William Hawrelak Park Renewal

Environmental Impact Assessment Pursuant to Bylaw 7188
Final Report

Prepared for:
City of Edmonton
Edmonton, Alberta

Project Number EP-926
December 2021

Prepared by:
Spencer Environmental Management Services Ltd.
Edmonton, Alberta

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

Suite 402, 9925 - 109 Street Edmonton, Alberta T5K 2J8
Phone (780) 429-2108 Fax (780) 429-2127

Achyut Adhikari
Ecological Planner
Planning and Environment Services
City of Edmonton
7th Floor Edmonton Tower
10111 – 104 Avenue NW
Edmonton AB T5J 0J4

15 December 2021
File: EP-926

Dear Mr. Adhikari,

Re: AA21-62 Final Environmental Impact Assessment (EIA) Pursuant to Bylaw 7188 for Hawrelak Park Renewal

We are pleased to submit this pdf copy of the above-mentioned final Environmental Impact Assessment (EIA) for your files. This report fulfils Bylaw 7188 environmental review requirements. This final report is created in response to a memo issued by City of Edmonton Planning and Environment Services on 01 December 2021, outlining comments and conditions generated during the City's review of the October 2021 draft EIA. The City comments are appended to this final report. In addition, new geotechnical information for the park in general and in support of replacement of an existing stairway on the east slope of the park, west of Groat Road, has been appended to the report with main body report revisions focused on updating the project description and geotechnical information in Sections 3.4, 4.2, 5.2.1, 8.4 and Appendices A and K.

A final Site Location Study (SLS) is provided under separate cover.

Thank you for the opportunity to be of service and assist with this river valley park rehabilitation project.

Sincerely,

Spencer Environmental
Management Services Ltd.

ALBERTA SOCIETY of Professional Biologists
Andra Bismanis
1236
PROFESSIONAL BIOLOGIST

Andra Bismanis, M.Sc., P.Biol.
Vice-President, Science Practice

ALBERTA SOCIETY of Professional Biologists
Lynn A. Maslen
545
PROFESSIONAL BIOLOGIST

Lynn Maslen, M.Sc., P.Biol.
President, Science Practice

cc: Rachel Dumont, City of Edmonton

Table of Contents

Chapter **Page**

1.0 INTRODUCTION 1

2.0 THE PROPERTY 5

2.1 Project Area Location, Disposition, Zoning 5
2.2 Historic Conditions 5
2.3 Environmental Site Assessment 6
2.3.1 Phase 1 ESA (April 2014) 6
2.3.2 Limited Phase II ESA (May 2014) 7
2.3.3 Phase 1 ESA (July 2014) 8
2.3.4 Tier 2 Risk Assessment (2014) 9
2.3.5 Limited Phase II Environmental Site Assessment (2021) 9

3.0 ENVIRONMENTAL CONTEXT 10

3.1 Overview of Study Area and Adjacent Lands 10
3.2 Environmental Sensitivities 10
3.2.1 Original (2016) Mapping 10
3.2.2 Updated (2021) Mapping 10
3.3 Surface Water, Groundwater and Fish Habitat 11
3.3.1 Methods 11
3.3.2 Description 12
3.4 Geomorphology, Geology and Soils 16
3.4.1 Methods 16
3.4.2 Description 17
3.5 Vegetation 19
3.5.1 Methods 19
3.5.2 Description 20
3.7 Wildlife 34
3.7.1 Field Investigations 34
3.7.2 Methods 34
3.7.3 Description 38
3.8 Historical Resources 53
3.8.1 Archaeological Resources 53
3.8.2 Palaeontological Resources 54

4.0 THE PROJECT 55

4.1 Renewal Project Scope 55
4.2 Renewal Component Description 56
4.2.1 Open Space, Outdoor Amenities, Wayfinding 57
4.2.2 Circulation 58
4.2.3 Facilities 60
4.2.4 Underground Utilities 62
4.2.5 Hawrelak Lake 65

4.3 Landscaping 65
4.4 Construction Schedule 66
4.5 Construction Laydown Area and Access 66
4.6 Project Phases and Associated Key Activities 66
4.6.1 Site Preparation Phase 67
4.6.2 Construction Phase 67
4.6.3 Reclamation Phase 70
4.6.4 Operation and Maintenance Phase 70
4.7 Summary of Environmental Regulatory Approvals 70

5.0 PROJECT IMPACTS AND MITIGATION MEASURES 74

5.1 Assessing Impacts 74
5.1.1 Potential Impact Identification and Analysis 74
5.1.2 Impact Characterization 74
5.1.3 Mitigation Development and Residual Impact Assessment 75
5.2 Impact Assessment Results and Mitigation Measures 76
5.2.1 Geology/Geotechnical Conditions 76
5.2.2 Soils 77
5.2.3 Surface Water Quality 78
5.2.4 Groundwater 80
5.2.5 Fish 80
5.2.6 Vegetation 82
5.2.7 Wildlife and Wildlife Habitat 86
5.2.8 Historical Resources 92
5.2.9 Project Incidents 93
5.3 Cumulative Effects (past projects, present projects, future planned projects) 94
5.3.1 Past Projects 95
5.3.2 Present/Ongoing Projects 95
5.3.3 Future Planned Projects 95
5.3.4 Conclusion 95

6.0 ENVIRONMENTAL MONITORING 97

7.0 PUBLIC, INDIGENIOUS AND STAKEHOLDER ENGAGEMENT 98

8.0 CONCLUSIONS 100

8.1 Adverse Residual Impacts and Sensitivities 100
8.2 Positive Residual Impacts 101
8.3 EIA Limitations 101
8.4 Summary of Key Mitigation Measures 102
8.5 Summary of Outstanding City Environmental Permitting Requirements 103

9.0 REFERENCES 105

9.1 Literature Cited 105
9.2 Personal Communications 109

APPENDIX A: FIGURES A1

APPENDIX B: PROJECT-SPECIFIC TERMS OF REFERENCE B1

APPENDIX C: CITY ADMINISTRATION BYLAW 7188 SIGN-OFF AND PROJECT CONDITIONS AND ADVISEMENTS C1

APPENDIX D1: TIER II RISK ASSESSMENT (AECOM 2014) D1

APPENDIX D2: LIMITED PHASE II ESA (CRIMSON 2021) D2

APPENDIX E: HAWRELAK LAKE WATER QUALITY FEASIBILITY STUDY (APPLIED ECOLOGICAL SERVICES 2020) E1

APPENDIX F. WILLIAM HAWRELAK PARK GEOTECHNICAL INVESTIGATION (THURBER 2021A) F1

APPENDIX G. STAIRWAY REPLACEMENT GEOTECHNICAL DESKTOP STUDY (THURBER 2021B) G1

APPENDIX H: HAWRELAK PARK PLANT COMMUNITY INVENTORY (JULY 2021) H1

APPENDIX I: WILDLIFE LIST I1

APPENDIX J: *HISTORICAL RESOURCES ACT* APPROVAL WITH CONDITIONS J1

APPENDIX K: PROJECT ACTIVITIES AND VECS MATRIX K1

APPENDIX L: PUBLIC ENGAGEMENT - REPORTING BACK (CITY OF EDMONTON 2018) L1

APPENDIX M: PUBLIC ENGAGEMENT - WHAT WE HEARD REPORT (CITY OF EDMONTON 2021) M1

APPENDIX N: MITIGATION AND PERMITTING ACTIONS SUMMARY N1

List of Tables

Table 3.1. Sensitivity Analysis Refinement 11
Table 3.3. Summary of Bird Species Observed in the Local Study Area by Habitat Type During the Breeding Bird Fixed-width Survey (June 2021) 45
Table 3.4. Total Number of Adult Birds Observed at Hawrelak Lake by Survey Station #, Survey # and Guild (June 2021). 46
Table 3.5. Total Number of Juvenile Birds Observed at Hawrelak Lake by Survey Station #, Survey # and Guild (June 2021). 47
Table 3.6. Special Status Wildlife Species with Potential to Occur in the Project Area .. 51
Table 4.1. Summary of Applicable Legislation and Bylaws 70
Table 5.1: Impact Descriptor Definitions. 74

List of Plates

Plate 1.1. Picnic Shelter #1 to be rehabilitated (20 October 2020). 1
Plate 1.2. Service yard near the park entrance to be rehabilitated (20 October 2020). 2
Plate 1.3. Roadway and parking area to be rehabilitated (20 October 2020). 2
Plate 1.4. Main Pavilion adjacent to the lake to be rehabilitated (20 October 2020). 3
Plate 1.5. Heritage Amphitheater to be rehabilitated (20 October 2020). 3

Plate 2.1. Stantec's (April 2014) Phase I ESA 7.94 ha Study Area on the East Side of Hawrelak Park [Source: Stantec (April 2014)]. 6
Plate 2.2. Stantec's (May 2014) Phase II ESA 0.45 ha Spray Park Study Area West of the Existing Playground [Source: Stantec (May 2014)]. 7
Plate 2.3. Stantec's (July 2014) Phase I ESA 1.16 ha EFCL 100 Anniversary Project Study Area on the East Side of Hawrelak Park [Source: Stantec (July 2014)]. 8
Plate 3.1. Hawrelak Park Stormwater Outfall 28 (existing outfall currently consists of a small pipe only; a headwall outfall will be constructed and the pipe repaired/replaced) on the East Bank of the NSR Upstream of the Pumphouse (12 May 2021). 14
Plate 3.2. Hawrelak Park Stormwater Outfall 25 (replace pipe; concrete outfall structure in good condition, no works required) on the East Bank of the North Saskatchewan River (12 May 2021)..... 14
Plate 3.3. Hawrelak Park Stormwater Outfall 26 (outfall used for lake discharge; 15
needs to be cleaned (rock debris removed from inside the pipe), and the pipe repaired/replaced on the East Bank of the North Saskatchewan River (12 May 2021). 15
Plate 3.4. View Downstream from the Buena Vista/Hawrelak Park Footbridge of the Steep East Riverbank in Hawrelak Park (12 May 2021). 17
Plate 3.5. Deciduous mixedwood mixed shrub community with a dense shrub understorey (21 July 2021). 21
Plate 3.6. Mixed deciduous mixed shrub community with dense shrub understorey (21 July 2021). 22
Plate 3.7. Mixed deciduous red-osier dogwood community with dense shrub layer dominated by red-osier dogwood (21 July 2021). 23
Plate 3.8. Riparian community along the creek channel with trees present (21 July 2021). 24
Plate 3.9. View to south of riparian community along west side of Hawrelak Lake with some open space trees present (21 July 2021). 25
Plate 3.10. View to west of riparian community around the constructed wetland at the headwaters of the constructed creek (23 July 2021). 25
Plate 3.11. View to south of riparian community along west side of lake that has not been mown (21 July 2021). 26
Plate 3.12. Typical manicured open space community comprising the majority of Hawrelak Park (20 October 2020)..... 27
Plate 3.13. Common ragweed showing leaves divided nearly to the midrib (21 July 2021). 28
Plate 3.14. Northern water-horehound showing opposite coarsely toothed leaves and white flower clusters in the leaf axils (21 July 2021). 29
Plate 3.15. Common buckthorn growing on a forest edge in Hawrelak Park (21 July 2021). 30
Plate 3.16. Purple loosestrife (foreground and background) found along the edge of Hawrelak lake (21 July 2021). 31
Plate 3.17. Creeping thistle infestation near park entrance (21 July 2021). 32
Plate 3.18. Creeping thistle infestation along western lakeshore (21 July 2021). 33
Plate 3.19. Small snags (circled in yellow) observed within the natural forest stands along the west margin of the LSA (20 October 2020). 39

Plate 3.20. Representative aquatic invertebrate habitat at Station 4 during Survey #1 (18 June 2021) 42
Plate 3.21. Typical dipnet contents from Station 15 during Survey #3 with very clear water and invertebrates including scuds, waterboatman, mayfly, diving beetle, leech, and snail (23 June 2021). 43
Plate 3.22. Series of small round holes of unknown origin in northwest corner of pumphouse fenceline (12 May 2021) 48
Plate 3.23. Potential den at base of slope east of regional trail near boat dock site (12 May 2021) 49
Plate 4.1. Existing (left) and proposed (right) park space configurations – conceptual (MBAC and PFS 2021). 57
Plate 4.2. Conceptual extension of forest into the park (MBAC and PFS 2021). 58
Plate 4.3. Hawrelak Park Stormwater Outfall 27 (erosion and concrete work to increase bank stability; pipe condition does not warrant replacement) on east bank of NSR downstream of the Pumphouse (20 October 2020). 63
Plate 4.4. Hawrelak Park Stormwater Outfall 28 (existing outfall currently consists of a small pipe only; a headwall outfall will be constructed and the pipe repaired/replaced) on the East Bank of the NSR Upstream of the Pumphouse (12 May 2021). 64
Plate 4.5. Hawrelak Park Stormwater Outfall 25 (replace pipe; concrete outfall structure in good condition, no works required) on the East Bank of the North Saskatchewan River (12 May 2021) 64

1.0 INTRODUCTION

William Hawrelak Park (Hawrelak Park) is a 68 ha park, featuring a 5 ha anthropogenic lake, located in the central Edmonton river valley situated between Groat Road to the east and the North Saskatchewan River (NSR) to the west. It is the most intensively used park in Edmonton (Figure 1, Appendix A). The park comprises the lake, open grassy areas, a border of native forest, and supporting amenities including a main pavilion, Heritage amphitheatre, boathouse, three picnic shelters and a parks operations yard. The park hosts several major festivals and events and supports picnic and other day uses throughout the year. Hawrelak Park is over 50 years old and requires life cycle replacements of utilities, transportation, open spaces and facility infrastructure to better support the site's existing varied and intensive uses. For example, roadways, trails, buildings and open space furnishings are all beginning to deteriorate and are in need of improvements (Plates 1.1 to 1.5).

Plate 1.1. Picnic Shelter #1 to be rehabilitated (20 October 2020).

Plate 1.2. Service yard near the park entrance to be rehabilitated (20 October 2020).

Plate 1.3. Roadway and parking area to be rehabilitated (20 October 2020).

Plate 1.4. Main Pavilion adjacent to the lake to be rehabilitated (20 October 2020).

Plate 1.5. Heritage Amphitheater to be rehabilitated (20 October 2020).

In 2019, the City of Edmonton (City) completed the *William Hawrelak Park Rehabilitation Implementation Plan (Capital Investment Plan*) (RPK Architects *et.al.* 2019) to guide renewal of Hawrelak Park over the next 10 years. The plan considered the physical and functional condition of the assets, the current policies that are in effect and the operational requirements to maintain and sustain the park. It identified priorities for renewal, cost estimates, schedules and explored options for sequencing the work. That plan provided the roadmap for rehabilitation of the park and support for next steps. Currently, park rehabilitation is intended to be delivered in three phases: Phase 1 – Schematic Design and Design Development (current phase); Phase 2 – Working Documents; Phase 2a (if required because critical items are identified) – Construction of Emergent Items; and Phase 3 –

Construction and Post-Construction Services. The rehabilitation project is characterized as addressing renewed facilities, renewed infrastructure and improved open space. The scope includes both renewal and growth elements that have been funded to be addressed in Phase 1. All growth elements will require additional Council-approved funding through the 2023-2026 budget cycle prior to proceeding to future phases. It is anticipated that construction will proceed during the 2023-2026 budget cycle.

Hawrelak Park is located wholly within the boundaries of the City of Edmonton's North Saskatchewan River Valley Area Redevelopment Plan (NSRV ARP) (Bylaw 7188) and, therefore, triggers the need for an environmental review pursuant to that Bylaw. City of Edmonton ecological planners have determined that the appropriate level of review for this park renewal project is an Environmental Impact Assessment (EIA) subject to approval by City Planning and City Council. A Site Location Study (SLS) is also required and is provided under separate cover.

The project is currently in Phase 1 – Schematic Design and Design Development and the City retained Marc Boutin Architectural Collaborative Inc. (MBAC) to provide prime consulting services for rehabilitation of Hawrelak Park. The City has retained Spencer Environmental Management Services Ltd. (Spencer Environmental) as environmental consultant for this project, and to fulfill EIA and SLS requirements.

This report comprises the Bylaw 7188 EIA prepared for the Hawrelak Park renewal project. The EIA format and content follows a project-specific Terms of Reference (ToR) developed through scoping discussions held with a City of Edmonton ecological planner (Appendix B). This EIA addresses all components of the Hawrelak Park renewal project having potential to affect lands within the NSRV ARP. It is based on the Phase 1 schematic design report and information supplied directly by the City and project detail available to us as of 30 September 2021, with one exception. During review of the draft EIA City personnel indicated that detailed design would include replacement of a wooden stairway located on the east valley slope, just west of Groat Road, and requested that the EIA be adjusted to recognize that project element. The intention is for the EIA to act as a resource for park renewal planning, design and construction activities moving forward through the remainder of the 10-year planning horizon.

The draft EIA was submitted to Urban Planning for Bylaw 7188 review and circulation. Based on that review process, City Administration has confirmed in writing that they have no further concerns with the proposed park rehabilitation project pursuant to Bylaw 7188. That letter includes conditions and advisements that must be adhered to during project implementation. A copy of that letter is provided in Appendix C.

2.0 THE PROPERTY

2.1 Project Area Location, Disposition, Zoning

Hawrelak Park is located on a river valley terrace on the east side of the North Saskatchewan River in central Edmonton. It is located south of the Royal Mayfair Golf Club, west of Groat Road and north of the Buena Vista/Hawrelak Park Footbridge (Figure 1, Appendix A). Hawrelak Park connects to Emily Murphy Park to the northeast and Buena Vista Park to the south, across the NSR. The Windsor Park Neighborhood is located to the east of the park, east of Groat Road. Figure 1 (Appendix A) illustrates Hawrelak Park's location in relation to the Bylaw 7188 boundary and adjacent lands. The park is City-owned land within the River Valley Mayfair neighborhood (a non-residential neighborhood) and is zoned as Metropolitan Recreation Zone (A) (Figure 2, Appendix A). Small portions of Hawrelak Park are located within the City of Edmonton's Flood Protection Overlay and within the flood way and flood fringe on Alberta's Flood Hazard Mapping (Figure 3, Appendix A).

2.2 Historic Conditions

Historical aerial photograph review was limited to a photograph series included in Stantec Consulting Ltd. (Stantec) (2014a) that spans the period 1950 to 2013. Recent Google Earth (2021) imagery spanning the period of 2004 to 2020, and City of Edmonton pictometry spanning from 2007 to 2021 was used to supplement the series. Historical aerial photographs show the following sequence of development. In 1950, much of Hawrelak Park was still undeveloped and naturally vegetated, with cutlines through the vegetation. The northeast portion of the park has been cleared and a gravel pit operation is visible. A road (present day Groat Road) is located to the east of the park and the Royal Mayfair Golf Club is present north of the park. The 1952 aerial photograph looked nearly identical to the 1950 photograph, with the main difference being more development (i.e., deeper hole) within the gravel pit; however, the gravel pit area had not expanded. In 1962, the gravel pit appears to be infilled and much of the park had been cleared of vegetation, with mainly perimeter forest and the two tree stands currently present between the ring road and lake remaining. Several ditches were also present on the west side of the park. In 1967, Hawrelak Lake is present along with the park's ring road and parking areas. The main parking area, service yard and area around the Main Pavilion appear to still be under construction. Hawrelak Park, then named Mayfair Park, officially opened on 01 July 1967 (MBAC et al. 2021). In 1970, the main parking lot, service yard and Main Pavilion are present, the rest of the park looks similar to the imagery from1967. In 1973, the park looks similar to how it did in 1970, except the boathouse and Picnic Shelter #3 are now present. There are also several trees present in the central grassy area. In 1980, the park appears to be unchanged since 1970. In 1985, a trail and gravel pad are present in the area of the present day Heritage Amphitheatre. In 1990, the Heritage Amphitheatre appears to be fully built. In 2001, the park remains similar in appearance as 1990; however, the Buena Vista/Hawrelak Park Footbridge is now present crossing the NSR to Buena Vista Park. In 2013, the playground adjacent to Picnic Shelter #3 is visible. The park remained unchanged from 2013 until 2021, when the Edmonton Community League Federation Pavilion was built.

2.3 Environmental Site Assessment

Stantec (2014) conducted two Phase I Environmental Site Assessments (ESAs) and one Phase II ESA in the period April – July 2014 in the eastern portion of Hawrelak Park and AECOM (2014) completed a Tier 2 Risk Assessment. More recently, Crimson Environmental Limited (Crimson) (Crimson 2021) conducted a Limited Phase II Environmental Site Assessment for the Hawrelak Park Maintenance Yard. A summary of these studies is provided below.

2.3.1 Phase 1 ESA (April 2014)

Stantec (April 2014) completed a Phase I ESA in April 2014 for an area comprising 7.94 ha in the eastern portion of the manicured turf area of the park (Plate 2.1). The study objective was to identify areas of potential environmental concern and/or liabilities associated with the site and/or adjacent properties due to current or historical land use.

Plate 2.1. Stantec's (April 2014) Phase I ESA 7.94 ha Study Area on the East Side of Hawrelak Park [Source: Stantec (April 2014)].

The scope of work for the Phase I ESA included a review of records, available environmental databases and previous environmental reports, interviews with persons having knowledge of the site and a site visit on 30 January 2014. Stantec (April 2014) noted three areas of potential concern:

- The previous use of the site for gravel mining and rock crushing operations and the configuration of the site at the time of the study suggested the potential presence of

imported fill within the site. The unknown quality of imported fill within the site represented an area of environmental concern.

- Three small hills, believed to be man-made, were present within the central portion of the study area. The unknown quality of imported fill used for the development of the landscaped hills represented an area of potential environmental concern.
- Hazardous materials may be present within Picnic Shelter #3 based on its age (circa 1975).

Stantec (April 2014) recommended that a Limited Phase II ESA be completed for the study area to investigate potential imported fill quality and to conduct another site visit under snow-free conditions to better assess the site for staining, stressed vegetation and dumping.

2.3.2 Limited Phase II ESA (May 2014)

Stantec (May 2014) completed a Limited Phase II ESA for an area comprising 0.45 ha of manicured turf immediately west of the existing playground in support of a proposed spray park (Plate 2.2). That study was commissioned to determine if the site contained impacted fill material associated with historical infilling of former gravel and rock crushing operations.

Plate 2.2. Stantec's (May 2014) Phase II ESA 0.45 ha Spray Park Study Area West of the Existing Playground [Source: Stantec (May 2014)].

Stantec's (May 2014) Limited Phase II ESA scope of work included completing public and private underground utility locates, advancement of eight boreholes to a maximum depth of 5.8 m (three of which were used to monitor groundwater), collection of soil samples

from each borehole, and analysis of soil samples for benzene, toluene, ethylbenzene, xylenes, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), salinity, partial size and metal concentrations. Borehole drilling and soil sampling investigations were conducted on 17 April 2014.

Laboratory analytical results from collected soil samples indicated that four metal concentrations (cobalt, nickel, hot water boron, arsenic) and four PAHs (anthracene, fluoranthene, phenanthrene, pyrene) exceeded the Alberta Tier 1 Guidelines (Stantec May 2014). Since a source of PAHs and metal impacts was not identified in Stantec's previous Phase I ESA (April 2014), the identified exceedances were expected to be from the presence of the imported fill (Stantec May 2014).

Stantec (May 2014) recommended that prior to development of the proposed spray park that fill material (up to three meters below ground) be removed and disposed of at an appropriate landfill and that native material below the fill should be analyzed for the presence of PAHs and metals once the fill has been removed. Alternatively, further assessment to delineate the impacts could be carried out prior to development. Following remediation of the area, Stantec (May 2014) recommended that a liner be installed around the site boundary to prevent potentially impacted surrounding fill material from re-impacting the site in the future.

2.3.3 Phase 1 ESA (July 2014)

Stantec (July 2014) completed a Phase I ESA in July 2014 in support of the proposed Edmonton Federation of Community Leagues (EFCL) 100 Anniversary Project (now called the Community League Plaza) for an area comprising 1.16 ha adjacent the southeast shore of Hawrelak Lake (Plate 2.3).

Plate 2.3. Stantec's (July 2014) Phase I ESA 1.16 ha EFCL 100 Anniversary Project Study Area on the East Side of Hawrelak Park [Source: Stantec (July 2014)].

As noted above for Stantec's April 2014 Phase I ESA, their scope of work was similar for this Phase I ESA, which comprised a review of records, available environmental databases and previous environmental reports, interviews with persons having knowledge of the site and a site visit on 22 May 2014.

Stantec (July 2014) identified one area of potential environmental concern for the proposed project area related to the previous use of the area for gravel mining and rock crushing operations. The configuration of the site suggested the potential presence of imported fill and the unknown quality of the imported fill represented an area of environmental concern. Further assessment was, therefore, recommended.

2.3.4 Tier 2 Risk Assessment (2014)

The City commissioned a Tier 2 Risk Assessment to evaluate Tier 1 soil non-compliances suspected to be related to the historical filling of gravel extraction and crushing operations within Hawrelak Park (AECOM 2014).

AECOM (2014) concluded that the risk assessment supported the overall conclusion that the trace levels of PAHs and metals in soil are not likely to result in any environmental impairment to the land or water within and around Hawrelak Park, and the human health protection objectives, embedded into the Tier 1 guidelines, can be considered to be met.

AECOM (2014) recommended that any excavated soil be tested to confirm its suitability for reuse. A copy of AECOM's report is provided in Appendix D1.

2.3.5 Limited Phase II Environmental Site Assessment (2021)

Crimson (2021, Appendix D2) conducted a Limited Phase II ESA of a portion of the Hawrelak Park maintenance yard to investigate the potential source of odours documented during the geotechnical investigation for the building expansion. Their study area was limited to the area immediately adjacent to the existing aboveground storage tanks (ASTs), which was also reported to be a former underground storage tank (UST) nest. The purpose of their investigation was to obtain soil quality data for a select list of petroleum hydrocarbon (PHC) constituents and/or lead at that location. Four boreholes were drilled on 22 July 2021 to approximate depths ranging between 3.0 and 7.3 meters below ground level. Collected soil samples were subjected to laboratory analytical testing. Data analysis resulted in no indication of any impact from either refined petroleum hydrocarbons or lead and no visual or olfactory indications of impacts were noted during the field investigations. Crimson (2021) determined that the odours detected by others were likely the result of operational fumes from the existing above ground storage tanks and recommended no further assessment was required. Crimson's full report is provided in Appendix D2.

3.0 ENVIRONMENTAL CONTEXT

3.1 Overview of Study Area and Adjacent Lands

Hawrelak Park is located on a river valley terrace on the east side of the North Saskatchewan River (NSR). The park is located on the west side of Groat Road south of the Royal Mayfair Golf Club and north of the Buena Vista/Hawrelak Footbridge (Figure 1, Appendix A). Hawrelak Park connects to Emily Murphy Park to the northeast and Buena Vista Park to the south, across the NSR, via the regional river valley trail system.

The EIA study area was defined at two scales: local and expanded. The local study area (LSA) comprises the lands within the Hawrelak Park boundaries and on the west extends into the river to capture park utilities on the riverbank and under the riverbed (Figure 1, Appendix A). The LSA comprises lands that have potential to be directly impacted by the proposed park renewal activities, permanently and temporarily. An expanded study area was established for assessment of some resources such as environmental sensitivities and wildlife movement. The expanded study area included adjacent river valley lands that are structurally connected bylaw lands and have potential to be indirectly (functionally) affected by the proposed project. The expanded study area is represented by the mapped extent of 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 the local study area. The majority of Hawrelak Park is mapped as 'high value' to the City. Lands where buildings, parking lots and Hawrelak Lake are located are mapped as 'low' to 'moderate value' to the City and could be restored to improve value. Lands around the perimeter of the park and adjacent to the NSR are mapped as having 'very high' to 'extremely high value' to the City. Beyond Hawrelak Park the river valley is predominantly 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 Updated (2021) Mapping

3.2.2.1 Methods

As requested by the ToR, using the 2021 site-specific vegetation data and mapping, we re-analyzed City of Edmonton's Environmental Sensitivities (2016) GIS layer for the study area. 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 2021 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 2021 mapped polygons. Scores were updated as shown in Table 3.1.

Table 3.1. Sensitivity Analysis Refinement

Where 2021 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.
Mixed Deciduous Mixed Shrubs (MD.1)	If not originally so, update to: Natural Vegetation ('AVegNat2' attribute) = 2 score; Non-Native Vegetation ('AVegNoNat1' attribute) = 0 score.
Mixed Deciduous Red-Osier Dogwood (MD.2)	If not originally so, update to: Natural Vegetation ('AVegNat2' attribute) = 2 score; Non-Native Vegetation ('AVegNoNat1' attribute) = 0 score.
Riparian (R)	If not originally so, update to: Natural Vegetation ('AVegNat2' attribute) = 2 score; Non-Native Vegetation ('AVegNoNat1' attribute) = 0 score.
Manicured (M)	If not originally so, update to: Non-Native Vegetation ('AVegNoNat1' attribute) = 1 score; Natural Vegetation ('AVegNat2' 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 per 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.

3.2.2.2 Description

Figure 5 (Appendix A) shows the results of the refined (2021) City of Edmonton environmental sensitivities within the LSA. The refined map increased the value of the northernmost island in Hawrelak Lake from 'moderate' to 'high value'. Part of the southernmost island also increased from 'high' to 'very high value'. A few small areas of the manicured portion of the park that were previously mapped as 'high' and 'very high value' were downgraded to 'moderate' and 'high value' respectively. No other noticeable changes to the environmental sensitivities mapping were noted.

3.3 Surface Water, Groundwater and Fish Habitat

3.3.1 Methods

Surface Water

Surface water in the project area was described based on examination of topographic maps and field observations. Available, relevant environmental assessments and background reports, including the recently completed "Hawrelak Lake Water Quality Feasibility Study" (Applied Ecological Services 2020, Appendix E) were also reviewed. Alberta's Fish and Wildlife Management Information System (FWMIS) (AEP 2021a) was also examined for mapped waterbodies and watercourses within the study area.

Groundwater

Groundwater within Hawrelak Park was described based on a review of available, relevant documentation including previously completed environmental assessments (ENC Testing Inc. 2015; Engineering Services 2012; AECOM 2014), geotechnical investigations [e.g., Engineering Services 2012 and Thurber 2021a (Appendix F)] and the recently completed Hawrelak Lake Water Quality Feasibility Study" (Applied Ecological Services 2020, Appendix E).

Fish Habitat

Fish habitat within the study area was described based on a desktop review of relevant environmental assessments (e.g., Pisces Environmental Consulting Services Ltd. 2015) and existing online data sources. FWMIS (AEP 2021a) was examined for records of fish or fish habitat inventories within the study area.

3.3.2 Description

Surface Water Bodies

Hawrelak Lake is the only surface water feature present within the LSA. Hawrelak Lake is located on the west side of Hawrelak Park and is approximately 5.1 ha in size with an approximate drainage area of 24.1 ha (Applied Ecological Services Inc 2020, Appendix E). Hawrelak Lake receives runoff from nearly all of Hawrelak Park; however, all surface water runoff from roadways, parking lots and turf outside the ring road enters stormwater basins that discharge into the NSR. A narrow, unmown vegetated buffer is present around most of the lake, but there are some stretches of the shoreline that have mown turf up to the water edge. Hawrelak Lake is susceptible to water quality issues (i.e., eutrophication) due to many physical factors: (1) it has a small drainage area, comprising mainly of managed turf; (2) the lake is shallow, only 1.5 m at its deepest point, which allows the water throughout the entire depth of the lake to be warm and sunlit during the summer months, creating ideal conditions for algae blooms; and (3) there is little connection to groundwater due to the clay liner present on the lake bottom (Applied Ecological Services Inc 2020, Appendix E). The lake bottom may be near the 1.5m groundwater level detected through boring near the southeast pond-stream area, but no evidence of a connection exists.

The lake receives chemical-laden surface water runoff from adjacent turf areas and from targeted chemical treatment prior to an annual triathlon swimming event; therefore, the lake water is considered contaminated and cannot be discharged into the NSR (Marc Boutin Architectural Collaborative Inc 2021, R. Dumont, *pers.comm.*), except under provincial approval. In the event lake levels become too high from significant precipitation events and pose a risk of flooding to the Main Pavilion or boat house, or to return water levels to normal levels after temporarily raising the levels by pumping water from the NSR for the triathlon swim event, lake water levels can be managed by using lake water to irrigate or to discharge to the NSR through an outfall (R. Dumont, *pers. comm*.). When a discharge to the NSR is required, there are two potential volume reduction procedures that can be used: 1) an emergency discharge directly into the North Saskatchewan River, as approved by the provincial government; or, if necessary, pumping water into two low lying depressions west of the lake (MBAC & PFS 2021), to be held while waiting for approval

from the Province. Once approved, the water is discharged from the depression to the river. With Provincial approval, after hosting the triathlon, the City also lowers the lake water level by discharging to the river after water quality parameters are acceptable.

Lake water is circulated within the park for aesthetic purposes only. Water enters an intake located in front of the boathouse, is pumped to a small, constructed wetland located approximately 155 m northeast of the southwest corner of the lake, and discharged into the wetland via an outfall. When full, the wetland discharges to a constructed creek, which flows back to the lake (R. Dumont, *pers. comm.*). The creek has a minimal amount of naturalized riparian habitat.

The NSR is located adjacent the west park boundary. A portion of the NSR is within the LSA to capture the park riverbank and water intake infrastructure. The riverbank and possibly some of the top-of-bank lands drain directly to the river.

Surface Drainage

Stormwater runoff in the park is managed by two separate systems which includes discharge to the North Saskatchewan River by way of four or five stormwater outfalls located within the LSA on the east riverbank (see examples in Plates 3.1, 3.2 and 3.3). All runoff from streets, parking lots, and turf outside of the perimeter (ring) road enters storm drains that discharge to the North Saskatchewan River (outfalls 27 and 25). Hawrelak Lake is separate from this and receives surface runoff only from adjacent turfed areas. Outfalls 26 and 28 are connected to the lake. In the infrequent event that lake dewatering is needed, regulatory approval is sought, supported by appropriate water quality data, and water is discharged to the river.

Plate 3.1. Hawrelak Park Stormwater Outfall 28 (existing outfall currently consists of a small pipe only; a headwall outfall will be constructed and the pipe repaired/replaced) on the East Bank of the NSR Upstream of the Pumphouse (12 May 2021).

Plate 3.2. Hawrelak Park Stormwater Outfall 25 (replace pipe; concrete outfall structure in good condition, no works required) on the East Bank of the North Saskatchewan River (12 May 2021)

Plate 3.3. Hawrelak Park Stormwater Outfall 26 (outfall used for lake discharge; needs to be cleaned (rock debris removed from inside the pipe), and the pipe repaired/replaced on the East Bank of the North Saskatchewan River (12 May 2021).

Groundwater

In 2011, City of Edmonton Engineering Services installed three (3) slotted 25 mm PVC standpipes during borehole investigations for a new retaining wall along the east side of Hawrelak Lake (Engineering Services 2012). Two weeks after the standpipes were installed groundwater levels were recorded at 1.4, 2.5 and 2.6 m below the ground surface. Five weeks after the standpipes were installed groundwater levels were recorded at 1.5, 2.5 and 2.6 m below the ground surface. Engineering Services (2012) noted that the observations noted at the project site were indicative of "perched" conditions, with water dominantly trapped in more permeable layers of fill or alluvial sand and gravel, overlying the low-permeability bedrock strata. Locally, groundwater levels at the project site are also expected to be governed by the adjacent lake levels (Engineering Services 2012).

In 2015, ENC Testing Inc installed nine (9) piezometric standpipes during borehole investigation for the Edmonton Federation of Community League's Plaza (ENC Testing Inc 2015). At the time of drilling all standpipes were dry with the exception of one standpipe which was located the closest to Hawrelak Lake. Seven to ten days later,

depending on the original installation date, recorded standpipe groundwater levels ranged from 2.15 to 6.7 m below the ground surface (ENC Testing Inc 2015).

As part of a Tier 2 Risk Assessment for Hawrelak Park, AECOM (2014) compiled data from all City of Edmonton groundwater monitoring wells installed throughout the east half of the park. The depths to the water table varied from 4.73 m toward the north portion of the investigated area to 1.56 m close to Hawrelak Lake. Depending on the geographic location in the park, the water table lies either within the shallow bedrock (southern portion) or sand and gravel units (northern portion) (AECOM 2014).

Thurber (2021a; Appendix F) measured groundwater levels at 18 standpipe piezometers in June and July 2021 and determined that short-term groundwater levels varied at depths between 1.3 m and 7. 9 m below the existing ground surface across the park. The highest ground water levels were observed in the test holes located closest to Hawrelak Lake.

Fish Habitat

Hawrelak Lake is the only potential fish habitat within the park. FWMIS (AEP 2021a) records indicate that the lake was stocked with rainbow trout and yellow perch until 1984. The University of Alberta found Ciclids within the lake during a survey using trap nets, minnow traps and dip nets on 15 September 2003. However, surveys conducted by the University of Alberta in the fall of 2007 found no fish within the lake (AEP 2021a). Persistent water quality issues in the lake may make it uninhabitable to fish.

The NSR reach in the LSA is known to be fish habitat. Pisces Environmental Consulting Services Ltd. (Pisces) (2015) conducted a streambank and channel assessment of the NSR adjacent to the park in 2015. At that time, the NSR streambank adjacent Hawrelak Park comprised trees and shrubs with minimal exposed surface present. The NSR streambed comprised fines, cobble and boulder material. Cover for fish was mainly provided by boulders, aquatic vegetation and small amounts of woody debris. Mean water depths ranged between 1.0 to 1.2 m (Pisces 2015). A fish assessment conducted in 2016 (AEP 2021a) in the river reach adjacent to the park found white sucker (*Catostomus commersonii*), silver redhorse (*Moxostoma anisurum*), trout-perch (*Percopsis omiscomaycus*), mooneye (*Hiodon tergisus*), longnose sucker (*Catostomus catostomus*), quillback (*Carpiodes cyprinus*), river shiner (*Notropis blennius*), walleye (*Sander vitreus*), emerald shiner (*Notropis atherinoides*), northern pike (*Esox lucius*) and shorthead redhorse (*Moxostoma macrolepidotum*).

3.4 Geomorphology, Geology and Soils

3.4.1 Methods

LSA geomorphology was described based on site observations and by referring to conditions described in MBAC & PFS (2021). Descriptions of geology and soils within Hawrelak Park also drew from available, relevant environmental site assessments. In addition, for this final report version, information was gleaned from select sections of Thurber Engineering (2021a) detailing geotechnical investigations completed in support of park rehabilitation detailed design, and Thurber (2021b), a desktop geotechnical study

prepared in support of stairway replacement west of Groat Road . Both Thurber reports are provided in Appendices F and G.

3.4.2 Description

Hawrelak Park is situated on a low-level terrace on the right bank of the North Saskatchewan River. The surficial geology consists of alluvial deposits, of clay, silt, sand, and gravel (fining upwards) overlying Cretaceous bedrock of the Edmonton Group (Thurber Engineering 2021a).

Geomorphology in the LSA is generally flat, reflective of its position in a historic floodplain. Park elevations range from about 620 m to 636 m and in general, the site slopes downward from the northeast corner to the southwest corner (Thurber 2021a). Generally, lands inside the park's perimeter road slope from east to west at ~ 1.5%, which conveys drainage overland to Hawrelak Lake (MBAC & PFS (2021). Outside of the perimeter roadway, grades in the LSA natural and naturalized areas are much steeper, often exceeding 15% and reaching as high as 40%. Particularly steep slopes are on the east park boundary, below Groat Road, and at the east riverbank (Figure 2, Appendix A and Plate 3.4). Existing developed park topography is reflective of the site's historic land use as a gravel extraction area and subsequent contouring to create the existing park features. Within the park some local, mounded features are present (e.g., at the playground) and the lake represents a topographic depression averaging ~ 1.0 m lower than adjacent turfed areas.

Plate 3.4. View Downstream from the Buena Vista/Hawrelak Park Footbridge of the Steep East Riverbank in Hawrelak Park (12 May 2021).

In 2011, City of Edmonton Engineering Services advanced three (boreholes) near the retaining wall on the eastern shore of the lake for a retaining wall replacement project

(Engineering Services 2012). Boreholes encountered variable thicknesses of clay fill, underlain by alluvial deposits of clay or sand. Clay shale bedrock was encountered below the alluvial deposits in two boreholes and directly below the clay fill in one borehole, commencing at depths of 2.0 to 3.6 m below ground surface, corresponding to elevations between 620.3 m and 621.8 m.

In 2015, ENC Testing Inc. advanced nine (9) test holes in support of the Edmonton Federation of Community League's Plaza (ENC Testing Inc. 2015). Test holes encountered an organic, black topsoil to depths of 0.1 to 0.9 m below ground surface. Sandy, low to medium plastic clay fill with coal, sandstone and gravel was found underlying the topsoil to depths of 0.9 to 3.4 m below soil surface. Clayey, gravel with organics was found in three of the nine test holes to depths of 0.9 to 2.4 m below ground surface. Silty, high plastic clay shale with coal inclusions was found in all test holes under the fill layer to depths between 5.8 and 8.8 m below ground surface. Clayey, medium to high plastic sandstone was found in all but one test hole to depths between 2.7 and 7.3 m below ground surface (ENC Testing Inc. 2015).

As part of a Tier 2 Risk Assessment for Hawrelak Park (see description in Section 2.3.4), AECOM (2014; Appendix D1) reviewed and interpreted data from geological logs produced by the City of Edmonton (1993), AGRA (1996 and 1997) and Stantec (April and May 2014) and simplified their findings into a single stratigraphy column for Hawrelak Park. Topsoil can be found at the surface, underlaid by fill characterized as primarily clay with depth varying significantly from 0.2 m to 3 m. Sand with some areas of silt can be found at varying depths below the fill, depth gradients increase toward the north and northeast. Sand has not been identified in the south portions of the park. Gravel and sand are predominantly identified as a basal unit below the sand and above the bedrock. Bedrock, comprising clay shale and sandstone, is encountered at variable depths ranging from 0.9 m in the south portions of the park to 10 m in the northeast (AECOM 2014).

In 2020, as part of the Hawrelak Lake Water Quality Feasibility Study (Applied Ecological Services 2020) geology and soils were generally described within the park. Surface soil was described as clay fill (20 cm to 3 m depth) over alluvial sands, gravels, and clays. Bedrock was close to the land surface in the south part of the park and 10 m below the surface in the north. Soil texture was either loam or clay loam and had an average phosphorus of 1171 mg/kg and average total Kjeldahl nitrogen of 7172 mg/kg.

Thurber (2021a) advanced numerous boreholes throughout the park, siting boreholes to overlap with proposed project activity locations. This study represents the most current and detailed description of park soils. At the park scale, Thurber indicated that subsurface soils at the drilled locations consisted of following main soil types, in descending order:

- Asphalt (under roadways and parking lots)
- Topsoil (under landscaped areas)
- Fill (Clay, Sand and Gravel)
- Clay and Silt
- Sand and Gravel

- Clay Till
- Bedrock (Clay Shale, Siltstone, Sandstone, Coal and Bentonite Layers).

A topsoil layer ranging from 40 mm to 610 mm in thickness was encountered below existing ground surface at the test hole locations in the landscaped areas and natural areas. Topsoil may be thicker or thinner between test holes.

Thurber's (2021b; Appendix G) desktop study and site reconnaissance in support of east stairway replacement determined that the general site geology on the valley slopes bordering the southeast corner of the park comprised a surficial colluvium deposit overlying, glacial till with interbedded sand and gravel deposits, overlying Upper Cretaceous clay shale and sandstone bedrock of the Horseshoe Canyon Formation. The colluvium deposits were expected to consist of a mixture of clay and clay till deposits resulting from previous slope movements. Thurber (2021b; Appendix G) noted that fills could have been placed on the slope during the original Groat Road construction. The expected depth to bedrock ranged from about 10 m to 30 m below existing grade and that bedrock underlay the base of the slope at the staircase location. In addition, Thurber (2021b) found the slopes were relatively uniform, well drained and there were no signs of recent slope instability or slope erosion. There was evidence of an old shallow landslide at the staircase location; however, that appeared to have resulted from the original Groat Road grading and appeared to have either stabilized naturally or by slope reconstruction, such that there is little evidence of the landslide at the current staircase location (Thurber 2021b; Appendix G).

Potential for soil contaminants to be present is described in Section 2.3.

3.5 Vegetation

3.5.1 Methods

Vegetation in the local study area was characterized by undertaking the following tasks:

- Preliminary plant community desktop delineations using high-resolution remote imagery.
- Plant communities were classified following the *Urban Ecological Field Guide for the City of Edmonton, Alberta, Canada* (City of Edmonton 2015). Manicured open spaces were classified as such.
- A search of the Alberta Conservation Information Management System (ACIMS) (AEP 2021b) for all records of special status plant species within the project area. Site accessed on 15 September 2021. The area searched consisted of legal section 36-52- 25-W4M.
- Site reconnaissance on 20 October 2020 to photograph and verify mapped plant communities.
- Plant community inventory and rare plant survey conducted on 21 July 2021 to characterize communities and identify occurrences of rare plants. Representative sites were photographed, and location of rare plants were marked using a GPS. A complete species list is available 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).

3.5.2 Description

Hawrelak Park is primarily manicured park lands with open space trees. Natural forest stands exist around the park's perimeter, as well as between the park's ring road and the west side of Hawrelak Lake. Five plant communities were mapped in the local study area during the 21 July 2021 plant community inventory and rare plant survey (Figure 6, Appendix A):

- Deciduous Mixedwood Mixed Shrubs (DLM.1)
- Mixed Deciduous Mixed Shrubs (MD.1)
- Mixed Deciduous Red-Osier Dogwood (MD.2)
- Riparian (R)
- Manicured (M)

3.5.2.1 Deciduous Mixedwood Mixed Shrubs (DLM.1)

The deciduous mixedwood mixed shrubs community is native forest and was characterized as having an overstorey comprising trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*) and white spruce (*Picea glauca*) with smaller amounts of Manitoba maple (*Acer negundo*). The overstorey was approximately 20 to 25 m in height. The shrub layer was dense (Plate 3.5) and comprised saskatoon (*Amelanchier alnifolia*), red-osier dogwood (*Cornus stolonifera*), beaked hazelnut (*Corylus cornuta*), choke cherry (*Prunus virginiana*), prickly rose (*Rosa acicularis*), common wild rose (*Rosa woodsii*), wild red raspberry (*Rubus idaeus*), red elderberry (*Sambucus racemosa*), buckbrush (*Symphoricarpos occidentalis*) and small European mountain-ash (*Sorbus aucuparia*) trees all occurring occasionally throughout the community. The herbaceous understorey comprised red and white baneberry (*Actaea rubra*), wild sarsaparilla (*Aralia nudicaulis*), sweet-scented bedstraw (*Galium triflorum*), wild lily-of-the-valley (*Maianthemum canadense*), star-flowered Solomon's seal (*Maianthemum stellatum*), veiny meadow rue (*Thalictrum venulosum*) and western Canada violet (*Viola canadensis*) all occurring occasionally. The exotic species smooth brome (*Bromus inermus*) and common dandelion (*Taraxacum officinale*) were also found occasionally in the herbaceous layer but were more commonly found along the forest perimeter. The prohibited noxious weed common buckthorn (*Rhamnus catharticus*) was found in small numbers along the forest edges of this community. The noxious weed species woolly burdock (*Arctium tomentosum*) and creeping thistle (*Cirsium arvense*) were found scattered throughout this community with larger numbers present along forest edges.

Overall, this plant community had a species richness of 38, of which 27 were native species, 8 were exotic species and 3 were prohibited noxious/noxious species.

Vegetation on the two islands in Hawrelak Lake was also characterized as a deciduous mixedwood mixed shrubs community through a visual inspection from the lakeshore only.

The islands were not visited; therefore, a rare plant survey was not completed on the islands.

Plate 3.5. Deciduous mixedwood mixed shrub community with a dense shrub understorey (21 July 2021).

3.5.2.2 Mixed Deciduous Mixed Shrubs (MD.1)

The mixed deciduous mixed shrubs community is also forest and had a canopy that was approximately 15 m tall and dominated by balsam poplar, trembling aspen and Manitoba maple with lesser amounts of white spruce, blue spruce (*Picea pungens*), amur maple (*Acer ginnala*) and ponderosa pine (*Pinus ponderosa*) (Plate 3.6). The understorey canopy comprised a dense shrub layer of several different species including saskatoon, red-osier dogwood, morden hawthorn (*Crataegus mordensis*), honeysuckle (*Lonicera sp.*), Siberian crab apple (*Malus baccata*), choke cherry, prickly rose, common wild rose, wild red raspberry and, buckbrush and high-bush cranberry (*Viburnum opulus*). Of these shrub species, buckbrush was most commonly found in this community. The herbaceous layer was dominated by the exotic grass smooth brome with the native species wild sarsaparilla, common fireweed (*Chamerion angustifolium*), northern bedstraw (*Galium boreale*), cow parsnip (*Heracleum maximum*), wild lily-of-the-valley, star-flower Solomon's seal, tall goldenrod (*Solidago altissima*), veiny meadow rue and western Canada violet also occurring occasionally. The prohibited noxious weed common buckthorn was found scattered throughout this community with most individuals located on forest edges. The noxious weeds creeping thistle, woolly burdock and perennial sow-thistle (*Sonchus arvensis*) were all observed scattered throughout this community.

Overall, this plant community had a species richness of 43, of which 25 were native species, 14 were exotic species and 4 were prohibited noxious/noxious species.

Plate 3.6. Mixed deciduous mixed shrub community with dense shrub understorey (21 July 2021).

3.5.2.3 Mixed Deciduous Red-Osier Dogwood (MD.2)

The mixed deciduous red-osier dogwood community, also forest, was characterized as having an overstorey comprising trembling aspen, balsam poplar and Manitoba maple with lesser amounts of white birch, white spruce, blue spruce, ponderosa pine, white willow (*Salix alba*) . Amur maple also present. The shrub layer was dense and dominated by red-osier dogwood (Plate 3.7) with many other shrub species also present including saskatoon, beaked hazelnut, cotoneaster (*Cotoneaster sp*.), morden hawthorn, honeysuckle, Siberian crab apple, choke cherry, burr oak (*Quercus macrocarpa*), prickly rose, common wildrose, wild red raspberry, buckbrush, European mountain-ash, low-bush cranberry (*Viburnum edule*) and high-bush cranberry. The exotic shrub species common caragana (*Caragana arborescens*) formed some small patches in this community, particularly along the river on the west side of the park. The herbaceous layer was dominated by the exotic grass smooth brome with the native species spreading dogbane (*Apocynum androsaemifolium*), wild sarsaparilla, common fireweed, showy aster (*Eurybia conspicua*), northern bedstraw, wild lily-of-the-valley, star-flowered Solomon's seal, Kentucky bluegrass (*Poa pratensis*), tall goldenrod, veiny meadow rue, wild vetch (*Vicia americana*) and western Canada violet. Some exotic species such as quackgrass (*Elymus repens*), hemp-nettle (*Galeopsis tetrahit*), common dandelion and alsike clover (*Trifolium hybridum*) were also found occasionally in the herbaceous layer of this community. The prohibited noxious weed common buckthorn was found scattered throughout this community with most individuals located

on forest edges. The noxious weeds creeping thistle, woolly burdock, perennial sow-thistle and Dalmatian toadflax (*Linaria dalmatica*) were all observed scattered throughout this community.

Overall, this plant community had a species richness of 67, of the identified species 35 were native species, 25 were exotic species and 5 were prohibited noxious/noxious species.

Plate 3.7. Mixed deciduous red-osier dogwood community with dense shrub layer dominated by red-osier dogwood (21 July 2021).

3.5.2.4 Riparian (R)

Riparian communities are not characterized as part of City of Edmonton (2015). Riparian communities are situated around water bodies and watercourses and generally comprise moisture-loving vegetation on moist soils. Within the LSA, riparian communities were found around Hawrelak Lake, the constructed wetland and creek channel that discharge into the lake. Within the riparian community an overstorey was only present along the channel (Plate 3.8) and along some portions of the lake shoreline where open space trees are present (Plate 3.9). Overstorey tree species included balsam poplar, white spruce, white birch, amur maple and willow (*Salix sp.*). A shrub layer was found in the riparian community around the wetland (Plate 3.10), channel and some areas around the lake. Shrub species included red-osier dogwood, prickly rose, beaked willow (*Salix bebbiana*) and narrow-leaf willow (*Salix exigua*). The herbaceous layer comprised many different species including water sedge (*Carex aquatilis*), awned sedge (*Carex atherodes*), small bottle sedge (*Carex utriculata*), northern willowherb (*Epilobium ciliatum*), hemp-nettle, meadow crane's-bill (*Geranium pratense*), foxtail barely (*Hordeum jubatum*), pineapple weed (*Matricaria discoide*a), white sweet-clover (*Melilotus alba*), wild mint (*Mentha arvensis*),

pale persicaria (*Persicaria lapathifolia*), reed canary grass (*Phalaris arundinacea*), common plantain (*Plantago major*), Kentucky bluegrass, American golden dock (*Rumex fueginus*), common great bulrush (*Schoenoplectus tabernaemontani*), annual sow-thistle (*Sonchus oleraceus*), common dandelion and common cattail (*Typha latifolia*) all occurring either frequently or occasionally. Some riparian areas around Hawrelak Lake were mown to the water's edge (Plate 3.9) and other areas contained considerably more vegetation (Plate 3.11) The prohibited noxious weed purple loosestrife (*Lythrum salicaria*) was found scattered along the shore of the lake with the highest concentration between the sandy beach area and the main pavilion. The noxious weed species woolly burdock, creeping thistle, white cockle (*Silene latifolia*), perennial sow-thistle, common tansy (*Tanacetum vulgare*) and scentless chamomile (*Tripleurospermum inodorum*) were all observed scattered throughout this community.

Overall, this plant community had a species richness of 57, of the identified species 31 were native species, 16 were exotic species and 7 were prohibited noxious/noxious species.

Plate 3.8. Riparian community along the creek channel with trees present (21 July 2021).

Plate 3.9. View to south of riparian community along west side of Hawrelak Lake with some open space trees present (21 July 2021).

Plate 3.10. View to west of riparian community around the constructed wetland at the headwaters of the constructed creek (23 July 2021).

Plate 3.11. View to south of riparian community along west side of lake that has not been mown (21 July 2021).

3.5.2.5 Manicured (M)

Manicured areas are those subject to regular mowing or maintenance and supporting open space trees (Plate 3.12). They are characterized by grassy areas and planted open space trees, as well as areas where original cover has been maintained but severely thinned. Open space trees were scattered throughout Hawrelak Park. The manicured community was not subject to a comprehensive plant community survey or rare plant survey as it is not a natural community and the likelihood of rare plants being present is low. Planted open space tree species included white spruce, blue spruce, lodgepole pine (*Pinus contorta*), jack pine (*Pinus banksiana*), Scots pine (*Pinus sylvestris*), white willow, morden hawthorn, green ash (*Fraxinus pennsylvanica*), Siberian crab apple and white oak (*Quercus alba*) (Ecofor Consulting Ltd. 2020). Turf areas comprised mostly of grass species such as Kentucky bluegrass (*Poa pratensis*), quack grass (*Elymus repens*) and smooth brome. Common dandelion (*Taraxacum officinale*), an exotic forb species, was also found occasionally in the turf area. Creeping thistle (*Cirsium arvense*), a noxious weed, was also observed scattered throughout this community.

Plate 3.12. Typical manicured open space community comprising the majority of Hawrelak Park (20 October 2020).

3.5.2.6 Special Status Species

In the City of Edmonton, rare plant species are considered those having an ACIMS conservation rank of S1, S2 or S3. S1 species are known from five or fewer locations in the province. S2 are species known from 6-20 occurrences, and S3 species are known from 21-100 occurrences in the province. A search of ACIMS data conducted on 15 September 2021 returned no records of special status vascular plant species in the LSA. A review of past Spencer Environmental projects in the LSA found an observation of one rare plant, tall meadow rue (*Thalictrum dasycarpum*; S3), along the west edge of the park near the boat dock in 2015. Two rare plant species, common ragweed (*Ambrosia artemisiifolia*; S3) and northern water-horehound (*Lycopus uniflorus*; S3), were observed during the 21 July 2021 rare plant survey. Both species were found in the riparian community around Hawrelak Lake. A description of these species and its occurrences is provided in the following sections.

Tall Meadow Rue (Thalictrum dasycarpum)

Tall meadow rue is a tall forb in the buttercup family (Ranunculaceae). It is characterized by three-lobed leaflets that are longer than broad and are hairy on the undersides (Moss 1981). The fruits are also typically hairy. Tall meadow rue has only been observed in the Central Parkland subregion of Alberta near Edmonton. It is found in damp meadows and thickets. In the project area, it was observed in the mixed deciduous red-osier dogwood community. It occurred as a single, isolated cluster of three or four individuals in a moist, shaded area with a high canopy and relatively open shrub layer (330653N 5934125E) (Figure 6, Appendix A).

Common Ragweed (Ambrosia artemisiifolia)

Common ragweed is an upright annual herbaceous plant in the aster family (Asteraceae). It is characterized by rough hairy foliage that is greyish-green in colour (Saskatchewan Wildflowers 2021). Male flowers are yellow and in terminal spikes that droop downwards; female flowers are located in the leaf axils and can be single or in clusters. Leaves are all cauline, petiolate, broadly ovate, pinnately twice-divided into narrow lobes. Leaves divided almost to the midrib (Plate 3.13). Common ragweed is found on roadsides and disturbed sites (Saskatchewan Wildflowers 2021). It occurred as a single individual on the southwest edge of Hawrelak Lake (330925N 5933883E) (Figure 6, Appendix A).

Plate 3.13. Common ragweed showing leaves divided nearly to the midrib (21 July 2021).

Northern Water-Horehound (Lycopus uniflorus)

Northern water-horehound is a perennial rhizomatous herb in the mint family (Lamiaceae). It is characterized by opposite leaves with margins coarsely and irregularly toothed and clusters of white flowers located in the leaf axils (Plate 3.14) (E-Flora BC 2021). Northern water-horehound can be found in marshes, fens and along the shorelines of lakes and streams (E-Flora BC 2021) and can be found throughout central and northern Alberta

(ABMI 2021). It occurred as many individuals along the northeast shoreline of Hawrelak Lake (331078N 5934172E) (Figure 6, Appendix A).

Plate 3.14. Northern water-horehound showing opposite coarsely toothed leaves and white flower clusters in the leaf axils (21 July 2021).

3.5.2.7 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 these species 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

Two prohibited noxious weed species were found within Hawrelak Park, common buckthorn and purple loosestrife.

Common buckthorn is widespread throughout Edmonton's river valley. Seeds of common buckthorn germinate readily in disturbed soils. Common buckthorn can be controlled using

herbicides, burning, hand pulling and flooding (Alberta Invasive Species Council 2014a); however, as with many invasive species, control is difficult and may require a multi-year effort. Common buckthorn was found scattered throughout Hawrelak Park, particularly along forest edges (Figure 7, Appendix A and Plate 3.15).

Plate 3.15. Common buckthorn growing on a forest edge in Hawrelak Park (21 July 2021).

Purple loosestrife is a hardy perennial of freshwater habitats and can be found in some wetlands in the Edmonton area. Purple loosestrife has tremendous reproductive capacity. Seedlings quickly develop a strong taproot from which new shoots arise annually. Stems increase in number each year – mature plants can have 30 to 50 stems per rootstock. Plants bloom throughout the growing season and a single plant can produce more than a million seeds each year (Alberta Invasive Species Council 2014b). Hand pulling young plants is

easily done and can eradicate small infestations. Herbicides are the most efficient method to eradicate larger infestations (Alberta Invasive Species Council 2014b). Control is difficult and will require a multi-year effort. Within Hawrelak Park, purple loosestrife was found scattered along the shoreline of the lake (Figure 7, Appendix A and Plate 3.16), particularly in more disturbed areas near the pavilion and sandy beach area.

Plate 3.16. Purple loosestrife (foreground and background) found along the edge of Hawrelak lake (21 July 2021).

Noxious Species

Seven noxious weed species were found in Hawrelak Park, woolly burdock, creeping thistle, dalmatian toadflax, white cockle, perennial sow-thistle, common tansy and scentless chamomile. Woolly burdock, dalmatian toadflax and perennial sow-thistle were

all found scattered throughout the park, with higher numbers occurring along forest edges alongside pathways and roadways/parking areas. White cockle, common tansy and scentless chamomile where found scattered in the riparian areas along the lakeshore and creek channel. Creeping thistle was the most abundant noxious weed species present in Hawrelak Park. It occurred throughout the park, with higher densities along forest edges adjacent to pathways and roadways/parking areas, along the lakeshore and in other disturbed areas (i.e., around buildings, playground, flower beds, etc.). Two larger, infestations of creeping thistle were noted during the 21 July 2021 plant community and rare plant survey (Figure 7, Appendix A): 1) located along the park's northern boundary, near the park entrance (Plate 3.17); and 2) located along the western shoreline of the lake (Plate 3.18).

Plate 3.17. Creeping thistle infestation near park entrance (21 July 2021).

Plate 3.18. Creeping thistle infestation along western lakeshore (21 July 2021).

3.7 Wildlife

3.7.1 Field Investigations

There were no documented wildlife observations from studies in the past three to five years available in support of this EIA, therefore, as recommended by the project-specific EIA ToR (Appendix B) for the proposed park renewal project, a comprehensive suite of wildlife surveys was completed in spring and summer 2021 during the preliminary design phase of the project. Those surveys included:

- Amphibian surveys (frogs/toads and western tiger salamander)
- Breeding bird survey of upland habitat
- Waterbird surveys of Hawrelak Lake
- Wildlife habitat survey (e.g., nests, dens, hibernacula, etc.)
- Wildlife connectivity ground-truthing / verification of the City of Edmonton's Environmental Sensitivities desktop-based connectivity mapping (mapping of likely wildlife movement corridors based on habitat, topography, adjacent human activity, wildlife observations, etc.)

The purpose of these investigations was to supplement incidental wildlife observations in the LSA and determine locations of significant wildlife habitat, wildlife populations, and movement corridors to inform project design. Methods for each of the surveys conducted in the LSA are provided below. All surveys were conducted by qualified professional biologists.

3.7.2 Methods

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

- Conducting two auditory breeding amphibian surveys at Hawrelak Lake on 05 May 2021 and 02 June 2021.
    - Two survey points were established at Hawrelak Lake (Figure 8a, Appendix A). The selected survey points enabled a survey of the entire lake as, under survey conditions, frog/toad calls were verified as audible up to 500 m distant.
    - Two surveys were conducted at each point, the first on 05 May 2021, within this region's peak wood frog and boreal chorus frog calling period. The second survey occurred on 02 June 2021, within this region's peak Canadian toad and western toad calling period and overlapping the latter part of the boreal chorus frog calling period. In this region, wood frog calling tends to subside by late May.
    - Survey order of stations was reversed for the second survey to account for potential time of day bias between stations.
    - Auditory surveys generally followed the methods recommended in the Alberta Volunteer Amphibian Monitoring Program (AVAMP; ACA and ASRD 2010) as follows:
        - All auditory amphibian surveys were performed between one half-hour after sunset and 1:00 AM, in weather conditions that would not

inhibit amphibians from calling or the surveyor from hearing calls (i.e., calm winds, no rain, temperature >5°C).
- The surveyor remained silent and still for one minute upon arrival at the survey location allowing any frogs/toads present to recover from any disturbance associated with the surveyor's approach.
- The surveyor then proceeded to listen for five minutes, recording all amphibian species heard and an estimate of each species' abundance using the following AVAMP call level codes:
  - 1 = individuals can be counted, no overlapping calls (approximately 1-3 animals)
  - 2 = individuals can be counted, some calls overlap (approximately 4-7 animals)
  - 3 = individuals cannot be counted, full chorus, calls overlapping (>8 animals)
- Amphibians observed incidentally (i.e., outside of auditory breeding amphibian surveys) were noted along with other incidental non-amphibian wildlife observations.

- Conducting a series of surveys to characterize Hawrelak Lake's existing aquatic vertebrate community, in conditions at least 2+ years post the last significant water quality management activities, with a focus on western tiger salamander.
  - Conducting one adult salamander spotlight survey on the evening of 05 May 2021 in combination with the above-noted auditory amphibian survey.
    - Two surveyors each used a Mastercraft 5W/280 Lumens waterproof LED spotlight to search the west Hawrelak Lake shoreline vegetation and water for adult salamanders between amphibian call station #1 at the north end of the lake and station #2 at the south end of the lake (Figure 8a, Appendix A).
    - Additional vegetated shoreline and lake water was searched between station #2 and the boat pavilion.
    - Each surveyor scanned the water along the shoreline and into the lake within each spotlight's range (approx. 3-4 m).
    - Lake levels were low due to dry spring conditions and bottom sediment and detritus were easily visible, including aquatic insects and leeches.
    - Surveyors hopscotched around each other to ensure full coverage of the length of the survey area and to minimize overlap and bright light impacts to wildlife (e.g., muskrat, Canada geese, waterbirds)
    - The creek was not actively flowing into the lake and was dry until just upstream of the footbridge to the Community League Plaza where creek water was pooled.

  - Conducting three salamander larval dip net surveys at Hawrelak Lake on 18 June 2021 (Survey #1), 23 June 2021 (Survey#2) and 30 July 2021 (Survey #3).

- Larval surveys were undertaken from the lakeshore, using dipnets to sweep the shallow-water, nearshore habitat. Surveyors did not enter the lake owing to the soft lake bottom, which had potential to entrap boots and poor water quality. In addition, walking in the water would have stirred up mud, reducing visibility. Surveyors wore latex gloves in the event they needed to handle larvae.
- The survey focussed on a ~180 m length of the south lakeshore, which was qualitatively assessed to be the highest quality salamander larvae habitat. Eleven (11) sampling stations were established at 15 m intervals along the south shoreline (Figure 8a, Appendix A). At each station, sampling consisted of a visual sweep of the water column and substrate within 2 m of the shore, followed by three (3) to five (5) dipnet passes through the water column and into the top 1-2 cm of substrate, covering approximately 2-3 m^2. Each pass began ~ 1 m from the shoreline and moved down and then toward the shore. Sweeps included passing under overhangs where present and near/under organic debris such as logs. After each pass, the contents of the net were inverted into a bucket, species, life history stage, and number of individuals captured were recorded and representative specimens photographed. Incidentally captured invertebrate species were identified to either order, family or genus and photographed when possible. All material was returned to the lake before leaving each station. The total # of sweeps per station was recorded.
- The remainder of the lake was sampled at a lower intensity at five (5) additional stations, established at ~ 150 m intervals, and field located, targeting the best habitat in that locale (Figure 8a, Appendix A) and using the same dipnet methods.
- All 16 survey stations were sampled during Surveys #1 and #2.
- Survey #3 sampled stations 1-3, 15, 16 and the constructed wetland. The remainder of the stations around the lake were disturbed and inaccessible due to mechanical weed operations occurring in the lake in preparation for the upcoming international triathlon.

- Conducting one snake hibernaculum survey of appropriate habitat in the LSA 12 May 2021.
  - The purpose of the survey was to determine whether there was evidence of snake habitat use indicating the potential presence of an occupied hibernaculum along the southwest facing riverbank and adjacent slopes along the west side of the LSA and Hawrelak Park (Figure 8a, Appendix A). Spencer Environmental's search protocol was based on provincial survey methods (Government of Alberta 2013) and communications with provincial experts.
  - The two surveyors conducted transects parallel with the river in areas that were safely accessible along the riverbank and at the top-

of-bank between the Buena Vista/Hawrelak Footbridge and Outfall #27 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).

- The survey 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 (K. Kendell p*ers. comm*.). Specifically, features surveyed included southwest facing slopes, outfall structures, pumphouse, riprap and infrastructure at the boat dock development. Surveyors looked for evidence of snake presence (e.g., dead or alive snakes, shed skins). If snakes and/or a hibernaculum were observed, the surveyors noted location, species and behaviour.

- Conducting one breeding bird survey in the LSA on 22 June 2021, at 0445 hours. One, 100 m wide, 5000 m long, fixed width transect (Figure 8b, Appendix A) was surveyed. The transect was walked slowly at a rate of 15-to-20 m per minute and all birds detected within a distance of 50 m on either side of the transect were recorded. The temperature at the time of the survey was 11°C. All birds seen or heard within the transect were recorded and estimated bird locations were mapped within the survey area.

- Conducting two visual waterbird surveys of Hawrelak Lake on 08 June 2021 (breeding) and 29 June 2021 (broods).
  - Hawrelak Lake was visited between 30 minutes before sunrise and 10:00 a.m. on both survey dates during the spring breeding season. All open water and immediately adjacent upland areas were visually scanned from six vantage points using binoculars (Figure 8b, Appendix A).
  - Surveys were conducted only during suitable weather conditions (i.e., no heavy precipitation, calm to light winds). The length of each survey period varied according to the length of time required at each vantage point to thoroughly scan the lake.
  - All waterbirds observed were identified to species and the abundance of each species recorded; vocalizations of unseen birds were also used to count and identify species. Waterbirds that were observed only flying over were noted as such, as they were not necessarily using the habitat at the site. Waterbirds incidentally observed at the site (i.e., outside of the formal survey period) were noted as such along with any other non-waterbird wildlife observed.
  - The sex (male/female), social grouping (mated pair, single, or grouped), and age (adult/juvenile) were recorded for each bird observed to the extent that could be confidently determined by the surveyor based on the evidence

available in the field. Any additional indicators of breeding behavior such as brood size, nesting, or courtship displays were also documented to help assess the quality of breeding habitat present.

- Inspecting buildings for evidence of bat use/guano.
- Visually surveying the LSA on 22 June 2021for the presence of wildlife trees.
- Documenting incidental wildlife and wildlife sign observations in the LSA 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 LSA. FWMIS was accessed on 15 September 2021 (AEP 2021a).
- 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 American Ornithological Society's 2020 Checklist (birds) (Chesser et. al. 2020) and the Government of Alberta's 2015 Wild Species Status List (mammals, amphibians, reptiles).

3.7.3 Description

3.7.3.1 Available Habitat, Observed and Potential Wildlife

Habitat in the river valley LSA is a matrix of developed parkland comprising patches of mature mixedwood forest, open park spaces (manicured turf and planted trees) and an anthropogenic lake. If found in functional, sizeable patches, the mixedwood forest generally provides high quality habitat for a wide variety of wildlife species. In the LSA, those areas of natural, mature trees and shrubs around the margins of Hawrelak Park, along with topographic variation along the riverbank, offer high-quality complex vertical and horizontal habitat structure and effective security cover. This area of the river valley also enjoys relatively strong structural connectivity to habitat to the north and south along the east and west sides of the river. The large manicured open space in the central area of the LSA, where most development has occurred in Hawrelak Park since 1967, provides some lower quality habitat value for some urban-adapted species. The constructed Hawrelak Lake with its two forested islands provides relatively unique urban aquatic/upland habitat in the river valley.

The LSA is bordered by the four-lane arterial Groat Road to the east, the NSR to the west and south and the Royal Mayfair Golf Club to the north. The regional granular trail system is located in the forested habitat along the west margin of the LSA. Ambient urban noise from traffic on Groat Road is significant at times, with episodic peaks (e.g., motorcycles

racing). There is existing lighting throughout the central part of the LSA, along the park perimeter road, along paved SUP's in the interior of the park and bright lighting associated with the new Community League Plaza facility on the southeast shore of Hawrelak Lake.

The LSA's positive habitat attributes – available high-quality habitat of a sizeable area having structural connectivity to the greater river valley along the west margin of the LSA and the presence of Hawrelak Lake – is tempered by the large central open space area. In combination, this suggests that a wide suite of wildlife species, including mammals, birds and snakes, might regularly inhabit this section of the river valley but that urban-tolerant, commonly occurring species are likely most abundant and dominate the wildlife community.

Numerous wildlife trees (i.e., trees with visible nests or large trees with cavities) and snags were observed in the LSA, particularly in the naturally vegetated areas located around the margins of the LSA (Plate 3.19). Many of the trees observed were, however, relatively young and small in size, therefore, they may not be favorable for cavity nesting wildlife.

Plate 3.19. Small snags (circled in yellow) observed within the natural forest stands along the west margin of the LSA (20 October 2020).

A list of all wildlife species potentially occurring in the LSA is provided in Appendix I.

3.7.3.2 Herptiles

Auditory Amphibian Surveys

Wood frogs and boreal chorus frogs were detected at Hawrelak Lake during auditory surveys (Table 3.2). Both species were detected at both survey stations during the first survey only. Wood frogs were more abundant and more widely present, recorded from both stations #1 and #2 with calling index codes of 2 and 3, respectively. At station #1 they were observed to be calling from the north bank area of the north island and along the west shore of the lake. At station #2, wood frogs were observed to be calling from the southwest corner of the lake, from the south shore of the south island and from near the shoreline of the brightly lit Community League Plaza. The relatively higher abundance of wood frogs at the south end of the lake and broader use of habitat suggested that there was more suitable and higher quality amphibian habitat at that end of the lake at the time of survey compared to the north end of the lake

Table 3.2. Call Levels of Amphibian Species Detected During Auditory Surveys at Hawrelak Lake (2021)

	Call Level* by Survey Station and Round			
Species	Station 1		Station 2	
	Survey 1	Survey 2	Survey 1	Survey 2
Wood Frog	2	0	3	0
Boreal Chorus Frog	0	0	1	0
Western toad	0	0	0	0
Canadian toad	0	0	0	0

*Call level codes:
1 = individuals can be counted, no overlapping calls (approx. 1-3 animals)
2 = individuals can be counted, some calls overlap (approx. 4-7 animals)
3 = individuals cannot be counted, full chorus, calls overlapping (>8 animals)

Boreal chorus frogs were recorded only from station #2 with a calling index code of 1. Calling was observed to be from the southeast corner of the lake and from the vicinity of the man-made stream flowing into the lake in that corner.

Despite conducting the survey during peak toad breeding season, no Canadian or western toads were detected.

Based on 15 years of experience conducting auditory amphibian breeding surveys in the Edmonton area, it was unusual not to observe any amphibians calling, particularly boreal chorus frogs, during the second survey in early June. This could be due to a period of unusually warm weather that occurred in June 2021. For example, the air temperature recorded during survey #2 was 27°C at 10:23 p.m. This unprecedented heat could have adversely affected amphibian behaviour and/or habitat conditions (e.g., amphibian breeding behaviour prematurely ended due to the heat, lake water temperatures became warmer than usual, food availability was adversely affected by the heat, etc.).

Western Tiger Salamander

Within Edmonton, Hawrelak Lake is an uncommon aquatic habitat type, one of a limited number of shallow permanent water bodies not designed as an urban stormwater management facility. The lake is not fish bearing but has been documented as supporting an abundant aquatic invertebrate community, amphibians, particularly salamanders, and a variety of other vertebrate species that use both those taxa as prey (M. Jenkins, *pers. comm.)* Recognizing that past lake management activities have had some adverse impacts on aquatic fauna (M. Jenkins, *pers. comm.),* the potential for future management regimes to adversely affect wildlife exists. Western tiger salamanders (*Ambystoma mavortium*) are of particular interest for several reasons: they are recognized as top predators of fishless water bodies, the Edmonton region is near the northern limits of its range in Alberta, and, since 2012 the prairie/boreal population has been federally listed under Schedule 1 of the Species at Risk Act (SARA) as *Special Concern*. A species of *Special Concern* is defined as "a wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats." In this case the threat is widespread disruption of migration routes, mortality through roadkill, and deterioration and loss of breeding and upland habitat.

No adult salamanders or larvae were observed at Hawrelak Lake during any of the salamander focussed surveys from the shoreline of the lake or at the constructed wetland. This was somewhat unexpected considering they had been observed in the past and the lake water had not been chemically treated in the past two years. Salamanders are known to be cryptic and difficult to detect. Therefore, the lack of salamander observations could be an accurate reflection of an absence of salamanders in 2021 or could reflect presence at low abundance. In fact, following our surveys, one live salamander was observed near the pavilion stairs in August 2021 during lake chlorine treatment in advance of the triathlon event (P. Daly, *pers. comm.*). It may be that aquatic habitat that could not be sampled (e.g., near the margins of the north and south islands) was better quality habitat and selectively used. In addition, weather conditions such as the cool, dry spring in 2021 or the extreme heat in June 2021 could have affected salamander behaviour and habitat selection (e.g., adults choosing deeper water in June). A potential salamander observation was made during the waterbird surveys noted below in Section 3.6.3.3. related to a red-necked grebe eating a large prey item that was not a fish.

Western tiger salamanders have been observed in the lake in past years by City personnel when applying 3 ppm chlorination treatments to the lake water in preparation for the swimming event in an international triathlon. In 2018, the last year the lake was treated prior to 2021, 11 salamanders were observed during the week-long treatment period (P. Daly, *pers. comm.*). In contrast, during lake treatment in August 2021, again over a one-week period and with 3 ppm chlorine, only one live salamander was observed (P. Daly, *pers. comm.*). The mature juvenile salamander appeared alert and vigorous. Its metamorphosis was almost entirely complete (its gills were almost entirely absorbed, and it was very clearly taking a breath with its nostrils exposed to the air). During 2021 treatment, no salamander casualties were observed around the shoreline or in the open

water and, unlike other years, bird activity on the lake did not indicate that affected salamanders near the lake surface were a ready prey source (P. Daly, *pers. comm.*).

Finally, City personnel indicated that salamanders are often observed around the boat dock and in the inundated basement of the boat house. However, none had been observed by City personnel or by Spencer Environmental at that location by the end of July 2021, further anecdotal evidence of relatively low salamander abundance in 2021.

Macro Aquatic Invertebrates

Incidentally captured invertebrate species during the salamander dipnet surveys included the following cumulative list (identified to variable taxonomic levels): *Amphipoda*-scuds, *Platyhelminthe*- flatworm, *Hirudinia* - leech, *Hemiptera* -water boatman, *Coleoptera* – diving beetle, *Anisoptera* -dragonfly, *Gastropoda* -snail, *Plecoptera*- stonefly, *Ephemeroptera*- mayfly, and *Trichoptera* – caddisfly. Relative invertebrate abundance was low across 15 of the survey stations during survey #1 on 18 June 2021 (Figure 8a, Appendix A). In general, the lake water was very clear and there was little cover in the form of aquatic vegetation at that time (Plate 3.20). Station 1 was the exception with a richer community of caddisfly, waterboatman, leech, mayfly and scud. A dragonfly nymph was observed in the net at Station 8.

Plate 3.20. Representative aquatic invertebrate habitat at Station 4 during Survey #1 (18 June 2021)

The second survey on 23 June 2021 indicated a slightly more productive environment in that aquatic invertebrates were observed in dipnet samples at more stations than the first survey, but species richness was low. For example, leeches and scuds were observed at Stations 2 and 3 and waterboatman and scuds were observed at Station 6. No invertebrates

were observed at Station 5. Station 15 on the west shore of the lake had the highest richness with scuds, waterboatman, snail, leech, diving beetle, and mayfly larvae.

The third survey on 30 July 2021 was adversely affected by the active mechanical vegetation removal occurring at the lake. Of the stations surveyed, Stations 1, 15 and 16 had relatively high invertebrate richness and high abundance of each species including waterboatman, snails, scuds, mayfly and larvae and leeches (Plate 3.21). The constructed wetland sampling yielded low aquatic invertebrate richness and abundance with only snails, waterboatman, leeches and a scud.

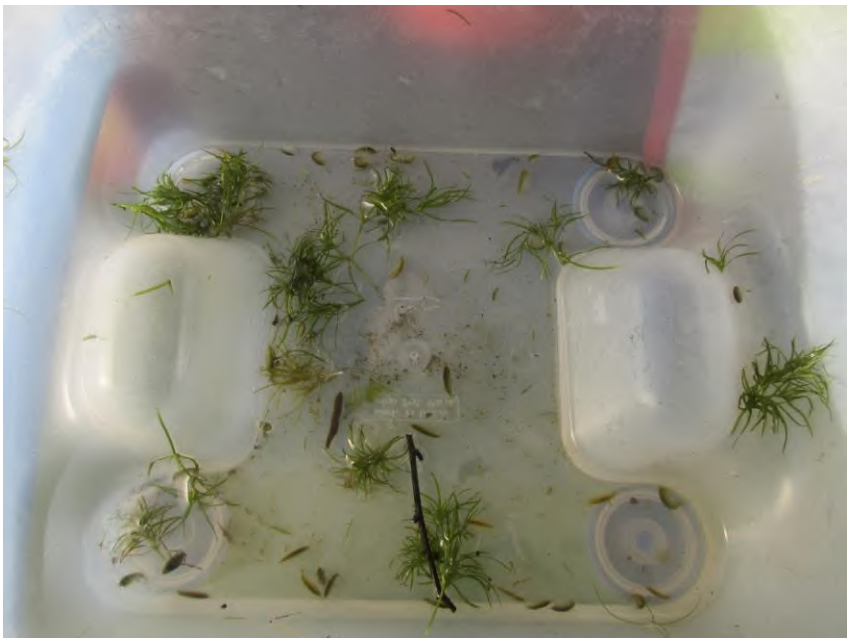


Plate 3.21. Typical dipnet contents from Station 15 during Survey #3 with very clear water and invertebrates including scuds, waterboatman, mayfly, diving beetle, leech, and snail (23 June 2021).

Snake Hibernacula

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.

No evidence of garter snakes (*Thamnophis* spp.) was observed by the surveyors during the hibernaculum survey conducted for the proposed project on 12 May 2021. No snakes were observed along the east riverbank and adjacent slopes, around Outfalls #23D, #25, #26 and #28, the pumphouse or the boat dock infrastructure, including riprap and retaining walls, at the time of survey.

The City of Edmonton did report that one snake (species unknown) was observed in the first week of May and on 13 May 2021 in the vicinity of Outfalls #25 and #26 during outfall inspections (R. Dumont, *pers. comm.*). This suggests there may be a hibernaculum in that area based on the consistency of the location of the sightings and the timing, i.e., early spring when snakes would likely still be located near their hibernaculum. Park operations staff indicated that they have not observed or reported the presence of snakes around the main park area and its infrastructure for many years (B. Turner and J. Reid, *pers. comm.)*

3.7.3.3 Avifauna

Breeding Bird Survey

The EIA's breeding bird survey provides a snapshot of passerine and other bird taxa use of the LSA . The survey recorded 111 individuals of 22 species along the transect across six habitat/plant community types (Table 3.3; Figures 6 and 8b; Appendix A). Most species observed are known to commonly breed in the Edmonton area.

Most of the species detected during the breeding bird survey were singing territorially and may have been nesting in the study area. Species abundance ranged from 2 to 41 across habitat types with the highest abundances observed in the open space manicured (M) areas and in the mixed deciduous red-osier dogwood (MD2) habitat types, likely because those habitat types represented the largest habitat areas surveyed relative to other habitat types. Numerous American crows, ring-billed gulls and Canada geese represented most of the individuals observed in the manicured areas. Red-eyed vireos and yellow warblers were the most abundant species observed in the MD2 forest habitat around the fringe of the park.

Species richness ranged from 2 to 11 species across habitat types with the MD2 habitat type having the highest species richness of 11. This likely reflects the horizontal and vertical structural diversity present in this forest habitat as well as the extent of this habitat around the fringe of the park. The manicured areas had the next highest species richness of 9 comprising urban-adapted species that take advantage of manicured habitats such as planted spruce trees (e.g., ruby-crowned kinglet, white-breasted and red-breasted nuthatches).

While the species abundance and richness observed during the breeding bird survey was considered reasonable for a busy urban park in June in the river valley, in general, bird activity was characterized as relatively quiet. June 2021 experienced unusually warm temperatures, which may have taxed birds and reduced activity including singing.

Table 3.3. Summary of Bird Species Observed in the Local Study Area by Habitat Type During the Breeding Bird Fixed-width Survey (June 2021)

	Habitat/Plant Community Type					
Species	**Deciduous Mixedwood Mixed Shrub (DLM1)**	**Manicured (M)**	**Mixed Deciduous Mixed Shrubs (MD1)**	**Mixed Deciduous Red-Osier Dogwood (MD2)**	**North Saskatchewan River**	**Riparian (constructed wetland)**
American crow	1	9	3	3		
Black-billed magpie			3			
Black-capped chickadee		2	1	5		
Blue jay				2		
Canada goose		10				
Chipping sparrow		1	2	3		
Common goldeneye					1	
Dark-eyed junco			1			
Downy woodpecker				2		
Mallard		1			1	
Ring-billed gull		10				
Red-breasted nuthatch		4				
Red-eyed vireo			2	9		
Red-winged blackbird						2
Ruby-crowned kinglet		1				
Song sparrow	2				1	1
Tennessee warbler				1		
White-breasted nuthatch				3		
White-throated sparrow				1		
Yellow warbler	1		6	10		
Yellow-rumped warbler	2	3		1		
Species abundance	**6**	**41**	**18**	**40**	**2**	**3**
Species richness	**4**	**9**	**7**	**11**	**2**	**2**

Waterbird Survey

Eight (8) adult bird species comprising five (5) guilds were observed using Hawrelak Lake and the adjacent shoreline/upland habitat (Table 3.4) during visual waterbird surveys #1 (08 June 2021) and #2 (29 June 2021). In both surveys, the highest abundance and richness of species were observed in the area surveyed from stations 1-3 at the south end of the lake. The most abundant species was Canada goose followed by lesser scaup (diving duck) with a total of 107 and 71 adult birds observed across both survey sessions, respectively. The two grebe species were only observed during Survey #1 in early June and there was no evidence of nesting. One red-necked grebe individual was observed in the water eating a large prey item, near the south shore of the south island. Fish are not expected to occur in the shallow lake; the size and shape of the object suggested it could have been a western tiger salamander.

Table 3.4. Total Number of Adult Birds Observed at Hawrelak Lake by Survey Station #, Survey # and Guild (June 2021).

		Survey Station #												
Guild		**1**		**2**		**3**		**4**		**5**		**6**		**Total Adults**
	Survey #	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	
	Common Name													
Dabbling Duck	American wigeon	0	2	0	0	0	0	0	0	0	0	0	0	**2**
	Mallard	2	3	3	0	1	0	2	0	0	0	4	0	**15**
Diving Duck	Common goldeneye	0	0	1	3	1	0	0	1	1	0	1	0	**8**
	Lesser scaup	4	7	7	14	13	4	5	6	3	3	5	0	**71**
Goose	Canada goose	34	48	4	0	17	0	3	0	0	0	1	0	**107**
Grebe	Red-necked grebe	1	0	0	0	1	0	0	0	1	0	0	0	**3**
	Horned Grebe	2	0	0	0	0	0	0	0	0	0	0	0	**2**
Gull	Ring-billed gull	3	0	0	0	0	0	1	0	0	0	0	0	**4**
Total Abundance		**46**	**60**	**15**	**17**	**33**	**4**	**11**	**7**	**5**	**3**	**11**	**0**	**212**
Species Richness		**6**	**4**	**4**	**2**	**5**	**1**	**4**	**2**	**3**	**3**	**4**	**0**	**8**

Four species - mallard, common goldeneye, lesser scaup and Canada goose - appeared to rear young at Hawrelak Lake (Table 3.5). Suitable nesting habitat for all observed species with broods was present in the park, and they may in fact have nested in the park. Geese are known to nest there. Canada goose young were most abundant, followed by mallard and common goldeneye. While most observations occurred at the south end of the lake consistent with adult use patterns, mallards and their ducklings appeared to also use the shoreline habitat at the north end of the lake at Stations 5 and 6.

Table 3.5. Total Number of Juvenile Birds Observed at Hawrelak Lake by Survey Station #, Survey # and Guild (June 2021).

		Station #												
Guild		**1**		**2**		**3**		**4**		**5**		**6**		**Total Juveniles**
	Survey #	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	
	Common Name													
Dabbling Duck	American wigeon	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Mallard	6	11	0	0	0	0	0	0	9	0	6	0	**32**
Diving Duck	Common goldeneye	0	3	2	0	3	3	1	1	3	0	0	0	**16**
	Lesser scaup	0	1	0	1	0	0	0	0	0	0	0	0	**2**
Goose	Canada goose	65	43	0	0	10	0	7	0	0	0	0	0	**125**
Grebe	Red-necked grebe	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Gull	Ring-billed gull	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Abundance		**71**	**58**	**2**	**1**	**13**	**3**	**8**	**1**	**12**	**0**	**6**	**0**	**175**
Species Richness		**2**	**4**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**0**	**1**	**0**	**4**

In addition to the formal visual waterbird surveys, incidental observations at Hawrelak Lake on 12 May 2021 included: blue-winged teal, mallard, red-necked grebe, Canada geese, common goldeneye, ring-billed gull, American coot, lesser scaup, Franklin's gull, American widgeon. According to anecdotal information from bird photographer's present at the lake, a wood duck pair had been observed near the north island over two days on 11 and 12 May 2021.

3.7.3.4 Incidental Observations

Potential Dens/Cavities

A series of well-defined holes of unknown origin were observed in the slope in the northwest corner of the fence line around the pumphouse (Plate 3.22). No evidence of wildlife use was observed at the time of survey, however, there is potential they could be used by small-sized animals (e.g., mice, voles, snakes, etc.).

Plate 3.22. Series of small round holes of unknown origin in northwest corner of pumphouse fenceline (12 May 2021)

A cavity/potential den was observed at the base of the slope on the east side of the regional trail near the Hawrelak Park Dock site during the hibernaculum survey (Plate 3.23). It appeared unused at the time of the survey.

Plate 3.23. Potential den at base of slope east of regional trail near boat dock site (12 May 2021)

Avifauna

Incidental observations during field investigations conducted in spring and summer 2021 in the LSA included: chipping sparrow, hairy woodpecker, American crow, song sparrow, black-billed magpie, pileated woodpecker. All except the pileated woodpecker were also observed during the breeding bird survey.

Mammals

An individual coyote was seen on multiple occasions in the northwest corner of the LSA in the vicinity of Picnic Shelter #1. Coyotes were also heard howling from the naturally vegetated west margin of the LSA. Snowshoe hare and least chipmunk were observed only in the naturally forested west margin of the LSA. Red squirrels were seen throughout the LSA and a beaver and a muskrat were observed several times in Hawrelak Lake. City personnel (J. Reid, *pers. comm*.) report that they occasionally observe deer in the LSA and, in fact, on 30 July 2021 City personnel reported observing a deer with two fawns on the lake's north island over the course of a few days. Moose and deer tracks are regularly observed at low frequency on the lake ice during late winter (L. Maslen, *pers. comm.*).

3.7.3.5 Wildlife Movement/Connectivity

Wildlife movement and habitat connectivity was considered at the scale of the expanded study area (Figure 1, Appendix A), extending upstream to Buena Vista Park to the south

and downstream to Emily Murphy Park and Victoria Park and beyond to the east along the the NSR. The province maps the NSRV and ravine system in the City of Edmonton as a Key Wildlife Biodiversity Zone (KWBZ) (AEP 2021a). This mapping is done at a coarse scale using major river corridors, valley topography, valley slope breaks and ungulate winter density data (AEP 2010). The KWBZ includes the Hawrelak Park LSA. Designation of the NSRV and ravine system as a KWBZ is consistent with the City of Edmonton's identification of the river valley as a regional biological corridor within the City's ecological network (City of Edmonton 1990 and 2007) and recent identification as a key component of City Plan's green and blue network (City of Edmonton 2020b). All of these designations recognize the importance of the river valley and ravine system as a major wildlife movement corridor having high value habitat, in undisturbed areas.

The whole of the park is permeable to wildlife movement, particularly at night when people are absent and darkness provides cover. During the day, human use of the park may discourage all but the most disturbance-tolerant of species from moving through open areas. The band of native mixedwood forest habitat around the margins of Hawrelak Park represents the best movement cover and acts as a connected and functional wildlife corridor for small-, medium- and large-sized animals. As noted in Section 3.2.2, that forest habitat is valued as very high to extremely high. That natural habitat is well-established and has been in this configuration around the central manicured area of the park since 1967 so urban-adapted species are well-adapted to its presence and the opportunity it provides for movement around the perimeter of the park during high levels of human use. The band of forest along the west fringe of the park parallel with the river affords an important connection to river valley forested habitats to the north and south of Hawrelak Park. While there are no known pinch points per se to wildlife movement around the park, there is a page-wire fence located along the property line between Hawrelak Park and the Royal Mayfair Golf Club to the north that extends almost the width of Hawrelak Park. The presence of that fence acts as a barrier to north/south wildlife movement and forces animals to travel parallel with the fence along the manicured edge of the thin strip of vegetation to the east towards Groat Road or to the west towards the river. Short game trails were observed leading through the narrow band of vegetation to the fence and the fence was sometimes bent down/damaged indicating wildlife may be attempting to cross over the fence (e.g., deer).

3.7.3.6 Special Status Species

Based on species habitat requirements, an understanding of the available habitat in the local study area, provincial species distributions and species records in the FWMIS database, a few special status species were identified as having potential to occur in the project area. 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 study area. 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 within 1 km of the project area with potential to occur in the project area: barred owl. We also identified four additional species on Schedule 1 of SARA with suitable habitat in the project area: little brown myotis, northern myotis, barn swallow and western tiger salamander. 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 Potential to Occur in the Project Area

Common Name	Provincial Status (General Status of AB Wild Species 2015)	Wildlife Act Designation*	COSEWIC Designation	SARA Designation	Observed/ Previous Record**	Likelihood of Occurrence	Potential Habitat Use
Barred Owl	Sensitive	Special Concern	N/A	N/A	FWMIS (2021)	High	Breeding, foraging
Northern Myotis	May Be At Risk	Data Deficient	Endangered	Schedule 1 (Endangered)		Moderate	Roosting, foraging
Little Brown Myotis	May Be At Risk	None Given	Endangered	Schedule 1 (Endangered)		High	Roosting, foraging
Barn Swallow	Sensitive	N/A	Special Concern	Schedule 1 (Threatened)	eBird (2020)	Moderate	Breeding, foraging
Western Tiger Salamander	Secure	N/A	Special Concern	Schedule 1 (Special Concern)	M. Jenkins and P. Daly	High	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
**FWMIS = fish and wildlife Management Information System (Accessed 15 September 2021, observation dates not known), eBird = The Cornell Lab of Ornithology eBird (Accessed 15 September 2021, observation dates in brackets), M. Jenkins = observed by City of Edmonton staff, P. Daly - CoE observations.

Barred Owl

Barred owls live year-round in mixed forests of large trees, often near water (Cornell University 2019a). Their preferred habitats range from swamps to stream sides to uplands, and may contain white spruce, trembling aspen, balsam poplar, Douglas-fir, lodgepole pine, or tamarack. Barred Owls usually nest in a natural cavity, 6-12 m high in a large tree. They may also use stick platform nests built by other animals (including hawks, crows, ravens, and squirrels (Cornell University 2019). Some suitable habitat exists for barred owls within the LSA and expanded study areas. eBird contains records of barred owl

observations for Hawrelak Park from 2012, 2013 and recently in August 2021 (including photographs) (Cornell Lab of Ornithology 2021). It is unknown where in the park these observations were made but there is suitable nesting and foraging habitat in the park and in the natural mixedwood forest around the margins of the park. The likelihood of occurrence in the LSA is thus rated as high.

Little Brown Myotis and Northern Myotis

Little brown myotis utilizes tree crevices (especially old dead or dying trees in mature deciduous forests), buildings and bridges for roosting and maternity roosts during the breeding season. Northern bats 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 Olson and Holroyd 2018).

There are some large open space trees and mature trees within natural stands in the local and expanded study areas that are suitable for bat roosts. While buildings within Hawrelak Park could also serve as potential maternity roosts, particularly for little brown myotis, City personnel have indicated they have no records of bats utilizing the inside of any of the buildings in the park (B. Turner, *pers. comm.*). Our inspection of the outside of the buildings in the park during field investigations revealed that most enclosed buildings have small mesh covering the gaps along the bottom of the buildings and where the walls meet the roof, which likely helps prevent bat entry into the buildings. A small amount of guano was observed on the ground in the southeast corner of the boat pavilion, likely from a bat that spent the day or night roosting on the side of the building. Guano accumulation was monitored on subsequent site visits and guano abundance did not change indicating the guano was likely the result of a single roosting event. Considering the lake, proximity of the NSR and the numerous trees in the LSA, it is quite possible that Hawrelak Park provides critical foraging habitat for supporting bats that roost elsewhere along the river valley (C. Olson, *pers. comm.*).

The likelihood of occurrence in the project area, therefore, for the little brown myotis was rated as high and northern myotis was rated as moderate because of the project area's proximity to the NSR and the presence of Hawrelak Lake, both suitable foraging areas and water sources, and suitable available habitat for roosting within and adjacent Hawrelak Park. 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.

Barn Swallow

Potential barn swallow habitat is present in the local and expanded study areas as this species often nests on bridges and buildings near open areas with water for foraging. Barn swallows build nests from mud and fasten them to a vertical wall or on a horizontal ledge underneath an overhang (Brown and Brown 2019). There are several records of flocks of barn swallows observed in Hawrelak Park during spring migration in late May and early June in eBird ranging from 2017-2020 (Cornell Lab of Ornithology 2021). While, no barn

swallow individuals or nests were observed during field investigations conducted in support of this project, there is suitable nesting and foraging habitat in the park and the likelihood of occurrence in the project area is thus rated as moderate.

Western Tiger Salamander

Western tiger salamanders occupy a variety of open habitats, including grasslands, parkland, subalpine meadows, and semi-deserts (COSEWIC 2012). Key habitat features include sandy or friable (crumbly) soils surrounding semi-permanent to permanent water bodies lacking predatory fish (COSEWIC 2012). Hawrelak Lake does provide western tiger salamander habitat, and their presence in the lake has been noted by City personnel (M. Jenkins, *pers. comm.*). See Section 3.6.3.2 above for further discussion of this species in Hawrelak Lake. The likelihood of occurrence in the project area is thus rated as high.

Sensitive Species Range Records

FWMIS sensitive species range records indicate that the study area falls within the province's sharp-tailed grouse (*Tympanuchus phasianellus*) survey area and the bald eagle range (AEP 2021). Sharp-tailed grouse are not expected to occur within the local study area because suitable grassland/shrubland habitat is not present. Suitable bald eagle nesting, perching and hunting habitat is present in the LSA. eBird (Cornell Lab of Ornithology 2021) contains sightings of bald eagles in the Hawrelak Park area, however, no stick nests were observed in the LSA that could potentially be used by bald eagles for nesting.

3.8 Historical Resources

Circle CRM Group Inc. (Circle CRM) conducted a desktop assessment that determined that the proposed park renewal project area includes lands designated with a Historic Resource Value (HRV) of 5 (high potential to contain a historic resource) for archaeology and palaeontology, due to being located within High Archaeological and Palaeontological Resource Sensitivity Zones. In addition, Circle CRM determined the proposed project intersects lands designated with an HRV of 5 and 4 for archaeology due to the proximity of a known historic resources site within the project footprint and known sites 800 m and 850 m northeast of the project area. Additionally, they determined the proposed project intersects lands with an HRV of 4 for palaeontology due to the proximity of a known historic paleo resource site. Based on the presence of known sites in and near the project area, *Historical Resources Act* (HRA) approval is required prior to proceeding with any development activities that include ground excavation.

3.8.1 Archaeological Resources

Circle CRM submitted an application to Alberta Culture, Multiculturalism and Status of Women (ACMSW) on 27 April 2021 for their review and determination of HRA requirements for the proposed park renewal project. ACMSW granted HRA approval related to archaeological resources subject to a Schedule of Conditions outlined in the approval provided in Appendix J. Those conditions include submission of development plans to ACMSW for their review for individual renewal components that are located

within or immediately adjacent the known archaeological site or within less disturbed areas bordering the riverbank that will result in substantial subsurface disturbance. Those project components include, but are not limited to, rehabilitation of the storm sewer system, upgrades to buried power, gas and telecommunication utilities, addition of new pathways, and any site grading. The plans for those individual components must be submitted in a new HRA application prior to the onset of development activities and must be accompanied by GIS shapefiles. Please see Appendix J for additional condition information.

ACMSW provided shape files showing the area of concern and an archaeological site boundary to be considered during project planning. The area of concern is shown on Figures 10 and 11 in Appendix A. For data confidentiality reasons, the archaeological site boundary has not been included in Figures 10 and 11 or in Appendix J.

3.8.2 Palaeontological Resources

ACMSW granted conditional HRA approval related to palaeontological resources with the condition that a Historic Resources Impact Assessment (HRIA) for palaeontological resources in the form of a monitoring program be conducted by a palaeontologist qualified to hold a palaeontological research permit in Alberta. Monitoring is to occur for areas of undisturbed fluvial deposits that sit outside the margins of the existing ring road where significant subsurface disturbance (>1 m below surface) will occur. No excavation activities greater than one (1) meter below surface are to take place in the above-noted areas until a professional consulting palaeontologist is on site to monitor construction activities. Figure 11 provides an indication of which renewal activities are expected to trigger monitoring. Please refer to Appendix J for the full conditional approval and conditions.

4.0 THE PROJECT

4.1 Renewal Project Scope

The proposed Hawrelak Park renewal/rehabilitation program will address the life-cycle rehabilitation of the park's many aging components [Marc Boutin Architectural Collaborative Inc. & PFS Studio (MBAC & PFS) 2021] and will include some growth components and some ecological enrichment components. Broadly speaking, the project aims to achieve the following:

- Improvements to open space and trail systems
- Enhance circulation and accessibility throughout the park
- Renew existing facilities on site, including outdoor amenities and aging structures
- Improve accessibility of structures
- Improve functional programming (includes layout) of the service yard
- Improve and expand underground utilities
- Improve water quality in Hawrelak Lake

The MBAC & PFS (2021) schematic design report identifies specific improvements for the above park components at the schematic design level. It does not detail the work to be undertaken. Design details for project components will be provided in later project stages. All elements identified in the MBAC & PFS (2021) report have been funded for Phase 1 of the project (Schematic Design and Design Development) and design will advance on those components. The recommended improvements will be undertaken as funding is obtained, unless design reveals critical items that need to be addressed during the 2019-2022 budget cycle.

For context, following is a summary of project phasing:

- Phase 1 - Schematic Design and Design Development: This phase includes scope confirmation, assessments and studies, functional program of main service yard, schematic design, and design development. Phase 1 will be considered complete by the City's approval of the Design Development report and class 3 cost estimate.

- Phase 2 - Working Documents: This phase includes detailed design and will be considered complete by the City's approval of the Tender documents.

- Phase 2a (if required) - Construction of Emergent Items: This phase is subject to funding and will proceed only if the design reveals critical items that need to be addressed during the 2019-2022 budget cycle.

- Phase 3 - Construction and Post Construction Services: Phase 3 is subject to funding and includes construction implementation as identified in Phase 1. Unless

critical components need to be addressed, it is anticipated that construction will proceed during the 2023-2026 budget.

Specific project components to be designed in Phase 1 and to be considered for construction are described below.

4.2 Renewal Component Description

Proposed renewal items listed in the MBAC and PFS (2021) schematic design report, in combination with information provided by City of Edmonton to reflect decisions made by the City up to end of September 2021, form the basis of this detailed project description, with one exception. During review of the draft EIA City personnel indicated that detailed design would include replacement of a wooden stairway located on the east valley slope, just west of Groat Road, and requested that the EIA be adjusted to recognize that project element. Project components are quite varied in type, scale, location and potential to affect EIA VECs in and adjacent to Hawrelak Park. For example, some components are limited to interior or exterior renovations of existing structures, others require shallow excavation or grading in small or extended areas of the park. Still others address widespread networks of below ground utilities. Some project components will be situated wholly within fully manicured locations in the park, others will be situated adjacent to or within more sensitive features, such as the lake, forest or areas of archaeological concern.

For EIA purposes, proposed project components have been organized into five categories and the primary anticipated renewal components items in each category listed. Together these components form the project that is the subject of this EIA. Project components judged to have potential to affect the VECs described in Section 3 and thus merit close examination are annotated with an asterisk*. Components judged to have a relatively small and contained footprint, or to involve neither on-site construction nor ground disturbance beyond post installation and thus to have no real potential for interface with a VEC, were considered to be of less importance to this EIA and are not marked with an asterisk. These components are listed here to provide a complete project characterization and an understanding of the overall scale and spatial extent of the full park renewal project but were not examined further beyond this section of the EIA. That said, the potential for any construction undertaking in a river valley park to disturb manicured space, including trees, is recognized. The potential impact for construction access and activities to damage manicured space is captured at the project wide level.

Finally, anticipated components comprise both rehabilitation and growth items, guided by the following definitions (RPK Architects *et.al.* 2019):

- Rehabilitation: The restoration of an existing element, so that it can continue to function as initially designed and installed.
- Growth: The provision of a new element, or system, that would augment existing infrastructure or park function.

All itemized project components listed below are proposed rehabilitation items, unless noted as growth items in parentheses. The majority of project components are shown

conceptually in (Figures 9a, 9b and 9c) to provide a spatial perspective of anticipated works within the LSA.

4.2.1 Open Space, Outdoor Amenities, Wayfinding

Landscaping

- Regrade and/or repair turf areas to address:
  - high use, compacted areas with poor growing conditions*
  - areas experiencing poor surface drainage*
- Regrade picnic sites to improve drainage and increase the number of accessible picnic sites that include an asphalt connection* and wayfinding signage (Plate 4.1)
- Enhance the perimeter forest edges, where reasonable* (Growth) (Plate 4.2)
- Add plantings around the park's entrance to create a 'gateway'* (Growth)
- Identify and remove invasive species* (Growth)
- Enhance native vegetation on margins of constructed wetland and anthropogenic creek that discharge recirculated water to the lake*

For more on landscaping approach refer to section 4.3.

Plate 4.1. Existing (left) and proposed (right) park space configurations – conceptual (MBAC and PFS 2021).

Plate 4.2. Conceptual extension of forest into the park (MBAC and PFS 2021).

Amenities

- Replace existing furnishings with new, enhanced and accessible furnishings
- Improve the playground, including providing accessible circulation, updating equipment and providing more diverse play features that appeal to a wider range of ages*
- Investigate the need to repair or replace the Hawrelak Lake dock with a removable option, and take action as necessary *
- Replace existing 3m wide bridge at the creek/lake interface with a 3.0 m wide vehicle rated bridge*
- Replace/update benches, picnic tables and garbage receptacles to adhere to the City's Access Design Guide v.3
- Install park benches and seating areas regularly along MUPs (Growth)
- Place moveable chairs and tables adjacent to the Main Pavilion (Growth)
- Install a new boardwalk, with integrated seating, along on the eastern lakefront (Growth)*
- Install playful seating elements (e.g., hammocks) throughout the park (Growth)

Wayfinding

- Update signage for the park using selected sign types from the City's river valley park sign family
- Install additional wayfinding signs based on park entry points transition areas and decision points (Growth)
- In particular, improve pedestrian, cyclist, and vehicular circulation with clear wayfinding to improve overall comprehension of the park on arrival

4.2.2 Circulation

Non-Vehicular Circulation

- Rehabilitate existing trails/paths*(Figure 9b, Appendix A)
- Replace one wooden stairway on east park slope* (Figure 9a)
- Add new paths to create a circulation network that encompasses the entire park to reduce potential vehicle pedestrian/cycle conflicts* (Figure 9b, Appendix A)

- Add signage that indicates the park's circulation road is a shared space for both cyclists and motorists (Growth)
- Create two primary interconnecting multi-use path (MUP) (4 m wide) loops, the forest loop and meadow loop, that link the park perimeter to the concentration of facilities and programing that occur at the center of the park (e.g., Main Pavilion, Heritage Amphitheatre, Community League Plaza)* (Growth)
- Add more bike parking spots (Growth)
- Unify the Main Pavilion, boat house, Heritage Amphitheatre and the Community League Plaza into a single, interconnected node

Vehicular Circulation

- Add additional parking to the main parking lot and to Shelter #2 adjacent to existing parking to replace parking count lost due to narrowing of roadway*
- Remove the existing D-loop road that provides access to the service yard and replace with a southbound lane on the main circulation road up to the southern most entrance to the service yard* (Growth) (Figure 9b, Appendix A)
- Remove the turn-around loop gates
- Reconfigure the dedicated parking stalls from 90 to 60 degrees in the main parking lot
- Repave all roads based on usage*
- Replace all curbing*
- Install pedestrian crossing where all trails intersect with the circulation roadway and within parking areas
- Install a level 2 electric vehicle charging station within the southeast corner of the main parking lot (Growth)
- Increase bicycle parking to a total of 125 stalls (Growth)
- Re-design the circulating roadway to include traffic calming features (Growth)
- Add signage that indicates the park's circulation road is a shared space for both cyclists and motorists (Growth)

Note: In general, proposed roadwork can be described as replacement work, with some adjustments as described above. The intention is to improve traffic flow, not accommodate higher traffic volumes. There is no intention to expand the park paved road network.

Circulation and Lighting Strategy

- Install lighting that clearly defines routes of travel through the park. Lighting design will comply with the City's 2019 Light Efficiency Community Guidelines Light Efficiency Guidelines, with consideration to neighbouring communities*
- Install new lighting at the access to the existing Buena Vista/Hawrelak Park pedestrian bridge.*

Note: Roadway and SUP lighting will be updated as required by roadway, parking and paved pathway changes. Lighting along regional pathways will not change.

4.2.3 Facilities

Facilities to be updated are widely spaced throughout the park as shown in Figure 9a.

Main Pavilion

- Replacement of the exterior deck*
- Rehabilitate/renew the structure, mechanical and electrical systems
- Upgrade interior finishes and fixtures (e.g., lighting, washroom fixtures)
- Replace below-grade duct work with overhead duct work
- Upgrade glazing and floor finishes (including skate tile)
- Provide triple-glazed custom upgrades to the building envelope to renew sealant and provide better insulation
- Add lockers and seating in the locker/changing area
- Relocate the skate rentals to operate out of the north side of the building allowing for direct outdoor public access (Growth)
- Relocate the mechanical space to the west side of the building (Growth)
- Provide a universal washroom (Growth)
- Improve pavilion food service area (Growth)

Heritage Amphitheatre

- Rehabilitate/renew the structure, mechanical and electrical systems
- Upgrade interior finishes and fixtures
- Reconfigure parking, road entry, turnaround and addition of pedestrian pathway*
- Review Life Cycle assessment to determine renewal or replacement needs of existing outdoor seating*
- Provide a universal washroom (Growth)
- Reconfigure green room including upgrades to shower facilities (Growth)
- Add lighting to support pedestrian access from the parking lot* (Growth)
- Reconfigure the existing fence around the facility using a slatted system*
- Add plantings along new fence* (Growth)
- Incorporate built-in bike shelters or other amenities along the fence (Growth)
- Place crushed gravel throughout the vendor and backstage areas (Growth)
- Install a new irrigation pump facility along the west side of the fence line (Growth)
- Regrade the slope coming up to the main entry to a 1:20 slope to create a more accessible path* (Growth)
- Reslope the stage access ramp (Growth)

Boat Pavilion

- Rehabilitate/renew the structure, mechanical and electrical systems
- Rehabilitate irrigation system equipment
- Investigate the washed-out fill below the boat pavilion and the potentially displaced column/beam support, and repair as necessary*
- Replace concrete patio surrounding the facility*
- Install additional lighting for security*
- Repurpose Boat Pavilion interior to provide boat storage (Growth)

- Insulate the facility to support winter storage and provide heating for winter storage (Growth).

Picnic Shelters

- Rehabilitate/renew the structure, mechanical and electrical systems
- Upgrade interior finishes and fixtures in the washrooms
- Accessibility upgrades to washroom doors (Shelter #1 only)
- Demolish Washroom 3 and build new expanded facility*
- Add gender inclusive washrooms to Shelter #1 and 2, and redevelopment of Shelter #3 to incorporate the gender inclusive concept. Add universal/family room which may result in the potential expansion of facilities* (Growth)
- Add heating and necessary envelope upgrades to allow for year-round function (Growth)
- Add custodial closets (Growth)

Service Yard *- assumes that changes made within this currently well-defined operations area will not affect lands outside of the area – potential exceptions to that assumption are noted with **

Main Services Building

- Rehabilitate/renew the structure mechanical and electrical systems
- Add a new shared office, storage unit, and two (2) open hoteling office stations (Growth)
- Reconfigure the kitchen and staff area (Growth)
- Add universal washroom with staff shower (Growth)
- Add screened staff lockers, addition of five (5) changing rooms and storage area with mounted key box (Growth)
- Add stairs up the east bank into the service yard and concrete flatwork beside the newly developed stairs to enable an outdoor staff lunch area (Growth)
- Extend the garage space of the main services building to provide a flexible workspace (Growth)

Vehicle Storage

- Demolish vehicle storage*
- Rehabilitate/renew the structure mechanical and electrical systems
- Life Cycle assessment of exterior cladding and electrical to determine the need for rehabilitation or replacement
- Structural investigation of roof beam

South Garage

- Rehabilitate all building systems
- Relocate the overhead door to the south of the building

Other

- Demolish Quonset Hut and build new storage facility in same location
- Demolish the existing aggregate and fuel sheds and replace them with a new aggregate and fuel facility along the west side of the service yard* (Growth)
- Remove the existing road on the west side of the yard and replace with a new gravel road located further west* (Growth)
- Expand staff parking and the main entrance to include 8 m two-way circulation* (Growth)

Note: in combination, the proposed service yard improvements are anticipated to result in an increase in the service yard area of ~ 40m^2.*

Pumphouse (G) *(The pumphouse, situated near the riverbank, is part of a system that withdraws water from the river and distributes it to Hawrelak Lake)*

- Rehabilitate/renew the structure, mechanical and electrical systems
- Life Cycle assessment of building facade and pump to determine need for rehabilitation or replacement, with subsequent implementation as necessary*
- Amour the pumphouse facility in graffiti-resistant metal cladding
- Remove surrounding chain link fence*
- Repair or replace river intake pipe, which runs underground from the pumphouse to ~ 50 m under the riverbed and daylights into the river, as needed – assessment in preparation *

Note: Newer facilities, such as the Edmonton Federation of Community Leagues Pavilion, are not part of the renewal program.

4.2.4 Underground Utilities

The underground scope of work consists of replacement, rehabilitation, and upgrades to deep utilities and shallow utilities throughout the park. Deep utilities are water, sanitary, and stormwater systems, which are buried greater than 2.5m below grade. Shallow utilities include primary/secondary power, gas, and telecommunication lines that are buried less than 2.5m below grade.

Water

- Rehabilitate the entire water distribution system within the park and expand the system as required to provide fire coverage at Washroom/Shelter #2, the Service Yard, Heritage Amphitheatre and Main Pavilion (Partial Growth)* (Figure 9c, Appendix A)

Sanitary and Storm Sewer

- Rehabilitate the sanitary and storm systems*
- Relocate the storm sewer network and associated catch basins if parking and road realignments are made, to accommodate new drainage patterns (Growth) *

- Repair or replace or otherwise improve structural elements of three outfalls located on the riverbank in the LSA and potentially abandon a fourth (Figure 9c, Appendix A). The extent of repairs will depend on final design of the proposed storm sewer system but works contemplated at time of writing include:
    - Outfall #27: erosion and concrete work to increase bank stability (Plate 4.3). Pipe condition does not warrant replacement.
    - Outfall#28: construct a headwall outfall. The existing outfall currently consists of a small pipe only (Plate 4.4). A proper outfall will be designed for construction at this location, and the pipe repaired/replaced as well.
    - Outfall #25: replace the pipe; outfall structure is in good condition and requires no work (Plate 4.5)
    - Outfall #26: This outfall, which is used to discharge water from the lake will need to be cleaned (rock debris removed from inside the pipe), and the pipe repaired/replaced.

Plate 4.3. Hawrelak Park Stormwater Outfall 27 (erosion and concrete work to increase bank stability; pipe condition does not warrant replacement) on east bank of NSR downstream of the Pumphouse (20 October 2020).

Plate 4.4. Hawrelak Park Stormwater Outfall 28 (existing outfall currently consists of a small pipe only; a headwall outfall will be constructed and the pipe repaired/replaced) on the East Bank of the NSR Upstream of the Pumphouse (12 May 2021).

Plate 4.5. Hawrelak Park Stormwater Outfall 25 (replace pipe; concrete outfall structure in good condition, no works required) on the East Bank of the North Saskatchewan River (12 May 2021)

Irrigation

- Abandon and replace irrigation line layout* (Figure 9c, Appendix A)
- Relocate the controls for irrigation into the service yard
- Irrigation system will use lake water and have a potable back up source.
- Upgrade water source for irrigation (assumes this is an off-site source and therefore has no potential for impact) (Growth)

Gas/Power/Telecommunications

- Replacement, rehabilitation, and upgrade, as needed

Other than outfall and associated pipe work to the west of the park, the underground scope of work described above will be limited to within Hawrelak Park (this must be remembered when interpreting the conceptual layout shown in Figure 9c).

General Construction Notes and Considerations

The deep utility scope of work is influenced by weather and must be completed in the spring/summer/early fall. Ideally, the shallow utility work would be done at the same time but could be completed in cold temperatures, if necessary. Multiple options exist for sequencing and resource loading and selected options will be identified as design progresses. Typical methodology for the underground work will be to work from deep to shallow and in a complete path so that the hardscaping/landscaping and building scopes can be completed concurrently or follow close behind. Open cut trenches are assumed for now. Less invasive, trenchless methods of repair, such as CIPP linings, can be explored for utilities through sensitive areas such as forests.

4.2.5 Hawrelak Lake

- Dredge the lake to remove the sediment that has accumulated over the years (R. Dumont, *pers. comm.*), to the original lake bottom elevation*
- Dredging may require lake dewatering to the river, depending on dredging method selected*
- Install an 8 m wide planted buffer around the majority of Hawrelak Lake to deter geese (as a water quality improvement measure)(Growth)*
- Establish woody vegetation in open areas on islands to deter goose nesting*
- Establish deep marsh emergent vegetation along select shoreline*
- Assess and replace (if necessary) river intake/lake outfall mechanical system*

In combination, the existing project components are located throughout the park, with the exception of some forested areas (Figures 9b and 9c, Appendix A).

4.3 Landscaping

The proposed project is intended to be consistent with the City of Edmonton's C532 Sustainable Building Policy through conscious green space design to reduce the need for over-watering greenery (MBAC & PFS 2021). This will be achieved using a typical landscaping strategy that reduces a reliance on water through creating organic micro-zones.

Trees/shrubs/vegetation that need to be removed to accommodate construction activities will be replaced with adaptive or native alternatives pursuant to the City's Corporate Tree Management Policy. Landscaping and Tree Protection Plans will be prepared as appropriate for each site-specific project when it is funded for construction. Landscaping will meet or exceed all applicable City guidelines. All soils will be handled appropriately to ensure protection of topsoil integrity and where needed new or augmented topsoil will be provided.

4.4 Construction Schedule

As noted in section 4.1, the proposed project will be developed and delivered in a phased approach, in accordance with the City of Edmonton Policy C591 - Capital Project Governance. Design of the Phase 1 approved renewal components will continue to advance as part of Phase 1 in 2021/2022. Construction of these components will be funded in the 2023-2026 budget cycle. If design identifies an imminent need to address failing infrastructure prior to 2023, an additional phase (Phase 2a) for construction of those items during the 2019-2022 budget cycle may be required, contingent on funding approval. Beyond the above, construction schedule details are not, therefore, known at this time.

4.5 Construction Laydown Area and Access

Construction access to the park is anticipated to be through the main park gate. Access to work areas within the park would be via existing park roadways and trails. Specific construction laydown areas will be established by the contractor; however, these areas are anticipated to be located in parking lots or on turf. All laydown areas will be restored to their original condition upon completion of construction.

4.6 Project Phases and Associated Key Activities

This EIA is prepared as part of Phase 1 of a three-phase delivery approach. Subject to funding milestones, pertinent project phasing is described as follows:

- Phase 1, Schematic Design and Design Development - will be considered complete by the City's approval of the Design Development report (now underway) and class 3 cost estimate (completed January 2021)
- Phase 2, Working Documents - includes detailed design and will be considered complete by the City's approval of the Tender documents (expected completion December 2021).

- Phase 2a (if required), Construction of Emergent Items (2019-2022).

- Phase 3, Construction and Post-Construction Services (2023-2026).

In the absence of detail or certainty regarding project construction sequencing or methods, based on proposed activities and past experience, and relying on information provided by the project Construction Manager, we have identified the following activities as <u>likely and relevant to this EIA:</u>

4.6.1 Site Preparation Phase

The following activities are anticipated, either in targeted work areas or in the park as a whole, and not necessarily in this order:

- Acquire required historical, environmental permits and municipal bylaws permits and meet all pre-construction conditions
- Develop and implement tree protection plans
- Clear/Strip trees/shrubs, signage, fixtures, existing infrastructure that is in the way of the new installs. Items such as benches and fixtures to either be handed over to the city or disposed of off site.
- Install fast fence (or other type) to create dedicated working areas and provide for public safety, as required
- Implement trail closures and detours, as required
- Establish laydown areas
- Locate utilities via private/secondary locates, record drawings and hydrovac
- Deter/manage goose nesting, as needed
- Prepare and implement effective site-specific temporary Erosion and Sediment Control (ESC) plans, as required
- Prepare other environmental protection plans, such as: ECO Plan, spill response, care of water plan, care of contaminated soils/lake sludge plan, native vegetation enhancement plans

The above plans could be site-specific plans or plans developed to apply to the park as a whole, or both as needed.

4.6.2 Construction Phase

Construction methods and specific activities are not yet determined; however, the City's Construction Manager provided the following insights into activities and execution strategies that will likely be involved during this phase.

4.6.2.1 Deep Utility Methodology

- Asphalt/concrete would be cut, stripped, and trucked off site for disposal.
- Existing utilities would be abandoned in place or dug up, removed, and disposed if they are in the way of new installs. Abandonment process likely involves excavation to the pipe location and a fillcrete plug on the end of the pipe.
- Trenches would be dug with an excavator to the design depths of the utilities (typically 3 m minimum). Soil would be stockpiled along side the trench to be used for backfill after pipe and pipe zone placement. Erosion and sediment controls would be put in place to prevent sediment runoff from the stockpiles.
- Trenches would be dewatered as needed throughout the work. Groundwater would be pumped to the storm system for discharge back into the North Saskatchewan River. Non-groundwater would be pumped to the sanitary system.

- Trenches would be sloped or shored to meet OH&S requirements prior to worker entry.
- Install pipe as per detailed design.
- Backfill pipe zone (area surrounding pipe and up to 1m above) with non-native granular material, rock, or fillcrete as per design.
- After pipe zone is complete, backfill and compact the remainder of the trench with the native material that was excavated and stockpiled along side the trench. Any excess material to be stockpiled in appropriate location for future use or trucked off site if not needed.
- Continue backfill and compaction until underside of landscape/hardscape is reached.
- New manholes & catchbasins would be installed in the same fashion although larger excavations would be required at these locations.
- Repair riverbank outfalls – methods to be determined
- Replace river water intake system – *under consideration* – assumed to involve instream work – methods to be determined

4.6.2.2 Shallow Utility Methodology

- Shallow utility work would follow deep utility work.
- Area would already be stripped and rough graded from deep utility installs.
- Coordinate utility installations with utility service providers. Option to open cut or horizontal directional drill depending on the utility.
- If open cut the installation would follow the deep utility process but on a smaller scale.

4.6.2.3 Landscaping/Hardscaping Methodology

This scope of work consists of everything surface level that the public will see once the project is complete including roadways, Shared Use Paths, sidewalks, signage, seating, lighting, etc. This scope of work would follow closely behind the deep utility work with some possible overlaps for schedule efficiencies. The bulk of this scope is highly seasonal and cannot be completed in the winter. The seasonal nature of the work will have to be considered in the final sequencing plan.

- Import of structural fill for road and pathway substructure where deep utility install took place. Areas not underneath roadways to be graded and then treated with topsoil and sod.
- Roadways and MUP's would be graded and compacted with heavy equipment.
- Concrete sidewalks and aprons would be formed, reinforced, and poured.
- Asphalt paving to roadways and install of MUP's.
- Install lighting, benches, and signage.
- Implement improvements to playgrounds
- Final grading, topsoil, and sod placement of landscaped areas.
- Augment native forest in select areas

4.6.2.4 Structures/Buildings Methodology

Each of the ten buildings has a unique scope of work and location within the park (Figure 9a) and would be completed concurrently with the underground/landscape scope within that phase of the project.

- Utility isolations and lockouts required on each building prior to starting work.
- Hazardous material testing and abatement. This would be unique to each building and would be required before proceeding with any subsequent work. Areas with hazardous material would be protected and sectioned off while removals are taking place and material would be removed and disposed of as per OH&S regulations.
- Selective demolition and removal of existing furniture and fixtures. Items would be either handed over to the city or removed from site and disposed.
- Structural repairs and modifications to proceed first. This includes interior and exterior work to concrete and structural members. Some excavation could be required on the perimeter of buildings requiring concrete work.
- Architectural rehabilitation on building exteriors after structural work is complete. This would require access around each building.
- Electrical/Mechanical rough ins and rehabilitation.
- Architectural rehabilitation finishes on building interiors.

4.6.2.5 Lake Dredging and Enhancement

- When work is ready to begin the lake would need to be isolated by shutting down the pumphouse at the river.
- Depending on time of year, avian nesting may need to be managed, with the focus being geese. Goose nesting deterrents may be needed, if work is to occur during the nesting or brood rearing season.
- Extensive dewatering program may be required. This would likely require multiple diesel-powered pumps, hoses, and monitoring.
- Dewater into the river, with approval from AEP or dewater into the sanitary system employing restricted discharge rates.
- Monitor water quality throughout dewatering.
- Sediment would have to be controlled at the hose discharge locations to prevent sediment accumulation and runoff.
- Use excavator to create an access ramp into the lake.
- Sediment that has accumulated on the existing clay liner will be gathered and removed off site with excavators, dozers, and tandem trucks. Average of 3cm of sediment across the lake bottom would result in approximately 2000M3 of sediment to be removed and trucked off site.
- Establish shrubs on islands, and around lake.
- Enhance vegetation along creek and wetland.
- Establish emergent vegetation in select areas of the lake.
- Remove invasive plant species present in the park.

4.6.3 Reclamation Phase

As this is a park renewal project, reclamation is an inherent project component. Reclamation activities will include the following:

- All turf areas affected by construction will be reclaimed to meet or exceed pre-disturbance conditions.
- All riverbank locations affected by outfall or other utility work, such as river intake replacement will be reclaimed to meet federal, provincial and municipal approvals and Bylaw 7188 conditions.
- All adversely affected forested areas will be reclaimed to a state leading to restoration.

4.6.4 Operation and Maintenance Phase

This phase is undescribed at time of writing.

4.7 Summary of Environmental Regulatory Approvals

All typically relevant federal, provincial and municipal environmental legislation, bylaws and policies were reviewed for their application to this project. As is often the case, several provincial and federal statutes prohibiting harm to select resources are relevant to project construction; however, Bylaw 7188 is the only trigger for an environmental assessment. 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 or Policy	Regulatory Agency	Authorization/ Approval/Permit Required	Responsibility, Approval Timeline or Potential Schedule Impact
Municipal			
North Saskatchewan River Valley Area Redevelopment Plan **(Bylaw 7188)**	City Planning	EIA and SLS required. EIA and SLS must be approved by City Council.	Anticipated Approval in early 2022.
Corporate Tree Management Policy **(C456C)**	City Forestry	City 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.	Meet with City Forestry to determine trees and shrubs that will be impacted by the project and compensation. Continued consultation throughout the project 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.	Contractor would seek permission from EPCOR.

Legislation or Policy	Regulatory Agency	Authorization/ Approval/Permit Required	Responsibility, Approval Timeline or Potential Schedule Impact
City of Edmonton Parkland **(Bylaw 2202)**	City of Edmonton	Laydown areas required inside Bylaw 7188 boundary and on lands zoned Metropolitan Recreation Zone (A). Permit required to stage for construction.	City or Contractor to obtain permit once construction dates are known.
Provincial			
Public Lands Act	Alberta Environment and Parks (Land Management Branch)	Work within the bed and shore of the crown-claimed watercourse (NSR) will require a *Public Lands Act* disposition.	City to submit applications for permanent and temporary works in the North Saskatchewan River bed and shore (e.g., water intake, outfalls, riprap, construction access, etc.) once detailed design and construction schedules are known; ~6 months to 1 year to obtain a Department License of Occupation (DLO).
Water Act	Alberta Environment and Parks (Water Approvals Branch)	The *Water Act* governs all activities that may impact water and the aquatic environment, including taking water from a watercourse, discharging to a watercourse and constructing within/ adjacent a watercourse. Based on proposed renewal activities, a *Water Act* application will be required for proposed water intake repair activities in the NSR, and for lake dewatering if discharging into the NSR. In addition, outfall repair or construction activities are regulated under the *Water Act* Code of Practice for Outfall Structures on Water Bodies.	The City will submit a *Water Act* application once detailed design and construction methodology and schedules are known; ~ 6 months to obtain approval. A Code of Practice Notification will need to be submitted at least 14 days prior to outfall construction activities.
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	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.

Legislation or Policy	Regulatory Agency	Authorization/ Approval/Permit Required	Responsibility, Approval Timeline or Potential Schedule Impact
		breeding season or undertaking a nest sweep before vegetation removal.	
Historical Resources Act	Alberta Culture, Multiculturalism and Status of Women (ACMSW)	All projects with potential to disturb historical, archaeological and paleontological resources will require Approval.	ACMSW granted conditional HRA approval related to archaeological resources subject to a Schedule of Conditions outlined in the approval provided in Appendix J. Submission of component-specific development plans located within or immediately adjacent the known archaeological site or within less disturbed areas bordering the river bank to ACMSW for their review is required. ACMSW granted conditional HRA approval related to palaeontological resources with the condition that a Historic Resources Impact Assessment (HRIA) for palaeontological resources in the form of a construction monitoring program be conducted.
Federal			
Fisheries Act	Fisheries and Oceans Canada (DFO)	If work within the fish-bearing NSR is required, submission of a Request for Review to DFO is recommended to remain compliant with the *Fisheries Act* and DFO protocols.	City to retain a Qualified Aquatic Environmental Specialist (QAES) to submit a Request for Review for proposed instream works (e.g., water intake, outfalls) in the NSR once detailed design and construction methodology is known. That process has no specific time limits; anticipate a minimum of three months. Schedule likely impacted only if Request for Review determines that Authorization is required.
Canadian Navigable Waters Act	Transport Canada	Approval may be required for water intake and outfall works if it causes substantial interference with navigation.	~4 months for review and publication of Public Notice for 30 days; City to submit application once detailed design and construction methodologies are known.
Migratory Birds Convention Act	Environment and Climate	The Act protects migratory birds (as populations and	City to schedule vegetation removal and lake work to

Legislation or Policy	Regulatory Agency	Authorization/ Approval/Permit Required	Responsibility, Approval Timeline or Potential Schedule Impact
	Change Canada	individuals), their nests and eggs. No permitting triggers; however, violation of the *MBCA* may result in penalties. Protected species include many commonly occurring species, such as Canada goose.	remain compliant with the Act. Any vegetation clearing/tree removal between 20 April and 20 August, would require a nest sweep and may result in findings that delay clearing. Lake work cannot interfere with bird nests or young.
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. Barn swallows are migratory birds designated as Threatened on Schedule 1 of SARA and could potentially nest on buildings in Hawrelak Park.

5.0 PROJECT IMPACTS AND MITIGATION MEASURES

5.1 Assessing Impacts

5.1.1 Potential Impact Identification and Analysis

The first step in impact identification was to develop a concise list of project components and activities likely to have potential to affect the VECs described in Section 3. This was done by reviewing the project components and activities described in Section 4 and applying our experience with similar projects. Project components deemed to have potential to affect VECs (positively or adversely) were annotated with an asterisk. That analysis was conservatively cautious, commensurate with the information available. Identified components and activities were then summarized into more concise project activities and entered into Appendix K, a project activity/VEC matrix. Note, turf areas were not included in the vegetation VEC. Potential interactions were then identified by overlaying project design information on mapped resources, reviewing construction method notes and again applying our professional experience with impact assessment and construction performance auditing in other, similar projects. Many activities were deemed to potentially interact with surface water quality or soils. The analysis identified activities in or adjacent to the lake and river, and, proposed underground works as having potential to interact with the greatest number of VECs.

We then examined the identified interactions in more detail, to identify and reframe the interactions as potential impacts that warranted assessment. Each VEC on the interaction matrix was carried forward for further analysis. The analysis assumed that all practices noted in the project description - e.g., proper soil handling and compliance with City landscape design and construction standards – will be adopted during construction. Interactions with soils primarily considered the potential to interact with contaminated soils. In addition, we separately examined the potential for equipment malfunction or construction accidents to result in a release of hazardous/deleterious substances in or outside of the project area and an associated adverse affect on the VECs.

5.1.2 Impact Characterization

Identified impacts were then characterized according to guidance received from the EIA Terms of Reference (Appendix B). 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 Geology/Geotechnical Conditions

There are no major/deep earthworks required for this project and other than a stairway replacement, no work is proposed for the steep east park slopes. Based on the results of their desktop study and visual site observations, Thurber (2021b; Appendix G) determined that the existing Hawrelak Park staircase alignment was a favourable location for staircase replacement based on the presence of relatively uniform, well drained slopes with no signs of recent slope instability or slope erosion. While there was evidence of an old shallow landslide at the staircase location likely from the original Groat Road grading, it had appeared to have either stabilized naturally or by slope reconstruction, such that there is little evidence of the landslide at the current staircase location. Thurber provided recommendations regarding stairway foundation design and construction in their report (Appendix G). Further geotechnical investigation should be undertaken if soil strength parameters are required for screw pile design.

The other steep area in the LSA, the riverbank, will experience some disturbance - three riverbank outfalls or associated pipe require repair and a fourth outfall may be abandoned. The work will require equipment access to those locations on the riverbank, with route(s) and construction methods as yet undetermined. The riverbank slope is assumed to be sensitive to disturbance and on that basis, potential impacts to geology/geotechnical conditions at the riverbank were identified as meriting examination.

Impacts

The proposed outfall work on the sensitive riverbank is assumed to involve bank slope disturbance and access to the work sites is assumed to require crossing the slope and/or moving between sites at the bottom of the slope. In the LSA, riverbank slope angles vary and the slopes are variably vegetated. Plate 3.4 (Section 3.4.2) illustrates the riverbank slope condition downstream of the pedestrian bridge (near Outfall 23d) and Plate 5.1 provides an indication of the slope and spring water conditions further downstream in the vicinity of Outfall 26. In the absence of additional slope stability information, design and construction detail including vegetation removal requirements, and plans for slope stabilization measures, the potential impact of outfall work on riverbank slope stability is rated as negative, direct, minor to major, local, permanent and likely.

Plate 5.1. Riverbank slope near Outfall 26 (12 May 2021)

Mitigation and Residual Impacts

This EIA assumes that geotechnical conditions at the riverbank will be investigated as part of future design phases. It further assumes that suitable mitigation will be prescribed to ensure slope stability post-construction. There are several proven slope stability mitigation measures, such as installing permanent hard or bioengineering bank armouring measures available to the design team. Bio-engineering, if feasible, is preferred for ecological reasons. The construction access to the sites should be carefully selected, with potential impacts to slopes, vegetation, fish and wildlife all considered. In the absence of more information, the residual impact cannot reliably be characterized. Outfall work is flagged as one of project components with the greatest potential to impact the local environment and likely to require careful mitigation design and implementation.

5.2.2 Soils

Soil conditions in Hawrelak Park are well documented. And the critical role of topsoil quality for site landscaping and reclamation is well understood. The City's standards for topsoil type, handling and placement will be followed. For this EIA, the salient soils point is the presence of documented soil contamination. Hawrelak Lake bottom sludge is also assumed to be contaminated. The following potential impacts related to soils were identified as warranting examination:

- Redistribution or exposure of in-situ contaminated soils
- Soil contamination resulting from lake dredging

5.2.2.1 Redistribution or Exposure of Contaminated Soils

Impacts

Considering the historic site use, the presence of large quantities of fill and the conclusions of past ESA work in the park, work involving ground disturbance has some potential to

encounter contaminated soils, with the potential being higher in areas of known fill. Mishandling of encountered contaminated soils could result in adverse impacts to clean soils (and then to vegetation and possibly other environmental resources). This potential impact is rated as a negative, direct, minor, local, permanent and likely impact. It is minor considering the conclusions of risk assessments to date.

Mitigation and Residual Impacts

All ground-disturbance work in the park will require a construction management plan, developed by Engineering Services, to ensure the AECOM (2014) contaminated soil risk management commendations are met. By employing these measures, the risk of impact associated with contaminated soils is deemed to be fully addressed and the residual impact is rated as negligible.

5.2.2.2 Soil Contamination Resulting from Lake Bottom Dredging

Impacts

The planned lake bottom dredging is assumed to involve handling sludge exceeding Tier 1 thresholds as a result of surface runoff constituents from adjacent park lands and large volumes of excrement from waterfowl. Dredging methods under consideration are dewatering followed by sludge excavation and removal, or bottom sediment suctioning by barge. Either process will expose workers and the environment to dredged sludge and will require appropriate handling and disposal. The City has successfully dredged the lake more than once in years past. This EIA assumes that an appropriate dredging and sludge handling plan, compliant with regulations and BMPs, will be in place. However, the dredging process is flagged as creating potential for exposed sludge to contaminate nearby shoreline and upland soils as a result of unexpected conditions or equipment malfunction. This potential is rated as a negative, direct, minor, local, temporary and unlikely impact.

Mitigation and Residual Impacts

This impact can be mitigated by ensuring the lake dredging plan is comprehensive and includes measures to prevent accidental releases and an emergency response plan, including release containment and clean-up. With that in place, the residual impact is expected to be negligible.

5.2.3 Surface Water Quality

The following potential impacts to surface water, were identified as meriting examination:

- Changes in Hawrelak Lake water quality
- Changes in North Saskatchewan River (NSR) water quality

5.2.3.1 Changes in Hawrelak Lake Water Quality

Impacts

Project components directly adjacent to Hawrelak Lake (e.g., concrete work, site grading to improve drainage), and project components occurring within Hawrelak Lake (e.g.,

dredging), create potential for lake water quality to be adversely affected. Affected water would be contained to the lake, if lake water remains isolated as is planned during lake dredging. The project team is well aware that dewatering to the river can only occur with approval, which requires suitable water quality. If water quality exceeds determined thresholds, lake water would be discharged to the sanitary system. If properly isolated and managed, impacts to lake water quality would be considered a negligible impact.

Conversely, project objectives include improving Hawrelak Lake water quality, through removing lake sediment and undertaking landscaping to render lake shorelines and top-of-bank and two islands less attractive for goose nesting and loafing. Overall, the project's potential impact on lake water quality is rated as a positive, direct, minor, permanent, local and likely impact.

Mitigation and Residual Impacts

The project currently plans to:

- implement effective ECO Plan measures and ESC plans for all work near or at the lake,
- discharge poor water quality to the sanitary system as needed,
- isolate lake water (e.g., ceasing pumping from the river and to the constructed wetland) when dredging is occurring. Isolation should also occur during construction activities at the main pavilion and boat pavilion.

Additional mitigation measures for lake water quality are not required. With the above measures, the residual impact is anticipated to be rated as a positive, direct, minor, permanent, local and likely impact.

5.2.3.2 Changes in NSR Water Quality

Impacts

Several project activities also have strong potential to affect river water quality if not undertaken carefully. The grading on turfed areas, all road and path work (see Figure 10, Appendix A), and landscaping and the widespread deep and shallow utilities work (see Figure 11, Appendix A), will all involve exposed soils. All of these lands drain to the river through the storm system, creating potential for sediment releases to the river. In addition, the outfall work required on the riverbank and replacement of the river intake pipe, if undertaken, have a high potential to adversely affect river surface water quality. The City has already committed to implementing effective, site-specific temporary ESC plans. Effective plans should control adverse impacts, however, most projects of this nature, working so close to the river do experience some releases owing to unforeseen conditions so some potential remains. Imprudent release of poor quality lake water could also adversely affect river water quality. Finally, groundwater depths described in Section 3 indicate that deep utility work will intersect with groundwater in some localities and/or will collect rainwater and require dewatering to the local storm system. That water could be sediment laden. Unauthorized releases to the river would be a contravention of the *Water Act* and may carry penalties or fines. If improperly handled, these project activities have

potential to result in a negative, direct, minor, local, temporary and likely impact on river water quality.

Mitigation and Residual Impacts

The City currently plans to implement effective ECO Plan measures and ESC plans for all work near or at the river, and for work within the park limits on lands that drain to the riverbank outfalls. They should also require contractors to have a Care of Water Plan that effectively governs water management. These plans should be of the highest quality and the City should commit to requiring contractors to retain a qualified CPESC to monitor ESC measures and environmental performance and the City should retain a qualified CPESC to undertake quality assurance auditing of the contractors' work.

With the above measures in place, the residual impact on river water quality is anticipated to be negligible.

5.2.4 Groundwater

The following potential impact to groundwater, was identified as meriting examination: potential for lake dredging to contaminate groundwater.

Impacts

There is some potential for lake dredging to damage the lake liner that currently prohibits mixing of groundwater with poor lake water and contaminated bottom sediments. The City is aware of this potential and has successfully managed lake dredging in the past. Nevertheless, the potential for accidental damage exists and the impact to groundwater is rated as negative, direct, minor, local, temporary and unlikely.

In addition, deep utility excavation is expected to intersect with groundwater in select areas, however, that interaction is related more to water management and surface water quality and has low potential to adversely affect groundwater.

Mitigation and Residual Impacts

The potential for liner damage will be mitigated by mandating liner protection measures such as dredging to an elevation slightly higher than the liner elevation (i.e.,leaving a buffer layer) and requiring the contractor to have a dredging-specific environmental protection plan. The City will also consider requiring the use of vacuum dredging, which would avoid the potential for mechanical damage to the lake liner. The residual impact to groundwater is rated as negligible.

5.2.5 Fish

The following potential impacts to fish, were identified as meriting examination:

- reduction in river water quality; and
- harmful alteration, destruction or disturbance to fish habitat

5.2.5.1 Reduction in River Water Quality

Impacts

Degradation of surface water quality in the river, as a result of release of sediment or harmful substances, could also affect fish in the NSR, altering behaviour and causing them to avoid the area. This would be a contravention of the *Fisheries Act* and may carry penalties or fines. Commensurate with the surface water quality impact rating, such an occurrence would be considered a negative, direct, minor, local, temporary and likely impact on fish. As described earlier, this impact could result from work inside the park limits via the storm sewer system, from discharging of unsuitable lake water or, more likely, from releases associated with the outfall or river intake repair work.

Mitigation and Residual Impacts

Mitigation measures described for surface water quality would also address this potential impact on fish. In addition, the City will expect the contractor to be compliant with any conditions attached to any Letter of Advice or Authorization issued by Fisheries and Oceans Canada (DFO). The residual impact to fish is expected to be negligible.

5.2.5.2 Harmful Alteration, Destruction or Disturbance to Fish Habitat

Repair work planned at several riverbank outfalls has potential to directly affect fish habitat. Because of the position of the outfalls on the bank, this work is expected to involve some activity on the riverbank at elevations below the ordinary high water mark, and possibly even require some isolation works in the river, and therefore to occur in fish habitat. Similarly, the river intake work would likely involve instream works or at the least work under the river, to access the existing pipe or install new pipe under the riverbed. These activities create potential for adverse effects to NSR fish habitat. If river isolation works are required, there is potential for fish entrapment to occur. Unmitigated and without offset, the potential impact on fish habitat and fish is rated as a negative, direct, minor, local, temporary and likely impact.

Mitigation and Residual Impacts

At a minimum, once design is more advanced, project activities proposed at the riverbank and under/in the river will be subject to a fisheries assessment by a Qualified Aquatic Environment Specialist (QAES). This will serve as an important first mitigation measure. The QAES assessment will include specifications and recommendations regarding how the works shall be carried out, to ensure compliance with federal and provincial law and to protect fish and fish habitat. That report may recommend that the City submit a Request for Review to Fisheries and Oceans Canada (DFO). Such a review may result in issue of a Letter of Advice or a requirement to apply for a *Fisheries Act* Authorization. The City will ensure that the contractor will comply with all requirements associated with any QAES assessment or federally issued documents. Full compliance with federal and provincial requirements will fully mitigate impacts to fish and fish habitat, resulting in a negligible residual impact.

Water quality and fish habitat impacts related to construction malfunctions or incidents are treated in section 5.2.9.

