occur during the growing season rather than in the winter, when snow cover and normal seasonal dormancy severely limit potential observations. Multiple site visits may be required to provide an adequate understanding of the existing conditions at the site; in these cases, winter site visits may be acceptable for the purpose of investigating seasonal wildlife or locating certain nests more easily seen when the trees are bare of leaves.

The initial site visit for the environmental impact assessment should occur prior to any clearing of natural vegetation, or intrusive site investigations (e.g. installation of test wells or boreholes). If, during this initial site visit, any potential areas of constraints are identified where intrusive surveys could result in negative impacts on significant natural features or ecological functions, recommendations to avoid or minimise these impacts will be required.

Ongoing dialogue between applicants, their consultants and City staff is expected during the completion of the environmental impact assessment. Concerns or questions may be raised with staff at any time. Recommended points of contact with City staff include:

- Following the background information review and field study, to confirm the scope of the environmental impact assessment and discuss any environmental constraints identified; and,
- During the impact assessment, to discuss potential impacts, options for mitigation, and possible monitoring requirements.

In some cases, it may be beneficial to hold such discussions at the site, with other agency staff included where appropriate.

Once the environmental impact assessment report is complete it is submitted to the Parks and Biodiversity Section of the City of Edmonton’s Sustainable Development Department. Electronic submission (PDF) of reports is sufficient to facilitate the review process. Applicants should be aware that the environmental impact assessment report, along with other supporting materials, may be posted on the City’s website as part of the public consultation process.

Once the report is submitted, Parks and Biodiversity will coordinate a review of the report and supporting information. A number of civic departments, as well as external agencies may be part of the review depending on the context and potential impacts of the proposed project. A minimum three weeks is required to complete the review and prepare comments to be forwarded to the proponent. Based on the results of the review, an environmental impact assessment may be accepted as written, or it may require revision to address comments and concerns raised by the reviewers or changes to the proposed project arising during the application review process. The resolution of comments or concerns may be achieved through discussions or meetings, or may in some cases require additional research or field investigations, with subsequent revision to the report. Open, ongoing communications between the assessor and the City during the preparation of the environmental impact assessment should significantly reduce the likelihood of substantial revisions being required.

Section One: The Property

At the outset of the process, existing legislation, plans and studies should be reviewed as a means of understanding the legislative restrictions, land-use history, and ecological landscape of the area in question. Recent and historic air photos for the project area and its surrounding environment should be reviewed and included in the report.

Basic information on the property to be referenced in the environmental report include:

- Land ownership;
- Location of the property (municipal address and legal address);
- Current zoning;
- Description of existing and historic land uses and reference to current and historic air photos;
- Summary of federal, provincial and municipal regulatory requirements that apply to the project area.

In cases where a master plan project is being undertaken, or where a project encompasses multiple properties the Property Description will identify the entire project area.

In some cases a Phase I Environmental Site Assessment, or other applicable environmental assessment may be required. Requirements for Environmental Site Assessments are generally determined through pre-consultation prior to commencing work on the environmental report. If required, approval of the Environmental Site Assessment shall precede environmental approval as per the North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188).

Section Two: Environmental Context

The description of the subject site and its environmental context provides the basis for the assessment of impacts to follow. This description should consider the lands adjacent to the site, not just the site itself. The level of detail required will vary based on the scale and complexity of the project. It is recognised that lack of access to adjacent lands may result in less detailed information. The environmental report should include an introductory overview that establishes the environmental setting for the proposed project relative to any known significant natural features on or adjacent to the site, followed by more detailed discussions of the various environmental components as outlined below. An environmental sensitivities map that clearly illustrates the key features associated with the site will be required to accompany the environmental report. The use of photographs to illustrate and accompany the environmental report is encouraged.

If the area in question has been assessed through a previous project/report please reference the project/report and include the relevant information as an appendix.

Depending on the location of the site, City staff may be able to provide background information and/or mapping resources.

2.1. Surface Water, Groundwater and Fish Habitat (Fish survey is recommended considering Class B waterbody)

Water features connect and contribute to the significance of natural system features and functions. While a detailed description of surface water, groundwater and fish habitat may not be required for all environmental reports, the following information must be identified:

- Delineation of the 1:100 year floodplain;
- Runoff characteristics. Runoff characteristics are relevant to identify locations where the buildup of moisture could potentially cause concern over a long period of time;
- Depth of the water table. The depth of water table is an indicator of areas that are developable/undevelopable.

2.2. Geology/Geomorphology and Soils (Additional geotechnical investigation as requested by City Geotechnical engineers)

While a brief description of the physical characteristics of the site is always relevant, detailed information on soils and geology may not be required for all environmental reports. The need for this information will be determined through pre-consultation meetings with staff from City Planning (Urban and other city departments as required. For all projects the geomorphological boundary and relevant geomorphological features must be included to highlight the location of steep slopes, floodplains, hills, ravine channels and any other relevant features.

The presence of modifying factors will influence the potential for slope movement and should be considered as part of project development. Modifying factors include:

- Presence of slope failure (active/inactive/recurrent);
- Evidence of river erosion;
- Potential for high water table;
- Previous mining activity;
- Presence of slip-off slope

Where modifying factors are present additional studies may be required in order to adequately inform the assessment of geotechnical risk, potential impacts from erosion, sedimentation and changes in local hydrogeology. Site-specific studies conducted in support of development proposals (e.g. hydrogeological and terrain analyses, geotechnical studies and/or slope stability analyses) should be referenced, when available.

Genetic Class of materials should be included in the site's description as it relates to soil classification. This description should include a brief description of soils on the site and surrounding area and shall include information on the following:

- Potential run-off: Involves the analysis of the slope and the infiltration capacity of the soil unit. Soil that has low or moderate-low runoff characteristics may pose a constraint.
- Erosion potential: Involves the analysis of the slope along with the infiltration capacity and erodibility rating of the soil unit.

If additional site-specific information is required, this background data should be supplemented with further soil characterization resulting from Ecological Land Classification field studies or other investigations (e.g. geotechnical studies). Where relevant, shallow and poorly drained soils should be indicated.

Environmental Contamination: Given the presence treated logs and potential soil contamination, Phase I ESA may require in addition to confirm the status of contamination and plan for risk management and restoration.

2.3. Vegetation (Rare Plant survey is recommended that covers the extent of impacts)

The report should include a description of the area’s vegetation, in order to assess habitat and biodiversity value, develop mitigation/management strategies, and strengthen the post-development ecological network. The need for specific field surveys may be identified during pre-consultation. The environmental report will include:

- Identification of vegetation community types present using classifications consistent with those in use by Alberta Environment and Sustainable Resource Development (e.g. Primary Land and Vegetation Inventory). If an alternative classification system is used to provide supplementary information, please reference and describe the system as required.
- Description of native plant diversity (e.g. number of species, evenness, etc.).
- List of rare or unique species or communities. This includes those species that are listed as:
    - Threatened or Endangered under the provincial Wildlife Act
    - Sensitive, May be At Risk under the General Status of Alberta Wild Species
    - S1, S2 or S3 by the Alberta Conservation Information Management System (ACIMS).

  Unique species are those that may not be listed as rare but are considered to be ecologically underrepresented in the Edmonton area.
- Description of the presence and distribution of invasive, non-native species or noxious/prohibited weed species.

2.4. Wildlife (Desktop based or reference from the recent studies)

As with vegetation cover, a thorough review of available background information on wildlife is expected as part of the environmental review. Incidental observations will be the minimum standard required for fieldwork. The need for specific field studies of taxonomic groups (e.g. breeding bird surveys, etc.) may be identified during pre-consultation. The environmental report will include:

- Lists of species observed, reported or expected to occur on or adjacent to the site, presented in tabular format (as an appendix) with notes on the species' relative abundance at the site, its residency status (i.e. is it present year-round, seasonally or only periodically; does it live on the property, forage there or use it as part of a movement corridor) and the evidence supporting its inclusion on the list (e.g., sighting, tracks previously reported);
- Description and mapping of any “wildlife trees” (i.e. tree with visible nests, or large trees with cavities) or other features that could provide nesting or den sites;
- An assessment of the site's suitability for any significant species (including species at risk - ANHIC, FWMIS, database research results on the potential presence of listed species at risk, species of special status or rare communities).

- An assessment of whether or not any significant wildlife habitat is present on or adjacent to the site.

2.5. Historical Resources (Confirm with Alberta Culture and Tourism)

The identification of historical/archeological sites within the River Valley and Ravine System does not indicate the existence of an environmental hazard. However, it does provide the location of potential areas to be preserved when future development/redevelopment is being proposed.

In accordance with Section 37(2) of the *Alberta Historical Resources Act*, the Minister of Alberta Culture and Tourism may require that any proposed activity that is likely to threaten the integrity of a historic resource be preceded by a Historic Resources Impact Assessment. In determining whether a Historic Resources Impact Assessment is required the proponent should submit a Historic Resources Application to Alberta Culture.

Historic Resource Impact Assessments and related mitigative strategies are paid for by the person or company (proponent) undertaking or proposing to undertake the project or activity. Professional private-sector archaeologists, paleontologists, historians and traditional use consultants perform the required work.

For additional information visit the Historic Resource Impact Assessments website for the Government of Alberta.

2.6. Environmental Sensitivities Map

The environmental sensitivities map illustrating the areas environmental sensitivities and identified development constraints will support the descriptive overview for the subject site. The map will include a key map to show the subject site’s location in relation to the surrounding major roads and other landmarks. The use of recent aerial photography as a base for the natural environment is strongly encouraged. The map will:

- Illustrate the property boundary or project area included in the scope of the assessment;
- Be drawn to scale, with standard mapping elements such as a scale bar, north arrow, date and legend;
- Identify all of the aquatic, terrestrial, and geomorphological features, natural ecosystems and vegetation communities on the site as referenced in the descriptive report and identified in Sections 2.1 - 2.5 of this report;

- Identify all of the terrestrial and aquatic natural features, natural ecosystems and vegetation communities in the surrounding area that might be affected by the proposed development or site alteration;
- Include topographic information (i.e. elevation contours) at a level of detail sufficient to show general slope trends and specific topographic features.
- Outline potential development constraints and opportunities for protection, conservation, and restoration/stewardship in accordance with Best Practices as outlined in Table One and based on the City of Edmonton's Environmental Sensitivity Mapping database

Section Three: The Project

In order to assess the environmental impacts of the proposed project on the identified natural features and functions on and adjacent to the site, a clear understanding of the project is required. Environmental sensitivities should be identified prior to beginning concept design, to the extent possible, to ensure the project is designed to avoid existing environmentally sensitive areas.

The project description must include information about all phases of the project, including site preparation, construction, landscaping and intended use of the property once the construction work is completed, and (in some cases) decommissioning, if this information is available. Any related off-site works by the proponent should also be included in the project description and impact assessment. This section of the report should also describe how any environmental constraints identified in Section 2 have been incorporated into the project. Consideration for project alternatives justifying why a location within the boundaries of the North Saskatchewan River Valley Area Redevelopment Plan shall be submitted as part of a Site Location Study (Appendix One).

The level of detail should reflect the size and complexity of the development or site alteration. The description must be accompanied by one or more graphic representations of the project.

3.1. Concept Plans and Drawings

The use of actual concept plans, development plans, site plans or other figures to illustrate and support the project description is required. At a minimum, the environmental report must include one or more plans showing the proposed development, park master plan or site alteration as an overlay applied to the environmental sensitivities map. The following information should be included in the plan(s), to the extent possible:

- Location of all existing and proposed lot lines, building envelopes and structures, fences, driveways, parking areas, roads, trails and pathways and any other park amenities;

- Services, including stormwater management facilities and drainage systems, public infrastructure and utilities;
- Erosion and sediment control measures;
- Grading limits and post grading contours; and,
- Natural features and areas of vegetation that will be removed.

Where vegetation impacts are anticipated including construction or project activity within five meters of a City-owned tree a Tree Protection Plan shall be required. The Tree Protection Plan will outline how project work will be accomplished while protecting public trees. Urban Foresters with the City of Edmonton can provide assistance in drafting the necessary tree protection plans.

It is recognized that this level of detail will not be available nor appropriate for all projects and that additional information may still be in development. The results of the environmental review will (and should) inform and be incorporated into the final plans for the project.

Section Four: Project Impacts and Mitigation Measures

Once an understanding of both the existing environment and the proposed project has been established, the identification and assessment of impacts can begin. Assessing impacts and recommending appropriate mitigation measures is the most difficult and important task of the environmental impact assessment. In some cases Provincial and Federal approvals may be required in addition to City approval as part of Bylaw 7188. This section should also highlight any relevant Provincial and Federal approval requirements.

It is important to provide a clear assessment methodology that will lead to specific recommendations. Tools should be employed that will provide demonstrable rationale for recommending specific mitigation measures. Examples include but are not limited to matrix evaluation, checklist evaluation, ecological land classification and valued ecosystem components. Assessment methodology should include the following:

- Approach to the assessment;
- Scoping the assessment;
- Spatial and temporal extents;
- Assessment of effects;
- Determining the significance of effects; and
- Cumulative effects Assessment: A description of potential positive and negative environmental, social, economic and cultural impacts of the proposed activity, including cumulative, regional, temporal and spatial considerations.

4.1. Assessing Impacts

This section further describes the project, the associated impacts and related mitigation. Details on the interactions between the specific project components identified and elements of the environment where there is a potential to result in an impact (positive or negative) should be identified.

The proponent will classify the potential environmental effects into negative impacts and positive environmental effects, and characterise them using standard criteria such as:

- Nature of Impact: Is it direct, such as the loss of a feature, or indirect, such as an increase in downstream sedimentation?
- Magnitude: What is the severity of the impact, especially as compared with available benchmarks or targets?
- Geographic extent: How large an area will be affected?
- Duration and timing: Is the impact temporary or permanent? Is it seasonal?
- Likelihood: What is the probability that the impact will occur?

- Potential for cumulative impacts: What is the potential for interacting impacts as a result of previous or future development or site alteration?

4.2. Identifying Cumulative Impacts

Cumulative impacts are compound environmental effects that may result due to multiple or successive development or site alteration activities (e.g. implementation of a park master plan which includes multiple elements). Cumulative impacts may affect natural features or their ecological functions, water quality or quantity, sensitive surface or groundwater features, and their related hydrologic functions. They are an important consideration in any environmental review.

Potential cumulative impacts are estimated by considering project effects within an expanded geographic area as well as a longer timeframe. For example, a cumulative impacts analysis should consider a reasonable and ecologically relevant area within which the proposed developed is located. Development in the recent past and probable development activities in the future should be described, and if relevant, mapped.

4.3. Mitigation Measures

Mitigation measures must be identified for each potential negative impact, to eliminate or reduce the impact to the extent possible. Preferred mitigation measures avoid or minimise impacts, and may be supported by compensatory measures such as site rehabilitation or restoration.

Avoiding or eliminating impacts through design (or redesign where necessary) is the preferred approach, and should always be considered as a first step. Designing around the feature is the only option when significant wetlands or significant habitat for endangered and threatened species occur within a proposed project's boundaries. Recommendations for the preservation of natural features within or adjacent to the project area must be accompanied by recommendations regarding appropriate setback distance(s) and any buffer required to protect the feature and its ecological functions from impact.

Minimising impacts to the extent possible is expected when avoidance is not feasible. Examples include the establishment of strict limits on the extent of vegetation clearing, or the use of specific timing windows for construction to reduce impacts on wildlife by avoiding sensitive life stages such as breeding seasons or hibernation. The supporting rationale for these measures is to be included in the environmental report.

Compensation may be required in circumstances where impacts cannot be avoided or minimised. This includes consideration for the City of Edmonton's Corporate Tree

Management Policy (C456A). Restoration and enhancement may also be recommended in the absence of such legal requirements, to support the long-term conservation of the City's natural systems.

In proposing mitigation measures, the environmental report should refer to recent science and/or guidelines, where necessary, to demonstrate that the measures will be sufficient to minimise impacts or replace lost habitat. The environmental report will include the following:

- A full description of proposed mitigation measures, including recommendations for timing windows or other specifications for implementation, for all potential negative impacts;
- For each negative impact, an indication of whether there will be any residual impact following implementation of the recommended mitigation measure(s);
- A description of proposed restoration or enhancement plans to compensate for impacts that cannot be avoided or minimised;
- Maps and/or drawings (if relevant) depicting the location, extent, and design details of proposed mitigation measures.

Section Five: Environmental Monitoring

Where impacts have been avoided or minimised through the environmental review process, monitoring may not be needed. In cases where negative impacts have not been eliminated, or where innovative solutions are being used, monitoring may be required to measure impacts over time. The environmental report must identify any monitoring needs associated with the project, and should provide recommendations regarding the design and implementation of the required monitoring program. Consultation with City staff will be required to establish the scope of all monitoring programs, and to ensure that recommendations are feasible and appropriate.

Monitoring will usually be site-specific and may be required during the pre-construction, construction, and/or post-construction periods. The environmental report should:

- Clearly differentiate between monitoring recommendations aimed at ensuring effectiveness of mitigation, and any monitoring required for legal compliance (e.g. to meet conditions of a Certificate of Approval);
- Specify the appropriate stage(s), schedule and duration for the monitoring program;
- Propose appropriate thresholds or benchmarks for monitoring purposes;
- Identify who will be responsible for monitoring, and the reporting structure required to ensure that results are acted upon as needed; and,
- Outline contingency plans if an impact is detected or if the proposed thresholds are not met.

Section Six: Public Consultation

Open and transparent public involvement is required for all projects. The proponent should demonstrate that the affected public and other stakeholders have been given the opportunity to become involved in reviewing the project, and should indicate how the proponent has considered or addressed any resultant questions and concerns. The opportunity for public involvement benefits citizens most when they take an active role at an early stage in the process, and clearly articulate their specific questions or concerns.

Information on public consultation should include:

- A completed Public Involvement Plan;
- A summary of consultation sessions including a summary of the information collected; and
- A statement as to how public feedback has been incorporated into the project.

Section Seven: Conclusions and Supporting Information

The environmental report must include a concise summary that addresses major points and highlights any issues of concern. Limitations of the study should be clearly identified (e.g. assumptions, timing, context).

This section must include a conclusion based on the results of the impact analysis. The assessor's professional opinion must be stated, responding to the following questions:

- Provided that the recommended mitigation measures are implemented as planned, will there be any residual negative impacts on natural features or ecological functions as a result of the proposed project?
- What is the significance of any such residual negative impacts to ecological function(s)?
- Can the proposed project be accepted as planned, or should it be (further) revised to prevent, eliminate or reduce impacts? If so, what specific changes are recommended to the proposal?

If the environmental report concludes that the project will have a residual negative impact on one or more of the values or functions of the triggering feature(s), then a recommendation to proceed with the project must be accompanied by a rationale for proceeding that is based upon the provisions of the existing City of Edmonton statutory plans, policies etc. Projects with residual negative impacts to significant natural features or ecological functions may not be supported.

Supporting Information

Supporting information may include:

- Literature cited;
- A list of people contacted during the study, along with their title and agency affiliation, where applicable, and the subject(s) on which they were consulted;
- Species lists;
- Geotechnical reports;
- Public Involvement Plan;
- Previous studies or reports that may apply to the subject site.

Site Location Study: Will confirm the requirements at a later date.

Appendix C: Environmental Site Assessment (Thurber 2019a)

LIMITED PHASE II
ENVIRONMENTAL SITE ASSESSMENT
SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT
WHITEMUD CREEK, EDMONTON, ALBERTA

THURBER ENGINEERING LTD.

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LIMITED PHASE II
ENVIRONMENTAL SITE ASSESSMENT
SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT
WHITEMUD CREEK, EDMONTON, ALBERTA

Report

to

City of Edmonton

Marcie Kennedy, B.Sc.
Environmental Scientist

Date: October 30, 2019
File: 26386

Neal Fernuik, M.Sc., P.Biol., P. Eng.
Review Principal

TABLE OF CONTENTS

1. INTRODUCTION

Thurber Engineering Ltd. (Thurber) was retained by the City of Edmonton (COE) to conduct a Limited Phase II Environmental Site Assessment (ESA) for future replacement of the Smith Crossing pedestrian bridge (BF#191) (the "Site") over Whitemud Creek in Edmonton, Alberta.

The Site consists of pedestrian bridge #191 and 10 m of surrounding embankments within the MacTaggart Sanctuary trail system. The pedestrian bridge currently consists of a single-span steel pony truss over Whitemud Creek immediately downstream the confluence with Blackmud Creek. The bridge north abutment is directly exposed to flow and protected by vegetated gabion baskets and riprap protects the south abutment during high water events.

Authorization to carry out the Limited Phase II ESA was provided by Ms. Christina Tatarniuk, P.Eng. of COE. A geotechnical investigation was conducted concurrently with the environmental program and is reported under a separate cover.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SCOPE OF WORK

The scope of work, as outlined in Thurber's June 10, 2019 proposal, was to assess the environmental condition of soil under the bridge and surrounding area. The proposed scope of work generally included the following:

- Drill up to 15 test holes to a depth of 0.3 m beneath the bridge and extending out from the bridge centreline and from each bank using a hand auger.
- Submit soil samples and one landfill characterization sample for lead chemical analyses.
- Compare analytical results to provincial guidelines and prepare a report.

The drilling program was completed on July 9, 2019 and September 12, 2019. Borehole locations are shown on Drawing 26386-1, Appendix A.

3. FIELD INVESTIGATION

Prior to initiating drilling activities, Thurber contacted Alberta One Call to arrange public utility locates at the Site.

On July 9, 2019 Thurber advanced ten environmental test holes (TH19E-1 through TH19E-10) and obtained samples at 0-0.15 m and 0.15 m to 0.3 m increments using a hand auger. During the assessment, additional test holes proposed for the island under the bridge could not be completed due to high water level. These additional test holes (TH19-11 through TH19-17) were completed September 12, 2019. The approximate test hole locations are shown on Drawing 26386E-1.

The test holes were visually logged and environmental soil samples collected from surface to 0.15 m below ground surface and 0.15 m to 0.30 m bgs intervals. Thurber placed soil samples in a plastic bag and transported to Element for chemical analysis.

4. STRATIGRAPHY

Based on the drilling program, soil conditions beneath the Site consist of silty clay to the maximum extent of investigation of 0.3 m bgs (below ground surface). Up to 0.05 m of topsoil was encountered in boreholes completed within the embankments.

Results from the deeper geotechnical investigation identified gravel or topsoil to 0.2 m bgs, underlain by clay or silt to 1.5 m bgs. One test hole encountered gravel up to 2.3 m bgs, clay till to 3 m and gravel to 6.1 m bgs. Clay shale was encountered in one test hole at 3.9 m and the other at 6.1 m bgs with up to 0.9 m sandstone layers to 15.5 m bgs, the maximum geotechnical extent of investigation.

5. REGULATORY GUIDELINES

Based on surrounding and existing land uses, the analytical data was compared to Alberta Environment and Parks (AEP) January 2019 *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* for Parkland use.

A landfill classification sample was compared to Alberta Environment and Sustainable Resource Development (AESRD) March 1995 Schedule to the Alberta User Guide for Waste Managers and Alberta Waste Control Regulation (AR 192/1996 and AR 272/2003).

6. SOIL CHEMICAL ANALYSES

Thirty-six soil samples (including two duplicates) were submitted to Element for analyses of lead. The soil was classified as fine grained by Thurber. The soil analytical results are presented in Table 1 in Appendix B and all soil samples analyzed met AEP Tier 1 parkland guidelines. AEP Tier 1 guidelines for metal parameters including lead are the same for fine or coarse-grained materials.

A landfill classification sample also met the applied Alberta Environment guidelines, as summarized in Table 2, Appendix B. The soil at the test hole locations would therefore not be considered to be a hazardous waste.

6.1 Quality Assurance / Quality Control

Quality assurance/quality control (QA/QC) procedures were followed to ensure the analytical results for soil samples collected during the assessment were accurate and representative. Chain of custody records were maintained to track sample handling between the field and laboratory. The QA/QC program included analysis of laboratory method blanks, surrogate recoveries and chemical spike recoveries. The laboratory quality assurance / quality control program summarized and performed by Element in Appendix C indicated that all equipment was calibrated (calibration checks) and operating within specified tolerance limits (recovery values for blanks and spike samples).

Duplicate soil samples (Dup B of TH19E-11 at 0 to 0.15 m and Dup C of TH19E-14 at 0 to 0.15 m bgs) were found to have comparable results to the original field samples as summarized in Appendix C. Relative percent differences (RPD) values ranged from 0 percent to 19.9 percent and were within acceptable limits.

7. ASSESSMENT

All of the soil samples analyzed at the 17 test hole locations beneath and on either side of the bridge met AEP 2019 Tier 1 parkland guidelines for lead. It is recommended that during planned construction in the vicinity of the bridge careful attention be paid to areas of visible lead paint during the excavation if encountered. Where lead paint chips or flecks are evident, in order to assess the extent and degree of soil impact at the location, an environmental sampling program should be conducted.

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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APPENDIX A

Drawing

N
W E
S

LEGEND

× APPROXIMATE HAND AUGER SAMPLE LOCATION

0 2.5 5 7.5 10 12.5 15 m

SCALE 1:250

2017 AIR PHOTO FROM THE CITY OF EDMONTON

THE CITY OF Edmonton

LIMITED PHASE II ENVIRONMENTAL SITE ASSESSMENT
SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT
WHITEMUD CREEK, EDMONTON, ALBERTA

SITE PLAN SHOWING APPROXIMATE TEST HOLE LOCATIONS

DWG No. 26386-1

DRAWN BY	ML
DESIGNED BY	MKK
APPROVED BY	NHF
SCALE	1:250
DATE	OCTOBER 2019
FILE No.	26386

THURBER ENGINEERING LTD.

H:\26000\26386 Smith Crossing Pedestrian Bridge - Edm. AB\Drafting\26386-1 OCTOBER 1, 2019.dwg - 1 - Oct. 01, 2019

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APPENDIX B

Analytical Tables

TABLE 1 - SOIL ANALYTICAL RESULTS: LEAD ANALYSIS
CITY OF EDMONTON
SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT
WHITEMUD CREEK, EDMONTON, ALBERTA

Sample Location	Sample Depth (m bgs)	Sample Date (dd-mmm-yy)	Lead (mg/kg)
[1]AEP Tier 1 - Parkland Use			**140**
TH19E-1	0-0.15	9-Jul-19	22.9
TH19E-1	0.15-0.3	9-Jul-19	15.1
TH19E-2	0-0.15	9-Jul-19	11.4
TH19E-2	0.15-0.3	9-Jul-19	9.6
TH19E-3	0-0.15	9-Jul-19	12.2
TH19E-3	0.15-0.3	9-Jul-19	8.4
TH19E-4	0-0.15	9-Jul-19	9.0
TH19E-4	0.15-0.3	9-Jul-19	8.9
TH19E-5	0-0.15	9-Jul-19	7.8
TH19E-5	0.15-0.3	9-Jul-19	16.8
TH19E-6	0-0.15	9-Jul-19	8.6
TH19E-6	0.15-0.3	9-Jul-19	8.8
TH19E-7	0-0.15	9-Jul-19	13.2
TH19E-7	0.15-0.3	9-Jul-19	9.9
TH19E-8	0-0.15	9-Jul-19	11.8
TH19E-8	0.15-0.3	9-Jul-19	12.3
TH19E-9	0-0.15	9-Jul-19	11.0
TH19E-9	0.15-0.3	9-Jul-19	10.4
TH19E-10	0-0.15	9-Jul-19	8.7
TH19E-10	0.15-0.3	9-Jul-19	8.0
TH19E-11	0-0.15	19-Sep-19	6.6
TH19E-11	0.15-0.3	19-Sep-19	7.6
TH19E-12	0-0.15	19-Sep-19	8.0
TH19E-12	0.15-0.3	19-Sep-19	6.8
TH19E-13	0-0.15	19-Sep-19	7.5
TH19E-13	0.15-0.3	19-Sep-19	8.1
TH19E-14	0-0.15	19-Sep-19	6.0
TH19E-14	0.15-0.3	19-Sep-19	7.1
TH19E-15	0-0.15	19-Sep-19	6.8
TH19E-15	0.15-0.3	19-Sep-19	7.6
TH19E-16	0-0.15	19-Sep-19	5.5
TH19E-16	0.15-0.3	19-Sep-19	4.5
TH19E-17	0-0.15	19-Sep-19	5.7
TH19E-17	0.15-0.3	19-Sep-19	6.3

Notes:

[1]- Alberta Tier I Soil and Groundwater Remediation Guidelines for Parkland Land Use based on fine-grained soils (AEP, 2019).

--- Not anlyszed or no guideline

BOLD Does not meet guideline

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TABLE 2 - LANDFILL CHARACTERIZATION
CITY OF EDMONTON
SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT
WHITEMUD CREEK, EDMONTON, ALBERTA

Sample	Unit	AESRD 1995 Waste Guidelines[1]	Landfill Classification
LEACHATE INORGANICS			
Antimony	mg/L	500	<0.005
Arsenic	mg/L	5.0	0.002
Barium	mg/L	100	1.12
Beryllium	mg/L	5.0	<0.001
Boron	mg/L	500	<0.2
Cadmium	mg/L	1	0.003
Chromium	mg/L	5	<0.005
Cobalt	mg/L	100	0.018
Copper	mg/L	100	<0.10
Iron	mg/L	1000.0	0.2
Lead	mg/L	5	<0.050
Mercury	mg/L	0.2	<0.001
Nickel	mg/L	5	<0.050
Selenium	mg/L	1	<0.002
Silver	mg/L	5	<0.005
Thallium	mg/L	5	<0.0005
Uranium	mg/L	2	<0.005
Vanadium	mg/L	100	<0.01
Zinc	mg/L	500	0.27
Zirconium	mg/L	500	<0.01
SOIL ACIDITY			
pH	1:2 Soil: Water	2 to 12.5	10.4
LEACHATE MONO-AROMATIC HYDROCARBONS			
Benzene	mg/L	0.5	<0.01
Toluene	mg/L	0.5	<0.01
Ethylbenzene	mg/L	0.5	<0.01
Total Xylenes (m,p,o)	mg/L	0.5	<0.02
PHYSICAL PROPERTIES			
Paint Filter	---	Solid Waste	Solid Waste
Flash	---	No	No
Flash Point	Degrees C	61	>75

[1] Alberta Environment and Sustainable Resource Development, March 1995. Schedule to the Alberta User Guide for Waste Managers and Alberta Waste Control Regulation (AR 192/1996 and AR 272/2003), pursuant to Alberta Environmental Protection and Enhancement Act

APPENDIX C

Analytical Results
Quality Assurance / Quality Control Results

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Edmonton, Alberta
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Report Transmission Cover Page

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 19, 2019
Report Number: 2424437

Contact	Company	Address			
Marcie Kennedy	**Thurber Engineering Ltd.**	4127 Roper Road Edmonton, AB T6B 3S5			
		Phone:	(780) 438-1460	Fax:	(780) 437-7125
		Email:	mkennedy@thurber.ca		

Delivery	Format	Deliverables
Email - Merge Reports	PDF	COC / COA
Email - Merge Reports	PDF	COC / Test Report
Email - Single Report	Legacy Crosstab in CSV	Test Report

Contact	Company	Address			
Sharon Bunn	**Thurber Engineering Ltd.**	4127 Roper Road Edmonton, AB T6B 3S5			
		Phone:	(780) 438-1460	Fax:	(780) 437-7125
		Email:	Sbunn@thurber.ca		

Delivery	Format	Deliverables
Email - Single Report	PDF	Invoice

Notes To Clients:

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Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 19, 2019
Report Number: 2424437

Reference Number 1364296-21
Sample Date July 09, 2019
Sample Time NA
Sample Location
Sample Description Landfill Classification
Sample Matrix Waste - industrial

Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Leachate Inorganic - TCLP						
Antimony	TCLP Leachate	mg/L	<0.005	0.005	500	Below Limit
Arsenic	TCLP Leachate	mg/L	0.002	0.002	5	Below Limit
Barium	TCLP Leachate	mg/L	1.12	0.05	100	Below Limit
Beryllium	TCLP Leachate	mg/L	<0.001	0.001	5	Below Limit
Boron	TCLP Leachate	mg/L	<0.2	0.2	500	Below Limit
Cadmium	TCLP Leachate	mg/L	0.003	0.001	1	Below Limit
Chromium	TCLP Leachate	mg/L	<0.005	0.005	5	Below Limit
Cobalt	TCLP Leachate	mg/L	0.018	0.001	100	Below Limit
Copper	TCLP Leachate	mg/L	<0.10	0.1	100	Below Limit
Iron	TCLP Leachate	mg/L	0.2	0.1	1000	Below Limit
Lead	TCLP Leachate	mg/L	<0.050	0.05	5	Below Limit
Mercury	TCLP Leachate	mg/L	<0.001	0.001	0.2	Below Limit
Nickel	TCLP Leachate	mg/L	<0.050	0.050	5	Below Limit
Selenium	TCLP Leachate	mg/L	<0.002	0.002	1	Below Limit
Silver	TCLP Leachate	mg/L	<0.005	0.05	5	Below Limit
Thallium	TCLP Leachate	mg/L	<0.0005	0.0005	5	Below Limit
Uranium	TCLP Leachate	mg/L	<0.005	0.005	2.0	Below Limit
Vanadium	TCLP Leachate	mg/L	<0.01	0.01	100	Below Limit
Zinc	TCLP Leachate	mg/L	0.27	0.1	500	Below Limit
Zirconium	TCLP Leachate	mg/L	<0.01	0.01	500	Below Limit
pH	Initial		10.3			
pH	Final		5.1			
Soil Acidity						
pH	1:1	pH	10.4		2-12.5	Within Limits
Waste Characterization						
Flash Point		°C	>75		61	Within Limit
Flash			No			
Paint Filter	Interpretation		Solid Waste			
Mono-Aromatic Hydrocarbons - Leachate						
Benzene	TCLP Leachate	mg/L	<0.01	0.01	0.5	Below Limit
Toluene	TCLP Leachate	mg/L	<0.01	0.01	0.5	Below Limit
Ethylbenzene	TCLP Leachate	mg/L	<0.01	0.01	0.5	Below Limit
Total Xylenes (m,p,o)	TCLP Leachate	mg/L	<0.02	0.02	0.5	Below Limit

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Analytical Report

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386	Lot ID:	**1364296**
		Project Name:	McTaggart Bridge	Control Number:	
		Project Location:	McTaggart Bridge	Date Received:	Jul 17, 2019
		LSD:		Date Reported:	Jul 19, 2019
Attn:	Sharon Bunn	P.O.:	26386	Report Number:	2424437
Sampled By:		Proj. Acct. code:	26386		
Company:	Thurber Engineering Ltd.				

Approved by: Anthony Neumann

Anthony Neumann, MSc
General Manager

Data have been validated by Analytical Quality Control and Element's Integrated Data Validation System (IDVS).
Generation and distribution of the report, and approval by the digitized signature above, are performed through a secure and controlled automatic process.

Quality Control

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 19, 2019
Report Number: 2424437

Leachate Inorganic - TCLP

Blanks	**Units**	**Measured**	**Lower Limit**	**Upper Limit**	**Passed QC**
Antimony	µg/L	0.0976591	-0.501	0.501	yes
Arsenic	µg/L	0.00245633	-0.201	0.201	yes
Barium	µg/L	0.103758	-5.01	5.01	yes
Beryllium	µg/L	0.00415806	-0.099	0.099	yes
Boron	µg/L	0.745377	-20.0	20.0	yes
Cadmium	µg/L	0.000839293	-0.0990	0.0990	yes
Chromium	µg/L	0.0900774	-0.501	0.501	yes
Cobalt	µg/L	0.00375887	-0.099	0.099	yes
Copper	µg/L	0.854649	-9.99	9.99	yes
Iron	µg/L	3.31431	-10.0	10.0	yes
Lead	µg/L	0.00766899	-5.010	5.010	yes
Mercury	µg/L	-0.00661388	-0.0990	0.0990	yes
Nickel	µg/L	0.178031	-0.501	0.501	yes
Selenium	µg/L	-0.000831805	-0.201	0.201	yes
Silver	µg/L	0.0102636	-0.501	0.501	yes
Thallium	µg/L	0.000764649	-0.0501	0.0501	yes
Uranium	µg/L	0.00225727	-0.501	0.501	yes
Vanadium	µg/L	0.156456	-1.00	1.00	yes
Zinc	µg/L	1.05315	-9.99	9.99	yes
Zirconium	µg/L	0.0030939	-0.99	0.99	yes

Date Acquired: July 18, 2019

Client Sample Replicates	**Units**	**Replicate 1**	**Replicate 2**	**% RSD Criteria**	**Absolute Criteria**	**Passed QC**
Antimony	mg/L	<0.005	<0.005	20	0.008	yes
Arsenic	mg/L	<0.002	<0.002	20	0.008	yes
Barium	mg/L	0.76	0.71	20	0.04	yes
Beryllium	mg/L	<0.001	<0.001	20	0.004	yes
Boron	mg/L	<0.2	<0.2	20	0.1	yes
Cadmium	mg/L	0.001	<0.001	20	0.0004	yes
Chromium	mg/L	<0.005	<0.005	20	0.020	yes
Cobalt	mg/L	<0.001	<0.001	20	0.004	yes
Copper	mg/L	<0.10	<0.10	20	0.04	yes
Iron	mg/L	<0.1	<0.1	20	0.4	yes
Lead	mg/L	<0.050	<0.050	20	0.004	yes
Nickel	mg/L	<0.050	<0.050	20	0.020	yes
Selenium	mg/L	<0.002	<0.002	20	0.008	yes
Silver	mg/L	<0.005	<0.005	20	0.004	yes
Thallium	mg/L	<0.0005	<0.0005	20	0.0020	yes
Uranium	mg/L	<0.005	<0.005	20	0.020	yes
Vanadium	mg/L	<0.01	<0.01	20	0.00	yes
Zinc	mg/L	<0.10	<0.10	20	0.04	yes
Zirconium	mg/L	<0.01	<0.01	20	0.04	yes
pH		5.2	5.1	0	0.3	yes

Date Acquired: July 18, 2019

Control Sample	**Units**	**Measured**	**Lower Limit**	**Upper Limit**	**Passed QC**

Quality Control

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 19, 2019
Report Number: 2424437

Leachate Inorganic - TCLP - Continued

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Antimony	mg/L	0.041	0.036	0.044	yes
Arsenic	mg/L	0.041	0.037	0.043	yes
Barium	mg/L	0.19	0.19	0.21	yes
Beryllium	mg/L	0.019	0.018	0.021	yes
Boron	mg/L	0.4	0.4	0.4	yes
Cadmium	mg/L	0.0021	0.0019	0.0022	yes
Chromium	mg/L	0.102	0.092	0.110	yes
Cobalt	mg/L	0.020	0.018	0.022	yes
Copper	mg/L	0.20	0.19	0.21	yes
Iron	mg/L	4.0	3.7	4.4	yes
Lead	mg/L	0.020	0.015	0.025	yes
Mercury	mg/L	0.0031	0.0027	0.0033	yes
Nickel	mg/L	0.102	0.090	0.110	yes
Selenium	mg/L	0.039	0.035	0.043	yes
Silver	mg/L	0.020	0.017	0.021	yes
Thallium	mg/L	0.0100	0.0088	0.0108	yes
Uranium	mg/L	0.098	0.093	0.109	yes
Vanadium	mg/L	0.02	0.02	0.02	yes
Zinc	mg/L	0.20	0.18	0.22	yes
Zirconium	mg/L	0.20	0.19	0.23	yes

Date Acquired: July 18, 2019

Mono-Aromatic Hydrocarbons - Leachate

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Benzene	ng	0	-9.99	9.99	yes
Toluene	ng	0	-9.99	9.99	yes
Ethylbenzene	ng	0	-9.99	9.99	yes
m,p-Xylene	ng	0	-9.99	9.99	yes
o-Xylene	ng	0	-9.99	9.99	yes

Date Acquired: July 18, 2019

Calibration Check	Units	% Recovery	Lower Limit	Upper Limit	Passed QC
Benzene	ng	98.01	85	115	yes
Toluene	ng	97.87	85	115	yes
Ethylbenzene	ng	98.85	85	115	yes
m,p-Xylene	ng	101.16	85	115	yes
o-Xylene	ng	104.17	85	115	yes

Date Acquired: July 18, 2019

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Benzene	mg/L	<0.01	<0.01	20	10.00	yes
Toluene	mg/L	<0.01	<0.01	20	10.00	yes
Ethylbenzene	mg/L	<0.01	<0.01	20	10.00	yes
m,p-Xylene	mg/L	<0.01	<0.01	20	10.00	yes
o-Xylene	mg/L	<0.01	<0.01	20	10.00	yes

Date Acquired: July 18, 2019

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Quality Control

Bill To: Thurber Engineering Ltd.
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Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 19, 2019
Report Number: 2424437

Soil Acidity

Blanks	**Units**	**Measured**	**Lower Limit**	**Upper Limit**		**Passed QC**
pH	pH	5.68	5.7	7.3		yes
Date Acquired:	July 18, 2019					
Client Sample Replicates	**Units**	**Replicate 1**	**Replicate 2**	**% RSD Criteria**	**Absolute Criteria**	**Passed QC**
pH	pH	7.8	7.7	0	0.3	yes
Date Acquired:	July 18, 2019					
Control Sample	**Units**	**Measured**	**Lower Limit**	**Upper Limit**		**Passed QC**
pH	pH	6.2	5.4	6.6		yes
Date Acquired:	July 18, 2019					

Waste Characterization

Control Sample	**Units**	**Measured**	**Lower Limit**	**Upper Limit**	**Passed QC**
Flash Point	°C	52	50	55	yes
Date Acquired:	July 18, 2019				

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Methodology and Notes

Bill To: Thurber Engineering Ltd.
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T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 19, 2019
Report Number: 2424437

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Flash Point (Closed cup)	ASTM	*	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester, D 93	Jul 18, 2019	Element Edmonton - Roper Road
Flash Point (Closed cup)	ASTM	*	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester, D 93-16a	Jul 18, 2019	Element Edmonton - Roper Road
Leachate Inorganic (TCLP) ICP-MS	US EPA	*	Toxicity Characteristic Leaching Procedure, SW-846, EPA 1311	Jul 18, 2019	Element Edmonton - Roper Road
Leachate Organic (TCLP-BTEX)	US EPA	*	Toxicity Characteristic Leaching Procedure, SW-846, EPA 1311	Jul 18, 2019	Element Edmonton - Roper Road
Paint Filter Liquids Test	US EPA	*	Paint Filter Liquids Test, 9095B	Jul 19, 2019	Element Edmonton - Roper Road
pH and Conductivity in general soil 1:1	McKeague	*	1:1 Soil:Water Ratio, 4.11	Jul 18, 2019	Element Edmonton - Roper Road

** Reference Method Modified*

References

ASTM	Annual Book of ASTM Standards
McKeague	Manual on Soil Sampling and Methods of Analysis
US EPA	US Environmental Protection Agency Test Methods

Guidelines

Guideline Description	Class 2 Landfill (AB)
Guideline Source	AEP Waste Control Regulation, Alberta Regulation 192/96
Guideline Comments	Limits for analytes that may be required for Class 2 Landfill Acceptance may not be presented in this report. Consult the AENV Waste Control Regulation for hazardous waste limits, and ERCB D058 for dangerous oilfield waste properties.

element
www.Element.com

Project Information

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
Legal Location:
PO/AFE#: 26386
Proj. Acct. Code:
Quote #: RFP 1310

Invoice To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road
Edmonton, AB T6B 3S5
Attention: Sharon Bunn
Phone: 780-438-1460
Cell:
Fax:
E-mail: sbunn@thurber.ca
Agreement ID:
Copy of Report: YES / **NO**

Report To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road NW
Edmonton, AB T6B 3S5
Attention: Marcie Kennedy
Phone: 780-438-1460
Cell: 780-232-0829
Fax: 780-437-7125
E-mail 1: mkennedy@thurber.ca
E-mail 2:
Copy of Invoice: YES / **NO**

Additional Reports to

1) Name:
E-mail:
2) Name:
E-mail:

Sample Custody

Sampled by:
Company: Thurber Engineering Ltd.
I authorize Element to proceed with the work indicated on this form:
Signature:
Date/Time:

RUSH Priority

☐ Same Day (200%)
☐ Next Day/Two Day (100%)
☐ Three or Four Days (50%)
☐ 5 to 7 Days (Regular TAT)

Date Required

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples. If not all samples require RUSH, please indicate in the special instructions.

Report Results

☑ Email ☑ QA/QC
☐ Online ☑ PDF
☐ Fax ☑ Excel

Requirements

☐ HCDWORG ☐ SPIGEC
☑ AB Tier 1 ☐ BCCSR

Other (list below)

Special Instructions/Comments (please include contact information including phone number if different from above).

Enter tests above (✓ relevant samples below)

	Site I.D.	Sample Description	Depth start	Depth end	Date/Time sampled	Matrix	Sampling method	Number of Containers #	MeOH Field Preserved? ✓	CLASS2 (Landfill)	PS24 (Texture)	ABT1SAL-S (Salinity)	ABT1MET-S (Metals)	CCMEC (BTEX, F1-F4)	PAH2 (PAHs)	LEAD	GLY2 (Glycols)	ALC2 (Alcohols)	PE1 (Sterilant Screen)	AMILOS-A (Amines)	HOLD
			in cm m																		
1		TH19E-1	0	0.15	9-Jul-19	soil	grab	1								X					
2		TH19E-1	0.15	0.3	9-Jul-19	soil	grab	1								X					
3		TH19E-2	0	0.15	9-Jul-19	soil	grab	1								X					
4		TH19E-2	0.15	0.3	9-Jul-19	soil	grab	1								X					
5		TH19E-3	0	0.15	9-Jul-19	soil	grab	1								X					
6		TH19E-3	0.15	0.3	9-Jul-19	soil	grab	1								X					
7		TH19E-4	0	0.15	9-Jul-19	soil	grab	1								X					
8		TH19E-4	0.15	0.3	9-Jul-19	soil	grab	1								X					
9		TH19E-5	0	0.15	9-Jul-19	soil	grab	1								X					
10		TH19E-5	0.15	0.3	9-Jul-19	soil	grab	1								X					
11		TH19E-6	0	0.15	9-Jul-19	soil	grab	1								X					
12		TH19E-6	0.15	0.3	9-Jul-19	soil	grab	1								X					
13		TH19E-7	0	0.15	9-Jul-19	soil	grab	1								X					
14		TH19E-7	0.15	0.3	9-Jul-19	soil	grab	1								X					
15		TH19E-8	0	0.15	9-Jul-19	soil	grab	1								X					

Please indicate any potentially hazardous samples

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Page 1 of 2 Control #
ED 120-005

ot: 1364296 COC

Temp. received: 7.8 °C
Date/Time stamp: JUL 17 AM11:05
Delivery Method: hand
Waybill:
Received by:

Special Instructions/Comments (please include contact information including ph. # if different from above).

	Site I.D.	Sample description	Depth start in cm	end m	Date/Time sampled	Matrix	Sampling method	Number of Containers #	MeOH Field Preserved? ✓	CLASS2 (Landfill)	PS24 (Texture)	ABT1SAL-S (Salinity)	ABT1MET-S (Metals)	CCMEC (BTEX, F1-F4)	PAH2 (PAHs)	LEAD	GLY2 (Glycols)	ALC2 (Alcohols)	PE1 (Sterilant Screen)	AMILOS-A (Amines)	HOLD
		TH19E-8	0.15	0.3	9-Jul-19	soil	grab	1								X					
		TH19E-9	0	0.15	9-Jul-19	soil	grab	1								X					
		TH19E-9	0.15	0.3	9-Jul-19	soil	grab	1								X					
		TH19E-10	0	0.15	9-Jul-19	soil	grab	1								X					
		TH19E-10	0.15	0.3	9-Jul-19	soil	grab	1								X					
		Landfill Classification		---	10-Jul-19	soil	grab	3		X											

Enter tests above
(✓ relevant samples below)

Please indicate any potentially hazardous samples

Page __2____ of __2____

Control #

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Report Transmission Cover Page

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 22, 2019
Report Number: 2424435

Contact	Company	Address
Marcie Kennedy	**Thurber Engineering Ltd.**	4127 Roper Road Edmonton, AB T6B 3S5 Phone: (780) 438-1460 Fax: (780) 437-7125 Email: mkennedy@thurber.ca

Delivery	Format	Deliverables
Email - Merge Reports	PDF	COC / COA
Email - Merge Reports	PDF	COC / Test Report
Email - Single Report	Legacy Crosstab in CSV	Test Report

Contact	Company	Address
Sharon Bunn	**Thurber Engineering Ltd.**	4127 Roper Road Edmonton, AB T6B 3S5 Phone: (780) 438-1460 Fax: (780) 437-7125 Email: Sbunn@thurber.ca

Delivery	Format	Deliverables
Email - Single Report	PDF	Invoice

Notes To Clients:

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Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 22, 2019
Report Number: 2424435

		Reference Number	1364296-1	1364296-2	1364296-3	
		Sample Date	Jul 09, 2019	Jul 09, 2019	Jul 09, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-1 / 0-0.15	TH19E-1 / 0.15-0.3	TH19E-2 / 0-0.15	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	22.9	15.1	11.4	0.1

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Analytical Report

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386	Lot ID:	**1364296**
		Project Name:	McTaggart Bridge	Control Number:	
		Project Location:	McTaggart Bridge	Date Received:	Jul 17, 2019
		LSD:		Date Reported:	Jul 22, 2019
Attn:	Sharon Bunn	P.O.:	26386	Report Number:	2424435
Sampled By:		Proj. Acct. code:	26386		
Company:	Thurber Engineering Ltd.				

		Reference Number	1364296-4	1364296-5	1364296-6	
		Sample Date	Jul 09, 2019	Jul 09, 2019	Jul 09, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-2 / 0.15-0.3	TH19E-3 / 0-0.15	TH19E-3 / 0.15-0.3	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	9.6	12.2	8.4	0.1

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Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 22, 2019
Report Number: 2424435

		Reference Number	1364296-7	1364296-8	1364296-9	
		Sample Date	Jul 09, 2019	Jul 09, 2019	Jul 09, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-4 / 0-0.15	TH19E-4 / 0.15-0.3	TH19E-5 / 0-0.15	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	9.0	8.9	7.8	0.1

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Analytical Report

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386	Lot ID:	**1364296**
		Project Name:	McTaggart Bridge	Control Number:	
		Project Location:	McTaggart Bridge	Date Received:	Jul 17, 2019
		LSD:		Date Reported:	Jul 22, 2019
Attn:	Sharon Bunn	P.O.:	26386	Report Number:	2424435
Sampled By:		Proj. Acct. code:	26386		
Company:	Thurber Engineering Ltd.				

		Reference Number	1364296-10	1364296-11	1364296-12	
		Sample Date	Jul 09, 2019	Jul 09, 2019	Jul 09, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-5 / 0.15-0.3	TH19E-6 / 0-0.15	TH19E-6 / 0.15-0.3	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	16.8	8.6	8.8	0.1

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Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 22, 2019
Report Number: 2424435

		Reference Number	1364296-13	1364296-14	1364296-15	
		Sample Date	Jul 09, 2019	Jul 09, 2019	Jul 09, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-7 / 0-0.15	TH19E-7 / 0.15-0.3	TH19E-8 / 0-0.15	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	13.2	9.9	11.8	0.1

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Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 22, 2019
Report Number: 2424435

		Reference Number	1364296-16	1364296-17	1364296-18	
		Sample Date	Jul 09, 2019	Jul 09, 2019	Jul 09, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-8 / 0.15-0.3	TH19E-9 / 0-0.15	TH19E-9 / 0.15-0.3	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	12.3	11.0	10.4	0.1

Analytical Report

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386
		Project Name:	McTaggart Bridge
		Project Location:	McTaggart Bridge
		LSD:	
Attn:	Sharon Bunn	P.O.:	26386
Sampled By:		Proj. Acct. code:	26386
Company:	Thurber Engineering Ltd.		

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 22, 2019
Report Number: 2424435

Reference Number	1364296-19	1364296-20
Sample Date	Jul 09, 2019	Jul 09, 2019
Sample Time	NA	NA
Sample Location		
Sample Description	TH19E-10 / 0-0.15	TH19E-10 / 0.15-0.3
Matrix	Soil	Soil

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	8.7	8.0		0.1

Approved by: Anthony Neumann

Anthony Neumann, MSc
General Manager

Quality Control

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By:
Company: Thurber Engineering Ltd.

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
LSD:
P.O.: 26386
Proj. Acct. code: 26386

Lot ID: **1364296**
Control Number:
Date Received: Jul 17, 2019
Date Reported: Jul 22, 2019
Report Number: 2424435

Metals Strong Acid Digestion

Blanks	**Units**	**Measured**	**Lower Limit**	**Upper Limit**	**Passed QC**
Lead	µg/L	0.00262937	-5.0	5.0	yes
Date Acquired:	July 18, 2019				

Client Sample Replicates	**Units**	**Replicate 1**	**Replicate 2**	**% RSD Criteria**	**Absolute Criteria**	**Passed QC**
Lead	mg/kg	8.9	9.2	20	0.2	yes
Date Acquired:	July 18, 2019					

Control Sample	**Units**	**Measured**	**Lower Limit**	**Upper Limit**	**Passed QC**
Lead	mg/kg	19.4	18.3	21.5	yes
Date Acquired:	July 18, 2019				
Lead	mg/kg	248	198.7	305.5	yes
Date Acquired:	July 18, 2019				

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Methodology and Notes

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386	Lot ID:	**1364296**
		Project Name:	McTaggart Bridge	Control Number:	
		Project Location:	McTaggart Bridge	Date Received:	Jul 17, 2019
		LSD:		Date Reported:	Jul 22, 2019
Attn:	Sharon Bunn	P.O.:	26386	Report Number:	2424435
Sampled By:		Proj. Acct. code:	26386		
Company:	Thurber Engineering Ltd.				

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Metals ICP (Hot Block) in soil	EPA	*	Sample Preparation Procedure for Spectrochemical Determination of Total Recoverable Elements, October 1999, 200.2	Jul 18, 2019	Element Edmonton - Roper Road
Metals ICP (Hot Block) in soil	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	Jul 18, 2019	Element Edmonton - Roper Road

** Reference Method Modified*

References

EPA	Environmental Protection Agency Test Methods - US
US EPA	US Environmental Protection Agency Test Methods

Please direct any inquiries regarding this report to our Client Services group.
Results relate only to samples as submitted.
The test report shall not be reproduced except in full, without the written approval of the laboratory.

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Project Information

Project ID: 26386
Project Name: McTaggart Bridge
Project Location: McTaggart Bridge
Legal Location:
PO/AFE#: 26386
Proj. Acct. Code:
Quote #: RFP 1310

Invoice To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road
Edmonton, AB T6B 3S5
Attention: Sharon Bunn
Phone: 780-438-1460
Cell:
Fax:
E-mail: sbunn@thurber.ca
Agreement ID:
Copy of Report: YES / **NO**

Report To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road NW
Edmonton, AB T6B 3S5
Attention: Marcie Kennedy
Phone: 780-438-1460
Cell: 780-232-0829
Fax: 780-437-7125
E-mail 1: mkennedy@thurber.ca
E-mail 2:
Copy of Invoice: YES / **NO**

Additional Reports to

1) Name:
E-mail:
2) Name:
E-mail:

Sample Custody

Sampled by:
Company: Thurber Engineering Ltd.
I authorize Element to proceed with the work indicated on this form:
Signature:
Date/Time:

RUSH Priority

☐ Same Day (200%)
☐ Next Day/Two Day (100%)
☐ Three or Four Days (50%)
☐ 5 to 7 Days (Regular TAT)
Date Required

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples. If not all samples require RUSH, please indicate in the special instructions.

Report Results

☑ Email ☑ QA/QC
☐ Online ☑ PDF
☐ Fax ☑ Excel

Requirements

☐ HCDWORG ☐ SPIGEC
☑ AB Tier 1 ☐ BCCSR
Other (list below)

Special Instructions/Comments (please include contact information including phone number if different from above).

Enter tests above (✓ relevant samples below)

	Site I.D.	Sample Description	Depth start in cm m	Depth end	Date/Time sampled	Matrix	Sampling method	Number of Containers #	MeOH Field Preserved? ✓	CLASS2 (Landfill)	PS24 (Texture)	ABT1SAL-S (Salinity)	ABT1MET-S (Metals)	CCMEC (BTEX, F1-F4)	PAH2 (PAHs)	LEAD	GLY2 (Glycols)	ALC2 (Alcohols)	PE1 (Sterilant Screen)	AMILOS-A (Amines)	HOLD
1		TH19E-1	0	0.15	9-Jul-19	soil	grab	1								X					
2		TH19E-1	0.15	0.3	9-Jul-19	soil	grab	1								X					
3		TH19E-2	0	0.15	9-Jul-19	soil	grab	1								X					
4		TH19E-2	0.15	0.3	9-Jul-19	soil	grab	1								X					
5		TH19E-3	0	0.15	9-Jul-19	soil	grab	1								X					
6		TH19E-3	0.15	0.3	9-Jul-19	soil	grab	1								X					
7		TH19E-4	0	0.15	9-Jul-19	soil	grab	1								X					
8		TH19E-4	0.15	0.3	9-Jul-19	soil	grab	1								X					
9		TH19E-5	0	0.15	9-Jul-19	soil	grab	1								X					
10		TH19E-5	0.15	0.3	9-Jul-19	soil	grab	1								X					
11		TH19E-6	0	0.15	9-Jul-19	soil	grab	1								X					
12		TH19E-6	0.15	0.3	9-Jul-19	soil	grab	1								X					
13		TH19E-7	0	0.15	9-Jul-19	soil	grab	1								X					
14		TH19E-7	0.15	0.3	9-Jul-19	soil	grab	1								X					
15		TH19E-8	0	0.15	9-Jul-19	soil	grab	1								X					

Please indicate any potentially hazardous samples

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Page 1 of 2 Control #
ED 120-005

ot: 1364296 COC

Temp. received: 7.8 °C
Date/Time stamp: JUL 17 AM11:05
Delivery Method: hand
Waybill:
Received by:

Special Instructions/Comments (please include contact information including ph. # if different from above).

Enter tests above
(✓ relevant samples below)

	Site I.D.	Sample description	Depth start in cm	m end	Date/Time sampled	Matrix	Sampling method	Number of Containers #	MeOH Field Preserved? ✓	CLASS2 (Landfill)	PS24 (Texture)	ABT1SAL-S (Salinity)	ABT1MET-S (Metals)	CCMEC (BTEX, F1-F4)	PAH2 (PAHs)	LEAD	GLY2 (Glycols)	ALC2 (Alcohols)	PE1 (Sterilant Screen)	AMILOS-A (Amines)	HOLD
		TH19E-8	0.15	0.3	9-Jul-19	soil	grab	1								X					
		TH19E-9	0	0.15	9-Jul-19	soil	grab	1								X					
		TH19E-9	0.15	0.3	9-Jul-19	soil	grab	1								X					
		TH19E-10	0	0.15	9-Jul-19	soil	grab	1								X					
		TH19E-10	0.15	0.3	9-Jul-19	soil	grab	1								X					
		Landfill Classification		---	10-Jul-19	soil	grab	3		X											

Please indicate any potentially hazardous samples

Page __2____ of __2____

Control #

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Report Transmission Cover Page

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By: MKK
Company: Thurber

Project ID: 26386
Project Name: Soil Sampling
Project Location: McTaggart Santuary
LSD:
P.O.: 26836
Proj. Acct. code: 26386

Lot ID: **1378081**
Control Number:
Date Received: Sep 19, 2019
Date Reported: Sep 27, 2019
Report Number: 2445951

Contact	Company	Address
Marcie Kennedy	**Thurber Engineering Ltd.**	4127 Roper Road Edmonton, AB T6B 3S5 Phone: (780) 438-1460 Fax: (780) 437-7125 Email: mkennedy@thurber.ca

Delivery	Format	Deliverables
Email - Merge Reports	PDF	COC / COA
Email - Merge Reports	PDF	COC / Test Report
Email - Single Report	Legacy Crosstab in CSV	Test Report

Contact	Company	Address
Sharon Bunn	**Thurber Engineering Ltd.**	4127 Roper Road Edmonton, AB T6B 3S5 Phone: (780) 438-1460 Fax: (780) 437-7125 Email: Sbunn@thurber.ca

Delivery	Format	Deliverables
Email - Single Report	PDF	Invoice

Notes To Clients:

- Sep 27, 2019 - Report was issued to change the sample descriptions for sample #1 & 2 from TH19-9 to TH19-16 and change the sample descriptions for samples #3 & 4 from TH19-10 to TH19-17 requested by Marcie K. of Thurber on Sept.27,2019. Previous report #2443295.

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Analytical Report

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386	Lot ID:	**1378081**
		Project Name:	Soil Sampling	Control Number:	
		Project Location:	McTaggart Santuary	Date Received:	Sep 19, 2019
		LSD:		Date Reported:	Sep 27, 2019
Attn:	Sharon Bunn	P.O.:	26836	Report Number:	2445951
Sampled By:	MKK	Proj. Acct. code:	26386		
Company:	Thurber				

		Reference Number	1378081-1	1378081-2	1378081-3	
		Sample Date	Sep 19, 2019	Sep 19, 2019	Sep 19, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-16 / 0-0.15	TH19E-16 / 0.15-0.3	TH19E-17 / 0-0.15	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	5.5	4.5	5.7	0.1

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E: info.Edmonton@element.com
W: element.com

Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By: MKK
Company: Thurber

Project ID: 26386
Project Name: Soil Sampling
Project Location: McTaggart Santuary
LSD:
P.O.: 26836
Proj. Acct. code: 26386

Lot ID: **1378081**
Control Number:
Date Received: Sep 19, 2019
Date Reported: Sep 27, 2019
Report Number: 2445951

		Reference Number	1378081-4	1378081-5	1378081-6	
		Sample Date	Sep 19, 2019	Sep 19, 2019	Sep 19, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-17 / 0.15-0.3	TH19E-11 / 0-0.15	TH19E-11 / 0.15-0.3	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	6.3	6.6	7.6	0.1

Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
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Project ID: 26386
Project Name: Soil Sampling
Project Location: McTaggart Santuary
LSD:
P.O.: 26836
Proj. Acct. code: 26386

Lot ID: **1378081**
Control Number:
Date Received: Sep 19, 2019
Date Reported: Sep 27, 2019
Report Number: 2445951

		Reference Number	1378081-7	1378081-8	1378081-9	
		Sample Date	Sep 19, 2019	Sep 19, 2019	Sep 19, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-12 / 0-0.15	TH19E-12 / 0.15-0.3	TH19E-13 / 0-0.15	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	8.0	6.8	7.5	0.1

Element
7217 Roper Road NW
Edmonton, Alberta
T6B 3J4, Canada

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W: element.com

Analytical Report

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386	Lot ID:	**1378081**
		Project Name:	Soil Sampling	Control Number:	
		Project Location:	McTaggart Santuary	Date Received:	Sep 19, 2019
		LSD:		Date Reported:	Sep 27, 2019
Attn:	Sharon Bunn	P.O.:	26836	Report Number:	2445951
Sampled By:	MKK	Proj. Acct. code:	26386		
Company:	Thurber				

		Reference Number	1378081-10	1378081-11	1378081-12	
		Sample Date	Sep 19, 2019	Sep 19, 2019	Sep 19, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-13 / 0.15-0.3	TH19E-14 / 0-0.15	TH19E-14 / 0.15-0.3	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	8.1	6.0	7.1	0.1

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Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By: MKK
Company: Thurber

Project ID: 26386
Project Name: Soil Sampling
Project Location: McTaggart Santuary
LSD:
P.O.: 26836
Proj. Acct. code: 26386

Lot ID: **1378081**
Control Number:
Date Received: Sep 19, 2019
Date Reported: Sep 27, 2019
Report Number: 2445951

		Reference Number	1378081-13	1378081-14	1378081-15	
		Sample Date	Sep 19, 2019	Sep 19, 2019	Sep 19, 2019	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	TH19E-15 / 0-0.15	TH19E-15 / 0.15-0.3	Dup B	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	6.8	7.6	6.6	0.1

Analytical Report

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By: MKK
Company: Thurber

Project ID: 26386
Project Name: Soil Sampling
Project Location: McTaggart Santuary
LSD:
P.O.: 26836
Proj. Acct. code: 26386

Lot ID: **1378081**
Control Number:
Date Received: Sep 19, 2019
Date Reported: Sep 27, 2019
Report Number: 2445951

Reference Number	1378081-16
Sample Date	Sep 19, 2019
Sample Time	NA
Sample Location	
Sample Description	Dup C
Matrix	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	6.9			0.1

Approved by:

Darlene Lintott, MSc
Consulting Scientist

Quality Control

Bill To: Thurber Engineering Ltd.
4127 Roper Road
Edmonton, AB, Canada
T6B 3S5
Attn: Sharon Bunn
Sampled By: MKK
Company: Thurber

Project ID: 26386
Project Name: Soil Sampling
Project Location: McTaggart Santuary
LSD:
P.O.: 26836
Proj. Acct. code: 26386

Lot ID: **1378081**
Control Number:
Date Received: Sep 19, 2019
Date Reported: Sep 27, 2019
Report Number: 2445951

Metals Strong Acid Digestion

Blanks	**Units**	**Measured**	**Lower Limit**	**Upper Limit**	**Passed QC**
Lead	µg/L	0.00155419	-5.0	5.0	yes
Date Acquired:	September 20, 2019				

Client Sample Replicates	**Units**	**Replicate 1**	**Replicate 2**	**% RSD Criteria**	**Absolute Criteria**	**Passed QC**
Lead	mg/kg	9.0	8.9	20	0.2	yes
Date Acquired:	September 20, 2019					

Control Sample	**Units**	**Measured**	**Lower Limit**	**Upper Limit**	**Passed QC**
Lead	mg/kg	20.3	18.3	21.5	yes
Date Acquired:	September 20, 2019				
Lead	mg/kg	246	198.7	305.5	yes
Date Acquired:	September 20, 2019				

Element
7217 Roper Road NW
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T6B 3J4, Canada

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W: element.com

Methodology and Notes

Bill To:	Thurber Engineering Ltd. 4127 Roper Road Edmonton, AB, Canada T6B 3S5	Project ID:	26386	Lot ID:	**1378081**
Attn:	Sharon Bunn	Project Name:	Soil Sampling	Control Number:	
Sampled By:	MKK	Project Location:	McTaggart Santuary	Date Received:	Sep 19, 2019
Company:	Thurber	LSD:		Date Reported:	Sep 27, 2019
		P.O.:	26836	Report Number:	2445951
		Proj. Acct. code:	26386		

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Metals ICP (Hot Block) in soil	EPA	*	Sample Preparation Procedure for Spectrochemical Determination of Total Recoverable Elements, October 1999, 200.2	Sep 20, 2019	Element Edmonton - Roper Road
Metals ICP (Hot Block) in soil	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	Sep 20, 2019	Element Edmonton - Roper Road

** Reference Method Modified*

References

EPA	Environmental Protection Agency Test Methods - US
US EPA	US Environmental Protection Agency Test Methods

Comments:

- Sep 27, 2019 - Report was issued to change the sample descriptions for sample #1 & 2 from TH19-9 to TH19-16 and change the sample descriptions for samples #3 & 4 from TH19-10 to TH19-17 requested by Marcie K. of Thurber on Sept.27,2019. Previous report #2443295.

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www.Element.com

Project Information

Project ID: 90 26386
Project Name: Soil Sampling
Project Location: McTaggart Sanctuary
Legal Location:
PO/AFE#: 26386
Proj. Acct. Code:
Quote #: RFP 1310

Invoice To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road
Edmonton, AB T6E 3S5
Attention: Sharon Bunn
Phone: 780-438-1460
Cell:
Fax:
E-mail: sbunn@thurber.ca
Agreement ID:
Copy of Report: YES / **NO**

Report To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road NW
Edmonton, AB T6B 3S5
Attention: Marcie Kennedy
Phone: 780-438-1460
Cell: 780-232-0829
Fax: 780-437-7125
E-mail 1: mkennedy@thurber.ca
E-mail 2: 23609
Copy of Invoice: YES / **NO**

Additional Reports to

1) Name:
E-mail:
2) Name:
E-mail:

Sample Custody

Sampled by: MKK
Company: Thurber Engineering Ltd.
I authorize Element to proceed with the work indicated on this form:
Signature:
Date/Time: Sept 19/19 PM

RUSH Priority

☐ Same Day (200%)
☐ Next Day/Two Day (100%)
☐ Three or Four Days (50%)
☐ 5 to 7 Days (Regular TAT)
Date Required

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples. If not all samples require RUSH, please indicate in the special instructions.

Report Results

☑ Email ☑ QA/QC
☐ Online ☑ PDF
☐ Fax ☑ Excel

Requirements

☐ HCDWORG ☐ SPIGEC
☑ AB Tier 1 ☐ BCCSR
Other (list below)

Special Instructions/Comments (please include contact information including phone number if different from above).

	Site I.D.	Sample Description	Depth start in cm m	end	Date/Time sampled	Matrix	Sampling method	# Number of Containers	✓ MeOH Field Preserved?	CLASS2 (Landfill)	PS24 (Texture)	ABT1SAL-S (Salinity)	ABT1MET-S (Metals)	CCMEC (BTEX, F1-F4)	PAH2 (PAHs)	ABT1VOC-S (VOCs)	GLY2 (Glycols)	ALC2 (Alcohols)	PE1 (Sterilant Screen)	AMILOS-A (Amines)	~~HOLD~~ LEAD
1		TH19E-9	0	0.15	19-Sep-19 PM	soil	grab	1													✓
2		TH19E 9	0.15	0.3	↓	↓	↓	1													✓
3		TH19E 10	0.	0.15	↓	↓	↓	1													✓
4		TH19E-10	0.15	0.3	↓	↓	↓	1													✓
5		TH19E-11	0	0.15	↓	↓	↓	1													✓
6		TH19E-11	0.15	0.3	↓	↓	↓	1													✓
7		TH19E-12	0	0.15	↓	↓	↓	1													✓
8		TH19E-12	0.15	0.3	↓	↓	↓	1													✓
9		TH19E-13	0	0.15	↓	↓	↓	1													✓
10		TH19E-13	0.15	0.3	↓	↓	↓	1													✓
11		TH19E-14	0	0.15	↓	↓	↓	1													✓
12		TH19E-14	0.15	0.3	↓	↓	↓	1													✓
13		TH19E-15	0	0.15	↓	↓	↓	1													✓
14		TH19E-15	0.15	0.3	↓	↓	↓	1													✓
15		DUP B						1													✓

Enter tests above
(✓ relevant samples below)

Please indicate any potentially hazardous samples

Submission of this form acknowledges acceptance of Element's Standard of terms and conditions (https://www.element.com/terms/terms-and-conditions)

Page 1 of 2
Control #
ED 120-005

Indicate lot # or affix barcode here
Lot: 1378081 COC

Temp. received: 21.5 °C
Date/Time stamp: SEP 19 PM4:12
Delivery Method: Hand
Waybill:
Received by: SW

element
www.Element.com

Project Information

Project ID: 216386
Project Name: Soil Sampling
Project Location: McTaggart Sanctuary
Legal Location:
PO/AFE#: 216386
Proj. Acct. Code:
Quote #: RFP 1310

Invoice To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road
Edmonton, AB T6E 3S5
Attention: Sharon Bunn
Phone: 780-438-1460
Cell:
Fax:
E-mail: sbunn@thurber.ca
Agreement ID:
Copy of Report: YES / **NO**

Report To

Company: Thurber Engineering Ltd.
Address: 4127 Roper Road NW
Edmonton, AB T6B 3S5
Attention: Marcie Kennedy
Phone: 780-438-1460
Cell: 780-232-0829
Fax: 780-437-7125
E-mail 1: mkennedy@thurber.ca
E-mail 2: 23609
Copy of Invoice: YES / **NO**

Additional Reports to

1) Name:
E-mail:
2) Name:
E-mail:

Sample Custody

Sampled by: MKK
Company: Thurber Engineering Ltd.
I authorize Element to proceed with the work indicated on this form:
Signature:
Date/Time: 19-Sep-19 PM

RUSH Priority

☐ Same Day (200%)
☐ Next Day/Two Day (100%)
☐ Three or Four Days (50%)
☐ 5 to 7 Days (Regular TAT)
Date Required

When "ASAP" is requested, turn around will default to a 100% RUSH priority, with pricing and turn around time to match. Please contact the lab prior to submitting RUSH samples. If not all samples require RUSH, please indicate in the special instructions.

Report Results

☑ Email
☐ Online
☐ Fax
☑ QA/QC
☑ PDF
☑ Excel

Requirements

☐ HCDWORG
☑ AB Tier 1
☐ SPIGEC
☐ BCCSR
Other (list below)

Special Instructions/Comments (please include contact information including phone number if different from above).

	Site I.D.	Sample Description	Depth start in cm m	end	Date/Time sampled	Matrix	Sampling method	Number of Containers #	MeOH Field Preserved? ✓	CLASS2 (Landfill)	PS24 (Texture)	ABT1SAL-S (Salinity)	ABT1MET-S (Metals)	CCMEC (BTEX, F1-F4)	PAH2 (PAHs)	ABT1VOC-S (VOCs)	GLY2 (Glycols)	ALC2 (Alcohols)	PE1 (Sterilant Screen)	AMILOS-A (Amines)	~~HOLD~~ LEAD
										Enter tests above (✓ relevant samples below)											
1		DUP C	—		19-Sep-19 PM	soil	grab	1													✓
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					

Please indicate any potentially hazardous samples

Submission of this form acknowledges acceptance of Element's Standard of terms and conditions (https://www.element.com/terms/terms-and-conditions)

Page 2 of 2 Control #
ED 120-005

Indicate lot # or affix barcode here

Temp. received: °C
Date/Time stamp:
Delivery Method:
Waybill:
Received by:

THURBER

QUALITY ASSURANCE RESULTS - FIELD DUPLICATES
CITY OF EDMONTON
SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT

Parameter	Units	Method Detection Limit	TH19E-11 0 - 0.15 m	DUP B	Relative Percent Difference	Comments
Lead	mg/kg	0.100	6.6	6.6	0.0%	

Parameter	Units	Method Detection Limit	TH19E-14 0 - 0.15 m	DUP C	Relative Percent Difference	Comments
Lead	mg/kg	0.100	6	6.9	14.0%	

Notes:

---	Parameter not analyzed or not calculated.
MDL	Method Detection Limit
RPD	Relative Percent Difference

Appendix D: Soil Quality Assessment (CRIMSON 2021)

Soil Quality Assessment
Smith Crossing Bridge Site
Edmonton, Alberta

Prepared by

CRIMSON Environmental Limited
PO Box 24 - #314 – 222 Baseline Road
Sherwood Park, Alberta, T8H 1S8
Telephone: 780.719.4959
The Association of Professional Engineers and Geoscientists of Alberta
Permit to Practice P08305

for

The City of Edmonton
Engineering Services Section
Integrated Infrastructure Services
Infrastructure Planning and Design
11004 - 190 Street NW
Edmonton, Alberta
T5S 0G9

Project Number: CEL-37556
May 23, 2021

EXECUTIVE SUMMARY

CRIMSON Environmental Limited (CRIMSON) was retained by the City of Edmonton to conduct a Soil Quality Assessment (ESA) of the area immediately underlying and/or adjacent to the Smith Crossing Bridge in the city's Whitemud Creek Ravine South Neighbourhood. There is no municipal address for the bridge site. However, the shared municipal address of the lots situated immediately east and west of the subject site is 12503 – 23 Avenue NW Edmonton, Alberta (Figures 1 and 2). This report summarizes the scope of work, methodology and findings of the investigation.

The purpose of the investigation was to obtain soil quality data with respect to a select list of Alberta Tier I trace metals and/or salinity related parameters. The assessment was completed specifically to ascertain the quality of the surface soils that are situated immediately adjacent to and/or underlying the existing bridge structure. It is CRIMSON's understanding that the bridge is scheduled for replacement.

The intrusive portion of this investigation was completed on May 13, 2021. A total of five boreholes were advanced using a hand auger operated by CRIMSON Staff. All of the boreholes were drilled to approximate depths ranging between 0.5 and 1.0 mbgl and were backfilled with drill cuttings upon completion. The completion locations of all boreholes are provided on Figure 4 in Appendix A and borehole logs are provided in Appendix C. All of the collected soil samples were transported to the Element Materials Technology Canada Inc. Laboratory in Edmonton with the appropriate chain-of-custody information.

The results of the analytical testing obtained for all of the samples submitted to the laboratory during this assessment are not indicative of any impact from any of the analysed Alberta Tier 1 trace metals.

With regards to salinity related parameters, the results of the assessment are not indicative of wide spread or severe impairment from road salt.

Based on the results of the assessment, no further assessment or remediation of the on-site fill materials is recommended at this time.

Table of Contents

LIST OF FIGURES, TABLES AND APPENDICES

Figures

Tables

Appendices

1.0 INTRODUCTION

CRIMSON Environmental Limited (CRIMSON) was retained by the City of Edmonton to conduct a Soil Quality Assessment (ESA) of the area immediately underlying and/or adjacent to the Smith Crossing Bridge in the city's Whitemud Creek Ravine South Neighbourhood. There is no municipal address for the bridge site. However, the shared municipal address of the lots situated immediately east and west of the subject site is 12503 – 23 Avenue NW Edmonton, Alberta (Figures 1 and 2). This report summarizes the scope of work, methodology and findings of the investigation.

The purpose of the investigation was to obtain soil quality data with respect to a select list of Alberta Tier I trace metals and/or salinity related parameters. The assessment was completed specifically to ascertain the quality of the surface soils that are situated immediately adjacent to and/or underlying the existing bridge structure. It is CRIMSON's understanding that the bridge is scheduled for replacement.

1.1 Scope of Work

The final scope of work included the following tasks:

- Complete the drilling of five boreholes at the locations provided on Figure 4. All of the boreholes were drilled to approximate depths ranging between of 0.5 and 1.0 metres below ground level (mbgl);

- Complete a soil-sampling program during drilling for the purpose of quantifying potential impacts. This was to include the collection of soil samples from each borehole at approximate depths of 0.0-0.15 and 1.0 metres below ground level. Final collection depths were determined in the field and were dependent upon field conditions;

- Submit all of the collected soil samples to an accredited laboratory for chemical analysis; and

- Prepare a report documenting the findings of the investigation.

Authorization to complete the assessment was obtained from the City of Edmonton prior to commencement.

1.2 Methodology

This investigation was completed following the recommended procedures outlined in the Canadian Standards Association (CSA) Publication Z769-00 Phase II Environmental Site Assessment and the Alberta Environmental Site Assessment Standard (2016) provided by Alberta Environment and Parks (AEP). These documents are considered to be the standards for Phase II ESAs in Alberta and it is CRIMSON's experience that investigations completed in accordance with these documents are generally acceptable to AEP as well as major financial institutions. It should be noted that this investigation was limited to an assessment of soil quality and was not intended to meet all of the requirements of a Phase II ESA.

The field portion of the investigation was completed on May 13, 2021. The information contained in this report, including all conclusions and recommendations, is subject to the limitations presented in Section 9.

2.0 SITE DESCRIPTION

The subject site (also referred to as the bridge site) is limited to the area located immediately underlying and/or adjacent to the Smith Crossing Bridge in the city's Whitemud Creek Ravine South Neighbourhood. There is no municipal address for the bridge site. However, the shared municipal address of the lots situated immediately east and west of the subject site is 12503 – 23 Avenue NW Edmonton, Alberta (Figures 1 and 2). All surrounding lands within 30 meters of the bridge site are contained within the MacTaggart Sanctuary. 23 Avenue NW is situated approximately 40 metres north of the bridge site. Blackmud Creek and Whitemud Creek intersect approximately 20 metres east of the bridge site.

The topography of the subject property is sloped to the north and south towards Whitemud Creek. Surface water runoff is controlled by the site grading.

The closest water body to the site is the Whitemud Creek which is located immediately adjacent to the sampling locations.

The subject property possesses a shared zoning designation of AG (Agricultural Zone) with the property immediately to the west and A (Metropolitan Recreational Zone) with the property immediately to the east. All surrounding properties within 50 metres of the subject site are zoned A or AG. The on-site and surrounding land-use zonings are provided in Figure 3 (Appendix A).

2.1 Geology

As indicated by Kathol and McPherson (1975), the surficial geology in the general area of the subject property is reported to be comprised of stream alluvium and/or erosional features. These deposits are reported to consist of clay, silt, sand and or gravel. Glacio-lacustrine deposits are also reported to be present in the general area of the subject site.

The upper bedrock underlying the subject property is reported to be the Cretaceous aged Horseshoe Canyon Formation (also known as the Edmonton Formation). The bedrock is reported to be comprised of highly variable layers of sandstone, siltstone and mudstone as well as laterally continuous coal deposited in a non-marine to marginal marine environment (AGS, 2013).