5.2.6 Vegetation

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

- Loss of native plant communities
- Gain of native plant communities, including riparian communities
- Loss of open space trees
- Incidental tree damage
- Loss of special status plant species
- Change in invasive species or weeds conditions

5.2.6.1 Loss of Native Plant Communities

Impacts

Hawrelak Park renewal activities will result in both permanent and temporary, direct losses of some native plant communities. Four native plant communities are located within the LSA, deciduous mixedwood mixed shrubs, mixed deciduous mixed shrubs, mixed deciduous red-osier dogwood and riparian. A permanent loss of native vegetation is anticipated to be localized to the riparian community on the east side of Hawrelak Lake near the Main Pavilion and Boat Pavilion where a new boardwalk is proposed (Figure 10, Appendix A). Temporary losses of forest native plant communities are expected to occur during underground infrastructure renewal as work areas will need to be fully cleared for open excavation in locations wherever underground infrastructure lies beneath native communities. The loss would be temporary as reclamation following construction would be undertaken. Locations where proposed utility works are situated below native plant communities are shown, as a worst case scenario, in Figure 11 (Appendix A). However, we note that utility work is not currently contemplated on the east park slopes. The majority of locations where buried utility work intersect with native forest is in the park's west. Open excavation work is currently anticipated in ~ 4 locations in the mixedwood red-osier dogwood community, at one or two locations in the mixed deciduous mixed shrub community, and at three locations in the deciduous mixedwood mixed shrub community. It may be that work is not needed in all of those locations. Of those three forest communities, clearing within the deciduous mixedwood deciduous shrub forest is the most acute negative impact as that community had few weeds in the centre and had by far the highest proportion of native species. Additional native vegetation removal may be required for surface renewal works or picnic structure work where located close to native forest edges, to allow for equipment access and workspace (Figure 10, Appendix A). Wooden stairway replacement on the park east slope may result in some minor temporary tree and shrub loss. Replacement will involve a like-for-like stairway, but it is always possible that some vegetation removal would be required to accommodate construction activity.

Both permanent and temporary losses of vegetation are rated as negative, direct, minor, temporary to permanent, local and likely.

Mitigation and Residual Impacts

The following native plant community mitigation measures will be applied:

- In accordance with the City of Edmonton *Corporate Tree Management Policy C456C*, as design advances, have City Forestry assess/value all forest communities in the project area and integrate the values into work planning and final mitigation measure development. Compensate for losses as required.
- Minimize native plant community removal by adopting directional drilling wherever possible. The highest priority for directional drilling is through the deciduous mixedwood deciduous shrub forest. Employing directional drilling is the single best means of avoiding years of temporary loss while reclaimed areas mature and the need to control non-native species.
- Ensure that all cleared forest areas are restored to a native forest community similar to the ones removed. Prepare a forest restoration plan during detailed design that meets the City's business partner expectations.
- The planned naturalization of some of Hawrelak Lake shoreline with emergent vegetation will fully counter the inevitable permanent riparian loss at Hawrelak Lake near the two pavilions.

With these measures, the residual impact to native communities will be reduced to negligible. With use of directional drilling a negligible impact will be achieved much sooner.

5.2.6.2 Gain of Native Plant Communities

Impacts

The Hawrelak Park renewal project includes establishment of a planted 8 m wide buffer around most of Hawrelak Lake, enhanced shrub communities on the two lake islands and the possible augmentation of native perimeter forest communities, to close some existing gaps, all as growth items. These planned enhancements would result in a net gain of native plant communities within the park resulting in a positive, direct, minor, permanent, local and likely impact.

Mitigation and Residual Impacts

No mitigation needed. The residual impact remains positive, direct, minor, permanent, local and likely.

5.2.6.3 Loss of Open Space Trees

Impacts

Hawrelak Park renewal activities will result in the loss of some open space trees (Figure 9b, Appendix A). Proposed tree removal shown by the concept design is indicative and a final tally of all open space trees to be removed should be produced once final design is complete. Loss of open space trees is rated as a negative, direct, minor, temporary, local and likely impact.

Mitigation and Residual Impacts

The following open space tree mitigation measures will be applied:

- During design and in contract tenders, minimize the removal of open space trees.
- Once final design is complete, prepare a tree removal inventory.
- In accordance with the City of Edmonton *Corporate Tree Management Policy C456C*, have City Forestry assess/value all trees to be removed, consult regarding the need for further avoidance or other mitigation, and compensate/offset as required.
- Ensure landscaping plans specify the use of native tree species or ornamental species comparable to those removed.

The above effort will offset all losses, over time, as trees mature. In the long-term, the residual impact will be reduced to negligible.

5.2.6.4 Incidental Tree Damage

Impacts

Hawrelak Park renewal works will occur adjacent to open space trees and native forest (e.g., new boardwalk on east side of lake, new bridge crossing creek, path realignment, underground works, service yard renewal) (Figures 10 and 11, Appendix A), creating potential for tree limb, trunk and root damage during construction. The potential for such tree damage, some of which may ultimately result in tree loss, is rated as a negative, indirect, minor, permanent, local and likely impact.

Mitigation and Residual Impacts

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 project area 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 further reduce potential for impact on open space trees or native plant communities during construction, equipment storage, maintenance and refueling will be restricted to existing paved or turfed areas that are at least 10 m removed from trees. With these measures in place, the residual impact is expected to be negligible.

5.2.6.5 Loss of Special Status Plant Species

Impacts

Figures 10 and 11 show the spatial relationship between the location of known rare plants and proposed surface and underground works. Rare plants should not be affected by those activities. Not shown on Figure 10 is the planned extensive weed removal at the margin of the lake and establishment of an 8 m wide planted buffer along the majority of Hawrelak Lake. These activities have potential to negatively impact two rare plant species

populations if proper mitigation measures are not in place. Unmitigated, impacts to these plants would be negative, minor, temporary to permanent, local, direct and likely.

No project works are anticipated near the documented population of tall meadow rue near the river (Figure 10), therefore impacts to that community are not anticipated.

Mitigation and Residual Impacts

Prior to initiation of any Hawrelak Park renewal activities in the lake and on lands within the vicinity of identified rare plants (e.g., dredging, weed removal, planted buffer along Hawrelak Lake), a qualified plant ecologist should flag, buffer and fence all rare plants to ensure they are not accidentally impacted by construction activities. The rare plant species found along the lake should also be incorporated into the planned planted buffer to the extent possible, being mindful of growing conditions needed. With these measures in place impacts to special status plant species will be reduced to negligible.

5.2.6.6 Change in Invasive Species or Weeds Condition

Impacts

Surface disturbance from renewal activities could create ideal conditions for the prohibited noxious and noxious weed species on site to spread onto the disturbed soils at the work sites. In addition, construction equipment could carry in seed and rhizomes of new weed species, which then establish and potentially spread further into the river valley. 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.

Conversely, identification and removal of existing invasive plant species is a component of the Hawrelak Park renewal project. The program will target the several noxious and prohibited noxious weeds that have been identified throughout Hawrelak Park, generally along forest edges and in riparian areas. The removal and continued control of these weed species will result in a positive, direct, minor, local, temporary to permanent and likely impact.

Mitigation and Residual Impacts

Preventing weed establishment is the best and most economical approach for weed management. Following are the weed mitigation measures that will be place:

- Clean equipment before moving into the project area to reduce the potential transfer and spread of weedy species.
- Revegetate cleared areas with topsoil and an appropriate seed mix and native plantings approved by the City as soon as possible following disturbance/soil exposure.
- Post-construction, monitor for and control weeds as required until desired vegetation becomes established.
- Require the contractor's ECO Plan to describe all short-term weed control measures.

- Monitor the performance of the park invasive weed removal program and implement remedial measures as required.

With proper implementation of these measures and the removal and control of existing weed species, the residual impact is anticipated to be positive, direct, minor, local, temporary to permanent and likely impact. Continued weed control will be required for this positive impact to be permanent.

5.2.7 Wildlife and Wildlife Habitat

The following potential impacts to wildlife and wildlife habitat were identified as warranting examination:

- Loss of terrestrial habitat
- Disturbance of breeding wildlife
- Habitat alienation during construction
- Mortality or disturbance of special status wildlife species
- Barriers to ecological connectivity/wildlife movement
- Wildlife disturbance from changes to park lighting

5.2.7.1 Loss of Terrestrial Habitat Due to Clearing Activities

Impacts

Some areas of native vegetation clearing, and, thus, loss of terrestrial wildlife habitat, will be required for the proposed renewal project. Despite the required clearing and trimming of some natural vegetation, particularly in some small areas along the west margin of the park, relatively abundant terrestrial habitat will be retained in the remainder of the mixedwood forest habitat along the river and around the park. Clearing of native vegetation for outfall construction and access and underground utilities in the mixedwood forest habitat types will primarily impact avian and small mammal species with preferences for tall shrub and woodland habitat. Considering the amount and diversity of habitat that will be retained and the amount of clearing that has already occurred from other land uses (e.g., the central area of the park), the relatively small loss of native habitat is not expected to have detectable impacts on the wildlife community (i.e., richness and abundance) or population dynamics in the LSA. The impact of park renewal activities on the loss of native habitat is rated as negative, direct, minor, temporary to permanent, local and likely.

Mitigation and Residual Impacts

Applying all mitigation measures outlined in Section 5.2.6.1 above will also mitigate habitat loss. Overtime, the residual impact will be negligible.

5.2.7.2 Disturbance to 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 (MBCA) 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 open space trees or in the natural vegetation surrounding the park. 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, which could be in conflict with legislation. Should clearing due diligence not be employed, wildlife mortality resulting from clearing could occur. This would be a negative, direct, major, permanent, local and likely impact. It is rated as major because it represents contravention of the law.

Lake dewatering also has potential to disturb breeding birds. Many Canada geese are known to nest on the islands in the lake and then use the lake (and adjacent lawns) as brood rearing habitat. A few pairs of other waterbird species may also nest at the lake in the year of construction, as some were observed rearing broods in the lake in 2021. Observed species are also protected by the MBCA. Lake dewatering during the waterfowl breeding season would likely contravene that legislation. As above, this would be a negative, direct, major, permanent, local and likely impact.

Dewatering the lake during the period 01 May to 30 August also has potential to adversely affect western salamanders in the aquatic phase of their life cycle, if they are present in the construction year. Disturbance is not prohibited by law but avoiding disturbance to the extent possible represents a good conservation practice as the species is uncommon in the City of Edmonton. Dewatering without consideration for this species is rated as a negative, direct, minor, permanent, local and, based on historic presence in low numbers, likely impact.

Mitigation and Residual Impacts

If project scheduling results in vegetation clearing/tree removal or other activities requiring vegetation manipulation 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 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 sites 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.

Impacts to wildlife using Hawrelak Lake will be avoided through preparation of a wildlife management plan by a qualified wildlife biologist, detailing wildlife protection measures to employ for works in and adjacent to Hawrelak Lake. The plan will consider all vertebrate wildlife species known to use the lake (excluding wood and boreal chorus frogs as those commonly occurring, widespread species are not protected by law) and will detail mitigation measures tailored to the construction schedule and methods to avoid wildlife mortality and harm. For example, dewatering impacts to aquatic salamanders can be avoided by screening/filtering the dewatering pumps, periodically visually inspecting shallow pools of water for salamander presence and salvaging observed individuals. Alberta Environment and Parks (AEP) or Alberta Biodiversity Monitoring Institute (ABMI) can be asked to provide a list of suitable local wetlands for release of salvaged salamanders. Bird nesting and brood rearing protection would also be covered by the plan. For example, if Hawrelak Lake dewatering or other invasive activities, such as dredging or shrub installation on the lake islands, is planned to occur during the goose nesting or brood rearing season, the City may choose to monitor goose nest establishment and use deterrents to prevent nesting as required. Commitment to City preparation of a wildlife management plan for activities planned at and near the lake provides the flexibility required to mitigate for activities that are not yet in an advanced design phase and for which time of year and sequencing is not yet known. The plan should be developed by the in collaboration with the project's Construction Manager. The Contractor should have the opportunity to review the pal and suggest amendments suit their construction management intentions.

If invasive activities are planned for the lake during the period 20 April to 30 August, the City will engage a wildlife specialist to monitor the contractor's implementation of the wildlife management plan.

With the above measures in place, breeding wildlife disturbance should be avoided, and the residual impact should be reduced to negligible.

5.2.7.3 Habitat Alienation During Construction

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 useable habitat available to individuals. However, in this case, this potential impact has been rated as minor for the following reasons:

- Most wildlife species in the area are likely already adapted to human disturbance.
- Additional disturbance caused by construction activity is expected to be a minor contribution to the existing human presence in the study area (e.g., recreational park users).
- 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 is therefore also rated as negative, indirect, minor, temporary, local and likely.

5.2.7.4 Mortality or Disturbance of Special Status Species

Impacts

Five special status species with a moderate to high likelihood of occurrence could use habitat in the LSA including barred owl, barn swallow, little brown myotis and northern myotis. Western tiger salamanders are well known to occur in Hawrelak Lake.

Two special status bird species, barred owl and barn swallow, could potentially be adversely impacted by the proposed park renewal project. Suitable barred owl nesting habitat is present in the LSA in the unfragmented mixedwood forest around the margins of the park, particularly parallel with the river. They could use a natural cavity in a large tree or an existing stick nest for nesting anywhere in the park. Barn swallows usually attach their nests to buildings or other human structures. While no nests on buildings were observed at the time of the breeding bird survey for this EIA, building-related construction activities during the breeding bird nesting season could inadvertently destroy a barn swallow nest. As noted above in Section 5.2.7.2, 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, which could be in conflict with legislation. Should clearing due diligence not be employed, wildlife mortality resulting from clearing could occur. This would be a negative, direct, major, permanent, local and likely impact. It is rated as major because it represents contravention of the law.

Similar to birds, 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 on trees is of limited concern to bat conservation. Disturbance of maternity colonies is of more concern. That said, the probability of disturbance of this project is rated as low for the following reasons: the area of vegetation to be cleared is relatively small and no maternity roosts have been identified in any of the buildings in the park to date. Therefore, regardless of when clearing occurs the project is not anticipated to adversely affect local bat populations in the project area. 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 little brown bat and northern bat from the proposed project are, therefore, ranked as negligible.

Western tiger salamanders are documented to occur in Hawrelak Lake, a shallow, anthropogenic lake that is regularly managed for water quality, vegetation management and water level management. Despite the high level of management and manipulation, western tiger salamanders are occasionally observed at the lake. As noted above in Section 5.2.7.2., dewatering the lake during the period 01 May to 30 August also has potential to adversely affect western salamanders in the aquatic phase of their life cycle, if they are present in the construction year. Disturbance is not prohibited by law but avoiding disturbance to the extent possible represents a good conservation practice as the species is uncommon in the City of Edmonton. Dewatering without consideration for this species is rated as a negative, direct, minor, permanent, local and, based on historic presence in low numbers, likely impact.

Mitigation and Residual Impacts

Applying all mitigation measures outlined in Section 5.2.7.2. above will mitigate habitat loss. In addition, building exteriors should be inspected in the winter before work is to occur for the presence of barn swallow nests. If barn swallow (or other species nests) are found, develop a barn swallow/other species nest mitigation plan tailored to the schedule that ensures compliance with the legislation. With those measures in place, the residual impact to barred owl and barn swallow will be reduced to negligible.

Bat-specific mitigation measures are not warranted but we note that scheduling vegetation clearing to occur outside the breeding bird period also will significantly reduce the risk to roosting individual bats. The residual impact to little brown myotis and northern bat from the proposed project is rated as negligible.

As noted in Section 5.2.7.2, impacts to wildlife, including salamanders, using Hawrelak Lake will be avoided through preparation of a wildlife management plan, by a qualified wildlife biologist, for works in and adjacent to Hawrelak Lake. Please see Section 5.2.7.2 for wildlife management plan content details. With these measures in place, residual impacts from disturbance to special status species should be reduced to negligible.

5.2.7.5 Barriers to Ecological Connectivity/Wildlife Movement

Impacts

Wildlife corridors in the LSA comprise the unfragmented native mixedwood forest around the margins of the park, which have been in that configuration since 1967. Current barriers to wildlife movement in those forested areas are the page wire fence along the north property line of the park and the high level of human use in the park, particularly on regional river valley trails in the forest parallel with the river. Those barriers to movement are unlikely to change. The proposed renewal project, however, will not introduce any new permanent barriers to wildlife movement or significant fragmentation to ecological connectivity. As described in Section 5.2.6.1 above, relatively small areas of native vegetation will be cleared in support of underground and surface works proposed in the mixedwood forest habitat types along the west side of the LSA. While these activities may contribute to temporary habitat alienation during construction (see Section 5.2.7.3), they are not expected to introduce any significant new permanent barriers to wildlife movement through the LSA and greater river valley. Ecological connectivity may, in fact, be slightly improved between habitat patches if augmentation of native perimeter forest communities is realized (growth item) and some existing gaps between habitat patches are closed. Impacts to wildlife movement and ecological connectivity from the renewal project are rated as negligible.

Mitigation and Residual Impacts

No additional mitigation measures are required. Residual impacts remain negligible.

5.2.7.6 Wildlife Disturbance from Changes to Park Lighting

Impacts

Park renewal includes renewal of park lighting, in particular new lighting along roads and pathways to provide for improved wayfinding and for CPTED, new/improved illumination at the boat pavilion and introduction of a new light at the access to the pedestrian bridge over the river. Artificial lighting is proven to interfere with wildlife behaviour, in varying ways and to varying degrees (International Dark Sky Association 2021, City of Edmonton 2019 and Rich and Longcore 2005). Therefore, renewal plans to install new and additional lighting has some potential to affect wildlife, particularly movement of nocturnal species within and through the park and nocturnal wildlife use of the lake.

The potential for adverse effect of lighting on wildlife movement is expected to be tempered by two considerations: 1) lighting design (not yet determined) will follow contemporary standards and City guidelines as noted in Section 4 and can be required to tightly focus on target areas, be directed downward only and reduce unnecessary glare and light trespass; and 2) regional pathways in the park through forested areas are not currently illuminated and this will not change. This means that the highest quality movement corridors in the park will remain relatively dark. Some lake margins are currently illuminated. There are no data regarding if this results in wildlife, such as birds, being attracted or repelled to illuminated areas. In the absence of any detail regarding light

design, including placement, the potential impact of lighting on wildlife is rated as a negative, direct, minor, permanent, local and likely impact.

Mitigation and Residual Impacts

Consistent with the new Light Efficiency Community Guidelines (City of Edmonton 2019), lighting design goals will include minimizing glare and trespass lighting into native plant communities and onto the lake, with a view to reducing the existing level of nighttime illumination in sensitive and important wildlife habitats and movement corridors. Successfully employing the guidelines would result in a positive impact to wildlife compared to existing conditions and residual impacts of lighting changes on wildlife associated with this project would be 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/archaeological resources
- Disturbance to known and undiscovered paleontological resources

5.2.8.1 Disturbance to Historical/Archaeological Resources

Impacts

Alberta Culture, Multiculturalism and Status of Women (ACMSW) granted conditional HRA approval related to archaeological resources for the proposed renewal project subject to a Schedule of Conditions outlined in the approval provided in Appendix J. Those conditions include submission of development plans to ACMSW for their review for individual renewal components that are located within or immediately adjacent the known archaeological site or within less disturbed areas bordering the riverbank that will result in substantial subsurface disturbance. ACMSW provided shape files showing the area of concern and an archaeological site boundary to be considered during project planning. The area of concern is shown on Figures 10 and 11 in Appendix A. For data confidentiality reasons, the archaeological site boundary has not been included in Figures 10 and 11 or in Appendix J. Until design advances for project renewal components that will occur in the area of concern and approval is granted by ACMSW, there is some high potential to encounter known or unknown archaeological resources in the LSA. Impacts related to disturbing known or unknown archaeological resources are, therefore, rated as negative, direct, major, temporary to permanent, local and likely.

Mitigation Measures and Residual Impacts

In compliance with the conditional approval related to archaeological resources, the City will submit component-specific applications to ACMSW for their review and determination of requirements pursuant to the *Historical Resources Act* (HRA) and/or approval prior to construction. Until project component specific approvals are received from ACMSW, the residual impact to archaeological resources remains negative, direct, major, temporary to permanent, local and likely.

Once approvals are received for proposed works and construction activities commence, and in accordance with ACMSW approval requirements, all work will be immediately suspended and ACMSW contacted should potential historical/archaeological resources be discovered during construction. Appropriate follow-up measures would then be implemented.

5.2.8.2 Disturbance to Palaeontological Resources

Impacts

Alberta Culture, Multiculturalism and Status of Women (ACMSW) granted conditional HRA approval related to palaeontological resources with the condition that a Historic Resources Impact Assessment (pHRIA) for palaeontological resources in the form of a construction monitoring program be conducted by a qualified palaeontologist. Monitoring is to occur for construction activities in areas of undisturbed fluvial deposits that sit outside the margins of the existing park ring road where significant subsurface disturbance (>1 m below surface) will occur. The potential for adverse impacts to palaeontological resources is considered high, therefore, impacts to palaeontological resources are rated as negative, major, permanent, local to regional and likely.

Mitigation Measures and Residual Impacts

The City will implement the palaeontological construction monitoring program for all works in the areas and at the depths specified by ACMSW. If significant palaeontological resources are encountered during construction activities the Royal Tyrrell Museum of Palaeontology must be contacted. With these mitigation measures in place, residual impacts are rated as negligible.

5.2.9 Project Incidents

5.2.9.1 Release of Hazardous/Deleterious Substances On or Off-site

Impacts

Fuels, lubricants and other hazardous materials are anticipated on-site. Spills or releases can occur during refueling, as a result of equipment failure (e.g., leaking hose), accidents, or improper storage/containment at sites. Spills can cause localized contamination of soils, plant communities, wildlife habitat on and off site and if they enter catch basins, they could travel to the NSR. Most spills would likely be small in nature, but if uncontrolled, spills could spread over large areas. Small spills are anticipated at most construction sites. Large spills are more preventable. Spill migration is particularly likely on the relatively steep NSR bank slopes and shallower slopes around Hawrelak Lake. Unprotected catch basins and manholes in the project area that lead into the City's storm sewer system have the potential to capture unmitigated releases of deleterious materials and transmit them to downstream water bodies including the NSR. Catch basins are especially vulnerable where they are situated at the foot of unprotected slopes where long slopes produce higher flow velocities and can capture higher flow volumes that could overwhelm insufficient protective measures.

If appropriate plans and practices are not put into place, the impact of a hazardous or deleterious substance spill could be negative, direct and indirect, minor to major, permanent, local and likely impact on local resources such as plants, soils, surface water and potentially fish and aquatic resources in the NSR.

Mitigation and Residual Impacts

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 provide a spill prevention and emergency response plan and a hazardous waste management plan. The plans must also include construction monitoring protocols and frequency. With these measures in place the residual impact should be negligible.

5.2.9.1 Release of Sediment or Other Debris On or Off-site

Impacts

Park renewal construction activities will result in the removal of vegetation and exposure of bare soil surfaces, likely for extended periods of time. Construction activities on exposed soils can result in erosion and loss of top-soils and sub-soils, degradation of top-soil quality, weakened slope stability, or introduce sediments directly into the park's pond or indirectly to the NSR through catch basins. In areas where existing vegetation cover is cleared, exposed soils are susceptible to fluvial (surface water) erosion in wet conditions, and, to a lesser extent, aeolian (wind) erosion in dry conditions. The clearing of vegetation on steep slopes will expose soils that are especially susceptible to erosion resulting from surface runoff given high slope gradients. Eroded soils can accumulate in downslope undisturbed vegetated areas. If mitigation measures (controls and clean-up measures) are not put into practice, the impact on vegetation, habitat, Hawrelak Lake and the NSR would be negative, direct, minor to major, permanent, local and likely.

Mitigation and Residual Impacts

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 a site-specific temporary ESC plan, to City of Edmonton specifications, and a site-specific care of water plan. 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 to the NSR should be negligible.

5.3 Cumulative Effects (past projects, present projects, future planned projects)

The cumulative effects assessment study area was defined as the expanded study area (Figure 1, Appendix A). The assessment considered past projects, known projects and publicly announced future projects.

5.3.1 Past Projects

Past projects that have recently taken place within the expanded study area include the Edmonton Federation of Community Leagues (EFCL) Community League Plaza in Hawrelak Park – completed in October 2020, Groat Road Bridges Renewal Project - completed November 2020, the Emily Murphy Park Renewal Project - completed October 2021 . The EFCL Community League Plaza comprised construction of a new plaza along the southeast shore of Hawrelak Lake in commemoration of the EFCL's 100th Anniversary. The facility includes new seating, lake and creek viewing areas, public art installations, displays and historical information. The Groat Road Bridges Renewal Project comprised replacement of the bridge superstructure with the addition of a wider SUP, renewal of adjacent roadways and sidewalks and construction of a new boat dock facility in adjacent Emily Murphy Park. The Emily Murphy Park Renewal Project consisted of renewal of existing park roads, parking areas, and signage.

5.3.2 Present/Ongoing Projects

Present projects occurring in the expanded study area include the Buena Vista/Laurier Park Plan, Royal Mayfair Golf Club Clubhouse Rejuvenation and 99 Avenue Sanitary Trunk Rehabilitation Project. The Buena Vista/Laurier Park Plan expands opportunities to view the river, introduces additional amenities, enhances existing facilities, increases barrier-free design through the park, identifies preservation areas and implements measures to protect and stabilize shoreline areas along the river. This phased project started in 2012 and is currently active. The Royal Mayfair Golf Club Clubhouse Rejuvenation Project comprises the renovation of the clubhouse building. Construction commenced in fall 2021 and will be completed in 2022. EPCOR's 99 Avenue Sanitary Trunk Rehabilitation Project, located on the west side of the NSR to the northwest of Hawrelak Park, comprises the renewal of an existing sanitary trunk and construction of a new sanitary trunk in order to better service 100,000 residences. The project started in 2020 and is anticipated to be completed in 2024. That project involves work within road right-of-ways and residential neighbourhoods.

5.3.3 Future Planned Projects

The Touch the Water Promenade - Northshore Promenade project (NSP) is the only known planned project within the expanded study area. The NSP project is proposed to extend along the north shore of the NSR between Government House Park and upstream of the Walterdale Bridge. The proposed project will upgrade the current SUP system in this area and provide more opportunities for the public to access and view the NSR. The project start date is unknown at this time.

5.3.4 Conclusion

As Hawrelak Park is a long-established, destination river valley park in need of rejuvenation to maintain that status and continue to host many events. Park renewal is not triggered by other projects. The proposed project represents a stand-alone project and is not contingent upon past or ongoing projects in the expanded study area or elsewhere. Connectivity to other parks already exists and is not changing. Hawrelak Park renewal is

also independent of the future NSP project. The proposed park renewal is not anticipated to act as a catalyst for NSP or any additional future development in this area. The proposed project, therefore, has no potential to result in impacts that act cumulatively with impacts of past, present or identified planned (future) projects.

6.0 ENVIRONMENTAL MONITORING

This EIA identifies several monitoring commitments to be undertaken during project construction:

- Pursuant to City of Edmonton's Environmental Management System (Enviso), contractor implementation of the project's Environmental Construction Operations (ECO) Plan should be monitored, weekly. This must be undertaken by a specialist engaged by the project Contractor(s) or directly by the City. If done by the Contractor, the City should undertake quality control auditing of ECO Plan implementation and environmental performance.
- Similarly, as a subset of the above, monitor efficacy of the contractor's ESC Plan. This should be done by a Certified Professional in Erosion and Sediment Control (CPESC) or equivalent.
- Monitor implementation of the project's Care of Water Plan
- Monitor implementation of the project's Tree Protection Plan.
- Monitor implementation of the project's Weed Control Plan.
- Monitor the performance of the park-wide invasive weed removal program. monitoring should continue following construction.
- If lake dewatering or other invasive activities, such as shrub installation on the lake islands, is required during the goose breeding season, monitor goose nesting at the lake and use deterrents to prevent nesting as needed to remain compliant with the law.
- If invasive activities are planned for the lake during the period 20 April to 30 August, engage a wildlife specialist to monitor implementation of the project's wildlife management plan.
- Undertake water quality monitoring during lake dewatering.
- A professional consulting palaeontologist must be on site to monitor construction activities involving excavation activities greater than one (1) meter below surface in the prescribed area of concern.

7.0 PUBLIC, INDIGENIOUS AND STAKEHOLDER ENGAGEMENT

The City has held two public engagement sessions for the proposed Hawrelak Park renewal project, one took place in 2018 and the other in 2021 (Appendices L and M). In 2018, engagements were held online, at Hawrelak Park through intercept and drop box surveys, at a neighborhood in-person session, and through festival and event organizer group sessions (City of Edmonton 2018, Appendix L). The series of engagements were held between June and October 2018. In general, respondents indicated that washrooms should be the priority for rehabilitation. Other improvement areas included: more seating areas, better picnic sites, better walking paths, better signage, parking and an improved playground. The majority of respondents had no issues moving through the park and the main issue identified was the need for a paved SUP around the park to support moving pedestrians and bikes away from the road where traffic congestion and safety are a concern. Park users generally felt safe in the park, but felt there was a need to update lighting throughout the park to improve safety. Respondents indicated that many of the buildings within Hawrelak Park could be updated (City of Edmonton 2018).

Between 11 January 2021 and 26 January 2021, the City invited the public to advise on two pathway options using the Engaged Edmonton online platform (City of Edmonton 2021, Appendix M). Road signs, social media, public service announcements and notifications to stakeholders were used to invite feedback. A total of 3918 visited or contributed to the Engage Edmonton project page. Participants were asked to provide feedback on the two proposed trail design options (Option A: Internal Pathway Design; Option B: External Pathway Design).

For Option A, participants indicated they liked the visibility and sense of security of the internal pathway, the paved paths, the direct connection points to the lake and other amenities, the connection to grassy areas and open spaces, the ability to interact with nature, and the reduced impact on the natural landscape, river and wildlife in comparison to Option B (City of Edmonton 2021). Respondents indicated that Option A could be improved by having better connections to regional routes, providing alternative regional routes for cyclists to avoid off-leash areas, having safe vehicle entry and exit to the park, adding blue emergency phones and improved lighting to improve safety, enhancing connections to park amenities, enhancing the multi-use path that connects the wooden staircase on the southeast corner of the park, adding a path that circles the lake and not adding the new west path along the lake to limit environmental impact (City of Edmonton 2021).

For Option B, participants indicated that they liked the circulation on the external multi-use path, the connection with existing pathways, the limited road crossings, the paved path, the addition of a path on the north side of the park to create a full loop around the park, the limited impact on other park activities, vegetation, wildlife and the lake compared to Option A, and how the external park provides a better view of the river and park (City of Edmonton 2021). Respondents indicated that Option B could be improved by installing a physical barrier between the path and the road, enhancing the path on the southeast and

north sides so pedestrians do not have to use the road, consideration of cross-country ski trails and decreasing the width of the path to limit the impact on the natural landscape (City of Edmonton 2021).

In general, respondents advised that cyclists, pedestrians and vehicles should have their own path systems. It was also suggested that the use of pavement on trails should be limited to reduce the impact to the natural landscape, wildlife and vegetation. Some respondents thought that the pathway system within Hawrelak Park should not be rehabilitated at all. There was also general consensus that pathway design needs to consider winter activity use and that maintenance is critical year-round (City of Edmonton 2021).

Participants of the 2021 engagement also had an opportunity to provide feedback on the overall Hawrelak Park renewal project. Some suggestions included making the lake safe for swimming and watersports, increasing the number of bathrooms, upgrading current bathrooms and adding amenities (e.g., lockers, water stations, air pumps), addition of gardens, enhancing the wetland buffer, increasing the tree canopy, improved bus service and preservation of the amphitheater (City of Edmonton 2021).

Copies of the 2018 (Reporting Back) and 2021(What We Heard) public engagement reports can be found in Appendices M and N, respectively.

8.0 CONCLUSIONS

8.1 Adverse Residual Impacts and Sensitivities

This EIA has shown that *with the described mitigation measures applied*, all but three adverse impacts related to the construction phase of the project can be mitigated such that adverse residual impacts are reduced to negligible. The key sensitivities identified for the proposed project, therefore, are:

- geotechnical conditions - slope stability on the riverbank,
- habitat alienation during construction, and
- disturbance to known and undiscovered historical/archaeological resources.

Project information for proposed outfall works on the riverbank remains preliminary with few details available regarding outfall design, construction access and proposed construction activities relative to the sensitive NSR riverbank slopes in the LSA. While this EIA assumes that geotechnical conditions at the riverbank will be investigated as part of future design phases and that suitable mitigation will be prescribed to ensure slope stability post-construction, it is not possible to reliably characterize the residual impacts to riverbank slope stability without additional information at this time. Outfall work is, therefore, flagged as one of project components with the greatest potential to impact the local environment and likely to require careful mitigation design and implementation.

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.

Based on schematic design, Alberta Culture, Multiculturalism and Status of Women (ACMSW) granted conditional *Historical Resources Act* (HRA) approval related to archaeological resources for the proposed renewal project subject to a Schedule of Conditions outlined in the approval provided in Appendix J. When design advances and construction disturbance areas are known within the sensitive historical resource area of concern identified along the riverbank by ACMSW, the City will submit component-specific applications to ACMSW for their review and determination of requirements pursuant to the HRA and/or approval prior to construction. Until project component specific approvals are received from ACMSW, the residual impact to archaeological resources remains negative, direct, major, temporary to permanent, local and likely.

8.2 Positive Residual Impacts

Four residual impacts resulting from the proposed project could be rated as positive related to Hawrelak Lake surface water quality, native plant communities, change in invasive plants species or weeds condition and wildlife disturbance from changes to park lighting.

Project objectives include improving Hawrelak Lake water quality through removing lake sediment and undertaking landscaping to render lake shorelines and top-of-bank and two islands less attractive for goose nesting and loafing. Based on implementation of these measures, the project's overall potential impact on lake water quality is rated as a positive, direct, minor, permanent, local and likely impact.

The proposed project includes establishment of a planted 8 m wide buffer around most of Hawrelak Lake, enhanced shrub communities on the two lake islands and the possible augmentation of native perimeter forest communities, to close some existing gaps, all as growth items. These planned enhancements would result in a net gain of native plant communities within the park resulting in a positive, direct, minor, permanent, local and likely residual impact.

Identification and removal of existing invasive plant species is a component of the Hawrelak Park renewal project. The program will target the several noxious and prohibited noxious weeds that have been identified throughout Hawrelak Park, generally along forest edges and in riparian areas. The removal and continued control of these weed species will result in a positive, direct, minor, local, temporary to permanent and likely residual impact.

Consistent with the City's new Light Efficiency Community Guidelines, lighting design goals will include minimizing glare and trespass lighting into native plant communities and onto the lake, with a view to reducing the existing level of nighttime illumination in sensitive and important wildlife habitats and movement corridors. Successfully employing the guidelines would result in a positive impact to wildlife compared to existing conditions and residual impacts of lighting changes on wildlife associated with this project would be positive, direct, minor, permanent, local and likely.

Considering all of 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, with respect to environmental impacts.

8.3 EIA Limitations

This EIA has few limitations as site access was granted and field studies were undertaken at seasonally appropriate times. Impact characterizations are, however, based on schematic design and project information available to the end of September 2021 and are predicated on the assumption that the City's construction contractor will develop environmental controls intended to induce excellent environmental performance during construction. Hawrelak Park renewal is a dynamic, phased project that may be implemented over a relatively long period. As design advances and project decisions are made, the

recommended mitigation measures should be tracked with respect to adoption or need to modify, to ensure that environmental planning and mitigation remains current and effective through to contract tender preparation.

8.4 Summary of Key Mitigation Measures

The following represents a list of key mitigation measures that are important action items for future project stages. 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 distilled here to mitigate potential impacts to slope stability.
    - Conduct geotechnical investigations in future design phases related to outfall design, construction and access on the sensitive NSR riverbank slopes.
    - Ensure qualified geotechnical personnel conduct quality assurance inspections during construction, including for stairway replacement.

- The City must ensure that the construction contractor adheres to all mitigation measures listed in Section 5.2.2 and distilled here to address soil contamination and ensure compliance with EPEA and City requirements:
    - A construction management plan issued by Engineering Services will be required prior to any ground disturbance in the Park.
    - Prepare and implement a comprehensive lake dredging plan.

- The City must ensure that the construction contractor adheres to all the mitigation measures listed in Section 5.2.3 and distilled here to address changes in water quality in Hawrelak Lake and the North Saskatchewan River:
    - implement effective ECO Plan measures and ESC plans for all work near or at the lake and the river
    - Implement a lake dredging plan
    - Contractors to retain a qualified CPESC to monitor ESC measures and environmental performance for all work near or at the river
    - City should retain a qualified CPESC to undertake quality assurance auditing of the contractors' work near or at the river

- The City must ensure that the construction contractor adheres to all the mitigation measures listed in Section 5.2.4 and distilled here to address groundwater related to dredging of Hawrelak Lake:
    - Contractor to implement a dredging-specific environmental protection plan

- 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 fish in the NSR:

  - City will retain a QAES to prepare a fisheries assessment for proposed works in and near the river and comply with recommendations for relevant submissions to DFO for their review.
  - Contractor to comply with *Fisheries Act* conditions provided in Letter of Advice or Authorization

- The City must ensure that the construction contractor adheres to all the mitigation measures listed in Section 5.2.6 and distilled here to address vegetation loss and ensure compliance with the *Corporate Tree Management Policy*:
  - During design, City Forestry to assess/value all open space and native trees/shrubs to be removed to maximize tree protection and retention during design
  - Prepare a Landscaping Plan
  - Prepare a Tree Protection Plan
  - Revegetate exposed soils promptly
  - Discourage weed establishment
  - Ensure Contractor implements weed control and monitoring during the warranty period.

- The City must ensure that they, as proponent, and the retained contractor adhere to all mitigation measures listed in section 5.2.7 to mitigate potential wildlife impacts and ensure compliance with all Provincial and Federal legislation pertaining to wildlife. Note that vegetation clearing timing and working in bird nesting and brood rearing lake habitat are critical issues.

- 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 and distilled here to mitigate impacts to project incidents.

  - Prepare a detailed spill prevention and emergency response plan

8.5 Summary of Outstanding City Environmental Permitting Requirements

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

- North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188) – EIA and SLS approval - anticipated in early 2022

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

- *Historical Resources Act* – City to comply with conditional HRA approval related to archaeology and palaeontology requirements, including submitting component-specific applications to ACMSW for their review and determination of HRA requirements and/or approval and retaining a qualified palaeontologist to conduct a pHRIA in the form of construction monitoring.

- *Water Act* –City to submit application(s) for approval for instream and near stream works at the NSR and dewatering of Hawrelak Lake

- *Water Act – Code of Practice for Outfall Structures on Water Bodies* – City to submit Notification(s) to Alberta Environment and Parks (AEP) at least 14 days prior to construction onset.

- *Public Lands Act* – City to submit relevant disposition applications to AEP [e.g., DLOs, Temporary Field Authorizations (TFAs)] as required for water intake and outfall works on bed and shore of NSR.

- *Fisheries Act* – City to submit Request for Review for water intake and outfall works in and adjacent fish-bearing NSR.

- *Canadian Navigable Waters Act* – City to submit application to the federal Navigation Protection Program for works anticipated to interfere with navigation in the North Saskatchewan River (e.g., water intake, outfall works)

All of the above mitigation and permitting actions are summarized, by project phase in Appendix N.

9.0 REFERENCES

9.1 Literature Cited

AECOM. 2014. Tier 2 Risk Assessment: Hawrelak Park - Final. Prepared for City of Edmonton Engineering Services Edmonton, Alberta.

Alberta Biodiversity Monitoring Institute. 2021. Biodiversity Browser: Northern Water Horehound (*Lycopus uniflorus*). https://www.abmi.ca/home/data-analytics/biobrowser-home/species-profile?year=2017&tsn=99002695

Alberta Community Bat Program. 2018. Building Bat-Friendly Communities – Alberta Program Guide. Available at: https://www.albertabats.ca/wp-content/uploads/AlbertaBFC.pdf.

Alberta Conservation Association and Alberta Sustainable Resource Development (ACA and ASRD). 2010. Alberta Volunteer Amphibian Monitoring Program: Participants' Guide. Alberta Conservation Association. Edmonton, Alberta.

Alberta Environment and Parks. 2010. Key Wildlife and Biodiversity Zones Metadata. file://spnv-srv-01/Projects/GIS%20Material/Unlicensed%20data/AB_KeyWildlifeBioZones/KeyWildlifeAndBiodiversityZones.htm

Alberta Environment and Parks. 2018. List of all Vascular Plant Elements Recorded for Alberta in the ACIMS Database - March 2018. Accessed 14 July 2021.

Alberta Environment and Parks. 2021a. Fish and Wildlife Management Information System. https://maps.alberta.ca/FWIMT_Pub/Viewer/?TermsOfUseRequired=true&Viewer=FWIMT_Pub. Accessed: 15 September 2021.

Alberta Environment and Parks. 2021b. Alberta Conservation Information Management System. https://albertaparks.ca/acims-data/. Accessed: September 2021.

Alberta Invasive Species Council. 2014a. Common Buckthorn Fact Sheet. https://abinvasives.ca/wp-content/uploads/2017/11/FS-CommonBuckthorn.pdf. Accessed 20 August 2021.

Alberta Invasive Species Council. 2014b. Purple Loosestrife Fact Sheet. https://secureservercdn.net/198.71.233.231/yjc.cc8.myftpupload.com/wp-content/uploads/2020/07/PN_FS-PurpleLoosestrife.pdf?time=1629319842. Accessed on 20 August 2021.

Alberta Sustainable Resource Development and Alberta Conservation Association. 2009. Status of the Northern Myotis (*Myotis septentrionalis*) in Alberta: Update 2009.

Alberta Sustainable Resource Development. Wildlife Status Report No. 3 (Update 2009). Edmonton, Alberta.

Applied Ecological Services, Inc. 2020. Hawrelak Lake Water Quality Feasibility Study. Report for the City of Edmonton and Marc Boutin Architectural Collaborative Inc. Alberta, Canada.

Brown, M. B. and C. R. Brown (2019). Barn Swallow (*Hirundo rustica*), version 2.0. In The Birds of North America (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.barswa.02.

Chesser, R. T., S. M. Billerman, K. J. Burns, C. Cicero, J. L. Dunn, A. W. Kratter, I. J. Lovette, N. A. Mason, P. C. Rasmussen, J. V. Remsen, Jr., D. F. Stotz, and K. Winker. 2020. Check-list of North American Birds (online). American Ornithological Society.

City of Edmonton. 1990. Ribbon of Green: North Saskatchewan River Valley and Ravine System Concept Plan. Prepared for the City of Edmonton. Edmonton, Alberta.

City of Edmonton. 2007. Natural Connections Strategic Plan – City of Edmonton Integrated Natural Areas Conservation Plan. Edmonton, Alberta.

City of Edmonton. 2015. Urban Ecological Field Guide for the City of Edmonton, Alberta, Canada. Edmonton, Alberta.

City of Edmonton. 2018. Public Engagement Share Your Voice Shape Our City Reporting Back: 2018 William Hawrelak Park Rehabilitation Plan.

City of Edmonton. 2019 Light Efficiency Community Guidelines. https://www.edmonton.ca/public-files/assets/document?path=PDF/LightEfficiencyGuide.pdf

City of Edmonton. 2020a. Ribbon of Green SW + NE Plan. June 2020. https://www.edmonton.ca/city_government/documents/RibbonofGreenSW_NEPlanJune2020.pdf. Accessed 11 December 2020.

City of Edmonton. 2020b. Edmonton City Plan. Charter Bylaw 20,000. https://www.edmonton.ca/city_government/documents/PDF/City_Plan_FINAL.pdf. Accessed 11 December 2020.

City of Edmonton. 2021. What We Heard Report: William Hawrelak Park Rehabilitation Pathway Design.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2012. COSEWIC Assessment and Status Report on the Western Tiger Salamander (*Ambystoma mavortium*) Southern Mountain Population and Prairie/Boreal

Population in Canada. https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_w_tiger_salaman_tigree_1113_e.pdf.

Cornell Lab of Ornithology. 2021. eBird: An Online Database of the Distribution and Abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org.

Cornell University. 2019. All About Birds: Barred Owl. https://www.allaboutbirds.org/guide/Barred_Owl/lifehistory.

Crimson Environmental Limited. 2021. Limited Phase II Environmental Site Assessment, Hawrelak Park Maintenance Yard. Portion of 9330 Groat Road NW, Portion of Plan 6075AM, Block, X. Edmonton, Alberta. Prepared for the City of Edmonton, Engineering Services Section, IIS, Edmonton, Alberta.

Ecofor Consulting Ltd. 2020. Draft Tree and Shrub Inventory - Hawrelak Park. Prepared for Marker Geomatics Inc. Edmonton, Alberta.

E-Flora BC. 2021. Lycopus uniflorus Michx. northern water horehound (northern bugleweed) Lamiaceae (Mint family). http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Lycopus+uniflorus

ENC Testing Inc. 2015. Geotechnical Investigation Proposed 100th Anniversary Project Hawrelak Park East and West Plazas, Pedestrian Bridge and Boardwalks 9930 Groat Road NW, Edmonton, Alberta. Prepared for Urban Systems Ltd. Edmonton, Alberta.

Engineering Services. 2012. Hawrelak Park Pond Retaining Wall Geotechnical Investigation. Prepared for the City of Edmonton. Edmonton, Alberta.

Environment and Climate Change Canada. 2018. Recovery Strategy for the Little Brown Myotis (*Myotis lucifugus*), the Northern Myotis (*Myotis septentrionalis*), and the Tri-colored Bat (*Perimyotis subflavus*) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. ix + 172 pp.

Government of Alberta. 2013. Sensitive Species Inventory Guidelines. https://open.alberta.ca/dataset/93d8a251-4a9a-428f-ad99-7484c6ebabe0/resource/f4024e81-b835-4a50-8fb1-5b31d9726b84/download/2013-sensitivespeciesinventoryguidelines-apr18.pdf. Accessed 14 April 2021.

International Dark Sky Association. 2021. Light Pollution Effects on Wildlife and Ecosystems. https://www.darksky.org/light-pollution/wildlife/. Accessed 17 October 2021.

Kendell, K. 2020. Garter Snake (*Thamnophis* spp.) Surveys at Historical Den Sites in Alberta, 2017-2019. Data Report. Alberta Conservation Association, Sherwood Park, Alberta, Canada.

Marc Boutin Architectural Collaborative Inc. & PFS Studio. 2021. William Hawrelak Park Rehabilitation Schematic Design Report - Draft. Prepared for the City of Edmonton. Edmonton, Alberta.

Moss, E.H. 1983. Flora of Alberta. 2nd Edition, revised by J.G. Packer. University of Toronto Press. Toronto, Ontario.

Olson, C. and Holroyd, S. 2018. Building Bat-Friendly Communities. Alberta Program Guide. The Alberta Community Bat Program – Wildlife Conservation Society Canada. Available online: https://www.albertabats.ca/wpcontent/uploads/AlbertaBFC.pdf

Pisces Environmental Consulting Services Ltd. 2015. Assessment of the Fisheries Resources and Habitat of the North Saskatchewan River for a Proposed Boat Docks and Launches Project Within the City of Edmonton, Alberta. Prepared for Spencer Environmental Management Services Ltd. Edmonton, Alberta.

Rich, C. and T. Longcore. Eds. 2005. Ecological Consequences of Artificial Night Lighting. Island, Washington, DC, 478 pp.

RPK Architects Ltd. 2019. William Hawrelak Park Rehabilitation Implementation Plan. Prepared for the City of Edmonton. Edmonton, Alberta.

Saskatchewan Wildflowers. 2021. Ambrosia artemisiifolia (Annual Ragweed) - photos and description. https://www.saskwildflower.ca/nat_Ambrosia-artemisiifolia.html

Solstice Canada. 2016. Environmental Sensitivity Project, Draft Final Report. Prepared for the City of Edmonton. Edmonton, Alberta.

Stantec Consulting Ltd. April 2014. Hawrelak Park Phase 1 Environmental Site Assessment 9330 - Groat Road NW, Portion of Block X, Plan 6075AM, Edmonton, Alberta. File #1161- 101596. Prepared for the City of Edmonton. Edmonton, Alberta.

Stantec Consulting Ltd. May 2014. Hawrelak Park Limited Phase II Environmental Site Assessment, 9330 - Groat Road NW, Portion of Block X, Plan 6075AM, Edmonton, AB. File# 1161-101596. Prepared for the City of Edmonton. Edmonton, Alberta.

Stantec Consulting Ltd. July 2014. Hawrelak Park Phase I Environmental Site Assessment, 9330 - Groat Road NW, Portion of Block X, Plan 6075AM, Edmonton, AB. File # 1102-19185. Prepared for the City of Edmonton. Edmonton, Alberta.

Thurber Engineering Ltd. 2021a. William Hawrelak Park Rehabilitation. Edmonton, Alberta. Geotechnical Investigation. Revision 1. Prepared for City of Edmonton Engineering Services. Edmonton, Alberta.

Thurber Engineering Ltd. 2021b. William Hawrelak Park Rehabilitation Staircase Replacement on East Side of Park. Edmonton, Alberta. Geotechnical Desktop Study. Prepared for City of Edmonton Engineering Services. Edmonton, Alberta.

9.2 Personal Communications

Daly, P. Biological Sciences Technologist, Citizen Services, Community Standards & Neighbourhoods, City of Edmonton

Dumont, R. Program Manager, Facility Planning & Design, IIS, City of Edmonton

Jenkins, M. Pest Management Coordinator, Citizen Services, Community Standards & Neighbourhoods, City of Edmonton

Kendell, K., Senior Biologist, Alberta Conservation Association

Maslen, L., M.Sc., P.Biol., President, Spencer Environmental Management Services Ltd.

Olson, C., M.Sc., P.Biol., Alberta Bat Program Coordinator, Wildlife Conservation Society Canada.

Reid, J., River Valley Parks & Facilities, Citizen Services, City of Edmonton

Turner, B. Team Leader, River Valley Parks & Facilities, Citizen Services, City of Edmonton

Appendix A: Figures

Figure 1. Project Location with EIA Local and Expanded Study Areas
Figure 2. City of Edmonton Land Use Zoning
Figure 3. Flood Hazard Mapping
Figure 4. City of Edmonton Environmental Sensitivities – Original (2016)
Figure 5. City of Edmonton Environmental Sensitivities – Updated (2021)
Figure 6. Existing Plant Communities and Rare Plants
Figure 7. Weed Infestation Locations
Figure 8a. Wildlife Survey Locations - Snake Hibernaculum Survey Transect, Amphibian Survey Points & Salamander Dipnet Sampling Stations
Figure 8b. Wildlife Survey Locations - Breeding Bird Survey Transect & Waterbird Survey Stations
Figure 9a. Park Structures/Facilities to be Renewed
Figure 9b. Proposed Surface Works
Figure 9c. Proposed Underground Works
Figure 10. Surface Disturbance and Sensitive Features
Figure 11. Underground Disturbance and Sensitive Features

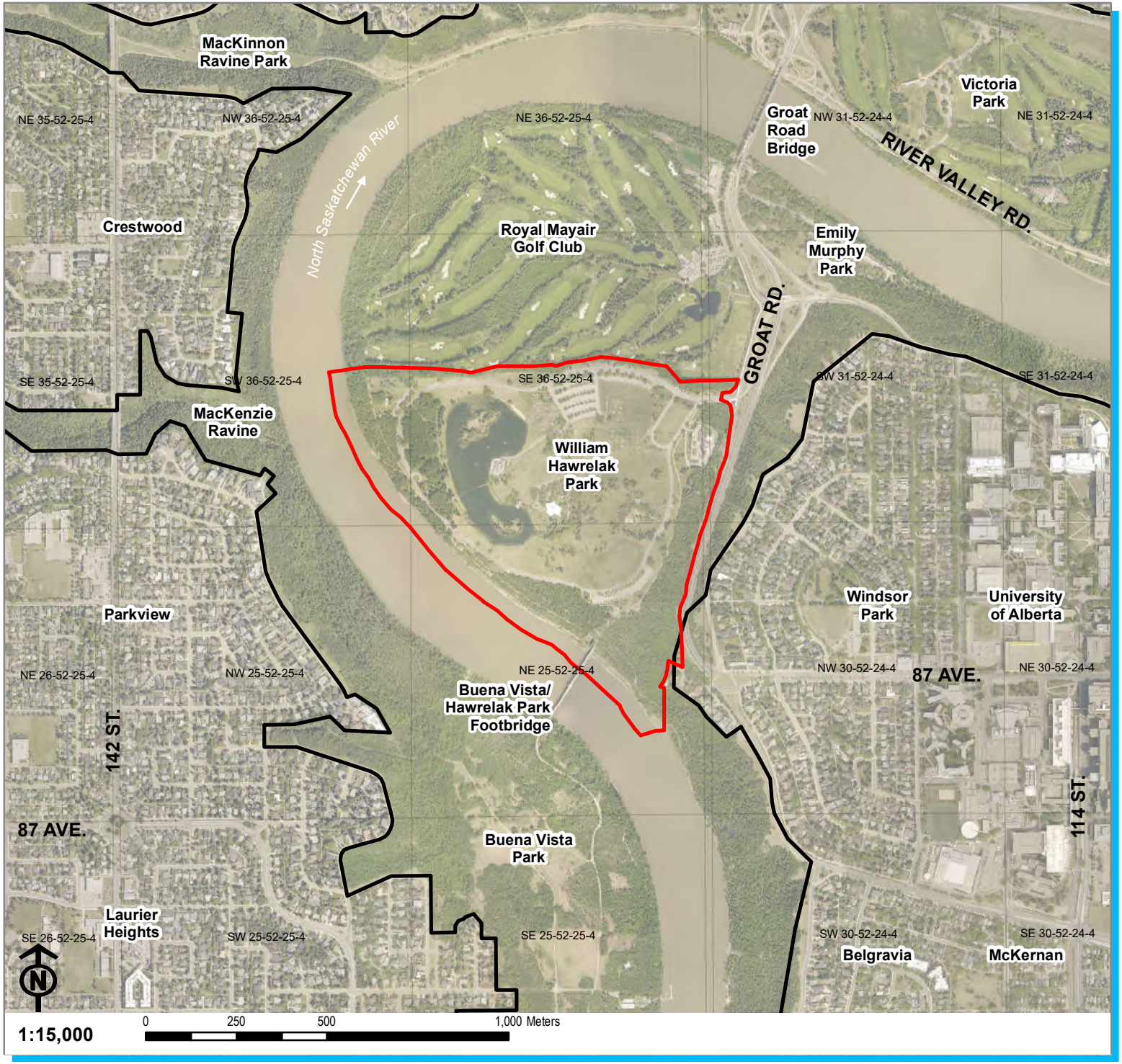
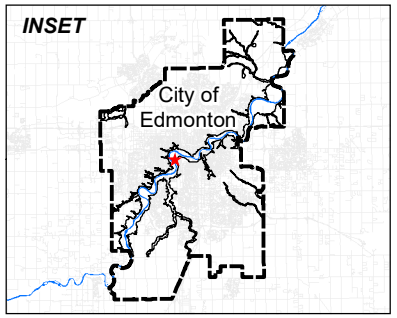


Figure 1.
Project Location with EIA Local and Expanded Study Areas
Hawrelak Park Renewal

Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

*Map extent reflects the Expanded Study Area.



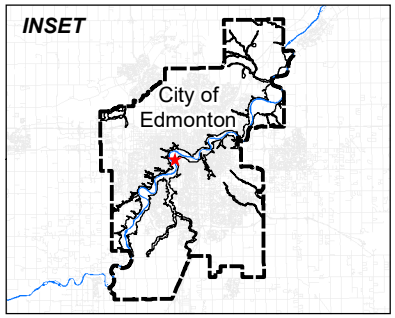
Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Figure 2.
City of Edmonton
Land Use Zoning
Hawrelak Park Renewal

Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)
- Contours (COE 2018)
- Zoning (COE 2020)



Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

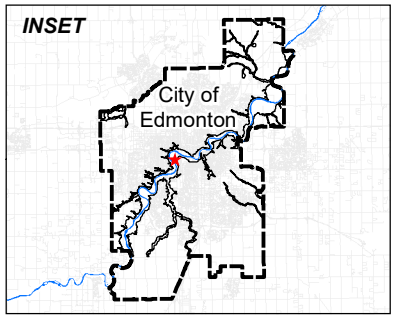
Figure 3.
Flood Hazard Mapping
Hawrelak Park Renewal

Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Flood Hazard Area*

- Floodway
- Flood Fringe



Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Flood Hazard Mapping (AEP, 2015); Government of Alberta is currently updating the City of Edmonton's flood hazard mapping data so the information presented here could change.

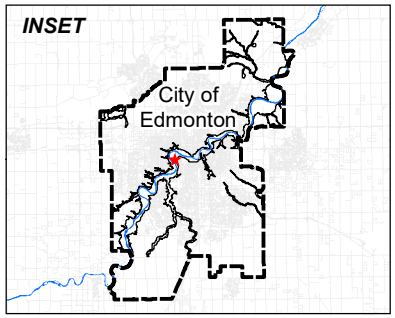
Figure 4.
City of Edmonton Environmental Sensitivities – Original (2016)
Hawrelak Park Renewal

Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Environmental Sensitivity*

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



Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*City of Edmonton Environmental Sensitivity Project (Solstice Canada, 2016).

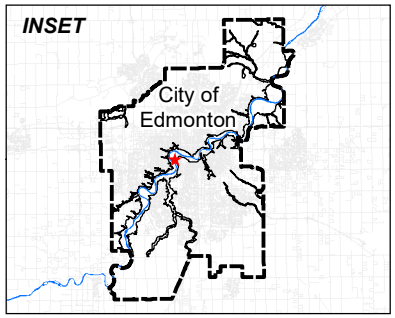
Figure 5.
City of Edmonton Environmental Sensitivities – Updated (2021)
Hawrelak Park Renewal

Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Environmental Sensitivity*

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



Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Update of City of Edmonton Environmental Sensitivity Project (Solstice Canada, 2016) data based on site-specific survey data conducted by Spencer Environmental (2021).

Figure 6. Existing Plant Communities and Rare Plants

Hawrelak Park Renewal

Legend

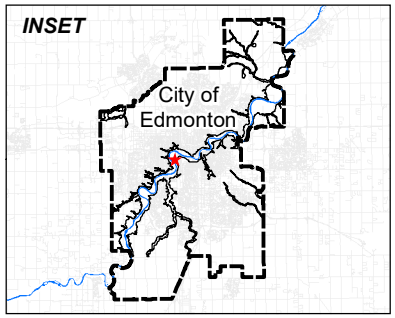
- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Rare Plants

- Tall Meadow Rue (S3)
- Common Ragweed (S3)
- Northern Water-Horehound (S3)

Plant Communities (2021)*

- Deciduous Mixedwood Mixed Shrubs (DLM.1)
- Mixed Deciduous Mixed Shrubs (MD.1)
- Mixed Deciduous Red-Osier Dogwood (MD.2)
- Riparian (R)
- Manicured (M)

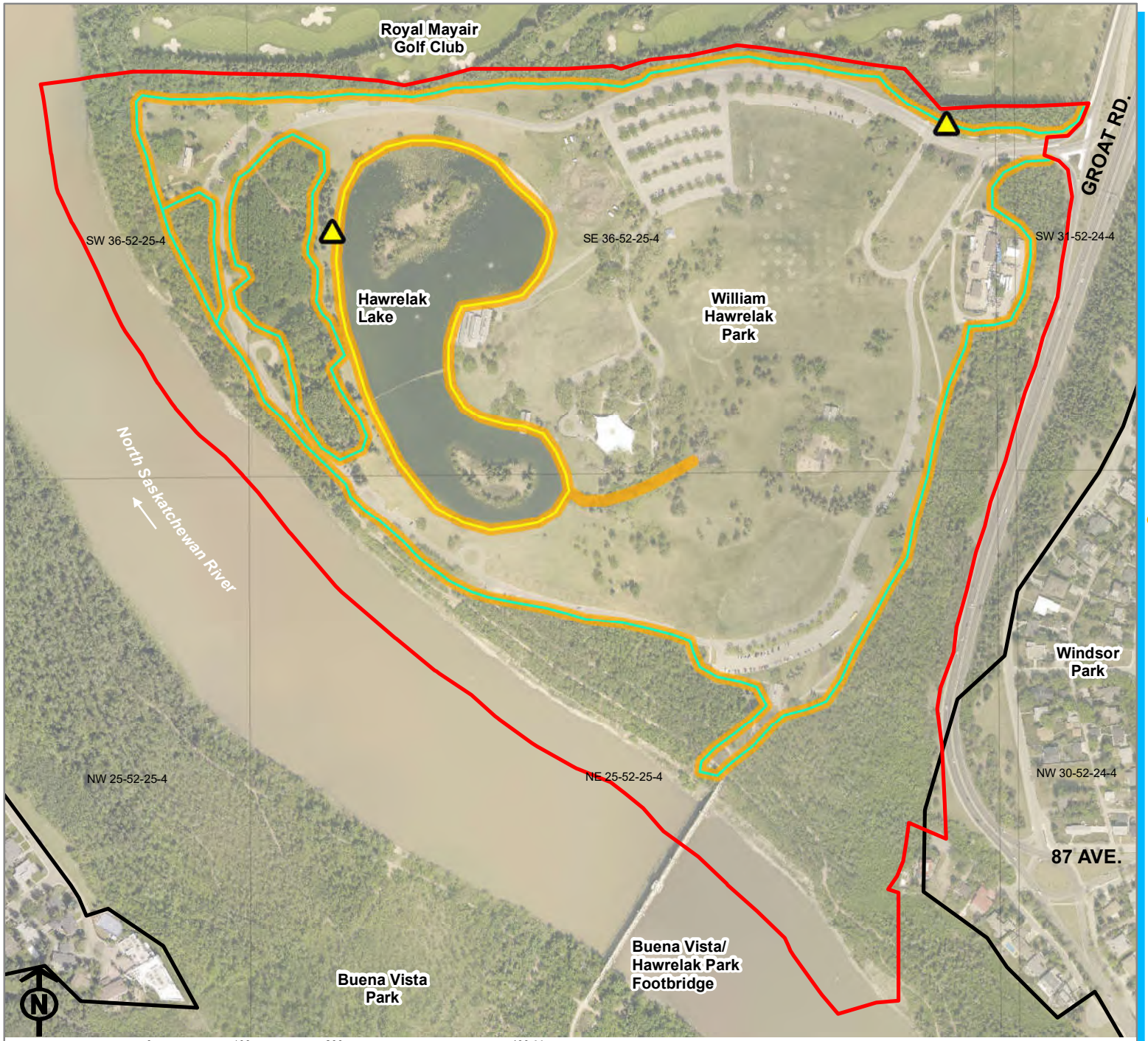


Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Plant community classification follows the Urban Ecological Field Guide for the City of Edmonton, Alberta, Canada (City of Edmonton 2015).
Hawrelak Lake islands were subject to a visual survey from the lakeshore only; therefore, they were not included in the rare plant survey.

Figure 7.
Weed Infestation Locations
Hawrelak Park Renewal



Legend

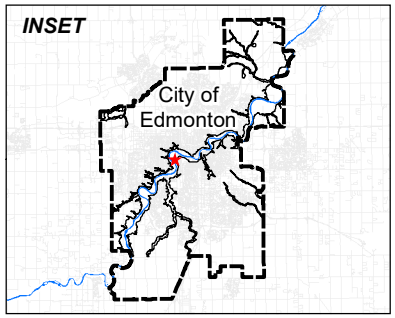
- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Prohibited Noxious Species

- Common Buckthorn General Location
- Purple Loosestrife General Location

Noxious Species

- Creeping Thistle Infestation (Approx.)
- Higher Noxious Weed Species Concentrations



Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

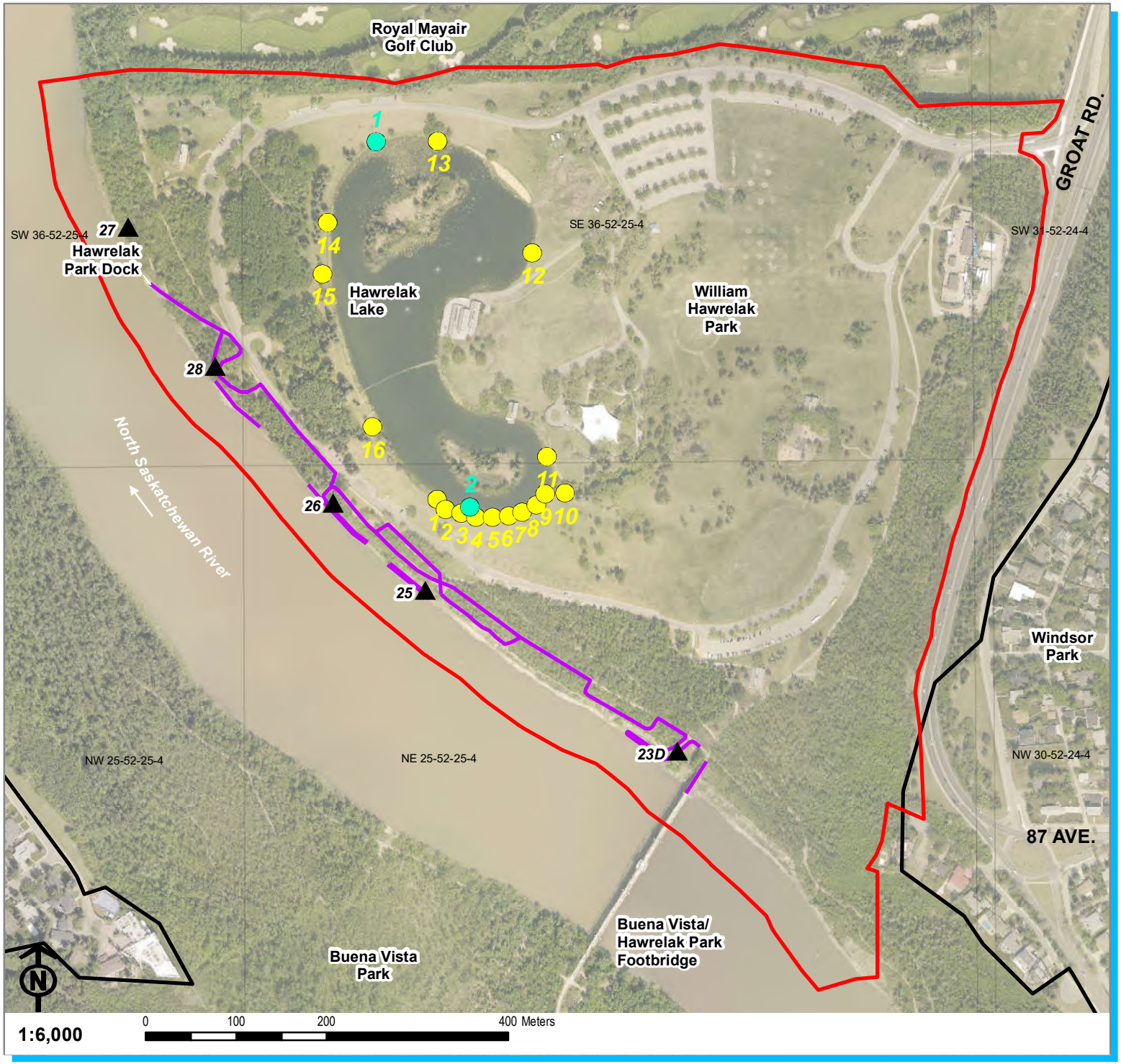


Figure 8a. Wildlife Survey Locations - Snake Hibernaculum Survey Transect, Amphibian Survey Points & Salamander Dipnet Sampling Stations

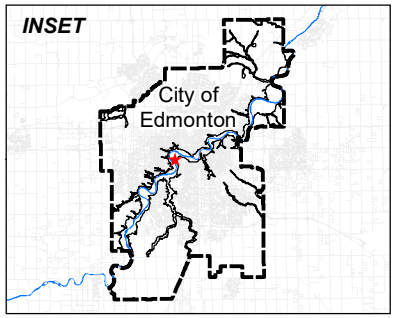
Hawrelak Park Renewal

Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)
- Drainage Outfall (ID#) (COE 2019)

Wildlife Survey Locations

- Snake Hibernaculum Survey Transect
- Amphibian Survey Points (ID#)
- Salamander Dipnet Sampling Stations (ID#)

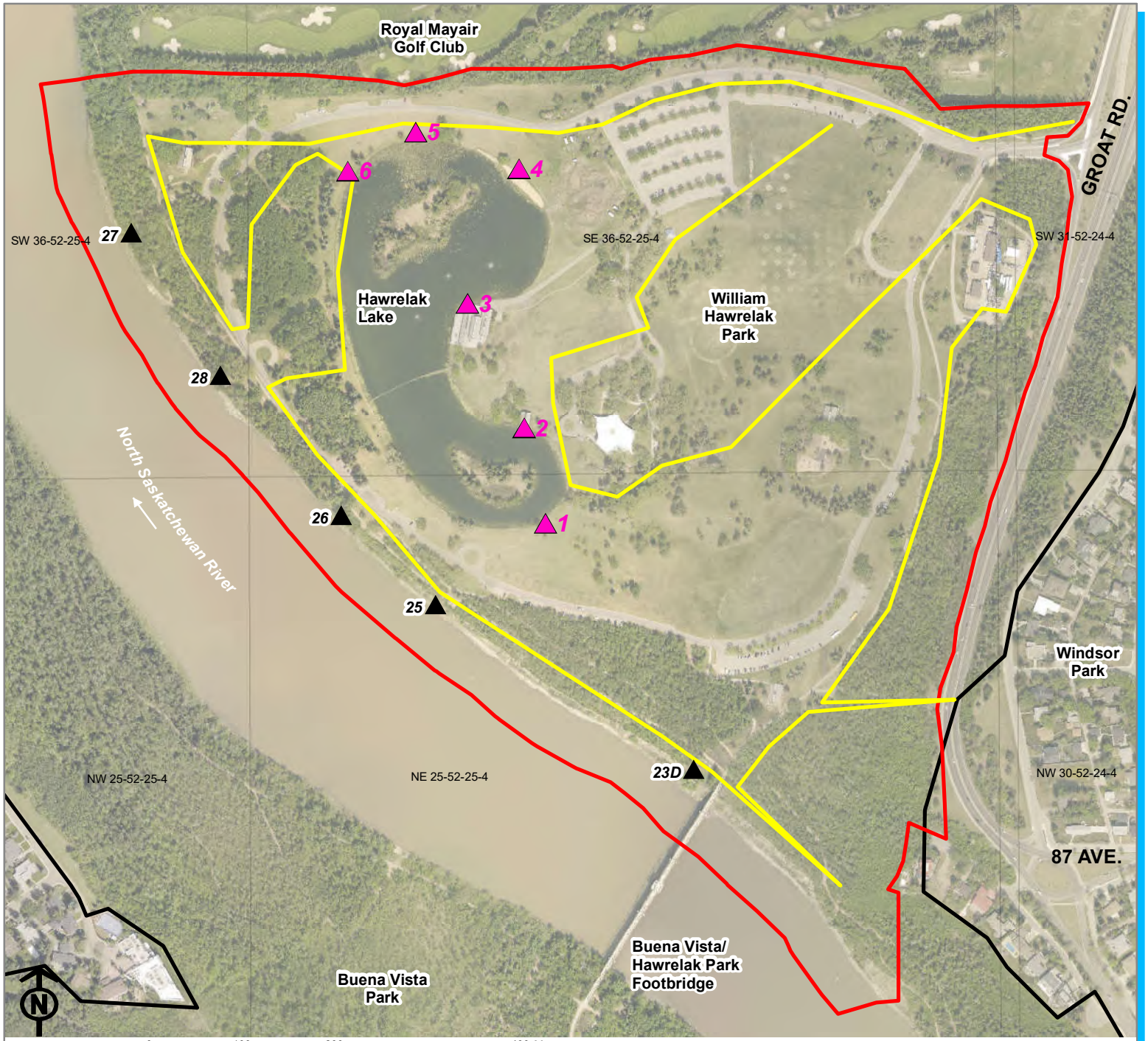


Map Date: 22 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Figure 8b. Wildlife Survey Locations - Breeding Bird Survey Transect & Waterbird Survey Stations

Hawrelak Park Renewal

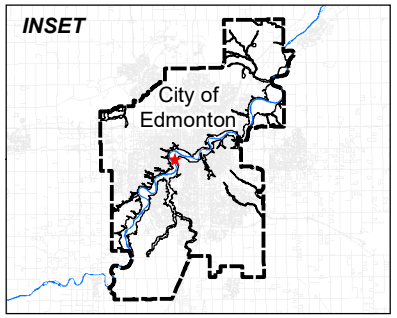


Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)
- Drainage Outfall (ID#) (COE 2019)

Wildlife Survey Locations

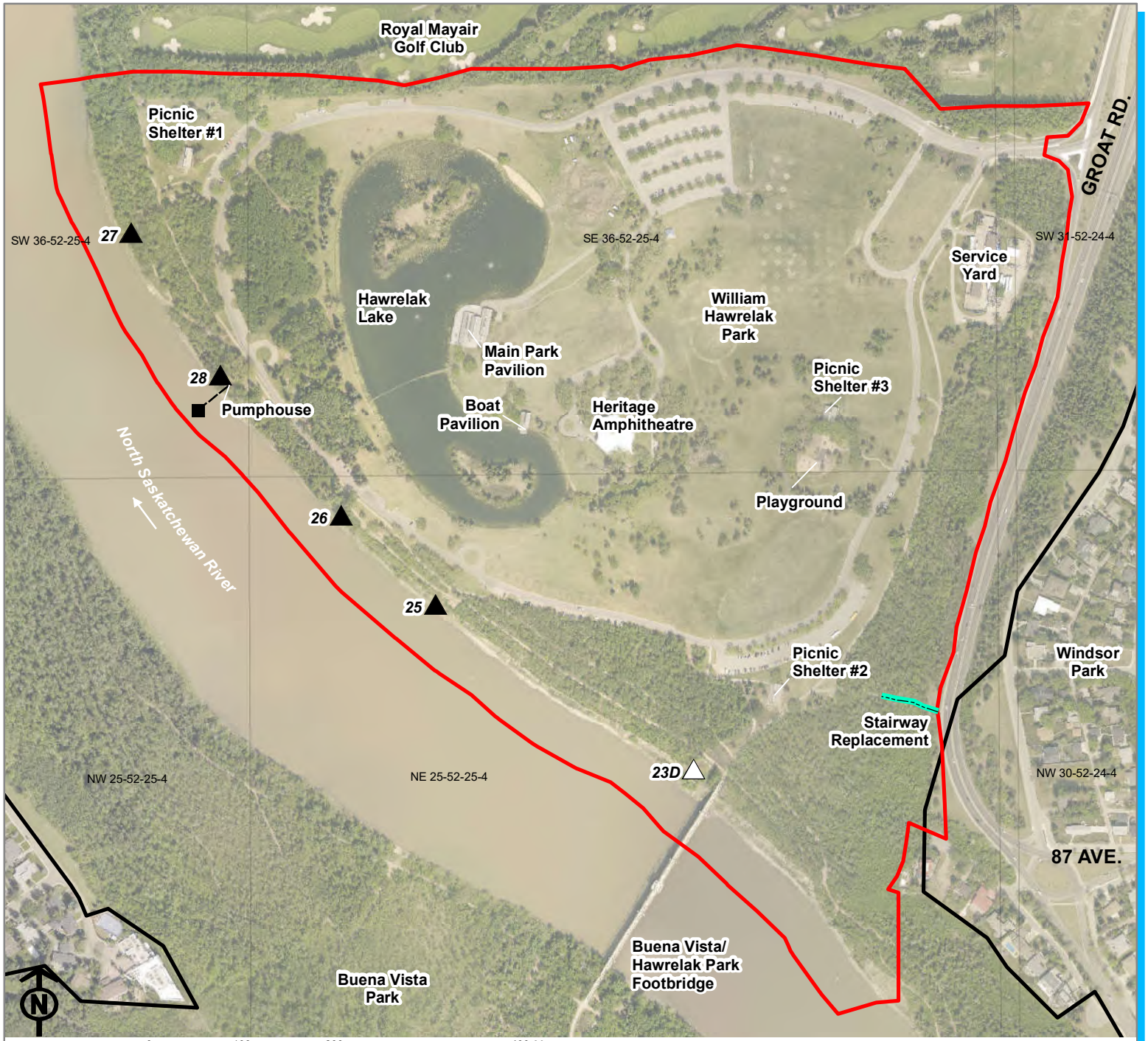
- Waterbird Survey Station (ID#)
- Breeding Bird Survey Transect (100m wide)



Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Figure 9a.
Park Structures/Facilities to be Renewed
Hawrelak Park Renewal

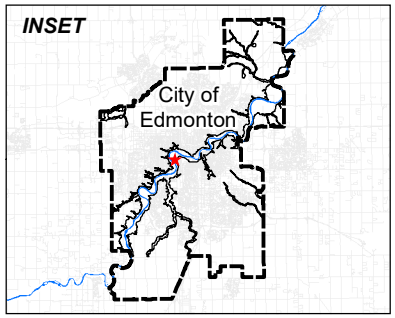


Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Drainage Outfalls (ID#) (COE 2019)

- Existing Outfall with Proposed Works*
- Existing Outfall
- Pumphouse River Intake & Pipe (on river bottom)*

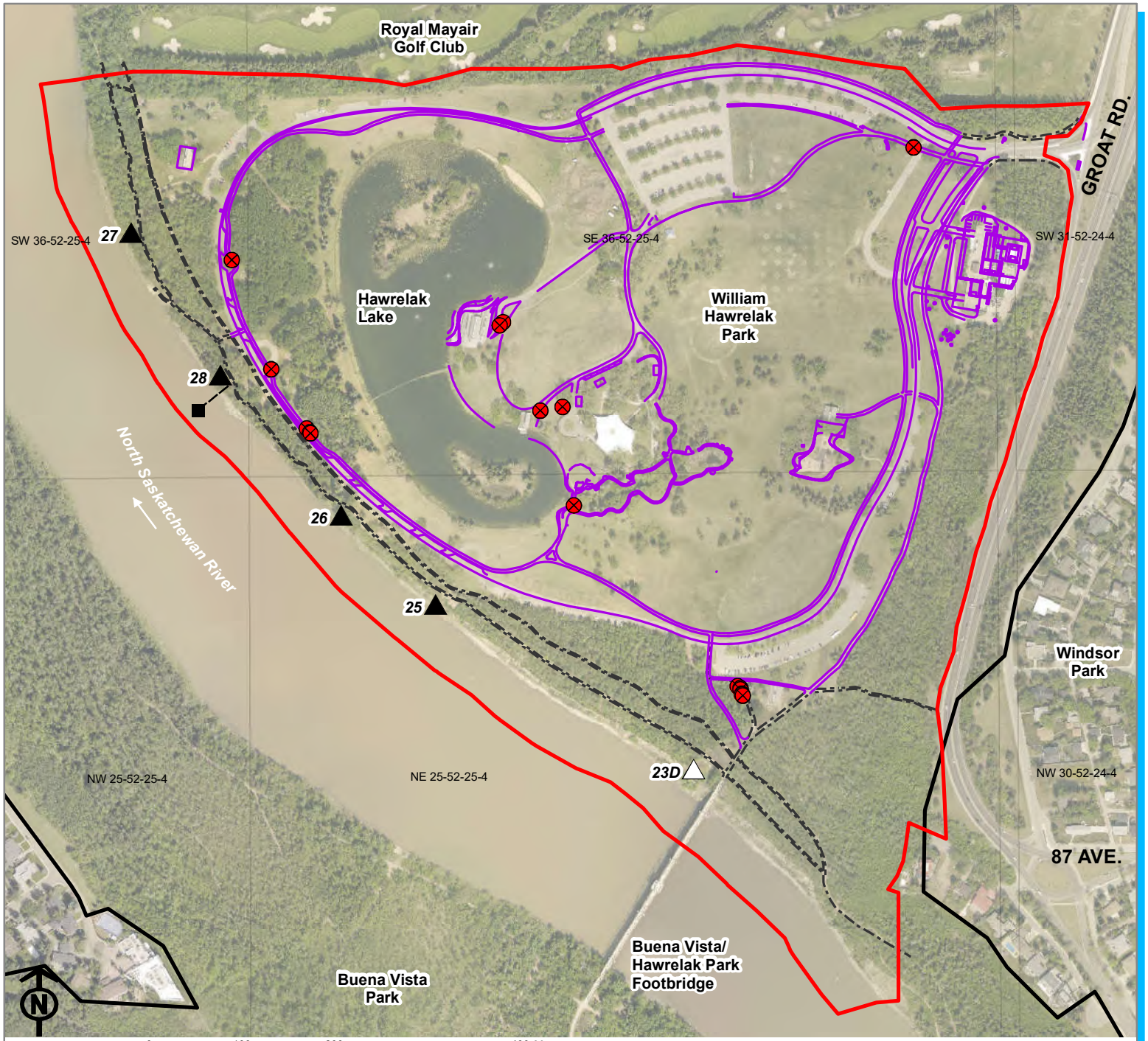


Map Date: 14 December 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Data provided by The Marc Boutin Architectural Collaborative Inc. (2021).

Figure 9b.
Proposed
Surface Works
Hawrelak Park Renewal



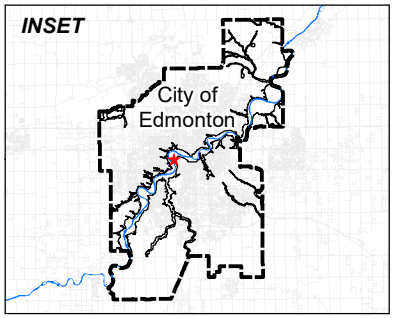
Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Drainage Outfalls (ID#) (COE 2019)

- Existing Outfall with Proposed Works*
- Existing Outfall
- Pumphouse River Intake & Pipe (on river bottom)*
- Proposed Tree Removal*
- Proposed Surface Works*
- Existing Regional Trails - No Change*

Proposed surface works are conceptual and intended to represent areas where surface works/changes, other than structure renewals, are likely to occur.
Does not include picnic area additions, turfed area grading improvements.
Does not include forest augmentation or Hawrelak Lake planting enhancements.
Proposed lighting changes not shown here.

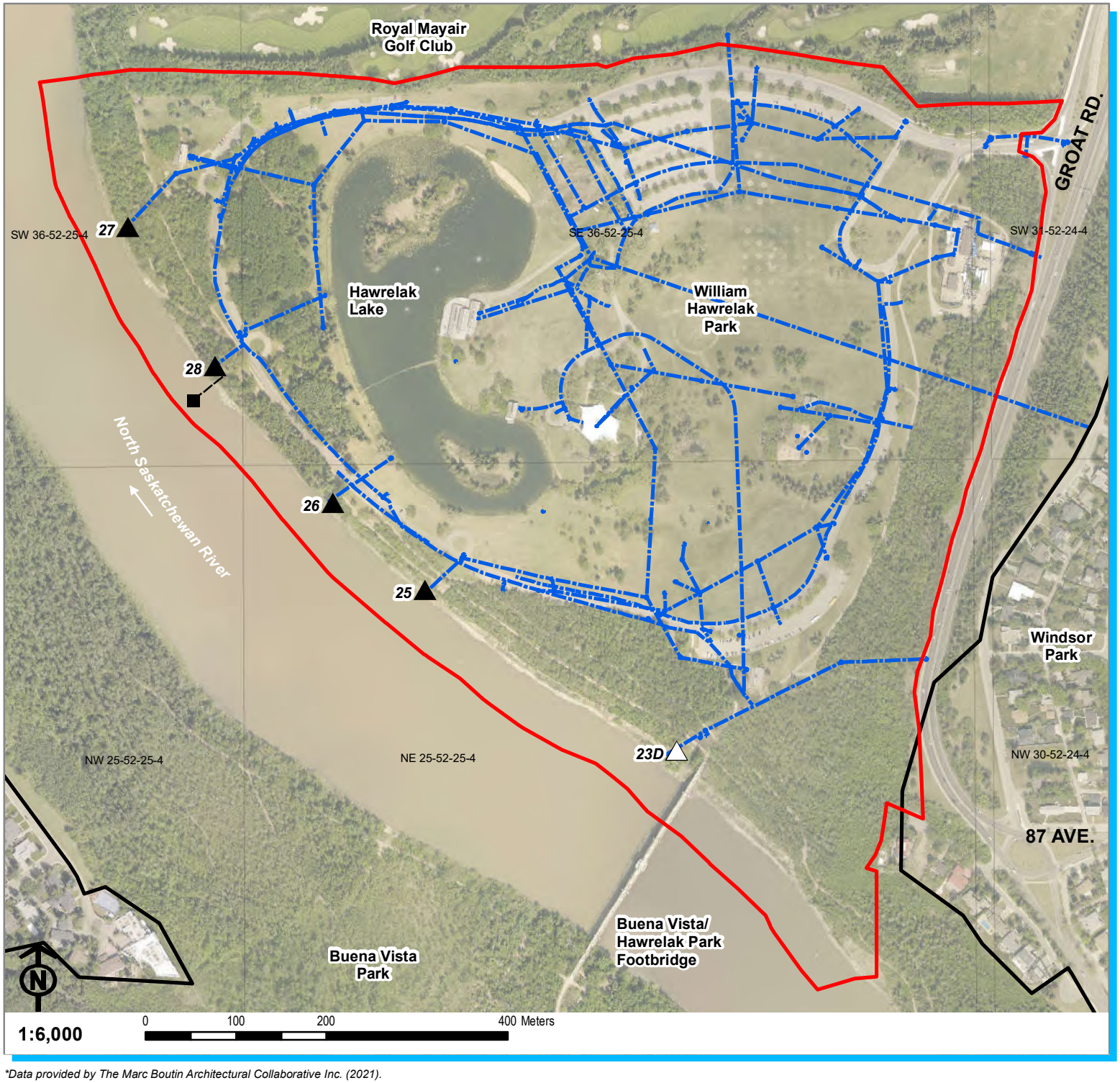


Map Date: 14 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Data provided by The Marc Boutin Architectural Collaborative Inc. (2021).

Figure 9c.
Proposed Underground Works
Hawrelak Park Renewal



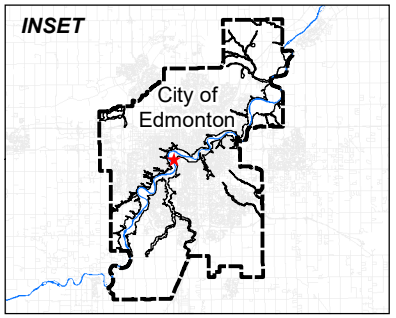
Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)

Drainage Outfalls (ID#) (COE 2019)

- Existing Outfall with Proposed Works*
- Existing Outfall
- Pumphouse River Intake & Pipe (on river bottom)*
- Proposed Underground Works*

Proposed underground works are conceptual only and represent underground utility networks subject to renewal or other change. Not all system components shown will be subject to active work. For example, no work is contemplated on the east park vegetated slopes, near Groat Road.

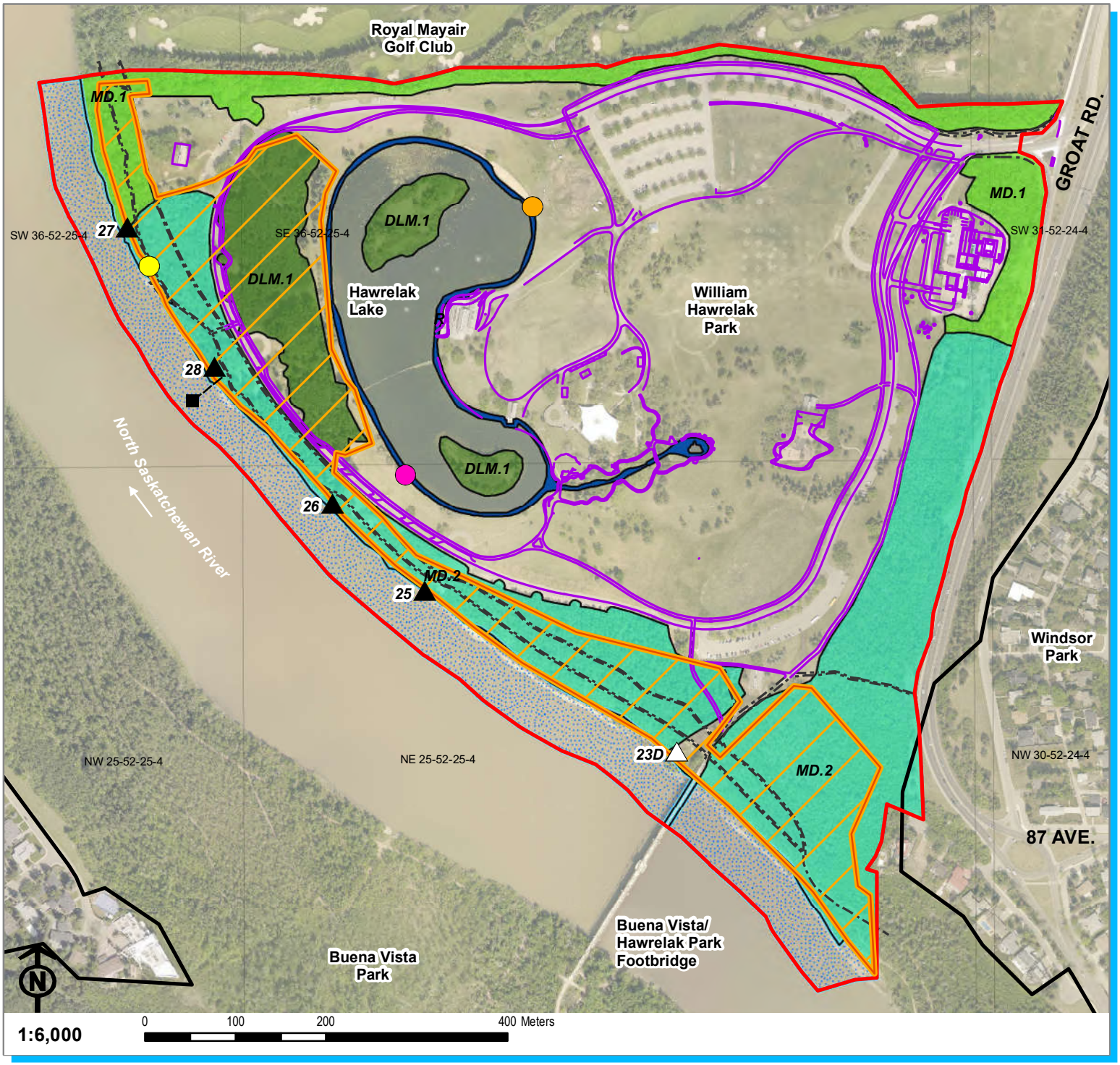


Map Date: 22 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Data provided by The Marc Boutin Architectural Collaborative Inc. (2021).

Figure 10.
Surface Disturbance and Sensitive Features
Hawrelak Park Renewal



Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)
- Historical Resources Area of Concern*

Drainage Outfalls (ID#) (COE 2019)

- Existing Outfall with Proposed Works*
- Existing Outfall
- Pumphouse River Intake & Pipe (on river bottom)*
- Proposed Surface Works*
- Existing Regional Trails* - No change other than stairway replacement shown on Figure 9a

Sensitive Aquatic Habitat

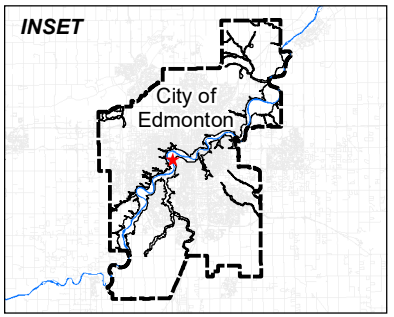
- North Saskatchewan River

Sensitive Plant Community/Habitat

- Deciduous Mixedwood Mixed Shrubs (DLM.1)
- Mixed Deciduous Mixed Shrubs (MD.1)
- Mixed Deciduous Red-Osier Dogwood (MD.2)
- Riparian (R)

Rare Plants

- Tall Meadow Rue (S3)
- Common Ragweed (S3)
- Northern Water-Horehound (S3)

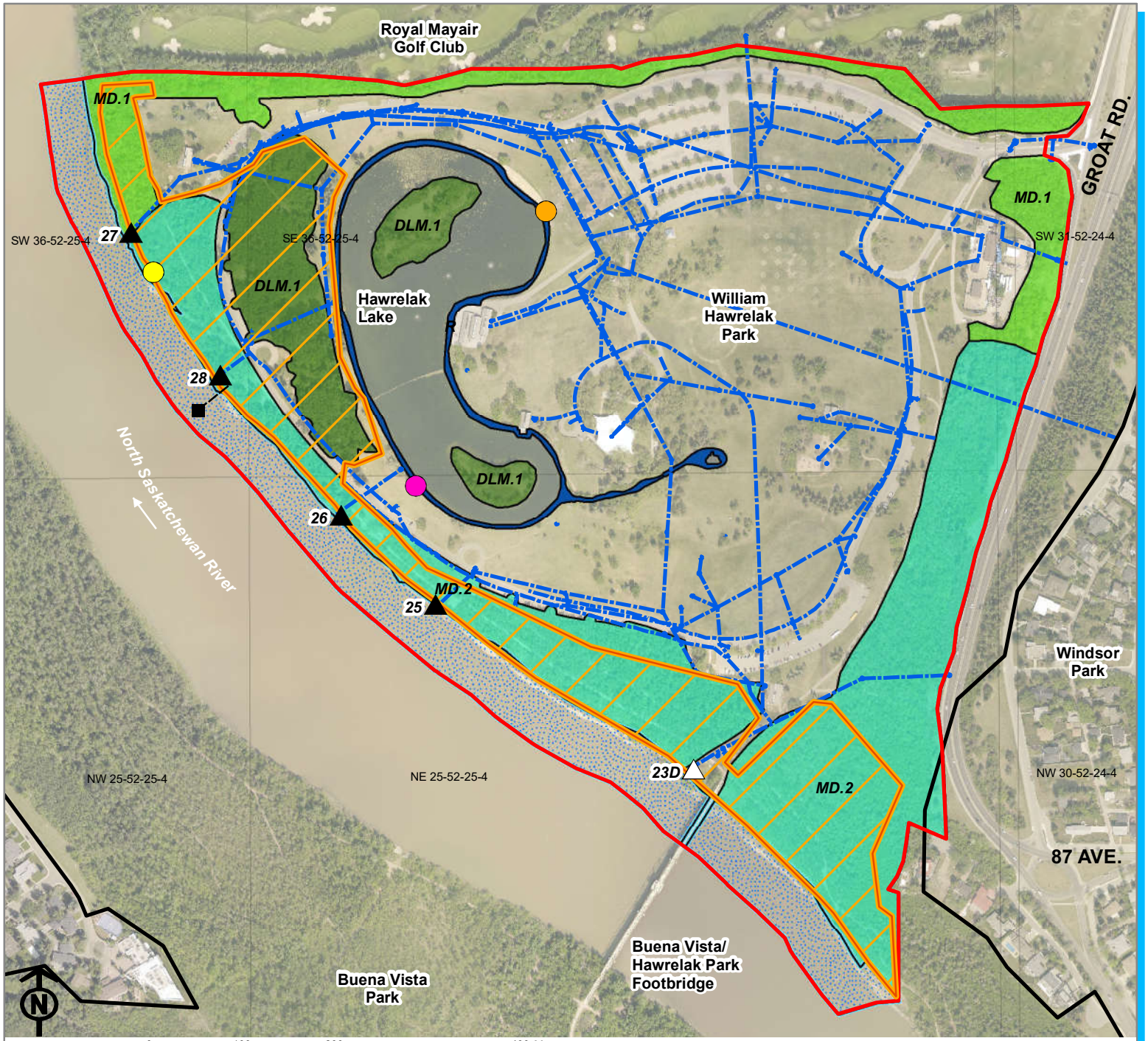


Map Date: 14 December 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Data provided by The Marc Boutin Architectural Collaborative Inc. (2021).

Figure 11.
Underground Disturbance and Sensitive Features
Hawrelak Park Renewal



Legend

- Local Study Area
- Bylaw 7188 Boundary (COE 2008)
- Historical Resources Area of Concern*

Drainage Outfalls (ID#) (COE 2019)

- Existing Outfall with Proposed Works*
- Existing Outfall
- Pumphouse River Intake & Pipe (on river bottom)*
- Proposed Underground Works*

Sensitive Aquatic Habitat

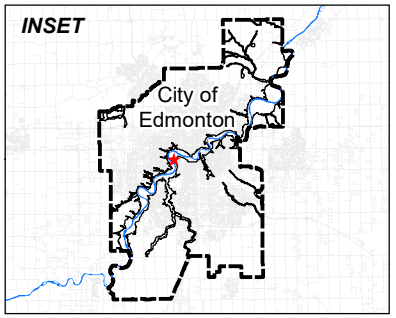
- North Saskatchewan River

Sensitive Plant Community/Habitat

- Deciduous Mixedwood Mixed Shrubs (DLM.1)
- Mixed Deciduous Mixed Shrubs (MD.1)
- Mixed Deciduous Red-Osier Dogwood (MD.2)
- Riparian (R)

Rare Plants

- Tall Meadow Rue (S3)
- Common Ragweed (S3)
- Northern Water-Horehound (S3)



Map Date: 22 October 2021
Imagery Mosaic: May-July 2019 (COE)

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

*Data provided by The Marc Boutin Architectural Collaborative Inc. (2021).

Appendix B: Project-Specific Terms of Reference

Terms of Reference for William Hawrelak Park Rehabilitation Project Environmental Impact Assessment

Document Purpose

In accordance with the North Saskatchewan River Valley Area Redevelopment Plan, Bylaw 7188, an environmental impact assessment (EIA) and site location study (SLS) are required to be completed and submitted for Council review and approval for the William Hawrelak Park Rehabilitation Project (the “Project”).

This document serves as the terms of reference (TOR) for the EIA and SLS required for the Project. This document is based on the standard, generic TOR template for projects in the River Valley, and has been modified to account for site-specific conditions and project-specific considerations.

The TOR have been prepared based on information provided by Integrated Infrastructure Services, including the Project Scope Statement, the Project Schematic Design Report, and an initial scoping meeting attended by representatives from the project team and an ecological planner representing the Urban Growth and Open Space Strategy section (City Planning, Urban Form and Corporate Strategic Development).

North Saskatchewan River Valley Area Redevelopment Plan

A Guide to Completing Environmental Impact Assessments

Table of Contents

Introduction

Environmental Impact Assessment Guide

Section One: The Property

Section Two: Environmental Context
- Surface Water, Groundwater and Fish Habitat
- Geology/Geomorphology and Soils
- Vegetation
- Wildlife
- Historical Resources
- Environmental Sensitivities Map

Section Three: The Project
- Concept Plans and Drawings

Section Four: Project Impacts and Mitigation Measures
- Assessing Impacts
- Identifying Cumulative Impacts
- Mitigation Measures

Section Five: Environmental Monitoring

Section Six: Public, Indigenous, and Stakeholder Engagement

Section Seven: Conclusions and Supporting Information

Appendix 1: Guide to Completing a Site Location Study

Introduction

The North Saskatchewan River Valley Area Redevelopment Plan (River Valley Area Redevelopment Plan) 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 and Schedule D of the North Saskatchewan River Valley Area Redevelopment Plan. 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, in addition to an environmental impact assessment, a Site Location Study that details costs, and social, environmental, and institutional constraints that make a River Valley location essential must be prepared for City Council approval, as per Section 3.5.3 of the River Valley Area Redevelopment Plan. The terms of reference and reporting requirements for the Site Location Study are included as Appendix 1 (Guide to Completing 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 assessment report, a pre-consultation scoping and project review with City Planning is strongly advised.

The pre-consultation meeting for an environmental impact assessment will include staff from City Planning, other review agency staff where appropriate, the individual(s) preparing the environmental impact assessment, and, if desired, the project proponent. If the applicant has already retained a consultant to complete the environmental report, then the consultant should be included in this meeting. The purpose of the pre-consultation meeting will be to:

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

Based on the outcomes of the meeting, a preliminary scope of work for the environmental report will be determined and will depend on the following:

- The scale and 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;
- The availability of previous studies and information; and,
- Any social or socio-economic considerations.

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 author of the report 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 City Planning. 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, City Planning 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 of 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 revisions to

the report. Open, ongoing communications between the report author 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, with reference to current and historic air photos;
- Description of planning context and summary of relevant planning documents for the site and surrounding area, such as master plans, land use plans, and strategic plans;
- Summary of federal, provincial and municipal regulatory requirements that apply to the project area.

Where possible, please provide specific information about how federal, provincial, and municipal regulatory requirements apply to this project, as opposed to general information about the legislation and regulations. Please note that mitigation measures to be applied to the project in order to meet regulatory requirements will be addressed in section 4.3.

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.

Section Two: Environmental Context

The description of the subject site and its environmental context provides the basis for the assessment. 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 (assets and threats) 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

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.

The EIA should summarize existing information on water quality in Hawrelak Lake, including aspects of water quality that may have impacts on aquatic and terrestrial wildlife in and around Hawrelak Lake. The EIA should identify opportunities to mitigate water quality concerns and minimize impacts to wildlife (including direct wildlife mortality as a result of water treatment during operation) as part of Project design (e.g., riparian plantings, low impact design, and engineered solutions).

2.2. Geology/Geomorphology and Soils

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 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.

2.3. Vegetation

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 the City of Edmonton (i.e. Urban 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.

Rare plant surveys do not apply to the project area as a whole. Rare plant surveys are strongly recommended in habitats with a high likelihood of supporting rare species (if any), as identified by the project biologist, or in areas with historical occurrences of rare species as indicated by database searches. Incidental rare plant observations should be documented and followed up with a formal rare plant survey in the vicinity of the incidental observation. Surveys should focus on areas of anticipated project impacts (direct or indirect), and are not expected to be completed across the entire project area.

2.4. Wildlife

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.

In addition to incidental wildlife observations, the following wildlife field surveys are recommended before or during the design phase:

- Amphibian survey, if none have been completed in the past three to five years
- Bird survey, if none have been completed in the past three to five years
- Wildlife habitat survey (e.g., nests, dens, hibernacula, etc.)
- Wildlife connectivity ground-truthing / verification of the City of Edmonton's Environmental Sensitivities desktop-based connectivity mapping (mapping of likely wildlife movement corridors based on habitat, topography, adjacent human activity, wildlife observations, etc.)

The purpose of the surveys listed above is to establish the locations of significant wildlife habitat, wildlife populations, and movement corridors to inform the project design (i.e., anticipate avoidance measures and other mitigation measures during concept, preliminary, and detailed design phases).

Existing reports describing surveys or incidental wildlife observations can be referenced in lieu of additional surveys, provided that wildlife observations were made in the past three to five years.

The outcomes of these surveys should also be used to inform restoration and/or re-naturalization elements of the project design. Incorporating restoration or enhancement of degraded habitat and movement corridors (i.e., reduction or elimination of major pinch points) through project design is highly recommended and would help offset negative impacts of the project. At minimum, park amenities and infrastructure must be sited away from existing pinch points so as not to further reduce wildlife movement and exacerbate existing constraints to wildlife movement.

Please note that pre-construction surveys (particularly breeding birds) will be required to ensure compliance with the federal *Migratory Birds Convention Act* and the provincial *Wildlife Act*.

An assessment of potential fish habitat in Hawrelak Park and in areas impacted by Hawrelak Park operations (e.g., outfalls to North Saskatchewan River) should form part of the EIA. However, fish surveys are not expected to be required, except where significant residual negative impacts to fish and fish habitat during project construction or operation may be reasonably anticipated. Any fish and fish habitat surveys completed should meet the standards of provincial and federal regulations (e.g., *Fisheries Act*).

2.5. Historical Resources

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.

Please submit, as part of the EIA, a copy of any historical resources reporting (or a summary thereof) required by provincial regulations, as well as confirmation of project approval (e.g., letter or memo from the ministry).

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 the site-specific Environmental Sensitivity Class based on consideration of environmental assets (vegetation, wildlife, aquatic habitat, unique landforms) and environmental constraints (slope, flood risk and cultural resources) in accordance with City of Edmonton's Environmental Sensitivity Mapping database (Table One).

Table One: Environmental Sensitivity Class

Environmental Sensitivity Class	**Description of Sensitivity**	**Best Practices**	**Ribbon of Green Equivalent**
Extremely high	These sites are mostly found in the River Valley, its tributary ravines and near Big Lake.. Sites are often dominated by native vegetation, and have multiple ecological and physical assets and steep slopes or other physical or cultural constraints that would limit development activities. Threats due to land use or aquatic impacts to these sites are minimal. Many of these sites are already protected, particularly in the River Valley and at Big Lake, but will require management of surrounding lands to ensure connectivity, and buffer from adjacent land use.	Planning for building infrastructure in these areas is not recommended due to the abundance of assets. These areas should be protected from future development. Buffering such sites through conservation or restoration of lower sensitivity sites will help sustain their assets, and minimize impacts due to adjacent land use. Opportunities to maintain or enhance connectivity of these sites to other sensitive sites should be assessed across the City and implemented through the development and planning process. Develop strategic initiatives to engage developers or residents in conservation, restoration and stewardship of these sites and adjacent lands, to promote broader awareness and support for their conservation.	Protection
Very high	These areas are found in the River Valley, in and near its tributary ravines and at Big Lake.. They too are often dominated by native vegetation and have multiple ecological assets and/or cultural or	Planning for building infrastructure in these areas is not recommended due to the abundances of assets. Limiting land use to passive recreation and	Protection

	physical constraints, and less likely to be affected by land use or aquatic threats.	development to low impact infrastructure will best protect the resources in these areas. Buffering these sites by conserving or restoring adjacent sensitive sites and maintaining connectivity, as recommended for extremely high sensitive sites will be important to sustain ecological function. Similarly, strategic initiatives to raise awareness of the need for conservation and stewardship of these areas, as recommended above, will help develop community support and cooperation in conservation and site stewardship.	
High	High sensitivity sites are found across the City and range in size from relatively small sites up to larger sites found in the River Valley, Big Lake, Beaver Hills moraine and Devon Dunes areas. These sites have various combinations of ecological and physical assets, and may also be affected by threats. Vegetation could include some non-native vegetation communities, but would mainly comprise native communities. In the River Valley, these sites could contain any one or a combination of ecological or physical and/or cultural or development constraints.	Conservation and protection of these sites can add to the ecological network. These areas require the greatest scrutiny and study at the site level, as combinations of assets may vary and sites may be contiguous with those of other sensitivities. Detailed evaluation is needed to ensure appropriate planning and land use for the assets at a given site. Limited development may be possible at some sites in the river valley, depending on the assets present. Where threats exist, management may reduce their effect. Explore opportunities to buffer these sites, enhance connectivity or restore key ecological functions within the site and in adjacent sensitive sites. This could include stewardship activities on private lands, encouraged through engagement programs targeting local residents and businesses.	Conservation
Moderate	These sites are the most abundant type of sensitive site in the City and are distributed across the City. They support fewer assets than higher sensitivity sites, and are more likely to include non-native vegetation. They are located in areas that are influenced by human land use. Larger sites lie within unique landscapes that may have limited development in the past. Such sites may contain ecological assets that are limited distribution or are easily disturbed by development (e.g., sandy soils, wetlands). These areas often have strong restoration potential that can benefit surrounding ecological assets, as well as sustaining their own ecological value. They also often lie within connective habitat and play a role in linking other sensitive areas.	Retention or enhancement of these sites can add to the ecological network, by buffering higher sensitivity sites or enhancing connectivity. Opportunities to conserve all or part of these sites should be explored during the land development or redevelopment planning process, or as part of open space planning. Where public lands will be dedicated or retaining (in the case of development) and the proposed land use is compatible with conservation of natural areas, site specific conservation or restoration may be possible. Where these sites lie within existing developed lands under private ownership, City-sponsored habitat enhancement and stewardship programs could enhance ecological functions (e.g. planting native trees or shrubs, managing weedy species,	Conservation Restoration/ Stewardship

		minimizing pesticide or herbicide use).	
Low	These sites are also found across the City, and range from moderately large to quite small sites. They may include both native and non-native vegetation communities, which may be their sole environmental asset. Such sites can play an important role in ecological connectivity or in buffering adjacent higher sensitivity lands, despite a lack of other ecological or physical assets. They are likely affected by land use or aquatic threats, an effect that can be reversed through land management and appropriate stewardship. Some sites are located in public lands such as the Transportation Utility Corridor and other transportation or utility rights-of-way, and have some level of protection through limitations on land development.	Development and redevelopment proposals should consider how to retain or enhance the contributions of these sites to the ecological network. Appropriate recommendations will require site survey and site-specific plans that consider site context, site assets and local connectivity. As noted above, options to maintain, restore or enhance natural areas may existing on private and public land. Depending on the site, opportunities to buffer other higher sensitivity sites, or enhance connectivity may exist. City sponsored habitat enhancement and stewardship programs could help to retain ecological function of these sites, as well as adjacent lands. Some low sensitivity sites include naturalized stormwater facilities and associated upland areas, as well as naturalized parks. Consider how creation of such features might be incorporated into development and redevelopment plans, to add to the ecological network.	Conservation Restoration/ Stewardship
Intensive Use	Existing developed areas, with land uses ranging from open space/recreational area to transportation, commercial, industrial and residential.	Intensive use areas are private or public lands adjacent to or surrounding many of the sensitive sites identified above, and can influence the ecological health of those sites. Stewardship options to reduce threats will be critical to long term sustainability of sensitive sites. Programs targeting City corporate operations (e.g., drainage, transportation, parks) and the public can help reduce the impact of key threats by promoting naturalization, minimal use of herbicides and pesticides, and removal of invasive species.	Intensive Use

2.7 Spatial Data Delivery

Spatial information collected during the production of the environmental impact assessment is to be delivered electronically to the City, and shall consist of a series of export files in ArcGIS or GeoMedia format (with associated metadata). The projection of the data for Edmonton is 3TM, NAD83.

Please submit spatial data associated with all maps and figures created for the EIA. If preparation of this data is found to be particularly resource-intensive, please discuss the scope of this requirement with City Planning.

Spatial outputs requested may include shape files associated with the requirements outlined above which could include, but not be limited to:

- Study Area and area of construction impact (Section 1.0);
- Delineation of 1:100 year floodplain (Section 2.1);
- Geomorphic features of the site (Section 2.2);
- Homogeneously mapped vegetation community types updated to the most recent year of available aerial photography (Section 2.3)
    - Note: The City's urban Primary Land and Vegetation Inventory (uPLVI) was last updated for the entire City (plus a 3.2 km buffer) in 2015
    - These uPLVI base files are available for use by the applicant from which to update vegetation mapping, increase resolution to an appropriate size for the study area, and align vegetation mapping with the City's existing data sets;
    - For more information, please see the following:
        - Greenlink, 2016. *Primary land and vegetation inventory for urban environments (Urban PLVI). 2015 edition*. Prepared for: The City of Edmonton, Alberta –Parks and Biodiversity, Sustainable Development. Prepared by: Greenlink Forestry Inc. Edmonton Alberta.
        - Greenlink, 2016. *Primary land and vegetation inventory for urban environments (Urban PLVI). Interpretation Manual.* Third edition. Prepared for: The City of Edmonton, Alberta –Parks and Biodiversity, Sustainable Development. Prepared by: Greenlink Forestry Inc. Edmonton Alberta;
- Locations (points and routes) of vegetation community types and weed locations that were verified in the field (Section 2.3);
- Locations (points) of wildlife observed (include date of observation and common and scientific name in spatial file) (Section 2.4); and/or
- Environmental Sensitivities Map (Section 2.5)
    - Note: in 2016, City Planning completed a City-wide Environmental Sensitivities Mapping Project
    - These Environmental Sensitivity spatial files are available for use by the applicant from which to update the Environmental Sensitivity Mapping, increase resolution to an appropriate level for the study area in question, and align environmental sensitivity analysis with the City's existing work.
    - For more information, please see the following:
        - Solstice, 2016. *Environmental Sensitivity Project, Model data.* Prepared for: The City of Edmonton, Alberta –Parks and Biodiversity, Sustainable Development. Prepared by: Solstice Canada. Edmonton Alberta.
        - Solstice, 2016. *Environmental Sensitivity Project, draft final report.* Prepared for: The City of Edmonton, Alberta –Parks and Biodiversity, Sustainable Development. Prepared by: Solstice Canada. Edmonton Alberta.

As part of any geodatabase compilation, the applicant is requested to ensure that the data is cleaned and corrected for:

- overlapping polygons
- over-/under shoots
- dangling arcs
- duplicates or near duplicates removed
- short spikes removed
- polygons are closed
- sliver polygons
- gaps/holes
- no polygons without attributes

The applicant may submit preliminary datasets for examination. All requested spatial files are to be submitted to City Planning together with the first submission of the Environmental Impact Assessment.

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 considered and mitigated. Consideration of project alternatives justifying why a location within the boundaries of the North Saskatchewan River Valley Area Redevelopment Plan is essential 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 graphical 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, including, but not limited to:

- 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?

Please ensure that any project impacts to off-site Valued Ecosystem Components (e.g., seepage or surface release of untreated discharge from Hawrelak Lake) are identified and addressed. Mitigation of potential negative impacts associated with discharge to the North Saskatchewan River should be considered as part of project design (e.g., discharging to sanitary servicing rather than to natural water bodies).

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.

Within section 4 or as an appendix to the EIA, please include a list or table of recommendations to be carried forward and implemented during future project stages. These stages can include, but are not limited to: concept design, preliminary design, detailed design, construction phase, and operation phase. This will allow Project Managers to

differentiate between mitigation that is to be carried out through project design (e.g., choosing alignments that avoid sensitive vegetation), those to be carried out as part of construction (e.g., installation of standard erosion and sediment control measures), and those to be carried out as part of operation (e.g., ongoing weed management). Please differentiate, where applicable, between non-mandatory and mandatory recommendations (i.e., those that allow the project to meet guidelines and standards versus those that allow the project to meet legal and regulatory requirements).

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, Indigenous, and Stakeholder Engagement

Open and transparent public, Indigenous, and stakeholder involvement is recommended for all projects. The onus is on the proponent to identify the appropriate level of engagement to be undertaken for a given project in alignment with City policies, standards, and best practices related to engagement.

The EIA should summarize the engagement opportunities provided as part of the project, the feedback heard through engagement, and how feedback was incorporated into Project design and delivery. Where available, existing documentation, such as public involvement plans and “what we heard” reports, can be provided as appendices to the report.

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 report author'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 subject matter experts or other individuals 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.

Appendix 1: Guide to Completing a *Site Location Study*

Pursuant to the North Saskatchewan River Valley Area Redevelopment Plan, all proposals for the development of a major facility that is publicly owned or is developed on public lands shall be subject to a Site Location Study detailing costs, and social, environmental and institutional constraints which make a River Valley location essential. The following identifies the information and reporting requirements for completing a Site Location Study.

When completing the Site Location Study report please be as thorough and descriptive as possible. The Site Location Study shall stand as a separate document in support of the accompanying Environmental Impact Assessment and will be forwarded to City Council for review.

The Site Location Study and related Environmental Impact Assessment shall require approval by City Council.

Site Location Study Report:
Table of Contents

1. Cover Page
    1.1. Project Name (consistent with the Environmental Impact Assessment report)
    1.2. Proponent information
2. Executive Summary
3. Project Description
    3.1. Figure One: map indicating location of project consistent with Environmental Impact Assessment report
4. Project Scope
    4.1. Figure Two: supporting plan or image of each component included as part of the Site Location Study report
5. Location Analysis and Justification
    5.1. Alternative Location Review
    5.2. River Valley Dependencies
    5.3. Overview of Bylaws/Plans/Policies
6. Constraints Analysis
    6.1. Financial Constraints
    6.2. Institutional Constraints
    6.3. Social Constraints
    6.4. Environmental Constraints
7. Conclusion

Executive Summary:

The Project Name should be the same as that referenced in the Environmental Impact Assessment.

Project Description:

Describe the project including location and surrounding context. This information can be copied directly from the accompanying Environmental Impact Assessment report. Where relevant, please include supporting maps.

Project Scope:

Identify what is included as part of this project. The Site Location Study should only reference project components that meet the definition of a Major Facility as defined in the North Saskatchewan River Valley Area Redevelopment Plan:

A MAJOR FACILITY is defined as any permanent or temporary development or use which is included in the Zoning Bylaw (12800) under the following use class definition:

- Basic service
- Community, educational, recreational, cultural services
- Natural resource development

Where relevant please include supporting plans and drawings which illustrate project components included as part of the Site Location Study.

A discussion of construction methodology or mitigation measures identified in the Environmental Impact Assessment is not required as part of the Site Location Study.

Location Analysis and Justification

The following questions must be addressed within this section of the report:

1. What other locations were considered for this project including other river valley and non river valley locations?
2. Could the proposed project reasonably function at a location outside of the North Saskatchewan River Valley Area Redevelopment Plan boundary?
3. Is the project dependent on either the river valley and ravine location or the users of the park system?

Please describe any relevant Bylaws/Plans/Policies which support the project's location within the North Saskatchewan River Valley Area Redevelopment Plan boundary.

Constraints Analysis

The Site Location Study must identify potential constraints that relate to the project that make a river valley location essential. Do the constraints (financial, social, environmental, institutional) limit the feasibility of locating the project outside of the river valley?

If the project includes multiple *'Major Facility'* components, each component must be assessed separately to address the following questions:

1. What are the financial constraints which limit the feasibility of locating the project outside of the river valley?
2. What are the social constraints which limit the feasibility of locating the project outside of the river valley?
3. What are the environmental constraints which limit the feasibility of locating the project outside of the river valley?
4. What are the institutional constraints which limit the feasibility of locating the project outside of the river valley?

Conclusion

Appendix C: City Administration Bylaw 7188 Sign-off and Project Conditions and Advisements

URBAN PLANNING AND ECONOMY
PLANNING AND ENVIRONMENT SERVICES

City of Edmonton
7th Floor, 10111 - 104 Avenue NW
Edmonton, AB T5J 0J4

Email: sdrivervalleybylaw@edmonton.ca

December 01, 2021 Reference No. 413041215-001

To: Rachel Dumont, Infrastructure Planning and Design, IIS
Andra Bismanis, Spencer Environmental Management Services Ltd.

From: Achyut Adhikari, Planning and Environment Services

Subject: AA21-62 William Hawrelak Park Renewal Project - EIA and SLS- Sign off

---

We have completed review of the William Hawrelak Park Renewal Project Environmental Impact Assessment (EIA) and Site Location Study (SLS) reports. This letter is a sign off that the Administration has no further concerns with the proposed development under the North Saskatchewan River Valley Area Redevelopment Plan (NSRV ARP).

Please note the proposed development meets the definition of a major facility, and as such, City Council must approve the EIA and SLS, and must deem the proposed location in the River Valley as essential, to ensure the policy requirements of the NSRV ARP are satisfied. In addition, the following advisements and conditions apply to the project:

Comments from EPCOR Drainage
No concerns, all drainage infrastructure within Hawrelak Park is privately owned by the City of Edmonton, including the outfalls. If connections to EPCOR's systems must be made, detailed drawings must be submitted to Drainage and accepted.

Comments from EPCOR Water and Sewer
Our records indicate that water services exist within the area of the proposal directly off EPCOR mains. Please refer to the response from EPCOR Water for the location of these water services within the park. . The owner/developer must conform to the requirements of the City of Edmonton Erosion and Sedimentation Control Guidelines and Field Manual.
If you have any questions about this reply, please contact this office at 780-496-5444, or e- mail us at wass.drainage@epcor.com.

Comments from Urban Growth and Open Space Strategy (Urban Planning and Environment):
We have reviewed the William Hawrelak Park Renewal Project. In general, the EIA report identified major environmental impacts and appropriate approaches for mitigation measures.

It appears that the project team have considered detailed biophysical assessment and identified potential sensitive plant and wildlife species within the project area. The project team should cautiously monitor the EIA outlined mitigation options for successful implementation given the detailed landscaping and restoration plan was not available at the time of EIA reporting.

There are certain areas requiring detailed attention including potential conflicts with wildlife (both in lake and in the riparian area) and rare plant species that were reported in the previous survey.

City of Edmonton
7th Floor, 10111 - 104 Avenue NW
Edmonton, AB T5J 0J4

Email: sdrivervalleybylaw@edmonton.ca

The project once progressed to the detailed design stage, the detailed tree protection/conservation plan, restoration and landscaping plan to offset impacts from the proposed renewal work should be submitted for our review and approval. In particular, we are in support of retrofitting existing lake areas to tackle the water quality issues. Please provide detailed information on new grading and landscaping plans along the lake center and shoreline for our review once available. The major retrofitting would require significant impact to the existing flora and fauna. The project team should consider a plan to protect sensitive flora and fauna during construction following the outcomes and recommended actions provided through this EIA report.

The project should implement best construction practices to avoid invasive spread during construction considering the sensitive natural environment within the close proximity of the project area. Also, the project should consider options to avoid conflict with wildlife habitat during construction period.

Please ensure the waste material including contaminated and nutrient loaded soil if excavated through lake retrofitting should be handled and managed properly. The storage and access areas should be fully restored to the pre construction stage following City standards.

The project should consider best construction practices to minimize impacts during the outfall rehabilitation and demolition activities. The details of the restoration plan to offset impact through the construction stages should be prepared and implemented.

The project once completed will generate additional stormwater runoff through the addition of growth components as proposed through this project. The project team should consider potential green infrastructure e.g. LID to reduce the additional stormwater for maximizing infiltration capacity prior to its release to the outfall and the river system.

We also recommend the project team to explore bioengineering options along the riparian area if there are opportunities to consider through outfall rehabilitation. Please consider river bio engineering options whenever possible for the slope protection measures at the detailed design stages.

The EIA should be updated with the additional technical information including geotechnical investigation, landscaping plan and detailed design and drawings if available.

Comments from Planning Coordination (Urban Planning and Environment):
From a review of the EIA and SLS, any potentially contaminated soil and groundwater encountered or produced during the project will be managed adequately. The environmental management is satisfactory for the project from the perspective of Environmental Planning. If any additional environmental information is submitted during the project, please forward it to our unit for review.

Comments from Infrastructure Planning & Design (Engineering Services):
Please see a separate memo for detailed comments and conditions.

Comments from Community and Recreation Facilities (River Valley Parks and Facilities):
River Valley Parks and Facilities are already extensively involved with this project - any comments would already be noted with project

Comments from Civic Events and Festivals
We ask that we continue to be part of the discussions for this project as this has a significant impact on our area.

City of Edmonton
7th Floor, 10111 - 104 Avenue NW
Edmonton, AB T5J 0J4

Email: sdrivervalleybylaw@edmonton.ca

Comments from Partnership and Event Attraction Strategy:
No comment

Comments from Parks and Roads Services (Natural Areas Operations)

The project appears to have done a good job to minimize tree removals throughout the design planning. However, please take into consideration that construction often impacts additional trees and every effort should be made to preserve the existing mature canopy in the project area.

Please ensure trenchless, directional drilling methods are used for utility installation near and within the forested stands or any park trees to minimize disturbance. Outfalls will also likely impact the surrounding vegetation, particularly for equipment access. We recommend alternative methods are considered to reduce impacts to the surrounding vegetation community.

The project should adhere to all vegetation mitigation measures identified within the EIA report.

As noted in the EIA, the prohibited and noxious weeds found within the project area will require a multi-year effort to control and eradicate. It is great to see the project taking on this work, but it is important to note that this work should be started at the beginning of the project construction due to the length of time proper eradication will require.

Please ensure Natural Area Operations is engaged early to review the weed management plans.
Future public engagement should include tree removal and tree planting details.
Please be aware that a specific natural stand Tree Preservation Plan will be required prior to construction. It is recommended this plan be completed as soon as possible to ensure the preservation of trees throughout the design phases.
As the project proceeds through the design phases, please ensure that 'naturalization' and 'restoration' landscaping is differentiated on the plans, as the inventories will be managed differently by City Operations.

NAO recommends a review of the plan to incorporate a more well-rounded approach to wildlife management in an outdoor venue that includes areas that would attract or herd geese to preferable habitat and away from the more desirable turf areas.

General Conditions for vegetation removal:

- Upon approval of the plan, a site meeting with Natural Areas will be required to review construction plans and tree protection. This meeting will need to be scheduled a minimum of four weeks in advance of the construction start date. This is to review access points, placement of all permanent or temporary construction material required for this project, and to determine tree protection requirements for construction within 5 meters of any City tree or 10 meters from a natural stand. For any vegetation removal, please ensure the area has been clearly staked. Note the laydown area fencing must be installed outside the dripline of any adjacent trees.
- Please be advised that all costs associated with pruning, removal, tree damage, or replacement shall be covered by the Proponent as per the Corporate Tree Management Policy. Natural Areas will schedule and carry out all required tree work involved with this project. Please contact naturalareaoperations@edmonton.ca to arrange this meeting.

City of Edmonton
7th Floor, 10111 - 104 Avenue NW
Edmonton, AB T5J 0J4

Email: sdrivervalleybylaw@edmonton.ca

- Any soil damage or compaction compromising the tree's root system within the parkland space shall be corrected by and at a cost to the Proponent. Please be advised that all costs associated with soil remediation, watering, and tree protection shall be covered by the Proponent as per the Corporate Tree Management Policy.
- Please note that the removal of vegetation has the opportunity to impact birds and bird habitat. Protection of migratory and non-migratory birds is legislated federally and provincially and enforceable regardless of whether or not individual environmental reviews conducted in accordance with the River Valley Bylaw include discussions of these topics. The onus is on the individual or company conducting habitat disturbance or construction activities to ensure that due diligence has been exercised to avoid harm to migratory and non-migratory birds. Individuals or companies that do not avoid harm to most wildlife species risk prosecution under the *Wildlife Act* and, in some cases, the *Species at Risk Act*. In the case of migratory birds, prosecution under the *Migratory Birds Convention Act* is also possible.

Comments from Parks and Roads Services (Land Development):

When designing the Landscape for this project:

1. Please supply a detailed landscape design to scale. Shrub and tree symbols shall be shown at mature spread with no overlap on the landscape drawing. Service levels and ease of maintenance must be considered in all landscape design for this project.
2. Please incorporate naturalized plantings in lieu of mass ornamental planting in all landscaped areas. Naturalization is supported by the City of Edmonton as a means to provide more sustainable landscapes, to enhance biodiversity, and to provide educational opportunities. We encourage naturalized planting that meets construction standards and that is sustainable. Note: Please consider our current service levels when designing shrub beds. Designs incorporating monocot grassess, and daylilies are encouraged.
3. Please ensure that the vegetation used is native to the Central Parkland Ecoregion to help ensure survival.
4. All plant and tree material design and selection must be reviewed and approved by Open Space Operations and Urban Forestry.
5. Please define all mow and no mow areas. Please ensure all turf transitions from mow to non mow naturalized area planting or vegetation are staged in height where possible.
6. Please consider that vehicles and equipment accessing the paths may be heavy for maintenance program purposes (i.e. water trucks, bucket trucks, etc). This infrastructure should be built to accommodate this type of heavier maintenance vehicle or equipment.
7. Please consider that any granular road, trail or path may not be cleared in the winter. If maintenance is required the surface must be a hard surface.
8. Please follow the City of Edmonton Design and Construction Standards Volume 5 - Landscaping (2021).

General Conditions:

1. All mitigation measures and commitments outlined by City reviewers must be incorporated into the construction work plan.
2. The proponent is responsible for seeking approval for any other regulatory permits from provincial and federal agencies.

City of Edmonton
7th Floor, 10111 - 104 Avenue NW
Edmonton, AB T5J 0J4

Email: sdrivervalleybylaw@edmonton.ca

3. Please contact the Neighbourhood Resource Coordinator Erin Flaherty (780-288-8673) in the area to ensure appropriate community notification.
4. For potential impacts to City parks and facilities:
    a. Hard surface access/haul routes are preferred.
    b. Please ensure restoration of the site occurs and meets existing site conditions. All damages to parkland must be restored to City of Edmonton Construction Standards and City Operations' satisfaction.
    c. Noxious weeds shall be managed and controlled as required within any fenced area and should be the responsibility of the contractor/department during construction.
    d. Signage must be posted indicating a project contact person and phone number for inquiries.
5. All trail closures shall adhere to the City's Trail Closure Procedures. All trail closure activities must be approved through River Valley Operations prior to construction and closure of trails. Please contact **Braeden Holmstrom** (Team Leader, River Valley & Horticulture) at **587-986-2841or braeden.holmstrom@edmonton.ca** to obtain the necessary trail closure approvals. This shall be done a minimum of two weeks in advance of planned construction.
6. Please attach this letter for any further City of Edmonton approvals.

Should you have any questions or concerns, please contact me by e-mail or by phone at 780-442-0695.

Regards,

Achyut Adhikari

INTEGRATED INFRASTRUCTURE SERVICES
Infrastructure Planning & Design
Engineering Services Section

City of Edmonton
11004 - 190 Street NW
Edmonton, AB T5S 0G9
Tel.: 780.496.6770

edmonton.ca

Memorandum

Date: November 4, 2021

File: 508.001; CAD: 922+32-23
Posse: 413041215-001

TO: Achyut Adhikari, Ecological Planner
Open Space Strategy, Urban Planning and Economy

FROM: Christina Tatarniuk, Senior Geotechnical Engineer
Engineering Services, Integrated Infrastructure Services

SUBJECT: AA21-62 William Hawrelak Park Renewal Project EIA
9330 Groat Road NW

I reviewed the Environmental Impact Assessment (EIA) for the proposed rehabilitation of Hawrelak Park. The EIA document was prepared by Spencer Environmental and dated October 2021. The EIA document did not reference a geotechnical report, however a geotechnical report was prepared by Thurber Engineering dated September 7, 2021 for the rehabilitation work at Hawrelak Park.

Engineering Services has been involved in the Hawrelak Park Rehabilitation project since the early concept phases. The Engineering Services geotechnical group procured Thurber Engineering through our Geotechnical Standing Agreement, to complete the geotechnical engineering assessment for this project. Additional geotechnical assessment and reporting was also completed for the main pavilion concrete apron rehabilitation as well as for the replacement of the wooden stairway. Therefore, geotechnical review of the geotechnical aspects of the project have been ongoing and the geotechnical reports have been previously reviewed by Engineering Services. I would have no further comments on the content of the geotechnical reports. I would have the following comments related to the EIA:

1) The EIA should refer to the geotechnical report dated September 7, 2021 prepared by Thurber Engineering. This report provides a thorough review of the geotechnical site conditions and provides geotechnical recommendations for the rehabilitation project. This report could also be appended to the EIA if appropriate.

2) The EIA makes note of three riverbank outfalls or associated pipes that require repair and a fourth outfall which may be abandoned as part of the Hawrelak Rehabilitation Project. Construction activities will take place on the riverbank slope which will be sensitive to disturbance. It is noted that geotechnical evaluation of the outfall infrastructure repair work was not addressed in the primary geotechnical report prepared by Thurber Engineering dated September 7, 2021. Therefore, geotechnical review and assessment of these locations will be required in order to support the design of the proposed outfall rehabilitation and ensure long-term stability of the valley slopes.

I would have the following general comments for the project:

1) 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 the valley slopes must also be strictly avoided during all construction work related to this project.

2) An erosion and sediment control plan must be incorporated into the construction. During construction, the work should be staged in order to limit the amount of time the subgrade is exposed to reduce both the 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.

3) Geotechnical risk associated with this project must also be mitigated through the ongoing involvement of the geotechnical engineering consultant in the design and construction. It is expected that the geotechnical engineer will complete inspection during construction of the geotechnical-related project components. Geotechnical materials such as fill materials and geotextiles 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.

Provided the recommendations of the geotechnical engineer, Thurber Engineering, are adhered to with appropriate construction inspection and review and good local construction techniques are implemented, I would have no further questions or comments regarding the Hawrelak Park Rehabilitation Project at this time.

Should you have any questions regarding these comments, please call me at (780) 999-9921.

CGT

Appendix D1: Tier II Risk Assessment (AECOM 2014)

Environment

City of Edmonton – Engineering Services

Tier 2 Risk Assessment: Hawrelak Park-Final

Prepared by:

AECOM
101 – 18817 Stony Plain Road NW 780 486 7000 tel
Edmonton, AB, Canada T5S 0C2 780 486 7070 fax
www.aecom.com
www.aecom.com

Project Number:

60330705 (401)

Date:

December 15, 2014

Statement of Qualifications and Limitations

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

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

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

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by Consultant represent Consultant's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since Consultant has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, Consultant, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by Consultant and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

Consultant accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of Consultant to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2012-01-06
© 2009-2014 AECOM Canada Ltd. All Rights Reserved.

AECOM
18817 Stony Plain Road
Edmonton, AB, Canada T5S 1C2
www.aecom.com

780 486 7000 tel
780 486 7070 fax

December 15, 2014

Tami Dolen, P. Ag. E.P.
Environmental Scientist
City of Edmonton, Engineering Services
11004 – 190 Street,
Edmonton, AB T5S 0G9

Dear Mrs. Dolen:

Project No: 60330705 (401)

Regarding: Tier 2 Risk Assessment: Hawrelak Park– Final

We are pleased to provide this Final report for your review and consideration. If there are additional information requests, please do not hesitate to contact the undersigned.

Sincerely,
AECOM Canada Ltd.

Craig Harris, M.Sc., P. Geol., R.P.Bio.
Senior Risk Assessor

CH:cn

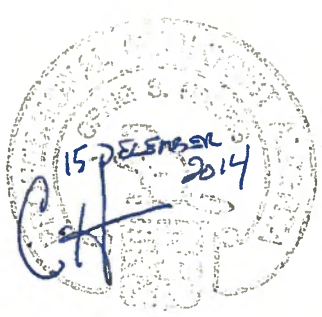
Distribution List

# of Hard Copies	PDF Required	Association / Company Name
5	X	City of Edmonton Engineering Services

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
0	C. Harris	15 December 2014	Final

AECOM Signatures



Report Prepared By:

Craig Harris, M.Sc., P. Geol., R.P.Bio.
Senior Risk Assessor

Report Reviewed By:

Wade Husak, P. Geol., P. Eng.
Senior Hydrogeologist

PERMIT TO PRACTICE
AECOM CANADA LTD.
Signature
Date Dec 16/14
PERMIT NUMBER: P 10450
The Association of Professional Engineers and Geoscientists of Alberta

Table of Contents

Statement of Qualifications and Limitations
Letter of Transmittal
Distribution List

page

1. Introduction and Problem Formulation 1
1.1 Scope of Work 1
1.2 Historical Document Review 1
1.2.1 Historical Activities Summary 2
1.2.2 Characteristics of Contamination 2
1.2.2.1 Drilling Results: Current Study 2
1.2.2.2 Final Soil Contaminants of Concern 3
1.3 Land Use, Physiographic Setting and Hydrogeology 4
1.3.1 Land Use On-Site and Off-Site 4
1.3.2 Water Bodies 4
1.3.3 Geology and Hydrogeology 4
1.3.3.1 Localized Geology and Hydrogeology: Hawrelak Park 4
1.3.4 Hydrogeological Model 5
1.3.4.1 Water Table Elevation 5
1.3.4.2 Soil Matrix Parameters and Hydraulic Conductivity 5
1.3.4.3 Conceptual Cross Sections 7

2. Receptor-Pathway Analysis 8
2.1 Hawrelak Park: Tier 2 Receptor-Pathway Section 8
2.1.1 Tier 2 Soil Data Interpretation 8
2.2 Tier 2 Approach 9
2.3 Conceptual Exposure Model 9

3. Exposure and Effects Assessment 11
3.1 PAHs and Aquatic Life Exposure Pathway 11
3.1.1 Experimental Leachate 11
3.1.2 Groundwater Sampling 12
3.1.2.1 Methods 12
3.1.2.2 Results 13
3.2 Aquatic Life Exposure Assessment 13
3.3 Inorganic Substances 13
3.3.1 Statistical Distributions: Exposure Assessment 13
3.3.2 Toxicological Basis for SQG: Hazard Assessment 14
3.3.3 Direct Biological Observations: Effects Assessment 15
3.3.4 Groundwater Check: Aquatic Life and DUA 15
3.3.5 Risk Characterization: Weight of Evidence 16

4. Risk Management 17

5. References 18

List of Tables

Table 1: Soil Matrix Parameters and Hydraulic Conductivity 6
Table 2: Soil Matrix Fraction Organic Carbon 7
Table 3: Ecological and Human Health Pathway Receptor Tier 2 / Risk Management Approaches 9
Table 4: Theoretical PAH Leachate Relative to Experimental Results 12
Table 5: Summary Statistics: Inorganic Substances 14
Table 6: Inorganic Substances: Risk Characterization Summary 16

Appendices

Appendix A. Borehole Logs (City of Edmonton)
Appendix B. Water Sampling Field Sheet (City of Edmonton)
Appendix C. Flexible Wall Permeameter Tests
Appendix D. EXOVA Analytical Reports
Appendix E. Memorandum: Inorganic Statistical Analysis

Illustration in Report

Illustration 1: Conceptual Exposure Model: Hawrelak Park

Figures

Figure 1 Site Location Plan
Figure 2 Geodetic Groundwater Elevation
Figure 3 Cross Section Lines
Figure 4 Geological Cross Sections

Tables

Soil and Groundwater Tables

- Table A: Soil Quality
- Table B: Groundwater Quality

1. Introduction and Problem Formulation

AECOM has been contracted by City of Edmonton Engineering Services to assist with a Tier 2 risk assessment to evaluate the actual human health and environmental hazards of specific Tier 1 soil non-compliance issue suspected to be related to the historical filling of gravel extraction and crushing operation within Hawrelak Park.

The City of Edmonton is pursuing specific improvements within the park as part of the Water Play Feature. With the identification of non-compliant Tier 1 soil quality, the City faces a choice to either remediate to the Tier 1 values or pursue a scientifically defensible Tier 2 environmental risk assessment that resolve the issues without excavating.

1.1 Scope of Work

The scope of work for this Tier 2 risk assessment was conceived following a preliminary review of the Limited Phase II Environmental Site Assessment (ESA) report completed by Stantec (2014). The scope of work for this project is as follows:

- Review of past environmental investigations, including any Phase 1 reports and investigations from other areas (i.e. Hawrelak Park maintenance compound)
- Develop a Tier 2 strategy and provide detailed gap closure work plans for the City of Edmonton staff to execute
- Review, tabulate and interpret data collected by the City of Edmonton and Stantec
- Completion of specific tasks under the Tier 2 strategy:
    - Develop geological cross sections and a more refined conceptual site model and mechanisms of possible contamination
    - Electronically tabulate all historic and recent inorganic soil quality data for statistical analysis
    - Using the site-specific data supplied, calculate the theoretical lecahate concentrations for organic contaminants and compare these to site-specific experimental leachate and groundwater quality
- Document the Tier 2 risk assessment in a draft and final report, including any risk management that may be warranted

The following Deliverables arose from this scope of work:

1. Specific design details for gap closure work transmitted via email and telephone communication
2. Formalized Tier 2 Report

1.2 Historical Document Review

The following documents have been reviewed, and data incorporated in the preparation of this Tier 2 risk assessment:

- Stantec Consulting Ltd. (April 2014). Hawrelak Park Phase I Environmental Site Assessment, 9330 – Groat Road NW, Portion of Block X, Plan 6075AM, Edmonton, AB.
- Stantec Consulting Ltd. (May 2014). Hawrelak Park Limited Phase II Environmental Site Assessment, 9330 – Groat Road NW, Portion of Block X, Plan 6075AM, Edmonton, AB.
- AGRA Earth & Environmental (September 1996). Phase II and III Environmental Site Assessment and Site Remediation Hawrelak Park Maintenance Compound, Edmonton, AB
- AGRA Earth & Environmental (April 1997). Phase III Site Remediation Closure Report, Hawrelak Park Maintenance Compound, Edmonton, AB

- City of Edmonton, Materials Engineering, Roadway Engineering Branch (July 1993). Subgrade Evaluation Hawrelak Park, East Roadway and Trial.

1.2.1 Historical Activities Summary

The Stantec Phase I ESA identified the fact that a gravel extraction and crushing operation had operated on the southeastern portions of the 8 hectare area between ~ 1950 through 1967. After this time the area was filled, graded and turned into a park. Other than activities at the maintenance compound, which included storage of diesel fuel in an underground tank, there were no other on-going activities that would pose an environmental concern. The origin of the fill soils is unknown and is the source of the current environmental concerns over Tier 1 failures for polycyclic aromatic hydrocarbons (PAHs) and metals.

The historical petroleum hydrocarbon contamination at the maintenance compound was reportedly remediated and Stantec (April 2014) indicated that confirmatory soil samples would meet today's Alberta Environment and Sustainable Resource Development (ESRD) Tier 1 guidelines. This area was not included in the current scope of work.

1.2.2 Characteristics of Contamination

Based on the review of the above documentation, a brief synopsis of the contaminant characteristics is provided below.

The soils investigated within the proposed footprint of the water play park (Stantec, May 2014) contain a range of detectable PAHs, hot water soluble boron, cobalt, nickel and arsenic with maxima concentrations exceeding the ESRD Tier 1 criteria. Upon a review of the drilling logs and final Maxxam Analytics analytical report, AECOM notes the lithology descriptions within the offending soil commonly note 'coal inclusions'. However, the analytical data shows the presence of petroleum hydrocarbons (PHC) fraction 2 and fraction 3 in borings S14-1 and S14-4. In one instance (S14-4) elevated arsenic co-occurred with the PHC and PAH; while in another it occurred deep within the bedrock.

1.2.2.1 Drilling Results: Current Study

Based on detailed guidance provided by AECOM, the field drilling was completed by Dale Durham of the City of Edmonton on August 7, 2014. A truck mounted B52 auger rig was used to advance eight boreholes between 5.5 and 7.0 metres below ground. Fifty millimetre (mm) diameter PVC Schedule 40 groundwater monitoring wells were constructed within each boring. Lithological descriptions, sample locations and well construction details are available in the borehole logs (Appendix A).

The soil sampling program included grab samples every 0.7 metres (m) and at least one Shelby tube was pushed into the shallow fill. Initially, the focus of the soil testing program was on the fill, since this was the material suspected of triggering the Tier 1 non-compliance issues. However, the testing program was modified because of the variability in the thickness of the fill. Consequently soil testing occurred on all three categories of soil: fill, native alluvium and bedrock. The chemistry testing program focused on PAHs and metals, but also captured the total organic carbon parameter. Selected Shelby tube samples were submitted to a geotechnical laboratory for the ASTM 5084 flexible wall permeameter test.

1.2.2.2 Final Soil Contaminants of Concern

Considering both Stantec (May 2014) and the most recent City of Edmonton soil testing, the following generalized trends are identified:

- The fill in the area of the former gravel extraction and crushing contains soil with non-compliant (Tier 1) concentrations of anthracene, fluoranthene and pyrene often in association with non-compliant concentrations of hot water soluble boron;
- Non compliant concentrations of nickel and cobalt appear to be associated, but the occurrences are not depth consistent: they are found in the fill at S14-01 and further south in the bedrock (14-06);
- With the exception of the occurrence in S14-4, elevated arsenic is almost exclusively associated with bedrock, and the log of S14-4 describes the suspect "FILL" as ...*highly to completely weathered clay shale and sandstone.;*
- Deeper non-compliant concentrations of pyrene, without any extractable petroleum hydrocarbons and other PAHs or boron, can be attributed to the occurrence of coal, or coal inclusions described in the logs (*e.g.* S14-2 and 14-05); and
- The single occurrence of selenium (1.8 milligrams per kilogram; mg/kg) in excess of its Tier 1 concentration in 14-03 appears deep within the native alluvial channel and may simply reflect a natural upper bound concentration.

The originally conceived mechanism of contamination (*i.e.* placement of suspect quality fill) is not fully supported by the soil quality data collected to date. To some degree the suspect fill may have contained traces of PHC and associated lighter molecular weight PAH. These organic contaminants may, or may not, be related to the observed inorganic parameters of boron, nickel and cobalt. Arsenic and pyrene appear to be associated primarily with the bedrock, with and without co-occurrence of coal. The selenium is unlikely to be associated with any anthropogenic activity.

Despite this uncertainty in the original mechanisms of 'contamination', this Tier 2 risk assessment will include all soil contaminants, such that assurances of human health and environmental protection are provided for future developments in the park.

1.3 Land Use, Physiographic Setting and Hydrogeology

The purpose of this section of the risk assessment is to identify, based on the physical setting, the applicable Alberta ESRD Tier 1 receptor-pathway combinations. The location of Hawrelak Park in relation to the City of Edmonton is depicted in Figure 1.0.

1.3.1 Land Use On-Site and Off-Site

Hawrelak Park is located in Urban Parkland Land Use zone. As illustrated in Figure 1.0, the surrounding land use is as follows:

East..... Groat Road followed by Residential (Windsor Park)
West..... North Saskatchewan River
South..... North Saskatchewan River
North ..... Golf Course (Parkland)

1.3.2 Water Bodies

The North Saskatchewan River surrounds the west and southwest boundaries of Hawrelak Park. Although the hydrogeology is complicated by the variable nature of the subsurface lithogies, it is reasonable to expect groundwater will eventually discharge to the North Saskatchewan River. Surface water bodies are also present within the immediate area of the future park improvements.

1.3.3 Geology and Hydrogeology

The objective of this regional hydrogeological description is to establish a knowledge of the important aquifers in the area. This section is developed from the review of Andriashek, L.D., 1988, Hydrogeological Consultants Ltd., 2001, and Kathol, C.P. and McPherson, R.A., 1975.

The bedrock in the area consists of the Cretaceous-aged Horseshoe Canyon Formation. The Horseshoe Canyon Formation consists of non-marine interbedded clayey sandstones, bentonitic mudstones and carbonaceous shale with scattered coal and bentonite beds of variable thickness. Based on cross sectional data in Kathol & McPherson, 1975, the bedrock may be encountered at shallow depths in the river terrace areas.

Hawrelak Park is located within the North Saskatchewan River flood plain. Kathol & McPherson, 1975 mapped the entire area as a river terrace alluvial deposits consisting of sand and gravel. Quaternary deposits, including tills and Glacial Lake Edmonton silts are not present in this particular area of the river flood plain. There is a mapped pre-glacial bedrock channel (the New Serepta Valley) that cuts through Windsor Park in a southwest-northeast orientation. The sand and gravel observed toward the northeast, including the maintenance compound, is likely connected to what is known as the Empress Formation sediments in the pre-glacial channel.

Groundwater within this pre-glacial alluvial channel would potentially provide sufficient yield to classify as a domestic use aquifer (DUA). Kathol & McPherson 1975 gave this channel a ‘high potential’ when they mapped aquifers in the Edmonton area.

1.3.3.1 Localized Geology and Hydrogeology: Hawrelak Park

Based on the review and interpretation of the geological logs produced by the City of Edmonton (1993), AGRA (1996), Stantec (May 2014) and the most recent logs (Appendix A), the lithology displays some complexity, yet can be simplified into the following stratigraphic column:

- Topsoil.
- FILL characterized as primarily clay with some less frequent textural descriptors of silt and sand. The depth of this FILL varies significantly from 3 m in the area of the proposed water park to 20 cm immediately north at BH14-01.
- SAND (alluvium) with a minor area identified as SILT (BH14-01). The depth of this SAND varies with an increasing gradient toward the north, northeast (AGRA BH96-02). The SAND is not identified in the south portions of the property.
- GRAVEL and SAND (alluvium) predominantly identified as a basal unit below the SAND and above the BEDROCK contact.
- BEDROCK (clay shale with sandstone) encountered at significantly variable depths: as shallow as 0.9 m in the south portions of the investigated area to roughly 10 m in the northeast (AGRA BH96-02).

This site-specific lithological description is consistent with the regional picture. Stantec (May 2014) tested three soil samples for sieve analysis: two in the fill and one in a sand and gravel. Despite the lithology descriptions, all the samples were dominated by fines. The selection of grain size for surface related exposure pathways is FINE. Groundwater mediated pathways will be governed by the flow within the coarser grained sand and gravel; therefore, a COARSE criterion would apply to groundwater mediated pathways.

1.3.4 Hydrogeological Model

1.3.4.1 Water Table Elevation

To help further the understanding of the hydrogeological conceptual model, all the monitoring wells installed by the City of Edmonton, under this project, have been surveyed for geodetic elevations and static water levels recorded (12-August 2014). This tabulated data is attached as Appendix B. The depths to the water table varied from 4.73 m toward the north portion of the investigated area to 1.56 m close to the stream and pond (BH14-08). Depending on the geographic location in the park, the water table lies either within the shallow bedrock (southern portion) or sand and gravel units (northern portion).

When the geodetic water table surface is evaluated, the sand and gravel channel toward the north and northeast appears to act as a sink drawing in groundwater. The relatively thick sand and gravel unit is unconfined with an unsaturated vadose zone reaching to depths of greater than 4 m below grade. The flow direction within this sand and gravel channel cannot be definitively calculated given the limited information. AGRA (1996) appeared somewhat surprised to discover a flow direction at the maintenance compound that was away from the direction expected (*i.e*. toward the river). They hypothesized it was related to mounding of groundwater from the pond. This interpretation did not have the benefit of seeing the wider hydrogeological picture, nor did they reference the regional studies. In the southern portions of Hawrelak Park where the groundwater is present within the shallow bedrock, flow direction closely follows topographic contours; consequently, discharge to the river is predicted.

Figure 2 illustrates the rough divide between the presence and absence of the sand and gravel and how this likely creates an apparent groundwater divide through the middle of Hawrelak Park.

1.3.4.2 Soil Matrix Parameters and Hydraulic Conductivity

As part of the scope of work for this Tier 2 risk assessment, basic soil matrix parameters used to calculate theoretical Tier 1 guidelines were obtained. These matrix parameters enable the calculation of soluble organic contaminants that may arise from dissolution during rainwater infiltration. The bulk density and porosity matrix parameters are summarized in Table 1 and the fraction organic carbon is summarized in Table 2. In addition to these fundamental soil matrix parameters, Table 1 captures all the available hydraulic conductivity data for Hawrelak Park.

Table 1: Soil Matrix Parameters and Hydraulic Conductivity

Location	Soil sample depth (m)	Lithology	Bulk density (Kg/m^3)	Total porosity	Water filled porosity	Air filled porosity (calculated)	Hydraulic conductivity (m/sec)	Method
96-1		Sand / gravel					9.6×10^{-5}	Rising head (Hvorslev)
96-2							1.3×10^{-4}	
96-3							5.7×10^{-6}	
96-4							3.1×10^{-5}	
14-01	1.1-1.5	SILT	1767	0.339	0.317	0.022	1.7×10^{-10}	ASTM D5084
14-02	0.9-1.3	FILL	1683	0.35	0.36	Nil	9.1×10^{-10}	
14-03	0.8-1.2	FILL	1422	0.467	0.350	0.117	1.3×10^{-8}	
14-04	0.8-1.2	FILL	1714	0.35	0.331	0.019	8.8×10^{-10}	

The arithmetic mean bulk density, water and air filled porosities are: 1646 kilograms per cubic metre (kg/m^3), 0.34 and 0.05, respectively. The geotechnical laboratory report detailing the results of the ASTM flexible wall permeameter tests are available in Appendix C. The hydraulic conductivity data from the 96 series wells is available in the AGRA (September 1996) Phase II and III report. This hydraulic conductivity data from the alluvial deposits would trigger the Domestic Use Aquifer (DUA) classification. However, depending on the saturated thickness in the alluvial channel, yield may not achieve the required 0.76 litres per minute (L/minute).

Table 2: Soil Matrix Fraction Organic Carbon

Location	Soil Sample Depth (m)	Lithology	f_{oc}
14-01	0.4	SILT	0.00049
14-01	1.8	SAND	0.00205
14-01	2.3	SAND	0.00116
14-02	1	FILL	0.00114
14-02	1.9	FILL	0.00284
14-02	3.5	CLAY	0.00046
14-03	0.4	FILL	0.0025
14-03	1.5	FILL	0.0042
14-03	3.0	SAND	0.00027
14-03	4.8	SAND	0.00101
14-04	1.4	FILL	0.00076
14-04	3.0	BEDROCK	0.00014
14-04	4.7	BEDROCK	0.00046
14-05	0.5	FILL	0.00153
14-05	1.8	BEDROCK	0.00206
14-05	2.4	COAL	0.00387
14-06	0.2	SAND	0.00113
14-06	0.9	BEDROCK	0.00071
14-06	2.7	BEDROCK	0.00008
14-07	0.2	FILL	0.00101
14-07	0.7	FILL	0.00013
14-07	0.9	BEDROCK	0.00018
14-07	2.2	BEDROCK	0.00051
14-08	0.3	FILL	0.00479
14-08	2.7	BEDROCK	0.00028

The geometric mean fraction organic carbon in the FILL is 0.0014. For the overall data set the geometric mean is 0.0008. This data is captured in the EXOVA analytical report, which is attached as Appendix D. To cross check the lithology, the geological logs are attached in Appendix A.

1.3.4.3 Conceptual Cross Sections

AECOM constructed two geological cross sections perpendicular to the North Saskatchewan River. The section lines are shown in plan view in Figure 3 and the cross sections in Figure 4. The cross sections included geological logs from City of Edmonton (July 1993), AGRA (September 1996), Stantec (May 2014) and the most recent City of Edmonton logs provided in Appendix A. The sections include screened intervals, geodetic groundwater elevation and they indicate locations of soil Tier 1 non-compliance issues. The following comments summarize the important features of these cross sections:

- The down cutting of the bedrock and infilling with the sand and gravel channel is clearly evident in the northern portions of the sections: Fill is thicker in these areas where the sand and gravel is present and the fill thins toward the south.
- The geodetic groundwater elevations lie within the bedrock in the southern portions of the sections and within the sand or gravel in the northern portions of the sections.
- Tier 1 soil non-compliance is identified in all three major lithologic categories: fill, granular alluvium and bedrock.

2. Receptor-Pathway Analysis

As per the definition in the ESRD's Tier 1 Soil and Groundwater Remediation Guidelines, Residential Land Use is defined broadly and includes recreational activities within urban parks.

The guidelines in Alberta are established using a scientifically defensible, risk-based approach. Numerical standards are established for various land use specific, generic pathway-receptor combinations. The pathway-receptor combination which is the most sensitive to that particular contaminant drives the generic Tier 1 numerical criteria.

The following pathway-receptors are relevant and applicable under the generic Residential Tier 1 guidelines:

Human Pathways

- Protection of groundwater for DUA
- Direct soil exposure: ingestion, dermal, dust inhalation
- Indoor vapour intrusion and inhalation

Ecological Pathway

- Protection of groundwater for aquatic life where water bodies lie within a 300 m radius
- Direct soil and groundwater exposure: plants and invertebrates

2.1 Hawrelak Park: Tier 2 Receptor-Pathway Section

Based on the description of the land use, surrounding environment and hydrogeological setting, the following receptor-pathway combinations are deemed relevant and applicable for Hawrelak Park.

Human Pathways

- Protection of groundwater for DUA, but only in the area underlain by the alluvial channel
- Direct soil exposure: ingestion, dermal, dust inhalation
- Indoor vapour intrusion and inhalation

Ecological Pathway

- Protection of groundwater for aquatic life
- Direct soil and groundwater exposure: plants and invertebrates

Essentially, all the receptor-pathway combinations will apply for Hawrelak Park. Nevertheless, the data will be interpreted relative to the specific Tier 2 pathways to understand the perceived human health or environmental risk better.

2.1.1 Tier 2 Soil Data Interpretation

The Stantec (May 2014) and most recent soil quality data has been consolidated into a single table (Table A) capturing organic and inorganic substances. The data are compared to the individual Tier 2 pathway numerical

guidelines to help define the risk assessment objectives, and/or risk management strategy. The following bullets capture the essential findings from the tabulated soil quality data:

- The PAHs are failing the pathway for the protection of aquatic life only
- The metals are failing the pathway for the protection of soil dwelling plants and invertebrates
- In one instance, arsenic also fails the pathway for direct human soil exposure

2.2 Tier 2 Approach

Table 3 summarizes the offending Tier 1 pathways for human and ecological receptors and indicates the specific substances and Tier 2 approach to be taken.

Table 3: Ecological and Human Health Pathway Receptor Tier 2 / Risk Management Approaches

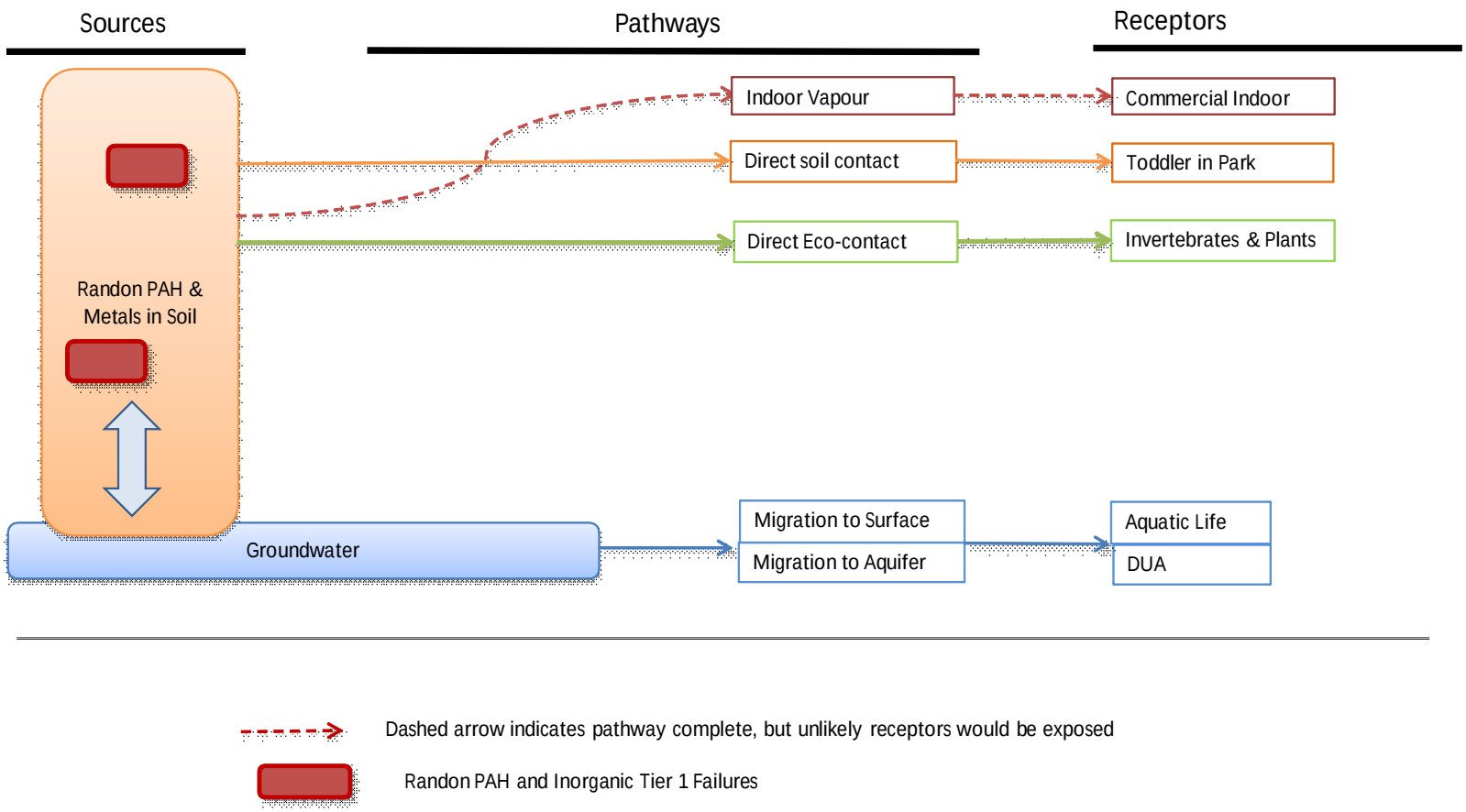
Applicable Pathway-Receptor	Non-compliant Contaminants in Soil	Tier 2 Approach
Protection of groundwater for Aquatic Life	Anthracene, fluoranthene, phenanthrene, pyrene	Demonstrate Tier 1 equivalent protection through measured experimental soil leachate ([1]) & groundwater concentrations
Direct eco- contact	Arsenic, boron, cobalt, nickel, selenium	Evaluate eco-exposure for upper statistical bound concentrations
Direct human contact	Arsenic and other where Tier 2 guidelines are not published	Evaluate human-exposure for upper statistical bound concentration

Footnotes: ([1]) Leachate test: US EPA's Method 1312, synthetic precipitation leaching procedure, or SPLP. This test is designed for semi volatiles and imitates rain water leachate in soil matrix either rich in organic carbon, or poor in organic carbon. This is an 18 hour duration standardized test that most laboratories will be capable of running.

2.3 Conceptual Exposure Model

The pathway-receptors considered in this Tier 2 risk assessment are diagrammatically shown in Illustration 1. The pathways are reflective of those that are summarized in Table A. The indoor vapour intrusion pathway is operable, but considering the lack of volatile contaminants, this pathway is not expected to result in any exposure. The key pathways for this Tier 2 risk assessment are the groundwater mediated pathway for aquatic life and the direct soil ecological pathway.

Illustration 1: Conceptual Exposure Model: Hawrelak Park



3. Exposure and Effects Assessment

The following describes the fundamental approaches taken to address the exposure and effects components of this risk assessment. The initial paragraph discusses the approach taken for the PAHs and the second paragraph discusses the approach taken for the inorganic substances.

AECOM investigated the possibility that the PAH soil guideline development calculation over predicts leachate concentrations. This approach was taken because the conclusions would be independent of horizontal migration, which requires more detailed knowledge of delineation in the soil, as well as in-depth hydrogeological details. When the mechanism of contamination is suspect fill, this approach, once refined, could provide practitioners with an alternate Tier 2 adjustment tool. In order for this approach to be robust, soil must be collected across the site-specific soil PAH and textural gradient. The secondary approach to the PAH exposure problem was to ensure that all borings reached the groundwater, and that monitoring wells were installed. These approaches evaluate the exposure component only. An effects assessment was not included: CCME freshwater aquatic life standards for PAHs serve as the endpoint objective in the back-calculated Tier 1 soil quality guidelines for this pathway.

The methodological approach for the inorganic substances will address both exposure and effects. AECOM will evaluate multiple lines of evidence: (i) application of an area-wide statistical endpoint to express both the upper bounds on direct soil exposure and the upper probability tolerance to help characterize soil that may be exposed during development in the park; (ii) evaluate the toxicological basis of the soil quality guidelines to understand if the fundamental studies are applicable to parkland settings; and (iii) qualitative biological observation to understand if ecological harm is visually apparent.

3.1 PAHs and Aquatic Life Exposure Pathway

3.1.1 Experimental Leachate

In the Province of Alberta the PAH soil quality guidelines protective of aquatic life are based upon partitioning from the soil into the soil pore water (rain water) and subsequent dilution with lateral (advective and dispersive) transport within the groundwater. Where the source and extent of the soil PAH is well understood, a Tier 2 adjustment can be performed to account for the lateral off-set from the aquatic water body. Because the source and extent of the PAHs is not well understood, and in fact, may be characterized as ‘random fill’, this lateral off-set argument is difficult to apply in Hawrelak Park.

AECOM is proposing to address this issue at the initial partitioning point in the guideline development. Leachate concentrations resulting from the interaction between the contaminated matrix and infiltrating rain water is estimated with the following equation:

$$C_l = \frac{C_s}{K_{oc} f_{oc} + \theta_w/\rho_b + H' \theta_a/\rho_b} \; x \; 1000$$

Where

C_l = chemical concentration in leachate (µg/L)
C_s = chemical concentration in soil (µg/g)
K_{oc} = organic carbon partition coefficient (chemical specific. cm^3/g)
f_{oc} =fraction organic carbon (soil matrix. g/g)
θ_a = air filled porosity (soil matrix, unitless)
θ_w = water filled porosity (soil matrix, unitless)
ρ_b = bulk density (soil matrix. g/cm^3)
H’ = Henry Law Constant, dimensionless and chemical - specific

The equation is simply a re-arrangement of the Tier 1 Dilution Factor 1. The original risk assessment strategy was to evaluate whether this model was over predicting the soil leachate concentrations under true 'field condition'. The intent was to compare predicted leachate to experimental leachate concentrations extracted from site-specific soil with PAH concentrations in excess of Tier 1. During the August 7, 2014 drilling there were only two fill soil samples obtained with PAH concentrations above Tier 1. The theoretical leachate concentration from the coal rich horizon in the bedrock (BH14-05 @ 2.4 m) is summarized in Table 4.

Table 4: Theoretical PAH Leachate Relative to Experimental Results

PAH compound	Soil input (C_s) in µg/g	Henry law (H')	Organic carbon partition (k_{oc}) cm^3/g	Predicted leachate (µg/L)	Experimental (SPLP) leachate (µg/L)
Anthracene	0.003*	CCME (0.0015) EPA (0.00267)	CCME (19953) EPA (29500)	0.04 0.03	< 0.005
Phenanthrene	0.01*	CCME (0.000609) EPA (0.00173)	CCME (6607) EPA (22400)	1.17 0.35	< 0.1
Fluoranthene	0.03	CCME (0.000609) EPA (0.00066)	CCME (41687) EPA (10700)	0.27 0.45	< 0.01
Pyrene	**0.07**	CCME (0.000466) EPA (0.000451)	CCME (69183) EPA (10500)	0.47 0.38	0.03

*Footnotes: **Bold** soil concentration exceeds Tier 1 (aquatic life). * - actual soil concentration was < this value. Common matrix parameters: ρ_b = 1646 g/cm3; θ_w= 0.34; θ_a = 0.05 (arithmetic means from Table 1); f_{oc} = 0.00387 (14-05 @ 2.4m). Chemical specific parameters from ESRD Tier 1 (March 2014) and US EPA Soil Screening Level (SSL) as cited on Oak Ridge Risk Assessment Information System (RAIS) 22 October 2014.*

3.1.2 Groundwater Sampling

A secondary strategy to evaluate the potential aquatic life exposure to PAHs was to simply measure the concentrations in the groundwater throughout Hawrelak Park. Comparison of groundwater results to the theoretical Tier 1 leachate concentration would not be appropriate because the groundwater results integrate Dilution factor 2 (diffusion and biodegradation through the vadose zone) and Dilution factor 3 (infiltration rate and mixing onto a dynamic groundwater table). The following Sections discuss the methods and results from the groundwater sampling.

3.1.2.1 Methods

The City of Edmonton staff completed two sampling events: one on 04 September 2014 and one on 11 September 2014. The latter event was to collected true dissolved phase trace metals, and this will be discussed in Section 3.2.4. The following points summarize the field methods employed during the both events. The only difference between the 04 September and 11 September sampling events was the number of wells sampled. On September 4, all eight new wells plus Stantec's S14-3 were sampled. On 11 September specific wells were sampled to target 'worst case' dissolved metals: S14-3, 14-02; 14-03 and 14-06.

- On August 12, 2014 all monitoring wells were developed by purging 3 well casing volumes with plastic bailers
- Sampling methodology included:
  - Static water levels were recorded in all monitoring wells
  - Three casing well volumes of water were removed using a peristaltic pump
  - Laboratory supplied water sampling containers were filled

- Bottles were stored in a chilled cooler and transported on the same day, with a chain of custody, to EXOVA analytical laboratory

Field sampling sheets from the City of Edmonton are available in Appendix B.

3.1.2.2 Results

The analytical results from September 4, 2014 were electronically transferred into summary table (Table B) and compared against ESRD Tier 1 DUA and Aquatic Life guidelines. The final EXOVA analytical report is contained within Appendix D. There were no PAHs detected in any groundwater samples within the area of interest.

3.2 Aquatic Life Exposure Assessment

Based on the very limited experimental leachate data, the evidence suggests that the theoretical predicted leachate in the soil quality guideline development could be over predicting leachate concentrations by an order of magnitude. Due to limited data from this specific exposure study, significant uncertainty remains. Nevertheless, the clean groundwater results provide a convincing case to support the prediction that the soil quality guidelines may be over conservative, at least for this site-specific example.

Aquatic life within the North Saskatchewan River, and other water bodies, are not at risk of being exposed to the PAHs found within the fill and native soils at Hawrelak Park.

3.3 Inorganic Substances

3.3.1 Statistical Distributions: Exposure Assessment

As identified in Section 1.2.2.2 the metal Tier 1 non-compliance occurrences are not exclusively associated with the upper fill, rather they are distributed throughout all major lithologies. Because of the uncertainties regarding the distribution and mechanisms of contamination, this statistical analysis was completed on the entire data set, regardless of depth. Furthermore, future development may expose this material to unspecified depths.

The parkland direct soil ecological protection objectives, expressed as dry soil concentrations (mg/kg), are intended to support, or sustain typical parkland soil dependent species and should not adversely affect wildlife. Because of the distribution of the inorganic contaminants in the subsurface, this protection objective for the ecological receptors would be best predicted from a statistical endpoint of the site-wide soil quality: the upper 95th percent confidence limit on the mean (95% UCLM).

During future park development, soils are expected to be disturbed, and the quality of that soil may be a concern. In order to predict what the inorganic contaminant concentration may be in any disturbed soil, the 95% Upper Tolerance Limit (UTL) with 90% coverage has been calculated. This statistic predicts that 90% of future soil quality observations will be below the calculated statistic with 95% confidence. Appendix E contains the working details for this statistical analysis and the summary statistics are provided in Table 5.

Table 5: Summary Statistics: Inorganic Substances

Inorganic Substance	*n*	% non-detect	Maximum (mg/kg)	Minimim (mg/kg)	Mean	Standard Deviation	Coefficient of Variation	Skewness	UCL 95 (mg/kg)	UTL 95 (mg/kg)	Method
Arsenic	41	0%	30.0	1.4	8.43	5.61	0.66	1.88	10.14	19.81	Raw Statistic
Boron	41	22%	5.65	0.21	1.02	1.18	1.16	--	1.19	2.99	LogROS
Cobalt	41	0%	25.7	1.9	10.27	4.71	0.46	1.52	11.78	18.8	Raw Statistic
Nickel	41	0%	110	7.5	31.44	20.81	0.66	2.61	38.5	66.5	Raw Statistic
Selenium	41	56%	1.8	0.3	0.55	0.28	0.51	--	0.52	0.844	KM

Footnotes: UTL95 is the calculated 95% Upper Tolerance Limits with 90% Coverage.

3.3.2 Toxicological Basis for SQG: Hazard Assessment

Brief profiles are provided for each inorganic substance to understand the fundamental basis for the soil quality guideline (SQG). The ESRD Tier 1 SQGs are dominated by ecological protection, but only rarely list guidelines for inorganic substances designed for human health protection. Where the data are available from Canadian Council of Ministers of the Environment (CCME), or other jurisdictions, human health based SQG will be presented to help assure stakeholders that human health protection objectives can be achieved. The Ontario Ministry of Environment, April 2011) was the preferred alternate jurisdictional source for SQGs. The Ontario MoE has developed rigorous, risk-based human health SQG that adhere to Canadian federal guidance, and would be comparable to the ESRD Tier 1 rigor.

The purpose of this hazard assessment is to understand if the Tier 1 SQGs are appropriate for the setting in Hawrelak Park, and if not, to propose alternate SQGs.

Arsenic

CCME 1997 is the primary reference for the arsenic SQG. Sufficient ecotoxicological and human toxicological data were available to allow for the development of ecological (SQG_{Eco}) and human health (SQG_{HH}). In the development of the $SQG_{HH,}$ CCME used an incremental lifetime carcinogenic risk (ILCR) threshold of 1 in 1,000,000. Alberta ESRD prefers the ILCR threshold of 1 in 100,000. Consequently, the ESRD Tier 1 SQG_{HH} was re-calculated to 21 mg/kg. This Tier 1 SQG_{HH} also considers a background arsenic soil concentration of 10 mg/kg. The CCME (1997) SQG_{Eco} was adopted by ESRD unchanged at 17 mg/kg.

There is no reason to believe these SQGs would not be appropriate for the setting in Hawrelak Park.

Boron (hot water)

The Alberta ESRD Tier 1 guideline of 2 mg/kg came from CCME 1991 and was intended strictly for agricultural land use. Ontario MoE, April 2011 calculates a SQG_{Eco} for hot water extracted boron of 1.5 mg/kg, but Ontario MoE only applies this guideline in shallow soils where plant roots are present. For all other receptors (*i.e*. humans) and subsoils, the acid extract total boron SQG is 120 mg/kg.

Equilibrium Environmental Inc. and EXOVA Laboratories have been working on developing the Alberta Tier 1 SQG_{Eco}, but this work is still in development[1]. Toxicological testing has been completed with agricultural and boreal species. Preliminary results seem to suggest agricultural plant growth EC_{25} threshold between 8.9 and 32 mg/kg, with the lower threshold associated with coarse textured soil and the higher threshold with finer textured soil. The researchers are focusing in on a Tier 1 guideline that will likely be expressed in the aqueous saturated paste phase (milligrams per litre; mg/L), since this reduces most of the variability around the soil: water dissociation constant (k_d), which is driven by the soil textural characteristics.

[1] *PTAC Soil and Groundwater Forum (March 2013). Presentation is available online at the PTAC website.*

Golder (June 2008) developed a human health soil based site-specific remedial objective (SSRO) for boron, expressed as total acid extractable. This SSRO was 721 mg/kg.

At this point there are no good SQG_{Eco} for hot water soluble boron. The default is to go with the Tier 1 guideline and recognize the significant uncertainty in this value. The hot water extraction methods are not appropriate for evaluating the human health risk from soil bound boron.

Cobalt

CCME, 1991 produced an interim parkland value of 50 mg/kg. Alberta ESRD in their Tier 1 development applied 'professional judgement' to establish the Tier 1 guideline at 20 mg/kg. Ontario MOE, June 2011 using a weight of evidence method described in CCME (1996), derived SQG_{Eco} of 33 mg/kg. Species included soil invertebrates and agricultural plants. Ontario MoE, April 2011 produced a conservative surface SQG_{HH} of 22 µg/g. This Ontario human health guideline is constructed around a scenario for toddler soil ingestion, inhalation and dermal contact and compares the exposure dose to Agency for Toxic Substances and Disease Registry (ATSDR) minimum risk level (MRL) toxicity reference values.

Given the calculation of SQG_{HH} from Ontario MoE, April 2011 the ESRD Tier 1 guideline appears appropriate for use at Hawrelak Park. It can be applied for both ecological and human health protection.

Nickel

CCME, 1999 publishes a nickel SQG_{Eco} of 50 mg/kg, which was adopted in Alberta as the Tier 1 criterion. No SQG_{HH} was developed. Ontario MoE, April 2011 produced a conservative surface SQG_{HH} that seems applicable for parkland land use: 330 µg/g. This Ontario human health guideline is constructed around a scenario identical to that described for cobalt, but the exposure dose was compared to US EPA IRIS toxicological reference values.

The CCME and Ontario MoE SQGs are considered appropriate for the setting in Hawrelak Park.

Selenium

Environment Canada (2001) produced a scientific supporting rationale for selenium SQG. There was insufficient ecotoxicological data to use the CCME (1996) weight of evidence methodology, so the authors used the lowest observed effects concentration (LOEC) of 1 mg/kg, which was related to growth reduction in *Sorghum valgare*. No uncertainty factor was applied. Alberta adopted this value as the Tier 1 criterion, but did not identify any SQG_{HH}. Environment Canada (2001) calculated a residential / parkland SQG_{HH} based on toddler exposure with comparison to US EPA IRIS toxicity reference values. The SQG_{HH} calculated is 28 mg/kg.

There is no reason to believe these two Environment Canada (2001) SQG would not be appropriate for the setting in Hawrelak Park.

3.3.3 Direct Biological Observations: Effects Assessment

One of the most obvious tools in the ecological risk assessment methods is simple field observations. The grasses and trees in Hawrelak Park have not shown any signs of distress from the perceived ecotoxicological impairment that may transpire from direct exposure to metals. This is only a qualitative conclusion, but given the other lines of evidence presented previously, this is a sufficient level of rigor for this risk assessment.

3.3.4 Groundwater Check: Aquatic Life and DUA

In order to provide further assurances in regards to the inorganic substances, the City of Edmonton conducted groundwater sampling of dissolved metals on selected monitoring wells throughout Hawrelak Park, as described in Section 3.1.2. The approach was to sample locations in which soil Tier 1 non-compliance issues had appeared to understand if groundwater non compliance issues would arise. The sampling occurred on September 11, 2014 and

all data reflect field filtration (0.45 µm) and acid preservation. The final EXOVA analytical report is attached in Appendix D and the data have been compared against the Tier 1 DUA and aquatic life guidelines in Table B. All the results showed concentrations of the offending metals that were less than Tier 1 groundwater guidelines.

3.3.5 Risk Characterization: Weight of Evidence

The risk characterization is an opportunity to synthesize the exposure, hazard and effects assessments into a unified conclusion. Table 6 summarizes the conclusions from the upper bounds on the mean exposure relative to the ecological and human soil quality guidelines. Based on this data, the upper bound exposure would not exceed either ecological or human health soil quality guidelines. This conclusion predicts that Hawrelak Park would show no evidence of ecological impairment with the vegetation, and none has been observed. The groundwater check also supports the logical conclusion that these scattered trace metals in the soils at Hawrelak Park are not representing and ecological or human health risk.

Table 6: Inorganic Substances: Risk Characterization Summary

Inorganic substance	Exposure in Soil 95 UCL on Mean	Hazard SQG $_{Eco}$	Hazard SQG $_{HH}$	Adverse Effects Observations	GW Check for Aquatic / DUA	Conclusions
Arsenic	10.14 mg/kg	17 mg/kg	21 mg/kg	nil	< Tier 1	Acceptable risk
Boron (hot water)	1.19 mg/kg	2 mg/kg	----	nil	< Tier 1	Acceptable risk
Cobalt	11.78 mg/kg	20 mg/kg	20 mg/kg	nil		Acceptable risk
Nickel	38.5 mg/kg	50 mg/kg	330 mg/kg	nil	< Tier 1	Acceptable risk
Selenium	0.52 mg/kg	1 mg/kg	28 mg/kg	nil	< Tier 1	Acceptable risk

For excavated soils, the statistical upper tolerance limits indicate that it would be highly unlikely to encounter soil that exceeded the SQG_{HH}. However, there is a potential that excavated soils may display trace metals that exceed the SGG_{Eco}. Regardless of whether or not these exceedances result in ecological impairment, the City of Edmonton should take steps to properly characterize stockpiled soils before deciding on where they may be deposited.

4. Risk Management

The evidence presented in this risk assessment supports the overall conclusion that these trace levels of PAHs and metals in soil are not likely to result in any environmental impairment to the land or water within and around Hawrelak Park. Furthermore, the human health protection objectives, imbedded into the Tier 1 guidelines, can be considered to be met. As such, AECOM is not recommending any on-going *in-situ* risk management actions.

However, when future development results in ground disturbance and *ex-situ* soils, the City of Edmonton should be taking steps to ensure:

(i) The exposed soils are not violating any of the assumptions within this risk assessments (*i.e. ex-situ* soil quality complies with the SQG_{Eco} or SQG_{HH}); and
(ii) The *ex-situ* soil is properly handled and deposited in appropriate locations, given the documented soil quality.

To ensure that any future *ex-situ* confirmation soil sampling design will meet all required expectations and be properly interpreted (e.g. sample replications and parameters compared to the appropriate criterion), the City should retain an environmental professional.

5. References

Alberta Environment Sustainable Resource Development (ESRD). March 2014. ESRD Tier 1 soil and groundwater remediation guidelines.

Andriashek, L.D., 1988. *Quaternary Stratigraphy of the Edmonton Map Area NTS 83H*. Alberta Research Council Open File Report #198804.

AGRA Earth & Environmental (September 1996). Phase II and III Environmental Site Assessment and Site Remediation Hawrelak Park Maintenance Compound, Edmonton, AB

AGRA Earth & Environmental (April 1997). Phase III Site Remediation Closure Report, Hawrelak Park Maintenance Compound, Edmonton, AB

Canadian Council of Ministers of the Environment (CCME). March 1996. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. The National Contaminated Sites Remediation Program.

CCME (1991, updated 1997 & 1999). Canadian Environmental Quality Guidelines. Environment Canada, Guidelines and Standards Division. Hull, Quebec.

City of Edmonton, Materials Engineering, Roadway Engineering Branch (July 1993). Subgrade Evaluation Hawrelak Park, East Roadway and Trial.

Environment Canada. 2001. Canadian Soil Quality Guidelines SELENIUM (Environmental and Human Health Effects). Scientific Supporting Document. National Guidelines and Standards Office, Environment Canada.

Golder Associates. June 2008. Soil Quality Investigation Spartan Park Development Area 12104 – 70th Street, Edmonton, Alberta. Submitted to City of Edmonton, Transportation Department.

Kathol, C.P. and McPherson, R.A., 1975. *Urban Geology of Edmonton*. Alberta Research Council Bulletin 32.

Oak Ridge National Laboratory Risk Assessment Information System http://rais.ornl.gov/

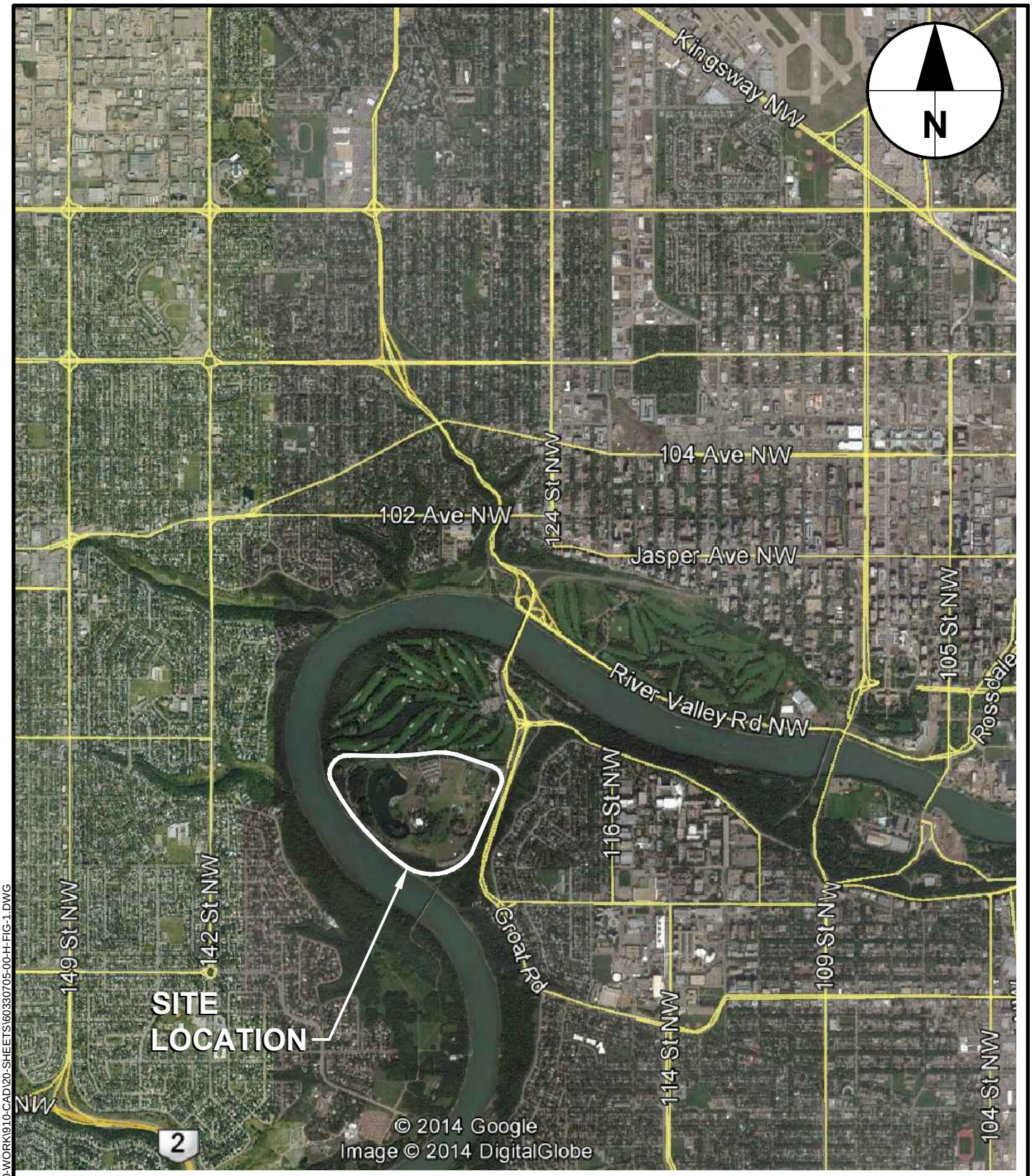
Ontario Ministry of Environment, April 2011, Rational for the Development of Soil and Groundwater Standards for use at Contaminated Sites in Ontario. Prepared by Standards Development Branch, Ontario MoE.

Stantec Consulting Ltd. (April 2014). Hawrelak Park Phase I Environmental Site Assessment, 9330 – Groat Road NW, Portion of Block X, Plan 6075AM, Edmonton, AB.

Stantec Consulting Ltd. (May 2014). Hawrelak Park Limited Phase II Environmental Site Assessment, 9330 – Groat Road NW, Portion of Block X, Plan 6075AM, Edmonton, AB.

US Environmental Protection Agency (EPA). Integrated Risk Information System (IRIS). http://www.epa.gov/iris/index.html

Figures



Hawrelak Park
SITE LOCATION PLAN

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ANSI A 215.9mm x 279.4mm

Last saved by: CASTLE-JANSCHP (2014-10-31) Last Plotted: 2014-12-15
Filename: P:\60330705\900-WORK\910-CAD\20-SHEETS\60330705-00-H-FIG-1.DWG

City of Edmonton Engineering Services
Hawrelak Park Tier 2 Risk Assessment

0 200 400 600m

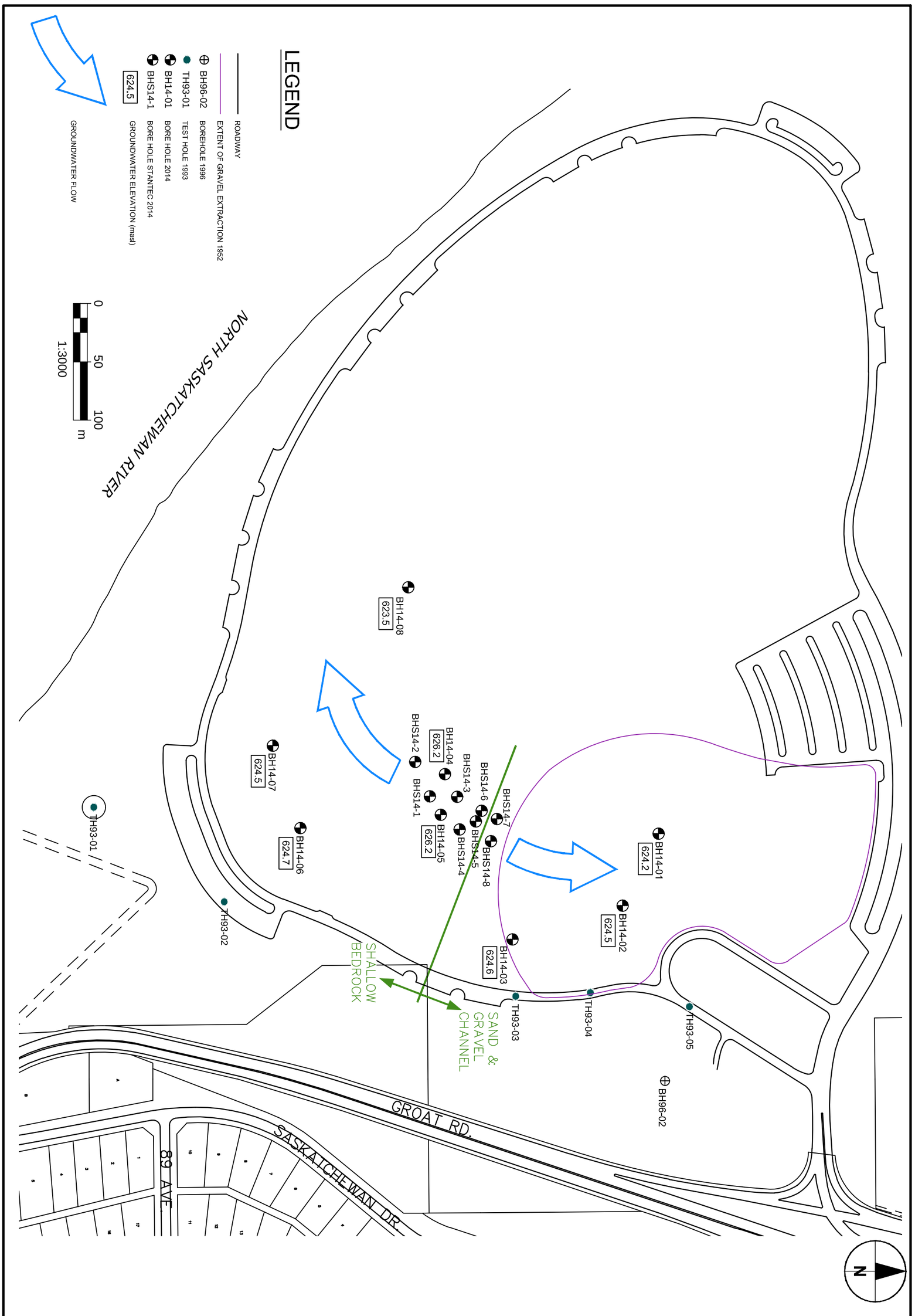
SCALE 1:20,000

AECOM

Project No.: 60330705 Date: 2014-12-15

Figure: 1

Filename: P:\60330705\900-WORK\910-CAD\20-SHEETS\60330705-00-H-FIG-2.DWG



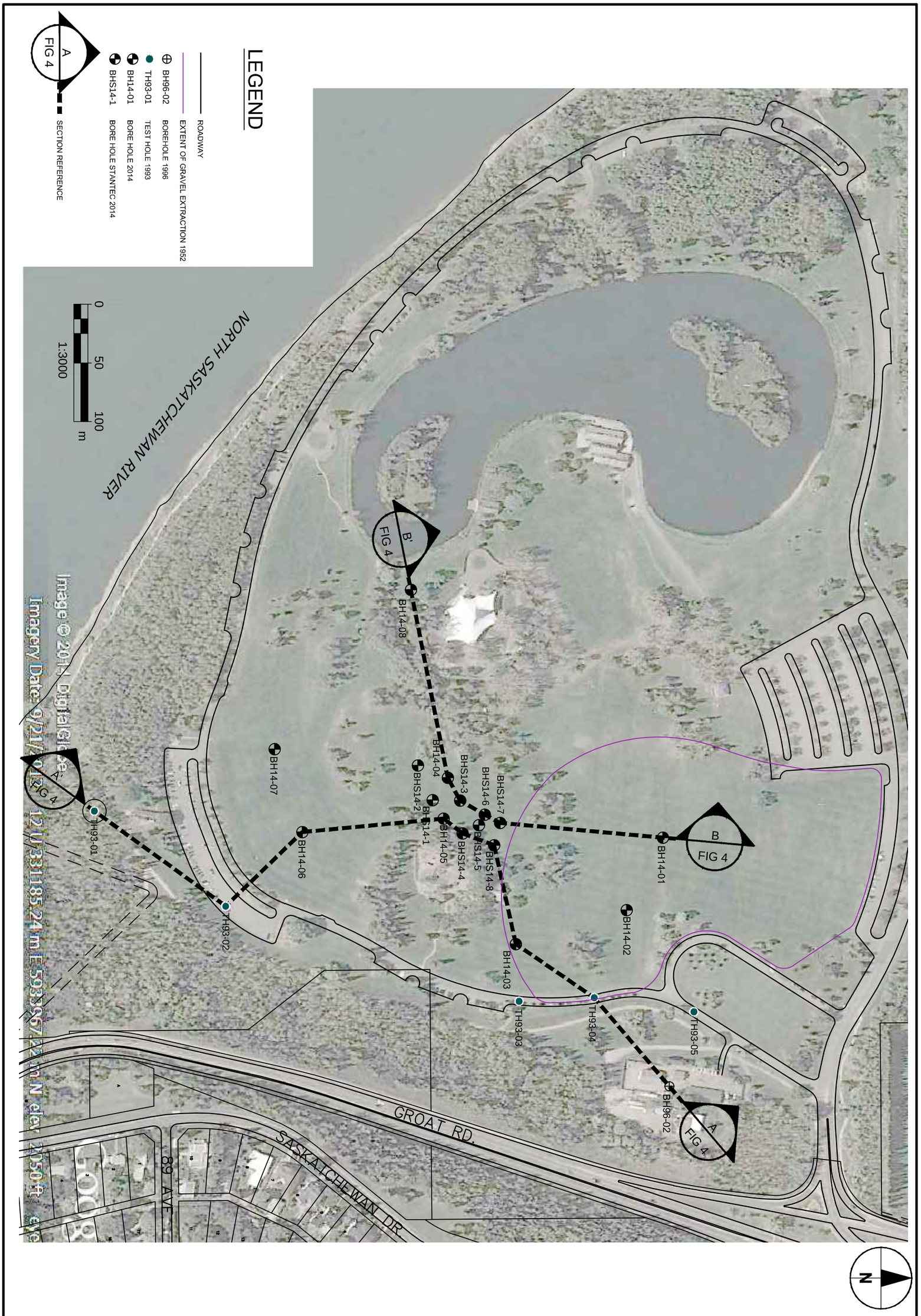
City of Edmonton Engineering Services
Hawrelak Park Tier 2 Risk Assessment
AECOM 60330705
Date: 2014-12-15

GEODETIC GROUNDWATER ELEVATION

AECOM

FIGURE 2

Filename: P:\60330705\900-WORK\910-CAD\20-SHEETS\60330705-00-H-FIG-3.DWG



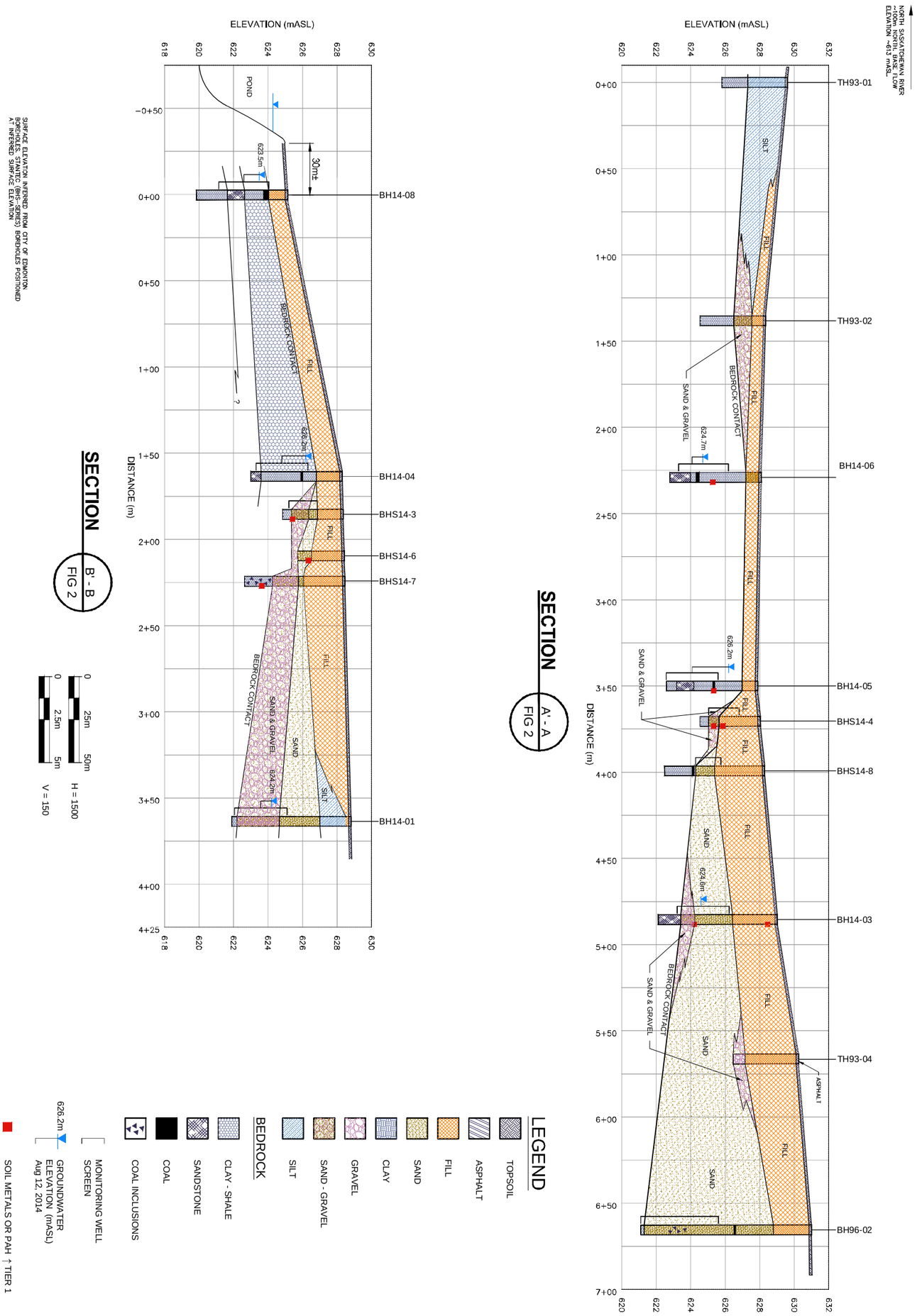
City of Edmonton Engineering Services
Hawrelak Park Tier 2 Risk Assessment
AECOM 60330705
Date: 2014-12-15

CROSS SECTION LINES

AECOM

FIGURE 3

Last saved by: CASTLE-JANSCHP (2014-10-21) Last Plotted: 2014-10-21
Filename: P:\60330705\900-WORK\910-CAD\20-SHEETS\60330705-00-H-FIG-4.DWG
ARCH C 18" x 24"



City of Edmonton
Engineering Services
AECOM Project No.: 60330705

Hawrelak Park Tier 2 Risk Assessment

GEOLOGICAL CROSS SECTIONS

AECOM

FIGURE 4

Soil and Groundwater Tables

Soil and Groundwater Data Tables

- **Tables A: Soil Quality**
- **Table B: Groundwater Quality**

Table A: Soil Quality Hawrelak Park

			Tier 2 Guidelines -					JK1925	JK1926	JK1927	JK1928	JK1929	JK1930	JK1931	JK1932	JK1933	JK1934	JK1935	JK1936	JK1940	JK1941	JK1942	JK1943	JK1944
								S14-1 @ 0.6m	S14-1 @ 1.3m	S14-2 @ 2.1m	S14-2 @ 2.8m	S14-3 @ 1.3m	S14-3 @ 2.1m	S14-3 @ 2.8m		S14-4 @ 1.6m	S14-4 @ 1.9m	S14-4 @ 2.6m	S14-5 @ 1.3m	S14-6 @ 2.1m	S14-7 @ 2.8m	S14-7 @ 4.9m		S14-8 @2.1m
								FILL	SILT	SILT	SILT	FILL	SAND	SAND		FILL	FILL w BR	SAND/ GR	FILL	FILL	SAND/ GR	BR		FILL
			Aquatic Life (Coarse)	DUA (Coarse)	Indoor Vapour (Fine)	Human Contact (Fine)	Eco-Direct Contact (Fine)																	
Extractable Hydrocarbons																								
F2 (C10-C16)		mg/kg	*520*	2900	2400	6800	150	<10	42	<10	<10	<10	<10	<10	<10	<10	16	<10	<10	<10	<10	<10	<10	<10
F3-(C16-C34)		mg/kg	--	--	--	15000	1300	<50	190	<50	<50	<50	<50	<50	<50	<50	140	<50	<50	59	<50	<50	<50	<50
F4 (C34-C50)		mg/kg	--	--	--	21000	5600	<50	<50	<50	<50	<50	<50	<50	<50	<50	55	<50	<50	<50	<50	<50	<50	<50
Chrom to baseline at NC50								yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
VOLATILES																								
Benzene		mg/kg	*1.6*	0.078	1.7	78	60	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene		mg/kg	*0.49*	0.95	1900	20000	110	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ethylbenzene		mg/kg	*540*	0.21	930	8500	120	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Xylene (total)		mg/kg	*250*	28	250	140000	65	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
F1 (C6-C10) - BTEX		mg/kg	*1300*	2200	610	12000	210	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12
Total Organic Carbon		%																						
Moisture		%						14	21	25	20	17	14	17	15	21	27	17	24	31	17	17	16	19
PAHs																								
Naphthalene		mg/kg	*0.017*	53	25	34,000	--	<0.005	0.0076	0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005
Acenaphthylene		mg/kg	--	--	--		--	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005
Acenaphthene		mg/kg	*0.38*	--	--	75,000	--	<0.005	0.056	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005
Fluorene		mg/kg	*0.34*	--	--	46,000	--	<0.005	0.045	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005
Phenanthrene		mg/kg	*0.061*	--	--		--	0.0065	*0.089*	0.0087	<0.005	<0.005	<0.005	<0.005		0.057	0.04	0.011	*0.098*	<0.005	<0.005	0.011		0.012
Anthracene		mg/kg	*0.0056*	--	--	300,000	2.5	<0.004	*0.02*	<0.004	<0.004	<0.004	<0.004	<0.004		<0.004	0.005	<0.004	<0.004	<0.004	<0.004	<0.004		<0.004
Fluoranthene		mg/kg	*0.039*	--	--	50,000	50	0.012	*0.12*	<0.005	0.013	0.006	0.0069	0.0058		0.013	*0.09*	0.024	0.0074	<0.005	<0.005	0.01		0.017
Pyrene		mg/kg	*0.04*	--	--	34,000	--	0.026	*0.24*	<0.005	*0.089*	0.0098	0.011	0.012		0.022	*0.18*	*0.043*	0.014	0.0087	<0.005	0.026		0.019
Benzo(a)anthracene		mg/kg	*0.083*	3.1	--		--	<0.005	0.02	<0.005	<0.005	<0.005	0.0058	<0.005		0.012	0.075	0.017	<0.005	<0.005	<0.005	<0.005		0.0079
Chrysene		mg/kg	--	19	--		--	<0.005	0.014	<0.005	0.0069	0.0052	0.0053	<0.005		0.0093	0.051	0.013	<0.005	<0.005	<0.005	0.005		0.011
Benzo(b+j)fluoranthene		mg/kg	--	1.4	--		--	0.013	0.05	<0.005	0.023	0.024	0.027	0.025		0.05	0.34	0.076	0.021	0.012	0.016	0.027		0.02
Benzo(k)fluoranthene		mg/kg	--	0.31	--		--	<0.005	0.011	<0.005	<0.005	<0.005	0.0053	<0.005		0.011	0.085	0.017	<0.005	<0.005	<0.005	<0.005		0.0053
Benzo(a)pyrene		mg/kg	*0.77*	3.4	--		20	0.0063	0.027	<0.005	0.0092	0.0096	0.0086	0.0084		0.018	0.078	0.02	0.083	<0.005	<0.005	0.012		0.0084
Indeno(1,2,3-c,d)pyrene		mg/kg	--	24	--		--	<0.005	0.013	<0.005	0.0065	0.0095	0.01	0.009		0.02	0.088	0.024	0.01	0.0062	0.0076	0.0084		0.0097
Dibenzo(a,h)anthracene		mg/kg	--	2.1	--		--	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	0.012	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005
Benzo(g,h,i)perylene		mg/kg	--	63	--		--	0.0064	0.0078	<0.005	<0.005	0.01	0.011	0.0084		0.018	0.067	0.021	0.01	0.0063	0.0053	0.0083		0.011
IARC Equivalency_Coarse		mg/kg	--	1	--		--																	
IARC Equivalency_ Fine			--	1	--	8																		
Metals (total)																								
Boron (Hot Water)		mg/kg	--	--	--		2	0.27	4.3	0.46	0.24	0.29	0.41	0.5		0.52	1.5	0.48	0.52	2.2	0.22	0.28		0.41
Hex. Chromium		mg/kg	--	--	--		0.4	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		<0.15 [(1)]	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		<0.15
Antimony		mg/kg	--	--	--		20	<1.	2.1	<1.	<1.	<1.	<1.	<1.		<1.0	1.3	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0
Arsenlc		mg/kg	--	--	--	21	17	4.9	4.9	6.4	11	11	16	19		12	30	11	8.6	13	5.5	20		10
Barium		mg/kg	--	--	--	10000	500	200	170	190	190	160	150	140		150	220	190	240	430	150	170		220
Berylium		mg/kg	--	--	--		5	0.79	3.1	0.75	0.7	0.58	0.59	0.54		0.69	1.2	0.72	0.47	0.48	<0.4	0.46		0.51
Cadmium		mg/kg	--	--	--	14	10	0.32	0.16	0.18	0.15	0.25	0.25	0.22		0.32	0.48	0.25	0.2	0.26	0.2	0.23		0.19
Chromium		mg/kg	--	--	--	220	64	18	9.1	21	45	34	50	25		18	12	19	16	12	14	14		15
Cobalt		mg/kg	--	--	--		20	24	10	7.7	14	10	9.4	7.6		11	9.6	8.9	7.2	6.3	9.2	14		8.8
Copper		mg/kg	--	--	--	1100	63	34	15	13	15	19	13	11		21	22	18	15	16	5.1	19		14
Lead		mg/kg	--	--	--	140	300	9.3	8.8	7.7	8.6	9.8	6.9	5.9		11	11	9.3	7.6	7.4	4.3	8.9		8.4
Mercury		mg/kg	--	--	--	6.6	12	0.08	0.055	<0.05	<0.05	<0.05	<0.05	<0.05		0.054	0.059	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05
Molybdenum		mg/kg	--	--	--		4	2.5	3.9	1.1	1.8	1.6	1.9	2.1		1.1	1.9	1.2	2	3.4	0.67	1.4		1.9
Nickel		mg/kg	--	--	--		50	110	45	22	39	35	38	25		31	33	29	21	18	21	38		22
Selenium		mg/kg	--	--	--	80	1	0.59	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	0.52	<0.5	<0.5	0.52	<0.5	<0.5		<0.5
Silver		mg/kg	--	--	--		20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0
Thallium		mg/kg	--	--	--		1.4	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3		<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3		<0.3
Tin		mg/kg	--	--	--		5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0
Uranium		mg/kg	--	--	--		500	<1.0	1.4	<1.0	<1.0	2.3	1.9	2.2		1.5	1.2	1	1.2	1.9	<1.0	1.4		1.9
Vanadium		mg/kg	--	--	--		130	30	20	29	24	24	22	18		25	22	25	20	18	13	14		20
Zinc		mg/kg	--	--	--		200	78	38	54	51	61	54	42		61	45	53	49	50	31	61		49

BR= bedrock

Table A: Soil Quality Hawrelak Park

			Tier 2 Guidelines -					JK1945	1019155-1	1019155-2	1019155-3	1019155-4	1019155-5	1019155-6	1019155-7	1019155-8	1019155-9	1019155-10	1019155-11	1019155-12	1019155-13	1019155-14	1019155-15	1019155-16
								S14-8 @ 2.3m	14-01 @ 0.4m	14-01 @ 1.8m	14-01 @ 2.3m	14-02 @ 1.0m	14-02 @ 1.9m	14-02 @ 3.5m	14-03 @ 0.4m	14-03 @ 1.5m	14-03 @ 3.0m	14-03 @ 4.8m	14-04 @ 1.4m	14-04 @ 3.0m	14-04 @ 4.7m	14-05 @ 0.5m	14-05 @ 1.8m	14-05 @ 2.4m
								FILL	SILT	SAND	SAND	FILL	FILL	CLAY	FILL	FILL	SAND	SAND	FILL	BR	BR	FILL	BR	COAL
			Aquatic Life (Coarse)	DUA (Coarse)	Indoor Vapour (Fine)	Human Contact (Fine)	Eco-Direct Contact (Fine)																	
Extractable Hydrocarbons																								
F2 (C10-C16)		mg/kg	*520*	2900	2400	6800	150	<10																
F3-(C16-C34)		mg/kg	--	--	--	15000	1300	<50																
F4 (C34-C50)		mg/kg	--	--	--	21000	5600	<50																
Chrom to baseline at NC50								yes																
VOLATILES																								
Benzene		mg/kg	*1.6*	0.078	1.7	78	60	<0.005																
Toluene		mg/kg	*0.49*	0.95	1900	20000	110	<0.02																
Ethylbenzene		mg/kg	*540*	0.21	930	8500	120	<0.01																
Xylene (total)		mg/kg	*250*	28	250	140000	65	<0.02																
F1 (C6-C10) - BTEX		mg/kg	*1300*	2200	610	12000	210	<12																
Total Organic Carbon		%							0.49	2.05	1.16	1.14	2.84	0.46	2.5	4.2	0.27	1.01	0.76	0.14	0.46	1.53	2.06	3.87
Moisture		%						16																
PAHs																								
Naphthalene		mg/kg	*0.017*	53	25	34,000	--	<0.005	<0.010	<0.010	<0.010	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene		mg/kg	--	--	--		--	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthene		mg/kg	*0.38*	--	--	75,000	--	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluorene		mg/kg	*0.34*	--	--	46,000	--	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene		mg/kg	*0.061*	--	--		--	0.0057	0.02	<0.01	<0.01	0.04	0.02	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene		mg/kg	*0.0056*	--	--	300,000	2.5	<0.004	<0.003	<0.003	<0.003	0.006	0.003	<0.003	0.009	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluoranthene		mg/kg	*0.039*	--	--	50,000	50	<0.005	<0.01	<0.01	<0.01	0.03	0.02	<0.01	*0.04*	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.03
Pyrene		mg/kg	*0.04*	--	--	34,000	--	0.0086	<0.01	<0.01	<0.01	0.03	0.01	<0.01	*0.04*	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.03	*0.07*
Benzo(a)anthracene		mg/kg	*0.083*	3.1	--		--	<0.005	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Chrysene		mg/kg	--	19	--		--	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b+j)fluoranthene		mg/kg	--	1.4	--		--	0.022	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene		mg/kg	--	0.31	--		--	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene		mg/kg	0.77	3.4	--		20	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene		mg/kg	--	24	--		--	0.0097	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo(a,h)anthracene		mg/kg	--	2.1	--		--	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene		mg/kg	--	63	--		--	0.0084	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
IARC Equivalency_Coarse		mg/kg	--	1	--		--		<0.001	<0.001	<0.001	0.003	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.042
IARC Equivalency_ Fine			--	1	--	8			<0.001	<0.001	<0.001	0.006	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.08
Metals (total)																								
Boron (Hot Water)		mg/kg	--	--	--		2	0.26	0.58	<0.20	<0.20	2.99	5.65	0.55	2.3	1.9	<0.20	0.21	<0.20	<0.20	0.21	0.81	0.26	0.43
Hex. Chromium		mg/kg	--	--	--		0.4	<0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Antimony		mg/kg	--	--	--		20	<1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenlc		mg/kg	--	--	--	21	17	8.3	5.9	4.4	6.5	6.4	7.1	5.2	5.9	5.7	5.9	7.3	11.2	1.4	6.3	7	4.1	3.1
Barium		mg/kg	--	--	--	10000	500	270	269	132	141	260	396	230	261	205	195	230	205	172	188	229	121	242
Berylium		mg/kg	--	--	--		5	0.59	0.5	0.6	0.6	0.7	1	0.6	0.9	0.7	0.5	0.7	1.1	0.7	0.6	0.8	0.5	0.9
Cadmium		mg/kg	--	--	--	14	10	0.19	0.21	0.09	0.25	0.24	0.32	0.33	0.2	0.24	0.13	0.26	0.23	0.26	0.26	0.16	0.46	0.18
Chromium		mg/kg	--	--	--	220	64	27	16.9	10.6	8	18.2	20.8	12.7	17.9	16.5	12.2	18.6	22.5	5.3	8.9	19	12.5	4.2
Cobalt		mg/kg	--	--	--		20	12	9.2	5.9	9	9.6	11.2	10.7	10.4	18.8	8.8	10.6	15	1.9	7.1	9.3	11.4	3.1
Copper		mg/kg	--	--	--	1100	63	9.6	17.7	9.4	7	20.9	33.6	18	19.6	18.3	11.6	14.6	20.8	21.2	23.7	14.6	36.3	13.8
Lead		mg/kg	--	--	--	140	300	6.6	9.5	5.2	<4.9	32.9	56	9.7	16.3	9.8	7.1	7.4	9.5	15.2	9.1	9.9	11.4	16.6
Mercury		mg/kg	--	--	--	6.6	12	<0.05	0.04	0.02	0.02	0.08	0.14	0.04	0.06	0.03	0.04	0.04	0.05	0.12	0.05	0.04	0.14	0.09
Molybdenum		mg/kg	--	--	--		4	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.3	1.1	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel		mg/kg	--	--	--		50	33	25.1	14.8	20	27.1	38.2	33.4	26.9	34.1	16.2	29.1	33.4	7.5	18.4	23.5	22.7	9
Selenium		mg/kg	--	--	--	80	1	<0.5	<0.3	<0.3	<0.3	0.4	0.5	<0.3	0.4	0.7	<0.3	1.8	<0.3	<0.3	0.3	0.4	0.5	0.4
Silver		mg/kg	--	--	--		20	<1.0	0.2	0.3	0.2	0.2	0.2	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1
Thallium		mg/kg	--	--	--		1.4	<0.3	0.17	0.14	0.15	0.17	0.2	0.24	0.2	0.21	0.13	0.16	0.28	0.31	0.17	0.19	0.28	0.25
Tin		mg/kg	--	--	--		5	<1.0	1.6	2.1	2.6	1.6	3	1.5	1.5	1.5	1.8	2.1	2	<1.0	1.9	1.9	1.5	1
Uranium		mg/kg	--	--	--		500	<1.	0.8	0.6	1.1	0.8	1.2	0.9	1.3	5.6	0.9	1.2	1.3	2.9	1.9	0.8	2.3	3.3
Vanadium		mg/kg	--	--	--		130	20	28.6	17.7	18.5	31.5	34.4	23.5	34.1	30.7	20.6	25.2	32.8	9.3	16.3	32.8	22.7	12.8
Zinc		mg/kg	--	--	--		200	44	53	25	34	74	115	51	64	67	45	51	55	35	68	57	80	36

BR= bedrock

Table A: Soil Quality Hawrelak Park

			Tier 2 Guidelines -					1019155-17	1019155-18	1019155-19	1019155-20	1019155-21	1019155-22	1019155-23	1019155-24	1019155-25
								14-06 @ 0.2m	14-06 @ 0.9m	14-06 @ 2.7m	14-07 @ 0.2m	14-07 @ 0.7m	14-07 @ 0.9m	14-07 @ 2.2m	14-08 @ 0.3m	14-08 @ 2.7m
								SAND	BR	BR	FILL	FILL	BR	BR	FILL	BR
			Aquatic Life (Coarse)	DUA (Coarse)	Indoor Vapour (Fine)	Human Contact (Fine)	Eco-Direct Contact (Fine)									
Extractable Hydrocarbons																
F2 (C10-C16)		mg/kg	*520*	2900	2400	6800	150									
F3-(C16-C34)		mg/kg	--	--	--	15000	1300									
F4 (C34-C50)		mg/kg	--	--	--	21000	5600									
Chrom to baseline at NC50																
VOLATILES																
Benzene		mg/kg	*1.6*	0.078	1.7	78	60									
Toluene		mg/kg	*0.49*	0.95	1900	20000	110									
Ethylbenzene		mg/kg	*540*	0.21	930	8500	120									
Xylene (total)		mg/kg	*250*	28	250	140000	65									
F1 (C6-C10) - BTEX		mg/kg	*1300*	2200	610	12000	210									
Total Organic Carbon		%						1.13	0.71	0.08	1.01	0.13	0.18	0.51	4.79	0.28
Moisture		%														
PAHs																
Naphthalene		mg/kg	*0.017*	53	25	34,000	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene		mg/kg	--	--	--		--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthene		mg/kg	*0.38*	--	--	75,000	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluorene		mg/kg	*0.34*	--	--	46,000	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene		mg/kg	*0.061*	--	--		--	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Anthracene		mg/kg	*0.0056*	--	--	300,000	2.5	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluoranthene		mg/kg	*0.039*	--	--	50,000	50	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene		mg/kg	*0.04*	--	--	34,000	--	<0.01	0.03	0.01	<0.01	<0.01	<0.01	0.01	0.02	<0.01
Benzo(a)anthracene		mg/kg	*0.083*	3.1	--		--	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene		mg/kg	--	19	--		--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b+j)fluoranthene		mg/kg	--	1.4	--		--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(k)fluoranthene		mg/kg	--	0.31	--		--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene		mg/kg	0.77	3.4	--		20	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene		mg/kg	--	24	--		--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo(a,h)anthracene		mg/kg	--	2.1	--		--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene		mg/kg	--	63	--		--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
IARC Equivalency_Coarse		mg/kg	--	1	--		--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
IARC Equivalency_ Fine			--	1	--	8		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Metals (total)																
Boron (Hot Water)		mg/kg	--	--	--		2	0.52	0.22	0.36	<0.20	1.3	<0.20	<0.20	1.59	<0.20
Hex. Chromium		mg/kg	--	--	--		0.4	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Antimony		mg/kg	--	--	--		20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenlc		mg/kg	--	--	--	21	17	7.2	4.2	2.9	7.2	2.4	2.6	17.8	5.4	10.8
Barium		mg/kg	--	--	--	10000	500	165	91	295	283	119	166	158	288	196
Berylium		mg/kg	--	--	--		5	0.8	0.6	0.9	1.7	1.3	0.8	0.6	1.2	0.3
Cadmium		mg/kg	--	--	--	14	10	0.16	0.2	0.31	0.59	0.51	0.19	0.27	0.19	0.17
Chromium		mg/kg	--	--	--	220	64	11.7	18.4	22.1	15.9	4	10.1	8.1	15.2	8.1
Cobalt		mg/kg	--	--	--		20	9.6	4.7	25.7	11	6.9	8.1	18	9.8	5.7
Copper		mg/kg	--	--	--	1100	63	11.2	23.1	33.6	13.9	15.8	27.8	21.9	17.6	14.7
Lead		mg/kg	--	--	--	140	300	6.2	11	13.3	8.6	27.3	9.6	10.3	12.6	7.1
Mercury		mg/kg	--	--	--	6.6	12	0.03	0.06	0.1	0.03	0.04	0.1	0.05	0.05	0.04
Molybdenum		mg/kg	--	--	--		4	<1.0	<1.0	1.4	1.2	<1.0	<1.0	1.4	<1.0	<1.0
Nickel		mg/kg	--	--	--		50	20.8	12.6	107	62.5	40.6	17.3	48.6	23.8	16.5
Selenium		mg/kg	--	--	--	80	1	<0.3	0.4	0.9	<0.3	0.4	0.4	0.4	0.4	<0.3
Silver		mg/kg	--	--	--		20	<0.1	<0.1	<0.1	0.2	0.3	0.2	0.1	0.2	<0.1
Thallium		mg/kg	--	--	--		1.4	0.24	0.17	0.34	0.78	0.48	0.26	0.45	0.19	0.12
Tin		mg/kg	--	--	--		5	2.2	1.1	3	2.3	1	1.2	1.7	1.3	1.9
Uranium		mg/kg	--	--	--		500	0.8	2	1.3	1.7	4	1.8	2.6	1.6	1.3
Vanadium		mg/kg	--	--	--		130	24.6	14.2	40.9	43.8	6	14	11.3	30.9	13
Zinc		mg/kg	--	--	--		200	36	47	75	69	69	64	86	51	70

BR= bedrock

Table B: Groundwater Quality Hawrelak Park

		ESRD Tier 2 Guidelines		S14-3	14-01	14-02	14-03	14-04	14-05	14-06	14.07	14-08
				4-Sep-14	4-Sep-14	4-Sep-14	4-Sep-14	4-Sep-14	4-Sep-14	4-Sep-14	4-Sep-14	4-Sep-14
Dissolved Hydrocarbons		Aquatic	Drinking									
Naphthalene	ug/L	***1.1***	***470***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Quinoline	ug/L			<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Acenaphthylene	ug/L	***46***		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	ug/L	***5.8***	***1400***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	ug/L	***3***	***940***	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	ug/L	***0.4***		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	ug/L	***0.012***		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Acridine	ug/L			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	ug/L	***0.04***		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	ug/L	***0.025***	***710***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	ug/L	***0.08***		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	ug/L			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b+j)fluoranthene	ug/L	***0.48***		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	ug/L	***0.48***		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	ug/L	***0.015***		<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Indeno(1,2,3-c,d)pyrene	ug/L			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo(a,h)anthracene	ug/L			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	ug/L			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Carcino B(a)P TPE	ug/L		***0.01***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dissolved Metals	mg/L			11-Sep-14		11-Sep-14	11-Sep-14			11-Sep-14		
Arenic	mg/L	***0.005***	***0.01***	0.0026		0.0004	0.0016			0.0012		
Boron	mg/L	***1.5***	***5***	0.035		0.109	0.047			0.083		
Cobalt	mg/L			0.0039		0.0009	0.0093			0.0025		
Nickel	mg/L	note d	--	0.0069		0.0047	0.0185			0.0126		
Selenium	mg/L	***0.001***	***0.01***	<0.0002		<0.0002	0.0002			0.0005		

note d & e = hardness dependent freshwater guidelines. *De-minimis* = 0.025 mg/L

Appendix A

Borehole Logs (City of Edmonton)

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-01**
Transportation and Streets	UTM ZONE: - N5932952.59 E30189.65	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 628.812 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

Depth (m) | ▲ Wet Unit Weight (kN/m³) ▲ 16 18 20 22 | PLASTIC M.C. LIQUID 20 40 60 80 | ◆ Soil Sulphates (%) ◆ 0.05 0.10 0.15 0.20 | ▲ Compressive Strength(kPa) ▲ 200 400 600 800 | ■ Standard Penetration (N) ■ 20 40 60 80 | SAMPLE TYPE | SPT (N) | USC | SOIL SYMBOL | SOIL DESCRIPTION | WELL INSTALLATION | ELEVATION (m)

Depth (m)	USC	SOIL DESCRIPTION	ELEVATION (m)
0	PEAT	TOPSOIL BROWN PT DAMP	628
	FI	- Silty, some clay, trace sand	
		- Root fibres	
		CLAY FILL BROWN CL-CI DAMP	
1	ML	- Very silty, low to medium plastic	
		- Topsoil intermixed	
		SILT BROWN CL DAMP	
		- Some clay, trace sand, low plastic	
		- at 1.0 to 1.8 m, Silt and Clay, trace sand, low to medium plastic, coal speks	
2		SAND BROWN - DARK BROWN SP DAMP	627
		- Trace to some gravel, trace silt, medium to coarse grained	
		- Rust staining, coal pieces, cleaner sand lenses, no odor	
		- at 2.3 to 3.8 m, Gravelly sand, trace to some silt, damp, coal pieces, gravel up to 50 mm diameter	
3			626
4		- at 3.8 m, Sand, gravelly, some silt, moist to wet, brown	625
	SP	- at 4.2 to 5.3 m, Wet gravelly sand, light seepage, brown, gravel up to 50 mm	
5			624
		- at 5.3 to 6.6 m, Wet gravelly sand, light seepage, random clay shale pockets, gravel up to 50 mm diameter	
6			623
	CS	CLAY SHALE GREY CH DAMP	
7		- Silty, high plastic	622
		End of hole at 6.9 m	
		- Slough at 4.9 m from surface at completion	
		- Water at 4.9 m from surface at completion	
8		- Two inch pvc well installed to 6.7 m	621
		- 10 foot machine slotted screen from 6.7 m to 3.7 m	
		- Sand from 6.7 m to 3.5 m	
		- Bentonite from 3.5 m to surface	
		- Flush mount protector at surface	
9		- No obvious odours while drilling	620

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/18/14

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 6.90 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-02**
Transportation and Streets	UTM ZONE: - N5932921.69 E30251.39	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 629.3 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

Wet Unit Weight (kN/m³): 16 18 20 22

PLASTIC M.C. LIQUID: 20 40 60 80

Soil Sulphates (%): 0.05 0.10 0.15 0.20

Compressive Strength(kPa): 200 400 600 800

Standard Penetration (N): 20 40 60 80

Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL INSTALLATION	ELEVATION (m)
0			PEAT		TOPSOIL BROWN PT DAMP - Silty, some clay, trace sand - Root fibres		629
1			FI		CLAY FILL BROWN CL-CI DAMP - Silty, trace to some sand, trace gravel, low to medium plastic - Dark brown pockets, silt stone pieces, coal pieces, root fibres - High plastic clay pockets - at 0.6 to 1.5 m, High plastic clay fill, trace to some sand, trace gravel, brown, topsoil pockets - at 0.8 m, Sandier pockets, clay shale intermixed, medium to high plastic clay pockets		628
2			SM		- at 1.5 to 2.2 m, Slag like material, topsoil intermixed - at 1.8 m, Asphalt pieces, small slag pieces		627
3					SAND BROWN SM DAMP - Some silt, trace gravel, fine to medium grained		
4			CI		CLAY BROWN CI DAMP - Clay till like, some silt, some sand, trace gravel, medium plastic - Sandy lenses, gravelly lenses, coal pieces - at 3.2 to 4.3 m, Clay Shale intermixed - at 4.0 to 4.3 m, Increases gravel and sand content, moist to wet		626
5			SP		SAND BROWN SP MOIST - WET - Gravelly, some silt, gravel up to 40 mm diameter - Clay interbedded, rust staining, sandier lenses		625
6			SS		SANDSTONE GREY SS DAMP - Silty, trace bentonite, fine grained, non cemented		624
7			CS		CLAY SHALE GREY CI-CH DAMP - Silty, medium to high plastic, coal speks		623
8					End of Hole at 6.9 m - Slough at 5.6 m from surface at completion - Water at 5.2 m from surface at completion - Two inch pvc well installed to 5.8 m - 10 foot machine slotted screen from 5.8 m to 2.8 m - Sand from 5.8 m to 2.5 m - Bentonite from 2.5 m to surface - Flush mount protector at surface - No obvious odours while drilling		622
9							621

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/18/14

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 6.90 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-03**
Transportation and Streets	UTM ZONE: - N5932827.25 E30280.25	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 629.016 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

Wet Unit Weight (kN/m³): 16 18 20 22

PLASTIC M.C. LIQUID: 20 40 60 80

Soil Sulphates (%): 0.05 0.10 0.15 0.20

Compressive Strength(kPa): 200 400 600 800

Standard Penetration (N): 20 40 60 80

Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL INSTALLATION	ELEVATION (m)
0			PEAT		TOPSOIL BROWN PT DAMP - Silty, some clay, trace sand - Root fibres		
					CLAY FILL BROWN CL-CI DAMP - Silty, some sand, trace gravel, low to medium plastic - Coal pieces, rust speks		
1					- at 0.6 to 0.8 m, Clay fill, high plastic, damp, brown, mottled		628
			FI		- at 0.8 to 2.6 m, Clay fill, trace sand, sandier lenses, wood pieces, peat intermixed, damp, no odour		
2					- at 1.7 to 2.6 m, Slight increase in moisture		627
					SAND BROWN SM MOIST - Silty, fine grained, clayey lenses		
3					- at 2.9 m, Clean sand lenses and partings, rust staining, coal streaks		626
4			SP				625
					- at 4.5 to 4.8 m, Silty sand, trace to some gravel, clay intermixed, brown, moist		
5					- at 4.8 to 5.6 m, Gravelly sand, cobbles, moist to wet, no free water		624
					SANDSTONE GREY SS DAMP - Silty, trace bentonite, fine grained - None cemented, random coal pieces		
6			SS				623
7					End of Hole at 6.9 m - No Slough at completion - Water at 6.4 m from surface at completion - Two inch pvc well installed to 5.8 m - 10 foot machine slotted screen from 5.8 m to 2.8 m - Sand from 5.9 m to 2.6 m - Bentonite from 2.6 m to surface - Flush mount protector at surface - No obvious odours while drilling		622
8							621
9							

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/19/14

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 6.90 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-04**
Transportation and Streets	UTM ZONE: - N5932769.22 E30138.57	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 628.308 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

Depth (m) | ▲ Wet Unit Weight (kN/m³) ▲ 16 18 20 22 | PLASTIC M.C. LIQUID 20 40 60 80 | ◆ Soil Sulphates (%) ◆ 0.05 0.10 0.15 0.20 | ▲ Compressive Strength(kPa) ▲ 200 400 600 800 | ■ Standard Penetration (N) ■ 20 40 60 80 | SAMPLE TYPE | SPT (N) | USC | SOIL SYMBOL

SOIL DESCRIPTION

Depth (m)	USC	SOIL DESCRIPTION	ELEVATION (m)
0	PEAT	TOPSOIL BROWN PT DAMP - Silty, some clay, trace sand - Root fibres	628
1	FI	CLAY FILL BROWN CL-CI DAMP - Silty, some sand, trace gravel, low to medium plastic - Top soil intermixed, rust staining, wood pieces - Coal speks, clay shale intermixed - at 1.2 m, Damp thin sand lens	627
2	CS	- at 1.3 to 1.5 m, Silty, medium plastic, trace to some gravel up to 40 mm diameter, brown, damp, coal pieces, clay shale intermixed, rust staining, silt nodules CLAY SHALE BROWN CI-CH DAMP - Silty, medium to high plastic, weathered	626
3	COAL	- Coal speks - at 2.0 to 2.3 m, Non weathered clay shale, medium to high plastic, coal speks, brown, damp COAL BLACK COAL DAMP - Seepage at base of coal	625
4	CS	CLAY SHALE GREY CH DAMP - Silty, trace bentonite, high plastic - Green - grey lenses, coal speks - at 3.6 to 3.7 m, Moist to wet lens, sandstone intermixed - at 3.7 to 4.7 m, Grey - Brown clay shale, medium to high plastic, sandstone intermixed, coal speks	624
5	SS	SANDSTONE GREY SS DAMP - Silty, trace bentonite, fine grained	623
6		End of Hole at 5.3 m - No Slough at completion - Water at 4.8 m from surface at completion - Two inch pvc well installed to 5.0 m - 10 foot machine slotted screen from 5.0 m to 2.0 m - Sand from 5.3 m to 1.7 m - Bentonite from 1.7 m to surface - Flush mount protector at surface - No obvious odours while drilling	622
7			621
8			620
9			

WELL INSTALLATION

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/18/14

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 5.30 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-05**
Transportation and Streets	UTM ZONE: - N5932765.75 E30173.41	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 627.88 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

Depth (m) | ▲ Wet Unit Weight (kN/m³) ▲ 16 18 20 22 | PLASTIC M.C. LIQUID 20 40 60 80 | ◆ Soil Sulphates (%) ◆ 0.05 0.10 0.15 0.20 | ▲ Compressive Strength(kPa) ▲ 200 400 600 800 | ■ Standard Penetration (N) ■ 20 40 60 80 | SAMPLE TYPE | SPT (N) | USC | SOIL SYMBOL

Depth (m)	USC	SOIL DESCRIPTION	ELEVATION (m)
0	PEAT	TOPSOIL DARK BROWN PT DAMP - Silty, some clay, trace sand - Root fibres	
	FI	CLAY FILL BROWN CL-CI DAMP - Silty, trace to some sand, trace gravel up to 30 mm diameter, low to medium plastic - Silt stone pieces, rust speks, sandy pockets - Dark brown topsoil like pockets, iron stone pieces	
1			627
	CS	CLAY SHALE BROWN CS DAMP - Silty to very silty, medium to high plastic - Coal pieces	
2			626
	COAL	- at 2.4 to 2.5 m, Carbonaceous Clay Shale, dark brown, coal pieces, silty - at 2.5 m, Thin Coal lens, free water, seepage	
3	CS	- at 2.6 to 3.0 m, Clay shale , silty, medium to high plastic, brown to dark brown, coal pieces - at 3.0 to 3.7 m, Grey brown shale, small coal pieces	625
4	SS	SANDSTONE GREY SS DAMP - Silty, trace bentonite, fine grained, non cemented - Coal streaks and pockets	624
5	CS	CLAY SHALE GREY - BROWN CS DAMP - Silty, medium to high plastic - Coal pieces	623
6		End of Hole at 5.3 m - No Slough at completion - Water at 1.2 m from surface at completion - Two inch pvc well installed to 5.3 m - 10 foot machine slotted screen from 5.3 m to 2.3 m - Sand from 5.3 m to 2.0 m - Bentonite from 2.0 m to surface - Flush mount protector at surface - No obvious odours while drilling	622
7			621
8			620
9			619

WELL INSTALLATION

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/18/14

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 5.30 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-06**
Transportation and Streets	UTM ZONE: - N5932645.25 E30184.89	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 628.09 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

Depth (m) | ▲ Wet Unit Weight (kN/m³) ▲ 16 18 20 22 | PLASTIC M.C. LIQUID 20 40 60 80 | ◆ Soil Sulphates (%) ◆ 0.05 0.10 0.15 0.20 | ▲ Compressive Strength(kPa) ▲ 200 400 600 800 | ■ Standard Penetration (N) ■ 20 40 60 80 | SAMPLE TYPE | SPT (N) | USC | SOIL SYMBOL

Depth (m)	USC	SOIL DESCRIPTION	WELL INSTALLATION	ELEVATION (m)
0	PEAT	TOPSOIL BROWN PT DAMP - Silty, some clay, some sand - Root fibres		628
	SP	SAND / SAND FILL BROWN SP DAMP - Some gravel up to 40 mm diameter, trace to some silt, fine to coarse grained - No odour - at 0.7 m, Cobbles, rough drilling		
1				627
		CLAY SHALE BROWN CS DAMP - Silty, medium to high plastic - at 1.3 m, Increased silt content		
2	CS	- at 1.5 to 2.3 m, Grey clay shale, silty to very silty, medium plastic - Hard drilling - at 2.3 to 3.0 m, Clay shale, cemented silt stone pieces		626
3		- at 3.0 to 3.6 m, Silty clay shale, brown, medium plastic, damp, sandstone intermixed		625
	COAL	COAL BLACK COAL DAMP		
4	CS	CLAY SHALE BROWN - DARK BROWN CS DAMP - Silty, medium plastic, coal speks		624
	SS	SANDSTONE GREY SS DAMP - Silty, trace bentonite, fine grained, non cemented - Clay shale intermixed		
5				623
		End of hole at 5.3 m - No Slough at completion - Dry at completion - Two inch pvc well installed to 4.9 m - 10 foot machine slotted screen from 4.9 m to 1.9 m - Sand from 5.3 m to 1.7 m - Bentonite from 1.7 m to surface - Flush mount protector at surface - No obvious odours while drilling		
6				622
7				621
8				620
9				

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/18/14

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 5.30 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-07**
Transportation and Streets	UTM ZONE: - N5932621.65 E30114.08	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 627.281 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

Depth (m) | ▲ Wet Unit Weight (kN/m³) ▲ 16 18 20 22 | PLASTIC M.C. LIQUID 20 40 60 80 | ◆ Soil Sulphates (%) ◆ 0.05 0.10 0.15 0.20 | ▲ Compressive Strength(kPa) ▲ 200 400 600 800 | ■ Standard Penetration (N) ■ 20 40 60 80 | SAMPLE TYPE | SPT (N) | USC | SOIL SYMBOL

SOIL DESCRIPTION

Depth (m)	USC	SOIL DESCRIPTION	WELL INSTALLATION	ELEVATION (m)
0	PEAT	TOPSOIL BROWN PT DAMP - Silty, some clay, trace sand - Root fibres		627
	FI	SAND FILL BROWN SP DAMP - Trace to some silt, trace clay fill intermixed - Rust stained		
1		CLAY FILL BROWN - DARK BROWN CH DAMP - Silty, high plastic - Coal powder, trace bentonite intermixed		626
2		CLAY SHALE BROWN CS DAMP - Silty, high plastic - no odour - at 1.6 to 2.6 m, Silty, fine grained, sandstone intermixed, grey, damp, coal streaks, rust stained partings		625
	CS	- at 2.6 to 4.1 m, Silty Clay shale, trace to some fine grained sandstone intermixed, grey-brown, coal streaks, medium to high plastic		
3				624
4	COAL	COAL BLACK COAL MOIST - at 4.2 to 4.3 m, Wet Coal, free water, seepage		623
	CS	CLAY SHALE DARK BROWN CS DAMP - Silty, medium plastic - Coal speks, trace sandstone intermixed		
5				622
		End of Hole at 5.3 m - No Slough at completion - Water at 4.4 m from surface at completion - Two inch pvc well installed to 5.3 m - 10 foot machine slotted screen from 5.3 m to 2.3 m - Sand from 5.3 m to 2.0 m - Bentonite from 2.0 m to surface - Flush mount protector at surface - No obvious odours while drilling		
6				621
7				620
8				619
9				

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 5.30 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07
	Page 1 of 1

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/18/14

HAWRELAK PARK - RISK ASSESSMENT	Hawrelak Park 9930 - Groat Road	BOREHOLE NO: **14-08**
Transportation and Streets	UTM ZONE: - N5932737.75 E29978.41	PROJECT NO: 512.020
START DATE: 2014/08/07	931+321+18	ELEVATION: 625.145 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

Depth (m) | ▲ Wet Unit Weight (kN/m³) ▲ 16 18 20 22 | PLASTIC M.C. LIQUID 20 40 60 80 | ◆ Soil Sulphates (%) ◆ 0.05 0.10 0.15 0.20 | ▲ Compressive Strength(kPa) ▲ 200 400 600 800 | ■ Standard Penetration (N) ■ 20 40 60 80 | SAMPLE TYPE | SPT (N) | USC | SOIL SYMBOL

SOIL DESCRIPTION

Depth (m)	USC	SOIL DESCRIPTION	ELEVATION (m)
0	PEAT	TOPSOIL BROWN PT DAMP - Silty, some clay, some sand - Root fibres	625
	FI	CLAY FILL BROWN CI DAMP - Silty, trace to some sand, medium plastic - at 0.4 to 1.1 m, Trace gravel, coal pieces, topsoil intermixed, iron stone pieces, brown to dark brown	
1	COAL	COAL BLACK COAL DAMP	624
	CS	CLAY SHALE DARK BROWN CI DAMP - Silty, medium plastic, coal pieces	
2		- at 2.3 to 2.5 m, Clay shale, dark brown, damp	623
	SS	SANDSTONE GREY SS DAMP - Silty, trace bentonite, non cemented	
3			622
	CS	CLAY SHALE BROWN-GREY CI DAMP - Silty, medium plastic	
4			621
		- at 4.5 to 5.3 m, Brown to dark brown, damp, hard drilling	
5			620
		End of Hole at 5.3 m - No Slough at completion - Dry at completion - Two inch pvc well installed to 4.0 m - 10 foot machine slotted screen from 4.0 m to 1.0 m - Bentonite from 5.3 to 4.3 m - Sand from 4.3 m to 0.8 m - Bentonite from 0.8 m to surface - Flush mount protector at surface - No obvious odours while drilling	
6			619
7			618
8			617
9			

WELL INSTALLATION

THE CITY OF Edmonton

Transportation
Engineering Services Section

LOGGED BY: DD	COMPLETION DEPTH: 5.30 m
REVIEWED BY: TD	COMPLETION DATE:2014/08/07
	Page 1 of 1

STANDPIP HAWRELAK PARK MONITORING WELLS.GPJ EDMONTON.GDT 8/18/14

Appendix B

Water Sampling Field Sheet (City of Edmonton)

THE CITY OF Edmonton

INSTRUMENTATION LOCATIONS: HAWRELAK PARK RISK ASSESSMENT G0188

CITY OF EDMONTON - TRANSPORTATION AND STREETS, ENGINEERING SERVICES

FIELD DATA SHEET

Table no. 1

	INPUT DATA					Date: Aug. 12, 2014 SM / JB		Sept. 4, 2014 DD/SM		Sept. 11, 2014 DD/SM		Date:	
Monitoring Well Number	STATUS	Elev. Top of Flush mount (m)	Ground Elevation (m)	Elev. Top of Well Pipe (m)	Bottom of Well Elev. (m)	Water Level From Top of Pipe (m)	Water level Elev. (m)	Water Level Top of Pipe (m)	Water level Elev. (m)	Water Level Top of Pipe (m)	Water level Elev. (m)	Water Level Top of Pipe (m)	Water level Elev. (m)
14-01	Operational	628.829	628.812	628.763	622.133	4.52	624.243	4.52	624.243				
14-02	Operational	629.343	629.300	629.265	623.545	4.73	624.535	4.73	624.535	4.73	624.535		
14-03	Operational	629.023	629.016	628.873	623.213	4.21	624.663	4.20	624.673	4.20	625.065		
14-04	Operational	628.306	628.308	628.234	623.304	2.05	626.184	2.23	626.004				
14-05	Operational	627.880	627.880	627.832	622.622	1.61	626.222	1.80	626.032				
14-06	Operational	628.119	628.090	628.088	623.148	3.39	624.698	3.45	624.638	3.48	624.608		
14-07	Operational	627.259	627.281	627.194	622.034	2.71	624.484	2.77	624.424				
14-08	Operational	625.207	625.145	625.082	621.142	1.56	623.522	2.05	623.032				
S14-3	Operational	Stantec						2.55		2.57			
S14-4	Operational	Stantec						Dry at 2.55 m		Dry at 2.55 m			

Wells developed August 12, 2014

Wells Sampled Sept. 4, 2014 for PAH and Dissolved Metals. Need to re-do dissolved metal at later date due to error in sampling

Wells Sampled Sept. 11, 2014 for Dissolved Metals. Filtered in the field 45 micron

Appendix C

Flexible Wall Permeameter Test Results

PROJECT: Hawrelak Park Risk Assessment **DATE TESTED: September 15, 2014**

PROJECT NO.: E12103416-01 **TESTED BY: SK**

CLIENT: City of Edmonton

Results from Shelby Tube Samples

Borehole No.	Depth (m)	Moisture Content (%)	Degree of Saturation (%)	Dry Density (Kg/m^3)	Specific Gravity	Total Porosity (n)	Water Filled Porosity (n_w)	Permeability (cm/sec)
14-01	1.1-1.5	17.9	93	1767	2.680	0.339	0.317	1.7E-08
14-02	0.9-1.3	19.4	93	1683	2.594	0.350	0.326	9.1E-08
14-03	0.8-1.2	24.6	75	1422	2.672	0.467	0.350	1.3E-06
14-04	0.8-1.2	19.3	95	1714	2.644	0.350	0.331	8.8E-08

Reviewed By: NI

TETRA TECH

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

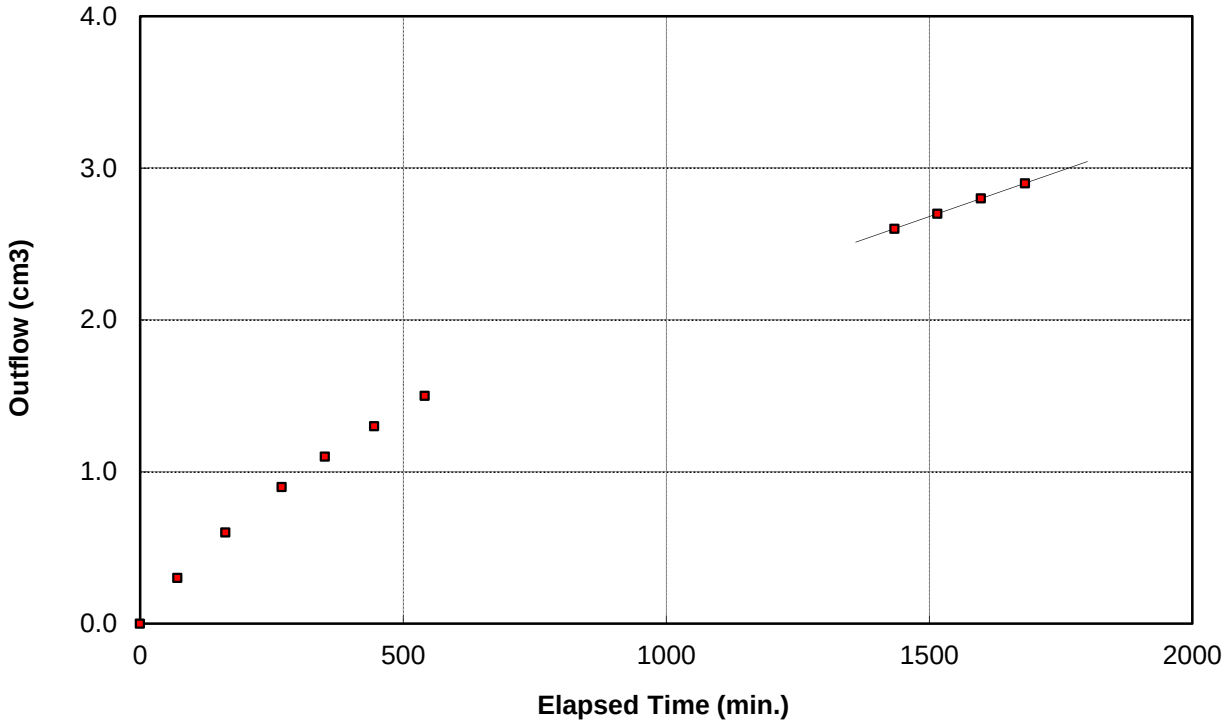
Project:	Hawrelak Park Risk Assessment	Test No.:	P-1
Project No.:	E12103416-01	Borehole No.:	14-01
Client:	City of Edmonton	Sample Depth:	1.1 - 1.5 m
Attention:		Date Tested:	August 29, 2014
		Tested By:	LL

Soil Description: CLAY, silty, some sand, brown

	Initial	Final
Moisture Content (%)	17.9	19.6
Dry Density (kg/m3)	1767	1757
Compaction SPD (if applicable)	NA	NA

Sample Height =	5.447	cm
Sample Diameter =	7.349	cm
Head Differential =	14	kPa
Flow Q =	2.0E-05	cm^3/sec
Hydraulic Gradient i =	26.23	
Area of Sample A =	42.42	cm^2

Hydraulic Conductivity k_{20} = **1.7E-08** **cm/sec**



Remarks: Shelby tube sample.

Reviewed By: NI P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech EBA. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech EBA will provide it upon written request.

TETRA TECH

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

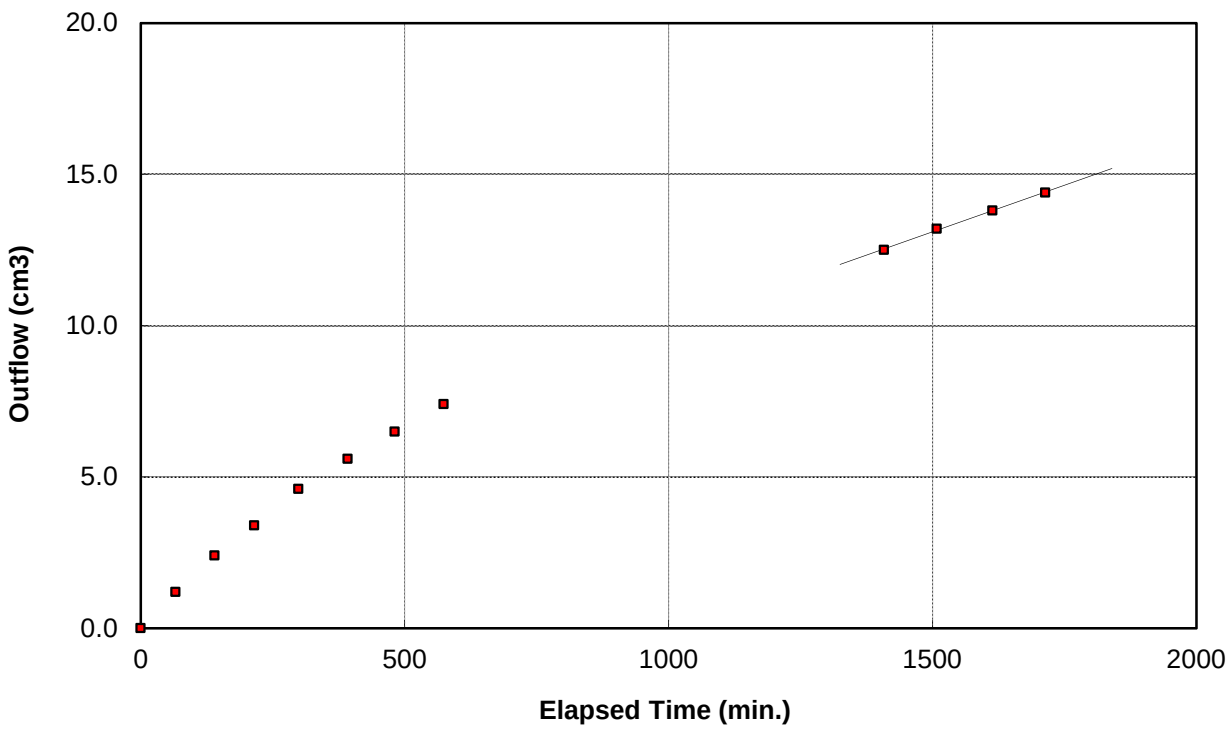
Project:	Hawrelak Park Risk Assessment	Test No.:	P-2
Project No.:	E12103416-01	Borehole No.:	14-02
Client:	City of Edmonton	Sample Depth:	0.9 - 1.3 m
Attention:		Date Tested:	August 30, 2014
		Tested By:	LL

Soil Description: CLAY, silty, some sand, trace gravel, organics, brown

	Initial	Final
Moisture Content (%)	19.4	21.9
Dry Density (kg/m3)	1683	1673
Compaction SPD (if applicable)	NA	NA

Sample Height =	5.538	cm
Sample Diameter =	7.372	cm
Head Differential =	14	kPa
Flow Q =	1.0E-04	cm^3/sec
Hydraulic Gradient i =	25.79	
Area of Sample A =	42.68	cm^2

Hydraulic Conductivity k_{20} = **9.1E-08 cm/sec**



Remarks: Shelby Tube sample.

Reviewed By: NI P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech EBA. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech EBA will provide it upon written request.

TETRA TECH

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

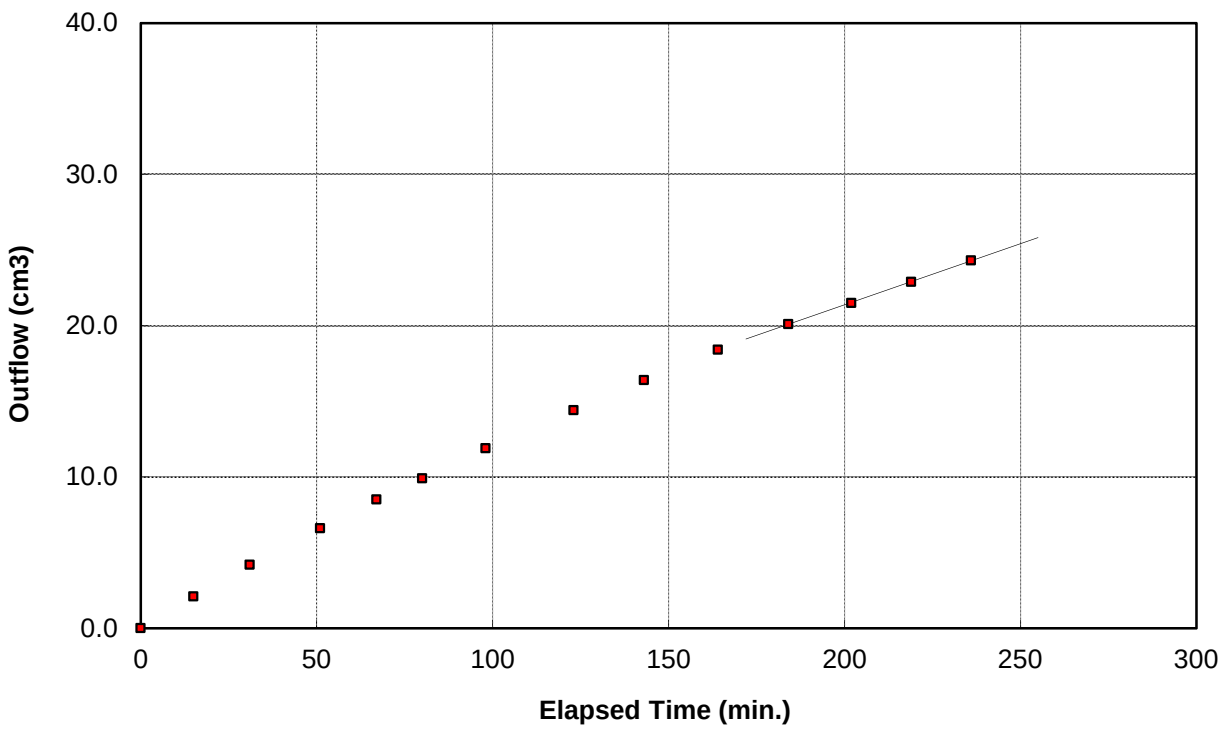
Project:	Hawrelak Park Risk Assessment	Test No.:	P-3
Project No.:	E12103416-01	Borehole No.:	14-03
Client:	City of Edmonton	Sample Depth:	0.8 - 1.2 m
Attention:		Date Tested:	September 2, 2014
		Tested By:	LL

Soil Description: CLAY, silty, trace sand, organics (rootlets), blocky, brown

	Initial	Final
Moisture Content (%)	24.6	33.6
Dry Density (kg/m3)	1422	1407
Compaction SPD (if applicable)	NA	NA

Sample Height =	5.878	cm
Sample Diameter =	7.322	cm
Head Differential =	14	kPa
Flow Q =	1.3E-03	cm^3/sec
Hydraulic Gradient i =	24.30	
Area of Sample A =	42.11	cm^2

Hydraulic Conductivity k_{20} = **1.3E-06 cm/sec**



Remarks: Shelby Tube sample.

Reviewed By: NI P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech EBA. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech EBA will provide it upon written request.

TETRA TECH

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

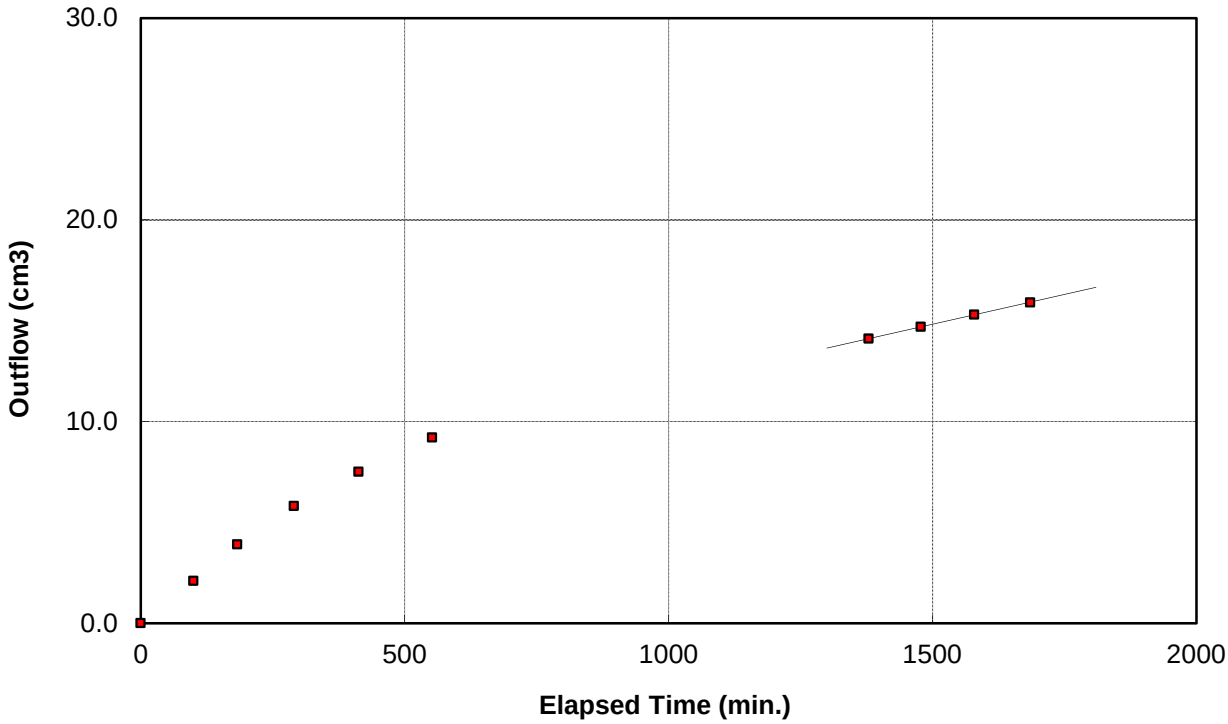
Project:	Hawrelak Park Risk Assessment	Test No.:	P-4
Project No.:	E12103416-01	Borehole No.:	14-04
Client:	City of Edmonton	Sample Depth:	0.8 - 1.2 m
Attention:		Date Tested:	September 5, 2014
		Tested By:	LL

Soil Description: CLAY, silty, some sand, trace gravel, organics, brown

	Initial	Final
Moisture Content (%)	19.3	21.0
Dry Density (kg/m^3)	1714	1710
Compaction SPD (if applicable)	NA	NA

Sample Height =	5.548	cm
Sample Diameter =	7.307	cm
Head Differential =	14	kPa
Flow Q =	9.8E-05	cm^3/sec
Hydraulic Gradient i =	25.75	
Area of Sample A =	41.93	cm^2

Hydraulic Conductivity k_{20} = **8.8E-08 cm/sec**



Remarks: Shelby Tube sample.

Reviewed By: NI P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech EBA is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech EBA. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech EBA will provide it upon written request.

TETRA TECH

Appendix D

EXOVA Final Analytical Reports

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Report Transmission Cover Page

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Contact & Affiliation	Address	Delivery Commitments
Tami Dolen City of Edm - Finance Dept.	11404 - 60th Avenue Edmonton, Alberta T6H 1J5 Phone: (780) 496-6782 Fax: null Email: tami.dolen@edmonton.ca	On [Lot Verification] send (COA) by Email - Multiple Reports By Agreement On [Lot Verification] send (COA) by Email - Multiple Reports By Agreement On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Lot Approval and Final Test Report Approval] send (COC, Test Report, Test Report, Invoice) by Email - Merge On [Lot Approval and Final Test Report Approval] send (COC, Test Report, Invoice) by Email - Merge Reports On [Lot Creation] send (COR) by Email - Multiple Reports By Agreement

Notes To Clients:

- Report was issued to include addition of leachable PAH analysis on 1019155-16 requested by Tami Dolen of City of Edmonton on August 19, 2014. Previous report 1938819
- Report was issued to include addition of SPLP leachable PAH analysis on sample 16 (reported as sample 26), requested by Tami Dolen of the City of Edmonton on Sep 12/14. Previous report 1941202.

The information contained on this and all other pages transmitted, is intended for the addressee only and is considered confidential.
If the reader is not the intended recipient, you are hereby notified that any use, dissemination, distribution or copy of this transmission is strictly prohibited.
If you receive this transmission by error, or if this transmission is not satisfactory, please notify us by telephone.

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Exova

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-1	1019155-2	1019155-3
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-01 / 0.4	14-01 / 1.8	14-01 / 2.3
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	0.49	2.05	1.16	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	0.58	<0.20	<0.20	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.04	0.02	0.02	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	5.9	4.4	6.5	0.2
Barium	Strong Acid Extractable	mg/kg	269	132	141	1
Beryllium	Strong Acid Extractable	mg/kg	0.5	0.6	0.6	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.21	0.09	0.25	0.01
Chromium	Strong Acid Extractable	mg/kg	16.9	10.6	8.0	0.5
Cobalt	Strong Acid Extractable	mg/kg	9.2	5.9	9.0	0.1
Copper	Strong Acid Extractable	mg/kg	17.7	9.4	7.0	1
Lead	Strong Acid Extractable	mg/kg	9.5	5.2	<4.9	5
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	25.1	14.8	20.0	0.5
Selenium	Strong Acid Extractable	mg/kg	<0.3	<0.3	<0.3	0.3
Silver	Strong Acid Extractable	mg/kg	0.2	0.3	0.2	0.1
Thallium	Strong Acid Extractable	mg/kg	0.17	0.14	0.15	0.05
Tin	Strong Acid Extractable	mg/kg	1.6	2.1	2.6	1
Uranium	Strong Acid Extractable	mg/kg	0.8	0.6	1.1	0.5
Vanadium	Strong Acid Extractable	mg/kg	28.6	17.7	18.5	0.1
Zinc	Strong Acid Extractable	mg/kg	53	25	34	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	30.7	18.7	13.9	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	0.02	<0.01	<0.01	0.01
Anthracene	Dry Weight	mg/kg	<0.003	<0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Pyrene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-1	1019155-2	1019155-3
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-01 / 0.4	14-01 / 1.8	14-01 / 2.3
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	99	104	107	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	93	94	97	30-130
p-Terphenyl-d14	PAH - Surrogate	%	94	92	92	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-4	1019155-5	1019155-6
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-02 / 1.0	14-02 / 1.9	14-02 / 3.5
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	1.14	2.84	0.46	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	2.99	5.65	0.55	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.08	0.14	0.04	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	6.4	7.1	5.2	0.2
Barium	Strong Acid Extractable	mg/kg	260	396	230	1
Beryllium	Strong Acid Extractable	mg/kg	0.7	1.0	0.6	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.24	0.32	0.33	0.01
Chromium	Strong Acid Extractable	mg/kg	18.2	20.8	12.7	0.5
Cobalt	Strong Acid Extractable	mg/kg	9.6	11.2	10.7	0.1
Copper	Strong Acid Extractable	mg/kg	20.9	33.6	18.0	1
Lead	Strong Acid Extractable	mg/kg	32.9	56.0	9.7	5
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	27.1	38.2	33.4	0.5
Selenium	Strong Acid Extractable	mg/kg	0.4	0.5	<0.3	0.3
Silver	Strong Acid Extractable	mg/kg	0.2	0.2	0.1	0.1
Thallium	Strong Acid Extractable	mg/kg	0.17	0.20	0.24	0.05
Tin	Strong Acid Extractable	mg/kg	1.6	3.0	1.5	1
Uranium	Strong Acid Extractable	mg/kg	0.8	1.2	0.9	0.5
Vanadium	Strong Acid Extractable	mg/kg	31.5	34.4	23.5	0.1
Zinc	Strong Acid Extractable	mg/kg	74	115	51	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	21.9	20.6	31.6	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	0.013	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	0.04	0.02	<0.01	0.01
Anthracene	Dry Weight	mg/kg	0.006	0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	0.03	0.02	<0.01	0.01
Pyrene	Dry Weight	mg/kg	0.03	0.01	<0.01	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

	Reference Number	1019155-4	1019155-5	1019155-6	
	Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014	
	Sample Time	NA	NA	NA	
	Sample Location				
	Sample Description	14-02 / 1.0	14-02 / 1.9	14-02 / 3.5	
	Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	0.01	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		0.003	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		0.006	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	112	110	108	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	94	89	96	30-130
p-Terphenyl-d14	PAH - Surrogate	%	92	92	93	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-7	1019155-8	1019155-9
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-03 / 0.4	14-03 / 1.5	14-03 / 3.0
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	2.50	4.20	0.27	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	2.30	1.90	<0.20	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.06	0.03	0.04	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	5.9	5.7	5.9	0.2
Barium	Strong Acid Extractable	mg/kg	261	205	195	1
Beryllium	Strong Acid Extractable	mg/kg	0.9	0.7	0.5	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.20	0.24	0.13	0.01
Chromium	Strong Acid Extractable	mg/kg	17.9	16.5	12.2	0.5
Cobalt	Strong Acid Extractable	mg/kg	10.4	18.8	8.8	0.1
Copper	Strong Acid Extractable	mg/kg	19.6	18.3	11.6	1
Lead	Strong Acid Extractable	mg/kg	16.3	9.8	7.1	5
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	26.9	34.1	16.2	0.5
Selenium	Strong Acid Extractable	mg/kg	0.4	0.7	<0.3	0.3
Silver	Strong Acid Extractable	mg/kg	0.1	<0.1	<0.1	0.1
Thallium	Strong Acid Extractable	mg/kg	0.20	0.21	0.13	0.05
Tin	Strong Acid Extractable	mg/kg	1.5	1.5	1.8	1
Uranium	Strong Acid Extractable	mg/kg	1.3	5.6	0.9	0.5
Vanadium	Strong Acid Extractable	mg/kg	34.1	30.7	20.6	0.1
Zinc	Strong Acid Extractable	mg/kg	64	67	45	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	21.6	1.0	8.7	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	0.04	<0.01	<0.01	0.01
Anthracene	Dry Weight	mg/kg	0.009	<0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	0.04	<0.01	<0.01	0.01
Pyrene	Dry Weight	mg/kg	0.04	<0.01	<0.01	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-7	1019155-8	1019155-9
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-03 / 0.4	14-03 / 1.5	14-03 / 3.0
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	0.01	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		0.003	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		0.006	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	101	83	97	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	99	105	94	30-130
p-Terphenyl-d14	PAH - Surrogate	%	98	87	97	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number		1019155-10	1019155-11	1019155-12
Sample Date		Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time		NA	NA	NA
Sample Location				
Sample Description		14-03 / 4.8	14-04 / 1.4	14-04 / 3.0
Matrix		Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	1.01	0.76	0.14	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	0.21	<0.20	<0.20	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.04	0.05	0.12	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	7.3	11.2	1.4	0.2
Barium	Strong Acid Extractable	mg/kg	230	205	172	1
Beryllium	Strong Acid Extractable	mg/kg	0.7	1.1	0.7	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.26	0.23	0.26	0.01
Chromium	Strong Acid Extractable	mg/kg	18.6	22.5	5.3	0.5
Cobalt	Strong Acid Extractable	mg/kg	10.6	15.0	1.9	0.1
Copper	Strong Acid Extractable	mg/kg	14.6	20.8	21.2	1
Lead	Strong Acid Extractable	mg/kg	7.4	9.5	15.2	5
Molybdenum	Strong Acid Extractable	mg/kg	1.3	1.1	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	29.1	33.4	7.5	0.5
Selenium	Strong Acid Extractable	mg/kg	1.8	<0.3	<0.3	0.3
Silver	Strong Acid Extractable	mg/kg	<0.1	<0.1	<0.1	0.1
Thallium	Strong Acid Extractable	mg/kg	0.16	0.28	0.31	0.05
Tin	Strong Acid Extractable	mg/kg	2.1	2.0	<1.0	1
Uranium	Strong Acid Extractable	mg/kg	1.2	1.3	2.9	0.5
Vanadium	Strong Acid Extractable	mg/kg	25.2	32.8	9.3	0.1
Zinc	Strong Acid Extractable	mg/kg	51	55	35	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	21.5	6.8	63.3	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Anthracene	Dry Weight	mg/kg	<0.003	<0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Pyrene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-10	1019155-11	1019155-12
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-03 / 4.8	14-04 / 1.4	14-04 / 3.0
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	100	113	111	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	100	92	94	30-130
p-Terphenyl-d14	PAH - Surrogate	%	99	97	98	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number		1019155-13	1019155-14	1019155-15
Sample Date		Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time		NA	NA	NA
Sample Location				
Sample Description		14-04 / 4.7	14-05 / 0.5	14-05 / 1.8
Matrix		Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	0.46	1.53	2.06	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	0.21	0.81	0.26	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.05	0.04	0.14	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	6.3	7.0	4.1	0.2
Barium	Strong Acid Extractable	mg/kg	188	229	121	1
Beryllium	Strong Acid Extractable	mg/kg	0.6	0.8	0.5	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.26	0.16	0.46	0.01
Chromium	Strong Acid Extractable	mg/kg	8.9	19.0	12.5	0.5
Cobalt	Strong Acid Extractable	mg/kg	7.1	9.3	11.4	0.1
Copper	Strong Acid Extractable	mg/kg	23.7	14.6	36.3	1
Lead	Strong Acid Extractable	mg/kg	9.1	9.9	11.4	5
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	18.4	23.5	22.7	0.5
Selenium	Strong Acid Extractable	mg/kg	0.3	0.4	0.5	0.3
Silver	Strong Acid Extractable	mg/kg	<0.1	<0.1	0.1	0.1
Thallium	Strong Acid Extractable	mg/kg	0.17	0.19	0.28	0.05
Tin	Strong Acid Extractable	mg/kg	1.9	1.9	1.5	1
Uranium	Strong Acid Extractable	mg/kg	1.9	0.8	2.3	0.5
Vanadium	Strong Acid Extractable	mg/kg	16.3	32.8	22.7	0.1
Zinc	Strong Acid Extractable	mg/kg	68	57	80	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	56.1	25.1	15.4	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Anthracene	Dry Weight	mg/kg	<0.003	<0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	0.01	<0.01	0.01	0.01
Pyrene	Dry Weight	mg/kg	0.03	<0.01	0.03	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

		Reference Number	1019155-13	1019155-14	1019155-15
		Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	14-04 / 4.7	14-05 / 0.5	14-05 / 1.8
		Matrix	Soil	Soil	Soil
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	112	104	81	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	88	100	89	30-130
p-Terphenyl-d14	PAH - Surrogate	%	93	94	89	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-16
Sample Date	Aug 07, 2014
Sample Time	NA
Sample Location	
Sample Description	14-05 / 2.4
Matrix	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Leachate(TCLP)						
Naphthalene		mg/L	<0.1			0.1
Acenaphthylene		mg/L	<0.1			0.1
Acenaphthene		mg/L	<0.1			0.1
Fluorene		mg/L	<0.1			0.1
Phenanthrene		mg/L	<0.1			0.1
Anthracene		mg/L	<0.1			0.1
Fluoranthene		mg/L	<0.1			0.1
Pyrene		mg/L	<0.1			0.1
Benzo(a)anthracene		mg/L	<0.1			0.1
Chrysene		mg/L	<0.1			0.1
Benzo(b+j)fluoranthene		mg/L	<0.1			0.1
Benzo(k)fluoranthene		mg/L	<0.1			0.1
Benzo(a)pyrene		mg/L	<0.1			0.1
Indeno(1,2,3-c,d)pyrene		mg/L	<0.1			0.1
Dibenzo(a,h)anthracene		mg/L	<0.1			0.1
Benzo(g,h,i)perylene		mg/L	<0.1			0.1
PAH - Leachate - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	86			23-130
2-Fluorobiphenyl	PAH - Surrogate	%	102			30-130
p-Terphenyl-d14	PAH - Surrogate	%	121			18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number		1019155-16	1019155-17	1019155-18
Sample Date		Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time		NA	NA	NA
Sample Location				
Sample Description		14-05 / 2.4	14-06 / 0.2	14-06 / 0.9
Matrix		Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	3.87	1.13	0.71	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	0.43	0.52	0.22	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.09	0.03	0.06	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	3.1	7.2	4.2	0.2
Barium	Strong Acid Extractable	mg/kg	242	165	91	1
Beryllium	Strong Acid Extractable	mg/kg	0.9	0.8	0.6	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.18	0.16	0.20	0.01
Chromium	Strong Acid Extractable	mg/kg	4.2	11.7	18.4	0.5
Cobalt	Strong Acid Extractable	mg/kg	3.1	9.6	4.7	0.1
Copper	Strong Acid Extractable	mg/kg	13.8	11.2	23.1	1
Lead	Strong Acid Extractable	mg/kg	16.6	6.2	11.0	5
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	<1.0	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	9.0	20.8	12.6	0.5
Selenium	Strong Acid Extractable	mg/kg	0.4	<0.3	0.4	0.3
Silver	Strong Acid Extractable	mg/kg	0.1	<0.1	<0.1	0.1
Thallium	Strong Acid Extractable	mg/kg	0.25	0.24	0.17	0.05
Tin	Strong Acid Extractable	mg/kg	1.0	2.2	1.1	1
Uranium	Strong Acid Extractable	mg/kg	3.3	0.8	2.0	0.5
Vanadium	Strong Acid Extractable	mg/kg	12.8	24.6	14.2	0.1
Zinc	Strong Acid Extractable	mg/kg	36	36	47	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	44.8	23.6	24.1	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Anthracene	Dry Weight	mg/kg	<0.003	<0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	0.03	<0.01	<0.01	0.01
Pyrene	Dry Weight	mg/kg	0.07	<0.01	0.03	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

	Reference Number	1019155-16	1019155-17	1019155-18	
	Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014	
	Sample Time	NA	NA	NA	
	Sample Location				
	Sample Description	14-05 / 2.4	14-06 / 0.2	14-06 / 0.9	
	Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	0.02	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		0.042	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		0.080	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	130	103	105	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	84	101	89	30-130
p-Terphenyl-d14	PAH - Surrogate	%	98	86	90	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number		1019155-19	1019155-20	1019155-21
Sample Date		Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time		NA	NA	NA
Sample Location				
Sample Description		14-06 / 2.7	14-07 / 0.2	14-07 / 0.7
Matrix		Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	0.08	1.01	0.13	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	0.36	<0.20	1.3	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.10	0.03	0.04	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	2.9	7.2	2.4	0.2
Barium	Strong Acid Extractable	mg/kg	295	283	119	1
Beryllium	Strong Acid Extractable	mg/kg	0.9	1.7	1.3	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.31	0.59	0.51	0.01
Chromium	Strong Acid Extractable	mg/kg	22.1	15.9	4.0	0.5
Cobalt	Strong Acid Extractable	mg/kg	25.7	11.0	6.9	0.1
Copper	Strong Acid Extractable	mg/kg	33.6	13.9	15.8	1
Lead	Strong Acid Extractable	mg/kg	13.3	8.6	27.3	5
Molybdenum	Strong Acid Extractable	mg/kg	1.4	1.2	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	107	62.5	40.6	0.5
Selenium	Strong Acid Extractable	mg/kg	0.9	<0.3	0.4	0.3
Silver	Strong Acid Extractable	mg/kg	<0.1	0.2	0.3	0.1
Thallium	Strong Acid Extractable	mg/kg	0.34	0.78	0.48	0.05
Tin	Strong Acid Extractable	mg/kg	3.0	2.3	1.0	1
Uranium	Strong Acid Extractable	mg/kg	1.3	1.7	4.0	0.5
Vanadium	Strong Acid Extractable	mg/kg	40.9	43.8	6.0	0.1
Zinc	Strong Acid Extractable	mg/kg	75	69	69	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	31.6	30.3	35.3	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Anthracene	Dry Weight	mg/kg	<0.003	<0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Pyrene	Dry Weight	mg/kg	0.01	<0.01	<0.01	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number		1019155-19	1019155-20	1019155-21
Sample Date		Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time		NA	NA	NA
Sample Location				
Sample Description		14-06 / 2.7	14-07 / 0.2	14-07 / 0.7
Matrix		Soil	Soil	Soil

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	128	107	122	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	93	100	121	30-130
p-Terphenyl-d14	PAH - Surrogate	%	90	96	115	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-22	1019155-23	1019155-24
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-07 / 0.9	14-07 / 2.2	14-08 / 0.3
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	0.18	0.51	4.79	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	<0.20	<0.20	1.59	0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.1	0.05	0.05	0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractable	mg/kg	2.6	17.8	5.4	0.2
Barium	Strong Acid Extractable	mg/kg	166	158	288	1
Beryllium	Strong Acid Extractable	mg/kg	0.8	0.6	1.2	0.1
Cadmium	Strong Acid Extractable	mg/kg	0.19	0.27	0.19	0.01
Chromium	Strong Acid Extractable	mg/kg	10.1	8.1	15.2	0.5
Cobalt	Strong Acid Extractable	mg/kg	8.1	18.0	9.8	0.1
Copper	Strong Acid Extractable	mg/kg	27.8	21.9	17.6	1
Lead	Strong Acid Extractable	mg/kg	9.6	10.3	12.6	5
Molybdenum	Strong Acid Extractable	mg/kg	<1.0	1.4	<1.0	1
Nickel	Strong Acid Extractable	mg/kg	17.3	48.6	23.8	0.5
Selenium	Strong Acid Extractable	mg/kg	0.4	0.4	0.4	0.3
Silver	Strong Acid Extractable	mg/kg	0.2	0.1	0.2	0.1
Thallium	Strong Acid Extractable	mg/kg	0.26	0.45	0.19	0.05
Tin	Strong Acid Extractable	mg/kg	1.2	1.7	1.3	1
Uranium	Strong Acid Extractable	mg/kg	1.8	2.6	1.6	0.5
Vanadium	Strong Acid Extractable	mg/kg	14.0	11.3	30.9	0.1
Zinc	Strong Acid Extractable	mg/kg	64	86	51	1
Barite Soil Analysis						
Barium	Extractable	mg/kg	36.6	14.9	19.5	0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10	<0.10	<0.10	0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010	<0.010	<0.010	0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Acenaphthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Fluorene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Phenanthrene	Dry Weight	mg/kg	<0.01	<0.01	0.01	0.01
Anthracene	Dry Weight	mg/kg	<0.003	<0.003	<0.003	0.003
Fluoranthene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Pyrene	Dry Weight	mg/kg	<0.01	0.01	0.02	0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-22	1019155-23	1019155-24
Sample Date	Aug 07, 2014	Aug 07, 2014	Aug 07, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	14-07 / 0.9	14-07 / 2.2	14-08 / 0.3
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	<0.01	<0.01	<0.01	0.01
Chrysene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05	<0.05	<0.05	0.05
IACR_Coarse	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
IACR_Fine	Index of Additive Cancer Risk		<0.001	<0.001	<0.001	0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	130	126	109	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	94	92	89	30-130
p-Terphenyl-d14	PAH - Surrogate	%	97	55	90	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-25
Sample Date	Aug 07, 2014
Sample Time	NA
Sample Location	
Sample Description	14-08 / 2.7
Matrix	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Classification						
Carbon	Total Organic	%	0.28			0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	<0.20			0.2
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.04			0.01
Antimony	Strong Acid Extractable	mg/kg	<0.2			0.2
Arsenic	Strong Acid Extractable	mg/kg	10.8			0.2
Barium	Strong Acid Extractable	mg/kg	196			1
Beryllium	Strong Acid Extractable	mg/kg	0.3			0.1
Cadmium	Strong Acid Extractable	mg/kg	0.17			0.01
Chromium	Strong Acid Extractable	mg/kg	8.1			0.5
Cobalt	Strong Acid Extractable	mg/kg	5.7			0.1
Copper	Strong Acid Extractable	mg/kg	14.7			1
Lead	Strong Acid Extractable	mg/kg	7.1			5
Molybdenum	Strong Acid Extractable	mg/kg	<1.0			1
Nickel	Strong Acid Extractable	mg/kg	16.5			0.5
Selenium	Strong Acid Extractable	mg/kg	<0.3			0.3
Silver	Strong Acid Extractable	mg/kg	<0.1			0.1
Thallium	Strong Acid Extractable	mg/kg	0.12			0.05
Tin	Strong Acid Extractable	mg/kg	1.9			1
Uranium	Strong Acid Extractable	mg/kg	1.3			0.5
Vanadium	Strong Acid Extractable	mg/kg	13.0			0.1
Zinc	Strong Acid Extractable	mg/kg	70			1
Barite Soil Analysis						
Barium	Extractable	mg/kg	50.8			0.05
Water Soluble Parameters						
Chromium (VI)	Water Soluble	mg/kg	<0.10			0.1
Polycyclic Aromatic Hydrocarbons - Soil						
Naphthalene	Dry Weight	mg/kg	<0.010			0.01
Acenaphthylene	Dry Weight	mg/kg	<0.05			0.05
Acenaphthene	Dry Weight	mg/kg	<0.05			0.05
Fluorene	Dry Weight	mg/kg	<0.05			0.05
Phenanthrene	Dry Weight	mg/kg	<0.01			0.01
Anthracene	Dry Weight	mg/kg	<0.003			0.003
Fluoranthene	Dry Weight	mg/kg	<0.01			0.01
Pyrene	Dry Weight	mg/kg	<0.01			0.01

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-25
Sample Date	Aug 07, 2014
Sample Time	NA
Sample Location	
Sample Description	14-08 / 2.7
Matrix	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Soil - Continued						
Benzo(a)anthracene	Dry Weight	mg/kg	<0.01			0.01
Chrysene	Dry Weight	mg/kg	<0.05			0.05
Benzo(b+j)fluoranthene	Dry Weight	mg/kg	<0.05			0.05
Benzo(k)fluoranthene	Dry Weight	mg/kg	<0.05			0.05
Benzo(a)pyrene	Dry Weight	mg/kg	<0.05			0.05
Indeno(1,2,3-c,d)pyrene	Dry Weight	mg/kg	<0.05			0.05
Dibenzo(a,h)anthracene	Dry Weight	mg/kg	<0.05			0.05
Benzo(g,h,i)perylene	Dry Weight	mg/kg	<0.05			0.05
IACR_Coarse	Index of Additive Cancer Risk		<0.001			0.001
IACR_Fine	Index of Additive Cancer Risk		<0.001			0.001
PAH - Soil - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	121			23-130
2-Fluorobiphenyl	PAH - Surrogate	%	96			30-130
p-Terphenyl-d14	PAH - Surrogate	%	100			18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Reference Number	1019155-26
Sample Date	Aug 07, 2014
Sample Time	NA
Sample Location	
Sample Description	14-05 / 2.4 / SPLP Leached Sample For PAH Analysis
Matrix	Liquids

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Water						
Naphthalene		ug/L	<0.1			0.1
Quinoline		ug/L	<0.3			0.3
Acenaphthylene		ug/L	<0.1			0.1
Acenaphthene		ug/L	<0.1			0.1
Fluorene		ug/L	<0.1			0.1
Phenanthrene		ug/L	<0.1			0.1
Anthracene		ug/L	<0.005			0.005
Acridine		ug/L	<0.1			0.1
Fluoranthene		ug/L	<0.01			0.01
Pyrene		ug/L	0.03			0.01
Benzo(a)anthracene		ug/L	<0.01			0.01
Chrysene		ug/L	<0.1			0.1
Benzo(b+j)fluoranthene		ug/L	<0.1			0.1
Benzo(k)fluoranthene		ug/L	<0.1			0.1
Benzo(a)pyrene		ug/L	<0.008			0.008
Indeno(1,2,3-c,d)pyrene		ug/L	<0.05			0.05
Dibenzo(a,h)anthracene		ug/L	<0.05			0.05
Benzo(g,h,i)perylene		ug/L	<0.05			0.05
CB(a)P	Carcinogenic Potency Equivalent	ug/L	<0.01			.01
PAH - Water - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	100			23-130
2-Fluorobiphenyl	PAH - Surrogate	%	100			30-130
p-Terphenyl-d14	PAH - Surrogate	%	80			18-137

Approved by:

Anthony Neumann, MSc
Laboratory Operations Manager

Data have been validated by Analytical Quality Control and Exova'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.

Terms and Conditions: www.exova.com/about/terms-and-conditions

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Methodology and Notes

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
1:5 Water Soluble Extraction	McKeague	*	Soluble Salts in Extracts of 1:5 Soil:Water Mixtures, 3.23	12-Aug-14	Exova Edmonton
Barium (Extractable) in soil (0.1 M CaCl2)	Ab Env		Analytical Method for Extractable Barium, 6.6.2	12-Aug-14	Exova Edmonton
Boron in general soil	McKeague	*	Hot Water Soluble Boron - Azomethine-H Method, 4.61	12-Aug-14	Exova Edmonton
Mercury (Hot Block) in Soil	US EPA	*	Determination of Hg in Sediment by Cold Vapor Atomic Absorption Spec, 245.5	12-Aug-14	Exova Edmonton
Metals ICP-MS (Hot Block) in soil	SW-846	*	Acid Digestion of Sediments, Sludges, and Soils, EPA 3050B	12-Aug-14	Exova Edmonton
PAH - Leachate	US EPA	*	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, 8270	20-Aug-14	Exova Calgary
PAH - Soil	AESRD		Index of Additive Cancer Risk (IACR), PAHs	11-Aug-14	Exova Calgary
PAH - Soil	US EPA	*	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, 8270	11-Aug-14	Exova Calgary
PAH - Water	AESRD		Carcinogenic PAHs Toxic Potency Equivalence (as B(a)P TPE), PAHw	12-Sep-14	Exova Calgary
PAH - Water	US EPA	*	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, 8270	12-Sep-14	Exova Calgary
Total Carbon, Nitrogen & Sulfur by Leco Combustion (Surrey)	SSSA Book Series 5	*	Total Carbon, Organic Carbon, and Organic Matter, Ch 34	13-Aug-14	Exova Surrey

** Reference Method Modified*

References

Ab Env	Alberta Environment, Soil Quality Guidelines for Barite
AESRD	Alberta Tier 1 Soil and Groundwater Remediation Guidelines
APHA	Standard Methods for the Examination of Water and Wastewater
McKeague	Manual on Soil Sampling and Methods of Analysis
SW-846	Test Methods for Evaluating Solid Waste

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Methodology and Notes

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	
	11404 - 60th Avenue	Name:	Hawrelak Park
	Edmonton, AB, Canada	Location:	9930 Groat Road
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (4618588)
Sampled By:	Dale Durhan	Acct code:	512.020
Company:	City of Edmonton		

Lot ID:	**1019155**
Control Number:	C0040174
Date Received:	Aug 8, 2014
Date Reported:	Sep 19, 2014
Report Number:	1947877

US EPA	US Environmental Protection Agency Test Methods

Comments:

- Report was issued to include addition of leachable PAH analysis on 1019155-16 requested by Tami Dolen of City of Edmonton on August 19, 2014. Previous report 1938819
- Report was issued to include addition of SPLP leachable PAH analysis on sample 16 (reported as sample 26), requested by Tami Dolen of the City of Edmonton on Sep 12/14. Previous report 1941202.

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.

Terms and Conditions: www.exova.com/about/terms-and-conditions

Exova Testing, calibrating, advising

www.exova.com ED 120-02

Project Information

Project ID:
Project Name: Hawrelak Park
Project Location: Hawrelak Park
Legal Location: 9930 Groat Rd.
PO/AFE#:
Proj. Acct. Code: 512.020
Quote #

Invoice to:

Company: City of Edmonton
Address: 11004 - 190 St. Edm. Alberta T5S 0G9
Attention: Tami Dolen
Phone: 780 496 6782
Cell: 780 717 7156
Fax: 780 944 7653
E-mail: tami.dolen@edmonton.ca
Agreement ID:
Copy of report: Tami Dolen

Report To:

Company:
Address:
Attention:
Phone:
Cell:
Fax:
E-mail 1:
E-mail 2:
Copy of invoice:

Report Results		Regulatory Requirement	
E-Mail		HCDWQG	
Mail		Ab Tier 1	
Online		SPIGEC	
Fax		BCCSR	
PDF	X	Other (list below)	
Excel	X		
QA/QC			

Sample Custody (please print)

Sampled by: DALE Durchan
Company: City of Edmonton

This section for Lab use only

Date/Time stamp: AUG 8 PM 3:25

RUSH Priority

Emergency (contact lab for turnaround and pricing)
Priority 1-2 working days (100% surcharge)
Urgent 2-3 working days (50% surcharge)

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.

Date Required: Signature:

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

Please Email results in Pdf and excel.

	Site I.D.	Sample Description	Depth start	Depth end	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	Metals	PAH	Organic Carbon
1	14-01	SO:1	0.4	0.4	Aug 7, 2014		Grab	3	✓	✓	✓
2	14-01	SO:1	1.8	1.8			Grab	3	✓	✓	✓
3	14-01	SO:1	2.3	2.3				3	✓	✓	✓
4	14-02		1.0	1.0				3	✓	✓	✓
5	14-02		1.9	1.9				3	✓	✓	✓
6	14-02		3.5	3.5				3	✓	✓	✓
7	14-03		0.4	0.4				3	✓	✓	✓
8	14-03		1.5	1.5				3	✓	✓	✓
9	14-03		3.0	3.0				3	✓	✓	✓
10	14-03		4.3	4.8				3	✓	✓	✓
11	14-04		1.4	1.4				3	✓	✓	✓
12	14-04		3.0	3.0				3	✓	✓	✓
13	14-04		4.7	4.7				3	✓	✓	✓
14											
15											

Enter tests above (√ relevant samples below)

Indicate in the space allotted any deficiencies by the corresponding number.

1. Indicate any samples that were not packaged well
2. Indicate any samples not received in Exova supplies
3. Indicate any samples that were not clearly labeled
4. Indicate any samples not received within the required hold time or temp.
5. Indicate any missing or extra samples
6. Indicate any samples that were received broken
7. Indicate any samples where sufficient volume was not received
8. Indicate any samples received in an inappropriate container

ED 120-02

Submission of this form acknowledges acceptance of Exova's Standard Terms and Conditions (http://www.exova.com/about/terms-and-conditions/)

Please indicate any potentially hazardous samples

Page 1 of 2

Control # C 0040174

LOT: 1019155 COC

Shipping: COD Y/ N
and size of coolers
Temp. received: 17.3
Delivery Method: hand
Waybill:
Received by: ML

Exova Testing, calibrating, advising

www.exova.com ED 120-02

Project Information

Project ID:
Project Name: Hawtelak Park
Project Location: Hawtelak Park
Legal Location: 9930 - Groat Rd.
PO/AFE#:
Proj. Acct. Code: 512-020
Quote #

Invoice to:

Company: City of Edmonton
Address: 11084 - 190 St.
Edm, Alb. T5S0G9
Attention: Tami Dolen.
Phone: 780-496-6782
Cell: 780 717 7156
Fax: 780 944 7653
E-mail: Tami.dolen@edmonton.ca
Agreement ID:
Copy of report: Tami Dolen.