3.0 REGULATORY GUIDELINES

The Alberta Tier 1 Soil and Groundwater Remediation Guidelines, (2019) provided by AEP are considered to be the applicable regulatory guidelines to determine impacts from trace metals in soil. This document summarizes the regulatory requirements in Alberta and provides a site management process for soil and groundwater contamination. Based on the current, on-site land use, the Alberta Tier 1 Guidelines for parkland land uses have been applied to the entire site. In addition, based on the zoning of the adjacent property to the west, the Tier 1 Guidelines for agricultural land uses have also been applied for assessment purposes. Based on the results of this assessment, the lowest guideline for either coarse grained or fine-grained sediments has been provided for assessment purposes. This is considered to be a conservative measure and is based on the limited amount of site specific geological data that is available at the time of publication.

With regards to salinity related parameters, the Alberta Tier 1 Salt Remediation Guidelines provided in the Alberta Tier 1 Soil and Groundwater Remediation Guidelines, (2019) are considered to be the applicable regulatory guidelines. Based on the location of the analysed soil samples, the guidelines for either topsoil or subsoil have been used for assessment purposes.

4.0 METHODOLOGY

4.1 Intrusive Investigation

The intrusive portion of this investigation was completed on May 13, 2021. A total of five boreholes were advanced using a hand auger operated by CRIMSON Staff. All of the boreholes were drilled to approximate depths ranging between 0.5 and 1.0 mbgl and were backfilled with drill cuttings upon completion. The completion locations of all boreholes are provided on Figure 4 in Appendix A and borehole logs are provided in Appendix C.

4.2 Soil Sampling

A total of ten soil samples were collected during this assessment at the depth intervals indicated on the borehole logs (Appendix C). At each sampling point, the soil sample for each depth interval was placed directly into a clearly labeled polyethylene bag. Sampling gloves were changed prior to the collection of every soil sample. Soil samples were transported to the Element Materials Technology Canada Inc. Laboratory in Edmonton with the appropriate chain-of-custody information. All soil samples were transported in chilled coolers.

5.0 RESULTS OF THE INVESTIGATION

5.1 Stratigraphy

The soil profile observed during this investigation included varying thicknesses of fill materials including sand, silt, organics, gravel and clay. Detailed descriptions are provided on the borehole logs in Appendix C.

5.2 Grain-size Analyses

Two soil samples were submitted for grain size analyses during this assessment. The results indicate that the analysed samples are classified as a mixture of fine and/or coarse grained soils under the Alberta Tier 1 Guidelines. The results are provided on Table 1 in Appendix A and a copy of the laboratory report is provided in Appendix D.

5.3 Chemical Analyses

The results of chemical analyses completed on the soil samples collected during this investigation are provided on Tables 2 - 4 in Appendix B. A copy of the laboratory report is provided in Appendix D. The results are summarized in the following subsections. With respect to analytical samples, selection was based upon the location of the borehole, geology, on-site observations, field screening results and professional judgment.

5.3.1 Alberta Tier 1 Trace Metals

Ten soil samples were submitted for chemical analyses of a select list of Alberta Tier 1 trace metals. The results of the analyses are provided on Table 2 (Appendix B) and indicate that the concentrations of the analysed parameters were below their respective, applicable Alberta Tier 1 Guidelines.

5.3.2 Salinity Related Parameters

Ten soil samples were submitted for chemical analyses of a select list of salinity related parameters during this investigation. The results of the analyses are provided on Tables 3 and 4 in Appendix B and are summarized as follows:

- The soluble conductivity values of the submitted samples ranged from 0.56 to 3.19 dS/m. The sample collected from the borehole labelled 21-02 at 0.0-0.15 mbgl is classified as "Fair" under the Alberta Tier 1 Salt Remediation Guidelines. All of the other analysed samples are classified as "Good" under the Alberta Tier 1 Salt Remediation Guidelines;

- The sodium adsorption ratios (SAR) values of the submitted samples ranged from 0.3 to 4.5. The sample collected from the borehole labelled 21-04 at 1.0 mbgl is classified as "Fair" under the Alberta Tier 1 Salt Remediation Guidelines. All of the other analysed samples are classified as "Good" under the Alberta Tier 1 Salt Remediation Guidelines;

- The concentrations of chloride in the analysed samples ranged from 8 mg/kg to 239 mg/kg and the soluble chloride values ranged from 15 mg/L to 465 mg/L;

- The concentrations of sodium in the analysed samples ranged from 8 mg/kg to 128 mg/kg; and

- The pH values reported for all of the samples were within the range specified in the Alberta Tier 1 Guidelines for agricultural and/or parkland land uses.

6.0 CONCLUSIONS & RECOMMENDATIONS

The results of the analytical testing obtained for all of the samples submitted to the laboratory during this assessment are not indicative of any impact from any of the analysed Alberta Tier 1 trace metals.

With regards to salinity related parameters, the results of the assessment are not indicative of wide spread or severe impairment from road salt.

Based on the results of the assessment, no further assessment or remediation of the on-site fill materials is recommended at this time.

7.0 QUALIFICATIONS OF THE ASSESSOR

This report was completed by Mr. Douglas Pankewich of CRIMSON Environmental Limited. Mr. Pankewich has over twenty five years of professional and project management experience as an environmental geologist in both the private and public sectors. He has worked on over 500 projects including Phase I, II, and III ESAs, contaminant delineation investigations, hydrogeological investigations and remediation projects for both soil and groundwater. Mr. Pankewich is a graduate of Laval University and the University of Québec at the National Institute for Scientific Research. He holds undergraduate degrees in Geology and Geological Engineering as well as a Master of Sciences degree in Earth Sciences.

8.0 REFERENCES

1. Alberta Environment and Parks. *Alberta Environmental Site Assessment Standard,* 2016;

2. Alberta Geological Survey. Map 600. *Bedrock Geology Map of Alberta.* Edmonton, Alberta. March, 2013;

3. City of Edmonton. *Environmental Site Assessment Guidebook.* Edmonton, Alberta. March, 2016;

4. CSA International Standard Z768-01. *Phase I Environmental Site Assessment.* Toronto, Ontario. 2016; and

5. Kathol and McPherson. *Urban Geology of Edmonton.* Alberta Research Council. Bulletin 32. Edmonton, Alberta. 1975.

9.0 STATEMENT OF LIMITATIONS

Subject to the following conditions and limitations, the investigation described in this report has been conducted in a manner consistent with a reasonable level of care and skill normally exercised by members of the health, safety and environmental consulting profession currently practicing under similar conditions in the area:

1. This report has been prepared for the exclusive use of the City of Edmonton. The report is intended to provide an assessment of known or potential environmental concerns and liabilities associated with past and current practices of the subject properties;
2. The report is based on data and information collected from available records, personal interviews and a site investigation conducted by CRIMSON personnel. CRIMSON has relied in good faith on information provided by individuals and sources noted in this report. We accept no responsibility for any deficiency, misstatements, or inaccuracy contained in this report as a result of omissions, misstatements, or fraudulent acts of persons interviewed;
3. The site investigation is based solely on the site conditions at the site at the time of the field investigation as described in this report;
4. The service provided by CRIMSON in completing the investigation is intended to assist the Client with a business decision. The liability of this site is not transferred to CRIMSON as a result of such services, and CRIMSON does not make recommendations regarding the purchase, sale or investment of the property;
5. The scope of the investigation described in this report has been limited by the budget set for the investigation in our contract. The scope of the investigation has been reasonable having regard to that budget constraint;
6. The investigation described in this report has relied upon information provided by third parties concerning the history of the site. Except as stated in this report, we have not made an independent verification of such historical information;
7. The investigation described in this report has been made in the context of existing government regulations generally promulgated at the date of this report. The investigation did not take account of any government regulations not in effect or not generally promulgated at the date of this report;
8. Where indicated or implied in this report, or where mandated by the condition of the site and its attendant structures, the conclusions of this report are based on visual observation of the site and a limited amount of sampling. The conclusions of this report do not apply to any areas of the site not available for inspection or areas not sampled;
9. The investigation was limited in scope. As such, the potential remains for the presence of unknown, unidentified, or unforeseen surface or subsurface contamination. If further evidence suggests potential contamination, a follow-up investigation including sampling and analysis would be recommended; and
10. This report is intended for the exclusive use of the company, organization or individual to whom it is addressed. It may not be used or relied upon in any manner whatsoever, or for any purpose whatsoever, by any other party. The Consultant makes no representation of fact or opinion of any nature whatsoever to any person or entity other than the company, organization or individual to whom this report is addressed.

10.0 CLOSURE

We trust that this report meets with your current requirements. Should you have any questions or concerns please do not hesitate to contact the undersigned.

Respectfully Submitted,

CRIMSON Environmental Limited

DOUGLAS PANKEWICH
ID 59254

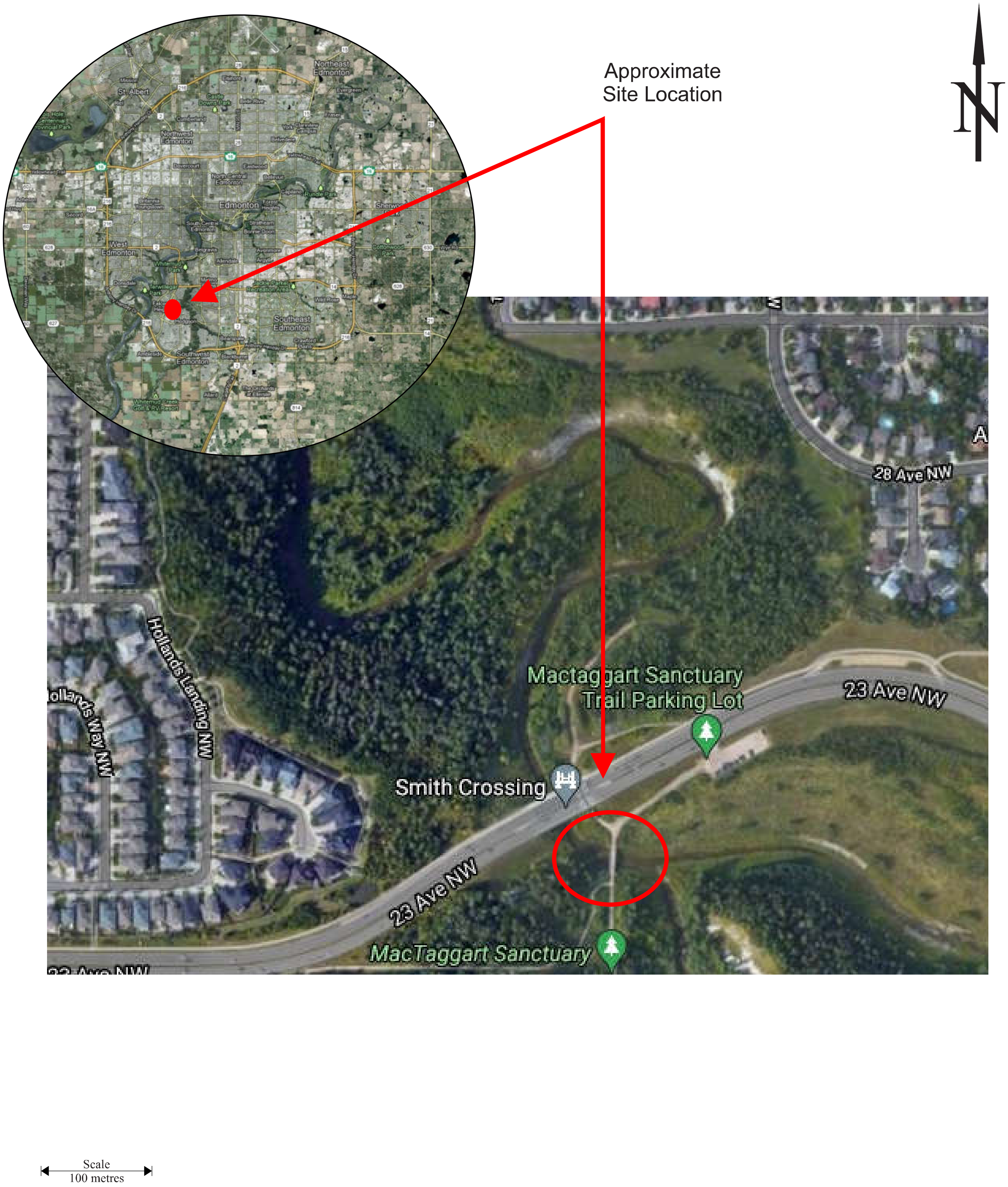
June 23, 2021

PERMIT TO PRACTICE
CRIMSON ENVIRONMENTAL LIMITED
RM SIGNATURE:
RM APEGA ID #: 59254
DATE: June 23, 2021
PERMIT NUMBER: P008305
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Douglas Pankewich, M.Sc., P.Geol., P.Eng.
Geological Engineer

Appendix A

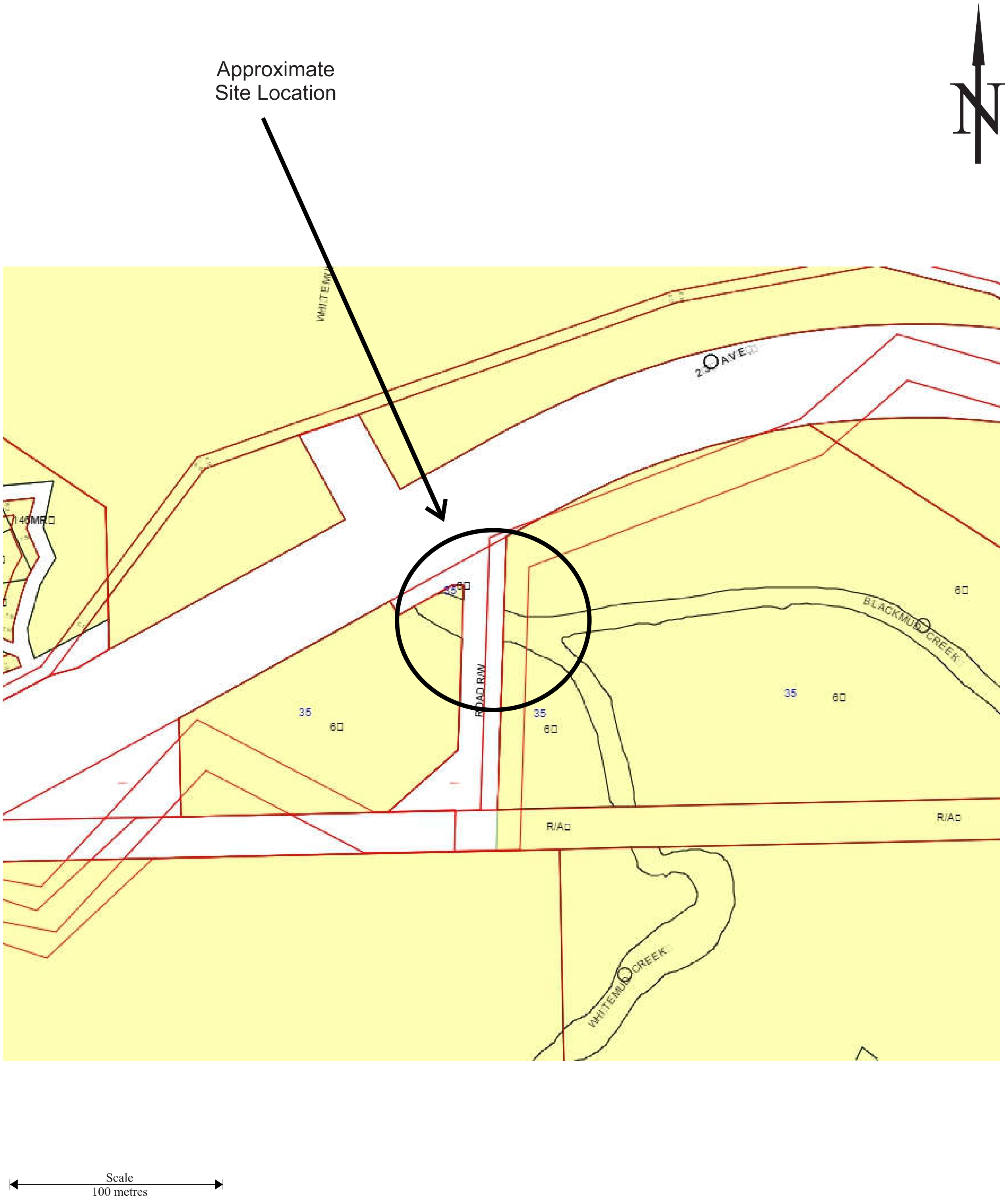
Figures



Reference: Goggle, 2021.

*Scale provided is approximate.
**This figure is not intended for design or construction purposes. Property lines are approximate.

CRIMSON ENVIRONMENTAL LIMITED	Site Location Plan	Figure 1 Scale: As Shown
	Smith Crossing Bridge Edmonton, Alberta	April, 2021 CEL-37556



Reference: Government of Alberta, 2021.

*Scale provided is approximate.
**This figure is not intended for design or construction purposes. Property lines are approximate.

CRIMSON
ENVIRONMENTAL
LIMITED

Site Survey Plan

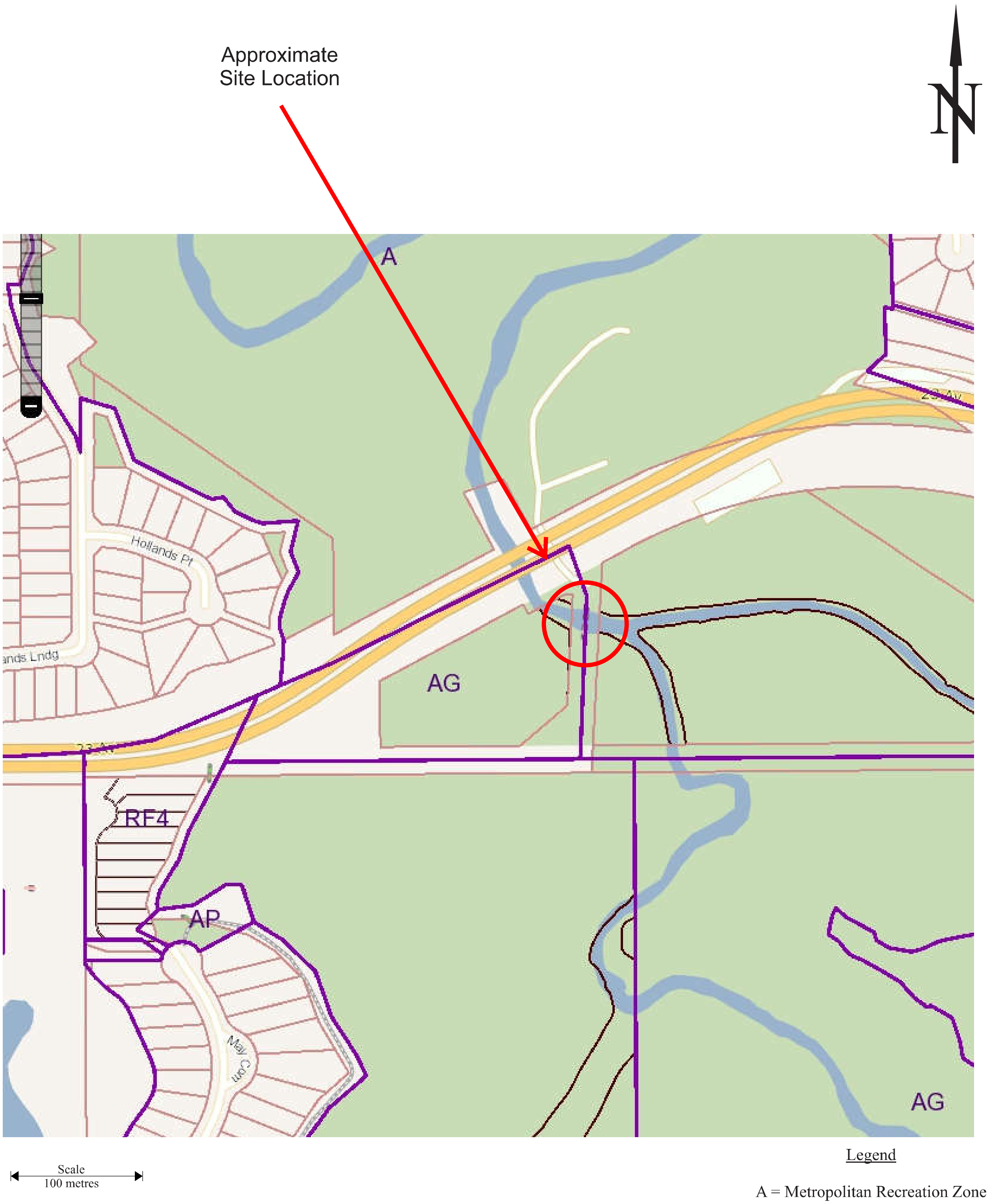
Smith Crossing Bridge
Edmonton, Alberta

Figure 2

Scale: As Shown

May, 2021

CEL-37556



Legend

A = Metropolitan Recreation Zone
AG = Agricultural Zone

Reference: The City of Edmonton, 2021.

*Scale provided is approximate.
**This figure is not intended for design or construction purposes. Property lines are approximate.

CRIMSON ENVIRONMENTAL LIMITED

Site Zoning Plan

Smith Crossing Bridge
Edmonton, Alberta

Figure 3

Scale: As Shown

May, 2021

CEL-37556

Scale
20 metres

Reference: Goggle, 2021.

*Scale provided is approximate.
**This figure is not intended for design or construction purposes. Property lines are approximate.

CRIMSON ENVIRONMENTAL LIMITED	Borehole Location Plan	Figure 4 Scale: As Shown
	Smith Crossing Bridge Edmonton, Alberta	May, 2021 CEL-37556

Appendix B

Tables

Table 1. Grain Size Data

Particle Size	Detection Limit	Units	Analytical Results	
			21-01 @ 1.0 m	21-05 @ 1.0 m
% Sand	1.0	%	61.0	50.0
% Silt	1.0	%	21.0	24.0
% Clay	1.0	%	18.0	26.0
Texture	-	-	Sandy Loam	Sandy Clay Loam
AB. Tier 1 Classification	-	-	Coarse	Fine/Coarse

Table 2. Soil Analytical Chemistry - Alberta Tier I Trace Metals

Parameter	Sample - Analytical Results										Regulatory Guideline[2]	
	21-01		21-02		21-03		21-04		21-05		Agriicultural Land Uses	Residential / Parkland Land Uses
	@ 0.0 - 0.15 m	@ 1.0 m	@ 0.0 - 0.15 m	@ 0.5 m	@ 0.0 - 0.15 m	@ 1.0 m	@ 0.0 - 0.15 m	@ 1.0 m	@ 0.0 - 0.15 m	@ 1.0 m		
Total Antimony (Sb)	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.5	20	20
Total Arsenic (As)	5.7	7.2	7.4	7.0	7.0	7.3	7.5	9.0	6.9	5.3	17	17
Total Barium (Ba)	165	185	183	132	195	178	184	181	181	176	750	500
Total Beryllium (Be)	0.4	0.5	0.6	0.4	0.5	0.6	0.6	0.5	0.4	0.7	5	5
Boron (B), Sat. Paste Ext.	0.06	0.15	<0.5	<0.5	<0.05	0.06	0.07	0.1	0.07	<0.5	1.4	3.3
Total Cadmium (Cd)	0.2	0.21	0.22	0.15	0.24	0.23	0.24	0.22	0.23	0.25	10	10
Total Chromium (Cr)	12	10.5	8.6	6.8	9.9	9.7	8.5	10.5	9.2	9.3	64	64
Hex. Chromium (Cr 6+)	0.1	0.1	<0.05	0.1	0.08	0.05	0.1	0.1	0.1	0.07	0.4	0.4
Total Cobalt (Co)	7.2	7.6	8.3	6.8	8.6	8.2	8.9	7.5	7.3	7.4	20	20
Total Copper (Cu)	11.6	12.9	16	10	16.8	15.6	17.1	13.8	14.2	20	63	63
Total Lead (Pb)	26.9	25.4	10	7.2	12.5	12.6	9.6	17.1	11.9	17	70	140
Total Mercury (Hg)	<0.05	<0.05	<0.05	<0.05	0.05	0.05	<0.05	<0.05	<0.05	0.05	6.6	6.6
Total Molybdenum (Mo)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4	4
Total Nickel (Ni)	16.8	19.7	20	15.7	20.3	20.6	20.5	19.9	17	17.1	45	45
Total Selenium (Se)	<0.3	<0.3	0.3	<0.3	0.3	0.3	0.3	0.3	<0.3	0.4	1	1
Total Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	20	20
Total Thallium (Tl)	0.12	0.14	0.16	0.13	0.17	0.16	0.17	0.15	0.14	0.18	1	1
Total Tin (Sn)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	5
Total Uranium (U)	0.9	1.3	1.6	1.1	1.5	1.5	1.5	1.1	1.2	2.3	23	23
Total Vanadium (V)	16.2	14.4	14.2	11.6	15.2	14.7	14.6	16	13.7	15.3	130	130
Total Zinc (Zn)	59	59	63	47	71	66	68	63	62	60	250	250

Notes:

1. All values expressed as parts-per-million (ppm). Mg/kg for all analyses except boron by sat. paste which is expressed as mg/L;
2. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines, 2019;*
3. -- = Sample not analysed for this parameter;
4. NG = No guideline provided by AEP; and
5. Values (if any) which exceed the applicable Alberta Tier 1 Guideline are highlighted. Orange Highlight is solely due to detection limit.

Table 3. Topsoil Analytical Chemistry - Salinity Related Parameters

Analytical Parameter	Units	Samples - Analytical Results					Regulatory Guidelines				
		21-01	21-02	21-03	21-04	21-05	Alberta Tier 1 Salt Remediation Guidelines for Subsoil [1]				Alberta Tier 1 Guidelines for Commercial Land Uses[2]
		@ 0.0 - 0.15 m	@ 0.0 - 0.15 m	@ 0.0 - 0.15 m	@ 0.0 - 0.15 m	@ 0.0 - 0.15 m	Good	Fair	Poor	Unsuitable	
Soluble Conductivity (Sat. Paste)	dS/m	**0.94**	**3.19**	**1.08**	**0.62**	**1.96**	<2	2 - 4	4 - 8	>8	4
Sodium Adsorption Ratio	N/A	**2.0**	**1.8**	**2.3**	**0.3**	**1.9**	<4	4 - 8	8 - 12	>12	12
% Saturation	%	62	54	58	57	54	--	--	--	--	--
Calcium	mg/kg	62.4	286	58.6	47.9	121	--	--	--	--	--
Magnesium	mg/kg	11.3	63.6	10.7	9.8	29	--	--	--	--	--
Sodium	mg/kg	51	95	55	8	66	--	--	--	--	--
Potassium	mg/kg	27	49	15	16	18	--	--	--	--	--
Chloride	mg/L	26	95	61	28	248	--	--	--	--	--
Chloride	mg/kg	16	51	35	16	135	--	--	--	--	--
Sulfate (SO4)	mg/kg	29.3	908	166	39.8	233	--	--	--	--	--
TGR	T/ac	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	--	--	--
Soluble ($CaCl_2$) pH	pH	7.1	7.7	7.5	7.6	7.6	--	--	--	--	6.0 to 8.5

Table 4. Subsoil Analytical Chemistry - Salinity Related Parameters

Analytical Parameter	Units	Samples - Analytical Results					Regulatory Guidelines				
		21-01	21-02	21-03	21-04	21-05	Alberta Tier 1 Salt Remediation Guidelines for Subsoil [1]				Alberta Tier 1 Guidelines for Commercial Land Uses[2]
		@ 1.0 m	@ 0.5 m	@ 1.0 m	@ 1.0 m	@ 1.0 m	Good	Fair	Poor	Unsuitable	
Soluble Conductivity (Sat. Paste)	dS/m	**0.56**	**2.17**	**1.41**	**0.76**	**2.5**	<3	3 - 5	5 - 10	>10	4
Sodium Adsorption Ratio	N/A	**0.7**	**1.5**	**2.8**	**4.5**	**3.9**	<4	4 - 8	8 - 12	>12	12
% Saturation	%	51	42	55	50	51	--	--	--	--	--
Calcium	mg/kg	36.4	120	70.6	23.3	115	--	--	--	--	--
Magnesium	mg/kg	7.7	30	13.8	3.6	25	--	--	--	--	--
Sodium	mg/kg	12	46	72	63	128	--	--	--	--	--
Potassium	mg/kg	10	21	12	7	19	--	--	--	--	--
Chloride	mg/L	15	254	138	43	465	--	--	--	--	--
Chloride	mg/kg	8	106	76	22	239	--	--	--	--	--
Sulfate (SO4)	mg/kg	31.1	262	203	29.7	276	--	--	--	--	--
TGR	T/ac	<0.1	<0.1	<0.1	<0.1	<0.1	--	--	--	--	--
Soluble ($CaCl_2$) pH	pH	7.3	7.5	7.6	7.6	8.1	--	--	--	--	6.0 to 8.5

Notes:
1. AEP. *Alberta Tier 1 Salt Remediation Guidelines, 2019.* Guideline for topsoil or subsoil provided as indicated;
2. Alberta Tier 1 Soil and Groundwater Remediation Guidelines, 2019. Commercial and/or industrial land uses; and
3. -- = No Standard Provided by AEP.

Appendix C

Borehole Logs

PROJECT: Soil Quality Assessment	CLIENT: City of Edmonton	TESTHOLE NO: **21-01**
LOCATION: Smith Crossing Bridge, Edmonton, AB		PROJECT NO.: CEL-37556
CONTRACTOR: CRIMSON Environmental Limited	METHOD: Solid Stem	ELEVATION (m):

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ⧄ NO RECOVERY ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ GRAVEL ▥ SLOUGH ⁙ GROUT ▨ CUTTINGS ⁘ SAND

DEPTH (m)	BACKFILL DETAILS	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	⊗ Vapour Concentration⊗ (ppm) 100 1000 10000	COMMENTS	DEPTH (m)
0	▨	▩	FILL, fine sand, silty, clayey, compact, moist, brown.	■	1			
1			End of borehole at 1.0 metre below ground level. Borehole backfilled with drill cuttings to surface. All details provided on this borehole log are approximate.	■	2			1
2								2
3								3
4								4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 1.00 m
REVIEWED BY: DP	COMPLETION DATE: 5/13/21
PROJECT MANAGER: Pankewich	Page 1 of 1

PROJECT: Soil Quality Assessment	CLIENT: City of Edmonton	TESTHOLE NO: **21-02**
LOCATION: Smith Crossing Bridge, Edmonton, AB		PROJECT NO.: CEL-37556
CONTRACTOR: CRIMSON Environmental Limited	METHOD: Solid Stem	ELEVATION (m):

SAMPLE TYPE	■ GRAB	▥ SHELBY TUBE	☒ SPLIT SPOON	☰ BULK	▨ NO RECOVERY	◧ CORE
BACKFILL TYPE	■ BENTONITE	⁘ GRAVEL	▥ SLOUGH	⁘ GROUT	▨ CUTTINGS	⁘ SAND

DEPTH (m)	BACKFILL DETAILS	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	⊗ Vapour Concentration⊗ (ppm) 100 1000 10000	COMMENTS	DEPTH (m)
0	▨	☒	FILL, fine sand, silty, clayey, compact, wet, brown.	■	1			
			End of borehole at 0.5 metre below ground level (Auger Refusal). Borehole backfilled with drill cuttings to surface. All details provided on this borehole log are approximate.	■	2			
1								1
2								2
3								3
4								4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 0.50 m
REVIEWED BY: DP	COMPLETION DATE: 5/13/21
PROJECT MANAGER: Pankewich	Page 1 of 1

PROJECT: Soil Quality Assessment	CLIENT: City of Edmonton	TESTHOLE NO: **21-03**
LOCATION: Smith Crossing Bridge, Edmonton, AB		PROJECT NO.: CEL-37556
CONTRACTOR: CRIMSON Environmental Limited	METHOD: Solid Stem	ELEVATION (m):

SAMPLE TYPE	■ GRAB	▥ SHELBY TUBE	☒ SPLIT SPOON	☰ BULK	▨ NO RECOVERY	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁘ GRAVEL	▥ SLOUGH	▩ GROUT	▨ CUTTINGS	⁘ SAND

DEPTH (m)	BACKFILL DETAILS	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	⊗ Vapour Concentration⊗ (ppm) 100 1000 10000	COMMENTS	DEPTH (m)
0	▨	▩	FILL, fine sand, silty, clayey, compact, moist, brown.	■	1			
1			End of borehole at 1.0 metre below ground level. Borehole backfilled with drill cuttings to surface. All details provided on this borehole log are approximate.	■	2			1
2								2
3								3
4								4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 1.00 m
REVIEWED BY: DP	COMPLETION DATE: 5/13/21
PROJECT MANAGER: Pankewich	Page 1 of 1

PROJECT: Soil Quality Assessment	CLIENT: City of Edmonton	TESTHOLE NO: **21-04**
LOCATION: Smith Crossing Bridge, Edmonton, AB		PROJECT NO.: CEL-37556
CONTRACTOR: CRIMSON Environmental Limited	METHOD: Solid Stem	ELEVATION (m):

SAMPLE TYPE	■ GRAB	▥ SHELBY TUBE	☒ SPLIT SPOON	☰ BULK	▨ NO RECOVERY	▌ CORE
BACKFILL TYPE	■ BENTONITE	⁘ GRAVEL	▥ SLOUGH	⁙ GROUT	▨ CUTTINGS	⁘ SAND

DEPTH (m)	BACKFILL DETAILS	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	⊗ Vapour Concentration⊗ (ppm) 100 1000 10000	COMMENTS	DEPTH (m)
0	▨	▩	FILL, fine sand, clayey, silty, trace gravel, compact, moist, brown.	■	1			
1			End of borehole at 1.0 metre below ground level. Borehole backfilled with drill cuttings to surface. All details provided on this borehole log are approximate.	■	2			1
2								2
3								3
4								4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 1.00 m
REVIEWED BY: DP	COMPLETION DATE: 5/13/21
PROJECT MANAGER: Pankewich	Page 1 of 1

PROJECT: Soil Quality Assessment	CLIENT: City of Edmonton	TESTHOLE NO: **21-05**
LOCATION: Smith Crossing Bridge, Edmonton, AB		PROJECT NO.: CEL-37556
CONTRACTOR: CRIMSON Environmental Limited	METHOD: Solid Stem	ELEVATION (m):

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ▨ NO RECOVERY ▌ CORE

BACKFILL TYPE ■ BENTONITE ⁘ GRAVEL ▥ SLOUGH ⁙ GROUT ▨ CUTTINGS ⁘ SAND

DEPTH (m)	BACKFILL DETAILS	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	⊗ Vapour Concentration ⊗ (ppm) 100 1000 10000	COMMENTS	DEPTH (m)
0	▨	▩	FILL, fine sand, clayey, silty, trace gravel, compact, moist, brown.	■	1			
1			End of borehole at 1.0 metre below ground level. Borehole backfilled with drill cuttings to surface. All details provided on this borehole log are approximate.	■	2			1
2								2
3								3
4								4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 1.00 m
REVIEWED BY: DP	COMPLETION DATE: 5/13/21
PROJECT MANAGER: Pankewich	Page 1 of 1

Appendix D

Laboratory Reports

Element
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Edmonton, Alberta
T6B 3J4, Canada

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Report Transmission Cover Page

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

Contact	Company	Address
Danielle Hutson	**Crimson Environmental Ltd.**	Edmotnon, AB null Phone: (555) 555-5555 Fax: Email: danielle.hutson@element.com

Delivery	Format	Deliverables
Email - Merge Reports	PDF	Invoice

Contact	Company	Address
Doug Pankewich	**Crimson Environmental Ltd.**	#24 -314 - 222 Baseline Road Sherwood Park, AB T8H 1S8 Phone: (780) 719-4959 Fax: Email: pankewich@shaw.ca

Delivery	Format	Deliverables
Email - Merge Reports	PDF	COC / COA
Email - Merge Reports	PDF	Invoice
Email - Multiple Reports By Agreement	PDF	COC / Test Report
Email - Single Report	Legacy Crosstab in CSV	Test Report

Notes To Clients:

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Analytical Report

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

		Reference Number	1492578-1	1492578-2	1492578-3	
		Sample Date	May 13, 2021	May 13, 2021	May 13, 2021	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	21-01 / 0.0-0.15 / m	21-01 / 1.0 / m	21-02 / 0.0-0.15 / m	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Boron	Saturated Paste	mg/L	0.06	0.15	<0.5	0.05
Antimony	Strong Acid Extractable	mg/kg	0.3	0.4	0.4	0.2
Arsenic	Strong Acid Extractable	mg/kg	5.7	7.2	7.4	0.2
Barium	Strong Acid Extractable	mg/kg	165	185	183	1
Beryllium	Strong Acid Extractable	mg/kg	0.4	0.5	0.6	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.20	0.21	0.22	0.01
Chromium	Strong Acid Extractable	mg/kg	12.0	10.5	8.6	0.5
Cobalt	Strong Acid Extractable	mg/kg	7.2	7.6	8.3	0.1
Copper	Strong Acid Extractable	mg/kg	11.6	12.9	16.0	1
Lead	Strong Acid Extractable	mg/kg	26.9	25.4	10.0	0.1
Mercury	Strong Acid Extractable	mg/kg	<0.05	<0.05	<0.05	0.05
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	16.8	19.7	20.0	0.5
Selenium	Strong Acid Extractable	mg/kg	<0.3	<0.3	0.3	0.3
Silver	Strong Acid Extractable	mg/kg	<0.10	<0.10	<0.10	0.1
Thallium	Strong Acid Extractable	mg/kg	0.12	0.14	0.16	0.05
Tin	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Uranium	Strong Acid Extractable	mg/kg	0.9	1.3	1.6	0.5
Vanadium	Strong Acid Extractable	mg/kg	16.2	14.4	14.2	0.1
Zinc	Strong Acid Extractable	mg/kg	59	59	63	1
Salinity						
Electrical Conductivity	Saturated Paste	dS/m	0.94	0.56	3.19	0.01
SAR	Saturated Paste		2.0	0.7	1.8	
% Saturation		%	62	51	54	
Calcium	Saturated Paste	mg/kg	62.4	36.4	286	
Magnesium	Saturated Paste	mg/kg	11.3	7.7	63.6	
Sodium	Saturated Paste	mg/kg	51	12	95	
Potassium	Saturated Paste	mg/kg	27	10	49	
Chloride	Saturated Paste	mg/L	26	15	95	2
Chloride	Saturated Paste	mg/kg	16	8	51	
Sulfate (SO4)	Saturated Paste	mg/kg	29.3	31.1	908	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	
Soil Acidity						
pH	1:2 Soil:CaCl2 sol.	pH	7.1	7.3	7.7	
Water Soluble Parameters						
Chromium (VI)	Dry Weight	mg/kg	0.1	0.1	<0.05	0.05

Element
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W: www.element.com

Analytical Report

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

Reference Number	1492578-2	1492578-10		
Sample Date	May 13, 2021	May 13, 2021		
Sample Time	NA	NA		
Sample Location				
Sample Description	21-01 / 1.0 / m	21-05 / 1.0 / m		
Matrix	Soil	Soil		

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Clay Loam		
Sand	50 µm - 2 mm	% by weight	61	50		0.1
Silt	2 µm - 50 µm	% by weight	21	24		0.1
Clay	<2 µm	% by weight	18	26		0.1

Analytical Report

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

Reference Number	1492578-4	1492578-5	1492578-6
Sample Date	May 13, 2021	May 13, 2021	May 13, 2021
Sample Time	NA	NA	NA
Sample Location			
Sample Description	21-02 / 0.5 / m	21-03 / 0.0-0.15 / m	21-03 / 1.0 / m
Matrix	Soil	Soil	Soil

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Strong Acid Digestion						
Boron	Saturated Paste	mg/L	<0.5	<0.05	0.06	0.05
Antimony	Strong Acid Extractable	mg/kg	0.3	0.4	0.4	0.2
Arsenic	Strong Acid Extractable	mg/kg	7.0	7.0	7.3	0.2
Barium	Strong Acid Extractable	mg/kg	132	195	178	1
Beryllium	Strong Acid Extractable	mg/kg	0.4	0.5	0.6	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.15	0.24	0.23	0.01
Chromium	Strong Acid Extractable	mg/kg	6.8	9.9	9.7	0.5
Cobalt	Strong Acid Extractable	mg/kg	6.8	8.6	8.2	0.1
Copper	Strong Acid Extractable	mg/kg	10.0	16.8	15.6	1
Lead	Strong Acid Extractable	mg/kg	7.2	12.5	12.6	0.1
Mercury	Strong Acid Extractable	mg/kg	<0.05	0.05	0.05	0.05
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	15.7	20.3	20.6	0.5
Selenium	Strong Acid Extractable	mg/kg	<0.3	0.3	0.3	0.3
Silver	Strong Acid Extractable	mg/kg	<0.10	<0.10	<0.10	0.1
Thallium	Strong Acid Extractable	mg/kg	0.13	0.17	0.16	0.05
Tin	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Uranium	Strong Acid Extractable	mg/kg	1.1	1.5	1.5	0.5
Vanadium	Strong Acid Extractable	mg/kg	11.6	15.2	14.7	0.1
Zinc	Strong Acid Extractable	mg/kg	47	71	66	1
Salinity						
Electrical Conductivity	Saturated Paste	dS/m	2.17	1.08	1.41	0.01
SAR	Saturated Paste		1.5	2.3	2.8	
% Saturation		%	42	58	55	
Calcium	Saturated Paste	mg/kg	120	58.6	70.6	
Magnesium	Saturated Paste	mg/kg	30	10.7	13.8	
Sodium	Saturated Paste	mg/kg	46	55	72	
Potassium	Saturated Paste	mg/kg	21	15	12	
Chloride	Saturated Paste	mg/L	254	61	138	2
Chloride	Saturated Paste	mg/kg	106	35	76	
Sulfate (SO4)	Saturated Paste	mg/kg	262	166	203	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	
Soil Acidity						
pH	1:2 Soil:CaCl2 sol.	pH	7.5	7.5	7.6	
Water Soluble Parameters						
Chromium (VI)	Dry Weight	mg/kg	0.10	0.08	0.05	0.05

Analytical Report

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

Reference Number	1492578-7	1492578-8	1492578-9
Sample Date	May 13, 2021	May 13, 2021	May 13, 2021
Sample Time	NA	NA	NA
Sample Location			
Sample Description	21-04 / 0.0-0.15 / m	21-04 / 1.0 / m	21-05 / 0.0-0.15 / m
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Metals Strong Acid Digestion						
Boron	Saturated Paste	mg/L	0.07	0.10	0.07	0.05
Antimony	Strong Acid Extractable	mg/kg	0.4	0.4	0.3	0.2
Arsenic	Strong Acid Extractable	mg/kg	7.5	9.0	6.9	0.2
Barium	Strong Acid Extractable	mg/kg	184	181	181	1
Beryllium	Strong Acid Extractable	mg/kg	0.6	0.5	0.4	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.24	0.22	0.23	0.01
Chromium	Strong Acid Extractable	mg/kg	8.5	10.5	9.2	0.5
Cobalt	Strong Acid Extractable	mg/kg	8.9	7.5	7.3	0.1
Copper	Strong Acid Extractable	mg/kg	17.1	13.8	14.2	1
Lead	Strong Acid Extractable	mg/kg	9.6	17.1	11.9	0.1
Mercury	Strong Acid Extractable	mg/kg	<0.05	<0.05	<0.05	0.05
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	20.5	19.9	17.0	0.5
Selenium	Strong Acid Extractable	mg/kg	0.3	0.3	<0.3	0.3
Silver	Strong Acid Extractable	mg/kg	<0.10	<0.10	<0.10	0.1
Thallium	Strong Acid Extractable	mg/kg	0.17	0.15	0.14	0.05
Tin	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Uranium	Strong Acid Extractable	mg/kg	1.5	1.1	1.2	0.5
Vanadium	Strong Acid Extractable	mg/kg	14.6	16.0	13.7	0.1
Zinc	Strong Acid Extractable	mg/kg	68	63	62	1
Salinity						
Electrical Conductivity	Saturated Paste	dS/m	0.62	0.76	1.96	0.01
SAR	Saturated Paste		0.3	4.5	1.9	
% Saturation		%	57	50	54	
Calcium	Saturated Paste	mg/kg	47.9	23.3	121	
Magnesium	Saturated Paste	mg/kg	9.8	3.6	29.0	
Sodium	Saturated Paste	mg/kg	8	63	66	
Potassium	Saturated Paste	mg/kg	16	7	18	
Chloride	Saturated Paste	mg/L	28	43	248	2
Chloride	Saturated Paste	mg/kg	16	22	135	
Sulfate (SO4)	Saturated Paste	mg/kg	39.8	29.7	233	
TGR	Saturated Paste	T/ac	<0.1	<0.1	<0.1	
Soil Acidity						
pH	1:2 Soil:CaCl2 sol.	pH	7.6	7.6	7.6	
Water Soluble Parameters						
Chromium (VI)	Dry Weight	mg/kg	0.1	0.1	0.1	0.05

Analytical Report

Bill To:	Crimson Environmental Ltd. #24-314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37556	Lot ID:	**1492578**
		Project Name:	Smith Crossing	Control Number:	
		Project Location:		Date Received:	May 14, 2021
		LSD:		Date Reported:	May 20, 2021
		P.O.:		Report Number:	2623438
Attn:	Accounts Payable	Proj. Acct. code:			
Sampled By:	DP				
Company:	Crimson				

Reference Number 1492578-10
Sample Date May 13, 2021
Sample Time NA
Sample Location
Sample Description 21-05 / 1.0 / m

Matrix Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Metals Strong Acid Digestion						
Boron	Saturated Paste	mg/L	<0.5			0.05
Antimony	Strong Acid Extractable	mg/kg	0.5			0.2
Arsenic	Strong Acid Extractable	mg/kg	5.3			0.2
Barium	Strong Acid Extractable	mg/kg	176			1
Beryllium	Strong Acid Extractable	mg/kg	0.7			0.1
Cadmium	Strong Acid Extractable	mg/kg	0.25			0.01
Chromium	Strong Acid Extractable	mg/kg	9.3			0.5
Cobalt	Strong Acid Extractable	mg/kg	7.4			0.1
Copper	Strong Acid Extractable	mg/kg	20.0			1
Lead	Strong Acid Extractable	mg/kg	17.0			0.1
Mercury	Strong Acid Extractable	mg/kg	0.05			0.05
Molybdenum	Strong Acid Extractable	mg/kg	<1.0			1
Nickel	Strong Acid Extractable	mg/kg	17.1			0.5
Selenium	Strong Acid Extractable	mg/kg	0.4			0.3
Silver	Strong Acid Extractable	mg/kg	<0.10			0.1
Thallium	Strong Acid Extractable	mg/kg	0.18			0.05
Tin	Strong Acid Extractable	mg/kg	<1.0			1
Uranium	Strong Acid Extractable	mg/kg	2.3			0.5
Vanadium	Strong Acid Extractable	mg/kg	15.3			0.1
Zinc	Strong Acid Extractable	mg/kg	60			1
Salinity						
Electrical Conductivity	Saturated Paste	dS/m	2.50			0.01
SAR	Saturated Paste		3.9			
% Saturation		%	51			
Calcium	Saturated Paste	mg/kg	115			
Magnesium	Saturated Paste	mg/kg	25			
Sodium	Saturated Paste	mg/kg	128			
Potassium	Saturated Paste	mg/kg	19			
Chloride	Saturated Paste	mg/L	465			2
Chloride	Saturated Paste	mg/kg	239			
Sulfate (SO4)	Saturated Paste	mg/kg	276			
TGR	Saturated Paste	T/ac	<0.1			
Soil Acidity						
pH	1:2 Soil:CaCl2 sol.	pH	8.1			
Water Soluble Parameters						
Chromium (VI)	Dry Weight	mg/kg	0.07			0.05

Analytical Report

Bill To:	Crimson Environmental Ltd. #24-314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37556	Lot ID:	**1492578**
		Project Name:	Smith Crossing	Control Number:	
		Project Location:		Date Received:	May 14, 2021
		LSD:		Date Reported:	May 20, 2021
Attn:	Accounts Payable	P.O.:		Report Number:	2623438
Sampled By:	DP	Proj. Acct. code:			
Company:	Crimson				

Approved by:

Benjamin Morris, B.Sc
Operations Manager

Quality Control

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

Metals Strong Acid Digestion

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Boron	mg/L	0.014	-0.05	0.07	yes
Antimony	µg/L	0.00346307	-0.1	0.2	yes
Arsenic	µg/L	-0.000251214	-0.2	0.2	yes
Barium	µg/L	0.07209	-1	1	yes
Beryllium	µg/L	0.00685682	-0.1	0.1	yes
Cadmium	µg/L	0.000680647	-0.01	0.01	yes
Chromium	µg/L	-0.00485292	-0.5	0.5	yes
Cobalt	µg/L	-0.00592412	-0.1	0.1	yes
Copper	µg/L	0.0423679	-0.6	1.2	yes
Lead	µg/L	0.0439675	-5.0	5.0	yes
Mercury	µg/L	0.000876771	-0.04	0.04	yes
Molybdenum	µg/L	0.00413824	-1.0	1.0	yes
Nickel	µg/L	0.0449025	-0.4	0.7	yes
Selenium	µg/L	0.00682215	-0.3	0.3	yes
Silver	µg/L	0.000185165	-0.09	0.14	yes
Thallium	µg/L	0.0113413	-0.04	0.04	yes
Tin	µg/L	0.00955578	-0.4	0.4	yes
Uranium	µg/L	0.00394158	-0.5	0.5	yes
Vanadium	µg/L	0.0282704	-0.1	0.1	yes
Zinc	µg/L	0.257213	-1	1	yes

Date Acquired: May 17, 2021

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Antimony	mg/kg	<0.2	<0.2	20	0.4	yes
Arsenic	mg/kg	3.6	3.0	20	0.4	yes
Barium	mg/kg	120	117	20	2	yes
Beryllium	mg/kg	0.2	0.2	20	0.2	yes
Cadmium	mg/kg	0.06	0.06	20	0.02	yes
Chromium	mg/kg	9.8	8.4	20	1.1	yes
Cobalt	mg/kg	3.4	3.1	20	0.2	yes
Copper	mg/kg	3.2	3.0	20	2.2	yes
Lead	mg/kg	6.5	6.2	20	0.2	yes
Mercury	mg/kg	<0.05	<0.05	20	0.05	yes
Molybdenum	mg/kg	<1.0	<1.0	20	2.2	yes
Nickel	mg/kg	7.6	6.5	20	1.1	yes
Selenium	mg/kg	<0.3	<0.3	20	0.7	yes
Silver	mg/kg	<0.10	<0.10	20	0.22	yes
Thallium	mg/kg	0.06	0.05	20	0.11	yes
Tin	mg/kg	<1.0	<1.0	20	2.2	yes
Uranium	mg/kg	<0.5	<0.5	20	1.1	yes
Vanadium	mg/kg	19.7	18.4	20	0.2	yes
Zinc	mg/kg	26	24	20	2	yes

Date Acquired: May 17, 2021

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Antimony	mg/kg	38.7	37.8	42.2	yes

Quality Control

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

Metals Strong Acid Digestion - Continued

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Arsenic	mg/kg	39.5	36.3	43.9	yes
Barium	mg/kg	197	188	212	yes
Beryllium	mg/kg	19.8	17.4	22.2	yes
Cadmium	mg/kg	2.04	1.88	2.28	yes
Chromium	mg/kg	98.1	93.2	107.0	yes
Cobalt	mg/kg	19.5	18.2	21.2	yes
Copper	mg/kg	199	183.1	212.7	yes
Lead	mg/kg	19.9	18.3	21.3	yes
Mercury	mg/kg	3.10	2.64	3.36	yes
Molybdenum	mg/kg	205	185.1	222.3	yes
Nickel	mg/kg	98.6	92.4	106.2	yes
Selenium	mg/kg	39.0	35.2	44.2	yes
Silver	mg/kg	19.7	18.20	22.40	yes
Thallium	mg/kg	9.67	9.02	10.82	yes
Tin	mg/kg	203	191.2	215.2	yes
Uranium	mg/kg	98.7	86.0	116.0	yes
Vanadium	mg/kg	19.5	18.0	21.6	yes
Zinc	mg/kg	201	186	210	yes
Date Acquired:	May 17, 2021				
Antimony	mg/kg	3.8	3.2	4.7	yes
Arsenic	mg/kg	4.6	3.1	5.5	yes
Barium	mg/kg	102	82	124	yes
Beryllium	mg/kg	0.3	0.2	0.5	yes
Cadmium	mg/kg	1.13	0.78	1.20	yes
Chromium	mg/kg	85.7	70.9	98.5	yes
Cobalt	mg/kg	6.9	5.8	8.2	yes
Copper	mg/kg	129	108.4	148.0	yes
Lead	mg/kg	276	200.6	318.8	yes
Mercury	mg/kg	0.06	0.05	0.09	yes
Molybdenum	mg/kg	1.0	0.9	1.4	yes
Nickel	mg/kg	27.2	22.5	32.1	yes
Selenium	mg/kg	<0.3	0.3	0.3	yes
Silver	mg/kg	4.0	2.28	6.00	yes
Thallium	mg/kg	0.07	0.05	0.10	yes
Tin	mg/kg	9.9	8.4	12.6	yes
Uranium	mg/kg	<0.5	0.3	0.7	yes
Vanadium	mg/kg	30.7	17.8	46.9	yes
Zinc	mg/kg	346	283	390	yes
Date Acquired:	May 17, 2021				

Physical and Aggregate Properties

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Sand	% by weight	28	20	32	yes
Clay	% by weight	32	27	36	yes
<50 um	% by weight	72.0	67.500	82.500	yes

Quality Control

Bill To: Crimson Environmental Ltd.
#24-314 - 222 Baseline Road
Sherwood Park, AB, Canada
T8H 1S8
Attn: Accounts Payable
Sampled By: DP
Company: Crimson

Project ID: CEL-37556
Project Name: Smith Crossing
Project Location:
LSD:
P.O.:
Proj. Acct. code:

Lot ID: **1492578**
Control Number:
Date Received: May 14, 2021
Date Reported: May 20, 2021
Report Number: 2623438

Physical and Aggregate Properties - Continued

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC

Date Acquired: May 17, 2021

Salinity

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Calcium	mg/L	0.0727	-0.4	0.5	yes
Magnesium	mg/L	-0.0076	-0.1	0.1	yes
Sodium	mg/L	0.0157	-0	2	yes
Potassium	mg/L	0.0702	-0.5	0.7	yes
Chloride	mg/L	1.6099	0	5	yes
Sulfate-S	mg/L	0.3982	-0	1	yes

Date Acquired: May 17, 2021

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Electrical Conductivity	dS/m	0.46	0.46	20	0.03	yes
Calcium	mg/kg	13.4	14.9	20	0.6	yes
Magnesium	mg/kg	2.6	2.7	20	0.6	yes
Sodium	mg/kg	9	9	20	1	yes
Potassium	mg/kg	3	3	20	1	yes
Chloride	mg/kg	11	12	15	3	yes
Sulfate-S	mg/kg	7.2	7.5	20	1.2	yes

Date Acquired: May 17, 2021

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Electrical Conductivity	dS/m	1.58	1.31	1.79	yes
% Saturation	%	60	55	67	yes
Calcium	mg/L	291	231.4	347.2	yes
Magnesium	mg/L	51.5	40.3	60.7	yes
Sodium	mg/L	24	20	26	yes
Potassium	mg/L	11.2	9.6	13.2	yes
Chloride	mg/L	30	25	33	yes
Sulfate-S	mg/L	200	175	242	yes

Date Acquired: May 17, 2021

Electrical Conductivity	dS/m	32.6	26.80	35.20	yes
Calcium	mg/L	247	231.3	256.5	yes
Magnesium	mg/L	99.0	92.7	101.7	yes
Sodium	mg/L	250	225	264	yes
Potassium	mg/L	254	222.6	270.6	yes
Chloride	mg/L	1980	1852	2229	yes
Sulfate-S	mg/L	149	138	156	yes

Date Acquired: May 17, 2021

Soil Acidity

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
pH	pH	6.0	5.9	10	0.3	yes

Date Acquired: May 17, 2021

Quality Control

Bill To:	Crimson Environmental Ltd. #24-314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37556	Lot ID:	**1492578**
		Project Name:	Smith Crossing	Control Number:	
		Project Location:		Date Received:	May 14, 2021
		LSD:		Date Reported:	May 20, 2021
Attn:	Accounts Payable	P.O.:		Report Number:	2623438
Sampled By:	DP	Proj. Acct. code:			
Company:	Crimson				

Soil Acidity - Continued

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
pH	pH	6.8	6.3	6.9	yes

Date Acquired: May 17, 2021

Water Soluble Parameters

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Chromium (VI)	mg/L	0	-0.10	0.10	yes

Date Acquired: May 17, 2021

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Chromium (VI)	mg/kg	0.09	0.08	10	0.01	yes

Date Acquired: May 17, 2021

Methodology and Notes

Bill To:	Crimson Environmental Ltd. #24-314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37556	Lot ID:	**1492578**
		Project Name:	Smith Crossing	Control Number:	
		Project Location:		Date Received:	May 14, 2021
		LSD:		Date Reported:	May 20, 2021
		P.O.:		Report Number:	2623438
Attn:	Accounts Payable	Proj. Acct. code:			
Sampled By:	DP				
Company:	Crimson				

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
1:5 Water Soluble Extraction	APHA	*	Colorimetric Method, 3500-Cr B	May 17, 2021	Element Edmonton - Roper Road
1:5 Water Soluble Extraction	McKeague	*	Soluble Salts in Extracts of 1:5 Soil:Water Mixtures, 3.23	May 17, 2021	Element Edmonton - Roper Road
Metals ICP (Hot Block) in soil	EPA	*	Sample Preparation Procedure for Spectrochemical Determination of Total Recoverable Elements, October 1999, 200.2	May 17, 2021	Element Edmonton - Roper Road
Metals ICP (Hot Block) in soil	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	May 17, 2021	Element Edmonton - Roper Road
Particle Size Analysis - GS	Carter	*	Hydrometer Method, 55.3	May 17, 2021	Element Edmonton - Roper Road
pH by CaCl2 (1:2 ratio) in soil	McKeague	*	pH in 0.01M Calcium Chloride, 3.11	May 17, 2021	Element Edmonton - Roper Road
Saturated Paste in General Soil	APHA	*	Automated Ferricyanide Method, 4500-Cl-E	May 17, 2021	Element Edmonton - Roper Road
Saturated Paste in General Soil	Carter	*	Electrical Conductivity and Soluble Ions, Chapter 15	May 17, 2021	Element Edmonton - Roper Road

** Reference Method Modified*

References

APHA	Standard Methods for the Examination of Water and Wastewater
Carter	Soil Sampling and Methods of Analysis.
EPA	Environmental Protection Agency Test Methods - US
McKeague	Manual on Soil Sampling and Methods of Analysis
US EPA	US Environmental Protection Agency Test Methods

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Appendix E: Hydrotechnical Assessment (Associated Engineering 2021)

Associated Engineering
75 YEARS

TECHNICAL MEMORANDUM

Morrison Hershfield Ltd.

Smith Crossing Pedestrian Bridge Hydrotechnical Assessment

SEPTEMBER 2021

TABLE OF CONTENTS

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1 INTRODUCTION

1.1 Background

Morrison Hershfield (MH) retained Associated to conduct a hydrotechnical assessment of the Smith Crossing Pedestrian Bridge across Whitemud Creek in Edmonton. This assessment is part of the design and preconstruction services being conducted by MH for the Bridge Replacement project for the City of Edmonton. The project site is located approximately 40 m downstream of the Blackmud and Whitemud Creek confluence, and 60 m upstream of the 23rd Avenue Bridge. The pedestrian bridge connects the MacTaggart Sanctuary trail system (**Figure 1-1**).

The Bridge is a single span (24.38 m) steel pony truss fabricated and constructed by Alberta Transportation in the early 1900s. The bridge carries the MacTaggart Sanctuary trail system across Whitemud Creek. The bridge is much loved by the public and a commemorative plaque on a boulder identifies the namesakes of the bridge.

The Smith Crossing Pedestrian Bridge location (project site) has an approximate drainage area of 1050 km^2. The channel reach within the project area is generally flat with gentle to steep banks. The channel has minimal vegetation within the banks and its surrounding is mostly heavily vegetated. The closest hydrometric information is available on Whitemud Creek 12 km upstream and 8 km downstream of the project site. However, there is no hydrometric information pertinent to open water and ice conditions available at the project site. Due to available historical information, the hydrotechnical assessment was based on open water conditions.

1.2 Available Information

The following information was available for this assessment:

- Light Detection and Ranging (LiDAR) data (1m resolution).
- 23 Avenue/Whitemud Creek Bridge Rehabilitation Record Drawings, 1998.
- City of Edmonton Smith Crossing Design Build Project 23rd Avenue Twinning Between 119th Street and Hodgson Way Hydrotechnical Assessment Study Final Report, Northwest Hydraulic Consultants, 2006.
- Nisku Flood Hazard Study Blackmud Creek, Northwest Hydraulic Consultants, 2014.
- Blackmud/Whitemud Creek Surface Water Management Study, Associated Engineering, 2017.
- Smith Crossing Pedestrian Bridge over Whitemud Creek South of 23rd Avenue (BF 191) Bridge Condition Assessment Draft Report, BPTEC, 2018.
- Bathymetric survey obtained on November 13, 2020 including elevations within the Blackmud and Whitemud Creek channels.
- City of Edmonton DRAINS data, November 5, 2020.

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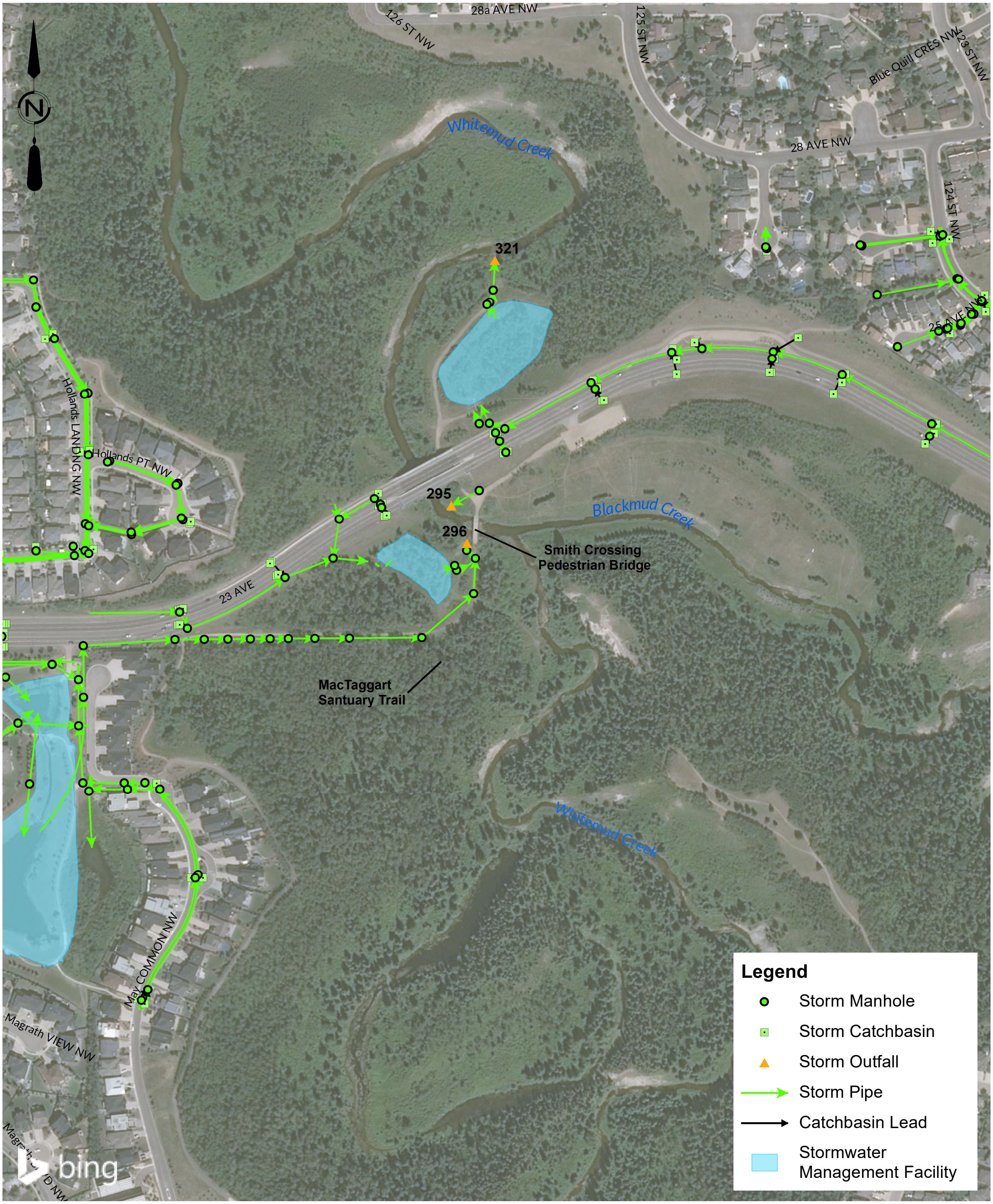

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FIGURE 1-1

SMITH CROSSING PEDESTRIAN BRIDGE

PROJECT SITE

1.3 Design Criteria and Assumptions

The following design criteria and assumptions were included in the hydrotechnical analysis:

- Design flood level – based on the 100-year design flood event during open water conditions.
- Blackmud and Whitemud Creek peak design flood estimates coincide.
- Discharges from storm outfalls (295, 296) were considered and applied assuming full flowing pipes for the simulation duration.
- Design flood event is mutually exclusive of design storm event.
- Proposed bridge bottom of soffit elevation determined based on the simulated 100-year design flood level plus a minimum of 0.3 m freeboard to allow for debris and ice (*Bridge Conceptual Design Guidelines Version 3.0*, Alberta Transportation, 2020).

2 HYDROLOGY ANALYSIS

Associated Engineering updated the flood frequency analysis which was completed during the Blackmud/Whitemud Surface Water Management Study in 2016. The updated analysis incorporated the most recent flow data (up to 2018) available from the Water Survey of Canada (WSC) to estimate the peak streamflows within the Blackmud and Whitemud Creeks. The following section summarizes the analysis completed for both creeks.

There is one WSC gauge located on Blackmud Creek and two gauges located on Whitemud Creek. **Figure 2-1** shows the gauge locations and outlines their catchment areas. **Table 2-1** presents key information about the gauges.

Table 2-1
WSC Gauge Information

Gauge	Description	Gross Drainage Area (km^2)	Effective Drainage Area (km^2)	Years of Available Data
05DF003	Blackmud Creek near Ellerslie	643	374	1935 + 1977 - 2018
05DF006	Whitemud Creek near Ellerslie	330	301	1969 - 2018
05DF009	Whitemud Creek at Edmonton	1,110	794	2013 - 2018

The flood event of record occurred on the Blackmud and Whitemud Creeks in 1974. Alberta Environment (1981) developed the 1974 event hydrograph with a peak occurring on Blackmud Creek on April 24. The maximum daily discharge on Blackmud Creek was estimated to be 87.8 m^3/s. The corresponding instantaneous peak was estimated to be 97.5 m^3/s by Northwest Hydraulic Consultants (NHC) in 2014 at the Blackmud Creek near Ellerslie gauge station (05DF003). This value was included in the updated flood frequency analysis for Blackmud Creek.

The updated flood frequency analysis was conducted using the available WSC data for maximum instantaneous values up to 2018. Where maximum instantaneous values were not available, they were estimated based on a linear relationship between maximum daily values and maximum instantaneous values, as shown in **Figures 2-2** and **2-3** for both creeks, respectively. The average ratio of instantaneous to daily maximum flow was estimated to be 1.1041 for Blackmud Creek and 1.1907 for Whitemud Creek.

Analysis was not completed at the Whitemud Creek at Edmonton gauge (05DF009) as this gauge only had four years of available data. Calculations were based on the analysis and comparison of Pearson Type III, Log Pearson Type III, Log Normal, and Gumbel frequency distributions. **Figure 2-4** presents the adopted flood frequency curves. **Table 2-2** provides a summary of the flood frequency estimates for the two gauge sites.

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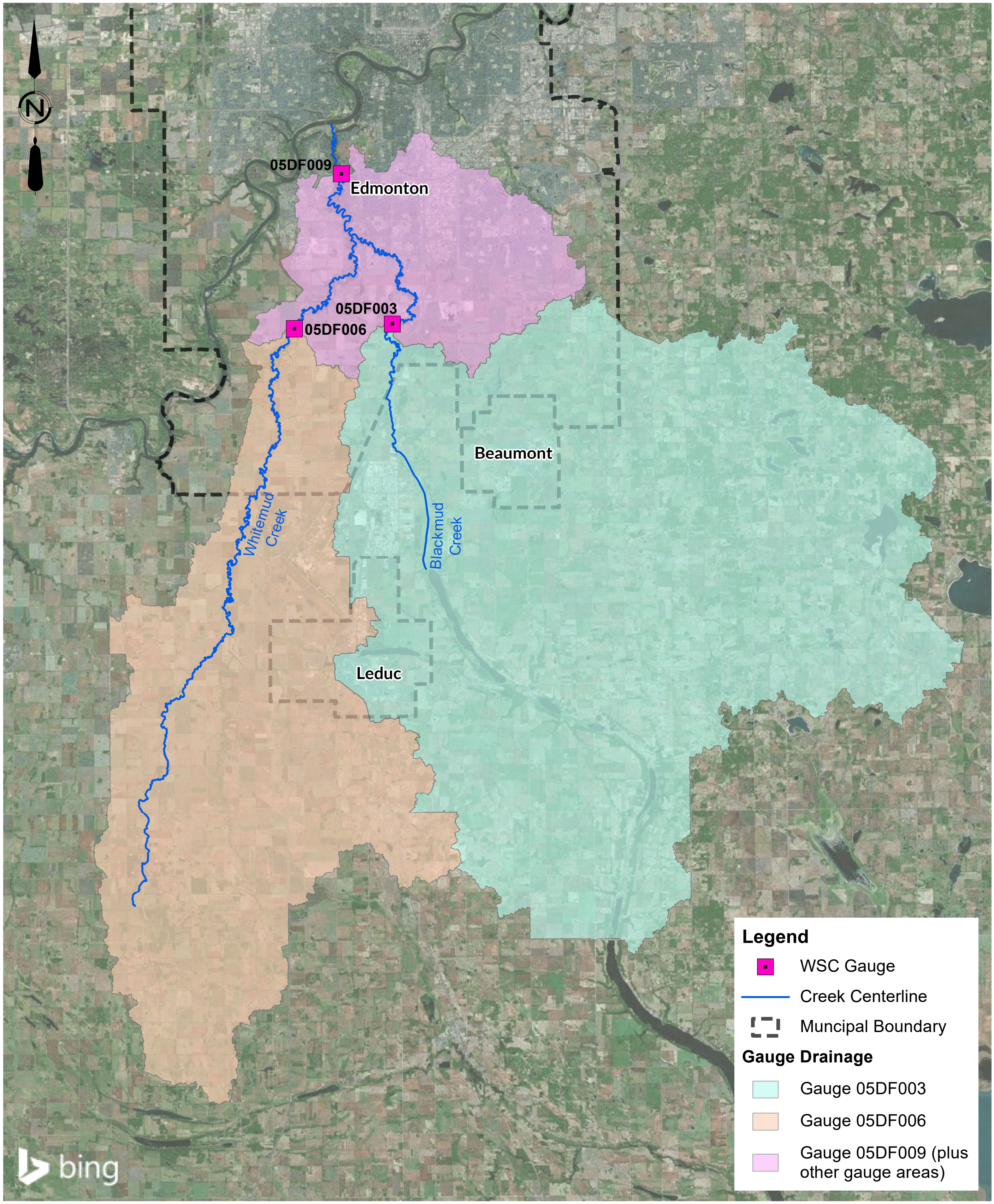

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FIGURE 2-1

SMITH CROSSING PEDESTRIAN BRIDGE

WSC GAUGE LOCATIONS AND CATCHMENT AREAS

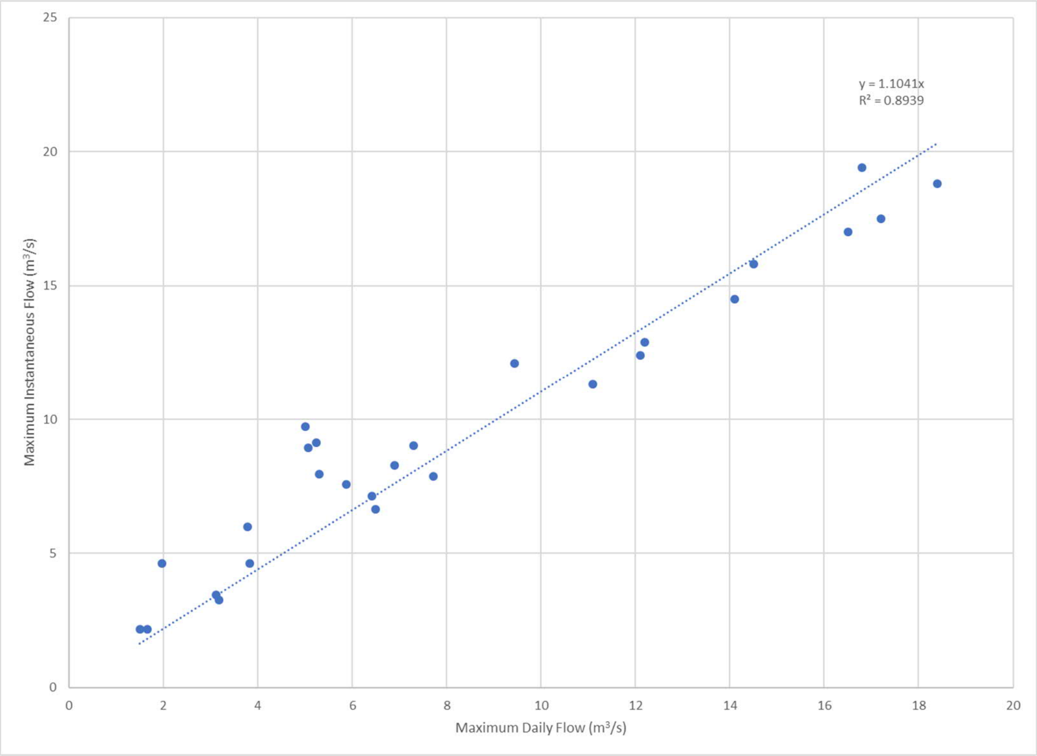


Figure 2-2
Blackmud Creek Peak to Mean Ratio

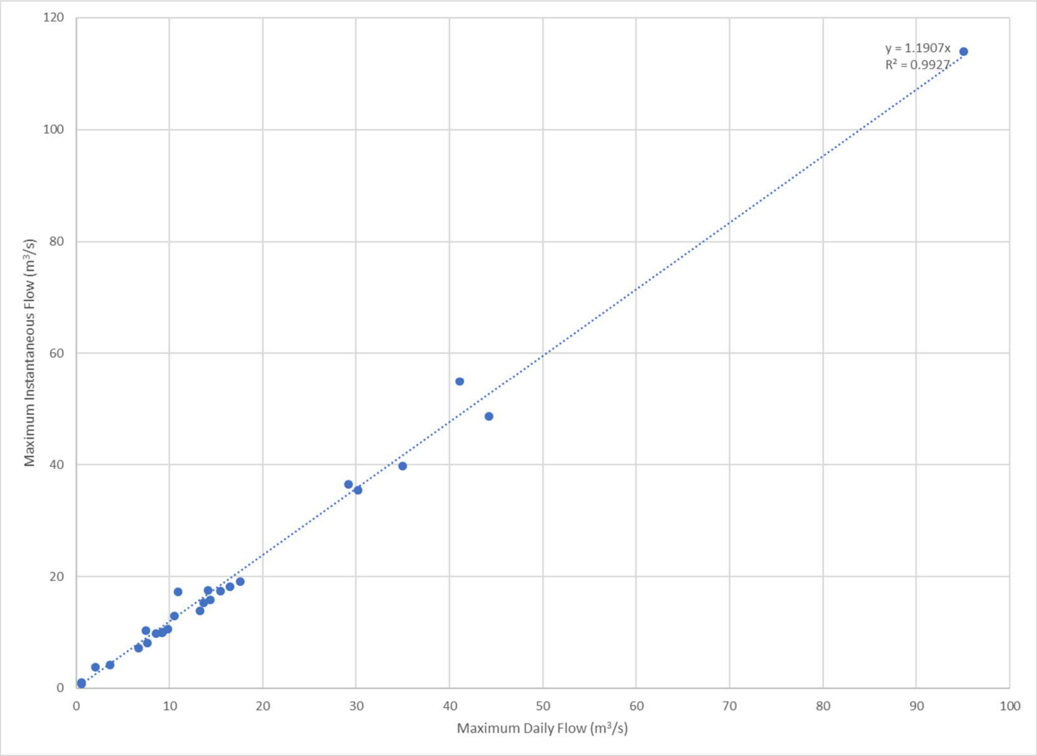
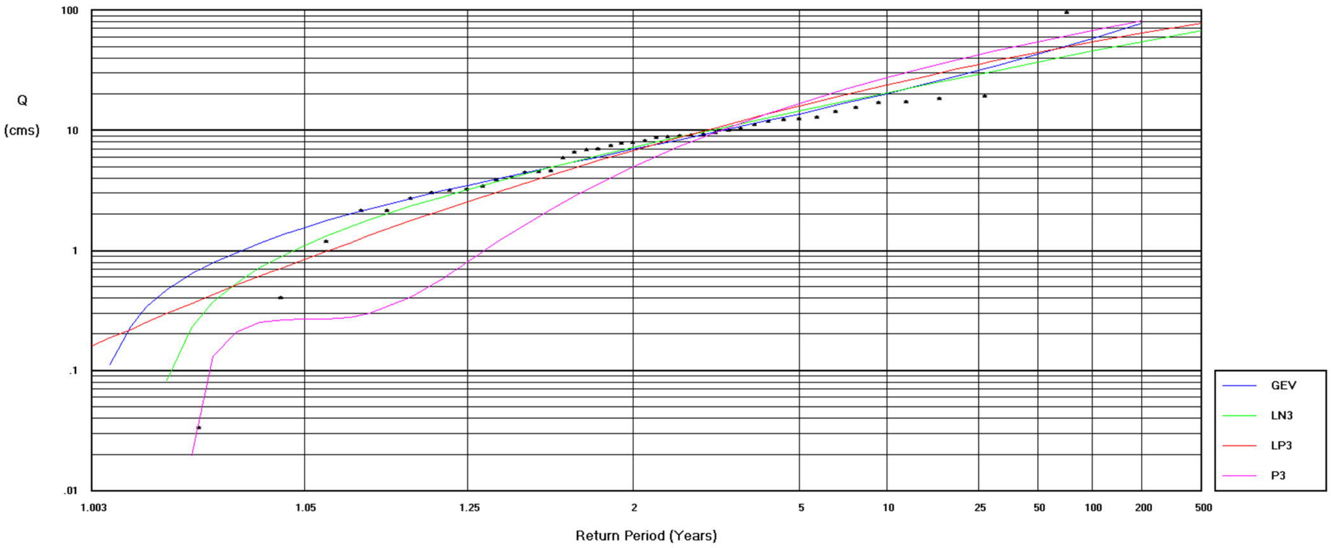


Figure 2-3
Whitemud Creek Peak to Mean Ratio

Blackmud Creek



Whitemud Creek

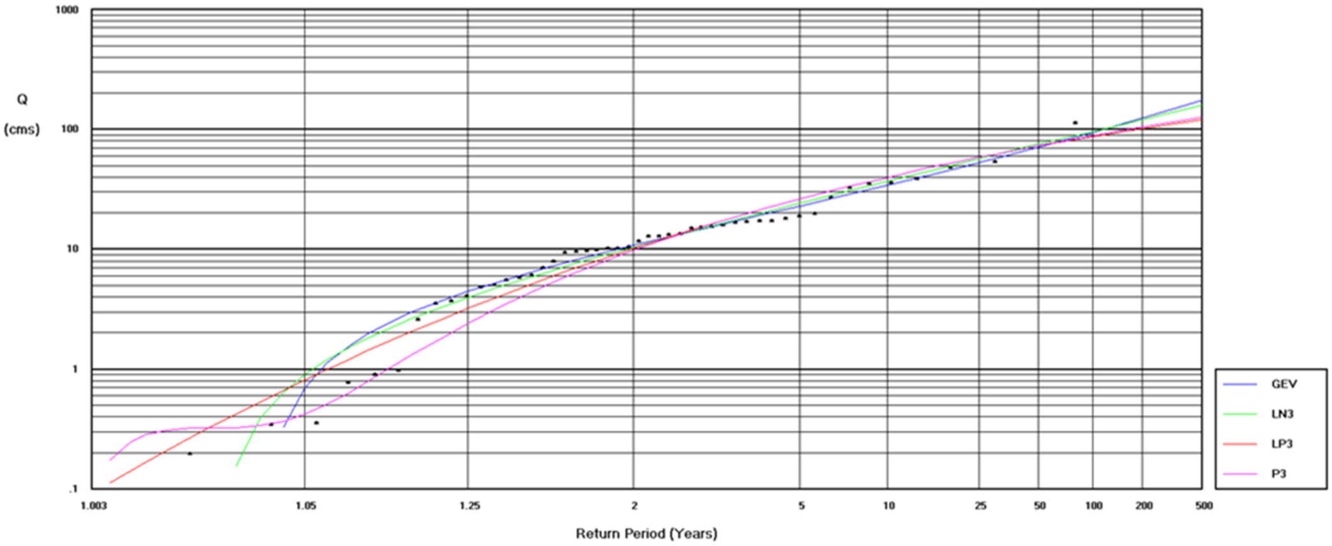


Figure 2-4
Flood Frequency Curves

Table 2-2
Maximum Instantaneous Flood Estimates

Return Period	Blackmud Creek WSC 05DF003	Whitemud Creek WSC 05DF006
(years)	(m^3/s)	
2	5.0	10.3
5	16.8	24.9
10	27.2	37.5
25	42.5	56.5
50	54.9	73.0
100	67.9	91.5

Based on the above data, the updated estimate of the 100-year design flood event is 67.9 m^3/s for Blackmud Creek and 91.5 m^3/s for Whitemud Creek at the WSC gauge sites.