Report To:

Company:
Address:
Attention:
Phone:
Cell:
Fax:
E-mail 1:
E-mail 2:
Copy of invoice:

Report Results		Regulatory Requirement	
E-Mail		HCDWQG	
Mail		Ab Tier 1	
Online		SPIGEC	
Fax		BCCSR	
PDF	X	Other (list below)	
Excel	X		
QA/QC			

Sample Custody (please print)

Sampled by: Dale Durham
Company: City of Edmonton

This section for Lab use only

Date/Time stamp: AUG 8 PM 3:25

RUSH Priority

- Emergency (contact lab for turnaround and pricing)
- Priority 1-2 working days (100% surcharge)
- Urgent 2-3 working days (50% surcharge)

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.

Date Required: Signature:

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

Please email results in pdf and excell.

	Site I.D.	Sample Description	Depth start (cm)	Depth end (m)	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	Metals	PAH	Organic Carbon	Enter tests above (√ relevant samples below)
1	14-05	Soil	0.15	0.5	Aug 7, 2014		Grab	3	√	√	√	
2	14-05		1.8	1.8				3	√	√	√	
3	14-05		2.4	2.4				3	√	√	√	
4	14-06		0.2	0.2				3	√	√	√	
5	14-06		0.9	0.9				3	√	√	√	
6	14-06		2.7	2.7				3	√	√	√	
7	14-07		0.2	0.2				3	√	√	√	
8	14-07		0.7	0.7				3	√	√	√	
9	14-07		0.9	0.9				3	√	√	√	
10	14-07		2.2	2.2				3	√	√	√	
11	14-08		0.3	0.3				3	√	√	√	
12	14-08		2.7	2.7				3	√	√	√	
13	~~14-08~~											
14												
15												

Indicate in the space allotted any deficiencies by the corresponding number.

1. Indicate any samples that were not packaged well
2. Indicate any samples not received in Exova supplies
3. Indicate any samples that were not clearly labeled
4. Indicate any samples not received within the required hold time or temp.
5. Indicate any missing or extra samples
6. Indicate any samples that were received broken
7. Indicate any samples where sufficient volume was not received
8. Indicate any samples received in an inappropriate container

Submission of this form acknowledges acceptance of Exova's Standard Terms and Conditions (http://www.exova.com/about/terms-and-conditions/)

Indicate lot # or affix barcode here

Shipping: COD Y/ N
and size of coolers
Temp. received: 17.8
Delivery Method: hand
Waybill:
Received by: MS

Please indicate any potentially hazardous samples

Page 2 of 2

Control # C 0040098

ED 120-02

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Report Transmission Cover Page

Bill To:	City of Edmonton	Project:		Lot ID:	**1024456**
Report To:	City of Edmonton	ID:	Hawrelak Park	Control Number:	
	11404 - 60th Avenue	Name:	Risk Assessment	Date Received:	Sep 4, 2014
	Edmonton, AB, Canada	Location:	Hawrelak Park	Date Reported:	Sep 10, 2014
	T6H 1J5	LSD:		Report Number:	1945739
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)		
Sampled By:	Pale Durham	Acct code:			
Company:	City of Edmonton				

Contact & Affiliation	Address	Delivery Commitments
Tami Dolen City of Edm - Finance Dept.	11404 - 60th Avenue Edmonton, Alberta T6H 1J5 Phone: (780) 496-6782 Fax: null Email: tami.dolen@edmonton.ca	On [Lot Verification] send (COA) by Email - Multiple Reports By Agreement On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Lot Approval and Final Test Report Approval] send (COC, Test Report) by Email - Merge Reports On [Lot Creation] send (COR) by Email - Multiple Reports By Agreement

Notes To Clients:

The information contained on this and all other pages transmitted, is intended for the addressee only and is considered confidential.
If the reader is not the intended recipient, you are hereby notified that any use, dissemination, distribution or copy of this transmission is strictly prohibited.
If you receive this transmission by error, or if this transmission is not satisfactory, please notify us by telephone.

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	Hawrelak Park
	11404 - 60th Avenue	Name:	Risk Assessment
	Edmonton, AB, Canada	Location:	Hawrelak Park
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)
Sampled By:	Pale Durham	Acct code:	
Company:	City of Edmonton		

Lot ID:	**1024456**
Control Number:	
Date Received:	Sep 4, 2014
Date Reported:	Sep 10, 2014
Report Number:	1945739

Reference Number	1024456-1	1024456-2	1024456-3
Sample Date	Sep 04, 2014	Sep 04, 2014	Sep 04, 2014
Sample Time	NA	NA	NA
Sample Location			
Sample Description	S14-3 / 10.0 °C	14-01 / 10.0 °C	14-02 / 10.0 °C
Matrix	Water	Water	Water

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Water						
Naphthalene		ug/L	<0.1	<0.1	<0.1	0.1
Quinoline		ug/L	<0.3	<0.3	<0.3	0.3
Acenaphthylene		ug/L	<0.1	<0.1	<0.1	0.1
Acenaphthene		ug/L	<0.1	<0.1	<0.1	0.1
Fluorene		ug/L	<0.1	<0.1	<0.1	0.1
Phenanthrene		ug/L	<0.1	<0.1	<0.1	0.1
Anthracene		ug/L	<0.005	<0.005	<0.005	0.005
Acridine		ug/L	<0.1	<0.1	<0.1	0.1
Fluoranthene		ug/L	<0.01	<0.01	<0.01	0.01
Pyrene		ug/L	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene		ug/L	<0.01	<0.01	<0.01	0.01
Chrysene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(b+j)fluoranthene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(k)fluoranthene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(a)pyrene		ug/L	<0.008	<0.008	<0.008	0.008
Indeno(1,2,3-c,d)pyrene		ug/L	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene		ug/L	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene		ug/L	<0.05	<0.05	<0.05	0.05
CB(a)P	Carcinogenic Potency Equivalent	ug/L	<0.01	<0.01	<0.01	.01
PAH - Water - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	100	90	90	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	110	90	100	30-130
p-Terphenyl-d14	PAH - Surrogate	%	110	100	120	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:		Lot ID:	**1024456**
Report To:	City of Edmonton	ID:	Hawrelak Park	Control Number:	
	11404 - 60th Avenue	Name:	Risk Assessment	Date Received:	Sep 4, 2014
	Edmonton, AB, Canada	Location:	Hawrelak Park	Date Reported:	Sep 10, 2014
	T6H 1J5	LSD:		Report Number:	1945739
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)		
Sampled By:	Pale Durham	Acct code:			
Company:	City of Edmonton				

	Reference Number	1024456-4	1024456-5	1024456-6	
	Sample Date	Sep 04, 2014	Sep 04, 2014	Sep 04, 2014	
	Sample Time	NA	NA	NA	
	Sample Location				
	Sample Description	14-03 / 10.0 °C	14-04 / 10.0 °C	14-05 / 10.0 °C	
	Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Water						
Naphthalene		ug/L	<0.1	<0.1	<0.1	0.1
Quinoline		ug/L	<0.3	<0.3	<0.3	0.3
Acenaphthylene		ug/L	<0.1	<0.1	<0.1	0.1
Acenaphthene		ug/L	<0.1	<0.1	<0.1	0.1
Fluorene		ug/L	<0.1	<0.1	<0.1	0.1
Phenanthrene		ug/L	<0.1	<0.1	<0.1	0.1
Anthracene		ug/L	<0.005	<0.005	<0.005	0.005
Acridine		ug/L	<0.1	<0.1	<0.1	0.1
Fluoranthene		ug/L	<0.01	<0.01	<0.01	0.01
Pyrene		ug/L	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene		ug/L	<0.01	<0.01	<0.01	0.01
Chrysene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(b+j)fluoranthene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(k)fluoranthene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(a)pyrene		ug/L	<0.008	<0.008	<0.008	0.008
Indeno(1,2,3-c,d)pyrene		ug/L	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene		ug/L	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene		ug/L	<0.05	<0.05	<0.05	0.05
CB(a)P	Carcinogenic Potency Equivalent	ug/L	<0.01	<0.01	<0.01	.01
PAH - Water - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	100	100	90	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	100	90	100	30-130
p-Terphenyl-d14	PAH - Surrogate	%	110	100	110	18-137

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	Hawrelak Park
	11404 - 60th Avenue	Name:	Risk Assessment
	Edmonton, AB, Canada	Location:	Hawrelak Park
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)
Sampled By:	Pale Durham	Acct code:	
Company:	City of Edmonton		

Lot ID:	**1024456**
Control Number:	
Date Received:	Sep 4, 2014
Date Reported:	Sep 10, 2014
Report Number:	1945739

	Reference Number	1024456-7	1024456-8	1024456-9	
	Sample Date	Sep 04, 2014	Sep 04, 2014	Sep 04, 2014	
	Sample Time	NA	NA	NA	
	Sample Location				
	Sample Description	14-06 / 10.0 °C	14-07 / 10.0 °C	14-08 / 10.0 °C	
	Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Polycyclic Aromatic Hydrocarbons - Water						
Naphthalene		ug/L	<0.1	<0.1	<0.1	0.1
Quinoline		ug/L	<0.3	<0.3	<0.3	0.3
Acenaphthylene		ug/L	<0.1	<0.1	<0.1	0.1
Acenaphthene		ug/L	<0.1	<0.1	<0.1	0.1
Fluorene		ug/L	<0.1	<0.1	<0.1	0.1
Phenanthrene		ug/L	<0.1	<0.1	<0.1	0.1
Anthracene		ug/L	<0.005	<0.005	<0.005	0.005
Acridine		ug/L	<0.1	<0.1	<0.1	0.1
Fluoranthene		ug/L	<0.01	<0.01	<0.01	0.01
Pyrene		ug/L	<0.01	<0.01	<0.01	0.01
Benzo(a)anthracene		ug/L	<0.01	<0.01	<0.01	0.01
Chrysene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(b+j)fluoranthene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(k)fluoranthene		ug/L	<0.1	<0.1	<0.1	0.1
Benzo(a)pyrene		ug/L	<0.008	<0.008	<0.008	0.008
Indeno(1,2,3-c,d)pyrene		ug/L	<0.05	<0.05	<0.05	0.05
Dibenzo(a,h)anthracene		ug/L	<0.05	<0.05	<0.05	0.05
Benzo(g,h,i)perylene		ug/L	<0.05	<0.05	<0.05	0.05
CB(a)P	Carcinogenic Potency Equivalent	ug/L	<0.01	<0.01	<0.01	.01
PAH - Water - Surrogate Recovery						
Nitrobenzene-d5	PAH - Surrogate	%	90	90	90	23-130
2-Fluorobiphenyl	PAH - Surrogate	%	100	100	100	30-130
p-Terphenyl-d14	PAH - Surrogate	%	110	100	110	18-137

Approved by:

Randy Neumann, BSc
Vice President

Data have been validated by Analytical Quality Control and Exova'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.

Terms and Conditions: www.exova.com/about/terms-and-conditions

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Methodology and Notes

Bill To:	City of Edmonton	Project:		Lot ID:	**1024456**
Report To:	City of Edmonton	ID:	Hawrelak Park	Control Number:	
	11404 - 60th Avenue	Name:	Risk Assessment	Date Received:	Sep 4, 2014
	Edmonton, AB, Canada	Location:	Hawrelak Park	Date Reported:	Sep 10, 2014
	T6H 1J5	LSD:		Report Number:	1945739
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)		
Sampled By:	Pale Durham	Acct code:			
Company:	City of Edmonton				

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
PAH - Water	AESRD		Carcinogenic PAHs Toxic Potency Equivalence (as B(a)P TPE), PAHw	05-Sep-14	Exova Calgary
PAH - Water	US EPA	*	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, 8270	05-Sep-14	Exova Calgary

** Reference Method Modified*

References

AESRD	Alberta Tier 1 Soil and Groundwater Remediation Guidelines
US EPA	US Environmental Protection Agency Test Methods

Comments:

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.

Exova Testing, calibrating, advising

www.exova.com ED 120-02

Project Information

Project ID: Hawrelak Park.
Project Name: Risk Assesment.
Project Location: Hawrelak Park.
Legal Location:
PO/AFE#:
Proj. Acct. Code:
Quote #

Invoice to:

Company: City of Edmonton
Address: 11004 - 190st
Attention: Tami Dolen
Phone: 780 496 6782
Cell:
Fax:
E-mail: tami.dolen@edmonton.ca
Agreement ID:
Copy of report:

Report To:

Company:
Address:
Attention:
Phone:
Cell:
Fax:
E-mail 1:
E-mail 2:
Copy of invoice:

Same

Report Results		Regulatory Requirement
E-Mail	✓	HCDWQG
Mail		Ab Tier 1
Online		SPIGEC
Fax		BCCSR
PDF	✓	Other (list below)
Excel	✓	
QA/QC		

Sample Custody (please print)

Sampled by: DAleDurham
Company: City of Edmonton

RUSH Priority

- Emergency (contact lab for turnaround and pricing)
- Priority 1-2 working days (100% surcharge)
- Urgent 2-3 working days (50% surcharge)

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.

Date Required: Signature:

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

This section for Lab use only

Date/Time stamp: SEP 4 PM 4:25

	Site I.D.	Sample Description	Depth start in cm	Depth end m	Date/Time Sampled	Matrix	Sampling Method	Number of Containers	Dissolved Metals	PAH's							
1																	
2																	
3	S14-4	Water			Sept 4, 2014		pump	2	✓	✓							
4	14-01	↓			↓		↓	2	✓	✓							
5	14-02	↓			↓		↓	2	✓	✓							
6	14-03	↓			↓		↓	2	✓	✓							
7	14-04	Water			Sept 4, 2014		pump	2	✓	✓							
8	14-05	↓			↓		↓	2	✓	✓							
9	14-06	↓			↓		↓	2	✓	✓							
10	14-07	↓			↓		↓	2	✓	✓							
11	14-08	↓			↓		↓	2	✓	✓							
12																	
13																	
14																	
15																	

Enter tests above (√ relevant samples below)

Indicate in the space allotted any deficiencies by the corresponding number.

1. Indicate any samples that were not packaged well
2. Indicate any samples not received in Exova supplies
3. Indicate any samples that were not clearly labeled
4. Indicate any samples not received within the required hold time or temp.
5. Indicate any missing or extra samples
6. Indicate any samples that were received broken
7. Indicate any samples where sufficient volume was not received
8. Indicate any samples received in an inappropriate container

Submission of this form acknowledges acceptance of Exova's Standard Terms and Conditions (http://www.exova.com/about/terms-and-conditions/)

Please indicate any potentially hazardous samples

Page ____ of ____ Control # C0042392

LOT: 1024456 COC

Shipping: COD Y/ N
and size of coolers
Temp. received: 10.0
Delivery Method: Hand
Waybill:
Received by: WV

ED 120-02

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Report Transmission Cover Page

Bill To:	City of Edmonton	Project:		Lot ID:	**1025855**
Report To:	City of Edmonton	ID:	Hawrelak Park	Control Number:	
	11404 - 60th Avenue	Name:	Risk Assessment	Date Received:	Sep 11, 2014
	Edmonton, AB, Canada	Location:	Hawrelak Park	Date Reported:	Oct 15, 2014
	T6H 1J5	LSD:		Report Number:	1958011
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)		
Sampled By:	Dale Durham	Acct code:			
Company:	City of Edmonton				

Contact & Affiliation	Address	Delivery Commitments
Tami Dolen City of Edm - Finance Dept.	11404 - 60th Avenue Edmonton, Alberta T6H 1J5 Phone: (780) 496-6782 Fax: null Email: tami.dolen@edmonton.ca	On [Lot Verification] send (COA) by Email - Multiple Reports By Agreement On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Report Approval] send (Test Report) by Email - Single Report On [Lot Approval and Final Test Report Approval] send (COC, Test Report, Test Report, Test Report, Invoice) by On [Lot Creation] send (COR) by Email - Multiple Reports By Agreement

Notes To Clients:

- Report was issued to correct the report to only show results for boron, selenium, cobalt and arsenic as requested . . Previous report 1947669.
- Report was issued to include addition of nickel analysis on all samples as requested by Craig Harris of AECOM on October 15, 2014. Previous report 1951576.

The information contained on this and all other pages transmitted, is intended for the addressee only and is considered confidential.
If the reader is not the intended recipient, you are hereby notified that any use, dissemination, distribution or copy of this transmission is strictly prohibited.
If you receive this transmission by error, or if this transmission is not satisfactory, please notify us by telephone.

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:		Lot ID:	**1025855**
Report To:	City of Edmonton	ID:	Hawrelak Park	Control Number:	
	11404 - 60th Avenue	Name:	Risk Assessment	Date Received:	Sep 11, 2014
	Edmonton, AB, Canada	Location:	Hawrelak Park	Date Reported:	Oct 15, 2014
	T6H 1J5	LSD:		Report Number:	1958011
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)		
Sampled By:	Dale Durham	Acct code:			
Company:	City of Edmonton				

		Reference Number	1025855-1	1025855-2	1025855-3	
		Sample Date	Sep 10, 2014	Sep 10, 2014	Sep 10, 2014	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	14-03 / 9.9 °C	14-02 / 9.9 °C	14-06 / 9.9 °C	
		Matrix	Water	Water	Water	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Dissolved						
Arsenic	Dissolved	mg/L	0.0016	0.0004	0.0012	0.0002
Boron	Dissolved	mg/L	0.047	0.109	0.083	0.002
Cobalt	Dissolved	mg/L	0.0093	0.0009	0.0025	0.0001
Nickel	Dissolved	mg/L	0.0185	0.0047	0.0126	0.0005
Selenium	Dissolved	mg/L	0.0002	<0.0002	0.0005	0.0002

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Analytical Report

Bill To:	City of Edmonton	Project:		Lot ID:	**1025855**
Report To:	City of Edmonton	ID:	Hawrelak Park	Control Number:	
	11404 - 60th Avenue	Name:	Risk Assessment	Date Received:	Sep 11, 2014
	Edmonton, AB, Canada	Location:	Hawrelak Park	Date Reported:	Oct 15, 2014
	T6H 1J5	LSD:		Report Number:	1958011
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)		
Sampled By:	Dale Durham	Acct code:			
Company:	City of Edmonton				

Reference Number	1025855-4
Sample Date	Sep 10, 2014
Sample Time	NA
Sample Location	
Sample Description	514-03 / 9.9 °C
Matrix	Water

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Metals Dissolved						
Arsenic	Dissolved	mg/L	0.0026			0.0002
Boron	Dissolved	mg/L	0.035			0.002
Cobalt	Dissolved	mg/L	0.0039			0.0001
Nickel	Dissolved	mg/L	0.0069			0.0005
Selenium	Dissolved	mg/L	<0.0002			0.0002

Approved by:

Anthony Neumann, MSc
Laboratory Operations Manager

Data have been validated by Analytical Quality Control and Exova'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.

Terms and Conditions: www.exova.com/about/terms-and-conditions

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Methodology and Notes

Bill To:	City of Edmonton	Project:	
Report To:	City of Edmonton	ID:	Hawrelak Park
	11404 - 60th Avenue	Name:	Risk Assessment
	Edmonton, AB, Canada	Location:	Hawrelak Park
	T6H 1J5	LSD:	
Attn:	Tami Dolen	P.O.:	D921050 (C-Release#)
Sampled By:	Dale Durham	Acct code:	
Company:	City of Edmonton		

Lot ID:	**1025855**
Control Number:	
Date Received:	Sep 11, 2014
Date Reported:	Oct 15, 2014
Report Number:	1958011

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Metals ICP-MS (Dissolved) in water	APHA/USEPA	*	Metals By Inductively Coupled Plasma/Mass Spectrometry, APHA 3125 B / USEPA 200.2, 200.8	15-Sep-14	Exova Edmonton

** Reference Method Modified*

References

US EPA	US Environmental Protection Agency Test Methods

Comments:

- Report was issued to correct the report to only show results for boron, selenium, cobalt and arsenic as requested . . Previous report 1947669.
- Report was issued to include addition of nickel analysis on all samples as requested by Craig Harris of AECOM on October 15, 2014. Previous report 1951576.

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.

Appendix E

Memorandum: Inorganic Substances Statistical Analysis

Appendix E: Selection of Summary Statistics From Environmental Concentration Data

This Appendix outlines the workflow process for computation of summary statistics, including 95% Upper Confidence Limits of the mean (UCL95) for environmental concentration data with and without non-detect. Summary statistics were computed using the US Environmental Protection Agencies' statistical platform ProUCL Version 4.1. This workflow was developed based on a review of relevant literature, and guidance delivered by Dr. Dennis Helsel [1,2]. The flowchart included as Figure 1 shows the workflow process. The rationale for selection of statistical procedures is described in the text below. Text specific to portion of the flowchart are signified by corresponding numbers, (ι) for example.

Calculating an upper confidence limit on environmental data that does not have ND values is largely influenced by the number of observations (n) and the skewness of the data. For data sets where the number of observations is less than twenty (n<20) bootstrap re-sampling techniques are unlikely to capture the breadth of the sample population shape, and are likely to return inaccurate estimates of the UCL. Under these circumstances either a normal or gamma distribution is assumed based on the strongest goodness of fit statistic provided by ProUCL (i.e. larger R-squared value). ProUCL does not include suitable methods for computation of 95% UCLs based on lognormal distributions, so non-normal (i.e. skewed) distributions are assumed to resemble a gamma distribution. Based on the selected distribution the 95% Student's-t UCL or 95% Adjusted Gamma UCL was carried forward for normal and gamma distributions respectively (ι). For datasets without non-detect values and a sample size of n≥20 bootstrap re-sampling techniques are the best way to compute a UCL95 from skewed data (Helsel, 2012). The Bias Corrected Accelerated Bootstrap (BCA) intervals are recommended for general use, especially for non-parametric problems[3]. The BCA bootstrap technique adjusts for skewness and provides a confidence limit of the mean that that should exceed the true population mean in 95% of cases (i.e 95% coverage). Under these circumstances (φ) the 95% BCA Bootstrap UCL was used.
In the past, regulatory guidance in environmental sciences supported the use of substitution methods for handing data below reportable limits of detection (ND values). Substitution methods introduce invasive data resulting in poor estimates and incorrect statistical tests (Helsel, 2012). Substitution methods do not provide adequate coverage for UCLs computed on censored data, even when censoring levels are as low as 10% [4] and based on this study the US EPA have stated that "*it is strongly recommended to avoid the use of the DL/2 method….even when the percentage of NDs if as low as 5-10%*"[5]. Accordingly, AECOM did not use substitution methods in this statistical analysis.

---

[1] Course presented January 19th 2012 to the Society of Contaminated Sites Approved Professionals of British Columbia titled *Environmental Statistics Using ProUCL.*
[2] Course presented November 29th 2012 titled *Practical Statistics for Contaminated Site Studies* through GeoEnviroLogic Professional Development.
[3] B. Efron and R. J. Tibshirani, An Introduction to the Bootstrap, Boca Raton, FL: CRC Press, 1994..
[4] Singh, A., Maichle, R., and Lee, S. 2006. On the Computation of a 95% Upper Confidence Limit of the Unknown Population Mean Based Upon Data Sets with Below Detection Limit Observations. EPA/600/R-06/022, March 2006. Available at: http://www.epa.gov/osp/hstl/tsc/softwaredocs.htm
[5] USEPA 2012 ProUCL Version 4.1 User Guide (Draft). EPA/600/r-07/041. US Environmental Protection Agency, Office of Research and Development, Washington, DC. Available at http:// http://www.epa.gov/osp/hstl/tsc/ProUCL_v4.1_user.pdf.

Two non-substitution methods for handling non-detects are include in ProUCL; (a) the Kaplan-Meier procedure (KM), and; (b) Robust Regression on Order Statistics (ROS).

a. Kaplan-Meier: The KM procedure is a nonparametric method thereby not requiring transformations or assumptions of distribution, and is the standard in medical and industrial statistics for estimating a mean of censored data[6]. KM was determined to be the most reliable method for computing the 95% upper confidence limit on the mean (UCL95) of concentration data[4]. The KM method was not developed for use where a single censoring value (i.e. one reportable detection limit) exists in the population. In this case the KM estimates of the mean will be equal to the mean based on DL substitution. Datasets with a single censoring level are common for projects of a short duration where a single laboratory has been used. AECOM have used KM methods for datasets with multiple detections limits (κ).
b. Robust Regression on Order Statistics (ROS): The ROS procedure is the most suitable method for datasets with a single detection limit [7]. ROS uses regression on a probability plot to estimate distributional parameters, usually in log units. Individual estimates are then predicted from the line, and retransformed back into original units. No transformation of the estimated summary statistics occurs. The imputed values are then used collectively with the detected data to compute summary statistics. This is the preferred method for datasets with a single censoring level (λ).

Calculation of summary statistics, including 95% UCLs, for datasets with NDs is based on the both the number of censoring levels as described above as well as the percentage of the dataset being censored (μ). For datasets where less than 40% of the observations are censored, the BCA method is used. BCA intervals are recommended for general use for datasets where the degree of censoring is low (<40%) however the method breaks down when the degree of censoring is high (≥40%) [4]. Under these circumstances the median value, which is used to make the adjustment for skewness, is difficult/impossible to determine [4]. Therefore, AECOM have elected to use BCA Bootstrap UCL95s for datasets where the degree of censoring is low (<40%), and 95% Percentile Bootstrap UCLs where 40% or more of the observations are NDs (μ).

Upper Tolerance Limits were calculated using ProUCL V. 4.1. Selection of upper tolerance limits followed the same decision making criteria as for selection of upper confidence limits. The upper tolerance limit calculates a threshold which should contain a certain percentage of each individual measurement in the population at a certain confidence level. In this case ProUCL was used to calculate 95% UTLs with 90% coverage (i.e. 90% of future observations will be below the calculated statistic with 95% confidence).

[6] Klein and Moeschberger, 2003; as cited in Denis R. Helsel. 2009. Summing Nondetects: Incorporating Low-Level contaminants in Risk Assessment. Integrated Environmental Assessment and Management. Vol.6, No. 3, pp. 361-366.
[7] Helsel D.R. 2005. Nondetects and data analysis: Statistics for censored environmental data. Hoboken (NJ). John Wiley & Sons, 250p.

Figure 1: Flowchart showing decision making process for selection of appropriate UCL95s from ProUCL output for environmental concentration data.

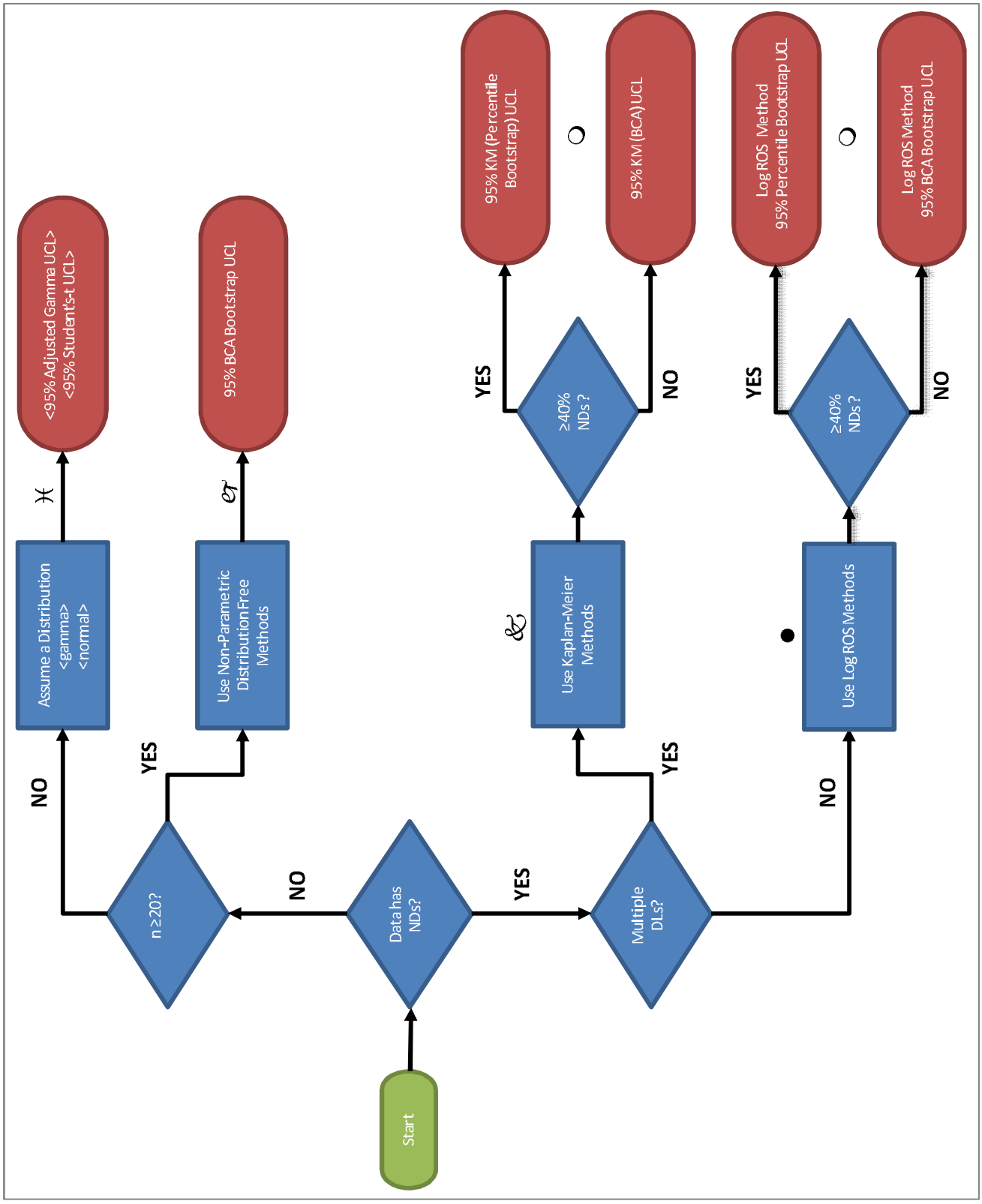


Table A-1: Summary Statistics

COPC	n	n >LOD	% ND	Max.	Min.	Mean	SD	CV	Skew	UCL95	UTL95	Method
As	41	41	0%	30	1.4	8.427	5.615	0.666	1.881	10.14	19.81	2
B	41	32	22%	5.65	0.21	1.023	1.184	1.157	-	1.194	2.99	6
Co	41	41	0%	25.7	1.9	10.27	4.709	0.459	1.516	11.78	18.8	2
Ni	41	41	0%	110	7.5	31.44	20.81	0.662	2.615	38.5	66.5	2
Se	41	18	56%	1.8	0.3	0.552	0.285	0.516	-	0.516	0.844	3

Method:
1. 95% Adjusted Gamma UCL
2. 95% BCA Bootstrap UCL
3. 95% KM (Percentile Bootstrap) UCL
4. 95% KM (BCA) UCL
5. Log ROS 95% Percentile Bootstrap UCL
6. Log ROS 95% BCA Bootstrap UCL

Appendix D2: Limited Phase II ESA (CRIMSON 2021)

Limited Phase II Environmental Site Assessment
Hawrelak Park Maintenance Yard
Portion of 9330 Groat Road NW
Portion of Plan 6075AM, Block X
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-37563
August 19, 2021

EXECUTIVE SUMMARY

CRIMSON Environmental Limited (CRIMSON) was retained by the City of Edmonton to conduct a Limited Phase II Environmental Site Assessment (ESA) of a portion of the Hawrelak Park Maintenance Yard. The study area was limited to the location situated immediately adjacent to the existing aboveground storage tanks (ASTs). This area is also reported to have been the location of a former underground storage tank (UST) nest.

The municipal address for the subject property is a portion of 9330 Groat Road NW Edmonton, Alberta (Figures 1 and 2). The legal description for the subject site is a portion of Plan 6075AM, Block X. 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 petroleum hydrocarbon (PHC) constituents and/or lead. The assessment was completed specifically to ascertain the soil quality in the area of the current ASTs and/or the former UST nest that is reported to have been previously present at the same location.

The intrusive portion of this investigation was completed on July 22, 2021. A total of four boreholes were drilled using a track mounted drill rig operated by Mobile Augers and Research Ltd. The rig was equipped with solid stem augers. All of the boreholes were drilled to approximate depths ranging between 3.0 and 7.3 mbgl and were backfilled with bentonite and drill cuttings upon completion. 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 either refined petroleum hydrocarbons or lead. In addition, no visual or olfactory indications of impacts were noted during the assessment. It is CRIMSON's opinion that the odours noted by Thurber Engineering Ltd. were likely the result of operational fumes from the existing above ground storage tanks. Based on the results of the investigation, no further assessment is recommended at this time.

Table of Contents

1.0 INTRODUCTION……... 1

2.0 SITE DESCRIPTION……... 2

3.0 REGULATORY GUIDELINES……... 3

4.0 METHODOLOGY……... 3

5.0 RESULTS OF THE INVESTIGATION…… 4

6.0 CONCLUSIONS & RECOMMENDATIONS…… 5

7.0 QUALIFICATIONS OF THE ASSESSOR…… 6

8.0 REFERENCES…… 6

9.0 STATEMENT OF LIMITATIONS…… 7

10.0 CLOSURE…… 8

LIST OF FIGURES, TABLES AND APPENDICES

Figures

Figure 1 – Site Location Plan
Figure 2 – Site Survey Plan
Figure 3 – Site Zoning Plan
Figure 4 – Borehole Location Plan

Tables

Table 1 – Grain Size Data
Table 2 – Surface Soil Analytical Chemistry - Refined PHC Constituents & Lead
Table 3 – Subsoil Analytical Chemistry - Refined PHC Constituents & Lead

Appendices

Appendix A – Figures
Appendix B – Tables
Appendix C – Borehole Logs
Appendix D – Laboratory Reports

1.0 INTRODUCTION

CRIMSON Environmental Limited (CRIMSON) was retained by the City of Edmonton to conduct a Limited Phase II Environmental Site Assessment (ESA) of a portion of the Hawrelak Park Maintenance Yard. The study area was limited to the location situated immediately adjacent to the existing aboveground storage tanks (ASTs). This area is also reported to have been the location of a former underground storage tank (UST) nest.

The municipal address for the subject property is a portion of 9330 Groat Road NW Edmonton, Alberta (Figures 1 and 2). The legal description for the subject site is a portion of Plan 6075AM, Block X. 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 petroleum hydrocarbon (PHC) constituents and/or lead. The assessment was completed specifically to ascertain the soil quality in the area of the current ASTs and/or the former UST nest that is reported to have been previously present at the same location.

1.1 Background

A site remediation program was completed by AGRA Earth & Environmental Limited (AGRA) in 1996 (Project Number: EE-91403). The remediation program consisted of the removal of two 500 gallon (approximately 2,000 litres) underground storage tanks (USTs) as well as the installation of a soil vapour extraction (SVE) system. The USTs were noted to be of steel construction and contain gasoline and diesel fuel. An unspecified volume of soil present adjacent to the USTs was removed from the site and disposed of at the Sturgeon Regional Landfill in 1996.

The SVE system was reported to have operated continuously between August 1996 and March 1997. A confirmatory soil sampling program was conducted in March 1997 which consisted of drilling one borehole (97-1) north of the former UST nest. Hydrocarbon concentrations in the two soil samples collected from the borehole were below the laboratory detection limits and the applicable guideline values. Further assessment and/or remediation was not recommended.

A geotechnical assessment completed for the subject site on July 22, 2021 as part of the proposed building expansion identified a hydrocarbon odour during the drilling of one borehole (TH21-10) northwest of the former USTs. Soil samples were not submitted for analytical testing, but recommendations were made for the completion of an ESA.

1.2 Scope of Work

The final scope of work included the following tasks:

- Observe the drilling of four boreholes at the locations provided on Figure 4. All of the boreholes were drilled to approximate depths ranging between of 3.0 and 7.3 metres below ground level (mbgl);
- Complete a soil-sampling program for the purpose of quantifying potential impacts. This included the collection of soil samples at a regular interval of approximately 0.75 metres or as deemed necessary by field staff. Final collection depths were determined in the field and were dependent upon field conditions;
- Complete combustible vapour screening of all soil samples collected during the investigation;
- Submit select 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 client and from the property owner prior to commencement.

1.3 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 July 22, 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 subject property) is located within a portion of Hawrelak Park Maintenance Yard. The study area was limited to the location situated immediately adjacent to the existing ASTs. This area is also reported to have been the location of a former UST nest. The municipal address for the subject property is a portion of 9330 Groat Road NW Edmonton, Alberta (Figures 1 and 2). The legal description for the subject site is a portion of Plan 6075AM, Block X.

With respect to adjacent properties, the study area is surrounded by other portions of the maintenance yard and/or Hawrelak Park. The main garage/office building is located immediately north of the ASTs. Storage sheds are located immediately west and southwest of the ASTs and outdoor storage areas are situated immediately east and directly south of the ASTs. The maintenance yard is located on the northeast corner of Hawrelak Park approximately 50 metres south of the park's main entrance. Groat Road NW is located approximately 50 metres east of the maintenance yard followed by parkland.

The topography of the subject property is generally flat with surface water runoff controlled by the site grading and the City of Edmonton's municipal storm sewer system.

The closest water body to the site is the North Saskatchewan River which is located approximately 500 metres southwest and 600 metres northeast of the study area.

The subject property and all surrounding properties within 50 metres of the subject site are currently zoned A (Metropolitan Recreation Zone). 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 alluvial terrace deposits. These deposits are reported to consist of sand and gravel with minor silt and clay. Erosional features are also reported to be present in the area east of the subject site across Groat Road NW and in the areas near the North Saskatchewan River.

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 refined petroleum hydrocarbons and/or lead 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 Tier 1 Guidelines for residential and/or parkland land uses have been applied to the entire site. 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 grain size data obtained during the assessment as well as the limited amount of site specific geological data that is available at the time of publication.

4.0 METHODOLOGY

4.1 Intrusive Investigation

The intrusive portion of this investigation was completed on July 22, 2021. A total of four boreholes were drilled using a track mounted drill rig operated by Mobile Augers and Research Ltd. The rig was equipped with solid stem augers. All of the boreholes were drilled to approximate depths ranging between 3.0 and 7.3 mbgl and were backfilled with bentonite and 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.

It should be noted that CRIMSON's borehole labelled 2021-02 was completed immediately adjacent to the Thurber borehole labelled TH21-10 in order to confirm the site status in that area of the property.

4.2 Soil Sampling

A total of twenty three soil samples were collected during this assessment. Duplicate samples were collected at all borehole locations at the depth intervals indicated on the borehole logs (Appendix C). At each sampling point, one portion of the soil sample for each depth interval was placed directly into a clearly labeled polyethylene bag for combustible vapour screening and/or analytical purposes (inorganic parameters only). The second portion of the soil sample at each depth interval was placed into clearly labeled, laboratory prepared, 125 millilitre glass jars complete with Teflon-lined plastic lids. In addition, approximately 5 milligrams of soil was inserted directly into each of two laboratory prepared vials filled with approximately 5 millilitres of methanol. 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 followed by a unit of sand with gravel, silt and clay. Auger refusal was experienced at three borehole locations between 3.0 mbgl (21-02 & 21-03) and 3.8 mbgl (21-04). Detailed descriptions are provided on the borehole logs in Appendix C. It should also be noted that no visual or olfactory indications of impacts were noted during the assessment.

5.2 Grain-size Analyses

Six 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 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 and 3 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 Refined Petroleum Hydrocarbons – Surface Soil

Six surface soil samples (collection depth ≤ 3.0 mbgl) were submitted for chemical analyses of a select list of refined petroleum hydrocarbon constituents. This includes analyses for benzene, toluene, ethylbenzene, total xylenes (BTEX) and petroleum hydrocarbon (PHC) fractions one through four (F1-F4). The results of the analyses are provided on Table 2 (Appendix B) and indicated that the concentrations of all analysed parameters in all of the submitted samples were below their respective, applicable Alberta Tier 1 Guidelines.

5.3.2 Refined Petroleum Hydrocarbons – Subsoil

Four subsoil samples (collection depth > 3.0 mbgl) were submitted for chemical analyses of a select list of refined petroleum hydrocarbon constituents. This includes analyses for BTEX and PHC fractions F1-F4. The results of the analyses are provided on Table 3 (Appendix B) and indicated that the concentrations of all analysed parameters in all of the submitted samples were below their respective, applicable Alberta Tier 1 Guidelines.

5.3.3 Lead

Five soil samples were submitted for chemical analyses of lead. The results of the analyses are provided on Tables 2 and 3 (Appendix B) and indicate that the concentrations of lead were below the applicable Alberta Tier 1 Guideline in all of the submitted samples.

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 either refined petroleum hydrocarbons or lead. In addition, no visual or olfactory indications of impacts were noted during the assessment. It is CRIMSON's opinion that the odours noted by Thurber Engineering Ltd. were likely the result of operational fumes from the existing above ground storage tanks. Based on the results of the investigation, no further assessment 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. AGRA Earth & Environmental Limited. *Phase II and III Environmental Site Assessment and Site Remediation, Hawrelak Park Maintenance Compound, Edmonton, Alberta.* Project Number: EE-91403. September 13, 1996;

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

3. Alberta Environment and Parks. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines,* 2019;

4. Alberta Environment and Parks. *Alberta Tier 2 Soil and Groundwater Remediation Guidelines,* 2019;

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

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

7. CSA International Standard Z769-00 *Phase II Environmental Site Assessment.* Toronto, Ontario. 2013; and

8. 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:

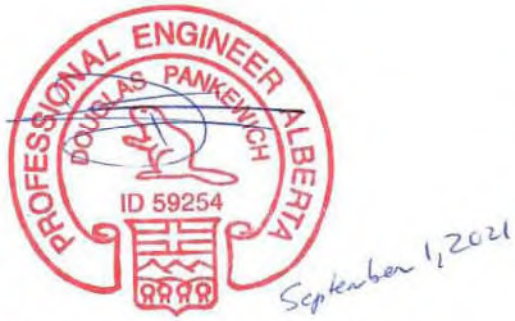
1. This report has been prepared for the exclusive use of the City of Edmonton. The report is intended to provide an assessment of known or potential environmental concerns and liabilities associated with past and current practices of the subject properties;
2. The report is based on data and information 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,

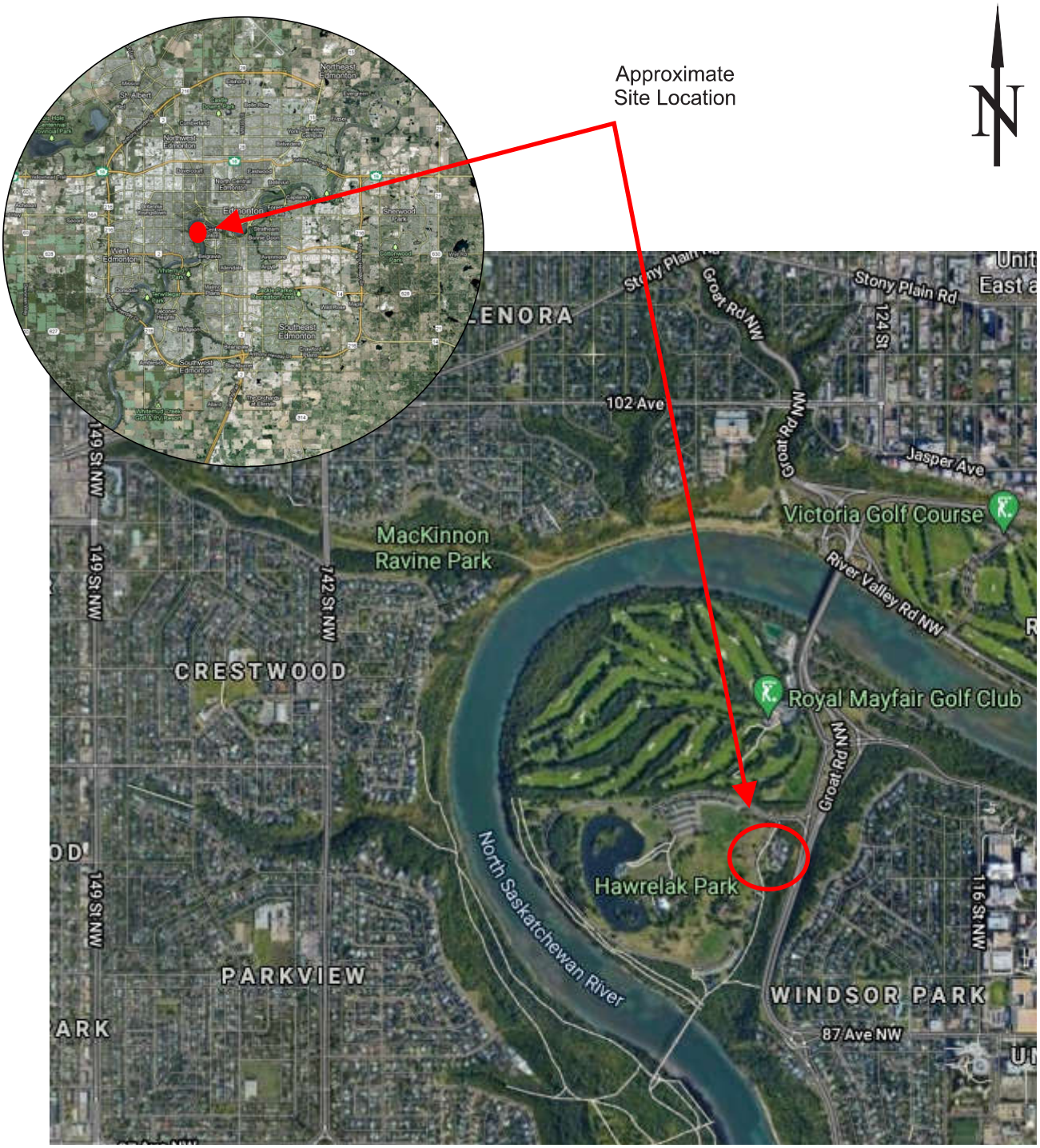
CRIMSON Environmental Limited



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

Appendix A

Figures

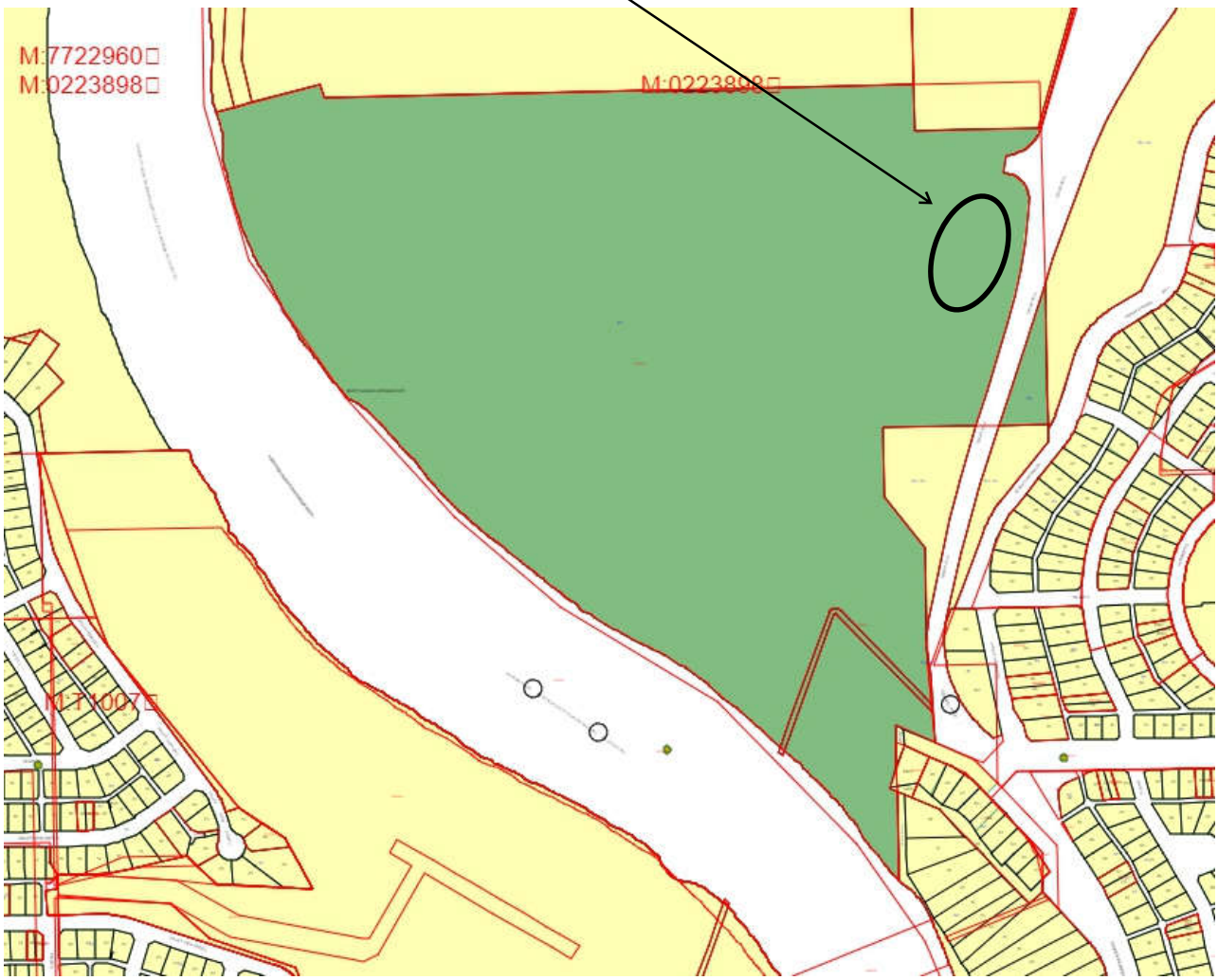


Scale
500 metres

Reference: Goggle, 2021.

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

CRIMSON ENVIRONMENTAL LIMITED	Site Location Plan	Figure 1
		Scale: As Shown
	Hawrelak Park Maintenance Yard Portion of 9330 Groat Road NW Edmonton, Alberta	August, 2021
		CEL-37563

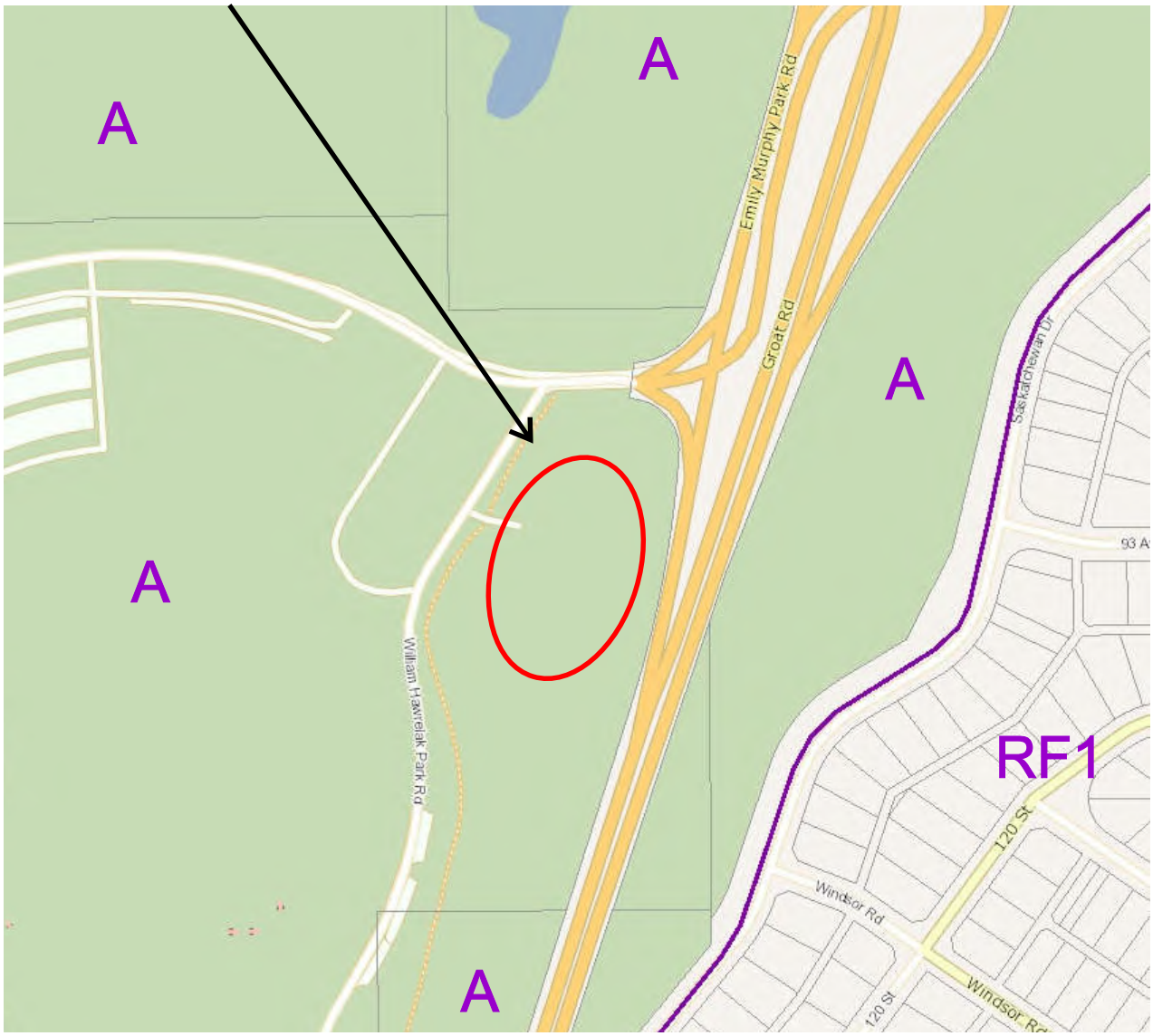


Scale
250 metres

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	Figure 2
		Scale: As Shown
	Hawrelak Park Maintenance Yard Portion of 9330 Groat Road NW Edmonton, Alberta	August, 2021
		CEL-37563



Scale
100 metres

Reference: 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	Figure 3
		Scale: As Shown
	Hawrelak Park Maintenance Yard Portion of 9330 Groat Road NW Edmonton, Alberta	August, 2021
		CEL-37563

Scale
10 metres

Legend

- Borehole Locations by CRIMSON
- Borehole Location by Thurber

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
Hawrelak Park Maintenance Yard 9330 Groat Road NW Edmonton, Alberta	July, 2021
	CEL-37563

Appendix B

Tables

Table 1. Grain Size Data

Particle Size	Detection Limit	Units	Analytical Results					
			21-01 @ 2.3 m	21-01 @ 3.0 m	21-01 @ 7.3 m	21-03 @ 3.0 m	21-04 @ 1.5 m	21-04 @ 3.8 m
% Sand	1.0	%	62	48	78	82	60	67
% Silt	1.0	%	26	28	12	10	24	17
% Clay	1.0	%	12	24	10	8	16	16
Texture	-	-	Sandy Loam	Sandy Clay Loam	Sandy Loam	Loamy Sand	Sandy Loam	Sandy Loam
AB. Tier 1 Classification	-	-	Coarse	Fine	Coarse	Coarse	Coarse	Coarse

Table 2. Surface Soil Analytical Chemistry - Refined Petroleum Hydrocarbon Constituents & Lead

Parameter	Sample - Analytical Results						Regulatory Guideline[2]
	21-01	21-02		21-03		21-04	Residential/Parkland Land Uses
	@ 2.3 m	@ 1.5 m	@ 3.0 m	@ 1.5 m	@ 3.0 m	@ 1.5 m	
Benzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.046
Toluene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.12
Ethylbenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.073
Total Xylenes	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.99
CWS Fraction 1 - BTEX	<10	<10	<10	<10	<10	<10	24
CWS Fraction 2 (C10-16)	<25	<25	<25	<25	<25	<25	130
CWS Fraction 3 (C16-34)	78	62	<50	<50	<50	<50	300
CW S Fraction 4 (C34-50)	<100	<100	<100	<100	<100	<100	2,800
CW S Fraction 4G (C34-50)	<100	<100	<100	<100	<100	<100	2,800
Lead	8.2	--	--	--	--	9.3	140

Notes:

1. All values expressed as parts-per-million (ppm);
2. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines, 2019.* Lowest guidelines for course or fine grained soil provided; and
3. Values (if any) which exceed the applicable Alberta Tier 1 Guideline are highlighted.

Table 3. Subsoil Analytical Chemistry - Refined Petroleum Hydrocarbon Constituents & Lead

Parameter	Sample - Analytical Results				Regulatory Guideline[2]
	21-01			21-04	Residential/Parkland Land Uses
	@ 3.8 m	@ 5.3 m	@ 7.3 m	@ 3.8 m	
Benzene	<0.005	<0.005	<0.005	<0.005	0.046
Toluene	<0.02	<0.02	<0.02	<0.02	0.12
Ethylbenzene	<0.005	<0.005	<0.005	<0.005	0.073
Total Xylenes	<0.03	<0.03	<0.03	<0.03	0.99
CWS Fraction 1 - BTEX	<10	<10	<10	<10	30
CWS Fraction 2 (C10-16)	<25	<25	<25	<25	160
CWS Fraction 3 (C16-34)	<50	<50	<50	<50	600
CW S Fraction 4 (C34-50)	<100	<100	<100	<100	5,600
CW S Fraction 4G (C34-50)	<100	<100	<100	<100	5,600
Lead	--	3.3	6.3	7.9	140

Notes:

1. All values expressed as parts-per-million (ppm);
2. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines, 2019.* Lowest guidelines for course or fine grained soil provided; and
3. Values (if any) which exceed the applicable Alberta Tier 1 Guideline are highlighted.

Appendix C

Borehole Logs

PROJECT: Limited Phase II ESA	CLIENT: City of Edmonton	TESTHOLE NO: **21-01**
LOCATION: Portion of 9330 Groat Road NW, Edmonton, AB		PROJECT NO.: CEL-37563
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			Sand/Gravel Fill					
			FILL, fine sand, silty, clayey, compact, dry, brown, moist.		1	⊗	< 25 ppm	
1					2	⊗	< 25 ppm	1
2					3	⊗	< 25 ppm	2
			FILL, fine to coarse sand, fine to medium gravel, silty, clayey with organics, compact, dry, brown/black, moist.		4	⊗	< 25 ppm	
3					5	⊗	< 25 ppm	3
			SAND, fine to medium grained, silty, trace clay, compact, moist, brown, trace coal.		6	⊗	< 25 ppm	
4					7	⊗	< 25 ppm	4
5					8	⊗	< 25 ppm	5
6					9	⊗	< 25 ppm	6
7			End of borehole at 7.3 metres below ground level. Borehole backfilled with bentonite with drill cuttings at surface. All details provided on this borehole log are approximate.		10	⊗	< 25 ppm	7
8								

LOGGED BY: DP	COMPLETION DEPTH: 7.30 m
REVIEWED BY: DP	COMPLETION DATE: 7/22/21
PROJECT MANAGER: Pankewich	Page 1 of 1

ENVIRONMENTAL BOREHOLE LOGS CEL-37563.GPJ UMA.GDT PRINT: 8/3/21 By:pankewich@shaw.ca

PROJECT: Limited Phase II ESA	CLIENT: City of Edmonton	TESTHOLE NO: **21-02**
LOCATION: Portion of 9330 Groat Road NW, Edmonton, AB		PROJECT NO.: CEL-37563
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			Sand/Gravel Fill					
			FILL, fine sand, silty, clayey, compact, dry, brown, moist.		1	⊗	< 25 ppm	
1								1
			SAND, fine grained with fine to coarse gravel, silty, trace clay, compact, moist, brown, trace coal.		2	⊗	< 25 ppm	
2								2
					3	⊗	< 25 ppm	
3			End of borehole at 3.0 metres below ground level (Auger Refusal due to increased gravel). Borehole backfilled with bentonite with drill cuttings at surface. All details provided on this borehole log are approximate.		4	⊗	< 25 ppm	3
4								4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 3.00 m
REVIEWED BY: DP	COMPLETION DATE: 7/22/21
PROJECT MANAGER: Pankewich	Page 1 of 1

ENVIRONMENTAL BOREHOLE LOGS CEL-37563.GPJ UMA.GDT PRINT: 8/3/21 By:pankewich@shaw.ca

PROJECT: Limited Phase II ESA	CLIENT: City of Edmonton	TESTHOLE NO: **21-03**
LOCATION: Portion of 9330 Groat Road NW, Edmonton, AB		PROJECT NO.: CEL-37563
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			Sand/Gravel Fill					
			FILL, fine sand, silty, clayey, compact, dry, brown, moist.		1	⊗	< 25 ppm	
1								1
			SAND, fine grained with fine to coarse gravel, silty, trace clay, compact, moist, brown, trace coal.		2	⊗	< 25 ppm	
2								2
					3	⊗	< 25 ppm	
3			End of borehole at 3.0 metres below ground level (Auger Refusal due to increased gravel). Borehole backfilled with bentonite with drill cuttings at surface. All details provided on this borehole log are approximate.		4	⊗	< 25 ppm	3
4								4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 3.00 m
REVIEWED BY: DP	COMPLETION DATE: 7/22/21
PROJECT MANAGER: Pankewich	Page 1 of 1

ENVIRONMENTAL BOREHOLE LOGS CEL-37563.GPJ UMA.GDT PRINT: 8/3/21 By:pankewich@shaw.ca

PROJECT: Limited Phase II ESA	CLIENT: City of Edmonton	TESTHOLE NO: **21-04**
LOCATION: Portion of 9330 Groat Road NW, Edmonton, AB		PROJECT NO.: CEL-37563
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			Sand/Gravel Fill					
			FILL, fine sand, silty, clayey, compact, dry, brown, moist.		1	⊗	< 25 ppm	
1								1
			SAND, fine grained with fine to coarse gravel, silty, trace clay, compact, moist, brown, trace coal.		2	⊗	< 25 ppm	
2								2
					3	⊗	< 25 ppm	
3					4	⊗	< 25 ppm	3
					5	⊗	< 25 ppm	
4			End of borehole at 3.8 metres below ground level (Auger Refusal due to increased gravel). Borehole backfilled with bentonite with drill cuttings at surface. All details provided on this borehole log are approximate.					4
5								5
6								6
7								7
8								

LOGGED BY: DP	COMPLETION DEPTH: 3.80 m
REVIEWED BY: DP	COMPLETION DATE: 7/22/21
PROJECT MANAGER: Pankewich	Page 1 of 1

ENVIRONMENTAL BOREHOLE LOGS CEL-37563.GPJ UMA.GDT PRINT: 8/3/21 By:pankewich@shaw.ca

Appendix D

Laboratory Reports

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Report Transmission Cover Page

Bill To:	Crimson Environmental Ltd. #24 -314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37563	Lot ID:	**1507784**
		Project Name:	Hawrelak Park	Control Number:	
		Project Location:		Date Received:	Jul 22, 2021
		LSD:		Date Reported:	Jul 28, 2021
Attn:	Doug Pankewich	P.O.:		Report Number:	2644133
Sampled By:	DP	Proj. Acct. code:			
Company:	CRIMSON	Alternate Client	CA01033		

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 - Single Report	PDF	COA
Email - Single Report	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:

The information contained on this and all other pages transmitted, is intended for the addressee only and is considered confidential.
If the reader is not the intended recipient, you are hereby notified that any use, dissemination, distribution or copy of this transmission is strictly prohibited.
If you receive this transmission by error, or if this transmission is not satisfactory, please notify us by telephone.

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

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

Project ID: CEL-37563
Project Name: Hawrelak Park
Project Location:
LSD:
P.O.:
Proj. Acct. code:
Alternate Client CA01033

Lot ID: **1507784**
Control Number:
Date Received: Jul 22, 2021
Date Reported: Jul 28, 2021
Report Number: 2644133

Reference Number	1507784-1	1507784-2	1507784-3
Sample Date	Jul 22, 2021	Jul 22, 2021	Jul 22, 2021
Sample Time	NA	NA	NA
Sample Location			
Sample Description	21-01 / 2.3 / m	21-01 / 3.8 / m	21-01 / 5.3 / m
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Mono-Aromatic Hydrocarbons - Soil						
Benzene	Dry Weight	mg/kg	<0.005	<0.005	<0.005	0.005
Toluene	Dry Weight	mg/kg	<0.02	<0.02	<0.02	0.02
Ethylbenzene	Dry Weight	mg/kg	<0.005	<0.005	<0.005	0.005
Total Xylenes (m,p,o)	Dry Weight	mg/kg	<0.03	<0.03	<0.03	0.03
Methanol Field Preservation			Yes	Yes	Yes	
Volatile Petroleum Hydrocarbons - Soil						
F1 C6-C10	Dry Weight	mg/kg	<10	<10	<10	10
F1 -BTEX	Dry Weight	mg/kg	<10	<10	<10	10
Extractable Petroleum Hydrocarbons - Soil						
Extraction Date	Total Extractables		23-Jul-21	23-Jul-21	23-Jul-21	
F2c C10-C16	Dry Weight	mg/kg	<25	<25	<25	25
F3c C16-C34	Dry Weight	mg/kg	78	<50	<50	50
F4c C34-C50	Dry Weight	mg/kg	<100	<100	<100	100
F4HTGCc C34-C50+	Dry Weight	mg/kg	<100	<100	<100	100
% C50+		%	8.1	<5	<5	
Silica Gel Cleanup						
Silica Gel Cleanup			Done	Done	Done	
Soil % Moisture						
Moisture	Soil % Moisture	% by weight	18.90	9.35	5.87	

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

Bill To:	Crimson Environmental Ltd. #24 -314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37563	Lot ID:	**1507784**
		Project Name:	Hawrelak Park	Control Number:	
		Project Location:		Date Received:	Jul 22, 2021
		LSD:		Date Reported:	Jul 28, 2021
Attn:	Doug Pankewich	P.O.:		Report Number:	2644133
Sampled By:	DP	Proj. Acct. code:			
Company:	CRIMSON	Alternate Client	CA01033		

Reference Number	1507784-1	1507784-3	1507784-4
Sample Date	Jul 22, 2021	Jul 22, 2021	Jul 22, 2021
Sample Time	NA	NA	NA
Sample Location			
Sample Description	21-01 / 2.3 / m	21-01 / 5.3 / m	21-01 / 7.3 / m
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	8.2	3.3	6.3	0.1

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

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

Project ID: CEL-37563
Project Name: Hawrelak Park
Project Location:
LSD:
P.O.:
Proj. Acct. code:
Alternate Client CA01033

Lot ID: **1507784**
Control Number:
Date Received: Jul 22, 2021
Date Reported: Jul 28, 2021
Report Number: 2644133

Reference Number	1507784-1	1507784-4	1507784-8
Sample Date	Jul 22, 2021	Jul 22, 2021	Jul 22, 2021
Sample Time	NA	NA	NA
Sample Location			
Sample Description	21-01 / 2.3 / m	21-01 / 7.3 / m	21-03 / 3.0 / m
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Loam	Loamy Sand	
Sand	50 µm - 2 mm	% by weight	62	78	82	0.1
Silt	2 µm - 50 µm	% by weight	26	12	10	0.1
Clay	<2 µm	% by weight	12	10	8	0.1

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

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

Project ID: CEL-37563
Project Name: Hawrelak Park
Project Location:
LSD:
P.O.:
Proj. Acct. code:
Alternate Client CA01033

Lot ID: **1507784**
Control Number:
Date Received: Jul 22, 2021
Date Reported: Jul 28, 2021
Report Number: 2644133

Reference Number	1507784-4	1507784-5	1507784-6
Sample Date	Jul 22, 2021	Jul 22, 2021	Jul 22, 2021
Sample Time	NA	NA	NA
Sample Location			
Sample Description	21-01 / 7.3 / m	21-02 / 1.5 / m	21-02 / 3.0 / m
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Mono-Aromatic Hydrocarbons - Soil						
Benzene	Dry Weight	mg/kg	<0.005	<0.005	<0.005	0.005
Toluene	Dry Weight	mg/kg	<0.02	<0.02	<0.02	0.02
Ethylbenzene	Dry Weight	mg/kg	<0.005	<0.005	<0.005	0.005
Total Xylenes (m,p,o)	Dry Weight	mg/kg	<0.03	<0.03	<0.03	0.03
Methanol Field Preservation			Yes	Yes	Yes	
Volatile Petroleum Hydrocarbons - Soil						
F1 C6-C10	Dry Weight	mg/kg	<10	<10	<10	10
F1 -BTEX	Dry Weight	mg/kg	<10	<10	<10	10
Extractable Petroleum Hydrocarbons - Soil						
Extraction Date	Total Extractables		23-Jul-21	23-Jul-21	23-Jul-21	
F2c C10-C16	Dry Weight	mg/kg	<25	<25	<25	25
F3c C16-C34	Dry Weight	mg/kg	<50	62	<50	50
F4c C34-C50	Dry Weight	mg/kg	<100	<100	<100	100
F4HTGCc C34-C50+	Dry Weight	mg/kg	<100	<100	<100	100
% C50+		%	<5	5.9	<5	
Silica Gel Cleanup						
Silica Gel Cleanup			Done	Done	Done	
Soil % Moisture						
Moisture	Soil % Moisture	% by weight	20.50	22.80	8.28	

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

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

Project ID: CEL-37563
Project Name: Hawrelak Park
Project Location:
LSD:
P.O.:
Proj. Acct. code:
Alternate Client CA01033

Lot ID: **1507784**
Control Number:
Date Received: Jul 22, 2021
Date Reported: Jul 28, 2021
Report Number: 2644133

Reference Number	1507784-7	1507784-8	1507784-9
Sample Date	Jul 22, 2021	Jul 22, 2021	Jul 22, 2021
Sample Time	NA	NA	NA
Sample Location			
Sample Description	21-03 / 1.5 / m	21-03 / 3.0 / m	21-04 / 1.5 / m
Matrix	Soil	Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Mono-Aromatic Hydrocarbons - Soil						
Benzene	Dry Weight	mg/kg	<0.005	<0.005	<0.005	0.005
Toluene	Dry Weight	mg/kg	<0.02	<0.02	<0.02	0.02
Ethylbenzene	Dry Weight	mg/kg	<0.005	<0.005	<0.005	0.005
Total Xylenes (m,p,o)	Dry Weight	mg/kg	<0.03	<0.03	<0.03	0.03
Methanol Field Preservation			Yes	Yes	Yes	
Volatile Petroleum Hydrocarbons - Soil						
F1 C6-C10	Dry Weight	mg/kg	<10	<10	<10	10
F1 -BTEX	Dry Weight	mg/kg	<10	<10	<10	10
Extractable Petroleum Hydrocarbons - Soil						
Extraction Date	Total Extractables		23-Jul-21	23-Jul-21	23-Jul-21	
F2c C10-C16	Dry Weight	mg/kg	<25	<25	<25	25
F3c C16-C34	Dry Weight	mg/kg	<50	<50	<50	50
F4c C34-C50	Dry Weight	mg/kg	<100	<100	<100	100
F4HTGCc C34-C50+	Dry Weight	mg/kg	<100	<100	<100	100
% C50+		%	<5	<5	<5	
Silica Gel Cleanup						
Silica Gel Cleanup			Done	Done	Done	
Soil % Moisture						
Moisture	Soil % Moisture	% by weight	12.00	13.50	13.50	

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

Bill To:	Crimson Environmental Ltd. #24 -314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37563	Lot ID:	**1507784**
		Project Name:	Hawrelak Park	Control Number:	
		Project Location:		Date Received:	Jul 22, 2021
		LSD:		Date Reported:	Jul 28, 2021
Attn:	Doug Pankewich	P.O.:		Report Number:	2644133
Sampled By:	DP	Proj. Acct. code:			
Company:	CRIMSON	Alternate Client	CA01033		

Reference Number	1507784-9	1507784-10	
Sample Date	Jul 22, 2021	Jul 22, 2021	
Sample Time	NA	NA	
Sample Location			
Sample Description	21-04 / 1.5 / m	21-04 / 3.8 / m	
Matrix	Soil	Soil	

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Metals Strong Acid Digestion						
Lead	Strong Acid Extractable	mg/kg	9.3	7.9		0.1

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

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

Project ID: CEL-37563
Project Name: Hawrelak Park
Project Location:
LSD:
P.O.:
Proj. Acct. code:
Alternate Client CA01033

Lot ID: **1507784**
Control Number:
Date Received: Jul 22, 2021
Date Reported: Jul 28, 2021
Report Number: 2644133

		Reference Number	1507784-9	1507784-10	1507784-11	
		Sample Date	Jul 22, 2021	Jul 22, 2021	Jul 22, 2021	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	21-04 / 1.5 / m	21-04 / 3.8 / m	21-01 / 3.0 / m	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Sandy Loam	Sandy Loam	Sandy Clay Loam	
Sand	50 µm - 2 mm	% by weight	60	67	48	0.1
Silt	2 µm - 50 µm	% by weight	24	17	28	0.1
Clay	<2 µm	% by weight	16	16	24	0.1

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

Bill To:	Crimson Environmental Ltd. #24 -314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37563	Lot ID:	**1507784**
		Project Name:	Hawrelak Park	Control Number:	
		Project Location:		Date Received:	Jul 22, 2021
		LSD:		Date Reported:	Jul 28, 2021
Attn:	Doug Pankewich	P.O.:		Report Number:	2644133
Sampled By:	DP	Proj. Acct. code:			
Company:	CRIMSON	Alternate Client	CA01033		

Reference Number	1507784-10
Sample Date	Jul 22, 2021
Sample Time	NA
Sample Location	
Sample Description	21-04 / 3.8 / m
Matrix	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Mono-Aromatic Hydrocarbons - Soil						
Benzene	Dry Weight	mg/kg	<0.005			0.005
Toluene	Dry Weight	mg/kg	<0.02			0.02
Ethylbenzene	Dry Weight	mg/kg	<0.005			0.005
Total Xylenes (m,p,o)	Dry Weight	mg/kg	<0.03			0.03
Methanol Field Preservation			Yes			
Volatile Petroleum Hydrocarbons - Soil						
F1 C6-C10	Dry Weight	mg/kg	<10			10
F1 -BTEX	Dry Weight	mg/kg	<10			10
Extractable Petroleum Hydrocarbons - Soil						
Extraction Date	Total Extractables		23-Jul-21			
F2c C10-C16	Dry Weight	mg/kg	<25			25
F3c C16-C34	Dry Weight	mg/kg	<50			50
F4c C34-C50	Dry Weight	mg/kg	<100			100
F4HTGCc C34-C50+	Dry Weight	mg/kg	<100			100
% C50+		%	<5			
Silica Gel Cleanup						
Silica Gel Cleanup			Done			
Soil % Moisture						
Moisture	Soil % Moisture	% by weight	22.10			

Approved by:

Benjamin Morris, B.Sc
Operations 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.

Terms and Conditions: https://www.element.com/terms/terms-and-conditions

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Quality Control

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

Project ID: CEL-37563
Project Name: Hawrelak Park
Project Location:
LSD:
P.O.:
Proj. Acct. code:
Alternate Client CA01033

Lot ID: **1507784**
Control Number:
Date Received: Jul 22, 2021
Date Reported: Jul 28, 2021
Report Number: 2644133

Extractable Petroleum Hydrocarbons - Soil

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
F2c C10-C16	µg/mL	0	-10	10	yes
F3c C16-C34	µg/mL	0	-30	30	yes
F4c C34-C50	µg/mL	0	-20	20	yes
F4HTGCc C34-C50+	µg/mL	0	-20	20	yes
Date Acquired: July 23, 2021					

Calibration Check	Units	% Recovery	Lower Limit	Upper Limit	Passed QC
F2c C10-C16	µg/mL	98.53	80	120	yes
F3c C16-C34	µg/mL	99.96	80	120	yes
F4c C34-C50	µg/mL	96.43	80	120	yes
F4HTGCc C34-C50+	µg/mL	93.44	80	120	yes
Date Acquired: July 23, 2021					

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
F2c C10-C16	mg/kg	<25	<25	50	10	yes
F3c C16-C34	mg/kg	<50	<50	50	10	yes
F4c C34-C50	mg/kg	<100	<100	50	10	yes
F4HTGCc C34-C50+	mg/kg	<100	<100	50	10	yes
Date Acquired: July 23, 2021						

Matrix Spike	Units	% Recovery	Lower Limit	Upper Limit	Passed QC
F2c C10-C16	mg/kg	74	70	130	yes
F3c C16-C34	mg/kg	84	70	130	yes
F4c C34-C50	mg/kg	96	70	130	yes
F4HTGCc C34-C50+	mg/kg	93	70	130	yes
Date Acquired: July 23, 2021					

Metals Strong Acid Digestion

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Lead	µg/L	0.032828	-5.0	5.0	yes
Date Acquired: July 26, 2021					

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Lead	mg/kg	11.1	11.8	20	0.2	yes
Date Acquired: July 26, 2021						

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Lead	mg/kg	19.7	18.3	21.3	yes
Date Acquired: July 26, 2021					
Lead	mg/kg	280	200.6	318.8	yes
Date Acquired: July 26, 2021					

Mono-Aromatic Hydrocarbons - Soil

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Benzene	ng	0	-0.005	0.005	yes
Toluene	ng	0	-0.06	0.06	yes
Ethylbenzene	ng	0	-0.030	0.030	yes

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Quality Control

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

Project ID: CEL-37563
Project Name: Hawrelak Park
Project Location:
LSD:
P.O.:
Proj. Acct. code:
Alternate Client CA01033

Lot ID: **1507784**
Control Number:
Date Received: Jul 22, 2021
Date Reported: Jul 28, 2021
Report Number: 2644133

Mono-Aromatic Hydrocarbons - Soil - Continued

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Total Xylenes (m,p,o)	ng	0	-0.09	0.09	yes
Styrene	ng	0	-0.030	0.030	yes
Date Acquired: July 23, 2021					

Calibration Check	Units	% Recovery	Lower Limit	Upper Limit	Passed QC
Benzene	ng	90.76	80	120	yes
Toluene	ng	83.67	80	120	yes
Ethylbenzene	ng	89.16	80	120	yes
m,p-Xylene	ng	91.26	80	120	yes
Total Xylenes (m,p,o)	ng	91.44	80	120	yes
Styrene	ng	87.92	80	120	yes
Date Acquired: July 23, 2021					

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Benzene	mg/kg	<0.005	<0.005	50	0.010	yes
Toluene	mg/kg	<0.02	<0.02	50	0.04	yes
Ethylbenzene	mg/kg	<0.005	<0.005	50	0.020	yes
m,p-Xylene	mg/kg	<0.02	<0.02	50	0.04	yes
o-Xylene	mg/kg	<0.02	<0.02	50	0.04	yes
Total Xylenes (m,p,o)	mg/kg	<0.03	<0.03	50	0.06	yes
Styrene	mg/kg	<0.01	<0.01	50	0.020	yes
Date Acquired: July 23, 2021						

Matrix Spike	Units	% Recovery	Lower Limit	Upper Limit	Passed QC
Benzene	mg/kg	87	70	130	yes
Toluene	mg/kg	108	70	130	yes
Ethylbenzene	mg/kg	89	70	130	yes
m,p-Xylene	mg/kg	97	70	130	yes
o-Xylene	mg/kg	107	70	130	yes
Styrene	mg/kg	92	70	130	yes
Date Acquired: July 23, 2021					

Physical and Aggregate Properties

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Sand	% by weight	26	20	32	yes
Clay	% by weight	32	27	36	yes
<50 um	% by weight	74.4	67.500	82.500	yes
Date Acquired: July 26, 2021					

Volatile Petroleum Hydrocarbons - Soil

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
F1 C6-C10	ng	0	-10	10	yes
Date Acquired: July 23, 2021					

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
F1 C6-C10	mg/kg	<10	<10	50	0	yes
F1 -BTEX	mg/kg	<10	<10	50	0	yes

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Quality Control

Bill To:	Crimson Environmental Ltd. #24 -314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37563	Lot ID:	**1507784**
		Project Name:	Hawrelak Park	Control Number:	
		Project Location:		Date Received:	Jul 22, 2021
		LSD:		Date Reported:	Jul 28, 2021
Attn:	Doug Pankewich	P.O.:		Report Number:	2644133
Sampled By:	DP	Proj. Acct. code:			
Company:	CRIMSON	Alternate Client	CA01033		

Volatile Petroleum Hydrocarbons - Soil - Continued

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Date Acquired: July 23, 2021						
Matrix Spike	**Units**	**% Recovery**	**Lower Limit**	**Upper Limit**		**Passed QC**
F1 C6-C10	mg/kg	105	70	130		yes
Date Acquired: July 23, 2021						

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Methodology and Notes

Bill To:	Crimson Environmental Ltd. #24 -314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37563	Lot ID:	**1507784**
		Project Name:	Hawrelak Park	Control Number:	
		Project Location:		Date Received:	Jul 22, 2021
		LSD:		Date Reported:	Jul 28, 2021
Attn:	Doug Pankewich	P.O.:		Report Number:	2644133
Sampled By:	DP	Proj. Acct. code:			
Company:	CRIMSON	Alternate Client	CA01033		

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
BTEX-CCME - Soil	CCME	*	Reference Method for Canada-Wide Standard for PHC in Soil, CWS PHCS TIER 1	Jul 23, 2021	Element Calgary
BTEX-CCME - Soil	US EPA	*	Volatile Organic Compounds in Various Sample Matrices Using Equilibrium Headspace Analysis/Gas Chromatography Mass Spectrometry, 5021/8260	Jul 23, 2021	Element Calgary
Metals ICP (Hot Block) in soil	EPA	*	Sample Preparation Procedure for Spectrochemical Determination of Total Recoverable Elements, October 1999, 200.2	Jul 26, 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	Jul 26, 2021	Element Edmonton - Roper Road
Particle Size Analysis - GS	Carter	*	Hydrometer Method, 55.3	Jul 26, 2021	Element Edmonton - Roper Road
TEH-CCME-Soil (Shake)	CCME	*	Reference Method for Canada-Wide Standard for PHC in Soil, CWS PHCS TIER 1	Jul 23, 2021	Element Calgary

** Reference Method Modified*

References

Carter	Soil Sampling and Methods of Analysis.
CCME	Canadian Council of Ministers of the Environment
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.

Terms and Conditions: https://www.element.com/terms/terms-and-conditions

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

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: info.Edmonton@element.com
W: www.element.com

Analytical Report

Bill To:	Crimson Environmental Ltd. #24 -314 - 222 Baseline Road Sherwood Park, AB, Canada T8H 1S8	Project ID:	CEL-37563	Lot ID:	**1507784**
		Project Name:	Hawrelak Park	Control Number:	
		Project Location:		Date Received:	Jul 22, 2021
		LSD:		Date Reported:	Jul 28, 2021
Attn:	Doug Pankewich	P.O.:		Report Number:	2644133
Sampled By:	DP	Proj. Acct. code:			
Company:	CRIMSON	Alternate Client	CA01033		

Petroleum Hydrocarbons in Soil

Batch Notes

1. The method used complies with the *Reference Method for the Canada Wide Standards for Petroleum Hydrocarbons in Soil - Tier 1*, April 2001, including Addendum 1, and is accredited for use in Element.
2. Modifications of the method: See *Notes and Methodology* for nonconformances (if applicable).
3. Qualifications on results: See *Notes and Methodology* for nonconformances (if applicable).
4. Silica gel treatment is performed for fractions F2, F3, F4.
5. F1-BTEX: BTEX has been subtracted from the F1 fraction.
6. If analyzed, naphthalene has been subtracted from fraction F2 and selected PAHs have been subtracted from fraction F3.
7. F4HTGC is reported when more than 5% of the total carbon envelope elutes past C_{50}.
8. Element does not routinely report Gravimetric Heavy Hydrocarbons (F4G or F4G-sg), F4HTGC through extended range high temperature GC is reported instead.
9. When both F4(C_{34}-C_{50}) and F4HTGC are reported, F4HTGC is the final F4 that is to be used for interpreting the CWS.
10. Quality criteria met for the batch: Data is reported in Quality Control Section of report (if requested).
    -nC_6 and nC_{10} response factors (RF) are within 30% of RF for toluene
    -nC_{10}, nC_{16} and nC_{34} RFs are within 10% of each other
    -nC_{50} RF is within 30% of the average RF for nC_{10}+nC_{16}+nC_{34}
    -linearity is within 15% for each of the calibrated carbon ranges
11. Batch data for analytical quality control are available on request.
12. Extraction and analysis holding times were met: See *Notes and Methodology* for nonconformances (if applicable).

Approved by:

Benjamin Morris, B.Sc
Operations 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.
Terms and Conditions: https://www.element.com/terms/terms-and-conditions

Appendix E: Hawrelak Lake Water Quality Feasibility Study (Applied Ecological Services 2020)

Hawrelak Lake Water Quality Feasibility Study

Prepared by

APPLIED ECOLOGICAL SERVICES

Prepared for

City of Edmonton, Alberta, Canada

and

the marc boutin architectural collaborative inc.

16 December 2020

Acknowledgements

Applied Ecological Services, Inc. (AES) gratefully acknowledges the following people, who contributed to the *Hawrelak Lake Water Quality Feasibility Study*:

Mike Jenkins	City of Edmonton, Biological Sciences Technician
Bill Barr	City of Edmonton, Biological Sciences Technologist
Brittany Hogaboam	City of Edmonton, Biological Sciences Technologist
Rachel Dumont	City of Edmonton, Program Manager
Junho Kim	City of Edmonton, Engineering Technologist
Tim Smith, AAA, MRAIC	the marc boutin architectural collaborative inc., Intern Architect
Maureen Hetzler, BES MLA BCSLA	PFS STUDIO, Associate
Don Laycraft	ion irrigation inc., Certified Irrigation Designer/ Auditor/ Landscape Water Manager

We also thank City staff and other individuals on the Technical Advisory Committee for the William Hawrelak Park Rehabilitation Project. They provided valuable input at key stages in the development of the water quality feasibility study.

This report was prepared for:
City of Edmonton and **the marc boutin architectural collaborative inc.**

This report was prepared by:
Applied Ecological Services, Inc.
Kim Alan Chapman, PhD
Steven I. Apfelbaum, MS
Joseph Miller, BS, PE
Doug Mensing, MS
Lauren Jennison, BS, LEED
Eoghan O'Neill, MS

Citation: Applied Ecological Services, Inc. 2020. Hawrelak Lake Water Quality Feasibility Study. Report for the City of Edmonton and the marc boutin architectural collaborative inc. Alberta, Canada.

Table of Contents

Acknowledgements i
Purpose of This Study 1
Inventory of Data Sources 1
Summary of Existing Conditions 2
Lake Setting 2
Water Quality in the Lake 7
Potential Phosphorus Inputs to the Lake 9
City Management of Water Quality in the Lake 15
Modeling of Water Quality Issues 16
Alternative BMPs to Address Water Quality Issues 21
Preferred Alternative 24

TABLES

Table 1. Land Cover in Hawrelak Park 3
Table 2. Hawrelak Lake phosphorus concentrations in bottom sediment 12
Table 3. Soil character in the watershed of Hawrelak Lake 14
Table 4. Potential BMPs to improve water quality at Hawerelak Lake 21

FIGURES

Figure 1. Hawrelak Park drainage area (blue) and local sub-basins (green) that drain to the lake; storm sewer pipes are shown draining to the river 2
Figure 2. Hawrelak Park land cover 3
Figure 3. Hawrelak Lake east shore, with riprap and a narrow, unmowed strip of vegetation 4
Figure 4. Hawrelak Lake north shore, west of beach, with turf mowed to water 4
Figure 5. Hawrelak Lake north shore, with turf mowed to water's edge 5
Figure 6. Hawrelak Lake west shore at river water outfall, with narrow, unmowed strip of vegetation 5
Figure 7. Hawrelak Lake west shore, with small patch of native bulrushes, a marsh plant 6
Figure 8. Hawrelak Lake south shore, with turf mowed to water's edge 6
Figure 9. Hawrelak Lake water quality sampling locations, 2020 7
Figure 10. Phosphorus concentrations in Hawrelak Lake, June-October, 2020 8
Figure 11. Enterococci/Streptococci concentrations in Hawrelak Lake, June-October 2020 9
Figure 12. Hawrelak Lake south shore, with evident high density of goose droppings 10
Figure 13. Goose nesting locations on Hawrelak Lake, 2020 10
Figure 14. Geese (150-200) on Hawrelak Lake ice, October 5, 2020 11
Figure 15. E. coli bacteria levels in the N. Saskatchewan River upstream of Hawrelak Park, 2005-2019 12
Figure 16. Phosphorus concentrations in the N. Saskatchewan River above Hawrelak Park (2010-2019) (concentrations above 0.09mg/L were truncated for graph readability) 12
Figure 17. Hawrelak Lake Park soil sampling areas (1-9) 14
Figure 18. Hawrelak Lake phosphorus loading model 18

Figure 19. Total annual phosphorus loading to Hawrelak Lake from different sources 19
Figure 20. Monthly phosphorus loading to Hawrelak Lake from different sources 20
Figure 21. Potential island plantings and 25-ft buffer (emergent plants are lakeward of the buffer) 26
Figure 22. Shaded stream corridor near the southeast corner of the lake 28
Figure 23. Schematic summary of preferred alternative 29

APPENDICES

Appendix 1. Inventory of Data Sources
Appendix 2. Soil Analysis Summary, August 2020
Appendix 3. Advisory Committee Meeting Notes on Alternative BMPs

Purpose of This Study

This report summarizes existing conditions in Hawrelak Lake and its watershed for the purpose of assessing the feasibility of best management practices (BMPs) to improve water quality in the lake. Applied Ecological Services, Inc. (AES) reviewed existing information sources (Appendix 1) including data from the City and other organizations. AES also obtained recent and new digital and field data for ground elevations, infrastructure, land cover, water quality, lake sediment depth, and soils. Using this baseline information, AES worked with City staff, the Park Rehabilitation Advisory Committee and the marc boutin architectural collaborative inc. (MBAC) team to identify and evaluate approaches for improving lake water quality in the park.

The information in this water quality feasibility study will allow readers to understand how the lake ecosystem is structured and functions, and the reasons for the choice of BMPs that comprise the preferred alternative.

The City expressed a desire for three outcomes of this study and the implementation of its recommended BMPs.

- Improve water quality and create a more pleasant lake environment for visitors. City Council has inquired multiple times on how to make the lake swimmable, but several constraints exist to achieving that outcome.
- Prevent cyanobacterial blooms and, to a lesser extent, other algal blooms for International Triathlon Union (ITU) events.
- Reduce *E. coli/Enterococcus* levels in the lake. Testing has demonstrated the bacteria have a bird origin. The City is shifting its monitoring standard from *E. coli* to *Enterococcus*.

Inventory of Data Sources

A variety of water quality and climate-related studies have been conducted since the 1980s for Hawrelak Lake and the associated North Saskatchewan River. Studies of other lakes provided additional insights into how best to manage Hawrelak Lake and address its history of algae blooms, elevated bacteria levels, and other issues that degrade the aesthetics and harm the recreational value of this popular Edmonton destination. Appendix 1 describes the data sources that were used in the development of this feasibility study.

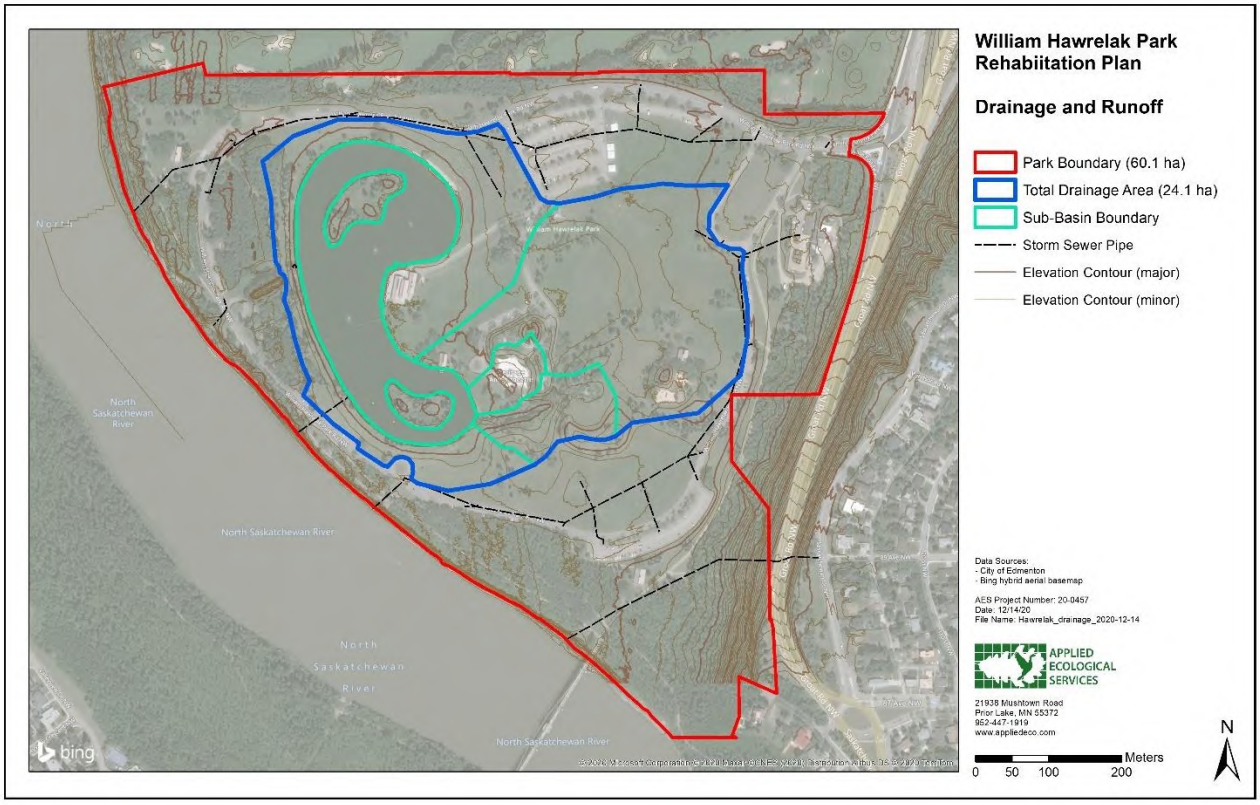
Summary of Existing Conditions

This summary is drawn from the existing data sources (Appendix 1) and new data collected to fill gaps in the understanding of the sources of lake pollution and causes of algae blooms, which are driven primarily by phosphorus. City staff were interviewed by AES and the MBAC team on May 26, 2020.

Lake Setting

- The park was a gravel pit from 1950-1967. It was graded and filled to create a "stormwater management basin" and park in the late 1960s.
- Surface soil is clay fill (20 cm to 3 m depth) over alluvial sands, gravels, and clays. Bedrock is close to the land surface in the south part of the park and 10 m below the surface in the north. A water table was detected at 1.5m below the surface in geotechnical borings near the pond-stream area southeast of the lake.
- The lake is susceptible to eutrophication due to physical factors (Figure 1).
    - It has a small drainage area (24.1 ha) primarily comprised of managed turf.
    - It is a shallow lake, 1.5m in the deepest parts. Because wind mixes the water of shallow lakes, there is no summer lake stratification—the formation of a deep cold layer of water and a shallow warm layer. Deep and shallow water are completely warmed and fully sunlit during the summer, which creates ideal conditions for algae blooms.

Figure 1. Hawrelak Park drainage area (blue) and local sub-basins (green) that drain to the lake; storm sewer pipes are shown draining to the river



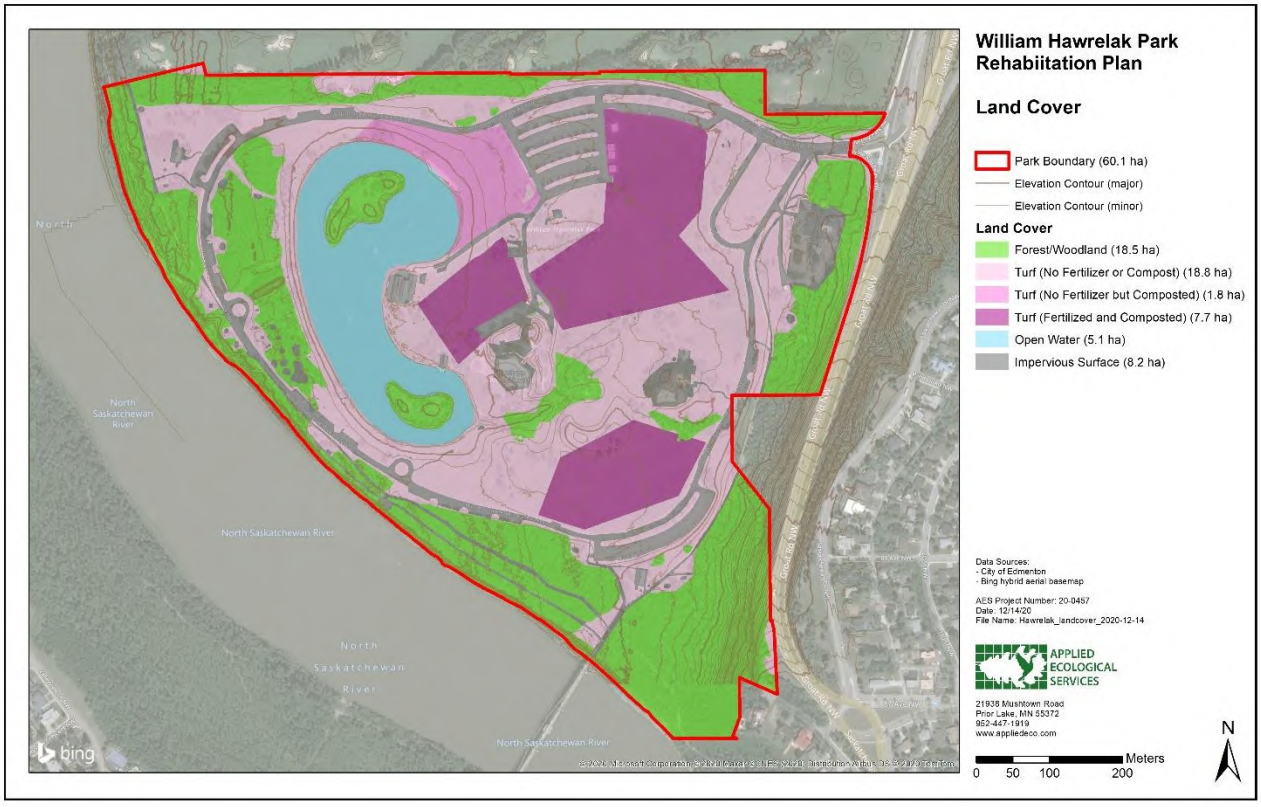
- There is little connection to groundwater due to the clay liner and depth of the aquifer. The clay liner was repaired in 1999 and 2013 when it was discovered to be leaking. Leakage indicates that the lake loses water, rather than gains it from groundwater.
- The average 1.5m lake bottom may be near the 1.5m groundwater level detected in the boring near the southeast pond-stream area, but no evidence of a connection exists.

- Nearly the entire park slopes towards the lake, but all runoff from streets, parking lots, and turf outside the ring road enters storm drains which discharge to the North Saskatchewan River. No runoff from impervious surfaces enters Hawrelak Lake, which is good for water quality.
- The park is approximately 60 ha in size. Turf comprises most of the park's land cover, with roughly equal amounts of impervious surface (pavement, buildings) and woodland (Table 1, Figure 2).

Table 1. Land Cover in Hawrelak Park

Land Cover	Area (ha)	Percent of Park
Forest/Woodland	18.5	30.8
Turf	28.3	47.1
Lake (Open Water)	5.1	8.4
Impervious Surface	8.2	13.6
Total	**60.1**	**100**

Figure 2. Hawrelak Park land cover



- There is a narrow, vegetated buffer along much of the lake edge, but little emergent vegetation. Photos taken on July 31, 2020, illustrate conditions at the lakeshore (Figures 3-8).
- The small pond and stream that drain to the lake are filled with lake water from a pump near the pavilion; the pump is managed by the City of Edmonton. The pond and stream are used as interpretive features by a volunteer organization.

Figure 3. Hawrelak Lake east shore, with riprap and a narrow, unmowed strip of vegetation

Figure 4. Hawrelak Lake north shore, west of beach, with turf mowed to water

Figure 5. Hawrelak Lake north shore, with turf mowed to water's edge

Figure 6. Hawrelak Lake west shore at river water outfall, with narrow, unmowed strip of vegetation

Figure 7. Hawrelak Lake west shore, with small patch of native bulrushes, a marsh plant

Figure 8. Hawrelak Lake south shore, with turf mowed to water's edge

Water Quality in the Lake

City staff reported that, for many years, filamentous and colonial green algae are commonly present in Hawrelak in the summer. Green algae do not pose a health risk but can make beaches and lakes unattractive. When the algae die they fall to the lake bottom and decompose, lowering oxygen levels. In 2015, blooms of blue-green algae (cyanobacteria) began. Cyanobacteria are a health risk to humans, pets, and wildlife due to the toxins they excrete.

E. coli and *Enterococcus* bacteria levels are sometimes higher than allowed for full body contact in the lake. In the 2003-2016 period, fecal coliform counts averaged 152.7 cfu/100 mL. Fortunately, genetic testing established that birds are the source of this bacteria, indicating that waterfowl are the source of bacteria in the lake.

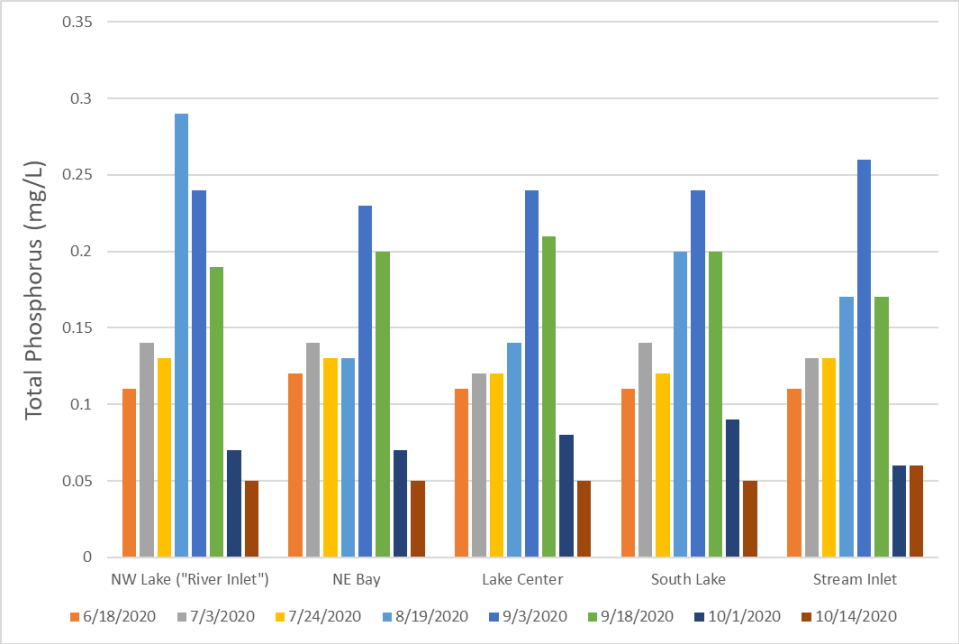
City staff began sampling water quality in the lake shortly after the master planning process began in spring 2020. Five sampling locations were chosen to represent different sections of the lake (Figure 9). Two samples were taken each month, beginning June 18 and ending October 14, 2020, after which ice formed, preventing water quality sampling. (Water quality sampling will begin again at ice-out in March or April and continue through June 2021 to complete a year's sampling.)

Figure 9. Hawrelak Lake water quality sampling locations, 2020

Water samples were collected using standard techniques and sent to a laboratory for analysis. Samples were tested for major factors related to lake eutrophication, algae blooms and water pollution: dissolved phosphorus, total phosphorus, nitrate-nitrogen, total suspended solids, *E. coli* bacteria, and fecal *Streptococci/Enterococci*.

Water quality sampling in summer 2020 detected an average of 0.14 mg/L of total phosphorus, increasing from spring into summer and decreasing in the fall (Figure 10). The five sampling locations in the lake were similar in their phosphorus concentrations, indicating that one sampling location could be used to represent the phosphorus concentration for the entire lake.

Figure 10. Phosphorus concentrations in Hawrelak Lake, June-October, 2020

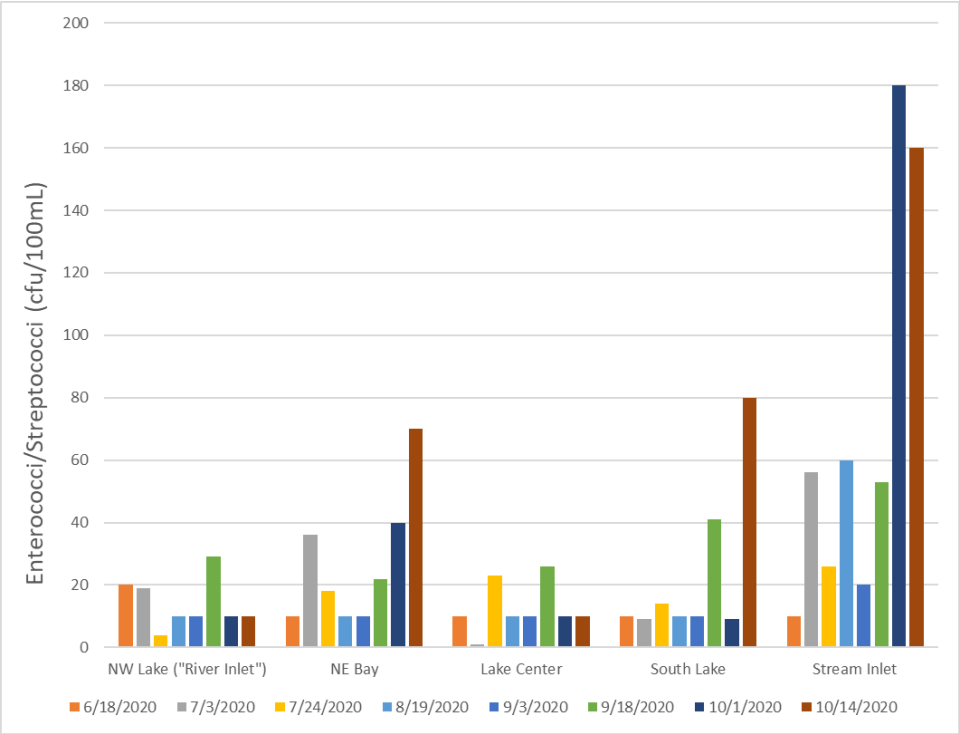


Studies suggest (Appendix 1) that, given favorable conditions, total phosphorus levels above 0.025 mg/L are associated with a greater probability of algae blooms. The average total phosphorus level in Hawrelak Lake in 2020 was an order of magnitude higher than this target concentration.

Enterococci bacteria counts in Hawrelak Lake from June-October 2020 were generally 10-20 cfu/100 mL or less, well below Canada Health's 2012 standard and the US Environmental Protection Agency's standard of <61-151 cfu/100mL for a single sample (Figure 11). This suggests swimmers could have swum in Hawrelak Lake in 2020 under conditions that met the guidance for full body immersion. In future years, however, bacteria counts could exceed the standard given the right conditions.

Enterococci counts increased in the fall, perhaps due to an increase in geese numbers as they congregated before the fall migration. Counts were especially high in the southeast lake near the pond-stream outlet. This finding is discussed in more detail below.

Figure 11. Enterococci/Streptococci concentrations in Hawrelak Lake, June-October 2020



Potential Phosphorus Inputs to the Lake

Waterfowl Feces. Geese dropping add phosphorus and nitrogen to land around lakes and deposit nutrients directly into lakes; perhaps half the droppings enter lakes while geese are floating on or flying over lakes, and half fall on the ground around the lake where geese graze and loaf (Figure 12). In 2020 City staff counted nine goose nests (Figure 13), fewer than in previous years, perhaps due to oiling of eggs as a population control measure.

For modeling phosphorus loading (see below), duck body mass was converted to goose units. Literature and AES's own data were used to estimate the quantity of droppings and phosphorus per goose. The model used counts by City staff to arrive at an estimate of 75 geese being present in all months except July, when 115 geese were counted, including young. In late October 2020, 140-150 geese were observed in the southeast park, presumably representing local geese and others that were congregating prior to migration.

Figure 12. Hawrelak Lake south shore, with evident high density of goose droppings

Figure 13. Goose nesting locations on Hawrelak Lake, 2020

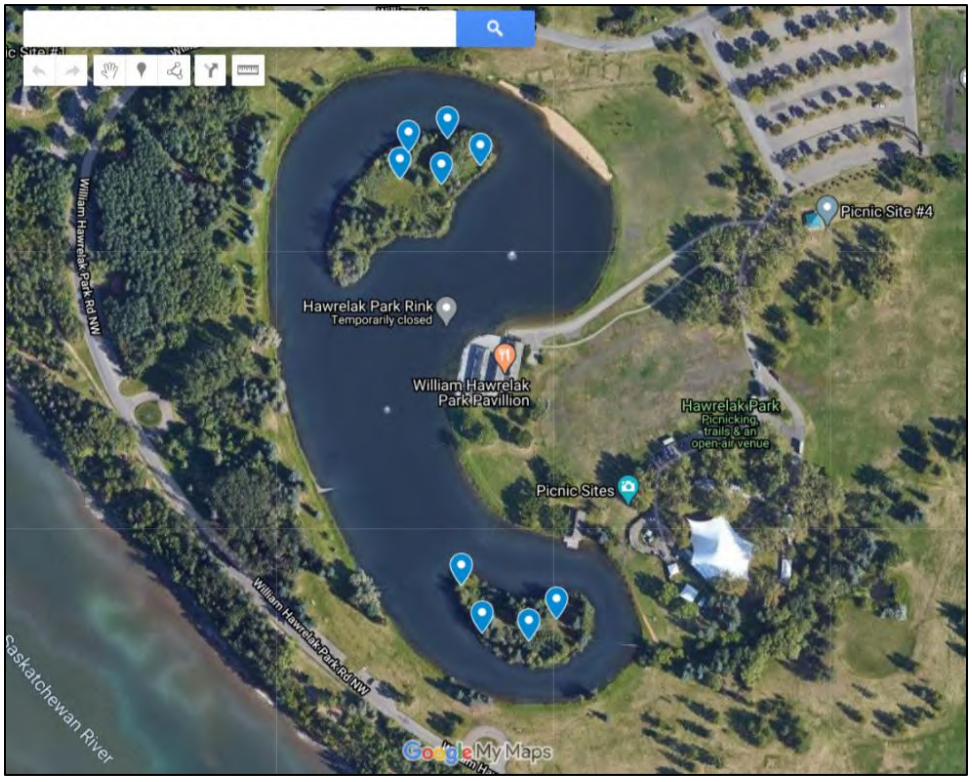


Figure 14. Geese (150-200) on Hawrelak Lake ice, October 5, 2020

Lake Sediment. Lake sediment accumulates on lake bottoms. Contributors to sediment in Hawrelak Lake are waterfowl droppings and feathers, algae that died and fell to the lake bottom, and sediment pumped into the lake from the river. The life cycle of cyanobacteria includes a dormant form (spores or akinetes) that overwinters in bottom sediment.

Removal of bottom sediment occurred in 1999 and 2013 to achieve the acceptable depth of 1.5m for the triathlon course. Sampling by City staff in 2020 established there is on average 3.5 cm of loose sediment across the lake bottom, but as much as 8 cm in some locations. If sediment was removed in 2013, roughly 0.6 cm of sediment has accumulated each year since.

In 2020, City staff also collected data on the phosphorus concentration of the sediment, using the same locations as for water quality sampling, plus four locations on the lake's west and east sides (Table 2). The average total phosphorus concentration in lake sediment was 12.4 mg/L, ranging from 3.0 in the northwest lake corner to 21.8-23.2 near the west shore of the lake.

When phosphorus containing sediment exists in a lake that freezes in winter, the lower oxygen levels in the sediment lead to the production of soluble (or dissolved) phosphorus. When ice-out occurs, the soluble phosphorus is mixed by wind and currents with the rest of the lake water, resulting in lake wide high total phosphorus concentrations until the phosphorus is consumed by plants and algae or becomes attached (adsorbed) to bottom sediment. Spring water quality sampling at ice-out in 2021 will establish whether an ice-out pulse of phosphorus occurs in Hawrelak Lake.

Table 2. Hawrelak Lake phosphorus concentrations in bottom sediment

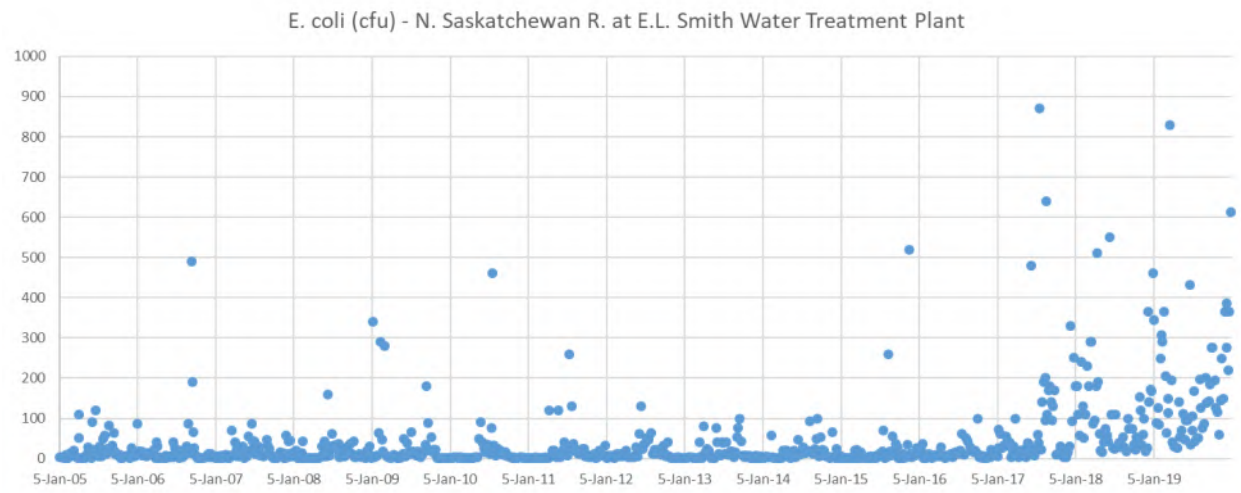
Sediment Sample	**Sed 1**	**Sed 2**	**Sed 3**	**Sed 4**	**Sed 5**
Sediment Location Name	NW Lake ("River Inlet")	NE Bay	Lake Centre	South Lake	Stream Inlet
Total Phosphorus (ml/L)	3.04	14.4	9.44	4.52	16.8
Sediment Sample	**Sed 6**	**Sed 7**	**Sed 8**	**Sed 9**	**Average**
Sediment Location Name	East Shore - North	East Shore - South	West Shore - North	West Shore - South	**Entire Lake**
Total Phosphorus (ml/L)	6.24	12.2	23.2	21.8	**12.4**

River Water. Often in June and before triathlons in summer, water with potentially high phosphorus concentrations (>0.03 mg/L) is pumped from the North Saskatchewan River to fill the lake. The pump is west of the lake near the river and the outfall into the lake is near the center of the lake's west shore.

There is also a standpipe in the lake's southwest corner which can be used, with pumping, to lower the water level in the lake.

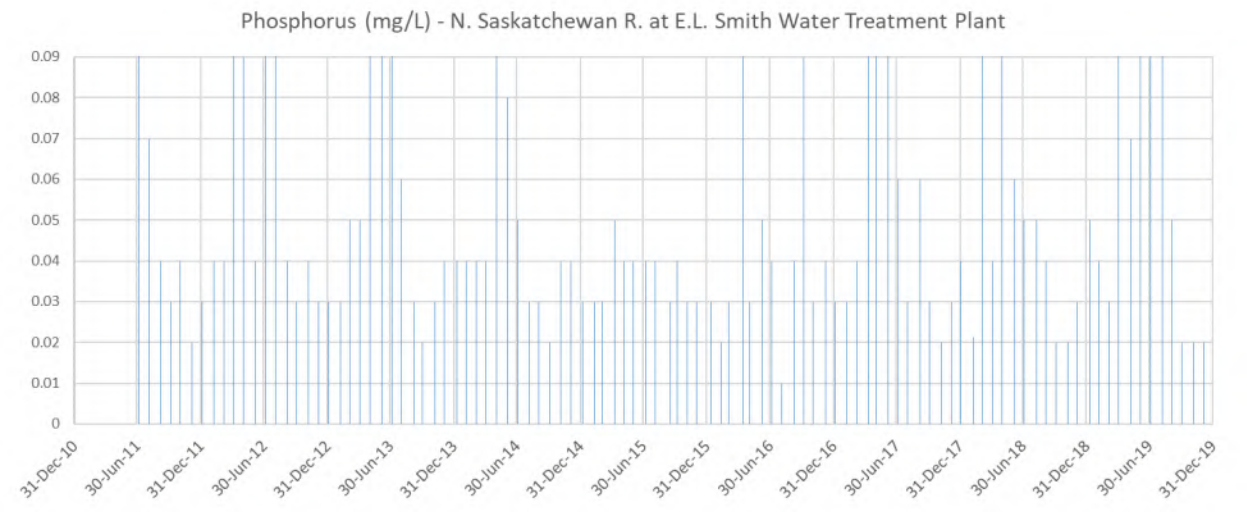
The quality of river water to fill the lake is changing and will continue to change. Climate studies detect and predict an increase in winter and spring precipitation in the region, which will increase the amount of runoff entering the river from its tributaries. *E. coli* bacteria levels in the river have noticeably increased since 2016, as detected in water quality testing at the intake of the E.L. Smith Water Treatment Facility (Figure 15).

Figure 15. E. coli bacteria levels in the N. Saskatchewan River upstream of Hawrelak Park, 2005-2019



Phosphorus levels in the river are usually higher than that at which algae blooms are likely to occur (0.02-0.03 mg/L), given warm water temperature (e.g., see Walker & Havens 1995, Carvalho et al. 2013). Only 10 percent of samples (11 of 111, 2010-2019) were below 0.03 mg/L (Figure 16). Dates and periods of high phosphorus in river samples correspond to dates and periods of elevated sediment and turbidity.

Figure 16. Phosphorus concentrations in the N. Saskatchewan River above Hawrelak Park (2010-2019) (concentrations above 0.09mg/L were truncated for graph readability)



Land Surface Runoff, including Lawn Fertilizer. Fertilizer is applied in three general locations in spring and usually fall (see Figure 2), using 40-3-3 (N-P-K) and sometimes 24-6-12 fertilizer. Near the east lakeshore, 8 bags of fertilizer and 100 cu yds of compost are applied. On lawns away from the lake, 56 bags of fertilizer and 280 cu yds of compost are applied most years. An area east of the beach receives only compost.

Soils were tested to determine character and bulk density, which can influence water quality. Appendix 2 presents the Soil Analysis Summary for the project. Nine soil testing areas of similar vegetation cover were sampled in July 2020 for chemical constituents and bulk density (Figure 17).

In each testing area, two soil samples from the top 10 cm of the soil profile were taken and mixed and one bulk density sample was obtained. Samples were sent to a laboratory that analyzed total phosphorus, total Kjeldahl nitrogen, percent sand-silt-clay and bulk density.

The total phosphorus and Kjehldahl nitrogen levels in all areas greatly exceeded typical levels in soils (Table 3, Appendix 2). This suggests the soil is a potential source of soluble phosphorus and nitrogen, which could be borne to the lake in shallow groundwater, assuming the lake's clay liner is breached or that groundwater movement is lateral rather than vertical. Sand-clay percentages indicate the soils are clay loams to loams. The dry bulk density (0.65 to 0.95), however, was consistent with loam soils.

Figure 17. Hawrelak Lake Park soil sampling areas (1-9)

Table 3. Soil character in the watershed of Hawrelak Lake

Soil Constituent	Unit	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
Texture		Clay loam	Clay loam	Clay loam	Clay loam	Clay loam
Sand	50 µm - 2 mm % by wt.	33	28	30	28	25
Silt	2 µm - 50 µm % by wt.	36	39	37	40	46
Clay	<2 µm % by wt.	31	33	33	32	29
Phosphorus	mg/kg	1340	1010	1470	1520	1050
Total Kjeldahl Nitrogen	mg/kg	7510	5700	8280	8380	7850

Soil Constituent	Unit	Soil 6	Soil 7	Soil 8	Soil 9	Average
Texture		Clay loam	Clay loam	Loam	Loam	
Sand	50 µm - 2 mm % by wt.	33	28	32	34	**30**
Silt	2 µm - 50 µm % by wt.	40	41	44	40	**40**
Clay	<2 µm % by wt.	27	31	24	26	**30**
Phosphorus	mg/kg	1060	1380	860	850	**1171**
Total Kjeldahl Nitrogen	mg/kg	6210	10000	5200	5420	**7172**

Minor Potential Sources of Phosphorus

- **Sodium Hypochlorite.** In preparation for ITU events, City staff apply on average 15,000 L (12 percent solution) of sodium hypochlorite to the lake. The actual amount ranges from several thousand to 50,000+ L, depending on the year. The effect of chlorinating the lake has been to reduce macroinvertebrate populations and eliminate limneids (snails and other gastropods)

from the lake ecosystem. Most formulations of sodium hypochlorite contain phosphorus, but the brand used by the City does not contain phosphorus.

- **Bare Soil**. Steep, bare banks around lakes are a source of phosphorus as the unstable slope angle allows soil to erode into the lake. Soil is a source of phosphorus. Photographs taken around the lakeshore on July 30, 2020 did not indicate extensive or significant bank erosion, but the high lake level may have concealed locations where banks were eroding.
- **Irrigation Water**. City staff are discussing the pros and cons of using potable City water rather than lake water for irrigating turf. At issue is the use of irrigation water from a "stormwater basin", which is the regulatory designation of Hawrelak Lake since it receives runoff from its surroundings. Irrigation water from stormwater basins must be managed to meet City and Alberta Health standards related to bacteria. Pros of irrigating with lake water are:
    - Lake water is more environmentally benign than using potable City water.
    - Lake water level can be easily and quickly lowered by irrigating turf, rather than seeking a permit to discharge to the river. High water levels can flood the Pavilion, risking damage to the heated floor, so time is of the essence when water levels must be lowered.
    - In future years, EPCOR Utilities will be required by Alberta Health to add 1 mg/mL of orthophosphate to potable water as a lead abatement strategy. This has the potential to add phosphorus to soils already rich in phosphorus.

  Pros of irrigating with potable City water are:

    - Reduced cost due to the avoided need to replace or maintain the existing irrigation pump or install an ultraviolet filtration system, which may be deemed necessary to comply with City and Alberta Health standards.
    - Public health concerns would be eliminated; management strategies, however, may also reduce public health concerns without the use of a UV filter.
- **Winter Road Safety Materials.** Because storm sewers draining impervious surfaces discharge to the river, no materials applied to roads reach the lake. Roads in the park, however, only receive sand that is swept up in spring. Small amounts of salt are applied to the ice castle's walkways but swept up after the ice melts.
- **Pet Wastes.** No pets are allowed in the park and those that bring pets in generally pick up after their pets.
- **Sanitary Sewer Leakage.** There is no sanitary sewer line running beneath or near the lake.
- **Lawn Clippings and Leaves.** Organic debris is a source of phosphorus. City turf management practices, however, generally keep lawn clippings and leaves out of the lake.

City Management of Water Quality in the Lake

The City's approach to managing water quality in Hawrelak Lake has evolved over time. Several studies have been completed to understand how best to manage water quality, in particular to prepare the lake for ITU events. A review of past City plans suggests that solutions have been directed at symptoms of poor water quality—algae blooms, high bacteria counts—rather than the root causes. The City wisely embarked on this water quality feasibility study in order to identify and address the root causes of poor water quality in Hawrelak Lake, which the City believes will lead to a holistic, ecologically based solution.

Past City solutions and practices to addressing poor water quality in the lake are:

- **Geese and Other Bird Control.** The City tested various techniques to control geese and gulls in the park and learned that hazing with dogs was most effective, but the public raised objections around concerns for animal welfare. Fencing at the lakeshore worked well because geese did not move from the lake to adjacent turf when there was this barrier. Obviously, fencing also limited people's access to and interrupted their visual enjoyment of the lake. Moving nests and geese away from the lake failed: geese simply returned to their previous haunts. Oiling eggs as a birth control measure appears to be reducing goose numbers in the nesting season.
- **Lake Sediment Removal.** Dredging the sediment in 1999 and 2013 was done for ITU events and is planned for future events to meet ITU lake depth standards. This would temporarily have reduced the amount of dissolved phosphorus released into the water at spring ice-out.
- **Reduced River Water Pumping**. The City repaired breaks in the clay liner in 1999 and perhaps 2013, which slowed leakage losses from the lake and reduced the need to pump lake water to top off the lake for ITU events.
- **Annual Application of Sodium Hypochlorite.** Since 2015, cyanobacteria blooms and elevated *E. coli/Enterococcus* bacteria levels have been observed. To manage this, each year the City now applies sodium hypochlorite—a form of chlorine—to reduce *E. coli/Enterococci* bacteria and cyanobacteria before to ITU events. Silt curtains and baffles are installed to separate the southern quarter of the lake from the northern part, where the swimmers are. The northern part is then treated. The baffles also confine paddle boats to the southern lake. After three applications over a few days, bacteria and cyanobacteria levels meet ITU event standards.
- **Invasive Aquatic Species Control.** As in many North American lakes, the invasive Eurasian water milfoil (*Myriophyllum spicatum*) is a problem at Hawrelak Lake. This species produces large amounts of vegetation in eutrophic lakes, such as Hawrelak. The vegetation prevents boaters and swimmers from moving freely. When it dies, it falls to the lake bottom and decomposes, consuming oxygen and adding to the accumulation of lake bottom sediment. The aquatic herbicide, Diquot, has been applied in mid-June to reduce Eurasian water milfoil abundance.
- **Fountains.** The three fountains on Hawrelak Lake are placed for aesthetics purposes. Fountains and other mechanical water quality improvement devices are discussed below.

Modeling of Water Quality Issues

A review of data to identify the likely sources of phosphorus loading to Hawrelak Lake identified five major sources. These sources were incorporated into a GIS- and spreadsheet-based model used to estimate the amount of phosphorus entering the lake from each source. The major sources were:

1. Waterfowl feces directly into the lake and on the ice
2. Lake sediment phosphorus release during spring ice-out
3. River water pumping to top-off the lake before the ITU
4. Land surface runoff
5. Fertilizer runoff

The following summarizes the methods used to estimate end-of-month concentrations of total phosphorus (TP) in Hawrelak Lake. The model estimates the volume of water and TP contributions from the various sources to the lake and calculates a volume-weighted average for each month starting in April 2020. The model is primarily spreadsheet based.

1. **Waterfowl Feces.** Hawrelak Lake is a natural habitat for waterfowl (primarily geese). The TP contributions from goose feces was estimated based on bird counts from the City of Edmonton, estimates of individual bird feces TP loadings, and the lake volume. Per-bird feces loadings and phosphorus content were estimated using values from an algal control study for a similar lake in Everett, Washington (Snohomish County, Washington 2020). Considering those data, it was assumed that Hawrelak Park geese weighed 4.8 kg, 2.28 percent of their body weight was deposited as feces each day, and the TP content of the feces was 1.5 percent. It was also assumed that 50 percent of all feces produced is deposited directly into the lake and the other 50 percent does not reach the lake, and that waterfowl were present from April through November.
2. **Lake Sediment Phosphorus Release.** The modeled timeframe begins in April, the typical month when ice-out occurs and soluble phosphorus is released into the water column available for algae and plant growth. Release rates were estimated from the study "Prediction of Phosphorus Release Rates from Total and Reductant-Soluble Phosphorus in Anoxic Lake Sediments" (Nurnberg 1988). Release rates for Hawrelak Lake were estimated by averaging the six highest release rates from the eight lakes in the study, or 4.6 TP/m^2/day. The model assumes that sediment TP is released only during ice-out in April and no other month.
3. **River Water Pumping.** The North Saskatchewan River, with variable TP concentrations, is used to top off the lake and meet the ITU dept requirement. This occurs around June of each year. The volume of river water pumped into the lake was estimated from data provided by the City. The summer background TP concentration of the River was averaged based on measurements taken between 2009 and 2019 at the E.L. Smith Water Treatment Plant (EPCOR 2020), approximately 12 km upstream of Hawrelak Park.
4. **Land Surface Runoff.** Runoff flows into Hawrelak Lake during medium to large storm events, with its sediment and adsorbed phosphorus, are carried downslope to the lake where mixing occurs. Historic rainfall data (Government of Canada 2020) and land use characteristics were used to estimate runoff contributions to the lake using the SCS Runoff Curve Number Method (SCS 1997 Update). Runoff-producing rainfall events occur during the months of May through September, with a July peak. The WinSLAMM model (Voorhees and Pitt 1997) was used to estimate concentrations of TP in runoff. WinSLAMM is used primarily in the Upper Midwest United States to identify and quantify sources of pollutants in urban stormwater runoff and to evaluate management alternatives for reducing pollutants.
5. **Fertilizer Runoff.** Fertilizer is applied to portions of the Hawrelak Park lawn every spring and fall (assumed to be in April and September). According to the City of Edmonton, forty-eight (48) 25 kg bags of 3 percent phosphorus fertilizer are applied for each fertilization. Based on Kussow (2004), 1 percent of the applied fertilizer is estimated to be lost to runoff. Runoff volumes

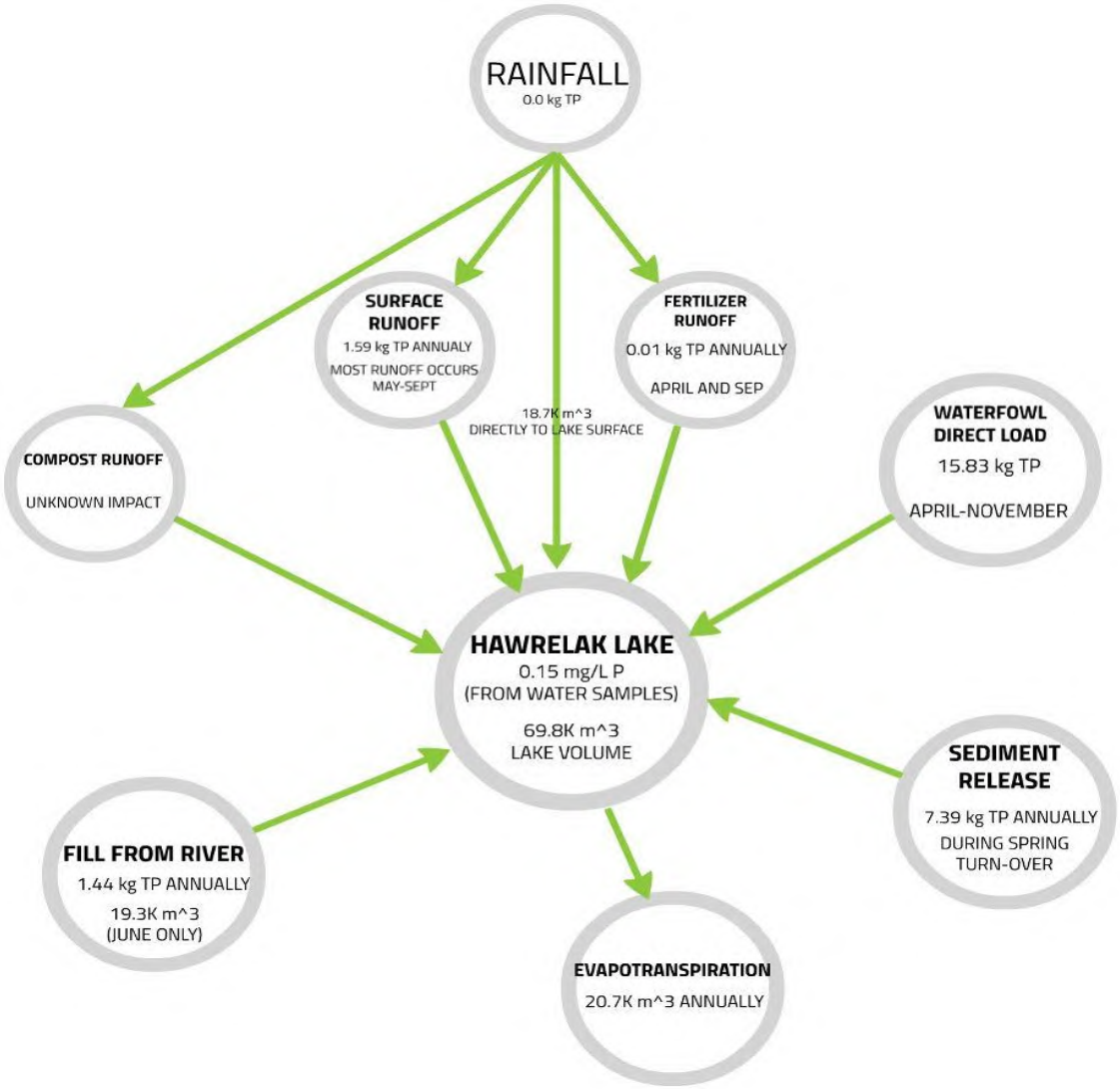
described in the previous section and TP losses in mass units were used to determine TP concentrations of fertilizer runoff to the lake.

Rainfall to Lake Surface

The model assumes the rainfall phosphorus concentration is 0.00 mg/L (Root et al. 2004) and thus makes no contribution of TP to Hawrelak Lake. Historical rainfall data (Government of Canada 2020) was used in the model to calculate the volume of rain falling directly onto the lake surface each month, diluting the TP concentration to some degree. Conversely, evapotranspiration (ET) accounts for water loss from the lake; ET was estimated from values taken from Alberta Environment and Sustainable Resource Development (2013).

The sources and amounts of phosphorus and other factors in the model are summarized in Figure 18.

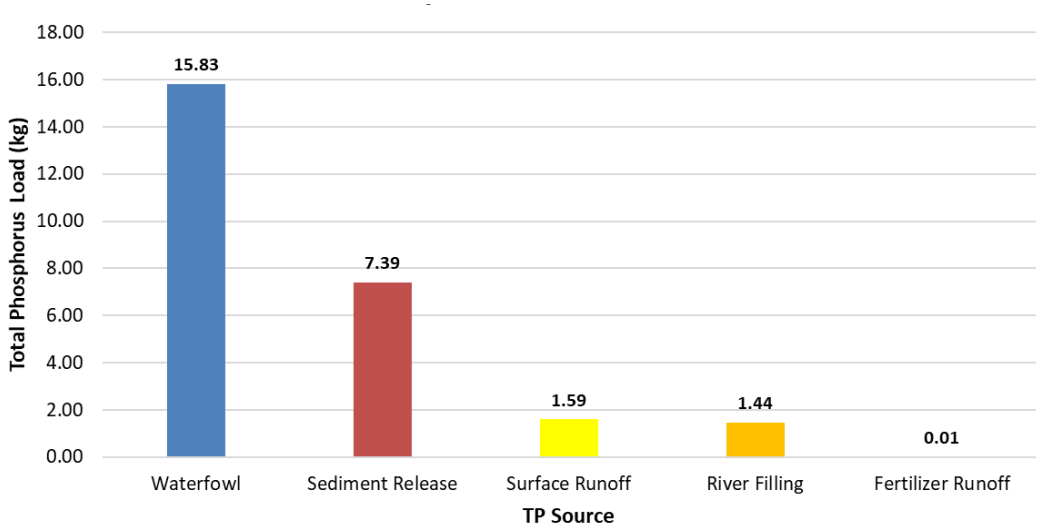
Figure 18. Hawrelak Lake phosphorus loading model



The model indicated that waterfowl droppings directly into the lake are the largest source of phosphorus to the lake (Figure 19). The release of phosphorus from the 3.5 cm of bottom sediment at spring ice-out is another large source. Together these sources contribute 23.2 kg of phosphorus, or 88.4 percent of the annual phosphorus load to the lake. For comparison, an instantaneous loading 1.74 kg of phosphorus to the lake would produce a phosphorus concentration of 0.025 mg/L, the target concentration to ensure a low chance of an algae bloom. Waterfowl and sediment loading exceed this by an order of magnitude.

Surface land runoff, filling the lake with river water, and fertilizer runoff were minor contributors overall. Pumping river water into the lake, however, has the potential to temporarily increase phosphorus concentrations in June when water temperature is rising and river flows and phosphorus concentration levels are high. In June water levels in the river tend to be higher than later in the summer due to snowmelt in the Rocky Mountains and spring/early summer rains. High phosphorus and sediment concentrations are associated with higher river levels.

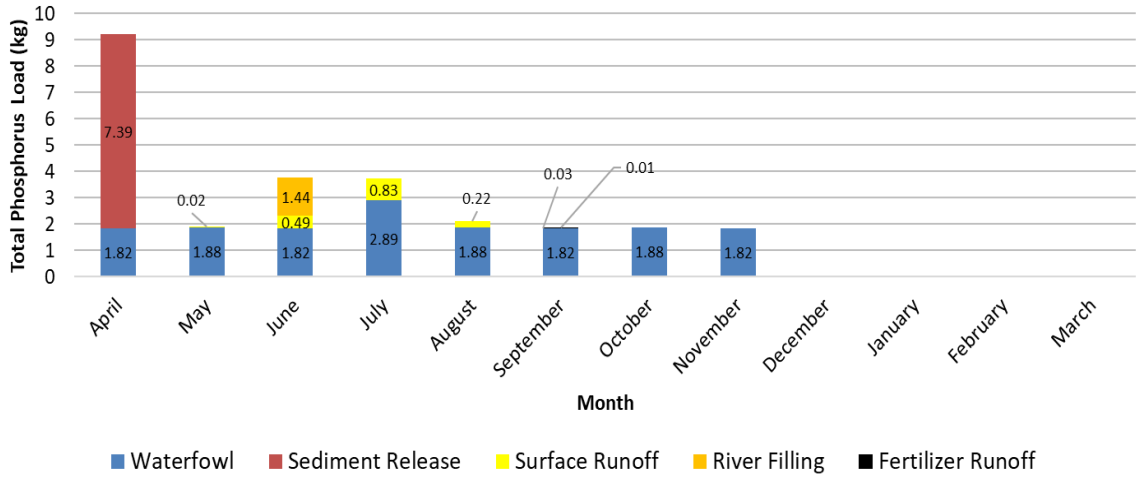
Figure 19. Total annual phosphorus loading to Hawrelak Lake from different sources



The concentration of phosphorus in the lake changes over the course of a year due to the timing of the source's effects (Figure 20). The year begins at ice-out when bottom sediment releases a pulse of phosphorus after a winter of anaerobic bacterial activity in the bottom sediment. Because water quality sampling began in June, empirical evidence of the ice-out phosphorus pulse is lacking, but is a common phenomenon in temperature zone lakes. (The City will begin sampling again at ice-out in March or April to detect this pulse.) In theory, phosphorus concentrations should be high in April after ice-out, but cold water temperatures reduce the chance of algae blooms. Unless all the phosphorus is taken up by plants, algae, and sediment, the high phosphorus concentration may carry over into later months.

Waterfowl—primarily geese, but also ducks in smaller number and size—arrive while ice is still on the lake to set up nesting territories, build nests, and court. At ice-out their droppings fall into the lake. For the remainder of the year and into the fall, even after ice forms, waterfowl drop feces over the lake.

Figure 20. Monthly phosphorus loading to Hawrelak Lake from different sources



The loading amount from waterfowl varies slightly month to month, with more waterfowl present in early summer after nesting, and again in fall as waterfowl congregate and stage in the park before migrating south. Regardless, each month the phosphorus load from waterfowl exceeds the loading of 1.74 kg that produces the target concentration of 0.025 mg/L of phosphorus in the lake.

The continuous waterfowl phosphorus inputs combined with warm lake water in August and September can stimulate blooms of microscopic colonial algae (*Scenedesmus, Desmodesmus*, etc.), which tints the water green. Filamentous green algae (*Spirogyra, Cladophora,* etc.) may form on rocks or accumulate on the surface of the lake, often driven by waves into the lake's shallows. Colonial and filamentous green algae do not pose health risks to humans or wildlife but can create unattractive conditions for swimmers. More concerning is blue-green algae, or cyanobacteria, which does pose a health risk due to excreted toxins and for which Alberta Health and Health Canada have established a swimming standard. The chance for a cyanobacteria bloom is reduced when phosphorus concentrations are below 0.025 mg/L.

Rainfall patterns affect the timing of river filling, which usually occurs in June or July. Phosphorus inputs from surface runoff and fertilized turf are affected by rainfall—summer thunderstorms having the potential to send runoff to the lake. In general, though, surface runoff and fertilizer pollution are minor sources of TP. River pumping is more influential as it can rapidly tip the balance from below 0.025 mg/L concentration to above.

Alternative BMPs to Address Water Quality Issues

In order to arrive at a preferred suite of best management practices (BMPs) to address the poor water quality in Hawrelak Lake, AES compiled all BMPs that could be applied or had been tried by the City. Aes Focused on BMPs that address sources of phosphorus in a shallow lake, rather than treating symptoms as has been recommended in past reports (e.g., continue to chlorinate the lake and install a piped velocity mixer system, as recommended by Associated Engineering (2017)). The list is organized by the categories in the model, in the order of the significance of their phosphorus loading. Goose management and lake sediment, contributing the most phosphorus, are at the top of the list (Table 4).

Table 4. Potential BMPs to improve water quality at Hawerelak Lake

BMP/Model Category	BMP Technique	TP Reduction Effect[1]	Est. Cost[2]	Comments
Goose Management	Goose hunt/other fatal actions	3	3	Potential public opposition
	Active chase by dogs, raptors	3	3	potential public opposition
	Densely plant shrubs on islands	2/3	3	Reduce area of nesting habitat
	Sound or other deterrent	?	2/3?	Unknown effectiveness of sound; birds habituate
Lake Sediment Management	Remove sediment by dredging to clay liner	3	1	City has budgeted for this
	Alum treatment	3	2	Repeat every 8-15 years
	Sediment vacuum to prairie biofilter	2	1	High labor costs
	Beneficial bacteria/enzyme application	2	1	Typically involves frequent repeat applications
Land Runoff Management	Plant shoreline buffer on land	1/2	3	Native seeding 25ft wide; aids goose management
	Plant emergent vegetation in water at lake edge	1/2	2	Live plants at water's edge; aids goose management
	Bioinfiltration/Raingarden/Bioswale	1	2	Only around buldings & plazas next to lake
	Soil Quality Restoration (SQR)	1/2	3	Apply lime, iron, organic matter, etc. Plant & harvest deep-rooted herbaceous plants
	Treat irrigation water to remove P (bioswale, etc.)	1	2	City water treated with orthophosphate for lead
Manage River Water to Fill Lake	Pump during low-turbidity/phosphorus periods	2	3	Monitor turbidity, change operations
	Level-spread water with sheetflow to lake	3	2	Use ravine; swale/berm at shoreline
	Iron-enhanced sand filter (IESF)	3	1	Use ravine & water flow paths
Fertilizer Runoff Management	Use no-phosphorus fertilizer	1	3	Soil phosphorus and nitrogen levels already are very high
Lake Water Treatment (Not in Model)	Treat pond/stream water (IESF in stream is best)	2	1	Adapt pumped lake-pond-stream system
	Diffusers/aeration	1	2	Low effectiveness in shallow lake
	Additional fountains	1	2	Do not recommend

[1] 1=low, 2=medium, 3=high

[2] 3=low, 2=medium, 1=high

The AES and the MBAC team met with City staff and the Technical Advisory Committee (TAC) for the Hawrelak Park Rehabilitation Project to evaluate potential BMPs. The TAC provided feedback (Appendix 3). AES then met with the MBAC team and the Park Rehabilitation project manager, Rachel Dumont, to follow up on the TAC discussion and define a short list of BMPs that would provide a holistic solution to the root causes of poor water quality in Hawrelak Lake.

Goose Management. Hunting, other fatal actions, and active chasing by dogs and raptors were rejected due to potential public opposition on an animal welfare basis, based on the City's past experimentation with these techniques. Sound and other sensory deterrents were rejected due to their unknown effectiveness.

Lake Sediment Management. The City previously rejected alum treatment due to high cost, temporary effects, and questions around the long-term effect of adding aluminum to the lake. The City previously rejected the application of beneficial bacterial and enzyme applications as not appropriate for Hawrelak Lake. Considerations included cost, its temporary nature, and the regulatory requirements of adding

bacteria to public waters. Vacuum removal of sediment was rejected due to logistical challenges and novelty of the approach; while it is being tried elsewhere, more needs to be learned about cost, effort, and effects.

Land Runoff Management. While not rejected as a BMP for the park, biofinfiltration methods—raingardens, infiltration basins, bioswales—are best used in this project to reduce phosphorus and other pollutants that originate at the Pavilion and boat rental area. The MBAC team will develop this BMP as it refines landscaping plans for these locations.

Soil Quality Restoration (SQR) improves turf quality and reduces the need for fertilization and irrigation, but because runoff contributes little to the lake phosphorus loading and can be addressed by other BMPs that provide multiple benefits (see shoreline buffer/emergent planting below), it is not a recommended BMP to address poor water quality. On the other hand, improving the quality of soil in Hawrelak Park may be good in its own right and reduce the need for fertilization and irrigation of turf. (For methods to improve turf, see Appendix 2.) Irrigation water from the lake, which is high in phosphorus, has the potential to return to the lake in overland and subsurface lateral flow. However, the distance between most irrigated areas and the lake, the judicious use of irrigated water, the high potential cost of removing phosphorus before irrigation, and other reasons discussed, removes this BMP from further consideration.

Manage River Water to Fill Lake. Picking the right time to pump low-phosphorus river water into the lake requires planning and daily monitoring. City staff initially balked at this challenge, given existing responsibilities. The alternative to timing river water pumping during ongoing park operations is to construct a surface phosphorus management structure for river water. AES proposed moving the outfall of the pumped river water to the head of a small ravine on the west side of the lake, and constructing a series of water quality treatment cells in the ravine with a level spreader along the lakeshore that would further treat river water and allow diffuse infiltration and overflow along the lake's west side (see Appendix 3 for details). As a further measure, an iron-enhanced sand filter that removes phosphorus would be installed. The costs and ongoing maintenance of this set-up were rejected as more onerous than asking City staff to develop a plan to monitor river water and time its pumping to both meet the lake level requirements for ITU events and the need to pump only low-phosphorus river water.

Fertilizer Management. The City already uses a low phosphorus fertilizer. Given the high phosphorus content of the soil, a lower phosphorus fertilizer may still be appropriate. In combination with SQR, the need for fertilizer on an annual basis may be reduced. It is not the charge of this water quality feasibility study to evaluate the need for SQR or advance methods to achieve it.

Lake Water Treatment. Initially City staff and the Advisory Committee proposed using the pond-stream system to recirculate and clean lake water. On further consideration, it was understood that this would treat a small volume of water at high cost. While evaluating this BMP, however, it was discovered that *Enterococci/Streptococci* bacteria levels in the southeast corner of the lake near the pond-stream outlet rose significantly in late summer and fall of 2020, greatly exceeding the regulatory standard. For this reason, the focus on the pond-stream system changed from phosphorus removal to reducing bacteria. Details are discussed elsewhere. Other in-lake water treatment options, including those not listed, were

rejected. For instance, an algicide addresses the symptoms, not the cause, of poor water quality and introduces a chemical to the lake that is not necessary if other BMPs are employed.

Diffusers, Aeration Devices, and Fountains. Aeration and mixing of lake water by mechanical devices has been offered as a way to reduce phosphorus concentration in surface waters and increase rates of sediment decomposition and phosphorus consumption by lake biota. However, Hawrelak Lake's shallow depth enables wind to mix the water, resulting in a relatively homogeneous waterbody, as seen in the similar TP levels across the lake throughout the growing season. Because the water is uniform in phosphorus concentrations and likely temperature and oxygen levels, the reason to install these devices is eliminated.

Details on the effectiveness of these devices is provided despite their lack of utility at Hawrelak Lake. Manufacturers of fountains and diffusers state that these systems improve water quality, empirical studies supporting such statements are sparse. AES conducted a literature review of mechanical water quality devices and concluded they have limited to no value for water quality improvement in most applications. A large amount of equipment is required to treat a large volume of water and achieve the minimal benefits these devices purport to deliver.

Fountains primarily function as a water feature that some find appealing. Fountains typically recirculate water, drawing water from near the surface and spraying it into the air. This provides some aeration of local surface water but does little to aerate most of a basin's water volume, including deeper levels where aeration would be most beneficial. Fountains and diffusers can agitate the water surface and push algae or vegetation away from the spray/bubble zone. Fountains may limit the breeding of some mosquito species and reduce potentially toxic bloom of blue-green algae (cyanobacteria) in small ponds, but it is not clear if such benefits would be realized in Hawrelak Lake.

Diffusers are more efficient than fountains in reducing thermal and chemical stratification and improving dissolved oxygen levels. Higher dissolved oxygen levels in lakes can reduce winter fish kill, increase aerobic microbial decomposition, and increase fish biomass in a pond. Increasing dissolved oxygen throughout a pond can also increase aerobic microbial activity, which reduces the production of hydrogen sulfide by bacteria that do well in low-oxygen environments (anaerobic bacteria). If diffusers are used, fine-bubbled diffusers are more economically efficient than coarse-bubbled diffusers. They have limitations, however, as filters of fine-bubbled diffusers need periodic cleaning and are slower at improving dissolved oxygen levels. If used, diffusers should be elevated above the bottom of the basin in order to limit basin bottom erosion and disturbance of bottom sediments.

In summary, fountains are not a method to achieve water quality improvement. Diffusers may be most useful in deep basins that experience stratification, winter fish kills, lack aquatic species diversity, or emit offensive odors, but are most effective in ponds not lakes. The shallowness of Hawrelak Lake suggests that diffusers would provide little benefit and, moreover, would treat a symptom, not the cause of poor water quality.

Preferred Alternative

On September 17, 2002, the TAC met with the consultant team to discuss irrigation, review the results of the phosphorus loading model, and discuss proposed best management practices (BMPs) for improving water quality in Hawrelak Lake (Appendix 3). On 30 October, 2020, AES and MBAC team met with the City's project manager Rachel Dumont, to refine the conclusions of the TAC so that a cost estimate could be prepared for BMPs that are most likely to be implemented, given park user preferences, the ease of implementation, and the operations and maintenance burden placed on City staff (Table 5).

Table 5. BMPs in Preferred Alternative with Estimated Phosphorus Reduction and Cost

BMP/Model Category	BMP Technique	TP Load Reduction Potential[1]	Likely Install'n. Cost[2]	Likely O&M Effort[3]	Notes
Goose Management	Monitor & remove nests	3	3	2/3	Potential public opposition
	Densely plant shrubs on islands	2/3	3	3	Reduce area of nesting habitat
Lake Sediment Management	Remove sediment by dredging to clay liner	3	1	3	City has budgeted for this; repeat every 5-10 years
	Deepen lake to 2m by excavating below clay liner	2	1	3	Dredge from 1.55m average to 2m average (ITU dive entry depth)
Manage River Water to Fill Lake	Fill lake when turbidity & phosphorus levels are low	2	3	1/2	Monitor in real time E.L. Smith Water Treatment Plant data
Land Runoff Management	Plant shoreline buffer on land	1/2	3	3	Native seeding; 25 ft width; aids goose management
	Plant emergent vegetation in water at lake edge	1/2	2	3	Live plants at water's edge; aids goose management
	Bioinfiltration/Raingarden/Bioswale	1	2	2/3	Only around buildings & plazas next to lake
Fertilizer Runoff Management	Use no-phosphorus fertilizer	1	3	3	Soil phosphorus and nitrogen levels are already very high
Bacteria Management (Not In Model)	Re-landscape & dredge pond & stream area	2/3	2	2/3	Sunlight (UV) reaching pond & stream bottom kills bacteria
	Landscape taller plants/shrubs in staging area near pond	2/3	3	3	100-200 geese stage here in fall; aids goose management

[1] Load Reduction Potential. 3=high, 2=medium, 1=low
[2] Likely Installation Cost. 3=low, 2=medium, 1=high
[3] Likely O&M Effort. 3=low, 2=medium, 1=high

Goose and Lake Sediment Management. The largest sources of phosphorus to the lake are geese and the release of phosphorus at ice-out, accounting for nearly 90 percent of the annual load. While phosphorus release occurs in the spring, it sets the lake up for high phosphorus levels all summer long because geese contribute enough each month to exceed the 0.025mg/L target, below which chances for an algae bloom are greatly reduced. Managing the goose population and removing the average 3.5cm of sediment from the lake bottom are the top priorities to improve water quality in the lake.

Steps to achieve this are summarized below.

- **Monitor and remove nests.** It is relatively easy to monitor and remove nests at the lake edge by foot or canoe. Monitoring must begin while ice is still on the lake in March and early April.
- **Densely plant shrubs on islands.** This will make the island nesting habitat a poor nesting habitat option for most geese, though they may attempt to nest at the edges of islands or along the

mainland shore. (Shoreline plantings discussed below will further discourage geese nesting.) Shrubs will also discourage people from visiting the islands.

- **Remove sediment by dredging to clay liner**. The City is planning and budgeting, to accommodate ITU events, the removal of the sediment from the lake bottom. Controlling geese, preventing algae blooms, and adding river water with no sediment (see below) will lengthen the time between dredging events. Rather than dredge every 5-10 years, perhaps that would occur once every 20-30 years.
- **Deepen lake to 2m.** In discussions with City staff, it was proposed that deepening the lake to 2m—i.e., about 0.5m deeper than the current 1.5m average—would a) increase lake volume, which would reduce phosphorus concentrations given current loading, b) establish the 2m required depth for a triathlon dive entry, and c) lower the lake level, which would help reduce flooding of the pavilion (assuming no groundwater enters the lake due to its clay liner and groundwater depth). This water quality study was not scoped with evaluating the feasibility of this proposal. However, a cost estimate to deepen the lake is provided, assuming 0.5m of material are removed, the clay liner is removed and stockpiled, and the liner replaced with clay added to account for loss and the increased lake bottom surface area. There are several unknowns in this proposal. What material lies below the current lake bottom? Can a 2m lake water depth be maintained while simultaneously protecting the pavilion from flooding? Other unknowns exist, such as groundwater level relative to the potential 2m lake bottom depth.

River Water Management

Phosphorus in river water is a lesser source of phosphorus to the lake than geese and bottom sediment, but when it is pumped to top off the lake for ITU events, it can increase the phosphorus level above the 0.025 mg/L target, raising the chance that an algae bloom will occur afterwards. Pumping river water when phosphorus and sediment levels are low requires monitoring levels in the river daily and anticipating when the lake will need to be topped off to accommodate an ITU event. Daily phosphorus and sediment river data are available from the E.L. Smith Water Treatment Facility just upstream of Hawrelak Park. A City employee would need to be assigned to monitor river conditions and lake water levels and decide when to pump river water into the lake. A water level monitoring device can be installed in the lake which the employee could monitor, along with rainfall, temperature and humidity, to decide generally the week when pumping should occur. The actual date of pumping within that week can be decided based on river conditions. Generally, in April-June river sediment is high and phosphorus is well above the 0.025mg/mL target. The July-August period has lower phosphorus levels, usually 0.02-0.04 mg/L, but some days have higher levels than others. Pumping would occur on a day when the phosphorus concentration is closer to the 0.025 mg/mL target.

Land Runoff Management

Phosphorus loading from surface runoff is the next largest contributor, but not much more than pumped river water. BMPs for runoff are relatively low cost to implement and have a low ongoing maintenance cost compared to more engineered water quality improvement solutions.

- **Plant shoreline buffer on land.** In this BMP a diverse mix of perennial, deep-rooted plants are seeded in a strip from the water's edge and inland 25 feet (Figure 21). Plowing the lake for

winter skating and piling and moving snow on the shoreline buffer will not affect the vegetation. The buffer will make the shoreline less attractive to geese, reduce goose droppings around the lakeshore, and filter runoff from nearby mowed turf. This BMP will serve a dual purpose: filtering overland runoff and making the shoreline less attractive to geese, which would reduce the amount of goose droppings near the lake. The public reaction to taller vegetation around the lakeshore will dictate feasibility.

- **Plant emergent vegetation in water.** In this BMP, a mix of native aquatic species is installed as live plants, from the water's edge generally out to 3 feet. Chlorination for ITU events will not affect the vegetation if plant species are chosen for chlorine tolerance. A dense emergent planting will discourage goose nesting at the shoreline. The public reaction to taller vegetation around the lakeshore will dictate feasibility.

Figure 21. Potential island plantings and 25-ft buffer (emergent plants are lakeward of the buffer)

- **Bioinfiltration practices**. No storm sewers from pavement and parking areas discharge to the lake, eliminating that source of phosphorus and other pollutants. The pavilion and boat rental area, however, have rooftop and paving that discharges untreated to the lake. This is a minor source of phosphorus loading, less than any of the sources discussed. On the other hand, installing bioinfiltration practices would model good runoff management. During park renovation, bioinfiltration practices, such as raingardens and bioswales, could be incorporated into the landscaping around the pavilion and boat rental area to remove phosphorus from local runoff before it reaches the lake.

Fertilizer Runoff Management

Fertilizer is widely applied in judicious fashion to discrete turf areas in the park, mostly distant from the lakeshore. As soils in the park already have excessive amounts of phosphorus, switching to a lower phosphorus fertilizer may be appropriate.

In some settings over winter, dissolved phosphorus in soil pore water generated under winter anaerobic conditions may move laterally in shallow groundwater into lakes and streams. If this were occurring at Hawrelak Park, the clay liner around the lake would be a barrier to shallow groundwater moved to the lake from the surrounding landscape.

If desired, the high phosphorus levels in the soil can be reduced by the addition of lime and iron. Under the higher alkaline conditions created by the lime addition, phosphorus binds more readily to iron and soil, which reduces the rate of dissolved phosphorus formation. It may be worthwhile to consider an overall program of soil health improvement that benefits turf growth, rather than focusing on the contribution of phosphorus in subsurface runoff from turf areas to the lake.

Bacteria Management

In general *Enterococci/Streptococci* bacteria counts in Hawrelak Lake water samples in summer, 2020 did not exceed USEPA water quality standard of 61 cfu/100 mL in any one sample (Figure X). (Canadian standards could not be applied as the lab samples were reported in units that do not coincide with the Canadian standard.) Water quality sampling in October, however, detected high counts of *Enterococci/Streptococci* bacteria in the southeast corner of the lake, near the outlet of the stream draining the artificially maintained pond. In addition, bacteria levels were consistently higher here than elsewhere for all water quality samples.

The source of the bacteria is unknown but may be related to the large number of geese that appear to be staging nearby before migrating south. A bacteria source in the pond or stream sediment also could explain the higher bacteria counts here. The stream corridor is shaded. Bacteria are known to persist, once established, in the bottom sediment of shaded streams and be moved downstream in flowing water, especially after storms. Whatever the source, water pumped from the lake through the pond-stream system may be associated with the spike in bacteria counts near the stream outlet to the lake. For that reason, measures that address these two potential sources of bacteria are proposed.

- **Re-landscape and dredge the pond and stream area.** If the pond-stream system harbors bacteria, and if the bacteria are not killed in winter when water is no longer pumped from the lake to the pond, exposing the pond bottom and streambed to ultraviolet radiation in sunlight could kill bacteria in the sediment. The stream, however, is shaded, reducing the amount of sunlight reaching it (Figure 22). Measures to expose the stream to sunlight would include selectively thinning the tree canopy and understory and planting trees away from the stream to compensate for canopy loss. Dredging the pond and stream of sediment could remove that potential source of bacteria. This work could be incorporated into landscaping plans for the Pavilion and vicinity. Before proceeding, the presence and abundance of bacteria in the pond bottom and streambed sediments should be evaluated.

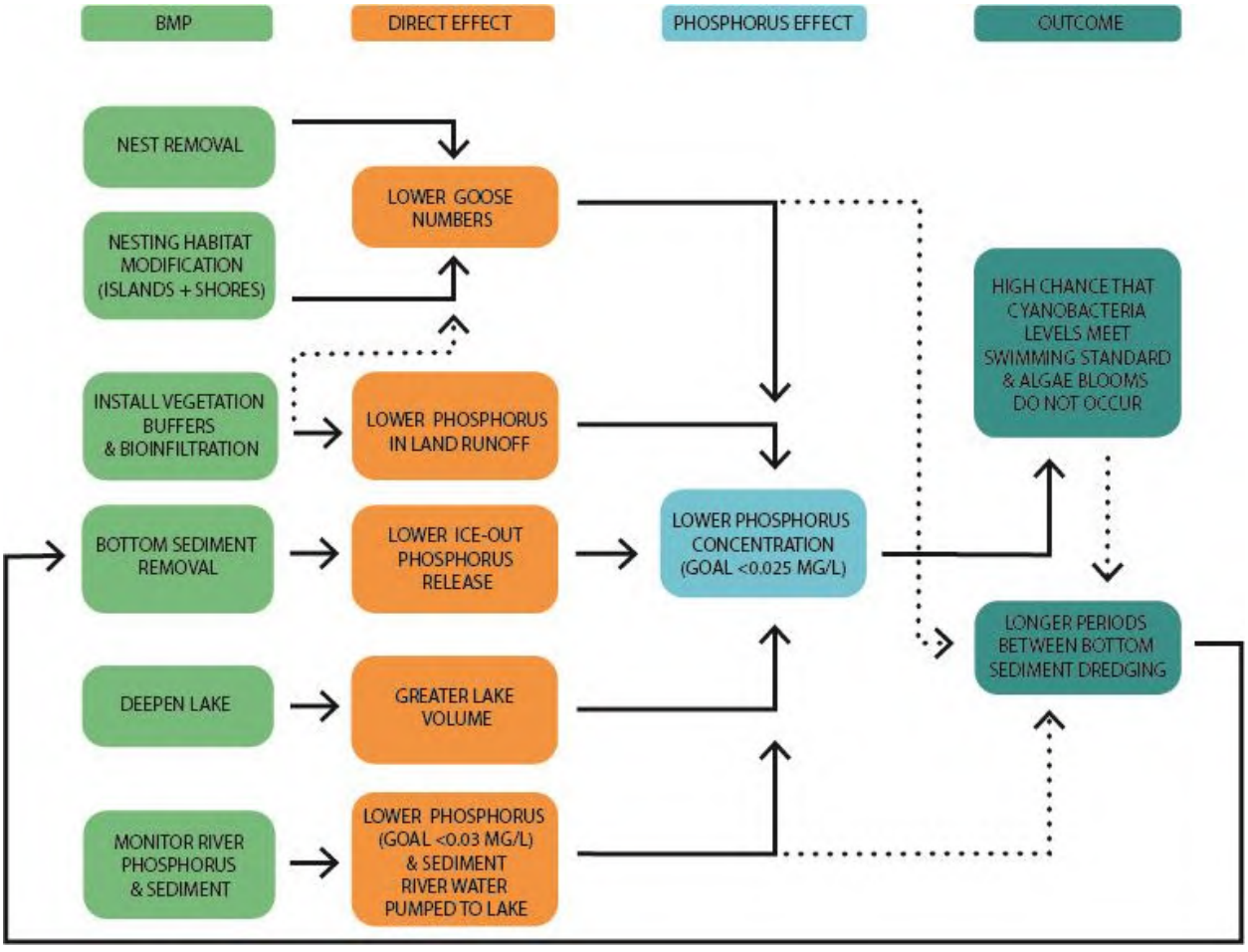
Figure 22. Shaded stream corridor near the southeast corner of the lake

- **Landscape with taller plants and shrubs in staging area near pond.** Before migrating south, large numbers of geese apparently stage in the park, including near the pond, grazing on turf grass and roosting and loafing on the lake and lake ice. While geese graze in different areas of the park, grazing near the pond-stream location may contribute to high bacterial counts in the lake. Increasing the height of vegetation and planting shrubs will create habitat that is not useful or attractive to geese. The boundaries of the taller vegetation area would be integrated with overall landscaping and programming plans for the park.

Summary of Preferred Alternative

The preferred alternative addresses the two largest sources of phosphorus—geese and sediment (Figure 23). It also addresses a large summer contributor of phosphorus—river water pumping. Sediment dredging is an expensive initiative that the City intends to execute for other reasons. The recommended nest removal and vegetation planting to deter geese from nesting on the islands and lakeshores are low-cost practices that should be used in combination to ensure maximum effectiveness. This approach also requires a consistent and creative program of public education and stakeholder mobilization in order to overcome some public preference to not manage the goose population. Operations and maintenance would largely consist of vegetation management and the annual sweep to remove nests.

Figure 23. Schematic summary of preferred alternative



Pumping low-phosphorus river water has great potential to reduce phosphorus loading to the lake at low cost. This necessitates that a City employee be designated who will establish a protocol, monitor river and lake conditions, and make the decision to pump during low-phosphorus periods in the river and in time to fill the lake for ITU events.

Installing a vegetation buffer and emergent planting at the shoreline will treat runoff from adjacent turf and discourage the use of the shoreline and its vicinity by geese. (The City's fencing experiment showed the benefit of barrier between the lake and turf, which a vegetated buffer would also achieve.) This is a low-cost practice with the benefit of largely eliminating phosphorus from goose droppings near the lake. Once established, operations and maintenance of the vegetated buffer would consist of annual inspection and control of invasive and noxious weeds. Improving soil health may be more beneficial for turf management than to reduce the amount of phosphorus reaching the lake in shallow groundwater, given the lake's clay liner.

Water quality sampling revealed that the southeast lake corner experiences high bacteria counts, possibly connected to the artificially maintained pond-stream system and associated with use of the area by geese. The overall landscaping plans for the park could incorporate tree canopy and understory management to increase sunlight reaching the sediment of the pond bottom and streambed, and planting of taller vegetation to discourage geese from staging near this area.

Appendix 1. Inventory of Data Sources

Citation	Source	Description
AECOM. 2014. Tier 2 Risk Assessment: Hawrelak Park- Final. Project # 60330705 (401)	Report	This is a Tier 2 risk assessment for a proposed water park. The gravel pit operated 1950-1967. The park was created by grading and filling with clay soil. Soil tests indicated that Alberta's Tier 1 guidelines for soil remediation would be met. Bedrock is near the surface in the south park--sandstone, mudstone, shale, with scattered bentonite and coal beds. Alluvial sands and gravels are present. The fill is primarily clay and varies from 20cm to 3m. A water table was detected at 1.5m depth near the stream-pond area and in the bedrock, and at 10m depth in the north; discharge of groundwater to the river is expected, rather than to the lake which higher than the groundwater table.
Alberta Environment and Sustainable Resource Development. 2013. Evaporation and Evapotranspiration in Alberta. Alberta, Canada.	Report	Provides data regarding evaporation and evapotranspiration rates for Alberta, including a volume specific to the Edmonton region.
Applied Ecological Services, Inc. 2020. Wm Hawrelak Park Lake: Water Quality in Aerial Photos 2004-2017.	Powerpoint	Series of aerial photographs of Hawrelak Lake from Google Earth illustrating change in lake water color from nearly black to light green, depending on the amount of algae growth in the lake.
Associated Engineering. 2017. Hawrelak Lake Algae Remediation Phase 2 - Concept Development. Project # 2016-3835.	Report	Focused on reducing fecal bacteria and cyanobacteria by physical, biological and chemical means. After evaluating all treatment options, recommended actions were to use multiple controls to control cyanobacteria in lake sediment and use sodium hypochlorite to control blooms. To control bacteria, control wildlife inputs, remove or degrade organic matter with dredging and aerators/mixers, and apply disinfectants. In the long term, the study recommended dredging, lining with a synthetic material, and installation of a piped velocity mixer system on the lake bottom.
Carvalho, L., McDonald, C., de Hoyos, C., et al. 2013. Sustaining recreational quality of European lakes: minimizing the health risks from algal blooms through phosphorus control. Journal of Applied Ecology 50:315–323.	Journal	Studying 800+ European lakes, the researchers suggested that concentrations of total phosphorus above 0.02 mg/L (20 µg/L) were associated with cyanobacteria blooms exceeding the WHO's low and medium risk thresholds in medium and high-alkalinity lakes. Other factors influence cyanobacteria blooms, such as nitrogen level.
City of Edmonton. 2020. Water Quality Sampling of Hawrelak Lake. Edmonton, Canada.	Excel Sheets & Lab Reports	Two grab samples taken twice each month (June through October 2020) from five sampling locations in the lake. Water samples analyzed for major factors related to lake eutrophication, algae blooms and water pollution: dissolved phosphorus, total phosphorus, nitrate-nitrogen, total suspended solids, E. coli bacteria, and fecal *Streptococci/Enterococci.*

Citation	Source	Description
City of Edmonton. 2020. Soil and Sediment Chemistry & Bulk Density Sampling of Hawrelak Park. Edmonton, Canada.	Excel Sheets & Lab Reports	Nine upland soil testing areas sampled and analyzed for total phosphorus, total Kjeldahl nitrogen, percent sand-silt-clay and bulk density. In addition, lake bottom sediment was sampled from the same locations used for water quality sampling plus four additional locations on the west and east sides of the lake. Sediment samples were analyzed for phosphorus concentration.
City of Edmonton. 2020. Bacteria Counts at Hawrelak Lake. Edmonton, Canada.	Excel Sheets	"Fecal bacteria" samples from Hawrelak Lake 1999-2019, with a focus on testing along the triathlon route
City of Edmonton. 2020. Lawn maintenance activities. Edmonton, Canada.	Map	Spring and usually fall applications; near east lakeside apply 8 bags fertilizer and 100 cu yds. compost; on lawns away from lake to east apply 56 bags fertilizer and 280 cu yds. compost
City of Edmonton. 2020. LiDAR data for Hawrelak Park. Edmonton, Canada.	Digital Data	Bare-ground LiDAR data from City used to create 6 cm contour intervals in park, establish watershed boundaries, and determine surface flow paths.
City of Edmonton. 2019. William Hawrelak Park Rehabilitation Implementation Plan. No. 930731 RPK No. 1818. Edmonton, Canada.	Report	Primarily focused on upgrading infrastructure and human uses of the park.
City of Edmonton. 2016. Bacteria levels in Hawrelak Lake, 2003-2016. Edmonton, Canada.	Excel Sheet	Without chlorination, bacterial levels (*E. coli?*) ranged from 10 CFUs to 520 CFUs, with an average of 153 CFUs. Chlorination reduced bacterial numbers the next day but caused a dramatic increase on the second and third day after treatment. A second treatment thereafter reduced bacterial levels well below the standard of 200 CFU mean over 30 days, or 400 CFU in any one sample. The low levels persisted. The City has since switched the metric from *E. coli* to *Enterococcus*. The City determined that the source of bacteria is exclusively from birds, mostly likely geese; it is not from mammals or other organisms.
Davidson, D.J. 2010. Climate change projections and implications for Edmonton; Discussion Paper 6, The Edmonton Sustainability Papers. University of Alberta, Saskatchewan AB.	Report	Climate models predict warmer winters and springs in Saskatchewan, and wetter summers. Soil moisture will decrease due to interaction of rising temperature and timing of precipitation. Snowpack feeding surface waters will decrease, resulting in earlier spring runoff and less baseflow during remainder of year, a pattern already seen in 100 years of decreasing annual flows in N. Saskachewan River in Edmonton. Heavy rainfall events have been increasing since the 1960s and will continue to do so. These have the potential to cause flooding. Higher cost of living is expected, increasing downward pressure on taxes and reducing government capacity to pay for non-essential services.
EPCOR. 2020. Water quality data at the E.L. Smith Facility.	Excel Sheet	North Saskatchewan River water samples from the facility inlet upstream of Hawrelak Park, assumed to represent river conditions at Hawrelak Park 12 km downstream. Parameters included alkalinity, *E. coli*, total phosphorus, nitrate nitrogen, total suspended solids, and turbidity.
Google Earth Aerial Image. 2017. Hawrelak Lake	Digital Data	Image 8/25/2017 with park boundary; used for land cover map

Citation	Source	Description
Government of Canada. 2020. Canadian Climate Normals 1981-2010 Station Data, Data for Edmonton City Centre A.	Web Site	Precipitation data for the Edmonton region
Jenkins, Mike - City of Edmonton. 2020. Goose activity at Hawrelak Park	Pers. Comm.	Map of goose nests at Hawrelak Park; information on goose numbers in park
Kussow, W.R. 2004. Phosphorus Runoff Losses from Lawns. Better Crops 88 (3).	Journal	Table 3 shows P additions for various applications and associated losses pe acre. The soluble P losses were much less than 1% (AES model used 1% to be conservative). The document found that 98% -100% of phosphorus lost to runoff was from soluble P, not adsorbed/suspended P.
Nurnberg, G.K. 1988. Prediction of Phosphorus Release Rates from Total and Reductant-Soluble Phosphorus in Anoxic Lake Sediments. Canadian Journal of Fisheries and Aquatic Sciences 45(3):453-462.	Journal	Research quantifying release rates of phosphorus in anoxic lakes.
Root, E., W. Jones, B. Schwarz, and J. Gibbons. 2004. Rainwater Chemistry Across the United States. Bereket Haileab, Advisor.	Report	Used for estimating phosphorus concentration in rainfall
Saunders C. & P. Ruffell. 2006. Hawrelak Lake Depth Study.	Unpublished paper	Investigation of lake condition and triathlon water level needs. Lake appeared to have been dredged and the clay liner repacked in 1999. The lake bottom around the triathlon racecourse varies from 622.4-622.6m, with a depth when the lake is "topped off" of 1.2-1.5m. To raise 5 ha of water surface by 6 cm required the addition of 3,000m3 of river water. Over the 2003-2005 seasons, the average added potable water was 12,300m3.
SCS. (1954, 1956, 1964, 1965, 1971, 1972, 1985, 1986, 1993, 1997). 'Hydrology', National Engineering Handbook, Supplement A, Section 4, Chapter 10, Soil Conservation Service, USDA, Washington, D.C.	Report	Presents the Runoff Curve Number Method.
Shawn, R.D., P.A. Mitchell and A.M. Anderson. 1994. Water quality of the North Saskatchewan River in Alberta. Alberta Environmental Protection, Edmonton AB.	Report	Water quality study 1985-1989 documenting seasonal change, influences on water quality, and macroinvertebrate community. Above Edmonton water quality is good, deteriorating below due to wastewater discharge. Agricultural inputs above Edmonton were not quantified. Overall, the river met water quality standards and the macroinvertebrate community was not impaired, but productivity increased below Edmonton due to nutrient inputs.

Citation	Source	Description
Snohomish County, Washington. 2020. Sunday Lake Algae Control Plan. Surface Water Management Division, Public Works Department, with technical analysis assistance by TetraTech. Everett, WA.	Report	Plan to address algae blooms in a 49-acre recreational lake.
Summit Environmental Consultants, Inc. 2013. Hawrelak Lake Rehabilitation Environmental Screening Report. Project # 2013-3864.	Report	To prepare for the ITU Grand Final Triathlon, the lake conditions and race standards were evaluated. The lake is a high alkalinity, eutrophic, shallow lake excavated in the mid-1960s in a gravel pit as a "stormwater management basin" but subsequently used as a park feature. Phosphorus concentrations, linked to algae blooms, were over 0.05 mg/L, which is high. Water is pumped from the North Saskatchewan River to "top off" the lake in preparation for annual triathlon events. The two islands are used for nesting by waterfowl. Turf is mowed to within 0.25-2m of the lake water. Design of the deeper channel for triathletes was presented.
Voorhees, J. and B. Pitt. 1997. WinSLAMM (Source Loading And Management Model): An urban area nonpoint source water-quality model for Wisconsin.	Report	Model used for estimating pollutant concentrations in surface runoff.
Walker, W. W. and K. E. Havens. 1995. Relating algal bloom frequencies to phosphorus concentrations in Lake Okeechobee. Lake and Reservoir Mgt. 11:77-83.	Journal	Concentrations of phosphorus below 0.03 mg/L (30 µg/L) were not associated with algae blooms in the littoral zone of Lake Okeechobee, but the relationship was weaker in the deeper open water. Interactions with nitrogen occurred but reducing nitrogen concentrations increases the risk of nitrogen-fixing cyanobacteria blooms.

Appendix 2. Soil Analysis Summary, August 2020

William Hawrelak Park Rehabilitation

Hawrelak Park Water Quality Feasibility Study

Applied Ecological Services, Inc.

Steven I. Apfelbaum

Summary of Soil Chemistry and Bulk Density Sampling at Hawrelak Park

City staff with AES guidance gathered soil samples from Hawrelak Park to understand the constituents and character of soils and their potential effect on the water quality of Hawrelak Lake. Two soil samples from the top 10cm of the soil profile were obtained and combined for analysis in each of nine soil sampling areas at Hawrelak Park (Figure 1). Soil samples were taken in July, 2020. Soil bulk density samples also were obtained in each of the soil sampling areas in the same time period.

Figure 1. Soil sampling areas at Hawrelak Park

The soil samples were analyzed for constituents and character. The total phosphorus and Kjehldahl nitrogen levels in all soil sampling areas greatly exceeded typical levels in soils (Table 1). The sand-clay percent on average type the soils as clay loams, tending towards loams.

Table 1. Soil constituents and character of soil samples at Hawrelak Park

Soil Constituent	Unit	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
Texture		Clay loam	Clay loam	Clay loam	Clay loam	Clay loam
Sand	50 µm - 2 mm % by wt.	33	28	30	28	25
Silt	2 µm - 50 µm % by wt.	36	39	37	40	46
Clay	<2 µm % by wt.	31	33	33	32	29
Phosphorus	mg/kg	1340	1010	1470	1520	1050
Total Kjeldahl Nitrogen	mg/kg	7510	5700	8280	8380	7850

Soil Constituent	Unit	Soil 6	Soil 7	Soil 8	Soil 9	Average
Texture		Clay loam	Clay loam	Loam	Loam	
Sand	50 µm - 2 mm % by wt.	33	28	32	34	**30**
Silt	2 µm - 50 µm % by wt.	40	41	44	40	**40**
Clay	<2 µm % by wt.	27	31	24	26	**30**
Phosphorus	mg/kg	1060	1380	860	850	**1171**
Total Kjeldahl Nitrogen	mg/kg	6210	10000	5200	5420	**7172**

Three key characteristics of the soils at Hawrelak Park can be described from these data: infiltration rate and potential for soils to contribute phosphorus and nitrogen to the lake.

Infiltration rates. Although sand-clay percentages could be typed as clay loams, the dry bulk density (0.65 to 0.95) was consistent with loamy soil. Shallow groundwater levels are deep enough to not affect infiltration; therefore, the samples with the lowest bulk density and highest sand percentage would have the highest infiltration rates. Regardless of infiltration rate, lateral and downward vertical movement of water through the soil is expected to be moderate to high under dry conditions and would decrease as soil saturation increased due to rain and snowmelt.

Potential phosphorus loading. Phosphorus levels are exceedingly high compared to typical ranges across a wide variety of soils (Table 2). In the soil samples around Hawrelak Lake, phosphorus levels were 644 to 1,380 ppm. These high levels suggest the soil is a potential source of soluble phosphorus. Phosphorus is bound to organic matter in the soil (adsorption) but can be released (desorption) into soil water and move laterally to open water, increasing the concentration of total phosphorus in the water. Barriers to dissolved phosphorus movement can reduce this effect, such as the clay liner of Hawrelak Lake or the downward movement of soil water to groundwater.

Potential nitrogen loading. Nitrogen levels are exceedingly high compared to typical normal ranges (Table 2). Ranges of 6,210 to 10,000 ppm suggest the soil is a major source of soluble nitrogen, which is readily dissolved in soil water and easily carried laterally to open water or downward into groundwater.

Table 2. Desirable range of soil chemical constituents at 0-20 cm depth

Constituent/Characteristic	Units	Desirable Range	
		Low	High
pH		6.2	7.5
Organic matter	g/kg	30	50
Humus	% by weight	2	3
Clay	% by weight	30	
Sand (fine & coarse)	% by weight	30	
Silt	% by weight	30	
Bulk Density	g/cm^2	1.1	1.4
Chloride	g/kg		<0.07
Sulfate	g/kg	.0075	25 .025
Alkalinity	%	.003	.006
Available phosphorus	ppm	16	50
Available potassium	ppm	75	150
Organic carbon	%	48	58
Exchangeable calcium	cmol/kg	700	1300
Available iron	ppm	12	24
Cation exchange capacity	cmol/kg	5	10+
Total Cadmium	Ppm	0.01	1.8

Soil Quality Improvement Strategies

Lowering phosphorus and nitrogen levels in the soil will reduce the probability of these chemicals reaching the open water of Hawrelak Lake. Strategies for accomplishing that are described below.

How Does Soil Phosphorus Pollute Open Water? During a spring thaw and after the early growing season rainfalls, some percentage of the meltwater and stormwater enters the soil and moves laterally and potentially vertically through the rooting zone (rhizosphere) of the turf plants in Hawrelak Park. The water follows the contours of the land surface initially (topographic gradient), then moves with the shallow water table (piezometric surface) until it discharges at an open body of water—the small pond, Hawrelak Lake and the North Fork Saskatchewan River.

When oxygen levels in the soil are low, such as when soil is saturated or during hot summer conditions, phosphorus that is bound molecularly (adsorbed) to soil colloids (i.e., clay and organic matter) but can be dissolved into the soil water (desorbed). That dissolved phosphorus has the potential to enter open water, as described above.

The intact clay liner forming the basin of Hawrelak Lake is likely to limit the movement of dissolved phosphorus into the lake. The small pond and stream near the lake's southwest corner, however, may intercept shallow groundwater with high dissolved phosphorus levels and act as a conduit to move that water directly to the lake's southeast corner. Thus, treating the issues that are known to directly affect the lake water quality—waterfowl, sediment phosphorus release, river water topping-off—may not entirely resolve the water quality problem.

If this is the case, a strategy of binding phosphorus to soil and plant materials is required. The strategy would include increasing the level of organic matter and clays in the soil and planting long-lived deep-rooted plants. These actions together will reduce the amount of dissolved phosphorus in soil water and shallow groundwater.

Assuming the high phosphorus are held in the topsoil, assumed to be a 6-12" thick layer over the entire uplands, the following solutions are the most relevant to consider:

What actions are effective for reducing phosphorus?

1. **Apply lime and iron hydroxide.** Applying a combination of calcium carbonate (lime) and iron will cause the phosphorus to bind to iron compounds in the soil (chelation) and remain in the soil matrix. This will reduce the potential for phosphorus to become soluble and be transported by soil water and surface groundwater.
2. **Apply organic matter and clay.** Apply granular bentonite clay and biochar (a high carbon combustion product) and work this into the upper several inches of soil. This increases the soil's binding sites which adsorb and hold phosphorus.
3. **Plant & harvest deep-rooted, quick-growing, large herbaceous plants.** Plant oil seed sunflower (*Helianthus annuus*), sorghum (*Sorghum bicolor*), sudan grass (*Sorghum x drummondii*) and similar plants that grow quickly and take up large quantities of phosphorus and nitrogen. These herbaceous plants are harvested at the end of each growing season and used outside the watershed. Plants of this type can be invasive and displace other vegetation. The risks of using these types of plants should be considered and control measures in place should be in place before such species are planted.
4. **Intercept and redirect or clean surface runoff and shallow groundwater.** Surface runoff and shallow groundwater can be intercepted by shallow surface swales and directed to treatment areas or sent directly to other water bodies with greater capacity to assimilate high-phosphorus water.

Additional Information Regarding Soil Improvement

Using Iron

Iron can be applied to help tie up phosphorus using rates and formulations as in Table 3. Two fertilizer formulations that may be available and considered for use are listed, with the targeted percentage of the specific mineral/element for each formulation.

Table 3. Micronutrient application rate for soil

Mineral	Application Rate (dry lbs/acre of mineral)	Example Fertilizer Options (% targeted mineral)
Iron	1.5	Ferrous ammonium sulfate (14%), ferrous ammonium phosphate (29%)

To achieve the application rate of the elemental mineral for each macronutrient, please note that the fertilizer formulation will need to be consulted to determine the actual pounds per acre of the fertilizer that will need to be applied to achieve the application rate of the elemental mineral.

Many fertilizer suppliers can create custom premixed micronutrient fertilizers that can be applied as a dry powder or granular spreadable. Do not attempt to spread a dry powder in windy conditions, unless the fertilizer applicator implement can forcefully direct the applied fertilizer downwards to the ground.

Materials should be added only after soil texture and organic matter improvements have been achieved. Micronutrient fertilizers can be spread as a powder or granular material and then tilled into the upper topsoil layer, especially when using a cover crop with the additions.

Improve soil pH and increase calcium and magnesium

Consider applying two types of lime amendments over three years (Table 4). In years 1 and 2, the rates of application should be about 5 tons/acre each year of each lime amendment. In years 3 and 4, the application rate should be revised based on actual re-measurements of soil pH. A starting point for consideration would be to apply about 5 tons/acre.

Table 4. Schedule for pH management of soil

		One-Time Application to Achieve Targeted pH		Annual Projected Applications			
pH Test Results	Targeted pH Level	Pure CaCo3 Application Rate (T/acre)	Agricultural Ground Limestone (T/acre)	Year 1 (T/acre)	Year 2 (T/acre)	Year 3 (T/acre)	Year 4 (T/acre)
5.0	6.2-7.5	16.9	18.0	5.0	5.0	5.0	5.0

Soil pH, calcium and magnesium can be simultaneously adjusted with calcium carbonate, ag-lime or another material (Table 5). The application amounts are approximate but should adjust the pH to an

optimal pH range of 6.2-7.5. If alternative materials are used, the soil should be tested before application to ensure the correct amounts are applied.

Table 5. Alternate and supplementary materials for pH adjustment

Material	Calcium (%)	Magnesium (%)	Total Neutralizing Power
Wood ash	23	2.2	
Calcium magnesium carbonate	29	4.0	60-90
Burned lime (CaO)	60-70		150-175
Calcium limestone ($CaCO^3$)	32	3.0	85-100
Hydrated lime ($Ca(OH)^2$)	45-55		120-135
Marl	35	0.5	90-100
Gypsum ($MgSO^4\ 2H_2O$)	23		

The lime recommendation assumes that the lime is rated at 100 percent calcium carbonate equivalence (CCE), a measure of the neutralizing power of the lime. If the lime is guaranteed at below 90 percent CCE, the application rate should be increased proportionally. If the lime requirement to reach a target pH is more than 125 lb per 1000 sq. ft., a split application is recommended over two or more years to adjust the pH gradually and avoid possible nutrient balance problems. If lime is to be top dressed, application should be limited to 100 lb per 1000 sq. ft. in any one year.

Lime is a primary source of calcium. An optimum pH should automatically result in an adequate calcium level if the pH has been adjusted using lime. The lime recommendation is usually the only recommendation made to adjust the soil calcium level.

After uniform application to the soil surface, lime should be thoroughly tilled into the soil for optimal neutralization of soil acidity. Since the liming material can only react at the depth at which it is incorporated, subsurface tillage may be necessary to ameliorate subsoil acidity. Liming soils with a seeding of perennial plants will require little or no tillage. Irrigation and rainfall will slowly leach the lime (which is relatively insoluble) into the soil profile. The proper fertilizer formulation is needed when managing soil acidification, particularly in perennial crop systems where liming is less easily incorporated than in annual or short-term systems.

Over-liming soil has an adverse effect, making the calculation of the amount to add very important. If the pH of the soil is too high, deficiencies of phosphorus and micronutrient deficiencies, as well as molybdenum toxicity, can result.

Once soil pH reaches equilibrium, soils should be tested every 2-3 years. However, if nutrient or pH levels are excessively high or low, sampling should be done each year and applications adaptively managed.

Appendix 3. Technical Advisory Committee Meeting Notes on Alternative BMPs

William Hawrelak Park Rehabilitation
Water Quality Feasibility Study

Preferred Alternative

On September 17, 2002, the Advisory Committee met with the consultant team to discuss irrigation, review the results of the phosphorus loading model, and discuss proposed best management practices (BMPs) for improving water quality in Hawrelak Lake. The following summarizes the input from the Advisory Committee. Followed that is a table summarizing the preferred alternative. Lastly, notes from the September 17 meeting are provided at the end.

Dredge & Manage Geese & River Water – Base Scenario

- A reasonable scenario without much additional cost or effort above what City plans to do.
- **Planting shrubs on islands** to stop goose nesting will generate little public reaction at small cost. This addressed the largest source of phosphorus to the lake, waterfowl. The planting serves a dual purpose in also keeping people off the islands. Will the geese move to the lake edges? Possibly, but it is easier to monitor and remove nests at lake edge and may reduce the density of the nests from nine in 2020 to a lower number in future years.
- City plans to **dredge to clay liner**. This will remove sediment and prevent a phosphorus pulse at ice-out. Preventing rapid build-up of sediment in the future depends on controlling the goose population, stopping algae blooms, and pumping river water without sediment. This would greatly extend the time until the next dredging.
- **Pumping clean river water—only in low-sediment/low-phosphorus periods** is programmatically challenging because topping off the lake depends on lake level, the irrigation needs, and triathlon timing. The need may not coincide with a period of low sediment and phosphorus in the river. A plan for deciding when to pump river water would improve the chances of pumping when sediment and phosphorus are low. Generally, in April-June river sediment is high and phosphorus is much above the 0.025mg/mL lake concentration target. The July-August period has lower phosphorus levels, usually 0.02-0.04 mg/L. City staff can use the EL Smith Water Treatment Facility's daily measurements of sediment and phosphorus to pick days when river water could be pumped at P concentrations closer to the 0.025 mg/mL target, thereby not increasing phosphorus loading to the lake.

Native Vegetation Plantings

- **Install vegetation filter & level spreader for pumped river water** in the ravine at the west side of the lake. The area involved is small and not regularly used by park visitors. This BMP could be designed as a new feature of the park—moving water through the BMP to the lake when water is pumped from the river to raise the lake level. Two designs for a level spreader were proposed. Because pumped lake water is the greatest source of phosphorus in the month it is added to the lake, this BMP is expected to have a demonstrable effect on P loading and lake water quality in those months.
    - In the first option, the ravine would be configured as a cascade of cells and a swale and berm would be constructed at the lake edge to function as a level spreader. The area would be vegetated with perennial, deep-rooted native plants, shrubs, and scattered trees. Water would

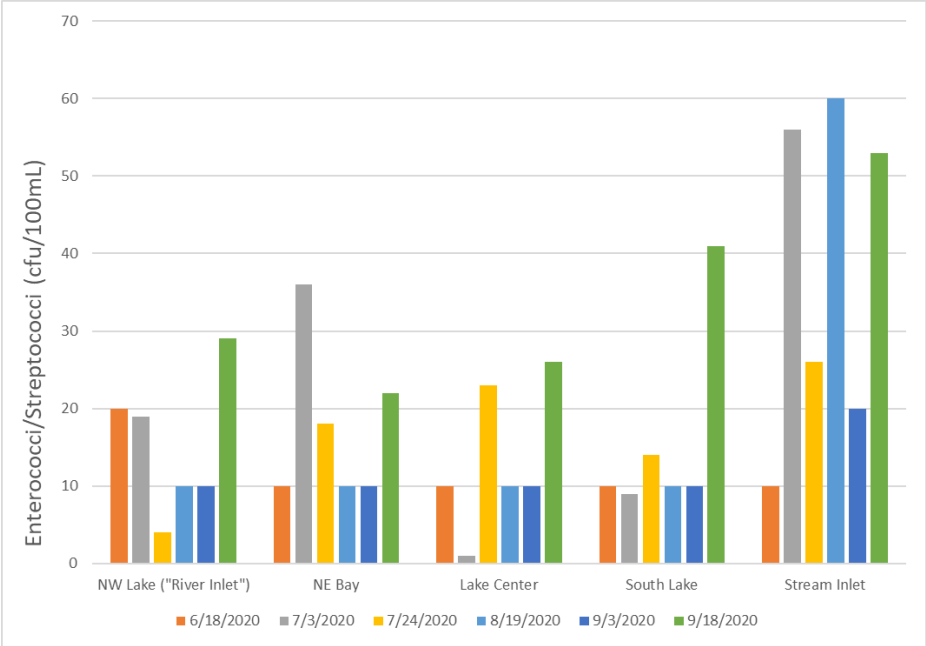
be pumped from the river to the head of the ravine, flow downhill through vegetated cells, spread out in the swale (where some water will infiltrate to shallow groundwater), and overtop the berm to flow into the lake.

  - The second option retains the treatment in the ravine but installs a piped system from the foot of the ravine along the lakeshore to direct water through many holes in the pipe, which will flood an upland vegetated buffer that fringes the lakeshore. Water would then move overland through the buffer into the lake.

- **Install 25-foot wide vegetation buffer in uplands along the shoreline and emergent plants in the shallow water** next to the shoreline. The public reaction to taller vegetation around the lakeshore will dictate feasibility. Snow management and chlorination for the triathlon are not issues for the vegetation that would be planted. A vegetation buffer and emergent zone serves a dual purpose—discouraging goose movement between the lake and lawns and reducing local inputs of surface and shallow subsurface runoff to the lake at relatively low cost. If dense enough, it will discourage goose nesting at the shoreline. The phosphorus loading from surface runoff is the third largest contributor but not much more than the pumped river water. This BMP will serve a dual purpose: filtering overland runoff and making the shoreline less attractive to geese, which would reduce the amount of goose droppings near the lake.

Other BMPs

- **Install an iron enhanced sand filter (IESF) in the recirculating pond-stream system.** This would be installed as a series of cells in the stream receiving the pond water. The pond is filled with lake water by a pump that is separate from the irrigation system. With an IESF installed, the pond-stream system would become a filtration system for the lake by removing phosphorus whenever the stream is flowing. Maintenance of an IESF requires access to a skid-steer to lift the cage containing the filter out and replace the sand and iron filings. The amount of phosphorus being treated affects the replacement time. In general, replacement is needed at six years after installation.
  - Interestingly, although phosphorus levels in 2020 were no higher in the lake at the stream inlet, *Enterococcus* bacteria levels were consistently higher than elsewhere in the lake (see figure below). This suggest a bacteria source at the pond or in the stream. The stream corridor is shaded. Bacteria are known to persist, once established, in shaded streams and move into downstream waters. (In 2020 water quality sampling of Hawrelak Lake, *Enterococcus* counts did not exceed the US EPA standard of 61 cfu/100mL *Enterococcus* in any one sample.)
  - Sand filters remove bacteria from water, but a removal rate of up to 99 percent is possible by adding biochar to the filter. The University of Minnesota's St. Anthony Falls Lab is conducting research on this topic and the results are promising. See http://www.shinglecreek.org/uploads/5/7/7/6/57762663/2019_overview.pdf. In addition to phosphorus removal, a more pressing reason to install an IESF in the stream would be to remove bacteria before it reaches the lake.



- **Install an IESF in the ravine** for additional treatment of pumped river water. This would increase the amount of phosphorus removed from pumped river water and reduce the need for a level spreader because treatment would occur over the flow length of the ravine. Maintenance access would need to be provided for a skid-steer from the perimeter road.
- **Improve the soil quality in the pond-stream watershed**. If shallow surface runoff is adding phosphorus to the lake, that most likely is occurring at the pond where the water table is shallowest in the park. The high phosphorus levels in the soil can be reduced by the addition of lime and iron. This will cause phosphorus to bind to iron and soil particles and reduce the amount of dissolved phosphorus in shallow groundwater. The phosphorus concentrations in lake water at the stream inlet, however, were no higher than at other locations in the lake, and the amount of phosphorus in the overland runoff and subsurface groundwater that reaches the pond-stream system comes from a very area compared to the rest of the park. It may be worthwhile to consider an overall program of soil health improvement that benefits turf growth, rather than focusing on the contribution of phosphorus in subsurface runoff to the lake from the pond.

Summary of Preferred Alternative

The preferred option addresses the two largest sources of phosphorus—geese and sediment. It also addresses a large contributor of phosphorus to the lake in the summer—river water pumping. These BMPs are either planned already (dredging) or involve engineering, earthwork and vegetation establishment—the ravine vegetation filter—which can be completed at a low to medium cost level. O&M would consist largely of vegetation management and erosion monitoring and control.

Pumping clean river water has great potential to reduce phosphorus loading to the lake at low cost, but coordinating this practice is a challenge. For that reason, if river water phosphorus cannot be reduced sufficiently in the vegetation filter approach above, an IESF would be installed in the ravine.

If the load reduction is insufficient to meet the target 0.025mg/mL total phosphorus concentration in all growing season months, installing an IESF in the recirculating stream-pond system would provide continuous phosphorus removal while also reducing this large source of Enterococcus bacteria.

Installing vegetation buffers and emergent plants will intercept and treat runoff from adjacent turf, as well as discourage the use of the planted shoreline by geese. This is a low-cost BMP but the greatest benefit may be to lower the input of phosphorus from goose droppings near the lake. Improving soil health may be more beneficial in turf management than reducing the amount of phosphorus reaching the lake in shallow groundwater, given the depth of groundwater and clay liner of the lake. It may be more important in reducing phosphorus inputs from the pond-stream system where groundwater is shallow.

Table 1. Summary of BMPs in Preferred Alternative

Best Management Practice	Preferred Option to Model P Load Reduction	Add If Load Reduction Not Enough	Load Reduction Potential[1]	Likely Installation Cost[2]	Likely O&M Effort[3]
Plant Shrubs on Islands	Yes		2/3	3	3
Dredge to Clay Liner	Yes		3	1	3
Install Vegetation Filter for River Water	Yes		3	2/3	3
Install IESF in Ravine		Yes	3	1	2
Pump Clean River Water		Yes	3	3	3
IESF in Recirculation Stream-Pond System		Yes	2	1	2
Install Vegetation Buffer & Emergent Plants		Yes	1/2	2/3	3
Improve Soil Quality of Turf		?	1/2	3	3

[1] Load Reduction Potential. 3=high, 2=medium, 1=low

[2] Likely Installation Cost. 3=low, 2=medium, 1=high

[3] Likely O&M Effort. 3=low, 2=medium, 1=high

William Hawrelak Park Rehabilitation
Water Quality Feasibility Study
Model Results & Alternative BMPs

Technical Advisory Committee Meeting Notes
September 17, 2020

Irrigation

Will the City use treated lake water or potable? What standard is the City using for lake water re-use? Can permission be gained to grandfather irrigation at Hawrelak? Can using lake water for irrigation reduce phosphorus loading to the lake? Soon Canada will mandate adding 1 mg/L orthophosphate to potable water to reduce lead levels.

City (Juanita) said the City is not set on source of irrigation water. When blue-green algae are present in the lake, there is a concern about using it for irrigation. The park recently got very dry and needed irrigation. Algae and sludge in lake water also clog the irrigation system. Fairy shrimp have also clogged the system. Using potable water for irrigation is expected to result in higher costs than using lake water. Overall using lake water is more environmentally benign.

Bryan said lake water irrigation is used to manage the lake level. It is challenging to release excess lake water to the river due to permitting requirements. It is rare to pump river water into the lake for irrigation, but if the lake gets too high and threatens the amphitheater, the City will irrigate to lower the lake level. There may be a leak in the clay liner again, because the water level has been dropping somewhat faster than expected.

There are two pumps—one for irrigation and one to keep the little pond/stream system going.

Improving lake water quality should facilitate its use for irrigation and lessen concerns regarding its release to the river—but a permit to do so would still be needed.

The City's standards are that the City allows subsurface irrigation using lake water, but requires potable water or water treatment if irrigation is above the ground—spray, etc. The pump house has a filter and UV set-up to treat bacteria and algae before using it for spray irrigation.

Juanita expects water quality regulations in the future will be more rigorous regarding lake water use for irrigation.

Kim mentioned the possibility of using lake water to distribute irrigation water at ground level without spray (may reduce requirements/concerns).

Alternative Approaches

Juanita thought Base Scenario was reasonable. The City does plan to dredge the lake. She likes the dense plantings of islands to keep both geese and people off them. River pumping may or may not be timed for low phosphorus periods. Public argument for reducing goose numbers is that they are by far biggest contributor and must be addressed to solve the lake's water quality problem. Goose control in

the past has been problematic from a public relations standpoint, and this would need to be carefully messaged prior to implementation.

Adding Vegetated Buffer. There was a sense that the public may push back on a vegetated buffer strip in the uplands and an emergent marsh zone in the lake shallows. Juanita also expressed concern regarding snow plowing and storage and its effect on native plantings in the shoreline buffer and emergent marsh area.

(Another staff member said that a pond at the Texaco refinery had fish, possibly from river water that was pumped into it. Fish in Hawlrelak would not be a problem but would likely die out each year due to low oxygen over the winter—shallow lakes with ice and snow are subject to winter kill.)

Bryan was concerned about snow plowing and storage. City provided snow storage location data to AES, as well as chlorine use data for triathlon preparation. The City clarified that snow is plowed off the lake using a front-end loader with a bucket and snow blower. Snowbanks are created by plow trucks along the lake edge. When the banks get too high, a snowblower with an auger is used to lower the height of the snowbank. The loader bucket is also used to lift heavy snow from the lake and move it to the bank or reduce the height of banks by moving it elsewhere. In this way snowbanks are reduced to a height of one foot. There is a concern that the front-end loader would damage the taller vegetation. There is little evidence in photos of the shoreline that the lakeshore edge itself is damaged.

Kim pointed out that if existing vegetation and turf can survive the snow plowing and storage operations, the native plantings of appropriate species will also tolerate the treatment. The perennial, deep-rooted native plant species used in the upland vegetation buffer and emergent zone have growing tips near the ground and grow back each year after winter. If the soil is not damaged and blades and augers don't go below 1 foot above the ground, there will be no damage to the vegetation buffer or emergent plants. Doug mentioned that, if doubts remain, the winter effects of show removal could be tested by planting a portion of the shoreline and evaluating the aesthetic look and recovering of vegetation after a winter.

AES understands that the plants selected for use in the lake must tolerate the chlorine treatments for the triathlon. If phosphorus loading to the lake can be reduced and the sediment removed, however, it may be that chlorination would not be necessary in the future.

Bryan was interested in using the ravine as water quality treatment opportunity for pumped river water. He wondered whether that area would make for an attractive park feature or should it be hidden. How will it look? Kim thought it would be best for the vegetation used in water quality treatment if it were open to the sun and had no continuous tree canopy; scattered trees would be fine around the edges. It might be interesting for park users to observe the water being pumped from the river as it flows through the treatment facility and into the lake.

Bryan asked about filter replacement, a very important issue. Kim said John Gulliver recommends caged filters replaced approximately every 6 years, but design would need to consider flow rates and P levels; likely skid steer could replace filters. Timing of maintenance and the cost. Access for cleanout. Skid steer removal.

Next Steps

AES will summarize a preferred approach based on this input for review by the team. With the team agreement, AES will re-run the phosphorus loading model with the preferred approach to determine load reduction and the monthly concentration in lake. This will determine if additional BMPs are needed. When the preferred approach has final sign-off, AES will provide an opinion of probable cost to construct and maintain the water quality improvement measures.

Rachel will send regulatory requirements for consideration by the consultant team.

Appendix F. William Hawrelak Park Geotechnical Investigation (Thurber 2021a)

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA
GEOTECHNICAL INVESTIGATION

REVISION 1

THURBER ENGINEERING LTD.

THURBER ENGINEERING LTD.

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA
GEOTECHNICAL INVESTIGATION

REVISION 1

Report

to

City of Edmonton

Thomas Vogt, M.Eng., P.Eng.
Geotechnical Engineer

Date: September 7, 2021
File: 31566

Robin Tweedie, M.Sc., P.Eng.
Principal | Senior Geotechnical Engineer

THURBER

TABLE OF CONTENTS

1. INTRODUCTION 1

2. PROPOSED DEVELOPMENT 1

3. SCOPE OF WORK 2

4. METHOD OF INVESTIGATION 2
   - 4.1 Historical Desktop Study 2
   - 4.2 Site Reconnaissance 3
   - 4.3 Field Drilling Program 3
   - 4.4 Laboratory Testing 5

5. SITE DESCRIPTION 7
   - 5.1 Geology 7
     - 5.1.1 Investigative Methodology 7
     - 5.1.2 Geologic Description 8
       - 5.1.2.1 General 8
       - 5.1.2.2 Bedrock 8
       - 5.1.2.3 Surficial Deposits 9
     - 5.1.3 Gravel Extraction and Backfilling 10
   - 5.2 General Site Conditions 10
   - 5.3 General Subsurface Conditions 10
     - 5.3.1 Asphalt 11
     - 5.3.2 Topsoil 11
     - 5.3.3 Fill (Clay, Sand and Gravel) 11
     - 5.3.4 Clay and Silt 12
     - 5.3.5 Sand and Gravel 12
     - 5.3.6 Clay Till 13
     - 5.3.7 Bedrock (Clay Shale, Siltstone, Sandstone, Coal and Bentonite) 13
   - 5.4 Groundwater and Slough Conditions 13
   - 5.5 Frost Effects 14

6. SERVICE AREA 15

6.1 General 15
6.2 Subsurface conditions 15
6.2.1 Asphalt 16
6.2.2 Topsoil 16
6.2.3 Fill (Clay and Gravel) 16
6.2.4 Clay and Clay Till 16
6.2.5 Sand and Gravel 17
6.2.6 Groundwater Conditions 17
6.3 Building Foundations 17
6.3.1 Cast-in-Place Concrete Friction Piles 18
6.3.2 Spread Footings 19
6.3.3 Reinforced Concrete Raft Foundation 19
6.4 Miscellaneous 19
6.4.1 Pavement For Staff Parking Lot Expansion 20
6.4.2 Fuel Tank Foundations 20

7. MAIN PAVILION AND CONCRETE APRON 21
7.1 General 21
7.2 Subsurface Conditions 23
7.2.1 Topsoil 23
7.2.2 Clay Fill 23
7.2.3 Sand and Gravel 23
7.2.4 Clay 24
7.2.5 Bedrock (Clay Shale) 24
7.2.6 Groundwater Conditions 24
7.3 Geotechnical Evaluation and Recommendations 24
7.3.1 Existing Cast-In-Place Concrete End Bearing Piles 24
7.3.2 Uplift Design 25
7.3.2.1 Uplift Capacity 25
7.3.2.2 Frost Heave Effects 26

8. TIMBER RETAINING WALL 27
8.1 General 27

8.2 Subsurface Conditions 27
8.2.1 Topsoil 28
8.2.2 Clay Fill 28
8.2.3 Clay and Clay Till 28
8.2.4 Bedrock (Clay Shale, Coal and Bentonite) 28
8.2.5 Groundwater Conditions 28
8.3 Retaining Walls 29
9. AMPHITHEATRE 29
9.1 General 29
9.2 Subsurface Conditions 29
9.2.1 Topsoil and Asphalt 30
9.2.2 Clay Fill 30
9.2.3 Clay 30
9.2.4 Sand and Gravel 30
9.2.5 Bedrock (Clay Shale and Sandstone) 30
9.2.6 Groundwater Conditions 31
9.3 Geotechnical Evaluation and Recommendations 31
9.3.1 Retaining Walls 31
9.3.2 Cast-In-Place Concrete Piles 31
9.3.3 Spread Footings 32
9.4 Pavement Upgrades 33
9.5 Irrigation Pumphouse 33
9.5.1 Retaining Walls 33
9.5.2 Foundations 34
9.5.3 Cast-In-Place Concrete Piles 34
9.5.3.1 Spread Footings 35
9.5.3.2 Reinforced Concrete Raft Foundation 35
10. BOARDWALK AROUND LAKE 36
10.1 General 36
10.2 Subsurface Conditions 36
10.2.1 Topsoil 36

10.2.2 Clay Fill 37
10.2.3 Sand and Gravel 37
10.2.4 Clay 37
10.2.5 Bedrock (Clay Shale) 37
10.2.6 Groundwater Conditions 37
10.3 Geotechnical Evaluation and Recommendations 38
10.3.1 Cast-in-Place Concrete Friction Piles 38
10.3.2 Spread Footings 39
11. TIMBER PEDESTRIAN BRIDGE 39
11.1 General 39
11.2 Subsurface conditions 39
11.2.1 Topsoil 40
11.2.2 Fill (Clay, Sand and Gravel) 40
11.2.3 Bedrock (Clay Shale and Sandstone) 40
11.2.4 Groundwater Conditions 40
11.3 Geotechnical Evaluation and Recommendations 41
11.3.1 General 41
11.3.2 Cast-In-Place Concrete Piles 41
11.3.3 Uplift Design 42
11.3.3.1 Uplift Capacity 42
11.3.3.2 Frost Heave Effects 42
12. PLAYGROUND MOUND 42
12.1 General 42
12.2 Subsurface Conditions 43
12.2.1 Topsoil 43
12.2.2 Clay Fill 43
12.2.3 Sand 43
12.2.4 Clay 44
12.2.5 Bedrock (Clay Shale and Sandstone) 44
12.2.6 Groundwater Conditions 44
12.3 Foundations 44

12.3.1 Cast-in-Place Concrete Friction Piles 45
12.4 Preliminary Slope Stability Assessment 45
13. MULTI-USE PATHS 46
13.1 General 46
13.2 Subsurface Conditions 46
13.2.1 Topsoil 47
13.2.2 Clay Fill 47
13.2.3 Clay 47
13.2.4 Sand and Gravel 47
13.2.5 Bedrock (Clay Shale, Siltstone and Sandstone) 47
13.2.6 Groundwater Conditions 48
13.3 Geotechnical Evaluation and Recommendations 48
14. ROADS AND PARKING AREAS 48
14.1 General 48
14.2 Subsurface Conditions 48
14.2.1 Asphalt 49
14.2.2 Fill (Clay, Sand and Gravel) 49
14.2.3 Clay and Silt 49
14.2.4 Sand and Gravel 50
14.2.5 Bedrock (Clay Shale and Sandstone) 50
14.2.6 Groundwater Conditions 50
14.2.7 Existing Asphalt Structure 50
14.3 Geotechnical Evaluation and Recommendations 51
15. UTILITIES 52
15.1 General 52
15.2 Subsurface Conditions 52
15.2.1 Topsoil 52
15.2.2 Fill (Clay and Sand) 53
15.2.3 Clay 53
15.2.4 Sand and Gravel 53

15.2.5 Bedrock (Clay Shale and Sandstone) 53
15.2.6 Groundwater Conditions 54
15.3 Geotechnical Evaluations and Recommendations 54
15.3.1 Trench Excavations 54
15.3.2 Pipe Bedding and Backfilling of Trenches 55
16. GENERAL GEOTECHNICAL RECOMMENDATIONS 55
16.1 General Evaluation 55
16.2 Site Preparation, Grading and Surface Drainage 55
16.2.1 General 55
16.2.2 Groundwater Seepage and Drainage 56
16.2.3 Placement and Compaction 56
16.3 Frost Design 58
16.3.1 General 58
16.3.2 Heated and Unheated Buildings 58
16.3.3 Utility Lines 59
16.4 Foundation Types 64
16.5 Pile Foundations Limit States Design 64
16.6 Cast-In-Place Concrete Piles 66
16.7 Uplift Design 67
16.7.1 Uplift Capacity 67
16.7.2 Frost Heave Effects 67
16.8 Lateral Loads on Piles 68
16.8.1 General 68
16.9 Pile Caps and Grade Beams 68
16.10 Spread Footings 70
16.11 Earth Pressures 72
16.12 Concrete Slabs on Grade 73
16.13 Cold Weather Construction 74
16.13.1 Grading and Compaction 74
16.13.2 Foundation Concrete Construction 75
16.14 Cement 76

16.15 Seismicity 76

17. CONSTRUCTION INSPECTION 76

18. LIMITATIONS AND USE OF REPORT 77

19. REFERENCES 77

STATEMENT OF LIMITATIONS AND CONDITIONS

APPENDICES

APPENDIX A

Drawing No. 31566-1 – Site Plan Showing Approximate Test Hole Locations
Drawing No. 31566-2 – Stratigraphic Cross-section A-A'
Drawing No. 31566-3 – Stratigraphic Cross-sections B-B' and C-C'
Drawing No. 31556-4 – Geology Map
Drawing No. 31566-5 – Isopach Maps
Drawing No. 31566-6 – Selected Air Photos 1924, 1930, 1948 and 1952
Drawing No. 31566-7 – Selected Air Photos 1957, 1965, 1978 and 1988
Main Pavilion Concrete Apron Slab Foundation Plan
Main Pavilion Concrete Apron Slab Details and Sections

APPENDIX B

Modified Unified Soils Classification
Symbols and Terms Used on Test Hole Logs
Test Hole Logs

APPENDIX C

Laboratory Test Results

APPENDIX D

William Hawrelak Park Rehabilitation
Main Pavilion Concrete Apron Slab Concrete Coring
Geotechnical Investigation

Appendix E

Playground Mound Stability Analysis

Appendix F

Recommended Construction Procedures

THURBER

1. INTRODUCTION

This report presents the results of a geotechnical investigation carried out by Thurber Engineering Ltd. (Thurber) for the William Hawrelak Park Rehabilitation Project in Edmonton, Alberta.

The scope and requirements of the geotechnical investigation were outlined in our proposal to Ms. Christina Tatarniuk, P.Eng. of the City of Edmonton (City) dated May 6, 2021. Authorization to proceed with the geotechnical investigation was received from the City on May 17, 2021.

The report supersedes our draft report dated July 20, 2021 that was issued to the City for review. This revised report includes the results of the main pavilion concrete apron slab investigation that was completed subsequent to issuing our draft report. This report also includes results of additional laboratory testing and recommendations for the playground mound.

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. PROPOSED DEVELOPMENT

We understand that William Hawrelak Park is planning for a major rehabilitation project with construction scheduled in 2022. The project is extensive and involves the rehabilitation of many aspects of the park. The Hawrelak Park Rehabilitation Project is on the IIS watch list and therefore timelines are expected to be critical.

As part of the detailed design phase of this project, a geotechnical investigation is required to support the upgrades including the existing ring road and parking lot upgrades, new multi-use trails, underground utility upgrades, new structure construction, retaining wall assessments and slope stability assessments.

Hawrelak Park was formerly a gravel extraction site and has a complex geotechnical history of past site development. Due to the all-encompassing nature of the geotechnical work at this site, a historical site review of the past site developments is important to indicate areas of past gravel extraction and backfilling that may impact the proposed park upgrades.

A site plan showing the Hawrelak Park site and highlighting the areas of proposed development is presented in Drawing 31566-1 in Appendix A. Further details on the proposed developments are presented in later sections of the report.

3. SCOPE OF WORK

Details on the overall scope of work were presented in a memo from the City dated April 6, 2021. Briefly, Thurber's scope of work consisted of the following tasks:

- Conduct a historical desktop study to review the geotechnical history of the park site including past site developments highlighting areas of gravel extraction and site filling.
- Undertake a site reconnaissance with the City and Project Team Personnel to gain an understanding of the scope of park upgrades.
- Conduct a geotechnical investigation including laboratory testing of soil samples to provide soil and groundwater information in areas of proposed park upgrades.
- Prepare a geotechnical report summarizing the work carried out, providing analyses, results, and recommendations for the project upgrades based on investigation results.

Section 4 presents a description of the geotechnical investigation methodology.

Section 5 presents an overall site description including geology, past park area developments, and surface and subsurface conditions.

Sections 6 to 15 provide geotechnical recommendations for specific elements of the park upgrades; and Section 16 provides general geotechnical recommendations for plant site developments and foundation designs.

4. METHOD OF INVESTIGATION

4.1 Historical Desktop Study

Prior to initiation of the field drilling program, Thurber conducted a review of available geotechnical investigations in the park area, as provided to us by the City, as well as a few reports in our library to provide information on expected soil conditions. A reference list of reports obtained and reviewed is presented at the end of the text.

Thurber also conducted a historical review of selected air photos and geologic history of the park to provide an overall assessment of the past park development. A summary of the desktop review is presented in Section 5.1 and the information was used in our overall assessment and recommendations presented in subsequent sections of the report.

4.2 Site Reconnaissance

An initial site reconnaissance was undertaken by Mr. Robin Tweedie of Thurber on May 2, 2021, with members of the City and the project team including the Architect and Structural Engineer.

The purpose of the site reconnaissance was to gain an overall understanding of the existing park conditions, inspect areas of major upgrades, check locations and access for bore hole investigations.

Mr. Thomas Vogt of Thurber also undertook several site inspections prior to and during the drilling program to locate specific bore holes throughout the park and check for possible underground utilities and above-ground conflicts.

4.3 Field Drilling Program

The original geotechnical drilling program scope of work included drilling a total of 76 test holes to depths ranging from 2.7 m to 11.9 m between June 7 and 18, 2021, at the approximate locations shown on Drawing No 31566-1 in Appendix A. However, six bore holes were subsequently canceled in discussion with the City as the information gathered in those areas was considered adequate for design purposes.

In addition, three core three holes were completed through the existing concrete apron slab at the Main Pavilion on July 26, 2021 to assist in assessing the condition of the slab and underlying pile foundations. Personnel from Entuitive (Structural Engineers) witnessed the core hole investigation.

A summary of the geotechnical investigation program is presented in Table 4.1.

THURBER

TABLE 4.1
TEST HOLE SUMMARY

PROJECT AREA	NUMBER OF TEST HOLES	TEST HOLE NUMBERS	DEPTH OF TEST HOLES (m)	STANDPIPE PIEZOMETERS
Ring road rehabilitation	9	TH21-01 to -09	3	-
Service yard and buildings	7	TH21-10 to -16	3 to 9	2
Parking lot rehabilitation	4	TH21-17, -18, -20 and -21	3	-
Gully settlement	1	TH21-22	6	1
Playground mound	1	TH21-23	12	1
Small bridge	2	TH21-24 and -25	9	2
New boat pavilion	2	TH21-26 and -27	9	2
Timber retaining wall	1	TH21-28	9	1
Amphitheatre washroom retaining walls and ramp	3	TH21-29 to -31	6	1
Pump House	1	TH21-32	9	1
Amphitheatre (surface treatment, asphalt, and slab)	2	TH21-33 and -34	3	-
Main Pavilion slab settlement	1	TH21-35	3	-
Multi-Use Path	12	TH21-36 to -41 and TH21-43 to -51	3	-
Boardwalk	3	TH21-52 to -54	3	-
Buried utilities	18	TH21-55 to -59, -61, -62, -64 to -67 and -70 to -73	6	7
Main Pavilion Concrete Apron	3	TH21-74 to - 76	Core holes through slab	-
TOTAL	70			18

Prior to the drilling program, underground utilities were cleared using the Alberta One Call system. A private utility locator (Hawkeye Line Locators Inc.) was also retained to scan for utilities not registered with the Alberta One Call system.

The drilling was completed using truck and track mounted auger drill rigs provided by All Services Drilling Inc of Nisku, Alberta. Supervision and test hole logging will be conducted by Mr. Greg Swan, C.E.T. of Thurber. Soil samples were obtained at regular intervals and Standard Penetration Tests (SPTs) were conducted at selected depths.

Sloughing and water levels were measured during drilling and prior to backfilling. Drill cuttings from the test holes were used to backfill the test holes and a hydrated bentonite cap was placed

at surface with a cold mix asphalt patch in paved areas. Excess cuttings were stored in soil bags and disposed of including the required testing for landfill disposal.

Slotted 25 mm PVC standpipe piezometers were installed in selected test holes to monitor the groundwater levels at the site. The test holes with piezometers were protected with flush mounted instrument protectors to ensure the continued functionality of the park and landscaping activities. The piezometers were read after completion of the drilling program prior to demobilizing from the site, and again on July 5, 2021, approximately two weeks after the drilling program to record the stabilized water table.

The City has also conducted coring of the asphalt roadways separately from this investigation and have provided the results to Thurber. The information is included in this report. We understand that the City will be deciding on the strategy for pavement upgrading. Thurber will be pleased to provide additional recommendations as required.

Environmental sampling and testing were not part of the current scope of this project.

4.4 Laboratory Testing

Laboratory testing included visual classification and determination of the natural water content of all soil samples. In addition, the following laboratory tests were carried out on selected soil samples to provide information on the geotechnical properties:

- Atterberg limits tests.
- Grain size analysis tests.
- Unconfined compressive strength tests; and
- Soluble sulphate content tests.

The results of the geotechnical drilling and laboratory program are summarized in the test hole logs provided in Appendix B. An explanation of the symbols and terms used to describe observations in the test hole logs, and the Modified Unified Soil Classification are also provided in Appendix B.

The laboratory test results are also summarized in Tables 4.2 to 4.5, respectively, and attached in Appendix C.

THURBER

TABLE 4.2
SUMMARY OF ATTERBERG LIMITS TESTS

TEST HOLE	SAMPLE DEPTH (m)	MATERIAL	WATER CONTENT (%)	ATTERBERG LIMITS			MODIFIED USCS*
				LL (%)	PL (%)	PI (%)	
TH21-4	1.5	Clay	13	35	21	14	CI
TH21-6	2.3 to 2.7	Clay	15	35	21	14	CI
TH21-8	1.5	Clay	14	37	20	17	CI
TH21-10	0.3	Clay	29	65	28	37	CH
TH21-13	3.0	Clay	13	26	15	11	CL
TH21-13	6.1	Clay	17	33	22	11	CI
TH21-14	6.1	Clay	20	29	21	8	CL
TH21-15	0.3	Clay	29	55	27	28	CH
TH21-15	3.8 to 4.3	Clay/Silt	11	23	17	6	CL-ML
TH21-22	6.1	Clay/Silt	27	28	21	7	CL-ML
TH21-26	2.3 to 2.7	Clay	14	31	21	10	CI
TH21-27	0.3	Clay	25	41	20	21	CI
TH21-37	1.5	Clay	10	33	15	18	CI
TH21-59	6.1	Silt	29	27	22	5	ML

*Modified Unified Soils Classification

TABLE 4.3
SUMMARY OF GRAIN SIZE ANALYSES RESULTS

TEST HOLE	SAMPLE DEPTH (m)	MATERIAL	FRACTION (%)		
			GRAVEL	SAND	FINES*
TH21-5	0.15	Sand	33.6	54.6	11.8
TH21-8	0.15	Sand	44.5	51.1	4.4
TH21-10	6.1	Sand	0	92.6	7.4
TH21-13	5.3 to 5.8	Sand	31.4	54.2	14.4
TH21-20	2.3 to 2.7	Sand	31.7	55.7	12.6
TH21-32	1.6	Gravel	52.7	35.5	11.8
TH21-39	1.5	Gravel	51.0	25.7	23.3
TH21-52	2.3 to 2.7	Gravel	45.6	45.3	9.1
TH21-55	6.9 to 7.3	Sand	38.3	48.5	13.2
TH21-61	3.0	Sand	11.5	69.8	18.7
TH21-65	4.6	Sand	2.7	87.3	10.0
TH21-66	1.5	Sand	28.5	51.7	19.8
TH21-72	3.0	Sand	43.0	45.6	11.4

* Fines – Percent silt plus clay sizes (percent passing 80-micron sieve)

THURBER

TABLE 4.4
SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH TESTS

TEST HOLE	SAMPLE DEPTH (m)	MATERIAL	UNDRAINED SHEAR STRENGTH (kPa)	DRY DENSITY (kg/m^3)
TH21-14	2.3 m to 2.8 m	Clay	164	1530
TH21-28	2.3 m to 2.8 m	Clay	19	1435
TH21-30	2.3 m to 2.8 m	Clay	87	1386

TABLE 4.5
SUMMARY OF SOLUBLE SULPHATE ION CONTENT TESTS

TEST HOLE	SAMPLE DEPTH (m)	SOLUBLE SULPHATE CONTENT (%)
TH21-10	4.6	0.00
TH21-13	1.5	0.02
TH21-15	3.4	0.02
TH21-23	1.5	0.02
TH21-26	1.5	0.02
TH21-28	3.4	0.02
TH21-30	1.5	0.04
TH21-32	4.6	0.02
TH21-35	1.8	0.02

5. SITE DESCRIPTION

5.1 Geology

5.1.1 Investigative Methodology

The geological assessment was based on reviewing existing available maps, reports, Lidar map and air photos, including the following material:

- L.A. Bayrock. Surficial Geology Edmonton. NTS 83H. Alberta Research Council. Published 1972.
- C.P. Kathol and R.A. McPherson. Urban Geology of Edmonton. Bulletin 32. Alberta Research Council. Published 1975.

- L.D. Andriashek. Bedrock Topography and Valley Talwegs of the Edmonton Map Area. NTS 83H. Alberta Research Council. Published 1987.
- D.J. Glass. Lexicon of Canadian Stratigraphy. Volume 4. Western Canada. Canadian Society of Petroleum Geologists. Calgary, Alberta. 1990 and 1997.
- Atkinson, N. and Lyster S. Thickness and Distribution of Quaternary and Neogene Sediments in Alberta, (Canada). Alberta Geological Survey. 2012.
- Alberta Energy Regulator/ Alberta Geological Survey. Bedrock Geology of Alberta. Map 600. Published 2013.
- Alberta Government. Alberta Energy Regulator. Coal Mine Map Viewer. https://extmapviewer.aer.ca/AERCoalMine/Index.html.
- Reports provided by the City.
- Thurber's reports.
- Air photographs from 1924 year to 1988 year.

5.1.2 Geologic Description

5.1.2.1 General

Hawrelak Park is situated on a low-level terrace on the right bank of the North Saskatchewan River. The surficial geology consists of alluvial deposits, of clay, silt, sand, and gravel (fining upwards) overlying Cretaceous Bedrock of the Edmonton Group. A geology map showing surficial and bedrock information is presented on Drawing No 31566-2 in Appendix A.

The site was formerly used for gravel extraction in the 1950's that covered much of the park. These areas were subsequently infilled predominantly with clay fill deposits. The inferred areal extent and thicknesses of the fill deposits, based on airphoto interpretation and available test hole information, is shown on Drawing No 31566-3 in Appendix A. The depth of fill over most of the park is around 2 m to 4 m thick, however deeper areas of fill up to about 6 m are present.

5.1.2.2 Bedrock

The uppermost portion of the bedrock in the area is comprised of deposits of the Upper Cretaceous Period, Horseshoe Canyon Formation (see Drawing No 31566-3).

The Horseshoe Canyon Formation consists of deltaic and fluvial deposits of interbedded and interlensed fresh and brackish water sandstone, siltstone, and shale. Typical sediments consist of soft grey, greenish and white weathered bentonitic feldspathic sandstone, brown bentonitic

shales, coal seams and beds of carbonaceous shale. Less common are concretions and beds of hard calcareous sandstone, thin nodular beds of red-brown ironstone and thin beds of bentonite. The Horseshoe Formation is underlain by Bearpaw Formation composed of marine shale.

5.1.2.3 Surficial Deposits

Bedrock topography was formed during existence and retreat of the continental ice sheet. The geologically recent North Saskatchewan River valley was formed after the Edmonton glacial lake was drained some 10,000 years ago. The river valley has cut rapidly through surficial deposits and into bedrock. During this process, the bedrock at the Hawrelak Park site was modified by the North Saskatchewan riverbed lateral movement.

The site is a large point bar formed at the bottom of the North Saskatchewan River valley. The deposits are alluvial point bar deposits. These alluvial (point bar) deposits are composed of sand and gravel with silt and clay layers and bodies. Occasionally some bodies of bedrock or till like deposits are present within the alluvium. In general, the deeper portions of alluvial are composed of coarser deposits, starting with lag gravel and the shallower portions are composed of finer-grained sand deposits overlain with flood-plain silt and clay. This trend is not always present because of different scale and intensity of river floods and consequently erosions and deposition in the historical times.

In the surrounding areas, outside of the point bar deposits, (e.g., at the base of the adjacent river valley slopes) the bedrock is covered by surficial deposits composed of glacial moraine, glaciolacustrine, and colluvium deposits.

Glacial moraine deposits at the site are till composed of mixture of clay, silt, and boulders. The till occasionally contains discontinuous bodies of gravel and sand or -ice-thrust (rafted) bedrock blocks.

Glaciolacustrine deposits overlie the moraine deposits in the uplands and are composed of layered silt, sand, and clay. The glaciolacustrine deposits were formed in the glacial Edmonton Lake in the time of Laurentide ice retreat.

Colluvium derived from past landslide movements is present at the riverbanks. Such deposits are present at the south corner of the study area, outside of the point bar. Colluvium within alluvial deposits is present as slumps caused primarily by river water level fluctuation and secondary by river erosion and accelerated by groundwater discharge.

5.1.3 Gravel Extraction and Backfilling

Review of stereo aerial photographs between 1924 and 1988, as shown on Drawing Nos 31566-4 to -5, indicates that the alluvial sand and gravel deposits were excavated roughly between the years of 1948 and 1960. The air photographs show the expansion of borrow pits from 1948 to their maximum extent around 1957. In the 1965 airphoto, landscaping and forming of the current lake can be seen. From 1965, onwards the airphotos show the park development more or less in its current topography.

It is expected that the gravel extraction process may have resulted in excavation and sorting of suitable and unsuitable granular aggregates, and some of the less desirable “dirty” sand and gravel deposits (i.e., containing high fines contents) were left on site and large portions of that material were later landscaped. It is also probable that fill material was imported from other excavations in the city and backfilled within the gravel extraction pits. All this material is recognized as “fill” on the test hole logs.

A map showing the estimated depths of fill, based on review of available test hole logs and air photos, is presented in Drawing No 31566 -3. It can be seen that the depths of fill range from approximate 2 m thick but could be more than 6 m thick at some locations.

5.2 General Site Conditions

Hawrelak Park is mostly flat lying parkland, with a central lake and numerous single storey recreational and maintenance buildings located around the park. Specific site descriptions are presented in the following sections.

The Park elevations range from about 620 m to 636 m. In general, the site slopes downward from the northeast corner to the southwest corner. However, the lake located within the western half of the site is one of the lowest lying areas within the site with the exception of the riverbanks located adjacent to the North Saskatchewan River.

5.3 General Subsurface Conditions

A description of subsurface conditions observed at each test hole location is presented on the test hole logs in Appendix B. In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Asphalt (under roadways and parking lots)
- Topsoil (under landscaped areas)

- Fill (Clay, Sand and Gravel)
- Clay and Silt
- Sand and Gravel
- Clay Till
- Bedrock (Clay Shale, Siltstone, Sandstone, Coal and Bentonite Layers).

Stratigraphic cross-sections A-A' through C-C' through the test holes showing the generalized soil condition is presented in Drawing No. 31566-2 to -3 in Appendix A.

Following is a summary of the site wide soil conditions as encountered in the test hole locations. Site specific geotechnical descriptions are presented for the various areas in Sections 6 to 15.

5.3.1 Asphalt

An asphalt layer ranging from 50 mm to 100 mm in thickness was encountered below existing ground surface at the test hole locations in the pavement areas.

5.3.2 Topsoil

A topsoil layer ranging from 40 mm to 610 mm in thickness was encountered below existing ground surface at the test hole locations in the landscaped areas and natural areas. The natural water content of the topsoil ranged from 13 to 110 percent.

It should be noted that the topsoil may be thicker or thinner between test holes. If accurate volume quantities of topsoil for stripping purposes are required, it is recommended that additional shallow test pits or test holes be undertaken on a smaller grid spacing.

5.3.3 Fill (Clay, Sand and Gravel)

Variable fills, consisting of clay, sand and gravel were encountered underlying the asphalt or topsoil in a large number of test holes. In test holes TH21-10, -15 and -24, gravel fill was encountered at ground surface. The fill extended to depths ranging between 0.1 m to 4.3 m below existing ground surface.

The clay fill was generally brown to grey, silty, and contained trace amounts of sand, gravel, oxides, and rootlets. The natural water content of the clay fill ranged from 10 to 47 percent. SPT "N" values in the clay fill ranged from 4 to 47 blows per 300 mm penetration, indicating a firm to hard consistency.

The sand fill was generally brown, silty, fine grained and contained trace amounts of gravel and oxides. The natural water content of the sand fill ranged from 0.2 to 17 percent, and a single SPT “N” value was 26 blows per 300 mm penetration, indicating a compact relative density.

Gravel fill was generally brown, silty, sandy, and fine grained. The natural water content of the gravel fill ranged from 2 to 9 percent.

5.3.4 Clay and Silt

Clay was encountered underlying the fill or directly below the topsoil in many test holes. Silt was encountered underlying the clay or clay fill in test holes TH21- 4, -6, -17, -22, -30 and -49.

The clay extended to depths ranging between 0.4 m to 4.2 m below existing ground surface. The clay was generally brown to grey, silty, contained some sand and trace amounts of oxides and gravel. The natural water content of the clay ranged from 9 to 34 percent. SPT “N” values in the clay ranged from six to 62 blows per 300 mm penetration, indicating a firm to very hard consistency.

The silt extended to depths ranging between 2.3 m to 7.2 m below existing ground surface. The silt was generally brown, clayey, contained some sand and trace amounts of oxides. The natural water content of the silt ranged from 7 to 33 percent. SPT “N” values in the silt ranged from five to 27 blows per 300 mm penetration, indicating a loose to compact relative density.

5.3.5 Sand and Gravel

Sand and gravel were encountered below the fill, clay, and silt layers in the majority of test holes.

The sand extended to depths ranging between 1.2 m to the termination depth of the test holes at 8.8 m below existing ground surface. The sand was generally brown, silty, fine grained, and contained trace amounts of gravel. The natural water content of the sand ranged from 3 to 31 percent, and SPT “N” values ranged from two to 63 blows per 300 mm penetration, indicating a very loose to very dense relative density.

The sand and gravel extended to depths ranging between 2.7 m to the termination depths of the test hole at 8.8 m below existing ground surface. The sand and gravel was generally brown, silty, fine grained and contained trace amounts of cobbles and oxides. The natural water content of the sand and gravel ranged from 6 to 22 percent, and SPT “N” values ranged from 12 to more than 100 blows per 300 mm penetration, indicating a compact to very dense relative density.

A 0.5 m thick gravel layer was encountered in test hole TH21-32 underlying the clay fill at 1.8 m below existing ground surface. The gravel was generally brown, silty, sandy, and fine grained. The natural water content of the gravel was 6 percent.

5.3.6 Clay Till

Glacial clay till was encountered underneath the clay or sand/gravel layer in test holes TH21-14, -15, -28 and -67 and extended to depths ranging from 3.8 m to 8.4 m below existing ground surface.

The clay till was generally dark brown, silty, sandy, and contained trace amounts of gravel, coal, and oxides. The natural water content of the clay till ranged from 11 to 30 percent. SPT “N” values of the clay till mainly ranged from 7 to 41 blows per 300 mm penetration, indicating a firm to hard consistency.

It should also be noted that the presence of cobbles and boulders is common within clay till strata.

5.3.7 Bedrock (Clay Shale, Siltstone, Sandstone, Coal and Bentonite)

Bedrock was generally encountered in some of the deeper test holes and extended to the test hole termination depths ranging from 2.7 m to 11.9 m below existing ground surface.

The bedrock was generally brown to grey, silty, and contained trace amounts of oxides. The natural water content of the bedrock ranged from 14 to 54 percent. SPT “N” values of the bedrock ranged from 10 to more than 100 blows per 300 mm penetration, indicating a stiff to very hard consistency in soil mechanics terminology (extremely weak to very weak in rock mechanics terminology).

5.4 Groundwater and Slough Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test hole logs in Appendix B. Standpipe piezometers were installed in 18 test holes to allow for future monitoring of groundwater levels. The groundwater levels were measured prior to demobilizing from the site and again on July 5, 2021, approximately two weeks after the drilling program completion.

THURBER

TABLE 5.1
SUMMARY OF SLOUGH AND GROUNDWATER LEVELS

TEST HOLE	TEST HOLE DEPTH B.G.S. (m)	SLOUGH ON COMPLETION B.G.S. (m)	FREE WATER ON COMPLETION (ABOVE SLOUGH) B.G.S. (m)	STANDPIPE WATER LEVEL B.G.S. (m)	
				June 18, 2021	July 5, 2021
TH21-14	8.8	8.1	8.0	8.1	7.9
TH21-15	8.4	5.9	DRY	DRY	DRY
TH21-22	7.3	6.4	5.9	5.4	5.7
TH21-23	11.9	11.7	DRY	6.0	6.0
TH21-24	8.8	8.5	5.5	1.8	1.6
TH21-25	8.8	8.2	4.0	1.5	1.3
TH21-26	8.8	8.2	6.4	1.6	1.5
TH21-27	8.8	8.5	7.9	1.9	1.9
TH21-28	8.8	8.5	7.6	3.7	4.1
TH21-31	5.8	5.6	DRY	DRY	DRY
TH21-32	8.8	NONE	DRY	3.0	3.1
TH21-56	7.3	NONE	DRY	DRY	DRY
TH21-59	7.3	6.7	6.4	7.0	7.0
TH21-62	5.8	4.6	4.5	1.9	2.0
TH21-67	5.8	4.3	4.1	3.8	3.7
TH21-71	5.8	NONE	5.5	2.3	2.5
TH21-72	5.8	2.7	2.6	2.5	2.4
TH21-73	5.8	NONE	DRY	DRY	DRY

Note: B.G.S = Below Ground Surface

The short-term groundwater measurements indicate that the groundwater levels varied at depths between 1.3 m and 7.9 m below the existing ground surface across the park. It should be noted that the highest ground water levels were observed in the test holes located closest to the lake.

It should be noted that the groundwater measurements are short-term, and the groundwater table may vary between locations, and that seasonal fluctuations of groundwater levels may be encountered due to precipitation and other climatic factors. Hence, the actual groundwater conditions at the time of construction could vary from those recorded during this investigation.

5.5 Frost Effects

The surficial clay and sand are considered to have moderate to high frost susceptibility; in addition, the groundwater table is expected to be at a shallow depth. Hence, frost action is a concern and should be considered in the design of foundations, grade-supported slabs, and roadways. In addition, uplift forces on piles due to frost action will have to be considered.

The expected depths of frost penetration have been estimated using average estimated thermal parameters for the in-situ materials. The frost penetration has been estimated for:

- The mean annual air freezing index of 1760 ºC-days
- The 50-year return period annual freezing index of 2640 ºC-days.

The estimated frost penetration depths are provided for a variety of materials in Table 5.2.

TABLE 5.2
ESTIMATED DEPTH OF FROST PENETRATION

MATERIAL	ESTIMATED DEPTH OF FROST PENETRATION (m)	
	MEAN AFI	50-YEAR RETURN AFI
Clay Fill/Clay/Clay Till/Clay Shale	1.8	2.4
Sand and Gravel / Sand and Gravel Backfill	2.4	3.0

The estimated depth of frost penetration is for a uniform soil type with no snow cover. The depth of frost penetration will be shallower if turf or snow cover is present. The 50-year return estimated frost penetration depth is generally used for design.

6. SERVICE AREA

6.1 General

The service area is located near the park entrance and contains several maintenance buildings, storage areas, a Quonset hut and fuel tanks.

It is understood that the following additions and modification are being considered:

- The storage bays will be demolished and moved towards the outside.
- Parking area will be expanded and most of the existing pavement will be replaced.
- The existing building will be expanded to the south.
- Existing above ground fuel tanks will be moved to the southeast side of the Quonset.

6.2 Subsurface conditions

Test holes TH21-10 to TH21-16 were drilled in the service area and encountered the following soil and groundwater conditions.

In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Asphalt
- Topsoil
- Fill (Clay, Sand and Gravel)
- Clay and Clay Till
- Sand and Gravel.

Stratigraphic cross-section C-C' on Drawing No. 31566-3 in Appendix A shows the generalized soil conditions of the test holes in close proximity to the service area.

6.2.1 Asphalt

An asphalt layer was encountered below existing ground surface in test hole TH21-11 and was 50 mm in thickness.

6.2.2 Topsoil

A topsoil layer ranging from 80 mm to 300 mm in thickness was encountered below existing ground surface at the test hole locations. The natural water content of the topsoil ranged from 41 to 91 percent.

6.2.3 Fill (Clay and Gravel)

The gravel fill was generally brown, silty, sandy, and fine grained. The water content of the gravel fill ranged from 4 to 9 percent.

The clay fill was generally brown to grey, silty, and contained trace amounts of gravel, rootlets, oxides, and coal. The water content of the clay fill ranged from 12 to 29 percent and SPT "N" values ranged from eight to 39 blows per 300 mm penetration, indicating a stiff to hard consistency.

6.2.4 Clay and Clay Till

The clay was generally brown, silty with some to trace amounts of sand and trace amounts of oxides. The natural water content of the clay ranged from 9 to 22 percent and SPT "N" values ranged from 9 to 62 blows per 300 mm penetration, indicating a stiff to very hard consistency.

The clay till was generally brown, silty, sandy, and contained trace amounts of gravel, coal, and oxides. The natural water content of the clay till ranged from 11 to 21 percent and SPT “N” values ranged from seven to 41 blows per 300 mm penetration, indicating a firm to hard consistency.

An inter-till sand and gravel layer was encountered in test hole TH21-15 from depths ranging between 4.3 m to 5.8 m below existing ground surface. The sand and gravel was generally brown, silty, fine grained and contained trace amounts of clay. The natural water content of the sand and gravel was 11 percent and one SPT “N” value in the sand and gravel was 63 blows per 300 mm penetration, indicating a very dense relative density.

6.2.5 Sand and Gravel

The sand was generally brown, silty, find grained and contained trace amounts of gravel and oxides. The natural water content of the sand ranged from 3 to 26 percent and SPT “N” values ranged from two to 58 blows per 300 mm penetration, indicating a very loose to very dense relative density.

The sand and gravel layers were generally brown, silty, fine grained and contained trace amounts of coal. The natural water content of the sand and gravel ranged from 12 to 22 percent and SPT “N” values ranged from 12 to more than 100 blows per 300 mm penetration, indicating a compact to very dense relative density.

6.2.6 Groundwater Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test hole logs in Appendix B. Standpipe piezometers were installed in two test holes, (TH21-14 and -15) within in the service area to monitor the short-term groundwater levels. The groundwater levels were measured prior to demobilizing from the site and again on July 5, 2021, approximately two weeks after the drilling program completion.

The short-term groundwater level readings indicated that the groundwater level was approximately 7.9 m below existing ground surface (elev. 624.6 m). The standpipe near the Quonset was dry which indicates that the groundwater level is deeper than 5.8 m below existing ground surface (elev. 629.5 m).

6.3 Building Foundations

No information was provided on the building layouts or foundation loading conditions at the time of report preparation. The following building foundation types may be considered for the service buildings:

- Cast-in-place concrete piles
- Spread footings.
- Reinforced concrete raft foundation.

From a geotechnical perspective, pile foundations are preferred for the building expansion as they are less prone to settlements and seasonal movements and will therefore provide less differential settlement between the existing building and the new expansion building.

Spread footings or a raft foundation are considered feasible foundation types to support the building expansion on the south side of the existing building; however, differential settlements between the existing building and the building expansion will need to be taken into consideration.

Further evaluation and foundation recommendations may be provided when more details on the building expansions are available.

6.3.1 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles should be designed and installed according to the recommendations given below.

- Table 6.1 defines the factored ULS shaft resistance values that may be used for the design of concrete cast-in-place friction piles:

TABLE 6.1
CAST-IN-PLACE CONCRETE FRICTION PILES
ULS SHAFT RESISTANCE PARAMETERS

DEPTH BELOW EXISTING GROUND LEVEL (m)	SOIL TYPE	ULTIMATE SHAFT RESISTANCE (kPa)	FACTORED ULS SHAFT RESISTANCE (kPa)	
			Compression (Φ =0.4)	Tension (Φ=0.3)
0 – 1.5(1)	Fill	0	0	0
1.5 – 4	Clay Fill / Clay Till / Sand and Gravel	30	12	9
Below 4	Clay Till / Sand and Gravel	55	22	16.5

Note: 1) Ignore upper 1.5 m below ground surface or depth of fill, whichever is greater

A minimum pile length of 6 m is recommended for design of cast in place concrete friction piles to provide adequate uplift resistance for frost heave effects for unheated buildings and heated buildings during construction.

It should be noted that sand and gravel layers were encountered at relatively shallow depths in the bore holes and are expected to result in sloughing conditions. Where sloughing sand and gravel layers are encountered at the design level, it will be necessary to provide the temporary casing(s) of the pile holes to advance the piles to the specified depths.

Further recommendations for the design and installation of cast-in-place concrete pile recommendations are provided in Section 16.6.

6.3.2 Spread Footings

Spread footings should be founded on the undisturbed inorganic native clay or sand. Footings founded on the undisturbed inorganic clay or sand may be designed using a factored ULS bearing resistance of 90 kPa for strip footings and 110 kPa for square footings. This is based on an ultimate bearing capacity of 180 kPa for strip footings and 220 kPa for square footings, and a geotechnical resistance factor of 0.5.

Further recommendations for the design and installation of spread footing recommendations are provided in Section 16.10.

6.3.3 Reinforced Concrete Raft Foundation

A reinforced raft foundation bearing may be founded on the native, undisturbed clay and sand below all topsoil. The raft foundation should be designed using a factored ULS net bearing resistance of 110 kPa, based on net ultimate bearing capacity of 220 kPa and a Geotechnical Resistance Factor of 0.5.

Frost design and insulation recommendations are provided in Section 16.3. A typical detail for insulated slab-on-grade is provided in Figure 16.2.

The reinforced concrete raft founded on the undisturbed clay and sand may be designed based on a modulus of subgrade reaction k_{s1} of 25 MN/m^3. A correction should be applied in the structural analysis to account for the size of raft element used in the analysis.

6.4 Miscellaneous

Modifications within the service area include an expansion to the existing staff parking lot, reconfiguration of the gravel surfaced perimeter roadway and relocation of the existing above ground fuel tanks to the southeast side of the Quonset. Recommendations for the pavement upgrades and fuel tank foundations are provided in the sections below.

6.4.1 Pavement For Staff Parking Lot Expansion

The subgrade for the expanded staff parking lot area should be prepared following the recommendations provided in Section 16.2.

A soaked California Bearing Ratio (CBR) value of 3 is considered applicable to the types of subgrade materials at this site for design of the pavement structure. It is assumed that the light duty parking areas will not be used by heavy trucks, but for passenger vehicles and light trucks only. For preliminary design purposes, the pavement structures presented in Table 6.2 may be used. A more detailed analysis should be undertaken when the exact traffic loads are known.

TABLE 6.2
RECOMMENDED PAVEMENT STRUCTURE

PAVEMENT TYPE	PAVEMENT STRUCTURE
Light Duty (such as parking areas for light cars and pickup trucks) 5 X 10^4 ESALs	75 mm Asphaltic Concrete (LT) over 250 mm Crushed Granular Base Course over 150 mm prepared subgrade

Pavement material should be provided and constructed in accordance with the latest edition of the City of Edmonton Standard Specifications.

6.4.2 Fuel Tank Foundations

The proposed above ground fuel tanks may be supported on a concrete slab-on-grade bearing on compacted granular fill, overlying adequately prepared subgrade soil. The bearing pressure at the base of the slab-on-grade should not exceed a factored ULS bearing resistance of 90 kPa, based on an ultimate bearing capacity of 180 kPa and a Geotechnical Resistance Factor of 0.5.

Recommended procedures for site preparation and grading are provided in Section 16.2. The following additional recommendations apply for the generator slab-on-grade:

- All vegetation, organic materials, loose/soft or wet soils (refer to test hole log TH21-15) should be removed from below the footprint of the proposed slab-on-grade. Field review of the exposed base of sub-excavation should be conducted by qualified geotechnical personnel.
- The exposed subgrade should be scarified to a depth of at least 150 mm and recompacted to at least 95 percent of Standard Proctor Maximum Dry Density (ASTM D698).

- Care should be taken to prevent freezing of the native soil at the base of sub-excavation during construction. Soils that become disturbed because of exposure to the elements or construction traffic should be removed and replaced with compacted fill.
- Fill soils needed to attain the design subgrade level should consist of low to medium plastic clay or clay till. Fill material should be placed in 150 mm thick lifts and compacted to at least 98 percent of the SPMDD at moisture contents within zero to 2 percent above the OMC.
- The finished subgrade should be sloped at a minimum gradient of 1 percent toward perimeter ditches or catch basins (where present) to drain any subsurface water away from the structure.
- A minimum of 300 mm of clean, well-graded sand and gravel (e.g., City of Edmonton Designation 3, Class 20 granular base) should be placed beneath the concrete slab for support and drainage purposes. Coarse material greater than 50 mm in size should be avoided directly beneath the slab to prevent stress concentrations. The granular course should be compacted to a uniform dry density of a minimum of 100 percent of SPMDD. A recommended typical gradation for free draining granular material, for use under grade-supported slabs, is provided in Table 6.3.
- The slab-on-grade should be designed to tolerate some movement, possibly in the order of 25 mm to 50 mm, due to frost heave effects. If the proposed fuel tanks foundation is sensitive to frost heave movement, insulation should be provided below the concrete slab to limit frost penetration. A typical detail for insulated slab-on-grade is provided in Figure 16.2. Where there is potential for hydrocarbon spills, other types of insulation such as cellular concrete (e.g., Cematrix) should be used.

7. MAIN PAVILION AND CONCRETE APRON

7.1 General

We understand that the current concrete apron slab between the main pavilion and the lake has major drainage issues including ponding of water during spring melt and periods of precipitation.

Available drawings (see Appendix A) indicate that the concrete apron slab is supported on bored cast-in-place concrete piles on an approximately 5 m x 5 m grid spacing. The piles consist of 4 m long belled concrete piles with shaft diameters of 600 mm and bell diameters of 900 mm. The drawings also indicate that 100 mm of crushable void form was installed underneath the existing concrete apron slab, which was presumably used to eliminate or reduce potential uplift frost heave

pressures on the underside of the structural raft slab. No specifications are available for the type of void form used, in order to confirm the compressive strength of the void form.

No as-built construction records are available to verify that the piles were properly installed or that the bases were formed in appropriate bearing soils.

Visual observations during our May 2021 site visit indicated that the slab has heaved close to the lake edge and may have separated from a few piles. Information provided by the City indicates that some of the void form close to the edge of the slab may have become detached from the slab and has been seen floating in the lake.

Subsequent visual inspections under the apron slab by Thurber personnel on July 15 and 26, 2021, during the slab coring investigation, also indicated that some of the void form is missing and there is a gap between the underside of the concrete slab and the ground surface. The condition of the void form throughout the remainder of the area not feasible to inspect is not known.

It appears that the lake water levels vary throughout the year and sometimes the lake rises and flows under the apron slab. In addition, the ice level is kept relatively high during winter for easy access from the steps onto the lake ice surface. As a result, it is suspected that frost heave is a major issue during winter resulting in frost heave of the slab and distress to the slab/pile connections. It was noted that the apron slab has jacked up about 200 mm compared to the adjacent concrete curb at the south edge of the slab.

Three concrete cores will be obtained to assess the conditions of select slab/pile connections underlying the concrete apron slab. The number and locations of the concrete cores were selected by Entuitive. Scanning for anomalies and rebar was conducted on July 15 and 26, 2021, using a ground penetrating radar (GPR) scanner at core locations 1 to 3 shown on the available construction drawing (see Appendix A). The GPR scanner indicated a large number of anomalies and rebar at core locations 1 to 3. Adjustments were made onsite to reposition the cores to avoid conflicts with existing steel reinforcement within the concrete slab.

The concrete cores and test holes were extended to 170 mm below the top of the concrete slab elevation to assess the slab/pile connections. Visual inspections of the concrete cores, side walls of the concrete core excavations and pile foundations supporting the slab were inspected with a telescoping camera. A hand auger was used to excavate approximately 1 m below the existing soil elevation to obtain disturbed soil samples underlying the concrete slab.

For further information regarding the main pavilion concrete apron slab concrete coring investigation, refer to Thurber's memorandum provided in Appendix D.

7.2 Subsurface Conditions

Test holes TH21-35, -52, -72 and -74 to -76 were drilled close to the main pavilion building and encountered the following soil and groundwater conditions.

In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Topsoil
- Clay Fill
- Sand and Gravel
- Clay
- Bedrock (Clay Shale).

Stratigraphic cross-section A-A' on Drawing No. 31566-2 in Appendix A shows the generalized soil conditions of the test holes in close proximity to the main pavilion.

7.2.1 Topsoil

A topsoil layer ranging from 80 mm to 130 mm in thickness was encountered below existing ground surface in test holes TH21-35, -52 and -72. The natural water content of the topsoil ranged from 50 to110 percent.

7.2.2 Clay Fill

The clay fill was generally brown to grey, silty, and contained some sand and trace amounts of gravel, oxides, and rootlets. The water content of the clay fill ranged from 15 to 34 percent and SPT "N" values ranged from 11 to 47 blows per 300 mm penetration, indicating a stiff to hard consistency.

7.2.3 Sand and Gravel

The sand and gravel was generally brown, silty, and fine grained. The natural water content of the sand and gravel ranged from 9 to 22 percent and SPT "N" values ranged from 29 to 40 blows per 300 mm penetration, indicating a compact to dense relative density.

7.2.4 Clay

The clay was generally brown, silty, contained some sand and trace amounts of gravel, coal, and oxides. The natural water content of the clay was 19 percent and one SPT “N” value in the clay was 11 blows per 300 mm penetration, indicating a stiff consistency.

7.2.5 Bedrock (Clay Shale)

The clay shale was generally brown, silty, and contained trace amounts of coal, sandstone pockets, sandstone lenses and oxides. The natural water content of the clay shale was 26 percent and one SPT “N” value was 35 blows per 300 mm penetration, indicating a hard consistency in soil mechanics terminology (extremely weak in rock mechanics terminology).

7.2.6 Groundwater Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test, hole logs in Appendix B. One standpipe piezometer was installed in test hole TH21-72 near the main pavilion to monitor the short-term groundwater levels.

The short-term groundwater level readings on July 5, 2021, approximately two weeks after the drilling program completion, was approximately 2.4 m below existing ground surface (elev. 622 m).

7.3 Geotechnical Evaluation and Recommendations

The following recommendations may be used for assessment of existing concrete piles supporting the apron slab. These recommendations can also generally be applied to design of new concrete pile foundations in this location.

7.3.1 Existing Cast-In-Place Concrete End Bearing Piles

Information provided on the design drawings indicate that the cast-in-place concrete piles consist of 4 m long belled concrete piles with shaft diameters of 600 mm and bell diameters of 900 mm. The piles will be subjected to vertical compression loading due to the weight of slab plus live loading on the slab. In winter, the piles will also be subjected to frost heave forces.

The nearest bore holes indicate that the near surface soils below the slab are expected to consist of medium plastic clay and the groundwater table is expected to be relatively high throughout most of the year. Hence, swelling of the soils is not expected to be a significant concern, particularly when compared to the potential for frost heaving. However, the soil conditions may

be quite variable throughout the slab areal extent and may include clay fill near surface, with sand and gravel layers, and possibly clay shale bedrock at some depth below the pile bases.

For design checks of the existing pile compressive capacities, the following end bearing, and shaft friction values may be used:

- Cast-in-place concrete end bearing piles founded in the stiff clay may be designed using a factored ULS bearing resistance of 280 kPa, based on an ultimate bearing capacity of 700 kPa and a Geotechnical Resistance Factor (Φ) of 0.4.
- Where necessary, shaft resistance may be included from a depth of 1.5 m below grade to one shaft diameter above the pile bell using an ultimate shaft resistance of 35 kPa, and a factored ULS shaft resistance in compression of 14 kPa based on a geotechnical resistance factor of 0.4, and 10.5 kPa in tension, based on a geotechnical resistance factor of 0.3.

Refer to Section 16.5 for pile foundation limit states design information.

7.3.2 Uplift Design

7.3.2.1 Uplift Capacity

Belled concrete piles may resist uplift load by developing skin friction along the pile shaft, and uplift resistance on the annulus area between the shaft and the bell.

For cast-in-place concrete end bearing piles with depth to shaft diameters of greater than three, the ultimate uplift resistance of the bell may be taken as the ultimate bearing capacity of the material above the bell times the area of the annulus area (i.e., the projected horizontal surface) between the pile bell and the shaft, that is:

$$Q_{B\ (uplift)} = q_b \times (A_B - A_S),\ kN$$

Where:

q_b = ultimate bearing resistance of soil above base in uplift, use 700 (kPa)

A_B, A_S = areas of the base and shaft, respectively (m^2).

The factored ULS uplift bearing resistance of the annulus area is therefore 210 kPa, based on a geotechnical resistance factor of 0.3 in uplift (see Table 16.1)

Where necessary, shaft resistance may be included using the values given in Section 7.3.1, above.

7.3.2.2 Frost Heave Effects

Piles subjected to frost heave forces should be checked for adequate resistance to uplift. Adfreeze forces may be estimated based on an adfreeze friction value of 65 kPa for concrete piles applied around the pile circumference over the expected depth of freezing (assume 2.4 m depth below grade). Since these are ultimate adfreeze values applied to the one in 50-year design frost depth, a load factor of 1.0 is generally applied in determining the required pile embedment depth to resist frost heave.

Resistance to frost uplift force will be provided by dead load acting on the pile, the weight of the pile, the frictional resistance on the shaft below the frozen zone, and end bearing resistance on the annular area between the shaft and bell. Since the adfreeze values are ultimate values, and the frost depths provided are based on 50-year return periods, a geotechnical resistance factor of 0.8 should be applied to the ultimate shaft resistance value of 35 kPa, and ultimate end bearing value of 700 kPa given above in resisting frost heave.

Transient uplift (i.e., wind) loads and dynamic loads need not be added to frost heave forces in the calculation of pile length requirements for uplift resistance but should be checked independently.

It should be noted that uplift frost heave forces on the underside of the structural apron slab may also need to be taken into account, where the void form has been damaged or destroyed (i.e., not present in the current state). Frost uplift heave forces on underside of slabs can be very high, and hence the normal procedure is to avoid them by placing adequate insulation or void form below the slab to accommodate the potential frost heave and designing for the crushing strength of the void form used.

For frost heave estimation purposes, it may be assumed that the amount of frost heave movement of the underlying soils during freezing could be up to 50 mm (i.e., 50 percent of the original void form thickness of 100 mm). The resulting uplift pressure on the underside of the concrete apron slab is therefore determined from the stress-strain curve of the specific void form and determining the compressive stress at the equivalent 50 percent strain. We do not have information on the void form used and cannot therefore determine the expected frost heave upward pressure on the underside of the concrete apron slab.

It should be noted that frost heave pressures on horizontal surfaces that are restrained from upward movement by piles and where no void form is present to absorb the upward frost heave movements can be very large, possibly in the range of 200 kPa or more. On this basis it is more appropriate to provide sufficient void form to accommodate the frost heave movements, than to try and design for the resulting frost heave uplift force.

As a general guideline, the compressive strain of the void form is generally restricted to 25 percent of the original void form thickness to maintain the void form within the recoverable range; hence a void form thickness of at least 200 mm of rebounding type void form would be more appropriate for this application.

A compressible non-rebounding type of insulation is not appropriate in this application where the water level can be quite high, since the water can enter the void space left behind after the void form compresses and subsequently freeze, resulting in higher uplift stresses on the underside of the concrete slab.

8. TIMBER RETAINING WALL

8.1 General

It is understood that three timber retaining walls located on the North Saskatchewan riverbank on the west side of the park are showing signs of distress. The timber retaining walls have been used to stabilize the riverbank slope to provide trail access down to the waterfront of the North Saskatchewan River.

No details of proposed retaining wall refurbishment or replacement were available at the time of report preparation. Further evaluation and recommendations can be provided when more details are available.

8.2 Subsurface Conditions

Test hole TH21-28 was drilled near the timber retaining wall on the North Saskatchewan riverbank and encountered the following soil and groundwater conditions, in descending order:

- Topsoil
- Clay Fill
- Clay and Clay Till
- Bedrock (Clay Shale, Coal and Bentonite).

Following is a brief description of the soil conditions. For further information, refer to the individual test hole logs.

8.2.1 Topsoil

A 150 mm thick topsoil layer was encountered below existing ground surface. The natural water content of the topsoil was 13 percent.

8.2.2 Clay Fill

The clay fill was generally brown, silty, and contained trace amounts of sand, coal, and oxides. The water content of the clay fill was 25 percent.

8.2.3 Clay and Clay Till

The clay and clay till was generally brown, silty, contained some sand and trace amounts of gravel, coal, and oxides. The natural water content of the clay and clay till ranged from 21 to 30 percent. SPT “N” values in the clay and clay till ranged from seven to 12 blows per 300 mm penetration, indicating a firm to stiff consistency.

8.2.4 Bedrock (Clay Shale, Coal and Bentonite)

Clay shale and bentonite was generally brown to grey, silty, high plastic and contained trace amounts of coal and oxides. The natural water content of the clay shale and bentonite ranged from 17 to 43 percent. SPT “N” values in the clay shale and bentonite ranged from 11 to more than 100 blows per 300 mm penetration, indicating a stiff to very hard consistency in soil mechanics terminology (extremely weak to very weak in rock mechanics terminology).

A 1.0 m thick coal layer was encountered within the clay shale at 7.3 m below existing ground surface. The coal was generally black and contained trace amounts of clay shale. The natural water content of the coal was 45 percent.

8.2.5 Groundwater Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test, hole logs in Appendix B. A single standpipe piezometer was installed in test holes TH21-28 to monitor the short-term groundwater levels. The groundwater levels were measured prior to demobilizing from the site and again on July 5, 2021, approximately two weeks after the drilling program completion and was approximately 4.1 m below existing ground surface (elev. 616.3 m).

8.3 Retaining Walls

For preliminary assessment of the retaining walls, lateral earth pressures are provided in Section 16.11. Thurber should check the global stability of the retaining walls once more details are available.

Further recommendations can be provided when more details on the retaining wall redesigns are available.

9. AMPHITHEATRE

9.1 General

Numerous upgrades are planned in the amphitheater area, including:

- Redesign of the access ramp behind the main stage for better access. This will require a new retaining wall.
- Widening of the main access path to the amphitheater which may require small retaining walls on each side.
- New access into the washroom facilities, which will require a new retaining wall.
- Repair of the existing retaining wall (including backfilling).

In addition, there will be a new pumphouse located on the north side of the Amphitheatre.

9.2 Subsurface Conditions

Test holes TH21-29 to -34 were drilled in the amphitheater area and encountered the following soil and groundwater conditions, in descending order:

- Topsoil and Asphalt
- Fill (Clay and Gravel)
- Clay
- Sand and Gravel
- Bedrock (Clay Shale and Sandstone).

Stratigraphic cross-section B-B’ on Drawing No. 31566-3 in Appendix A shows the generalized soil conditions of the test holes in the amphitheatre area.

Following is a brief description of the soil conditions. For further information, refer to the individual test hole logs.

9.2.1 Topsoil and Asphalt

A topsoil layer ranging from 100 mm to 300 mm in thickness was encountered below existing ground surface in test holes TH21-29 to -33. The natural water content of the topsoil ranged from 33 to 54 percent.

A 75 mm thick asphalt layer was encountered underlying the existing ground surface in test hole TH21-34. Gravel fill was encountered underlying the asphalt in test hole TH21-34. The gravel fill extended to 300 mm below existing ground surface. The gravel fill was generally brown, silty, sandy, and fine grained. The waster content of the gravel fill was 5 percent.

9.2.2 Clay Fill

The clay fill was generally brown to grey, silty, and contained trace amounts of sand, gravel, oxides, and rootlets. The water content of the clay fill ranged from 11 to 31 percent and SPT “N” values ranged from 10 to 13 blows per 300 mm penetration, indicating a stiff consistency.

9.2.3 Clay

The clay was generally brown to grey, silty, and contained trace amounts sand, oxides, and coal. The natural water content of the clay ranged from 18 to 33 percent and SPT “N” values ranged from nine to 12 blows per 300 mm penetration, indicating a stiff consistency.

9.2.4 Sand and Gravel

The sand and gravel were generally brown, silty, and fine grained. The natural water content of the sand ranged from 6 to 17 percent and one SPT “N” value was 10 blows per 300 mm penetration, indicating a loose to compact relative density.

9.2.5 Bedrock (Clay Shale and Sandstone)

The clay shale was generally brown to grey, silty, high plastic and contained trace amounts of silt lenses and sandstone. The natural water content of the clay shale ranged from 15 to 31 percent and SPT “N” values ranged from 13 to more than 100 blows per 300 mm penetration, indicating a stiff to very hard consistency in soil mechanics terminology (extremely weak to very weak in rock mechanics terminology).

Sandstone layers typically less than one metre thick were generally encountered within the clay shale in most of the test holes. The sandstone was generally grey, silty, fine grained and contained trace amounts of oxides. The natural water content of the sandstone ranged from 17 to 20 percent and SPT “N” values ranged from 32 to 53 blows per 300 mm penetration, indicating a dense to very dense relative density in soil mechanics terminology (extremely weak in rock mechanics terminology).

9.2.6 Groundwater Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test hole logs in Appendix B. Standpipe piezometer was installed in test holes TH21-31 and -32 to monitor the short-term groundwater levels. The groundwater levels were measured prior to demobilizing from the site and again on July 5, 2021, approximately two weeks after the drilling program completion and was approximately 3.1 m below existing ground surface (elev. 622.5 m). The standpipe near the main walkway in the amphitheater was dry which indicates that the groundwater level is deeper than 5.8 m below existing ground surface (elev. 623 m).

9.3 Geotechnical Evaluation and Recommendations

9.3.1 Retaining Walls

It is understood that there will be several relatively low retaining walls required in the Amphitheatre. The walls may consist of MSE walls or cantilever retaining walls. For design of retaining wall and ramps in the Amphitheatre area, lateral earth pressures are provided in Section 16.11. Thurber should check the global stability of the retaining walls once more details are available.

The following foundation types may be considered for support of the retaining walls and ramps:

- Cast-in-place concrete piles
- Spread footings.

9.3.2 Cast-In-Place Concrete Piles

Cast-in-place concrete friction piles should be designed and installed according to the recommendations given below.

- Table 9.1 defines the factored ULS shaft resistance values that may be used for the design of concrete cast-in-place friction piles:

TABLE 9.1
CAST-IN-PLACE CONCRETE FRICTION PILES
ULS SHAFT RESISTANCE PARAMETERS

DEPTH BELOW EXISTING GROUND LEVEL (m)	SOIL TYPE	ULTIMATE SHAFT RESISTANCE (kPa)	FACTORED ULS SHAFT RESISTANCE (kPa)	
			Compression (Φ =0.4)	Tension (Φ=0.3)
0 – 1.5(1)	Fill	0	0	0
1.5 – 4	Clay Fill / Clay / Sand and Gravel / Clay Shale	30	12	9
Below 4	Clay Shale / Sandstone	80	32	24

Note: 1) Ignore upper 1.5 m below ground surface or depth of fill, whichever is greater

A minimum pile length of 6 m is recommended for design of cast in place concrete friction piles in unheated areas to provide adequate uplift resistance for frost heave effects.

It should be noted that sand and gravel layers were encountered at relatively shallow depths in the bore holes and are expected to result in sloughing conditions. Where sloughing sand or gravel layers are encountered at the design level, it will be necessary to provide the temporary casing(s) of the pile holes to advance the piles to the specified depths.

Refer to Section 16.5 for pile foundation limit states design information. Further recommendations for the design and installation of cast-in-place concrete pile recommendations are provided in Section 16.6.

9.3.3 Spread Footings

Spread footings should be founded on the undisturbed inorganic native clay, sand and gravel, or clay shale.

Spread footings supporting cantilever retaining walls that can tolerate some movements may be founded at a suggested minimum depth of 1.5 m below ground surface.

Spread footings founded on the undisturbed inorganic clay, gravel or clay shale may be designed using a factored ULS bearing resistance of 180 kPa for strip footings and 210 kPa for square footings. This is based on an ultimate bearing capacity of 360 kPa for strip footings and 420 kPa for square footings, and a geotechnical resistance factor of 0.5.

It should be noted that high plastic clay shale has a high swelling/shrinking potential which may cause having/settling of the footings if the water content of the material varies significantly. Care

should be taken to prevent the high plastic clay from becoming desiccated or exceedingly wet during and after construction of the footings.

Further recommendations for the design and installation of spread footing recommendations are provided in Section 16.10.

9.4 Pavement Upgrades

It is understood that the access road into the Amphitheatre is showing signs of distress. Reconstruction of the pavements will be required for roadway pavements in poor condition, at failed areas and areas with alligator cracking. No details of the method of reconstruction are available at the present time. Further details can be provided when the details of reconstruction are available.

A soaked California Bearing Ratio (CBR) value of 3 is considered applicable to the types of subgrade materials at this site for design of the pavement structure.

Pavement material should be provided and constructed in accordance with the latest edition of the City of Edmonton Standard Specifications.

9.5 Irrigation Pumphouse

It is understood that a new irrigation pumphouse is proposed on the north side of the Amphitheatre located west of the existing Amphitheatre washrooms. The pumphouse will be required to upgrade the sprinkler system within the park. The irrigation pumphouse has a proposed building footprint of 50 m^2 and will be constructed into the existing berm on the north side of the Amphitheatre.

9.5.1 Retaining Walls

It is understood that the proposed irrigation pumphouse will be embedded into the slope on the north side of the Amphitheatre and a retaining wall will be required. The walls may consist of MSE walls or cantilever retaining walls. For design of the retaining wall around the irrigation pumphouse, lateral earth pressures are provided in Section 16.11. Thurber should check the global stability of the retaining walls once more details are available.

The following foundation types may be considered for support of the retaining walls (see Sections 9.5.2.1 and 9.5.2.2):

- Cast-in-place concrete piles

- Spread footings.

9.5.2 Foundations

The following building foundation types may be considered for the irrigation pumphouse:

- Cast-in-place concrete piles
- Spread footings.
- Reinforced concrete raft foundation.

9.5.3 Cast-In-Place Concrete Piles

Cast-in-place concrete friction piles should be designed and installed according to the recommendations given below.

- Table 9.2 defines the factored ULS shaft resistance values that may be used for the design of concrete cast-in-place friction piles:

TABLE 9.2
CAST-IN-PLACE CONCRETE FRICTION PILES
ULS SHAFT RESISTANCE PARAMETERS

DEPTH BELOW EXISTING GROUND LEVEL (m)	SOIL TYPE	ULTIMATE SHAFT RESISTANCE (kPa)	FACTORED ULS SHAFT RESISTANCE (kPa)	
			Compression (Φ =0.4)	Tension (Φ=0.3)
0 – 1.5(1)	Fill	0	0	0
1.5 – 4 (Elev. 624 to 621.5)	Gravel / Clay Shale / Sandstone	35	14	10.5
Below 4 (Elev. 621.5)	Clay Shale / Sandstone	60	24	18

Note: 1) Ignore upper 1.5 m below ground surface or depth of fill, whichever is greater

A minimum pile length of 6 m is recommended for design of cast in place concrete friction piles to provide adequate uplift resistance for frost heave effects for unheated buildings and heated buildings during construction.

It should be noted that gravel layers were encountered at relatively shallow depths in the bore holes and are expected to result in sloughing conditions. Where sloughing gravel layers are encountered at the design level, it will be necessary to provide the temporary casing(s) of the pile holes to advance the piles to the specified depths.

Refer to Section 16.5 for pile foundation limit states design information. Further recommendations for the design and installation of cast-in-place concrete pile recommendations are provided in Section 16.6.

9.5.3.1 Spread Footings

Footings should be founded on the undisturbed inorganic gravel or clay shale. Footings founded on the undisturbed inorganic gravel or clay shale may be designed using a factored ULS bearing resistance of 180 kPa for strip footings and 210 kPa for square footings. This is based on an ultimate bearing capacity of 360 kPa for strip footings and 420 kPa for square footings, and a geotechnical resistance factor of 0.5.

It should be noted that high plastic clay shale has a high swelling/shrinking potential which may cause having/settling of the footings if the water content of the material varies significantly. Care should be taken to prevent the high plastic clay from becoming desiccated or exceedingly wet during and after construction of the footings.

Further recommendations for the design and installation of spread footing recommendations are provided in Section 16.10.

9.5.3.2 Reinforced Concrete Raft Foundation

A reinforced raft foundation bearing may be founded on the native, undisturbed gravel or clay shale below all topsoil. The raft foundation should be designed using a factored ULS net bearing resistance of 210 kPa, based on net ultimate bearing capacity of 420 kPa and a Geotechnical Resistance Factor of 0.5.

It should be noted that high plastic clay shale has a high swelling/shrinking potential which may cause having/settling of the raft foundation if the water content of the material varies significantly. Care should be taken to prevent the high plastic clay from becoming desiccated or exceedingly wet during and after construction of the footings.

Frost design and insulation recommendations are provided in Section 16.3. A typical detail for insulated slab-on-grade is provided in Figure 16.2.

The reinforced concrete raft founded on the undisturbed clay and sand may be designed based on a modulus of subgrade reaction k_{s1} of 25 MN/m^3. A correction should be applied in the structural analysis to account for the size of raft element used in the analysis.

10. BOARDWALK AROUND LAKE

10.1 General

We understand that it is proposed to construct a boardwalk around the edge of the lake extending from the ITU launching area to the existing boat house as shown on the drawings.

Several different designs are currently being considered for the boardwalk at the time of report preparation. Preferably, the boardwalk would be located close to edge of lake and may partially cantilever over water. The construction materials selected for the boardwalk have not been determined at the time of report preparation.

According to the available information provided in the William Hawrelak Park Rehabilitation schematic design report, the proposed boardwalk will be 4 m to 5 m wide. The removeable ITU platform will be supported by a permanent concrete foundation.

10.2 Subsurface Conditions

Test holes TH21-52 to -54 were drilled near to the ITU launching area and proposed boardwalk alignment and encountered the following soil and groundwater conditions.

In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Topsoil
- Clay Fill
- Sand and Gravel
- Clay
- Bedrock (Clay Shale).

Stratigraphic cross-section A-A’ on Drawing No. 31566-2 in Appendix A shows the generalized soil conditions of the test holes in close proximity to the boardwalk.

10.2.1 Topsoil

A topsoil layer ranging from 80 mm to 610 mm in thickness was encountered below existing ground surface in test holes TH21-52 to -54. The natural water content of the topsoil ranged from 36 to 110 percent.

10.2.2 Clay Fill

The clay fill was generally brown to grey, silty, and contained some sand and trace amounts of gravel, oxides, and rootlets. The water content of the clay fill ranged from 20 to 34 percent and SPT “N” values ranged from 7 to 16 blows per 300 mm penetration, indicating a firm to very stiff consistency.

10.2.3 Sand and Gravel

The sand and gravel was generally brown, silty, fine grained and contained trace amounts of gravel. The natural water content of the sand and gravel ranged from 15 to 22 percent and one SPT “N” value was 29 blows per 300 mm penetration, indicating a compact relative density.

10.2.4 Clay

The clay was generally grey, silty, contained some sand and trace amounts oxides. The natural water content of the clay was 19 percent and one SPT “N” value in the clay was 21 blows per 300 mm penetration, indicating a very stiff consistency.

10.2.5 Bedrock (Clay Shale)

The clay shale was generally brown to grey, silty, high plastic and contained trace amounts of silt lenses and siltstone. The natural water content of the clay shale was 20 percent and one SPT “N” value was 40 blows per 300 mm penetration, indicating a hard consistency in soil mechanics terminology (extremely weak in rock mechanics terminology).

10.2.6 Groundwater Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test, hole logs in Appendix B. One standpipe piezometer was installed in test hole TH21-72 near the main pavilion to monitor the short-term groundwater levels. The groundwater levels were measured prior to demobilizing from the site and again on July 5, 2021, approximately two weeks after the drilling program completion.

The short-term groundwater level readings indicated that the groundwater level was approximately 2.4 m below existing ground surface (elev. 622 m). However, it is expected that groundwater levels are closer to the existing ground surface elevation around the perimeter of the lake.

10.3 Geotechnical Evaluation and Recommendations

The following foundation types may be considered for the boardwalk and ITU platform:

- Cast-in-place concrete piles
- Spread footings.

From a geotechnical perspective, pile foundations are less prone to settlements and seasonal movements.

10.3.1 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles should be designed and installed according to the recommendations given below.

- Table 10.1 defines the factored ULS shaft resistance values that may be used for the design of concrete cast-in-place friction piles.

TABLE 10.1
CAST-IN-PLACE CONCRETE FRICTION PILES
ULS SHAFT RESISTANCE PARAMETERS

DEPTH BELOW EXISTING GROUND LEVEL (m)	SOIL TYPE	ULTIMATE SHAFT RESISTANCE (kPa)	FACTORED ULS SHAFT RESISTANCE (kPa)	
			Compression (Φ =0.4)	Tension (Φ=0.3)
0 – 1.5(1)	Clay Fill	0	0	0
1.5 – 4.0	Sand / Clay / Clay Shale	40	16	12
Below 4.0	Clay Shale	60	24	18

Note: 1) Ignore upper 1.5 m below ground surface or depth of fill, whichever is greater

For lightly loaded piles subjected to frost, a minimum pile length of 6 m may be taken for preliminary design, to provide adequate resistance to frost heave.

It should be noted that sand layers were encountered at relatively shallow depths in the bore holes and are expected to result in sloughing conditions. Where sloughing sand layers are encountered at the design level, it will be necessary to provide the temporary casing(s) of the pile holes to advance the piles to the specified depths.

Refer to Section 16.5 for pile foundation limit states design information. Further recommendations for the design and installation of cast-in-place concrete pile recommendations are provided in Section 16.6.

10.3.2 Spread Footings

Spread footings should be founded on the undisturbed inorganic native clay or sand below design frost depth of 2.4 m for unheated footings.

Spread footings founded on the undisturbed inorganic clay or sand may be designed using a factored ULS bearing resistance of 110 kPa for strip footings and 130 kPa for square footings. This is based on an ultimate bearing capacity of 220 kPa for strip footings and 260 kPa for square footings, and a geotechnical resistance factor of 0.5.

Further recommendations for the design and installation of spread footing recommendations are provided in Section 16.10.

11. TIMBER PEDESTRIAN BRIDGE

11.1 General

The existing timber pedestrian bridge over the stream near the Community League building is showing signs of frost heave related movements. It is understood that it is necessary to conduct routine maintenance on the bridge approaches each year to compensate for frost heave related movements. It is suspected that the cast in place concrete piles supporting the bridge abutments have heaved from frost related loadings.

11.2 Subsurface conditions

Test holes TH21-24 and -25 were drilled near to the timber pedestrian bridge and encountered the following soil and groundwater conditions.

In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Topsoil
- Fill (Clay, Sand and Gravel)
- Bedrock (Clay Shale and Sandstone).

11.2.1 Topsoil

A 40 mm thick topsoil layer was encountered below existing ground surface in test hole TH21-25.

11.2.2 Fill (Clay, Sand and Gravel)

The clay fill was generally brown, silty, and contained trace amounts of sand, gravel, and oxides. The water content of the clay fill ranged from 30 to 34 percent and one SPT “N” value was 21 blows per 300 mm penetration, indicating a very stiff consistency.

A 50 mm thick gravel fill layer was encountered at ground surface in test hole TH21-24. The gravel fill was generally brown, silty, and sandy. The water content of the gravel fill was 0.2 percent.

The sand fill was generally, brown, silty, fine grained and contained some gravel and oxides. The natural water content of the sand fill was 15 percent.

11.2.3 Bedrock (Clay Shale and Sandstone)

The sandstone was generally brown to grey, silty, fine grained and contained trace amounts of oxides. The natural water content of the sandstone ranged from 18 to 28 percent and one SPT “N” value was 11 blows per 300 mm penetration, indicating a compact relative density in soil mechanics terminology (extremely weak in rock mechanics terminology).

The clay shale was generally, brown to grey, silty, high plastic and contained trace amounts of siltstone and sandstone lenes. The natural water content of the clay shale ranged from 16 to 36 percent and SPT “N” values ranged from 52 to more than 100 blows per 300 mm penetration, indicating a very hard consistency in soil mechanics terminology (extremely weak to very weak in rock mechanics terminology).

11.2.4 Groundwater Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test hole logs in Appendix B. Standpipe piezometers were installed in test holes TH21-24 and -25 near the timber pedestrian bridge to monitor the short-term groundwater levels. The groundwater levels were measured prior to demobilizing from the site and again on July 5, 2021, approximately two weeks after the drilling program completion.

The short-term groundwater level readings indicated that the groundwater levels ranged between 1.3 m to 1.6 m below existing ground surface at an approximate elevation of 623 m.

11.3 Geotechnical Evaluation and Recommendations

11.3.1 General

A structural and condition assessment should be completed to assess the current condition of the timber pedestrian bridge and determine appropriate rehabilitation or replacement strategies.

In either event, it appears that the existing foundations were installed to an insufficient depth and are subject to frost heave on an annual basis. New foundation designs should follow the geotechnical parameters and recommendations provided below.

11.3.2 Cast-In-Place Concrete Piles

At the time of this draft report, construction records of the existing cast-in-place concrete piles that support the timber pedestrian bridge have not been provided to Thurber. It may be possible to perform low-strain dynamic load tests (Pile Integrity Tests) to estimate the pile installation depths of the existing foundation.

For design checks of the following shaft friction values and end bearing resistances provided in Table 11.1 may be used.

TABLE 11.1
CAST-IN-PLACE CONCRETE FRICTION PILES
ULS SHAFT RESISTANCE AND END BEARING PARAMETERS

DEPTH BELOW EXISTING GROUND LEVEL (m)	SOIL TYPE	ULTIMATE SHAFT RESISTANCE (kPa)	ULTIMATE END BEARING RESISTANCE (kPa)
0 – 1.5(1)	Fill / Sandstone	0	0
1.5 - 5	Sandstone / Clay Shale	55	0
Below 5	Clay Shale	80	2,000

Note: 1) Ignore upper 1.5 m below ground surface or depth of fill, whichever is greater

For lightly loaded piles subjected to frost, a minimum pile length of 6 m may be taken for preliminary design of straight shaft friction piles, to provide adequate resistance to frost heave.

End bearing piles should be founded in the hard clay shale and sandstone bedrock at a minimum depth of 5 m below existing ground surface.

It should be noted that sand layers were encountered at relatively shallow depths in the bore holes and are expected to result in sloughing conditions. Where sloughing sand layers are encountered

at the design level, it will be necessary to provide the temporary casing(s) of the pile holes to advance the piles to the specified depths.

Refer to Section 16.5 for pile foundation limit states design information. Further recommendations for the design and installation of cast-in-place concrete pile recommendations are provided in Section 16.6.

11.3.3 Uplift Design

11.3.3.1 Uplift Capacity

Straight shaft piles resist uplift by shaft resistance along the shaft. Belled concrete piles may resist uplift load by developing skin friction along the pile shaft, and uplift resistance on the annulus area between the shaft and the bell.

For cast-in-place concrete end bearing piles with depth to shaft diameters of greater than three, the ultimate uplift resistance of the bell may be taken as the ultimate bearing capacity of the material above the bell times the area of the annulus area (i.e., the projected horizontal surface) between the pile bell and the shaft, that is:

$$Q_{B\ (uplift)} = q_b \times (A_B - A_S),\ kN$$

Where:

q_b = ultimate bearing resistance of soil above base in uplift,

use 1,200 (kPa)

A_B, A_S = areas of the base and shaft, respectively (m^2).

11.3.3.2 Frost Heave Effects

Refer to Section 16.7.2 for frost heave effect recommendations.

12. PLAYGROUND MOUND

12.1 General

We understand that upgrades are planned for the existing playground. A mound approximately four meters higher than the surrounding area is located on the northwest side of the playground. Due to the existing topography of the mound, we understand that the integration of structures such as slides have been proposed at the mound.

A preliminary slope stability assessment of the playground mound was conducted. This assessment included a review of visual observations and test hole information. The stability of the playground mound slope was modeled using limit equilibrium methods. Further details regarding the preliminary slope stability assessment of the playground mound are provided Section 12.4 below.

12.2 Subsurface Conditions

Test hole TH21-23 was drilled on top of the playground mound and encountered the following soil and groundwater conditions.

- Topsoil
- Clay Fill
- Sand
- Clay
- Bedrock (Clay Shale and Sandstone)

12.2.1 Topsoil

A 100 mm thick topsoil layer was encountered below existing ground surface. The natural water content of the topsoil was 27 percent.

12.2.2 Clay Fill

The clay fill was encountered underlying the topsoil and extended to 4.3 m below existing ground surface. The clay fill was generally brown, silty, and contained trace amounts of sand, gravel, oxides, and rootlets. The water content of the clay fill ranged from 11 to 22 percent. SPT “N” values in the clay fill ranged from 12 to 21 blows per 300 mm penetration, indicating a stiff to very stiff consistency.

12.2.3 Sand

The sand was encountered underlying the clay fill and extended to 5.3 m below existing ground surface. The sand was generally brown, silty, fine grained and contained trace amounts of coal. The natural water content of the sand was 11 percent.

12.2.4 Clay

The clay was encountered underlying the sand and extended to 6.1 m below existing ground surface. The clay was generally brown to grey, silty, and contained trace amounts of oxides. The natural water content of the clay was 26 percent. One SPT “N” value in the clay was 28 blows per 300 mm penetration, indicating a very stiff consistency.

12.2.5 Bedrock (Clay Shale and Sandstone)

Bedrock (clay shale and sandstone) was encountered underlying the clay and extended to the test hole termination depth of 11.9 m below existing ground surface. The bedrock (clay shale) was generally brown to grey, silty, high plastic and contained trace amounts of sandstone and oxides. The natural water content of the clay shale ranged from 16 to 18 percent. SPT “N” values were greater than 100 blows per 300 mm penetration, indicating a very hard consistency in soil mechanics terminology (very weak in rock mechanics terminology).

The sandstone was generally grey, silty, fine grained and contained trace amounts of coal. The natural water content of the sandstone ranged from 14 to 19 percent. SPT “N” values were greater than 100 blows per 300 mm penetration, indicating a very dense relative density in soil mechanics terminology (very weak in rock mechanics terminology).

12.2.6 Groundwater Conditions

Sloughing and groundwater conditions encountered in the test holes during drilling are shown in Table 5.1 and on the test, hole logs in Appendix B. One standpipe piezometer was installed in test holes TH21-23 on top of the playground mound to monitor the short-term groundwater levels. The groundwater levels were measured prior to demobilizing from the site and again on July 5, 2021, approximately two weeks after the drilling program completion.

The short-term groundwater level readings indicated that the groundwater level was 6.0 m below existing ground surface at an approximate elevation of 625 m.

12.3 Foundations

No information was provided on the proposed structure layouts or foundation loading conditions at the time of report preparation. The following foundation types may be considered for lightly loaded structures on the playground mound:

- Cast-in-place concrete piles
- Spread footings.

Further evaluation and foundation recommendations may be provided when more details on the proposed structures are available.

12.3.1 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles should be designed and installed according to the recommendations given below.

- Table 12.1 defines the factored ULS shaft resistance values that may be used for the design of concrete cast-in-place friction piles:

TABLE 12.1
CAST-IN-PLACE CONCRETE FRICTION PILES
ULS SHAFT RESISTANCE PARAMETERS

DEPTH BELOW EXISTING GROUND LEVEL (m)	SOIL TYPE	ULTIMATE SHAFT RESISTANCE (kPa)	FACTORED ULS SHAFT RESISTANCE (kPa)	
			Compression (Φ =0.4)	Tension (Φ=0.3)
0 – 1.5(1)	Fill	0	0	0
1.5 – 6	Clay Fill / Sand / Clay	35	14	10.5
Below 6	Clay Shale / Sandstone	75	30	22.5

Note: 1) Ignore upper 1.5 m below ground surface

A minimum pile length of 6 m is recommended for design of cast in place concrete friction piles to provide adequate uplift resistance for frost heave effects for unheated buildings.

It should be noted that sand layers were encountered at relatively shallow depths in the bore holes and are expected to result in sloughing conditions. Where sloughing sand layers are encountered at the design level, it will be necessary to provide the temporary casing(s) of the pile holes to advance the piles to the specified depths.

Further recommendations for the design and installation of cast-in-place concrete pile recommendations are provided in Section 16.6.

12.4 Preliminary Slope Stability Assessment

Subsurface conditions encountered in the playground mound test hole indicates that the mound is composed of clay fill overlying native soils. Topographic survey information of the playground mound was not available at the time of completing this report. To complete the preliminary

assessment of the existing playground mound, a maximum clay fill height of 4 m and a 4H:1V side slope has been assumed.

No signs of instability were observed based on visual observations of the playground mound. The stability of the playground mound slope was modeled using limit equilibrium methods. A schematic of the limit equilibrium model and geotechnical parameters assumed in the analysis are provided in Appendix E. Based on the limit equilibrium model and assumed geotechnical parameters, the existing playground mound has a factor of safety of 2.0.

It should be noted that increasing the slope of the mound and loading the slope with dead loads or live loads will decrease the factor of safety. When more details become available regarding the intended use of the playground mound, Thurber should be contacted to check the global stability of the structure.

13. MULTI-USE PATHS

13.1 General

According to the available information provided in the William Hawrelak Park Rehabilitation schematic design report, the proposed multi-use paths (MUP) will be 4 m wide and will be surfaced with asphalt pavement. The MUP upgrades are proposed throughout the park with a loop around the lake. A second loop is proposed around the eastern half of the site that will tie into existing sidewalks and river valley trials.

13.2 Subsurface Conditions

Test holes TH21-36 to -41 and -43 to -51 were drilled throughout Hawrelak Park in close proximity to the proposed MUP preliminary alignments and encountered the following soil and groundwater conditions.

In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Topsoil
- Clay Fill
- Clay
- Sand and Gravel
- Bedrock (Clay Shale, Siltstone and Sandstone).

13.2.1 Topsoil

A topsoil layer ranging from 50 mm to 300 mm in thickness was encountered below existing ground surface in several test holes. The natural water content of the topsoil ranged from 18 to 80 percent.