Associated Engineering investigated the timing of peaks in recent years between the upstream and downstream WSC gauge locations to validate the assumption of the peak flows coinciding. Figures 2-5 to 2-8 show the daily discharge recorded at each WSC gauge location for the years 2013, 2014, 2015, and 2018. Note, the WSC gauge 05DF009 was installed in 2013. In addition, the flows at WSC gauges 05DF003 and 05DF006 were added and plotted on these figures for comparison.

This analysis shows that the peak flows on the Blackmud and Whitemud Creeks upstream of the confluence consistently occur within a week of each other. Note, the peak flows on both creeks coincided on the same day in 2014. Therefore, adding the peak flows together to determine the flow estimate at the project site is a reasonable assumption. For this analysis, Associated Engineering added the design flood event estimates on the Blackmud and Whitemud Creeks to determine the design flow at the project site. This approach will provide a factor of safety and a robust design for the Smith Crossing Pedestrian Bridge replacement project. Noting that the climate is changing, with more intense and frequent storm events occurring which impact rivers and creeks.

In addition, two concrete storm outfalls (295, 296) are located downstream of the pedestrian bridge (Figure 1-1). Outfall 295 is 600 mm in diameter and Outfall 296 is 1050 mm in diameter. The catchment areas for these storm outfalls are unknown. Therefore, it was assumed that both pipes flowing full represent the maximum discharge into Whitemud Creek for modelling purposes. In addition, this assumes that the design flood event is mutually exclusive from design storm events, meaning outfall discharge is not tied to a design storm return period.

Note, the 23rd Avenue bridge immediately downstream of the Smith Crossing Pedestrian Bridge is not expected to influence Whitemud Creek in any way. The 23rd Avenue bridge does not have piers located within the Whitemud Creek channel and was constructed above the creek valley. Therefore, it will not affect boundary conditions applied within the hydraulic model.

Table 2-3 summarizes the model input flows within the Blackmud and Whitemud Creeks and at each storm outfall used to assess the hydraulic capacity at the pedestrian bridge location.

Table 2-3
Model Flows

Location	2-Year Flow (m^3/s)	100-Year Flow (m^3/s)
Blackmud Creek	5.0	67.9
Whitemud Creek	10.3	91.5
Outfall 295	0.4	
Outfall 296	1.2	

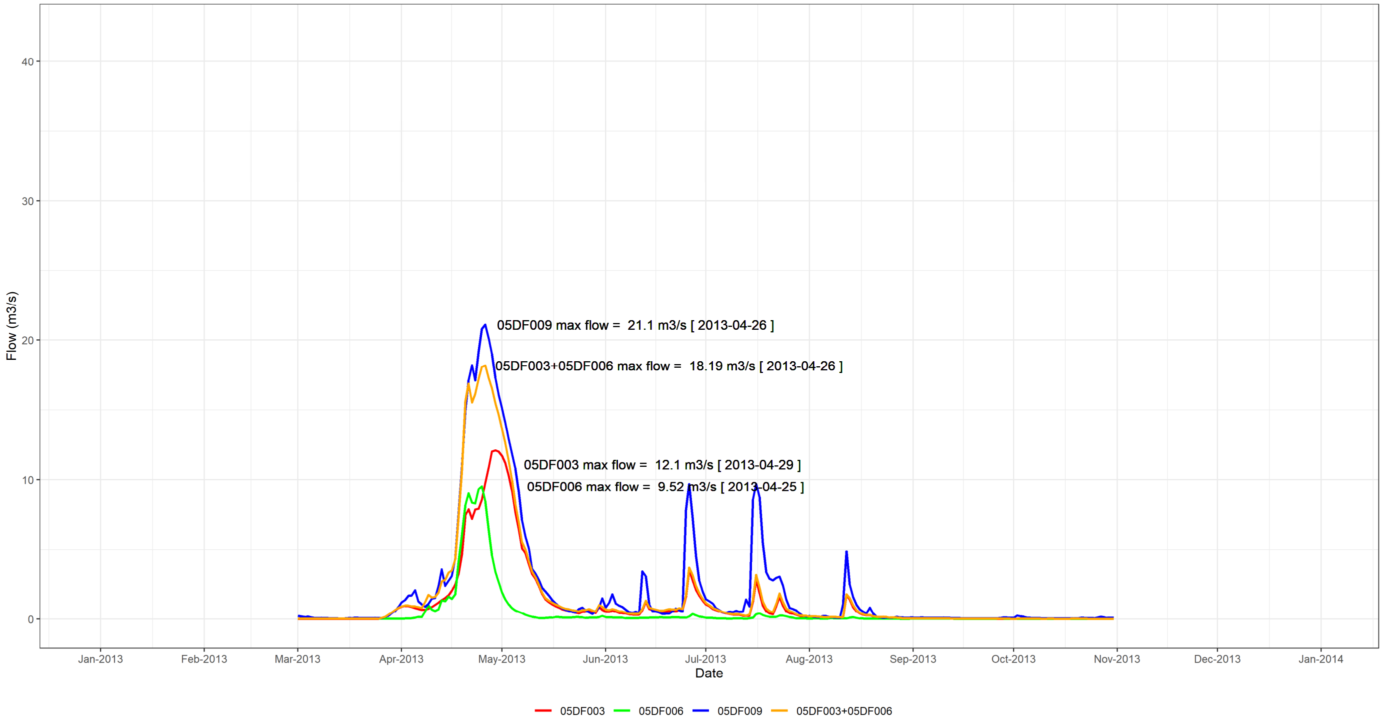


Figure 2-5
2013 WSC Gauge Daily Data

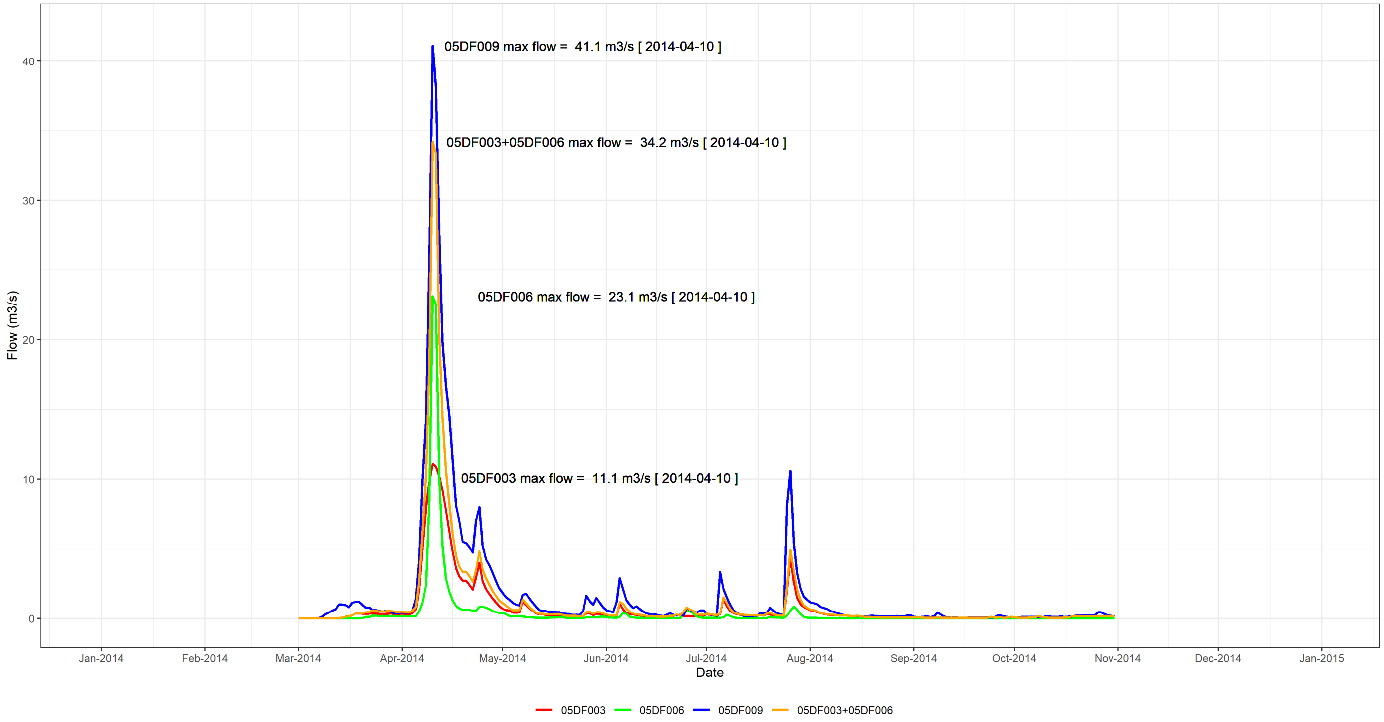


Figure 2-6
2014 WSC Gauge Daily Data

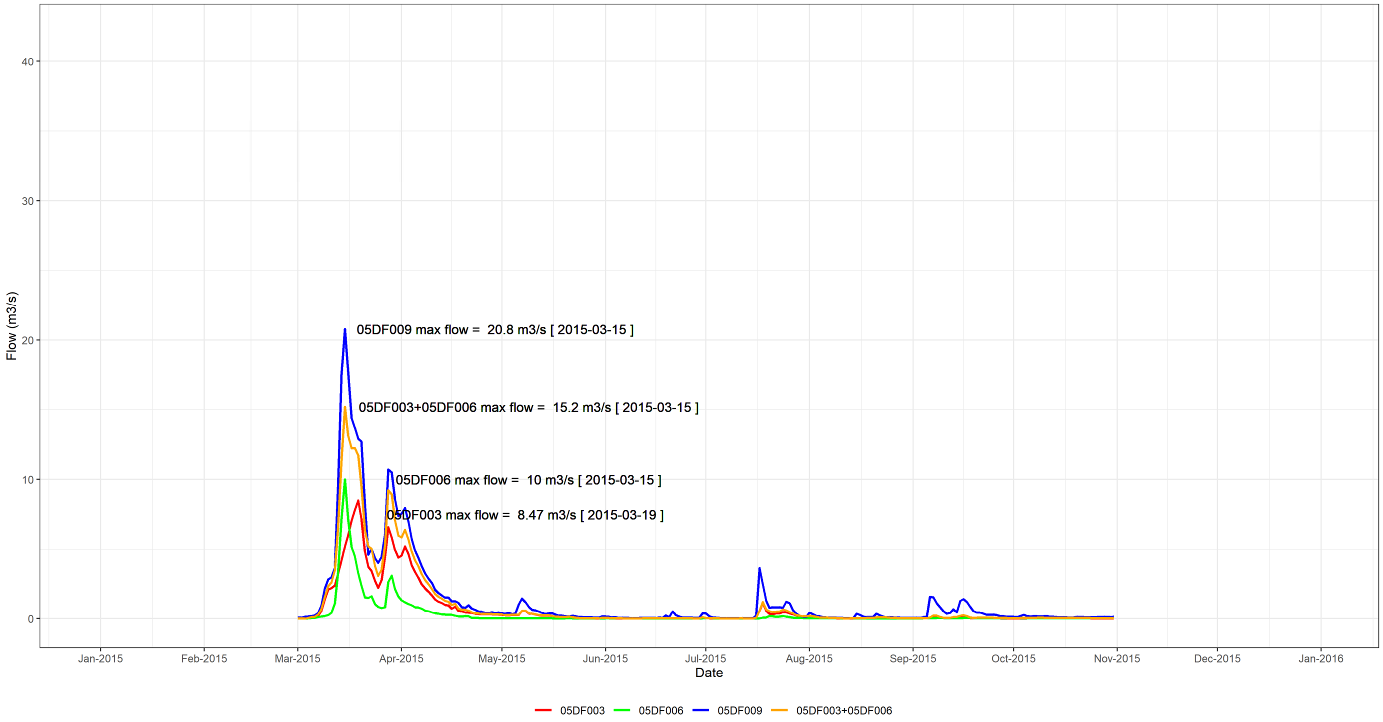


Figure 2-7
2015 WSC Gauge Daily Data

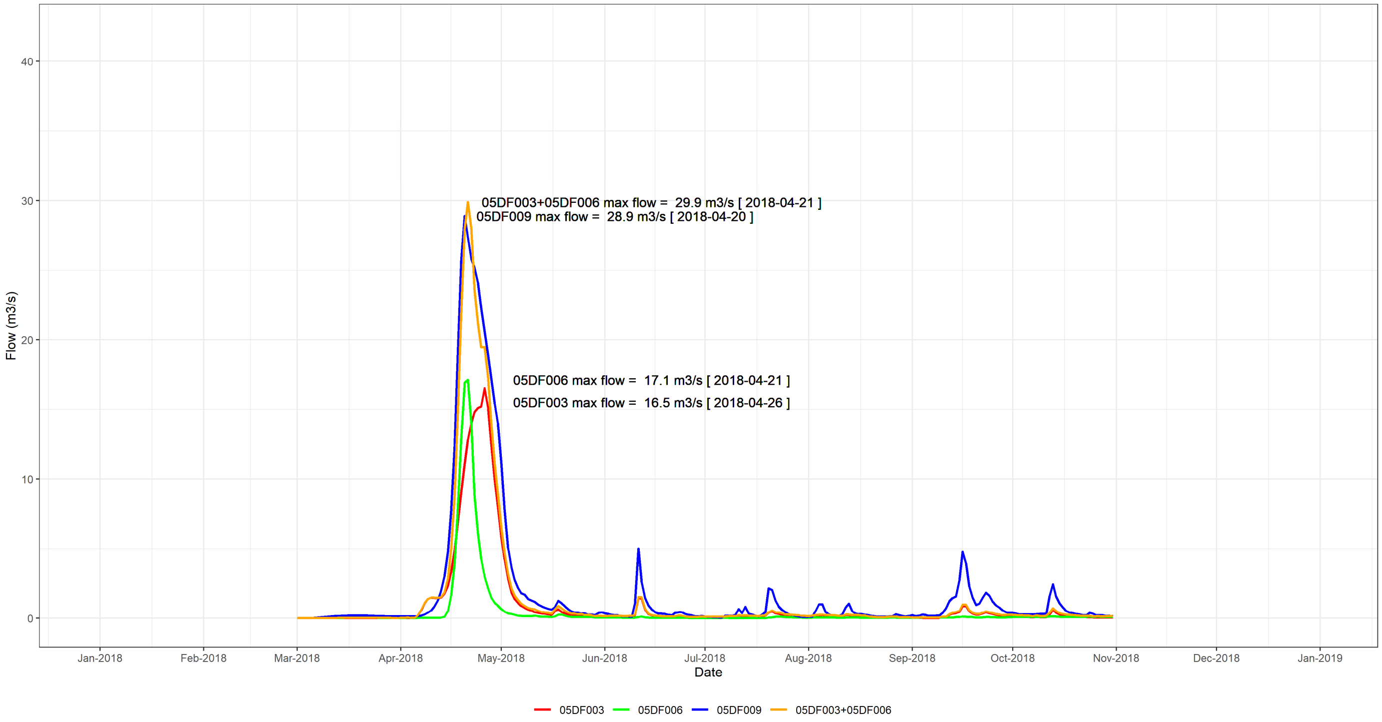


Figure 2-8
2018 WSC Gauge Daily Data

3 HYDROTECHNICAL ASSESSMENT

Associated Engineering developed both a one-dimensional (1D) and a two-dimensional (2D) numerical model for the Smith Crossing Pedestrian Bridge Hydrotechnical Analysis. Both models provide similar information; however, the 2D model provides a better representation of flood extent and velocity distribution which can be used to understand erosion potential within the project area.

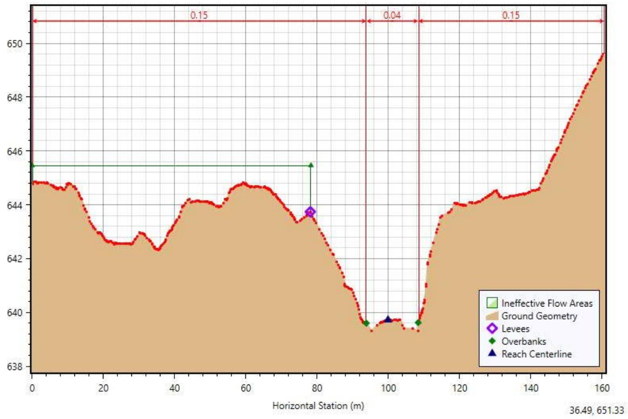
The existing Smith Crossing Pedestrian Bridge is located outside of the channel and has no piers. Therefore, both models were simulated with no pedestrian bridge in place. Model results represent the natural channel flood depths, extents, and velocities. In addition, the 23rd Avenue bridge was also not included within the hydraulic model as it is not expected to influence Whitemud Creek due to its elevation above stream bed and span across the creek.

The following sections provide details of the model development pertinent to the hydrotechnical assessment.

3.1 1D - Model

The 1D numerical model was developed using the GeoHec-Ras software to simulate key processes along the Blackmud and Whitemud Creeks. GeoHec-Ras is a 1D and 2D commercially available software developed by CivilGEO. This software is compatible with AutoCAD, MicroStation, ESRI ArcGIS, and HEC-RAS software. GeoHec-Ras uses the HEC-RAS engine, developed by the U.S. Army Corps of Engineers, to simulate steady and unsteady flow conditions within open channels.

The 1D numerical model was developed using bathymetric survey and the provided LiDAR data. The channel centreline was defined at the center of the creek channels. A total of 14 cross-sections were defined perpendicular to the channel centerline along the Blackmud and Whitemud Creek reaches, as shown in **Figure 3-1**. Elevation data applied to these cross-sections was a combination of the bathymetric survey and the provided LiDAR data.



A normal depth boundary condition was applied at the downstream reach of the model. This boundary is not affected by the 23rd Avenue bridge as previously mentioned. The normal depth was estimated for a slope of 0.004 m/m based on the bathymetric survey and the provided LiDAR data. The design flood events were applied as an upstream boundary condition (flow data) to the modelled creeks. These design flood events were based on the hydrology analysis discussed within **Section 2**.

There are very limited theoretical estimates that provide an approach to determine the Manning's roughness coefficients (Manning's N) within creeks and overbanks in Alberta. This coefficient is a function of several factors which include land use, depth of flow, channel sinuosity, vegetation type and maturity.

The typical Manning's N for the channel and overbanks were reviewed based on the following:

- Field observations on September 16, 2020.
- Previous studies on the Blackmud and Whitemud Creeks.
- United States Geographical Survey (USGS) Water- Supply Publication (1989).
- Open Channel Hydraulics, Chow, V.T (1959).

In previous studies, Associated Engineering (2017) applied a Manning's n of 0.035 and 0.1 for both creek channels and overbank areas, respectively. Northwest Hydraulic Consultants (NHC) (2014) applied a Manning's n of 0.029 and a range of 0.05 – 0.1 for the Blackmud Creek channel and overbank areas, respectively. NHC (2006) applied a Manning's n ranging from 0.03 – 0.065 for the Blackmud Creek channel and 0.03 – 0.15 for the overbank areas. A Manning's n of 0.040 and 0.15 was applied for the Whitemud Creek channel and overbank areas, respectively.

The Manning's Roughness Coefficients used for this assessment are provided in **Table 3-1**.

Table 3-1
Manning's Roughness Coefficients

Creek	Channel	Overbank
Blackmud	0.03	0.15
Whitemud	0.04	0.15

Note, these values were not calibrated and validated due to lack of hydrometric data at the project site. However, these values are consistent with other previous studies.

The model was simulated as a steady-state scenario using the above parameters and boundary conditions for the 2-year and 100-year design flood events.

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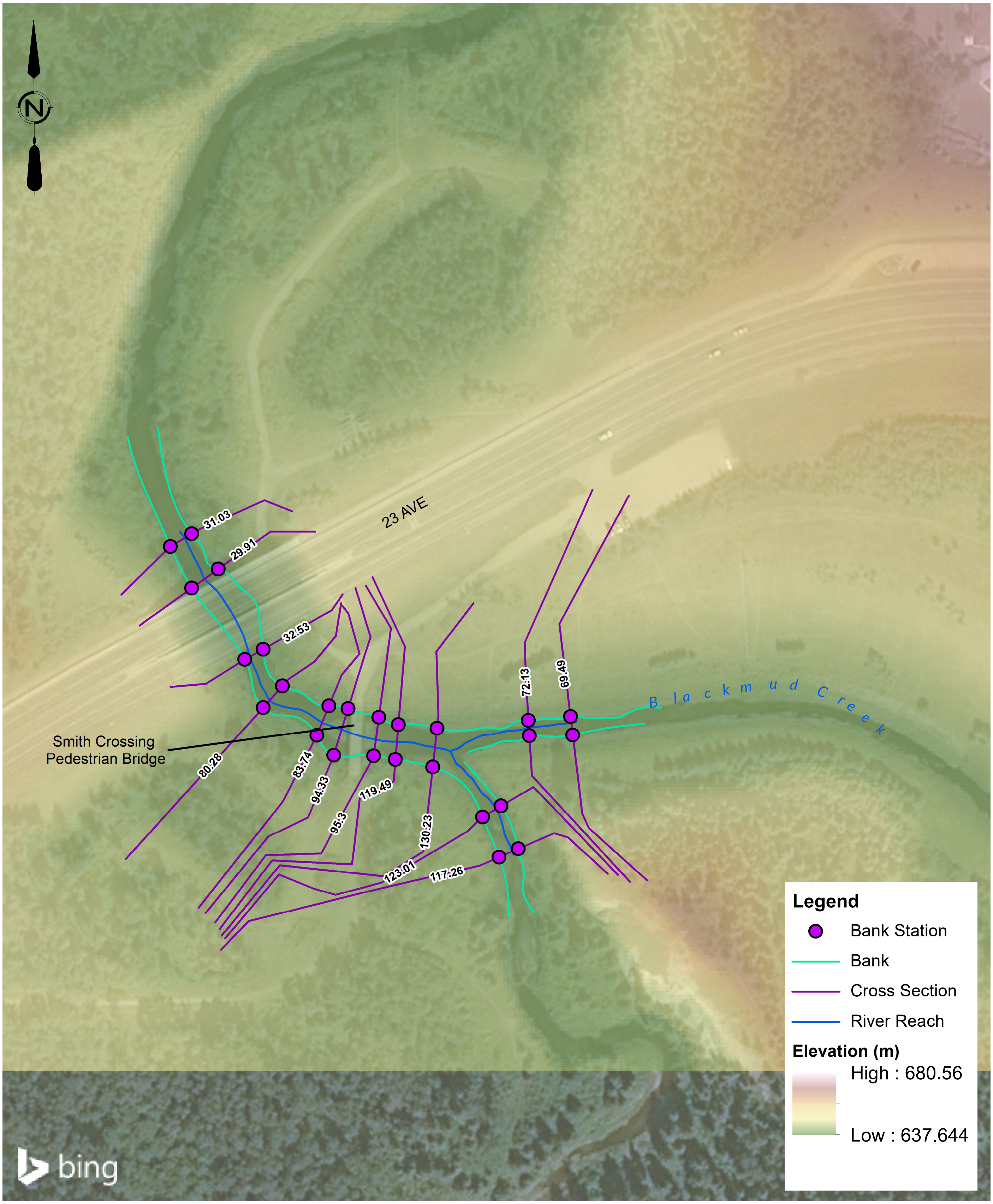

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FIGURE 3-1

SMITH CROSSING PEDESTRIAN BRIDGE

1D MODEL SETUP

3.2 2D – Model

The 2D numerical model was developed using the commercially available MIKE-21 Hydrodynamic (HD) software developed by Danish Hydraulic Institute (DHI). This software is widely used and contains 1D, 2D and three-dimensional (3D) modules for urban and rural environments. The MIKE-21 HD model has a variety of basic modules each simulating a particular phenomenon within a river system or overland flow. The MIKE-21 HD flexible mesh (FM) module was used to develop a fully distributed 2D numerical model during open water conditions for the project site.

The topography can be represented within the MIKE-21 HD FM module as a structured (quadrangular) element, unstructured (triangular) element or a combination of both. These elements are typically known as meshes. The 2D equations are solved from cell to cell within the mesh to simulate flow, water level, velocity, and other hydraulic parameters. In general, it provides a more detailed representation (distributed) of a model domain (model extent) and result outputs when compared to a 1D model (averaged). However, it requires a much longer computational time.

The developed 2D model encompasses the Blackmud and Whitemud Creeks approximately 100 m upstream of their confluence within the City of Edmonton and approximately 200 m downstream. The bathymetry/surface used within the 2D model was developed by combining the 1m LiDAR data and the bathymetric survey completed in November 2020.

The flexible element routine within MIKE 21 FM develops a combination of quadrangular and triangular elements in which the individual cell spacing is varied to better represent key features within the project area. The element sizes and arrangement affect the resolution of the final results and require a compromise between element resolution and computation times. This study used quadrangular elements within the developed model at a spacing of 1 m. **Figure 3-2** shows the 2D model domain and element routine used.

Spatially distributed roughness coefficients (Manning's n) were applied to the 2D topography as shown in **Figure 3-2**. Similar to the 1D model, channel roughness was assigned as 0.03 within Blackmud Creek and 0.04 within Whitemud Creek, with overbanks of 0.15.

Creek flows were applied as upstream boundary conditions. In addition, point source inflows representing City of Edmonton outfalls 295 and 296 were applied within the model. These point sources assume both outfalls are flowing full for the duration of model simulation. Creek and outfall flow inputs within the model are summarized in **Section 2**. The downstream boundary at the Whitemud Creek was assumed as a free outfall without any backwater effect.

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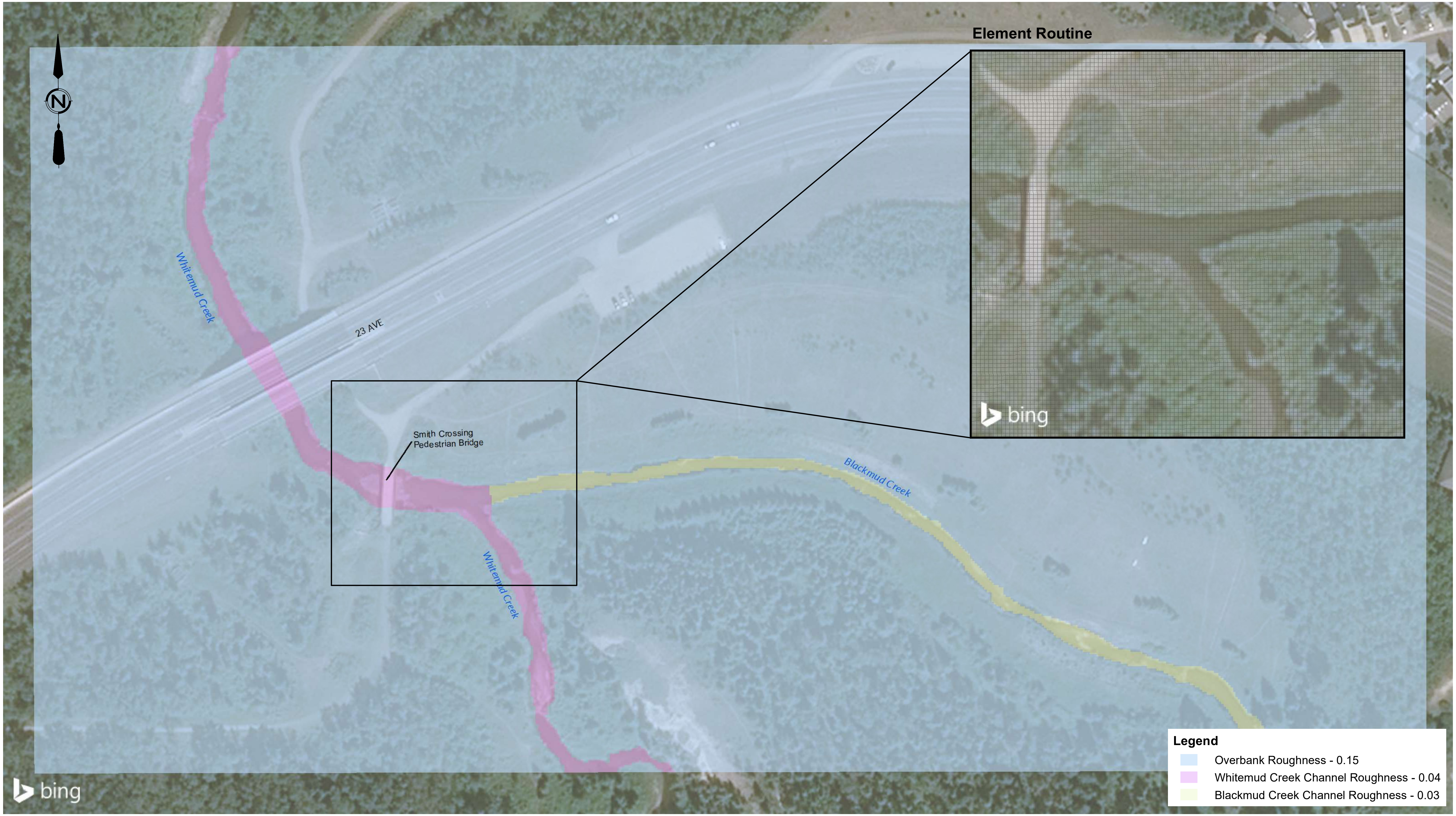

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FIGURE 3-2

SMITH CROSSING PEDESTRIAN BRIDGE

2D MODEL DOMAIN, ELEMENT ROUTINE AND SPATIALLY DISTRIBUTED ROUGHNESS COEFFICIENTS

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4 RESULTS AND DISCUSSION

The 1D and 2D models were simulated for two design flood events based on the peak flow analysis. The simulated design flood events were:

- 2-Year
- 100-Year

Results were not calibrated or validated due to lack of flow data at the project site. Calibration and validation should be considered if future data becomes available. However, the results from both model simulations were compared against each other to ensure values were similar using different computational engines.

4.1 Flood Depth and Extent

Figure 4-1 shows the maximum simulated water level at the cross section immediately upstream of the Smith Crossing Pedestrian Bridge from the 1D model during both design flood events.

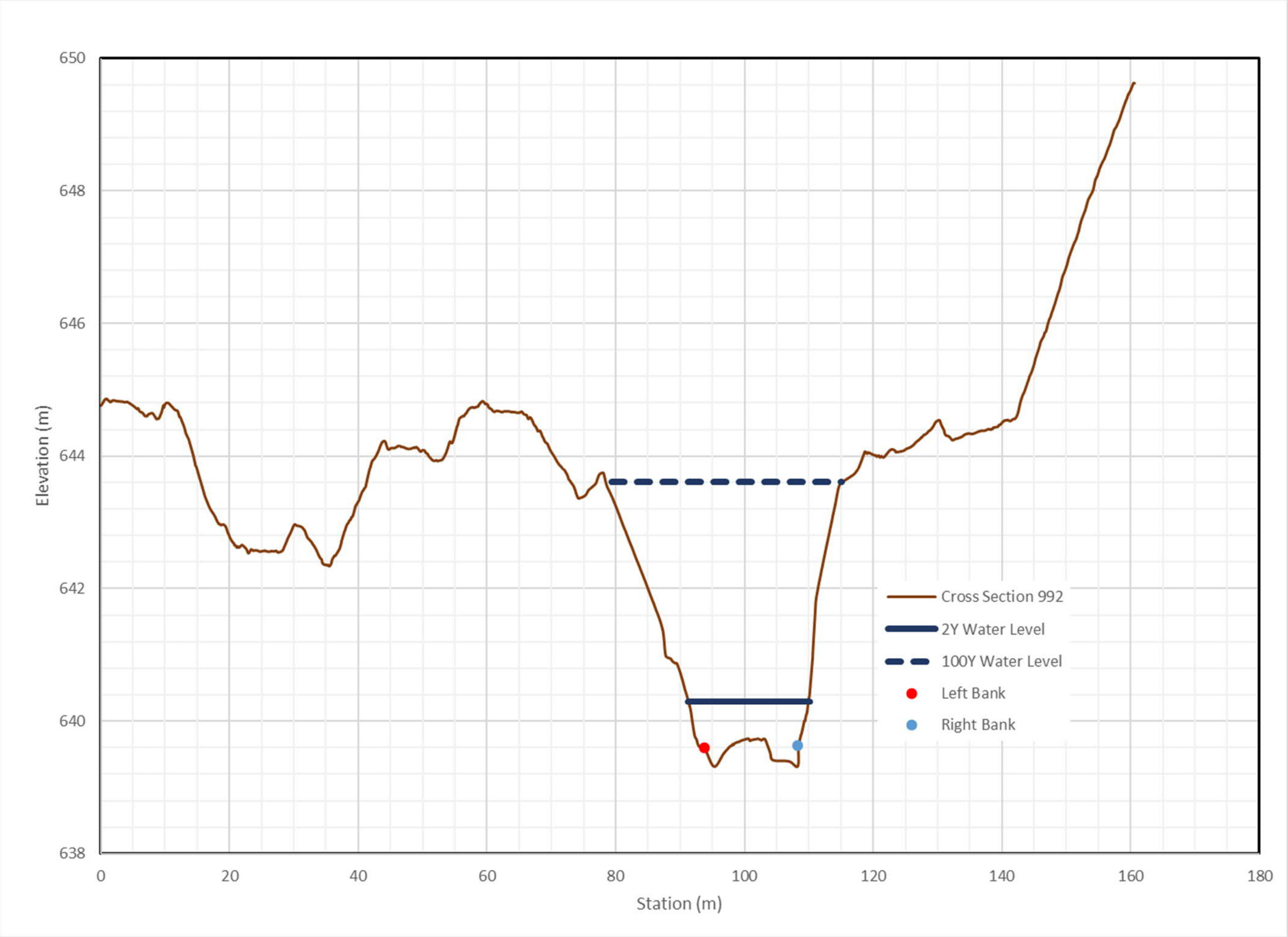

Figure 4-1
Simulated 1D Water Level Immediately Upstream of Bridge

Figures 4-2 and **4-3** show the maximum simulated flood depths and extents within the 2D model domain during each design flood event. The water level elevations at the Smith Crossing Pedestrian Bridge during each model simulation are summarized in **Table 4-1**.

The existing bridge soffit is at an elevation of approximately **642.5 m**.

Table 4-1
Simulated Water Level Elevation at Smith Crossing Pedestrian Bridge

Return Period	1D Simulated Water Level Elevation	2D Simulated Water Level Elevation
(years)	(m)	(m)
2	640.3	640.7
100	643.6	643.7

Results indicate that during the 100-year design flood event, the existing bridge soffit elevation is under water. High water levels have not significantly impacted the bridge during its lifespan. Therefore, the replacement pedestrian bridge bottom of soffit elevation should be located at or above the existing elevation.

The Blackmud and Whitemud Creeks are considered navigable at the project site; federal permits under the Canadian Navigable Waters Act will likely be based on the navigation envelope remaining largely unchanged. Therefore, clearance from the ordinary water level (2-year water level) to the bottom of the superstructure is expected to be similar to (or larger than) the original bridge. Note, the current bridge configuration provides a clear opening of 1.8 m in relation to the simulated 2-year water level.

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FIGURE 4-2

SMITH CROSSING PEDESTRIAN BRIDGE

SIMULATED 2D FLOOD EXTENT 2-YEAR DESIGN FLOOD EVENT

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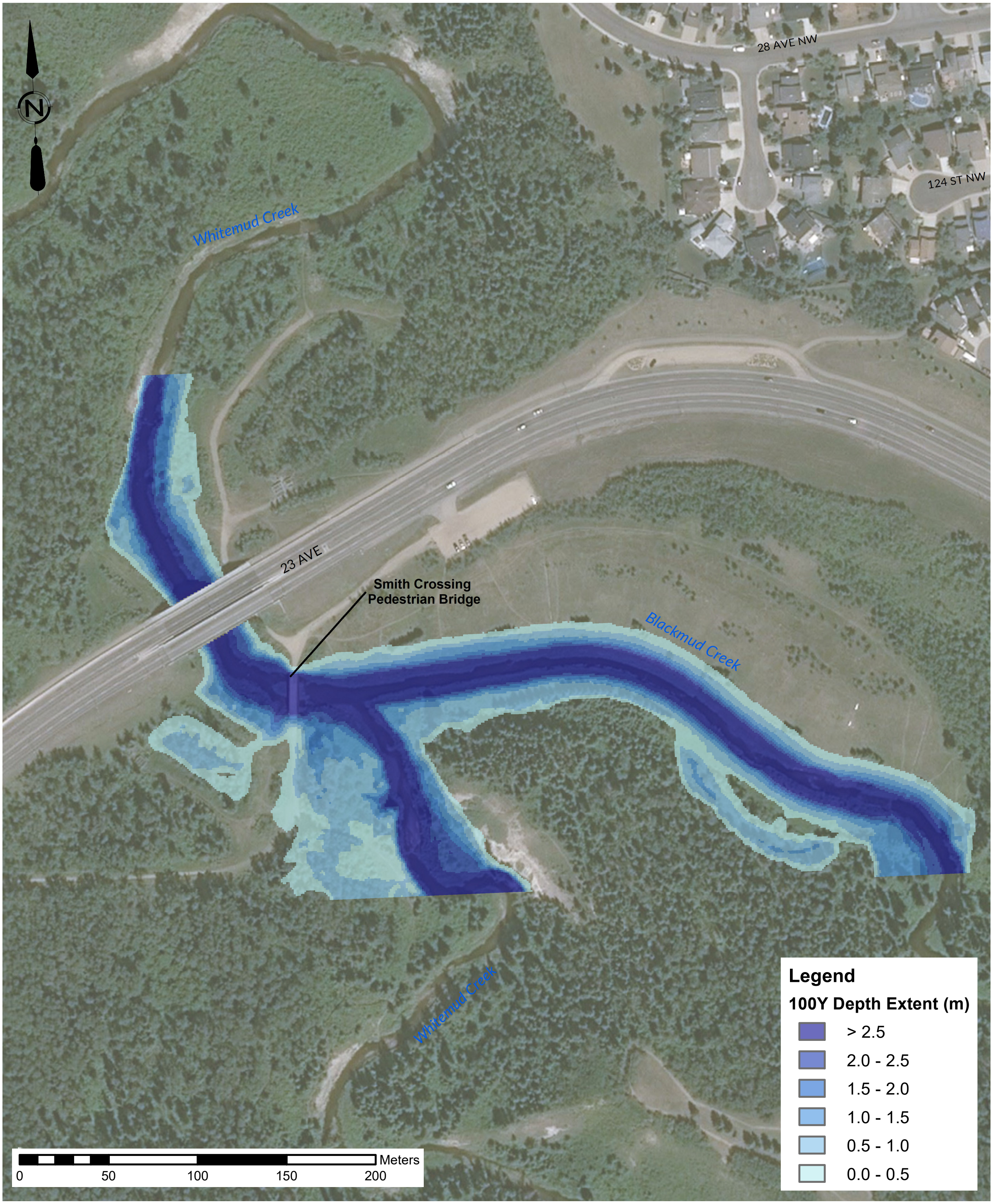

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FIGURE 4-3

SMITH CROSSING PEDESTRIAN BRIDGE

SIMULATED 2D FLOOD EXTENT 100-YEAR DESIGN FLOOD EVENT

4.2 Velocity

Figures 4-4 and 4-5 show the maximum simulated velocities within the 2D model domain during each design flood event. The average velocities through the Smith Crossing Pedestrian Bridge during each model simulation are summarized in Table 4-2.

Table 4-2
Simulated Average Velocity through Smith Crossing Pedestrian Bridge

Return Period	1D Simulated Average Velocity	2D Simulated Average Velocity
(years)	(m/s)	(m/s)
2	1.3	0.9
100	2.4	2.8

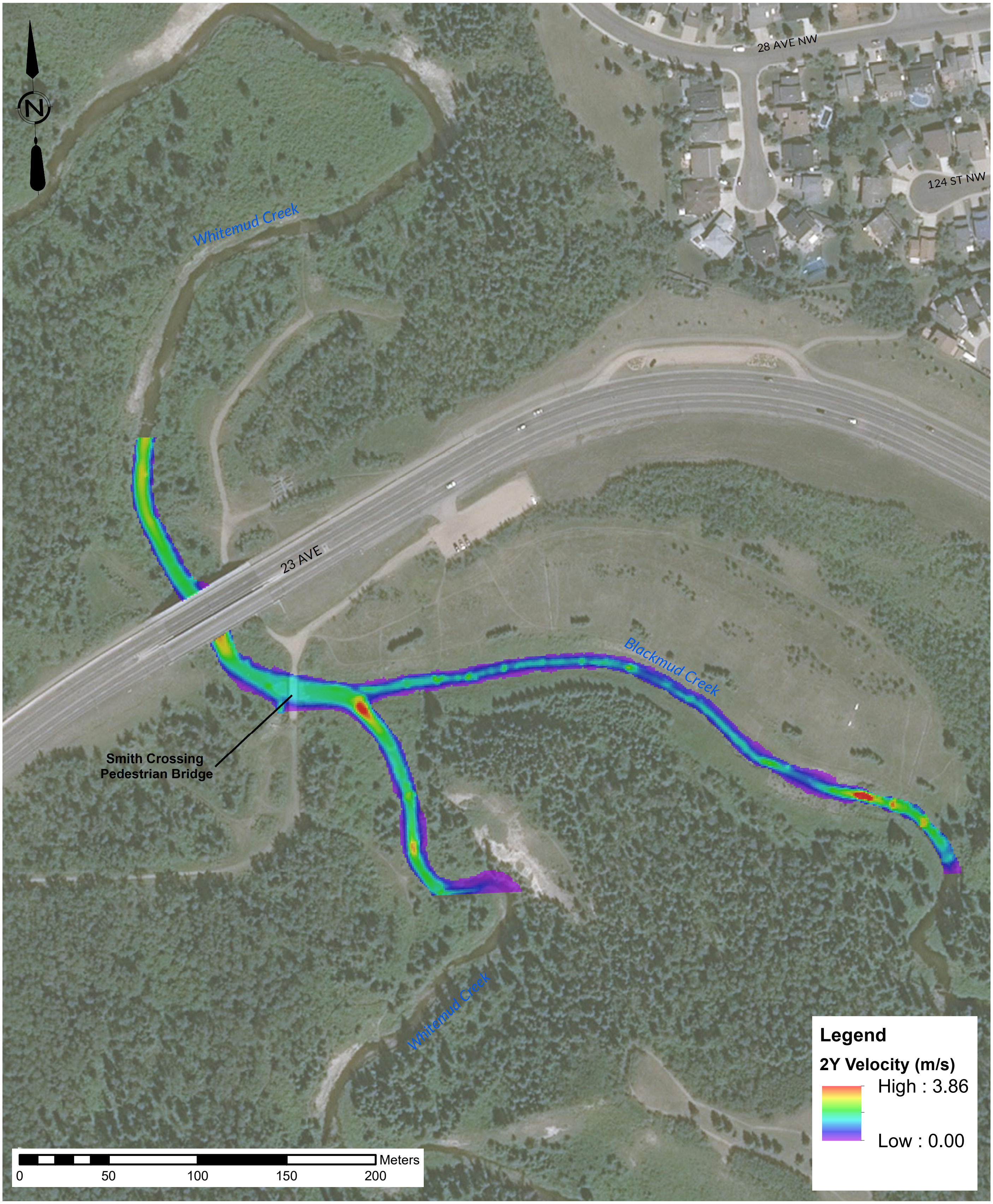
The velocities shown above differ between the 1D and 2D simulations. This is due to the 2D model calculations providing a more detailed representation (distributed) of velocities within the model domain when compared to the 1D (averaged) results, as previously stated.

The average velocity results from 2D simulation indicate that Class 2 riprap would be required to armour beneath the pedestrian bridge during a 100-year design flood event based on *Bridge Conceptual Design Guidelines Version 3.0* (Alberta Transportation, May 2020). The nominal diameter for Class 2 riprap is 0.5 m. Riprap classifications, sizes, and non-woven geotextile specifications are based on Alberta Transportation *Specifications for Bridge Construction* (2010). Temporary soil fencing should be installed around the site to prevent siltation and minimize impact to downstream waterbodies during installation.

According to the Alberta Environment and Parks (AEP) Codes of Practice Maps (2006), Whitemud Creek and Blackmud Creek are Class B and C water bodies, respectively, with a Restricted Activity Period (RAP) between April 16 and June 30. Proposed construction for bridge replacement should occur outside of the RAP.

In addition, proposed bridge replacements should avoid any constriction within the Whitemud Creek channel which would increase channel velocities.

IF NOT 25 mm ADJUST SCALES
25 mm
SCALE(S) SHOWN ARE INTENDED FOR LETTER (8.5x11) SIZE DRAWINGS UNLESS NOTED OTHERWISE



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DATA SOURCE: © 2020 Microsoft Corporation © 2020 Maxar ©CNES (2020) Distribution Airbus DS;

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BEST MANAGED COMPANIES
CANADA
Platinum member

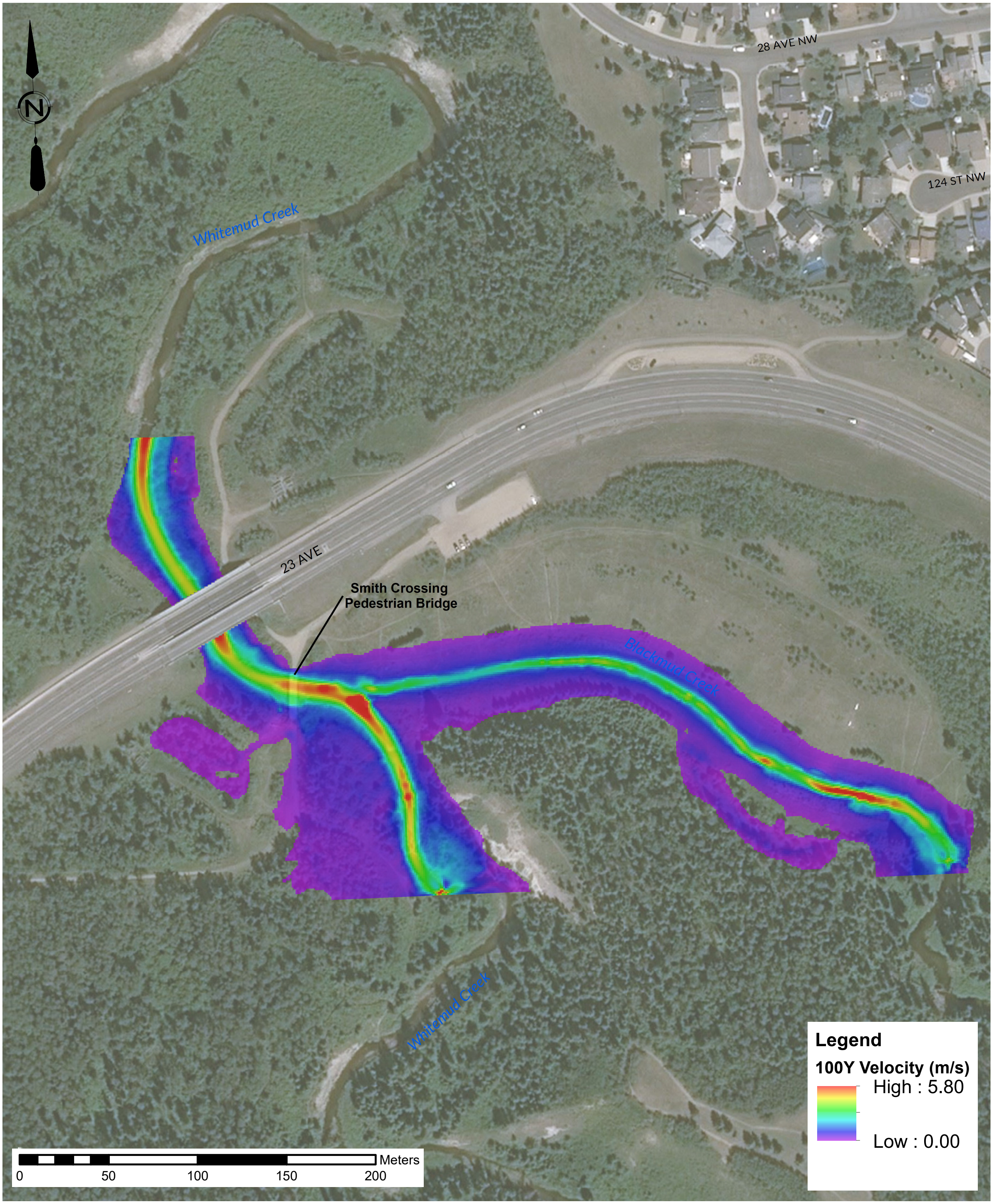
AE PROJECT No.	2020-8715
SCALE	1:3,000
APPROVED	
DATE	2021JAN12
REV	
DESCRIPTION	

FIGURE 4-4

SMITH CROSSING PEDESTRIAN BRIDGE

SIMULATED 2D VELOCITY EXTENT 2-YEAR
DESIGN FLOOD EVENT

IF NOT 25 mm ADJUST SCALES
25 mm
SCALE(S) SHOWN ARE INTENDED FOR LETTER (8.5x11) SIZE DRAWINGS UNLESS NOTED OTHERWISE



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DATA SOURCE: © 2020 Microsoft Corporation © 2020 Maxar ©CNES (2020) Distribution Airbus DS;

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BEST MANAGED COMPANIES
CANADA
Platinum member

AE PROJECT No.	2020-8715
SCALE	1:3,000
APPROVED	
DATE	2021JAN12
REV	
DESCRIPTION	

FIGURE 4-5

SMITH CROSSING PEDESTRIAN BRIDGE

SIMULATED 2D VELOCITY EXTENT 100-YEAR
DESIGN FLOOD EVENT

5 OTHER DESIGN CONSIDERATIONS

In addition to maximum water levels and channel velocities discussed above for the proposed Smith Crossing Pedestrian Bridge, the following sections describe other design considerations.

5.1 Erosion and Scour Potential

The 2-year design flood event is typically assumed to be the normal flow within the channel. Based on the simulated 2-year velocities and the site visit conducted in September 2020, the potential for erosion within the project site is minimal. However, erosion potential tends to increase with increasing flows. Therefore, erosion potential during the 100-year design flood event might be significant.

Natural channel degradation is expected to occur within the project site based on historical geomorphology, creek geometry, and soil conditions. Any potential for scour will occur at the toes of the abutments. However, this area is recommended to be protected with riprap based on the simulated velocities.

As stated above, Class 2 riprap will be required to armour the bridge abutments and their surroundings. We propose the following based on *Bridge Conceptual Design Guidelines* (Alberta Transportation, 2020):

- Extent of protection will extend to the high-water level with a double thickness launching apron at the toe.
- Apron length will be 4-5 times the maximum rock thickness.
- Extend armouring approximately 5 m upstream and downstream of the bridge:
  - Tie-in with the existing gabion baskets armouring along the Blackmud Creek channel right bank.
  - Tie-in with willow live staking downstream on right bank.
  - Tie-in with existing Outfall 296 riprap on left bank downstream.

Note that extensive work has recently been completed within the area, specifically at Outfalls 295 and 296. Therefore, no impacts to the recently completed works at the outfalls is proposed unless required due to the final bridge design configuration.

5.2 Ice Impacts

There is no historical documentation on ice properties and ice jams within the project area. In addition, there are no records of ice jams being a significant problem at the Smith Crossing Pedestrian Bridge. Therefore, this study did not assess water levels due to ice. However, ice impacts have not been a concern during the lifespan of the current bridge. It is recommended that the proposed bridge replacement be constructed with a similar bridge opening as existing conditions to withstand ice impacts.

5.3 Environmental Considerations

It is understood that there are fish present within the Blackmud and Whitemud Creeks based on AEP Codes of Practice. Therefore, fish passage assessment is required. The main purpose for assessing fish passage is to ensure that the average velocity through the crossing is less than or equal to the average velocity within the existing channel at a fish passage design flow. The proposed pedestrian bridge structure will consist of a single span bridge with no proposed channel modifications. Therefore, the average velocities will be unchanged and fish passage criteria should be maintained. Hydraulic model results support this conclusion. Proposed construction for bridge replacement should occur outside of the previously noted RAP.

As discussed in **Section 4.2**, Class 2 riprap is required at the proposed pedestrian bridge. However, the placement of riprap is not expected to change average velocities within the channels because no expansion or contraction phenomena will be created.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Following are the key findings of the assessment:

- The updated estimate of the 100-year design flood event is 67.9 m^3/s for Blackmud Creek and 91.5 m^3/s for Whitemud Creek at the WSC gauge sites.
- Recent flow data shows that the peak flows on the Blackmud and Whitemud Creeks upstream of the confluence consistently occur within a week of each other. Note, the peak flows on both creeks coincided on the same day in 2014. Therefore, adding the peak flows together to determine the flow estimate at the project site is a reasonable assumption.
- Associated Engineering developed both a one-dimensional (1D) and a two-dimensional (2D) numerical model for the Smith Crossing Pedestrian Bridge Hydrotechnical Analysis. Results were not calibrated or validated due to lack of flow data at the project site.
- Results indicate that the 100-year design flood water level is 643.7 m. The existing bridge soffit elevation is approximately 642.5 m. This indicates that the existing bridge would be under water during the 100-year design flood event.
- The average velocity resulting from the 2D simulation during a 100-year design flood event is 2.8 m/s. Based on the Alberta Transportation *Bridge Conceptual Design Guidelines Version 3.0*, Class 2 riprap would be required to armour beneath the pedestrian bridge.
- Whitemud Creek and Blackmud Creek are Class B and C water bodies, respectively, with a Restricted Activity Period (RAP) between April 16 and June 30.
- There is no historical documentation on ice properties and ice jams within the project area. Ice impacts have not been a concern during the lifespan of the current bridge.
- There are fish present within the Blackmud and Whitemud Creeks based on AEP Codes of Practice.

6.2 Recommendations

Following are the key recommendations of the assessment:

- The replacement pedestrian bridge bottom of soffit elevation should be located at or above the existing elevation.
- Class 2 riprap should be used to provide armouring at the replacement bridge.
- Proposed construction for bridge replacement should occur outside of the RAP.
- Proposed bridge replacements should avoid any constriction within the Whitemud Creek channel which would increase channel velocities.
- Erosion protection should extend to the high-water level with a double thickness launching apron at the toe.
- Launching apron length should be 4-5 times the maximum rock thickness.
- Armouring should extend approximately 5 m upstream and downstream of the bridge.
    - Tie-in with the existing gabion baskets armouring along the Blackmud Creek channel right bank.
    - Tie-in with willow live staking downstream on right bank.
    - Tie-in with existing Outfall 296 riprap on left bank downstream.
- No work should impact the recently completed works at the storm Outfalls 295 and 296.
- The proposed bridge replacement should be constructed with a similar bridge opening as existing conditions to withstand ice impacts.
- The proposed pedestrian bridge structure should consist of a single span bridge with no proposed channel modifications. Therefore, the average velocities will be unchanged and fish passage criteria should be maintained.

CLOSURE

This report was prepared for the Morrison Hershfield Ltd. to provide the hydrotechnical assessment for the Smith Crossing Pedestrian Bridge Replacement over Whitemud Creek.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

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Appendix F: Fisheries Resources Assessment (Kingfisher 2021)

Whitemud Creek - Smith Crossing

Fisheries Resources Assessment

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March 2021

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Appendices

1.0 INTRODUCTION

The City of Edmonton (the City) is planning to replace the existing Smith Crossing Pedestrian Bridge over Whitemud Creek near 23rd Ave (the Project). On behalf of the City, Spencer Environmental Services Ltd. (Spencer Environmental) has retained Kingfisher Aquatics Ltd. to complete a fisheries resources assessment of Whitemud Creek and prepare an fisheries impact assessment for the Project.

This report presents the results of the fisheries resources assessment of Whitemud Creek conducted on September 5, 2019. The scope of work for the fisheries assessment was developed to provide the City with sufficient fisheries information to satisfy the information requirements of Fisheries and Oceans Canada (DFO) and the Alberta Code of Practice for Watercourse Crossings (Alberta Government 2019). The primary objectives of the fisheries assessment are described below.

- Characterize the fisheries resources in Whitemud Creek within the vicinity of the Project.
- Assess the potential effects to fisheries resources that may occur as a result of the Project.
- Identify strategies to mitigate adverse effects to fisheries resources as a result of the Project.

2.0 PROJECT INFORMATION

2.1 SETTING

The Project is located on Whitemud Creek within the City of Edmonton approximately 8 km upstream from the confluence with the North Saskatchewan River. Blackmud Creek flows into Whitemud Creek approximately 200 m upstream from the Project. According to the Code of Practice St. Paul Management Area Map, Whitemud Creek is a mapped Class B waterbody (at the Project location) and is subject to a restricted activity period (RAP) that extends from April 16 to June 30 which is in place to protect walleye spawning habitat (AESRD 2012). Class B habitat is considered to be sensitive enough to be damaged by in-water activities (Alberta Environment 2001). Additional information regarding the Project and Whitemud Creek is provided in Table 1 and Figure 1.

Table 1. Project location and drainage information.

Site Location - NAD 83 UTM (Zn 12)	330934 E 5926247 N
ATS Location	SE 1-52-25 W4M
Natural Region[1]	Central Parkland
Drainage Basins	North Saskatchewan River
Length of drainage upstream to headwaters[2]	~ 95 km
Length of drainage downstream to the North Saskatchewan River[2]	~ 8 km
Strahler Order[3]	5

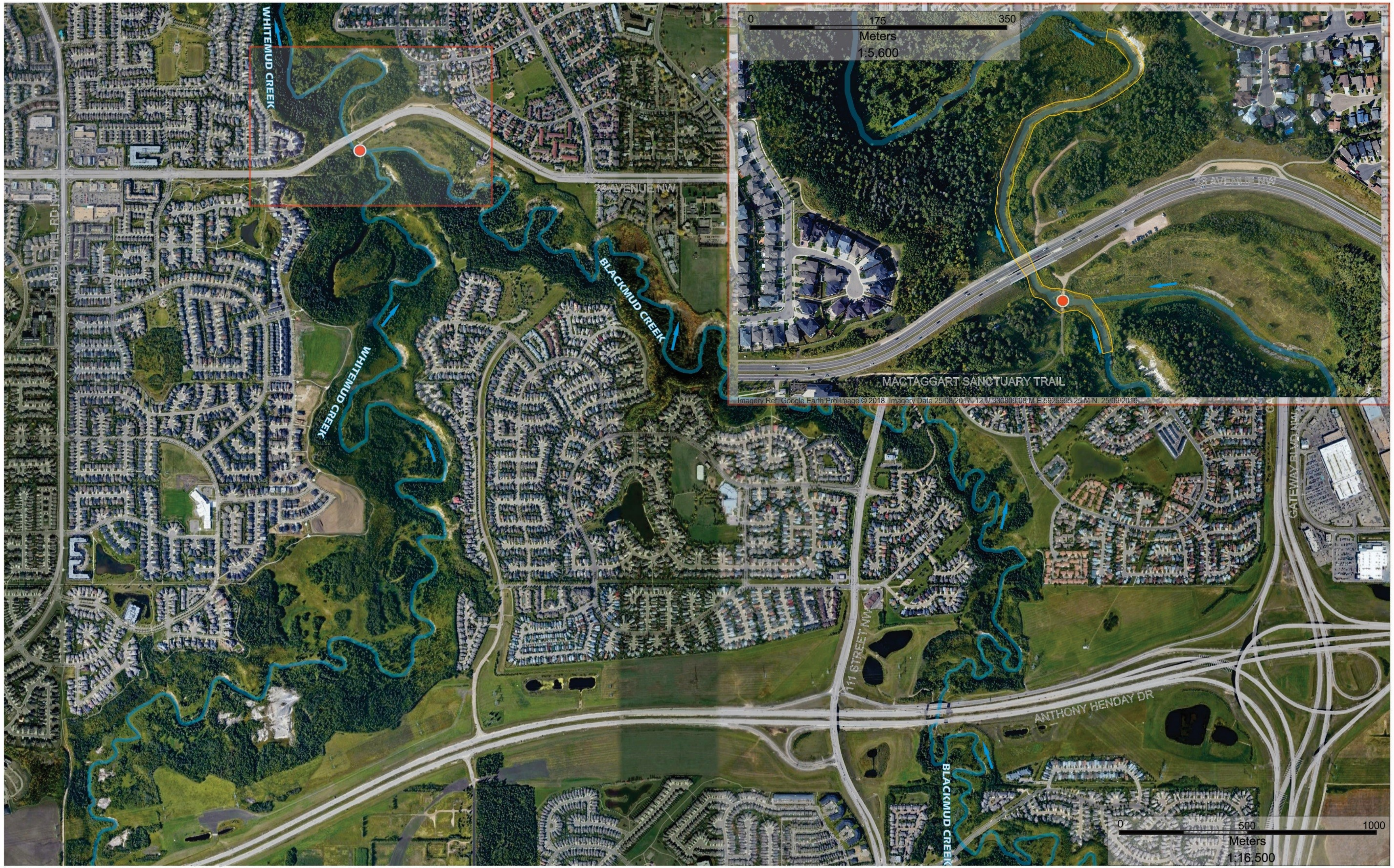
[1]Natural Regions Committee (2006)
[2]FWMIS (AEP 2020a)
[3]Strahler order as reported by FWMIS (AEP 2020a)

FIGURE 1.

Location Overview

LEGEND

- ▬ Watercourses
- ▬ Study Area
- ▬ Roads
- ● Pedestrian Bridge Crossing
- → Flow Direction



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Kingfisher Aquatics

2.2 PROJECT DESCRIPTION

The existing crossing structure is a single span (24.4m) steel pony truss bridge on mass cast-in-place concrete abutments with footings. Final design plans for the replacement structure are currently being prepared and construction is expected to begin in the fall of 2021, and end in the late spring or early summer of 2022. Preliminary project design information is presented in Appendix A.

The Project will involve the demolition and removal of the existing bridge deck, bridge abutment installation, riprap armouring, bridge superstructure erection, pathway regrading, and general landscape restoration. While there are four design options for the replacement superstructure, the substructure and in-water environmental footprint is comparable between options.

3.0 STUDY AREA

A 673 m long study area that extended from 541 m downstream of the crossing site to 132 m upstream of the crossing site was established on Whitemud Creek (Figure 1).

4.0 METHODS

4.1 FISHERIES INFORMATION REVIEW

The Fish and Wildlife Management Information System (FWMIS) was queried to identify historical fish sampling efforts in the Whitemud Creek drainage.

4.2 FIELD INVESTIGATIONS

Field investigations were conducted following Kingfisher's standard procedures for small to medium watercourse crossings (Appendix A). The procedures were developed to be consistent with the methods described in the Alberta Fish Habitat Manual (AT 2009), which were designed to meet the requirements of the Code of Practice for Watercourse Crossings (AEP 2019) as well as information requirements of Fisheries and Oceans Canada (DFO).

Field investigations were conducted on September 5, 2019. The investigations included:

- habitat inventory of a 673 m section of Whitemud Creek at and adjacent to the Project site;
- characterization of the channel profile at seven transects that were established on Whitemud Creek in the vicinity of proposed works; and
- in-situ sampling of select water chemistry variables (pH, temperature, dissolved oxygen, conductivity, and turbidity) at one location within Whitemud Creek.

4.3 DOCUMENTATION

Data collected during field investigations was recorded electronically on standardized forms. Field data and historical information was reviewed and analyzed to assess potential impacts to fisheries resources as a result of the Project. Potential impact pathways to fisheries resources were identified and potential effects were evaluated based on preliminary design information. Mitigation strategies were developed and assessed to determine the potential for residual impacts.

5.0 EXISTING CONDITIONS

5.1 FISH POPULATIONS

A query of the FWMIS database identified 20 different fish species that are known to inhabit Whitemud Creek (Table 2). Species previously captured from Whitemud Creek include several sport fish species, a variety of large-bodied non-sport species, and numerous forage fish species. None of the fish species previously captured from Whitemud Creek are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or under the Species at Risk Act (SARA) and all are considered to be either Secure, Undetermined, or Exotic under the Alberta Wildlife Act (SARA Public Registry 2021, AEP 2021).

Table 2. Status of fish species captured from Whitemud Creek[1].

Fish Species			**Status**		
Common Name	**Scientific Name**	**Species Code**	**Federal[2]**		**Provincial[3]**
			COSEWIC	**SARA**	**Wildlife Act**
Brook Stickleback	*Culaea inconstans*	BRST	No Listing	No Status	Secure
Burbot	*Lota lota*	BURB	No Listing	No Status	Secure
Emerald Shiner	*Notropis atherinoides*	EMSH	No Listing	No Status	Secure
Finescale Dace	*Phoxinus neogaeus*	FNDC	No Listing	No Status	Undetermined
Fathead Minnow	*Pimephales promelas*	FTMN	No Listing	No Status	Secure
Goldfish	*Carassius auratus*	GOFS	No Listing	No Status	Exotic/Alien
Lake Chub	*Couesius plumbeus*	LKCH	No Listing	No Status	Secure
Longnose Dace	*Rhinicthys cataractae*	LNDC	No Listing	No Status	Secure
Longnose Sucker	*Catostomus catostomus*	LNSC	No Listing	No Status	Secure
Mountain Sucker	*Catostomus platyrhynchus*	MNSC	Not at Risk	No Status	Secure
Northern Crayfish	*Oronectes virilis*	NOCY	No Listing	No Status	Not Listed
Northern Pike	*Esox lucius*	NRPK	No Listing	No Status	Secure
Peal Dace	*Semotilus margarita*	PRDC	No Listing	No Status	Undetermined
River Shiner	*Notropis blennius*	RVSH	No Listing	No Status	Undetermined
Spottail Shiner	*Notropis hudonius*	SPSH	No Listing	No Status	Secure
Threespine Stickleback	*Gasterosteus Aculeatus*	THST	No Listing	No Status	Exotic/Alien
Trout-perch	*Percopsis omiscomaycus*	TRPR	No Listing	No Status	Secure
Walleye	*Sander vitreus*	WALL	No Listing	No Status	Secure
White Sucker	*Catostomus commersoni*	WHSC	No Listing	No Status	Secure
Yellow Perch	*Perca flavescens*	YLPR	No Listing	No Status	Secure

1 FWMIS 2021 (AEP 2021a)
2 SARA Public Registry 2021
3 AEP 2021b

A summary of fish capture records from 2011 to 2019 for the 8 km reach of Whitemud Creek between the Project and the North Saskatchewan River is presented in Table 3. Lake chub, emerald shiner, and white sucker have accounted for almost 90% of all fish captured over that time period. Several other coarse and forage fish species have been captured somewhat routinely but in low numbers, while the 4 sport fish species known to utilize Whitemud Creek have been encountered relatively infrequently.

Table 3. Historic fish captures (from FWMIS) for the 8 km of Whitemud Creek between the Project and the North Saskatchewan River[1]

Species	Year									Total
	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Brook Stickleback	-	1	3	-	1	-	-	1	-	6
Burbot	1	-	1	-	-	1	-	-	4	7
Emerald Shiner	-	-	-	-	-	-	499	-	-	499
Finescale Dace	-	-	-	-	-	-	-	-	-	0
Fathead Minnow	-	-	1	1	2	-	-	1	1	6
Goldfish	-	-	-	-	4	-	-	-	-	4
Lake Chub	-	23	69	10	496	-	5	216	61	880
Longnose Dace	-	-	5	1	3	11	9	3	2	34
Longnose Sucker	6	-	12	-	2	-	14	11	-	45
Mountain Sucker	-	-	-	-	-	-	-	-	-	0
Northern Crayfish	12	-	6	-	-	-	-	24	-	42
Northern Pike	-	-	-	-	-	1	-	-	-	1
Peal Dace	65	6	-	-	-	1	7	-	-	79
River Shiner	-	-	-	-	-	-	-	-	-	0
Spottail Shiner	-	-	-	-	-	7	-	-	-	7
Threespine Stickleback	-	-	-	-	-	1	-	-	-	1
Trout-perch	-	-	10	-	-	9	4	1	3	27
Walleye	-	-	1	-	-	-	-	-	-	1
White Sucker	3	5	53	31	59	57	90	67	7	372
Yellow Perch	-	-	1	-	-	-	-	-	-	1

1 FWMIS 2021 (AEP 2021a)

AEP has designated three of the native sportfish species found within the watercourse (including burbot, northern pike, walleye) as higher management priority (priority ranking 1 to 3) according to fisheries management objectives set out for the North Saskatchewan River (ASRD 2008).

Burbot

Burbot typically lead a nocturnal, solitary life in the colder parts of large rivers, sheltering under rocks, weed beds, debris, and cut-banks during the day, and foraging at night (McPhail 1997). They are predominantly piscivorous, but they also eat insects, macro-invertebrates, and prey heavily on whitefish eggs in some systems (Nelson and Paetz 1992). The spawning season occurs from mid winter to early spring, often under ice (Nelson and Paetz 1992). In rivers, burbot spawn in low velocity areas in main channels, or in side channels behind depositional bars where water depths are less than 2 m (McPhail 1997). The preferred substrate in rivers appears to be fine gravel, sand, or even fine silt; eggs are broadcast into the water column above the streambed but eventually settle into interstices in the substrate (McPhail 1997).

Northern Pike

Northern pike prefer relatively shallow, vegetated, clear waters. They typically avoid high velocity habitat and seek out side channels, sloughs, and backwater areas in river systems. Northern pike are largely sedentary and territorial, only moving in and out of deeper water as needed during seasonal changes (Harvey 2009). Using an ambush style of hunting that relies on camouflage in aquatic vegetation, northern pike are predominantly piscivores, but will also eat invertebrates, crustaceans, and mammals such as muskrats and ducklings (Harvey 2009). They spawn in the early spring in shallow, marshy areas or flooded vegetation in shallow bays.

Walleye

Walleye are tolerant of a wide range of conditions. In rivers they are found most often in habitats with stable banks and cobble/fines or boulder/gravel substrates where the shoreline is uniform and water velocities are low and where instream cover is limited to roughness and overhead cover is provided by turbidity (Hartman 2009). Walleye feed mostly on fish and aquatic invertebrates (Nelson and Paetz 1992). Spawning occurs in early spring along cobble or gravel reefs with depths of 0.5 – 1.3 m. Water velocity at spawning sites can vary but are usually relatively swift. Walleye are broadcast spawners that release eggs into the water column where they fall to the bottom, adhere to the gravel, and sink into interstitial spaces (Scott and Crossman 1973).

5.2 FISH HABITAT

5.2.1 Habitat Inventory

A summary of habitat inventory results is presented in Appendix C and photographs depicting typical conditions at the time of assessment are presented in Appendix D.

Fish habitat within the study section consisted primarily of shallow (<0.5 m deep) run habitat. Moderate depth (0.5 m to 1.0 m deep) run habitat and riffle habitat were present in modest quantities, while deep (>1 m deep) run habitat and pools were relatively rare (Figure C-1, Appendix C). Fines and coarse substrates were present in similar quantities overall, with the coarse fraction composed of comparable proportions of gravel, cobbles, and boulders. The streambanks within the study section were composed almost entirely of fine materials. In general, the riparian area was well vegetated with a mixture of grasses, shrubs, and trees; however, some erosion and a lack of vegetation was noted along the outside of several channel meanders. Cover for fish was relatively sparse within the study section overall. Overhanging vegetation, woody debris, and overhanging banks were the most prevalent forms of cover while boulders and aquatic vegetation afforded limited cover opportunities. In general, there was minimal cover for larger-bodied fish due to the lack of deep-water habitat.

5.2.2 Streambank and Channel Characteristics

Whitemud Creek within the study area was generally confined within a neutral channel with an irregular meander pattern and could best be described as a Rosgen (1994) Type E channel. The mean wetted width over the 7 transects was 10.6 m while the mean channel width was 13.0 m. Water depths varied considerably between transects and averaged approximately 0.4 m at the crossing site. The streambanks were composed of fine materials at almost all transects, while streambed substrates were composed of a mixture of fine materials, gravels, cobbles, and boulders. The streambanks were well vegetated with a mixture of grasses and shrubs and were generally stable; however, some localized erosion and bank slumping was evident at certain locations. A record of the streambank and channel measurements obtained at the transects is provided in Table 4.

Table 4. Streambank and channel information for Whitemud Creek adjacent to the crossing site.

Location	**Transect Number**		1	2	3	4	5	6	7
	Distance from Crossing (m)		-25	-15	-5	0	5	15	25
Left Upstream Bank	**Bank Height** (m)		0.55	0.63	0.46	0.58	0.82	0.95	0.75
	Bank Angle (°)		50	70	90	80	50	70	60
	Bank Cover		OV	OV	OV	None	OV	OB	OB
	Riparian Vegetation		GR	SH	GR	GR	GR	SH	SH
	Bank Stability		S	S	S	S	S	S	S
	Undercut Measurement (m)		0	0	0.06	0	0	0.16	0.22
	Bank Substrate		Fn	Fn	Fn	Fn	Fn	Fn	Fn
Right Upstream Bank	**Bank Height** (m)		0.33	0.7	0.56	0.54	0.4	0.8	0.5
	Bank Angle (°)		75	90	90	45	80	80	80
	Bank Cover		OV	OB	OB	OB	OB	OV	OV
	Riparian Vegetation		GR	SH	SH	GR	GR	SH	GR
	Bank Stability		S	S	S	S	S	S	S
	Undercut Measurement (m)		0	0.35	0.25	0.43	0.17	0	0
	Bank Substrate		Fn	Fn	Fn	Fn	Fn	Fn	Bl
Channel	**Habitat Type at Transect**		R1	R2	RF	R3	R1	R2	R1
	Streambed Substrate	Dominant	Fn	Fn	Gr	Gr	Cb	Fn	Bl
		Subdominant	Gr	Gr	Cb	Cb	Bl	Gr	Cb
	Instream Cover		None	None	WD	WD	BL	WD	BL
	Wetted Width (m)		13	13	15	13	13	11	12
	Bankfull Width (m)		14	14	15	20	14	13	14
	Depths (m)	left	0.84	0.12	0.26	0.48	0.44	0.85	0.85
		centre	1.3	0.54	0.34	0.27	1.05	0.82	0.9
		right	0.58	0.31	0.23	0.29	0.55	0.62	1.1

5.2.3 Water Quality and Stream Discharge

In situ water quality and stream discharge was measured at a single location within the study section. Results of the analysis are provided in Table 5.

Table 5. In situ water chemistry and stream discharge for Whitemud Creek.

Dissolved Oxygen (mg/L)	**pH**	**Turbidity** (NTU)	**Temperature** (^{O}C)	**Specific Conductivity** (µS/cm)	**Discharge (m3/s)**
9.62	8.17	12.78	17.1@ 13:20	917	0.235

6.0 DISCUSSION

Whitemud Creek is known to support a number of sport and non-sport fish species. Historical fish capture data suggests that several non-sport species utilize the habitat on a year-round basis while sport fish presence is likely seasonal. Habitat within the study section was relatively diverse, although the amount of deep water (>1m) was limited and there was minimal cover that was suitable for larger-bodied fish. In addition, optimal spawning habitat for burbot, northern pike, or walleye was not identified within the study section. Overall, the capability of the fish habitat within the study section was judged to be moderate as described in Table 6.

Table 6. Analysis of fish habitat capability of Whitemud Creek in the vicinity of the Project.

Evaluation		**Rationale**	**Overall Capability**
Criteria	**Ranking**		
Sensitivity	Low	Habitat is primarily utilized by forage and coarse fish species but may support certain sport fish species on a seasonal basis.	Moderate
Utility	Moderate	Habitat is important but not critical for survival of species. ➢ Habitat in the study section is expected to be utilized by a number of forage and coarse fish species for a range of life cycle phases. ➢ Regular use of the study section by sport fish species is not expected; however, walleye spawning habitat may be present downstream of the study area.	
Rarity	Moderate	➢ Habitat within the study section appears to be common and widely available within Whitemud Creek but is relatively unique within the portion of NSR watershed that is within the City of Edmonton.	

7.0 POTENTIAL IMPACTS AND MITIGATION

7.1 POTENTIAL IMPACTS

Assessment of potential impacts to fisheries resources associated with the proposed Project was based on:

- review of preliminary project plans (Appendix A);
- existing conditions and fish habitat capability; and
- review of the DFO Pathway of Effects Diagrams.

Potential impact pathways identified for the proposed project are presented in Table 7.

Table 7. Analysis of potential effects to fisheries resources associated with the Project.

Impact Pathway		Potential Effect	
Category	**Potential Source**	**Description**	**Analysis**
Release of sediment	➢ Clearing of riparian area(s) ➢ Installation/removal of isolation works ➢ General earthworks	➢ Alteration of potential fish habitat due to deposition of sediment ➢ Decreased food production due to deposition of sediment ➢ Reduced fish health and/or increased fish mortality due to suspended sediment	Possible negative effects due to: ➢ Instream works associated with the in-channel placement of material ➢ Instream works associated with installation/removal of isolation works Possible positive effects due to: ➢ Stabilization and revegetation of the eroded bank
Release of deleterious substances	➢ Operation of heavy equipment near water ➢ Construction processes (i.e. pouring concrete)	➢ Reduced fish health and/or increased fish mortality	Possible negative effect due to: ➢ Instream and riparian works will require heavy equipment to be in close proximity to the watercourse
Invasive Species/Disease	➢ In-water construction activities using contaminated equipment	The spread of invasive species and/or disease can result from: ➢ Bringing contaminated machinery or materials on site ➢ Not disposing of contaminated materials appropriately	Possible negative effect due to: ➢ Instream and riparian works will require equipment to be in close proximity to the watercourse
Entrapment, impingement, entrainment of fish	➢ Installation of isolation works ➢ Dewatering/water management with pumps	➢ Fish mortality can occur when fish become stranded in isolation areas ➢ Fish mortality can occur when fish become impinged on screens or entrained in pumps when isolated areas are dewatered	Possible negative effect due to: ➢ Installation of isolation works to facilitate placement of bank material and riprap ➢ Dewatering and flow management operations that may be required to complete the Project
At Risk Species	➢ In-water construction activities	➢ Instream work can adversely affect species that are *At Risk* or *Threatened* under Provincial and/or Federal legislation	Not expected: ➢ No *At Risk* or *Threatened* species are found in Whitemud Creek
Change in access to fish habitat	➢ Installation of isolation works	➢ Isolation works can temporarily impede fish movements if structures completely block or excessively constrict the channel width	Possible negative effect due to: ➢ Installation of isolation works to facilitate in-channel activities
Alteration or destruction of potential habitat	➢ Bank stabilization works ➢ Temporary isolation works	➢ The amount and/or quality of available habitat can be permanently reduced if the bank stabilization and armouring results in a physical habitat footprint	Neutral effect due to: ➢ Upslope riprap under the bridge will be confined to areas that have limited riparian value (i.e. lack vegetation and/or are denuded). ➢ Upslope riprap adjacent to the bridge will be covered with fill and revegetated as part of the bioengineered riverbank protection. ➢ In-water (below 1:2 year high water mark) riprap placed along the RUB (for 10 m) and LUB (for 15 m) will result in a change in substrate composition (from being dominated by fines to being dominated by large cobbles and boulders)

7.2 MITIGATION AND QAES SPECIFICATIONS AND RECOMMENDATIONS

Potential impacts to fisheries resources as a result of the Project can be mitigated through implementation of best management practices (BMP's) and specific management/protection plans described below. These mitigation measures were developed based on the preliminary design information provided in Appendix A; additional mitigation may be required depending on final design plans and construction methodologies for the Project.

7.2.1 Design Measures

Morrison Hershfield has incorporated several mitigation measures into the Project design. Design measures that will assist in mitigating potential impacts to fisheries resources include:

- The new abutments will be located behind the existing abutments (which will partially remain in place to minimize disturbances to the streambanks), and will be constructed above the average high-water mark.
- A landscaping restoration plan that will include bioengineered streambank protection techniques (i.e. incorporation of willow cuttings and other plants into riprap) will be implemented.