13.2.2 Clay Fill

The clay fill was generally brown, silty, and contained trace amounts of sand, gravel, oxides, and rootlets. The water content of the clay fill ranged from 13 to 47 percent. SPT “N” values in the clay fill ranged from eight to 30 blows per 300 mm penetration, indicating a stiff to hard consistency.

13.2.3 Clay

The clay was generally brown, silty, and contained trace amounts of sand and oxides. The natural water content of the clay ranged from 12 to 27 percent. SPT “N” values in the clay ranged from seven to 29 blows per 300 mm penetration, indicating a firm to very stiff consistency.

13.2.4 Sand and Gravel

The sand was generally brown, silty, fine grained and contained trace amounts of clay. The natural water content of the sand ranged from 9 to 16 percent and SPT “N” values ranged from three to 36 blows per 300 mm penetration, indicating a very loose to dense relative density.

The sand and gravel was generally brown, silty, and fine to medium grained. The natural water content of the sand and gravel ranged from 9 to 10 percent. A single SPT “N” value in the sand and gravel was 43 blows per 300 mm penetration, indicating a dense relative density.

13.2.5 Bedrock (Clay Shale, Siltstone and Sandstone)

The bedrock (weathered clay shale, clay shale and siltstone) was generally brown to grey, silty, high plastic and contained trace amounts of sandstone and oxides. The natural water content of the weathered clay shale ranged from 22 to 33 percent. SPT “N” values ranged from 13 to 24 blows per 300 mm penetration, indicating a stiff to very stiff consistency in soil mechanics terminology (extremely weak in rock mechanics terminology).

The sandstone was generally brown, silty, fine grained, contained some clay shale and trace amounts of coal. The natural water content of the sandstone was 23 percent and one SPT “N” value was 12 blows per 300 mm penetration, indicating a compact relative density in soil mechanics terminology (extremely weak in rock mechanics terminology).

13.2.6 Groundwater Conditions

Sloughing and groundwater conditions encountered in select test holes during drilling are shown in Table 5.1 and on the test, hole logs in Appendix B.

The short-term groundwater measurements indicate that the groundwater levels varied at depths between 1.3 m and 7.9 m below the existing ground surface across the park. It should be noted that the highest ground water levels were observed in the test holes located closest to the lake.

13.3 Geotechnical Evaluation and Recommendations

All topsoil, organics and any poor-quality fills should be stripped from under the multi-use paths. Site preparation and grading and should follow the recommendations provided in Section 16.2. The recommended pavement structures for the multiuse paths are presented in Table 13.1 below.

TABLE 13.1
RECOMMENDED PAVEMENT STRUCTURE

PAVEMENT TYPE	PAVEMENT STRUCTURE
Multi-use Path	75 mm Asphaltic Concrete (LT) over 300 mm Crushed Granular Base Course over 150 mm prepared subgrade

Pavement material should be provided and constructed in accordance with the latest edition of the City of Edmonton Standard Specifications.

14. ROADS AND PARKING AREAS

14.1 General

We understand that asphalt roadways and parking lots will be upgraded. Thurber's scope of work consisted of drilling test holes and providing information on the existing asphalt structure.

It is understood that the City will arrange for separate coring of the asphalt pavement to assess the current condition of the asphalt and the results will be provided to Thurber.

14.2 Subsurface Conditions

Test holes TH21-1 to -9, -17, -18, -20 and -21 were drilled throughout the Hawrelak Park perimeter roadway and main parking lot area and encountered the following soil and groundwater conditions.

In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Asphalt
- Fill (Clay, Sand and Gravel)
- Clay and Silt
- Sand and Gravel
- Bedrock (Clay Shale and Sandstone).

14.2.1 Asphalt

An asphalt layer ranging from 50 mm to 100 mm in thickness was generally encountered below existing ground surface in most of the test holes.

14.2.2 Fill (Clay, Sand and Gravel)

The gravel fill extended to 300 mm below existing ground surface, was generally brown, silty, sandy, and fine grained. The water content of the gravel fill ranged from 2 to 7 percent. The sand and gravel fill was generally brown, silty, and fine grained. The water content of the sand and gravel fill ranged between 3 to 6 percent.

The clay fill was generally brown to grey, silty, and contained trace amounts of sand, gravel, oxides, and rootlets. The water content of the clay fill ranged from 10 to 30 percent. SPT “N” values in the clay fill ranged from four to 24 blows per 300 mm penetration, indicating a firm to very stiff consistency.

14.2.3 Clay and Silt

The clay was generally brown, silty, and contained trace amounts of sand, coal, and oxides. The water content of the clay ranged from 13 to 32 percent. SPT “N” values in the clay fill ranged from 7 to 26 blows per 300 mm penetration, indicating a firm to very stiff consistency.

The silt was generally brown, clayey, and contained trace arounds of sand and oxides. The natural water content of the silt ranged between 7 and 8 percent. A single SPT “N” value in the silt was 27 blows per 300 mm penetration, indicating a compact relative density.

14.2.4 Sand and Gravel

The sand was generally brown, silty, fine grained and contained trace amounts of gravel. The natural water content of the sand ranged from 8 to 20 percent. SPT “N” values in the sand were 20 blows per 300 mm penetration, indicating a compact relative density.

The sand and gravel was generally brown, silty, and fine grained. The natural water content of the sand and gravel was 6 percent. A single SPT “N” value in the sand and gravel was 62 blows per 300 mm penetration, indicating a very dense relative density.

14.2.5 Bedrock (Clay Shale and Sandstone)

The clay shale was generally brown, silty, high plastic and contained trace amounts of coal and oxides. The natural water content of the clay shale was 20 percent. A single SPT “N” value in the clay shale was 33 blows per 300 mm penetration, indicating a hard consistency in soil mechanics terminology (extremely weak in rock mechanics terminology).

The sandstone was generally brown, silty, fine grained and contained trace amounts of oxides. The natural water content of the sandstone ranged from 14 to 20 percent. SPT “N” value in the sandstone ranged from 29 to more than 100 blows per 300 mm penetration, indicating a compact to very dense relative density in soil mechanics terminology (extremely weak to very weak in rock mechanics terminology).

14.2.6 Groundwater Conditions

Standpipe piezometers were not installed in test holes TH21-1 to -9, -17, -18, -20 and -21. However, sloughing and groundwater conditions encountered in select test holes during drilling are shown in Table 5.1 and on the test, hole logs in Appendix B.

14.2.7 Existing Asphalt Structure

The City has conducted an independent coring investigation of the existing pavement structure within Hawrelak Park. A total of 17 core locations were investigated throughout the Hawrelak Park roadways and parking areas. A summary of the existing pavement structure, as provided to us by the City, is provided below in Table 14.1.

THURBER

TABLE 14.1
EXISTING PAVEMENT STRUCTURE SUMMARY

SAMPLE NUMBER	LOCATION (LATITUDE, LONGITUDE)	EXISTING PAVEMENT STRUCTURE (THICKNESSES OVERLYING SUBGRADE)
1	53.5299777, -113.5422716	Asphalt: 160 mm Gravel: 210 mm
2	53.5302948, -113.5441608	Asphalt: 70 mm Gravel: 260 mm
3	53.5304249, -113.5438054	Asphalt: 130 mm Gravel: 150 mm
4	53.53049, -113.54677	Asphalt: 180 mm Gravel: 260 mm
5	53.52989, -113.5465	Asphalt: 90 mm Soil Cement: 300 mm
6	53.53028, -113.55064	Asphalt: 110 mm Soil Cement: 250 mm
7	53.52979, -113.55391	Asphalt: 70 mm Soil Cement: 130 mm
8	53.52926, -113.55382	Asphalt: 120 mm Gravel: 310 mm
9	53.5280115, -113.5532368	Asphalt: 70 mm Soil Cement: 240 mm
10	53.5267884, -113.5519604	Asphalt: 90 mm Gravel: 300 mm
11	53.52597, -113.54969	Asphalt: 70 mm Soil Cement: 200 mm
12	53.5253372, -113.5476175	Asphalt: 70 mm Soil Cement: 210 mm
13	53.5250076, -113.5447566	Asphalt: 70 mm Soil Cement: 230 mm
14	53.5265937, -113.5431081	Asphalt: 130 mm Soil Cement: 210 mm
15	53.5280130, -113.5426460	Asphalt: 90 mm Soil Cement: 210 mm
16	53.5293362, -113.5419675	Asphalt: 190 mm Gravel: 130 mm
17	53.5292385, -113.5431999	Asphalt: 155 mm Gravel: 125 mm

14.3 Geotechnical Evaluation and Recommendations

Reconstruction of the pavements will be required for roadway pavements in poor condition, at failed areas and areas with alligator cracking. No details of the method of reconstruction are available at the present time.

We understand that the City will decide on the appropriate pavement rehabilitation strategies. Further recommendations can be provided by Thurber when the details of reconstruction are available.

A soaked California Bearing Ratio (CBR) value of 3 is considered applicable to the types of subgrade materials at this site for design of the pavement structure.

Pavement material should be provided and constructed in accordance with the latest edition of the City of Edmonton Standard Specifications.

15. UTILITIES

15.1 General

Locations of underground utilities are shown on Drawing No 31566-1 in Appendix A. It is understood that installation depths up to 5 m below existing ground surface are proposed for the stormwater outfall located on the western side of the park. Additional upgrades to the gas, water and sanitary utilities have also been proposed.

15.2 Subsurface Conditions

Test holes TH21-55 to -59, -61, -62, -64 to -67 and -70 to -73 were drilled throughout Hawrelak Park in close proximity to the proposed utility alignments and encountered the following soil and groundwater conditions.

In general, the subsurface soils at the drilled locations consisted of the following main soil types, in descending order:

- Topsoil
- Fill (Clay and Sand)
- Clay
- Sand and Gravel
- Bedrock (Clay Shale and Sandstone).

15.2.1 Topsoil

A topsoil layer ranging from 50 mm to 460 mm in thickness was encountered below existing ground surface in all test holes. The natural water content of the topsoil ranged from 14 to 76 percent.

15.2.2 Fill (Clay and Sand)

The clay fill was generally brown, silty, and contained trace amounts of sand, gravel, and oxides. The water content of the clay fill ranged from 10 to 45 percent and SPT “N” values ranged from seven to 47 blows per 300 mm penetration, indicating a firm to hard consistency.

The sand fill was generally brown, silty, fine grained and contained trace amounts of gravel. The water content of the sand fill ranged from 13 to 17 percent. A single SPT “N” value in the sand fill was 26 blows per 300 mm penetration, indicating a compact relative density.

15.2.3 Clay

The clay was generally brown, silty, and contained trace amounts of sand, gravel, and oxides. The natural water content of the clay ranged from 11 to 34 percent and SPT “N” values ranged from 6 to 37 blows per 300 mm penetration, indicating a firm to hard consistency.

15.2.4 Sand and Gravel

The sand was generally brown, silty, fine grained and contained trace amounts of gravel. The natural water content of the sand ranged from 3 to 31 percent. SPT “N” values in the sand ranged from two to 63 blows per 300 mm penetration, indicating a very loose to very dense relative density.

The sand and gravel was generally brown, silty, and fine grained. The natural water content of the sand and gravel ranged from 8 to 20 percent. SPT “N” values in the sand and gravel ranged from 30 to 31 blows per 300 mm penetration, indicating a dense relative density.

15.2.5 Bedrock (Clay Shale and Sandstone)

The sandstone was generally brown, silty, fine grained and contained trace amounts of clay shale. The natural water content of the sandstone ranged from 14 to 20 percent. SPT “N” values in the sandstone ranged from 51 to more than 100 blows per 300 mm penetration, indicating a very dense relative density in soil mechanics terminology (extremely weak to very weak in rock mechanics terminology).

The clay shale was generally brown to grey, silty, high plastic, contained trace amounts oxides and sandstone. The natural water content of the clay shale ranged from 18 to 44 percent. SPT “N” values in the clay shale ranged from 20 to more than 100 blows per 300 mm penetration, indicating a very stiff to very hard consistency in soil mechanics terminology (extremely weak to very weak in rock mechanics terminology).

15.2.6 Groundwater Conditions

Sloughing and groundwater conditions encountered in select test holes during drilling are shown in Table 5.1 and on the test, hole logs in Appendix B.

The short-term groundwater measurements indicate that the groundwater levels varied at depths between 2.0 m and 7.0 m below the existing ground surface across the proposed utility alignments.

15.3 Geotechnical Evaluations and Recommendations

15.3.1 Trench Excavations

Temporary excavations may be required for installation of new underground utilities. Temporary excavations are expected to extend through mixed soil conditions including clay fill/clay, sand and gravel and bedrock.

The short-term groundwater measurements indicate the groundwater levels varied at depths between 2.0 m and 7.0 m below the existing ground surface across the proposed utility alignments.

Temporary trench excavations in the surficial firm to hard clay/clay fill up to a depth of about 5 m is recommended to be no steeper than 1H:1V. Local flattening of slopes may be required if softer materials are encountered during excavation. Temporary trench excavations in the surficial loose to compact sand/gravel layers up to a depth of about 5 m are recommended to be no steeper than 1.5H:1V to 2H:1V depending on the stability of the sand.

It is recommended that the trench excavations be carried out in a timely manner and backfilled as soon as practical. The ground surface outside the excavation should be sloped away from the structures to prevent surface water from flowing into the open excavation. Consideration should be given to covering the excavated slopes with tarps to reduce erosion, raveling, and sloughing of excavation walls during periods of rain.

Excavated material should be stockpiled not closer than 3 m, or the depth of trench excavation, whichever is greater, to the crest of excavation slopes. When personnel are required to enter trenches or foundation excavations, the excavation slopes greater than 1.5 m deep should be cut back to 1H:1V or alternatively, temporary trench bracing should be used. Permanent slopes are recommended to be no steeper than 3H:1V in clay till material or 2H:1V in granular fills.

The above slope excavations are provided for design purposes and are not to be considered as clearance for Occupational Health and Safety requirements; therefore, at all times, the Alberta Occupational Health and Safety Regulation and Code must be followed by the contractor.

15.3.2 Pipe Bedding and Backfilling of Trenches

It is recommended that a minimum thickness of 150 mm of granular pipe bedding material be placed below piping. The bedding material should also be extended to a width sufficient to permit compaction with base plate compactors and should extend vertically at least 300 mm above the top of the pipe. Where soft wet conditions are encountered in the base of the excavations, it may be necessary to over excavate below the pipe invert and provide a special foundation pad consisting of 300 mm of washed gravel enveloped with a non-woven geotextile. This method provides a working platform in the base of the trench to permit pipe installation and backfilling.

The granular bedding should consist of well-graded sand and gravel with less than 10 percent passing the 80-micron sieve and should be free of organics and construction rubble.

The on-site inorganic clay till is generally suitable for the backfilling of trenches above the pipe zone. Organics, ice, snow, or frozen material should not be included in the trench backfill. Imported granular material should be used for bedding and backfill, where suitable native materials are not present. Recommended compaction standards are provided in Section 16.2.3. The supplier's recommendations for bedding/surround materials, dimensions and compaction levels should be followed if more stringent.

16. GENERAL GEOTECHNICAL RECOMMENDATIONS

16.1 General Evaluation

Following are general geotechnical recommendations that supplement the geotechnical recommendations provided in Sections 6 to 15.

16.2 Site Preparation, Grading and Surface Drainage

16.2.1 General

No information on the design site grades was provided at the time of this report preparation. However, the site is relatively flat, and hence it is expected that site grading should be relatively minimal, typically involving topsoil stripping and minor fills where necessary to achieve level site grades. The following general guidelines are provided for site development; however, these should be reviewed once further details on the design grades are available.

All topsoil, organics, and any poor-quality fills should be removed from under areas of development prior to site grading.

As a general requirement, the exposed subgrade should be scarified to a depth of at least 150 mm and recompacted to at least 95 percent of Standard Proctor Maximum Dry Density (ASTM D698).

Any soft or disturbed clay or sand, if existed, should be subexcavated and replaced with suitable compacted clay fill. The subgrade should be inspected by qualified geotechnical personnel, and proof rolled as necessary to determine the condition of the prepared subgrade prior to final grading. At that time, appropriate measures can be determined for subgrade improvement and/or subexcavation and replacement, as necessary.

It is recommended that the site grading fill placement be scheduled as far in advance of foundation construction as practical to allow fill settlement to take place prior to foundation construction.

Further recommendations for site grading and drainage are provided in the following sections.

16.2.2 Groundwater Seepage and Drainage

The short-term groundwater measurements indicate the groundwater levels varied throughout the site at depths between 1.3 m and 7.9 m below the existing ground surface across the project site. In addition, the groundwater may be higher following spring thaw and after a period of heavy precipitation.

Where the groundwater table is intercepted by foundation excavations or utility trenches, groundwater seepage from clay or clay till material is expected to be at relatively low rates and should be of a magnitude that can be handled by trench grading and use of sump and pump drainage where required.

If thick water-bearing sand layers are encountered, groundwater flow may be initially greater and may require drainage measures, such as the installation of temporary vertical perforated culverts backfilled with free-draining gravel installed in the base of the excavations to control groundwater seepage.

16.2.3 Placement and Compaction

All fill required for site raising should consist of inorganic low to medium plastic clay or granular fill as required. The on-site clay till is generally considered suitable for site grading fill, providing it is at a suitable moisture content. Where necessary, moisture conditioning may be required

to obtain suitable moisture content for compaction depending on the time of year and precipitation conditions.

Following are general guidelines for fill placement and compaction:

- All fill should be placed in 150 mm compacted lift thickness.
- Structural fill supporting slabs, equipment, and other settlement-sensitive structures should be compacted to a minimum of 98 percent of Standard Proctor maximum dry density (SPMDD), within ±2 percent of Optimum Moisture Content (OMC).
- Backfilling of subexcavations and utility trenches under the above areas should be compacted to the same standards noted above and not less than 98 percent of SPMDD, within ±2 percent of OMC. Granular bedding material for pipes should also be compacted to a minimum of 95 percent of SPMDD.
- General fill under access roadways and for site grading (not directly under building or process areas) should be compacted to a minimum of 95 percent of SPMDD, within ±2 percent of OMC.
- The upper 300 mm of subgrade under roads and parking areas should be compacted in 150 mm lifts to 100 percent of SPMDD within ±2 percent OMC.
- Where the City's compaction specifications exceed the above-recommended compaction standards, they may be followed in preference to the above-noted standards.

Frozen fill, snow, ice, or other deleterious material should not be included in fills; otherwise, poor subgrade conditions and surface settlement will result upon thawing. Alternatively, clean well-graded pit-run gravel could be used as backfill in freezing conditions.

The finished subgrade should be sloped at a minimum gradient of 1 percent toward perimeter ditches to drain any subsurface water away from the structures and roadways. This will reduce the likelihood of ponding water, which could result in frost effects of the subgrade.

Geotechnical site inspection is recommended during subgrade preparation to confirm the subgrade consistency. In addition, the density of compacted fills should be confirmed by field density test measurements during construction.

16.3 Frost Design

16.3.1 General

The surficial clay and sand are considered to have moderate to high frost susceptibility. In addition, the groundwater table may be relatively high throughout parts of the site. Frost heave is, therefore, a concern for uninsulated or unheated foundations and grade-supported slabs.

Foundations should be designed to accommodate potential frost heave effects. Where required, spread foundations should be founded below design frost depth, or they should be insulated to reduce the depth of frost penetration.

Insulation may be used to reduce the depth of frost penetration and also reduce frost heave effects below and around buildings. Rigid foam insulation (Styrofoam HI or equivalent) or cellular concrete (e.g., Cematrix) may be used around buildings or over buried utilities to reduce frost penetration depth. The insulation type should be checked for compatibility with plant chemicals such that they will not deteriorate if a spill were to occur.

For design purposes, frost heave at finished grade in non-heated, uninsulated areas of the project site may be taken as 50 mm in the clay and clay fills with a high-water table. Frost heave could be higher where sand/silt is present within the depth of frost penetration.

The following general recommendations are provided for heated and unheated buildings and utility installations.

16.3.2 Heated and Unheated Buildings

Exterior footings for heated structures may be insulated to reduce frost effects. Insulation requirements for shallow footings supporting heated structures are shown in Figure 16.1. The recommended minimum depth for footings is 0.75 m, subject to suitable foundation conditions. However, note that spread footings should not be founded in fills or weak native soils, unless an evaluation of potential fill settlement is made and is acceptable to foundation performance.

For buildings heated to a minimum of 18°C, a recommended thickness of rigid insulation of 50 mm should be applied to the outside of the footing walls to the top of the footing, and should extend horizontally outwards a minimum distance of 1.2 m. For buildings heated to a minimum of 7°C, the corresponding recommended thickness of rigid insulation is 100 mm, extending horizontally outwards a minimum distance of 1.8 m.

Alternatively, cellular concrete (Cematrix CMI-475 or equivalent) may be used for insulation around buildings. The design of Cematrix is generally provided by the supplier based on the expected soil and operating conditions.

Foundations and slabs in non-heated areas (i.e., exterior slabs or unheated buildings) will be subjected to frost action. In many cases, this is acceptable for non-sensitive slabs. All fill placed below the exterior slab areas for site raising should consist of low to medium plastic clay/clay till fill or clean granular fill. Silt, silty sand or other highly frost susceptible soils should not be placed within the fill.

Where slabs on grade in unheated areas are movement-sensitive, insulation will be required below the slab. Typical details for insulation under unheated slabs on grade are shown in Figure 16.2. The minimum recommended distance (L) from the wall is 2.4 m. A minimum thickness of 200 mm of rigid insulation is recommended, underlain by 300 mm or more of compacted frost stable fill (imported sand having not more than 7 percent passing an 80-micron sieve, or well-graded gravel not having more than 10 percent passing an 80-micron sieve). The minimum depth for insulation placement is 0.5 m below finished grade, subject to suitable foundation conditions. The insulation should be checked to confirm that it is resistant to hydrocarbon spills. Alternatively, the slab could be supported on piles with suitable void form.

The insulation should be designed in accordance with the expected loading conditions during and after construction. Where insulation is required to withstand high bearing pressures, high strength closed cell insulation (Styrofoam HI or equivalent) with appropriate design compressive strength may be used.

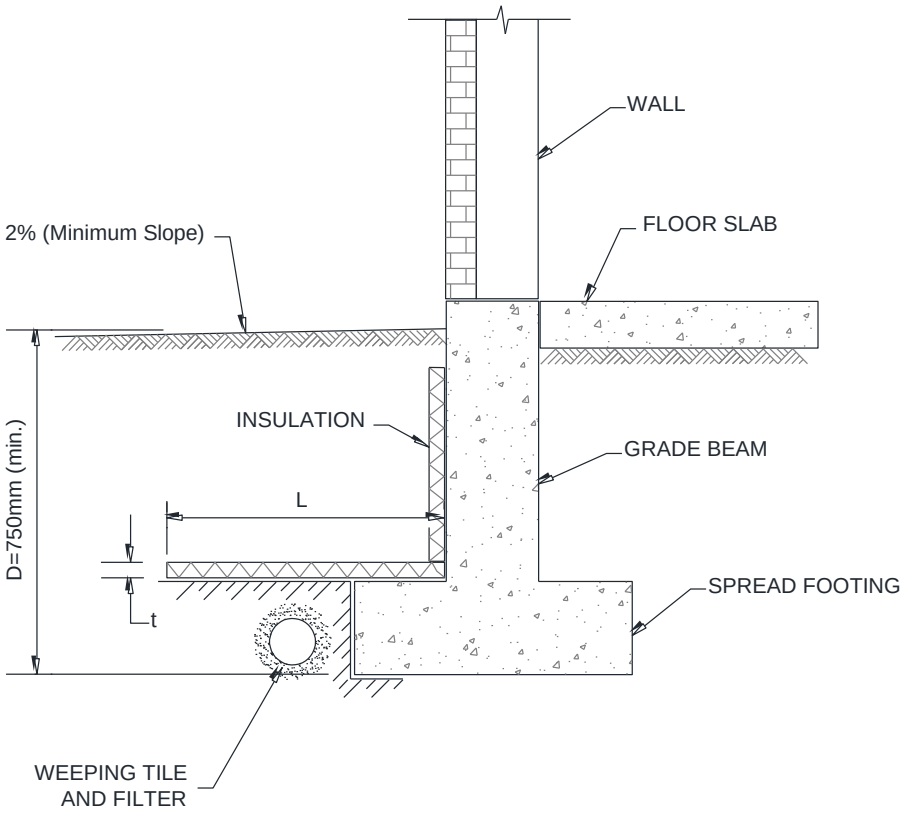
Placement of a subdrain at the base of slabs or pile caps may also be used to provide drainage around the sides of pile caps and grade beams and reduce potential adfreeze forces on the sides of the pile caps, slabs, and grade beams.

16.3.3 Utility Lines

Utility lines in unpaved areas that are subject to freezing should be buried below the depth of frost penetration of 2.4 m (or 3.0 m for granular soils). Alternatively, an insulation layer may be placed over the pipes to reduce frost penetration depth locally. This may be required, for example, at ditch crossings where the depth of pipe cover is reduced.

A 150 mm thick layer of rigid Styrofoam placed 600 mm below the ground surface can be expected to limit frost penetration to a depth of about 1.8 m below ground. These frost penetration depths assume the insulation layer extends a minimum horizontal distance of 2.4 m on either side of the

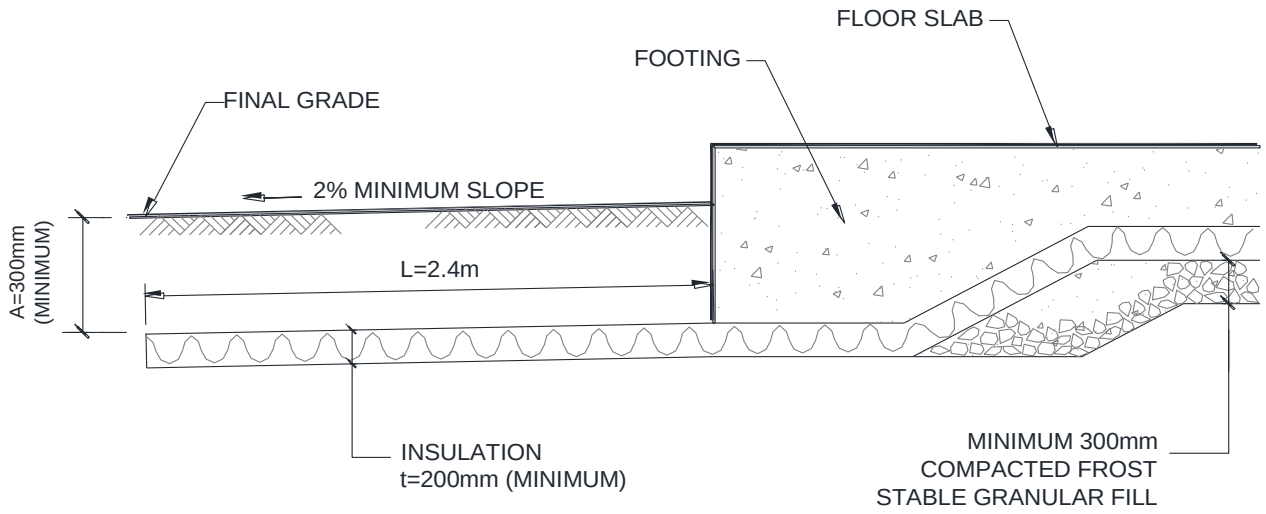
pipe. A typical trench insulation detail for pipe trenches is provided in Figure 16.3. Backfill below the rigid insulation may consist of common fill, providing frost heaving is not a concern. Further thermal analyses should be carried out to verify the insulation design if the insulation of buried utilities is considered during detailed design.



MINIMUM BUILDING TEMPERATURE	RECOMMENDED	
	RIGID INSULATION THICKNESS (t)	OUTWARD HORIZONTAL DISTANCE (L)
18°C (64°F)	50mm	1.2m
7°C (45°F)	100mm	1.8m

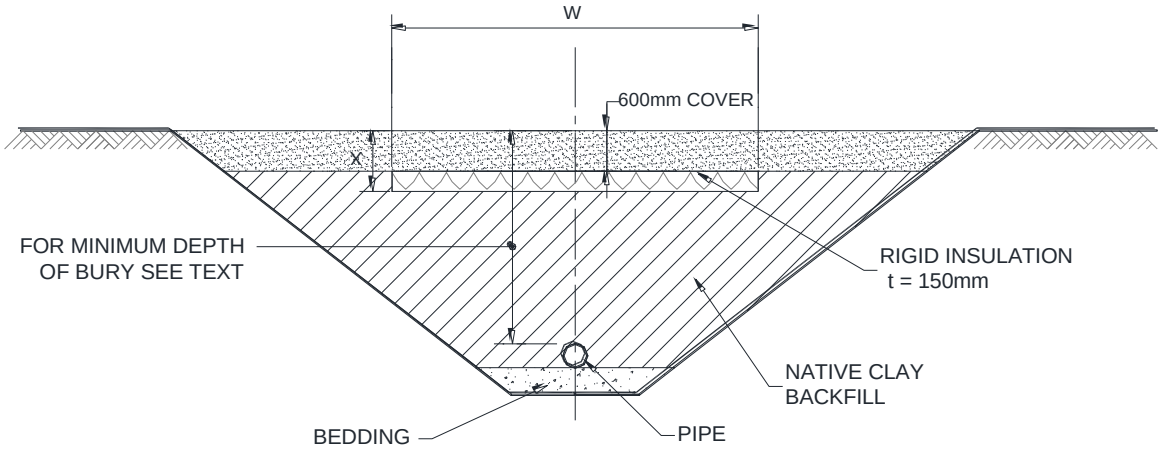
TYPICAL INSULATED FOUNDATION FOR HEATED BUILDING

FIGURE 16.1



TYPICAL INSULATED SLAB ON GRADE FOUNDATION FOR UNHEATED BUILDING (SENSITIVE TO MOVEMENT)

FIGURE 16.2



W = D + 2(F - X) - 0.3 = D + 2(2.4-0.75) - 0.3 = D + 3.0 (m)

where:
D = PIPE DIAMETER (m)
F = FROST DEPTH (m)
X = INSULATION DEPTH (m)

NOTES:

1. INSULATION MUST BE MAINTAINED AND REPLACED AFTER ANY DAMAGE DUE TO FUTURE EXCAVATIONS, ETC
2. 600mm COVER MAY CONSIST OF SAND BACKFILL OR CRUSHED GRAVEL UNDER ROADWAYS. PIT-RUN GRAVEL SHOULD NOT BE PLACED DIRECTLY AGAINST INSULATION TO AVOID POTENTIAL DAMAGE.

TYPICAL TRENCH INSULATION DETAIL FOR UTILITY LINE

FIGURE 16.3

16.4 Foundation Types

The following foundation types are considered most practical at this site

- Cast-in-place concrete piles.
- Spread footings

The choice of foundation types will depend on location, design foundation layout and loading, and tolerance to movement.

Cast-in-place concrete piles have been used throughout the existing site for many ancillary structures and are considered a suitable foundation They have the disadvantage of requiring temporary steel casings to advance the piles through the expected saturated sand layers at this site.

Spread footings are generally less feasible since depths of installation for frost effects and variability of near surface clay fills make these foundations less attractive at this site. They may be feasible for site specific lightly loaded structure and can be reviewed upon request.

It should be noted that concrete piles are less susceptible to seasonal movement dues to swelling, shrinkage and frost effects than spread footings and are generally less difficult to install.

Helical piles are a suitable foundation for relatively lightly loaded ancillary structures at this site.

Driven steel piles are also a feasible foundation type at this site. However, they may not be economical when used in small numbers throughout the park. Also, potential construction vibrations of any nearby sensitive structures or equipment would need to be taken into consideration. Recommendations for driven steel piles can be provided upon request.

Site specific recommendations for piles and spread footings were presented in Sections 6 to 12. General geotechnical recommendations for the above-mentioned foundation types are provided in the following sections. General recommended construction procedures are presented in Appendix F. Recommendations for helical piles or driven steel piles can be provided upon request.

16.5 Pile Foundations Limit States Design

Design of pile foundations should be carried out using Limit States Design in accordance with the NBC 2015 – Alberta Edition 2019 and should consider Ultimate Limit State (ULS) and Serviceability Limit State (SLS) conditions. The ULS is to prevent geotechnical or plunging

failure of the pile, whereas the SLS is to maintain the foundation settlements within project tolerable limits.

Pile foundations may be designed based on a combination of skin friction plus end bearing resistance as follows, unless noted otherwise in the following sections:

$$Q_T = Q_B + Q_s$$

Where:

Q_T = Ultimate static pile capacity (kN)

Q_B = Ultimate end bearing resistance (kN)

Q_s = Ultimate shaft friction (kN).

The factored ULS pile capacities are based on the product of the estimated ultimate pile capacity and appropriate geotechnical resistance factors. The geotechnical resistance factors are prescribed in the National Building Code Alberta Edition (2019 NBC (AE)) and are dependent on the method used to determine the ultimate pile capacity, as summarized in Table 16.1.

TABLE 16.1
RECOMMENDED GEOTECHNICAL RESISTANCE FACTOR
FOR LIMIT STATES DESIGN OF DEEP FOUNDATIONS
(2019 NBC (AE))

DESCRIPTION	GEOTECHNICAL RESISTANCE FACTOR (GRF)
(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: Use bolded values for preliminary design.

The bolded values may be used for the preliminary design of ultimate limit states. Where pile capacities are verified by pile load test programs, the higher geotechnical resistance factors given

in Table 16.1 may be used. For the application of dynamic tests on piles using PDA methods, an increased geotechnical resistance factor of 0.5 may be used in Limit States Design. If static load tests are carried out, an increased geotechnical resistance factor of 0.6 may be used, increasing the ULS capacity by 50 percent. Past experience generally indicates that the cost of pile load tests is more than offset by the reduction in piling costs and piling schedule.

16.6 Cast-In-Place Concrete Piles

Cast-in-place concrete friction piles should be designed and installed in accordance with the recommendations given below.

- Ultimate and factored ULS shaft resistance values that may be used for the design of concrete friction piles should follow the values provided in previous sections (ref Tables 6.1, 9.1, 9.2, 10.1, 11.1 and 12.1) for specific areas of the park.
- The shaft resistance should not be included in the upper 1.5 m of the pile below final grade or within the depth of fill, whichever is greater to allow for the possibility of soil drying and shrinking away from the pile shaft.
- End-bearing resistance should not be included in calculating the design load of a friction pile.
- A minimum pile spacing of 2.5 shaft diameter is recommended for straight shaft concrete piles.
- A minimum pile shaft diameter of 400 mm is recommended to prevent voids from forming during pouring of the concrete.
- A minimum pile length of 6 m below finished site grade is recommended for lightly loaded friction piles that may be subjected to freezing temperatures, either during construction or long-term, to provide sufficient uplift resistance to frost heave forces in unheated areas.
- Longitudinal reinforcement should be provided through the pile shaft to resist potential uplift forces on the pile. If piles are designed as tension elements, the pile reinforcing should be designed to resist the anticipated uplift stresses.
- Water should not be allowed to accumulate at the base of the pile hole prior to placing concrete. A temporary casing should be available onsite and used as required to seal the pile holes during excavation.

- It should be noted that cobbles/boulders are frequently encountered within the clay till and could hamper the installation of the piles if encountered during piling. The contractor should be suitably equipped to deal with this situation if occurred during construction.
- Concrete should be poured immediately after drilling of the pile hole to reduce the risk of groundwater seepage and sloughing soil.
- The concrete materials and methods of concrete construction should be as per CSA A23.1-19/A23.2-19.

16.7 Uplift Design

16.7.1 Uplift Capacity

Vertical piles may resist uplift load by developing skin friction along the pile shaft.

Straight shaft piles will resist uplift load by developing skin friction along the pile shaft. The shaft resistance is obtained by multiplying the shaft area by the applicable factored ULS skin friction values.

Uplift resistance should be neglected to a depth of 1.5 m below the existing ground surface in the uplift load calculation. End bearing resistance should not be included in the calculation of the uplift capacity of straight shaft piles.

For cast-in-place concrete end bearing piles, the ultimate uplift resistance of the bell may be taken as the ultimate bearing capacity of the material above the bell times the area of the annulus between the pile bell and the shaft, that is:

$$Q_{B\ (uplift)} = q_b \times (A_B - A_S),\ kN$$

Where:

q_b = factored ULS bearing resistance of soil above base in uplift (kPa)

A_B, A_S = areas of the base and shaft, respectively (m^2).

16.7.2 Frost Heave Effects

Piles subjected to frost heave forces should be checked for adequate resistance to uplift. Adfreeze forces may be estimated based on an adfreeze friction value of 65 kPa for concrete piles applied around the pile circumference over the expected depth of freezing

(assume 2.4 m depth below grade). Since these are ultimate adfreeze values applied to the 1 in 50-year design frost depth, a load factor of 1.0 is generally applied in determining the required pile embedment depth to resist frost heave.

Resistance to frost uplift force will be provided by dead load acting on the pile, the weight of the pile, and the frictional resistance on the shaft below the frozen zone. Since the adfreeze values are ultimate values, and the frost depths provided are based on 50-year return periods, a geotechnical resistance factor of 0.8 should be applied to the ultimate shaft resistance values in tension given in Tables 6.1, 9.1, 9.2, 10.1, 11.1 and 12.1 in resisting frost heave.

Transient uplift (i.e., wind) loads and dynamic loads need not be added to frost heave forces in the calculation of pile length requirements for uplift resistance but should be checked independently.

For lightly loaded piles subjected to frost, a minimum pile length of 6 m may be taken for preliminary design, to provide adequate resistance to frost heave. The minimum pile length for driven steel piles can also be determined by the structural engineer using the ultimate skin friction values for the unfrozen pile length, as provided in Tables 6.1, 9.1, 9.2, 10.1, 11.1 and 12.1.

16.8 Lateral Loads on Piles

16.8.1 General

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 head 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 (e.g., LPILE) or by structural analyses where the horizontal subgrade modulus is used to determine spring constants for pile design.

We will be pleased to undertake lateral pile analyses for specific pile types and lateral load conditions when these are available.

16.9 Pile Caps and Grade Beams

Where piles are used to support equipment or structures, concrete pile caps or grade beams may be required along the top of the piles. Precautions should be taken to prevent heaving of the pile

caps grade beams due to frost penetration or seasonal moisture variation, or swelling of the underlying soil, where the pile caps or grade beams will be uninsulated and will be situated above the seasonal frost line.

The following recommendations are provided for accommodating frost heave under uninsulated unheated pile caps and grade beams within the depth of seasonal frost penetration and are presented herein for completeness.

The recommended construction procedure for preventing frost heave under the uninsulated unheated pile caps and grade beams subject to frost action is shown in Figure 16.4 and consists of providing a suitable void form underneath the grade beam or pile cap. In this method, the grade beam or pile cap must be designed in accordance with the crushing strength of the void form used or the stress vs strain characteristic of the frost cushion, and the piles must be able to resist the resulting uplift.

Non-collapsible void form such as Nordic void form (or equivalent) should be used where there is potential for groundwater ingress below the pile cap or grade beam. These products have a higher compressive strength, and the pile cap and piles should be designed to resist the resulting uplift forces. A minimum thickness of void form of 200 mm should be used, and a potential frost heave of 50 mm should be assumed, resulting in an elastic deformation of 25 percent.

The void form must be capable of supporting the applied loading due to the weight of concrete slabs, pile caps, etc., during construction. The void form should be placed on a sand bedding layer at least 75 mm thick (with less than 10 percent passing an 80-micron sieve) or 50 mm thick lean concrete. The void form must be checked for resistance to chemicals that will be present at this site. Ethafoam may be used where resistance to hydrocarbons is required.

Alternatively, insulation (e.g., Cematrix or rigid Styrofoam) may be placed around and below pile caps and grade beams to reduce the depth of frost penetration using the methods provided in Figures 16.1 and 16.2.

Adfreeze forces on the sides of pile and pile caps exposed to freezing should also be accounted for in foundation design. The preferred method is to provide a bond breaker between the concrete and soil to eliminate potential adfreeze forces. The bond breaker should, however, be checked for potential degradation due to hydrocarbon attack.

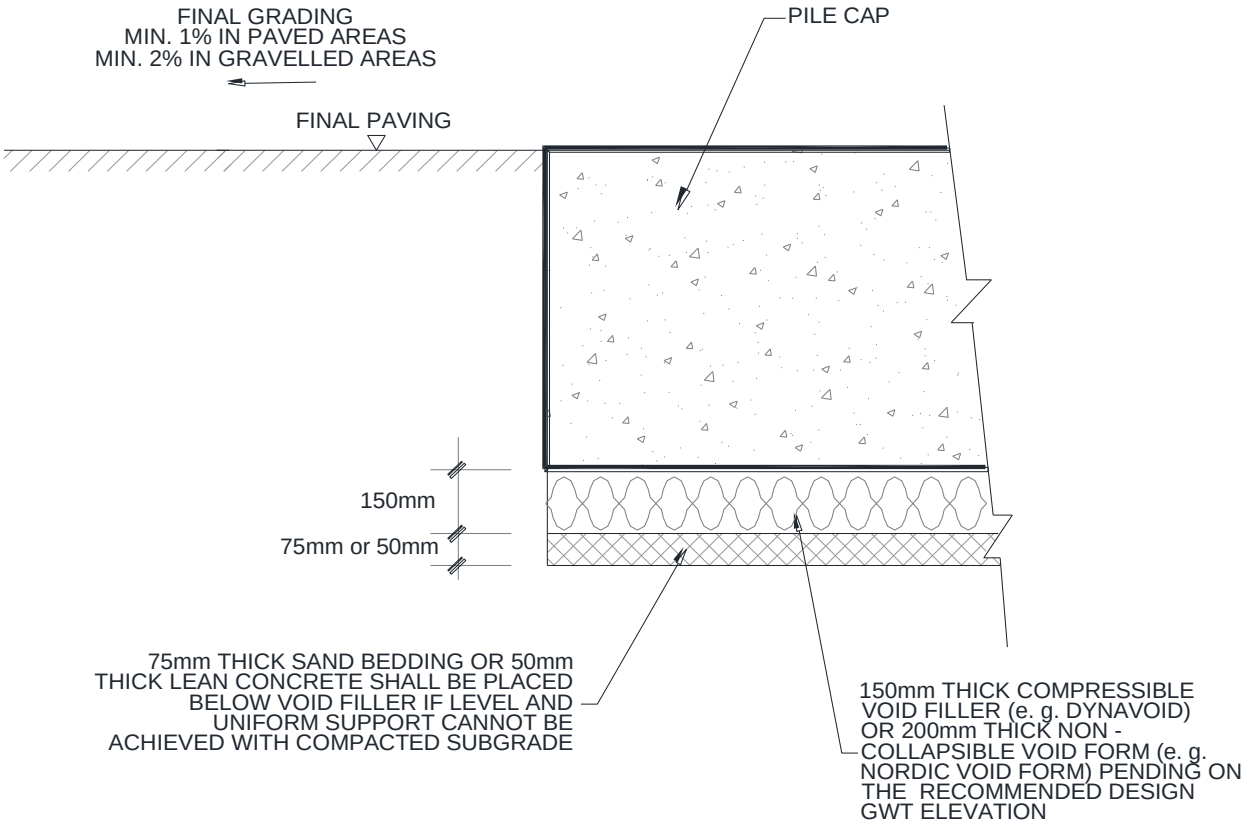
Types of bond breakers that have been used for past industrial projects include rigid insulation (e.g., 50 mm of expanded Styrofoam) placed against the pile caps and grade beams, asphalt-impregnated boards, and PVC sheeting. A single layer of 30 mil PVC, LDPE or equivalent

sheeting may also be used for this purpose; however, it is important to ensure the survivability of the PVC sheeting through the construction period.

16.10 Spread Footings

Spread footings should be designed and constructed according to the following recommendations:

- Exterior footings supporting heated structures should be founded at a minimum depth of 1.5 m below finished grade to reduce frost effects. Interior footings should be founded at a minimum depth of 1 m below finished grade.
- All footings should be inspected by qualified geotechnical personnel to ensure that the footings are located on native soils. Where local soft zones, organic materials, or fill are encountered in the footing trenches it may be necessary to remove these materials and replace them with lean concrete, or to extend the foundation depth to have the footing resting on the native soil. Disturbed soil should not be allowed to remain in the footing trenches.
- Spread footings should be protected freezing during and after construction.



NOTE:

PILE CAP AND PILES SHALL BE DESIGNED TO RESIST THE FROST HEAVE FORCES TRANSFERRED BY THE SELECTED VOID FORM.

TYPICAL SECTION VIEW FOR PILE CAP / GRADE BEAM IN NON HEATED AREAS WITH VOID FORM

FIGURE 16.4

16.11 Earth Pressures

A triangular earth pressure distribution may be used for the design of retaining walls resisting earth pressures. The horizontal earth pressure, P_h, may be calculated as follows using the coefficients given in Table 16.2, assuming a horizontal backfill surface behind the wall. The horizontal earth pressure P_h at depth h may be calculated as follows:

p_h = k [(W x h) + q] (kPa)

Where:

k = the appropriate coefficient of earth pressure from Table 16.2

W = the bulk unit weight (kN/m^3)

h = the depth below backfill surface (m)

q = surcharge pressure (kPa).

TABLE 16.2
LONG-TERM EARTH PRESSURE COEFFICIENTS FOR VERTICAL RETAINING WALLS ASSUMING STIFF WALL GOOD SURFACE DRAINAGE AND HORIZONTAL BACKSLOPE

SOIL DESCRIPTION	BULK UNIT WEIGHT kN/m^3	COEFFICIENTS OF PRESSURE		
		Ka Active	Ko At-Rest	Kp Passive
Clay Backfill - on site clay and clay till (compacted to 98% of SPMDD)	21	0.40	0.58	2.5
Sand backfill – on site sand (compacted to 98% of SPMDD)	21	0.3	0.45	3.4
Pit Run Gravel backfill (Compacted to 98% of SPMDD)	22	0.27	0.43	3.7

Active earth pressure may be used to design retaining walls that can be allowed to move laterally at the top at 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 at a distance of 0.02 times the height of the wall. For rigid walls that are restrained from moving laterally, such as basements, pump house walls, etc., the at-rest earth pressure should be used.

Appropriate load factors should be applied to earth pressures in Limit States Design. Where passive resistance is required, a geotechnical resistance factor of 0.5 should be applied to the estimated ultimate passive resistance for Limit States Design.

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 surcharge loading due to soil compaction should also be considered. The surcharge loading will depend on the size of compaction equipment used behind the wall. In lieu of such information, a minimum lateral soil pressure of 12 kPa should be applied at the top of the wall.

Where retaining walls extend below the groundwater table, hydrostatic pressures should be included below the water table using the following formula:

$$P_h = k[(W' \times h) + q] + [9.8 \times h] \text{ (kPa)}$$

Where:

W' = Submerged unit weight (use W – 9.8 kN/m^3).

Alternatively, perimeter drains may be provided below the base level to maintain the groundwater table below the base of the walls. Perimeter drainage, where used, should consist of perforated drains surrounded by filter cloth or an inverted granular filter. Free draining sand or gravel should be placed against the wall to about 0.3 m below the ground surface, and an impervious clay cap should be formed at the ground surface.

Backfill behind the retaining walls should be placed in 150 mm lifts and compacted to 95 percent of SPMDD. Heavy compaction equipment should not be operated immediately adjacent to the permanent walls. Care should be taken not to over compact the backfill; otherwise, higher earth pressures will be created, which may distress the wall.

It should be noted that these values assume a horizontal ground surface behind the wall and should be increased if an inclined ground surface is constructed.

16.12 Concrete Slabs on Grade

It is possible that the project site may have area concrete paving slabs on grade outside of pile caps and grade beams. Backfill under slabs on grade should consist of select inorganic low to medium plastic clay fill (or imported frost stable granular fill) compacted to the standards recommended in Section 16.2.

Concrete slabs may be supported on engineered fill prepared as discussed in Section 16.2, subject to the following recommendations.

A minimum of 150 mm of clean, well-graded sand or gravel is recommended beneath the floor slab and along the outside of footings or grade beams for levelling and drainage purposes. Coarse material greater than 50 mm in diameter should be avoided directly beneath the floor slab to prevent stress concentrations within the slab. The granular levelling course should be compacted to a uniform dry density of at least 100 percent of SPMDD.

It should be recognized that slabs in non-heated areas will be subject to frost heave. In many cases, this is acceptable for non-sensitive slabs. Where movement due to frost action is to be avoided, the slab should either have insulation protection or alternatively should be supported on piles. Frost action is further discussed in Section 16.3.

16.13 Cold Weather Construction

16.13.1 Grading and Compaction

Special considerations are required for grading or backfilling during winter conditions. Cold weather compaction of soils requires that the fill be hauled, placed, and compacted before it freezes, and that the soil can be compacted to the desired condition without moisture conditioning. In some cases, the compacted soil must also be protected from freezing after placement.

As a guideline, compaction to adequate standards can generally be achieved at air temperatures above -7°C and are increasingly difficult between -7°C to -12°C. Below -12°C, compaction becomes very difficult, and it becomes critical to follow appropriate compaction practices to prevent freezing of material before the fill is compacted.

Cold weather compaction requires greater attention to fill quality, particularly moisture content, and placement and compaction practices. More compactive effort will be required to achieve the specified density (compared to compaction when temperatures are above freezing); because thicker lifts are used, and less time is available for compaction. It is not possible to adjust the moisture content of borrow soils when temperatures are below freezing. Therefore, material that may be suitable for summer construction by altering the moisture content may have to be wasted in winter.

Where compaction standards are not being met, the choice is either to suspend placement, implement more stringent placement and compaction procedures, or to recompact material that does not meet compaction standards after the thaw. Unless approved by the design engineer, fill

that freezes prior to being compacted to the required standards should be removed and wasted. In the case of shallow fill, it may be possible to recompact the material after it thaws.

16.13.2 Foundation Concrete Construction

The following guidelines apply to cold weather concrete placement and construction:

- As a minimum, the concrete is required to be cured at a minimum temperature of 10°C for a minimum of 3 days as stated in CSA specifications A23.1-19 Table 20. In order to facilitate this, the ground temperature should be maintained above 0°C during the casting and curing of the concrete. In addition, heating and hoarding should be provided to maintain the concrete temperature above 10°C for at least three days. It is not possible to specify the number of days prior to pouring that the area should be heated, as this will depend on the ground and air temperature, depth of freezing, etc. As a general guideline, it is desirable to thaw the subgrade entirely below slabs for concrete construction and also to prevent possible settlement problems after thawing of the soils. The delivery of warmed concrete (i.e., at least 20°C) should also be specified to assist in keeping the concrete warm during pouring and curing. During freezing weather, water curing (if used) should be terminated 12 hours before the end of the protection period.
- It should be possible to pour concrete slabs at most times throughout the winter, providing the above standards are met. It should be noted, however, that the depth of frost will increase during the winter, and hence the time required for thawing the upper subgrade will also likely increase through the winter. Where possible, use of insulated tarps on areas of concrete slabs should be carried out to reduce potential frost penetration depth. It should also be recognized that any trapped frozen soil will eventually thaw and may result in some slab settlement.
- It is assumed that the subgrade will be prepared and compacted before the onset of freezing. Obviously, it will be very difficult to undertake earthworks during winter. Placement and levelling of the granular base under slabs will require heating and hoarding and use of unfrozen materials for compaction. The subgrade should be checked to confirm that it is thawed to the depth suggested above before pouring the concrete.
- Protection of concrete in piling from freezing is also required. This can generally be achieved by providing insulation around the tops of the piles until the concrete has cured as per the requirements stated in Table 20 of CSA A23.1-19.
- As a general comment on concrete curing, the required “curing types” for concrete for various exposure conditions are stated in Table 2 of CSA A23.1-19.

16.14 Cement

Nine sulphate tests were conducted to determine the water-soluble sulphate ion content of soil samples recovered from the test holes drilled for this project (see Table 4.5).

These results indicated the presence of nil to 0.04 percent water-soluble sulphate content in the soil sample, indicating that there is no potential for sulphate attack on the subsurface concrete. As a result, CSA Type GU (General Use hydraulic cement) may be used in the subsurface concrete at this project site.

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 that 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.

16.15 Seismicity

Based on the available geotechnical information, the site is classified as Site Class C in accordance with the site classification as per Table 4.1.8.4A of the National Building Code (NBCC 2019).

17. CONSTRUCTION INSPECTION

The performance of the various site facilities and structures will depend upon the quality of workmanship during construction. This is particularly important in regard to foundation installations where variations in foundation soil conditions could occur. Therefore, it is recommended that monitoring be provided by qualified geotechnical personnel during foundation installation to confirm that the piles for the proposed structures are installed in competent bearing material and that the stratigraphy is similar to that assumed for the design.

Geotechnical site inspection is also recommended during subgrade preparation to confirm the subgrade consistency. In addition, the density of compacted fills should be confirmed by field density test measurements during construction.

18. 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, the contract documents, or as observed 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 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, safety, and equipment capabilities.

19. REFERENCES

L.A. Bayrock. Surficial Geology Edmonton. NTS 83H. Alberta Research Council. Published 1972.

C.P. Kathol and R.A. McPherson. Urban Geology of Edmonton. Bulletin 32. Alberta Research Council. Published 1975.

L.D. Andriashek. Bedrock Topography and Valley Talwegs of the Edmonton Map Area. NTS 83H. Alberta Research Council. Published 1987.

D.J. Glass. Lexicon of Canadian Stratigraphy. Volume 4. Western Canada. Canadian Society of Petroleum Geologists. Calgary, Alberta. 1990 and 1997.

Atkinson, N. and Lyster S. Thickness and Distribution of Quaternary and Neogene Sediments in Alberta, (Canada). Alberta Geological Survey. 2012.

Alberta Energy Regulator/ Alberta Geological Survey. Bedrock Geology of Alberta. Map 600. Published 2013.

Alberta Government. Alberta Energy Regulator. Coal Mine Map Viewer. https://extmapviewer.aer.ca/AERCoalMine/Index.html.

Reports provided by the City.

Thurber's reports.

Air photographs from 1924 year to 1988 year.

THURBER

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.

THURBER

APPENDIX A

Drawing No. 31566-1 – Site Plan Showing Approximate Test Hole Locations

Drawing No. 31566-2 – Stratigraphic Cross-section A-A’

Drawing No. 31566-3 – Stratigraphic Cross-sections B-B’ and C-C’

Drawing No. 31556-4 – Geology Map

Drawing No. 31566-5 – Isopach Maps

Drawing No. 31566-6 – Selected Air Photos 1924, 1930, 1948 and 1952

Drawing No. 31566-7 – Selected Air Photos 1957, 1965, 1978 and 1988

Main Pavilion Concrete Apron Slab Foundation Plan

Main Pavilion Concrete Apron Slab Details and Sections

H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566-1 JUNE 30, 2021.dwg - 1 - Aug. 20, 2021

EXISTING WATER TO BE REMOVED, L=70m

"NEW CONNECTION TO 38mm HERITAGE DISTRIBUTION REQUIRED"

EXISTING WATER TO BE REMOVED, L=875m

"NEW CONNECTION TO 38mm HERITAGE DISTRIBUTION REQUIRED"

"TIE TO EXISTING PRV CHAMBER

NEW SERVICE

EXISTING WATER TO BE ABANDONED IN PLACE L=189m

EXISTING WATER TO BE ABANDONED IN PLACE L=113m

EXISTING WATER TO BE REMOVED, L=42m

POTENTIAL REMOVAL WITH UPGRADED LAKE OUTFALL CONSTRUCTION L=34m

PROP SS 250 PVC

PROP 150mm WAT L=29.0m

EX SANITARY (TO BE ABANDONED)

EX SS 200 PVC

NEW SERVICE

NEW SERVICE

EX 2424 MH (TO BE ABANDONED)

EXISTING WATER TO BE ABANDONED IN PLACE L=596m

"NEW CONNECTION TO 38mm HERITAGE DISTRIBUTION REQUIRED"

EXISTING WATER TO BE REMOVED, L=83m

GROAT ROAD

TH21-01 TH21-02 TH21-03 TH21-04 TH21-05 TH21-06 TH21-07 TH21-08 TH21-09 TH21-10 TH21-11 TH21-12 TH21-13 TH21-14 TH21-15 TH21-16 TH21-17 TH21-18 TH21-20 TH21-21 TH21-22 TH21-23 TH21-24 TH21-25 TH21-26 TH21-27 TH21-28 TH21-29 TH21-30 TH21-31 TH21-32 TH21-33 TH21-34 TH21-35 TH21-36 TH21-37 TH21-38 TH21-39 TH21-40 TH21-41 TH21-43 TH21-44 TH21-45 TH21-46 TH21-47 TH21-48 TH21-49 TH21-50 TH21-51 TH21-52 TH21-53 TH21-54 TH21-55 TH21-56 TH21-57 TH21-58 TH21-59 TH21-61 TH21-62 TH21-64 TH21-65 TH21-66 TH21-67 TH21-70 TH21-71 TH21-72 TH21-73

N
W E
S

LEGEND

APPROXIMATE TEST HOLE LOCATION (2021)

0 50 100 150 200 250m
SCALE 1:4000

BASE PLAN PROVIDED BY THE CITY OF EDMONTON

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

SITE PLAN SHOWING APPROXIMATE TEST HOLE LOCATIONS

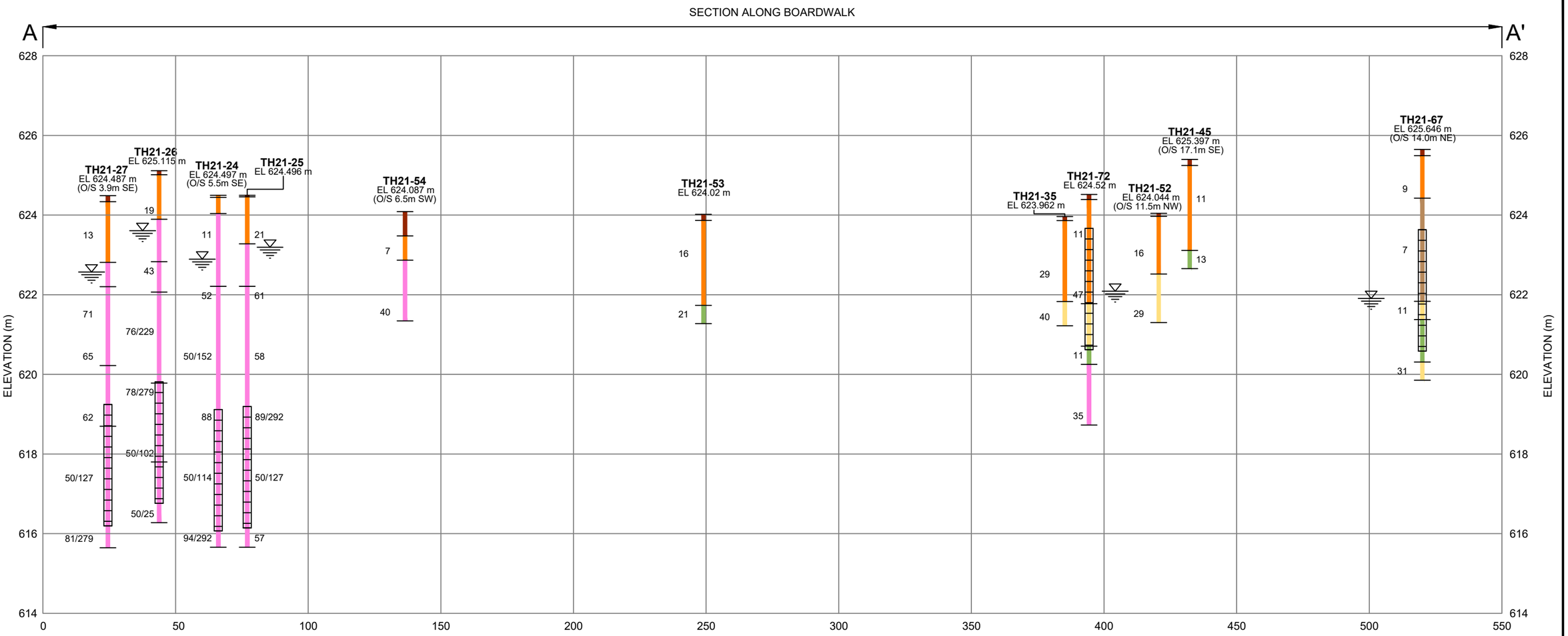
DWG No. 31566-1

DRAWN BY	ML
DESIGNED BY	TGV
APPROVED BY	RWT
SCALE	1:4000
DATE	AUGUST 2021
FILE No.	31566

THURBER ENGINEERING LTD.

H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566-2~3 AUGUST 20, 2021.dwg - 2 - Aug. 30, 2021

SECTION ALONG BOARDWALK



DISTANCE (m)

LEGEND

- 15 — SPT N VALUE
- WATER LEVEL IN HOLE AT END OF DRILLING
- STANDPIPE PIEZOMETER SCREENED INTERVAL

- TOPSOIL
- FILL
- CLAY
- CLAY TILL
- SAND, GRAVEL
- SILT
- CLAY SHALE / SANDSTONE

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.

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

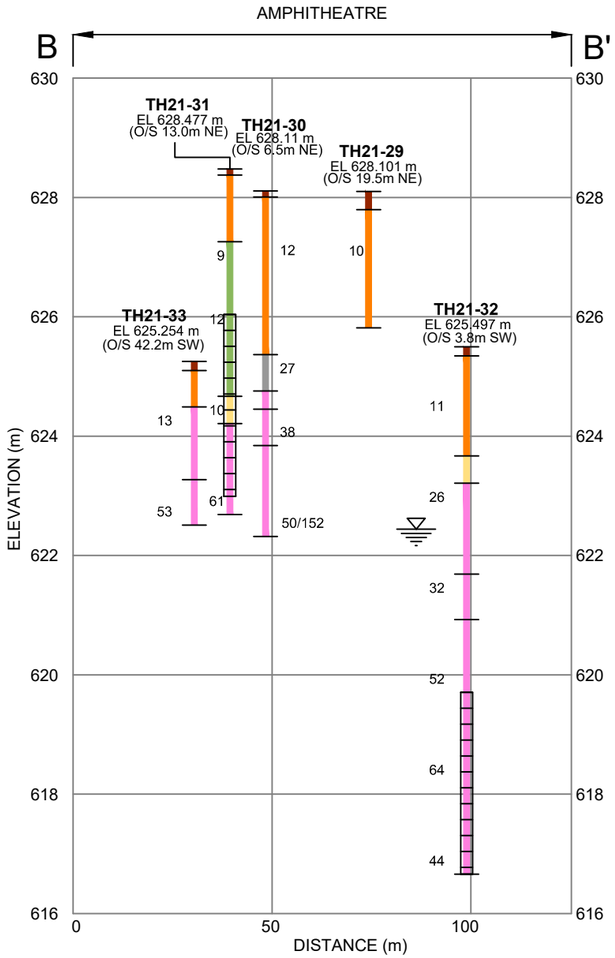
STRATIGRAPHIC CROSS - SECTION A - A'

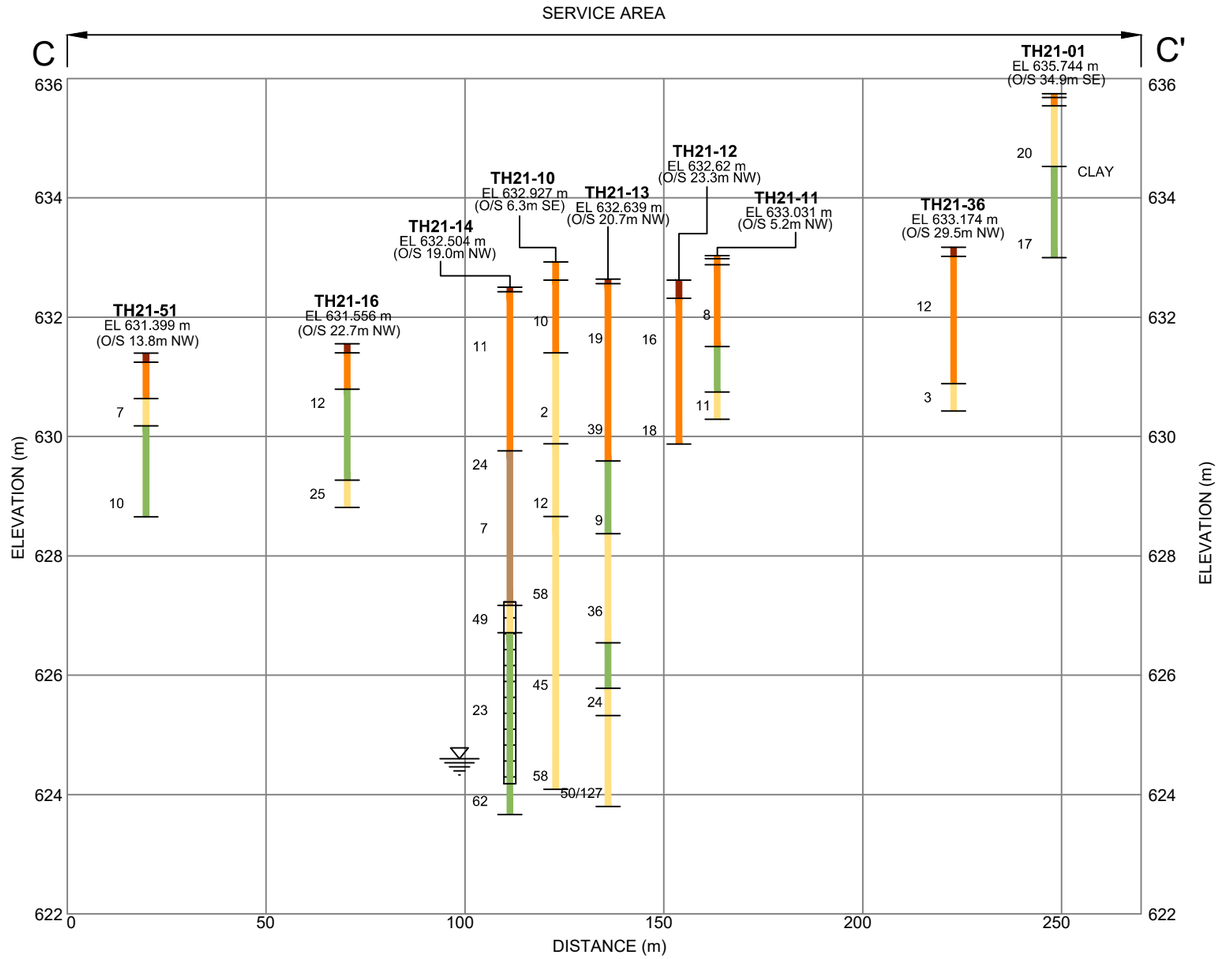
DWG No. 31566-2

DRAWN BY	ML
DESIGNED BY	TGV
APPROVED BY	RWT
SCALE	H 1:1500 V 1:100
DATE	AUGUST 2021
FILE No.	31566

THURBER ENGINEERING LTD.

H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566-2~3 AUGUST 20, 2021.dwg - 3 - Aug. 30, 2021





LEGEND

- 15 — SPT N VALUE
- WATER LEVEL IN HOLE AT END OF DRILLING
- STANDPIPE PIEZOMETER SCREENED INTERVAL

- TOPSOIL
- FILL
- CLAY
- CLAY TILL
- SAND, GRAVEL
- SILT
- CLAY SHALE / SANDSTONE

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.

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

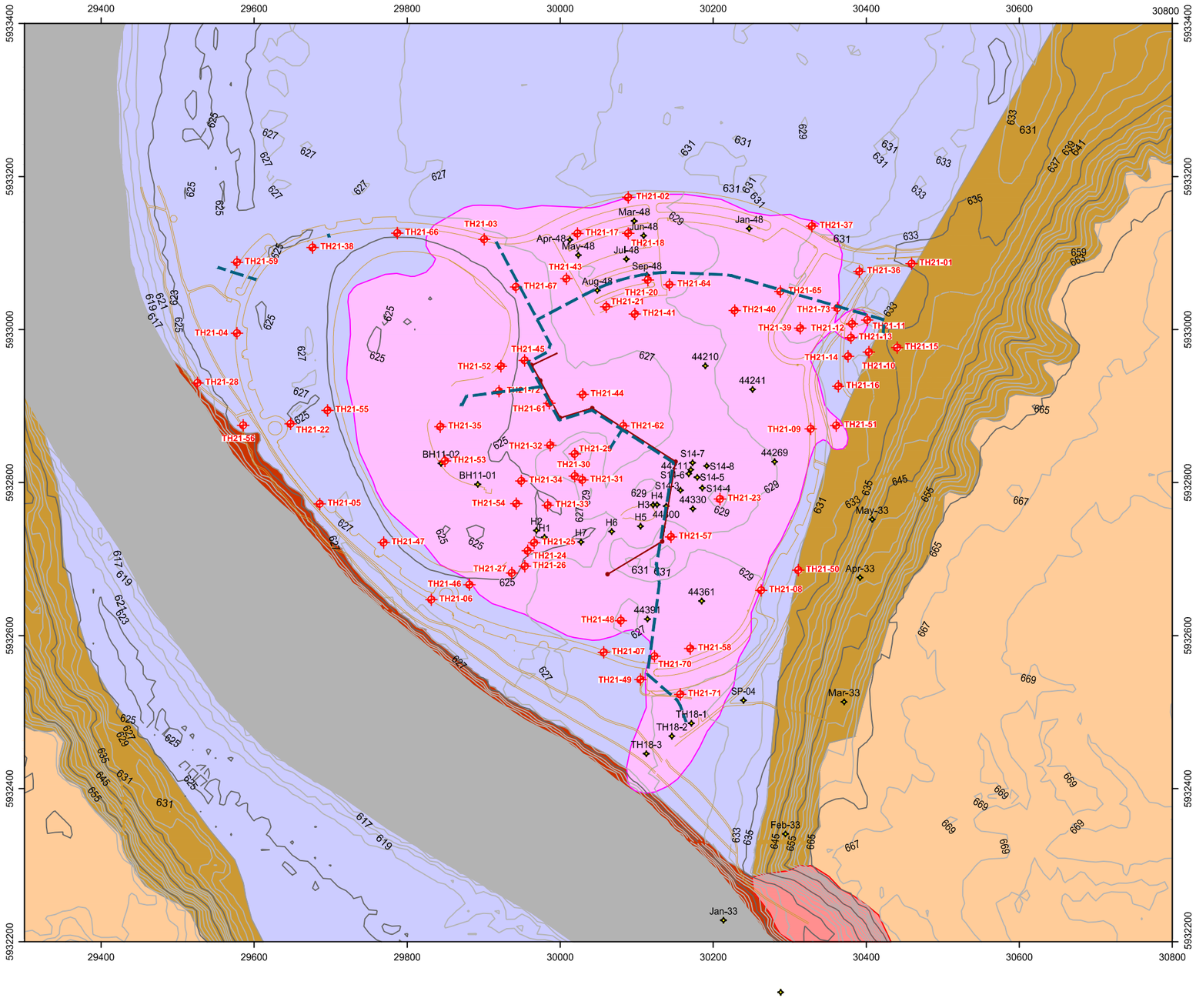
STRATIGRAPHIC CROSS - SECTIONS
B - B' AND C - C'

DWG No. 31566-3

DRAWN BY	ML
DESIGNED BY	TGV
APPROVED BY	RWT
SCALE	H 1:1500 V 1:100
DATE	AUGUST 2021
FILE No.	31566

THURBER ENGINEERING LTD.

H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566-4 AUGUST 20, 2021.dwg - 1 - Aug. 20, 2021



N
W E
S

LEGEND

- APPROXIMATE TEST HOLE LOCATION (2021)
- APPROXIMATE TEST HOLE LOCATION (PREVIOUS)
- PROPOSED SS PVC PIPE
- PROPOSED WATER ALIGNMENT OPTION A
- RIVER
- FILL: CLAY, TILL, SILT, REFUSE
- LANDSLIDE
- BANK RIVER SLUMP
- COLLUVIUM: GRAVITACIONALY MOVED, WEATHERED MATERIAL
- ALLUVIUM: GRAVEL, SAND, CLAY, TILL BODIES
- GLACIOLACUSTRINE: SILT, CLAY, SAND

0 50 100 150 200 300 m
SCALE 1 : 6 000

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

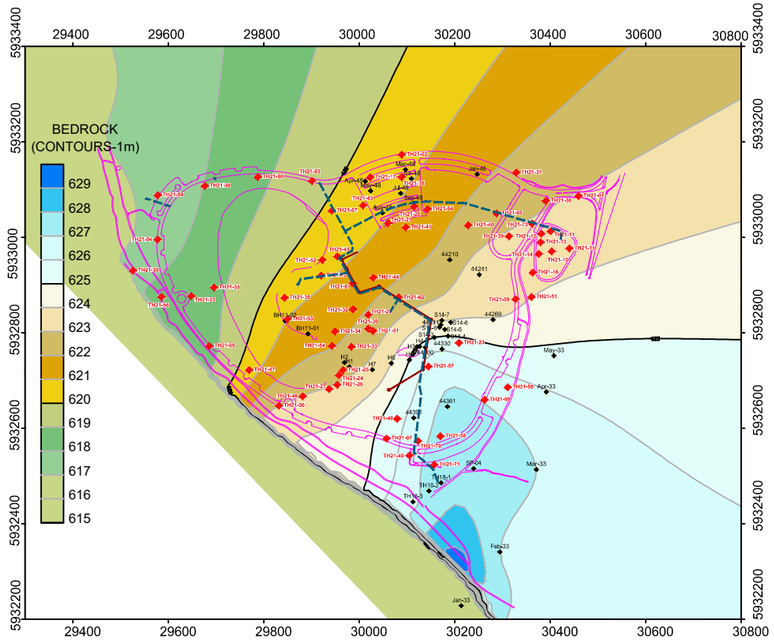
GEOLOGY MAP

DWG No. 31566-4

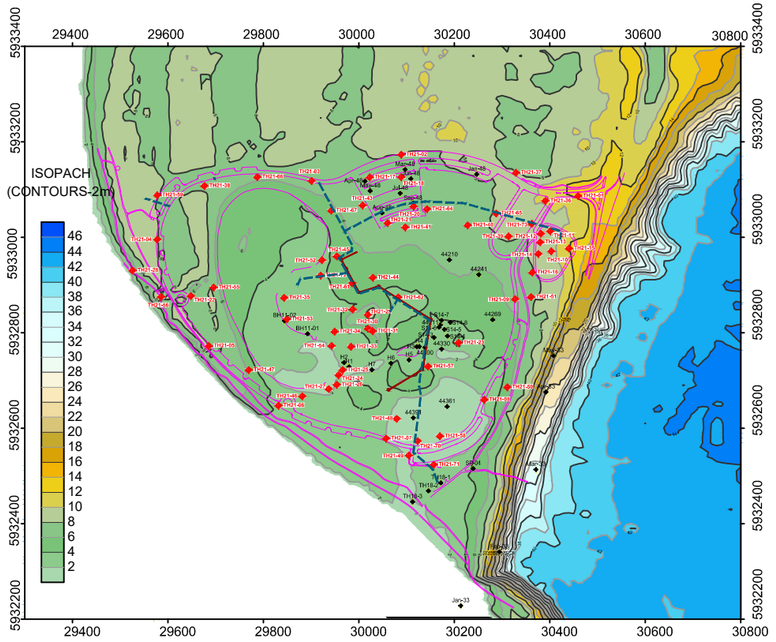
DRAWN BY	ML
DESIGNED BY	MLB
APPROVED BY	RWT
SCALE	1:6000
DATE	AUGUST 2021
FILE No.	31566

THURBER ENGINEERING LTD.

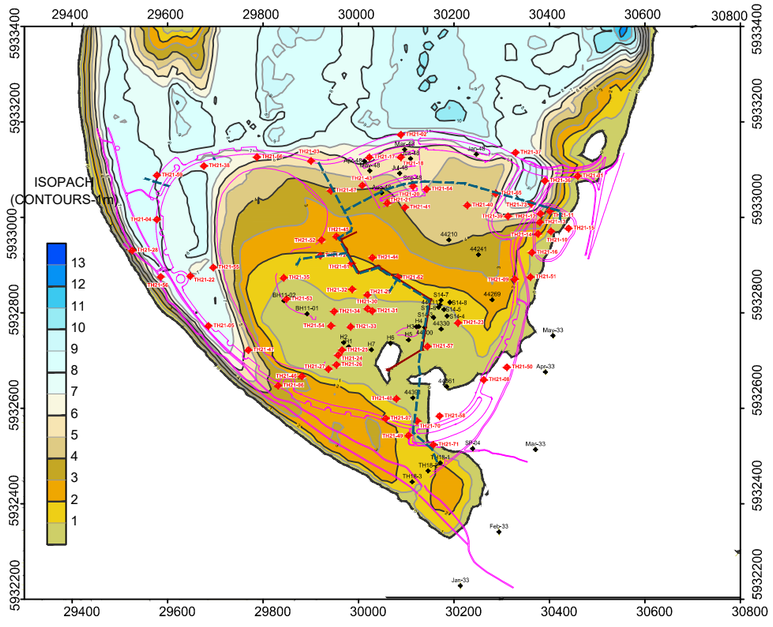
H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566-5 AUGUST 20, 2021.dwg - 1 - Aug. 20, 2021



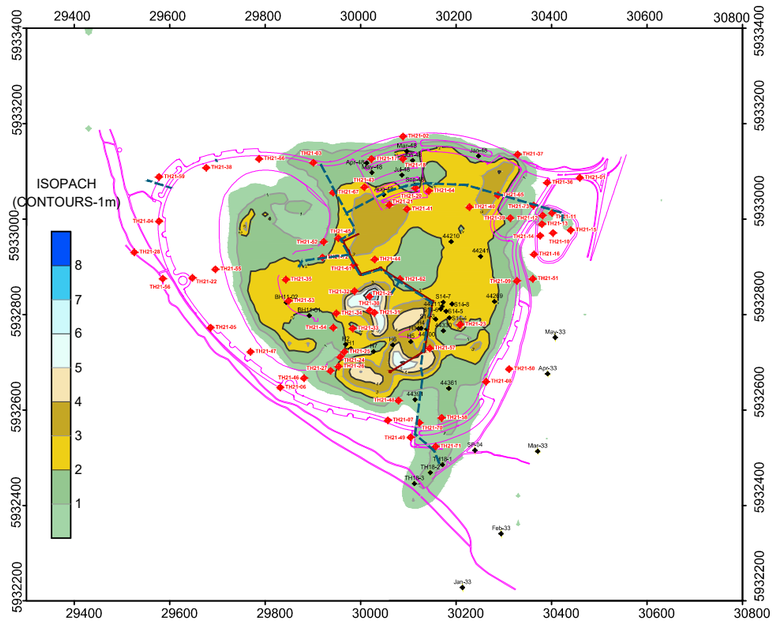
BEDROCK TOPOGRAPHY



SURFICIAL DEPOSITS (ALLUVIUM AND FILL) ISOPACH MAP



ALLUVIAL DEPOSITS ISOPACH



FILL MATERIAL ISOPACH MAP

LEGEND

- APPROXIMATE TEST HOLE LOCATION (2021)
- APPROXIMATE TEST HOLE LOCATION (PREVIOUS)
- PROPOSED SS PVC PIPE
- PROPOSED WATER ALIGNMENT OPTION A

0 100 200 300 400 500 600 700 m

SCALE 1:12500

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

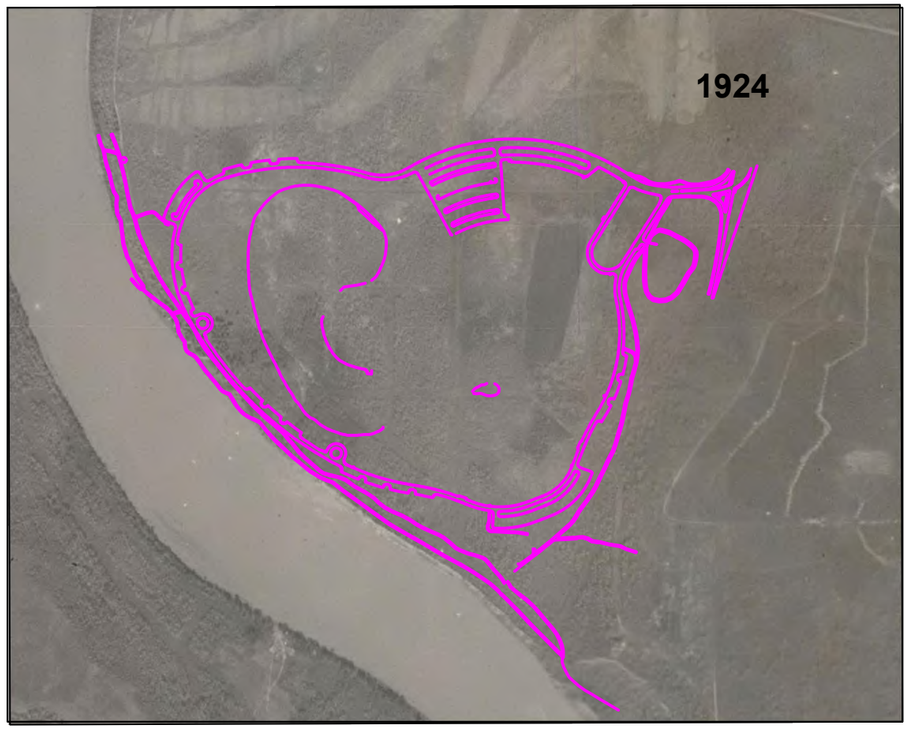
ISOPACH MAPS

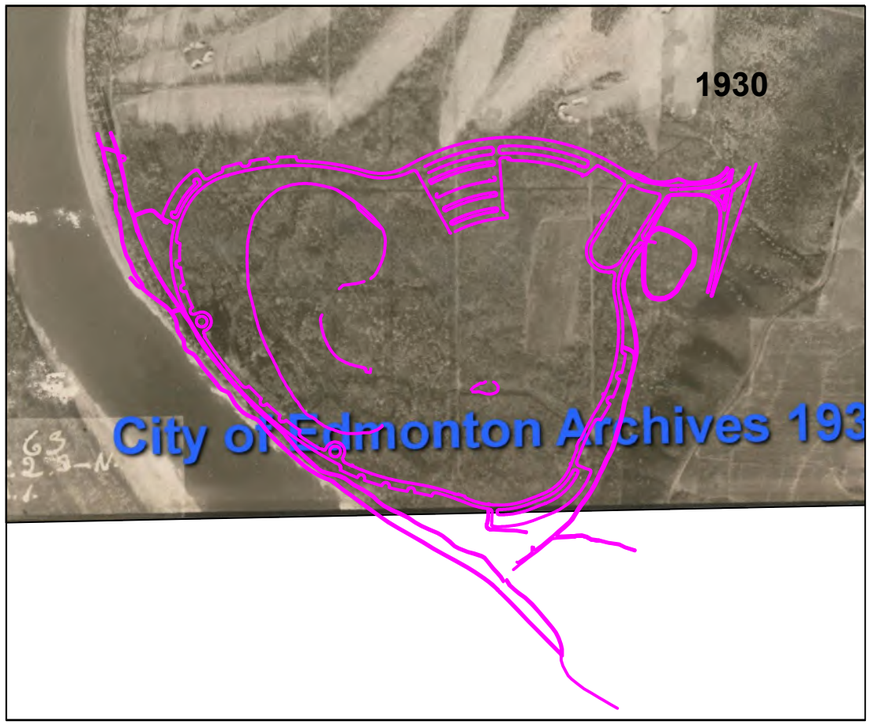
DWG No. 31566-5

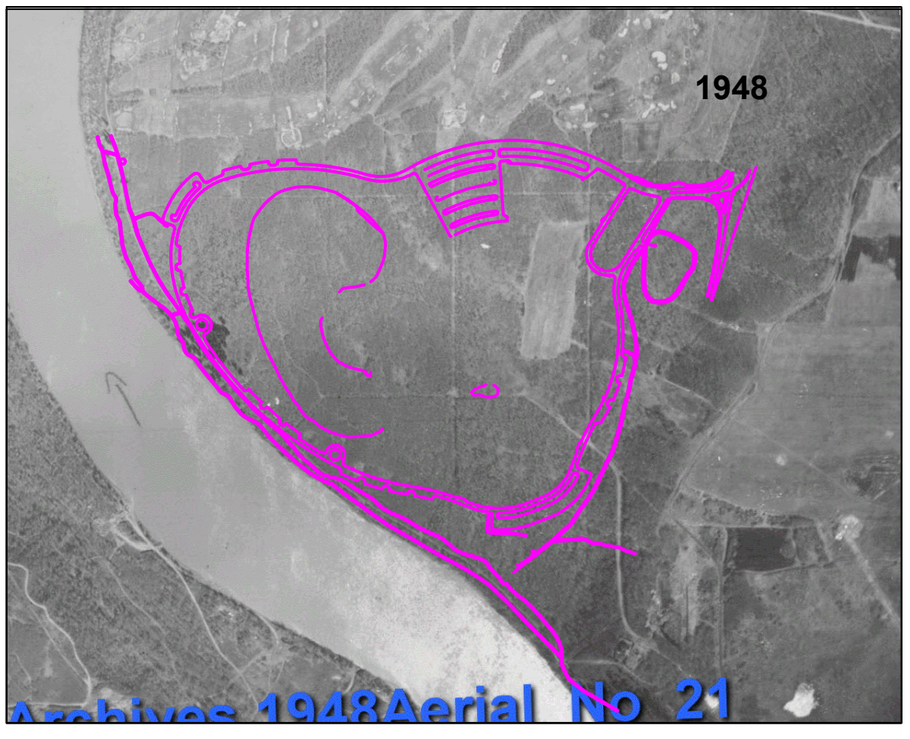
DRAWN BY	ML
DESIGNED BY	MLB
APPROVED BY	RWT
SCALE	1:12 500
DATE	AUGUST 2021
FILE No.	31566

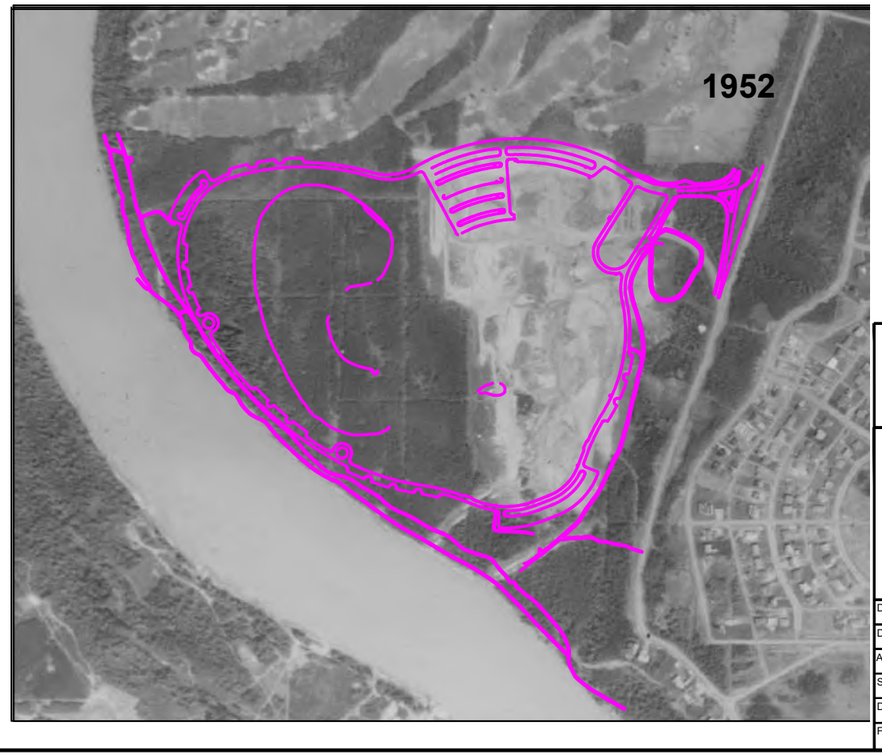
THURBER ENGINEERING LTD.

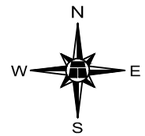
H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566-6-7 AUGUST 20, 2021.dwg - 6 - Aug. 20, 2021











0 100 200 300 400 500 600m

SCALE 1:10000

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

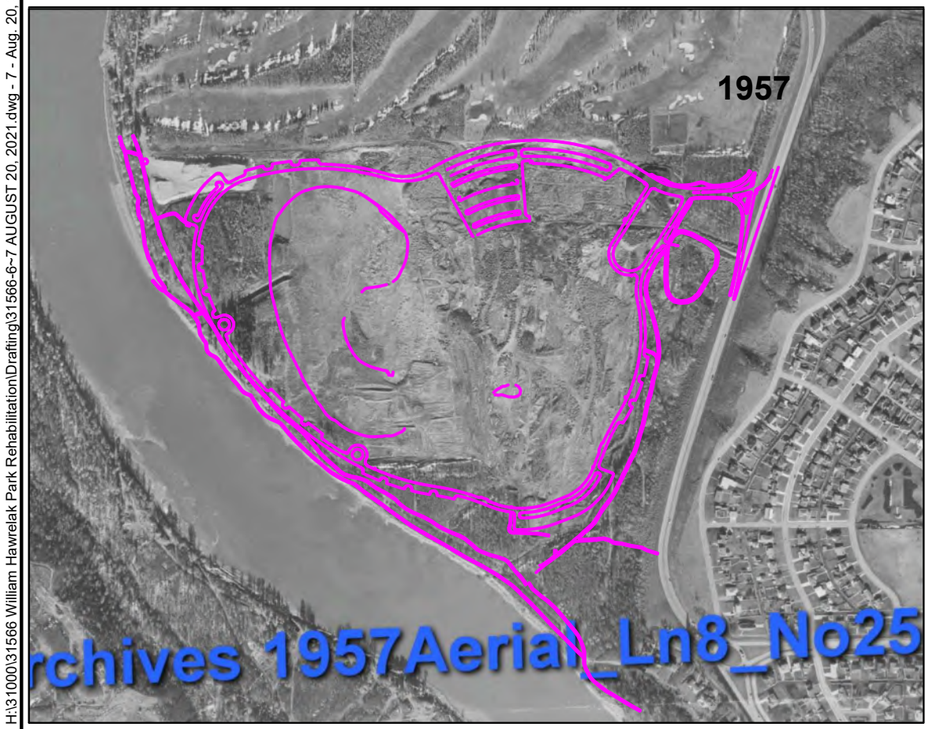
SELECTED AIR PHOTOS
1924, 1930, 1948 AND 1952

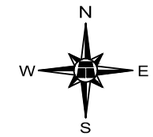
DWG No. 31566-6

DRAWN BY	ML
DESIGNED BY	TGV
APPROVED BY	RWT
SCALE	1:10 000
DATE	AUGUST 2021
FILE No.	31566

THURBER ENGINEERING LTD.

H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566-6-7 AUGUST 20, 2021.dwg - 7 - Aug. 20, 2021





0 100 200 300 400 500 600m

SCALE 1:10000

THE CITY OF Edmonton

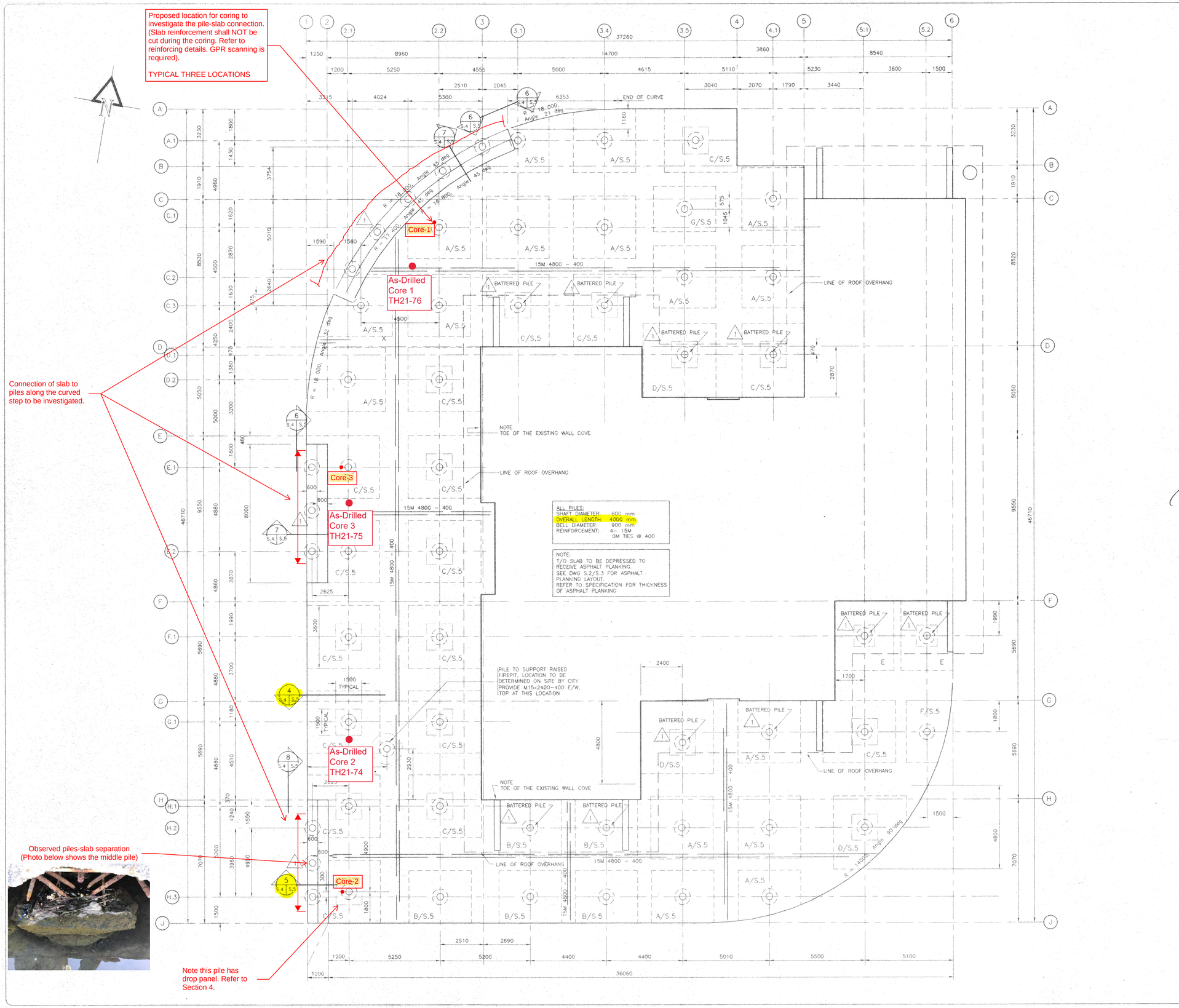
WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

SELECTED AIR PHOTOS
1957, 1965, 1978 AND 1988

DWG No. 31566-7

DRAWN BY	ML
DESIGNED BY	TGV
APPROVED BY	RWT
SCALE	1:10 000
DATE	AUGUST 2021
FILE No.	31566

THURBER ENGINEERING LTD.



notes

Recommendation for slab deck investigation

May 3, 2021

no.	description	date	checked
1	REVISED FOR THE RECORD	01-14-00	

revisions

issue date	date
ISSUED FOR CLIENT APPROVAL	
ISSUED FOR QUOTATION / TENDER	
ISSUED FOR CONSTRUCTION	

detail legend

A DETAIL NO.
B LOCATION DWG. NO.
C DETAIL DWG. NO.

DETAIL NUMBERS TO

seal

seal

permit

PERMIT TO PRACTICE
VENTURE ENGINEERING CONSULTANTS LTD.
Signature
Date FEB 3, 2000
PERMIT NUMBER: P 4526
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

consultants

VENTURE
ENGINEERING CONSULTANTS LTD.

#200, 10453 - 178 STREET, EDMONTON, ALBERTA TEL (780) 484-1974 FAX (780) 484-1975

consultant project no.

THE CITY OF Edmonton COMMUNITY SERVICES

project

HAWRELAK PARK
SKATING PAVILION
DECK SLAB UPGRADE
9330 GROAT ROAD, EDMONTON

drawing title

FOUNDATION PLAN
STRUCTURAL DECK SLAB

scale 1 : 100

drawn by AbS-ATL
date

checked by R.A.K.
date

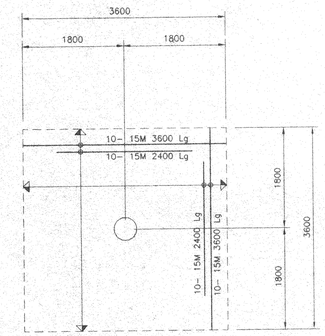
reviewed by
date

drawing no. S.4
sheet no. of

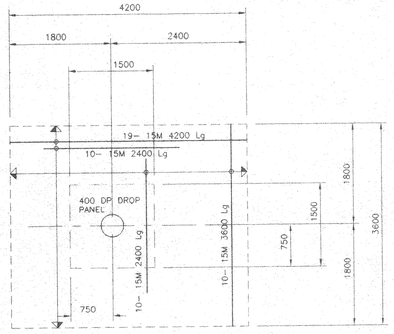
project no.

all dimensions are in millimetres

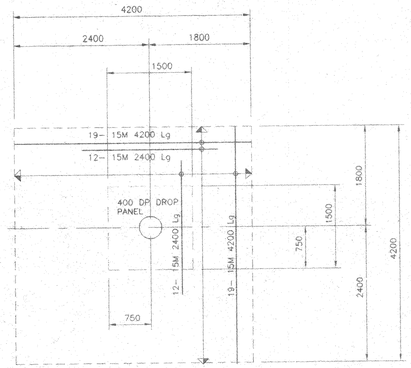
WIL101(xx)-00-S4



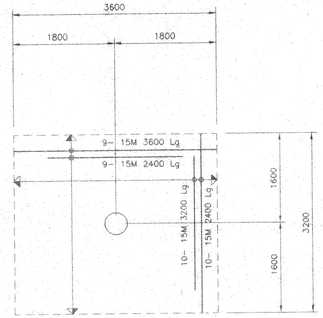
A S.4 S.5 PLAN DETAIL SCALE: 1:50



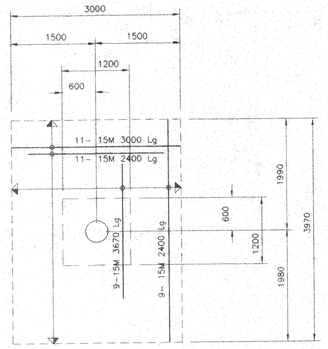
B S.4 S.5 PLAN DETAIL SCALE: 1:50



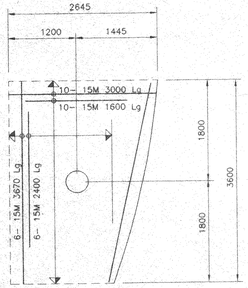
C S.4 S.5 PLAN DETAIL SCALE: 1:50



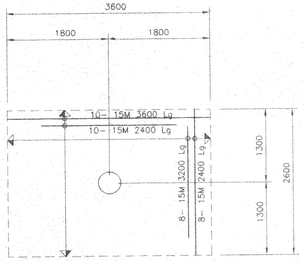
D S.4 S.5 PLAN DETAIL SCALE: 1:50



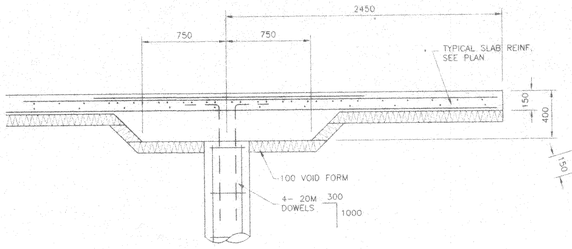
E S.4 S.5 PLAN DETAIL SCALE: 1:50



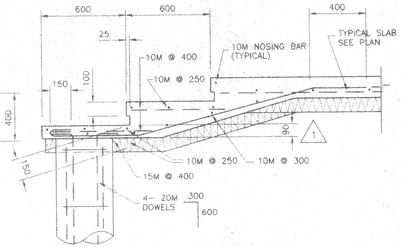
E S.4 S.5 PLAN DETAIL SCALE: 1:50



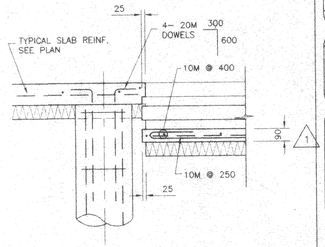
G S.4 S.5 PLAN DETAIL SCALE: 1:50



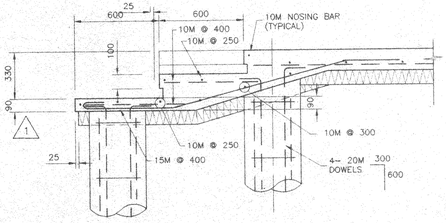
4 S.2 S.3 SECTION SCALE: 1 : 25



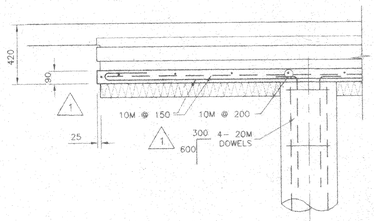
5 S.4 S.5 SECTION SCALE: 1 : 20



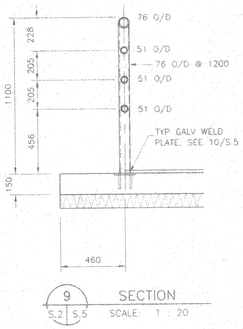
6 S.4 S.5 SECTION SCALE: 1 : 20



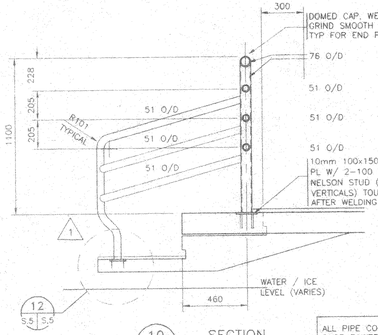
7 S.4 S.5 SECTION SCALE: 1 : 20



8 S.2 S.5 SECTION SCALE: 1 : 20



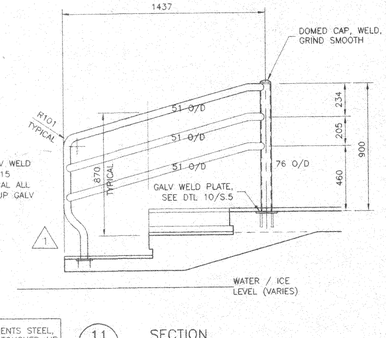
9 S.2 S.5 SECTION SCALE: 1 : 20



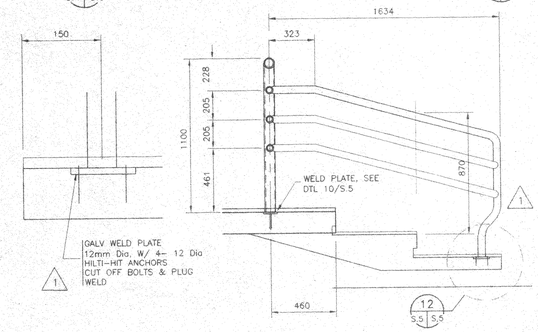
12 S.5 S.5

10 S.2 S.5 SECTION SCALE: 1 : 20

ALL PIPE COMPONENTS STEEL, SHOP PAINTED & TOUCHED–UP IN FIELD AFTER INSTALLATION

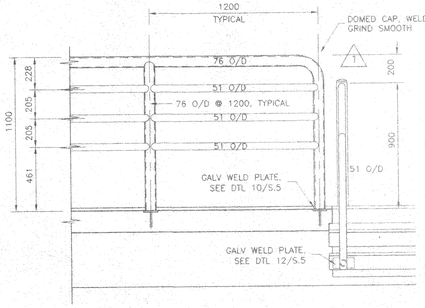


11 S.4 S.5 SECTION SCALE: 1 : 20



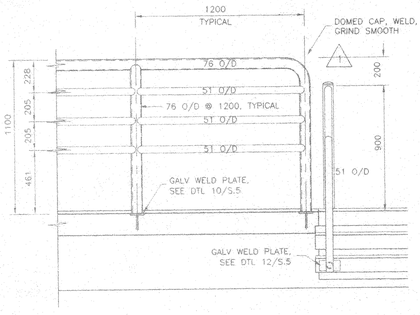
12 S.5 S.5

12 S.2 S.5 DETAIL SCALE: 1 : 5

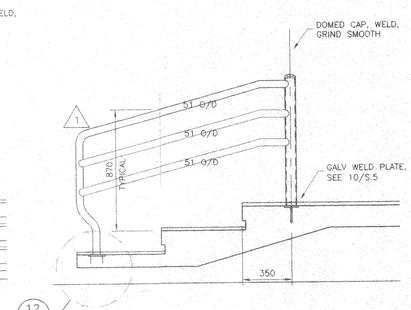


13 S.2 S.5 ELEVATION SCALE: 1 : 20

14 S.2 S.5 ELEVATION SCALE: 1 : 20



15 S.2 S.5 ELEVATION SCALE: 1 : 20



12 S.5 S.5

16 S.2 S.5 ELEVATION SCALE: 1 : 20

notes

no.	description	date	checked
1	REVISED FOR THE RECORD	01–14–00	

revisions

issue data	date
ISSUED FOR CLIENT APPROVAL	
ISSUED FOR QUOTATION / TENDER	
ISSUED FOR CONSTRUCTION	

detail legend

A DETAIL NO.
B LOCATION DWG. NO.
C DETAIL DWG. NO.

DETAIL NUMBERS TO

seal

PROFESSIONAL ENGINEER ALBERTA TERRY A. KALMANSON

Feb 8/2000

seal

permit

PERMIT TO PRACTICE
VENTURE ENGINEERING CONSULTANTS LTD.
Signature
Date FEB 8, 2000
PERMIT NUMBER: P 5526
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

consultants

VENTURE
ENGINEERING CONSULTANTS LTD.
#200, 10453 – 178 STREET, EDMONTON, ALBERTA TEL (780) 484–1974 FAX (780) 484–1975

consultant project no.

THE CITY OF Edmonton COMMUNITY SERVICES

project

HAWRELAK PARK
SKATING PAVILION
DECK SLAB UPGRADE
9330 GROAT ROAD, EDMONTON

drawing title

DETAILS, SECTIONS

scale 1 : 100

drawn by AbS–ATL date

checked by R.A.K. date

reviewed by date

drawing no. S.5 sheet no. of

project no. WIL101(xx)–00–S5

all dimensions are in millimetres

THURBER

APPENDIX B

Modified Unified Soils Classification

Symbols and Terms Used on Test Hole Logs

Test Hole Logs

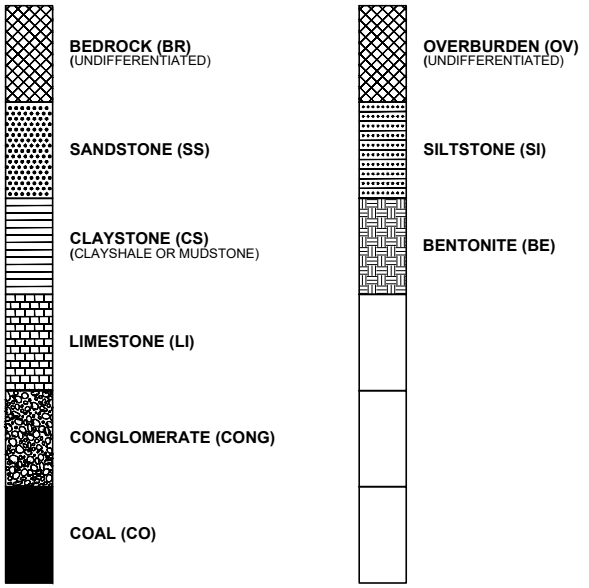
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

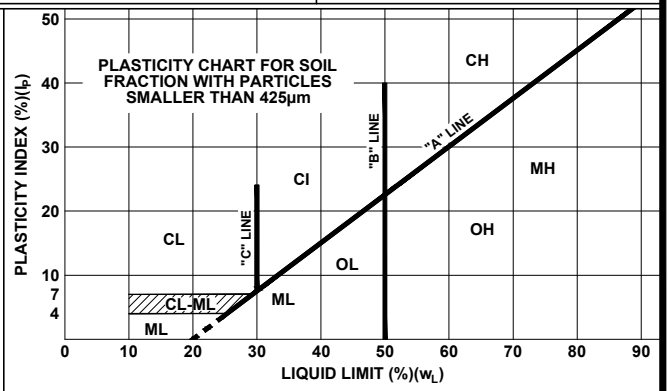
(MODIFIED BY PFRA, 1985)

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 4.75mm	CLEAN GRAVELS (LITTLE OF NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ 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
			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 4.75mm	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
			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

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





THURBER ENGINEERING LTD.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(MODIFIED BY PFRA, 1985)

Revised October 22, 2019

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	15 to 30
Hard	200 - 300 kPa	National Building	Greater than 30
Very Hard	Greater than 300 kPa	Code	

* 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
Dense	30 - 50	National Building
Very Dense	Over 50	Code

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

Shelby Tube SPT No Recovery A-Casing Grab 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

TERMS DESCRIBING QUANTITIES

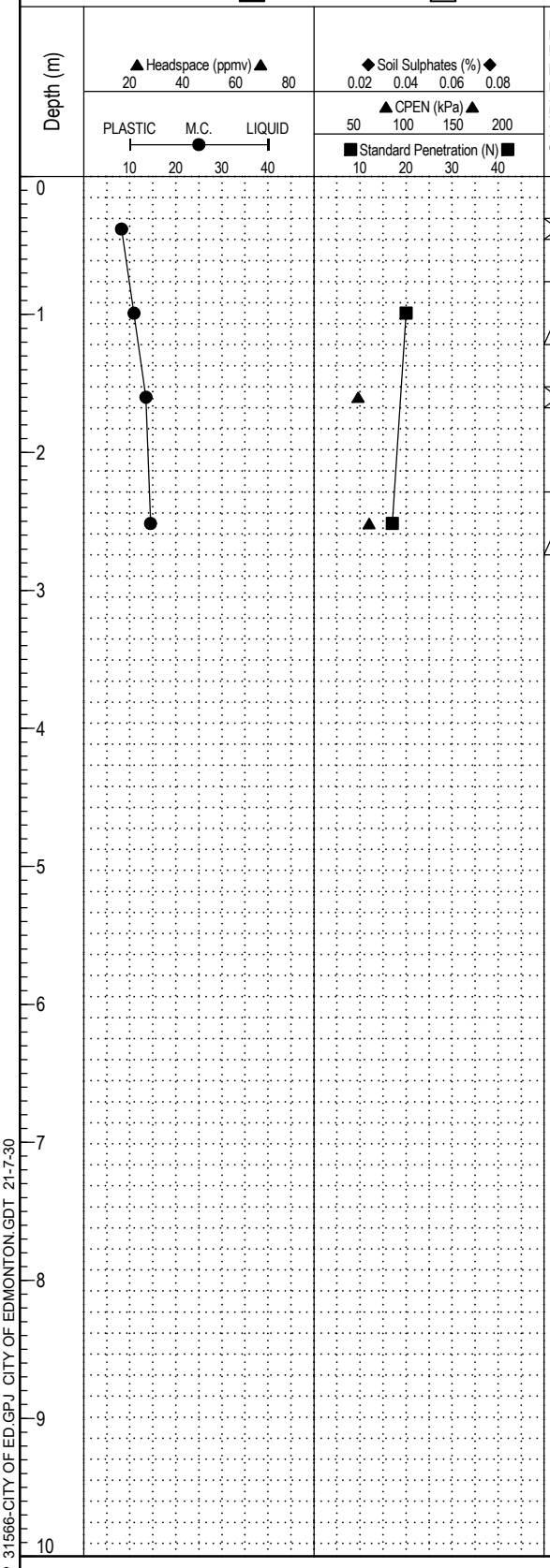
'and'	35% to 50% of each size group
'sandy'	20% to 35%
'some'	10% to 20%
'trace'	Less than 10%
'mixture'	Soils containing three or more size groups within 20% of each other and each group greater than 10%

THURBER ENGINEERING LTD.

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-01**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5933086.18, E30459.32	ELEVATION: 635.74 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
				ASPHALT	
				CONCRETE	
		SM		SAND compact, brown silty, fine grained, some gravel, trace clay lumps	635
	20	SM		-trace oxides, possible sandstone	
				CLAY	
		CI		very stiff, brown, silty, fine sandy, some sandstone, trace oxides	634
	17	CI		-brown to grey, trace clay shale	633
				END OF TEST HOLE AT 2.7m UPON COMPLETION: Backfilled with drill cuttings, bentonite chips, and cold mix at surface	632 631 630 629 628 627 626

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

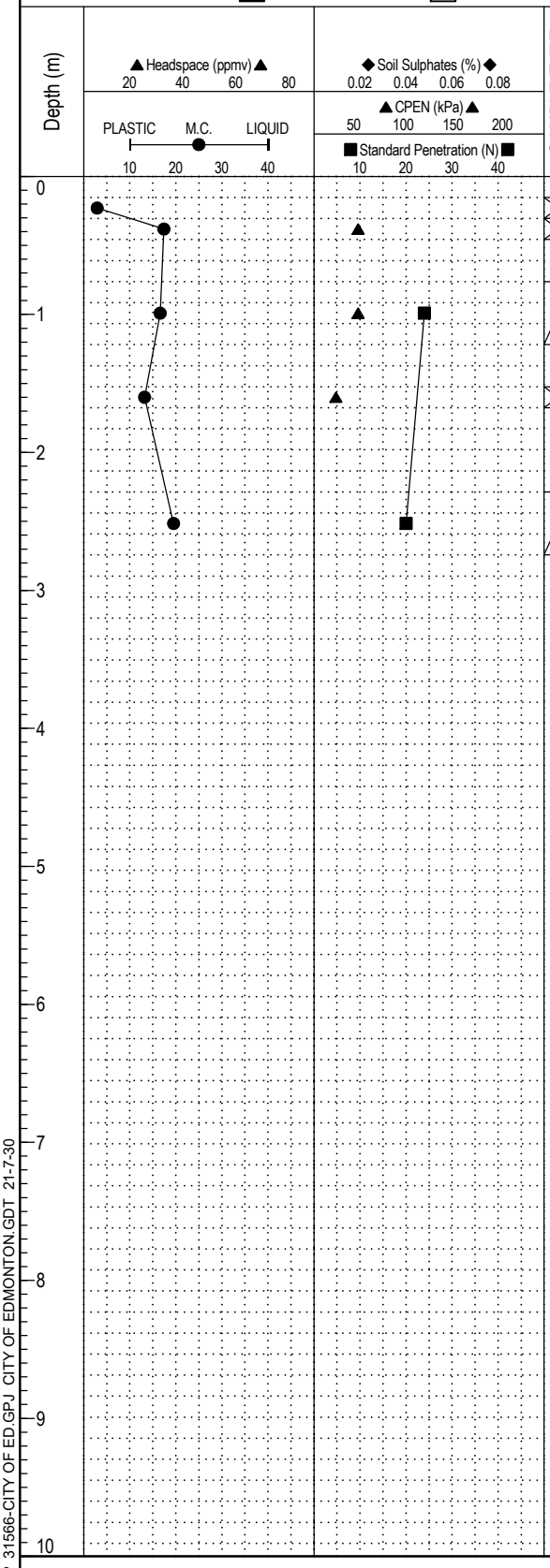
COMPLETION DATE: 21-6-15

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-02**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5933172.71, E30089.01	ELEVATION: 628.42 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		GM		ASPHALT	
		CI		GRAVEL (FILL), dark brown, silty, fine, sandy	628
				CLAY (FILL) dark brown, silty, some fine sand, trace gravel and oxides	
	24	CI			627
		CI		CLAY dark brown to black, silty, trace coal and gravel	
	20	SM		SAND, compact, dark brown, silty, fine to coarse grained, some coal, trace gravel	626
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	625
					624
					623
					622
					621
					620
					619

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-15

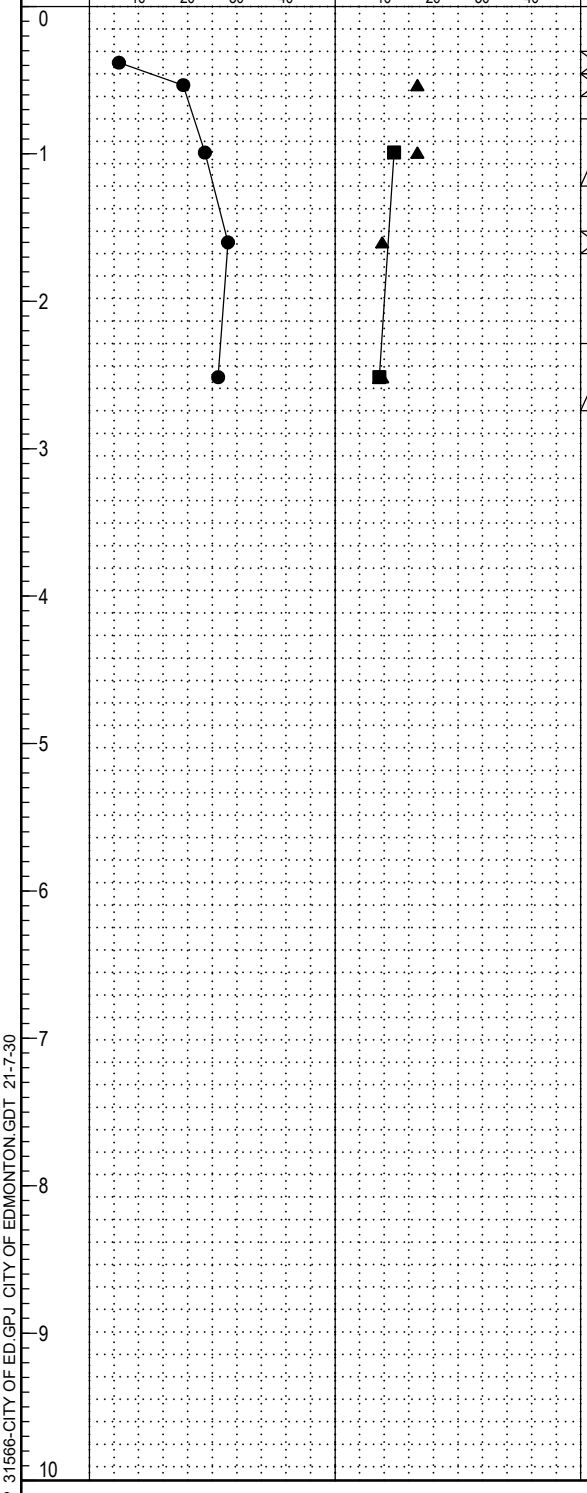
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-03**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5933117.77, E29900.81	ELEVATION: 626.77 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
				ASPHALT	
		SM-GM		SAND AND GRAVEL (FILL), dark brown, silty, fine grained sand, trace clay lumps	
		CI		CLAY (FILL)	
	12	CI		stiff, dark grey, silty, trace fine sand, gravel, and sandstone pockets	626
				-some organics, trace clay shale and oxides	
		CI			625
	9	CI			624
				END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.4m -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	623
					622
					621
					620
					619
					618
					617

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-15

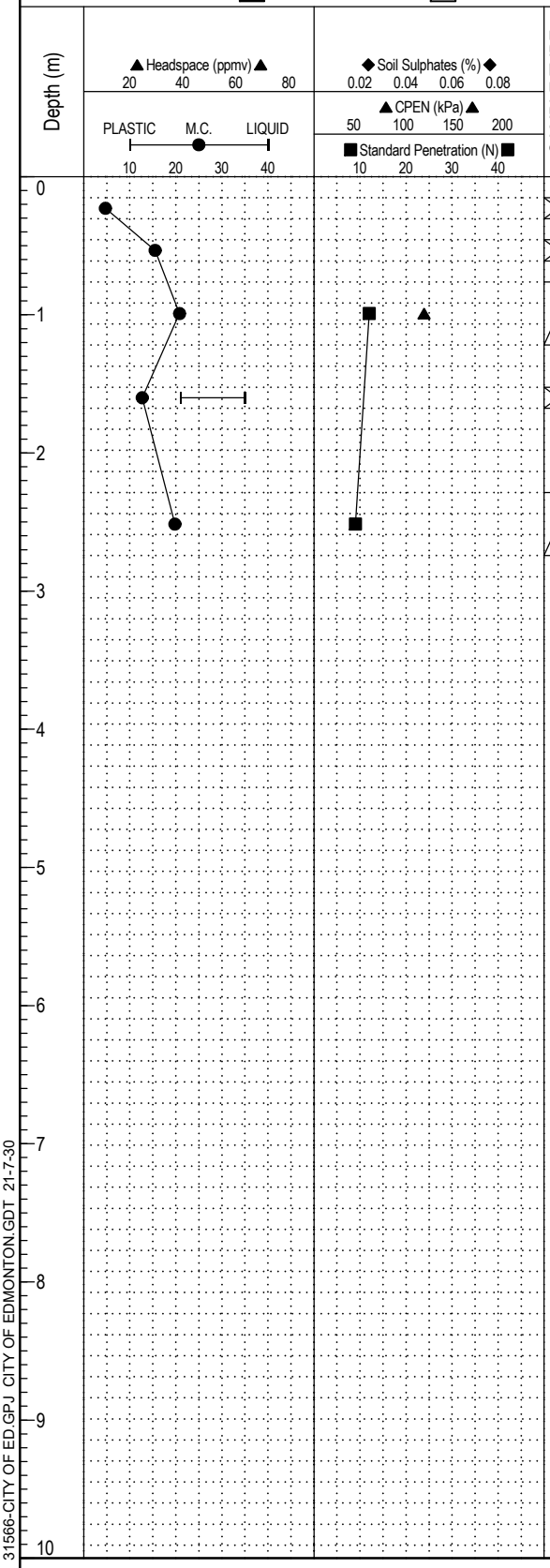
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-04**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932995.09, E29577.69	ELEVATION: 625.58 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		GM		ASPHALT	
				GRAVEL (FILL), dark brown, silty, fine, sandy, trace clay lumps	
		CI		CLAY (FILL)	625
				dark brown, silty, some fine sand, trace gravel	
	12	CI		CLAY stiff, brown to dark brown, silty, trace fine sand and oxides	
		CI			624
	9	CI		-trace oxides	623
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	622
					621
					620
					619
					618
					617
					616

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-11

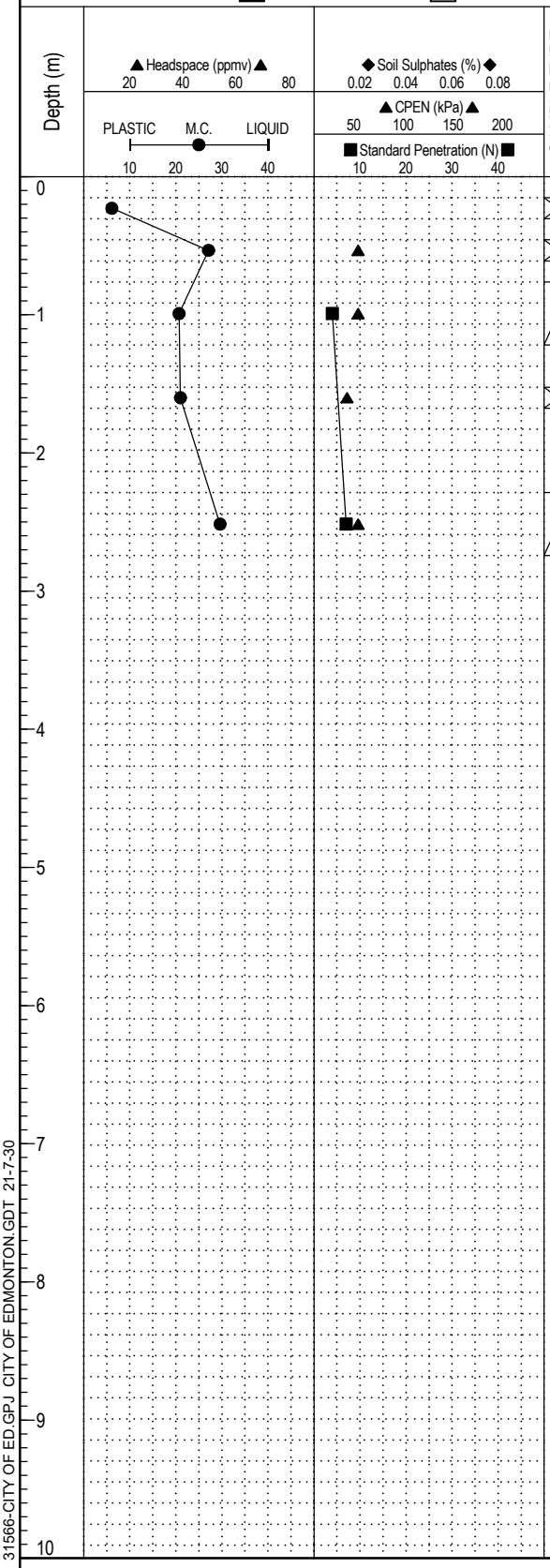
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-05**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932772.05, E29685.73	ELEVATION: 626.74 (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



ASPHALT

GRAVEL (FILL), dark brown, silty, fine sandy
-Gravel = 33.6%, Sand = 54.6%, Fines = 11.8%

CLAY (FILL)
firm, dark brown, silty, some fine sand and silt
-trace organics and rootlets

CLAY
firm, brown, very silty, trace fine sand, oxides, and rootlets

-trace coal

END OF TEST HOLE AT 2.7m
UPON COMPLETION:
-No slough
-No water
Backfilled with drill cuttings, bentonite chips, and cold mix at surface

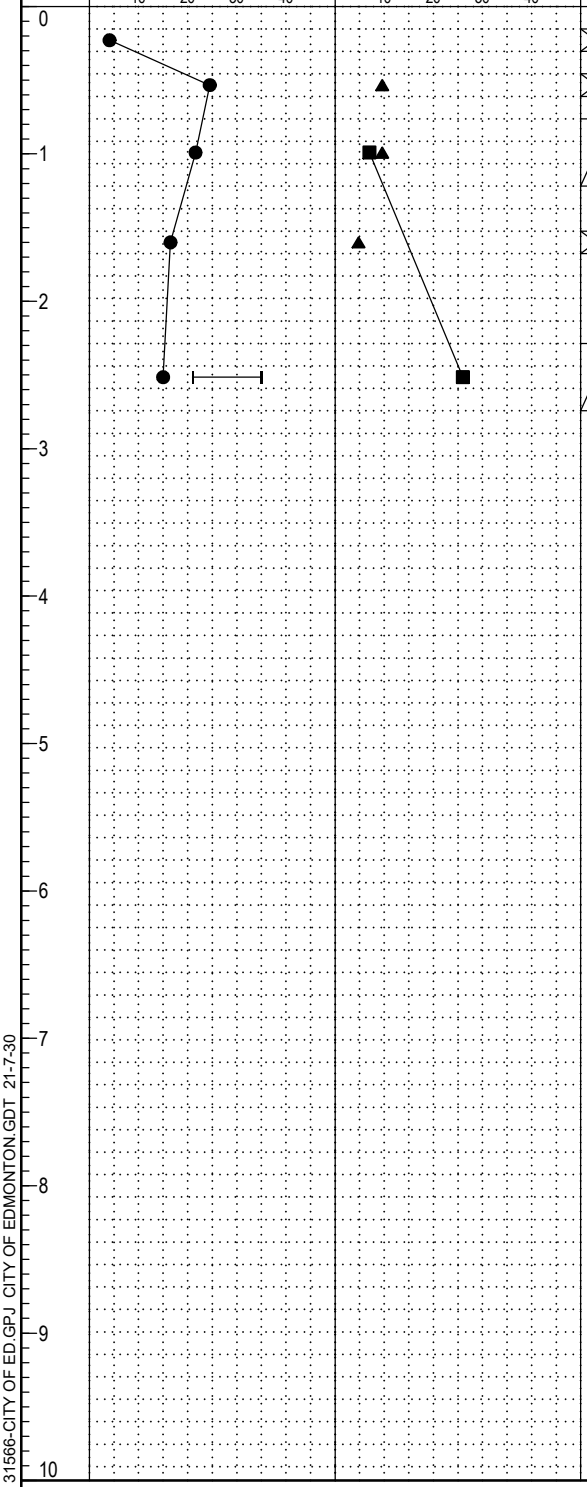
THE CITY OF Edmonton — Transportation Engineeering Services Section	THURBER ENGINEERING LTD.	COMPLETION DEPTH: 2.7 m
		COMPLETION DATE: 21-6-11
	LOGGED BY: GS / REVIEWED BY: TGV / RWT	Page 1 of 1

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-06**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932646.86, E29831.71	ELEVATION: 626.08 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
				ASPHALT	626
		GM		GRAVEL (FILL), dark brown, silty, fine, sandy	
		CI		CLAY firm, brown, silty, trace fine sand, oxides, and rootlets	
	7	CI		-very silty, some silt lenses	625
		CI		-very silty	624
	26	CI			
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	623
					622
					621
					620
					619
					618
					617

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-14

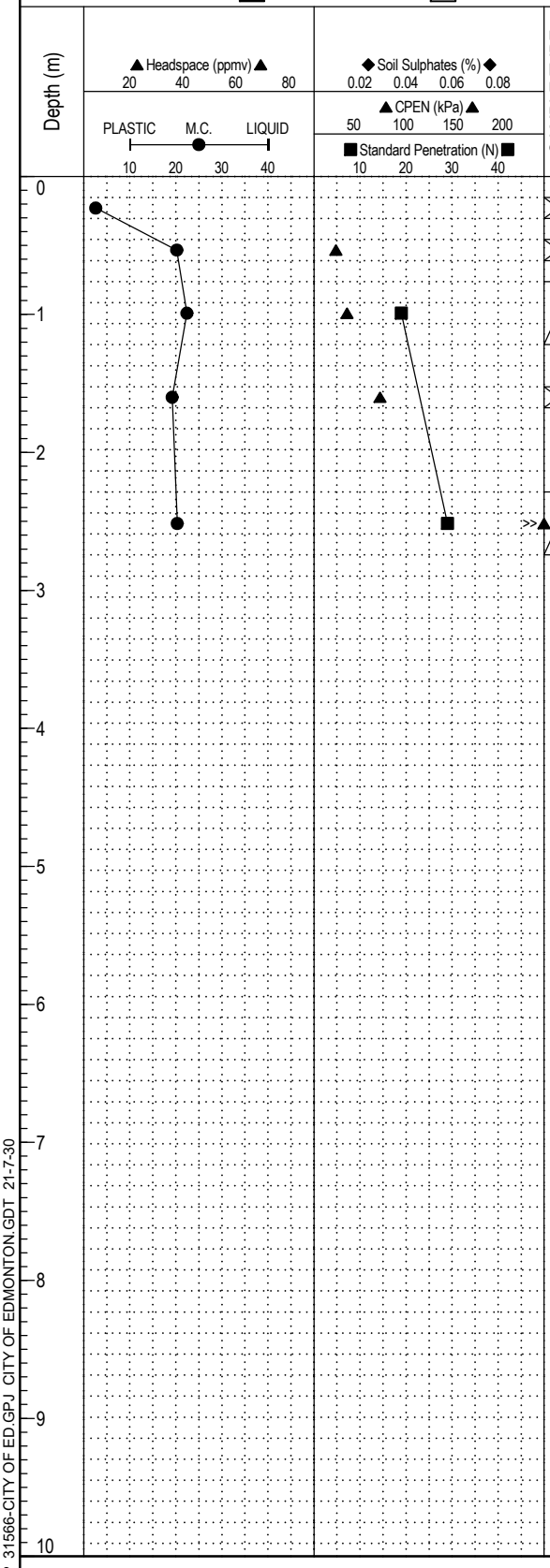
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-07**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932578.1, E30057.02	ELEVATION: 627.28 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
				ASPHALT	
		GM		GRAVEL (FILL), dark brown, silty, fine, sandy, trace clay lumps	627
		CI		CLAY very stiff, brown, very silty, trace fine sand, oxides, and rootlets	
	19	CI		-some silt lenses	626
		CI		-very silty	
					625
	29	SS-CI		SANDSTONE, compact, grey, silty, fine grained, trace oxides and coal	
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	624
					623
					622
					621
					620
					619
					618

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-14

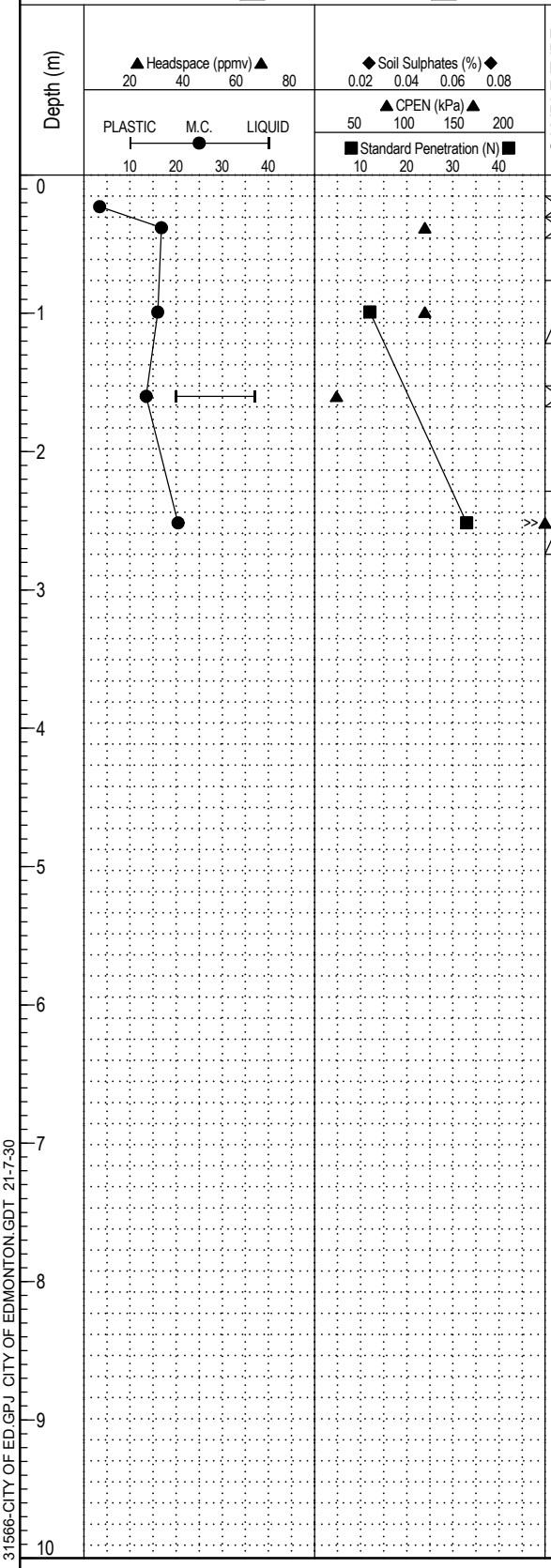
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-08**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932659.22, E30262.76	ELEVATION: 628.79 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
				ASPHALT	
		SM-GM		SAND AND GRAVEL (FILL)	
		CI		brown, silty, fine grained sand, some silt	
				-Gravel = 44.5%, Sand = 51.1%, Fines = 4.4%	628
	12	CH		CLAY (FILL), grey, silty, trace sandstone, oxides, and high plastic clay lenses	
				-stiff, dark brown, silty, trace fine sand, gravel, organics, rootlets, and oxides	
		CI		-gravelly	627
	33	CS-CH		CLAY SHALE, hard, dark brown, silty, trace coal and oxides, high plastic	626
				END OF TEST HOLE AT 2.7m	
				UPON COMPLETION: (Below ground surface)	
				-Slough at 2.3m	
				-No water	
				Backfilled with drill cuttings, bentonite chips, and cold mix at surface	625
					624
					623
					622
					621
					620
					619

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

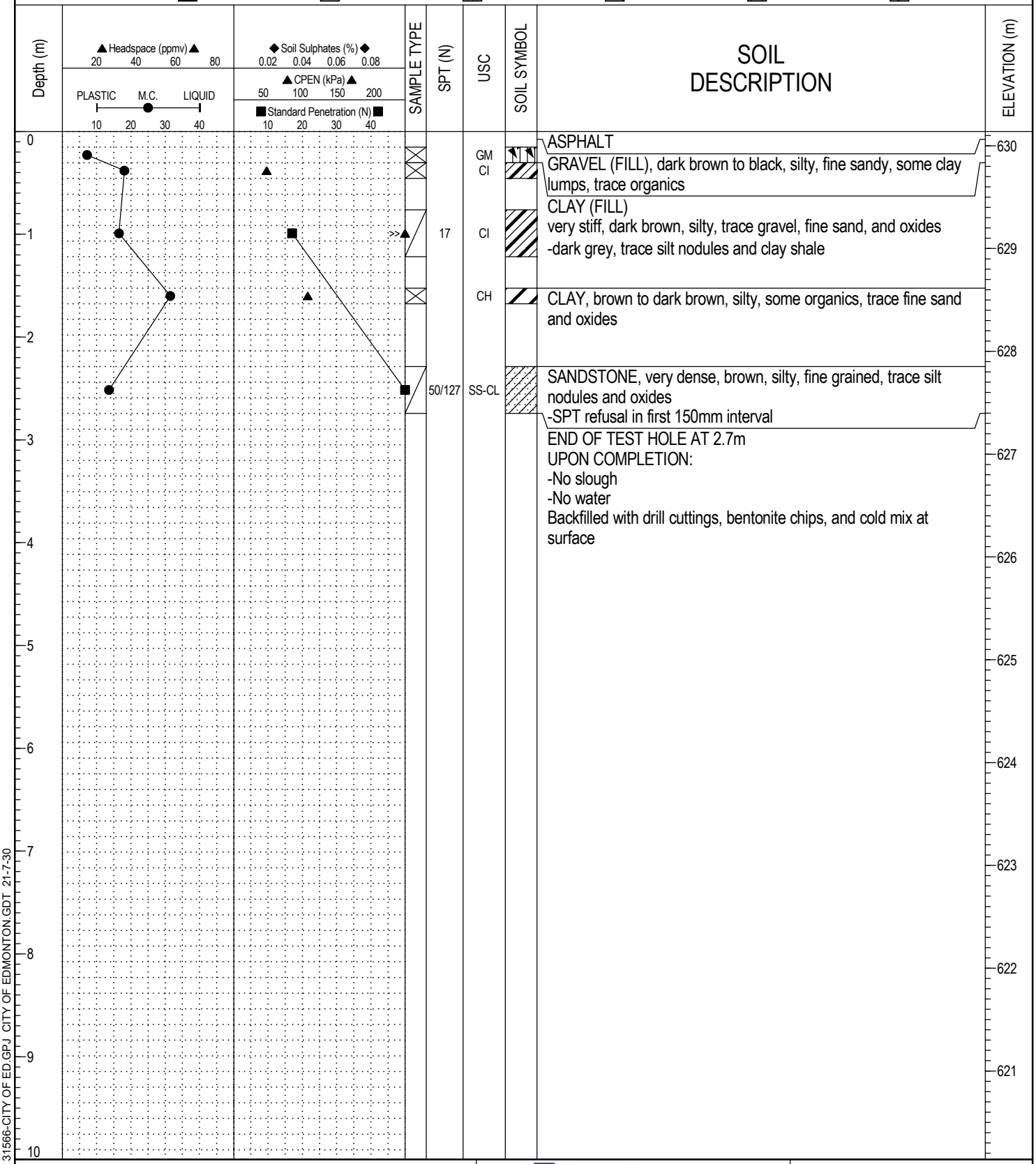
COMPLETION DATE: 21-6-14

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-09**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932870.3, E30327.43	ELEVATION: 630.14 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

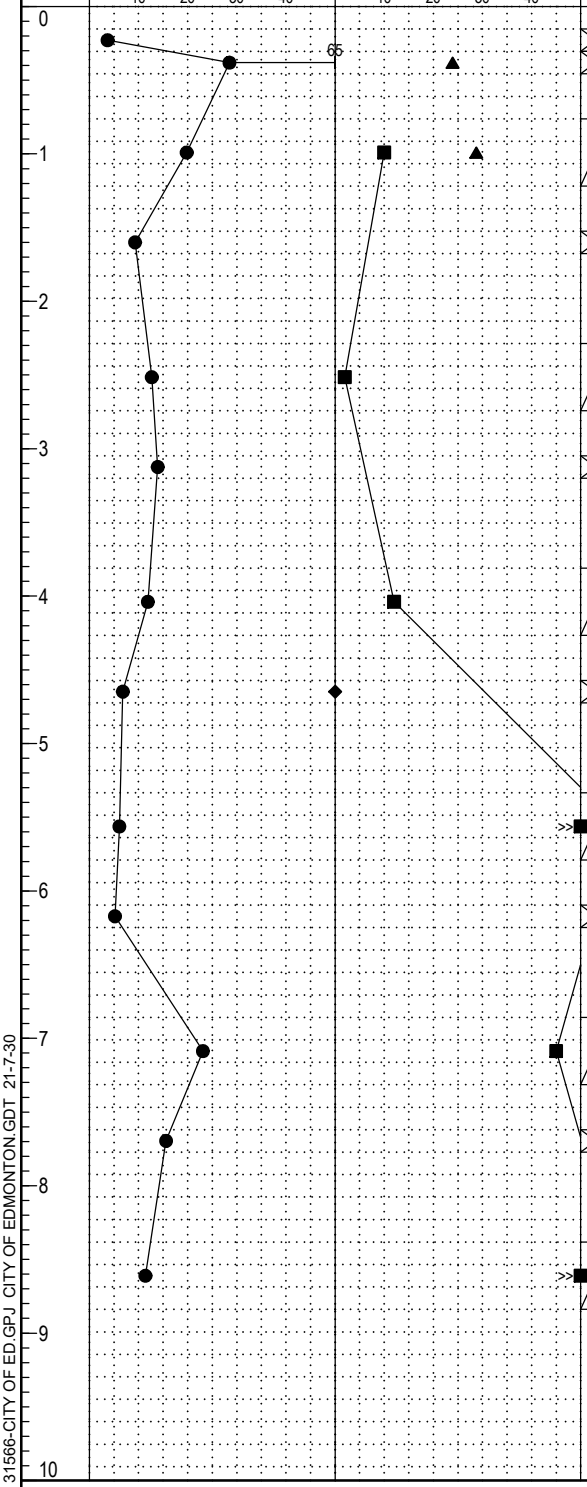
COMPLETION DATE: 21-6-14

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-10**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-18	LOCATION: N5932970.46, E30403.36	ELEVATION: 632.93 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			GM		GRAVEL (FILL), brown, silty, fine sandy	
			CH		CLAY (FILL) stiff, dark grey, silty, trace fine sand, gravel, and organics	
1		10	CH			632
			SP-SM		SAND very loose, brown, very silty, fine grained, some silt, trace oxides	
2		2	SP-SM			631
3			SM		SAND AND GRAVEL compact, dark brown, silty, fine grained sand, fine grained gravel	630
4		12	SM			629
			SP		SAND very dense, brown, silty, fine grained, trace oxides and coal	
5					-strong chemical odour	628
		58	SP			
6			SP		-slight chemical odour -Gravel = 0.0%, Sand = 92.6%, Fines = 7.4%	627
7		45	SM		-dense, trace coal -strong chemical odour	626
			SM		-some coal	
8						625
		58	SM		-very dense, trace gravel, coal, and clay lumps	
9					END OF TEST HOLE AT 8.8m UPON COMPLETION: (Below ground surface) -Slough at 7.8m -Trace of water Backfilled with drill cuttings and bentonite chips at surface	624
10						623

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-18

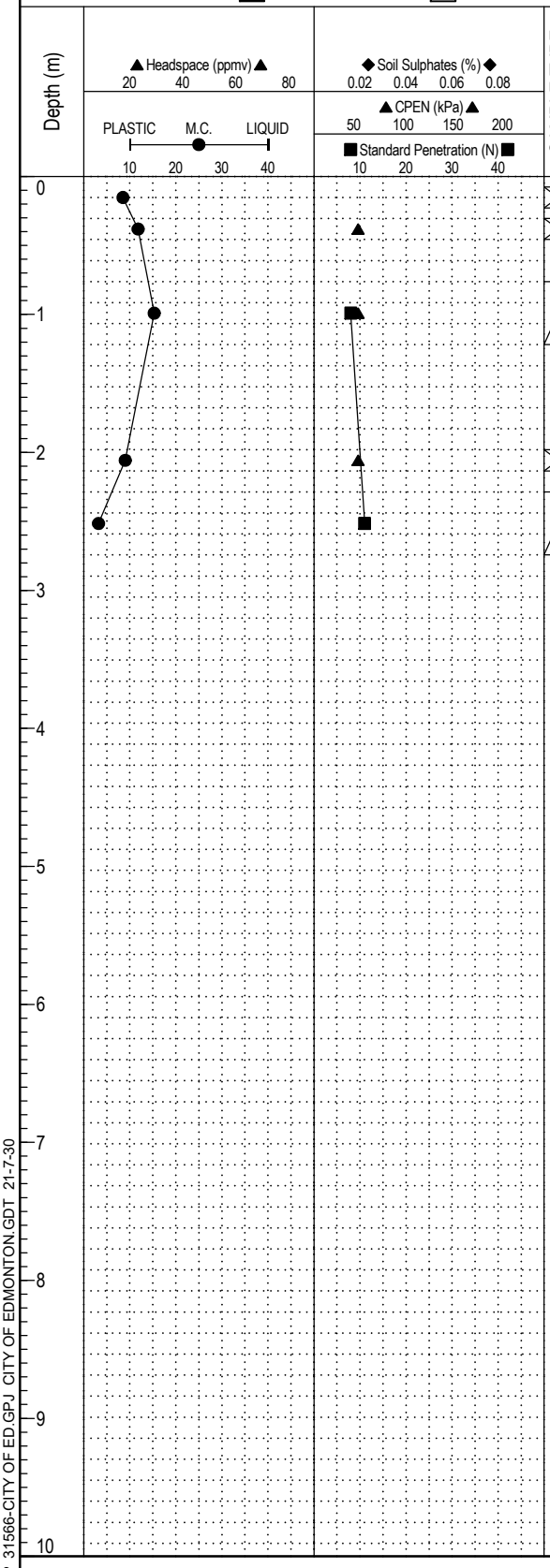
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-11**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-18	LOCATION: N5933012.51, E30401.23	ELEVATION: 633.03 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			GM		ASPHALT	
			CI		GRAVEL (FILL), dark brown, silty, fine, sandy	
					CLAY (FILL) stiff, dark brown, silty, some fine sand, trace gravel and organics -trace oxides	
1		8	CI			632
					CLAY, brown to dark brown, very silty, trace fine sand, oxides, and silt nodules	
2			CI			631
		11	SP		SAND, compact, brown, silty, fine grained, trace gravel	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	630
4						629
5						628
6						627
7						626
8						625
9						624
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-18

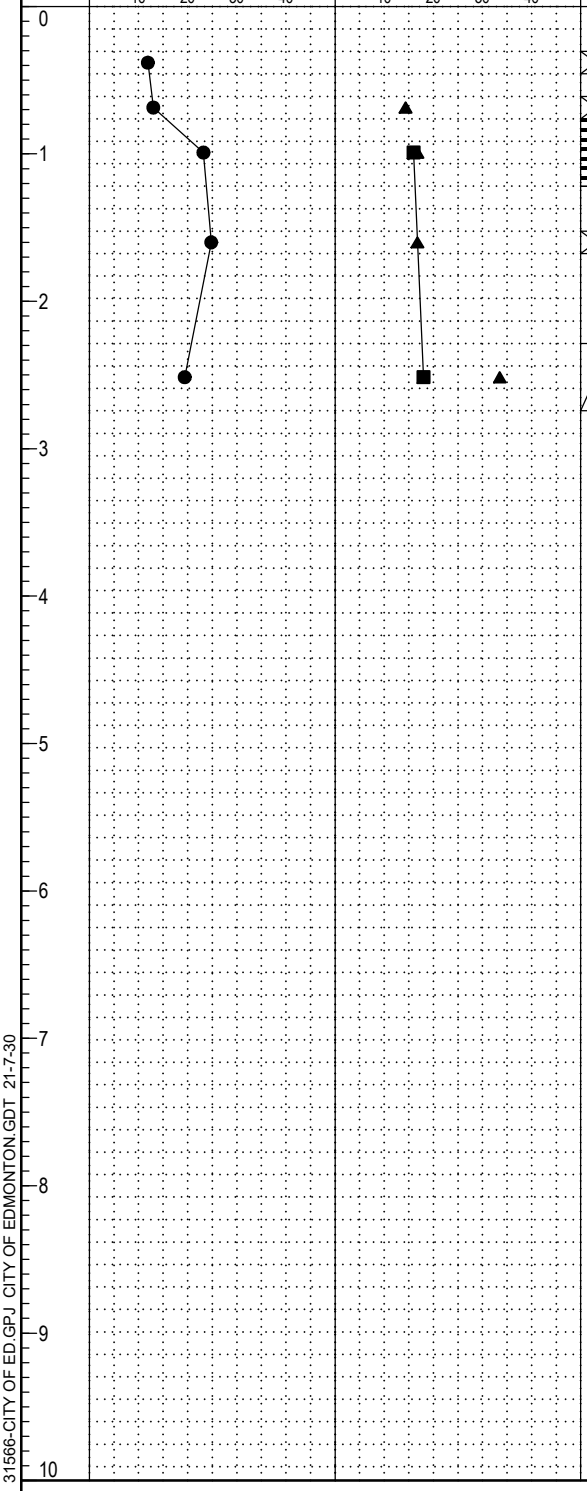
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-12**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-10	LOCATION: N5933007.26, E30381.41	ELEVATION: 632.62 (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	SOIL DESCRIPTION	ELEVATION (m)
		TOPSOIL, dark brown, silty, rootlets, trace fine sand and gravel	
	CI	CLAY (FILL)	
	CI	dark brown, silty, some fine sand, trace gravel	632
16	CI	-some organics, trace rootlets and oxides	
	CH	-trace organics	631
18	CI	-very stiff, some organics, trace coal	630
		END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.3m -No water Backfilled with drill cuttings and bentonite chips at surface	629
			628
			627
			626
			625
			624
			623

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

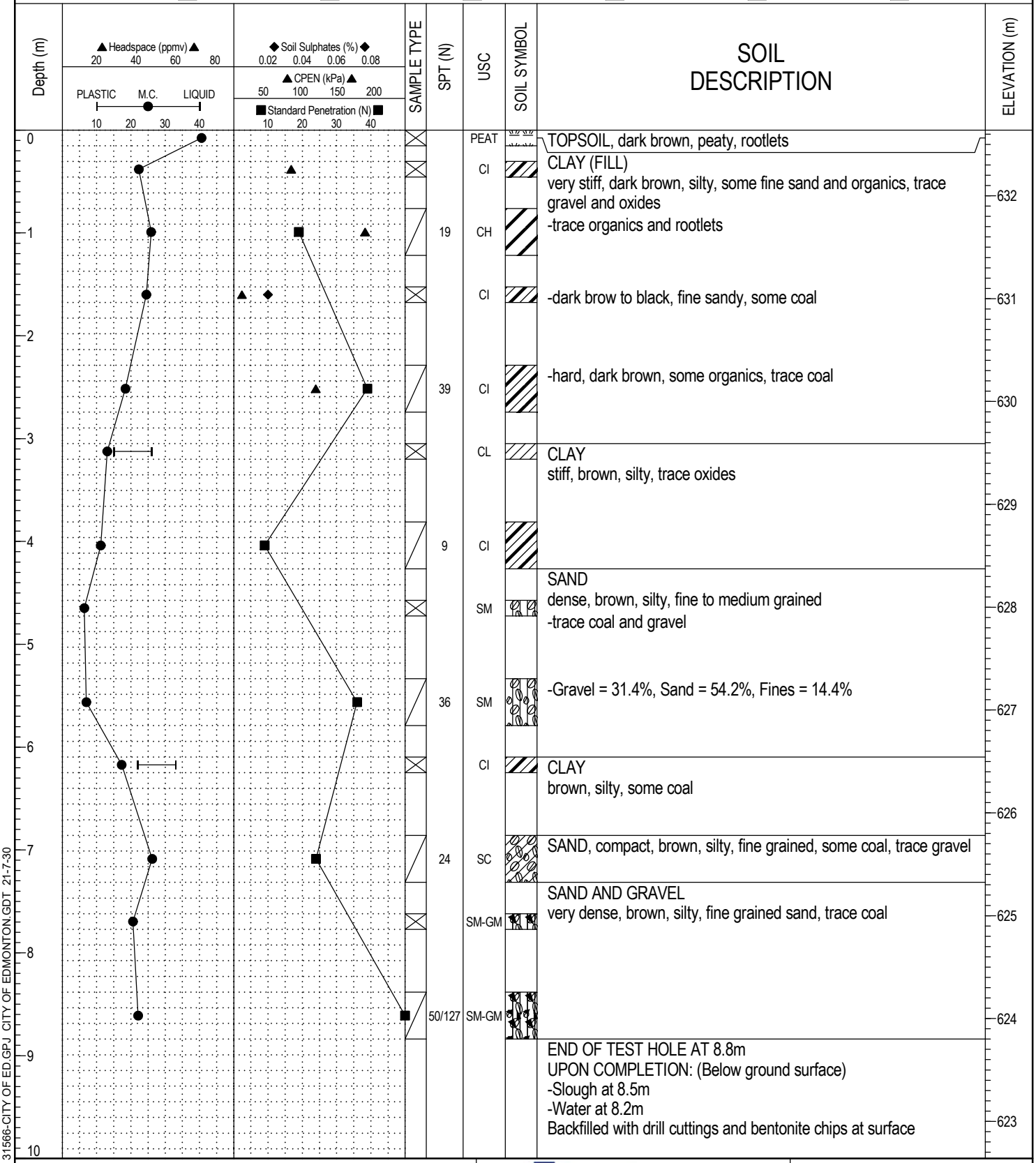
COMPLETION DEPTH: 2.7 m
COMPLETION DATE: 21-6-10

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-13**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932989.3, E30380.03	ELEVATION: 632.64 (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



TOPSOIL, dark brown, peaty, rootlets

CLAY (FILL)
very stiff, dark brown, silty, some fine sand and organics, trace gravel and oxides
-trace organics and rootlets

-dark brow to black, fine sandy, some coal

-hard, dark brown, some organics, trace coal

CLAY
stiff, brown, silty, trace oxides

SAND
dense, brown, silty, fine to medium grained
-trace coal and gravel

-Gravel = 31.4%, Sand = 54.2%, Fines = 14.4%

CLAY
brown, silty, some coal

SAND, compact, brown, silty, fine grained, some coal, trace gravel

SAND AND GRAVEL
very dense, brown, silty, fine grained sand, trace coal

END OF TEST HOLE AT 8.8m
UPON COMPLETION: (Below ground surface)
-Slough at 8.5m
-Water at 8.2m
Backfilled with drill cuttings and bentonite chips at surface

THE CITY OF Edmonton
Transportation
Engineeering Services Section

THURBER ENGINEERING LTD.

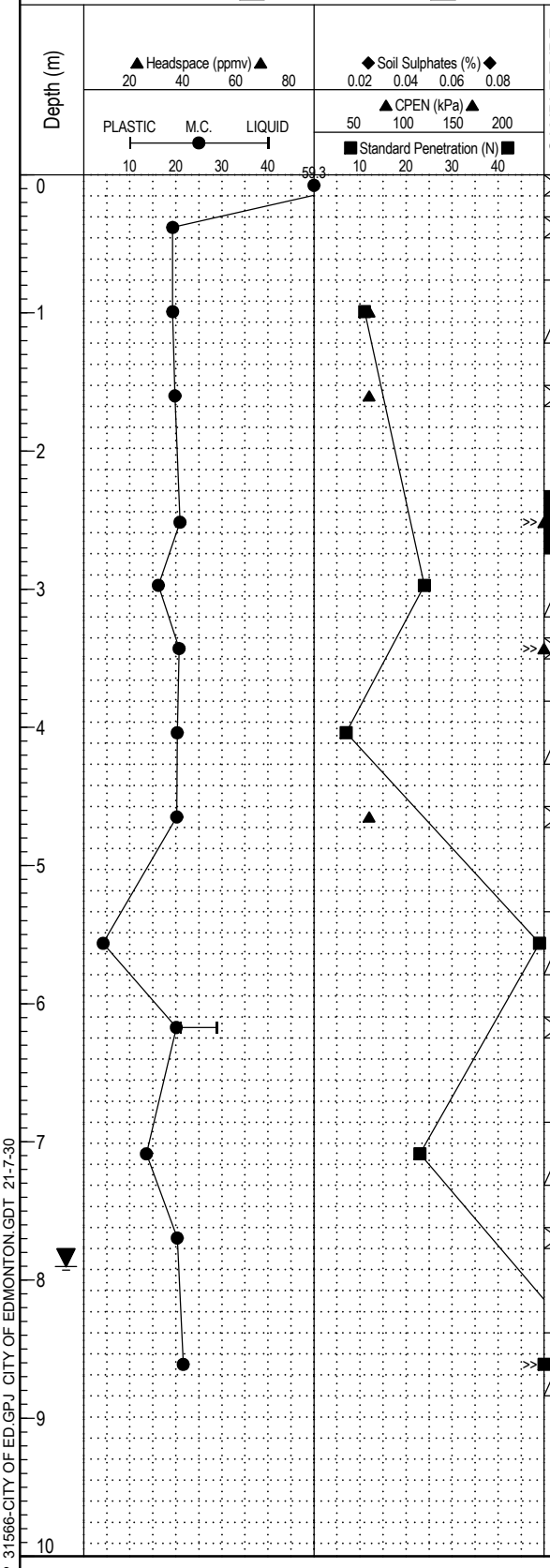
COMPLETION DEPTH: 8.8 m
COMPLETION DATE: 21-6-11
LOGGED BY: GS
REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-14**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932964.87, E30376.15	ELEVATION: 632.50 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
		PEAT		TOPSOIL, dark brown, peaty, rootlets		
		CI		CLAY (FILL) stiff, dark brown to black, silty, rootlets, trace gravel		632
	11	CI		-stiff, dark brown, some fine sand and organics, trace coal		
		CI		-some coal		631
		CI		-Dry density = 1530kg/m³, Cu = 164kPa -fine sandy, some gravel		630
	24	CI		CLAY (TILL) very stiff, dark brown, silty, some fine to medium grained sand, trace oxides and coal		
		CI		-brown, silty, fine sandy, trace oxides		629
	7	CI		-firm, brown, silty, sandy, some clay lumps, trace oxides		
		CI		-dark brown, silty, fine sandy, some coal, trace gravel		628
	49	SP		SAND dense, brown, silty, fine grained		627
		CL		CLAY brown to dark brown, silty, some coal		626
	23	CI		-very stiff, trace oxides and coal		
		CI		-very hard, dark brown, silty, some sand and gravel, race cobbles up to 100mm		625
	62	CI-CL		-some clay lumps		624
				END OF TEST HOLE AT 8.8m UPON COMPLETION: (Below ground surface) -Slough at 8.1m -Water at 8.0m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE:		623

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-11

LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-14**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932964.87, E30376.15	ELEVATION: 632.50 (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

Depth (m)	Headspace (ppmv) 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Soil Sulphates (%) 0.02 0.04 0.06 0.08 / CPEN (kPa) 50 100 150 200 / Standard Penetration (N) 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							-June 11, 2021 = Dry -June 18, 2021 = 8.1m -July 5, 2021 = 7.9m		622
11									621
12									620
13									619
14									618
15									617
16									616
17									615
18									614
19									613
20									

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

LOGGED BY: GS | REVIEWED BY: TGV / RWT

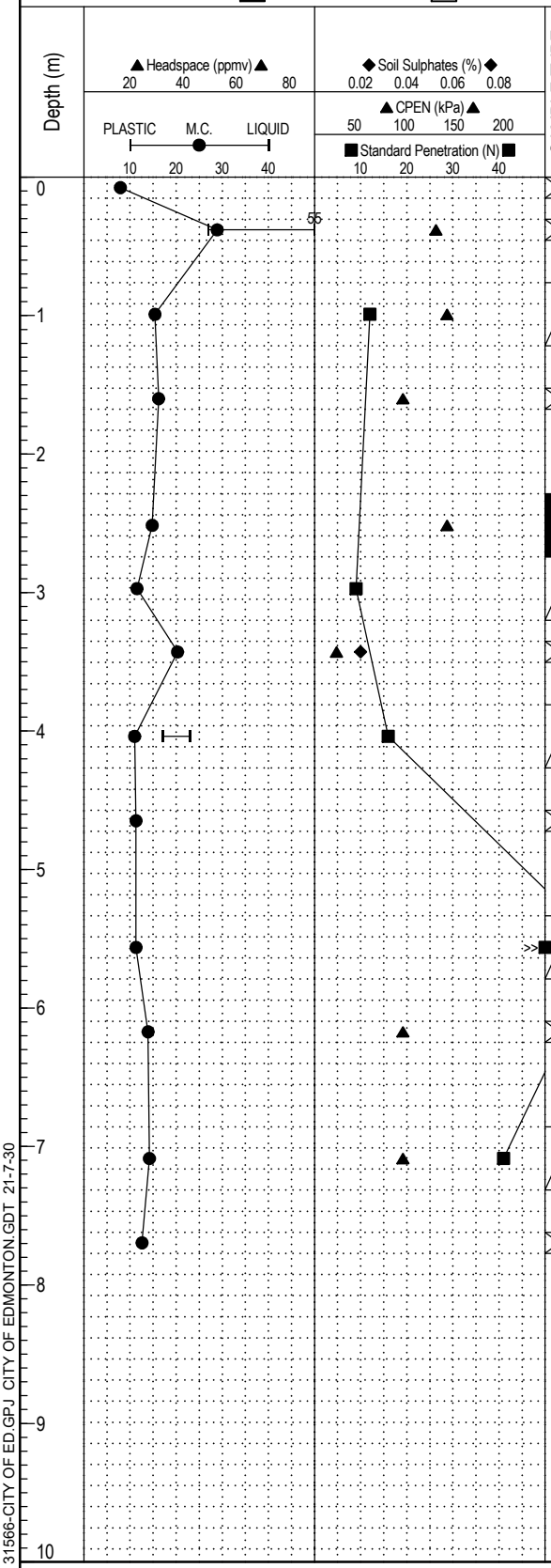
COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-11

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-15**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932976.38, E30440.35	ELEVATION: 635.34 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
		GM		GRAVEL (FILL), brown, silty, fine sand mixed		
		CH		CLAY (FILL) stiff, dark brown, silty, trace fine sand, gravel, organics, and coal		635
	12	CI		-some fine sand, trace oxides		
		CI		CLAY (TILL) brown to dark brown, silty, some fine sand, trace gravel, coal, and oxides		634
		CI		-fine sandy		633
	9	CL		-fine sandy lenses		
		CI		-brown, silty, fine sandy, trace oxides		632
	16	CL-ML		-very stiff, brown, silty, sandy, trace oxides		
		SM		SAND, some gravel, trace clay lumps		631
	63	SM-GM		SAND AND GRAVEL, very dense, brown, silty, fine grained sand		630
		CI		CLAY (TILL) hard, dark brown, silty, fine sandy, gravelly, trace oxides		629
	41	CI				628
		CI				627
				END OF TEST HOLE AT 8.4m UPON COMPLETION: (Below ground surface) -Slough at 5.9m -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 11, 2021 = Dry -June 18, 2021 = Dry		626

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.4 m

COMPLETION DATE: 21-6-11

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-15**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932976.38, E30440.35	ELEVATION: 635.34 (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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							-July 5, 2021 = Dry		625
11									624
12									623
13									622
14									621
15									620
16									619
17									618
18									617
19									616
20									

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.4 m

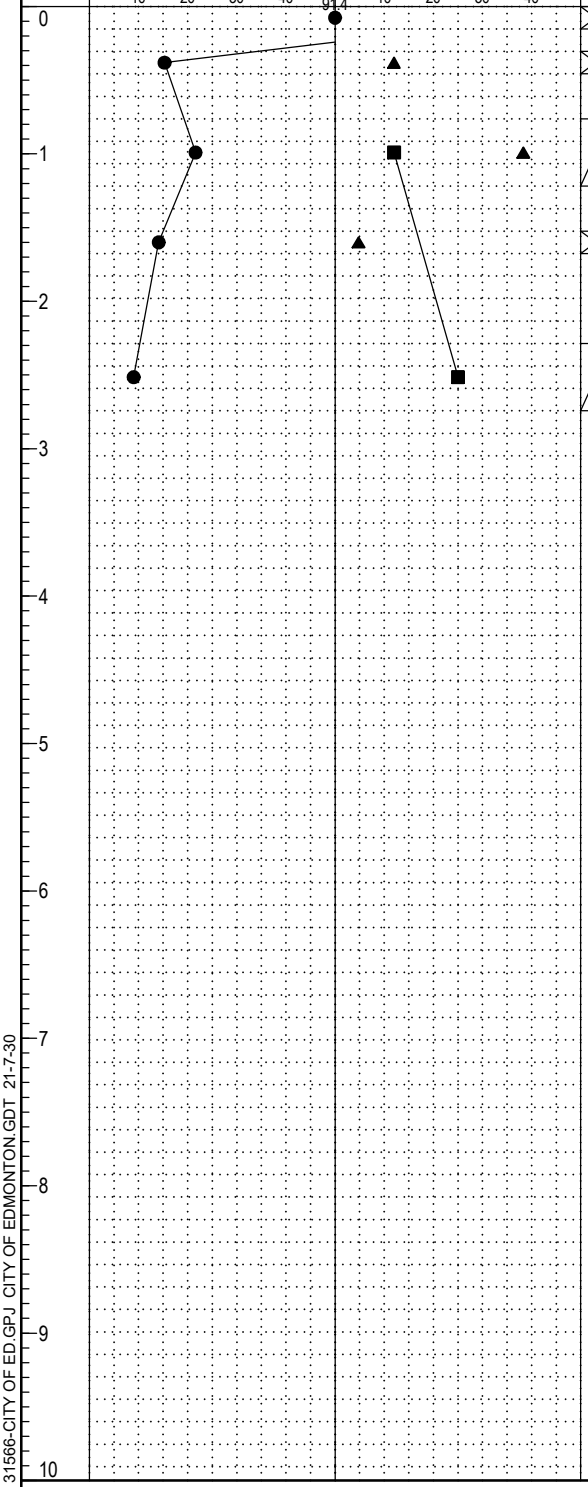
COMPLETION DATE: 21-6-11

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-16**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5932925.84, E30363.4	ELEVATION: 631.56 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	
			CI		CLAY (FILL) dark brown, silty, some fine sand, trace organics, gravel, and oxides	631
1		12	CI-CH		CLAY stiff, brown, silty, some fine sand, trace oxides	
			CI		-very silty, trace fine sand	630
2						
		25	SM		SAND, compact, brown, silty, fine grained, trace oxides and clay lumps	629
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.3m -No water Backfilled with drill cuttings and bentonite chips at surface	
4						628
5						627
6						626
7						625
8						624
9						623
10						622

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-11

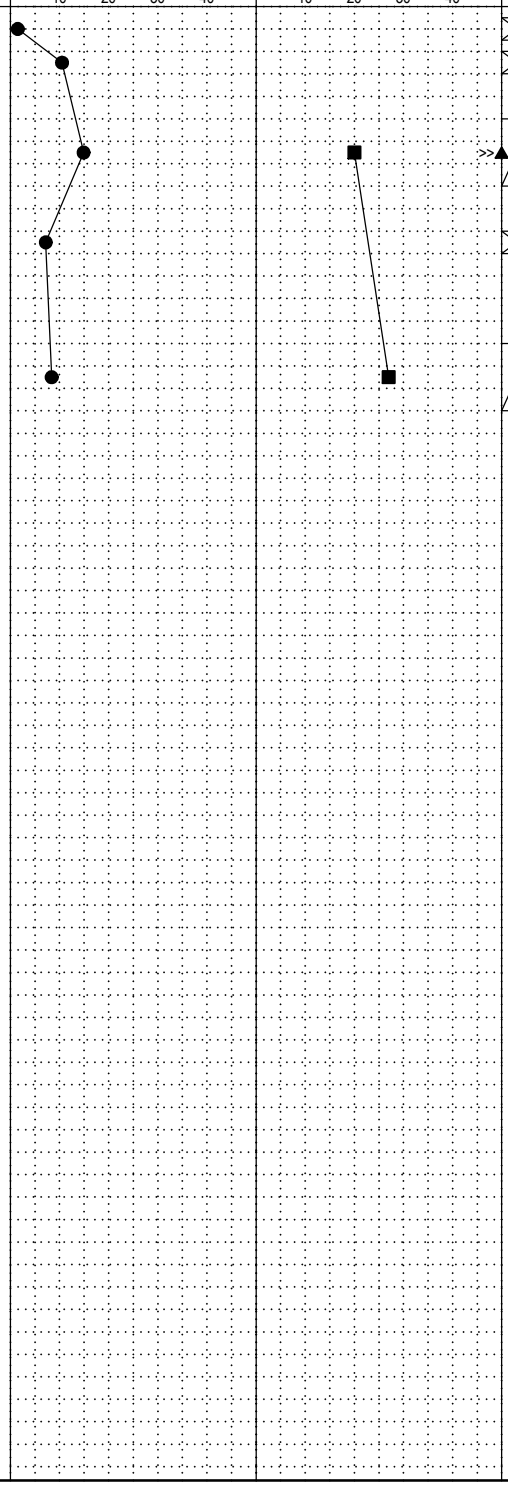
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-17**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5933125.46, E30022.73	ELEVATION: 627.78 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			GM		ASPHALT	
			CI		GRAVEL (FILL), brown, silty, fine, sandy	
					CLAY (FILL) very stiff, dark brown, very silty, trace fine sand, gravel, organics, rootlets, and oxides	627
1		20	CH			
			ML		SILT compact, brown, clayey, some fine sand	626
2						
		27	ML		-dark brown, fine sandy, trace clay lumps	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	625
4						624
5						623
6						622
7						621
8						620
9						619
10						618

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-16

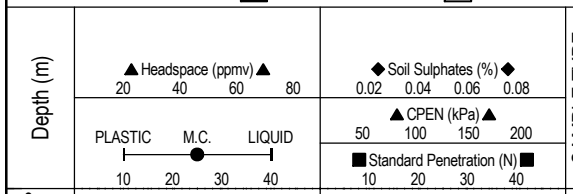
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-18**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5933125.61, E30088.91	ELEVATION: 627.90 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			GM		ASPHALT	
			CH		GRAVEL (FILL), dark brown, silty, fine, sandy	
					CLAY (FILL)	
1		9	CH		stiff, dark grey, silty, some organics, trace fine sand, gravel, and oxides	627
					-dark brown, trace debris, organics, and rootlets	
			CH			
2						626
		12	CH		-some organics	
3					END OF TEST HOLE AT 2.7m	625
					UPON COMPLETION:	
					-No slough	
					-No water	
					Backfilled with drill cuttings, bentonite chips, and cold mix at surface	
4						624
5						623
6						622
7						621
8						620
9						619
10						618

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-16

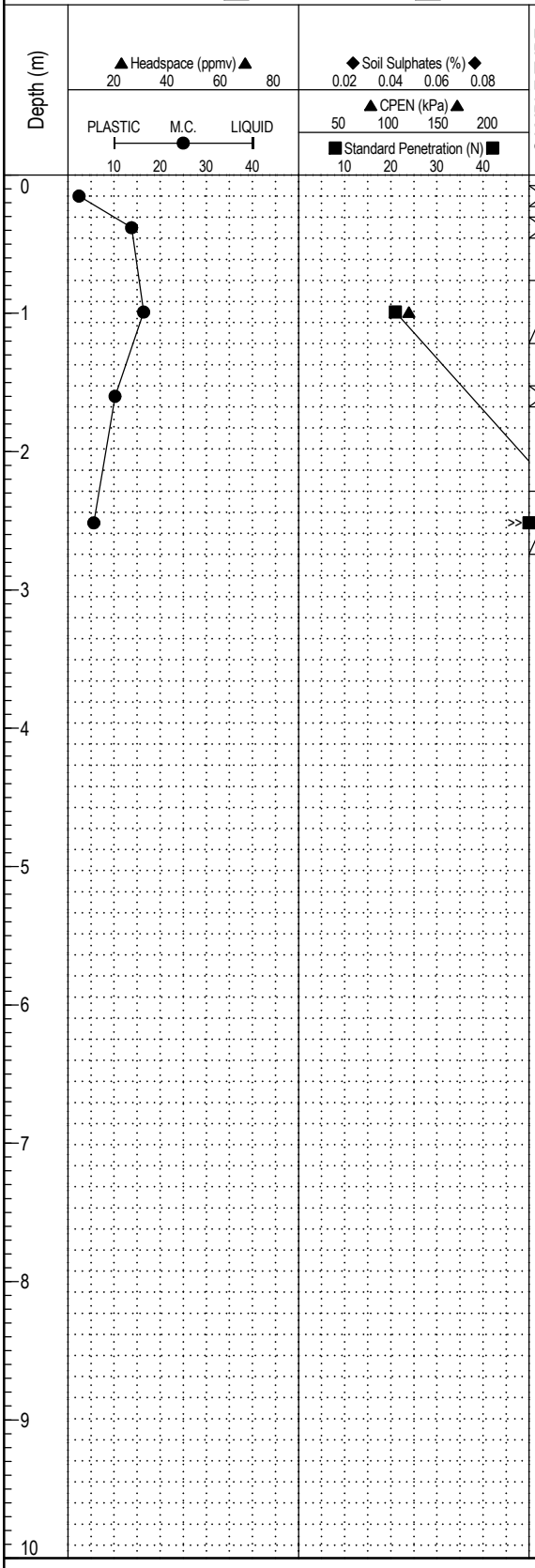
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-20**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5933064.7, E30114.64	ELEVATION: 628.20 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		GM		ASPHALT	628
		CI		GRAVEL (FILL), brown, silty, fine sandy	
				CLAY (FILL) very stiff, dark brown, very silty, trace fine sand, gravel, rootlets, and organics	
	21	CH		-brown, trace fine sand	627
		CI			
					626
	62	SM-GM		SAND AND GRAVEL, very dense, brown, silty, fine grained sand, trace oxides -Gravel = 31.7%, Sand = 55.7%, Fines = 12.6%	
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings, bentonite chips, and cold mix at surface	625
					624
					623
					622
					621
					620
					619

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

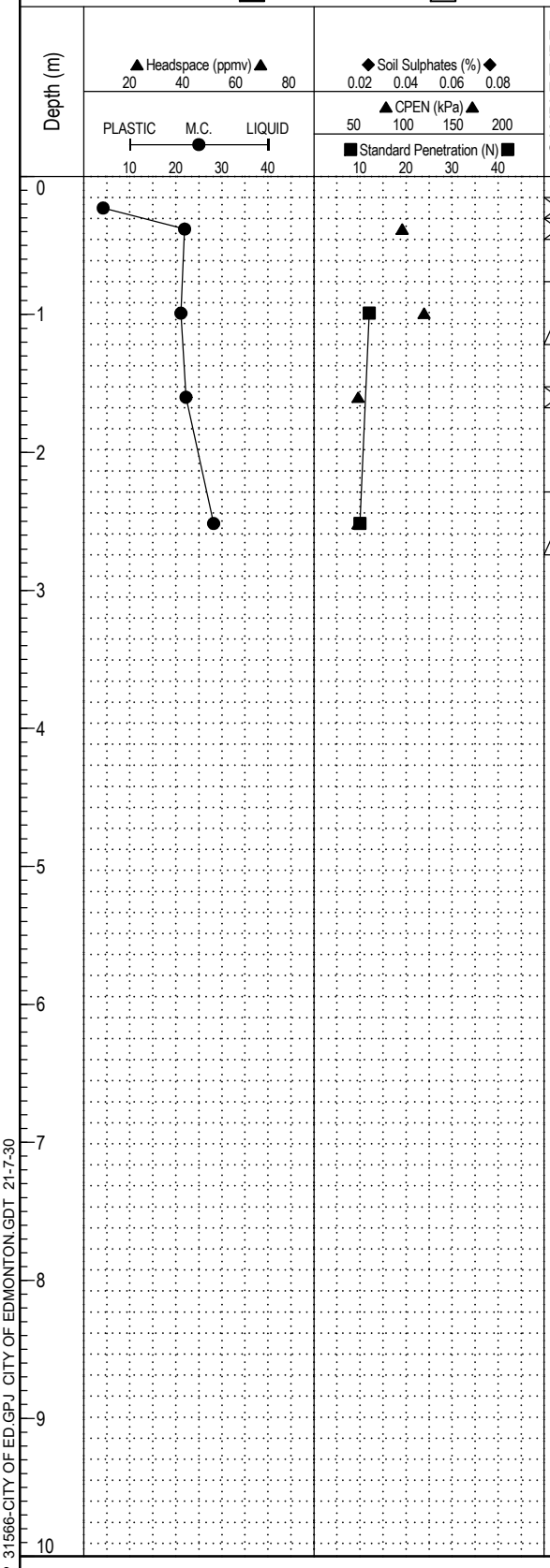
COMPLETION DATE: 21-6-16

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-21**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5933029.61, E30060.28	ELEVATION: 627.62 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
				ASPHALT	
		GM		GRAVEL (FILL), dark brown, silty, fine sandy, trace clay lumps	
		CI-CH		CLAY (FILL)	627
				stiff, dark grey, silty, trace fine sand, gravel, and organics	
	12	CH		-dark grey to dark brown	
		CI		-stiff, brown, silty, some fine sand, trace oxides	626
	10	CI-OL		CLAY, brown, silty, sandy, trace rootlets	625
				END OF TEST HOLE AT 2.7m	
				UPON COMPLETION:	
				-No slough	
				-No water	
				Backfilled with drill cuttings, bentonite chips, and cold mix at surface	624
					623
					622
					621
					620
					619
					618

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

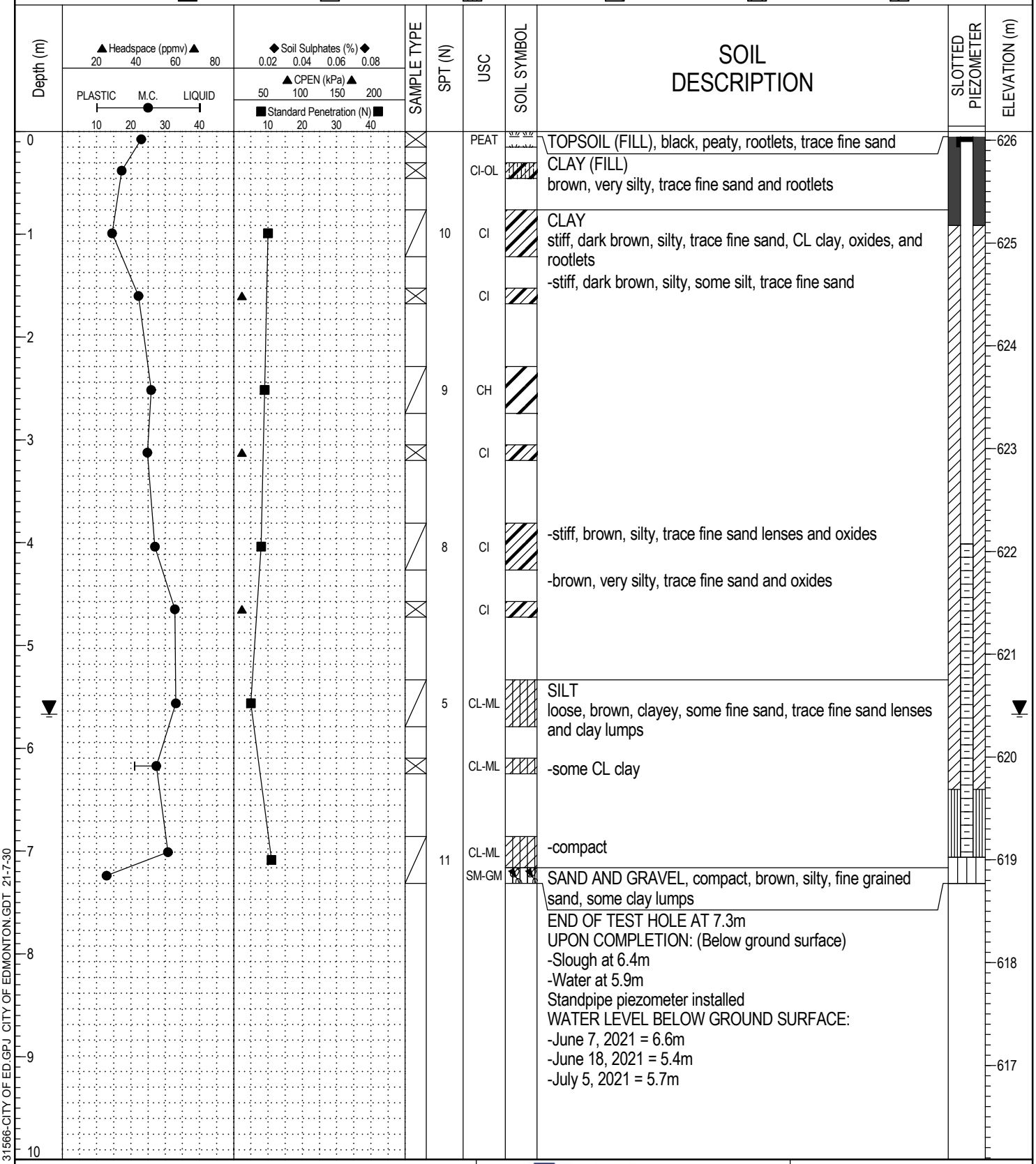
COMPLETION DATE: 21-6-16

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-22**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-7	LOCATION: N5932876.72, E29647.77	ELEVATION: 626.08 (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



END OF TEST HOLE AT 7.3m
UPON COMPLETION: (Below ground surface)
-Slough at 6.4m
-Water at 5.9m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 7, 2021 = 6.6m
-June 18, 2021 = 5.4m
-July 5, 2021 = 5.7m

THE CITY OF Edmonton
Transportation
Engineeering Services Section

THURBER ENGINEERING LTD.

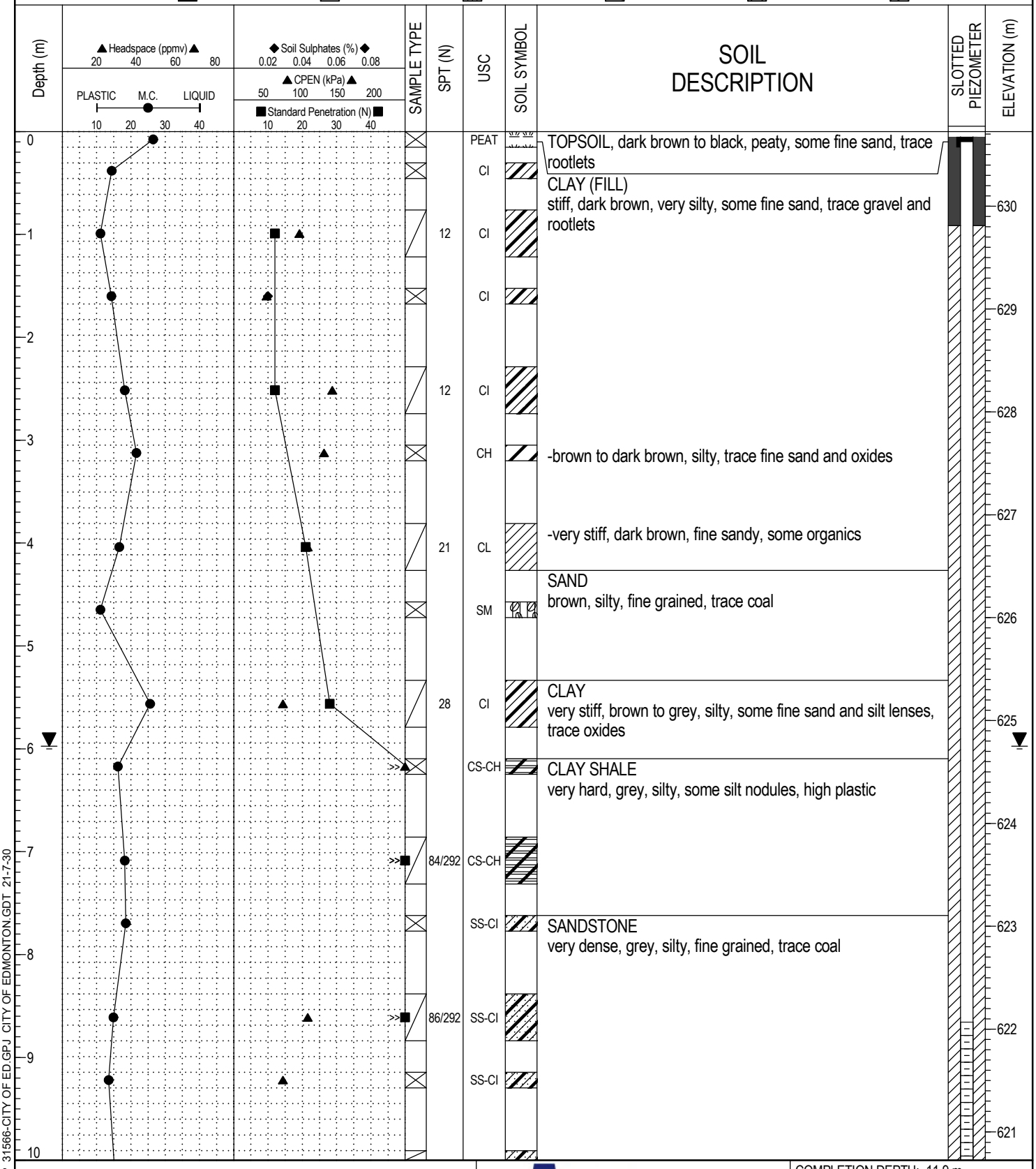
COMPLETION DEPTH: 7.3 m
COMPLETION DATE: 21-6-7
LOGGED BY: GS
REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-23**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-17	LOCATION: N5932778.54, E30208.74	ELEVATION: 630.72 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton

Transportation
Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 11.9 m

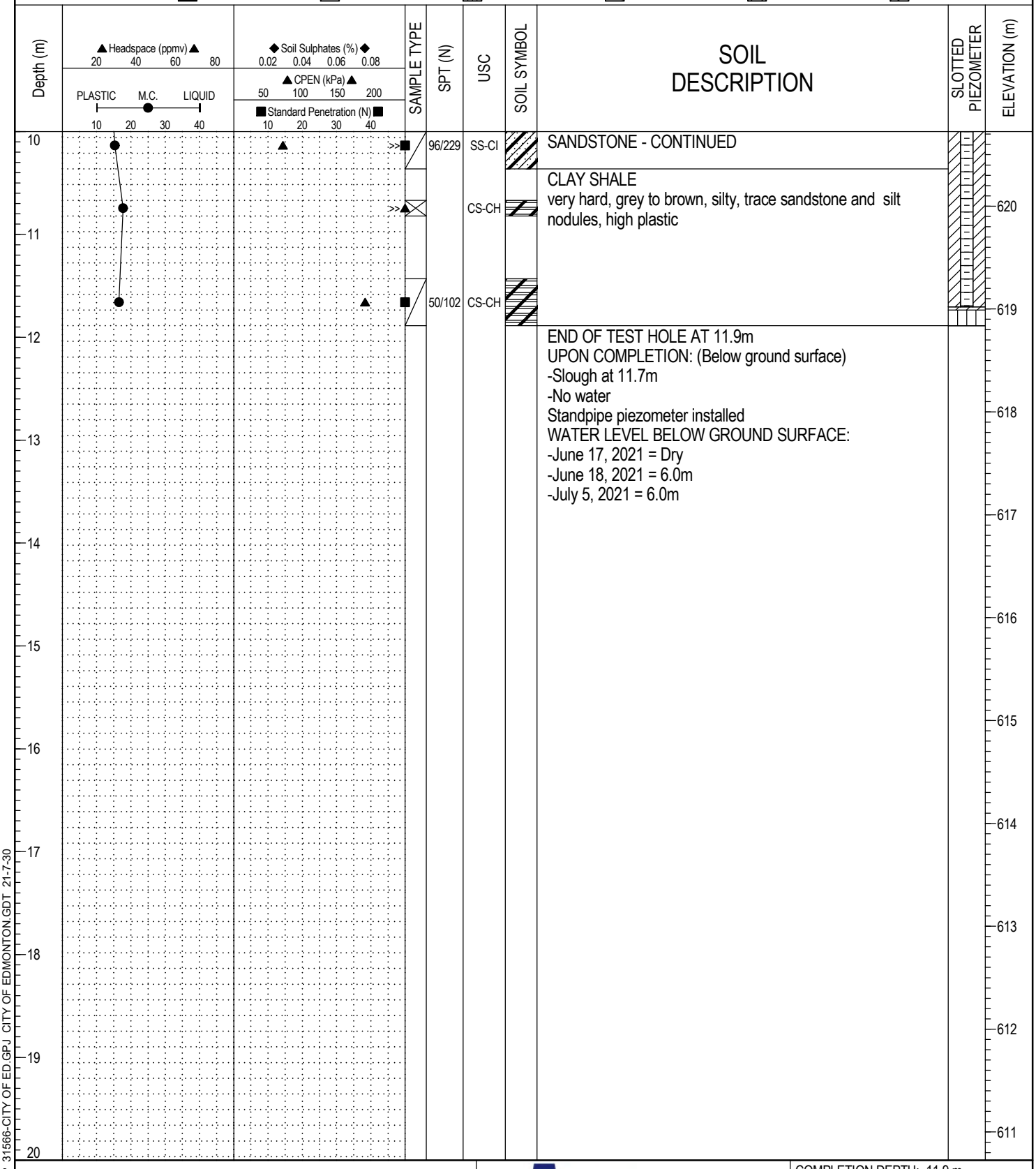
COMPLETION DATE: 21-6-17

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-23**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-17	LOCATION: N5932778.54, E30208.74	ELEVATION: 630.72 (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



THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 11.9 m

COMPLETION DATE: 21-6-17

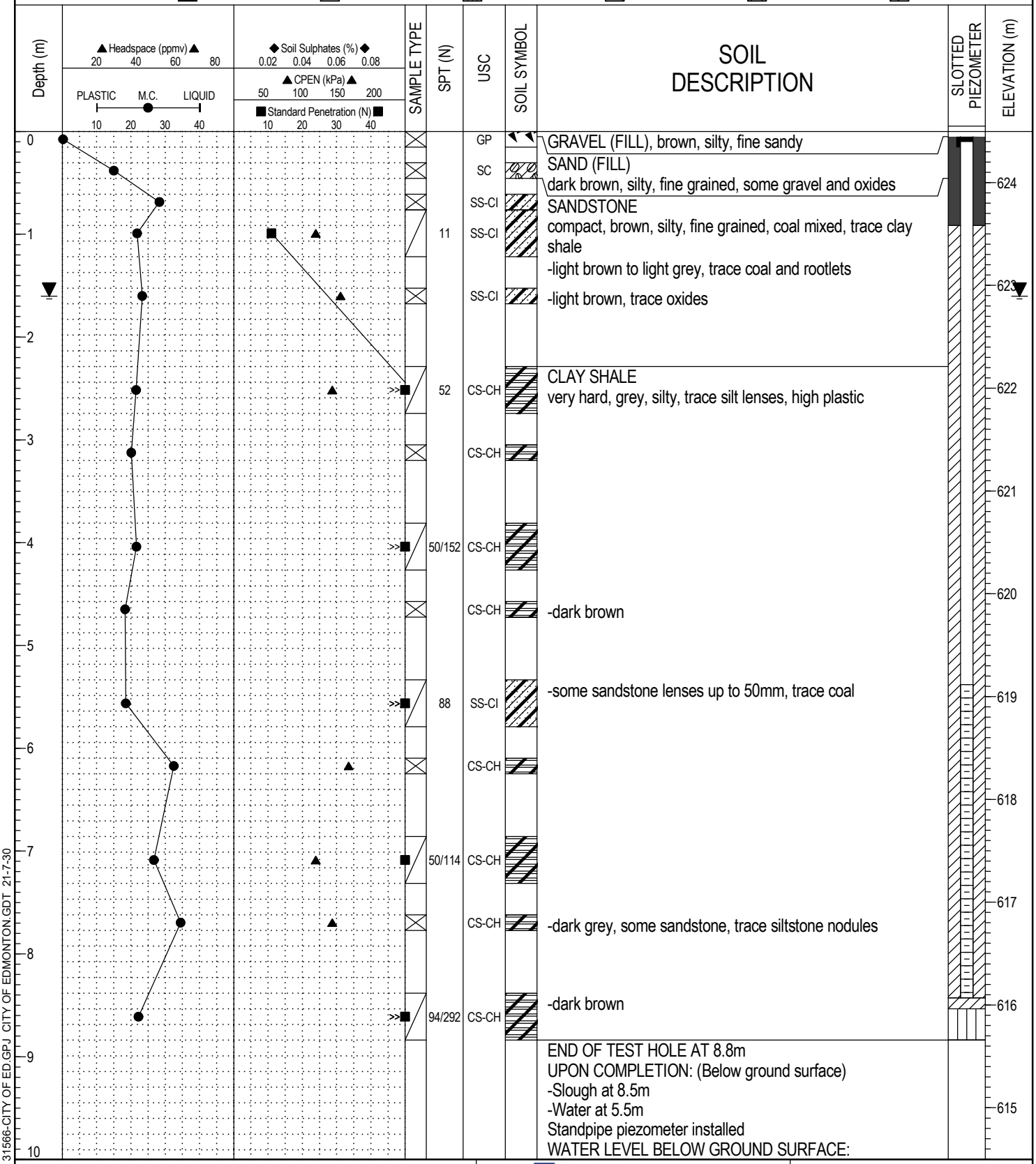
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-24**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932710.92, E29957.53	ELEVATION: 624.50 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-8

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-24**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932710.92, E29957.53	ELEVATION: 624.50 (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

Depth (m)	Headspace (ppmv) 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Soil Sulphates (%) 0.02 0.04 0.06 0.08 / CPEN (kPa) 50 100 150 200 / Standard Penetration (N) 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							-June 8, 2021 = 3.6m -June 18, 2021 = 1.8m -July 5, 2021 = 1.6m		614
11									613
12									612
13									611
14									610
15									609
16									608
17									607
18									606
19									605
20									

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

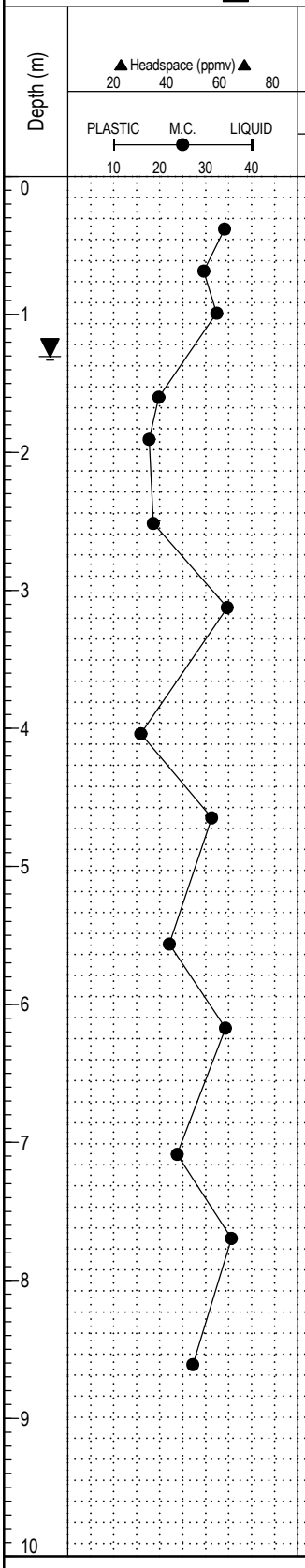
COMPLETION DATE: 21-6-8

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-25**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932721.35, E29965.97	ELEVATION: 624.50 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
				TOPSOIL, dark brown, peaty, rootlets		
		CI-OL		CLAY (FILL) black, silty, rootlets, trace fine sand and gravel		624
		CH		-dark brown, trace oxides		
	21	CI		-very stiff, dark brown, silty, some clay shale, trace silt deposits		
				SANDSTONE		
		SS-CI		brown, silty, fine grained, trace oxides		623
		SS-CI		-grey		
	61	CS-CH		CLAY SHALE very hard, dark grey, silty, trace sandstone lenses, high plastic		622
		CS-CH		-dark brown, some coal, trace siltstone nodules		
						621
	58	CS-CH		-dark brown to dark grey		
		CS-CH		-dark grey		620
	89/292	CS-CH		-trace siltstone lenses		619
		CS-CH				
						618
	50/127	CS-CH				
		CS-CH		-dark grey to dark brown		617
	57	CS-CH				616
				END OF TEST HOLE AT 8.8m UPON COMPLETION: (Below ground surface) -Slough at 8.2m -Water at 4.0m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE:		615

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-8

LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-25**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932721.35, E29965.97	ELEVATION: 624.50 (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

Depth (m)	Headspace (ppmv) 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Soil Sulphates (%) 0.02 0.04 0.06 0.08 / CPEN (kPa) 50 100 150 200 / Standard Penetration (N) 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							-June 8, 2021 = 2.0m -June 18, 2021 = 1.5m -July 5, 2021 = 1.3m		614
11									613
12									612
13									611
14									610
15									609
16									608
17									607
18									606
19									605
20									

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

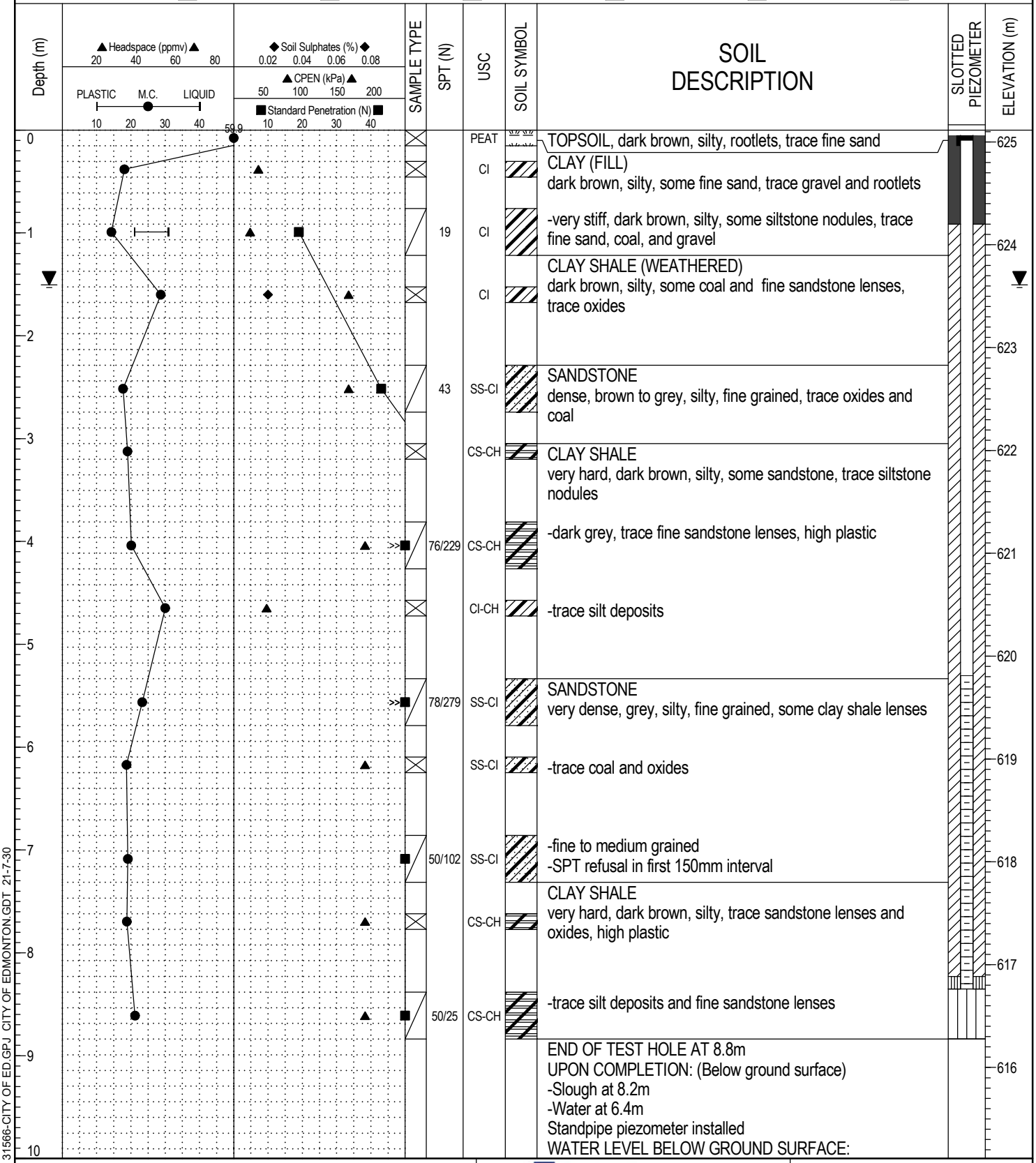
COMPLETION DATE: 21-6-8

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-26**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-7	LOCATION: N5932690.68, E29953.84	ELEVATION: 625.11 (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



THE CITY OF Edmonton

Transportation
Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m	
COMPLETION DATE: 21-6-7	
LOGGED BY: GS	REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-26**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-7	LOCATION: N5932690.68, E29953.84	ELEVATION: 625.11 (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

Depth (m)	Headspace (ppmv) 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Soil Sulphates (%) 0.02 0.04 0.06 0.08 / CPEN (kPa) 50 100 150 200 / Standard Penetration (N) 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							-June 7, 2021 = 1.8m -June 18, 2021 = 1.6m -July 5, 2021 = 1.5m		615
11									614
12									613
13									612
14									611
15									610
16									609
17									608
18									607
19									606
20									

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

LOGGED BY: GS | REVIEWED BY: TGV / RWT

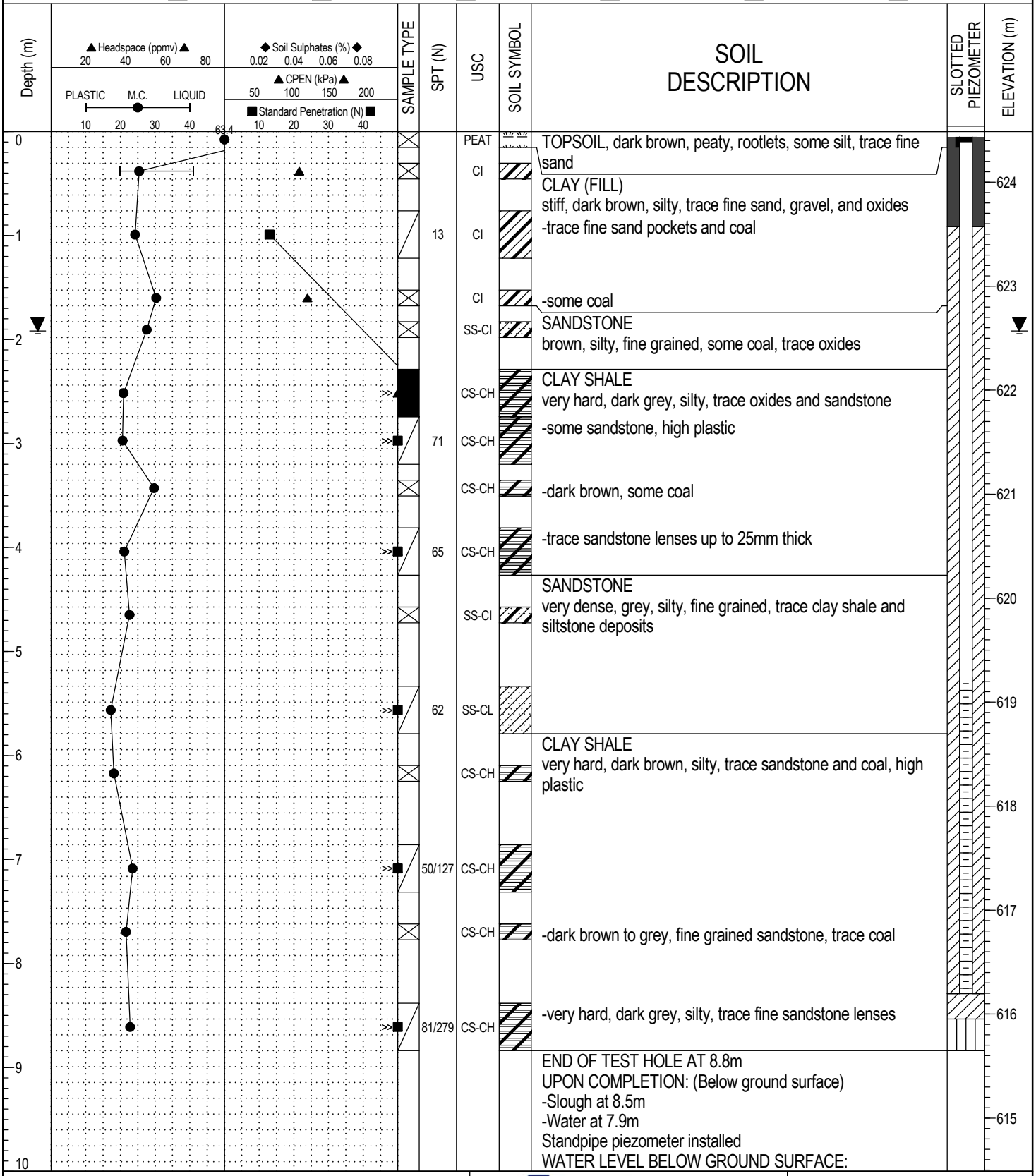
COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-7

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-27**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-7	LOCATION: N5932681.86, E29936.88	ELEVATION: 624.49 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-7

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-27**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-7	LOCATION: N5932681.86, E29936.88	ELEVATION: 624.49 (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

Depth (m)	Headspace (ppmv) 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Soil Sulphates (%) 0.02 0.04 0.06 0.08 / CPEN (kPa) 50 100 150 200 / Standard Penetration (N) 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							-June 7, 2021 = 3.9m -June 18, 2021 = 1.9m -July 5, 2021 = 1.9m		614
11									613
12									612
13									611
14									610
15									609
16									608
17									607
18									606
19									605
20									

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-7

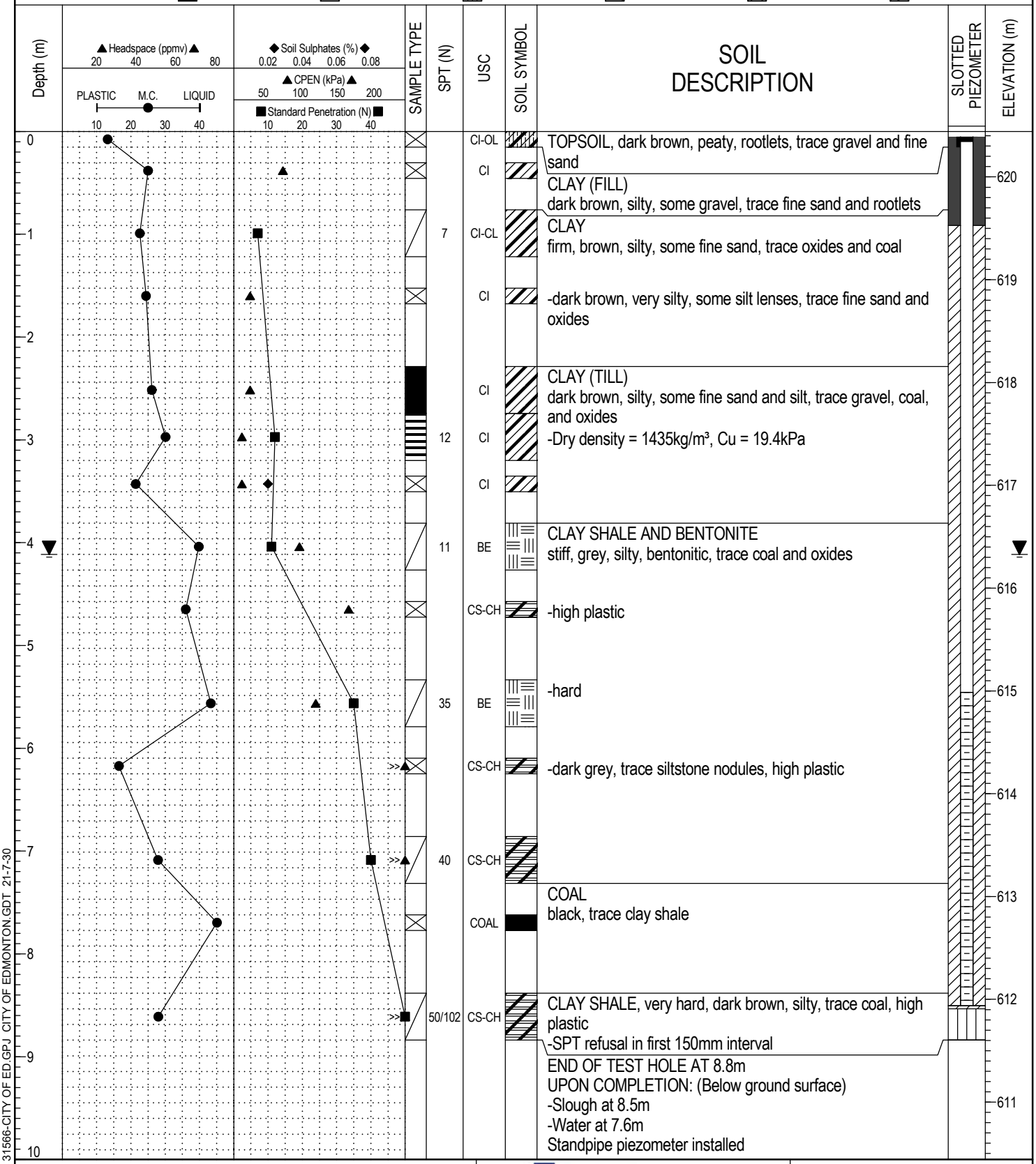
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-28**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932930.08, E29526.02	ELEVATION: 620.44 (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



TOPSOIL, dark brown, peaty, rootlets, trace gravel and fine sand

CLAY (FILL)
dark brown, silty, some gravel, trace fine sand and rootlets

CLAY
firm, brown, silty, some fine sand, trace oxides and coal

-dark brown, very silty, some silt lenses, trace fine sand and oxides

CLAY (TILL)
dark brown, silty, some fine sand and silt, trace gravel, coal, and oxides

-Dry density = 1435kg/m³, Cu = 19.4kPa

CLAY SHALE AND BENTONITE
stiff, grey, silty, bentonitic, trace coal and oxides

-high plastic

-hard

-dark grey, trace siltstone nodules, high plastic

COAL
black, trace clay shale

CLAY SHALE, very hard, dark brown, silty, trace coal, high plastic

-SPT refusal in first 150mm interval

END OF TEST HOLE AT 8.8m

UPON COMPLETION: (Below ground surface)

-Slough at 8.5m

-Water at 7.6m

Standpipe piezometer installed

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-28**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932930.08, E29526.02	ELEVATION: 620.44 (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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							WATER LEVEL BELOW GROUND SURFACE: -June 8, 2021 = 6.4m -June 18, 2021 = 3.7m -July 5, 2021 = 4.1m		610
11									609
12									608
13									607
14									606
15									605
16									604
17									603
18									602
19									601
20									

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m

COMPLETION DATE: 21-6-8

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-29**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-17	LOCATION: N5933981, E331158	ELEVATION:

SAMPLE TYPE: Shelby Tube; Drive Sample; Auger Sample; No Recovery; A Casing; Cored Sample

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

Headspace (ppmv): 20 40 60 80

PLASTIC M.C. LIQUID: 10 20 30 40

Soil Sulphates (%): 0.02 0.04 0.06 0.08

CPEN (kPa): 50 100 150 200

Standard Penetration (N): 10 20 30 40

Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			CI-OL		TOPSOIL, dark brown, peaty, rootlets	
			CH		CLAY (FILL) stiff, dark brown, silty, trace fine sand, gravel, rootlets, and oxides	
1		10	CH			
			CH			
2					-concrete debris from 2.0 - 2.3m	
					END OF TEST HOLE AT 2.3m	
3						
4						
5						
6						
7						
8						
9						
10						

THE CITY OF Edmonton

Transportation
Engineeering Services Section

THURBER ENGINEERING LTD.

LOGGED BY: GS | REVIEWED BY: TGV / RWT

COMPLETION DEPTH: 2.3 m

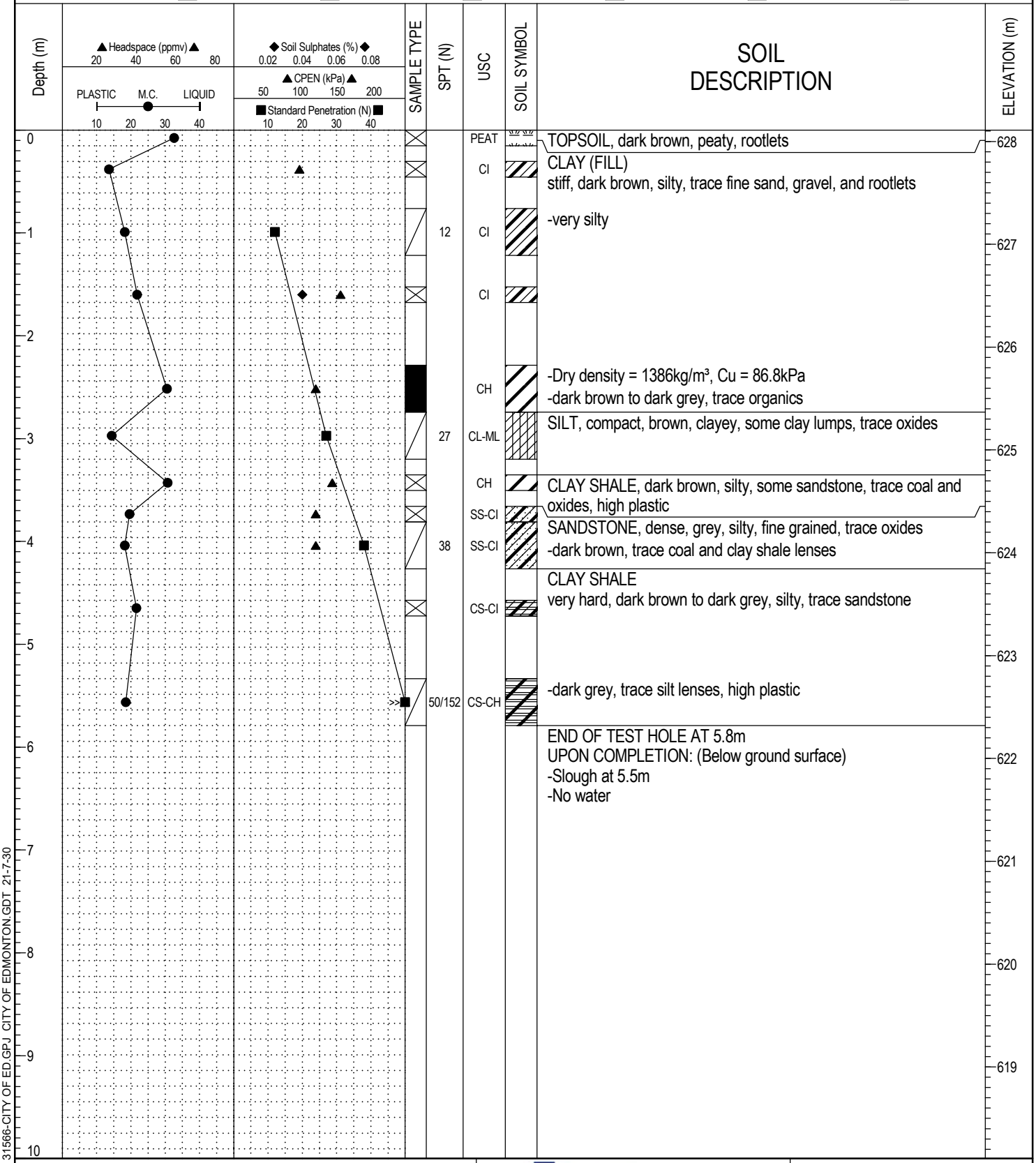
COMPLETION DATE: 21-6-17

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-30**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-17	LOCATION: N5932808.38, E30019.07	ELEVATION: 628.11 (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



THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-17

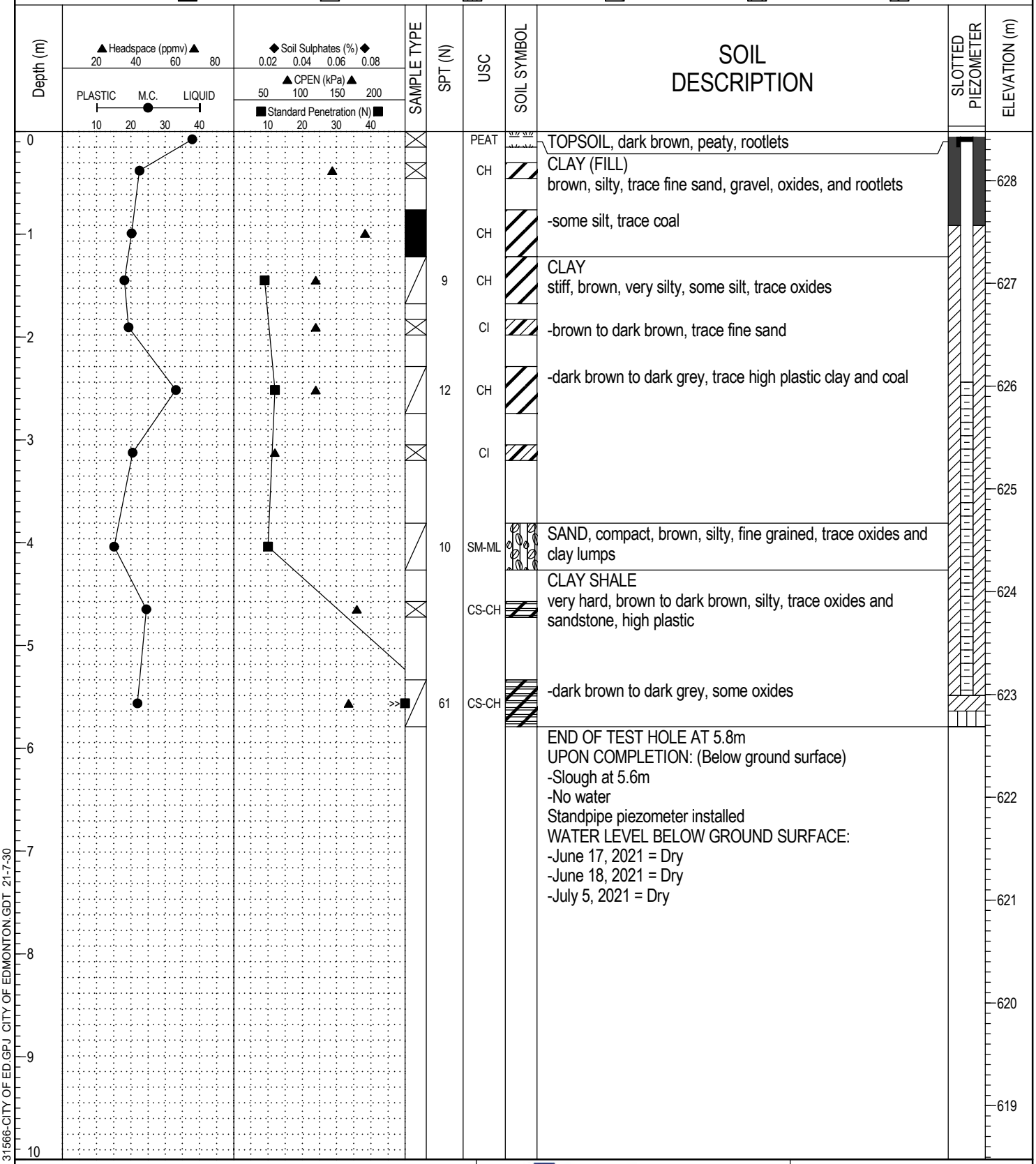
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-31**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-17	LOCATION: N5932803.32, E30028.95	ELEVATION: 628.48 (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



TOPSOIL, dark brown, peaty, rootlets

CLAY (FILL)
brown, silty, trace fine sand, gravel, oxides, and rootlets

-some silt, trace coal

CLAY
stiff, brown, very silty, some silt, trace oxides

-brown to dark brown, trace fine sand

-dark brown to dark grey, trace high plastic clay and coal

SAND, compact, brown, silty, fine grained, trace oxides and clay lumps

CLAY SHALE
very hard, brown to dark brown, silty, trace oxides and sandstone, high plastic

-dark brown to dark grey, some oxides

END OF TEST HOLE AT 5.8m
UPON COMPLETION: (Below ground surface)
-Slough at 5.6m
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 17, 2021 = Dry
-June 18, 2021 = Dry
-July 5, 2021 = Dry

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton
Transportation
Engineeering Services Section

THURBER ENGINEERING LTD.

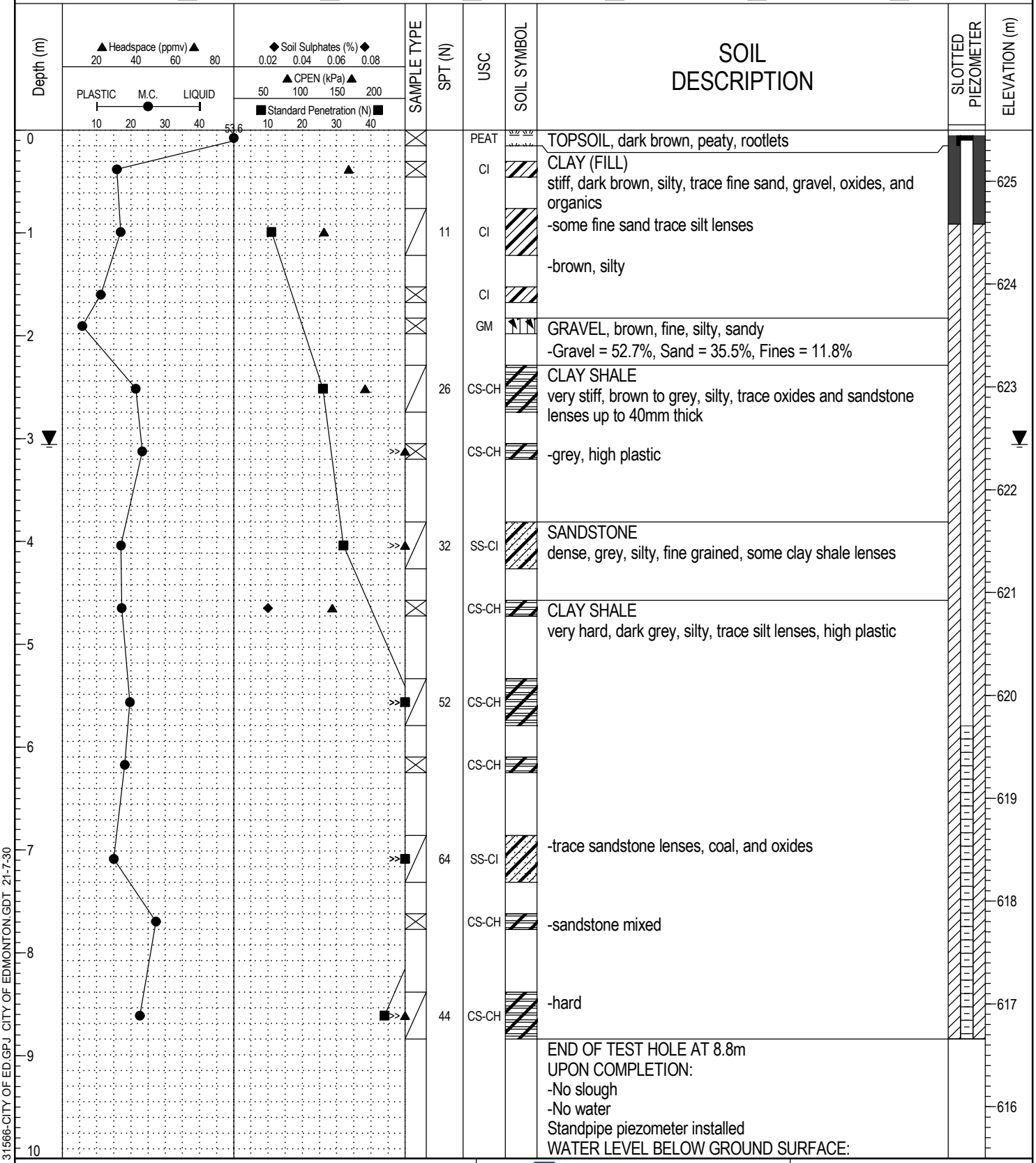
COMPLETION DEPTH: 5.8 m
COMPLETION DATE: 21-6-17

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-32**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932848.87, E29987.09	ELEVATION: 625.50 (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



TOPSOIL, dark brown, peaty, rootlets

CLAY (FILL)
stiff, dark brown, silty, trace fine sand, gravel, oxides, and organics

-some fine sand trace silt lenses

-brown, silty

GRAVEL, brown, fine, silty, sandy
-Gravel = 52.7%, Sand = 35.5%, Fines = 11.8%

CLAY SHALE
very stiff, brown to grey, silty, trace oxides and sandstone lenses up to 40mm thick

-grey, high plastic

SANDSTONE
dense, grey, silty, fine grained, some clay shale lenses

CLAY SHALE
very hard, dark grey, silty, trace silt lenses, high plastic

-trace sandstone lenses, coal, and oxides

-sandstone mixed

-hard

END OF TEST HOLE AT 8.8m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton
Transportation
Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 8.8 m
COMPLETION DATE: 21-6-16

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-32**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932848.87, E29987.09	ELEVATION: 625.50 (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

Depth (m)	Headspace (ppmv) 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Soil Sulphates (%) 0.02 0.04 0.06 0.08 / CPEN (kPa) 50 100 150 200 / Standard Penetration (N) 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10							-June 16, 2021 = Dry -June 18, 2021 = 3.0m -July 5, 2021 = 3.1m		615
11									614
12									613
13									612
14									611
15									610
16									609
17									608
18									607
19									606
20									

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

LOGGED BY: GS | REVIEWED BY: TGV / RWT

COMPLETION DEPTH: 8.8 m

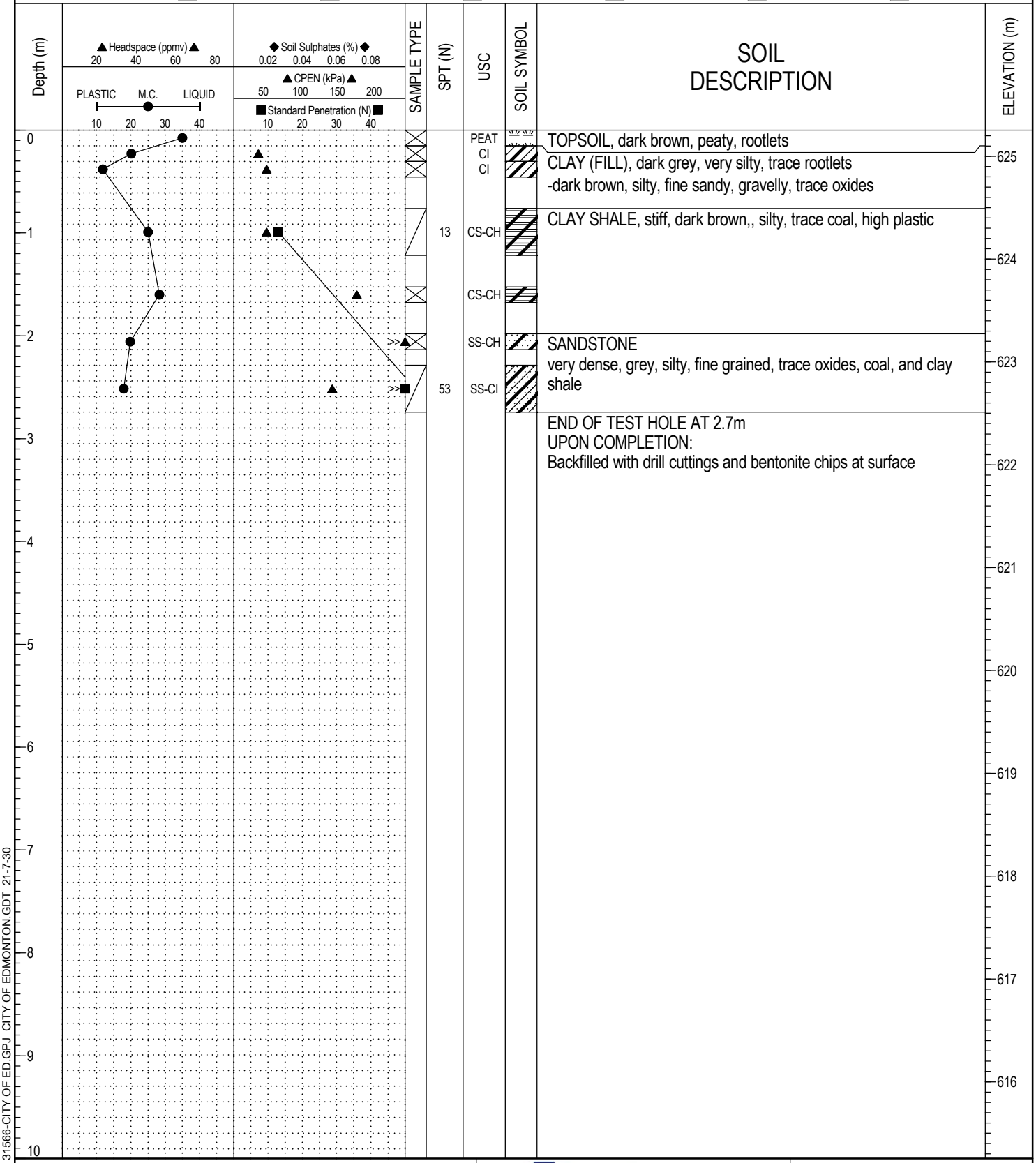
COMPLETION DATE: 21-6-16

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-33**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-17	LOCATION: N5932770.42, E29983.64	ELEVATION: 625.25 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

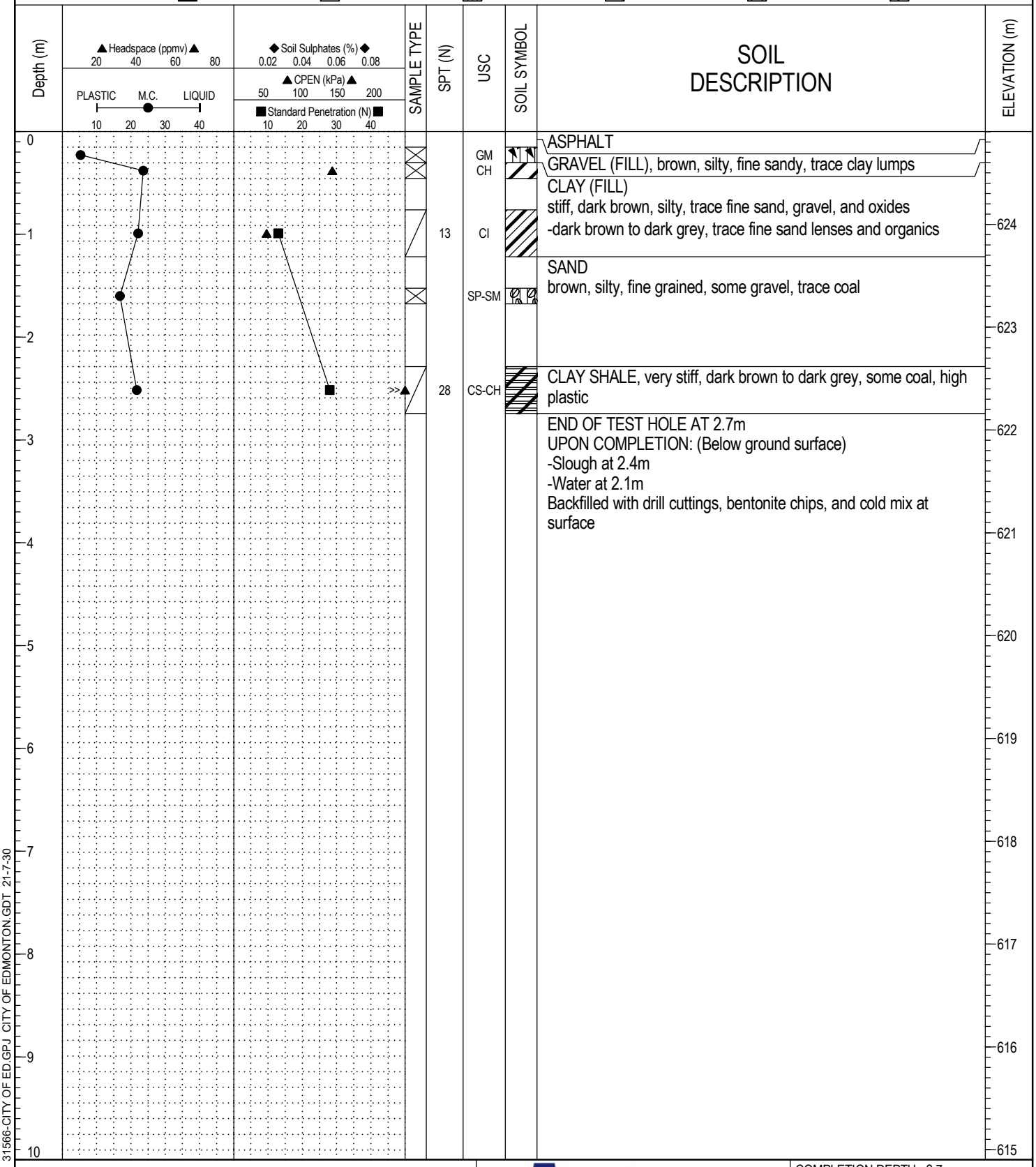
THURBER ENGINEERING LTD.

		COMPLETION DEPTH: 2.7 m
		COMPLETION DATE: 21-6-17
LOGGED BY: GS	REVIEWED BY: TGV / RWT	Page 1 of 1

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-34**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-17	LOCATION: N5932802.27, E29949.14	ELEVATION: 624.90 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

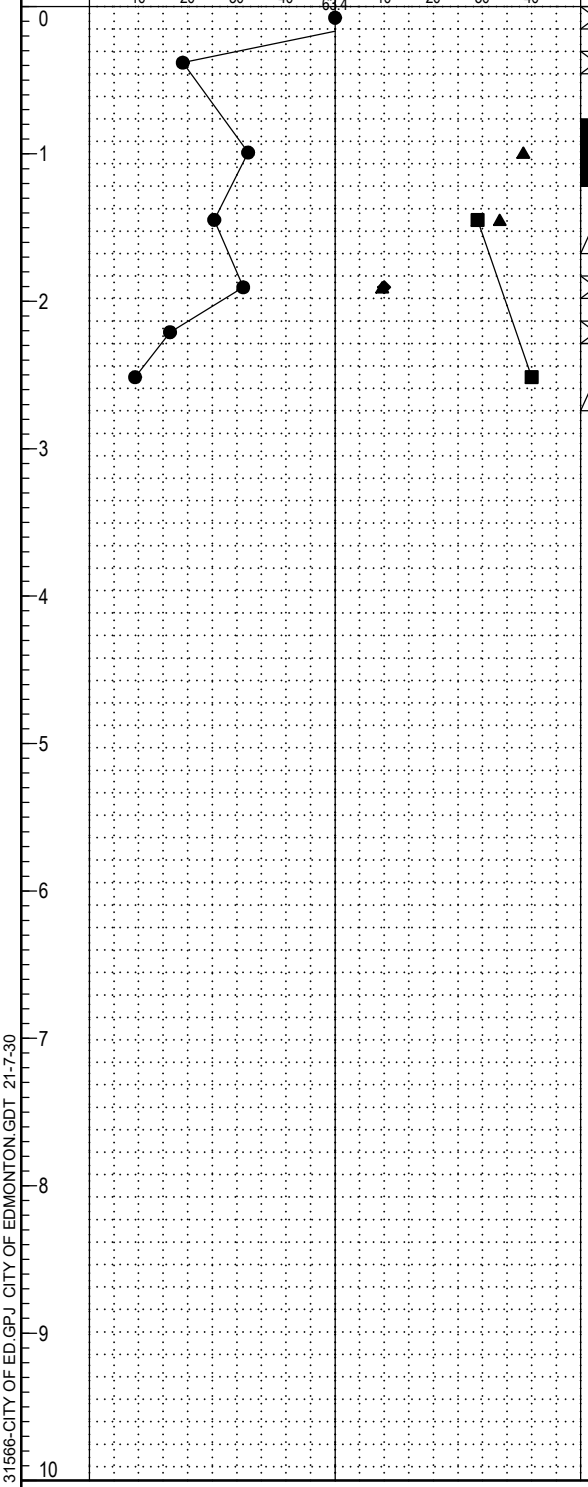
COMPLETION DATE: 21-6-17

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-35**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932873, E29843.4	ELEVATION: 623.96 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	
			CI		CLAY (FILL) dark brown, silty, trace fine sand, gravel, oxides, and rootlets	
1			CI		-some organics	623
		29	CI		-very stiff, trace sand and gravel	
2			CI		-dark grey, silty, trace fine sand and silt	622
			SM		SAND AND GRAVEL, dense, brown, silty, fine grained sand	
		40	GM			
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.1m -Water at 2.1m Backfilled with drill cuttings and bentonite chips at surface	621
4						620
5						619
6						618
7						617
8						616
9						615
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-16

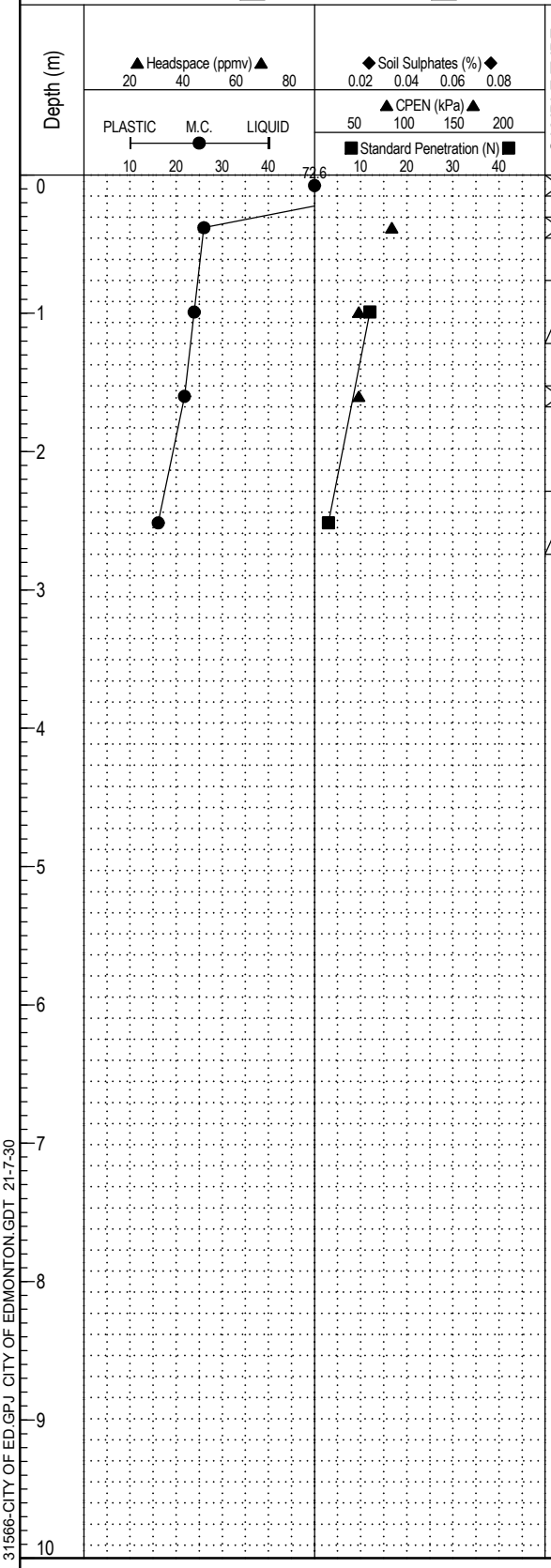
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-36**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5933075.94, E30390.89	ELEVATION: 633.17 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	633
			CH		CLAY (FILL) stiff, dark brown, silty, some organics, trace fine sand and gravel	
1		12	CI		-trace organics and oxides	632
			CI		-some organics	
2						631
		3	SC-CL		SAND, very loose, dark brown, silty, fine grained, trace oxides and clay lumps	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.3m -No water Backfilled with drill cuttings and bentonite chips at surface	630
4						629
5						628
6						627
7						626
8						625
9						624
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-15

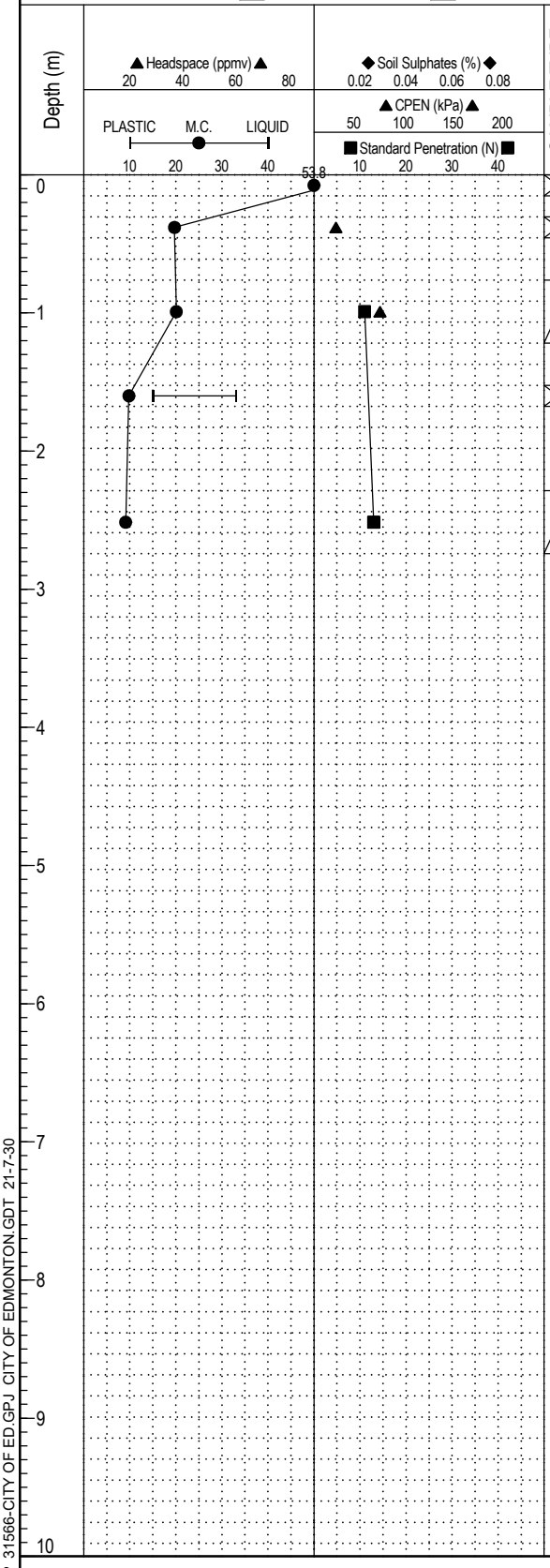
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-37**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5933135.12, E30328.99	ELEVATION: 630.55 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	630
			CI		CLAY silty, trace fine sand	
1		11	CI		-trace rootlets and oxides	629
					SAND compact, brown, silty, fine grained, trace clay lumps	
2		13	SC-CI		-silty	628
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	627
4						626
5						625
6						624
7						623
8						622
9						621
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-15

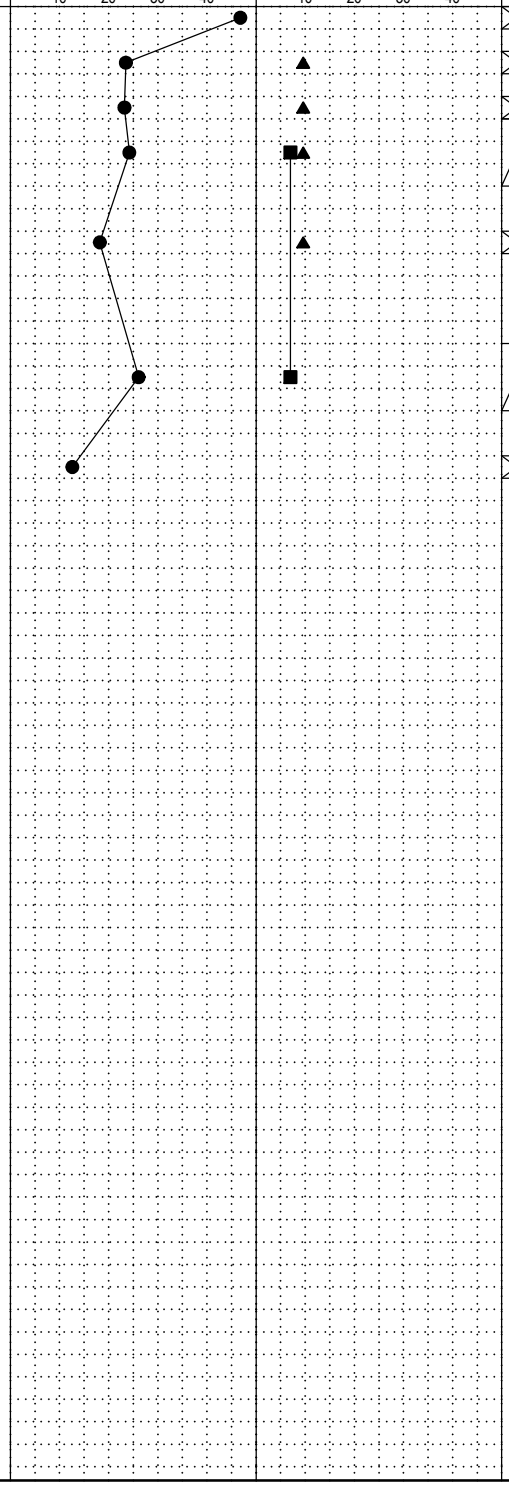
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-38**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5933107.25, E29676.42	ELEVATION: 625.60 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 3.8 m

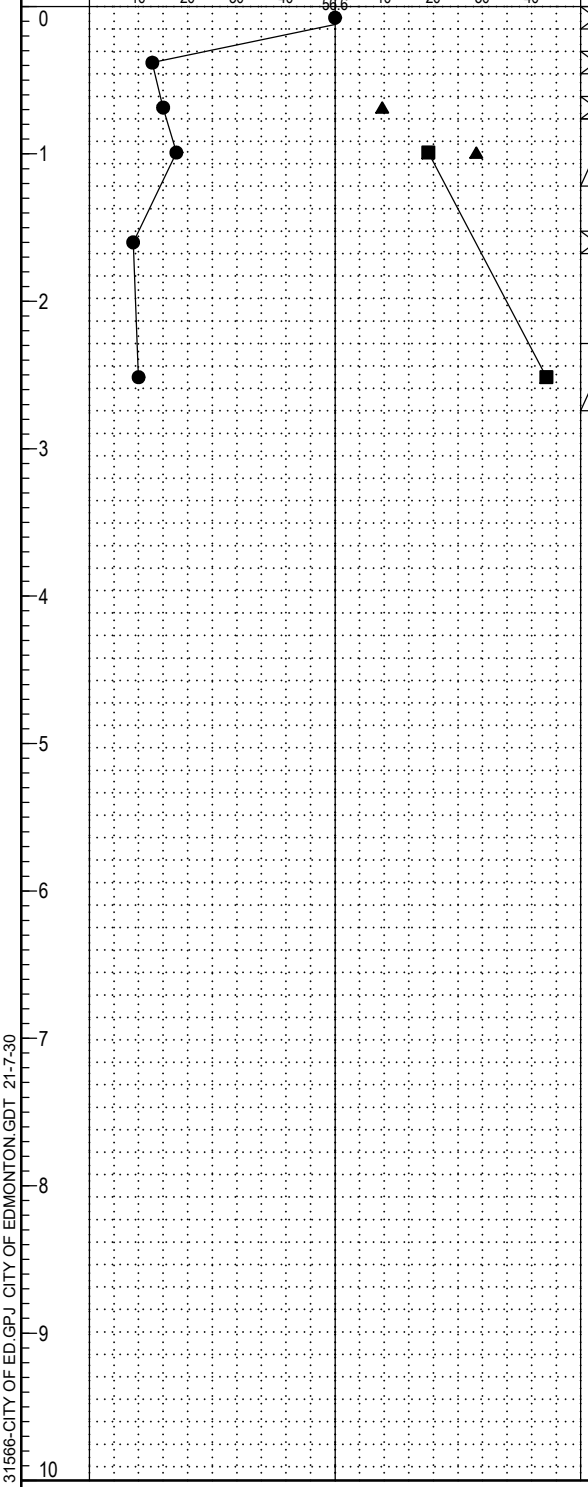
COMPLETION DATE: 21-6-8

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-39**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-10	LOCATION: N5933001.76, E30313.62	ELEVATION: 631.31 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	631
			CI		CLAY (FILL) brown, silty, rootlets	
			CI		-very stiff, dark brown, silty, trace fine sand, gravel, and oxides	
1		19	CH		-very silty, trace coal	
			GC		SAND AND GRAVEL dense, dark brown, silty, fine to medium grained sand -Gravel = 51.0%, Sand = 25.7%, Fines = 23.3%	630
2		43	SP-SM			629
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.4m Backfilled with drill cuttings and bentonite chips at surface	628
4						627
5						626
6						625
7						624
8						623
9						622
10						

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

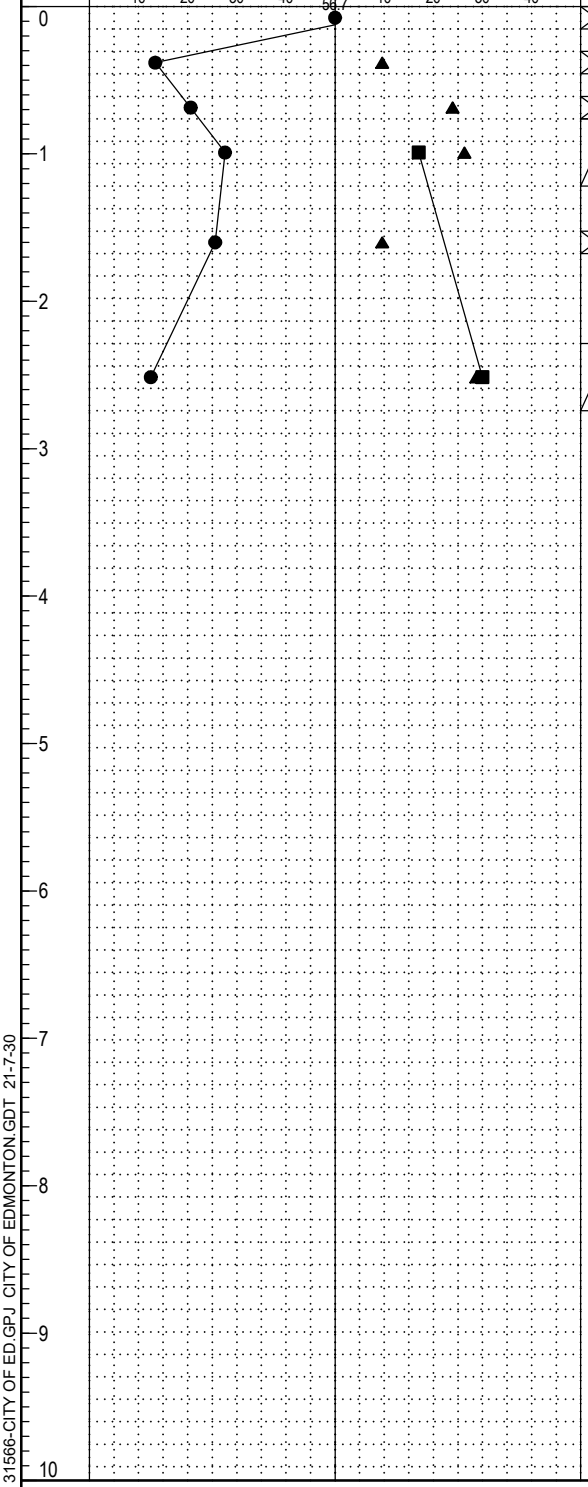
COMPLETION DEPTH: 2.7 m
COMPLETION DATE: 21-6-10

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-40**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-10	LOCATION: N5933024.85, E30228	ELEVATION: 629.38 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		PEAT		TOPSOIL, dark brown, peaty, rootlets	
		CI		CLAY (FILL) dark brown, silty, some fine sand, trace gravel and rootlets	629
		CH		-trace fine sand and oxides	
	17	CI-CH		-very stiff, some organics	628
		CI			
					627
	30	CL		-hard, dark brown to black, silty, some fine sand, trace gravel, coal, and oxides	
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	626
					625
					624
					623
					622
					621
					620

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

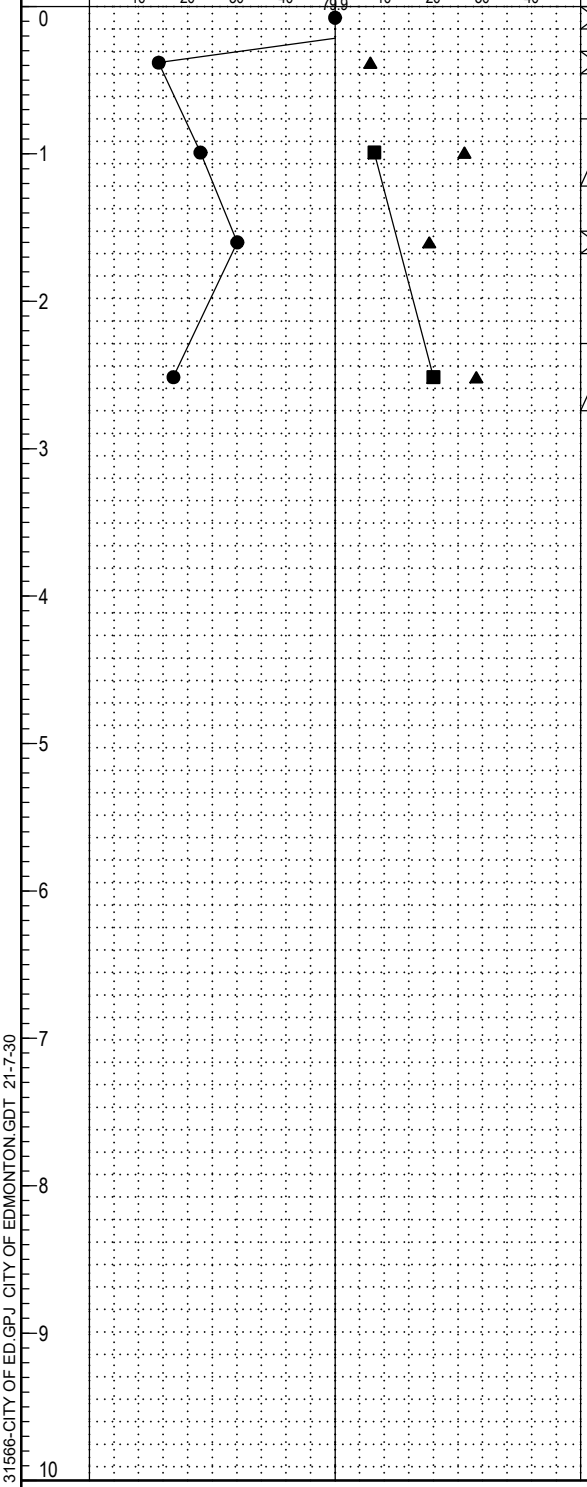
COMPLETION DEPTH: 2.7 m
COMPLETION DATE: 21-6-10

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-41**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-10	LOCATION: N5933020.34, E30097.43	ELEVATION: 628.56 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	
			CI		CLAY (FILL) stiff, brown to dark brown, silty, some silt, trace fine sand, gravel, and oxides	628
1		8	CH		-dark brown, silty	
			CH		-trace organics	627
2		20	CI		-very stiff, some oxides, sand, and oxides, trace coal	626
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.3m -No water Backfilled with drill cuttings and bentonite chips at surface	625
4						624
5						623
6						622
7						621
8						620
9						619
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-10

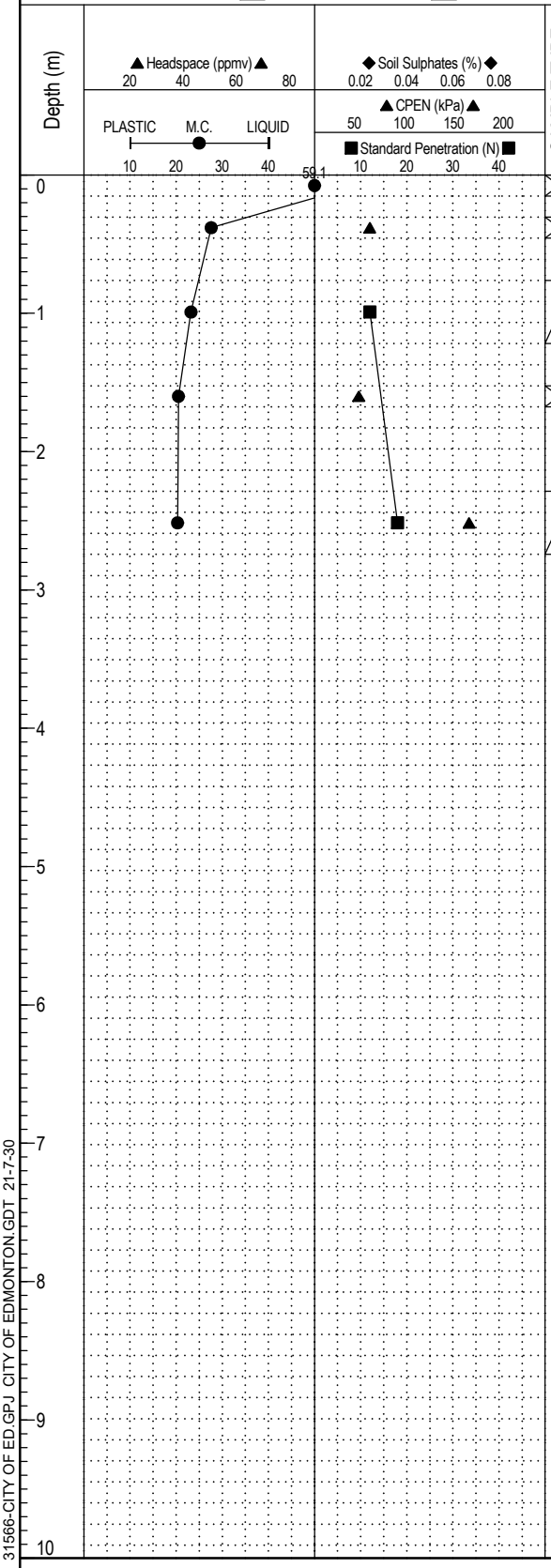
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-43**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5933066.42, E30008.11	ELEVATION: 627.49 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		PEAT		TOPSOIL, dark brown, peaty, rootlets	
		CH		CLAY (FILL) stiff, brown to dark brown, silty, trace fine sand and rootlets	627
	12	CH		-some organics	
				-very stiff, dark brown, silty, trace fine sand, oxides, and clay shale	626
		CI			
	18	CI		-trace sandstone lenses and silt deposits	625
				END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.0m -No water Backfilled with drill cuttings and bentonite chips at surface	624
					623
					622
					621
					620
					619
					618

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-15

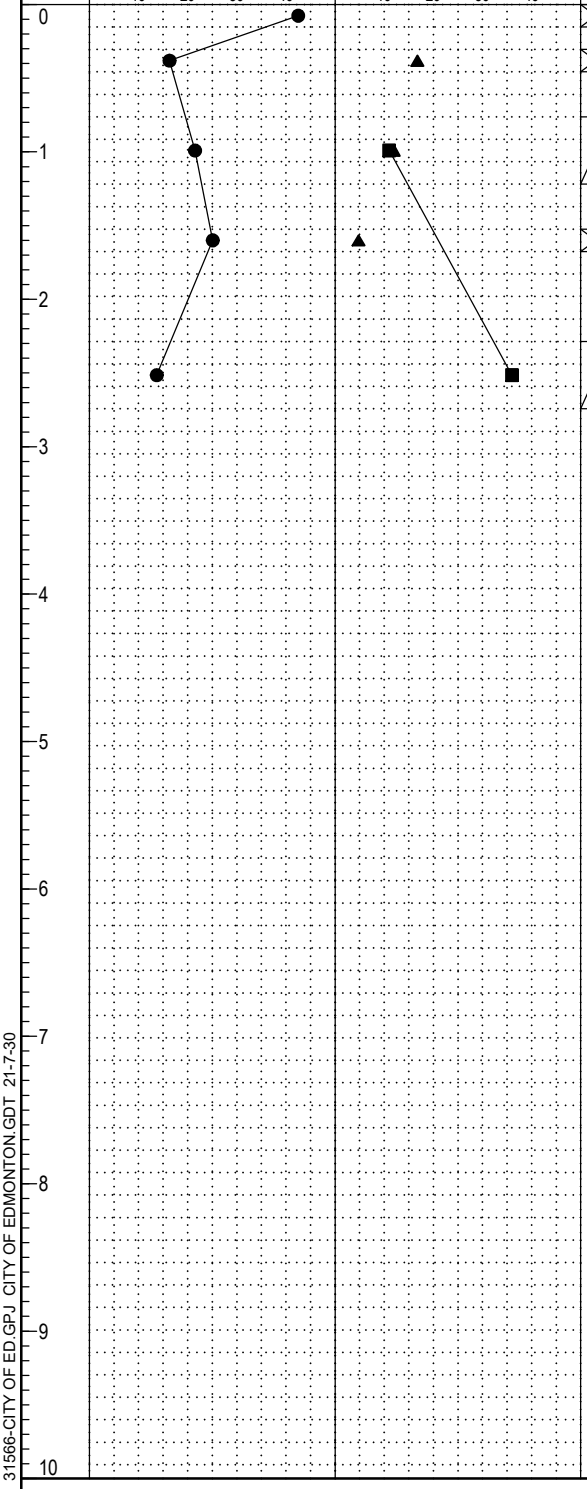
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-44**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932915.13, E30029.38	ELEVATION: 626.37 (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

Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			OL		TOPSOIL, dark brown, peaty, rootlets	
			CI		CLAY (FILL) dark brown, silty, trace oxides, fine sand, gravel, and rootlets	626
1		11	CI		-stiff, brown to dark brown, silty, trace fine sand, coal, and oxides	625
2			CI		-brown, trace silt lenses	624
		36	SM		SAND, dense, brown, silty, fine grained, trace gravel, coal, and oxides	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.0m -No water Backfilled with drill cuttings and bentonite chips at surface	623
4						622
5						621
6						620
7						619
8						618
9						617
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-16

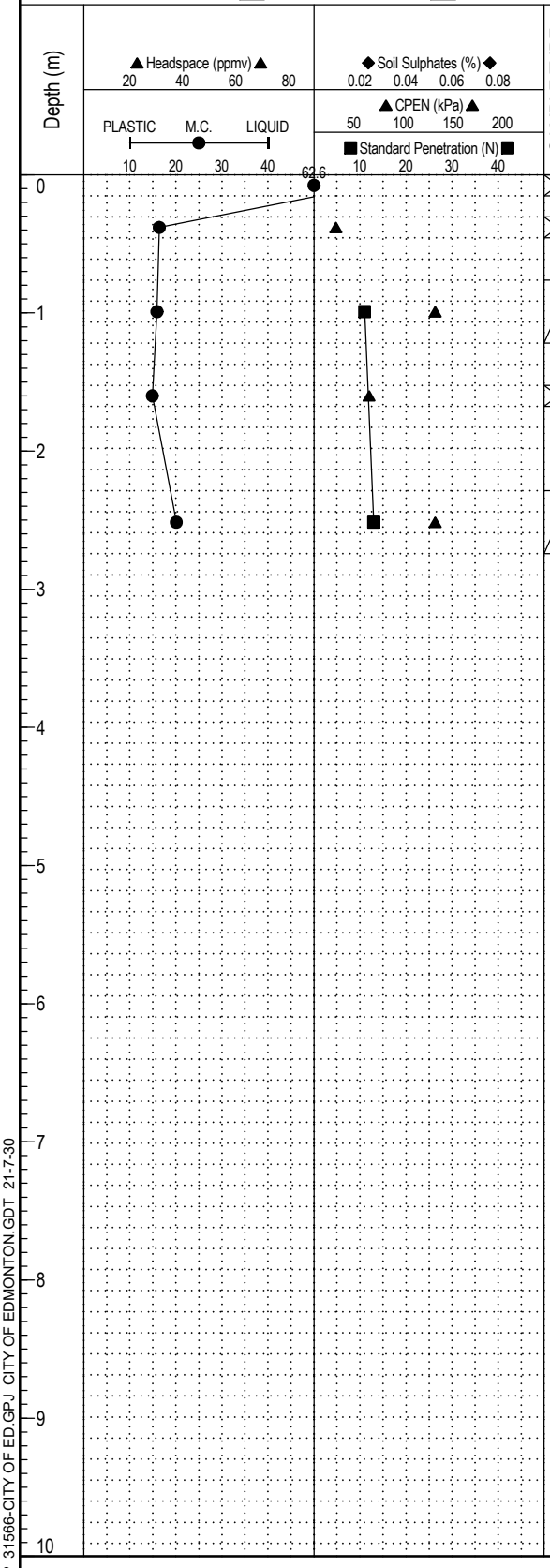
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-45**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5932959.7, E29953.62	ELEVATION: 625.40 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, rootlets	
			CI		CLAY (FILL) stiff, dark brown, very silty, some organics, trace fine sand	625
1		11	CI		-trace coal, oxides, organics, and fine sand lenses	
			CI			624
2		13	CI		CLAY, stiff, grey, silty, trace fine sand, rootlets, oxides, and clay shale	623
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	622
4						621
5						620
6						619
7						618
8						617
9						616
10						

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

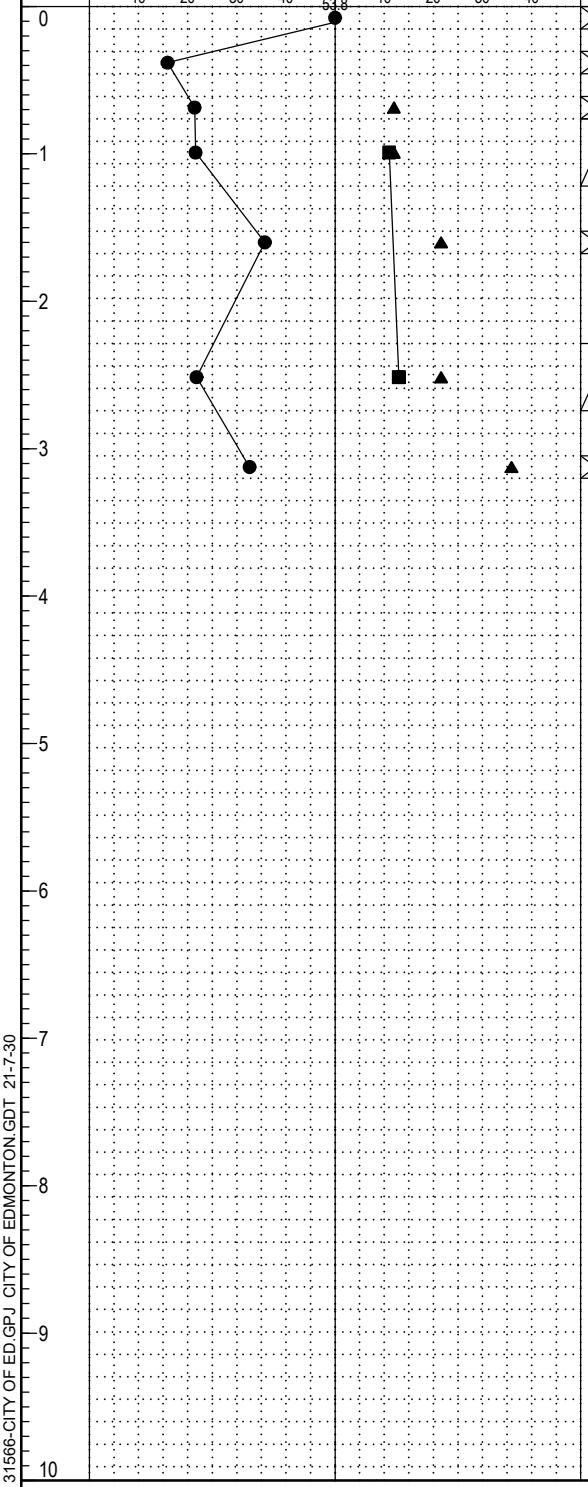
COMPLETION DEPTH: 2.7 m
COMPLETION DATE: 21-6-15

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-46**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932666.62, E29881.43	ELEVATION: 626.05 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, silty, trace fine sand and rootlets	
			CI		CLAY (FILL) brown, trace organics and rootlets	
			CI		-stiff, dark brown, silty, trace fine sand, gravel, and oxides	
1		11	CH		-trace coal and wood chunks	625
			CI-OL		-trace clay shale and peat	
2						624
		13	CS-CH		CLAY SHALE (WEATHERED), stiff, brown to grey, silty, some coal, trace oxides	
3			CI		-dark brown, silty, some sandstone lenses, trace oxides and siltstone deposits	623
4					END OF TEST HOLE AT 3.8m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	622
5						621
6						620
7						619
8						618
9						617
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 3.8 m

COMPLETION DATE: 21-6-8

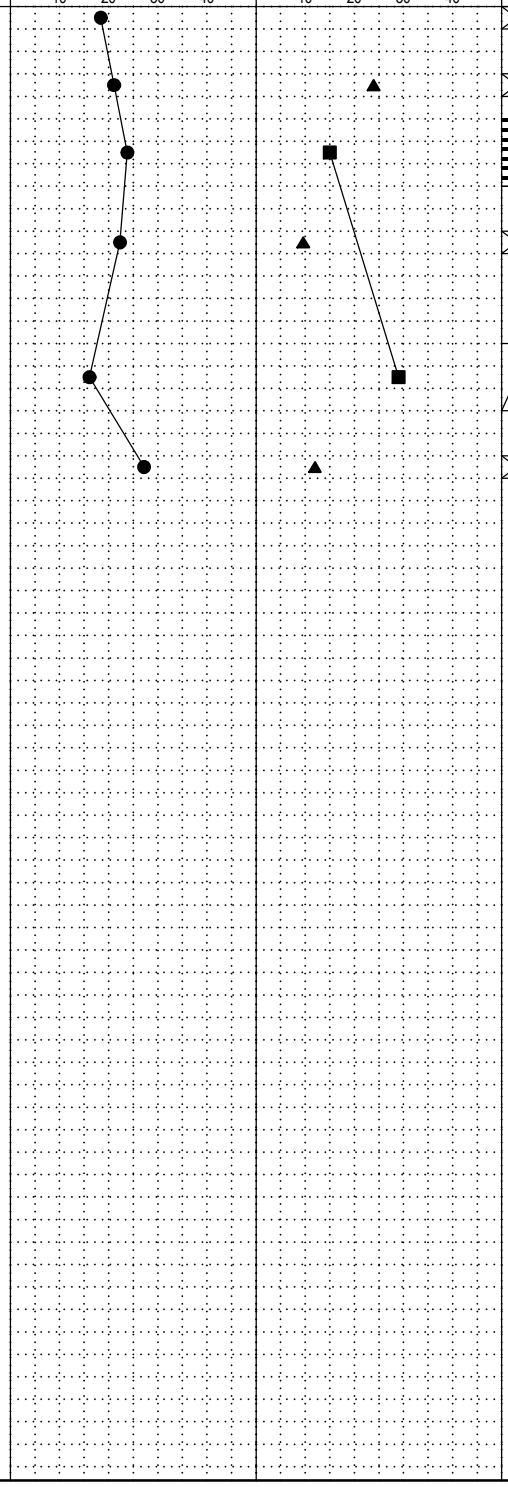
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-47**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5932721.58, E29769.31	ELEVATION: 626.32 (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	SOIL DESCRIPTION	ELEVATION (m)
	CI-OL	TOPSOIL, dark brown, silty, trace fine sand and peat	626
	CH	CLAY (FILL) dark brown, silty, trace fine sand, gravel, rootlets, and oxides	
15	CH	-trace wood chunks	625
	CI	CLAY dark brown, silty, some fine sand and sandstone lenses, trace oxides and clay shale lenses	
29	CI	-very stiff, brown to dark brown, very silty, some silt lenses, trace fine sand, gravel, and oxides	624
	CI	-trace wood chunks and coal	623
		END OF TEST HOLE AT 3.8m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	622
			621
			620
			619
			618
			617

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 3.8 m

COMPLETION DATE: 21-6-8

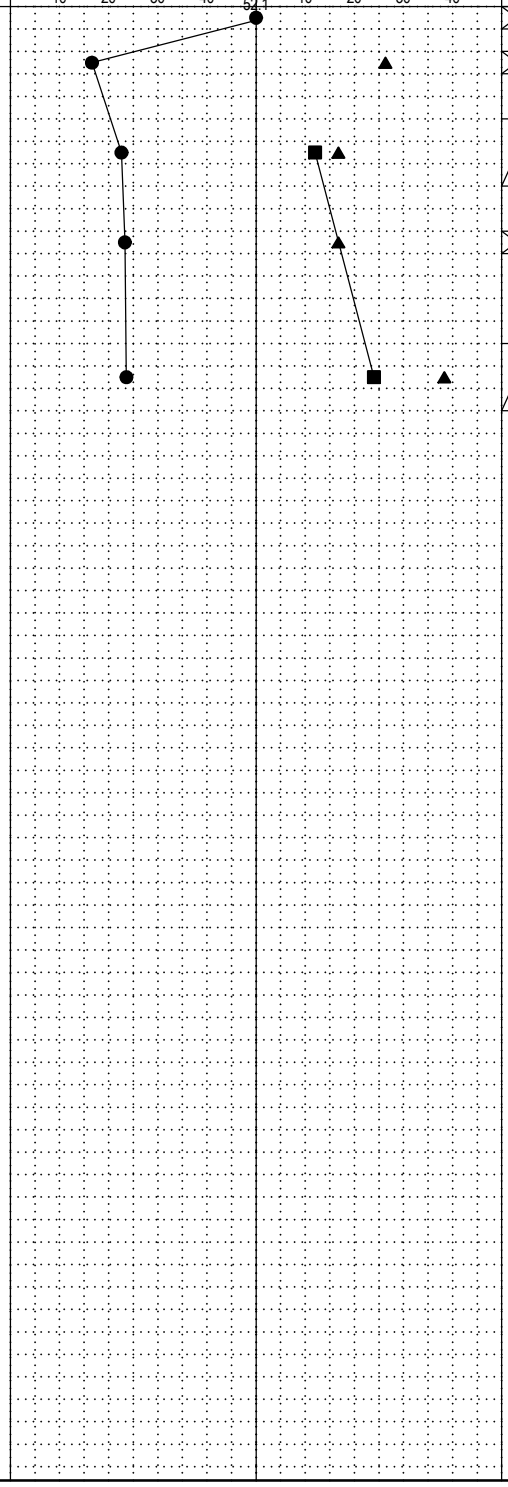
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-48**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932619.59, E30079.37	ELEVATION: 626.96 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	
			CI		CLAY (FILL) dark brown, silty, some fine sand, trace gravel, clay shale, and oxides	
1		12	SS-CI		SANDSTONE, compact, brown, silty, fine grained, some clay shale, trace oxides and coal	626
			SI-CI		CLAY SHALE AND SILTSTONE very stiff, dark brown, silty, some oxides, trace sandstone	
2						625
		24	CS-CH		-brown to dark grey, high plastic	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.4m -No water Backfilled with drill cuttings and bentonite chips at surface	624
4						623
5						622
6						621
7						620
8						619
9						618
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-14

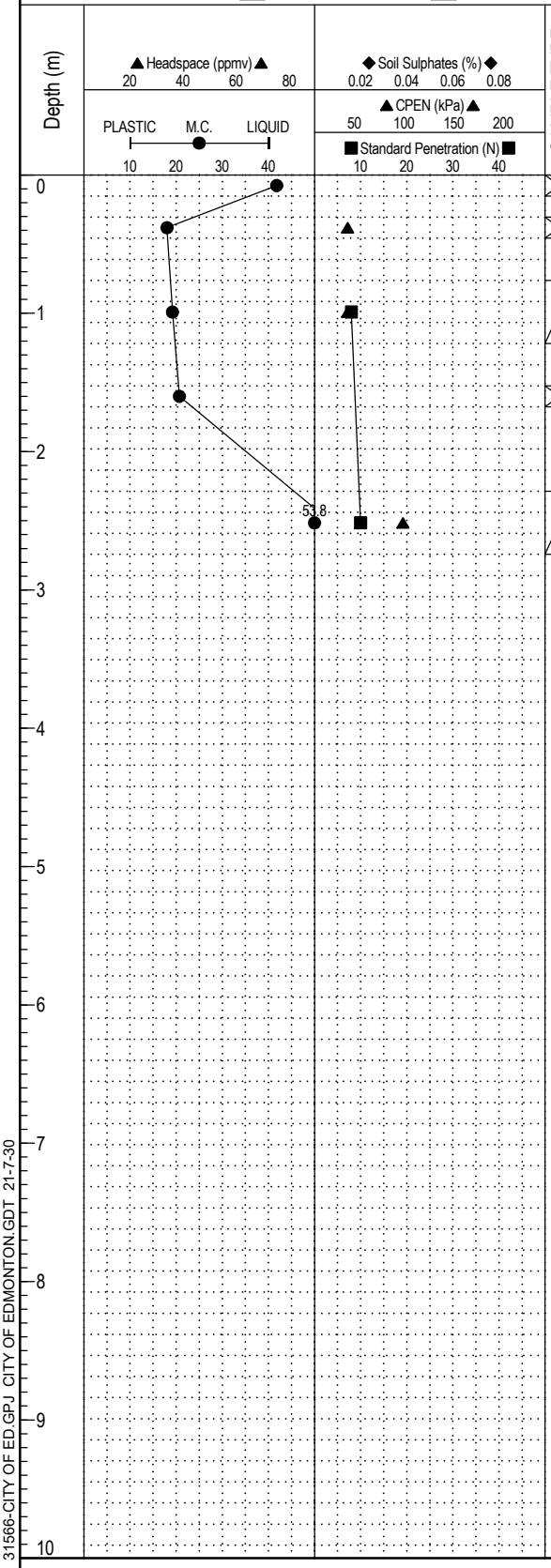
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-49**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932542.59, E30104.96	ELEVATION: 628.39 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		CI-OL		TOPSOIL, dark brown, peaty, rootlets	
		CI		CLAY stiff, brown to dark brown, silty, trace rootlets, fine sand, and oxides	628
	8	CI		-brown, very silty	
		ML		SILT brown, clayey, some fine sand, trace oxides and CL clay	627
	10	BE		BENTONITE, stiff, yellowish brown, silty, trace coal and oxides	626
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	625 624 623 622 621 620 619

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

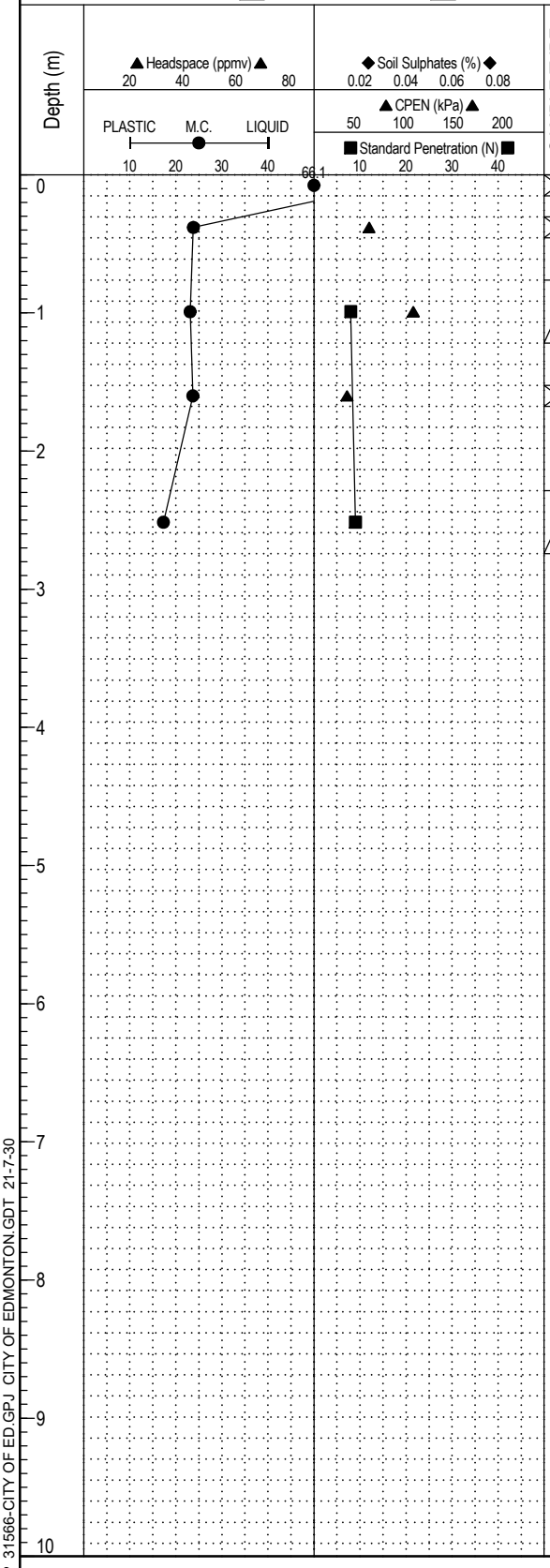
COMPLETION DATE: 21-6-14

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-50**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932685.49, E30311.12	ELEVATION: 631.51 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		CI-OL		TOPSOIL, dark brown, peaty, rootlets	
		CI		CLAY stiff, dark brown, silty, some organics, trace fine sand, gravel, and rootlets	631
	8	CI			
		CI		-brown, silty, trace fine sand, oxides, rootlets, and silt lenses	630
	9	CI-CL		-stiff, brown, silty, fine sandy, trace oxides and rootlets	629
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	628 627 626 625 624 623 622

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

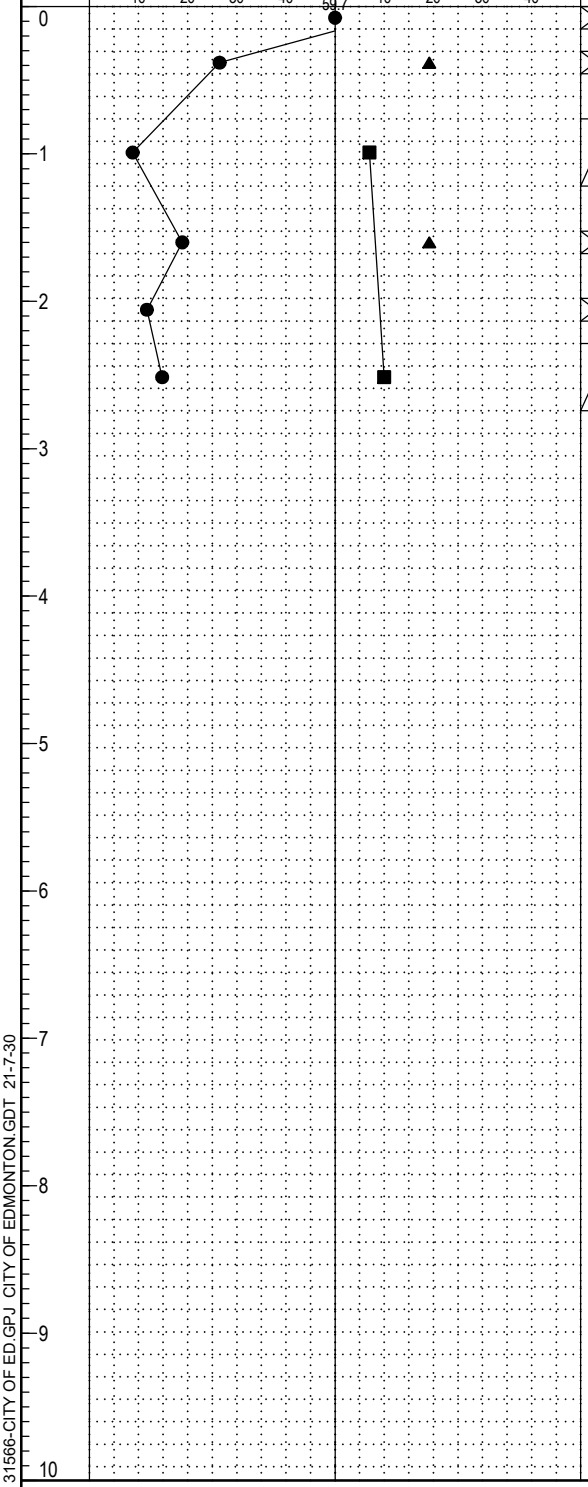
COMPLETION DATE: 21-6-14

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-51**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932874.58, E30360.71	ELEVATION: 631.40 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	
			CI		CLAY (FILL) dark brown, very silty, some organics, trace fine sand and gravel	631
1		7	SM		SAND, loose, dark brown, silty, fine grained, trace coal	
			CI-CH		CLAY brown, silty, fine sandy, trace oxides	630
2			CI-CL		-stiff, brown, silty, sandy	
		10	CI-CL			629
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.0m -No water Backfilled with drill cuttings and bentonite chips at surface	628
4						627
5						626
6						625
7						624
8						623
9						622
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-14

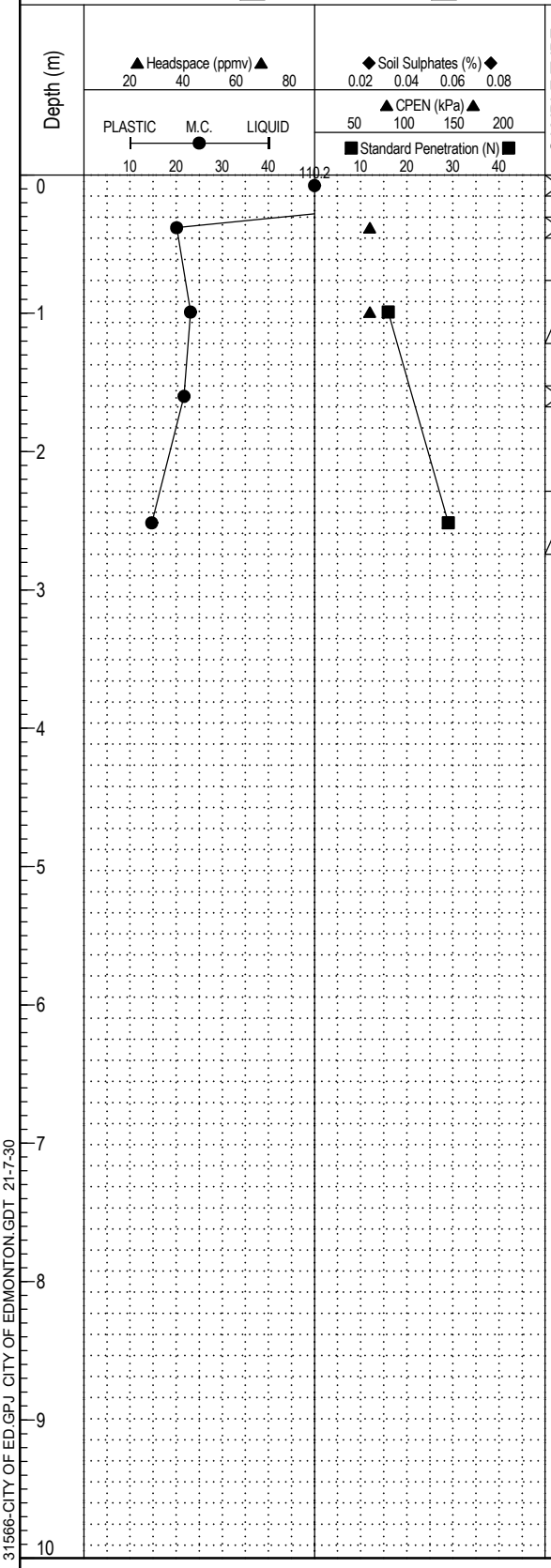
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-52**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5932952.02, E29922.62	ELEVATION: 624.04 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	624
			CI		CLAY (FILL) very stiff, dark brown to dark grey, silty, some fine sand, trace gravel	
1		16	CI		-dark brown	623
			SM		SAND AND GRAVEL, brown, silty, fine grained sand	
2						622
		29	SM		-Gravel = 45.6%, Sand = 45.3%, Fines = 9.1%	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 2.1m -Water at 1.8m Backfilled with drill cuttings and bentonite chips at surface	621
4						620
5						619
6						618
7						617
8						616
9						615
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-15

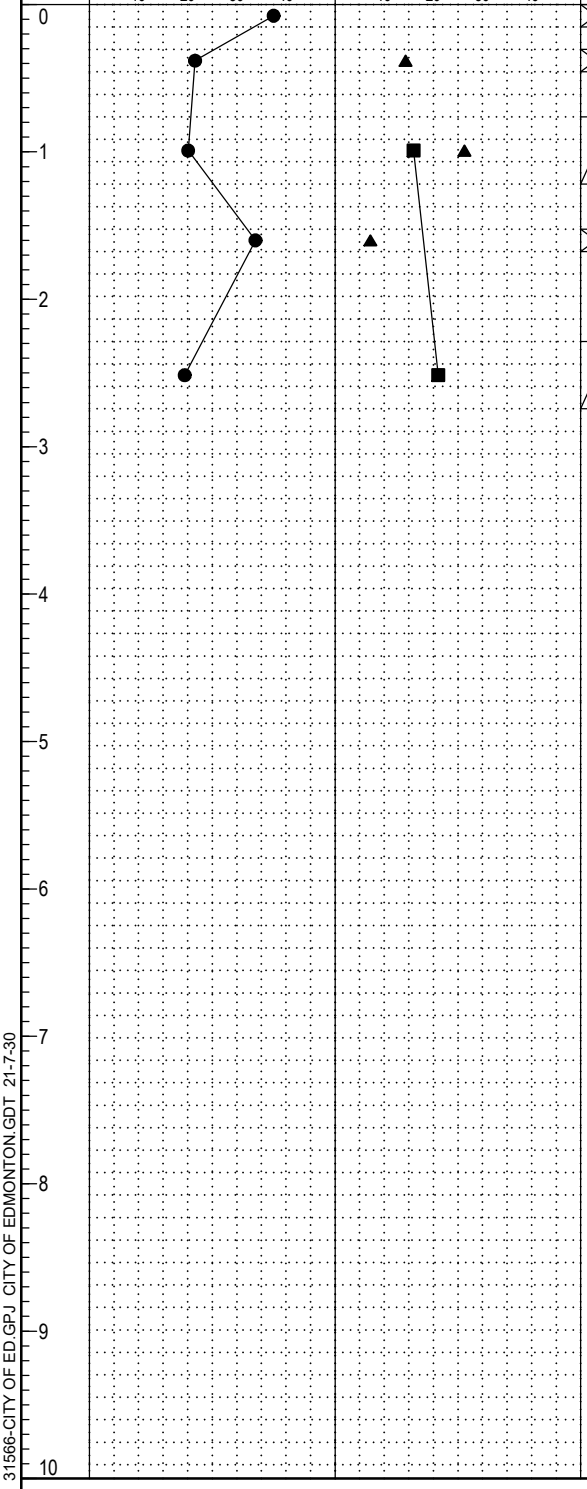
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-53**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932828.32, E29849.37	ELEVATION: 624.02 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		OL		TOPSOIL, dark brown, peaty, rootlets	
		CI		CLAY (FILL) very stiff, dark brown, silty, trace fine sand, gravel, and rootlets	
	16	CI		-trace coal and clay shale	623
		CI		-dark grey, trace organics and wood	622
	21	CI		CLAY, very stiff, dark grey, silty, some fine sand, trace oxides and silt lenses	
				END OF TEST HOLE AT 2.7m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	621 620 619 618 617 616 615

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

LOGGED BY: GS | REVIEWED BY: TGV / RWT

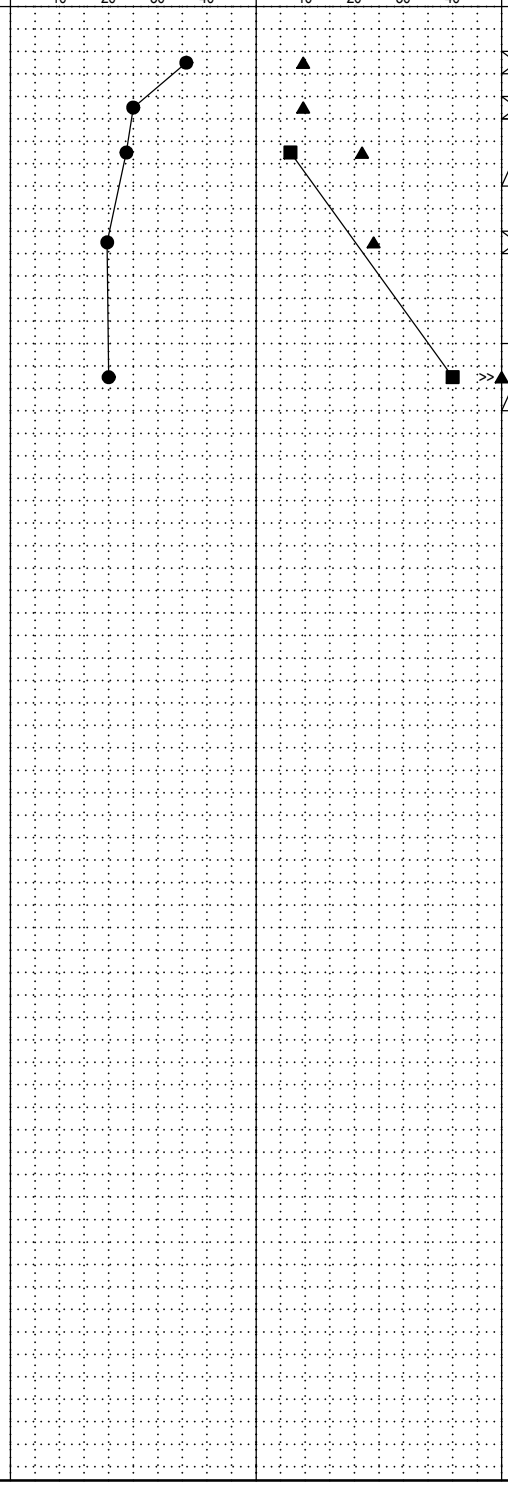
COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-16

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-54**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932772.51, E29942.55	ELEVATION: 624.09 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0					TOPSOIL black, silty, rootlets, trace clay	624
			OL			
			CI		CLAY (FILL), firm, dark brown, silty, trace fine sand, gravel, and organics	
1		7	CI-CH		-trace oxides	623
					CLAY SHALE hard, brown to grey, silty, trace silt lenses, siltstone nodules, and oxides, high plastic	
2			CS-CH			622
		40	CS-CH		-grey	
3					END OF TEST HOLE AT 2.7m UPON COMPLETION: (Below ground surface) -Slough at 1.8m -No water Backfilled with drill cuttings and bentonite chips at surface	621
4						620
5						619
6						618
7						617
8						616
9						615
10						

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 2.7 m

COMPLETION DATE: 21-6-16

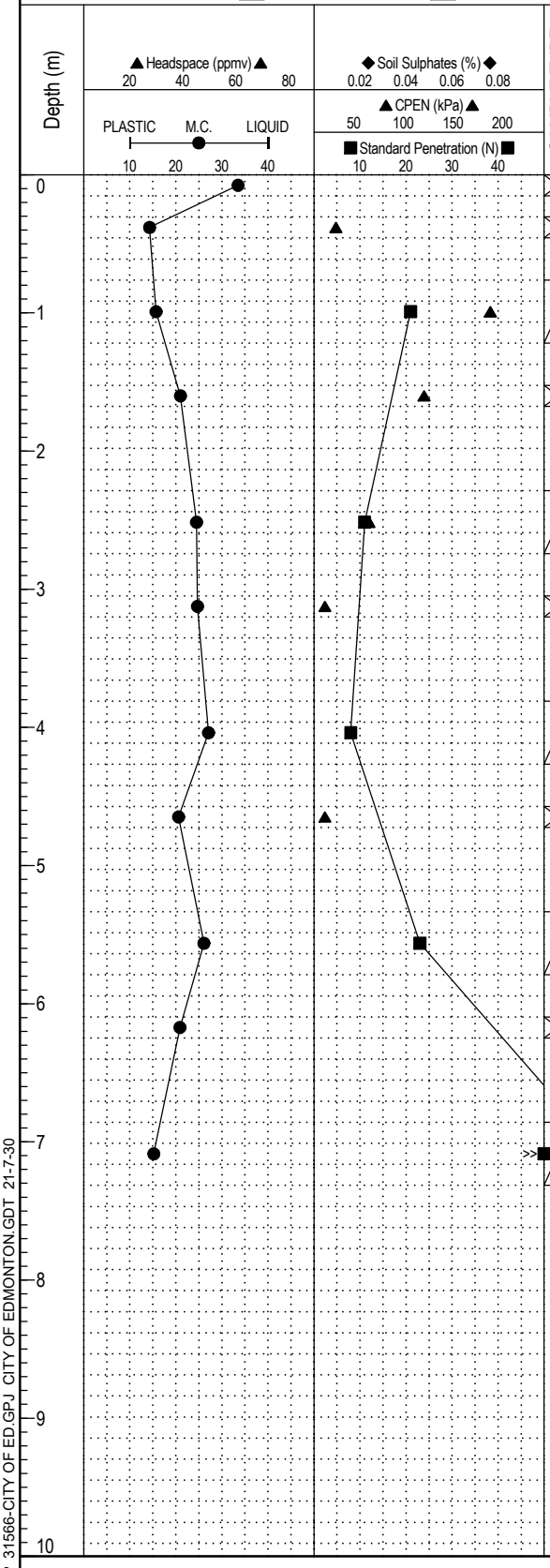
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-55**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-7	LOCATION: N5932894.44, E29695.89	ELEVATION: 626.53 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		CI-OL		TOPSOIL, dark brown, peaty, rootlets, some fine sand	
		CI		CLAY very stiff, brown, silty, some silt, trace fine sand, gravel, and rootlets	626
	21	CI		-trace oxides and organics	
		CI		-some CL clay and silt, trace coal	625
	11	CI-CH		-stiff, dark brown, very silty, some silt lenses, trace rootlets, fine sand, and organics	624
		CI		-very silty	
					623
	8	CI		-stiff, brown, silty, trace oxides and very fine to fine grained sand	
		CI		-brown, silty, some fine sand and gravel, trace cobbles up to 115mm	622
	23	CI		-very stiff, some sand and gravel	621
		CI			620
	63	SM		SAND, very dense, brown, silty, fine grained, some coal, trace clay lumps -Gravel = 38.3%, Sand = 48.5%, Fines = 13.2%	619
				END OF TEST HOLE AT 7.3m UPON COMPLETION: (Below ground surface) -Slough at 5.5m -Water at 5.0m Backfilled with drill cuttings and bentonite chips at surface	618
					617

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 7.3 m

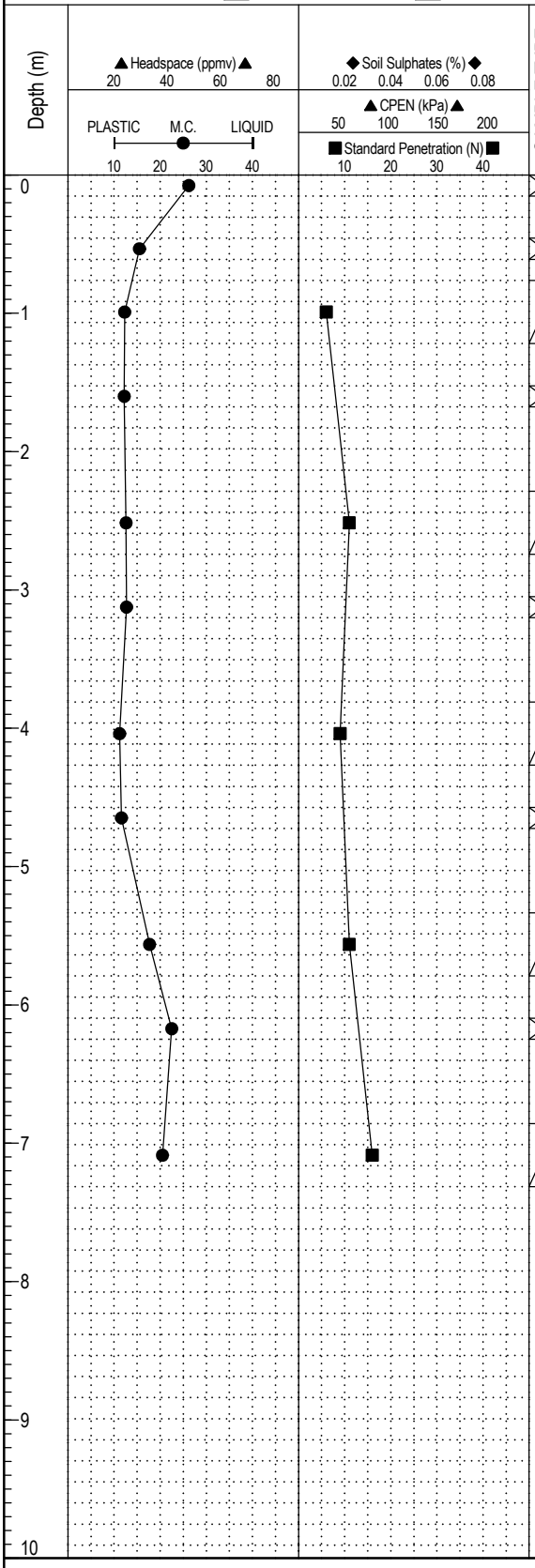
COMPLETION DATE: 21-6-7

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-56**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-7	LOCATION: N5932874.87, E29585.82	ELEVATION: 626.29 (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



TOPSOIL, dark brown, silty, peaty, trace fine sand and rootlets

CLAY, dark brown, very silty, trace fine sand, organics, and rootlets

-firm, brown, silty, trace rootlets, fine sand, and organics

-stiff

-fine sandy

-stiff, some fine sand

-stiff

-very stiff, some clay lumps

END OF TEST HOLE AT 7.3m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 7, 2021 = Dry
-June 18, 2021 = Dry
-July 5, 2021 = Dry

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

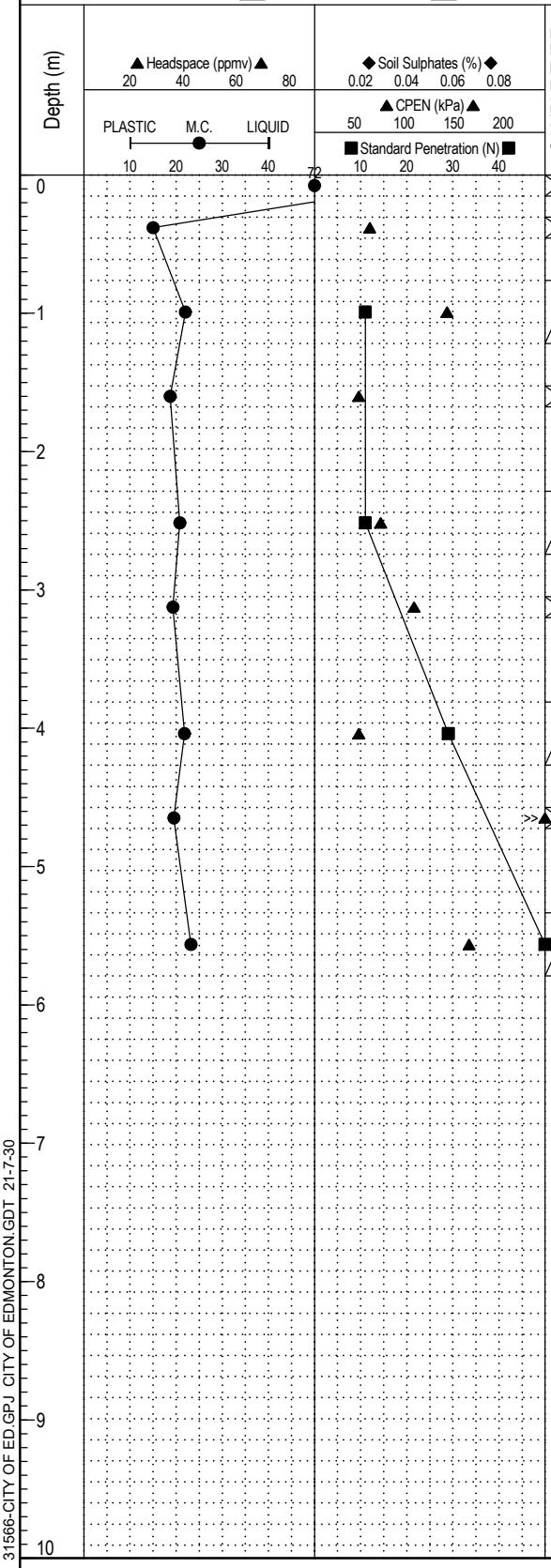
THURBER ENGINEERING LTD.