7.2.2 General Measures

Standard BMP's described below should be implemented during construction as deemed necessary depending on Project details and local conditions:

- Clearing of riparian vegetation should be kept to a minimum.
- The duration and intensity of instream work should be kept to a minimum.
- Minimize the removal of natural woody debris, rocks, sand or other materials from the banks, or the bed of the watercourse below the ordinary high-water mark.
- Immediately stabilize banks disturbed by any activity associated with the Project to prevent erosion and/or sedimentation, preferably through re-vegetation with native species suitable for the site.
- Restore bed and banks of the waterbody to their original contour and gradient. Where original bank form can not be restored due to instability, establish a new gradient that maintains bank stability and does not encroach on fish habitat.
- All construction materials should be removed from the site upon Project completion.
- Implement mitigation measures described in DFO's measures to protect fish and fish habitat (DFO 2019).

7.2.3 Erosion and Sediment Control

- Minimize disturbances to streambanks and riparian vegetation.
- Ensure that an erosion and sediment control plan is developed, implemented, and maintained for the duration of the Project.
- BMP's outlined in the City of Edmonton's Erosion and Sediment Control guidelines (2005a) and manual (2005b) should be implemented as required based on site conditions.

7.2.4 Management of Contaminants

- Ensure that machinery arrives on site in a clean condition and is maintained free of fluid leaks, invasive species and noxious weeds.
- Wash, refuel, and service machinery and store fuel and other materials for the machinery in such a way as to prevent any deleterious substances from entering the water.
- Develop a spill response plan to be implemented immediately in the event of a spill and keep an emergency spill kit on site and accessible at all times.

7.2.5 Decontamination Protocols

- The Project is located in the White Zone of the Province (low risk for whirling disease; AEP 2021d). Care should be given to equipment that has come in contact with other waterbodies in the Alberta Environment and Parks Red and Yellow Decontamination Risk Zones (AEP 2021d).
- All machinery should arrive on site in a clean condition, free of invasive aquatic species, dirt, and noxious weeds. The Contractor's ECO Plan should address Alberta Environment and Parks (AEP 2021c) *Decontamination Protocols for Work in or Near Water* (https://www.alberta.ca/stop-whirling-disease.aspx).
- Construction equipment shall be decontaminated following the *Decontamination Instructions for Industrial and Construction Operations* (https://open.alberta.ca/publications/decontamination-instructions-for-industrial-and-construction-operations#summary).
- Non-construction related equipment should be decontaminated following the Decontamination Protocol at the Stop the Spread of Whirling Disease website (https://www.alberta.ca/stop-whirling-disease.aspx).
- All decontamination efforts should be documented and tracked by completing the decontamination record template found in the Decontamination Protocol. (https://open.alberta.ca/publications/decontamination-instructions-for-industrial-and-construction-operations#summary).

7.2.6 Scheduling of Works

- Instream construction should be scheduled to avoid periods of high precipitation and high stream flows. If possible, construction should be completed during a low water period (i.e. winter) when the eroded area is above the surface water elevation (i.e. not instream).
- Instream construction should be completed outside of the RAP, which extends from April 16 to June 30th (AESRD 2012).
- Isolation works that block more than 2/3 of the channel width have the potential to restrict fish migration and should not be left in place for more than 14 consecutive days without implementing alternative measures to accommodate fish passage.

7.2.7 Fish Capture and Release

- In the event that construction activities result in the potential entrapment of fish, a QAES should be retained to complete the following:
    - Prepare a fish capture and release (FC&R) plan.
    - Obtain a Fish Rescue Research Licence from Alberta Environment and Parks.
    - Conduct FC&R operations whereby stranded fish are captured from within isolated areas and relocated to an appropriate release location within Whitemud Creek.

7.2.8 Instream Isolation

- Instream construction activities should be isolated from the flowing waters of the waterbody to prevent the mobilization of the sediment into the watercourse and to prevent other deleterious substances from entering the waterbody.
- Instream isolation(s) should be constructed of non-erodible materials that will remain functional throughout duration of instream activities and can be fully removed once instream activities have been completed.
- Instream isolation(s) should adhere to the schedules defined in Section 7.2.6.
- All isolations should be installed and removed in a manner than complies with DFO's *Interim code of practice: Temporary cofferdams and diversion channels* (http://www.dfo-mpo.gc.ca/pnw-ppe/codes/cofferdams-batardeaux-eng.html).
- Water pumped out of an isolated construction area should not be pumped directly into a waterbody. Water should be dewatered into a well-vegetated area in a manner that will not result in erosion, or into a settling tank/pond or geotextile bag to ensure water returning to the watercourse is of equal or better quality than that of water within receiving waterbody.
- When removing isolation works:
    - All construction debris, equipment and non-native streambed material must be removed prior to reintroducing water to the isolated area.
    - All isolation materials must be fully removed from the waterbody.

7.2.9 End-of-Pipe Fish Screens

- If pumping from fish bearing waters is required, all intakes should be screened in accordance with DFO's *Interim code of practice: end-of-pipe fish protection screens for small water intakes in freshwater* (https://www.dfo-mpo.gc.ca/pnw-ppe/codes/screen-ecran-eng.html).

7.2.10 Turbidity Monitoring

- A turbidity monitoring program should be implemented when instream work is being conducted. At a minimum the monitoring program should incorporate the following:
    - An independent QAES should be retained to develop and implement the program.
    - An equation that explains the relationship between turbidity and total suspended solids (TSS) should be developed prior to initiating instream works.
    - The program should outline frequency of monitoring during specific phases of the project.
    - The program should define sample sites and exceedance criteria.
    - The program should define response actions and protocols in the event that an exceedance occurs.

7.3 RESIDUAL EFFECTS

Potential impacts to fisheries resources due to the Project can be mitigated through implementation of the established BMP's and specific management/protection plans described in Section 7.2. A summary of the potential effects assessment, including an evaluation of the potential for the Project to result in adverse residual effects on fisheries resources in provided in Table 8.

Table 8. Description of potential impacts, mitigation, and residual impacts.

Impact Category	Mitigation	Potential for Residual Effects
Release of Sediment	➢ Implement general mitigation measures ➢ Implement erosion and sediment control measures ➢ Implement contaminant control measures ➢ Implement monitoring	Not expected
Release of Deleterious substances	➢ Implement general mitigation measures ➢ Implement contaminant control measures ➢ Implement monitoring	Not expected
Invasive Species/Disease	➢ Implement decontamination protocols as required	Not expected
Fish entrapment, entrainment, impingement	➢ Implement general mitigation measures ➢ Adhere to recommended schedules	Not expected
Change in access to fish habitat	➢ Implement general mitigation measures ➢ Adhere to recommended schedules	Not expected
Alteration or destruction of potential habitat	➢ Implement design measures ➢ Implement general mitigation measures ➢ Implement erosion and sediment control measures ➢ Implement contaminant control measures ➢ Implement monitoring ➢ Adhere to recommended schedules	Not expected

7.4 DFO REQUEST FOR REVIEW

In Canada, projects that will likely result in the death of fish and/or the harmful alteration, disruption, or destruction (HADD) of fish habitat must obtain an authorization from the Minister of Fisheries, Oceans and the Canadian Coast Guard as per the Canadian *Fisheries Act Regulations*.

As described in Table 8, residual effects to fisheries resources are not expected to occur as a result of the Project assuming that it proceeds as described in Section 2.2 and Appendix A, and provided that all mitigation measures outlined in Section 7.2 are implemented. Based on this analysis, the Project is considered unlikely to result in the death of fish and/or HADD of fish habitat. However, since the Project will involve instream work on a fish-bearing waterbody, it is recommended that a Request for Review form be submitted to DFO.

8.0 CLOSURE

We trust that the information presented in this report meets your requirements. If you have any questions or comments, please contact the undersigned.

Kingfisher Aquatics Ltd.

Sean Heap

Sean Heap, P. Biol.
Fisheries Biologist
Project Biologist

Erik Stemo, P.Biol.
Senior Fisheries Biologist
Project Manager

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Appendix A

Project Design Plans

MEMORANDUM

MORRISON HERSHFIELD

TO: City of Edmonton
Satya Gadidasu / Ahsan Karim

FROM: Donna Chen
Andrew Neilson

CC: Spencer Environmental - Andra Bismanis

PROJECT No.: 201932500

RE: Smith Crossing Pedestrian Bridge Replacement Project – Memo Accompanying Regulatory Application (DRAFT)

DATE: 2/3/2021

X:\PROJ\2020\201932500-PB5-SMITH CROSSING BRIDGE REPLACEME\08. WORKING\04 REPORTS (WORKING COPIES)\ENVIRONMENTAL PERMITTING\21-02-03 - MEMO - SMITH CROSSING - ENVIRONMENTAL PERMITTING MEMO - ISSUED.DOCX

Introduction / Purpose

For the Smith Crossing Pedestrian Bridge Replacement Project, the City of Edmonton (the City) has requested Spencer Environmental Ltd. (Spencer) to prepare and submit the municipal, provincial and federal environmental permitting and regulatory approvals applications. As the Prime Consultant for this bridge replacement project, Morrison Hershfield Limited (MH) has been tasked with providing drawings as well as this summary memo to support the environmental permitting and approvals process.

Project Details

The existing Smith Crossing bridge is a steel pony truss structure, over 100 years old, supported on concrete abutments and is in need of replacement. Based on existing site conditions and hydrotechnical / geotechnical / environmental assessment findings, the following adjustments are recommended for proposed replacement bridge.

- Increase in overall span length, with new abutments located behind the location of the existing abutments
- Increase in bridge soffit elevation, to meet 1-in-100 peak flood event. No freeboard will be provided, confirmed with the City following design discussions.
- Headslope slope stability and erosion improvement with provision of Class II riprap and toe thickening at the north abutment.

The scope of work includes:

- Excavation and backfilling;
- Demolition and removal of existing bridge;
- Bridge abutment installation including foundations, rip-rap armouring of upstream and downstream riverbanks;
- Bridge superstructure erection;

- Approach pathway regrading; and,
- Miscellaneous trail amenities modifications (public information panels, seating areas), and landscape restoration.

Permitting Requirements Summary

A summary of the identified permitting requirements is shown in Table 1

Table 1: Permitting Requirements for Smith Crossing Pedestrian Bridge Replacement

Act	Permit/Approval	Regulatory Trigger	Approximate Approval Timeline	Status
Fisheries Act	DFO Project Review	Work below the high water mark of a fish-bearing creek including work in water (i.e., replacement of the north abutment). Work in isolation of flowing water (e.g., coffer dam).	16 weeks / 4 months	Spencer preparing submission.
Bylaw 7188	Environmental Impact Assessment Approval	Completed by others; Approval from City Planning expected to be in place for the bridge.	6 months	Spencer preparing submission.
Water Act **Code of Practice for Watercourse Crossings**	Code of Practice Notification	Work in a mapped and coded watercourse, within the active channel. Work in isolation of flowing water (e.g., coffer dam). Supplement: Qualified Aquatic Environment Specialist (QAES) recommendations.	2 weeks	Spencer preparing submission.
Canadian Navigable Waters Act	Approval	Owner must apply for an approval for a major work (i.e., bridge) in any navigable water if the work interferes with navigation. If the City has an existing Approval under the old *Navigable Waters Act* or *Navigation Protection Act*, it can likely be amended.	16 weeks/ 4 months	Spencer preparing submission.
Historical Resources Act	Approval	Work in an area with a historical resources value listing.	3 months	Spencer preparing submission.
Public Lands Act	Disposition	Work within the bed and shore of a permanent (Crown-claimed) watercourse. Abutment removal and other toe of bank work will require a Disposition.	8 - 10 months (may potentially be reduced to 4 – 6 months)	Spencer preparing submission
Fisheries (Alberta) Act*	Fish Research Licence	Contractor's Delegated Environmental Consultant to conduct Fish Salvage during construction, as appropriate. Permit required prior to fish salvage during construction; to be included in Tender Documents / Special Provisions.	2 weeks	

Proposed Work Description

The proposed work and schedule are shown in Table 2. In general, the means and methods of construction are conventional, and Environmental Best Management Practices are expected to be sufficient to mitigate environmental impacts.

Table 2: Proposed Work and Schedule

Schedule	Item	Description
Fall 2021	1	Mobilization
Fall 2021	2	Remove Existing Bridge Superstructure
Fall 2021	3	Construct Temporary Isolation / Retaining Walls and Remove Existing Substructure
Winter 2021	4	Construct New Substructure (Cast-in-Place Steel Case Piles with Cast-in-Place Concrete Abutments) and Embankment Works
Winter 2021 / Spring 2022	5	Erect new bridge superstructure
Spring 2022	6	Approach Work, Trail Improvements and Site Landscaping
Spring / Summer 2022	7	Demobilization

Refer to the Issued for Permitting design drawings and notes below for additional description of the work scope, with particular emphasis on work scope near the bridge crossing over Whitemud Creek, as well as upstream and downstream at Whitemud Creek and Blackmud Creek. *It is noted that the temporary works listed are anticipated based on past project experience. The successful Contractor will ultimately be responsible for design and construction of the temporary works.*

Temporary Works near the Stream

- Whitemud Creek is a Class C waterbody and Blackmud Creek is a Class B waterbody, both with a Restricted Activity Period of April 16 to June 30. No in-stream works shall occur from April 16 to June 30.

- Temporary isolation (e.g. cofferdams and/or silt curtains) will be provided at each abutment and along the length of the rip-rap armouring to prevent sediment from entering the stream during earthworks.

- Isolation berms shall be constructed of non-erodible materials.

- Embankment works shall be conducted in Fall / Winter at low water and / or partially or fully frozen stream conditions.

- Fish rescue will be performed prior to dewatering isolated areas.

- Sediment monitoring shall be performed during cofferdam installation and removal.

- Temporary works will not impede the continuous flow of the stream between the isolation at each riverbank.

- Navigation:
    - Navigational clearance for recreational users will be maintained at all times during normal bridge operations. temporary closures during construction may be required during superstructure removal and installation.
    - In-stream temporary works shall occur at low water levels in Fall / Winter when stream is not navigable.
    - Construction ahead signs shall be placed upstream and downstream of construction to alert potential stream users.

Construction Methodology and Materials

- Existing Structure
    - The existing steel and timber bridge superstructure will be removed and disposed of. Demolition will occur at low-water or frozen stream conditions (Fall / Winter). Demolished components will not enter the stream.
    - The existing steel superstructure is coated in lead-based paint. Any paint removal required to facilitate demolition shall be fully contained. Lead painted components shall be removed and disposed of in accordance with provincial guidelines.
    - Existing concrete abutments will be removed and disposed of to the extents shown on Drawings, with remaining components buried in-place beneath rip-rap embankment armouring.
    - Careful attention will be paid to areas of visible lead paint encountered during excavation. Where lead paint chips or flecks are evident, an environmental sampling program shall be conducted to assess extent and degree of soil impact at encountered location. Excavated material will be removed and disposed of off-site, in accordance with provincial guidelines.
- Replacement Structure:
    - Superstructure - Design of the single-span pedestrian bridge superstructure is underway and will be composed of modern materials such as steel, reinforced concrete, timber, fibre-reinforced polymer, or similar.
    - Foundation type – Drilled cast-in-place reinforced concrete piles
    - Abutment – Cast-in-place reinforced concrete abutment
    - Headslope protection – Class II riprap (nominal diameter 500 mm)
    - Embankment protection – Class II riprap on non-woven geotextile extending vertically to the 1:100 year HWL, extending upstream and downstream of bridge headslopes. Rip-rap ties into existing gabion riverbank protection (riverbank NE of bridge), existing rip-rap riverbank protection (riverbank SW of bridge), and existing rip-rap and/or bioengineered

riverbank protection (riverbanks NW and SE of bridge). bank disturbance areas outside rip-rap footprint will be revegetated with dense willow stakes.

- The single-span superstructure will be erected / installed by lifting into place, launching, or similar conventional construction methods for single-span pedestrian bridges. There will be no disturbance to the streambed outside the limits of the temporary cofferdams / stream isolation required for bank armouring, as shown on the attached drawings.

- Project-specific erosion and sediment controls will be required at all areas of disturbed ground, around stockpiles, and around laydowns.

- Tree protection in the form of physical barriers shall be provided for any tree within 5 m of the work zone.

- All disturbed areas shall be revegetated following construction.

Wildlife Passage Considerations

The ravine ecosystem includes small and large wildlife ranging from small rodents, to muskrats, to deer and similar large mammals. A bat house is located immediately south of the bridge outside the project area. In accordance with the City's Wildlife Passage Engineering Design Guidelines (2010) Clause 3.3.3 "all Ecological Design Groups (EDGs) should be able to successfully cross a trail". The proposed replacement bridge will maintain similar conditions for wildlife passage to existing conditions, which allow wildlife to move freely up and down the Blackmud / Whitemud Ravine corridor by crossing the gravel trails on either side of the stream. Similar conditions will be maintained for the following areas:

- Approach trails: maintain gravel surfacing, designation for pedestrian use only, with fencing limited to the immediate ends of the bridge structure where required for pedestrian safety

- Bridge Headslopes / Stream Banks: Rip-rap armouring (Class 2 rock, nominal diameter 500 mm, maximum diameter 600 mm) similar to rock already present at the bridge crossing and at the drainage outfalls downstream of the bridge will be placed below the bridge for improved flood resilience. Rip-rap armouring will be naturalized by use of willow cuttings or similar vegetative measures

- Lighting: The existing bridge has no electric lights. No lighting will be introduced at the new bridge.

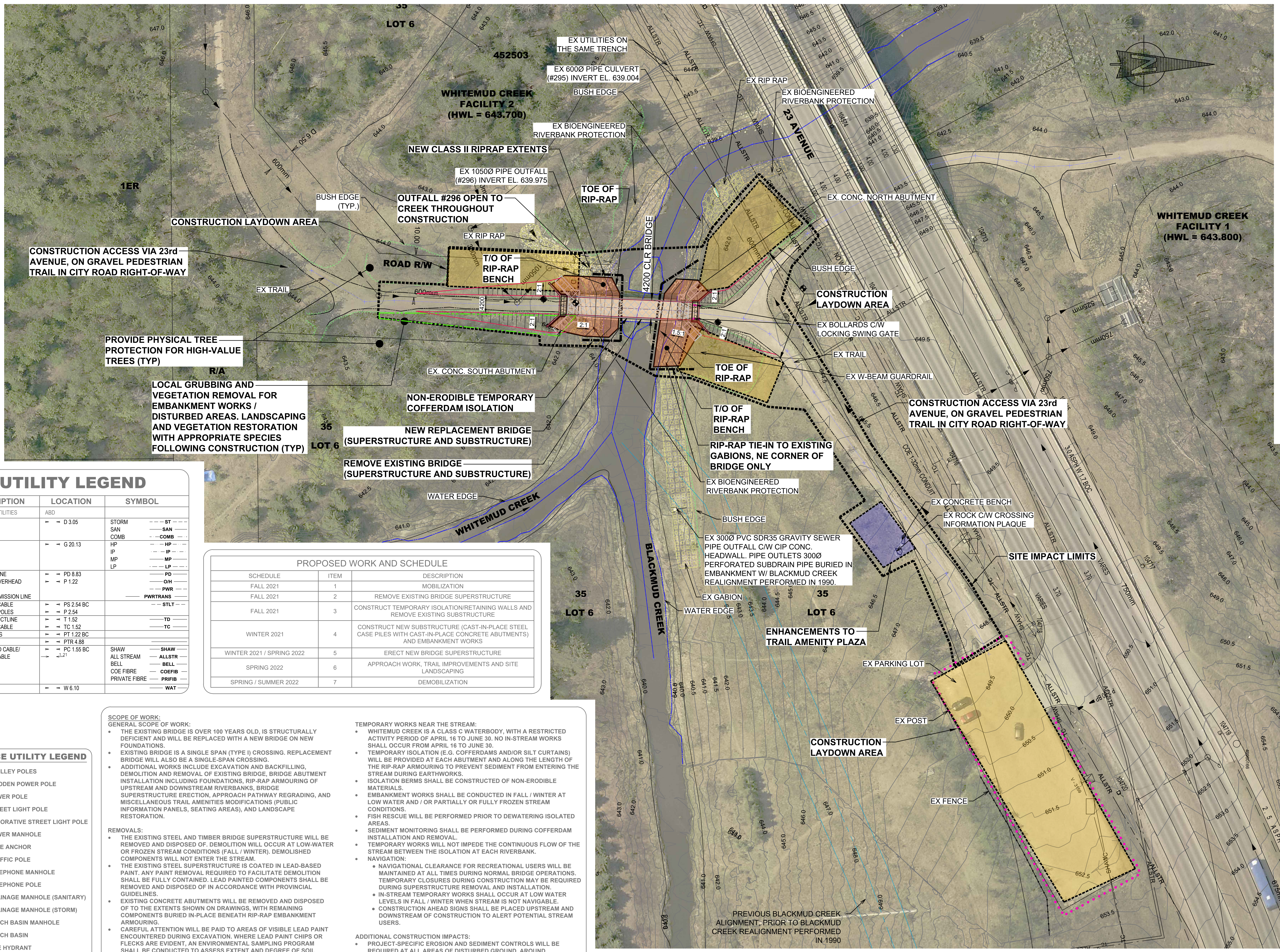
No additional special measures for wildlife passage will be introduced.

Restoration Plans to Support Reclamation Activities

A landscaping restoration plan including appropriate plant species for disturbed areas of the site – including willow cuttings incorporated into the rip-rap and other plant choices for disturbed areas on either side of the creek will be provided with the detailed design. Plantings will be selected based on appropriate natural species for the site, as well as considering sightlines, Crime Prevention Through Environmental Design (CPTED), and other design influences.

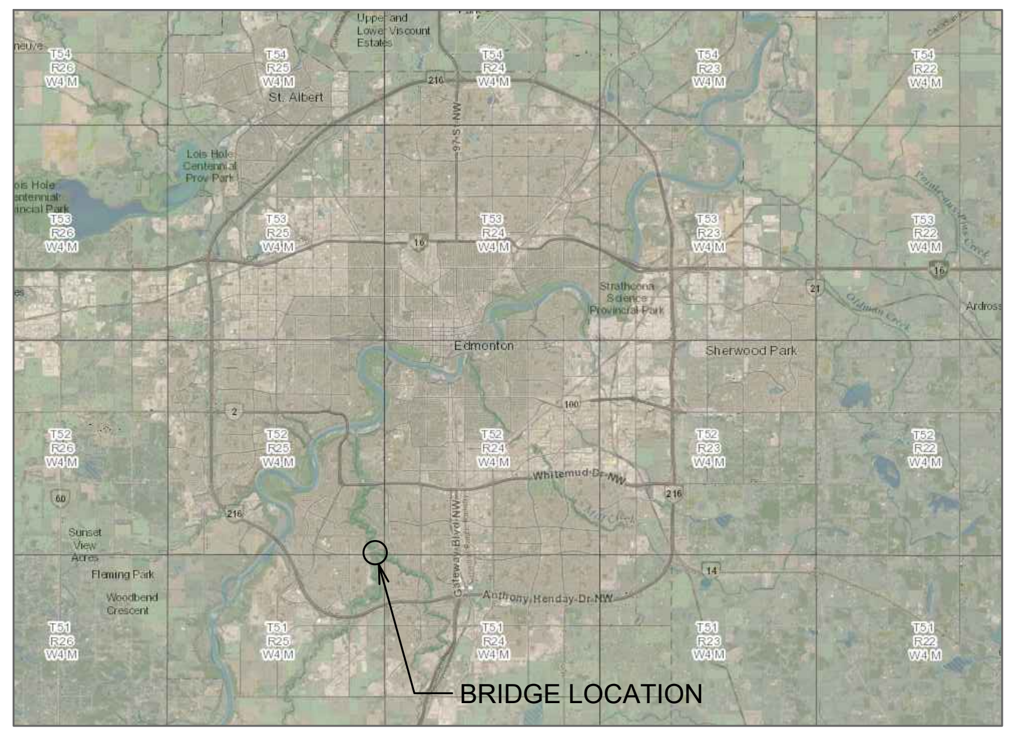
ATTACHMENTS:

1. (3 sheets) Issued for Permitting design drawings showing site plan, profile view, bridge details (general arrangement, elevation, cross-section)



PLAN

SCALE: 1:500



LOCATION PLAN

EXISTING BRIDGE PHOTO

UTILITY LEGEND

DESCRIPTION	LOCATION	SYMBOL	
ABANDONED UTILITIES	ABD		
DRAINAGE	➢ ⋖ D 3.05	STORM	ST
		SAN	SAN
		COMB	COMB
GAS LINES	➢ ⋖ G 20.13	HP	HP
		IP	IP
		MP	MP
		LP	LP
POWER DUCTLINE	➢ ⋖ PD 8.83		PD
POWER LINE OVERHEAD	➢ ⋖ P 1.22		O/H
POWER LINE			PWR
POWER TRANSMISSION LINE			PWRTRANS
STREETLIGHT CABLE	➢ ⋖ PS 2.54 BC		STLT
STREETLIGHT POLES	➢ ⋖ P 2.54		
TELEPHONE DUCTLINE	➢ ⋖ T 1.52		TD
TELE. BURIED CABLE	➢ ⋖ TC 1.52		TC
TROLLEY POLES	➢ ⋖ PT 1.22 BC		
URD TRENCH	➢ ⋖ PTR 4.88		
UNDERGROUND CABLE/ FIBER OPTIC CABLE	➢ ⋖ PC 1.55 BC → ← 1.21	SHAW	SHAW
		ALL STREAM	ALLSTR
		BELL	BELL
		COE FIBRE	COEFIB
		PRIVATE FIBRE	PRIFIB
WATERMAIN	➢ ⋖ W 6.10		WAT

PROPOSED WORK AND SCHEDULE

SCHEDULE	ITEM	DESCRIPTION
FALL 2021	1	MOBILIZATION
FALL 2021	2	REMOVE EXISTING BRIDGE SUPERSTRUCTURE
FALL 2021	3	CONSTRUCT TEMPORARY ISOLATION/RETAINING WALLS AND REMOVE EXISTING SUBSTRUCTURE
WINTER 2021	4	CONSTRUCT NEW SUBSTRUCTURE (CAST-IN-PLACE STEEL CASE PILES WITH CAST-IN-PLACE CONCRETE ABUTMENTS) AND EMBANKMENT WORKS
WINTER 2021 / SPRING 2022	5	ERECT NEW BRIDGE SUPERSTRUCTURE
SPRING 2022	6	APPROACH WORK, TRAIL IMPROVEMENTS AND SITE LANDSCAPING
SPRING / SUMMER 2022	7	DEMOBILIZATION

SURFACE UTILITY LEGEND

⬡	TROLLEY POLES
○	WOODEN POWER POLE
⊙	POWER POLE
□	STREET LIGHT POLE
⊠	DECORATIVE STREET LIGHT POLE
▭	POWER MANHOLE
→	POLE ANCHOR
▫	TRAFFIC POLE
T	TELEPHONE MANHOLE
Ⓣ	TELEPHONE POLE
◍	DRAINAGE MANHOLE (SANITARY)
○	DRAINAGE MANHOLE (STORM)
◒	CATCH BASIN MANHOLE
▽	CATCH BASIN
⌖	FIRE HYDRANT
⧖	WATER VALVE
⊤	WATER TEE
Ⓐ	ANODE

SCOPE OF WORK:

GENERAL SCOPE OF WORK:

- THE EXISTING BRIDGE IS OVER 100 YEARS OLD, IS STRUCTURALLY DEFICIENT AND WILL BE REPLACED WITH A NEW BRIDGE ON NEW FOUNDATIONS.
- EXISTING BRIDGE IS A SINGLE SPAN (TYPE I) CROSSING. REPLACEMENT BRIDGE WILL ALSO BE A SINGLE-SPAN CROSSING.
- ADDITIONAL WORKS INCLUDE EXCAVATION AND BACKFILLING, DEMOLITION AND REMOVAL OF EXISTING BRIDGE, BRIDGE ABUTMENT INSTALLATION INCLUDING FOUNDATIONS, RIP-RAP ARMOURING OF UPSTREAM AND DOWNSTREAM RIVERBANKS, BRIDGE SUPERSTRUCTURE ERECTION, APPROACH PATHWAY REGRADING, AND MISCELLANEOUS TRAIL AMENITIES MODIFICATIONS (PUBLIC INFORMATION PANELS, SEATING AREAS), AND LANDSCAPE RESTORATION.

REMOVALS:

- THE EXISTING STEEL AND TIMBER BRIDGE SUPERSTRUCTURE WILL BE REMOVED AND DISPOSED OF. DEMOLITION WILL OCCUR AT LOW-WATER OR FROZEN STREAM CONDITIONS (FALL / WINTER). DEMOLISHED COMPONENTS WILL NOT ENTER THE STREAM.
- THE EXISTING STEEL SUPERSTRUCTURE IS COATED IN LEAD-BASED PAINT. ANY PAINT REMOVAL REQUIRED TO FACILITATE DEMOLITION SHALL BE FULLY CONTAINED. LEAD PAINTED COMPONENTS SHALL BE REMOVED AND DISPOSED OF IN ACCORDANCE WITH PROVINCIAL GUIDELINES.
- EXISTING CONCRETE ABUTMENTS WILL BE REMOVED AND DISPOSED OF TO THE EXTENTS SHOWN ON DRAWINGS, WITH REMAINING COMPONENTS BURIED IN-PLACE BENEATH RIP-RAP EMBANKMENT ARMOURING.
- CAREFUL ATTENTION WILL BE PAID TO AREAS OF VISIBLE LEAD PAINT ENCOUNTERED DURING EXCAVATION. WHERE LEAD PAINT CHIPS OR FLECKS ARE EVIDENT, AN ENVIRONMENTAL SAMPLING PROGRAM SHALL BE CONDUCTED TO ASSESS EXTENT AND DEGREE OF SOIL IMPACT AT ENCOUNTERED LOCATION. EXCAVATED MATERIAL WILL BE REMOVED AND DISPOSED OF OFF-SITE, IN ACCORDANCE WITH PROVINCIAL GUIDELINES.

TEMPORARY WORKS NEAR THE STREAM:

- WHITEMUD CREEK IS A CLASS C WATERBODY, WITH A RESTRICTED ACTIVITY PERIOD OF APRIL 16 TO JUNE 30. NO IN-STREAM WORKS SHALL OCCUR FROM APRIL 16 TO JUNE 30.
- TEMPORARY ISOLATION (E.G. COFFERDAMS AND/OR SILT CURTAINS) WILL BE PROVIDED AT EACH ABUTMENT AND ALONG THE LENGTH OF THE RIP-RAP ARMOURING TO PREVENT SEDIMENT FROM ENTERING THE STREAM DURING EARTHWORKS.
- ISOLATION BERMS SHALL BE CONSTRUCTED OF NON-ERODIBLE MATERIALS.
- EMBANKMENT WORKS SHALL BE CONDUCTED IN FALL / WINTER AT LOW WATER AND / OR PARTIALLY OR FULLY FROZEN STREAM CONDITIONS.
- FISH RESCUE WILL BE PERFORMED PRIOR TO DEWATERING ISOLATED AREAS.
- SEDIMENT MONITORING SHALL BE PERFORMED DURING COFFERDAM INSTALLATION AND REMOVAL.
- TEMPORARY WORKS WILL NOT IMPEDE THE CONTINUOUS FLOW OF THE STREAM BETWEEN THE ISOLATION AT EACH RIVERBANK.
- NAVIGATION:
  - NAVIGATIONAL CLEARANCE FOR RECREATIONAL USERS WILL BE MAINTAINED AT ALL TIMES DURING NORMAL BRIDGE OPERATIONS. TEMPORARY CLOSURES DURING CONSTRUCTION MAY BE REQUIRED DURING SUPERSTRUCTURE REMOVAL AND INSTALLATION.
  - IN-STREAM TEMPORARY WORKS SHALL OCCUR AT LOW WATER LEVELS IN FALL / WINTER WHEN STREAM IS NOT NAVIGABLE.
  - CONSTRUCTION AHEAD SIGNS SHALL BE PLACED UPSTREAM AND DOWNSTREAM OF CONSTRUCTION TO ALERT POTENTIAL STREAM USERS.

ADDITIONAL CONSTRUCTION IMPACTS:

- PROJECT-SPECIFIC EROSION AND SEDIMENT CONTROLS WILL BE REQUIRED AT ALL AREAS OF DISTURBED GROUND, AROUND STOCKPILES, AND AROUND LAYDOWNS.
- TREE PROTECTION IN THE FORM OF PHYSICAL BARRIERS SHALL BE PROVIDED FOR ANY TREE WITHIN 5 m OF THE WORK ZONE.
- ALL DISTURBED AREAS SHALL BE REVEGETATED FOLLOWING CONSTRUCTION.

PRELIMINARY
ISSUED FOR DISCUSSION AND REVIEW PURPOSES ONLY

X:\PROJ\2020\201932500-PB5-SMITH CROSSING BRIDGE REPLACEME\09. CAD\07 SHEETS\ENVIRONMENTAL PERMITTING\A023 P20X – EX1 (DAS) DC.DWG

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1	TENDER AWARD DATE		

CONSTRUCTION RETURN

CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION MANAGER DATE

GENERAL SUPERVISOR DATE

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION

DATE

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADS DESIGN AND CONSTRUCTION DATE

MANAGER OF ROADS DESIGN AND CONSTRUCTION DATE

THE CITY OF Edmonton
TRANSPORTATION SERVICES
ROADS DESIGN AND CONSTRUCTION BRANCH

SURVEY

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DESIGNED - - - - DATE 20-11-02

CHECKED - - - - DATE 20-11-02

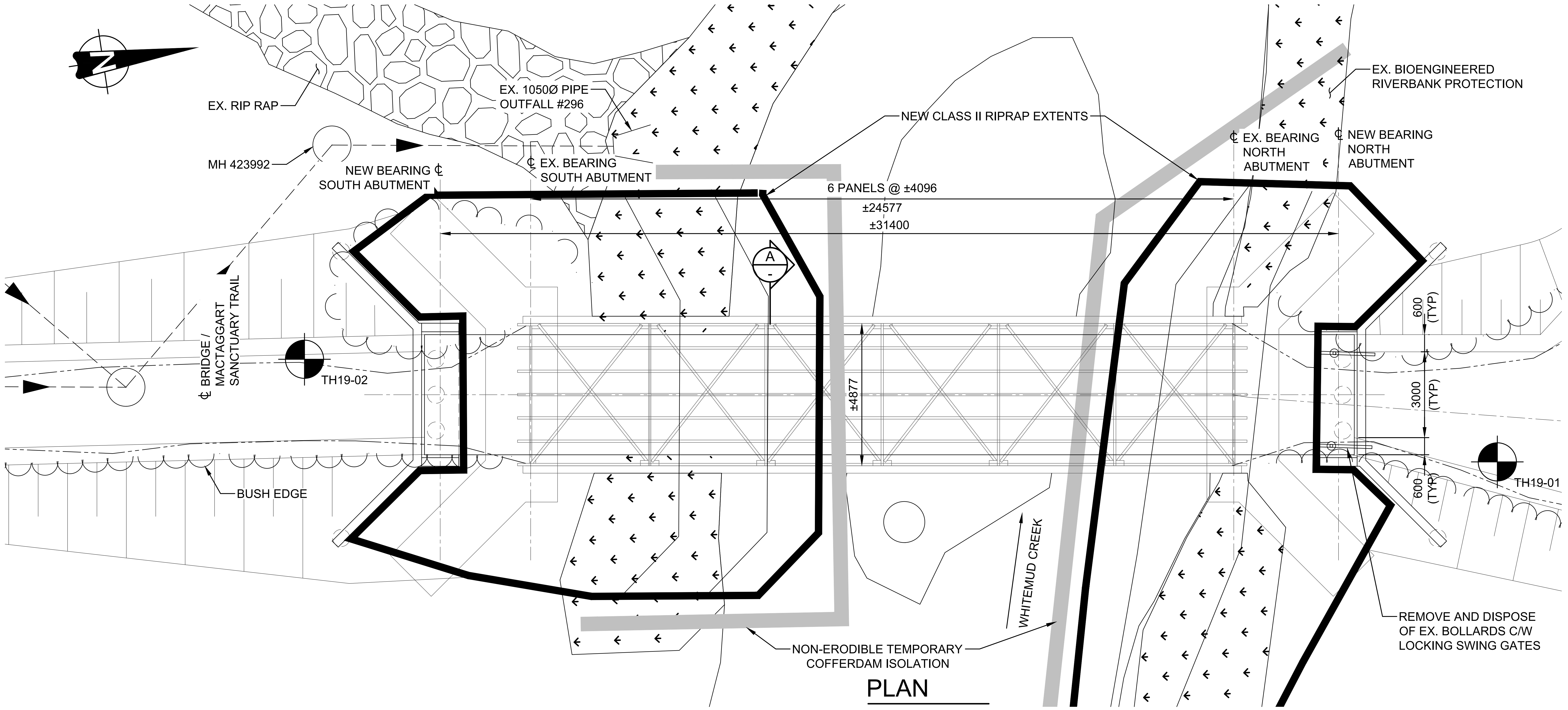
PROJECT

23rd AVENUE

SMITH CROSSING BRIDGE REPLACEMENT

SITE PLAN

DRAWING A023 P20X - EX1



PLAN

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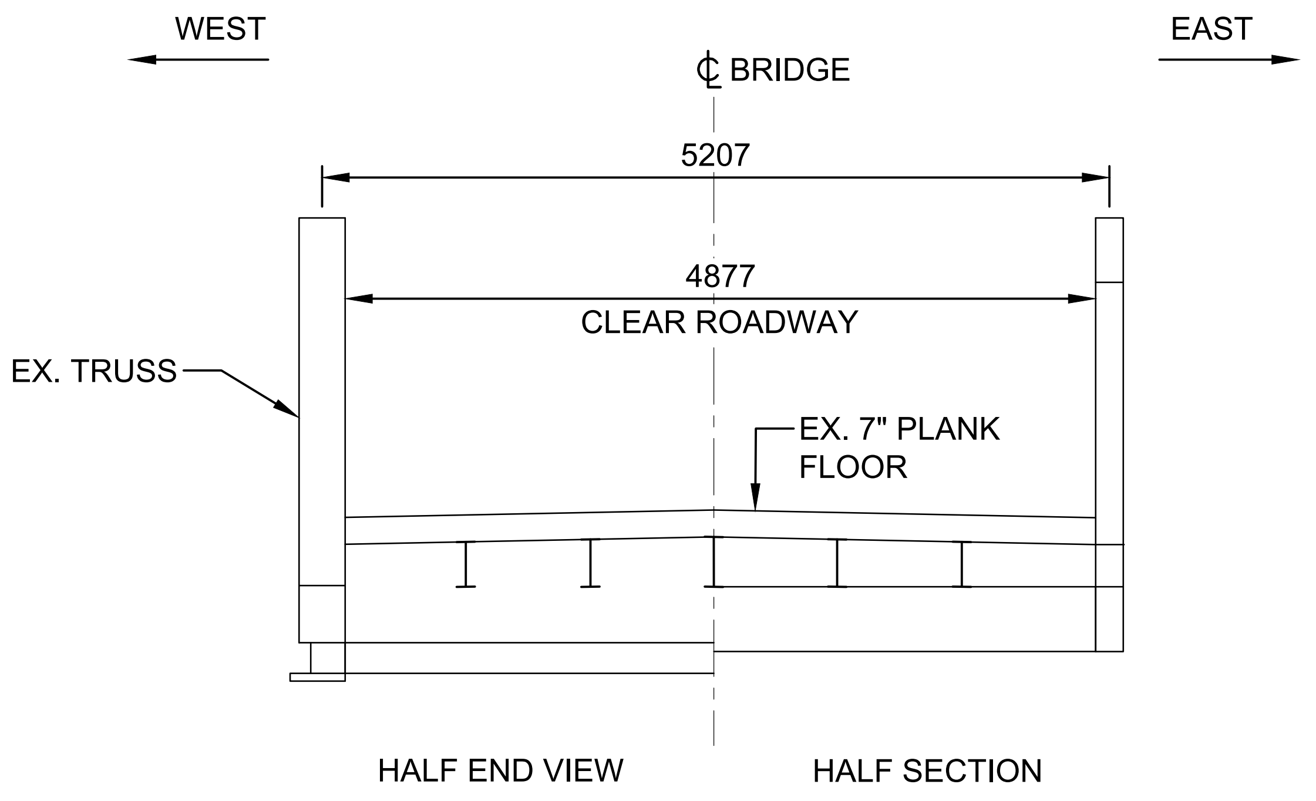
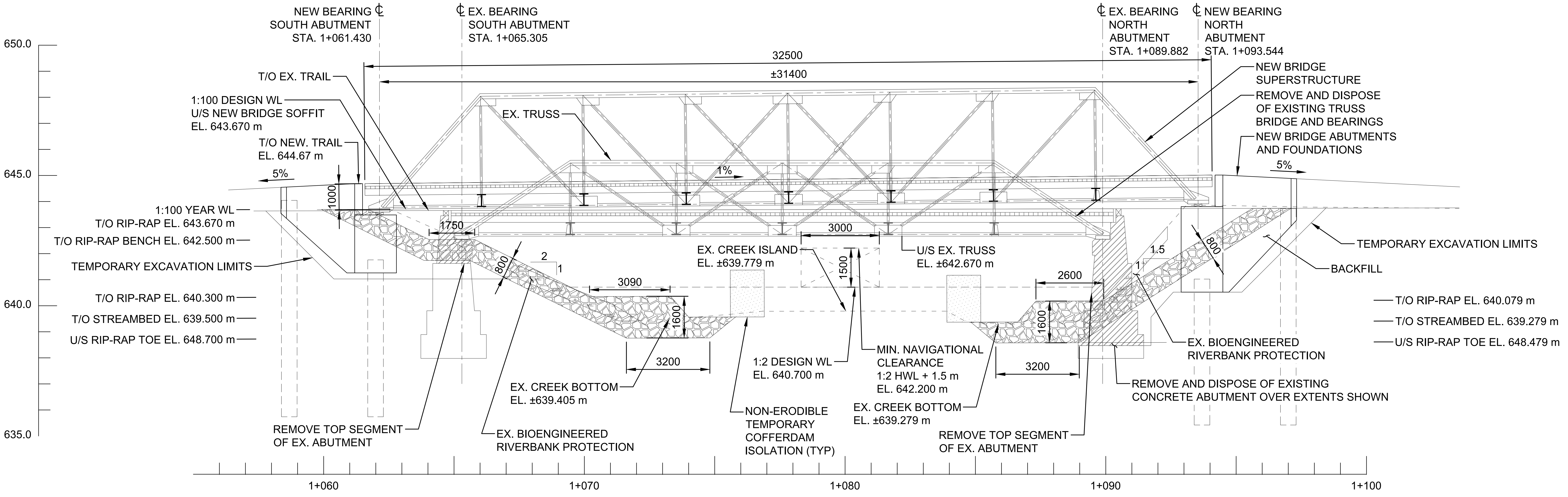


A - SECTION

1:50



ELEVATION

LOOKING WEST 1:100

BRIDGE DESIGN CRITERIA

- CANADIAN HIGHWAY AND BRIDGE DESIGN CODE (CHBDC) 2019
- CITY OF EDMONTON COMPLETE STREETS DESIGN AND CONSTRUCTION STANDARDS (2018)

BRIDGE LIVE LOAD DESIGN

- PEDESTRIANS LIVE LOAD (CAN/CSA S6-19 CL.3.8.9)
- MAINTENANCE VEHICLE LOAD (CAN/CSA S6-19 CL.3.8.11) USAGE: THE BRIDGE IS A RECREATIONAL PEDESTRIAN BRIDGE ON AN URBAN TRAIL SYSTEM. THE BRIDGE CAN BE CLOSED TO ALL USERS IN AN EMERGENCY OR DESIGN FLOOD EVENT.

HYDROTECHNICAL AND FISH PASSAGE DATA

- DESIGN DISCHARGE: $Q_{1:100}$ = 67.9 m^3/s (BLACKMUD CREEK), 91.5 m^3/s (WHITEMUD CREEK)
- MEAN VELOCITY THROUGH NEW REPLACEMENT BRIDGE FOR DESIGN DISCHARGE: V1% = 2.8 m/s
- HIGH WATER LEVEL – 1:100 YEAR = 643.67 m, 1:2 YEAR = 640.70 m
- DESIGN FLOOD EVENT: COMBINED 1:100 PEAK FLOOD FLOW FROM BLACKMUD CREEK AND WHITEMUD CREEK
- FREEBOARD: 1:100 HWL + 0 m

NAVIGATIONAL CLEARANCE

- NAVIGATIONAL CLEARANCE OF 2.97 m PROVIDED FROM 1:2 HWL TO UNDERSIDE OF BRIDGE SOFFIT.
- DESIGN VESSEL TYPE – BLACKMUD CREEK (CANOE / KAYAK AND WHITEWATER KAYAK), WHITEMUD CREEK (CANOE / KAYAK)
- DESIGN MAXIMUM VESSEL: CLEARANCE HEIGHT OF 1.5 m CLEARANCE WIDTH OF 3.0 m

MATERIALS

- FOUNDATION TYPE – DRILLED CAST-IN-PLACE REINFORCED CONCRETE PILES
- ABUTMENT – CAST-IN-PLACE CONCRETE ABUTMENT
- HEADSLOPE PROTECTION – CLASS II RIPRAP (NOMINAL DIAMETER 500 mm)
- EMBANKMENT PROTECTION – CLASS II RIPRAP ON NON-WOVEN GEOTEXTILE EXTENDING VERTICALLY TO THE 1:100 YEAR HWL, EXTENDING UPSTREAM AND DOWNSTREAM OF BRIDGE HEADSLOPES. RIP-RAP TIES INTO EXISTING GABION RIVERBANK PROTECTION (RIVERBANK NE OF BRIDGE), EXISTING RIP-RAP RIVERBANK PROTECTION (RIVERBANK SW OF BRIDGE), AND EXISTING RIP-RAP AND/OR BIOENGINEERED RIVERBANK PROTECTION (RIVERBANKS NW AND SE OF BRIDGE). BANK DISTURBANCE AREAS OUTSIDE RIP-RAP FOOTPRINT WILL BE REVEGETATED WITH DENSE WILLOW STAKES.

LIST OF ACRONYMS

HWL - HIGH WATER LEVEL
WL - WATER LEVEL
T/O - TOP OF
U/S - UNDERSIDE

ROADWAY IDENTIFICATION
CONST YR / PROJ
DWG CONTENT / DWG NO

NO.	REVISIONS	BY	DATE	APP'D
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1	ISSUED FOR PERMITTING REVIEW		21-02-03	

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2	AS BUILT		
1	TENDER AWARD		

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

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADWAYS DESIGN DATE
DIRECTOR OF ROADWAYS CONSTRUCTION DATE

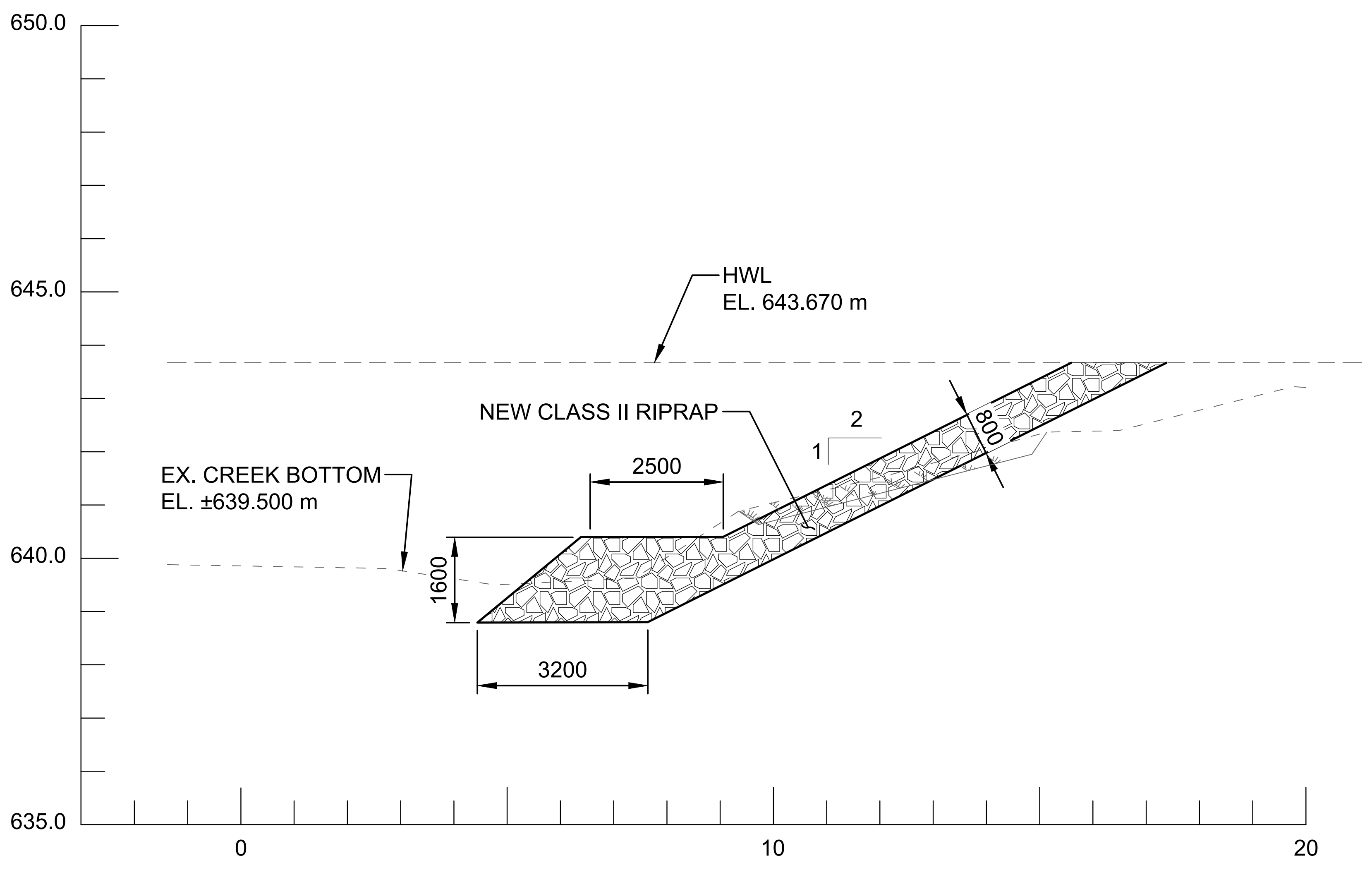
SURVEY
JOB NO. 201932500
SCALE AS SHOWN

DRAWN - DATE -
DESIGNED - DATE -
CHECKED - DATE -

THE CITY OF Edmonton TRANSPORTATION

PROJECT
23rd AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
GENERAL ARRANGEMENT

DRAWING A023 P20X - EX2



SECTION

TYPICAL RIVERBANK RIP-RAP ARMOURING WITHIN 5m UPSTREAM AND DOWNSTREAM OF BRIDGE 1:100

ROADWAY IDENTIFICATION

CONST YR / PROJ

DWG CONTENT / DWG NO

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3	MICROFILMED		
2	AS BUILT		
1	TENDER AWARD		

CONSTRUCTION RETURN

CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION ENGINEER DATE

GENERAL SUPERVISOR DATE

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADWAYS DESIGN DATE

DIRECTOR OF ROADWAYS CONSTRUCTION DATE

SURVEY

JOB NO. 201932500

SCALE AS SHOWN

DRAWN DATE
- -

DESIGNED DATE
- -

CHECKED DATE
- -

THE CITY OF Edmonton TRANSPORTATION

PROJECT

23rd AVENUE

SMITH CROSSING BRIDGE REPLACEMENT

RIP-RAP CROSS-SECTION

DRAWING

A023 P20X - EX3

Appendix B

Assessment Methods

Kingfisher Aquatics Ltd. (Kingfisher) Standard Procedures for Watercourse Crossings in Alberta have been developed to meet the information requirements of provincial and federal regulators for most instream activities associated with watercourse crossing construction or other similar sized projects that require instream works. These procedures may be utilized in combination with other assessment methods that do not strictly align with this document. In these instances, any modifications to the methodology described in this document will be described and rationalized in the main body of the report.

The Guide to the Code of Practice for Watercourse Crossings Including Guidelines for Complying with the Code of Practice (the Guide to the Code of Practice), Section B: Aquatic and Biological Site Assessments (Alberta Environment 2001) served as the primary reference and outline for these standard procedures.

A) ASSESSMENT PREPARATION

In order to determine assessment requirements; all available project information will be reviewed prior to initiation of the field assessment activities to aid in the determination of:

1) potential streambed, streambank and riparian disturbance;
2) anticipated potential effects on the aquatic environment; and
3) the estimated zone of impact resulting from potential effects.

Background topography and drainage information will be collected through the review of available maps, satellite imagery and air imagery. Historical fisheries information will be collected through:

1) Querying the provincial database known as the Fish and Wildlife Management Information System that is accessed through the Fish and Wildlife Internet Mapping Tool maintained by Alberta Environment and Parks; and
2) Reviewing available literature including articles from peer-reviewed journals, governments, private firms, non-government organizations, and aboriginal organization sources.

B) FIELD ASSESSMENT

A field assessment will be conducted when existing fish and/or fish habitat information is deemed to be insufficient to support an assessment of the potential effects of the project on the aquatic environment.

1) Study Area

Field assessments conducted for watercourse crossings require at a minimum:

- one 100 m or longer study section established upstream of the watercourse crossing or proposed watercourse crossing right of way; and
- one 300 m or larger study section located downstream of the watercourse crossing or proposed watercourse crossing right of way. The downstream study section must encompass the entire zone of impact. Additional study sections may be required to determine potential fish species that could be affected by the project.

2) Determining the Zone of Impact

The Guide to the Code of Practice (Alberta Environment 2001) defines the zone of impact as:

- the area of streambed and streambanks of the water body that will be altered or disrupted as a result of the works; and
- the area where 90% of the sediment discharged as a result of the works would be deposited.

FISH COLLECTION

When there is insufficient fisheries information available to evaluate potential project effects on the aquatic environment Kingfisher will conduct fish sampling to the extent required to meet the specific information requirements of the project.

1) Permitting

All fish sampling conducted by Kingfisher will be done so under licence from the Province of Alberta and, when applicable, the Government of Canada. The follow permits may be required to conduct fish sampling depending on the method used, the location of the waterbody being sampled, and the potential fish species present:

- Alberta Environment and Parks issued Research Licence
- Department of Fisheries and Oceans Canada issued Species at Risk Act Permit
- Parks Canada issued Research and Collection Permit

2) Fish Collection Data

In accordance with the Guide to the Code of Practice (Alberta Environment 2001) data collected from fish capture will include at a minimum:

- the length of the study section;
- the type of equipment used, and the electrofishing effort made (seconds) and catch per unit effort (other active and passive fish capture methods may be used to augment electrofishing where required);
- all fish species captured, the number of each species and the location or habitat types where fish were captured;
- the fork length and weight of all sportfish species captured;
- the gender and maturity of sportfish species if externally determinable;
- the spawning potential; and
- during restricted activity periods, any evidence of spawning activity (redds, fish on redds, etc.) and determine where possible the presence of fish and fry at the crossing site.

Alberta Fisheries Management Branch (AFMB) Standard for Sampling of Small Streams in Alberta (2013[a]) provides additional guidelines for minimum information requirements for both general fish sampling and specific sampling methods. Information requirements for specific fish sampling methods are provided in Section 3. Kingfisher will collect all information to meet the AFMB Standards for general fish sampling information as outlined below:

Sample Site Descriptors:

- Waterbody Name
- Waterbody ID
- Activity Date
- Crew Initials
- Starting Universal Transverse Mercator (UTM) coordinates
- Site Location Notes
- Project Site Number
- Water Temperature
- Conductivity
- Stream Stage (Dry, Low, Moderate, High, Flood)
- Wetted Width
- Maximum Depth

Fisheries Descriptors:

- Capture Method
- Sample Number
- Species
- Fork Length (mm)
- Total Body Weight (g)
- Injury Comments
- General Fisheries Comments

3) Fish Collection Methods

Selection of fish sampling gears is initially based of the following key points (Portt et al. 2006):

- the study question(s) that the investigators wish to answer;
- the habitats that are being investigated;
- the fish species that are being investigated; and
- the time of year when investigations will take place.

In addition to the key points listed above, Kingfisher also considers the catchability, efficiency, and lethality of fish sampling gear. In general, Kingfisher selects fish sampling gear that maximizes catchability and efficiency of sampling efforts while minimizing the potential for fish mortality.

Standard Kingfisher fish collection methods, application information, and guidance documents are provided in Table C.1.

Table C.1. Standard Fish Collection Methods, Application Information, and Guidance Documents.

Fish Collection Method	Habitat Type	Water Depths	Fish species	Guidance Documents
Angling (A)	Lotic or lentic habitats	>0.1 m	Medium to large-bodied sport fish and some coarse fish	Vancouver Island University. 2010. Electrofishing: Theory, Safety and Uses Version 6.0; AFMB. 2004. Electrofishing Policy Respecting Injuries to Fish.; BCMELP. 1997. Fish Collection Methods and Standards Version 4.0; AFMB. 2013^{a}.Standards for sampling of small streams in Alberta; AFMB. 2013^{a}.Standards for sampling of small-bodied fish in Alberta; AFMB. 2013^{c}.Standards for the ethical use of fishes in Alberta; AESRD. 2015. Fish Research Licence Application – Fish Rescue Best Practices. BCMFLNRO. Freshwater Fishing Regulation. Alberta Government. Sportfishing Regulations. Portt et al. 2006. A review of fish sampling methods commonly used in Canadian freshwater habitats. Alberta Transportation. 2009. Fish Habitat Manual.
Backpack Electrofishing (A)	Primarily lotic	Between 0.1 m and 0.5 m	Most species and sizes	
Boat Electrofishing (A)	Primarily lotic	Between 0.5 m and 2.0 m	Most species and sizes	
Gillnetting (P)	Lentic	>0.5 m	Medium to large bodied sport and course fish	
Minnow Trapping (P)	Primarily lentic	>0.3 m	Small bodied forage fish species and some sport fish	
Seine netting (A)	Primarily lentic	<1.0 m	Most species and sizes	

(A)=Active Technique
(P)=Passive Technique

Angling

Angling equipment and rigging are usually geared toward specific fish species or groups of fish species. This allows angling efforts to be very effective at targeting specific fish species with minimal bi-catch. In most presence/absence sampling scenarios it is ideal to utilize gear that maximizes catchability, such as electrofishing or seine netting that is capable of catching a wide variety of fish species. As such, angling is typically used for assessments that require sampling for a specific fish species that may not effectively be captured by other methods (i.e. Lake Sturgeon).

Angling is conducted in crews of two or more to maximize sampling effort. When multiple anglers are sampling a waterbody for multiple species anglers will use alternate rigging methods in an effort to expand the number of fish species and/or life stages of fish angling efforts could capture. Angling methods will largely rely on the experience of the crew members; however, all angling methods will comply with provincial sport fishing regulations.

Kingfisher will record all information to meet the AFMB Standard for Sampling of Small Streams in Alberta (2013[a]) required angling specific information:

- Number of Anglers,
- Hours Fished per Angler

Backpack Electrofishing

Electrofishing is the technique of passing electric current through the water to attract and immobilize fish for capture. It is most efficiently used in contained areas of small rivers and streams that are difficult to sample using nets or traps (BCMELP 1997).

Backpack electrofishing is conducted by a two-person crew. One of the two crew members will be a certified electrofishing crew leader who will operate the backpack electrofisher. The second crew member will capture immobilized fish with a fine mesh nylon or rubber net. Electrofishing is conducted by sweeping the anode pole of the electrofisher across the channel and downstream towards the cathode tail and netter. The crew progresses upstream through the study area moving back and forth across the stream in a zigzagging pattern. Sampling effort is evenly distributed throughout the sample section. Captured fish are collected and temporarily held in a water-filled pail (carried by the second crew member) or in a live-well. Electrofishing can only effectively be completed when crew members are able to readily spot immobilized fish. Therefore, electrofishing surveys are not conducted when turbidity levels are elevated or when the sample area is frozen.

Boat Electrofishing

Boat electrofishing is conducted following the same principles as backpack electrofishing but is used on larger streams and shallow lakes where water depths prevent wading. Two types of boats are used, drift boats (passive) or jet boats (active), the former is typically used on small rivers that may not accommodate a power boat and the latter is used on larger rivers where the operation of a large power boat is more feasible. The basic components of the shocking system include a power supply, voltage and current regulator, cathode, anode, and safety circuits. Boats used for electrofishing are large enough to hold all the equipment and provide a safe and adequate work space for the crew. The power is supplied to the boat electrofisher via a gas-powered generator. The cathodes are suspended from the sides of the boats and the anodes are normally one or two booms protruding from the front of the boat (BCMELP 1997).

Boat electrofishing is conducted with a crew of 3 to 4 members when the boat electrofishing set up utilizes a movable anode. When the boat electrofishing set-up utilized a fixed anode, a crew of 2 to 3 members can operate the system effectively. The use of fixed or moveable anodes depends on the fish sampling objectives of the assessment. Movable anodes typically allow for greater control of the habitat sampled, and as such are considered optimal for presence/absence sampling.

Kingfisher will record all information to meet the AFMB Standard for Sampling of Small Streams in Alberta (2013[a]) which stipulates collection of the following information:

- Electrofishing on-time
- Distance electrofished – 300 m or 40x the mean wetted width will be considered the minimum electrofishing survey distance
- Electrofisher Pulse Width
- Electrofisher Frequency
- Electrofisher Voltage

Gillnetting

Gillnets are suspended in the water column at different depths depending on the fish species type (pelagic, benthic, etc.) being targeted. Fish are captured when they swim into the mesh of the net and the maxillary or operculum area, teeth, spines, girth, or scales are caught on the mesh of the net as they attempt to pass through or free themselves from the mesh.

Net set times are dependent on whether the project requires non-lethal or lethal sampling. Gill nets are typically used when the sacrifice of fish is either necessary and/or where the risk (of gillnetting) to local fish populations is considered low. The length of the net set is a large factor in the amount of fish mortality observed. If deployed in lotic waterbodies they should be checked and cleared frequently (every two hours or less, particularly where non-lethal sampling is an objective). If deployed in lentic waterbodies they should be set overnight for no greater than 24 hours (AFMB 2013[b])

Gillnetting is conducted as per the B.C. standard procedure for gillnetting that has been developed for the use of gill nets in lakes for reconnaissance level inventories. The net consists of six nets or panels, 15.2 m long and of different mesh sizes, that are strung together in a "gang" to form a net 91.2 m long and 2.4 m deep. The mesh size is measured from knot to knot of a single, diagonally stretched mesh. Each mesh size is selective for a certain size fish (Table C.2), therefore, the individual panels used in the net have been chosen so the net is capable of catching a wide range of fish. The following is the standard order of the panels based on mesh size, the corresponding filament size used in the construction of the net and the mean fork length of the fish caught by each of the mesh sizes (BCMELP 1997; based on Hamley 1972):

Table C.2. Order, Mesh Size and Filament Size Standards relative to Fish Mean Fork Length (BCMELP 1997).

Order	Mesh Size (mm)	Filament Size (mm)	Fish Fork Length (mm)
1	25	0.20	114
2	76	0.25	345
3	51	0.20	228
4	89	0.30	380
5	38	0.20	178
6	64	0.25	280

Most gillnetting sampling requires the use of watercraft. As such, a minimum crew size of two is used during gillnetting. Crew size and number of watercraft employed for gillnet fish sampling is dependent on project objectives, the size and number of nets set, and the project time frame.

Kingfisher will record all information to meet the AFMB Standard for Sampling of Small Streams in Alberta (2013[a]) which stipulates collection of the following information:

- Date and time of net(s) set
- Date and time of net(s) lifted
- Mesh Size (mm)
- Length of net(s) set (m)
- Depth of net(s) set (m)

Minnow Trapping (Gee Trapping)

Minnow traps or Gee-minnow traps are used to target small-bodied fish in moderate to deep (>0.5 m) habitat where electrofishing becomes less effective, particularly on small-bodied fish. Due to the small size and ease of deployment of minnow traps, minnow trapping can be conduct by a single crew member (Portt et al. 2006); however, fish processing requirements typically dictate a minimum crew size of two.

Minnow traps usually consist of two wire baskets held together by a clip and attached to a marker float. The baskets are interlocked, and the clip is inserted to hold the two halves together. The float line is attached and the trap is positioned on the bottom or suspended at a particular depth. The position of the trap is marked by the float attached to the line. Traps can be set with or without bait. Fish swim inside the traps through funnel shaped openings that guide them from a large opening near the outside of the trap to the narrow opening close to the centre of the trap. Once inside it is difficult for the fish to locate the opening and escape (BCMELP 1997).

Kingfisher will complete minnow trapping in accordance with AFMB Standards for Sampling Small-bodied Fish in Alberta (2013[b]). When bait is used, the type and amount will be recorded. Traps will be set for a minimum of 18 (trapping) hours (trapping hours = # traps x hours of set time) and all traps will be checked at least once every 2 hours and cleared of fish.

Kingfisher will record all information to meet the AFMB Standard for Sampling of Small Streams in Alberta (2013[a]) required trap netting specific information:

- Date and time of trap(s) set
- Date and time of trap(s) lifted
- Trap type
- Number of traps

Seine Netting

Seine netting can be conducted by boat or by wading and can be an effective passive capture method. However, the effectiveness of seine netting can be limited by coarse substrates and/or fish cover (aquatic vegetation, woody debris, and overhanging bank) that can foul the net, interrupt net pulls, and allow fish to escape.

In lentic habitat, seine netting is conducted parallel to shore. The off-shore seiner walks in advance of the on-shore seiner. After the seine pull is completed the off-shore seiner brings their end of the seine net to shore and the seine is pulled in while making sure that the leadline remains in contact with the bottom and the floatline is in contact with the surface (AFMB 2013[b]). In lotic habitat, seine pulls vary depending on the local conditions.

The configuration of seine nets can vary depending on the application of the net and the target species. Most nets have a braided leadline or rolled lead weights to weigh the bottom of the net while the top of the net is typically supported by a floating corkline (BCMELP 1997). Kingfisher typically utilizes seines ranging from 3.3 m to 30 m long and 1.2 m to 1.8 m deep with mesh sizes 0.125 mm to 2.5 mm.

Kingfisher will record all information to meet the AFMB Standard for Sampling of Small Streams in Alberta (2013[a]) required seine haul specific information:

- *Net and mesh dimensions (m and mm)
- Area Sampled
- *Number of net pulls per area

*derived requirements based on AFMB Standard for Sampling of Small Streams in Alberta (2013[a]) and Standards for Sampling Small-bodied Fish in Alberta (2013[b])

C) FISH HABITAT ASSESSMENT

1) Habitat Inventory/Habitat Mapping

Fish habitat data collection is conducted by Kingfisher crews traversing study area(s), typically from downstream to upstream either by boat (Large River Fish Habitat Assessments) or by wading (Small Stream Fish Habitat Assessments). Information is collected in a sequentially ordered and spatially referenced manner that allows for the data to be presented as a habitat map or in a habitat inventory catalogue, depending on project requirements.

Small Stream Fish Habitat

Kingfisher standard methods for small stream fish habitat assessment are adapted from R.L.& L. (1994) and Hawkins et al. (1993) that are outlined in the Alberta Transportation Fish Habitat Manual (2009). Habitat is classified into discrete units based on water depth, velocity, and substrate. The dimensions of each unit are measured and fish cover type(s), substrate composition, riparian vegetation types, and bank stability are quantified and recorded. Definitions of habitat units are provided in Table D.1 and classifications based on water depth are provided in Table D.2. Fish cover types, streambed substrates, and riparian vegetation types are presented in Table D.3 while other in-channels are described in Table D.4.

Table D.1. Small Stream Fish Habitat Units, Symbols and Descriptions.

Habitat Unit	**Symbol**	**Description**
Cascade	CA	Extremely high gradient and velocity; extremely turbulent with entire water surface broken; may have short vertical sections, but overall is passable to fish; armoured substrate, may be associated with chutes and rapids
Chute	CH	Area of channel constriction, usually due to bedrock intrusions; associated with channel deepening and increase velocity
Rapids	RA	Extremely high velocity; deeper then riffle; substrate extremely coarse (large cobble/boulder); instream cover in pocket eddies and associated with substrate
Riffle	RF	High velocity/gradient relative to run habitat; surface broken due to submerged or exposed bed material, shallow relative to other channel units; coarse substrate; usually limited instream or overhead cover for juvenile or adult fish (generally ≤ 0.5 m deep).
Run (glide)	R1, R2, R3	Moderate to high velocity; surface largely unbroken; usually deeper than RF; substrate size dependent on hydraulics
Flat	F1, F2, F3	Area characterized by low velocity and near-uniform flow; differentiated from pool habitat by high channel uniformity; more depositional than R3 habitat
Pool	P1, P2, P3	Discrete portion of channel featuring increased depth and reduced velocity relative to riffle/run habitats; formed by channel scour.
*Backwater, snye, and impoundment habitat types have been removed because the functionality and form of these habitat types can be recorded through a combination of the listed habitat types and habitat in-channel features		

Table D.2. Small Stream Depth Classifications, Definitions, and Applicable Habitat.

Class	Definition	Applicable Habitat
1	Class 1 water depths range from 1 m to 1.5 m	Run (glide), Flat, Pool
2	Class 2 water depths range from 0.5 m to 1.0 m	
3	Class 3 water depths range from 0.1 m to 0.5 m	

Table D.3. Substrate, Fish Cover and Riparian Vegetation Classifications, Symbols and Descriptions.

Classification	Symbol	Description
Fish Cover		
Woody Debris	WD	Submerged branches, logs, or tree roots
Overhanging Bank	OB	Undercut bank
Overhanging Vegetation	OV	Terrestrial vegetation hanging over or into the waterbody
Aquatic Vegetation	AV	Vegetation rooted below the waters surface
Boulder	BL	Coarse substrate either capable of providing slack water or with interstitial spaces large enough to provide cover for the fish species present
Substrate		
Fines*	FN	<2 mm
Gravel (small & large gravels)*	GR	2 – 64 mm
Cobble*	CB	65 – 256 mm
Boulder*	BL	>256 mm
Bedrock	BR	Single large unit of substrate or single large aggregated unit of substrate
Riparian Vegetation		
Grass/bryophytes	Gr	Herbaceous, or bryophytic, low, non-woody plants
Shrubs	Sh	Multiple woody stemmed low to medium height plants including sapling trees
Tress	Tr	Single large woody stemmed plants
Exposed Bank	Ex	Unvegetated bank substrate composed of soil or aggregate material
Armoured Bank	Ar	Unvegetated bank substrate composed of bedrock or boulder armouring (i.e. riprap)

*defined by Overton et al 1997.

Table D.4. Small Stream In-Channel Features, Symbols, and Descriptions

Type	Symbol	Description
Substrate Ledge	SL	Area of bedrock, clay, or aggregated smaller streambed substrates intruding into the channel; often associated with chute or plunge pool habitat, may have a vertical drop affecting fish passage
Log Ledge	LL	An area where large woody debris has fallen perpendicular to stream flow and has backed up streamflow and loose substrate on the upstream side, commonly associated with a plunge pool habitat on the downstream side
Debris Pile	DP	Debris pile (e.g., log jam) which influences instream habitat; including effects on fish cover
Beaver Dam	BD	Partial or complete beaver constructed impoundments
Anthropogenic Feature	AF	Human-made structure that protrudes into a waterbody, effecting either fish habitat or stream geomorphology
Falls	FA	Highest water velocity; involves water falling over a vertical drop; impassable to fish
Discontinuous Channel	DC	Portions of the study section where channel definition is lost, or channel is lost underground. Assumes the unit width of the last defined unit downstream of the discontinuous channel.

Large River Fish Habitat

Kingfisher standard methods for large river fish habitat assessment are adapted from R.L. & L. (1994) and are outlined in the Alberta Transportation Fish Habitat Manual (2009). Large river habitat classification methodology is intended for use on large watercourses that do not consistently exhibit specific habitat units such as pools, runs, and riffles. With this methodology, habitat is characterized based on general channel form, shoreline features, as well as the presence of specific microhabitat features. A description of large river habitat classifications is presented in Table D.5 and D.6.

Table D.5. Large River Fish Habitat Components, Symbols and Descriptions

Type	Symbol	Description
Major Habitat Types		
Unobstructed Channel	U	Single main channel, no permanent island, side bars occasionally present, limited development of exposed mid-channel bars at low flow
Singular Island	S	Two channels around single, permanent island, side and mid-channel bars often present at low flow
Multiple Island	M	More than two channels and permanent islands, generally extensive side and midchannel bars at low flow
Bank Habitat Types		
Armoured/Stable	A1	Largely stable and at repose; cobble/small boulder/gravel predominant; uniform shoreline configuration; bank velocities low-moderate; instream/overhead cover limited to substrate and turbidity
	A2	Cobble/large boulder predominant; irregular shoreline due to cobble/boulder outcrops producing BW habitats; bank velocity low (BW)/moderate; instream/overhead cover from depth, substrate and turbidity
	A3	Similar to A2 with more boulder/bedrock; very irregular shoreline; bank velocities moderate-high with low velocity BW/eddy pools providing instream cover; overhead cover from depth/turbidity
	A4	Artificial riprap substrates consisting of angular boulder-sized fill; often associated with high velocity areas; shoreline usually regular; instream cover from substrate; overhead cover from depth/turbulence
Canyon	C1	Banks formed by valley walls; cobble/boulder bedrock; stable at bank-water interface; typically deep/high velocity water offshore; abundant velocity cover from substrate/bank irregularities
	C2	Steep, stable bedrock banks; regular shoreline; moderate-deep/moderate-fast water offshore; occasional velocity cover from bedrock fractures
	C3	Banks formed by valley walls, primarily fines with some gravel/cobble at base; moderately eroded at bank-water interface; moderate-high velocities; no instream cover
Depositional	D1	Low relief, gently sloping bank; shallow/slow offshore; primarily fines; instream cover absent or consisting of shallow depressions or embedded cobble/boulder; generally associated with bars
	D2	Similar to D1 with gravel/cobble substrate; some areas of higher velocities producing riffles; instream/overhead cover provided by substrate/turbulence; often associated with bars/shoals
	D3	Similar to D2 with coarser substrates (cobble/boulder); boulders often imbedded; moderate-high velocities offshore; instream cover abundant from substrate; overhead cover from turbulence
Erosional	E1	High, steep eroded banks with terraced profile; unstable; fines; moderate-high offshore velocity; deep immediately offshore; instream/overhead cover from submerged bank materials/vegetation/depth
	E2	Similar to E1 without the large amount of instream vegetative debris; offshore depths shallower
	E3	High, steep eroding banks; loose till deposits (gravel/cobble/sand); moderate-high velocities and depths; instream cover limited to substrate roughness; overhead cover provided by turbidity
	E4	Steep, eroding/slumping highwall bank; primarily fines; moderate-high depths/velocities; instream cover limited to occasional BW formed by bank irregularities; overhead cover from depth/turbidity
	E5	Low, steep banks, often terraced; fines; low velocity; shallow-moderate; no instream cover; overhead cover from turbidity
	E6	Low slumping/eroding bank; substrate either cobble/gravel or silt with cobble/gravel patches; moderate depths; moderate-high velocities; instream cover from abundant debris/boulder; overhead cover from depth/turbidity/overhanging vegetation

Table D.6. Special Habitat Features, Symbols, and Descriptions.

Type	Symbol	Description
Pool	P	High, steep eroded banks with terraced profile; unstable; fines; moderate-high offshore velocity; deep immediately offshore; instream/overhead cover from submerged bank materials/vegetation/depth
Tributary Confluence	TC	Confluence area of tributary entering mainstem; tributary confluence [sub-classified according to tributary flow and wetted width at mouth at the time of the survey]
	TC1	Intermittent flow, ephemeral stream
	TC2	Flowing, width < 5m
	TC3	Flowing, width 5 - 15m
	TC4	Flowing, width 16 - 30m
	TC5	Flowing, width 31 - 60m
	TC6	Flowing, width > 60m
Shoal	SH	Shallow (< 1m deep), submerged areas in mid-channel or associated with Depositional areas around islands/side bars
	SHC	Submerged area of coarse substrates
	SHF	Submerged area of fine substrates
Backwater	BW	Discrete, localized area exhibiting reverse flow direction and, generally, lower velocity than main current; substrate similar to adjacent channel with more fines
Rapid	RA	Area with turbulent flow, broken surface (standing waves, chutes etc.), high velocity (>1 m/s), armoured substrate (large boulder/bedrock) with low fines
Snye	SN	Discrete section of non-flowing water connected to a flowing channel only at its downstream end, generally formed in a side channel or behind a peninsula (bar)
Slough	SL	Non-flowing water body isolated from flowing waters except during flood events; oxbows
Log Jam	LJ	Accumulation of woody debris; generally located on island tips, heads of side channels, stream meanders; provide excellent instream cover

2) Streambank Assessment

Kingfisher standard procedures for streambank assessment are derived from the guidelines for complying with the Code of Practice for Watercourse Crossings Section B Physical Assessment Components (Alberta Environment 2001). At a minimum, five transects will be established within the study area perpendicular to stream flow. Table D.7 provides a description of the parameters that will be assessed along each transect.

Table D.7. Streambank Transect Parameters, Units and Descriptions.

Parameter Components	Parameter Units	Description
Channel Properties		
Wetted Width (m)	Metres	The distance across the wetted surface of the waterbody perpendicular to stream flows
Bankfull Width (m)	Metres	The distance between the LUB and the RUB at level of the 1:2 year highwater mark perpendicular to stream flows
Depth (m)	Metres	The distance from the water surface to a point vertically inline on the streambed
Velocity (m/s or s/m)	Metres per Second, Seconds per Metre	The distance travelled by flowing water per unit of time
Streambed Substrate (FN,GR,CB,BL,BR)	Fines, Gravel, Cobble, Boulder, Bedrock	The material composing the bottom of a stream below the usual water surface
Instream Cover (WD, OV, AV, BL)	Woody Debris, Overhanging Vegetation, Aquatic Vegetation, Boulder	Submerged stream features that are capable of providing shelter for the fish species present within the waterbody
Bank Properties		
Bank Height (m)	Metres	The distance from the water surface to the top of the level of the 1:2 year highwater mark
Bank Angle (º)	Degrees	The angle of the slope of the bank from the waters surface to the 1:2 year highwater
Bank Cover (WD, OB, OV)	Woody Debris, Overhanging Bank, Overhanging Vegetation	Bank features that are capable of providing shelter for the fish species present within the waterbody
Bank Substrate (FN, GR,CB,BL,BR)	Fines, Gravel, Cobble, Boulder, Bedrock	The material composing the streambanks adjacent to the usual water surface
Riparian Vegetation (Gr, Sh, Tr, Ex, Ar)	Grass/Bryophyte, Shrub, Tree, Exposed Bank, Armoured Bank	Vegetation (or the absence of the vegetation) rooted within the riparian area immediately adjacent to the bank
Bank Stability (S or U)	Stable or Unstable	Bank areas displaying slumping, fracturing, or other signs of erosion that would cause bank material to enter the waterbody
Bank Undercut (m)	Metres	Length of bank overhanging into the channel

3) Water Quality

In situ water quality as described in Table D.8 will be measured at one location within the study area.

Table D.8. *In Situ* Water Quality Variables and Units of Measure.

Variable	Parameter Units of Measure
Temperature	Degrees Celsius
pH	Potential of Hydrogen
Dissolved Oxygen	Milligrams per Litre
Conductivity	Micro-Siemens per Centimeter
Turbidity	Nephelometric Turbidity Unit

4) Photographic Documentation

Photographs will be taken to document general site and habitat conditions as well as channel and bank features with the study area. Typical photographic documentation may include the following:

- representative fish habitat and channel form within the study area;
- unique and/or important habitat or channel features;
- the waterbody looking upstream and downstream from the upstream end of the study area;
- the waterbody looking upstream and downstream from the downstream end of the study area;
- the waterbody looking upstream at the proposed right of way; and
- the waterbody looking downstream at the proposed right of way

D) HABITAT EVALUATION

The overall capability of the local habitat within the study section was evaluated based on the sensitivity of species that occupy the habitat, the utility of the habitat (what life processes it supports), and the rarity of the habitat (Table E.1).

Table E.1. Description of Habitat Evaluation and Ranking Criteria.

Evaluation Criteria	Description	Ranking
Sensitivity	What is the sensitivity of species that occupy the habitat?	Low – habitat is primarily utilized by forage and course fish species Moderate – habitat is primarily utilized by forage, coarse, and sport fish species but no highly sensitive species or species of concern are expected to utilize the habitat High – habitat is expected to be utilized by sensitive and/or threatened species.
Utility	For each fish guild (forage, coarse, sport), does the habitat support: • Spawning? • Rearing? • Feeding? • Migration? • Overwintering?	Low – habitat is not a requisite for survival of species Moderate – habitat is important but not critical for survival of species High – habitat is critical for survival of species
Habitat Rarity	How rare is the habitat within the study section and the within the general vicinity of the project?	Low - the habitat is common and available in large quantities Moderate - the habitat is not common and has limited distribution High - the habitat is in unique and only present in small quantities

E) LITERATURE CITED

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Appendix C

Habitat Inventory Results

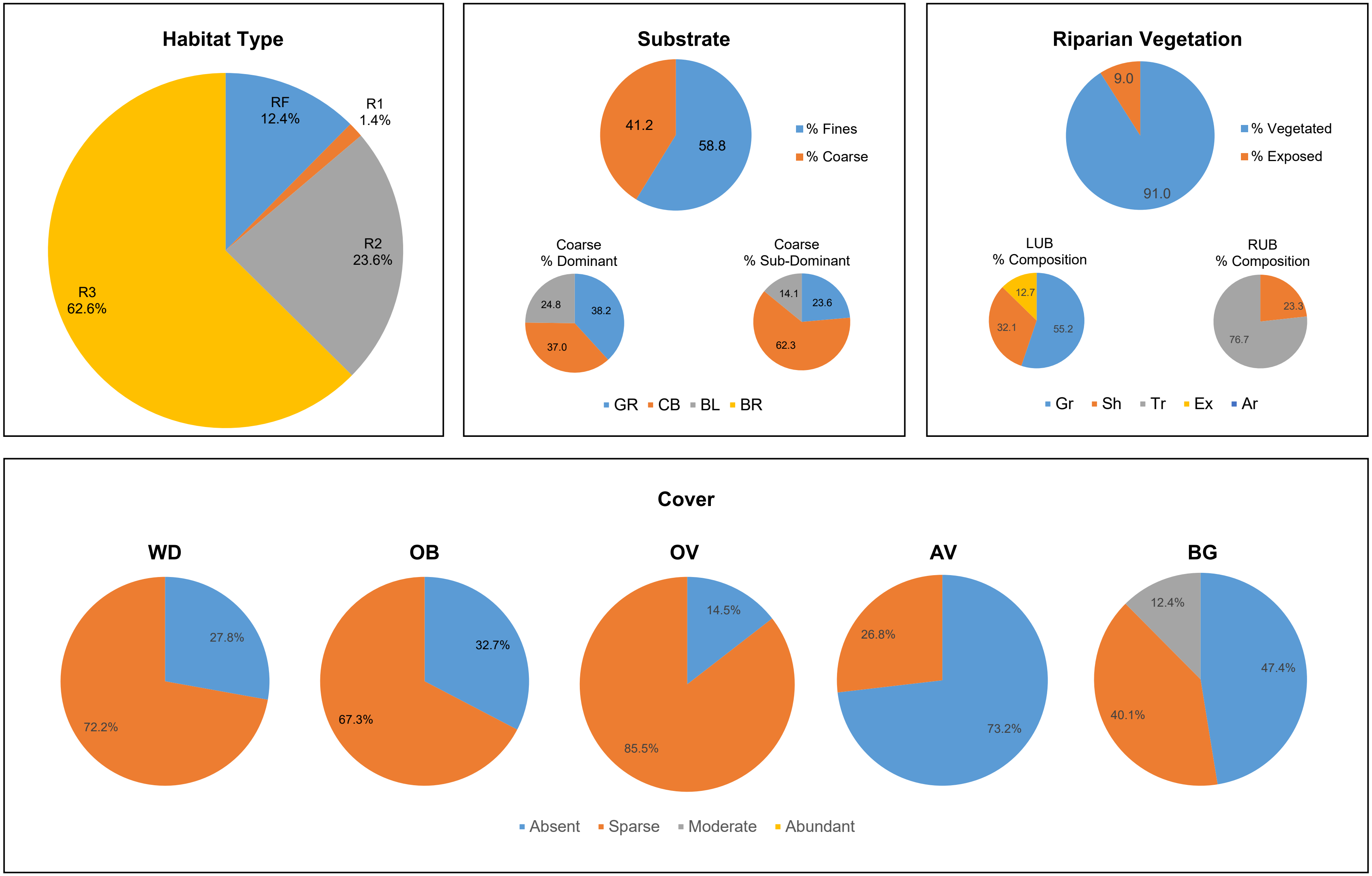

Figure C-1. Summary results for habitat inventory on Whitemud Creek adjacent to the Smith Crossing bridge structure.

Appendix D

Photographs

Plate 1: Looking upstream from the upstream end of the study section.

Plate 2: Looking downstream from the upstream end of the study section.

Plate 3: Looking downstream at the bridge structure.

Plate 4: Looking upstream at the bridge structure.

Plate 5: Looking downstream from below the bridge structure.

Plate 6: Looking upstream from below the bridge structure.

Plate 7: Looking upstream from the downstream end of the study section.

Plate 8: Looking downstream from the downstream end of the study section.

Appendix G: Geotechnical Reports (Thurber 2019b, 2021)

SMITH CROSSING (BF191)
PEDESTRIAN BRIDGE REPLACEMENT
GEOTECHNICAL INVESTIGATION

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SMITH CROSSING (BF191)
PEDESTRIAN BRIDGE REPLACEMENT
GEOTECHNICAL INVESTIGATION

Report
to
City of Edmonton

Graeme Law, M.A.Sc, E.I.T.
Geotechnical Engineer

Date: October 4, 2019
File: 26386

Robin Tweedie, P.Eng.
Review Principal

TABLE OF CONTENTS

1 INTRODUCTION

This report presents the results of a geotechnical investigation carried out by Thurber Engineering Ltd. (Thurber) for the pedestrian bridge replacement project at the Smith Crossing Pedestrian Bridge, over Whitemud Creek in Edmonton, Alberta.

The scope of the geotechnical investigation was outlined in our proposal to Ms. Christina Tatarniuk, M.Sc., P.Eng., of the City of Edmonton Engineering Services (COE) on June 10, 2019. Authorization to proceed with the investigation was received from Ms. Christina Tatarniuk via email on June 24th, 2019.

This investigation did not include an assessment of soil or groundwater for environmental contamination purposes.

This report supersedes our draft report dated August 30th, 2019, and addresses the comments received from the COE and the structural engineers, BPTEC Engineering (BPTEC).

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2 BACKGROUND

The COE is planning to replace the Smith Crossing pedestrian bridge over Whitemud Creek. The bridge is located south of 23rd Avenue on the MacTaggart Sanctuary trail system immediately downstream of its confluence with Blackmud creek (Photographs 1 and 2, included in Appendix E).

The existing bridge consists of a single-span steel pony truss and is supported on unreinforced cast-in-place concrete abutments (Photographs 3 and 4, included in Appendix E), which also retain the approach fills. The north abutment of the bridge is directly exposed to flow and protected by vegetated gabion baskets, while riprap has been placed on the southeast bank to protect the south abutment during high water events.

BPTEC has conducted a condition assessment of the existing bridge in 2018. It is understood that the new bridge will have a similar clearance as the existing bridge. Grade changes will be minimized but the bridge will consist of a longer, single span structure, such that the abutments will be moved back from the river's edge. We also understand the preferred foundation type is pre-cast abutments on driven steel piles.

3 METHOD OF INVESTIGATION

3.1 Field Drilling Program

The field investigation program consisted of drilling one test hole at each abutment location, as shown on Drawing No. 26386-1 in Appendix A.

The test holes were drilled between a period of July 10th and July 13th, 2019 using a track mounted M-4 auger drill rig operated by Mobile Augers and Research Ltd. of Edmonton. Test holes TH19-01 and TH19-02 were drilled to depths of 13.4 m (elevation 630.5 m) and 15.5 m (elevation 628.1 m) below ground surface respectively, and both test holes terminated in competent bedrock.

Prior to commencing the field drilling program, Thurber contacted Alberta One-Call to clear underground utilities at the borehole locations.

Disturbed and undisturbed samples were obtained during drilling and Standard Penetration Tests (SPTs) were carried out at selected depths in the test holes. The undrained shear strength (C_{pen} values) of cohesive soil samples was estimated at select locations using a pocket penetrometer.

Seepage and water levels in the test holes were recorded during and immediately after drilling. A standpipe piezometer was installed in TH19-01 to permit future monitoring of the groundwater. The standpipe piezometers were installed flushed to the ground surface. The standpipe piezometer was monitored at the completion of installation and on July 29, 2019.

Test hole TH19-02 was backfilled with drill cuttings and capped with bentonite chips near the ground surface. The results of the geotechnical drilling and field tests are summarized on the test hole logs included in Appendix B.

3.2 Laboratory Program

Laboratory testing consisted of visual classification and determination of the natural water content of all soil samples. Atterberg limits tests, grain size analyses, and soluble sulphate content tests were performed for selected soil samples. In addition, an undrained shear strength test was also conducted on a select undisturbed (Shelby Tube) sample from TH19-01.

The results of laboratory tests are summarized on the test hole logs in Appendix B. The results of strength tests and gradation plots are provided in Appendix D.

3.3 Existing Information Review

An extensive amount of geotechnical information is available from previous investigation along the 23rd Avenue alignment and adjacent slope instability areas. This information was obtained from the City of Engineering Services Library Search and our project files. A reference list at the end of this report summarizes the sources of this data.

Copies of relevant test hole logs close to the new pedestrian bridge location are included in Appendix C. The approximate locations of these test holes are shown on the site plan Drawing No. 26386-1 and subsurface stratigraphy Drawing No. 26386-2. The above information is also supplemented by available geological maps (Ref. 2 and Ref. 4).

4 SITE DESCRIPTION

4.1 Site Geology

The site geology is expected to be underlain by fluvial deposits derived from the Blackmud and Whitemud Creeks overlying Upper Cretaceous bedrock comprised of clay shales and sandstones of the Horseshoe Canyon Formations of the Edmonton Group (Ref. 2 and Ref. 4).

The clay shale and sandstone bedrock contain scattered coal and bentonitic beds. The bedrock materials are weakly cemented, often resembling hard over-consolidated clay, and exhibit many of the properties associated with soils such as softening and swelling on exposure to weathering.

The geology maps indicate that the bedrock is present and at approximately elevations of 635 m to 640 m at the bottom of the Whitemud Creek valley, consistent with the 2019 survey data provided by the COE. Recent fills from previous developments may be present on the river terraces.

4.2 Surface Conditions

The pedestrian bridge is located over the Whitemud Creek immediately downstream of its confluence point with Blackmud Creek (Photo 2, Appendix E). The site is immediately south of the 23rd Avenue twinned bridge crossing over the Whitemud Creek.

The north abutment is located on the edge of the creek and is directly exposed to the creek flows. The northeast riverbank upstream of the bridge is protected with gabion baskets which are overgrown with vegetation. The southwest riverbank downstream of the bridge is protected by heavy riprap where a storm water outlet discharges into the stream. .

Recent topographic surveys at the bridge location completed by the City were provided to Thurber and are illustrated on Drawing No. 26386-1 to 26386-2 in Appendix A. The bridge is relatively level, with ground surface elevations at about 643.5 m. The creek bed elevation at the project site is at about 639 m, hence the bridge deck sits 4 m above creek bed level.

The Whitemud Creek ravine slopes to the uplands area well away from the bridge site and are generally well vegetated with trees and shrubs or have undergone extensive slope stabilization measures in the past throughout the valley and were not assessed in this site-specific investigation. Selected photos of the site are provided in Appendix E.

4.3 Subsurface Conditions

The soil conditions encountered in the test holes are described on the test hole logs in Appendix B, and are summarized on the stratigraphic cross-section A-A' on Drawing No. 26286-2 in Appendix A. The stratigraphic conditions consist of the following main strata in descending order:

- Fill;
- Gravel;
- Clay; and
- Bedrock.

Further descriptions of the soil conditions encountered during drilling are provided in the following sections.

Review of available test hole logs from previous investigations (Ref. 5, 6, and Appendix C) indicate similar soil conditions and depth of surficial soils overlying clay shale. In the previous TH04-6, located near the south abutment, clay shale was encountered below gravel, sand and clay layers at a depth of 4.7 m (elevation of about 639 m) and extended to the termination depth of 6.0 m below original grade. In TH06-1, located about 20 m north of the north abutment, clay shale was encountered below sand and clay fills at a depth of 3 m (elevation of about 641 m) below original grade.

Surficial deposits of gravel and gravelly topsoil were encountered at the surface in the test holes. The thickness of the gravel ranged from about 50 mm to 200 mm.

4.3.1 Clay Fill

Clay fill was encountered under the surficial layers in both test holes advanced through the existing abutments. The clay fill extended to depths between about 3.0 m and 3.5 m below existing ground surface in test holes TH19-01 and TH19-02 respectively. The clay fill was generally dark brown, silty, and contained trace amounts of sand and coal chips. The fill likely originated from the local lacustrine clay and clay till materials from the upland areas. Traces of organics were occasionally encountered in the clay fill.

The natural water content of the clay fill ranged between about 17 and 30 percent. SPT “N” values of the clay ranged from 6 to 9 blows per 300 mm penetration indicating a firm to stiff consistency.

The result of an Atterberg limits test indicated the samples have a liquid limit ranging of 47 percent and a plastic limit ranging of 24 percent, indicating that the clay sample was medium plastic. A gradation analysis was conducted on a select sample, with sand, silt, and clay contents of 15, 62, and 23 percent respectively.

4.3.2 Gravel

Gravel was encountered underlying the clay fill layer in test hole TH19-02 at about 3 m below grade. The gravel layer was about 0.8 m thick and was compact, sandy and clayey, with a natural water content of ranging from 10 to 11 percent.

4.3.3 Clay

Silty clay was encountered underlying the gravel in test hole TH19-02 and extended to a maximum depth of about 3.8 m below existing ground surface. The clay was generally dark brown, silty, contained traces of sand, gravel, oxides, and coal.

The natural water content of the clay ranged from 17 and 25 percent. SPT “N” values of the clay ranged from 10 to 23 blows per 300 mm penetration, indicating a stiff to very stiff consistency.

4.3.4 Bedrock

Clay shale and sandstone bedrock was encountered underlying the clay fill or silty clay layers in both test holes. The depth to bedrock in the test holes ranged from 3.8 to 6.1 m, with corresponding top of bedrock elevations ranging from about 640 m (TH19-01) to 637 m (TH19-02).

The clay shale was generally dark brown or dark grey, silty, and contained varying amounts of sandstone. The natural water content of the clay shale ranged between about 15 and 37 percent. SPT "N" values of the clay shale ranged between 25 to over 100 blows per 300 mm penetration, indicating a very stiff to very hard consistency in soil mechanics terminology, generally increasing in stiffness with depth.

The sandstone encountered was generally grey, fine grained, silty, and contained trace to some amounts of clay shale and coal. The natural water content of the sandstone ranged between about 16 and 37 percent. SPT "N" values of the sandstone was 51 blows per 300 mm penetration, indicating a very dense state in soil mechanics terminology.

The result of one Atterberg limits tests indicated the clay shale has a liquid limit ranging from 79 percent and a plastic limit of 22 percent, indicating that the clay sample was highly plastic.

One unconfined compressive strength test was conducted on a Shelby tube sample of the upper clay shale. The results indicate the sample had a wet density of 1946 kg/m^3 and an undrained shear strength of about 131 kPa.

4.4 Groundwater Conditions

A standpipe piezometer was installed in TH19-01 to allow for future groundwater level monitoring. The groundwater levels were recorded upon completion of the standpipe piezometers installation and July 29, 2019.

The slough and groundwater levels are noted on the test hole logs in Appendix B and are summarized in Table 4.1.

TABLE 4.1
SEEPAGE AND SHORT-TERM GROUNDWATER LEVELS

TEST HOLE	GROUND ELEVATION	STANDPIPE INSTALLATION DEPTH * (m)	DEPTH * (ELEVATION) OF WATER TABLE	
			Upon Installation	July 29, 2019
TH19-01	643.87	13.0	4.1 (639.77)	1.5 (642.37)

Note: (*) Meters below current grade.

Results of the most recent monitoring on July 29, 2019 indicated that the groundwater level was about 642 m, which corresponds to about 3 m above creek level. It should be noted that groundwater levels can vary in response to seasonal factors and precipitation. Hence the actual groundwater conditions at the time of construction could vary from those recorded during this investigation.

4.5 Frost Effects

The surficial in-situ soils at this site are considered to have intermediate to high frost susceptibility. The expected depth of frost penetration has been estimated for the in-situ clay materials encountered in the test holes for both the mean annual Air Freezing Index (AFI) of 1400ºC-days, and the 50-year return period AFI of 2200ºC-days. The mean annual depth of frost penetration for the soils and the penetration for a 50-year return period are provided in Table 4.2.

TABLE 4.2
ESTIMATED DEPTH OF FROST PENETRATION

SOIL TYPE	MEAN ANNUAL AFI (1400ºC-days)	50-YEAR RETURN AFI (2200ºC-days)
Clay	2.1	2.5

The frost penetration depths are estimated for a uniform soil type with no insulative cover. If the area is covered with turf or significant snow cover, the depth of frost penetration will be less. The average frost depth may be used during construction with some risk; the 50-year return period depth should be used for design.

5 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

5.1 General

Based on discussions with COE, it is understood that the current recommendations are to replace the existing bridge with a new single span bridge. It currently consists of a single-span steel pony truss and is supported on unreinforced cast-in-place concrete abutments, which also retain the approach fills. The north abutment of the bridge is directly exposed to flow and protected by vegetated gabion baskets, while riprap has been placed on the southeast bank to protect the south abutment during high water events.

The preferred method is to install deep foundations with a pre-cast pile cap behind the existing concrete wing wall abutments. The following sections outline the comments on existing and proposed head slope stability, foundation types and estimated earth pressures.

5.2 Slope Stability Evaluation

5.2.1 General

The existing riverbank slopes are well vegetated and there does not appear to be any signs of riverbank instability. As reported by BPTEC, the heavy rock riprap on the southwest bank and the gabion basket slope protection on the northeast bank both appear to be functioning as intended at the present time. Select site photographs are included in Appendix E.

5.2.1.1 North Abutment

The northeast abutment is founded below the creek bed, and no head slope currently exists. The northeast bank incorporates gabion baskets at the toe of the riverbank slope up that extends up to the wing wall of the abutment. No details are available on the existing gabion baskets; however, it is assumed that the gabion baskets were installed in the past to prevent further toe erosion. In addition, the condition of the gabion baskets is not known.

At the present time, the northeast riverbank slope appears relatively stable and no evidence of bank erosion was observed during our site visits. It is recommended that the creek bank erosion protection be reviewed by a hydrotechnical consultant to evaluate the adequacy and determine if additional creek bank erosion protection is warranted.

5.2.1.2 South Abutment

It is understood the preferred foundation alignment is to install pile foundations behind the existing wing wall. Slope stability analyses of the south abutment were undertaken using the program SLOPE-W based on limit equilibrium stability analysis for two separate cases as follows:

- The first case employed geometries based on a cross-section of the existing surveyed slope profiles provided by the COE and the expected soil conditions were based on the available test hole logs.

- In the second case a 2:1 (H:V) slope was assumed to have been constructed of common fill materials and placed above the existing soils. The stability analyses and results are outlined in subsequent sections.

5.2.1.3 Stability Analysis

It should be recognized that the test holes were limited to accessible locations on the existing trail and hence the subsurface conditions between test holes and particularly on the creek slopes have been estimated based on the available geological observations.

Presumptive soil parameters were chosen based on the results of this investigation and also from comparison of soil parameters on similar soils and bedrock materials from other representative sites in the Edmonton area. Results of the stability analyses are presented in Appendix D and summarized in Tables 5.1.

TABLE 5.1
SOIL AND BEDROCK STRENGTH PARAMETERS
USED IN STABILITY ANALYSES

SOIL TYPE	UNIT WEIGHT (kN/m^3)	EFFECTIVE FRICTION ANGLE ϕ' (°)	EFFECTIVE COHESION c' (kPa)
Heavy Rock Rip Rap	22	45	0
Clay Fill	18	23	5
Sand and Gravel	21	34	0
Clay	18	23	5
Clay Shale	21	25	20

A target factor of safety of 1.5 is typically desired for the head slope stability of bridges. The effects of the existing concrete abutments on slope stability were also included in the slope stability assessment of existing conditions. The existing abutments are shown on the drawings provided by the COE and are included in Appendix A. Results of the slope stability analyses are presented in Table 5.2.

TABLE 5.2
RESULTS OF SLOPE STABILITY ANALYSES

CASE	FACTOR OF SAFETY	FIGURE
Existing Head Slope	1.55	D1
2H:1V Head Slope	1.89	D2

In both the present and proposed cases, the south head slope under the bridge appears to be in a stable condition, with a long-term factor of safety of at least 1.5. Given the relatively low height of the abutment, small anticipated surcharge loads, and the proximity to the bedrock, deep seated failure is not considered to be a governing factor for the stability of the bridge. At the present time, the south side slope also appears relatively stable. However, it is recommended to monitor these slopes and particularly the condition of the heavy rip rap in the future in order to obtain early warning of potential deterioration and/or slope movements such that any future repairs can be planned.

We understand the preferred foundation type for the proposed new bridge is piles. As a result, we do not anticipate the stability of the side slopes to be a significant factor in the upgrade to a new bridge.

Where necessary, Class II rip rap (City of Edmonton Construction Specifications Section 02374) could be placed at the toe of the riverbanks to enhance the riverbank erosion protection. However, the erosion protection should be reviewed by a hydrotechnical consultant to evaluate the adequacy and determine if additional riverbank erosion protection is warranted.

5.3 Foundation Types

5.3.1 General

It is understood that pile foundations will be required to support the new bridge. Potential foundation types being considered include cast-in-place concrete piles and driven steel piles.

It is expected that the final choice of foundation types will depend on load requirements, accessibility of piling equipment, ease of construction, as well as economic and scheduling considerations.

Recommendations for each of these foundation types are provided in the following sections. Additional recommended construction procedures are presented in Appendix F.

Both pile types may be designed based on a combination of skin friction plus end bearing resistance. The ultimate geotechnical pile capacity for Limit States Design (LSD) is defined as follows:

$$Q_T = Q_B + Q_s \quad (kN)$$

Where:

Q_T = Ultimate static pile capacity (kN)

Q_B = Ultimate end bearing capacity (kN)

Q_s = Ultimate skin friction capacity (kN)

The factored ULS pile capacities are based on the product of the estimated ultimate pile capacity and the appropriate geotechnical resistance factors. The geotechnical resistance factors are prescribed in the National Building Code (NBC, 2015) and are dependent on the method used to determine the ultimate pile capacity, as summarized in Table 5.3.

TABLE 5.3
RECOMMENDED GEOTECHNICAL RESISTANCE FACTOR FOR LIMIT STATES DESIGN OF DEEP FOUNDATIONS
(NBC 2015)

DESCRIPTION	GRF ^{1}
(a) Resistance to axial load	
(i) semi-empirical analysis using laboratory and in-situ test data	**0.4**
(ii) analysis using static loading test results	0.6
(iii) analysis using dynamic monitoring results	0.5
(iv) uplift resistance by semi-empirical analysis	**0.3**
(v) uplift resistance using loading test results	0.4
(b) Resistance to horizontal load	0.5

Note: *Bolded values should be used for pile design, unless appropriate pile load tests are conducted; and
(1) Geotechnical Resistance Factor.

The factored ULS geotechnical pile capacity is equal to the ultimate geotechnical pile capacity times a resistance factor. A resistance factor of 0.4 may be used for compression and 0.3 for tension (ref NBC 2015). The geotechnical resistance factor in compression may be increased to 0.5 if the capacity of driven steel piles is verified by dynamic testing of piles (i.e. PDA tests) during construction.

5.3.2 Cast-in-Place Concrete Piles

The following general recommendations are provided for design and installation of cast-in-place concrete piles.

a) Cast-in-place concrete end bearing piles should be founded at least 2 m into the hard to very hard clay shale (with SPT N values greater than 100) at a suggested minimum basing elevation at about 633 m. It should be noted that the depth of the bedrock varies across the site, and the closest test hole should be referred to during design and installation.

b) Cast in place concrete piles founded in the hard bedrock may be design using the factored ULS deign values presented in Table 5.4.

TABLE 5.4
RECOMMENDED ULS SKIN FRICTION AND END BEARING VALUES FOR CAST-IN-PLACE CONCRETE PILES

APPROX. DEPTH B.G.S. (m)	APPROX. ELEVATION (m)	SOIL TYPE	SKIN FRICTION (kPa)			END BEARING (kPa)	
			Ultimate	ULS Factored [2] Compression	ULS Factored[3] Tension	Ultimate	ULS Factored[2]
0 – 2[1]	644 – 642	Clay/ Clay Fill	0	0	0	IGNORE	IGNORE
4 – 8	642 – 636	Clay / Sand	60	24	18	IGNORE	IGNORE
> 8	Below 636	Clay Shale	100	40	36	2,500[4]	1,000

Note: (1) Depth of 2.0 m or the thickness of fill, whichever is greater;
(2) Geotechnical Resistance Factor Compression (GFR) = 0.4;
(3) Geotechnical Resistance Factor Tension (GFR) = 0.3; and
(4) For piles based in very hard clay shale at minimum basing elevation of 633 m.

c) Shaft adhesion may be included in the design of end bearing piles where necessary. Shaft adhesion should however not be included in the upper 2 m (or depth of fill) of the pile below final grade to allow for the possibility of soil drying and shrinking away from the pile shaft. Shaft adhesion should also be ignored within the design depth of scour at the pier pile locations.

d) In the case of belled piles, the bell diameter to shaft diameter ratio should not exceed 3:1, and the bell should not be sloped at more than 30° to the vertical.

e) Where belled piles are used, a minimum pile depth of 2.5 times the bell diameter has been assumed in calculating the above bearing capacity. If less cover is provided, the specified bearing capacity should be reviewed.

f) A minimum pile spacing of 3 shaft diameters is recommended for straight shaft and belled concrete piles. In addition, a minimum edge-to-edge spacing of 600 mm is recommended in the case of belled piles to reduce potential construction problems. Piles within 3 shaft diameters for straight shaft piles or 2 bell diameters for belled piles should not be drilled or poured consecutively within the same 24-hour period in order to allow the concrete in the adjacent pile to set.

g) A minimum pile shaft diameter of 400 mm is recommended to prevent voids from forming during pouring of the concrete. Larger diameter piles are generally required for piles subjected to lateral loading.

h) Longitudinal reinforcement is required through the pile shaft length to resist potential uplift forces on the pile due to frost action and seasonal moisture variations. If piles are designed as tension elements or are left exposed to freezing temperatures, the pile reinforcing should be designed to resist the anticipated uplift stresses.

i) Temporary steel casing(s) will be required to extend the pile holes through the sand and gravel layers, and to retain the ingress of the high groundwater level (Section 4.4) during construction. Where sand or gravel layers are encountered at or above pile basing depth, it will be necessary to provide steel casing and extend the pile bases deeper into self-supporting soil. The temporary steel casings will also be necessary to prevent potential river flow into the pile holes in the event of high-water levels in the creek.

j) All pile excavations should be thoroughly cleaned and visually inspected prior to pouring of the concrete to ensure a satisfactory base has been achieved. No slough or disturbed material should be allowed to remain in the pile excavations. Geotechnical inspection is recommended to confirm suitable bearing conditions have been achieved.

k) Concrete should be poured immediately after drilling of the pile hole to reduce the risk of groundwater seepage and sloughing soil.

l) Cobbles and boulders may be present within the clay, clay till, or sand and gravel layers which could hamper augering if encountered in the pile hole.

m) The concrete materials and methods of concrete construction should be as per CSA A23.1:19/A23.2:19.

5.3.3 Driven Steel Piles

5.3.3.1 General

Driven steel H-section or pipe piles are considered feasible to support the proposed structure at this site.

The piles should be driven to the required embedment depth into the bedrock layer. Pile length requirements will depend on the design loads and driving resistance. It is expected that the driving resistance may vary between abutments, and hence it is important that monitoring of pile driving should be carried out for all piles to verify that the required pile loads have been met.

Based on the available test holes it is anticipated that hard driving will be required to advance the piles through the bedrock. For estimation of pile penetration depths, it is expected that piles may meet practical refusal at about elevation 632 m at the north abutment, and about 634 m at the south abutment; however, the pile penetration depths may vary depending on the driving energy and bedrock conditions at the abutment locations.

The effect of driving vibrations and noise on the existing structures and site operations would also need to be taken into consideration in choosing driven steel piles for foundation support. As a general guideline, construction vibrations should be limited to peak particle velocities of about 25 to 50 mm/s (depending on the condition of the structure) to avoid potential damage to existing concrete structures (Ref. 1**).** Vibration propagation generally should not be a problem for structures located greater than about 15 m from the location of pile driving. However, this should be evaluated taking account of the condition of the existing structures and any underground pipelines near the new abutments. Monitoring of construction vibrations should be carried out during pile driving to check the magnitude of construction vibrations and make any modifications to the pile installation methods as necessary.

At the project site, an existing stormwater outfall exists on the south bank of the creek, about 10 m west of the south abutment of the Smith Crossing alignment. As such, we recommend vibration monitoring during pile installation due to given the subsurface conditions and proximity to construction.

5.3.3.2 Vertical Pile Capacity

Driven steel piles may be designed based on the ultimate and factored ULS skin friction and end bearing values provided in Tables 5.5 respectively.

TABLE 5.5
RECOMMENDED ULS SKIN FRICTION AND END BEARING VALUES FOR DRIVEN STEEL PILES

APPROX. DEPTH B.G.S. (m)	APPROX. ELEVATION (m)	SOIL TYPE	SKIN FRICTION (kPa)			END BEARING (kPa)	
			Ultimate	ULS Factored ^{2} Compression	ULS Factored^3 Tension	Ultimate	ULS Factored^2
0 – 2[1]	644 – 642	Clay/ Clay Fill	0	0	0	IGNORE	IGNORE
2 – 8	642 – 636	Clay / Sand	60	24	18	IGNORE	IGNORE
> 8	Below 636	Clay Shale	100	40	36	12,000[4]	4,800

Note: (1) Depth of 2.0 m or the thickness of fill, whichever is greater;
(2) Geotechnical Resistance Factor Compression (GFR) = 0.4;
(3) Geotechnical Resistance Factor Tension (GFR) = 0.3; and
(4) For piles driven to practical refusal in very hard clay shale and capacities verified by driving records.

The piles should be driven to a minimum embedment depth of 8 m to provide sufficient resistance to frost heave, without considering dead loads acting on the piles.

Shaft friction should not be included in the upper 2 m below finished grade to allow for the possibility of soil drying and shrinking away from the pile shaft.

5.3.3.3 Pile Driving

Steel piles should be driven with a hammer of appropriate size and rated energy, depending on the pile design load requirements. As a general guideline, the driving energy should be limited to 630 J per square cm of steel cross section area unless the results from WEAP analyses and/or PDA tests indicate that greater energy could be used without damage to the piles.

The minimum energy required will depend on the pile sizes and design loads and should be determined using WEAP analyses when the design sizes and loads are available. Pile driving records should be maintained during driving of all piles and should be reviewed to confirm that the set criteria have been achieved.

The following guidelines should generally be followed for pile driving and approval:

1. Piles should be driven to the specified pile embedment depths and the required set criteria unless the piles meet premature refusal. Practical refusal is typically defined as a blow count of greater than 125 blows per 250 mm (less than 2 mm per blow), however this

should be reviewed based on the results of the driving analysis.

2. Where the piles reach the target depths and the required set for long-term conditions is achieved at the end of initial drive (EOID), the piles may be accepted.

3. In the event that the required set is not achieved at EOID for the design pile embedment depths, the piles should be extended deeper until the set criteria are met. Alternatively, the piles may be allowed to set up for a period of at least 7 days (one week). Selected piles should then be re-tapped to determine if the set requirements are met after "set-up". The "restrike" should consist of not more than 10 blows of the same (or larger) hammer energy and should be conducted on piles that have not been subjected to potential disturbance from driving of adjacent piles within at least 10 m during the "set-up" period.

4. Where necessary, PDA tests may be undertaken on selected to confirm the pile capacity and verify the set criteria for a specific piling hammer.

5. In the event that premature refusal of the piles is met due to encountering dense material above the target depth, the piles should be reviewed by structural and geotechnical engineers to check that they have adequate capacity to resist the design compression and uplift forces.

6. All piles should be checked for plumbness, and potential damage due to driving at the end of the installation. An out-of-plumb tolerance of 2 percent is typically specified for driven steel piles. Care will be required in set-up and driving of the piles to meet these objectives.

7. Heave of adjacent piles is a concern for close pile spacing and should be monitored throughout the driving. All piles indicating heave of greater than about 5 mm should be re-driven to at least the original embedment depths. If necessary, pile heave may be reduced by pre-boring.

8. Pre-boring may be required through the bedrock within the depth of pile installations. Pre-boring may also be required through the frost zone in the event the pile installations are undertaken during winter when the ground is frozen.

11. The pre-boring hole diameter should be limited to 90 percent of the pile diameter/width or less. Where pre-boring is required through the frozen zone in winter operations, it is more common to oversize the pre-bored hole through the frost depth, and to subsequently backfill the annulus between the pile hole and the pile with lean concrete or compacted granular fill.

12. Driving of deep steel piles may cause a void to form near ground surface due to pile “flutter” during driving. When this occurs, the voids should be backfilled with either grout or tamped sand to maintain the contact between the pile and ground in order to provide the required resistance to vertical and horizontal loads. Voids in the surficial fill caused by flutter may also be filled with bentonite slurry to maintain the integrity of the fill. Pile Monitoring During Construction

Pile monitoring should be carried out during the pile installations for the proposed building to confirm that the required pile installation specifications and capacity are met.

There may be considerable variation in the hammer performance achieved during driving that affects the delivered energy to the pile. Thus, the actual pile capacity may be subject to significant variability for a given set.

5.4 Concrete Grade Beams and Pile Caps

Where pile foundations are used, grade beams or pile caps may be required to transfer the structure loads onto the tops of the piles. If the bases of the grade beam and pile caps are located within the design depth of frost penetration, precautions should be taken to prevent heaving of the grade beam and pile cap due to frost penetration or alternatively the piles and pile cap should be designed to resist the resulting uplift pressures.

The recommended construction procedure for preventing heave under the grade beams and pile caps involves placement of a layer of crushable non-degradable void form at least 150 mm thick under the pile cap. The grade beam must be designed in accordance with the crushing strengths of the void form used and the piles must be able to resist the resulting uplift load.

5.5 Retaining Walls

A triangular earth pressure distribution may be utilized for design of low retaining walls and structures resisting earth pressures. The horizontal earth pressure, p_h, at depth, h, may be calculated as follows:

p_h = k x [(W x h) + q) (kPa)

Where:

k = the coefficient of earth pressure (Table 5.6)

W = the bulk unit weight (kN/m^3)

h = the depth below backfill surface (m)

q = surcharge pressure (kPa)

TABLE 5.6
LONG-TERM EARTH PRESSURE COEFFICIENTS FOR VERTICAL RETAINING WALLS ASSUMING A STIFF WALL, GOOD SURFACE DRAINAGE, AND HORIZONTAL BACKSLOPE

SOIL DESCRIPTION	BULK UNIT WEIGHT kN/m^3	COEFFICIENTS OF EARTH PRESSURE		
		k_a ACTIVE	k_o AT-REST	k_p PASSIVE
Clay Backfill - on site clay and clay till (compacted to 95% of SPMDD)	21	0.40	0.58	2.5
Sand Backfill - on site sand (compacted to 95% SPMDD)	20	0.30	0.45	3.4
Pit Run Gravel Compact (compacted to 95% SPMDD)	22	0.27	0.43	3.7

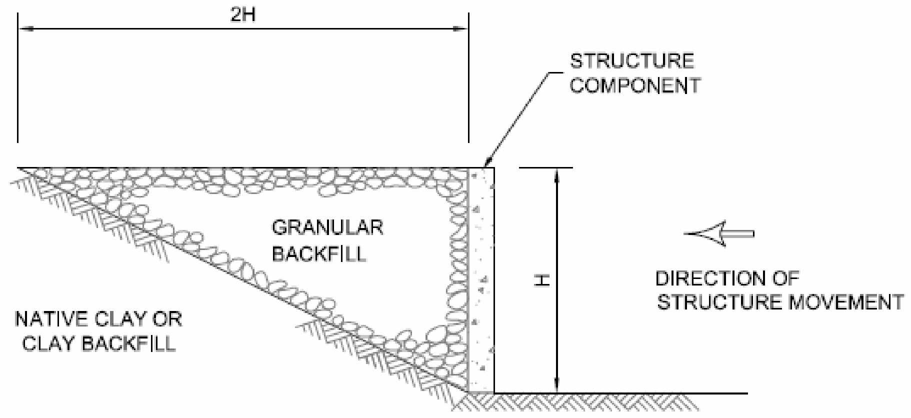
Note: SPMDD = Standard Proctor Maximum Dry Density

Active earth pressure may be used for design of relatively low retaining walls that can be allowed to move laterally at the top of wall a distance of 0.01 times the height of the wall. The passive pressure will be mobilized when the top of the wall has moved into the backfill a distance of 0.02 times the height of the wall. The passive resistance should only be used where there is assurance that the soil in front of the wall will not be displaced in the future either due to scour or excavation.

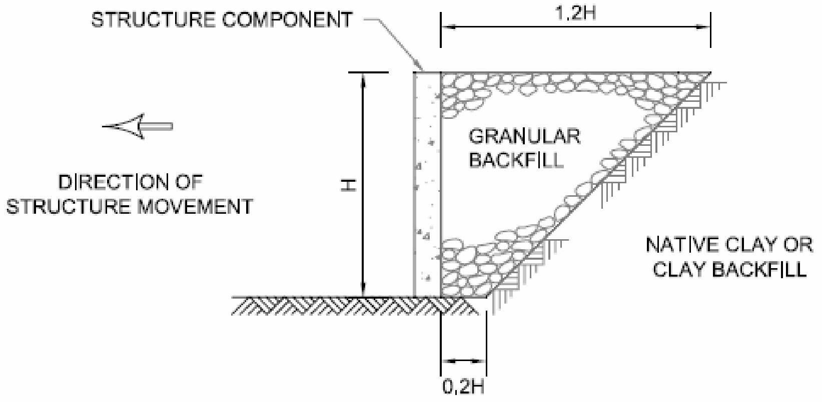
Appropriate load factors should be applied to the lateral earth pressures on retaining walls. A geotechnical resistance factor of 0.5 should be applied to the passive pressure. During detailed design, Thurber should be contacted to review the retaining wall design and to assess the global stability of the slopes retained by the walls.

Where traffic or other live loads may travel or operate near the retaining wall the horizontal pressures due to the live load should be superimposed on the static earth pressures.

The earth pressures are governed by the soil type within a zone of mobilized soil behind the wall. The minimum thickness of backfill required to mobilize the recommended coefficients of earth pressure for gravel is shown in Figure 5.1.



(a) MINIMUM THICKNESS OF GRANULAR BACKFILL TO MOBILIZE PASSIVE EARTH PRESSURES



(b) MINIMUM THICKNESS OF GRANULAR BACKFILL TO MOBILIZE ACTIVE EARTH PRESSURES

MINIMUM THICKNESS OF GRANULAR BACKFILL REQUIRED TO MOBILIZE RECOMMENDED COEFFICIENTS OF EARTH PRESSURES FOR GRAVEL

FIGURE 5.1

Where retaining structures will extend below the water table, either subdrainage should be provided to maintain the groundwater level below the base of the wall or alternatively the earth pressures should be calculated as follows, assuming full hydrostatic pressures (parameters defined above):

$$p_h = [k \times (W - 9.8) + 9.8] \times h \quad \text{(kPa)}$$

Perimeter drainage, where used, should consist of perforated drains surrounded by washed gravel and enveloped with a non-woven geotextile. Free-draining sand or gravel should be placed against the wall to about 600 mm below the ground surface and an impervious clay cap should be formed at the ground surface. The purpose of the free draining sand is to allow hydraulic flow to the subdrains. The purpose of the 600 mm clay cap is to prevent surface water infiltration into the backfill. Other types of impervious barriers such as geomembranes, concrete slabs or hard surfacing could be used to achieve this objective.

Frost action should also be considered in the design of retaining walls where the backfill is subject to freezing. The recommended approach for preventing horizontal frost pressures on the retaining walls is through the use of frost stable backfill combined with subdrainage where necessary.

Care should be taken not to over compact the backfill, otherwise higher earth pressure will result which may distress the wall.

Gravel fill behind the concrete retaining walls may consist of crushed gravel or pit run gravel meeting City of Edmonton Specifications Class 3, Designation 20 or Class 3, Designation 80 respectively.

5.6 Cement Type

Two water-soluble sulphate ion (SO_4) content tests were conducted on selected soil samples recovered from the test holes. The tests results show the presence of less than 0.1 percent of water-soluble sulphate content in the soil samples.

As a result, CSA Type GU (General Use hydraulic cement) may be used in the subsurface concrete at this project site. Results of the sulphate testing is presented on the test hole logs in Appendix B.

The recommendations stated above for the subsurface concrete at this site may require further additions and / or modifications due to structural, durability, service life or other considerations which are beyond the geotechnical scope.

In addition, if imported material is required to be used at the site and will be in contact with concrete, it is recommended that the fill soil be tested for sulphate content to determine whether the above stated recommendations remain valid.

In addition, if imported material is required to be used at the site and will be in contact with concrete, it is recommended that the fill soil be tested for sulphate content to determine whether the above stated recommendations remain valid.

5.7 Seismicity

Hard bedrock was encountered underlying the surficial soils at depths of about 6 m below existing grade. Based on Table 4.1.8.4A of the National Building Code (2010) definitions, the classification for seismic site response is Site Class C.

6 CONSTRUCTION INSPECTION

The performance of the structures 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 the piles for the are installed in competent bearing material and that the stratigraphy is similar to those that have been assumed for the design.

7 LIMITATIONS AND USE OF REPORT

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before any final design or construction details have been prepared or issued. Therefore, differences may exist between the report recommendations and the final design, in the contract documents, or during construction. In such instances, Thurber Engineering Ltd. should be contacted immediately to address these differences.

Designers and contractors undertaking or bidding the work should examine the factual results of the investigation, satisfy themselves on to the adequacy of the information for design and construction, and make their own interpretation of the data as it may affect their proposed scope of work, cost, schedules, and safety and equipment capabilities.

8 LIST OF REFERENCES

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

APPENDIX A

Drawing No. 26386-1 – Overall Site Plan Showing Test Hole Locations
Drawing No. 26386-2 – Stratigraphic Cross-Section at Bridge

H:\26000\26386 Smith Crossing Pedestrian Bridge - Edm, AB\Drafting\26386-1~2.dwg - 1 - Aug. 12, 2019

LEGEND

- 🔴 2019 TEST HOLE LOCATION
- ⚫ PREVIOUS TEST HOLE LOCATION (THURBER, HBT)

0 5 10 15 20 25m

SCALE 1:400

SURVEY DATA PROVIDED BY THE CITY OF EDMONTON ON JUNE 21, 2019
2017 AIR PHOTO FROM THE CITY OF EDMONTON

THE CITY OF Edmonton

SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT - WHITEMUD CREEK, EDMONTON, AB
GEOTECHNICAL INVESTIGATION

SITE PLAN SHOWING TEST HOLE LOCATIONS

DWG No. 26386-1

DRAWN BY	KLW
DESIGNED BY	GL
APPROVED BY	RWT
SCALE	1:400
DATE	AUGUST 2019
FILE No.	26386

THURBER ENGINEERING LTD.

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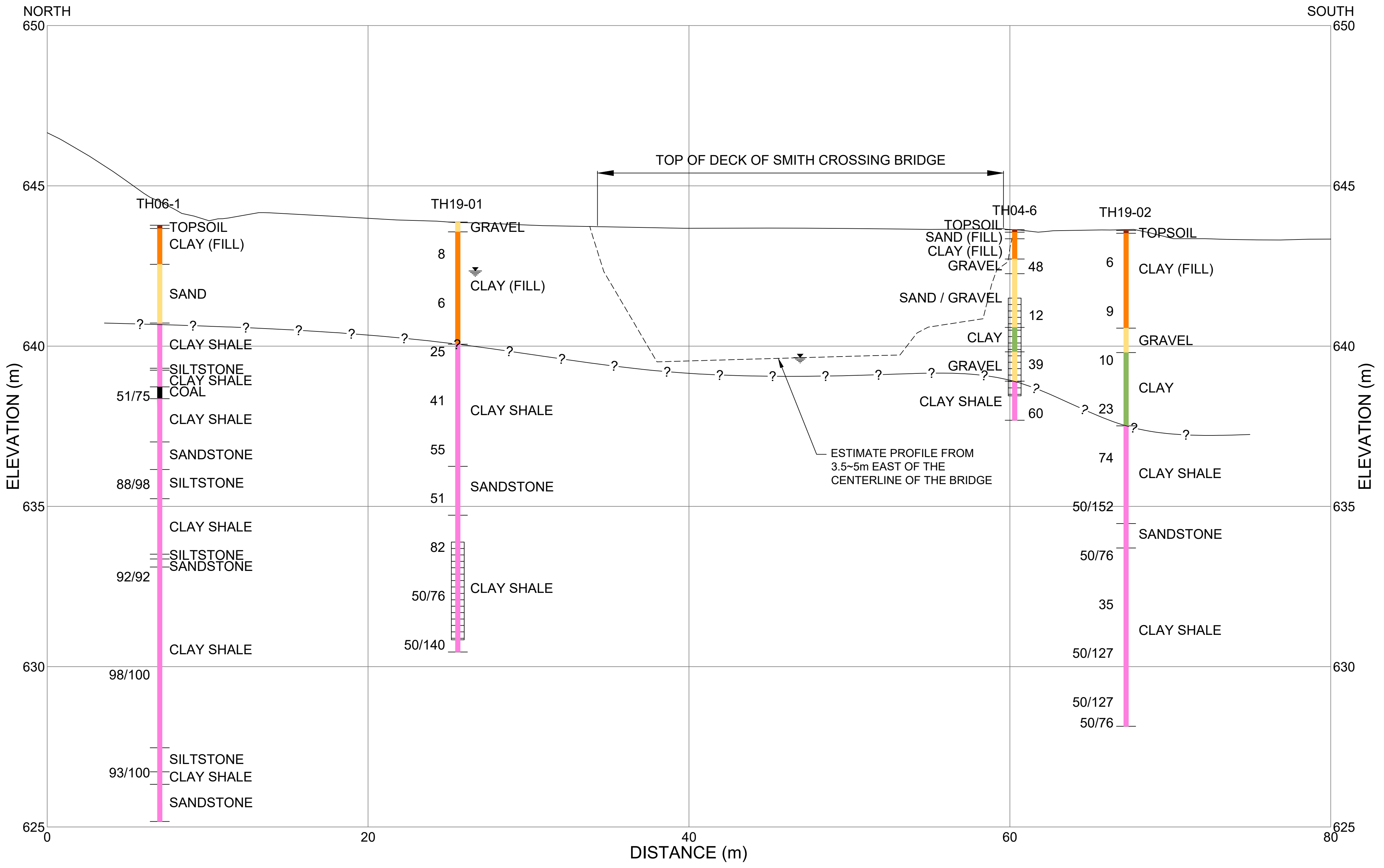

LEGEND

15 I SPT N VALUE

▽ WATER LEVEL IN PIEZOMETER

▤ STANDPIPE PIEZOMETER SCREENED INTERVAL

NOTE

DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

SURVEY DATA PROVIDED BY THE CITY OF EDMONTON ON JUNE 21, 2019

THE CITY OF Edmonton

SMITH CROSSING PEDESTRIAN BRIDGE #191
REPLACEMENT - WHITEMUD CREEK, EDMONTON, AB
GEOTECHNICAL INVESTIGATION

CROSS-SECTION A-A'

DWG No. 26386-2

DRAWN BY	KLW
DESIGNED BY	GL
APPROVED BY	RWT
SCALE	H 1:300 V 1:150
DATE	AUGUST 2019
FILE No.	26386

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THURBER

APPENDIX B

Symbols and Terms
Modified Unified Soils Classification System
Test Hole Logs

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

1. VISUAL TEXTURAL CLASSIFICATION OF MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200 mm	Greater than 200 mm
Cobbles	75 mm to 200 mm	75 mm to 200 mm
Gravel	4.75 mm to 75 mm	5 mm to 75 mm
Sand	0.075 mm to 4.75 mm	Visible particles to 5 mm
Silt	0.002 mm to 0.075 mm	Non-Plastic particles, not visible to the naked eye
Clay	Less than 0.002 mm	Plastic particles, not visible to the naked eye

2. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	APPROXIMATE UNDRAINED SHEAR STRENGTH		APPROXIMATE SPT * 'N' VALUE
Very Soft	Less than 10 kPa		Less than 2
Soft	10 - 25 kPa		2 to 4
Firm	25 - 50 kPa		4 to 8
Stiff	50 - 100 kPa		8 to 15
Very Stiff	100 - 200 kPa	Modified from National Building Code	15 to 30
Hard	200 - 300 kPa		Greater than 30
Very Hard	Greater than 300 kPa		

* SPT 'N' Value Standard Penetration Test 'N' Value - refers to the number of blows from a 63.5 kg hammer free falling a height of 0.76m to advance a standard 50mm outside diameter split spoon sampler for 0.3m depth into the undrilled portion of the test hole.

3. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	STANDARD PENETRATION TEST (SPT) (Number of Blows per 300 mm)	
Very Loose	0 - 4	
Loose	4 - 10	
Compact	10 - 30	Modified from National Building Code
Dense	30 - 50	
Very Dense	Over 50	

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

■	Shelby Tube	▤	A-Casing
◩	SPT	▥	Grab
☒	No Recovery	◫	Core

SYMBOLS USED FOR TEST HOLE LOGS

●		WC - Water Content (% by weight) of soil sample
▼		Water Level
■	SPT	Standard Penetration Test 'N' Value (Blows/300mm)
▲	CPen	Shear Strength determined by pocket penetrometer
	CVane	Shear Strength determined by pocket vane
	Cu	Undrained Shear Strength determined by unconfined compression test
	SO_4%	Percent (%) of water soluble sulphate ions

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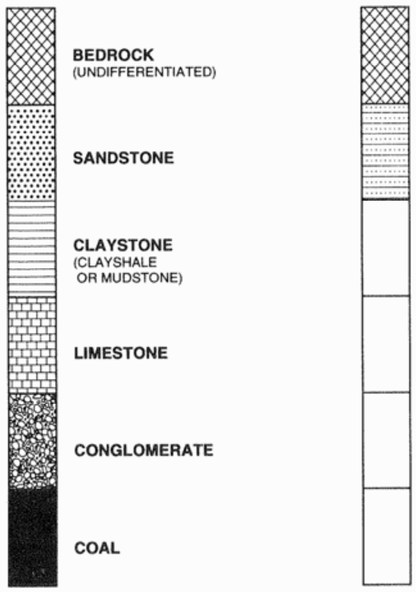
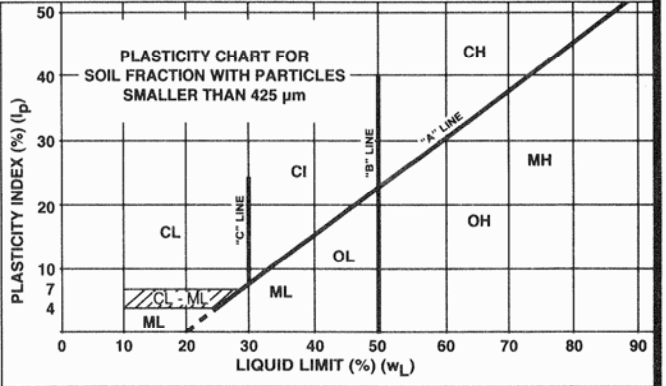
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

MAJOR DIVISION			GROUP SYMBOL	THURBER LOG SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	**GRAVELS** MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm	**CLEAN GRAVELS** (LITTLE OR NO FINES)	GW	△▽△	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75µm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}} > 4 ; C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP	▲▼▲	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR GW	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	▲▼▲	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	▨	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
	SANDS MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm	**CLEAN SANDS** (LITTLE OR 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	oooo	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR SW	
		SAND WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	▦	SILTY SANDS, SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	▨	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	**SILTS** BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 50\%$	ML	‖‖‖	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH 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			
		$30\% < w_L < 50\%$	CI	▨	INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, 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 AND MEDIUM PLASTICITY			
		$w_L > 50\%$	OH	▨	ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS			
HIGHLY ORGANIC SOILS			Pt	〰	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE		

SPECIAL SYMBOLS



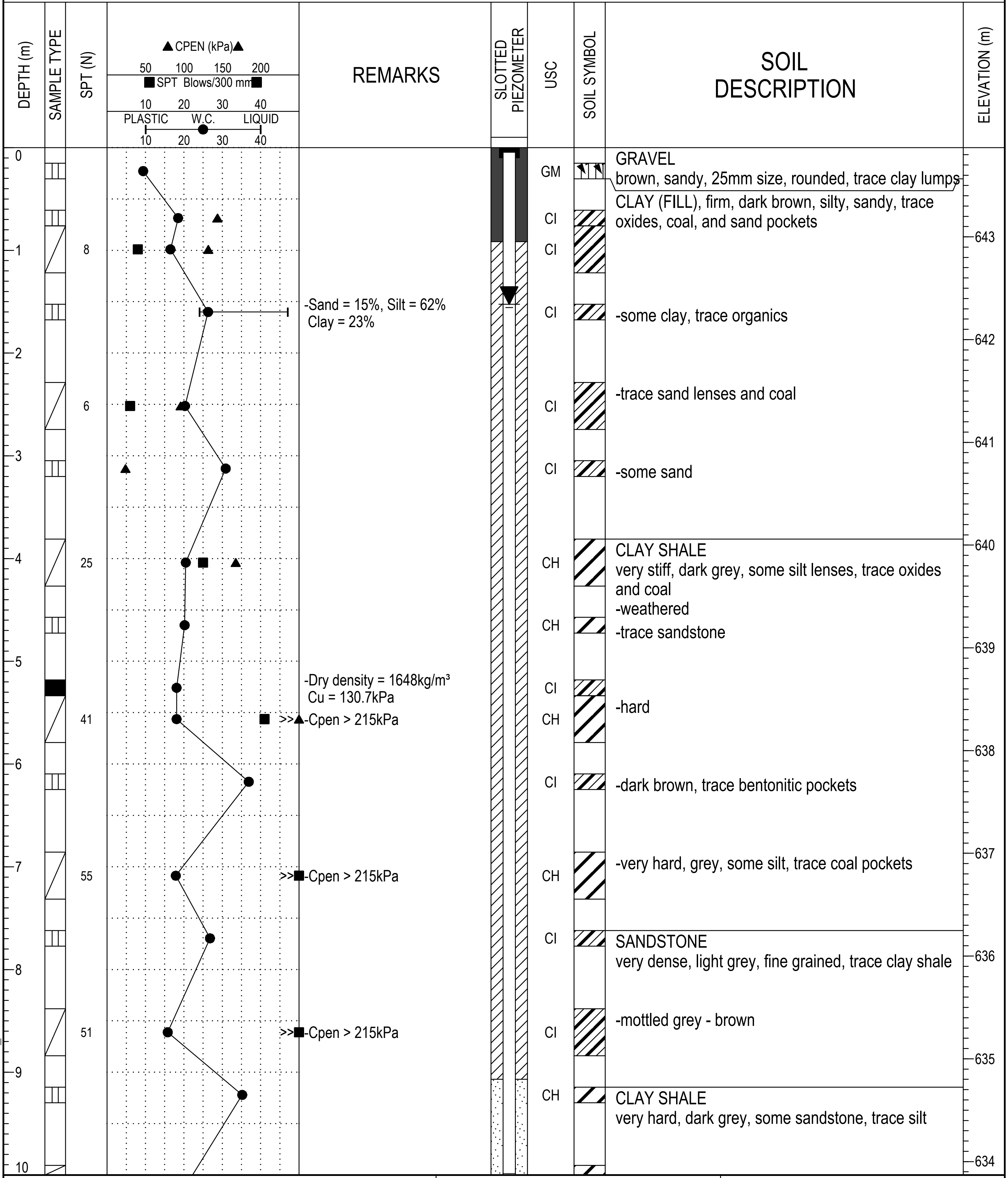


THURBER ENGINEERING LTD.

MODIFIED
UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

CLIENT: City of Edmonton
PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT
BOREHOLE NO: **TH19-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: July 10, 2019
PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers
LOCATION: N5924768.51, E30042.95
ELEVATION: 643.87 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE
BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛶ SAND ▥ SLOUGH



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
		GM	GRAVEL brown, sandy, 25mm size, rounded, trace clay lumps
			CLAY (FILL), firm, dark brown, silty, sandy, trace oxides, coal, and sand pockets
		CI	
8		CI	
	-Sand = 15%, Silt = 62% Clay = 23%	CI	-some clay, trace organics
6		CI	-trace sand lenses and coal
		CI	-some sand
25		CH	CLAY SHALE very stiff, dark grey, some silt lenses, trace oxides and coal -weathered
		CH	-trace sandstone
	-Dry density = 1648kg/m³ Cu = 130.7kPa	CI	
41	>>-Cpen > 215kPa	CH	-hard
		CI	-dark brown, trace bentonitic pockets
55	>>-Cpen > 215kPa	CH	-very hard, grey, some silt, trace coal pockets
		CI	SANDSTONE very dense, light grey, fine grained, trace clay shale
51	>>-Cpen > 215kPa	CI	-mottled grey - brown
		CH	CLAY SHALE very hard, dark grey, some sandstone, trace silt

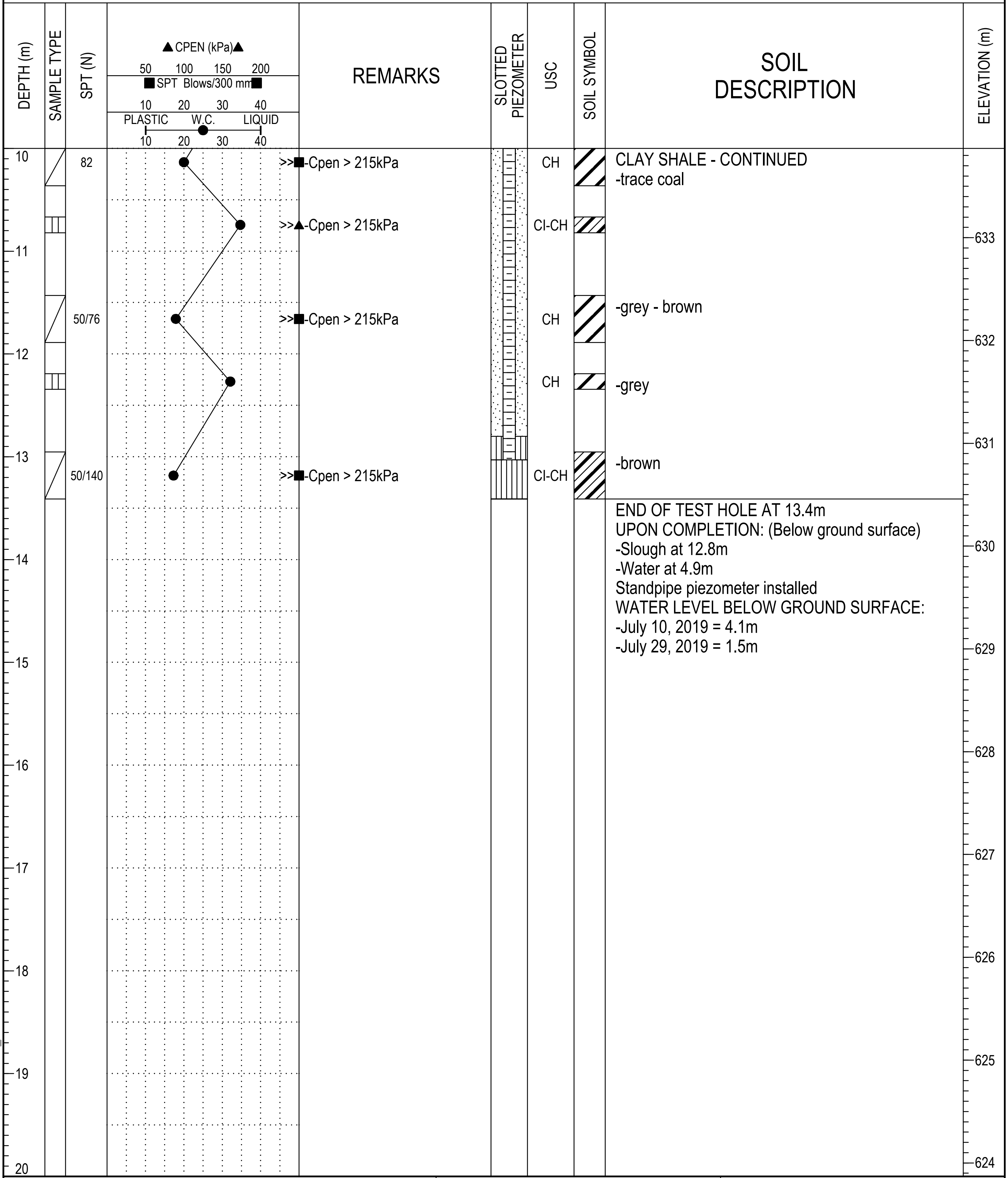
THURBER ENGINEERING LTD.

FIELD LOGGED BY: LRG
COMPLETION DEPTH: 13.4 m
PREPARED BY: GBL
COMPLETION DATE: 7/10/19
REVIEWED BY:

CLIENT: City of Edmonton	PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT	BOREHOLE NO: **TH19-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 10, 2019	PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers	LOCATION: N5924768.51, E30042.95	ELEVATION: 643.87 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
◸	82	>>■-Cpen > 215kPa	CH	CLAY SHALE - CONTINUED -trace coal
▥		>>▲-Cpen > 215kPa	CI-CH	
◸	50/76	>>■-Cpen > 215kPa	CH	-grey - brown
▥			CH	-grey
◸	50/140	>>■-Cpen > 215kPa	CI-CH	-brown

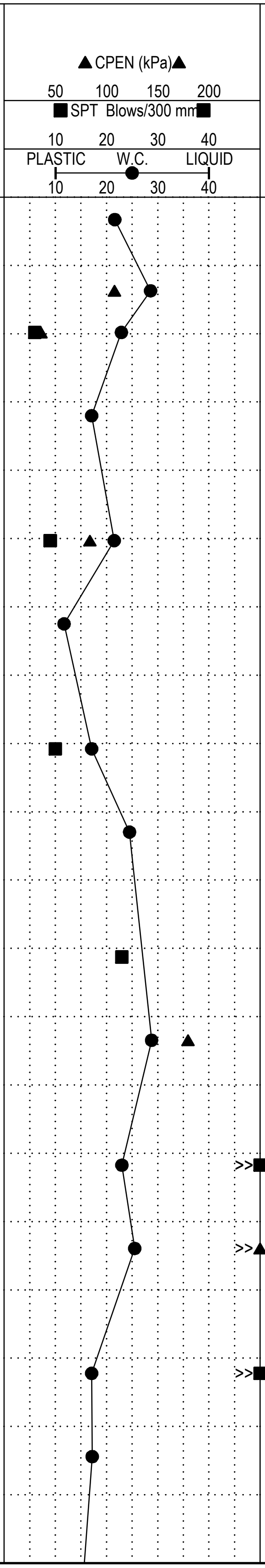
END OF TEST HOLE AT 13.4m
UPON COMPLETION: (Below ground surface)
-Slough at 12.8m
-Water at 4.9m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 10, 2019 = 4.1m
-July 29, 2019 = 1.5m

THURBER ENGINEERING LTD.

FIELD LOGGED BY: LRG	COMPLETION DEPTH: 13.4 m
PREPARED BY: GBL	COMPLETION DATE: 7/10/19
REVIEWED BY:	

CLIENT: City of Edmonton	PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT	BOREHOLE NO: **TH19-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 13, 2019	PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers	LOCATION: N5924727.02, E30037.49	ELEVATION: 643.61 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY



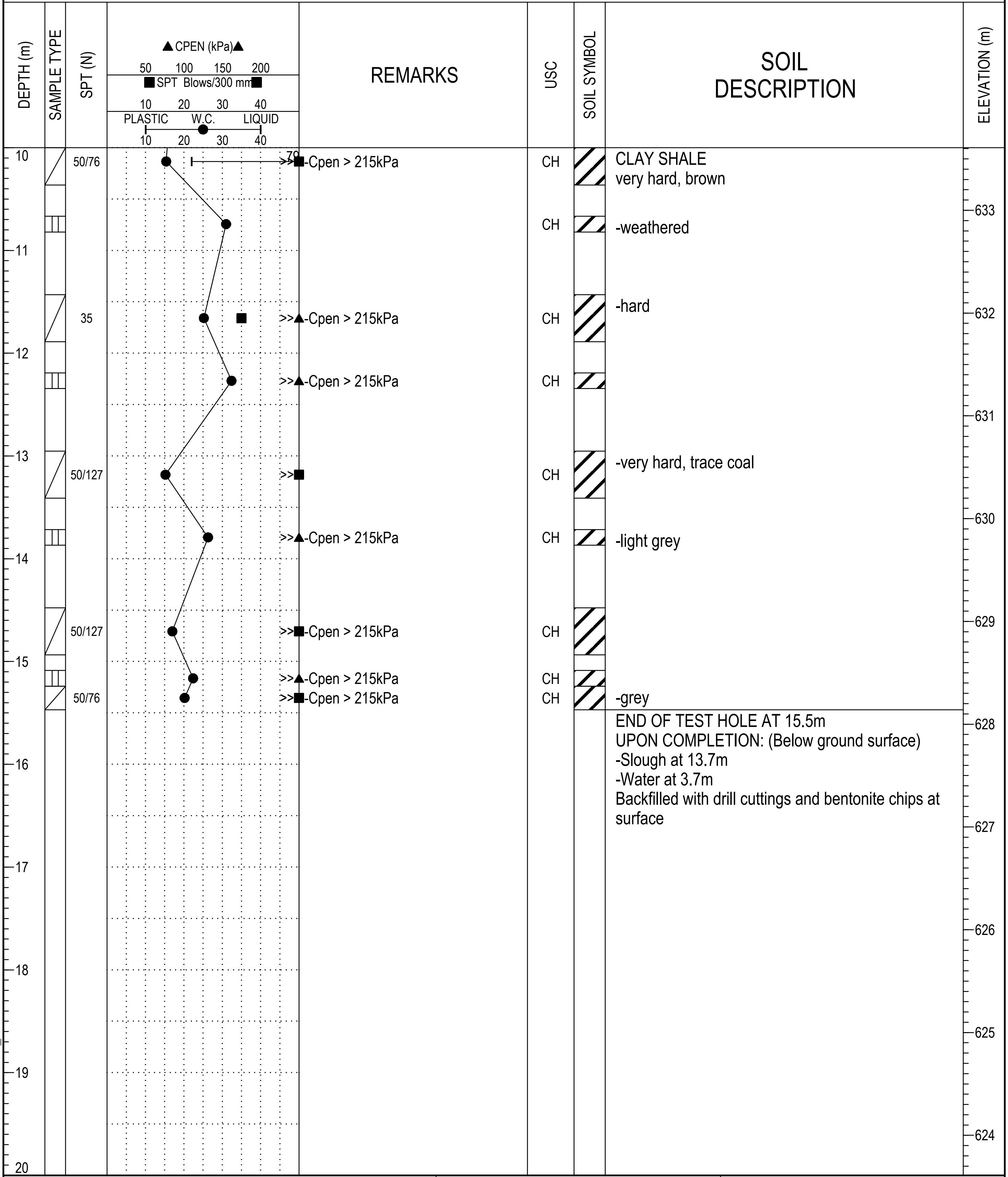
DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
0	▥			CI	TOPSOIL, trace gravel	
					CLAY (FILL) brown, silty, trace rootlets, organics, wood, and high plastic clay lenses	
	▥			CH		643
1	◿	6		CI	-some sand, trace oxides	
	▥		-SO_4 < 0.1%	CI	-brown, sandy, 20mm size, rounded gravel	642
2	■					
	◿	9		CI	-stiff, brown, silty, sandy, trace gravel, oxides, coal, and rootlets	641
3	▥		-Seepage	GC	GRAVEL compact, brown, clayey, sandy, 20 - 40mm size, rounded	640
4	◿	10		CI	CLAY stiff, brown, silty, sandy, trace coal	
	▥			CI	-gravelly	639
5						
	☒	23				638
6	▥			CI	CLAY SHALE very hard, dark brown, some silt, trace coal	637
7	◿	74	>>■-Cpen > 215kPa	COAL		
	▥		>>▲-Cpen > 215kPa	CH	-dark grey	636
8						
	◿	50/152	>>■	CH		635
9	▥			CI-SC	SANDSTONE grey, medium grained	634
10	◿					

THURBER ENGINEERING LTD.

FIELD LOGGED BY: LRG	COMPLETION DEPTH: 15.5 m
PREPARED BY: GBL	COMPLETION DATE: 7/13/19
REVIEWED BY:	

CLIENT: City of Edmonton	PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT	BOREHOLE NO: **TH19-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 13, 2019	PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers	LOCATION: N5924727.02, E30037.49	ELEVATION: 643.61 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY



50/76	-Cpen > 215kPa	CH	CLAY SHALE very hard, brown
		CH	-weathered
35	>>▲-Cpen > 215kPa	CH	-hard
	>>▲-Cpen > 215kPa	CH	
50/127	>>■	CH	-very hard, trace coal
	>>▲-Cpen > 215kPa	CH	-light grey
50/127	>>■-Cpen > 215kPa	CH	
	>>▲-Cpen > 215kPa	CH	
50/76	>>■-Cpen > 215kPa	CH	-grey

END OF TEST HOLE AT 15.5m
UPON COMPLETION: (Below ground surface)
-Slough at 13.7m
-Water at 3.7m
Backfilled with drill cuttings and bentonite chips at surface

BOREHOLE LOG 26386.GPJ THRBR_AB.GDT 8/6/19- LIBRARY-NEW LOGO-N E.GLB

THURBER ENGINEERING LTD.

FIELD LOGGED BY: LRG	COMPLETION DEPTH: 15.5 m
PREPARED BY: GBL	COMPLETION DATE: 7/13/19
REVIEWED BY:	

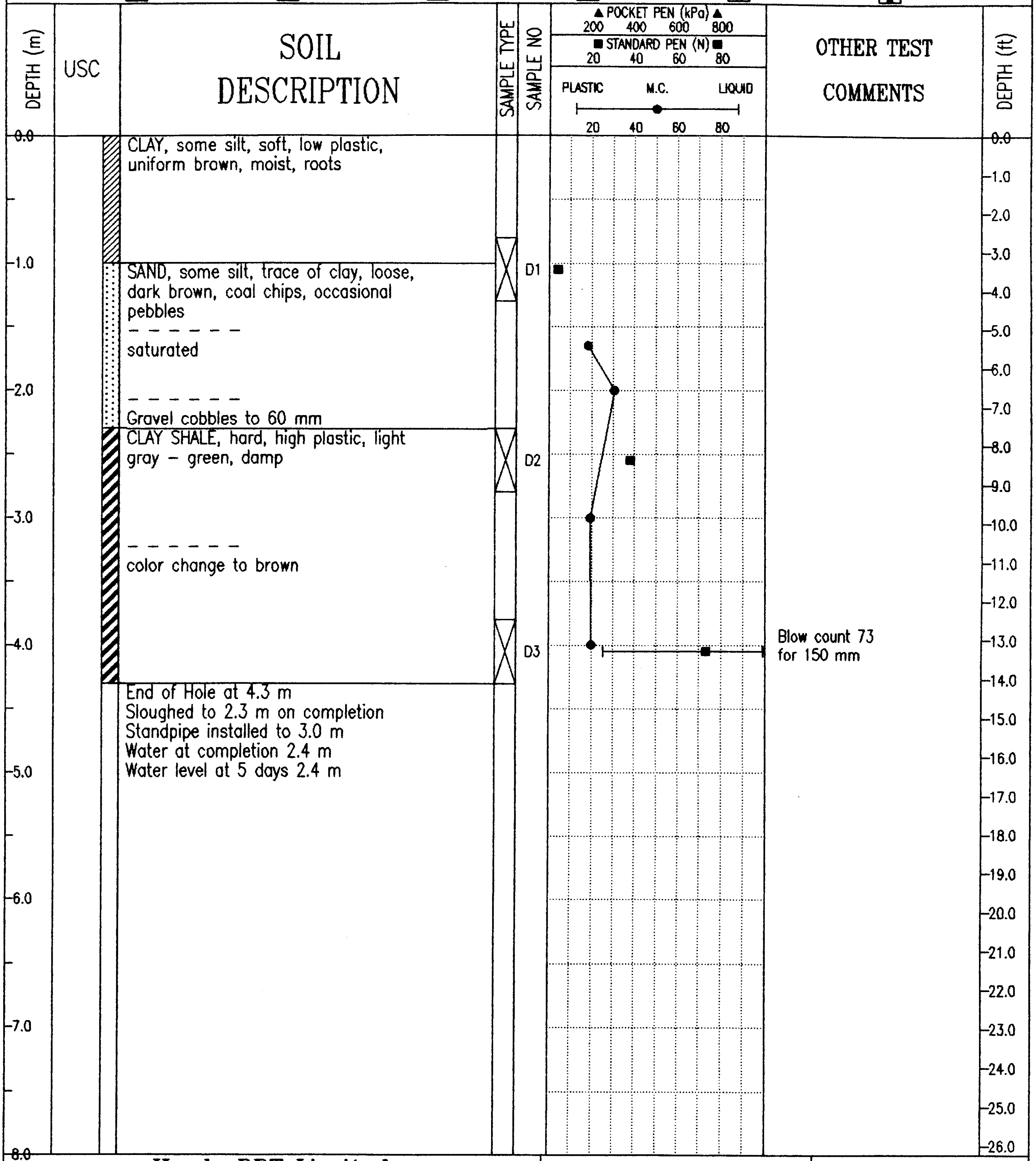
THURBER

APPENDIX C

Existing Test Hole Logs

CITY OF EDMONTON	BLACKMUD CREEK SLOPE STABILIZATION	BOREHOLE No. 10
ASSOCIATED ENGINEERING ALBERTA LIMITED	EDMONTON, ALBERTA	Project No: EG06545
B61 TRACK MOUNTED SOLID AUGER	23 AVENUE & BLACKMUD CREEK	ELEVATION 641.990 (m)

SAMPLE TYPE ■ SHELBY TUBE ◩ NO RECOVERY ☒ SPT TEST ▩ GRAB SAMPLE ▯ SPLIT PEN ▮ CORE SAMPLE



SOIL DESCRIPTION

CLAY, some silt, soft, low plastic, uniform brown, moist, roots

SAND, some silt, trace of clay, loose, dark brown, coal chips, occasional pebbles

\- - - - - -

saturated

\- - - - - -

Gravel cobbles to 60 mm

CLAY SHALE, hard, high plastic, light gray – green, damp

\- - - - - -

color change to brown

End of Hole at 4.3 m
Sloughed to 2.3 m on completion
Standpipe installed to 3.0 m
Water at completion 2.4 m
Water level at 5 days 2.4 m

OTHER TEST COMMENTS

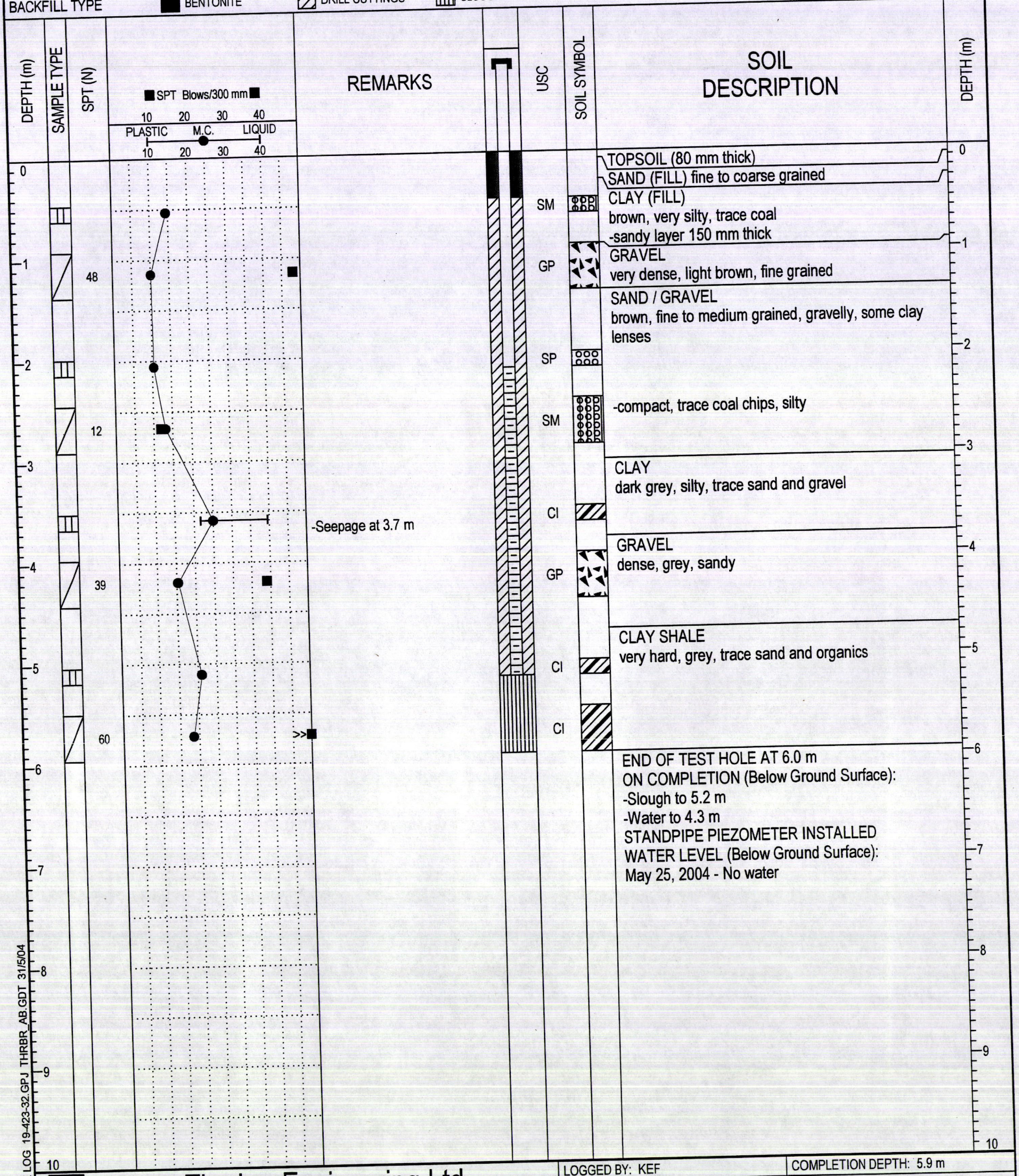
Blow count 73 for 150 mm

Hardy BBT Limited Edmonton, Alberta	COMPLETION DEPTH 4.3 m	COMPLETE 13/06/88
	LOGGED BY JPB	DWG NO.
		Page 1 of 1

CLIENT: IBI GROUP	PROJECT: Whitemud Creek 23 Avenue Stormwater Outfall	BOREHOLE NO: **TH04-6**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: May 7, 2004	PROJECT NO: 19-423-32
DRILL/METHOD: M5 / Solid Stem Auger	LOCATION: See Drawing 19-423-32-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



-Seepage at 3.7 m

TOPSOIL (80 mm thick)

SAND (FILL) fine to coarse grained

CLAY (FILL)
brown, very silty, trace coal
-sandy layer 150 mm thick

GRAVEL
very dense, light brown, fine grained

SAND / GRAVEL
brown, fine to medium grained, gravelly, some clay lenses

-compact, trace coal chips, silty

CLAY
dark grey, silty, trace sand and gravel

GRAVEL
dense, grey, sandy

CLAY SHALE
very hard, grey, trace sand and organics

END OF TEST HOLE AT 6.0 m
ON COMPLETION (Below Ground Surface):
-Slough to 5.2 m
-Water to 4.3 m
STANDPIPE PIEZOMETER INSTALLED
WATER LEVEL (Below Ground Surface):
May 25, 2004 - No water

BOREHOLE LOG 19-423-32.GPJ THRBR_AB.GDT 31/5/04

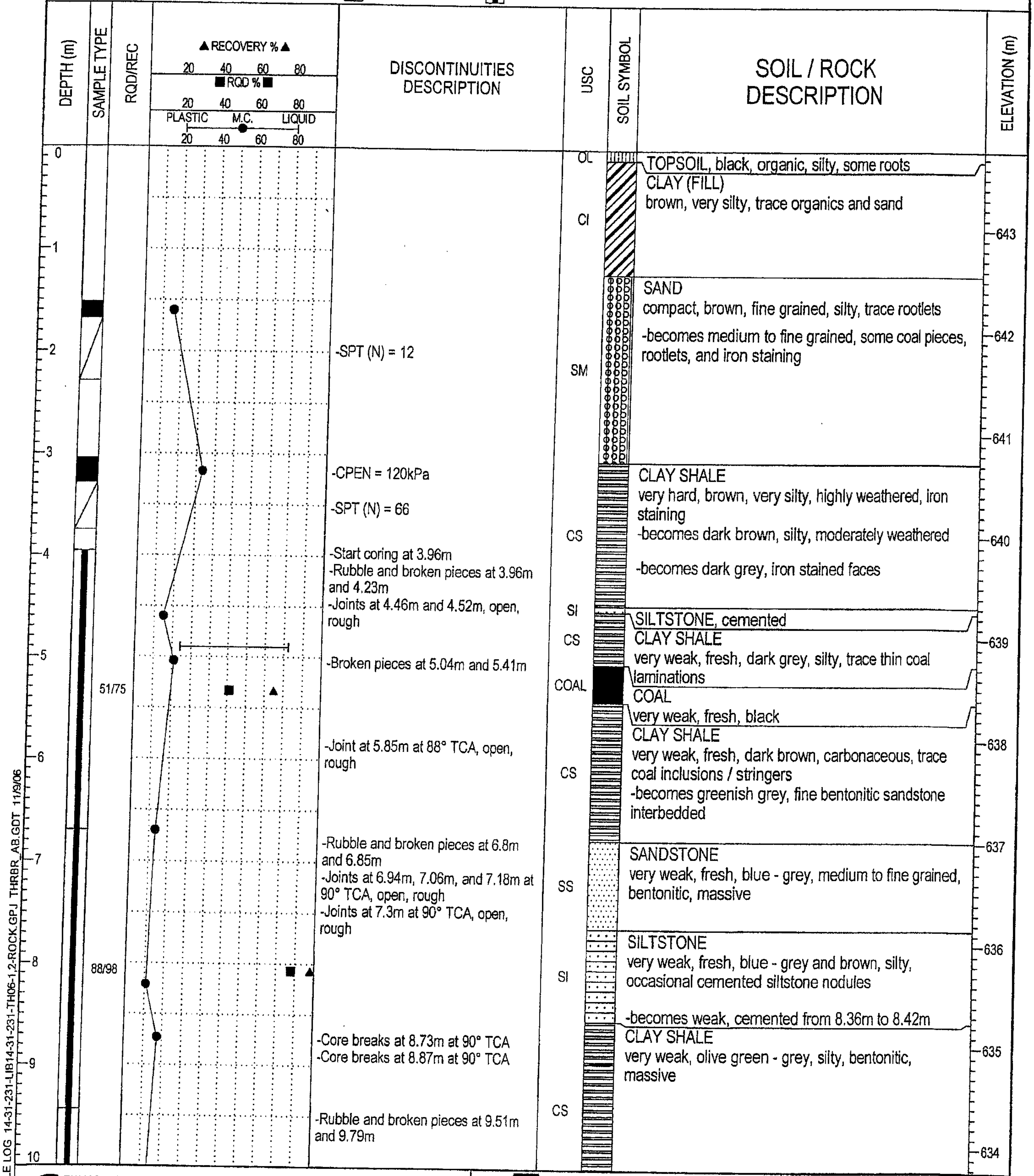
THURBER

Thurber Engineering Ltd.
EDMONTON, ALBERTA

LOGGED BY: KEF	COMPLETION DEPTH: 5.9 m
REVIEWED BY: RFM	COMPLETION DATE: 7/5/04

23Avenue Widening From 119Street to Hodgson Way	Truck Mounted Wet Rotary Rig	BOREHOLE NO: **TH06-1**
CITY OF EDMONTON	UTM ZONE: N5924786.19, E30024.28	PROJECT NO: 14-31-231
START DATE: June 9, 2006		ELEVATION: 643.77 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ▮ CORE



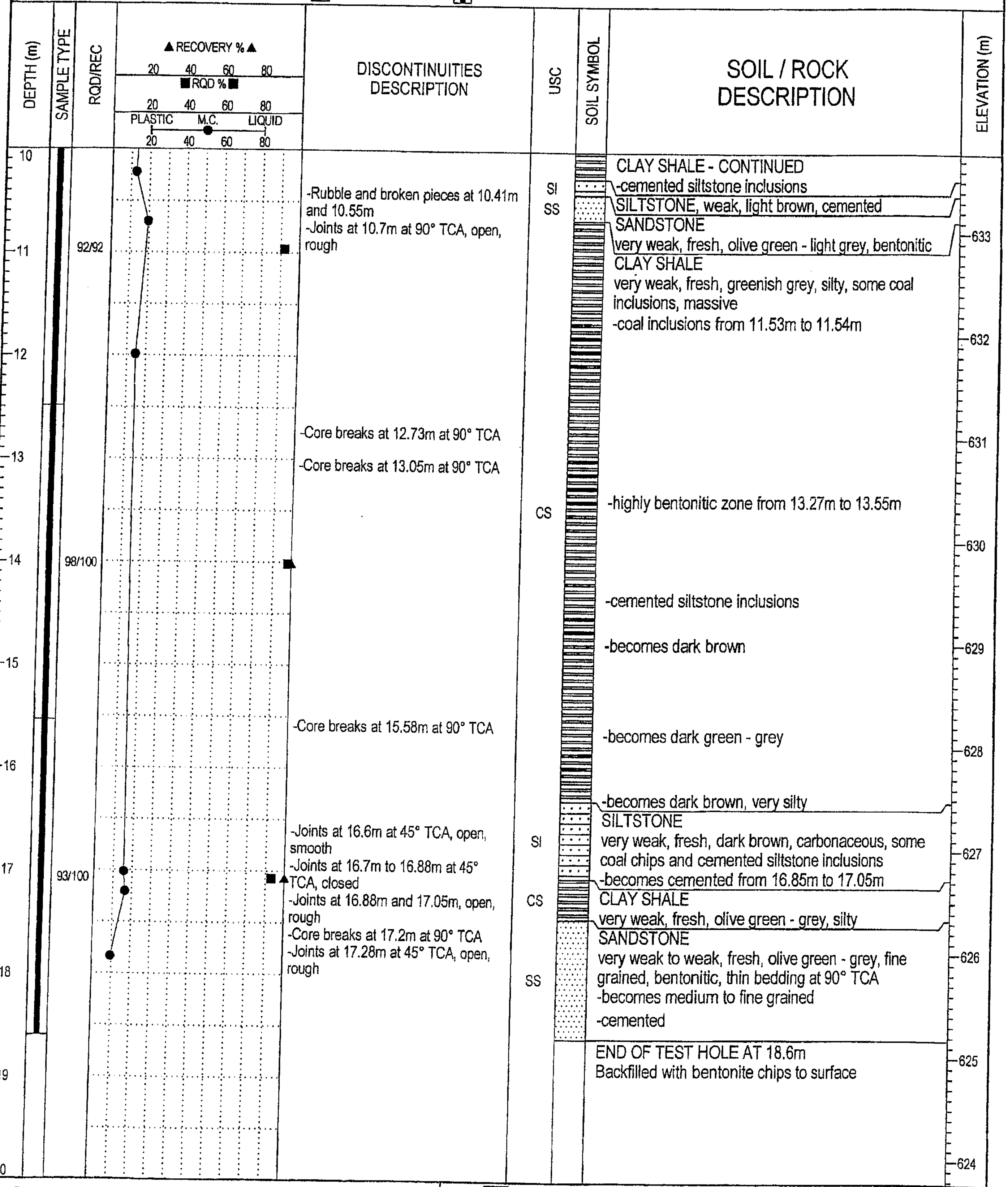
DEPTH (m)	RQD/REC	DISCONTINUITIES DESCRIPTION	USC	SOIL / ROCK DESCRIPTION
0			OL	TOPSOIL, black, organic, silty, some roots
			CI	CLAY (FILL) brown, very silty, trace organics and sand
		-SPT (N) = 12	SM	SAND compact, brown, fine grained, silty, trace rootlets -becomes medium to fine grained, some coal pieces, rootlets, and iron staining
3		-CPEN = 120kPa -SPT (N) = 66 -Start coring at 3.96m -Rubble and broken pieces at 3.96m and 4.23m -Joints at 4.46m and 4.52m, open, rough	CS	CLAY SHALE very hard, brown, very silty, highly weathered, iron staining -becomes dark brown, silty, moderately weathered -becomes dark grey, iron stained faces
			SI	SILTSTONE, cemented
5	51/75	-Broken pieces at 5.04m and 5.41m	CS	CLAY SHALE very weak, fresh, dark grey, silty, trace thin coal laminations
			COAL	COAL very weak, fresh, black
6		-Joint at 5.85m at 88° TCA, open, rough	CS	CLAY SHALE very weak, fresh, dark brown, carbonaceous, trace coal inclusions / stringers -becomes greenish grey, fine bentonitic sandstone interbedded
7		-Rubble and broken pieces at 6.8m and 6.85m -Joints at 6.94m, 7.06m, and 7.18m at 90° TCA, open, rough -Joints at 7.3m at 90° TCA, open, rough	SS	SANDSTONE very weak, fresh, blue - grey, medium to fine grained, bentonitic, massive
8	88/98		SI	SILTSTONE very weak, fresh, blue - grey and brown, silty, occasional cemented siltstone nodules -becomes weak, cemented from 8.36m to 8.42m
9		-Core breaks at 8.73m at 90° TCA -Core breaks at 8.87m at 90° TCA -Rubble and broken pieces at 9.51m and 9.79m	CS	CLAY SHALE very weak, olive green - grey, silty, bentonitic, massive

BOREHOLE LOG 14-31-231-LIB14-31-231-TH06-1,2-ROCK.GPJ THRBR_AB.GDT 11/9/06

THE CITY OF Edmonton	Transportation & Streets Engineering Services Section	THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS	COMPLETION DEPTH: 18.6 m COMPLETION DATE: 6/9/2006
		LOGGED BY: TC	REVIEWED BY: LWB

23Avenue Widening From 119Street to Hodgson Way	Truck Mounted Wet Rotary Rig	BOREHOLE NO: **TH06-1**
CITY OF EDMONTON	UTM ZONE: N5924786.19, E30024.28	PROJECT NO: 14-31-231
START DATE: June 9, 2006		ELEVATION: 643.77 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ▯ CORE



DISCONTINUITIES DESCRIPTION

-Rubble and broken pieces at 10.41m and 10.55m
-Joints at 10.7m at 90° TCA, open, rough

-Core breaks at 12.73m at 90° TCA

-Core breaks at 13.05m at 90° TCA

-Core breaks at 15.58m at 90° TCA

-Joints at 16.6m at 45° TCA, open, smooth
-Joints at 16.7m to 16.88m at 45° TCA, closed
-Joints at 16.88m and 17.05m, open, rough
-Core breaks at 17.2m at 90° TCA
-Joints at 17.28m at 45° TCA, open, rough

SOIL / ROCK DESCRIPTION

CLAY SHALE - CONTINUED
-cemented siltstone inclusions

SILTSTONE, weak, light brown, cemented

SANDSTONE
very weak, fresh, olive green - light grey, bentonitic

CLAY SHALE
very weak, fresh, greenish grey, silty, some coal inclusions, massive
-coal inclusions from 11.53m to 11.54m

-highly bentonitic zone from 13.27m to 13.55m

-cemented siltstone inclusions

-becomes dark brown

-becomes dark green - grey

-becomes dark brown, very silty

SILTSTONE
very weak, fresh, dark brown, carbonaceous, some coal chips and cemented siltstone inclusions
-becomes cemented from 16.85m to 17.05m

CLAY SHALE
very weak, fresh, olive green - grey, silty

SANDSTONE
very weak to weak, fresh, olive green - grey, fine grained, bentonitic, thin bedding at 90° TCA
-becomes medium to fine grained
-cemented

END OF TEST HOLE AT 18.6m
Backfilled with bentonite chips to surface

THE CITY OF Edmonton

Transportation & Streets
Engineering Services Section

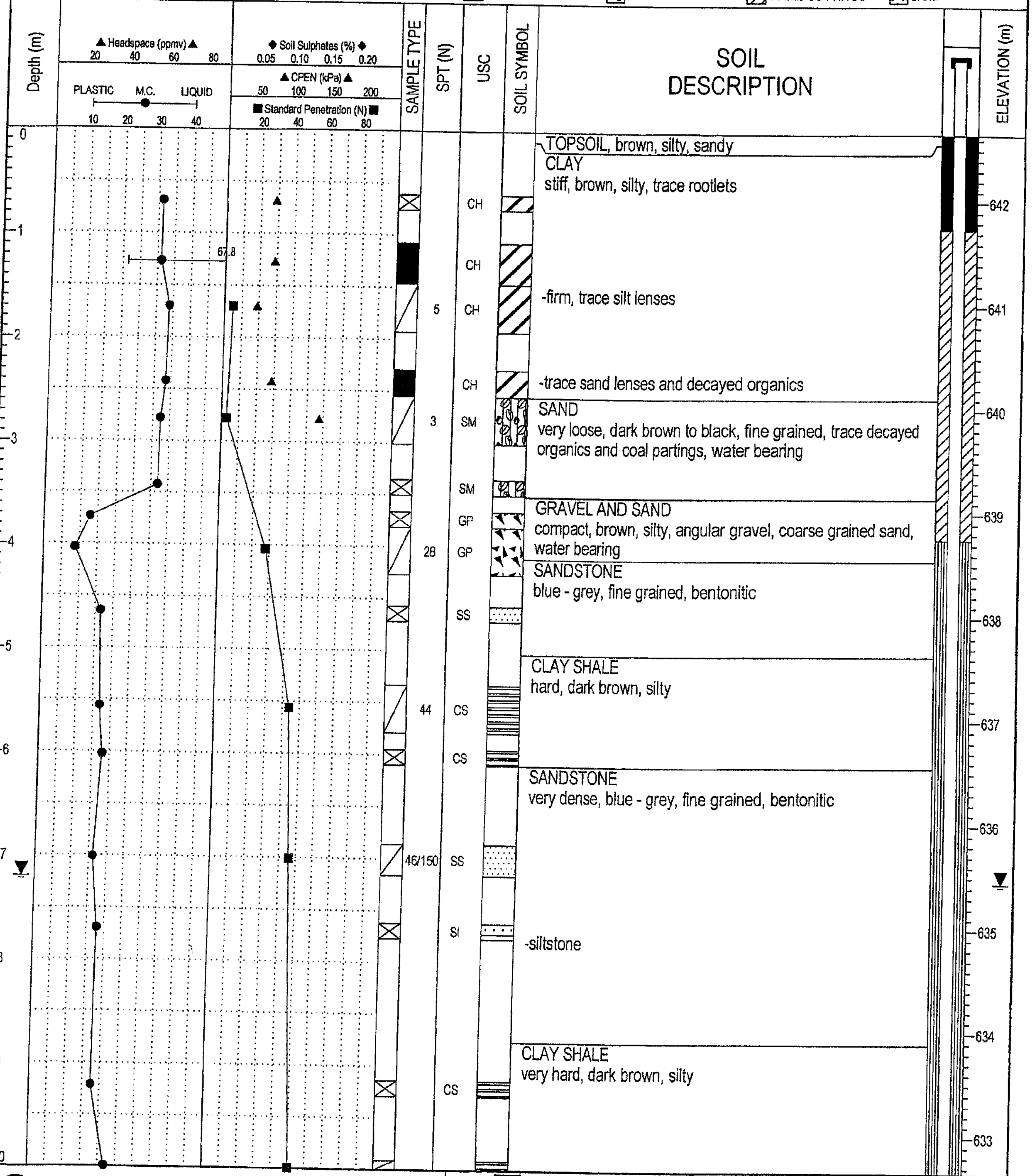
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

		COMPLETION DEPTH: 18.6 m
		COMPLETION DATE: 6/9/2006
LOGGED BY: TC	REVIEWED BY: LWB	Page 2 of 2

23Avenue Widening From 119Street to Hodgson Way	M5 Drill Rig	BOREHOLE NO: **TH06-3**
CITY OF EDMONTON	UTM ZONE: N5924755.04, E29991.77	PROJECT NO: 14-31-231
START DATE: 21/6/2006		ELEVATION: 642.65 m

SAMPLE TYPE ■ Shelby Tube ◩ Drive Sample ☒ Auger Sample ☰ No Recovery ▥ A Casing ▮ Cored Sample

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ⁙ GROUT ▨ DRILL CUTTINGS ⁙ SAND



SOIL DESCRIPTION

TOPSOIL, brown, silty, sandy

CLAY
stiff, brown, silty, trace rootlets

-firm, trace silt lenses

-trace sand lenses and decayed organics

SAND
very loose, dark brown to black, fine grained, trace decayed organics and coal partings, water bearing

GRAVEL AND SAND
compact, brown, silty, angular gravel, coarse grained sand, water bearing

SANDSTONE
blue - grey, fine grained, bentonitic

CLAY SHALE
hard, dark brown, silty

SANDSTONE
very dense, blue - grey, fine grained, bentonitic

-siltstone

CLAY SHALE
very hard, dark brown, silty

STANDPIP 14-31-231-CITY OF ED TEMP(LIB14-31-231(1A TO 28).GPJ CITY OF EDMONTON.GDT 11/9/06

THE CITY OF Edmonton

Transportation & Streets
Engineeering Services Section

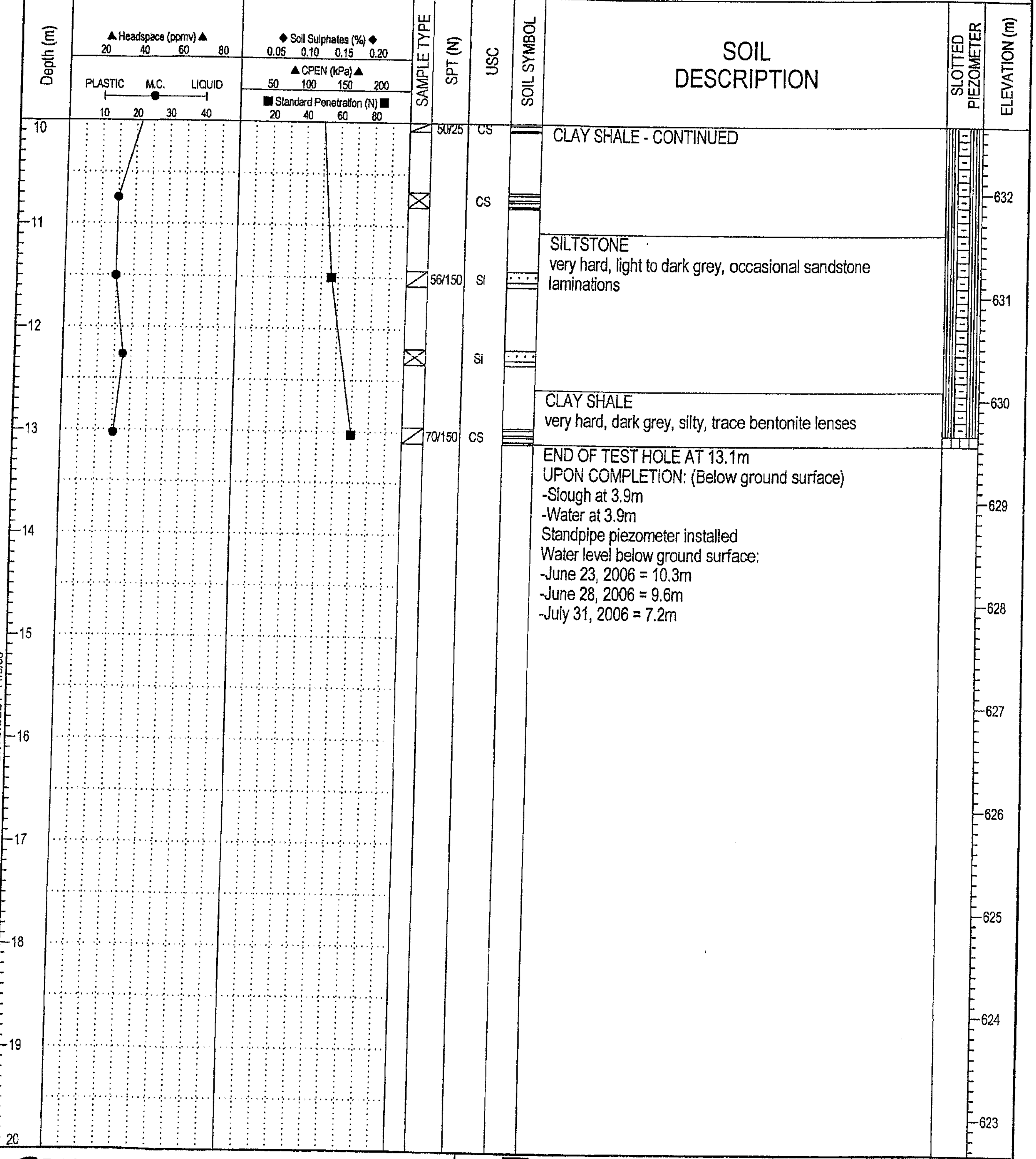
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: TC	REVIEWED BY: LWB	COMPLETION DEPTH: 13.1 m
		COMPLETION DATE: 21/6/06

23Avenue Widening From 119Street to Hodgson Way	M5 Drill Rig	BOREHOLE NO: **TH06-3**
CITY OF EDMONTON	UTM ZONE: N5924755.04, E29991.77	PROJECT NO: 14-31-231
START DATE: 21/6/2006		ELEVATION: 642.65 m

SAMPLE TYPE ■ Shelby Tube ▨ Drive Sample ☒ Auger Sample ☰ No Recovery ▥ A Casing ▮ Cored Sample

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ⁙ GROUT ▨ DRILL CUTTINGS ⁙ SAND



SPT (N)	USC
50/25	CS
	CS
56/150	SI
	SI
70/150	CS

SOIL DESCRIPTION

CLAY SHALE - CONTINUED

SILTSTONE
very hard, light to dark grey, occasional sandstone laminations

CLAY SHALE
very hard, dark grey, silty, trace bentonite lenses

END OF TEST HOLE AT 13.1m
UPON COMPLETION: (Below ground surface)
-Slough at 3.9m
-Water at 3.9m
Standpipe piezometer installed
Water level below ground surface:
-June 23, 2006 = 10.3m
-June 28, 2006 = 9.6m
-July 31, 2006 = 7.2m

THE CITY OF Edmonton	Transportation & Streets Engineeering Services Section	THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS	COMPLETION DEPTH: 13.1 m COMPLETION DATE: 21/6/06
		LOGGED BY: TC	REVIEWED BY: LWB

THURBER

APPENDIX D

Slope Stability Analyses

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟧	Clay	Mohr-Coulomb	18	5	23
🟫	Clay Fill	Mohr-Coulomb	18	5	23
■	Clay Shale (Becrock)	Mohr-Coulomb	21	20	25
⬜	Concrete	Bedrock (Impenetrable)			
⬛	Gravel (Rip Rap)	Mohr-Coulomb	22	0	45
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34

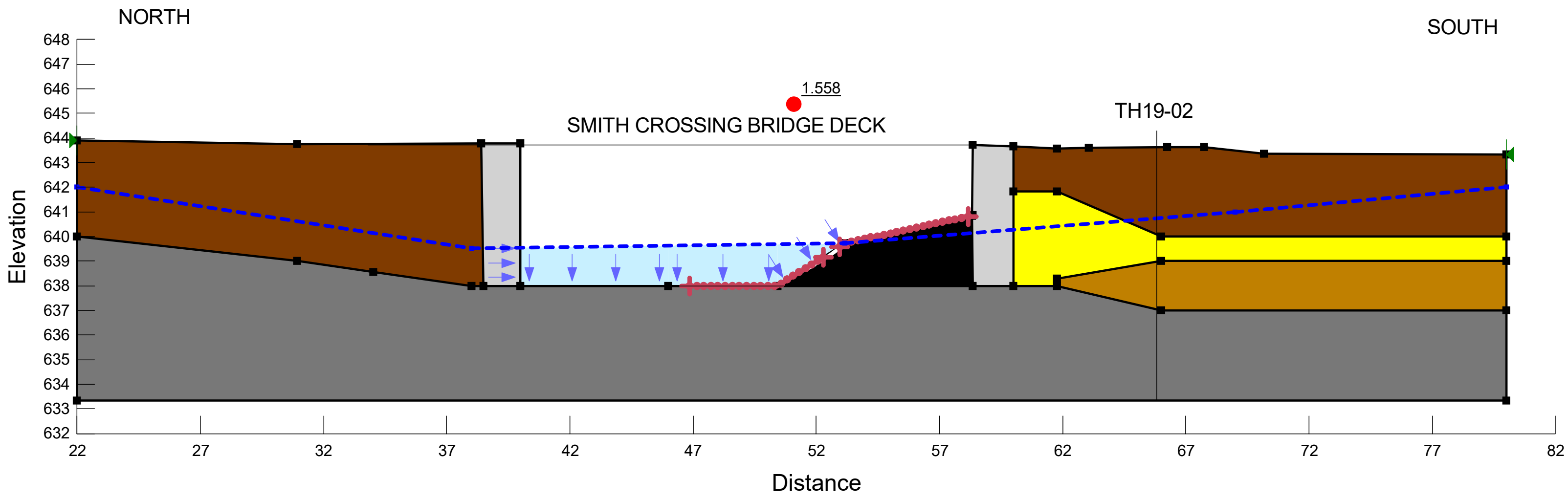


Figure D1: South Head Slope (Existing)

26386_South_r1.gsz

2019-08-28 1:300

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟧	Clay	Mohr-Coulomb	18	5	23
🟫	Clay Fill	Mohr-Coulomb	18	5	23
▨	Clay Shale (Becrock)	Mohr-Coulomb	21	20	25
⬜	Concrete	Bedrock (Impenetrable)			
⬛	Gravel (Rip Rap)	Mohr-Coulomb	22	0	45
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34

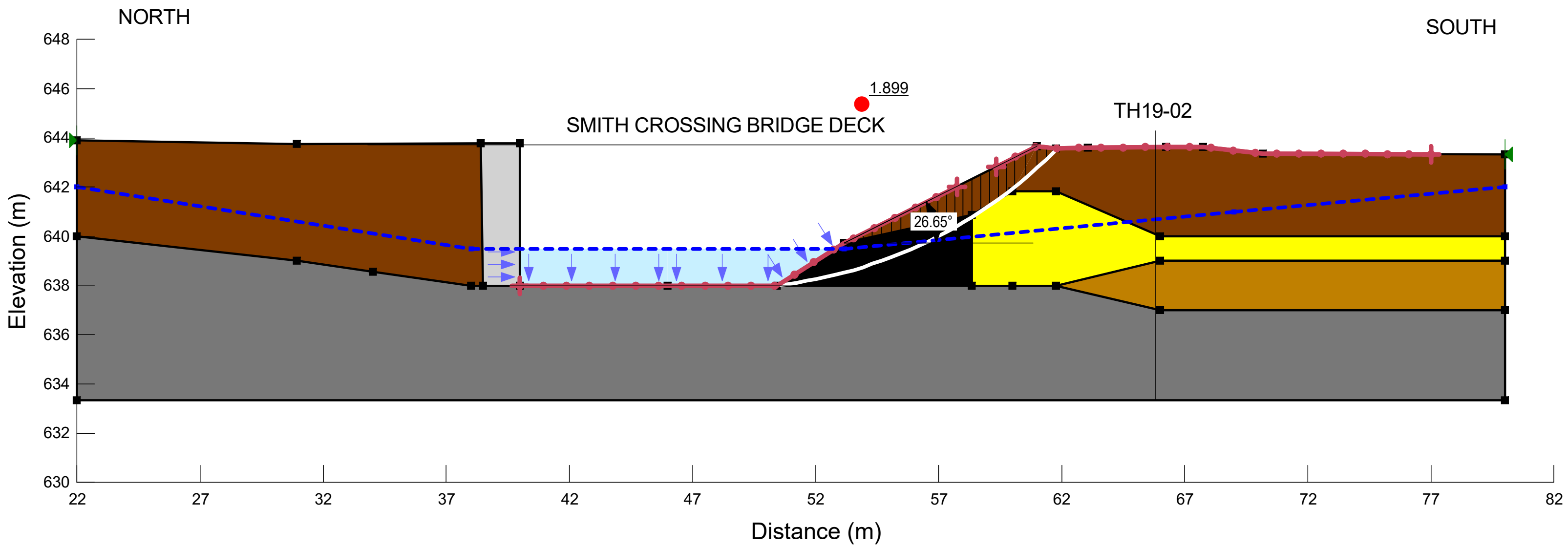


Figure D2: South Head Slope: 2:1 (H:V)

26386_South_r2.gsz

2019-08-30 1:300

APPENDIX E

Select Site Photographs

Photo 1 – View of Smith Crossing Bridge (Looking North).

Photo 2 – View of Confluence of Whitemud and Blackmud Creeks, and low-lying flood plains (Looking East)

Photo 3 – View of Existing North Abutment (Looking North)

Photo 4 – View of Existing South Abutment (Looking from East)

APPENDIX F

Recommended Construction Procedures

RECOMMENDED CONSTRUCTION PROCEDURES

The following construction procedures are considered to represent good practice and are to be read in conjunction with the text of this report.

1. BACKFILLING

1.1 Backfill around foundations should be placed in such a manner so as to prevent settlement and to be relatively impervious near the surface so that water does not pond against foundations nor be allowed to seep into the soil.

1.2 Backfill should not be placed until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction.

1.3 All backfill around grade beams, foundation walls, etc. must be carefully and uniformly compacted. The backfill should be placed in even layers and no frozen or organic material should be incorporated into the fill. All lumps of material must be broken down or squeezed together during placing and compaction.

1.4 The final grade (allowing for some settlement of the backfill) should shed water away from the structure.

1.5 During construction, precautions should be taken to prevent water ponding in grade beam excavations thereby acting as a source of water to soften the soil under the floor slab area or providing a source of water for frost action if the building is not heated during freezing weather.

2. BORED CAST-IN-PLACE CONCRETE PILES

2.1 If there is evidence of water bearing and/or sloughing soil, casing should be used to seal off the water or prevent the sloughing of the sides of the hole. The concrete and reinforcing steel should be on hand and placed as soon as the pile hole has been completed and approved.

2.2 Pile bells, if used, should be formed entirely in self-supporting soil and it may be necessary in some cases to extend the pile bell if caving occurs at the location of the bell.

2.3 Water should not be left ponded on the pile base and should be removed, or dried by the use of dry cement when permitted by the engineer.

2.4 Concrete should be placed without segregation and carefully vibrated throughout the full length of the pile to ensure that voids do not exist in the pile shaft. The concrete slump should be between 75 and 125 mm with a minimum compressive strength at 28 days of 21 MPa (3000 psi). Higher compressive strengths may be required for structural or durability reasons, and higher slumps may be necessary for closely spaced reinforcing bars or where concrete is to be tremied under water.

2.5 Steel reinforcing should be tied into the grade beam reinforcing steel. This recommendation is important where the soil below grade beam can swell from a change in moisture content or by frost action before the building is heated.

2.6 Piles closer than 2 1/2 diameters should not be drilled and poured consecutively unless permitted by the engineer and depending upon soil conditions. Where the drilling operation might affect the concrete in the adjacent pile, the drilling should not be carried out until the concrete has at least 24 hours to set, or before the concrete has reached its initial set.

3. DRIVEN STEEL PILES

3.1 Piles shall be driven by equipment having a striking weight of not less than one-third of the driven weight of the piles. The driver should be capable of delivering at least 27 kN-metres (20,000 ft-lbs) of energy.

3.2 The number of blows required to drive the pile each foot should be recorded for every pile as an indication of the satisfactory carrying capacity of the pile and as an indicator of potential tip damage.

3.3 The driving energy should be restricted to 6300 kN-metres per square metre (3,000 ft-lbs per square inch) of steel in the pile cross-section

3.4 After each pile is driven to its required depth an elevation should be taken of the pile top or on a suitable mark on the side of the pile. This elevation should be checked periodically to ensure that it is not heaved by the driving of adjacent piles. Piles that are heaved must be redriven.

3.5 For piles, which displace a considerable amount of soil during driving, such as closed-end piles, care must be taken that the driving does not cause damaging horizontal displacement of existing structures or foundations.

3.6 Where piles are designed to gain support by skin friction in the soil, it is essential that the pile have ends and walls free from protrusions, which would cause voids or disturbance of the adjacent soil during driving.

THURBER ENGINEERING LTD.

March 1, 2021 File No.: 29325

Morrison Hershfield Ltd.
Suite 300, 6807 Railway Street S.E.
Calgary, Alberta
T2H 2V6

Attention: Mr. Andrew Neilson, M.Sc., P.Eng., Principal, Deputy Lead – Bridges West

SMITH CROSSING PEDESTRIAN BRIDGE (BF191)
GEOTECHNICAL RECOMMENDATIONS FOR DETAILED DESIGN

Dear Mr. Neilson:

Further to our recent meeting and your email dated January 8, 2021, this letter provides our geotechnical recommendations for the detailed design of the Smith Crossing Pedestrian bridge, as outlined in our proposal dated June 25, 2020 and subsequent discussions with Morrison Hershfield Ltd. (Morrison Hershfield).

Use of this letter is subject to the Statement of Limitations and Conditions, which is included at the end of this document.

1. BACKGROUND

Thurber Engineering Ltd. (Thurber) conducted a geotechnical investigation for the Smith Crossing bridge in 2019 (ref. Thurber Report No. 26386 dated October 4, 2019). The geotechnical investigation consisted of drilling two test holes near the existing abutments and a geotechnical report was prepared providing information on the subsurface conditions and recommended preliminary geotechnical design considerations. Recommendations were provided for both cast-in-place concrete piles and driven steel piles. Preliminary stability assessments were also provided for the abutment head slopes.

We understand that as a result of discussions between the City of Edmonton and Morrison Hershfield, the preferred bridge design is “Option 2 - Existing soffit elevation + 1.0 m freeboard, to match the 1:100-year water level event”. The design is outlined on the drawings provided by Morrison Hershfield, which are included in Appendix A.

Using the bridge design information provided and the results of our previous investigation, this letter summarizes the following:

- Slope stability assessment of the updated head slopes and embankment geometries.
- Confirmation of the cast-in-place foundation recommendations previously provided and additional lateral pile design recommendations.
- Recommendations for site preparation and material specifications for the embankments, and potential temporary shoring options at the south embankment to limit deflection of adjacent utilities.

The following sections outline Thurber's additional assessment using the new proposed design information. They should be read in conjunction with the recommendations outlined in our previous 2019 geotechnical investigation report (ref. Thurber Report No. 26386 dated October 4, 2019).

2. STABILITY ASSESSMENT

Slope stability analyses were undertaken to estimate the factor of safety of the proposed north head slope, south head slope, and embankment side slope, using the proposed design geometry as shown on the marked-up Drawing No. A023 P20X-S01 provided to Thurber by Morrison Hershfield, included in Appendix A.

The proposed design of the abutments include:

- Temporary excavation of about 3 m of the existing fill with one working bench platform. The final abutment height will be about 1 m higher than the existing abutment.
- One row of cast-in-place concrete piles. Abutment fills will be partially retained by concrete pile cap and wing walls extending back from the creek.
- A 1.6H:1V head slope for the north abutment. A 1,000 mm thick layer of Class 2 rip rap on the head slope extending from the creek level to the top of the head slope.
- A 2:H:1V head slope for the south abutment. An 800 mm thick layer of Class 2 rip rap on the head slope extending from the creek level to the top of the head slope.

The proposed design of the embankments include:

- Raising the current embankment approaches by about 1 m to match the new abutment height. The elevation of the new approach (El. 644.7 m) will range from about 1 m higher than the surrounding ground level (El. 643.5 m) to about 3 m higher than the creek bank (El. 641.0 m) at the abutment.
- Approach transition grade assumed at 5%, with 2H:1V embankment side slopes.

It is understood that the existing south concrete abutment will be removed below the new head slope grade, with the remaining buried footing left in place. The abutment's presence in the slope increases the overall stability of the head slope. Since the quality of the abutment is unknown, an equivalent volume of granular fill was conservatively assumed to estimate the contribution of the concrete abutment for this analysis.

As per the design drawings and subsequent discussions with Morrison Hershfield, an 800 mm thick layer of rip rap was included on the head slopes to provide riverbank erosion protection and also enhance both stability of the head slopes. The design of the rip rap should be reviewed by a hydrotechnical consultant to confirm the adequacy and determine if additional riverbank erosion protection is warranted.

The soil parameters used in the stability analyses were generally consistent with the values presented in our 2019 Geotechnical Investigation report (File No. 26386, Table 5.1), and are considered applicable for these stability analyses. A lower bound case was also analyzed for the north slope considering a high-water table within the embankment and a reduction in strength of the clay fill due to potential long term strength degradation, by decreasing the effective cohesion of the clay fill from 5 kPa to 1 kPa.

The soil parameters used in the analyses are summarized on the stability figures included in Appendix C. Relevant test hole logs from previous investigations and their locations are included in Appendix B.

The following groundwater profiles were analyzed as part of this stability assessment:

- Using the ground levels observed from the standpipe piezometers in July of 2019 (TH20-01) and May of 2006 (TH06-01) and typical creek level of 639.7 m.
- Using a higher groundwater table (GWT) and the 1:2-year flood elevation of 640.7 m, as provided by Morrison Hershfield.
- Using a higher GWT and typical creek level of 639.7 m, the case was analyzed where the strength reduction in the embankment clay fill was taken into consideration by decreasing the effective cohesion of the clay fill from 5 kPa to 1 kPa.

Results of the additional stability analyses are presented on the stability figures in Appendix C and summarized in Table 2.1 below.

TABLE 2.1
RESULTS OF SLOPE STABILITY ANALYSES

CASE	SLOPE	FACTOR OF SAFETY	ACCEPTABLE (Y / N)	FIGURE	DESCRIPTION AND WATER LEVEL (1)
North Head Slope	1.6H:1V	1.6	Y	C1	▪ Creek Elevation El. 639.7 m ▪ Measured GWT
	1.6H:1V	1.5	Y	C2	▪ Creek Elevation El. 640.7 m ▪ High GWT
	1.6H:1V	1.5	Y	C3	▪ Creek Elevation El. 639.7 m ▪ Measured GWT ▪ Embankment clay fill softened. to c’ = 1 kPa
South Head Slope	2H:1V	1.8	Y	C4	▪ Creek Elevation El. 639.7 m ▪ Measured GWT
	1.5H:1V	1.5	Y	C5	
	2H:1V	1.6	Y	C6	▪ Creek Elevation El. 640.7 m ▪ High GWT
Embankment	2H:1V	1.9	Y	C7	▪ Creek Elevation El. 640.7 m ▪ High GWT

Note: (1) Design High Water Level 1:2-year flood elevation of 640.7 m. Refer to Morrison Hershfield Summary of Conceptual Hydraulic Analysis Results DRAFT Memo (File No. 201932500 dated 12/15/2020).
(2) Design Class II rip rap thickness increased from 800 mm to 1,000 mm thickness.

A target factor of safety (FOS) of 1.5 is typically desired for the head slope stability of bridges and a target factor of safety of 1.3 for embankment side slopes. Following are the conclusions and recommendations from the stability analysis:

- The north head slope meets the target FOS with a head slope of 1.6H:1V and a minimum Class II rip rap thickness of 1,000 mm.
- The south head slope meets the target factor of safety for the design slope angle of 2H:1V and a Class II rip rap thickness of 800 mm at the flood elevation of the creek.
- It is recommended to backfill from the temporary excavation limits around the abutment pile caps to the final design height using granular material. Considering the relatively limited extent of backfilling it would be preferable to use a crushed granular base coarse aggregate such as a City of Edmonton, Designation 3, Class 20 or 25 granular fill (Des.3 – Class 20 or 25, Table 2.1.1 in Vol. 2 City of Edmonton Complete Streets Design and Construction Standards, 2018) for ease of placement and compaction.
- The embankment side slopes meet the target factor of safety for the design slope angle of 2H:1V. The embankment fill outside the abutment granular zone may consist of suitable inorganic low to medium plastic clay fill.
- The granular fill and clay fill should be placed in 150 mm maximum lifts compacted thickness and compacted to at least 95 percent Standard Proctor Maximum Dry Density (SPMDD) within ±2 percent of Optimum Moisture Content (OMC).

Based on these results, it is recommended that the north head slopes at the bridge abutments are designed no steeper than 1.6H:1V with a minimum of 1000 mm thickness of Class II rip rap and the south head slope be designed at 2H:1V design slope with a minimum of 800 mm thickness of Class II rip rap.

The embankment slopes should be designed not steeper than 2H:1V.

3. FOUNDATIONS

It is understood that the current foundation design consists of a single row of vertical cast-in-place concrete piles to support the bridge. This design is considered feasible from a geotechnical perspective. Recommended design parameters for vertical and lateral loading are outlined in the following sections.

3.1 Cast-in-Place Concrete Piles

Cast-in-place concrete piles should be designed and installed using the general recommendations provided in the 2019 Thurber Geotechnical Investigation (File No. 26386, Section 5.3), and the additional recommended construction procedures presented in Appendix F of the report. Straight shaft or belled piles founded in the hard bedrock may be designed using the factored ULS design values summarized below in Table 3.1.

TABLE 3.1
RECOMMENDED ULS SKIN FRICTION AND END BEARING VALUES FOR CAST-IN-PLACE CONCRETE PILES

APPROX. DEPTH B.G.S. (m)	APPROX. ELEVATION (m)	SOIL TYPE	SKIN FRICTION (kPa)			END BEARING (kPa)	
			Ultimate	ULS Factored [2] Compression	ULS Factored[3] Tension	Ultimate	ULS Factored[2]
0 – 2[1]	642 – 640	Clay/ Clay Fill	0	0	0	IGNORE	IGNORE
2[1] – 5	640 – 637	Clay / Sand	60	24	18	IGNORE	IGNORE
> 5	Below 637	Clay Shale	100	40	36	2,500[4]	1,000

Note: (1) Depth of 2.0 m or the thickness of fill, whichever is greater.
(2) Geotechnical Resistance Factor Compression (GFR) = 0.4.
(3) Geotechnical Resistance Factor Tension (GFR) = 0.3; and
(4) For piles based in very hard clay shale at minimum basing elevation of 634 m.

3.2 Lateral Loads on Piles

Vertical piles are capable of sustaining horizontal loading. It is common practice to design the piles for vertical loading and then check for lateral pile capacity, pile deflections and bending moments by lateral pile analysis.

Design of laterally loaded piles is generally governed by Serviceability Limit States in limiting top of pile movement to tolerable limits. Lateral pile analysis involves soil structure interaction and requires soil stiffness properties. The analysis is generally performed by a lateral pile computer program or by structural analyses where the horizontal subgrade modulus is used to determine spring constants for pile design.

The lateral pile deflection is highly dependent on the soil types and properties in the upper few meters, or within the upper six pile diameters (approximately). Lateral pile performance may be calculated by structural analyses where the soil support is modelled using soil springs. The recommended soil models and parameters are shown in Figure 3.1, where the soil spring constants are calculated from the modulus of horizontal subgrade reaction values provided on the figures. It should be noted that the modulus of horizontal subgrade reaction is not a fundamental soil property but is also dependent on the pile diameter (or width).

To account for the possibility of poor lateral support within the upper 2 m below ground surface or base of pile caps due to possible future soil shrinkage or frost effects, it is recommended that the design horizontal subgrade modulus increase linearly from zero at ground surface to the recommended value of horizontal subgrade reaction at a depth of 2 m below existing ground surface.

The modulus of subgrade reaction, k_{s1}, applies to a pile width (diameter) of 1 m, and a correction must be applied for piles of greater or smaller diameter, using the following formula:

k_b = k_{s1} x 1/B (MN/m^3) [1]

Where:

k_b = modulus of horizontal subgrade reaction for a pile of diameter B (MN/m^3)

k_{s1} = modulus of horizontal subgrade reaction for a pile of 1 m diameter (MN/m^3)

B = pile diameter (m).

The spring constant, K, for a pile diameter of B and segment length of L is calculated as follows:

K = k_b x B x L (MN/m).

For example, the appropriate spring stiffness, K, for a 1 m long segment, of a 1 m diameter pile, below a depth of 2 m would be calculated as follows:

k_b = 30 MN/m^3 x [1 m / 1 m] = 30 MN/m^3

K = 30 MN/m^3 x 1 m x 1 m = 30 MN/m.

As noted, the spring constant, K, is independent of pile diameter. However, the section modulus of the pile increases in proportion with diameter to the power 4 (i.e., B^4). Hence the pile stiffness increases and resulting lateral deformations decrease significantly with an increased pile diameter.

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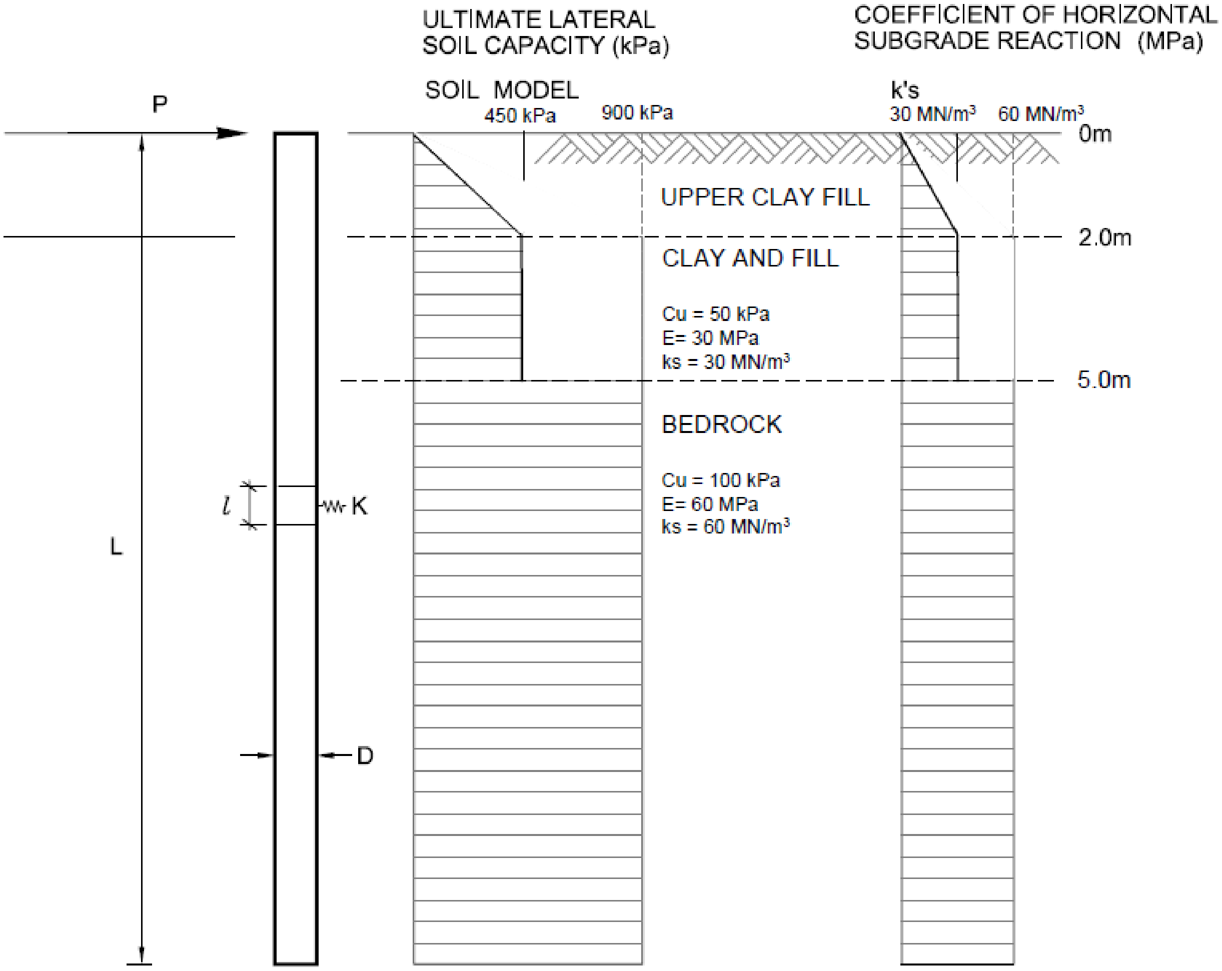
[1] Terzaghi, Karl. 1955. “Evaluation of Coefficients of Subgrade Reaction.” Geotechnique 5(4): 297–326.



PILE DIAMETER, D

l = SEGMENT LENGTH

K = SPRING CONSTANT = k's x l MN/m

Cu - UNDRAINED SHEAR STRENGTH
E - MODULUS OF ELASTICITY
P - LATERAL LOAD

LATERAL PILE ANALYSIS CARRIED OUT FOR SOIL MODEL USED FOR LATERAL PILE ANALYSIS

FIGURE 3.1

4. EMBANKMENT CONSIDERATIONS

Site preparation will include removal of all topsoil, and any poor-quality or disturbed fill material, within the new embankment footprint.

The subgrade should be inspected by qualified geotechnical personnel prior to placement of any additional fill required for site grading, to confirm that all deleterious material and organic soil has been removed. Any soft areas detected during the proof rolling should be sub-excavated and replaced with compacted low to medium plastic clay or granular soils. Recommendations for fill placement and compaction were presented in the above sections.

As shown on the design drawings provided by Morrison Hershfield, an existing utility line which leads to the City of Edmonton Outfall #296 is adjacent to the existing embankment of the south abutment. The pipe is 1,150 mm in diameter with an invert elevation of 640.01 m. Based on the cross sections with the proposed embankment and existing grade, the pipe lies about 9 m away from the centerline of the embankment and is covered by about 0.5 m of soil.

Based on the available information it is not anticipated that the temporary excavation for the wing wall should negatively impact the pipe support. However, this should be reviewed when more information is available on the temporary excavation works. Where necessary, temporary shoring could be installed to support the wingwall excavation if it is necessary to encroach within about two pipe diameters of the existing pipe location.

5. CLOSURE

We trust that this information is sufficient for your needs. Should you require clarification of any item or additional information, please contact the undersigned at your convenience.

Yours truly,
Thurber Engineering Ltd.
Robin Tweedie, P.Eng.
Review Principal

Graeme Law, E.I.T.
Geotechnical Engineer-in-Training
/jf

Attachments:

- Statement of Limitations and Conditions
- Appendix A - Conceptual Design Drawings Provided by Morrison Hershfield
- Appendix B - Thurber Site Plan and Stratigraphic Cross-Section, Report No. 26386
  Relevant Test Hole Logs
- Appendix C - Stability Figures

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

APPENDIX A

Conceptual Design Drawings Provided by Morrison Hershfield

UTILITY LEGEND

DESCRIPTION	LOCATION	SYMBOL	
ABANDONED UTILITIES	ABD		
DRAINAGE	➢ ➣ D 3.05	STORM SAN COMB	ST SAN COMB
GAS LINES	➢ ➣ G 20.13	HP IP MP LP	HP IP MP LP
POWER DUCTLINE POWER LINE OVERHEAD POWER LINE POWER TRANSMISSION LINE	➢ ➣ PD 8.83 ➢ ➣ P 1.22		PD O/H PWR PWRTRANS
STREETLIGHT CABLE STREETLIGHT POLES	➢ ➣ PS 2.54 BC ➢ ➣ P 2.54		STLT
TELEPHONE DUCTLINE TELE. BURIED CABLE	➢ ➣ T 1.52 ➢ ➣ TC 1.52		TD TC
TROLLEY POLES	➢ ➣ PT 1.22 BC		
URD TRENCH	➢ ➣ PTR 4.88		
UNDERGROUND CABLE/ FIBER OPTIC CABLE	➢ ➣ PC 1.55 BC → ← 1.21	SHAW ALL STREAM BELL COE FIBRE PRIVATE FIBRE	SHAW ALLSTR BELL COEFIB PRIFIB
WATERMAIN	➢ ➣ W 6.10		WAT

SURFACE UTILITY LEGEND

- ⬡ TROLLEY POLES
- ○ WOODEN POWER POLE
- ⊙ POWER POLE
- ☐ STREET LIGHT POLE
- ⊠ DECORATIVE STREET LIGHT POLE
- ▭ POWER MANHOLE
- → POLE ANCHOR
- ▫ TRAFFIC POLE
- Ⓣ TELEPHONE MANHOLE
- Ⓟ TELEPHONE POLE
- ● DRAINAGE MANHOLE (SANITARY)
- ○ DRAINAGE MANHOLE (STORM)
- ◒ CATCH BASIN MANHOLE
- ▿ CATCH BASIN
- ⌖ FIRE HYDRANT
- ⧖ WATER VALVE
- ┬ WATER TEE
- Ⓐ ANODE

PLAN

SCALE: 1:500

PRELIMINARY
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CONSTRUCTION RETURN

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DATE
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CONSTRUCTION MANAGER DATE
GENERAL SUPERVISOR DATE

APPROVED FOR CONSTRUCTION
DATE

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MANAGER OF ROADS DESIGN AND CONSTRUCTION DATE

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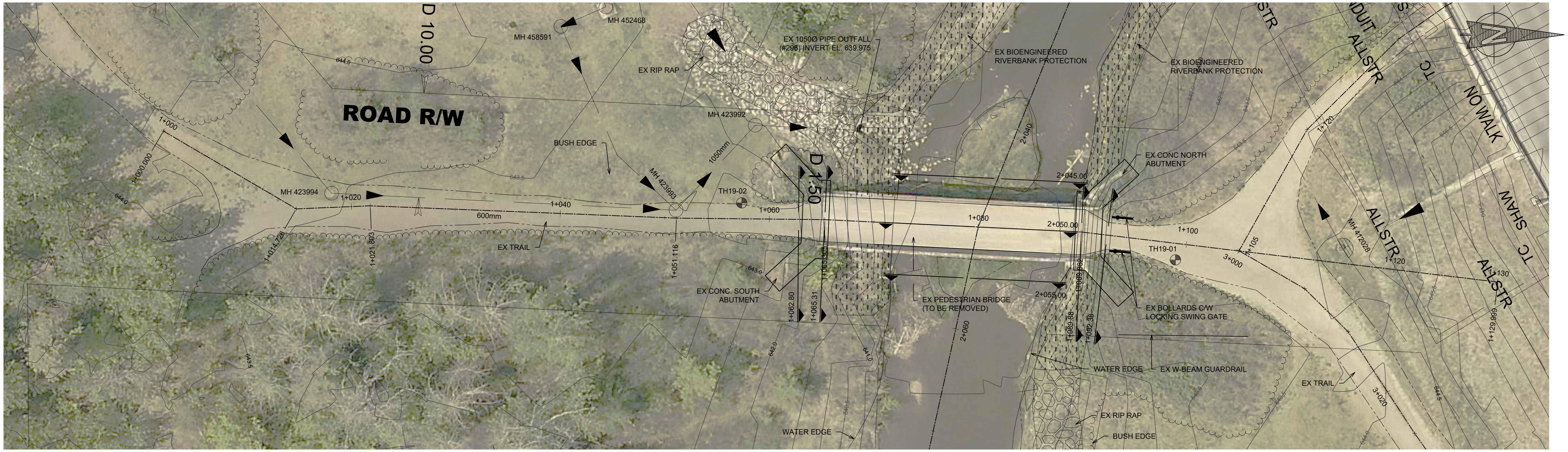
ROADS DESIGN AND CONSTRUCTION BRANCH

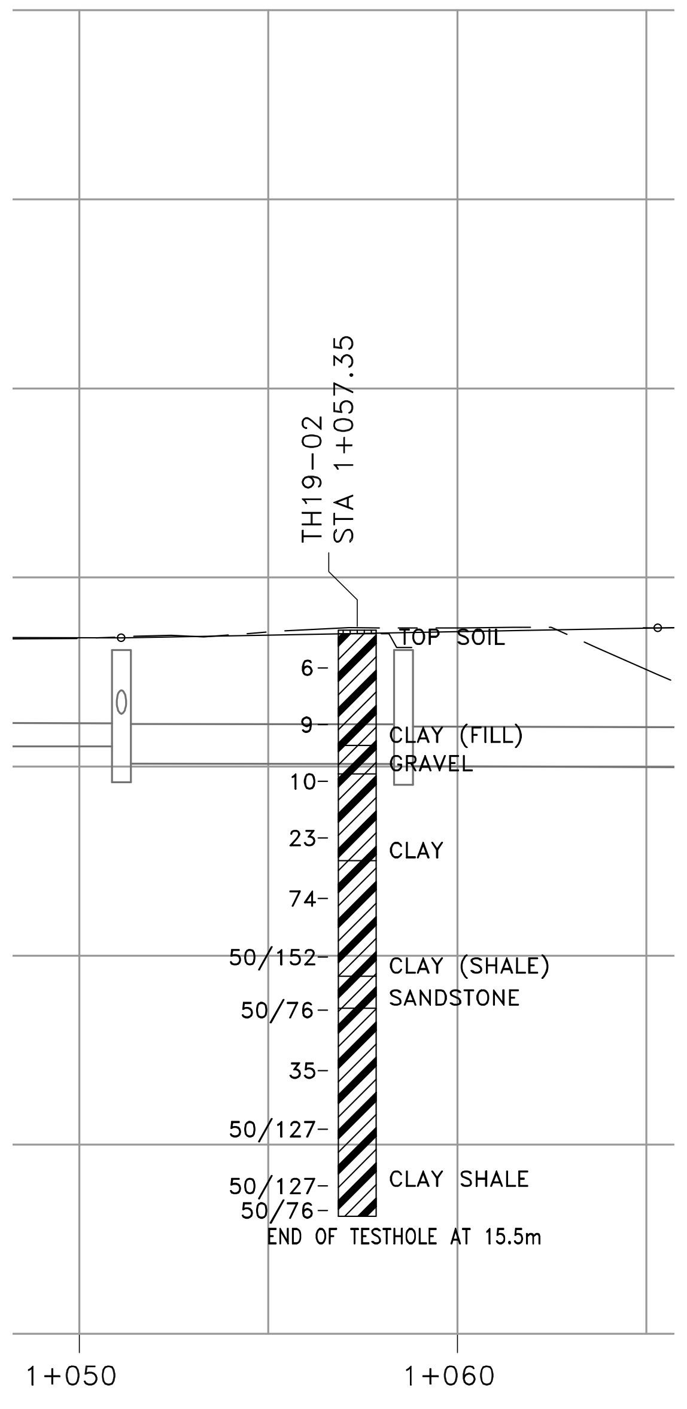
PROJECT
23 AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
SITE PLAN

DRAWING
A023 P20X - 001



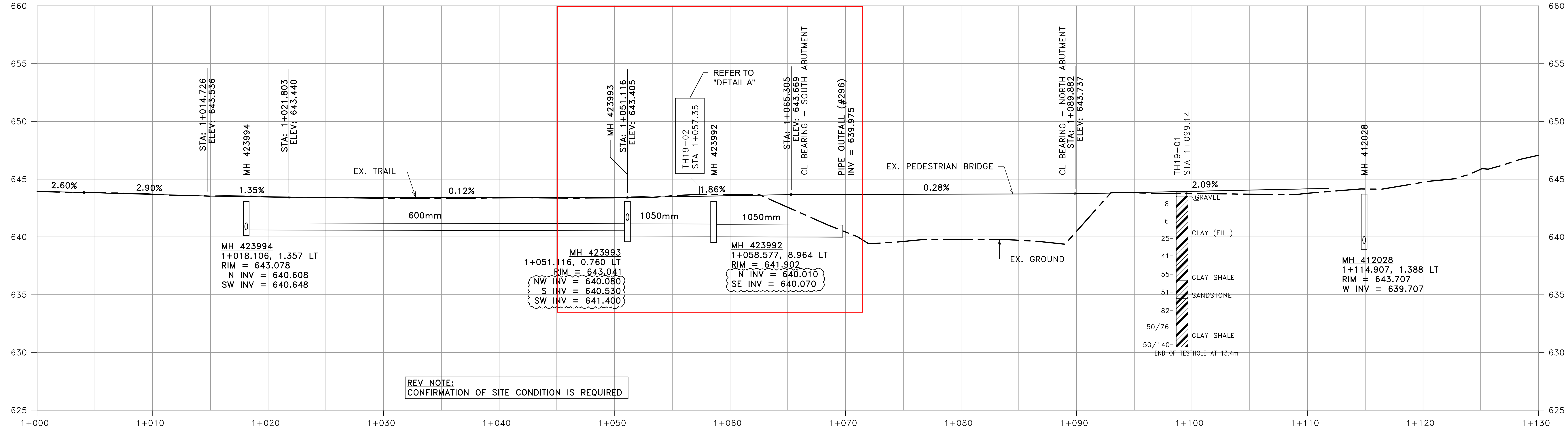
PLAN

SCALE: 1:200



DETAIL A

SCALE: 1:200 H & V



ALIGNMENT: Smith Bridge
NO VERTICAL EXAGGERATION

PROFILE

SCALE: 1:200 H & V

NOTE:
REFER TO SHEETS X02, X03, & EX1 FOR LOCATION OF ALL CROSS-SECTIONS.

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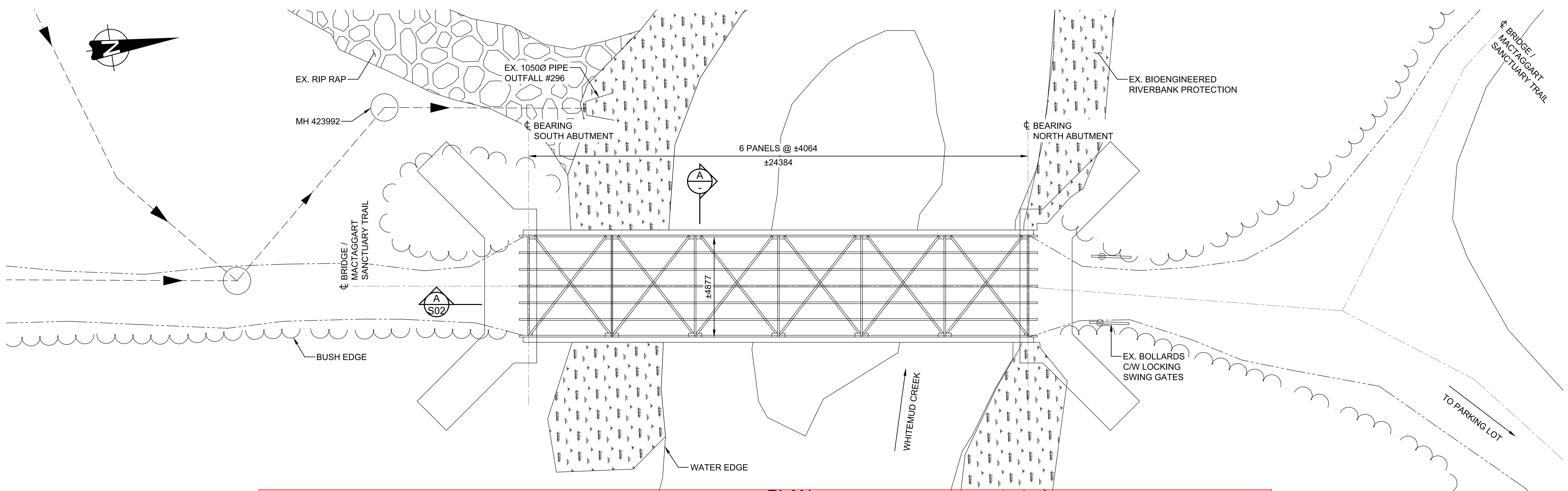
THE CITY OF Edmonton
TRANSPORTATION SERVICES
ROADS DESIGN AND CONSTRUCTION BRANCH

PROJECT
23 AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
PEDESTRIAN BRIDGE

DRAWING
A023 P20X - X01



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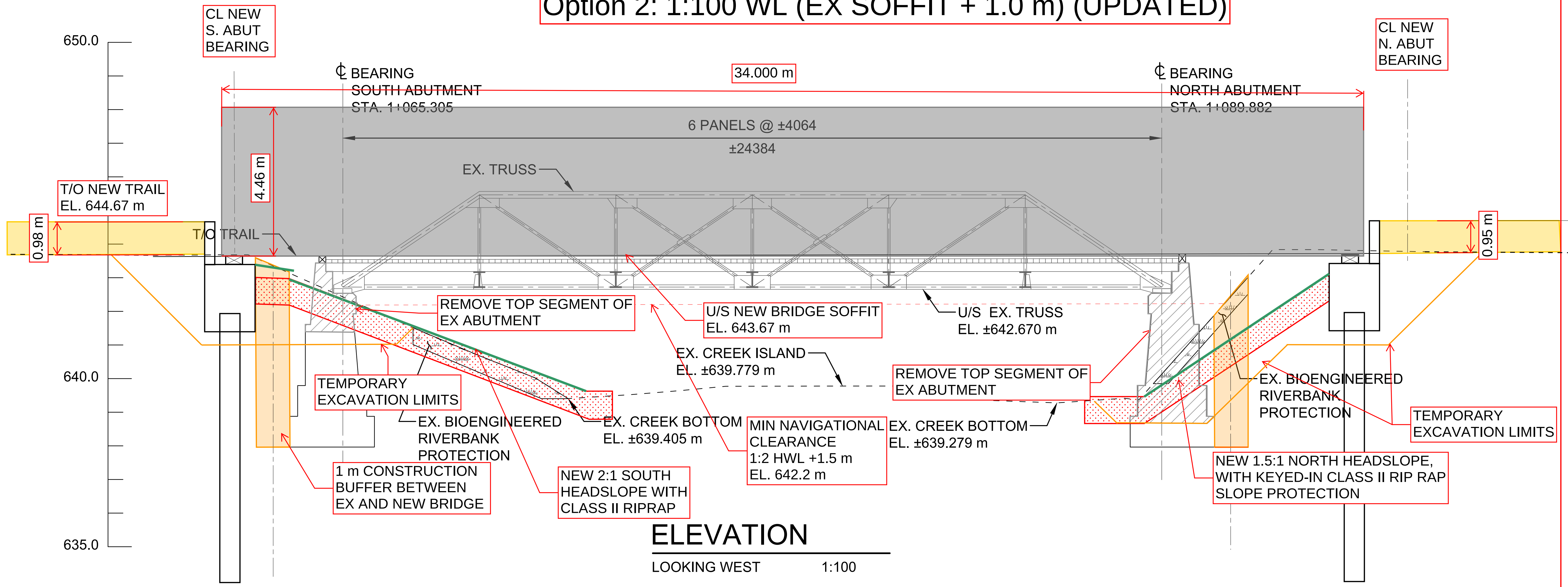
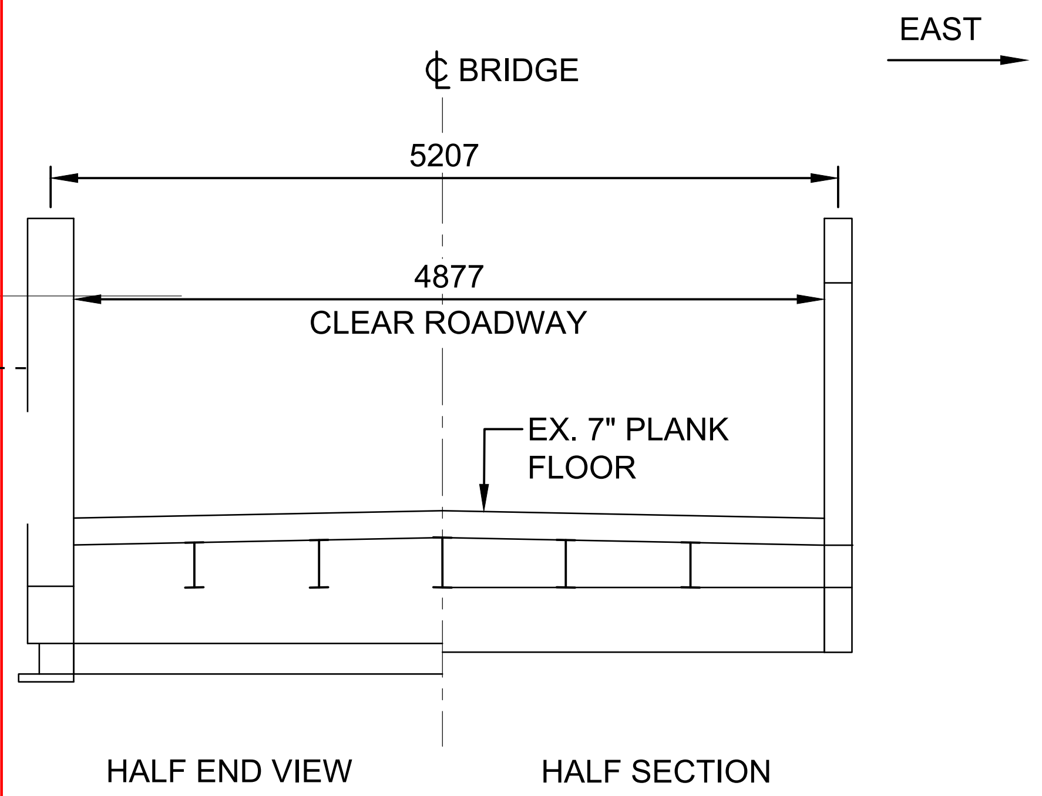
Option 2: 1:100 WL (EX SOFFIT + 1.0 m) (UPDATED)



ELEVATION

LOOKING WEST 1:100



A - SECTION

1:50

ROADWAY IDENTIFICATION

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CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION ENGINEER DATE

GENERAL SUPERVISOR DATE

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADWAYS DESIGN DATE

DIRECTOR OF ROADWAYS CONSTRUCTION DATE

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JOB NO. 201932500

SCALE AS SHOWN

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THE CITY OF Edmonton TRANSPORTATION

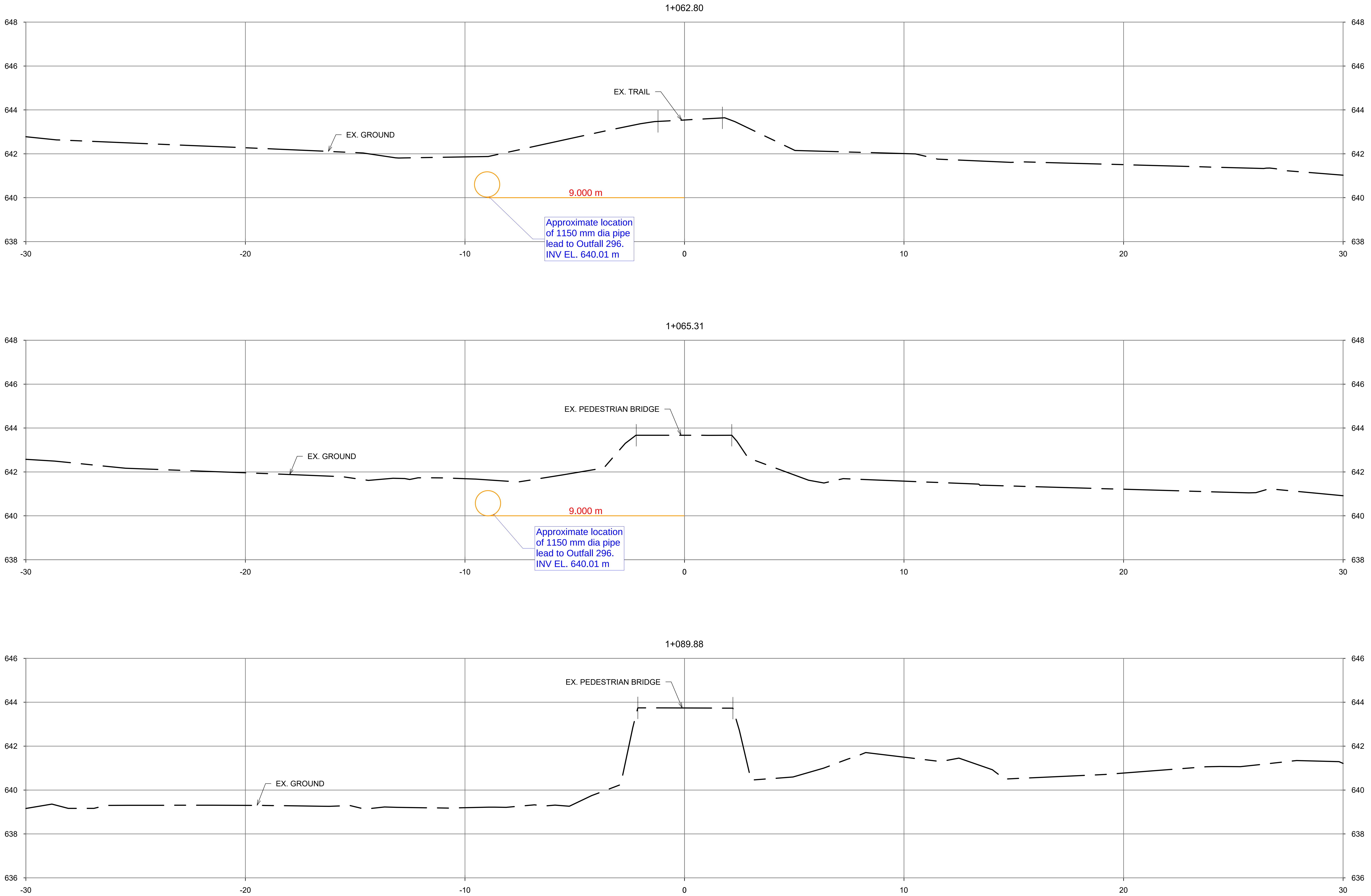
PROJECT

23 AVENUE

SMITH CROSSING BRIDGE REPLACEMENT

GENERAL ARRANGEMENT

DRAWING A023 P20X - S01



CROSS SECTIONS

SCALE: 1:100

NOTE:
REFER TO SHEET X01 FOR LOCATION OF ALL CROSS-SECTIONS.

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23 AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
PEDESTRIAN BRIDGE

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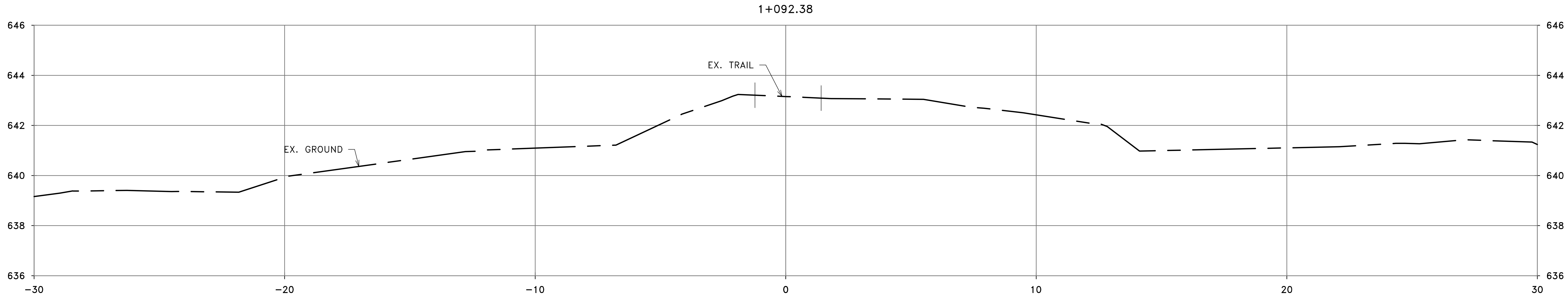

CROSS SECTIONS

SCALE: 1:100

NOTE:
REFER TO SHEET X01 FOR LOCATION OF ALL CROSS-SECTIONS.

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PROJECT

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SMITH CROSSING BRIDGE REPLACEMENT
PEDESTRIAN BRIDGE

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A023 P20X - X03

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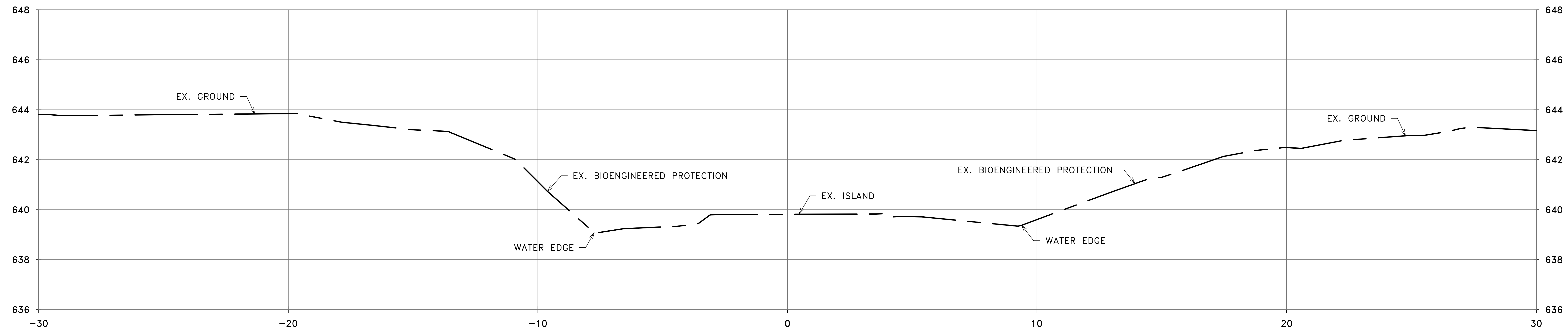

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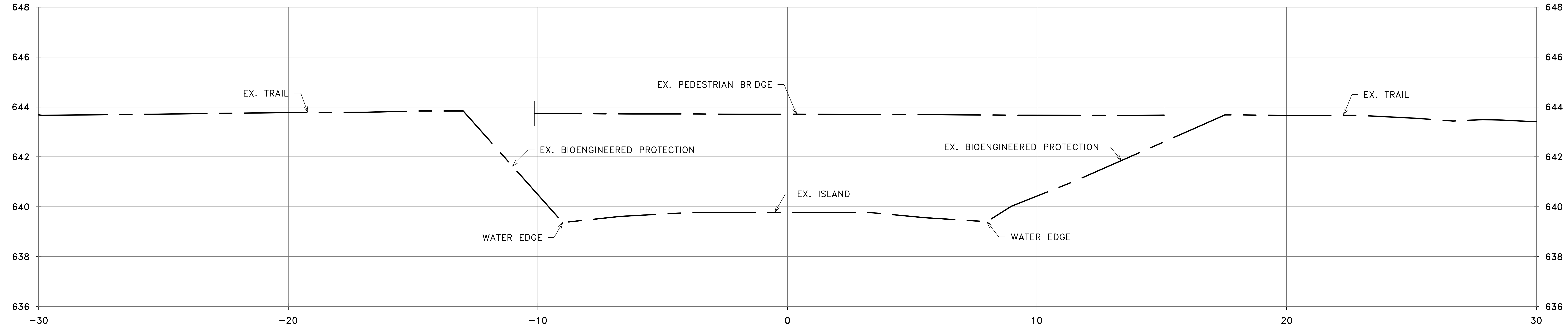

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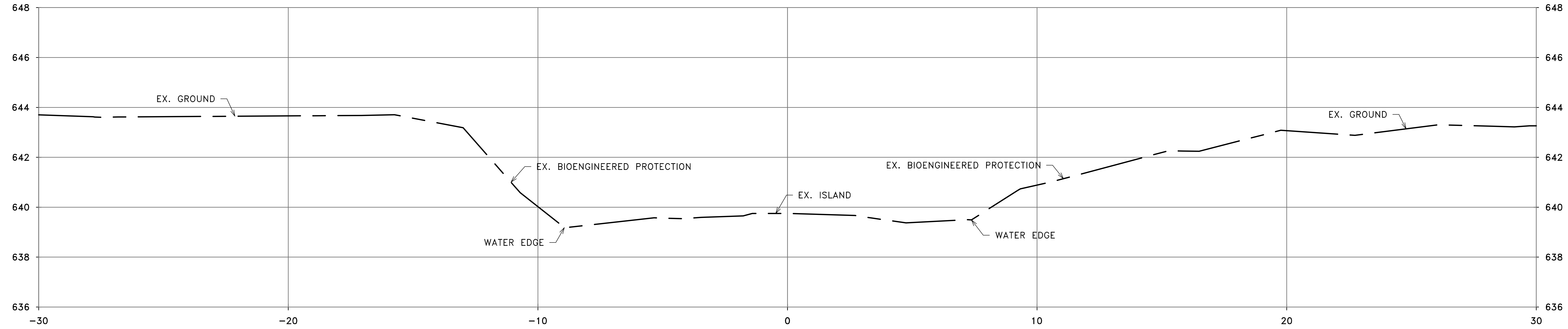

NOTE:
REFER TO SHEET X01 FOR LOCATION OF ALL CROSS-SECTIONS.

CROSS SECTIONS

SCALE: 1:100

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PROJECT
23 AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
BLACKMUD CREEK

DRAWING
A023 P20X - EX1

THURBER

APPENDIX B

Thurber Site Plan and Stratigraphic Cross-Section, Report No. 26386

Relevant Test Hole Logs

H:\26000\26386 Smith Crossing Pedestrian Bridge - Edm, AB\Drafting\26386-1~2.dwg - 1 - Aug. 12, 2019

LEGEND

- 2019 TEST HOLE LOCATION
- PREVIOUS TEST HOLE LOCATION (THURBER, HBT)

SURVEY DATA PROVIDED BY THE CITY OF EDMONTON ON JUNE 21, 2019
2017 AIR PHOTO FROM THE CITY OF EDMONTON

THE CITY OF Edmonton

SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT - WHITEMUD CREEK, EDMONTON, AB GEOTECHNICAL INVESTIGATION

SITE PLAN SHOWING TEST HOLE LOCATIONS

DWG No. 26386-1

DRAWN BY	KLW
DESIGNED BY	GL
APPROVED BY	RWT
SCALE	1:400
DATE	AUGUST 2019
FILE No.	26386

THURBER ENGINEERING LTD.

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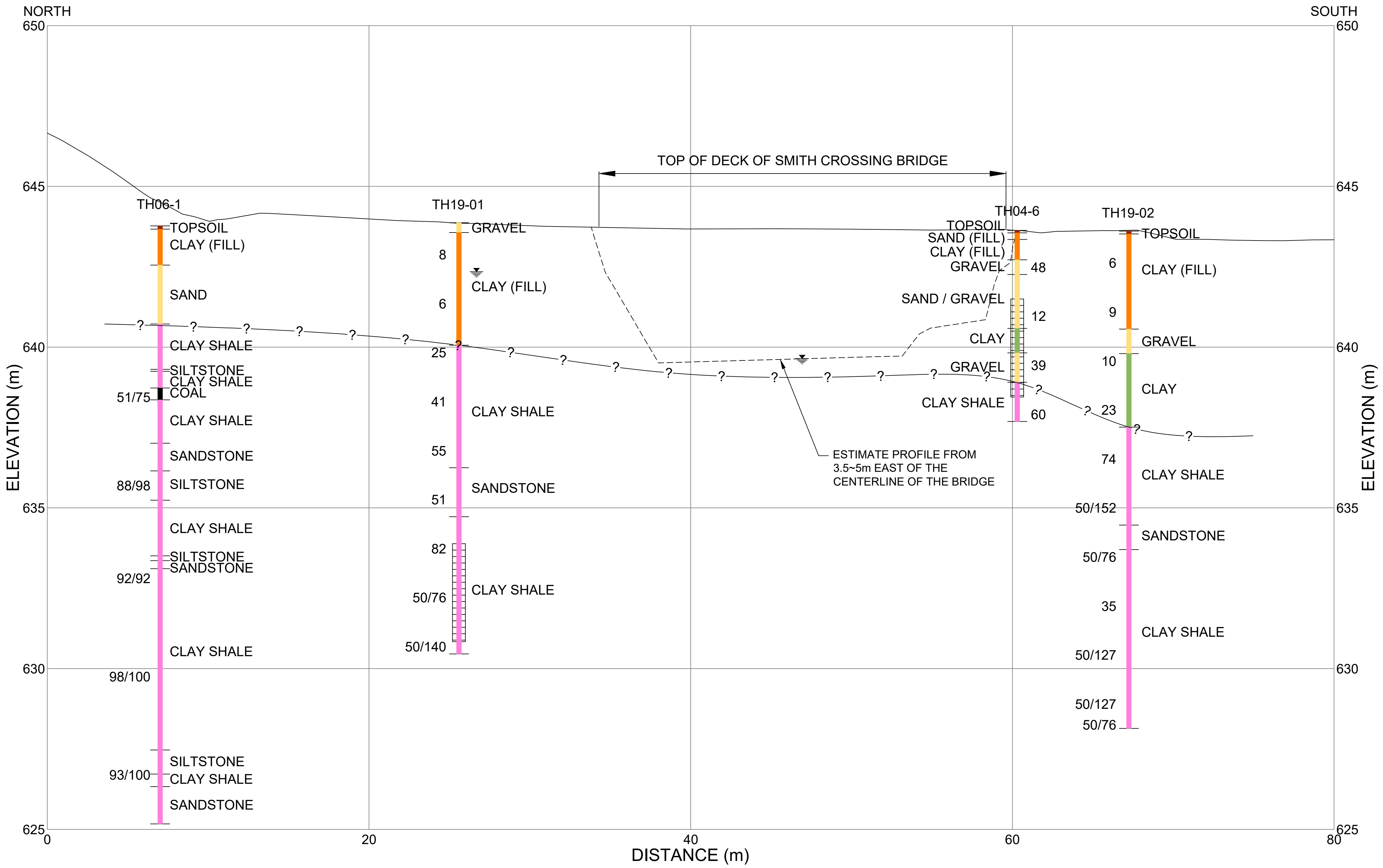

LEGEND

15 I SPT N VALUE

▽ WATER LEVEL IN PIEZOMETER

▤ STANDPIPE PIEZOMETER SCREENED INTERVAL

NOTE

DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

SURVEY DATA PROVIDED BY THE CITY OF EDMONTON ON JUNE 21, 2019

THE CITY OF Edmonton

SMITH CROSSING PEDESTRIAN BRIDGE #191
REPLACEMENT - WHITEMUD CREEK, EDMONTON, AB
GEOTECHNICAL INVESTIGATION

CROSS-SECTION A-A'

DWG No. 26386-2

DRAWN BY	KLW
DESIGNED BY	GL
APPROVED BY	RWT
SCALE	H 1:300 V 1:150
DATE	AUGUST 2019
FILE No.	26386

THURBER ENGINEERING LTD.

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SYMBOLS AND TERMS USED ON TEST HOLE LOGS

1. VISUAL TEXTURAL CLASSIFICATION OF MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200 mm	Greater than 200 mm
Cobbles	75 mm to 200 mm	75 mm to 200 mm
Gravel	4.75 mm to 75 mm	5 mm to 75 mm
Sand	0.075 mm to 4.75 mm	Visible particles to 5 mm
Silt	0.002 mm to 0.075 mm	Non-Plastic particles, not visible to the naked eye
Clay	Less than 0.002 mm	Plastic particles, not visible to the naked eye

2. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	APPROXIMATE UNDRAINED SHEAR STRENGTH		APPROXIMATE SPT * 'N' VALUE
Very Soft	Less than 10 kPa		Less than 2
Soft	10 - 25 kPa		2 to 4
Firm	25 - 50 kPa		4 to 8
Stiff	50 - 100 kPa		8 to 15
Very Stiff	100 - 200 kPa	Modified from National Building Code	15 to 30
Hard	200 - 300 kPa		Greater than 30
Very Hard	Greater than 300 kPa		

* SPT 'N' Value Standard Penetration Test 'N' Value - refers to the number of blows from a 63.5 kg hammer free falling a height of 0.76m to advance a standard 50mm outside diameter split spoon sampler for 0.3m depth into the undrilled portion of the test hole.

3. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	STANDARD PENETRATION TEST (SPT) (Number of Blows per 300 mm)	
Very Loose	0 - 4	
Loose	4 - 10	
Compact	10 - 30	Modified from National Building Code
Dense	30 - 50	
Very Dense	Over 50	

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

■	Shelby Tube	▤	A-Casing
⧄	SPT	▥	Grab
⊠	No Recovery	◫	Core

SYMBOLS USED FOR TEST HOLE LOGS

●		WC - Water Content (% by weight) of soil sample
▼		Water Level
■	SPT	Standard Penetration Test 'N' Value (Blows/300mm)
▲	CPen	Shear Strength determined by pocket penetrometer
	CVane	Shear Strength determined by pocket vane
	Cu	Undrained Shear Strength determined by unconfined compression test
	SO_4%	Percent (%) of water soluble sulphate ions

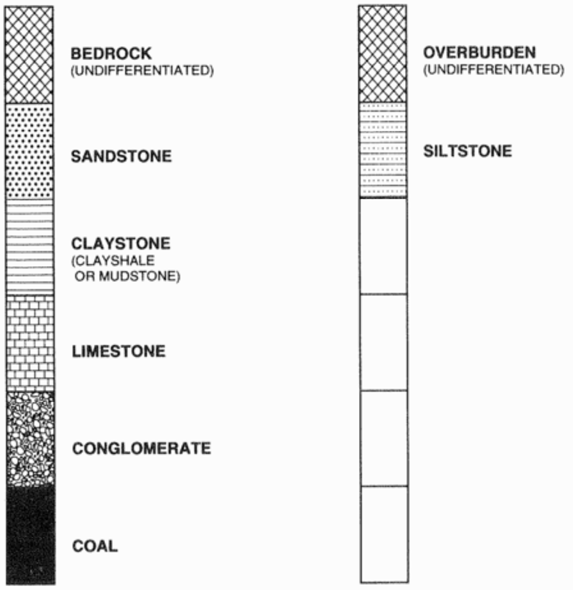
THURBER ENGINEERING LTD.

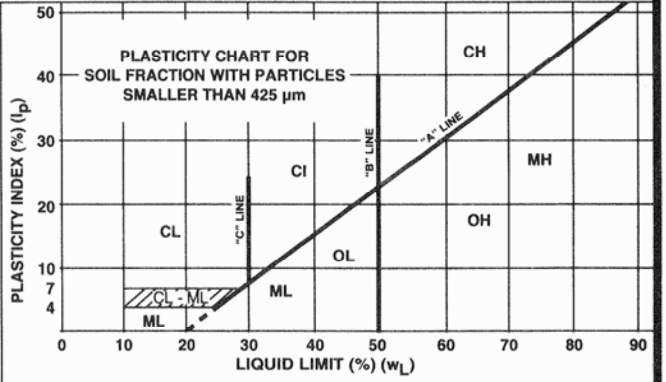
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(MODIFIED BY PFRA, 1985)

MAJOR DIVISION			GROUP SYMBOL	THURBER LOG SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	△▽△	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75µm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP	▲▼▲	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR GW	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	▥	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	▨	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
	SANDS MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	SW	⋰	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP	○○○○	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR SW	
		SAND WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	▦	SILTY SANDS, SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	▩	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 50\%$	ML	▥	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH 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			
		$30\% < w_L < 50\%$	CI	▨	INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, 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 AND MEDIUM PLASTICITY			
		$w_L > 50\%$	OH	▨	ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS			
HIGHLY ORGANIC SOILS			Pt	≈	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE		

SPECIAL SYMBOLS





THURBER ENGINEERING LTD.

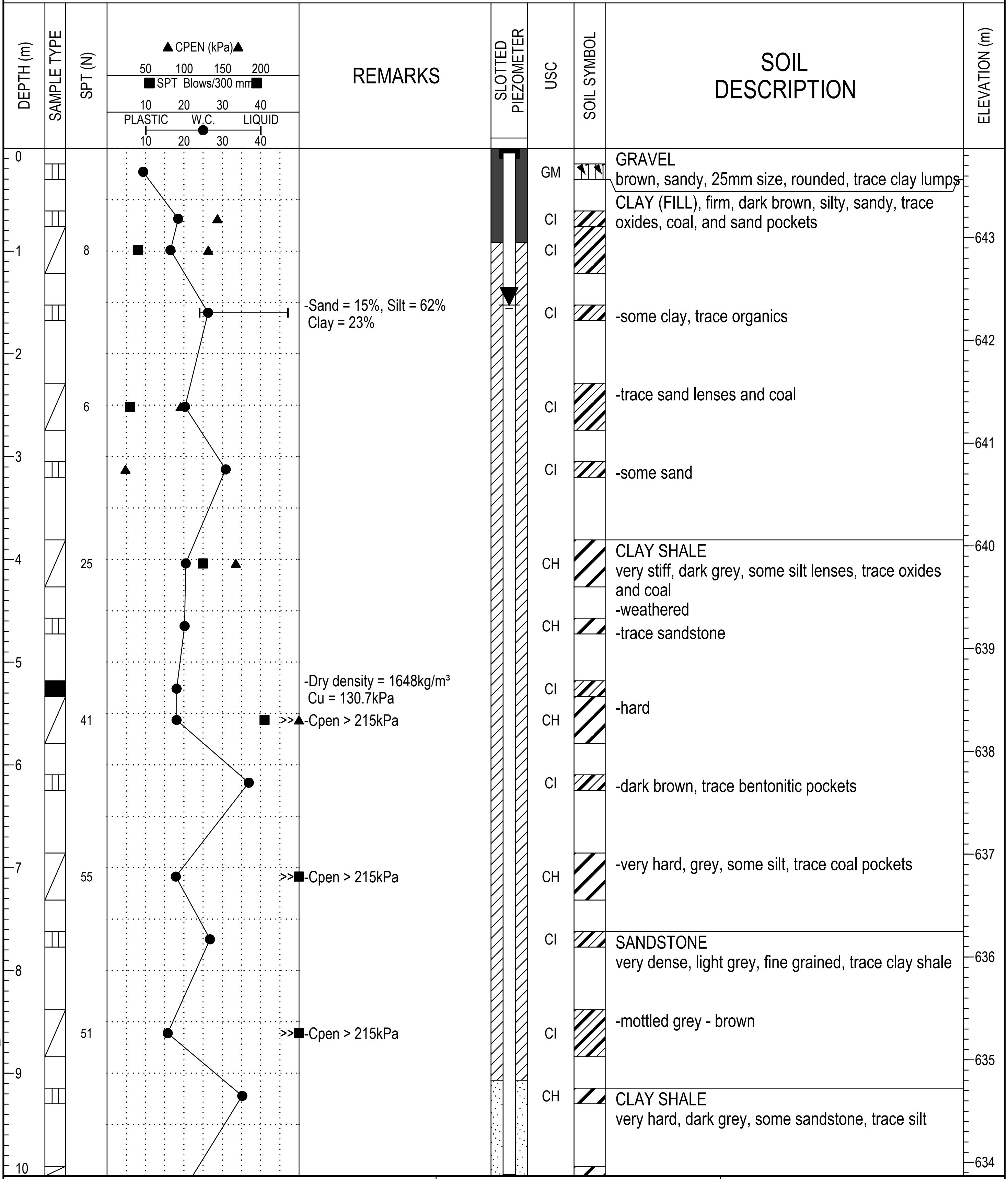
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(MODIFIED BY PFRA, 1985)

CLIENT: City of Edmonton	PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT	BOREHOLE NO: **TH19-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 10, 2019	PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers	LOCATION: N5924768.51, E30042.95	ELEVATION: 643.87 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND ▥ SLOUGH



REMARKS:

-Sand = 15%, Silt = 62%
Clay = 23%

-Dry density = 1648kg/m³
Cu = 130.7kPa

-Cpen > 215kPa

-Cpen > 215kPa

-Cpen > 215kPa

SOIL DESCRIPTION:

GRAVEL
brown, sandy, 25mm size, rounded, trace clay lumps

CLAY (FILL), firm, dark brown, silty, sandy, trace oxides, coal, and sand pockets

-some clay, trace organics

-trace sand lenses and coal

-some sand

CLAY SHALE
very stiff, dark grey, some silt lenses, trace oxides and coal
-weathered
-trace sandstone

-hard

-dark brown, trace bentonitic pockets

-very hard, grey, some silt, trace coal pockets

SANDSTONE
very dense, light grey, fine grained, trace clay shale

-mottled grey - brown

CLAY SHALE
very hard, dark grey, some sandstone, trace silt

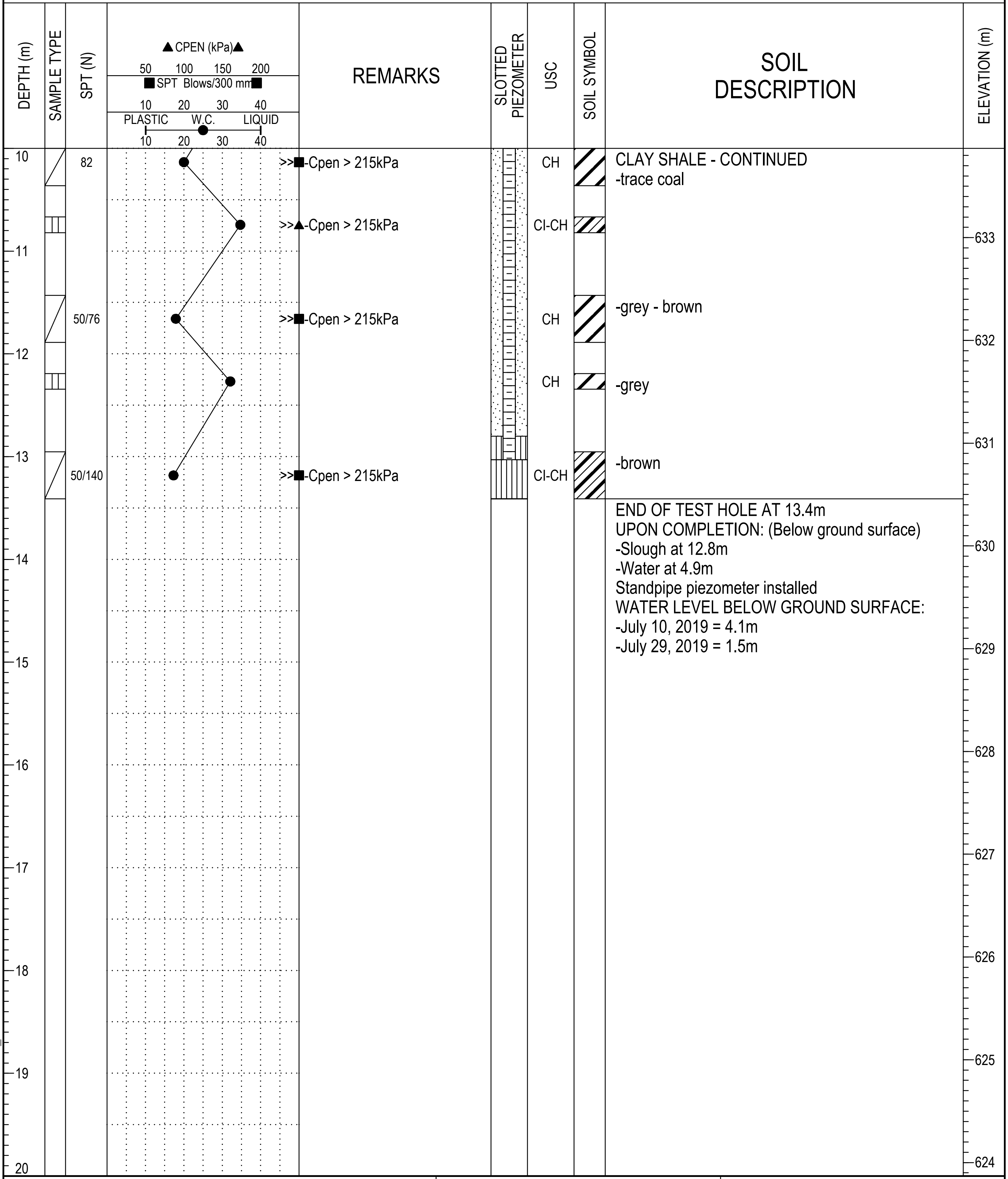
THURBER ENGINEERING LTD.	FIELD LOGGED BY: LRG	COMPLETION DEPTH: 13.4 m
	PREPARED BY: GBL	COMPLETION DATE: 7/10/19
	REVIEWED BY:	Page 1 of 2

BOREHOLE LOG 26386.GPJ THRBR_AB.GDT 8/6/19- LIBRARY-NEW LOGO-N E.GLB

CLIENT: City of Edmonton	PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT	BOREHOLE NO: **TH19-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 10, 2019	PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers	LOCATION: N5924768.51, E30042.95	ELEVATION: 643.87 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ░ SAND ▥ SLOUGH



CLAY SHALE - CONTINUED
-trace coal

-grey - brown

-grey

-brown

END OF TEST HOLE AT 13.4m
UPON COMPLETION: (Below ground surface)
-Slough at 12.8m
-Water at 4.9m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 10, 2019 = 4.1m
-July 29, 2019 = 1.5m

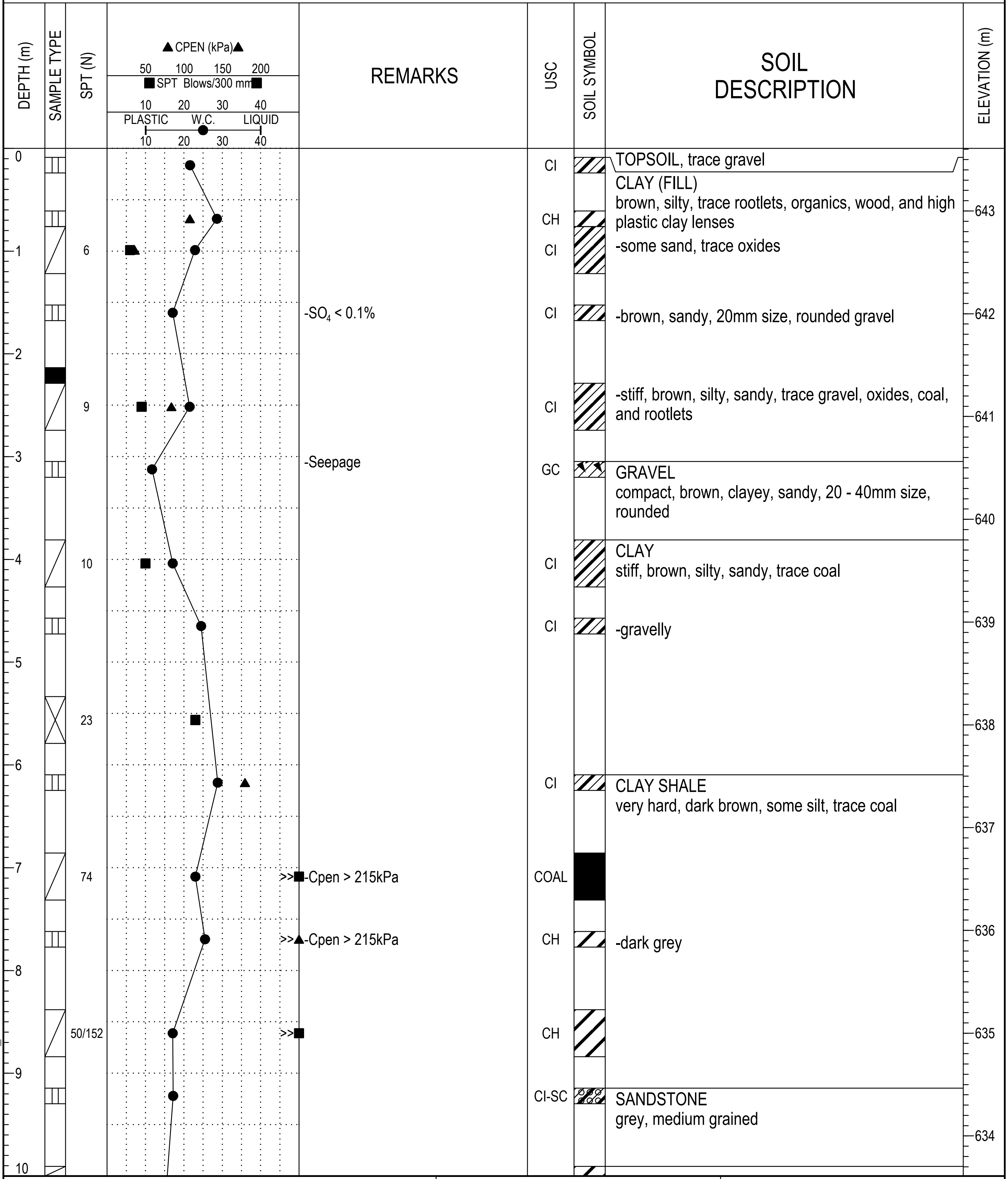
BOREHOLE LOG 26386.GPJ THRBR_AB.GDT 8/6/19- LIBRARY-NEW LOGO-N E.GLB

THURBER ENGINEERING LTD.

FIELD LOGGED BY: LRG	COMPLETION DEPTH: 13.4 m
PREPARED BY: GBL	COMPLETION DATE: 7/10/19
REVIEWED BY:	

CLIENT: City of Edmonton	PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT	BOREHOLE NO: **TH19-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 13, 2019	PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers	LOCATION: N5924727.02, E30037.49	ELEVATION: 643.61 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0.15	▥			CI	TOPSOIL, trace gravel
					CLAY (FILL) brown, silty, trace rootlets, organics, wood, and high plastic clay lenses
0.7	▥			CH	
1.0	◿	6		CI	-some sand, trace oxides
1.6	▥		-SO_4 < 0.1%	CI	-brown, sandy, 20mm size, rounded gravel
2.2	■				
2.5	◿	9		CI	-stiff, brown, silty, sandy, trace gravel, oxides, coal, and rootlets
3.0			-Seepage		
3.1	▥			GC	GRAVEL compact, brown, clayey, sandy, 20 - 40mm size, rounded
4.0	◿	10		CI	CLAY stiff, brown, silty, sandy, trace coal
4.6	▥			CI	-gravelly
5.5	☒	23			
6.2	▥			CI	CLAY SHALE very hard, dark brown, some silt, trace coal
7.0	◿	74	>>■-Cpen > 215kPa	COAL	
7.7	▥		>>▲-Cpen > 215kPa	CH	-dark grey
8.6	◿	50/152	>>■	CH	
9.2	▥			CI-SC	SANDSTONE grey, medium grained

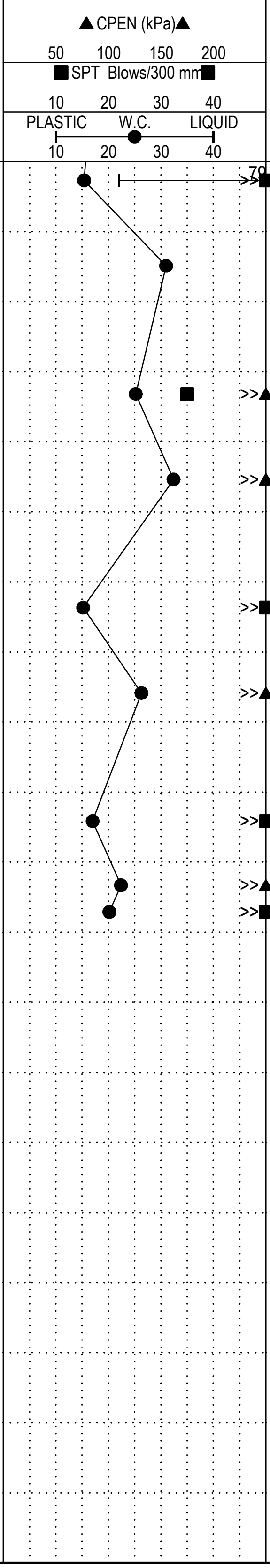
THURBER ENGINEERING LTD.

FIELD LOGGED BY: LRG	COMPLETION DEPTH: 15.5 m
PREPARED BY: GBL	COMPLETION DATE: 7/13/19
REVIEWED BY:	

BOREHOLE LOG 26386.GPJ THRBR_AB.GDT 8/6/19- LIBRARY-NEW LOGO-N E.GLB

CLIENT: City of Edmonton	PROJECT: SMITH CROSSING PEDESTRIAN BRIDGE #191 REPLACEMENT	BOREHOLE NO: **TH19-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 13, 2019	PROJECT NO: 26386
DRILL/METHOD: Track M4 / Solid Stem Augers	LOCATION: N5924727.02, E30037.49	ELEVATION: 643.61 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT ■ SHELBY TUBE ☒ NO RECOVERY



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
10	SPT	50/76	-Cpen > 215kPa	CH	CLAY SHALE very hard, brown	
	GRAB SAMPLE			CH	-weathered	633
11						
	SPT	35	-Cpen > 215kPa	CH	-hard	632
12	GRAB SAMPLE		-Cpen > 215kPa	CH		
						631
13	SPT	50/127		CH	-very hard, trace coal	
	GRAB SAMPLE		-Cpen > 215kPa	CH	-light grey	630
14						
	SPT	50/127	-Cpen > 215kPa	CH		629
15	GRAB SAMPLE		-Cpen > 215kPa	CH		
	SPT	50/76	-Cpen > 215kPa	CH	-grey	
					END OF TEST HOLE AT 15.5m UPON COMPLETION: (Below ground surface) -Slough at 13.7m -Water at 3.7m Backfilled with drill cuttings and bentonite chips at surface	628
16						
						627
17						
						626
18						
						625
19						
						624
20						

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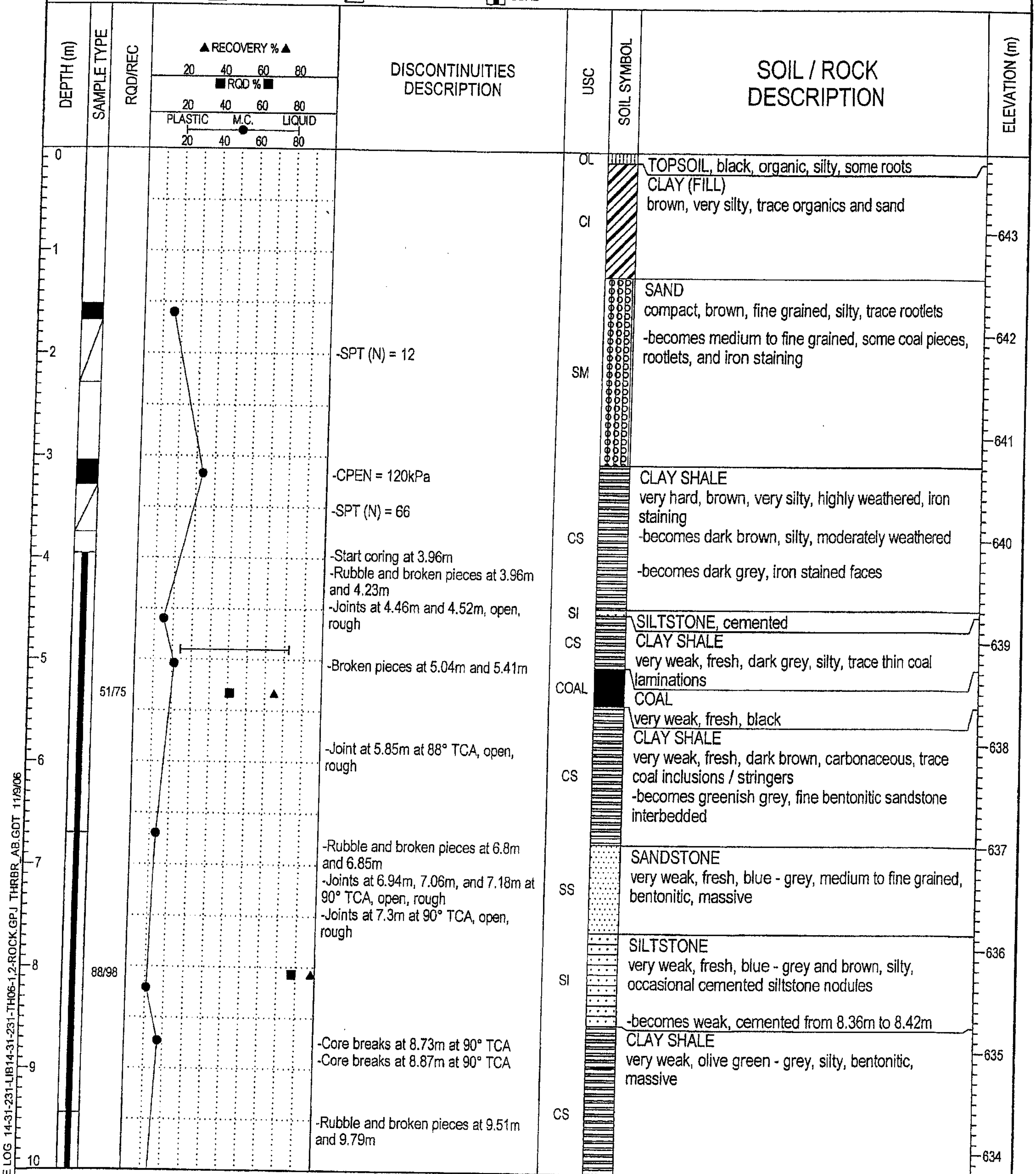
FIELD LOGGED BY: LRG	COMPLETION DEPTH: 15.5 m
PREPARED BY: GBL	COMPLETION DATE: 7/13/19
REVIEWED BY:	

23Avenue Widening From 119Street to Hodgson Way	Truck Mounted Wet Rotary Rig	BOREHOLE NO: **TH06-1**
CITY OF EDMONTON	UTM ZONE: N5924786.19, E30024.28	PROJECT NO: 14-31-231
START DATE: June 9, 2006		ELEVATION: 643.77 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ◧ CORE



DISCONTINUITIES DESCRIPTION

-SPT (N) = 12

-CPEN = 120kPa

-SPT (N) = 66

-Start coring at 3.96m
-Rubble and broken pieces at 3.96m and 4.23m
-Joints at 4.46m and 4.52m, open, rough

-Broken pieces at 5.04m and 5.41m

-Joint at 5.85m at 88° TCA, open, rough

-Rubble and broken pieces at 6.8m and 6.85m
-Joints at 6.94m, 7.06m, and 7.18m at 90° TCA, open, rough
-Joints at 7.3m at 90° TCA, open, rough

-Core breaks at 8.73m at 90° TCA
-Core breaks at 8.87m at 90° TCA

-Rubble and broken pieces at 9.51m and 9.79m

SOIL / ROCK DESCRIPTION

TOPSOIL, black, organic, silty, some roots

CLAY (FILL)
brown, very silty, trace organics and sand

SAND
compact, brown, fine grained, silty, trace rootlets
-becomes medium to fine grained, some coal pieces, rootlets, and iron staining

CLAY SHALE
very hard, brown, very silty, highly weathered, iron staining
-becomes dark brown, silty, moderately weathered
-becomes dark grey, iron stained faces

SILTSTONE, cemented

CLAY SHALE
very weak, fresh, dark grey, silty, trace thin coal laminations

COAL
very weak, fresh, black

CLAY SHALE
very weak, fresh, dark brown, carbonaceous, trace coal inclusions / stringers
-becomes greenish grey, fine bentonitic sandstone interbedded

SANDSTONE
very weak, fresh, blue - grey, medium to fine grained, bentonitic, massive

SILTSTONE
very weak, fresh, blue - grey and brown, silty, occasional cemented siltstone nodules
-becomes weak, cemented from 8.36m to 8.42m

CLAY SHALE
very weak, olive green - grey, silty, bentonitic, massive

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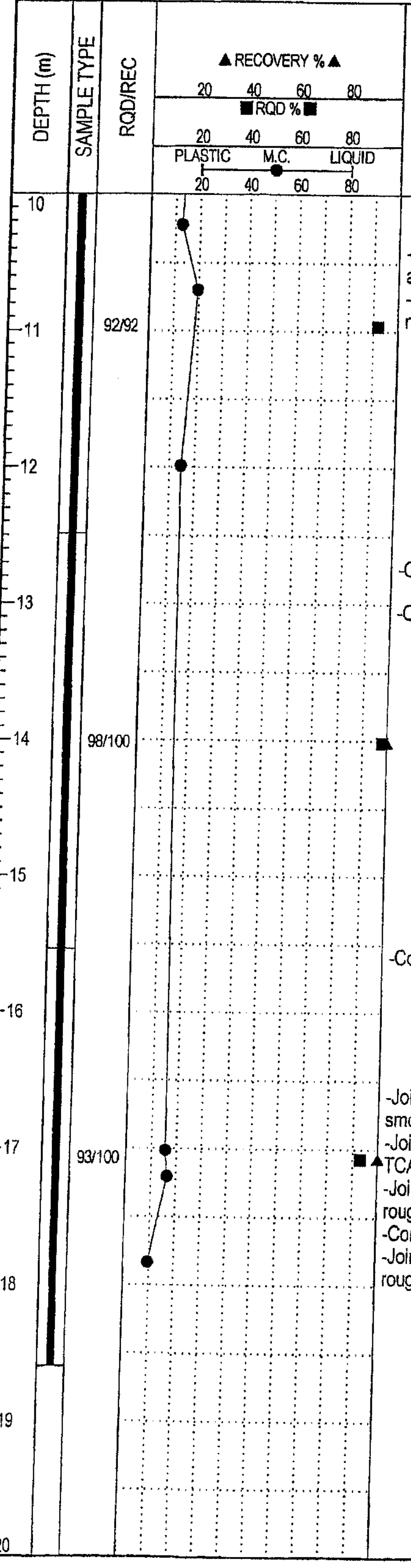
Transportation & Streets Engineering Services Section

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: TC	REVIEWED BY: LWB	COMPLETION DEPTH: 18.6 m
		COMPLETION DATE: 6/9/2006

23Avenue Widening From 119Street to Hodgson Way	Truck Mounted Wet Rotary Rig	BOREHOLE NO: **TH06-1**
CITY OF EDMONTON	UTM ZONE: N5924786.19, E30024.28	PROJECT NO: 14-31-231
START DATE: June 9, 2006		ELEVATION: 643.77 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ▯ CORE



DISCONTINUITIES DESCRIPTION

-Rubble and broken pieces at 10.41m and 10.55m
-Joints at 10.7m at 90° TCA, open, rough

-Core breaks at 12.73m at 90° TCA

-Core breaks at 13.05m at 90° TCA

-Core breaks at 15.58m at 90° TCA

-Joints at 16.6m at 45° TCA, open, smooth
-Joints at 16.7m to 16.88m at 45° TCA, closed
-Joints at 16.88m and 17.05m, open, rough
-Core breaks at 17.2m at 90° TCA
-Joints at 17.28m at 45° TCA, open, rough

SOIL / ROCK DESCRIPTION

USC	SOIL / ROCK DESCRIPTION
	CLAY SHALE - CONTINUED -cemented siltstone inclusions
SI	SILTSTONE, weak, light brown, cemented
SS	SANDSTONE very weak, fresh, olive green - light grey, bentonitic
CS	CLAY SHALE very weak, fresh, greenish grey, silty, some coal inclusions, massive -coal inclusions from 11.53m to 11.54m -highly bentonitic zone from 13.27m to 13.55m -cemented siltstone inclusions -becomes dark brown -becomes dark green - grey -becomes dark brown, very silty
SI	SILTSTONE very weak, fresh, dark brown, carbonaceous, some coal chips and cemented siltstone inclusions -becomes cemented from 16.85m to 17.05m
CS	CLAY SHALE very weak, fresh, olive green - grey, silty
SS	SANDSTONE very weak to weak, fresh, olive green - grey, fine grained, bentonitic, thin bedding at 90° TCA -becomes medium to fine grained -cemented
	END OF TEST HOLE AT 18.6m Backfilled with bentonite chips to surface

ELEVATION (m): 633, 632, 631, 630, 629, 628, 627, 626, 625, 624

BOREHOLE LOG 14-31-231-LIB14-31-231-TH06-1,2-ROCK.GPJ THRBR_AB.GDT 11/9/06

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Engineering Services Section

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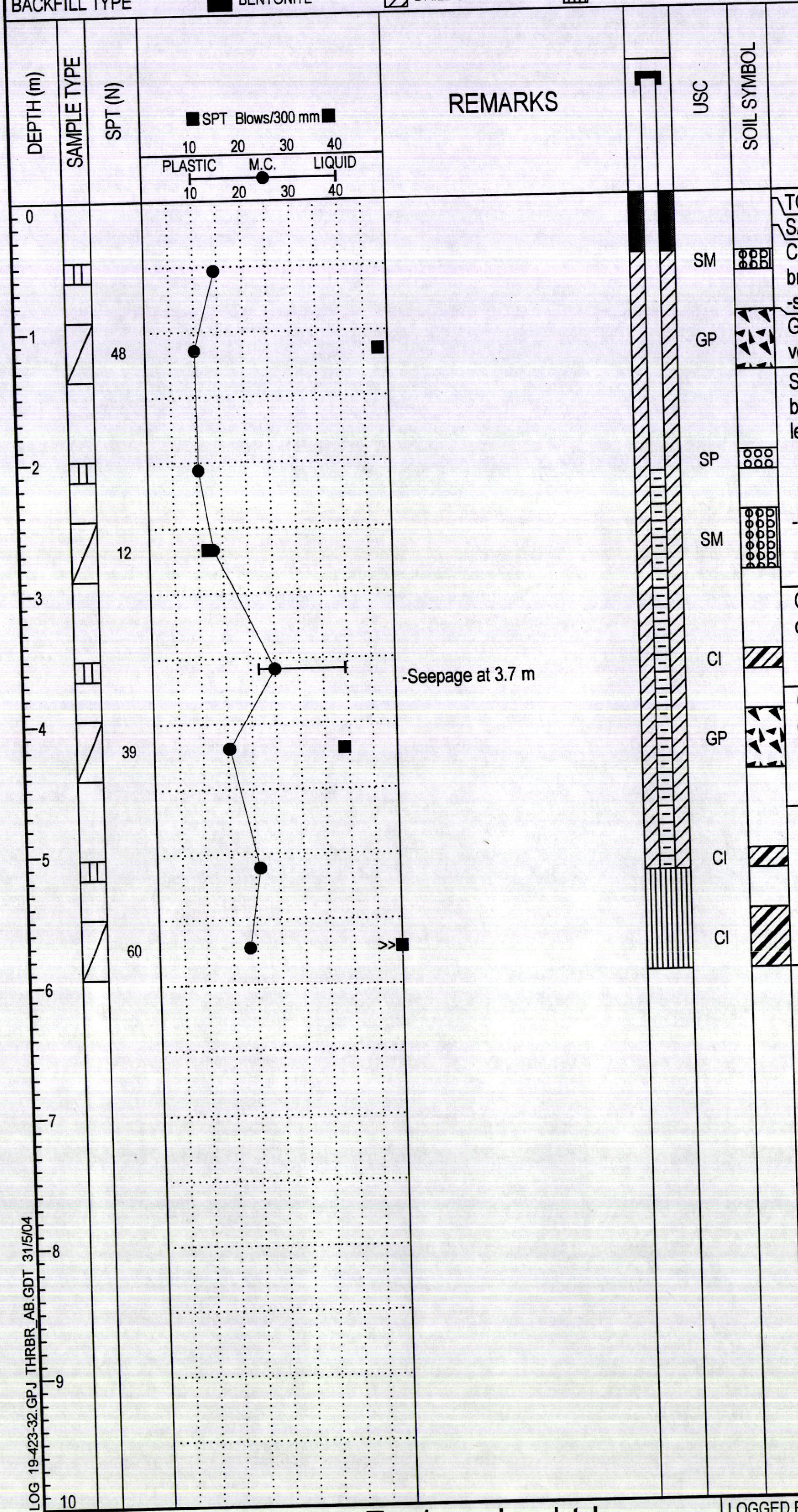
LOGGED BY: TC	REVIEWED BY: LWB	COMPLETION DEPTH: 18.6 m COMPLETION DATE: 6/9/2006

CLIENT: IBI GROUP
DRILLING COMPANY: Mobile Augers & Research Ltd.
DRILL/METHOD: M5 / Solid Stem Auger
PROJECT: Whitemud Creek 23 Avenue Stormwater Outfall
DATE DRILLED: May 7, 2004
LOCATION: See Drawing 19-423-32-1
BOREHOLE NO: **TH04-6**
PROJECT NO: 19-423-32
ELEVATION:

SAMPLE TYPE: ▥ GRAB SAMPLE ▨ SPT
BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



REMARKS:
-Seepage at 3.7 m

SOIL DESCRIPTION

DEPTH (m)	SOIL DESCRIPTION
0	TOPSOIL (80 mm thick)
	SAND (FILL) fine to coarse grained
	CLAY (FILL) brown, very silty, trace coal -sandy layer 150 mm thick
1	GRAVEL very dense, light brown, fine grained
	SAND / GRAVEL brown, fine to medium grained, gravelly, some clay lenses
2	-compact, trace coal chips, silty
3	CLAY dark grey, silty, trace sand and gravel
4	GRAVEL dense, grey, sandy
5	CLAY SHALE very hard, grey, trace sand and organics
6	END OF TEST HOLE AT 6.0 m ON COMPLETION (Below Ground Surface): -Slough to 5.2 m -Water to 4.3 m STANDPIPE PIEZOMETER INSTALLED WATER LEVEL (Below Ground Surface): May 25, 2004 - No water
7	
8	
9	
10	

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LOGGED BY: KEF
REVIEWED BY: RFM
COMPLETION DEPTH: 5.9 m
COMPLETION DATE: 7/5/04

THURBER

APPENDIX C

Stability Figures

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
🟧	Clay (Native)	Mohr-Coulomb	18	5	23	0	1
🟫	Clay Fill	Mohr-Coulomb	18	5	23	0	1
⬜	Clay Shale (Bedrock)	Mohr-Coulomb	21	20	25	0	1
▩	Granular Fill	Mohr-Coulomb	19	0	38	0	1
⬛	Rip Rap	Mohr-Coulomb	22	0	45	0	1
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34	0	1

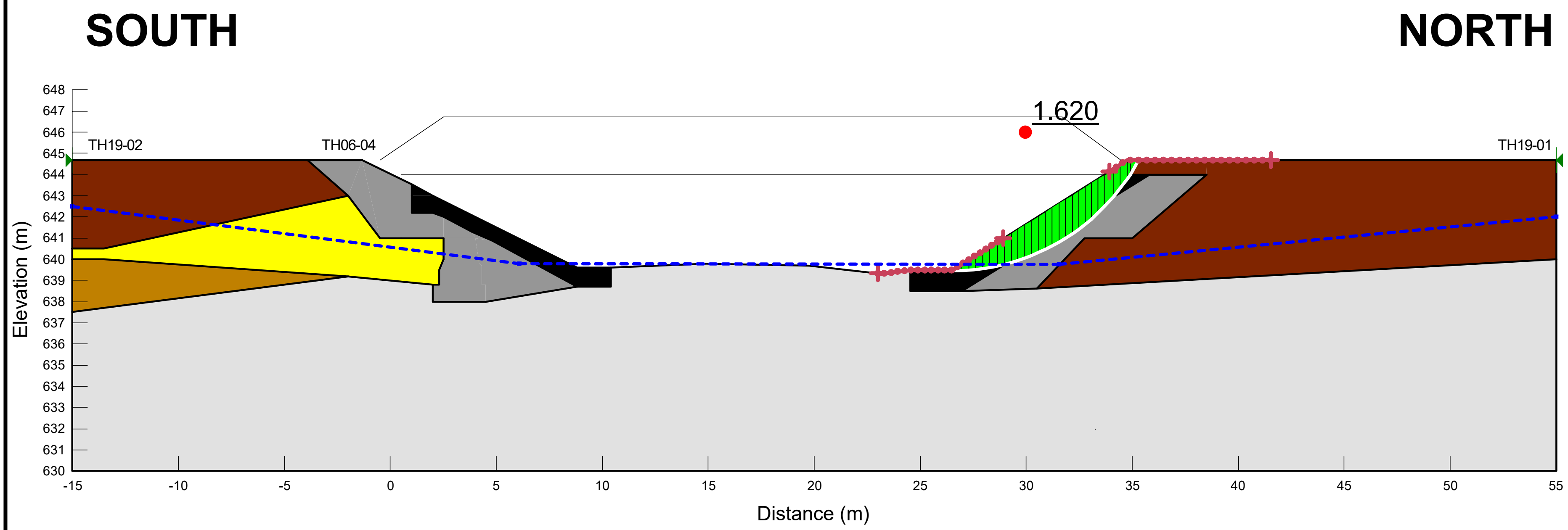

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Figure C1: North Headslope 1.6H:1V

20210224_Stability Analysis_29325.gsz

2021-02-25 1:300

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
🟧	Clay (Native)	Mohr-Coulomb	18	5	23	0	1
🟫	Clay Fill	Mohr-Coulomb	18	5	23	0	1
⬜	Clay Shale (Bedrock)	Mohr-Coulomb	21	20	25	0	1
▨	Granular Fill	Mohr-Coulomb	19	0	38	0	1
⬛	Rip Rap	Mohr-Coulomb	22	0	45	0	1
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34	0	1

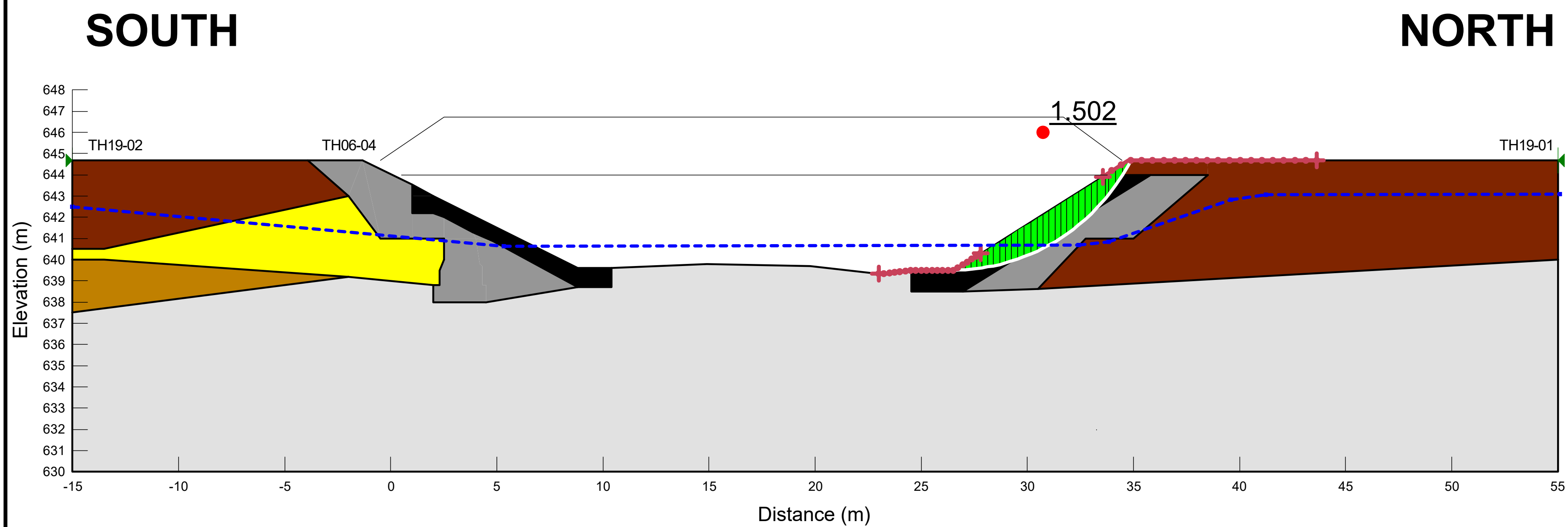

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Figure C2: North Headslope 1.6H:1V (High GWT)

20210224_Stability Analysis_29325.gsz

2021-02-25 1:300

Color	Name	Model	Unit Weight (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
🟧	Clay (Native)	Mohr-Coulomb	18	5	23	0	1
🟫	Clay Fill	Mohr-Coulomb	18	1	23	0	1
⬜	Clay Shale (Bedrock)	Mohr-Coulomb	21	20	25	0	1
▨	Granular Fill	Mohr-Coulomb	19	0	38	0	1
⬛	Rip Rap	Mohr-Coulomb	22	0	45	0	1
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34	0	1

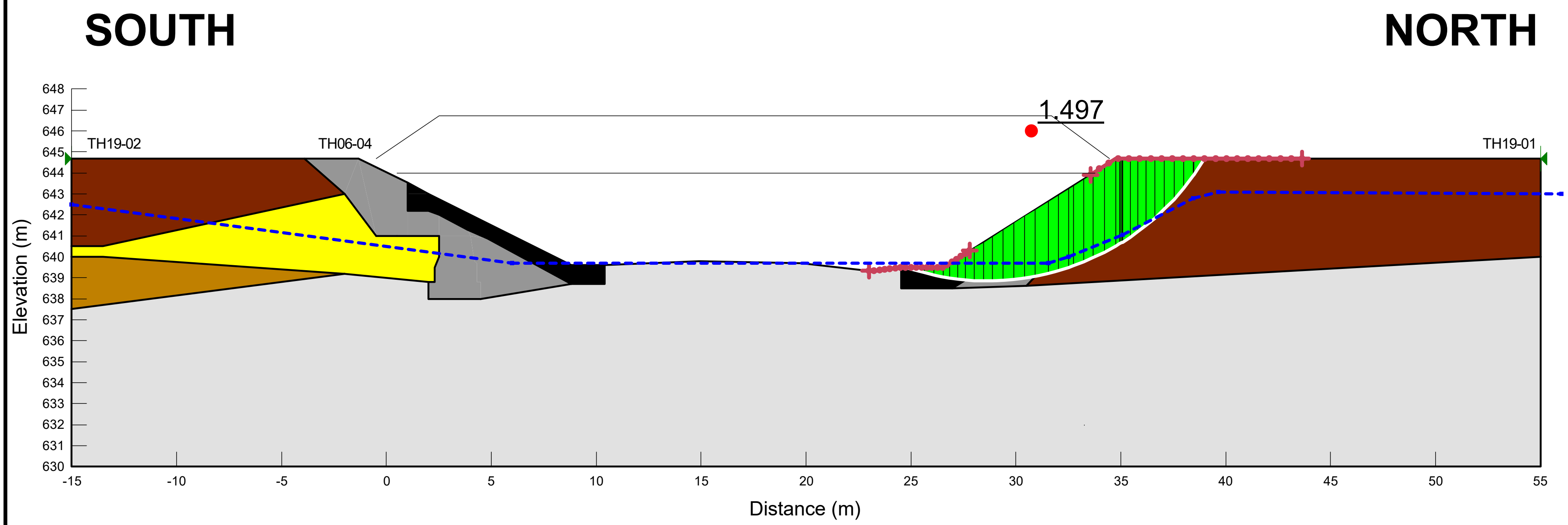

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Figure C3: North Headslope 1.6H:1V (Reduced c')

20210224_Stability Analysis_29325.gsz

2021-02-25 1:300

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
🟧	Clay (Native)	Mohr-Coulomb	18	5	23	0	1
🟫	Clay Fill	Mohr-Coulomb	18	5	23	0	1
⬜	Clay Shale (Bedrock)	Mohr-Coulomb	21	20	25	0	1
▩	Granular Fill	Mohr-Coulomb	19	0	38	0	1
⬛	Rip Rap	Mohr-Coulomb	22	0	45	0	1
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34	0	1

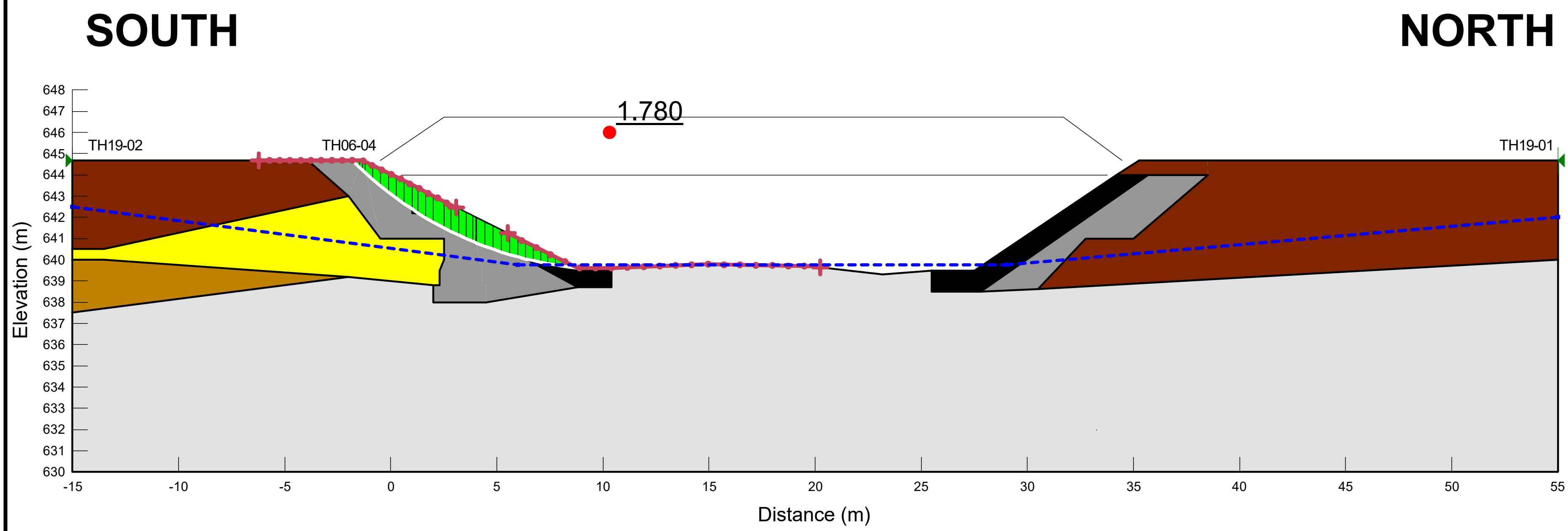

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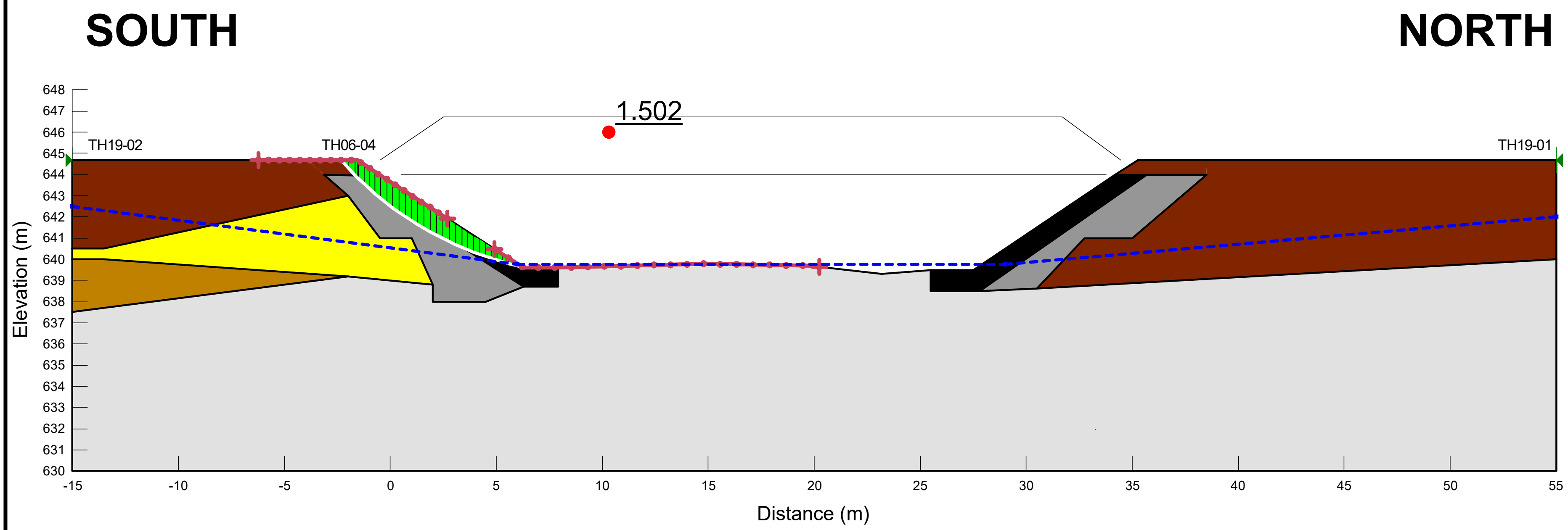
Figure C4: South Headslope 2H:1V

20210224_Stability Analysis_29325.gsz

2021-02-25 1:300

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
🟧	Clay (Native)	Mohr-Coulomb	18	5	23	0	1
🟫	Clay Fill	Mohr-Coulomb	18	5	23	0	1
⬜	Clay Shale (Bedrock)	Mohr-Coulomb	21	20	25	0	1
▩	Granular Fill	Mohr-Coulomb	19	0	38	0	1
⬛	Rip Rap	Mohr-Coulomb	22	0	45	0	1
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34	0	1



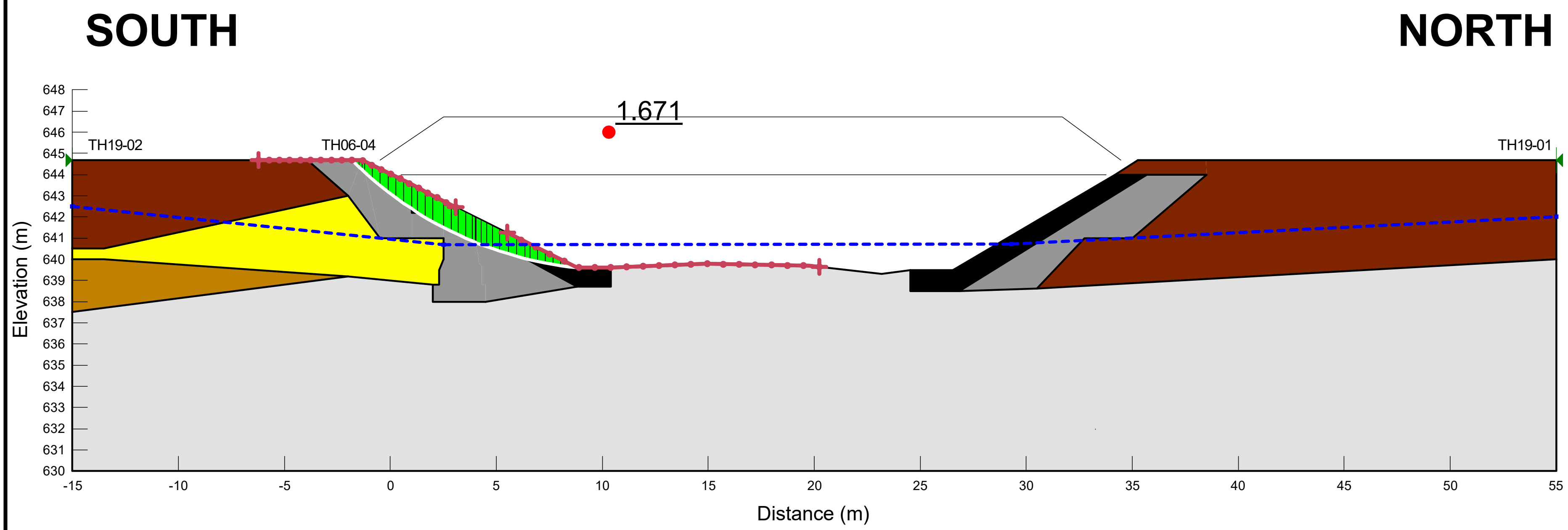
THURBER ENGINEERING LTD.

Figure C5: South Headslope 1.5H:1V

20210224_Stability Analysis_29325.gsz

2021-02-25 1:300

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
🟧	Clay (Native)	Mohr-Coulomb	18	5	23	0	1
🟫	Clay Fill	Mohr-Coulomb	18	5	23	0	1
⬜	Clay Shale (Bedrock)	Mohr-Coulomb	21	20	25	0	1
▩	Granular Fill	Mohr-Coulomb	19	0	38	0	1
⬛	Rip Rap	Mohr-Coulomb	22	0	45	0	1
🟨	Sand and Gravel (Native)	Mohr-Coulomb	21	0	34	0	1



THURBER ENGINEERING LTD.

Figure C6: South Headslope 2H:1V (High GWT)

20210224_Stability Analysis_29325.gsz

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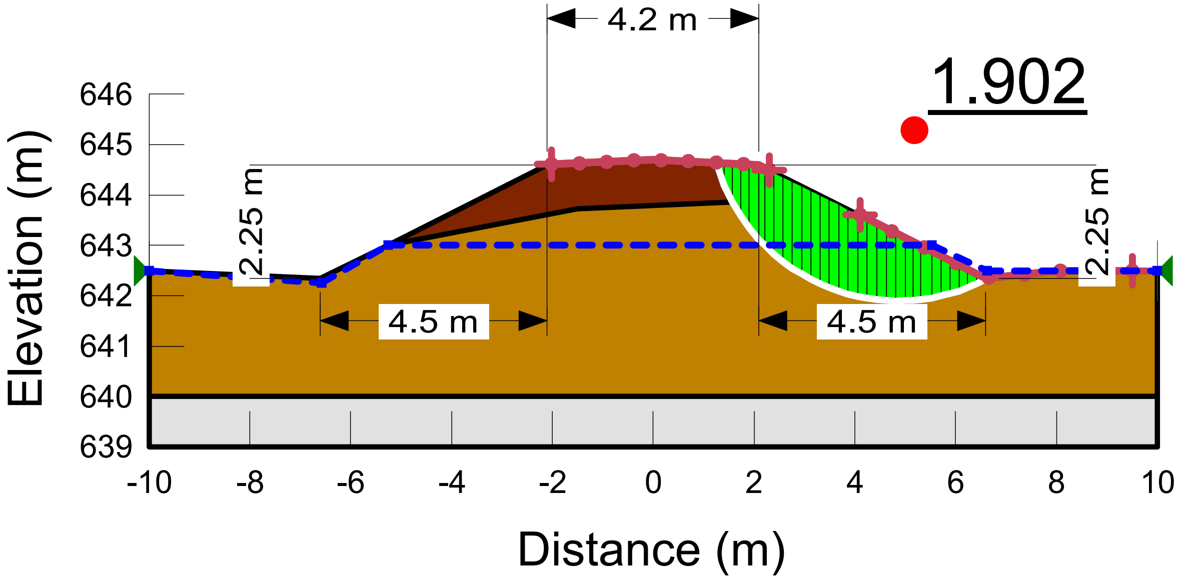

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Figure C7: Side Slope of Embankment

20210224_Stability Analysis_29325.gsz

2021-02-24 1:150

Appendix H: Plant Species Inventory

Smith Crossing Plant Species Inventory by Plant Community (19 July 2019)

Species				**Community***		
Scientific Name	**Common Name**	**ACIMS Rank**	**Origin**	**Deciduous Mixedwood – Mixed Shrub Forest (DLM.1)**	**Non-Forested Smooth Brome (NF.7)**	**Riparian (R)**
Tree						
Acer negundo	Manitoba maple	SU	native	O		O
Betula papyrifera	white birch	S5?	native			R
Picea glauca	white spruce	S5	native	A		R
Populus balsamifera	balsam poplar	S5	native	D	R	
Populus tremuloides	aspen	S5	native		R	
Shrub						
Alnus incana ssp. *tenuifolia*	river alder	S5	native			A
Alnus viridus	green alder	S5	native	F		
Amelanchier alnifolia	saskatoon	S5	native	O		
Cornus stolonifera	red-osier dogwood	S5	native	F		A
Cotoneaster lucidus	Peking cotoneaster	SNA	exotic		R	O
Elaeagnus commutata	silverberry	S5	native	O		A
Prunus virginiana	choke cherry	S5	native	O		
Ribes americanum	wild black currant	S4	native	R		
Rosa acicularis	prickly rose	S5	native	A		O
Rubus ideaus	wild red raspberry	S5	native	F		A
Salix exigua	narrow-leaf willow	S3S4	native		O	A
Salix lasiandra	shining willow	S5	native			A
Salix petiolaris	basket willow	S5	native			F
Sorbus aucuparia	European mountain-ash	SNA	exotic	O		
Symphoricarpos occidentalis	buckbrush	S5	native	A	F	F
Syringa sp.	lilac	SNA	exotic	A		

Species				Community*		
Scientific Name	**Common Name**	**ACIMS Rank**	**Origin**	**Deciduous Mixedwood – Mixed Shrub Forest (DLM.1)**	**Non-Forested Smooth Brome (NF.7)**	**Riparian (R)**
Viburnum opulus	high-bush cranberry	S3S4	native	R		
Forb						
Achillea alpina	many-flowered yarrow	S5	native			R
Achillea millefolium	common yarrow	S5	native			O
Actaea rubra	red and white baneberry	S5	native			R
Agrimonia striata	agrimony	S4	native			O
Anemone canadensis	Canada anemone	S5	native			O
Aralia nudicaulis	wild sarsaparilla	S5	native	A		A
Astragalus cicer	cicer milkvetch	SNA	exotic	F	A	F
Chamerion angustifolium	common fireweed	S5	native	O		
Chenopdium salinum	oak-leaved goosefoot	S5	native			R
Chenopodium album	lamb's-quarters	SNA	exotic		O	
Cirsium arvense	creeping thistle	SNA	noxious	F	F	F
Epilobium ciliatum	northern willowherb	S5	native			R
Equisetum arvense	common horsetail	S5	native			F
Equisetum sylvaticum	woodland horsetail	S5	native	F	R	F
Erigeron philadelphicus	Philadelphia fleabane	S5	native			O
Euphorbia esula	leafy spurge	SNA	noxious		O	F
Galeopsis tetrahit	hemp-nettle	SNA	exotic		R	
Geum aleppicum	yellow avens	S5	native			F
Heracleum maximum	cow-parsnip	S5	native	O		
Linaria vulgaris	common toadflax	SNA	noxious		O	O
Lotus corniculatus	bird's-foot trefoil	SNA	exotic		F	O
Maianthemum stellatum	star-flowered Solomon's-seal	S5	native	F		O
Medicago falcata	yellow lucerne	SNA	exotic		A	R
Medicago lupulina	black medick	SNA	exotic		F	

Species				Community*		
Scientific Name	**Common Name**	**ACIMS Rank**	**Origin**	**Deciduous Mixedwood – Mixed Shrub Forest (DLM.1)**	**Non-Forested Smooth Brome (NF.7)**	**Riparian (R)**
Medicago sativa	alfalfa	SNA	exotic	O	A	
Melilotus alba	white sweet-clover	SNA	exotic	O	F	
Plantago major	common plantain	SNA	exotic		R	R
Platanthera huronensis	northern green bog orchid	S5	native			R
Polygonum lapathifolium	pale persicaria	S5	native			F
Silene latifolia	white cockle	SNA	noxious		O	O
Solidago altissima	tall goldenrod	S5	native			R
Sonchus arvensis	perennial sow-thistle	SNA	noxious			O
Tanacetum vulgare	common tansy	SNA	noxious	O	O	F
Taraxacum officinale	common dandelion	SNA	exotic	O	F	O
Thalictrum venulosum	veiny meadow rue	S5	native	R		R
Thlaspi arvense	stinkweed	SNA	exotic		R	
Tragopogon dubius	common goat's-beard	SNA	exotic		R	
Trifolium hybridum	alsike clover	SNA	exotic	O	A	O
Trifolium pratense	red clover	SNA	exotic		O	
Tripleurospermum inodorum	scentless chamomile	SNA	noxious		O	R
Vicia cracca	tufted vetch	SNA	exotic		F	F
Graminoid						
Agropyron cristatum	crested wheatgrass	SNA	exotic		A	
Bromus inermis	smooth brome	SNA	exotic	F	D	F
Carex atherodes	awned sedge	S5	native			A
Carex sp.	sedge		native			O
Elymus repens	quackgrass	SNA	exotic		D	F
Hordeum jubatum	foxtail barley	S5	native		O	
Pascopyrum smithii	western wheatgrass	S5	native		O	
Phalaris arundinacea	reed canary grass	S5	native		O	D

Species				Community*		
Scientific Name	**Common Name**	**ACIMS Rank**	**Origin**	**Deciduous Mixedwood – Mixed Shrub Forest (DLM.1)**	**Non-Forested Smooth Brome (NF.7)**	**Riparian (R)**
Phleum pratense	timothy	SNA	exotic		A	
Poa pratensis	Kentucky bluegrass	S5	native	O	F	O
Schoenoplectus sp.	bulrush	S5	native			F
Species Richness			**74**	**30**	**35**	**51**
Native Species Richness			**45**	**20**	**9**	**34**
Exotic Species Richness			**22**	**8**	**20**	**10**
Noxious Species Richness			**7**	**2**	**6**	**7**

*Species abundance abbreviations are as follows: D=dominant, A=abundant, F=frequent, O=occasional, R=rare

Appendix I: Wildlife List

Smith Crossing Pedestrian Bridge Wildlife List (June 2021)

Common Name	Scientific Name*	Species Group	Provincial Status (General Status of AB Wild Species 2015)	Wildlife Act Designation and New Species Assessed by ESCC (see Comments)	COSEWIC Designation**	SARA Designation	Species Recorded in Study Area***	Potential Habitat Use	Likelihood of Occurrence
Western Toad	*Anaxyrus boreas*	Amphibian	Sensitive		Special Concern	Schedule 1			
Canadian Toad	*Anaxyrus hemiophrys*	Amphibian	May Be At Risk	Data Deficient	Not at Risk / HP Candidate (SSC)		FWMIS	foraging/dispersal	Low
Wood Frog	*Lithobates sylvaticus*	Amphibian	Secure		LP Candidate (SSC)				
Boreal Chorus Frog	*Pseudacris maculata*	Amphibian	Secure		LP Candidate (SSC)				
Western Tiger Salamander	*Ambystoma mavortium*	Amphibian	Secure		Special Concern	Schedule 1 (Special Concern)		foraging/dispersal	Low
Plains Garter Snake	*Thamnophis radix*	Reptile	Sensitive		MP Candidate (SSC)		FWMIS	breeding/foraging	Low
Common Garter Snake	*Thamnophis sirtalis*	Reptile	Sensitive		MP Candidate (SSC)		FWMIS	breeding/foraging	Low
Canada Goose	*Branta canadensis*	Bird	Secure						
Gadwall	*Mareca strepera*	Bird	Secure						
American Wigeon	*Mareca americana*	Bird	Secure						
Mallard	*Anas platyrhynchos*	Bird	Secure						
Lesser Scaup	*Aythya affinis*	Bird	Secure						
Bufflehead	*Bucephala albeola*	Bird	Secure						
Common Goldeneye	*Bucephala clangula*	Bird	Secure						
Common Merganser	*Mergus merganser*	Bird	Secure						
Gray Partridge	*Perdix perdix*	Bird	Exotic/Alien						
Horned Grebe	*Podiceps auritus*	Bird	Sensitive		Special Concern	Schedule 1 (Special Concern)		foraging	Low
Red-necked Grebe	*Podiceps grisegena*	Bird	Secure						
Ruby-throated Hummingbird	*Archilochus colubris*	Bird	Secure						
Killdeer	*Charadrius vociferus*	Bird	Secure		HP Candidate (SSC)				
Spotted Sandpiper	*Actitis macularius*	Bird	Secure						
Solitary Sandpiper	*Tringa solitaria*	Bird	Secure						
Greater Yellowlegs	*Tringa melanoleuca*	Bird	Secure						
Lesser Yellowlegs	*Tringa flavipes*	Bird	Secure		Threatened			foraging	Low
Bonaparte's Gull	*Chroicocephalus philadelphia*	Bird	Secure						
Franklin's Gull	*Leucophaeus pipixcan*	Bird	Secure		LP Candidate (SSC)				
Ring-billed Gull	*Larus delawarensis*	Bird	Secure						
California Gull	*Larus californicus*	Bird	Secure						
Great Blue Heron	*Ardea herodias*	Bird	Sensitive				FWMIS	foraging	Low
Bald Eagle	*Haliaeetus leucocephalus*	Bird	Sensitive		Not at Risk		FWMIS	foraging	Low
Northern Harrier	*Circus cyaneus*	Bird	Secure		Not at Risk				
Sharp-shinned Hawk	*Accipiter striatus*	Bird	Secure		Not at Risk				
Cooper's Hawk	*Accipiter cooperii*	Bird	Secure		Not at Risk				
Northern Goshawk	*Accipiter gentilis atricapillus*	Bird	Sensitive		Not at Risk				
Broad-winged Hawk	*Buteo platypterus*	Bird	Sensitive					foraging	Low
Swainson's Hawk	*Buteo swainsoni*	Bird	Secure						
Red-tailed Hawk	*Buteo jamaicensis*	Bird	Secure		Not at Risk				
Rough-legged Hawk	*Buteo lagopus*	Bird	Secure		Not at Risk				
Great Horned Owl	*Bubo virginianus*	Bird	Secure						
Barred Owl	*Strix varia*	Bird	Sensitive	Special Concern				foraging	Low
Northern Saw-whet Owl	*Aegolius acadicus*	Bird	Secure						
Belted Kingfisher	*Megaceryle alcyon*	Bird	Secure						
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Bird	Secure						
Downy Woodpecker	*Dryobates pubescens*	Bird	Secure				BBS		
Hairy Woodpecker	*Dryobates villosus*	Bird	Secure						
Northern Flicker	*Colaptes auratus*	Bird	Secure						
Pileated Woodpecker	*Colaptes pileatus*	Bird	Sensitive				FWMIS	foraging	Low
American Kestrel	*Falco sparverius*	Bird	Sensitive		LP Candidate (SSC)			foraging	Low
Merlin	*Falco columbarius*	Bird	Secure		Not at Risk				
Alder Flycatcher	*Empidonax alnorum*	Bird	Secure						

Smith Crossing Pedestrian Bridge Wildlife List (June 2021)

Common Name	Scientific Name*	Species Group	Provincial Status (General Status of AB Wild Species 2015)	Wildlife Act Designation and New Species Assessed by ESCC (see Comments)	COSEWIC Designation**	SARA Designation	Species Recorded in Study Area***	Potential Habitat Use	Likelihood of Occurrence
Least Flycatcher	*Empidonax minimus*	Bird	Sensitive		LP Candidate (SSC)		FWMIS	foraging	Moderate
Eastern Phoebe	*Sayornis phoebe*	Bird	Sensitive				BBS, FWMIS	foraging	Moderate
Eastern Kingbird	*Tyrannus tyrannus*	Bird	Sensitive					foraging	Low
Warbling Vireo	*Vireo gilvus*	Bird	Secure				BBS		
Red-eyed Vireo	*Vireo olivaceus*	Bird	Secure				BBS		
Blue Jay	*Cyanocitta cristata*	Bird	Secure						
Black-billed Magpie	*Pica hudsonia*	Bird	Secure						
American Crow	*Corvus brachyrhynchos*	Bird	Secure				BBS		
Common Raven	*Corvus corax*	Bird	Secure						
Tree Swallow	*Tachycineta bicolor*	Bird	Secure						
Bank Swallow	*Riparia riparia*	Bird	Sensitive		Threatened	Schedule 1 (Threatened)		foraging	Low
Barn Swallow	*Hirundo rustica*	Bird	Sensitive		Special Concern	Schedule 1 (Threatened)		breeding/foraging	Low
Black-capped Chickadee	*Poecile atricapillus*	Bird	Secure				BBS		
Red-breasted Nuthatch	*Sitta canadensis*	Bird	Secure						
White-breasted Nuthatch	*Sitta carolinensis*	Bird	Secure						
House Wren	*Troglodytes aedon*	Bird	Secure						
Golden-crowned Kinglet	*Regulus satrapa*	Bird	Secure						
Ruby-crowned Kinglet	*Regulus calendula*	Bird	Secure						
American Robin	*Turdus migratorius*	Bird	Secure						
Gray Catbird	*Dumetella carolinensis*	Bird	Secure				BBS		
European Starling	*Sturnus vulgaris*	Bird	Exotic/Alien						
Bohemian Waxwing	*Bombycilla garrulus*	Bird	Secure						
Cedar Waxwing	*Bombycilla cedrorum*	Bird	Secure				BBS		
House Sparrow	*Passer domesticus*	Bird	Exotic/Alien						
Pine Grosbeak	*Pinicola enucleator*	Bird	Secure						
Purple Finch	*Haemorhous purpureus*	Bird	Secure						
House Finch	*Haemorhous mexicanus*	Bird	Secure						
Red Crossbill	*Loxia curvirostra*	Bird	Secure						
White-winged Crossbill	*Loxia leucoptera*	Bird	Secure						
Common Redpoll	*Acanthis flammea*	Bird	Secure						
Hoary Redpoll	*Acanthis hornemanni*	Bird	Secure						
Pine Siskin	*Spinus pinus*	Bird	Secure						
American Goldfinch	*Spinus tristis*	Bird	Secure						
American Tree Sparrow	*Spizelloides arborea*	Bird	Secure						
Chipping Sparrow	*Spizella passerina*	Bird	Secure						
Clay-colored Sparrow	*Spizella pallida*	Bird	Secure				BBS		
Savannah Sparrow	*Passerculus sandwichensis*	Bird	Secure						
Le Conte's Sparrow	*Ammodramus leconteii*	Bird	Secure						
Song Sparrow	*Melospiza melodia*	Bird	Secure				BBS		
White-throated Sparrow	*Zonotrichia albicollis*	Bird	Secure				BBS		
Dark-eyed Junco	*Junco hyemalis*	Bird	Secure						
Tennessee Warbler	*Oreothlypis peregrina*	Bird	Secure						
Yellow Warbler	*Setophaga petechia*	Bird	Secure				BBS		
Yellow-rumped Warbler	*Setophaga coronata*	Bird	Secure						
American Redstart	*Setophaga ruticilla*	Bird	Secure						
Common Yellowthroat	*Geothlypis trichas*	Bird	Sensitive					breeding/foraging	Low
Snowshoe Hare	*Lepus americanus*	Mammal	Secure						
Least Chipmunk	*Neotamias minimus*	Mammal	Secure						
Red Squirrel	*Tamiasciurus hudsonicus*	Mammal	Secure						
Northern Pocket Gopher	*Thomomys talpoides*	Mammal	Secure						

Smith Crossing Pedestrian Bridge Wildlife List (June 2021)

Common Name	Scientific Name*	Species Group	Provincial Status (General Status of AB Wild Species 2015)	Wildlife Act Designation and New Species Assessed by ESCC (see Comments)	COSEWIC Designation**	SARA Designation	Species Recorded in Study Area***	Potential Habitat Use	Likelihood of Occurrence
American Beaver	*Castor canadensis*	Mammal	Secure						
Deer Mouse	*Peromyscus maniculatus*	Mammal	Secure						
Southern Red-backed Vole	*Myodes gapperi*	Mammal	Secure						
Meadow Vole	*Microtus pennsylvanicus*	Mammal	Secure						
Muskrat	*Ondatra zibethicus*	Mammal	Secure						
House Mouse	*Mus musculus*	Mammal	Exotic/Alien						
Meadow Jumping Mouse	*Zapus hudsonius*	Mammal	Secure						
Western Jumping Mouse	*Zapus princeps*	Mammal	Secure						
Common Porcupine	*Erethizon dorsatum*	Mammal	Secure						
Masked Shrew	*Sorex cinereus*	Mammal	Secure						
Little Brown Bat	*Myotis lucifugus*	Mammal	May Be At Risk		Endangered	Schedule 1 (Endangered)		roosting/foraging	Moderate
Northern Bat	*Myotis septentrionalis*	Mammal	May Be At Risk	Data Deficient	Endangered	Schedule 1 (Endangered)		roosting/foraging	Low
Silver-haired Bat	*Lasionycteris noctivagans*	Mammal	Sensitive		HP Candidate (SSC)			foraging	Low
Big Brown Bat	*Eptesicus fuscus*	Mammal	Secure						
Hoary Bat	*Aeorestes cinereus*	Mammal	Secure		HP Candidate (SSC)				
Coyote	*Canis latrans*	Mammal	Secure				Spencer		
Red Fox	*Vulpes vulpes*	Mammal	Secure						
Northern Raccoon	*Procyon lotor*	Mammal	Secure						
Long-tailed Weasel	*Mustela frenata*	Mammal	May Be At Risk		Not at Risk		FWMIS	breeding/foraging	Moderate
Ermine	*Mustela erminea*	Mammal	Secure						
Least Weasel	*Mustela nivalis*	Mammal	Secure						
Striped Skunk	*Mephitis mephitis*	Mammal	Secure						
Mountain Lion/Cougar	*Puma concolor*	Mammal	Secure						
Moose	*Alces alces*	Mammal	Secure				Spencer		
Mule Deer	*Odocoileus hemionus*	Mammal	Secure						
White-tailed Deer	*Odocoileus virginianus*	Mammal	Secure						

* Scientific names are based on the Cornell Lab of Ornithology's 2018 Clements Checklist (birds) and the Government of Alberta's 2015 Wild Species Status List (mammals, amphibians, reptiles)

** HP = High priority; MP = mid-priority; LP = low priority candidate by the species specialists subcommittee (SSC)

*** Sources of species records: BBS = breeding bird survey observation (26 June 2019), Spencer = site reconniassance observation 2021 and FWMIS = Fish and Wildlife Management Information System (Accessed 12 February 2021

Appendix J: Historical Resources Act Approval

HRA Number: 4715-21-0018-001
April 08, 2021

Historical Resources Act Approval

Proponent: City of Edmonton
12th Floor, Edmonton Tower, 10111- 104 Avenue NW, Edmonton, AB T5J 0J4
Contact: Ahsanul Karim

Agent: Circle Consulting Inc.
Contact: Margarita de Guzman

Project Name: **Smith Crossing Pedestrian Bridge**

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
Alberta Culture, Multiculturalism
and Status of Women

Lands Affected: All New Lands

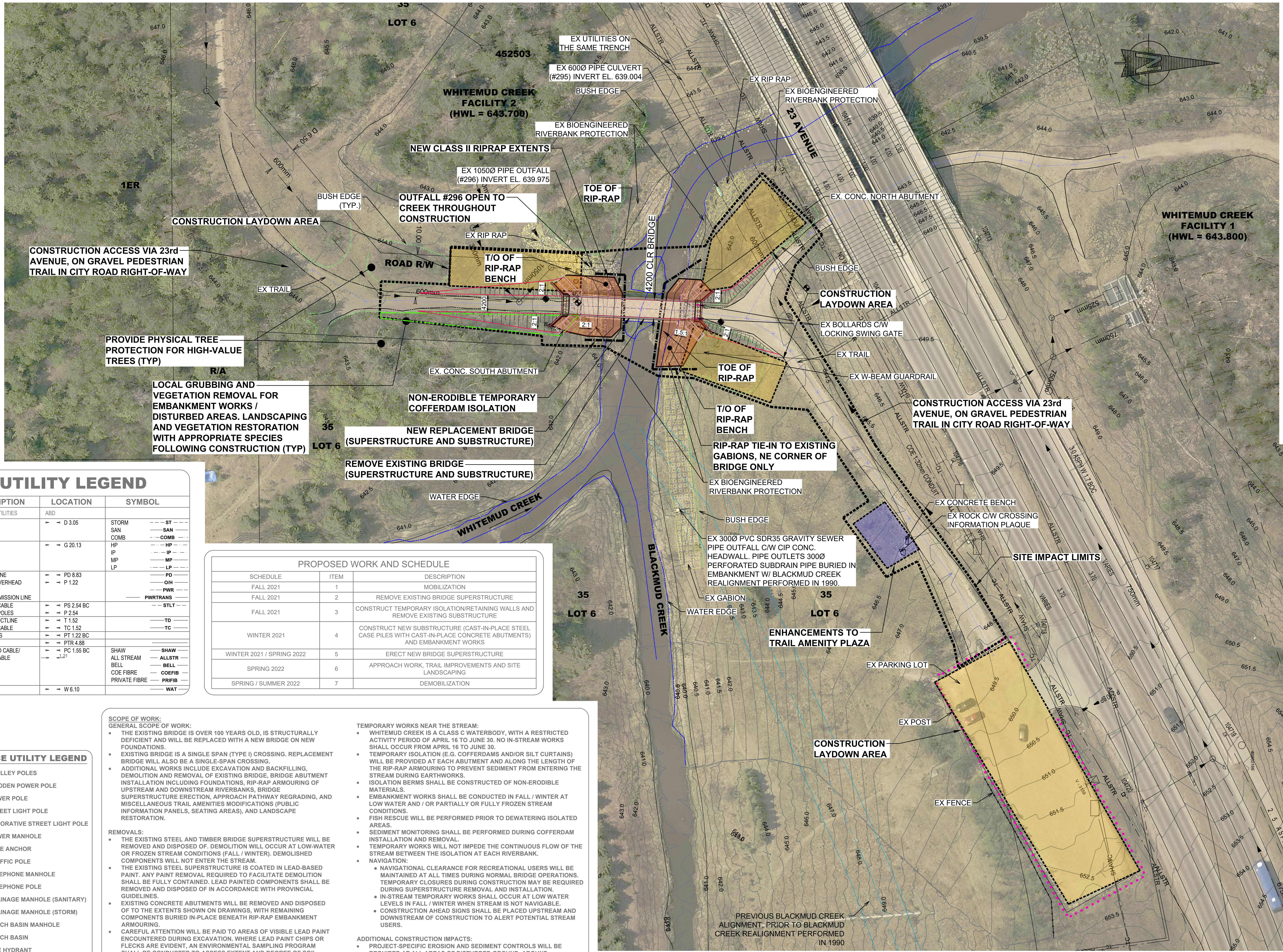
Proposed Development Area:

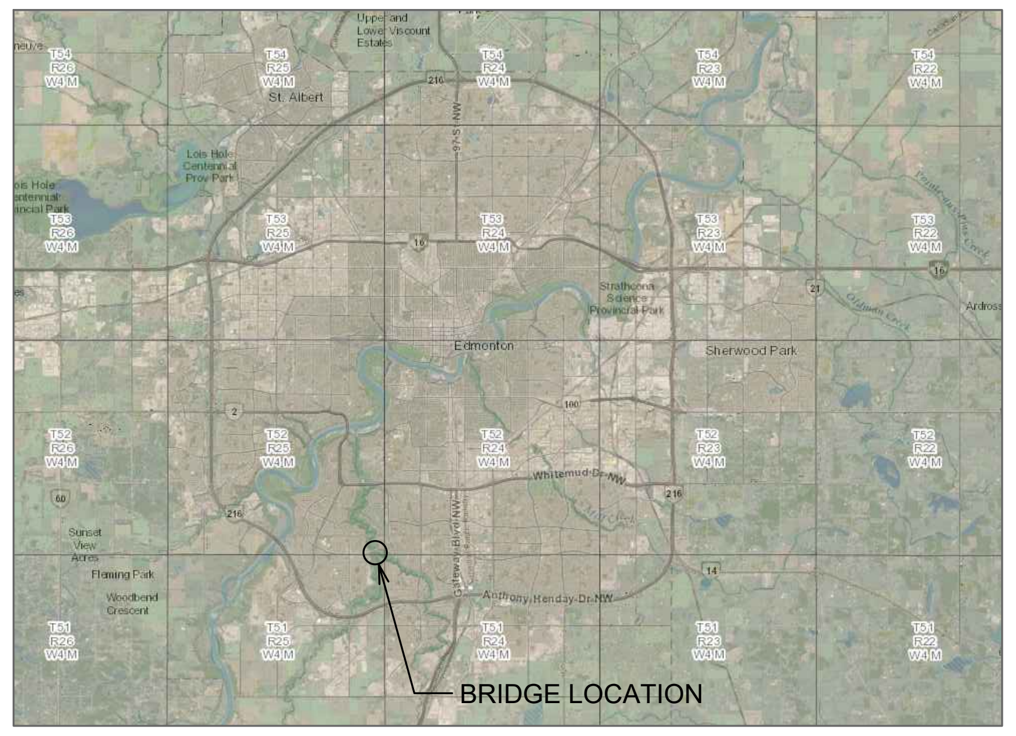
MER	RGE	TWP	SEC	LSD List
4	25	52	1	1-2

Documents Attached:

Document Name	Document Type
Project Plans	Illustrative Material

Appendix K: Design Drawings (Morrison Hershfield 2021)





LOCATION PLAN

EXISTING BRIDGE PHOTO

UTILITY LEGEND

DESCRIPTION	LOCATION	SYMBOL
ABANDONED UTILITIES	ABD	
DRAINAGE	➢ ≺ D 3.05	STORM — — ST — — SAN —— SAN —— COMB — · COMB — ·
GAS LINES	➢ ≺ G 20.13	HP — · · HP — · · IP — · IP — · MP —— MP —— LP — — LP — —
POWER DUCTLINE POWER LINE OVERHEAD POWER LINE POWER TRANSMISSION LINE	➢ ≺ PD 8.83 ➢ ≺ P 1.22	—— PD —— —— O/H —— — — PWR — — —— PWRTRANS ——
STREETLIGHT CABLE STREETLIGHT POLES	➢ ≺ PS 2.54 BC ➢ ≺ P 2.54	— — STLT — —
TELEPHONE DUCTLINE TELE. BURIED CABLE	➢ ≺ T 1.52 ➢ ≺ TC 1.52	—— TD —— —— TC ——
TROLLEY POLES	➢ ≺ PT 1.22 BC	
URD TRENCH	➢ ≺ PTR 4.88	————
UNDERGROUND CABLE/ FIBER OPTIC CABLE	➢ ≺ PC 1.55 BC → ← 1.21	SHAW —— SHAW —— ALL STREAM —— ALLSTR —— BELL —— BELL —— COE FIBRE —— COEFIB —— PRIVATE FIBRE —— PRIFIB ——
WATERMAIN	➢ ≺ W 6.10	—— WAT ——

PROPOSED WORK AND SCHEDULE

SCHEDULE	ITEM	DESCRIPTION
FALL 2021	1	MOBILIZATION
FALL 2021	2	REMOVE EXISTING BRIDGE SUPERSTRUCTURE
FALL 2021	3	CONSTRUCT TEMPORARY ISOLATION/RETAINING WALLS AND REMOVE EXISTING SUBSTRUCTURE
WINTER 2021	4	CONSTRUCT NEW SUBSTRUCTURE (CAST-IN-PLACE STEEL CASE PILES WITH CAST-IN-PLACE CONCRETE ABUTMENTS) AND EMBANKMENT WORKS
WINTER 2021 / SPRING 2022	5	ERECT NEW BRIDGE SUPERSTRUCTURE
SPRING 2022	6	APPROACH WORK, TRAIL IMPROVEMENTS AND SITE LANDSCAPING
SPRING / SUMMER 2022	7	DEMOBILIZATION

SURFACE UTILITY LEGEND

⬡	TROLLEY POLES
○	WOODEN POWER POLE
⊙	POWER POLE
□	STREET LIGHT POLE
◇	DECORATIVE STREET LIGHT POLE
▭	POWER MANHOLE
→	POLE ANCHOR
▫	TRAFFIC POLE
T	TELEPHONE MANHOLE
Ⓕ	TELEPHONE POLE
⊜	DRAINAGE MANHOLE (SANITARY)
⊙	DRAINAGE MANHOLE (STORM)
◡	CATCH BASIN MANHOLE
◡	CATCH BASIN
⌖	FIRE HYDRANT
⌛	WATER VALVE
⊤	WATER TEE
Ⓐ	ANODE

SCOPE OF WORK:

GENERAL SCOPE OF WORK:

- THE EXISTING BRIDGE IS OVER 100 YEARS OLD, IS STRUCTURALLY DEFICIENT AND WILL BE REPLACED WITH A NEW BRIDGE ON NEW FOUNDATIONS.
- EXISTING BRIDGE IS A SINGLE SPAN (TYPE I) CROSSING. REPLACEMENT BRIDGE WILL ALSO BE A SINGLE-SPAN CROSSING.
- ADDITIONAL WORKS INCLUDE EXCAVATION AND BACKFILLING, DEMOLITION AND REMOVAL OF EXISTING BRIDGE, BRIDGE ABUTMENT INSTALLATION INCLUDING FOUNDATIONS, RIP-RAP ARMOURING OF UPSTREAM AND DOWNSTREAM RIVERBANKS, BRIDGE SUPERSTRUCTURE ERECTION, APPROACH PATHWAY REGRADING, AND MISCELLANEOUS TRAIL AMENITIES MODIFICATIONS (PUBLIC INFORMATION PANELS, SEATING AREAS), AND LANDSCAPE RESTORATION.

REMOVALS:

- THE EXISTING STEEL AND TIMBER BRIDGE SUPERSTRUCTURE WILL BE REMOVED AND DISPOSED OF. DEMOLITION WILL OCCUR AT LOW-WATER OR FROZEN STREAM CONDITIONS (FALL / WINTER). DEMOLISHED COMPONENTS WILL NOT ENTER THE STREAM.
- THE EXISTING STEEL SUPERSTRUCTURE IS COATED IN LEAD-BASED PAINT. ANY PAINT REMOVAL REQUIRED TO FACILITATE DEMOLITION SHALL BE FULLY CONTAINED. LEAD PAINTED COMPONENTS SHALL BE REMOVED AND DISPOSED OF IN ACCORDANCE WITH PROVINCIAL GUIDELINES.
- EXISTING CONCRETE ABUTMENTS WILL BE REMOVED AND DISPOSED OF TO THE EXTENTS SHOWN ON DRAWINGS, WITH REMAINING COMPONENTS BURIED IN-PLACE BENEATH RIP-RAP EMBANKMENT ARMOURING.
- CAREFUL ATTENTION WILL BE PAID TO AREAS OF VISIBLE LEAD PAINT ENCOUNTERED DURING EXCAVATION. WHERE LEAD PAINT CHIPS OR FLECKS ARE EVIDENT, AN ENVIRONMENTAL SAMPLING PROGRAM SHALL BE CONDUCTED TO ASSESS EXTENT AND DEGREE OF SOIL IMPACT AT ENCOUNTERED LOCATION. EXCAVATED MATERIAL WILL BE REMOVED AND DISPOSED OF OFF-SITE, IN ACCORDANCE WITH PROVINCIAL GUIDELINES.

TEMPORARY WORKS NEAR THE STREAM:

- WHITEMUD CREEK IS A CLASS C WATERBODY, WITH A RESTRICTED ACTIVITY PERIOD OF APRIL 16 TO JUNE 30. NO IN-STREAM WORKS SHALL OCCUR FROM APRIL 16 TO JUNE 30.
- TEMPORARY ISOLATION (E.G. COFFERDAMS AND/OR SILT CURTAINS) WILL BE PROVIDED AT EACH ABUTMENT AND ALONG THE LENGTH OF THE RIP-RAP ARMOURING TO PREVENT SEDIMENT FROM ENTERING THE STREAM DURING EARTHWORKS.
- ISOLATION BERMS SHALL BE CONSTRUCTED OF NON-ERODIBLE MATERIALS.
- EMBANKMENT WORKS SHALL BE CONDUCTED IN FALL / WINTER AT LOW WATER AND / OR PARTIALLY OR FULLY FROZEN STREAM CONDITIONS.
- FISH RESCUE WILL BE PERFORMED PRIOR TO DEWATERING ISOLATED AREAS.
- SEDIMENT MONITORING SHALL BE PERFORMED DURING COFFERDAM INSTALLATION AND REMOVAL.
- TEMPORARY WORKS WILL NOT IMPEDE THE CONTINUOUS FLOW OF THE STREAM BETWEEN THE ISOLATION AT EACH RIVERBANK.
- NAVIGATION:
  - NAVIGATIONAL CLEARANCE FOR RECREATIONAL USERS WILL BE MAINTAINED AT ALL TIMES DURING NORMAL BRIDGE OPERATIONS. TEMPORARY CLOSURES DURING CONSTRUCTION MAY BE REQUIRED DURING SUPERSTRUCTURE REMOVAL AND INSTALLATION.
  - IN-STREAM TEMPORARY WORKS SHALL OCCUR AT LOW WATER LEVELS IN FALL / WINTER WHEN STREAM IS NOT NAVIGABLE.
  - CONSTRUCTION AHEAD SIGNS SHALL BE PLACED UPSTREAM AND DOWNSTREAM OF CONSTRUCTION TO ALERT POTENTIAL STREAM USERS.

ADDITIONAL CONSTRUCTION IMPACTS:

- PROJECT-SPECIFIC EROSION AND SEDIMENT CONTROLS WILL BE REQUIRED AT ALL AREAS OF DISTURBED GROUND, AROUND STOCKPILES, AND AROUND LAYDOWNS.
- TREE PROTECTION IN THE FORM OF PHYSICAL BARRIERS SHALL BE PROVIDED FOR ANY TREE WITHIN 5 m OF THE WORK ZONE.
- ALL DISTURBED AREAS SHALL BE REVEGETATED FOLLOWING CONSTRUCTION.

PLAN

SCALE: 1:500

PRELIMINARY
ISSUED FOR DISCUSSION AND REVIEW PURPOSES ONLY

X:\PROJ\2020\201932500-PB5-SMITH CROSSING BRIDGE REPLACEME\09. CAD\07 SHEETS\ENVIRONMENTAL PERMITTING\A023 P20X - EX1 (DAS) DC.DWG

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1	TENDER AWARD DATE		

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

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION
DATE

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADS DESIGN AND CONSTRUCTION DATE

MANAGER OF ROADS DESIGN AND CONSTRUCTION DATE

THE CITY OF Edmonton
TRANSPORTATION SERVICES
ROADS DESIGN AND CONSTRUCTION BRANCH

SURVEY
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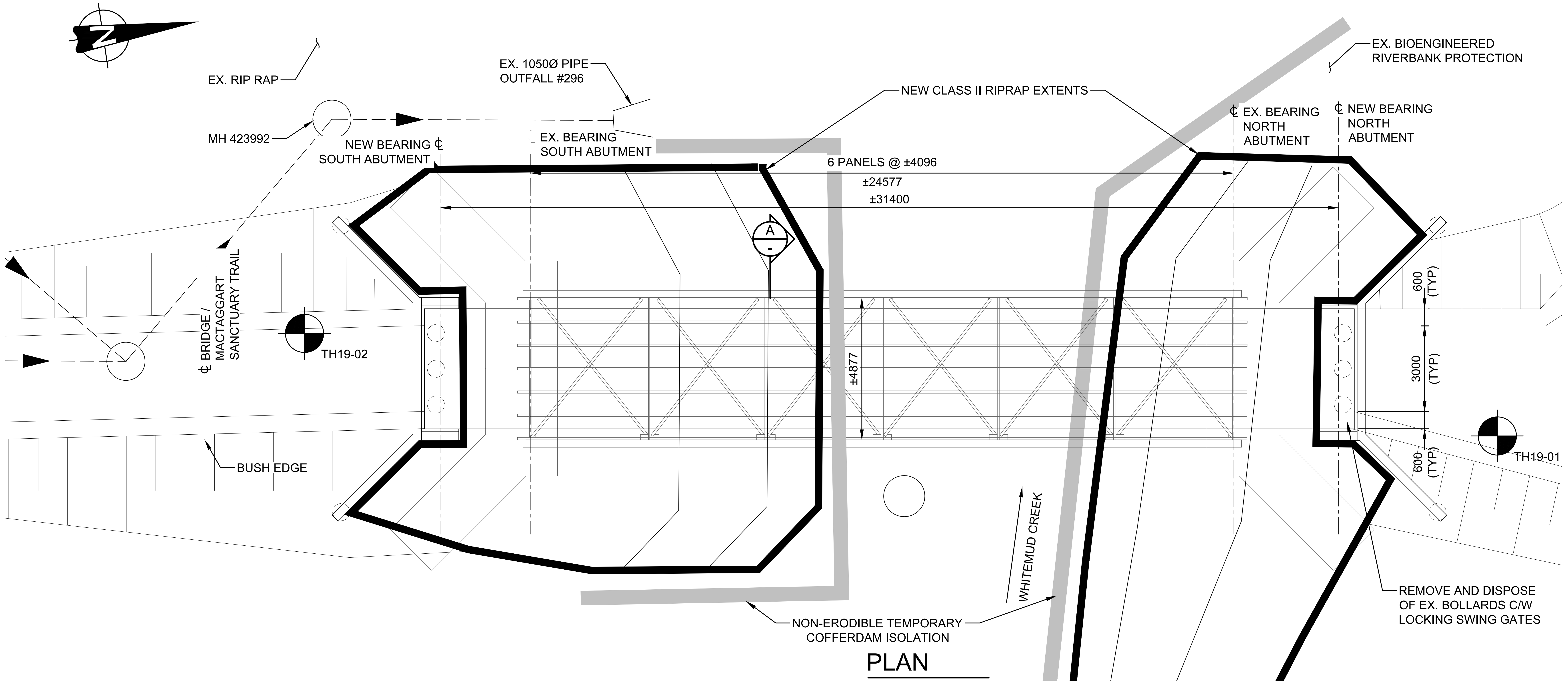
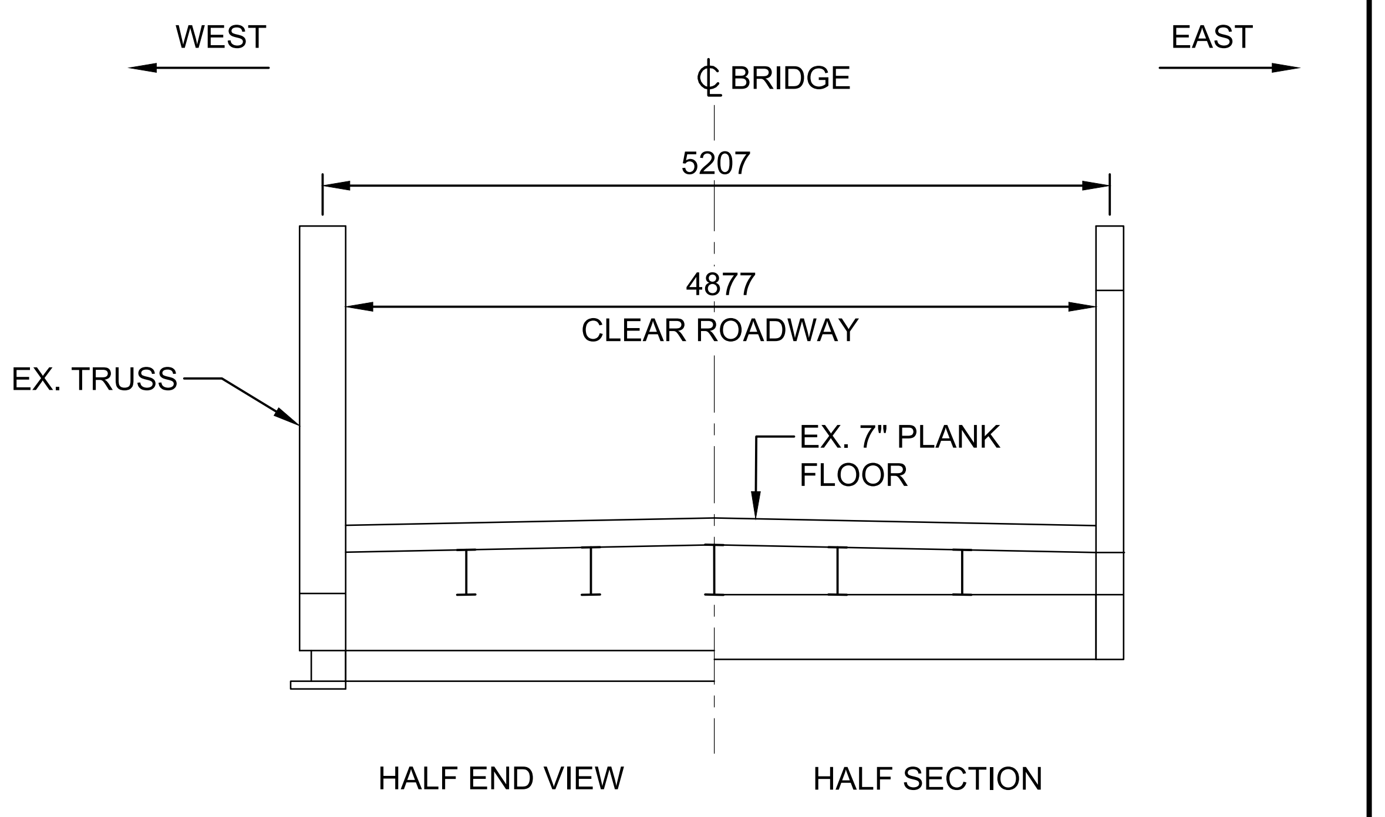
PROJECT
23rd AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
SITE PLAN

DRAWING
A023 P20X - EX1



PLAN

1:100



A - SECTION

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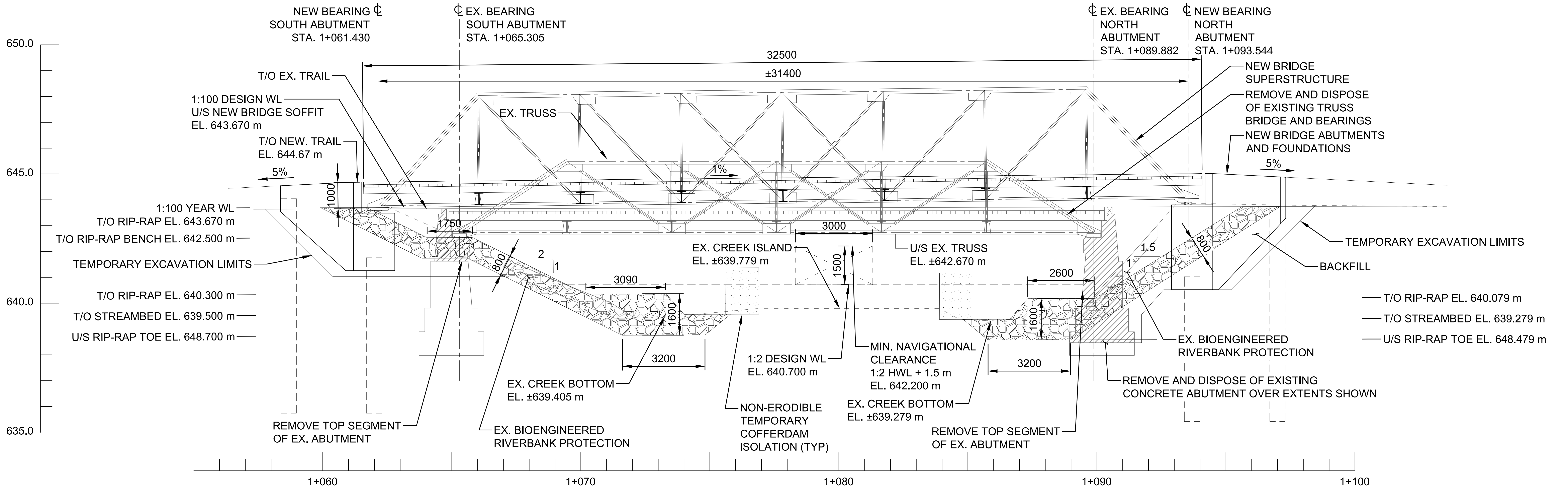

ELEVATION

LOOKING WEST 1:100

BRIDGE DESIGN CRITERIA

- CANADIAN HIGHWAY AND BRIDGE DESIGN CODE (CHBDC) 2019
- CITY OF EDMONTON COMPLETE STREETS DESIGN AND CONSTRUCTION STANDARDS (2018)

BRIDGE LIVE LOAD DESIGN

- PEDESTRIANS LIVE LOAD (CAN/CSA S6-19 CL.3.8.9)
- MAINTENANCE VEHICLE LOAD (CAN/CSA S6-19 CL.3.8.11) USAGE: THE BRIDGE IS A RECREATIONAL PEDESTRIAN BRIDGE ON AN URBAN TRAIL SYSTEM. THE BRIDGE CAN BE CLOSED TO ALL USERS IN AN EMERGENCY OR DESIGN FLOOD EVENT.

HYDROTECHNICAL DATA

- DESIGN DISCHARGE: $Q_{1:100}$ = 67.9 m^3/s (BLACKMUD CREEK), 91.5 m^3/s (WHITEMUD CREEK)
- MEAN VELOCITY THROUGH NEW REPLACEMENT BRIDGE FOR DESIGN DISCHARGE: V1% = 2.8 m/s
- HIGH WATER LEVEL – 1:100 YEAR = 643.67 m, 1:2 YEAR = 640.70 m
- DESIGN FLOOD EVENT: COMBINED 1:100 PEAK FLOOD FLOW FROM BLACKMUD CREEK AND WHITEMUD CREEK
- FREEBOARD: 1:100 HWL + 0 m

NAVIGATIONAL CLEARANCE

- NAVIGATIONAL CLEARANCE OF 2.97 m PROVIDED FROM 1:2 HWL TO UNDERSIDE OF BRIDGE SOFFIT.
- DESIGN VESSEL TYPE – BLACKMUD CREEK (CANOE / KAYAK AND WHITEWATER KAYAK), WHITEMUD CREEK (CANOE / KAYAK)
- DESIGN MAXIMUM VESSEL: CLEARANCE HEIGHT OF 1.5 m CLEARANCE WIDTH OF 3.0 m

MATERIALS

- FOUNDATION TYPE – DRILLED CAST-IN-PLACE REINFORCED CONCRETE PILES
- ABUTMENT – CAST-IN-PLACE CONCRETE ABUTMENT
- HEADSLOPE PROTECTION – CLASS II RIPRAP (NOMINAL DIAMETER 500 mm)
- EMBANKMENT PROTECTION – CLASS II RIPRAP ON NON-WOVEN GEOTEXTILE EXTENDING VERTICALLY TO THE 1:100 YEAR HWL, EXTENDING UPSTREAM AND DOWNSTREAM OF BRIDGE HEADSLOPES. RIP-RAP TIES INTO EXISTING GABION RIVERBANK PROTECTION (RIVERBANK NE OF BRIDGE), EXISTING RIP-RAP RIVERBANK PROTECTION (RIVERBANK SW OF BRIDGE), AND EXISTING RIP-RAP AND/OR BIOENGINEERED RIVERBANK PROTECTION (RIVERBANKS NW AND SE OF BRIDGE). BANK DISTURBANCE AREAS OUTSIDE RIP-RAP FOOTPRINT WILL BE REVEGETATED WITH DENSE WILLOW STAKES.

LIST OF ACRONYMS

HWL - HIGH WATER LEVEL
WL - WATER LEVEL
T/O - TOP OF
U/S - UNDERSIDE

ROADWAY IDENTIFICATION
CONST YR / PROJ
DWG CONTENT / DWG NO

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3	MICROFILMED		
2	AS BUILT		
1	TENDER AWARD		

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

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADWAYS DESIGN DATE
DIRECTOR OF ROADWAYS CONSTRUCTION DATE

SURVEY
JOB NO. 201932500
SCALE AS SHOWN

DRAWN DATE
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DESIGNED DATE
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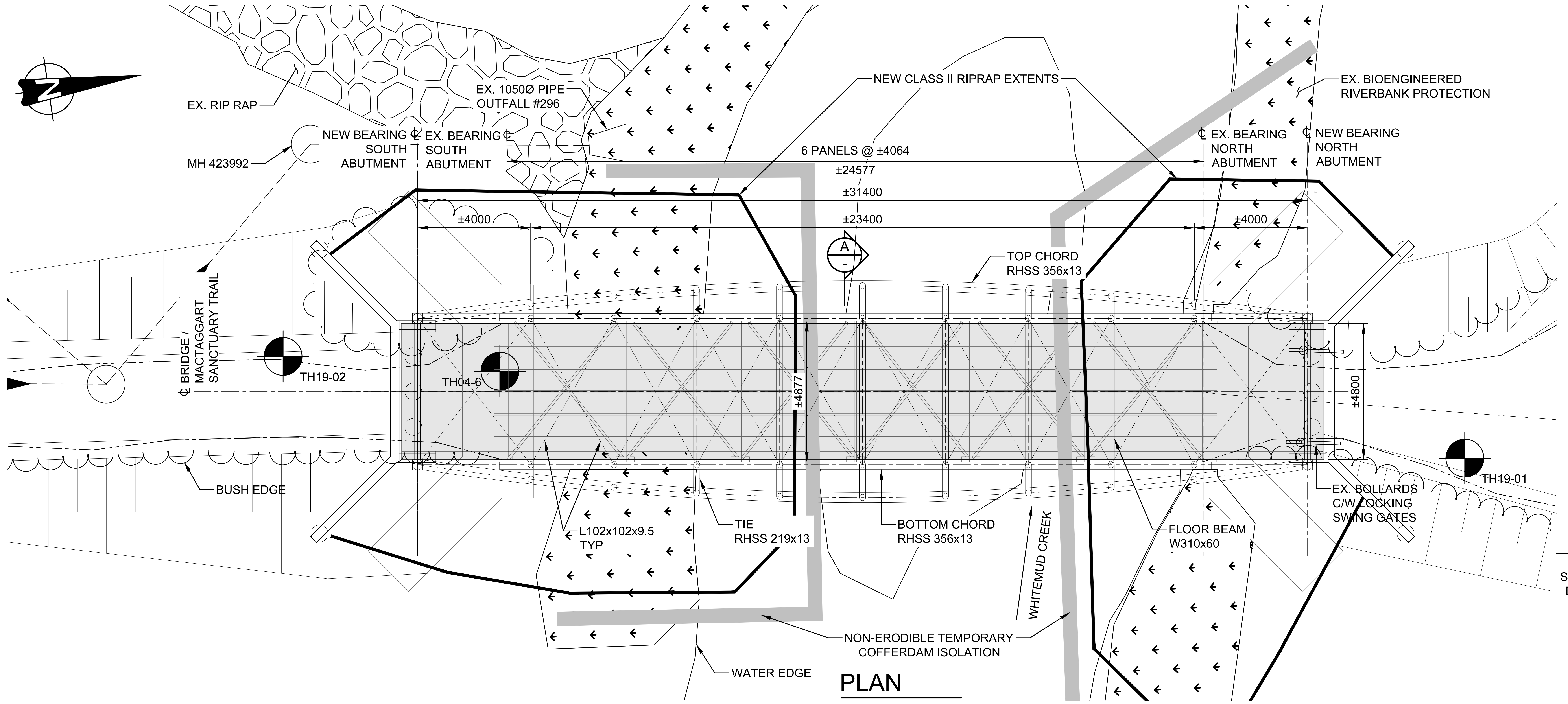
THE CITY OF Edmonton TRANSPORTATION

PROJECT
23rd AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
GENERAL ARRANGEMENT

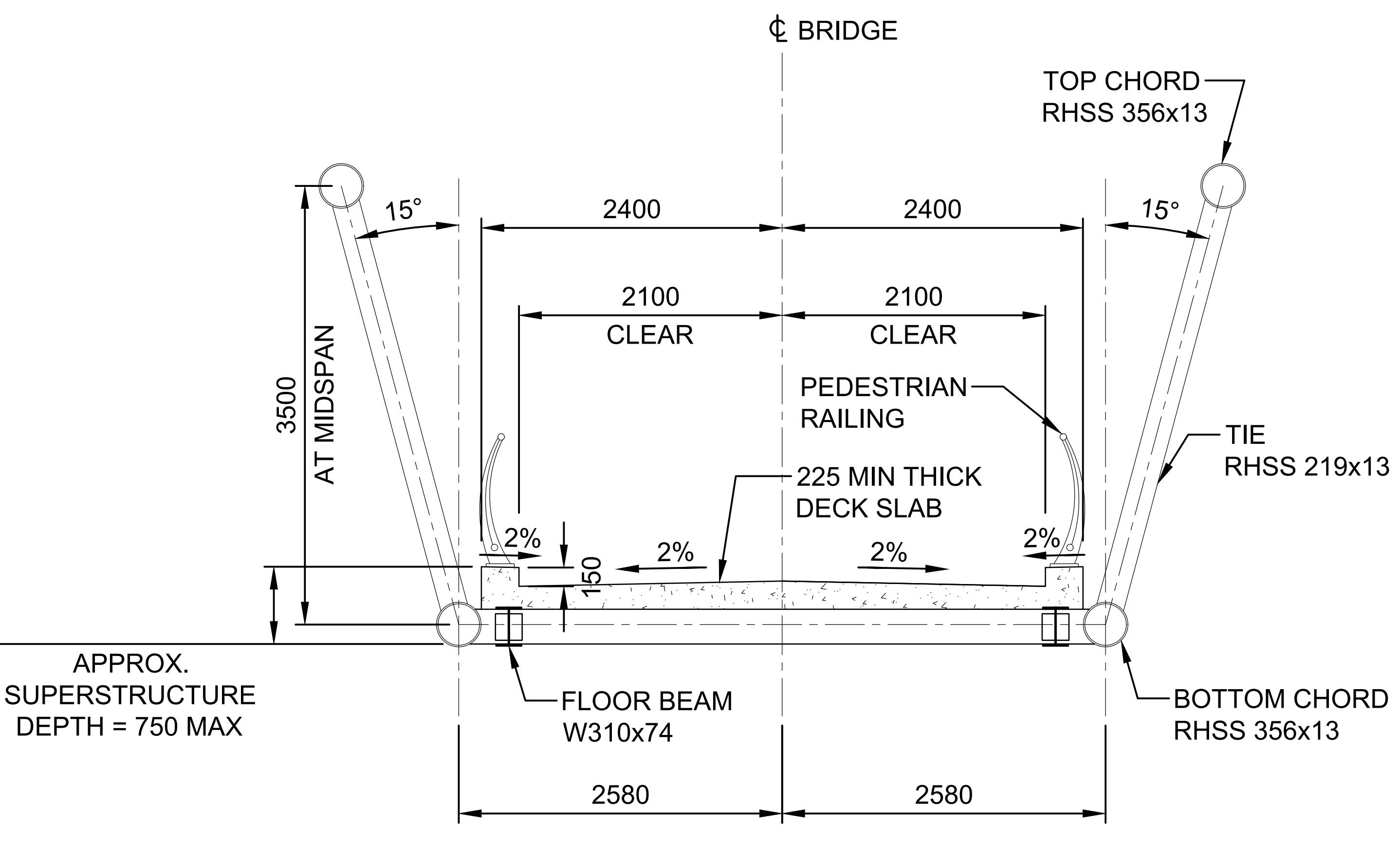
DRAWING
A023 P20X - EX2

Preferred Superstructure Option



PLAN

1:100



A - SECTION

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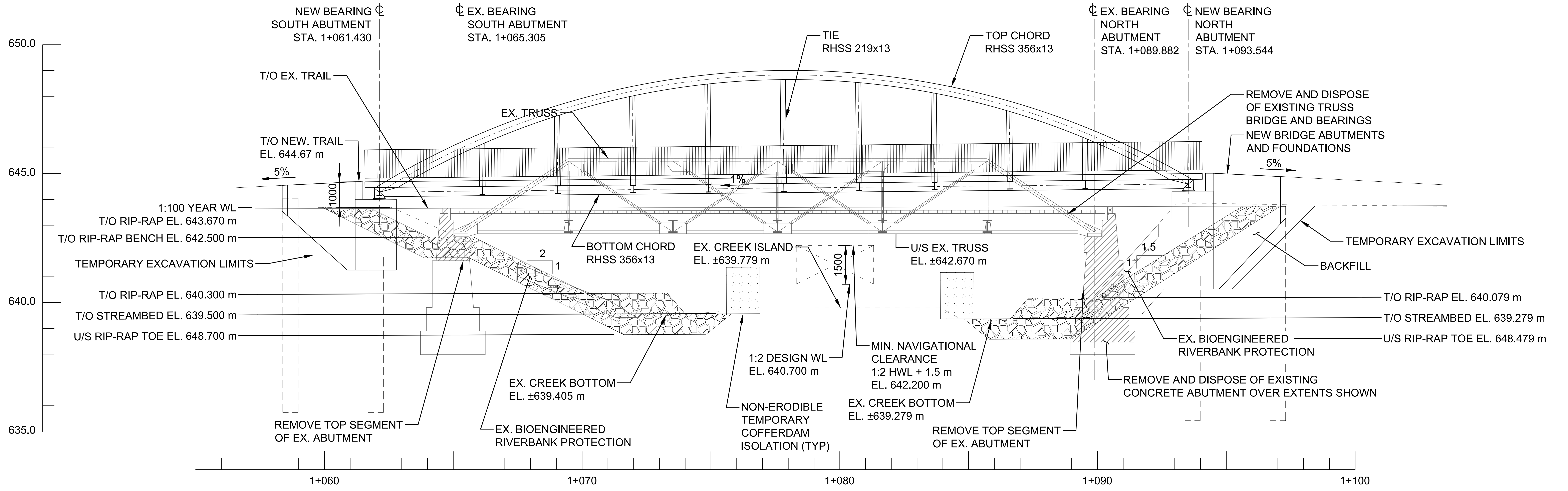

ELEVATION

LOOKING WEST 1:100

CONCEPTUAL OPTION
NOT FOR CONSTRUCTION

ROADWAY IDENTIFICATION

CONST YR / PROJ

DWG CONTENT / DWG NO

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1	TENDER AWARD		

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

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADWAYS DESIGN DATE
DIRECTOR OF ROADWAYS CONSTRUCTION DATE

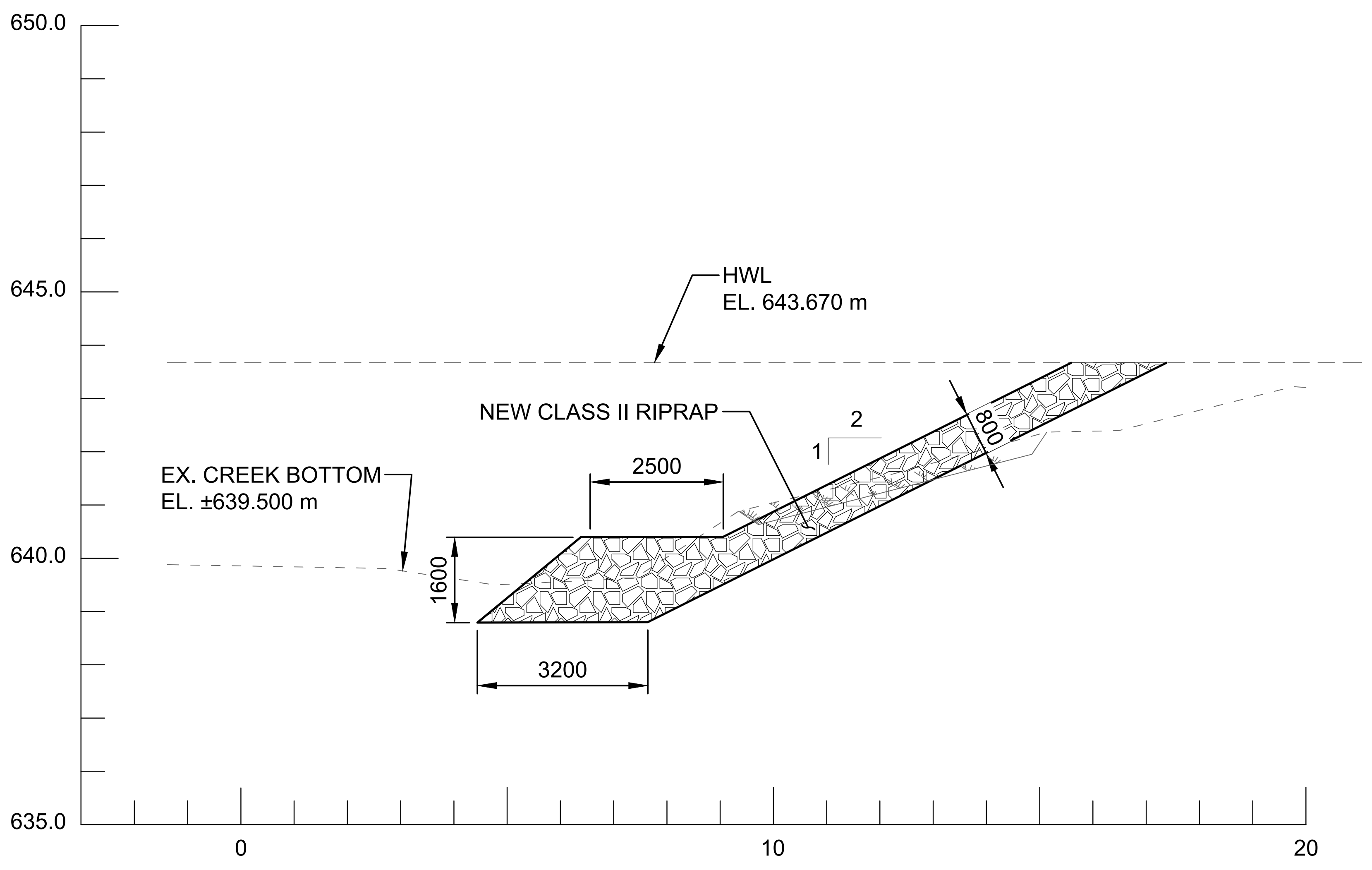
SURVEY
JOB NO. 201932500
SCALE AS SHOWN

DRAWN DATE - -
DESIGNED DATE - -
CHECKED DATE - -

THE CITY OF Edmonton TRANSPORTATION

PROJECT
23 AVENUE
SMITH CROSSING BRIDGE REPLACEMENT
CONCEPTUAL BRIDGE OPTION 1: TIED ARCH BRIDGE

DRAWING
A023 P20X - S03



SECTION

TYPICAL RIVERBANK RIP-RAP ARMOURING WITHIN 5m UPSTREAM AND DOWNSTREAM OF BRIDGE 1:100

ROADWAY IDENTIFICATION

CONST YR / PROJ

DWG CONTENT / DWG NO

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CONTRACT NO. –

NO.	ISSUE	BY	DATE
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3	MICROFILMED		
2	AS BUILT		
1	TENDER AWARD		

CONSTRUCTION RETURN

CONTRACTOR

SURVEYOR

DATE

FILE NUMBER

CONSTRUCTION ENGINEER DATE

GENERAL SUPERVISOR DATE

MORRISON HERSHFIELD

APPROVED FOR CONSTRUCTION

DEPARTMENT / BRANCH	APPROVAL	DATE

DIRECTOR OF ROADWAYS DESIGN DATE

DIRECTOR OF ROADWAYS CONSTRUCTION DATE

SURVEY

JOB NO. 201932500

SCALE AS SHOWN

DRAWN DATE
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DESIGNED DATE
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CHECKED DATE
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THE CITY OF Edmonton TRANSPORTATION

PROJECT

23rd AVENUE

SMITH CROSSING BRIDGE REPLACEMENT

RIP-RAP CROSS-SECTION

DRAWING

A023 P20X - EX3

Appendix L: Public Engagement Results (CoE 2021)

What We Heard Report

Smith Crossing Bridge Replacement

Stakeholder and Online Engagement

Ahsan Karim, Project Manager
smithcrossing@edmonton.ca
edmonton.ca/**smithcrossing**

SHARE YOUR VOICE
SHAPE OUR CITY

Edmonton

TABLE OF CONTENTS

A. Project Overview

The Smith Crossing Pedestrian Bridge, located along 23 Avenue, provides access to the MacTaggart and Larch Sanctuaries within the river valley system. The existing bridge was built in the early 1900s and has reached the end of its service life.

A new bridge will be designed and constructed to replace this pedestrian crossing over the Whitemud Creek. The new bridge will be near the existing bridge location to reduce environmental impacts and to retain the trail connections.

Design has commenced. Construction is anticipated to start in late fall 2021 and the bridge is expected to be open in spring 2022.

A new pedestrian bridge will be designed and constructed.

B. Public Engagement

The Smith Crossing, located near the MacTaggart and Larch Sanctuaries, will have a new bridge designed and constructed to replace the existing pedestrian crossing over the Whitemud Creek. The existing blue bridge is well known and has a high sentimental value, being the site of many wedding and family photographs. It also provides a connection to Edmonton's river valley – a natural area of importance within the City.

A commemorative plaque on a boulder identifies the namesakes of the bridge and there is family interest about the site.

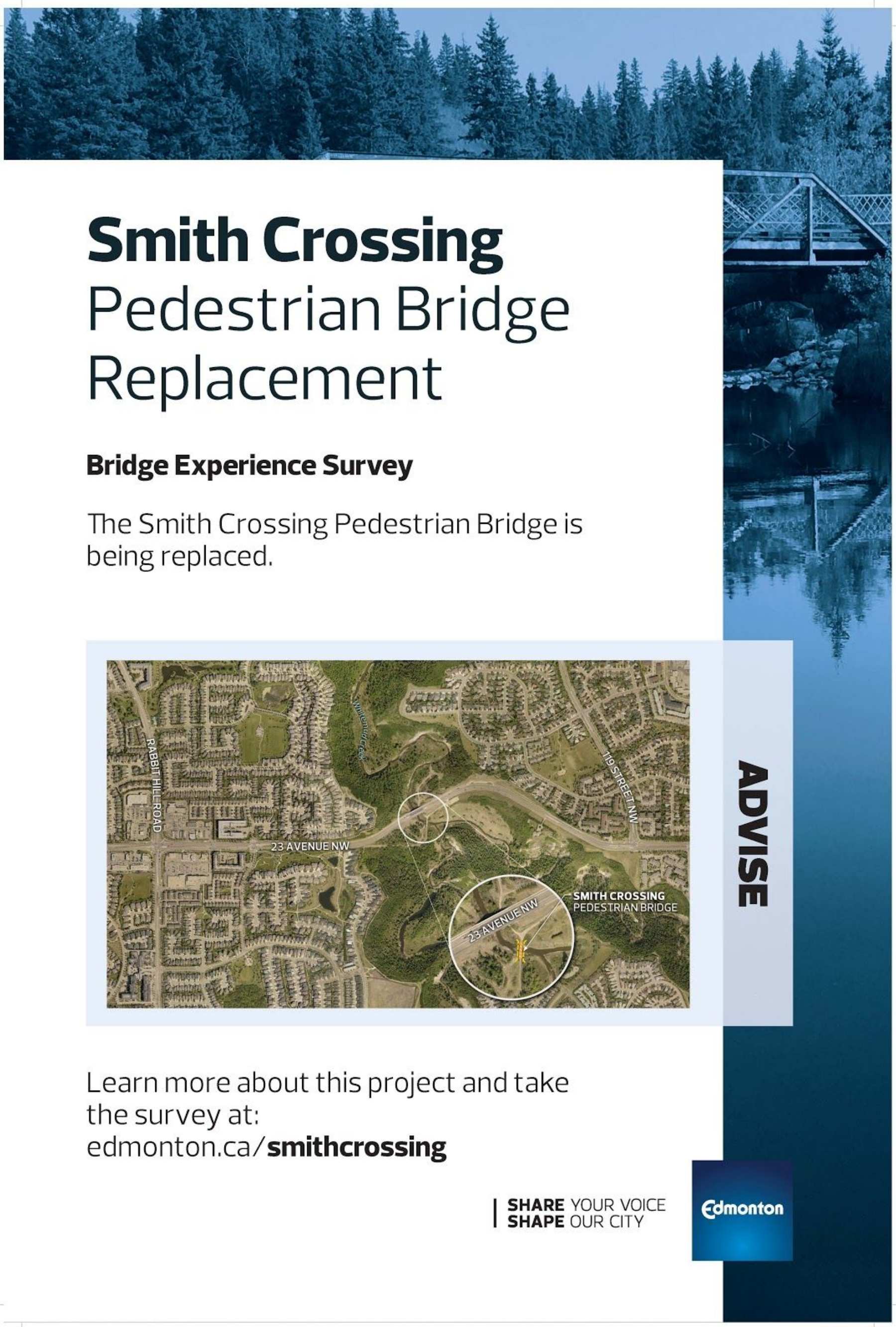
The historic value, potential environmental impacts, and aesthetic/environmental siting of the bridge will all be important topics of discussion during the engagement process. With a planned construction starting in early 2022, typical concerns such as noise, pedestrian detours and site restoration of the native vegetation will also be important.

Much of the decision making will be technical in nature.

It is anticipated that much of the Smith Crossing Pedestrian Bridge project will be technical in nature. The project will be influenced by stakeholders during the initial consultation/stakeholder meetings, including an online survey, and by the public at the public event at the ADVISE level. The bridge experience and 'feel' may also be commented on.

Policies and plans will provide direction for this project. These include, but are not limited to:

- The City Plan
- The Way We Move (Transportation Master Plan)
- Breathe
- Policy C593 – Public Engagement Policy



Smith Crossing Pedestrian Bridge Replacement

Bridge Experience Survey

The Smith Crossing Pedestrian Bridge is being replaced.

Learn more about this project and take the survey at:
edmonton.ca/**smithcrossing**

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SHAPE OUR CITY

Sidewalk signs near, and at, the bridge site were used to advertise the survey.

C. How We Engaged

An online survey was used to capture comments about specific topics at the Advise level.

Identified external stakeholders were emailed or mailed a letter introducing the project. This letter also invited each stakeholder to a one-on-one virtual meeting with the project team to capture information regarding the bridge experience, local knowledge about the site, preferred bridge experience, and comments about the environment as per the requirements of the River Valley Bylaw 7188.

In addition, an online survey was used to capture additional information on the same topics. The 13 question survey was created through the City of Edmonton's Sparq platform and was open from December 12, 2020 to midnight, January 4, 2021. Two questions gathered demographics. The remainder were related to the bridge and adjacent site.

Sidewalk signs advertising the survey were placed near the site at two bus stops on 23 Avenue (one eastbound and one westbound). One sign was placed in the parking lot south of 23 Avenue, which is used by residents accessing the MacTaggart and Larch Sanctuaries via the existing Smith Crossing Pedestrian Bridge.

External stakeholder groups were emailed on December 12, 2020 about the survey and provided information for posting on their webpages, if desired.

D. Who Was Engaged

External stakeholders, including environmental groups, community groups, recreation groups and immediately impacted landowners, were identified and contacted via email, or mail, for a one-on-one virtual meeting with the project team.

The survey was open to all residents of Edmonton and was available through the project webpage:
edmonton.ca/smithcrossing

There were 85 survey respondents and 81 were Smith Crossing Pedestrian Bridge users.

Survey respondents represented 36 communities out of 388 in Edmonton. Most respondents lived in the neighbourhoods near the project site with the highest representation from Terwillegar Towne (18%), Magrath Heights (11%), Blue Quill (7%) and Terwillegar South (5%). Each of the remaining communities represented under 5%.

There were no respondents under 18 years of age. The largest single age group was 35 to 44 at 36%. 20% were between 25 to 34. 27% were between 44 to 64 years of age. 14% were over the age of 65. 2% preferred not to provide their ages.

E. What We Asked and What We Heard Summary

The stakeholder meetings and online survey sought information about bridge use, access to the site, important elements of the existing bridge, sightings of wildlife and knowledge about potential sensitive environmental sites within the immediate area. Demographics related to age and neighbourhood were also requested in the survey.

The key themes about the bridge and site were:

- Keep the bridge in the same location
- The bridge must fit into the site (size, location, aesthetics), complement the natural site, and be a similar width
- The historic character of the bridge is important
- Construction impacts to the natural environment must be minimized
- Connections to adjacent neighbourhoods are important
- Year round access to the creek is important (including kayaking, canoeing, cross country skiing, snowshoeing)
- Some additional amenities, such as interpretive signage and seating, were identified as desirable
- Many wildlife sightings occur around the bridge and include a variety of species, including but not limited to: squirrels, beaver, deer, muskrat,, moose, rabbits, and numerous birds.
- Photography, for weddings, family gatherings and graduations, was identified as the most frequently seen activity on the bridge.

F. Summary of Results and Findings by Question

All comments are a summary of information provided by the survey respondents for 11 questions about the bridge and site. Demographic questions/responses (2) are covered in Section D Who We Engaged.

Q1 Do you use the Smith Crossing Pedestrian Bridge?
81 out of 85 respondents use the Smith Crossing Bridge.

Q2 How do you get to the Smith Crossing Pedestrian Site?
The main method of accessing the site was by driving and parking on the south side of 23 Avenue in the parking lot. Walking from the

adjacent neighbourhoods and the Sanctuaries was the second most popular method to access the site. Cycling (mainly on sidewalks) was the third most popular method of access. Transit was not often used.

Q3 Why do you use the Smith Crossing Pedestrian Bridge?
The majority of respondents use the bridge to access the trails in the ravine and to view the creek and natural areas. Taking photographs and gatherings for family and friends were also popular uses. Commuting, fitness activities and canoeing under the bridge were also identified.

Q4 Have you seen any other activities on the bridge? What activities have you seen on or around the bridge?
32% of respondents have seen other activities on the bridge. These included photography, using the bridge for access to the creek for boating and fishing, and for weddings and other gatherings.

Q5 What do you like about the existing bridge?
The look of the bridge is very important, with width being the most important. This was followed by how it fits into the site and the existing materials (steel and wood). Additional comments indicated that the historic value and look were important along with providing access to the creeks and sanctuaries.

Q6 What do you think is important about this bridge?
Bridge connections to the trails and MacTaggart and Larch Sanctuaries was considered most important, and was followed by access to the adjacent neighbourhoods. The history, look and views were also important.

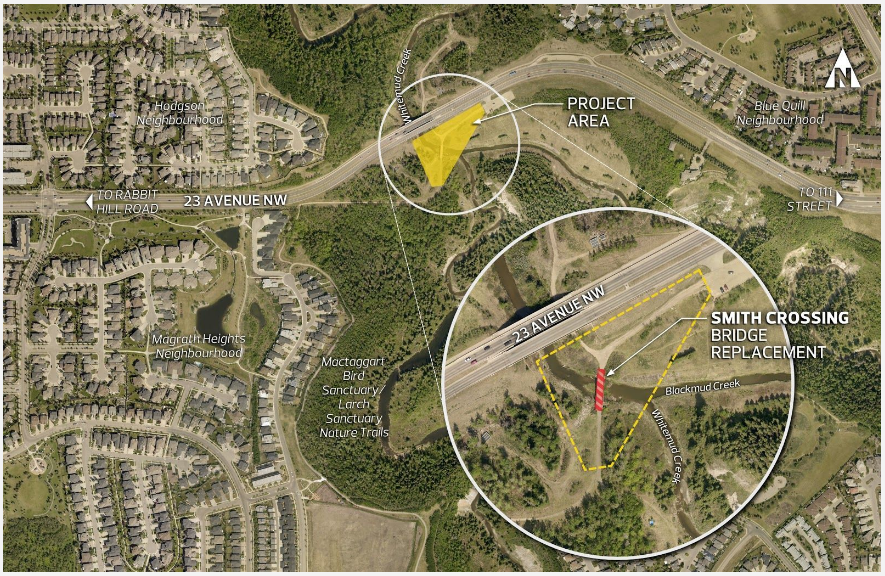
Q7 Is there something missing on, or near, the existing bridge that could improve your experience using the bridge? Please describe what could improve your experience.
24% of respondents indicated the bridge experience could be improved.
Improved creek access for recreation activities, improved site access and parking, additional site amenities such as benches, picnic tables and interpretive signage, would provide an improved experience.

Q8 Are you aware of any special natural sites near the bridge location that we should know about, such as the location of rare plants?
4% of respondents were aware of special natural sites. They identified beaver dams, garter snakes and a bat house.

Q9 Have you seen any wildlife near the bridge?
48% of respondents have seen wildlife near the bridge. They identified a wide variety including, but not limited to: beaver, bats, coyotes, deer, moose, muskrat, rabbits, snakes, squirrel, fox, porcupine, various birds, insects and fish.

Q10 To comply with the City of Edmonton's North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188), an Environmental Impact Assessment of the project is being conducted. Your input is important for the Smith Crossing Pedestrian Bridge Replacement Project in Whitemud Creek

Ravine. If desired, read Bylaw 7188. Please provide any information that you wish the project team to consider regarding the environment within, or adjacent to, the project boundaries as noted on the map. Your comments will be compiled and considered during the environmental assessment.



Project Boundaries Map

Several items were raised by 19 respondents:
The Environment:

- There is a weed infestation - require access for weed removal by volunteers during construction
- Adequate clearance for animal passages below the bridge, and boating clearance during high water
- Minimize disturbance to creek banks and wildlife during construction

Other Topics:

- Retain bridge as is
- Add parking
- Low maintenance design required
- More site furniture

Q 11 Is there anything you would like us to consider in the design of the new Smith Crossing Pedestrian Bridge? What should we consider?
49% of respondents provided the following design considerations:

Bridge Design, Standards and Safety:

- Design must meet all construction and safety standards, provide proper clearance below the bridge, and consider a child’s view
- Keep the historic look, rustic feel, simplistic design and materials
- Ensure a good fit into the site
- Keep the existing width (at a minimum)

Water Access and Impacts:

- Consider flooding and the impacts to the use of the bridge and site amenities
- Consider a design that does not impact the paddling experience
- Provide access to the creek for warm and cold weather activities

G. What Happens Next?

All comments will be considered in the preliminary design of the Smith Crossing Bridge Replacement.

A preliminary design of the bridge and site will be presented in late spring 2021 for review by the public. A 'What We Did' response to 'What We Heard' comments from this survey will be provided.

Existing Smith Crossing Pedestrian Bridge - looking west in fall 2020

Appendix M: Concordance Table in Response to City of Edmonton's Urban Planning and Economy's Comments and Conditions

City of Edmonton Bylaw 7188 Review Comments Summary
KP21-26 Smith Crossing Pedestrian Bridge
Environmental Impact Assessment – FINAL Report
Revised 14 September 2021

City of Edmonton—Initial Circulation Comments (July 2021)

Review Comment	Response and Select Construction Phase Related Commitments	EIA Report Section Reference
Urban Growth and Open Space Strategy (Urban Planning and Environment)		
Environmental Impact Assessment		
The EIA report in general identified major impacts and required mitigation during construction. There are many actions or plans to be prepared and implemented by the contractor including detailed demolition plan.	Comment noted.	N/A
Please ensure the demolition plan will ensure all the mitigation measures identified in the report including debris material handling and proper disposal. The contractor should be informed of potential best practices required to execute demolition work. The plan should provide location and timeline associated with site storage and proper mitigation or ESC measures if there is short-term storage required on site.	All of these requirements are typical of standard construction specifications and will be incorporated into the tender document.	N/A
Please ensure the restoration plan and detailed design will incorporate the recommendations outlined within this EIA report. Please follow up with such plans and designs once available for our review and approval. Moreover, the landscaping and revegetation plan should address the creek bank slope stability concerns as outlined under the Thurber report. It appears that the project has the potential to result in negative impact to creek bank slope stability and the recommendation outlines a more detailed understanding at the detailed design stage.	Landscaping restoration plans will be included with the Detailed Design / tender documents. Slope stability considerations based on the Thurber report are incorporated into the design and tender documents.	N/A
There should be a vegetation removal plan, tree protection and conservation plan to minimize the impact on the natural vegetation prior to construction.	• These plan requirements will be included in the tender documents. • Vegetation clearing limits and the need for a Tree Protection Plan are documented in the EIA.	Section 4.0

Review Comment	Response and Select Construction Phase Related Commitments	EIA Report Section Reference
We strongly recommend the project team to consider a bioengineering approach in developing a restoration plan that could complement both natural vegetation supporting both habitat and bank stabilization functions.	• This has already been considered and noted in Section 4.2 of the EIA: "Riprap areas will be bioengineered with willow cuttings". • As noted in the EIA (Section 1.0 and on Figures 2-6 in Appendix A of the EIA), adjacent bank areas upstream and downstream of the bridge were bioengineered by EPCOR in 2019. • The bioengineered rip rap associated with bridge replacement will tie into the existing adjacent bioengineered banks.	Sections 1.0, 4.2 and Figures 2-6 in Appendix A
As of now, the preliminary design of the proposed crossing did not identify specific measures and elements to support specific EDG and their habitat requirements. This report should inform the preliminary design for consideration of specific mitigation measures and identified areas for consideration at the detailed design stage. For e.g. the EIA could inform the preliminary design to incorporate appropriate mitigation measures to reduce the likelihood of at-grade crossing and/or facilitate safe at-grade crossing should wildlife attempt it. Please consider additional requirements at the detailed design drawings stages for the selected crossing that reflect:	• Wildlife passage was considered during preliminary design as documented in the EIA in Sections 3.7.2.2 and 5.2.7. • According to the City of Edmonton's Wildlife Passage Engineering Design Guidelines (WPEDG)(City of Edmonton 2010), all ecological design groups (EDG's) are expected to be able to successfully cross a recreational trail. • This is not a road project and the gravel trails in the local study area, including those approaching the bridge, therefore, are not considered a barrier to wildlife movement for urban-adapted wildlife species. Therefore, no mitigation measures for specific EDG's and their habitat requirements were considered during preliminary design because there is no movement issue.	Sections 3.7.2.2 and 5.2. 7
Estimated stream hydraulics (e.g., high water mark, stream velocity, etc.) demonstrating adequate passage during typical conditions as well as during/after storm events.	• Stream hydraulics are documented in Appendix E. • Water levels, bridge height, etc. are shown in the design drawings provided in Appendix K. • Please see Section 5.2.7 in EIA. This is an excerpt: The proposed replacement bridge will maintain similar conditions for wildlife passage compared to existing conditions (i.e., most EDG's, including LT (moose and deer) and MT (coyote) animals, can move unimpeded under the bridge under suitable	Section 5.2.7, Appendices E and K

Review Comment	Response and Select Construction Phase Related Commitments	EIA Report Section Reference
	conditions (e.g. low water and frozen conditions)]. The opening under the bridge will be larger compared to existing conditions with an increase of 1.0 m in bridge clearance to better accommodate 1:100 year flood events. In addition, the new bridge will be longer than the existing bridge, increasing the opening under the bridge. The granular approach trails will be maintained and designated for pedestrian use only, with fencing limited to the immediate ends of the bridge structure where required for pedestrian safety. Riprap armouring will be placed on the creek banks for improved flood resilience and will be similar to existing rock already present at the bridge crossing and at the nearby EPCOR stormwater outfall facilities, thereby not creating any new barriers to wildlife movement in the area. The riprap armouring will be naturalized with willow cuttings or similar. The existing bridge is not lit at night and the proposed project does not include introducing new bridge lighting, thereby maintaining the status quo. Impacts to ecological connectivity/wildlife movement as a result of bridge replacement are rated as positive, direct, minor, permanent, local and likely. This applies to LT, MT, ST, AM, AQ, AMP, WB and OB animals".	
Landscaping, including road right-of-way, in-stream, and riparian channel landscaping, intended to restore natural habitat and encourage use of the crossing by amphibian, small terrestrial, and medium terrestrial EDGs.	• Please see above response.	As above

Review Comment	Response and Select Construction Phase Related Commitments	EIA Report Section Reference
Landscaping and design features intended to facilitate safe and effective passage of aerial species (birds and bats) above grade.	• As noted above, according to the City of Edmonton's Wildlife Passage Engineering Design Guidelines (WPEDG)(City of Edmonton 2010), all ecological design groups (EDG's) are expected to be able to successfully cross a recreational trail. Birds and bats are able to safely move around the existing pedestrian bridge and the same is expected for the new bridge. No further mitigation is required.	As above
Please consider further information to be prepared at the design details that will minimize the visual and acoustic impacts of the trail access on wildlife, including, but not limited to: slope grading, lighting, and landscaping.	• As noted above and in Section 5.2.7 in the EIA, the existing bridge is not lit at night and the proposed project does not include introducing new bridge lighting, thereby maintaining the status quo. • No new trails or roadways are being proposed so no new visual or acoustic impacts are expected compared to existing conditions in the project area.	Section 5.2.7
There are a number of limitations as outlined under an EIA report including the development of environmental controls by the construction contractor. Please provide a clear mechanism on how the contractor will be able to replicate the mitigation measures and other plans developed from preliminary design to detailed design stage of the project. There is greater risk of undermining the EIA. Outcomes will not be well represented at the various construction stages that may have changes progressing at the detailed design stage.	The tender documents and construction contract will require all mitigation measures identified in the EIA be implemented and monitored. The Contractor will be required to submit an ECO Plan according to the City of Edmonton's ECO Plan Framework, which demonstrates how the contractor's construction methodology will satisfy the environmental compliance obligations.	Sections 5.0, 8.3.2
Please consider alternatives for the construction laydown areas as it currently covers a big portion of an environmentally sensitive location. Alternative could be a portion of the parking lot or location that is environmentally less sensitive.	• It is unclear what "environmentally sensitive location" is being referred to in this comment. All proposed laydown areas shown in Figure 3 in Appendix A of the EIA are located in previously disturbed areas, including the parking lot. • Though the parking lot provides a useful delivery and laydown area, practical construction sequence and methodology considerations for this work will require	Appendix A

Review Comment	Response and Select Construction Phase Related Commitments	EIA Report Section Reference
	the use of laydown areas adjacent to the bridge site as shown in the EIA.	
Infrastructure Planning and Design (Engineering Services)		
Environmental Impact Assessment		
It was noted that an unstamped and unsigned version of the geotechnical assessment dated October 4, 2019 appeared to be included in the EIA. A finalized, stamped version should be included in the final EIA report. Similarly, the additional geotechnical report prepared to inform the detailed design of the new bridge, particularly the proposed embankment slopes dated January 29, 2021, was submitted in draft form. A finalized, stamped and signed version of this report must also be included in the final EIA report, rather than the draft version, to solidify Thurber's role as the geotechnical engineer of record for this project. Thurber Engineering should be provided the opportunity to review the final design drawings to ensure the recommendations in their geotechnical reports have been adhered to.	Final stamped reports are included in the final EIA as requested.	EIA appendices
Vegetation should be retained where possible and adequate erosion control including establishment of vegetation will be particularly imperative on sloped areas and must be implemented as soon as possible following construction. Ponding of water at the crest of ravine slopes must also be strictly avoided. An erosion and sediment control plan must be incorporated into construction. During trail and bridge approach construction, the work should be staged in order to limit the amount of time the subgrade is exposed to reduce both risk of a softened subgrade and exposure to erosive forces. Landscaping should be implemented as soon as possible following construction completion and temporary erosion control matting should be put in place, particularly on sloped areas, if vegetation is not able to establish quickly or before winter.	All comments noted. An Erosion and Sediment Control (ESC) Plan is a standard contractual requirement and will be prepared and submitted by the Contractor prior to work being undertaken. Expectations for heightened erosion control management proximate to the watercourse will be described in the tender documents, including the need for temporary erosion control matting to protect disturbed areas prior to revegetation.	Sections 5.2.3, 8.3.2 and Appendix F
Geotechnical risk associated with this project must also be mitigated through ongoing involvement of the geotechnical engineering consultant in the design and construction. It is	The geotechnical engineer has ongoing involvement in the project and will provide inspection of pile foundation bearing surfaces during construction, and is available to provide	N/A

Review Comment	Response and Select Construction Phase Related Commitments	EIA Report Section Reference
understood that cast-in-place concrete piles and concrete abutments are proposed for the new bridge. It is expected that the geotechnical engineer will complete full-time inspection of the bridge foundation construction, as well as subgrade inspection of the approaches and embankment slopes prior to placement of subsequent layers including geotextile and rip rap placement. The geotextile, as well as any proposed fill, granular and rip rap materials must be approved by the geotechnical engineer of record prior to placement. The geotechnical engineer must be available during the tender and construction phase to provide input should any geotechnical issues arise.	advice on other geotechnical issues arising as required. The geotechnical engineer's involvement will be as per the Contract between the City and the Prime Consultant.	
Community and Recreation Facilities (River Valley Parks and Facilities)		
Environmental Impact Assessment		
As this work will be very impactful to trail users, has a detour plan been developed? Will information be distributed to the surrounding neighbourhoods?	• Please see Plate 4.5 in EIA for proposed trail closures and alternate access points • Construction impacts to trail users including closures and alternative access points have been shared with the public through the online public event held in May 2020 and currently available for viewing on the City website. A-frame trail signs providing closure information and website updates will be provided prior to construction.	Plate 4.5
Would appear the parking lot will be utilized for a laydown area, are there plans to rehab this upon completion?	• The Contractor will be required to restore the parking lot to its pre-construction condition, but will not be required to make any improvements to the parking lot; parking lot improvements are outside the scope of this bridge replacement project.	N/A
Has the project reached out to the UofA as they own the MacTaggart sanctuary and should be privy to impacts?	• The project impact area does not extend into the MacTaggart sanctuary, the portion of which that is immediately south of the project site is also now known as the Larch Sanctuary and is managed by the Edmonton and Area Land Trust. The Edmonton and Area Land Trust have been provided with the opportunity to provide comments on this project.	N/A

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Signage question: It would appear interpretive signage is noted throughout the document, who would be producing these? Will directional wayfinding also be added to the area for users?	• Interpretive signage to commemorate the existing bridge and history of the crossing will be produced by the City of Edmonton and installed in a small amenity area between the parking lot and the bridge. • No directional wayfinding is currently present at this site, in part because the trails at this site are not formally maintained by the City of Edmonton. The addition of directional wayfinding is under consideration and a decision will be made by the City of Edmonton during detailed design.	
EPCOR Water and Sewer		
Environmental Impact Assessment		
Our records indicate that no water and/or sewer services exist within the area of the proposal directly off EPCOR mains.	Comment noted and consistent with the project team's understanding.	N/A
Please note that there are outfalls and associated storm infrastructure within the study area/proposed work areas.	Comment noted. Project team is aware of this and has met directly with EPCOR technical representatives 12 December 2020 to discuss specific impacts and mitigations for storm infrastructure including manholes, storm drain pipe, and outfalls. Mitigations required of the Contractor for protection of EPCOR storm infrastructure as minuted at that meeting will be incorporated into the contract requirements.	N/A
The owner/developer must conform the requirements of the City of Edmonton Erosion and Sediment Control Guidelines and Field Manual.	The City of Edmonton is the owner of this bridge structure. The contractor retained to construct the bridge will be required to adhere to all City of Edmonton requirements, including preparation and implementation of an ECO Plan and temporary and permanent ESC plans.	Sections 2.1, 5.0, 8.3.2
Parks and Roads Services (Natural Areas Operations)		
Environmental Impact Assessment		
Please circulate the landscape restoration plans to naturalareaoperations@edmonton.ca for review prior to approval.	An opportunity for review of draft landscape restoration plans will be provided to Parks and Roads Services (Natural Areas Operations) prior to tender document finalization, as is typical.	N/A

Review Comment	Response and Select Construction Phase Related Commitments	EIA Report Section Reference
All identified mitigation measures should be adhered to throughout the length of the construction period.	Agreed.	Section 8.3.2
A Tree Preservation Plan will be required prior to construction. The plan should be sent to naturalareaoperations@edmonton.ca for review and approval. It is strongly recommended that we are contacted a minimum of 4 weeks in advance of the project start date to review tree preservation measures and review the vegetation removal areas so we are able to coordinate the work in a timely manner.	Agreed and as noted above. The City Project Manager for construction, Jason Reske or his representative will make contact with Parks and Roads Services (Natural Area Operations) prior to construction with respect to this item.	Section 8.3.2
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.	This will be considered in the tender documents.	Section 8.3.2
Specific weed management plans should be created for each of the identified vegetation areas (e.g., riparian) as they are distinct and will require different control methods. Given the abundance and diversity of regulated invasive species here, we would also recommend that plans for pre-emergent weed control and early seeding of the area be considered, along with restoration planting.	This will be considered in the tender documents.	N/A
In order to ensure the success of the restoration areas, the project should also consider the installation of snow 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 is strongly recommended.	The requirement to provide snow fencing around restoration areas will be included in the tender documents.	N/A
Parks and Roads Services (Resources Planning and Land Development)		
Environmental Impact Assessment		
A pre-construction inspection prior to accessing the site and a post-construction inspection once parkland restoration has occurred will be conducted by Land Development. Email: parkslandscapeinventory@edmonton.ca to request inspections.	The City Project Manager for construction, Jason Reske or his representative will make contact with Land Development to arrange such site visits.	N/A
This project must follow all City Policies and Servicing Agreements.	Agreed.	N/A

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The site is in compliance with the site's Natural Area Management Plan.	Comment noted.	N/A
The project must be reviewed and commented on by Natural Areas Operations, River Valley Parks and Facilities for possible impacts and landscaping material selection.	An opportunity for review of draft landscape restoration plans will be provided to Natural Areas Operations and River Valley Parks and Facilities prior to tender document finalization, as is typical.	N/A
Impacts to vegetation may require biological surveys such as rare plant surveys, breeding bird surveys, etc. These surveys must be completed within the appropriate time frame and with consideration to seasonality and construction timelines.	As noted in the EIA, seasonally appropriate rare plant and breeding bird surveys have been conducted. Construction anticipated to begin in July 2022.	N/A
Erosion and Sedimentation Control Measures must be in place prior to any construction activity to prevent any contaminants from entering infrastructure or waterbodies.	Agreed.	Section 8.3.2
Any damaged turf areas shall be re-sodded or repaired with like natural grasses/vegetation as required and maintenance (watering, mowing and weed control) of restored turf areas will be the responsibility of the proponent until the turf is established. All damages to natural areas must be restored to pre-existing conditions with natural plantings as required and the maintenance (watering and weed control) of restored natural areas will be the responsibility of the proponent until the natural area planting material is established and accepted by PARS. All other damages to parkland inventory (hardscape, furniture, fixtures, trees, shrubs beds, etc.) must be restored to pre-existing conditions and COE Construction Standards and PARS acceptance.	Agreed.	N/A
Any laydown, staging or haul route area on Parkland must be approved and fenced, with no vehicular operation or project activity outside of the fenced area. There should be no access to the laydown, 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 (e.g., watering, mowing, and weed control) of restored turf areas will be the responsibility of the proponent until the sod is established and accepted by PARS.	Agreed.	N/A

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Site drainage must not be affected by this project. Any overland drainage issue that is a result of this project will be corrected and repaired by the developer/contractor, not the City of Edmonton.	Agreed.	N/A
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, etc.).	Agreed.	N/A
Public access control measures must 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, etc.).	Agreed.	N/A
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.	Agreed.	N/A
Any new trail construction or rehabilitation must meet current City of Edmonton trail construction standards and have a minimum 1 m buffer zone, free of vegetation on either side of the trail.	Agreed.	N/A
All damages to trails and paths must be restored to pre-existing trail surface type conditions and to COE Construction Standards and PARS acceptance.	Agreed.	N/A
Any trail construction with steep side slopes (steeper than 3:1) must have a shoulder (minimum 600mm) built to current CoE trail/shared path construction standards. Please consider installing safety barriers (post and rail fence) on any trail sections that do not have a minimum 600mm shoulder before a steep decline off the trail surface edge.	A 600mm wide shoulder is being provided at all trails, which are typically 3.0m wide + 2 x 600mm wide shoulders. Current City of Edmonton trail / shared path construction standards are being considered in the design.	N/A
If tree conflicts (work within 5 m of a tree) are anticipated, or arise during construction, or a tree is within 3 m of the haul route a site meeting with 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.	Agreed. The City Project Manager for construction, Jason Reske or his representative will make contact with the City of Edmonton Urban and/or Natural Area to arrange a site visit.	Section 5.2.5.4

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Tree protection is required around existing boulevard trees near the site access points. A minimum 2 m protection barrier surrounding each tree required.	Agreed.	Section 8.3.2
There is no dumping or stockpiling on the site.	Agreed. Note that temporary construction laydown will be required as noted in the EIA.	Section 4.4.
Use of this area must be managed carefully to prevent any spills or release of contaminants.	Agreed.	Section 5.2.10
The developer/contractor is responsible for all weed control on the construction site, laydown or haul route areas during construction and until the site has been accepted by the City of Edmonton, PARS.	Agreed.	Section 8.3.2
Hard-surface access routes are preferred for large equipment.	Agreed. Hard-surface routes will be used where possible, however, some equipment access on gravel trails will be required.	N/A
All holes must be filled immediately to ensure public safety and testing is completed. This includes mitigating settlement that would create a future trip hazard.	Agreed.	N/A
The site is left in an intended state that meets the City's satisfaction.	Agreed.	N/A
For projects longer than one day, signage must be posted with an active project contact person and phone number for inquiries.	Agreed.	N/A
Please follow the City of Edmonton Design and Construction Standards Volume 5 - Landscaping (2021).	Agreed.	N/A
Contact Alberta One-Call (1-800-242-3447) to have all utility lines located at least 48 hours prior to any excavation.	Agreed.	N/A
This location may require OSCAN permit in order to facilitate crossing of the boulevard. The application for OSCAM permit can be obtained on the City Website.	Noted. OSCAM permits where required must be obtained by the Contractor through the typical City website application process.	N/A