COMPLETION DEPTH: 7.3 m
COMPLETION DATE: 21-6-7
LOGGED BY: GS
REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-57**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932729.06, E30144.75	ELEVATION: 630.44 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		PEAT		TOPSOIL, dark brown, peaty, rootlets	630
		CI		CLAY (FILL) stiff, brown, very silty, some silt, trace fine sand and gravel	
	11	CI		-dark brown, trace oxides, coal, and organics	629
		CI		-trace clay shale	
	11	CI		-brown, trace fine sand lenses	628
		CI		-dark brown to dark grey, trace rootlets	627
	29	CI		-very stiff, some organics	
>>		CS-CH		CLAY SHALE very hard, grey, silty, trace siltstone nodules, oxides, and silt lenses, high plastic	626
	50/127	COAL		COAL	625
				END OF TEST HOLE AT 5.8m UPON COMPLETION: (Below ground surface) -Slough at 5.5m -Trace of water Backfilled with drill cuttings and bentonite chips at surface	624
					623
					622
					621

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-16

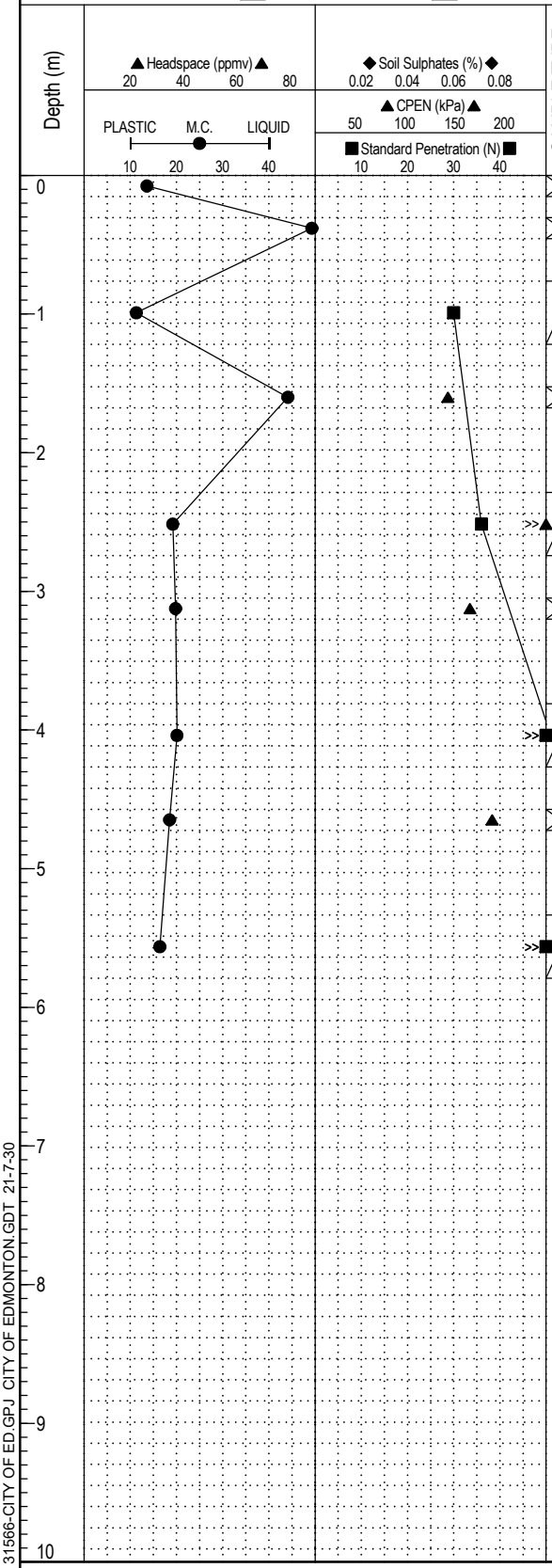
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-58**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932583.15, E30169.99	ELEVATION: 628.05 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		CI-OL		TOPSOIL, dark brown, peaty, rootlets	628
		PEAT		-brown to dark brown, silty, some organics	
				CLAY (FILL) hard, some sand and gravel	
	30	CI		-some clay lumps	627
		BE		CLAY SHALE hard, grey, silty, bentonitic, trace oxides and sandstone lenses, high plastic	626
	36	CS-CH		-dark brown, trace coal	
		CS-CI			625
	51	SS-CI		SANDSTONE very dense, some sandstone lenses	624
		SI-CI		-siltstone lens	
	85/279	SS-CI		-very dense, grey, silty, fine grained, trace clay shale lenses	623
				END OF TEST HOLE AT 5.8m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings and bentonite chips at surface	622
					621
					620
					619

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-14

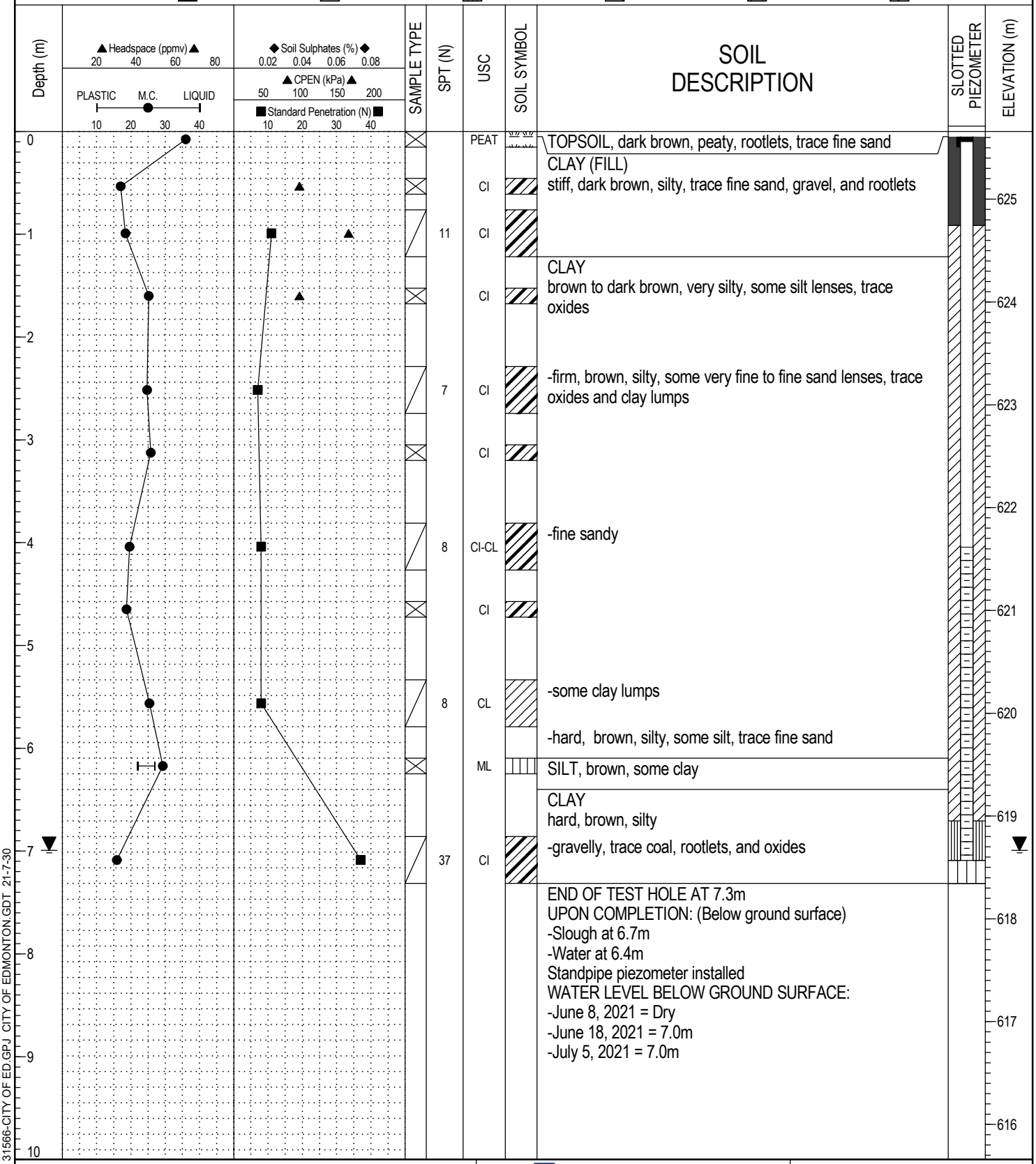
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-59**
CLIENT: City of Edmonton	DRILLING METHOD: Track / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-8	LOCATION: N5933087.9, E29577.66	ELEVATION: 625.66 (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



THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 7.3 m

COMPLETION DATE: 21-6-8

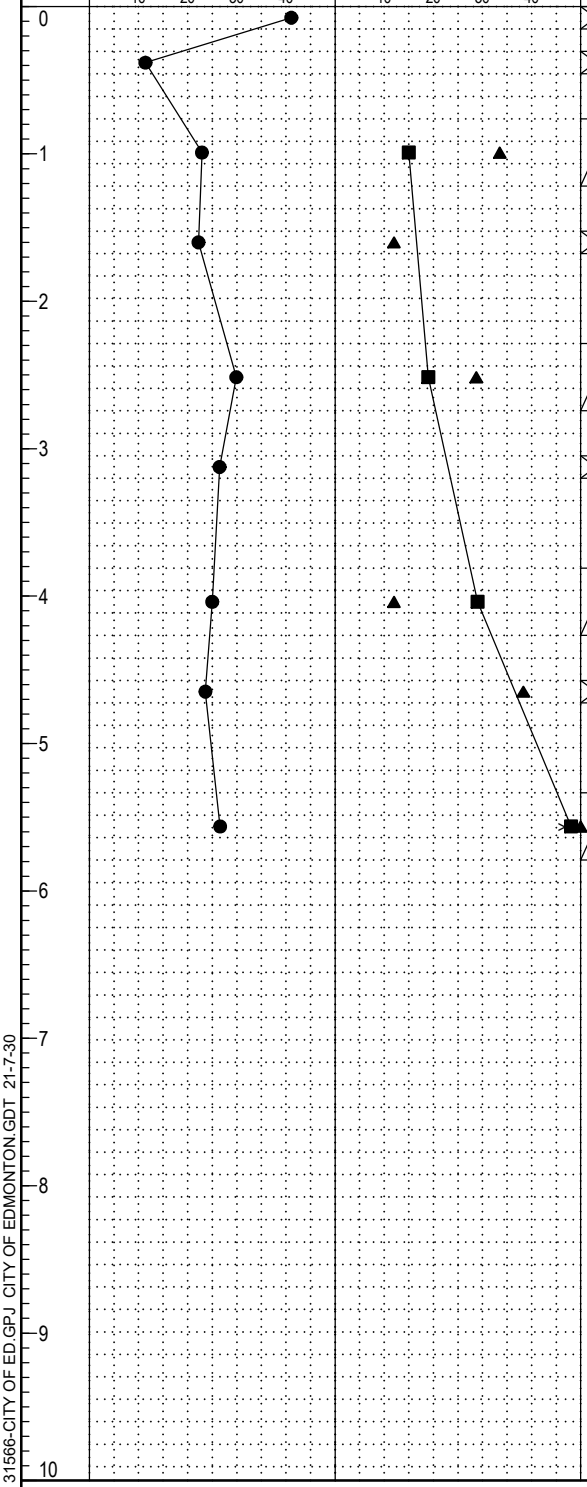
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-61**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5932903.67, E29985.8	ELEVATION: 626.05 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		PEAT		TOPSOIL, dark brown, peaty, rootlets	
		CI		CLAY (FILL) brown, trace fine sand and oxides	
	15	CH		-very stiff, dark brown, silty, some sandstone lenses, trace wood	625
		CI		-very stiff, dark brown, silty, trace fine sand, oxides, organics, and clay shale	624
	19	CI		-some organics	623
		SM		SAND compact, brown, silty, fine grained, trace organics and gravel -Gravel = 11.5%, Sand = 69.8%, Fines = 18.7%	
	29	CS-CH		CLAY SHALE dark brown, trace oxides	622
		CS-CH		-hard, grey to dark grey, silty, trace oxides, sandstone, and silt nodules, high plastic	621
	48	CS-CH			
				END OF TEST HOLE AT 5.8m UPON COMPLETION: (Below ground surface) -Slough at 4.0m -Water at 3.7m Backfilled with drill cuttings and bentonite chips at surface	620 619 618 617

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

LOGGED BY: GS | REVIEWED BY: TGV / RWT

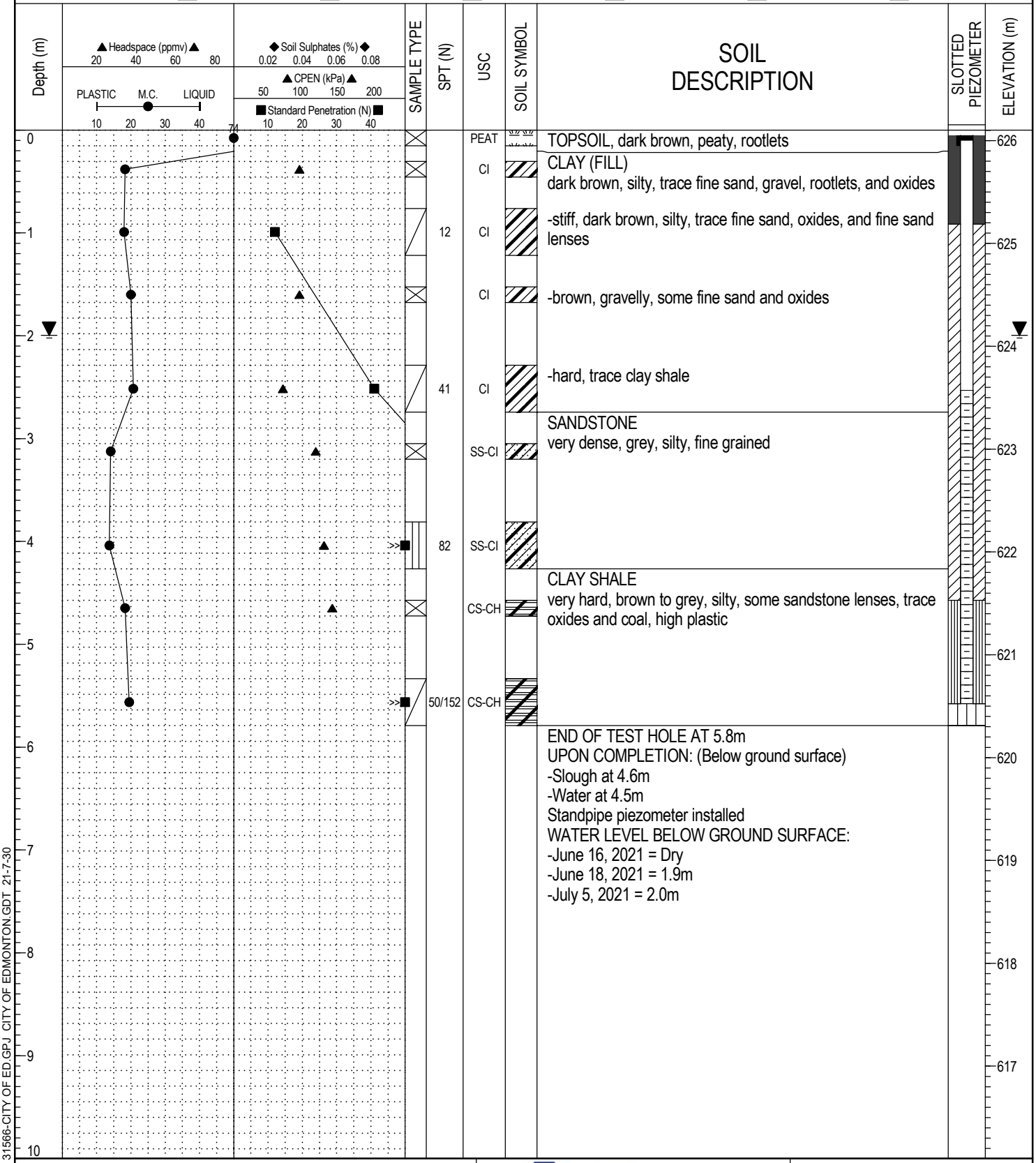
COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-15

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-62**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-16	LOCATION: N5932874.1, E30082.45	ELEVATION: 626.10 (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



TOPSOIL, dark brown, peaty, rootlets

CLAY (FILL)
dark brown, silty, trace fine sand, gravel, rootlets, and oxides

-stiff, dark brown, silty, trace fine sand, oxides, and fine sand lenses

-brown, gravelly, some fine sand and oxides

-hard, trace clay shale

SANDSTONE
very dense, grey, silty, fine grained

CLAY SHALE
very hard, brown to grey, silty, some sandstone lenses, trace oxides and coal, high plastic

END OF TEST HOLE AT 5.8m
UPON COMPLETION: (Below ground surface)
-Slough at 4.6m
-Water at 4.5m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 16, 2021 = Dry
-June 18, 2021 = 1.9m
-July 5, 2021 = 2.0m

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

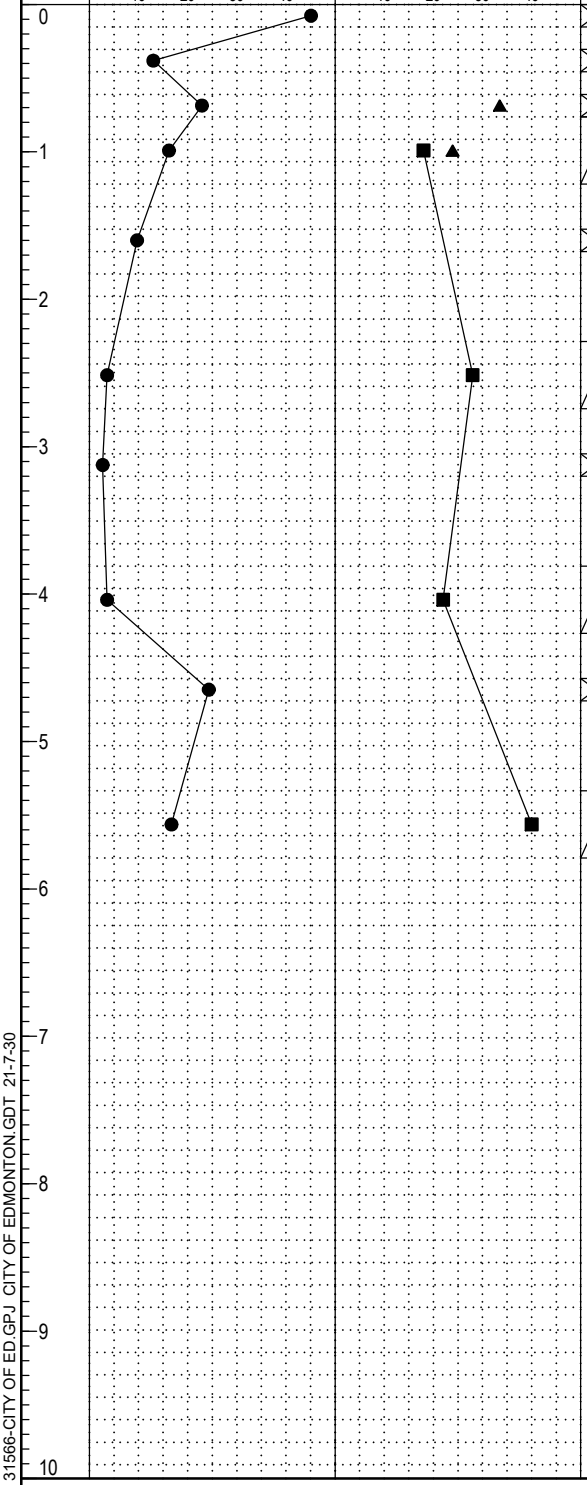
THURBER ENGINEERING LTD.

		COMPLETION DEPTH: 5.8 m
		COMPLETION DATE: 21-6-16
LOGGED BY: GS	REVIEWED BY: TGV / RWT	Page 1 of 1

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-64**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-10	LOCATION: N5933058.71, E30142.85	ELEVATION: 628.69 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		PEAT		TOPSOIL, dark brown, peaty, rootlets	
		CI-CH		CLAY (FILL), dark brown, silty, fine sandy, trace gravel, cobbles up to 100mm, and rootlets	
		CH		-silty, trace fine sand and oxides	628
	18	CL		-very stiff, some organics, trace coal and wood chunks	
				-some coal	
		CI-CL			627
	28	SP		SAND compact, brown, silty, fine to medium grained, trace oxides	626
		SP		-trace coal	
	22	SP			625
		SP		-some coal	624
	40	SP		-dense, some oxides, trace gravel	623
				END OF TEST HOLE AT 5.8m UPON COMPLETION: (Below ground surface) -Slough at 5.2m -Water at 5.0m Backfilled with drill cuttings and bentonite chips at surface	622
					621
					620
					619

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-10

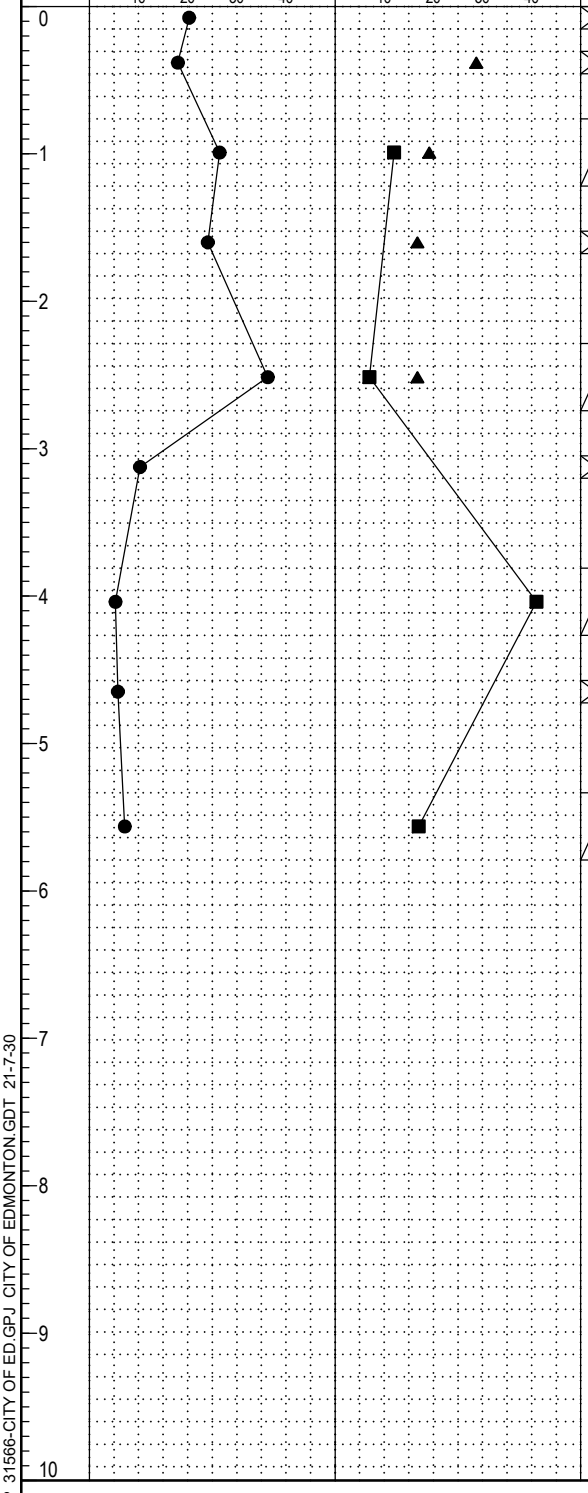
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-65**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-10	LOCATION: N5933049.76, E30287.89	ELEVATION: 630.75 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
		CI-OL		TOPSOIL, dark brown, silty, rootlets, trace fine sand	
		CH		CLAY (FILL) stiff, dark brown, silty, trace fine sand, gravel, rootlets, and oxides	630
	12	CH		-some organics	
		CH		-trace organics	629
	7	CH		-firm, dark brown to black, some organics, trace peat and coal	628
		CL			
	41	SP		SAND dense, brown, silty, fine grained, trace gravel and oxides	627
		SP		-Gravel = 2.7%, Sand = 87.3%, Fines = 10.0%	626
	17	SP		-compact	625
				END OF TEST HOLE AT 5.8m UPON COMPLETION: Backfilled with drill cuttings and bentonite chips at surface	624
					623
					622
					621

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-10

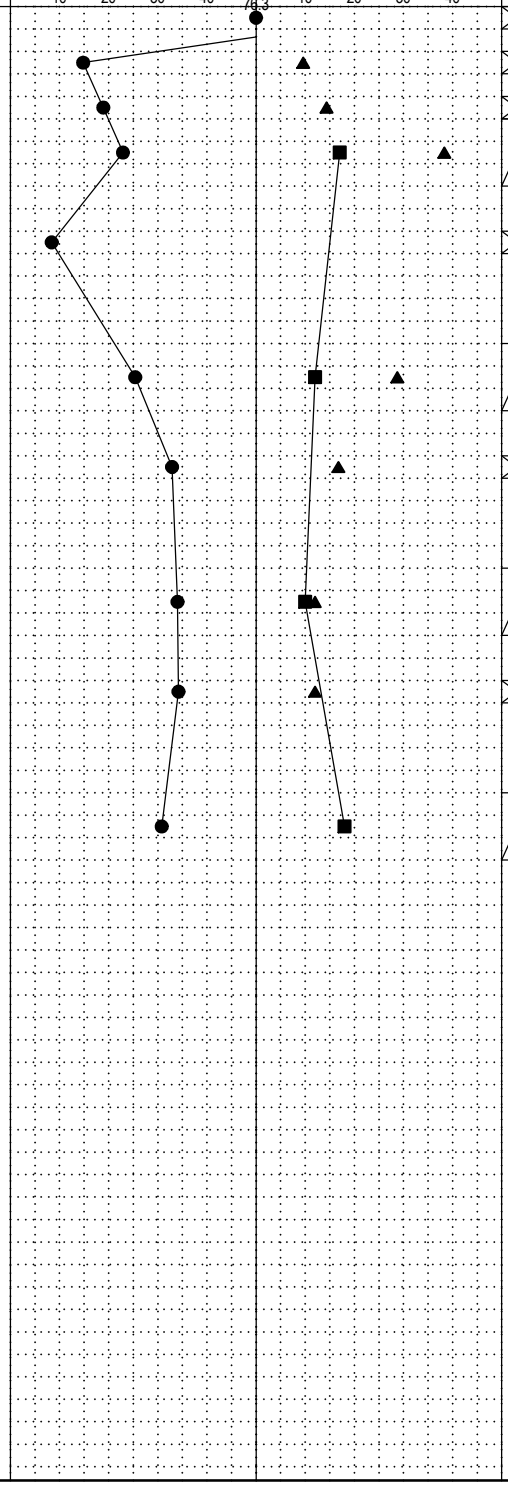
LOGGED BY: GS | REVIEWED BY: TGV / RWT

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-66**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-11	LOCATION: N5933125.95, E29787.2	ELEVATION: 625.57 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets	
			CI		CLAY (FILL) brown, very silty, trace rootlets and clay	625
			CI		-dark brown, silty, trace fine sand, gravel, and oxides	
1		17	CI		-very stiff, trace coal	
			SM		SAND, dark brown, silty, fine to medium grained, some gravel, trace oxides -Gravel = 28.5%, Sand = 51.7%, Fines = 19.8%	624
2						
		12	CI		CLAY stiff, dark brown, silty, trace fine sand, oxides, and high plastic clay lenses	623
3			CI		-dark brown to dark grey, trace coal	
						622
4		10	CI		-dark grey, trace clay shale	
			CI			621
5						
		18	CI		-very stiff, sand and gravel	620
6					END OF TEST HOLE AT 5.8m UPON COMPLETION: (Below ground surface) -No slough -Water at 5.5m Backfilled with drill cuttings and bentonite chips at surface	619
7						618
8						617
9						616
10						

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

LOGGED BY: GS | REVIEWED BY: TGV / RWT

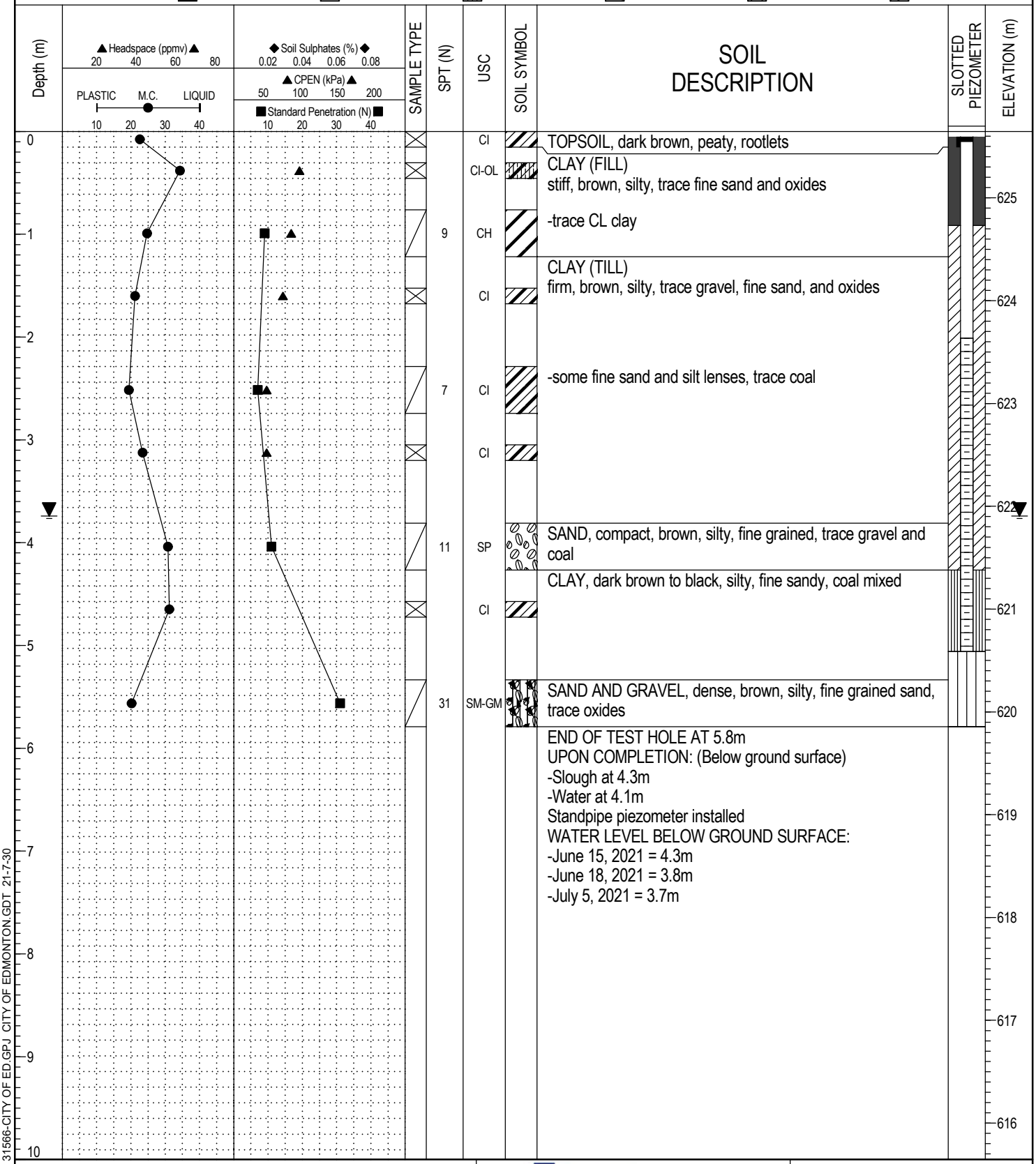
COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-11

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-67**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5933055.58, E29942.21	ELEVATION: 625.65 (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



TOPSOIL, dark brown, peaty, rootlets

CLAY (FILL)
stiff, brown, silty, trace fine sand and oxides

-trace CL clay

CLAY (TILL)
firm, brown, silty, trace gravel, fine sand, and oxides

-some fine sand and silt lenses, trace coal

SAND, compact, brown, silty, fine grained, trace gravel and coal

CLAY, dark brown to black, silty, fine sandy, coal mixed

SAND AND GRAVEL, dense, brown, silty, fine grained sand, trace oxides

END OF TEST HOLE AT 5.8m
UPON COMPLETION: (Below ground surface)
-Slough at 4.3m
-Water at 4.1m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 15, 2021 = 4.3m
-June 18, 2021 = 3.8m
-July 5, 2021 = 3.7m

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

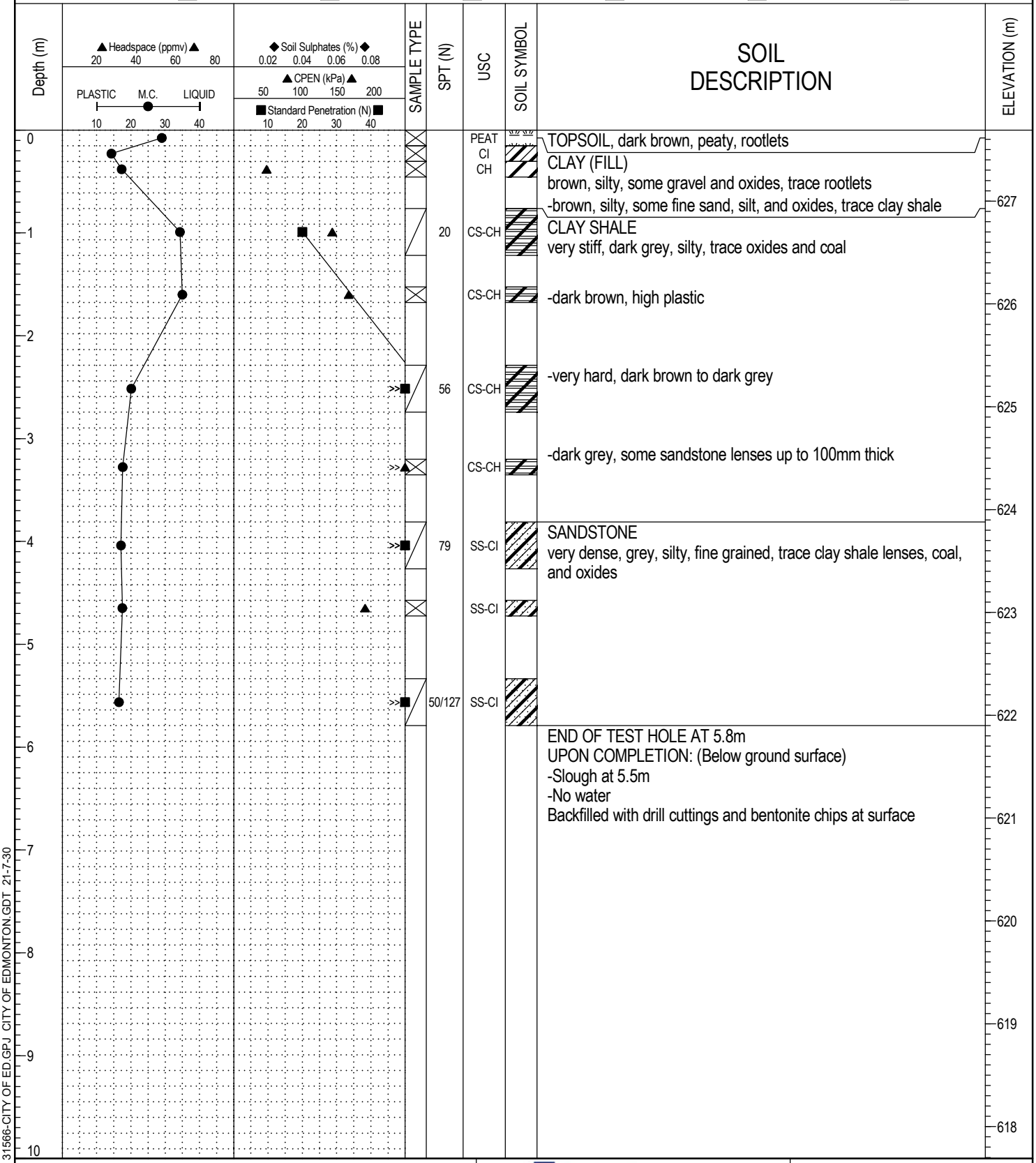
THURBER ENGINEERING LTD.

LOGGED BY: GS	REVIEWED BY: TGV / RWT	COMPLETION DEPTH: 5.8 m
		COMPLETION DATE: 21-6-15
		Page 1 of 1

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-70**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932572.94, E30123.12	ELEVATION: 627.69 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

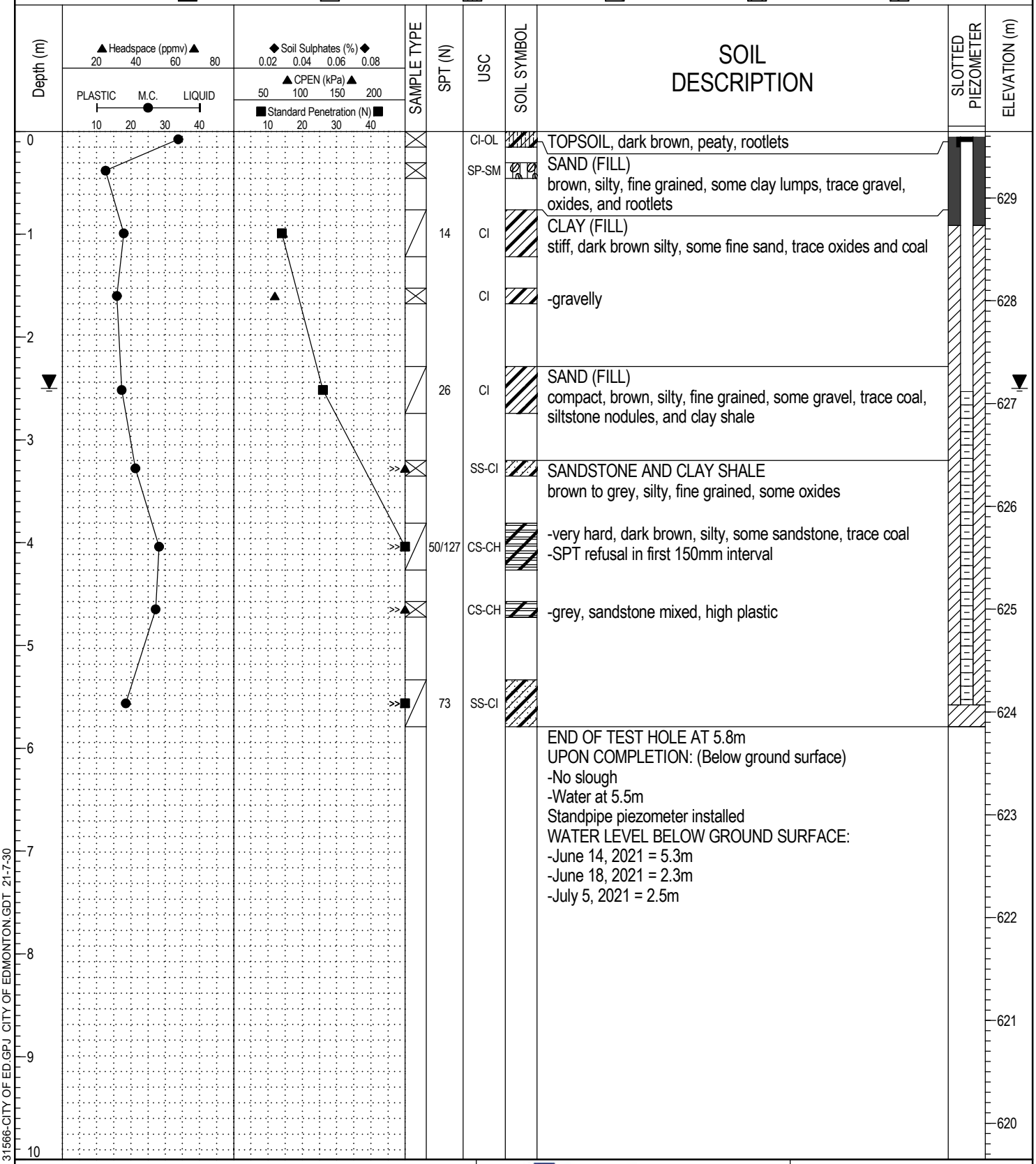
COMPLETION DATE: 21-6-14

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-71**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-14	LOCATION: N5932523.27, E30156.88	ELEVATION: 629.65 (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



STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

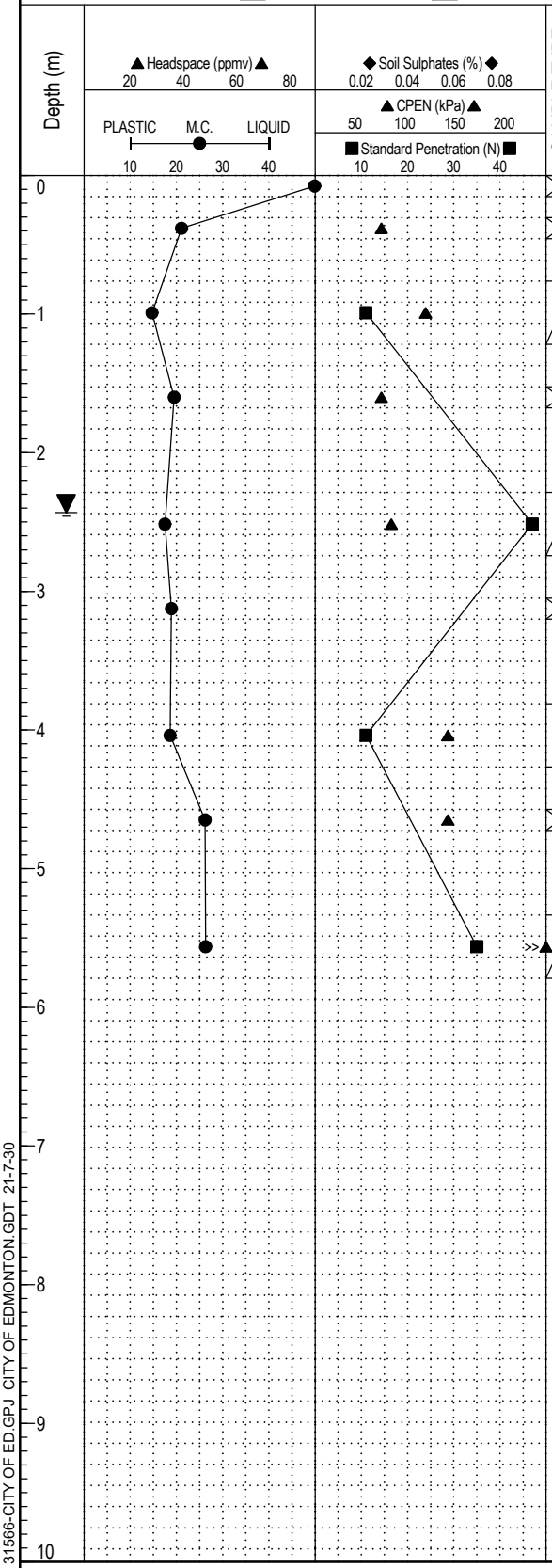
THURBER ENGINEERING LTD.

		COMPLETION DEPTH: 5.8 m
		COMPLETION DATE: 21-6-14
LOGGED BY: GS	REVIEWED BY: TGV / RWT	Page 1 of 1

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-72**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-15	LOCATION: N5932919.42, E29919.94	ELEVATION: 624.52 (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



SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
		PEAT		TOPSOIL, dark brown, peaty, rootlets		
		CH		CLAY (FILL) stiff, dark brown, silty, some fine sand, trace gravel and rootlets		624
	11	CI-CL		-trace fine sand lenses		
		CI		-fine sandy, some organics		623
	47	CI		-hard, fine sand		622
		SM-GM		SAND AND GRAVEL brown, silty, fine grained sand, trace cobbles and clay lumps -Gravel = 43.0%, Sand = 45.6%, Fines = 11.4%		621
	11	CI		CLAY, dark brown, silty, some fine sand, trace gravel, oxides, and coal		
		CS-CH		CLAY SHALE hard, dark brown, silty, trace coal and sandstone pockets, high plastic		620
>>	35	CS-CH		-dark grey, trace oxides and sandstone lenses		619
				END OF TEST HOLE AT 5.8m UPON COMPLETION: (Below ground surface) -Slough at 2.7m -Water at 2.6m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 15, 2021 = 3.7m -June 18, 2021 = 2.5m -July 5, 2021 = 2.4m		618 617 616 615

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

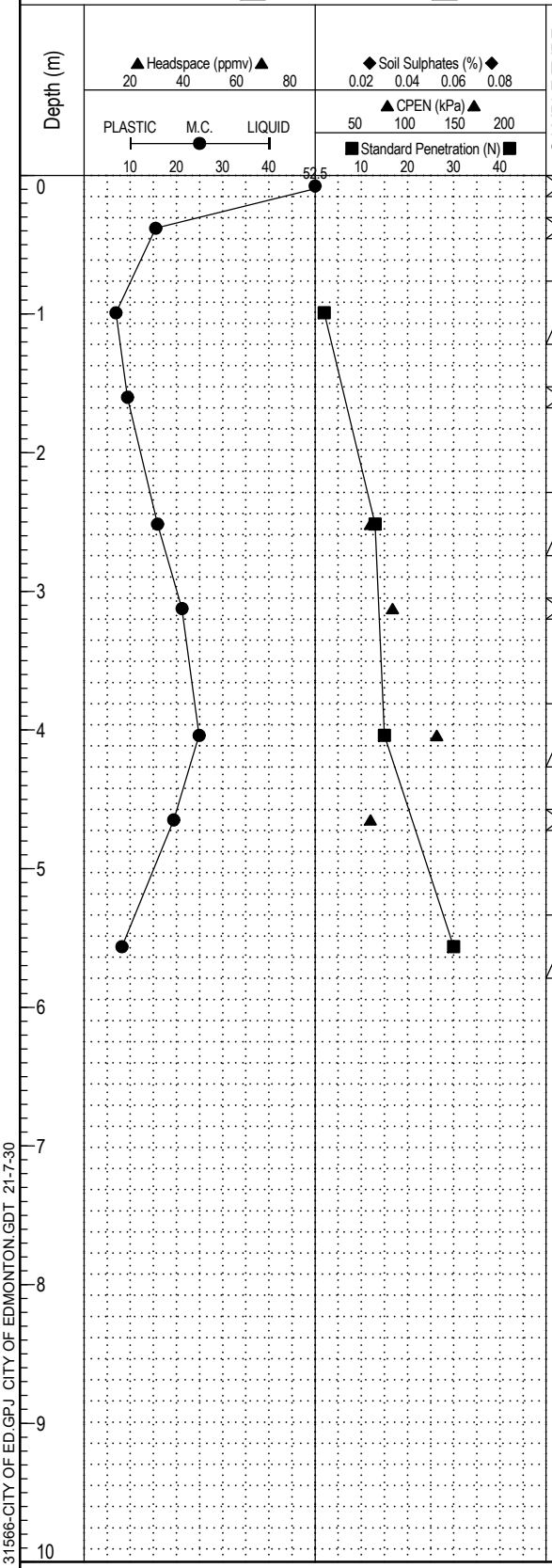
COMPLETION DATE: 21-6-15

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: ALL SERVICE DRILLING INC	BOREHOLE NO: **TH21-73**
CLIENT: City of Edmonton	DRILLING METHOD: Truck / Solid Stem Augers	PROJECT NO: 31566
START DATE: 2021-6-10	LOCATION: N5933028.2, E30362.4	ELEVATION: 631.74 (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



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
0			PEAT		TOPSOIL, dark brown, peaty, rootlets		
			CI		CLAY (FILL), trace gravel and fine sand		631
1		2	SP		SAND very loose, dark brown, silty, fine to medium grained, some gravel and oxides, trace clay lumps		
			SP		-brown, silty, fine grained, trace gravel, oxides, and coal		630
2							
		13	CH		CLAY stiff, brown silty, fine sandy, trace coal		629
3			CH				
							628
4		15	CH		-very stiff, trace oxides, silt lenses, and clay shale		
			CI		-dark brown, gravelly, some fine sand		627
5							
		30	SP-GP		SAND AND GRAVEL, dense, brown, silty, fine sandy, trace clay lumps and oxides		626
6					END OF TEST HOLE AT 5.8m UPON COMPLETION: -No slough -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 10, 2021 = Dry -June 18, 2021 = Dry -July 5, 2021 = Dry		625
7							
							624
8							
							623
9							
							622
10							

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 5.8 m

COMPLETION DATE: 21-6-10

LOGGED BY: GS | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: CanWest Concrete Cutting and Coring Inc.	BOREHOLE NO: **TH21-74 (Core2)**
CLIENT: City of Edmonton	DRILLING METHOD: Hand Auger	PROJECT NO: 31566
START DATE: 2021-7-26	LOCATION: Refer to Foundation Plan	ELEVATION:

SAMPLE TYPE: Shelby Tube | Drive Sample | Auger Sample | No Recovery | A Casing | Cored Sample

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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0							CONCRETE SLAB (165mm)	
							VOID (45mm)	
					CI		CLAY (FILL)	
					CI		firm, grey, brown streaks, trace sand	
1					CI			
					CI			
							END OF TEST HOLE AT 1.2m	
							UPON COMPLETION:	
							Backfilled with sand, void foam spray, and grout	
2								
3								
4								
5								
6								
7								
8								
9								
10								

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 1.2 m

COMPLETION DATE: 21-7-26

LOGGED BY: JH | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: CanWest Concrete Cutting and Coring Inc.	BOREHOLE NO: **TH21-75 (Core3)**
CLIENT: City of Edmonton	DRILLING METHOD: Hand Auger	PROJECT NO: 31566
START DATE: 2021-7-26	LOCATION: Refer to Foundation Plan	ELEVATION:

SAMPLE TYPE: Shelby Tube | Drive Sample | Auger Sample | No Recovery | A Casing | Cored Sample

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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0							CONCRETE SLAB (170mm)	
							VOID FORM, styrofoam (50mm)	
					CI		CLAY (FILL), firm, grey - brown, silty, trace sand	
					CI		-grey, sand lenses, trace oxides	
1					CI		-brown - grey, silty, sandy, trace oxides and gravel	
					CI		-coal	
							END OF TEST HOLE AT 1.2m	
							UPON COMPLETION:	
							Backfilled with sand, void foam spray, and grout	
2								
3								
4								
5								
6								
7								
8								
9								
10								

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 1.2 m

COMPLETION DATE: 21-7-26

LOGGED BY: JH | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: CanWest Concrete Cutting and Coring Inc.	BOREHOLE NO: **TH21-76 (Core1)**
CLIENT: City of Edmonton	DRILLING METHOD: Hand Auger	PROJECT NO: 31566
START DATE: 2021-7-26	LOCATION: Refer to Foundation Plan	ELEVATION:

SAMPLE TYPE: Shelby Tube | Drive Sample | Auger Sample | No Recovery | A Casing | Cored Sample

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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0							CONCRETE SLAB (170mm)	
							VOID (80mm)	
					CI		CLAY (FILL)	
					CI		firm to stiff, grey, silty, sandy	
1					CI		-grey, brown streaks, trace organics, sand, and gravel	
					CI			
							END OF TEST HOLE AT 1.2m	
							UPON COMPLETION:	
							Backfilled with sand, void foam spray, and grout	
2								
3								
4								
5								
6								
7								
8								
9								
10								

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

		COMPLETION DEPTH: 1.2 m
		COMPLETION DATE: 21-7-26
LOGGED BY: JH	REVIEWED BY: TGV / RWT	Page 1 of 1

THURBER

APPENDIX C

Laboratory Test Results

THURBER

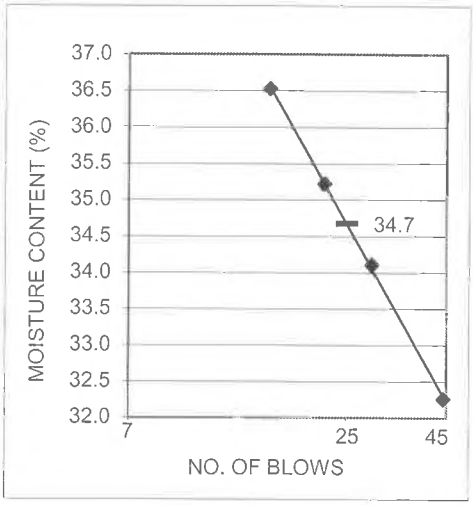
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-4
Sample No: G4
Depth: 5.0 ft.

Date Tested: 14-Jul-21
Tested By: JAP
Checked By:

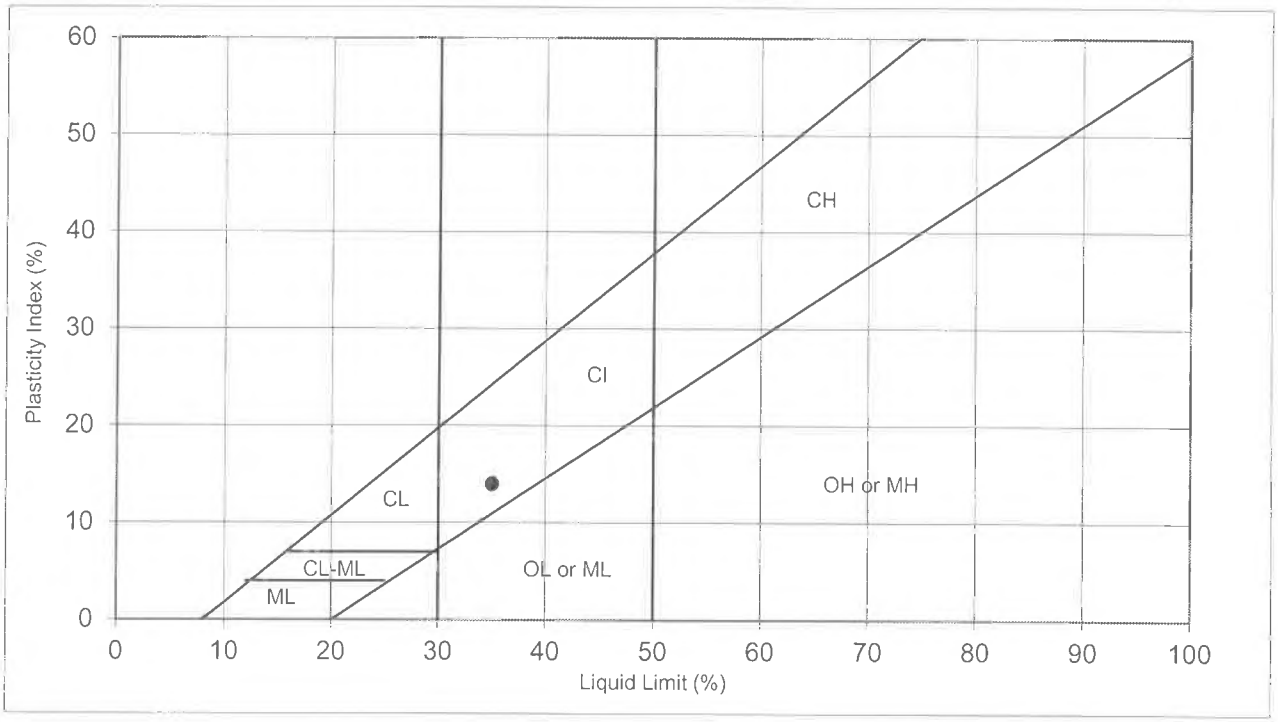
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	44	29	22	16
Container No.	1	2	3	4
Wet Soil + Container	17.22	17.97	18.39	17.83
Dry Soil + Container	13.02	13.40	13.6	13.06
Wt. Of Container	0	0	0	0
Moisture Content	32.3	34.1	35.2	36.5



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.38	29.26		
Dry Soil + Container	26.69	27.39		
Wt. Of Container	18.78	18.67		
Moisture Content	21.4	21.4		**21.4**



REMARKS

Liquid Limit:	**35**
Plastic Limit:	**21**
Plasticity Index:	**14**
USC Classification:	**CI**

THURBER

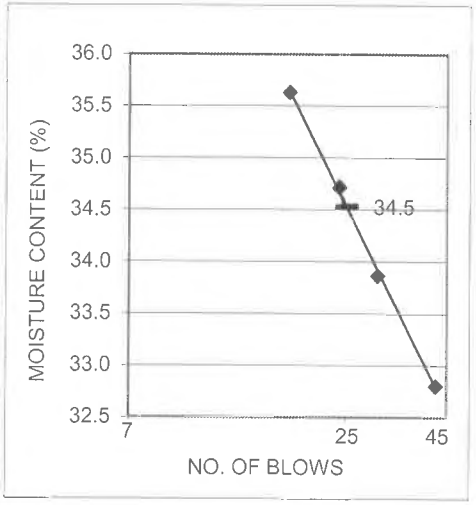
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-6
Sample No: P5
Depth: 7.5 - 9.0 ft.

Date Tested: 14-Jul-21
Tested By: JAP
Checked By:

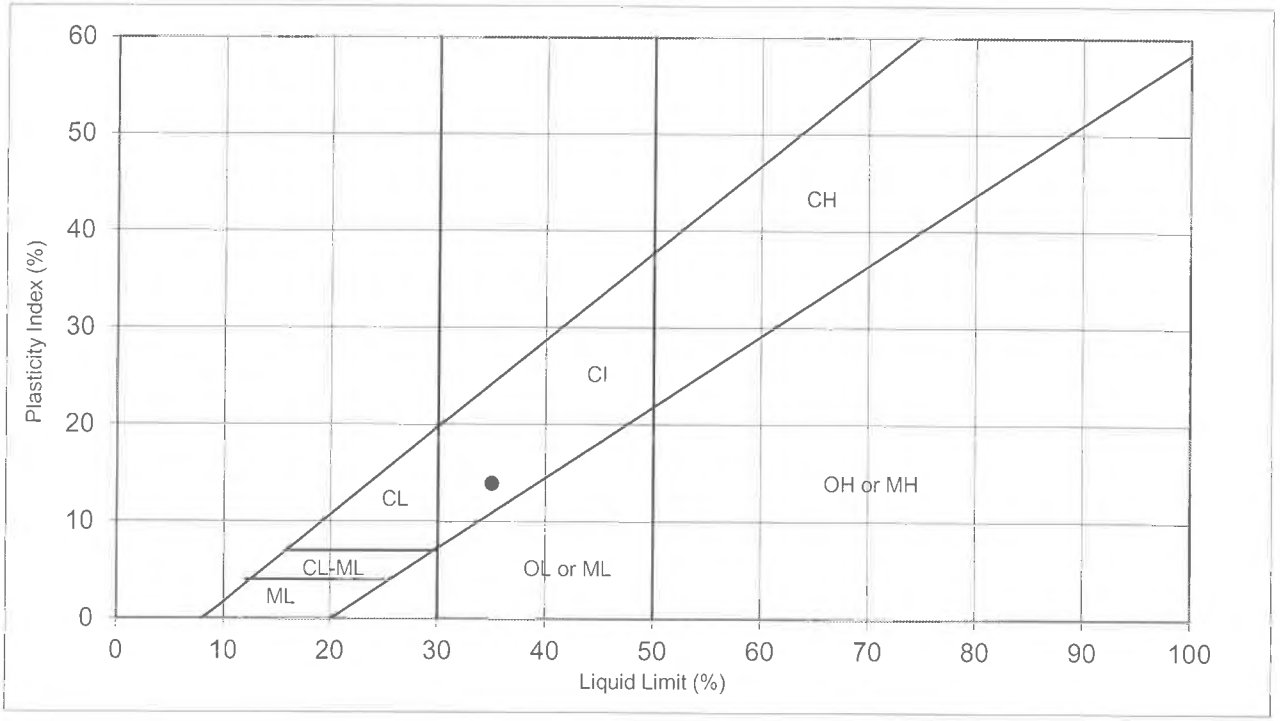
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	42	30	24	18
Container No.	1	2	3	4
Wet Soil + Container	17.57	17.51	16.57	16.33
Dry Soil + Container	13.23	13.08	12.3	12.04
Wt. Of Container	0	0	0	0
Moisture Content	32.8	33.9	34.7	35.6



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	30.27	30.96		
Dry Soil + Container	28.25	28.81		
Wt. Of Container	18.81	18.82		
Moisture Content	21.4	21.5		**21.5**



REMARKS

Liquid Limit:	**35**
Plastic Limit:	**21**
Plasticity Index:	**14**
USC Classification:	**CI**

THURBER

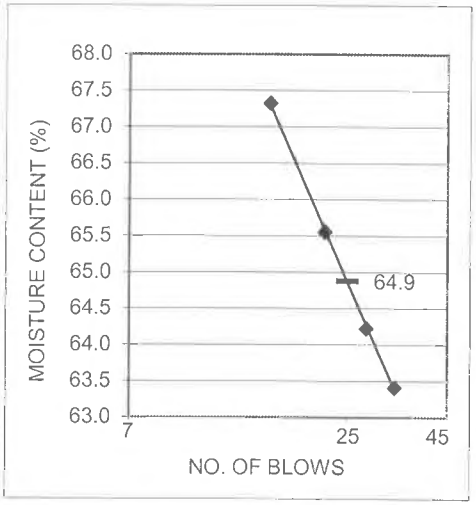
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-10
Sample No: G2
Depth: 1.0 ft.

Date Tested: 14-Jul-21
Tested By: JAP
Checked By:

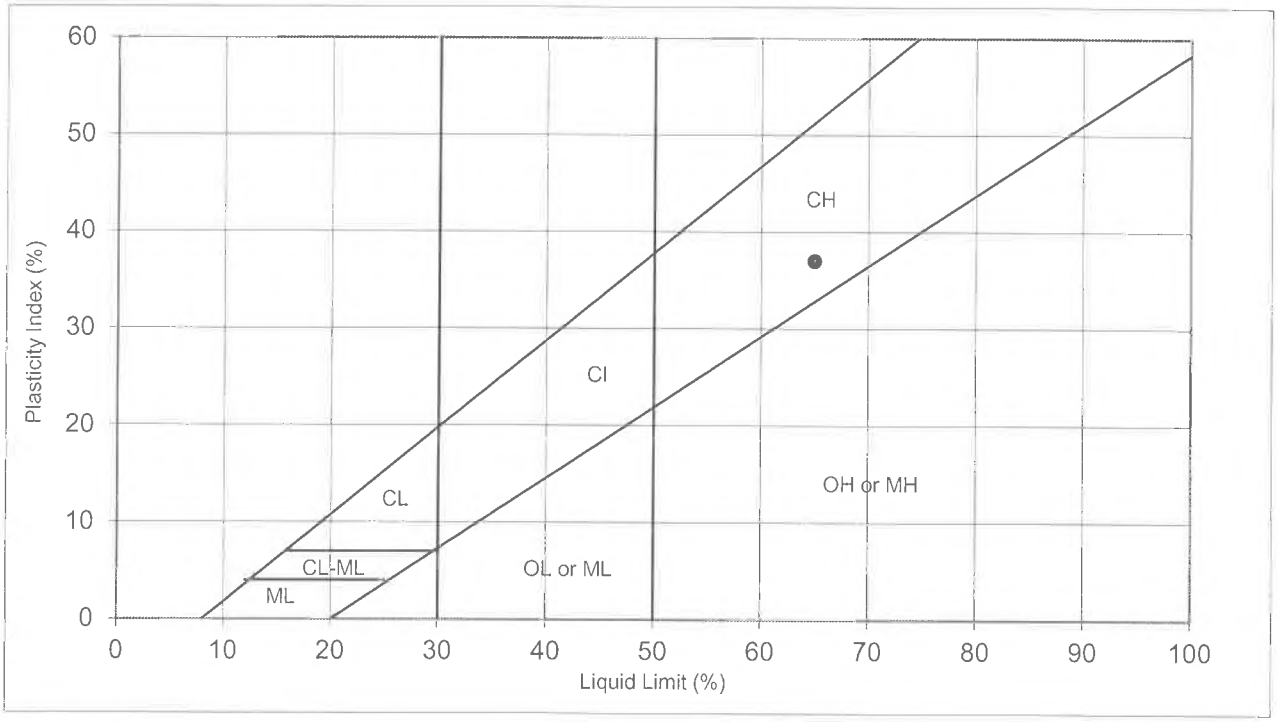
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	33	28	22	16
Container No.	1	2	3	4
Wet Soil + Container	15.23	15.93	12.88	12.75
Dry Soil + Container	9.32	9.70	7.78	7.62
Wt. Of Container	0	0	0	0
Moisture Content	63.4	64.2	65.6	67.3



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	29.23	28.09		
Dry Soil + Container	27.02	26.10		
Wt. Of Container	19.05	18.89		
Moisture Content	27.7	27.6		27.7



REMARKS

Liquid Limit:	**65**
Plastic Limit:	**28**
Plasticity Index:	**37**
USC Classification:	**CH**

THURBER

ATTERBERG LIMITS

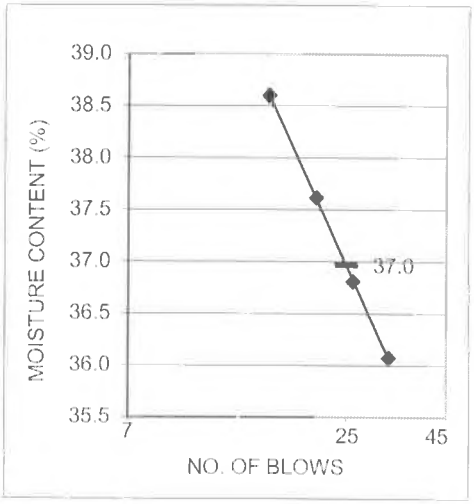
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-8
Sample No: G4
Depth: 5.0 ft.

Date Tested: 14-Jul-21
Tested By: NM
Checked By:

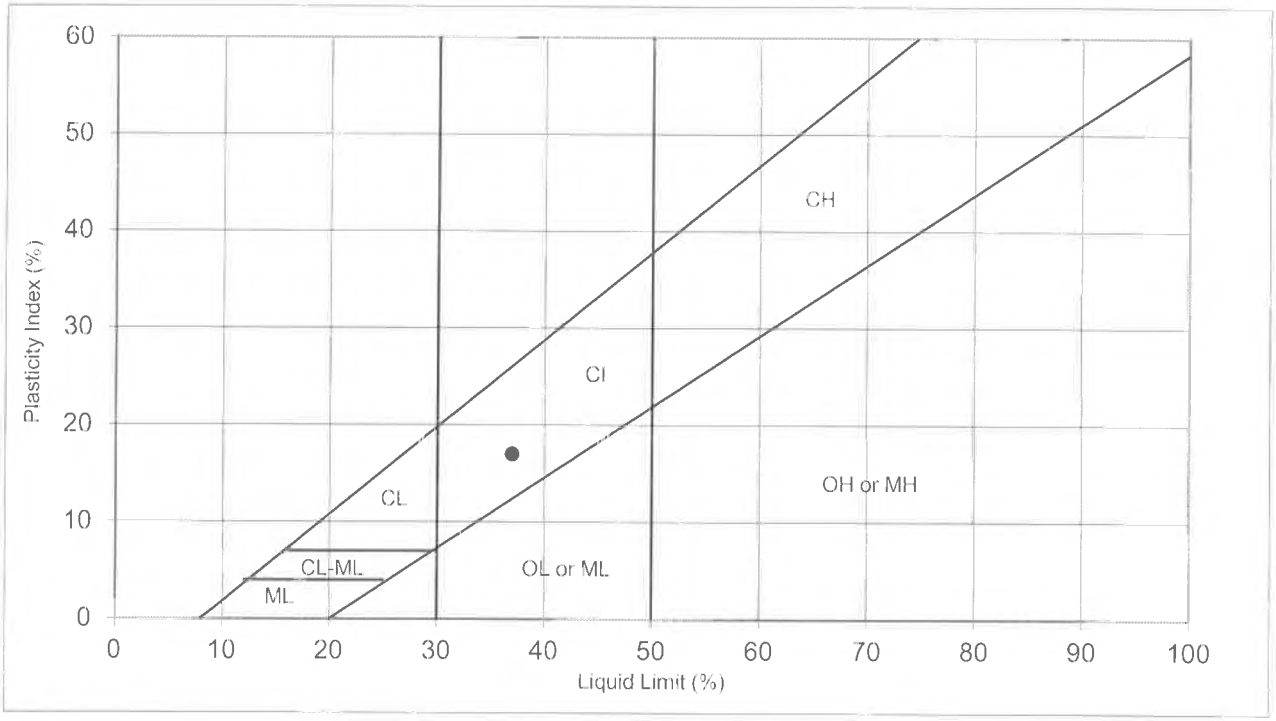
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	32	26	21	16
Container No.	1	2	3	4
Wet Soil + Container	13.24	12.60	13.28	13.43
Dry Soil + Container	9.73	9.21	9.65	9.69
Wt. Of Container	0	0	0	0
Moisture Content	36.1	36.8	37.6	38.6



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.32	28.31		
Dry Soil + Container	26.75	26.74		
Wt. Of Container	18.81	18.83		
Moisture Content	19.8	19.8		**19.8**



REMARKS

Liquid Limit:	**37**
Plastic Limit:	**20**
Plasticity Index:	**17**
USC Classification:	**CI**

THURBER

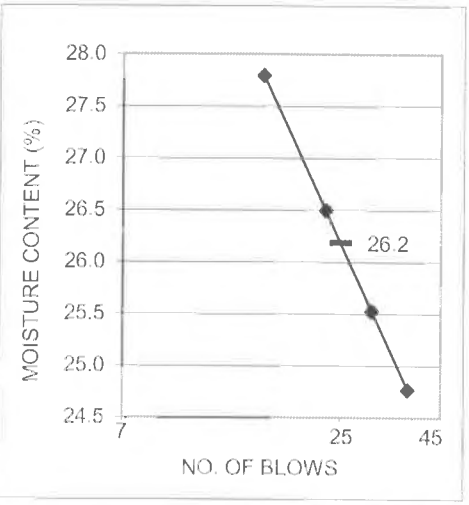
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-13
Sample No: G6
Depth: 10.0 ft.

Date Tested: 14-Jul-21
Tested By: NM
Checked By:

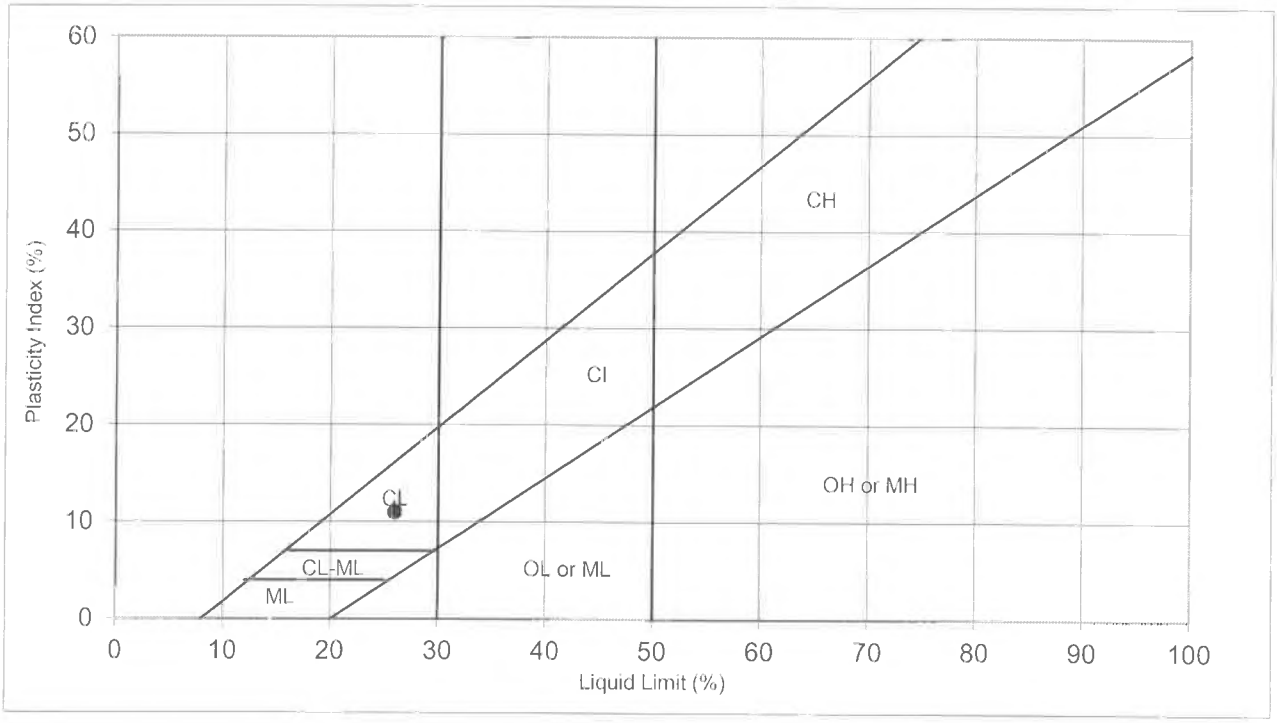
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	37	30	23	16
Container No.	1	2	3	4
Wet Soil + Container	12.29	13.03	12.84	14.16
Dry Soil + Container	9.85	10.38	10.15	11.08
Wt. Of Container	0	0	0	0
Moisture Content	24.8	25.5	26.5	27.8



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.35	28.66		
Dry Soil + Container	27.12	27.40		
Wt. Of Container	18.9	18.97		
Moisture Content	15.0	14.9		15.0



REMARKS

Liquid Limit:	**26**
Plastic Limit:	**15**
Plasticity Index:	**11**
USC Classification:	**CL**

THURBER

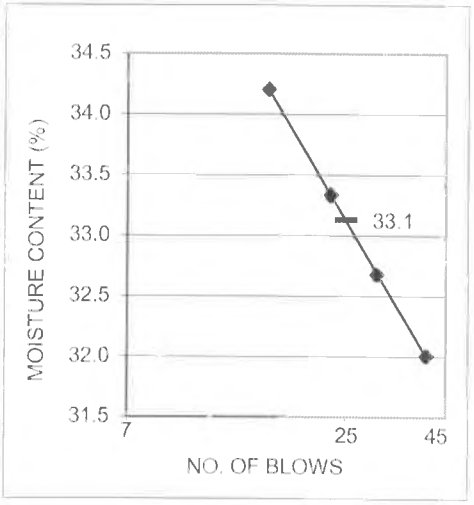
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-13
Sample No: G10
Depth: 20.0 ft.

Date Tested: 14-Jul-21
Tested By: NM
Checked By:

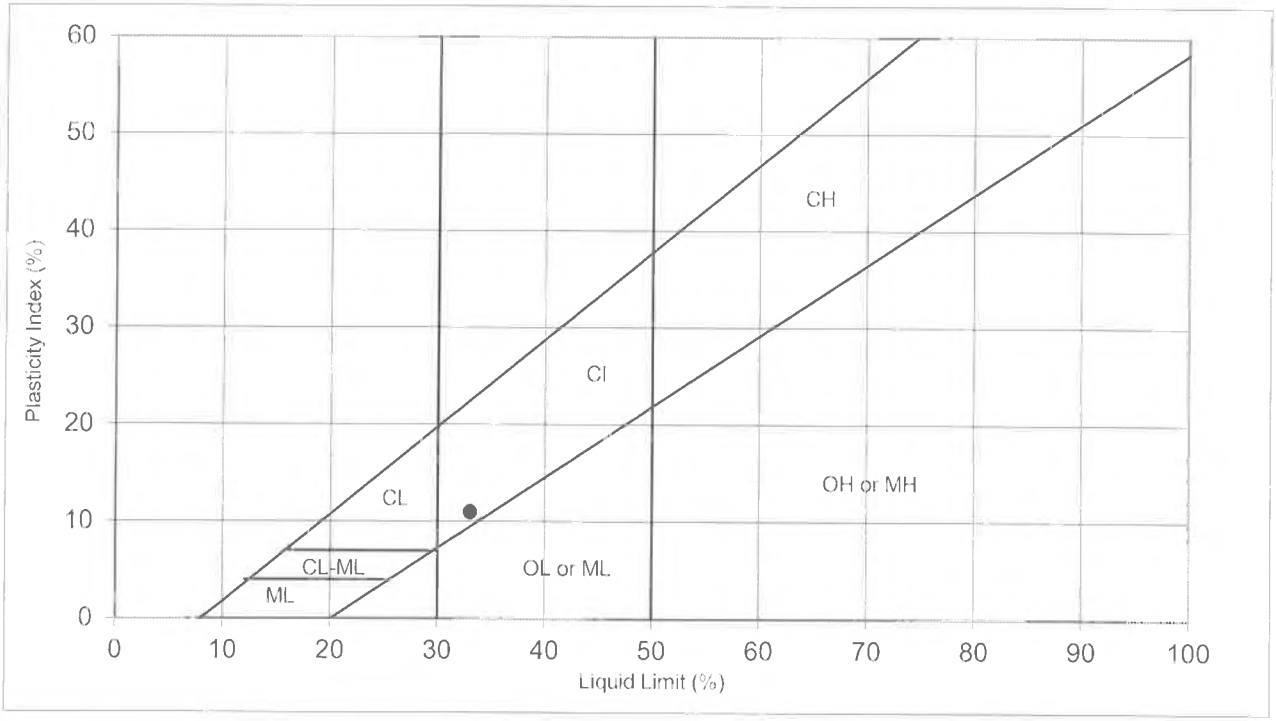
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	40	30	23	16
Container No.	1	2	3	4
Wet Soil + Container	15.55	14.82	14.32	14.44
Dry Soil + Container	11.78	11.17	10.74	10.76
Wt. Of Container	0	0	0	0
Moisture Content	32.0	32.7	33.3	34.2



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	29.07	28.15		
Dry Soil + Container	27.2	26.48		
Wt. Of Container	18.75	18.9		
Moisture Content	22.1	22.0		**22.1**



REMARKS

Liquid Limit:	**33**
Plastic Limit:	**22**
Plasticity Index:	**11**
USC Classification:	**CI**

THURBER

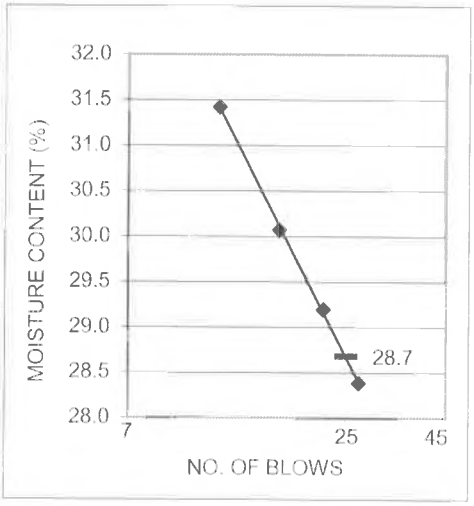
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-14
Sample No: G11
Depth: 20.0 ft.

Date Tested: 14-Jul-21
Tested By: NM
Checked By:

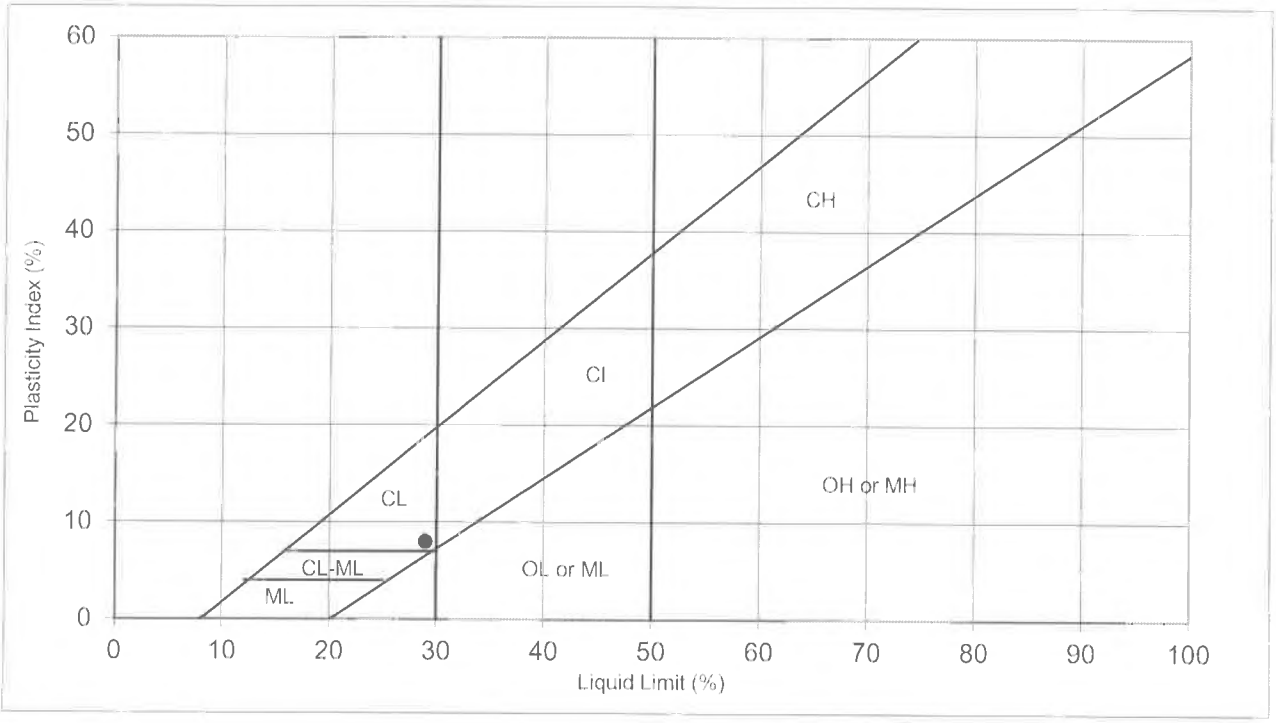
LIQUID LIMIT

Trial No.	1	2	3	4
No of Blows:	27	22	17	12
Container No.	1	2	3	4
Wet Soil + Container	14.43	15.18	13.67	12.34
Dry Soil + Container	11.24	11.75	10.51	9.39
Wt. Of Container	0	0	0	0
Moisture Content	28.4	29.2	30.1	31.4



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.41	28.64		
Dry Soil + Container	26.72	26.90		
Wt. Of Container	18.82	18.8		
Moisture Content	21.4	21.5		**21.4**



REMARKS

Liquid Limit:	**29**
Plastic Limit:	**21**
Plasticity Index:	**8**
USC Classification:	**CL**

THURBER

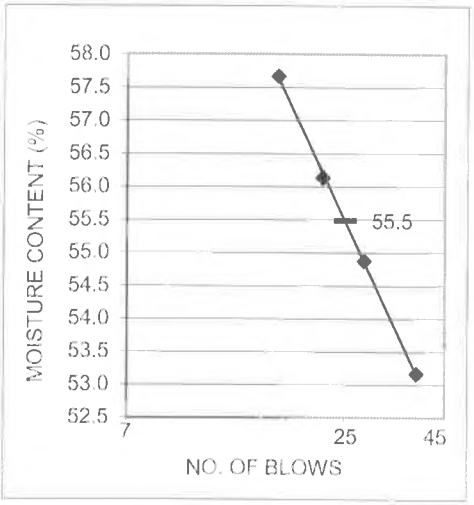
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-15
Sample No: G2
Depth: 1.0 ft.

Date Tested: 14-Jul-21
Tested By: NM
Checked By:

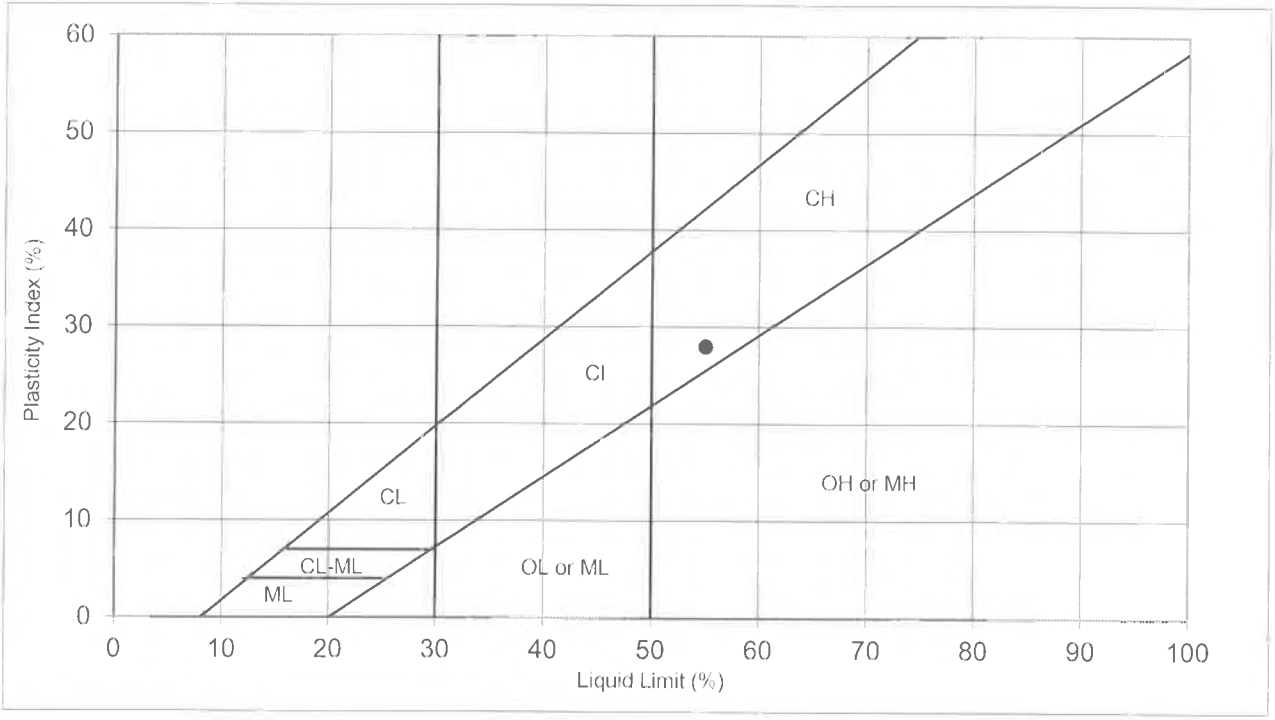
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	38	28	22	17
Container No.	1	2	3	4
Wet Soil + Container	13.05	13.01	12.21	13.26
Dry Soil + Container	8.52	8.40	7.82	8.41
Wt. Of Container	0	0	0	0
Moisture Content	53.2	54.9	56.1	57.7



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.06	28		
Dry Soil + Container	26.07	26.04		
Wt. Of Container	18.79	18.87		
Moisture Content	27.3	27.3		**27.3**



REMARKS

Liquid Limit:	**55**
Plastic Limit:	**27**
Plasticity Index:	**28**
USC Classification:	**CH**

THURBER

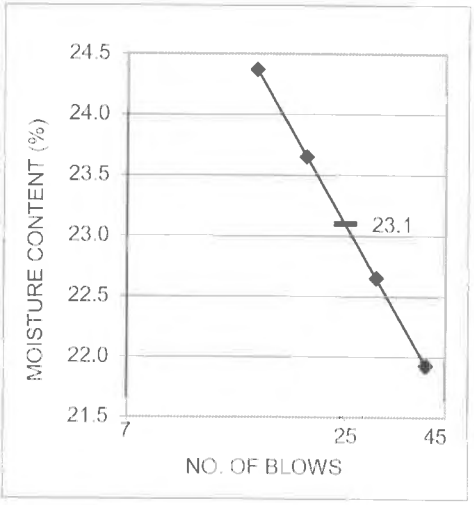
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-15
Sample No: P8
Depth: 12.5 - 14.0 ft.

Date Tested: 14-Jul-21
Tested By: NM
Checked By:

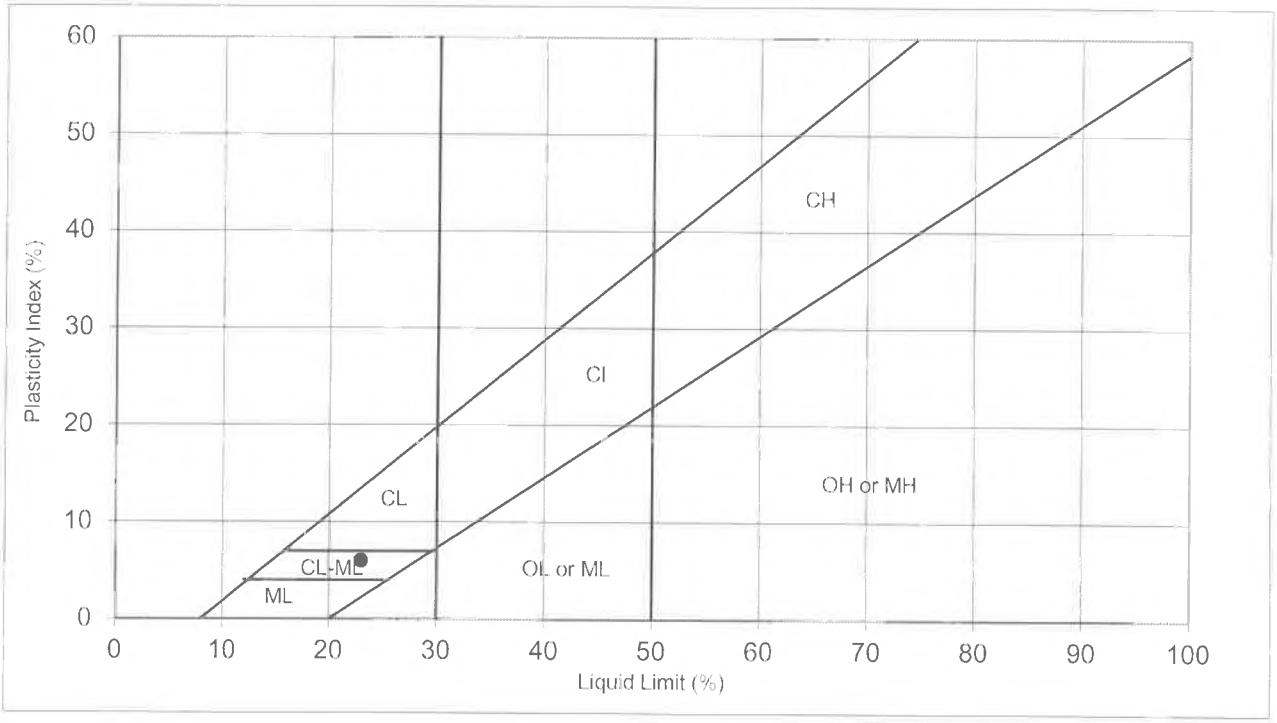
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	40	30	20	15
Container No.	1	2	3	4
Wet Soil + Container	13.79	16.57	16.26	16.23
Dry Soil + Container	11.31	13.51	13.15	13.05
Wt. Of Container	0	0	0	0
Moisture Content	21.9	22.6	23.7	24.4



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.6	28.49		
Dry Soil + Container	27.17	27.06		
Wt. Of Container	18.94	18.8		
Moisture Content	17.4	17.3		17.3



REMARKS

Liquid Limit:	**23**
Plastic Limit:	**17**
Plasticity Index:	**6**
USC Classification:	**CL-ML**

THURBER

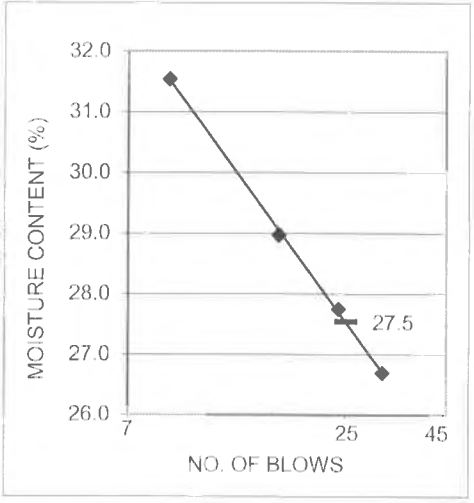
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-22
Sample No: G10
Depth: 20.0 ft.

Date Tested: 15-Jul-21
Tested By: LLK
Checked By:

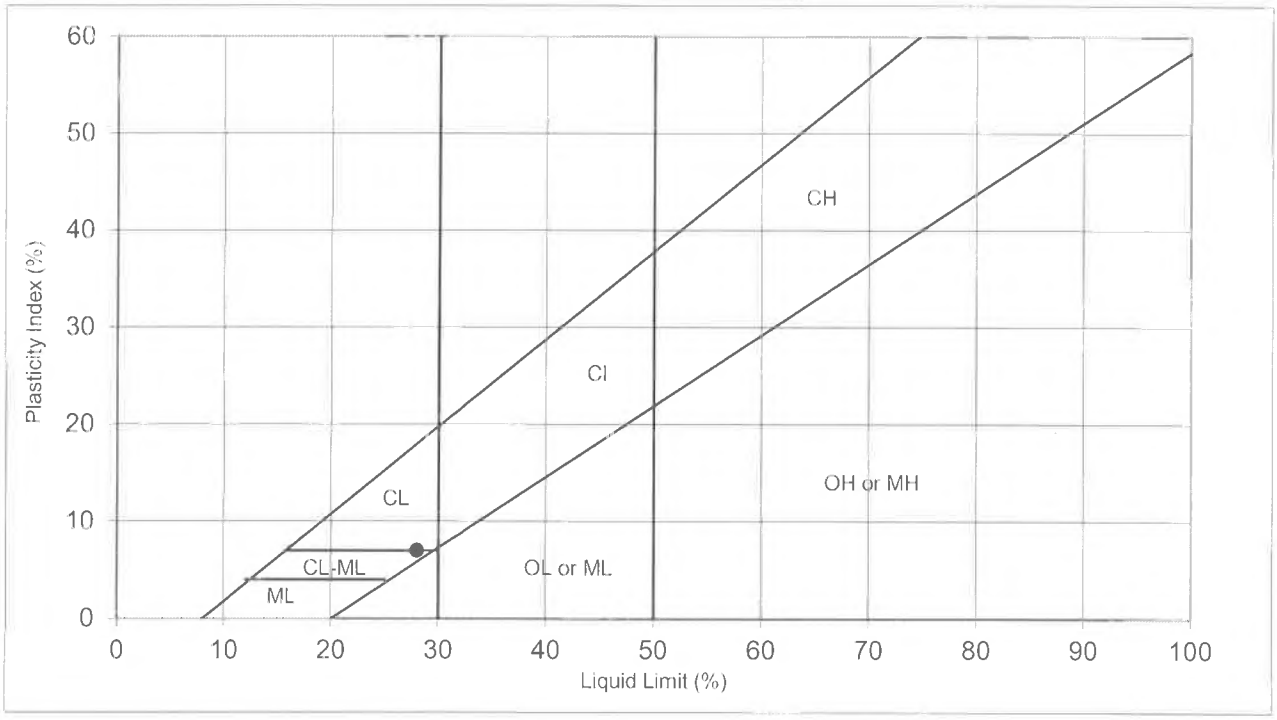
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	31	24	17	9
Container No.	1	2	3	4
Wet Soil + Container	21.55	19.66	25.02	24.69
Dry Soil + Container	17.01	15.39	19.4	18.77
Wt. Of Container	0	0	0	0
Moisture Content	26.7	27.7	29.0	31.5



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	27.22	27.45		
Dry Soil + Container	25.75	25.93		
Wt. Of Container	18.9	18.87		
Moisture Content	21.5	21.5		**21.5**



REMARKS

Liquid Limit:	**28**
Plastic Limit:	**21**
Plasticity Index:	**7**
USC Classification:	**CL-ML**

THURBER

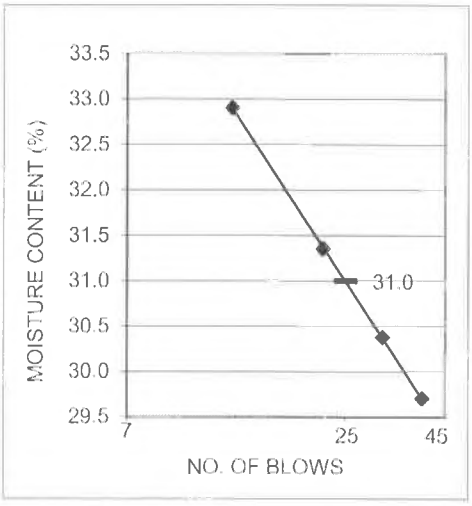
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-26
Sample No: P3
Depth: 2.5 - 4.0 ft.

Date Tested: 15-Jul-21
Tested By: LLK
Checked By:

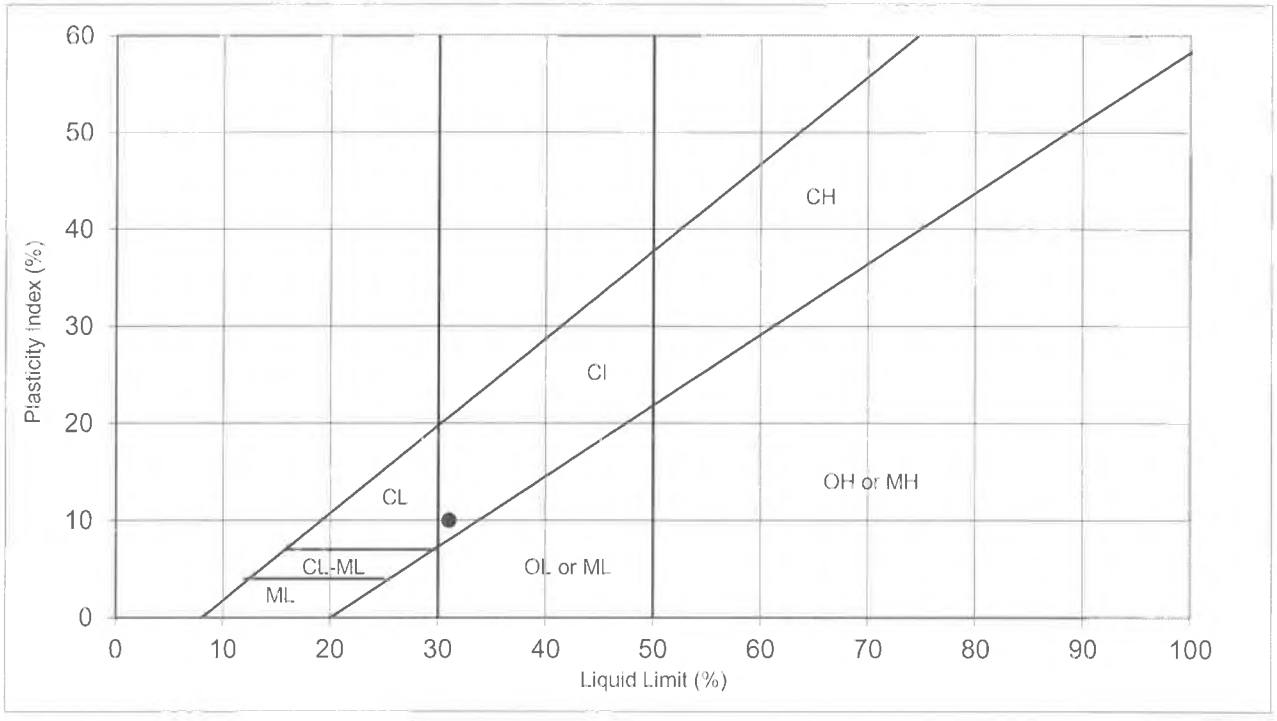
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	39	31	22	13
Container No.	1	2	3	4
Wet Soil + Container	23.14	25.49	21.45	27.02
Dry Soil + Container	17.84	19.55	16.33	20.33
Wt. Of Container	0	0	0	0
Moisture Content	29.7	30.4	31.4	32.9



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	28.11	28.46		
Dry Soil + Container	26.51	26.82		
Wt. Of Container	18.81	18.87		
Moisture Content	20.8	20.6		**20.7**



REMARKS

Liquid Limit:	**31**
Plastic Limit:	**21**
Plasticity Index:	**10**
USC Classification:	**CI**

THURBER

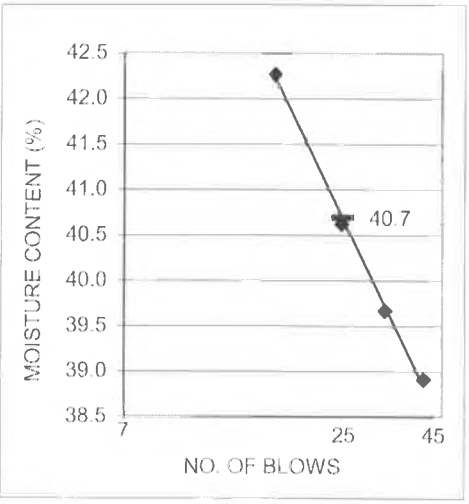
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-27
Sample No: G2
Depth: 1.0 ft.

Date Tested: 15-Jul-21
Tested By: LLK
Checked By:

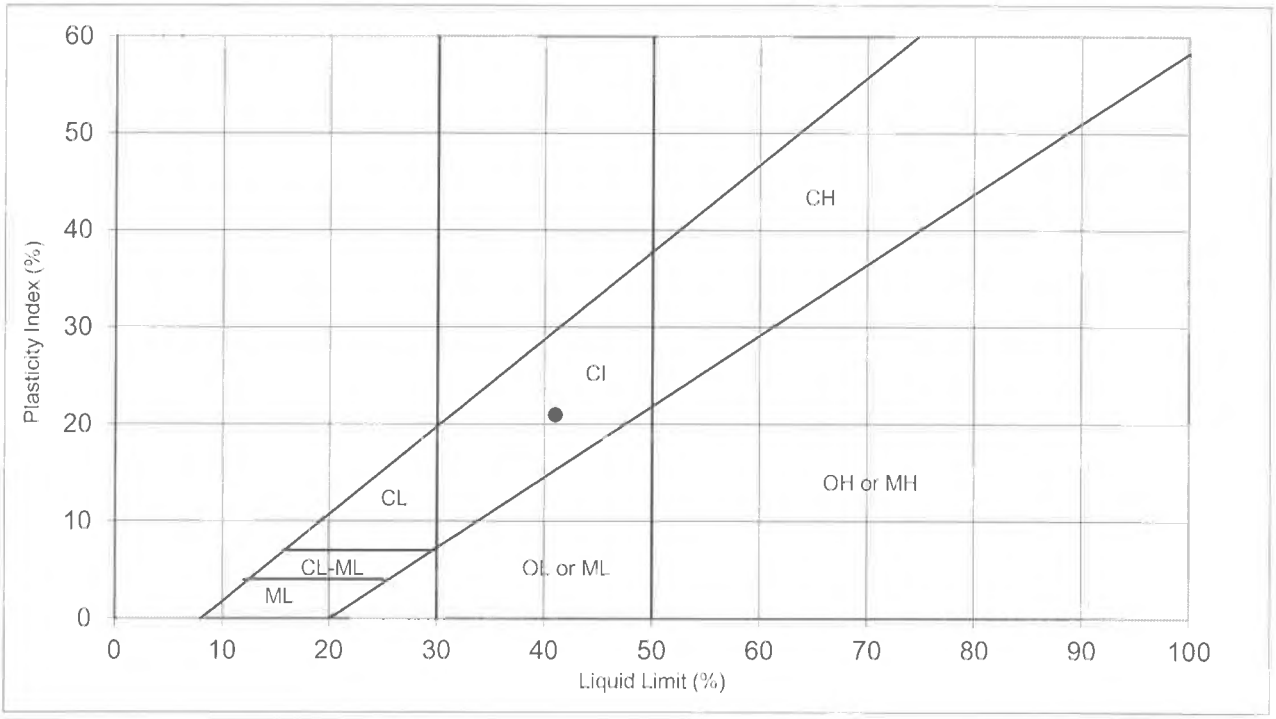
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	40	32	25	17
Container No.	1	2	3	4
Wet Soil + Container	19.35	23.45	20.32	25.11
Dry Soil + Container	13.93	16.79	14.45	17.65
Wt. Of Container	0	0	0	0
Moisture Content	38.9	39.7	40.6	42.3



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	30.69	30.2		
Dry Soil + Container	28.74	28.37		
Wt. Of Container	18.8	19.02		
Moisture Content	19.6	19.6		**19.6**



REMARKS

Liquid Limit:	**41**
Plastic Limit:	**20**
Plasticity Index:	**21**
USC Classification:	**CI**

THURBER

ATTERBERG LIMITS

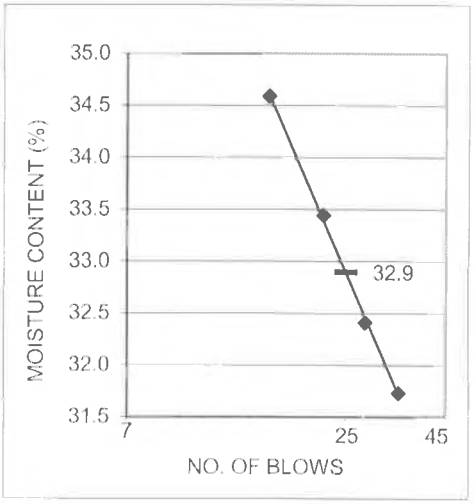
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-37
Sample No: G4
Depth: 5.0 ft.

Date Tested: 15-Jul-21
Tested By: LLK
Checked By:

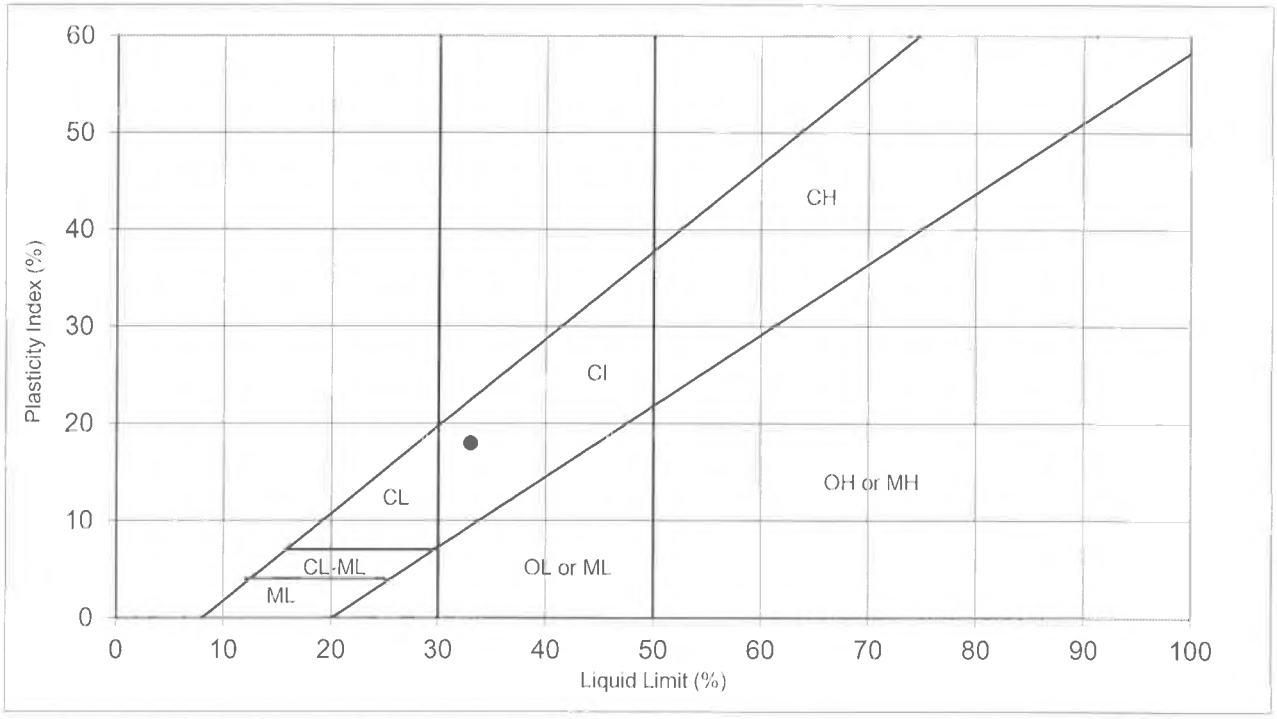
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	34	28	22	16
Container No.	1	2	3	4
Wet Soil + Container	23.29	23.49	20.47	24.28
Dry Soil + Container	17.68	17.74	15.34	18.04
Wt. Of Container	0	0	0	0
Moisture Content	31.7	32.4	33.4	34.6



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	29.24	29.63		
Dry Soil + Container	27.86	28.23		
Wt. Of Container	18.76	18.93		
Moisture Content	15.2	15.1		**15.1**



REMARKS

Liquid Limit:	**33**
Plastic Limit:	**15**
Plasticity Index:	**18**
USC Classification:	**CI**

THURBER

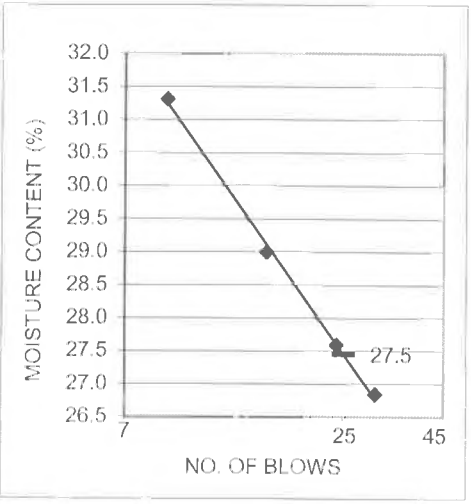
ATTERBERG LIMITS
ASTM D4318

Client: City of Edmonton
Project: Hawrelak Park Rehabilitation
Project No: 31566
Test Hole: TH21-59
Sample No: G10
Depth: 20.0 ft.

Date Tested: 15-Jul-21
Tested By: LLK
Checked By:

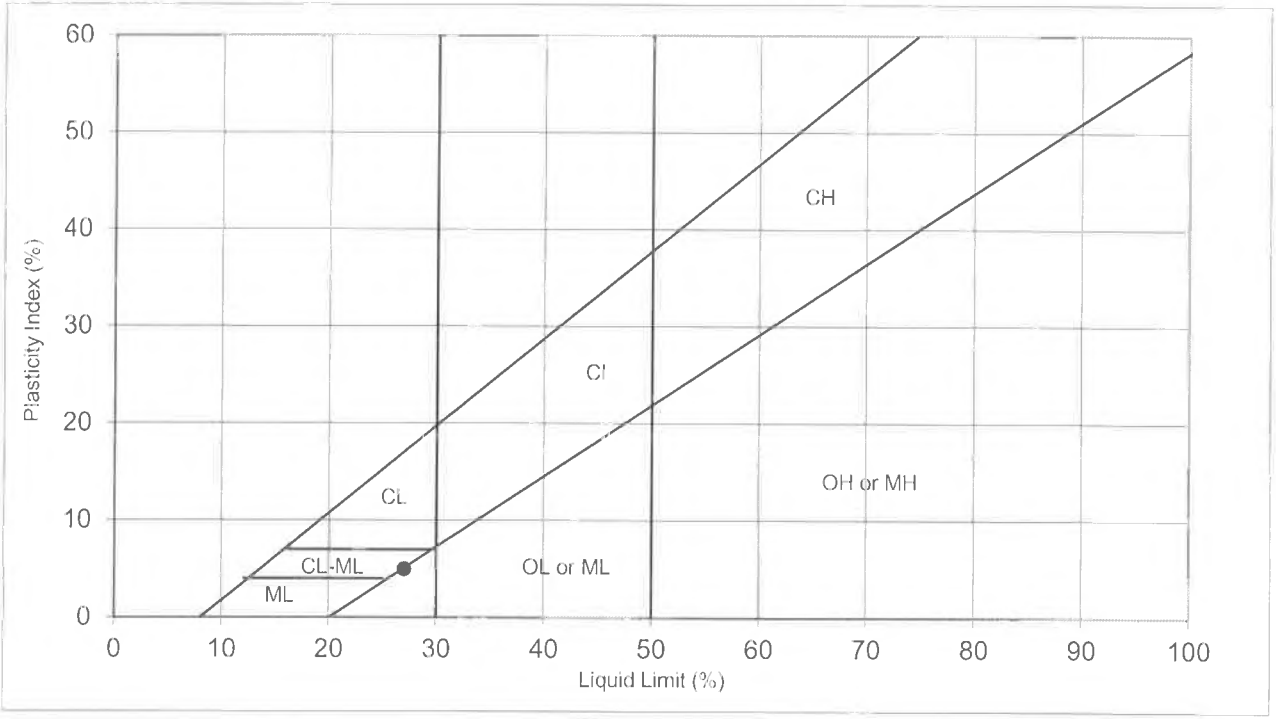
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	30	24	16	9
Container No.	1	2	3	4
Wet Soil + Container	21.69	19.33	21	25.21
Dry Soil + Container	17.1	15.15	16.28	19.2
Wt. Of Container	0	0	0	0
Moisture Content	26.8	27.6	29.0	31.3



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	5	6		
Wet Soil + Container	30.54	30.4		
Dry Soil + Container	28.46	28.35		
Wt. Of Container	18.89	18.81		
Moisture Content	21.7	21.5		**21.6**



REMARKS

Liquid Limit:	**27**
Plastic Limit:	**22**
Plasticity Index:	**5**
USC Classification:	**ML**

SIEVE ANALYSIS REPORT

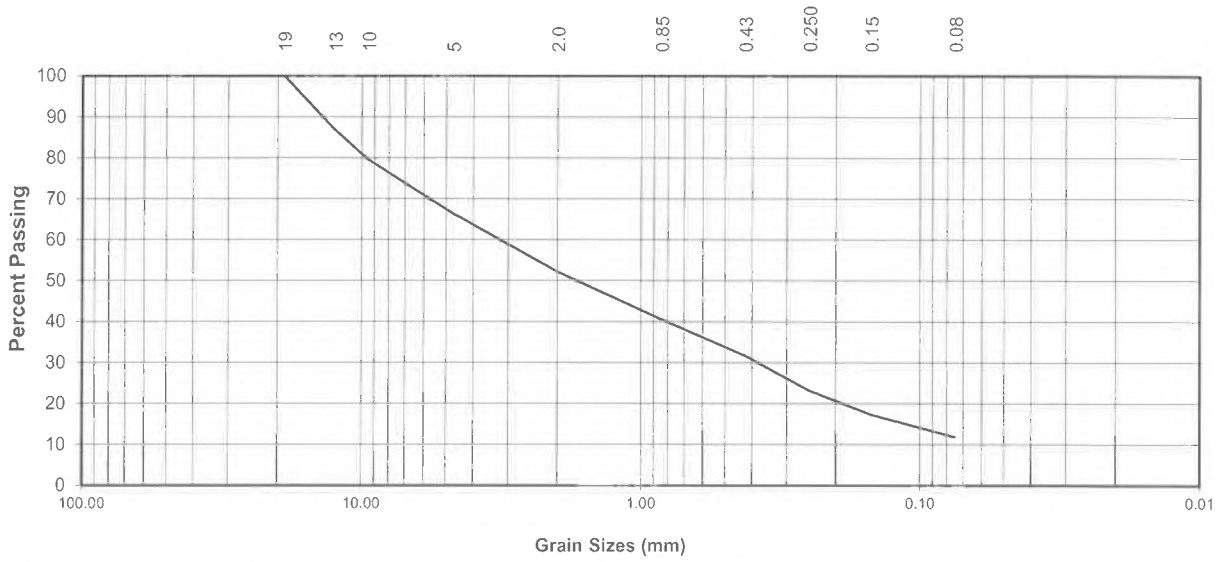
THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton **Project No.:** 31566

Project: Hawrelak Park Rehabilitation **Date:** 15-Jul-21

Sample Source: TH21-5 G1 @ 6"
Material Type:
Specification:
Unified Class:

Date Tested: 15-Jul-21
Sampled by: n/a
Date Sampled: n/a
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
3/4 ins	19	100.0		
1/2 ins	12.5	86.8		
3/8 ins	9.5	79.6		
#4	4.75	66.4		
#10	2	52.2		
#20	0.85	40.6		
#40	0.425	31.7		
#60	0.25	23.2		
#100	0.15	17.3		
#200	0.075	11.8		

Total Sample Proportions	
Gravel:	33.6 %
Sand:	54.6 %
Fines:	11.8 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 6.1%

Percent Crush: -
Faces Counted:

Computer File : TH21-5 G1
Series No.: n/a

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

SIEVE ANALYSIS REPORT

Client: City of Edmonton

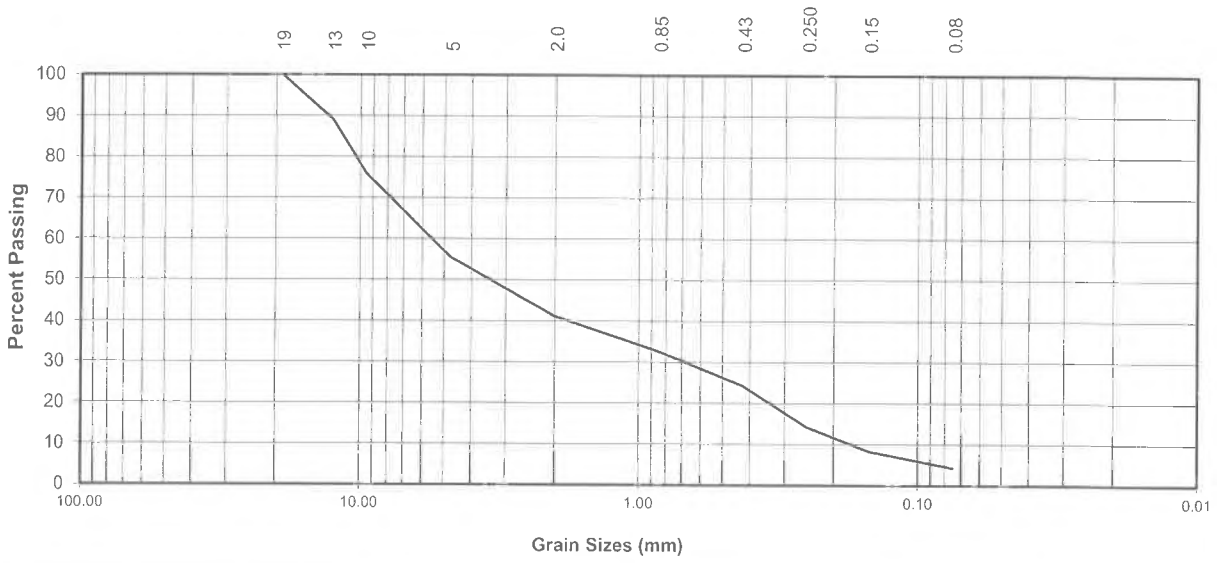
Project: Hawrelak Park Rehabilitation

Project No.: 31566

Date: 15-Jul-21

Sample Source: TH21-8 G1 @ 6"
Material Type:
Specification:
Unified Class:

Date Tested: 15-Jul-21
Sampled by: n/a
Date Sampled: n/a
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
3/4 ins	19	100.0		
1/2 ins	12.5	89.1		
3/8 ins	9.5	75.9		
#4	4.75	55.5		
#10	2	41.2		
#20	0.85	32.6		
#40	0.425	24.3		
#60	0.25	14.2		
#100	0.15	8.3		
#200	0.075	4.4		

Total Sample Proportions	
Gravel:	44.5 %
Sand:	51.1 %
Fines:	4.4 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 4.1%

Percent Crush: -
Faces Counted:

Computer File : TH21-8 G1
Series No.: n/a

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

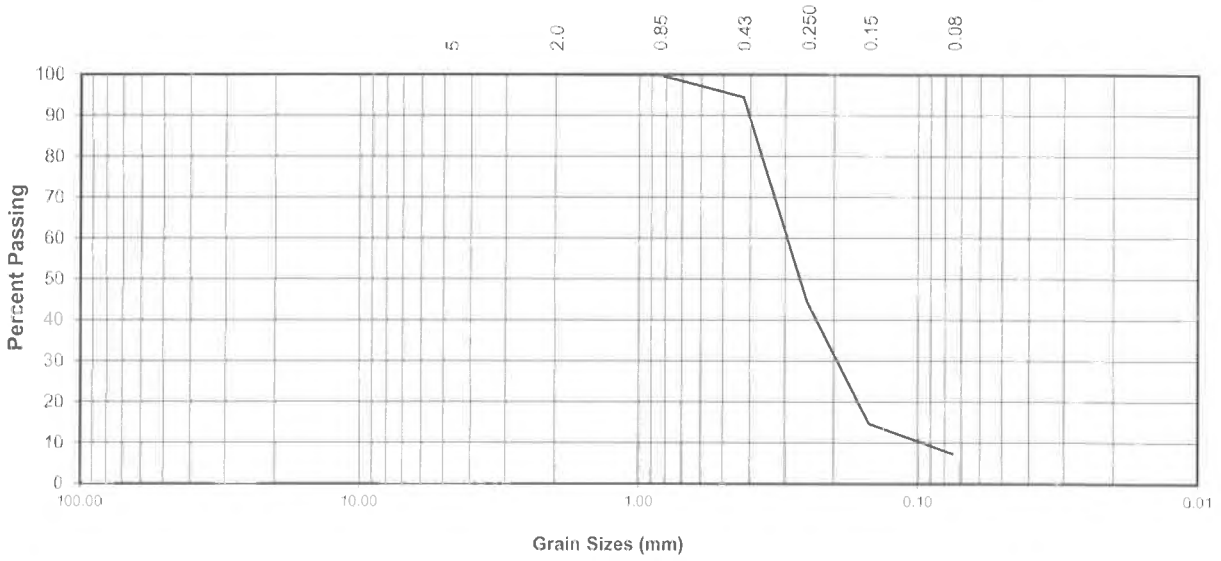
THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton **Project No.:** 31566

Project: Hawrelak Park Rehabilitation **Date:** 16-Jul-21

Sample Source: TH21-10 G10 @ 20.0 ft.
Material Type:
Specification:
Unified Class:

Date Tested: 14-Jul-21
Sampled by: N/A
Date Sampled: N/A
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
#4	4.75	100.0		
#10	2	99.9		
#20	0.85	99.9		
#40	0.425	94.6		
#60	0.25	44.5		
#100	0.15	14.8		
#200	0.075	7.4		

Total Sample Proportions	
Gravel:	0.0 %
Sand:	92.6 %
Fines:	7.4 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 4.9%

Percent Crush: -
Faces Counted:

Computer File : TH21-10 G10
Series No.: N/A

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

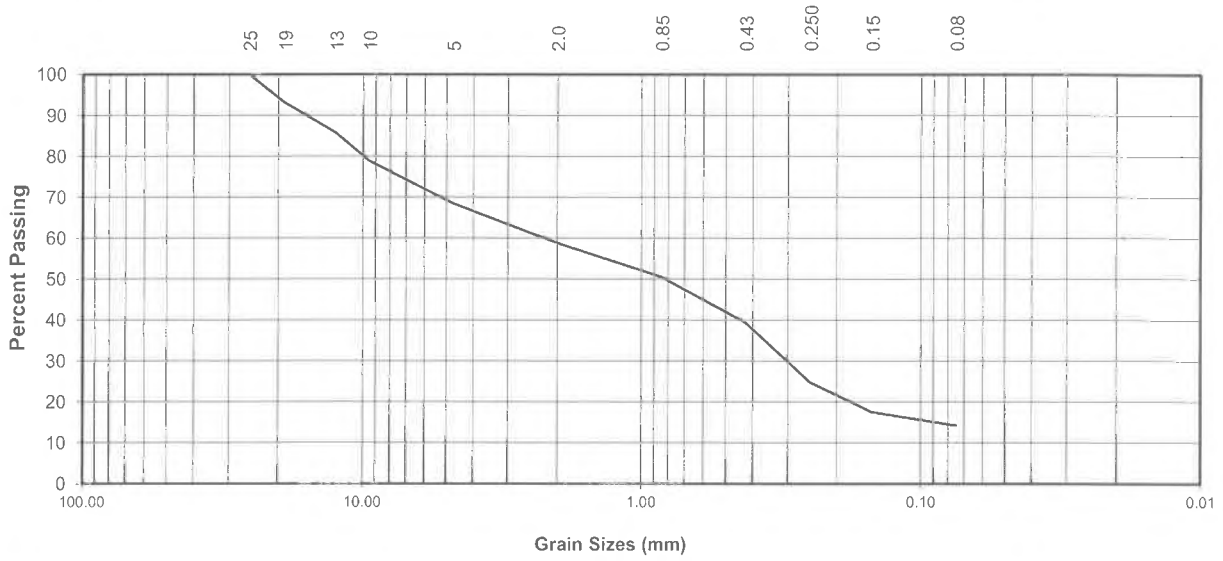
THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton **Project No.:** 31566

Project: Hawrelak Park Rehabilitation **Date:** 16-Jul-21

Sample Source: TH21-13 P9 @ 17.5 - 19.0 ft
Material Type:
Specification:
Unified Class:

Date Tested: 14-Jul-21
Sampled by: N/A
Date Sampled: N/A
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
1.0 ins	25.4	100.0		
3/4 ins	19	93.1		
1/2 ins	12.5	85.8		
3/8 ins	9.5	79.0		
#4	4.75	68.6		
#10	2	59.0		
#20	0.85	50.7		
#40	0.425	39.5		
#60	0.25	24.9		
#100	0.15	17.7		
#200	0.075	14.4		

Total Sample Proportions	
Gravel:	31.4 %
Sand:	54.2 %
Fines:	14.4 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 5.7%

Percent Crush: -
Faces Counted:

Computer File : TH21-13 P9
Series No.: N/A

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton

Project No.: 31566

Project: Hawrelak Park Rehabilitation

Date: 16-Jul-21

Sample Source: TH21-20 P5 @ 7.5 - 9.0 ft

Material Type:

Specification:

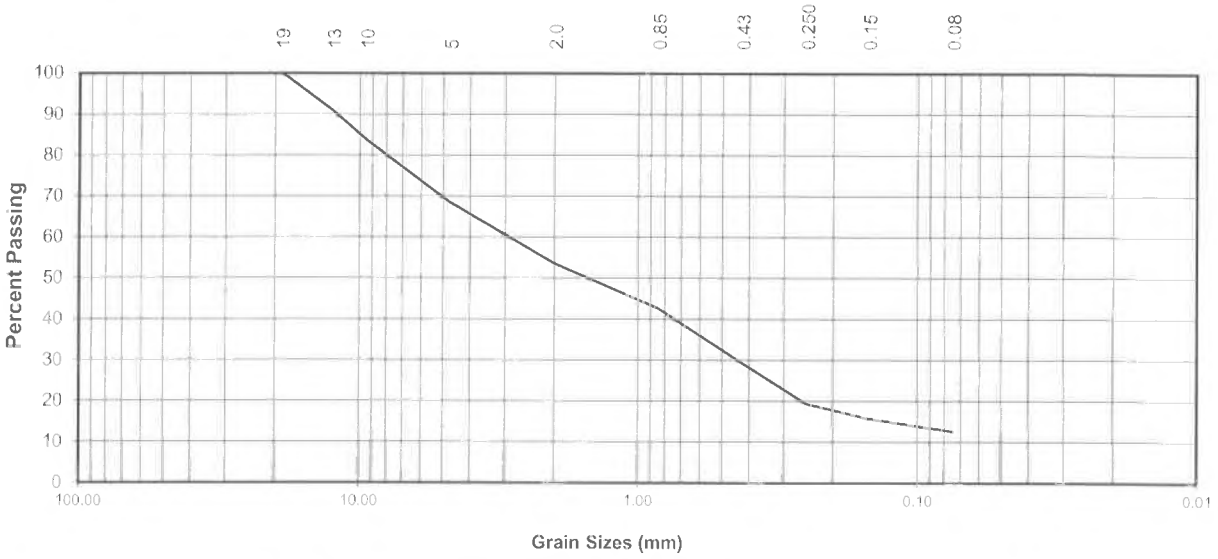
Unified Class:

Date Tested: 14-Jul-21

Sampled by: N/A

Date Sampled: N/A

Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
3/4 ins	19	100.0		
1/2 ins	12.5	90.8		
3/8 ins	9.5	83.7		
#4	4.75	68.3		
#10	2	53.4		
#20	0.85	42.6		
#40	0.425	29.2		
#60	0.25	19.3		
#100	0.15	15.6		
#200	0.075	12.6		

Total Sample Proportions	
Gravel:	31.7 %
Sand:	55.7 %
Fines:	12.6 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 4.8%

Percent Crush: -
Faces Counted:

Computer File : TH21-20 P5
Series No.: N/A

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton

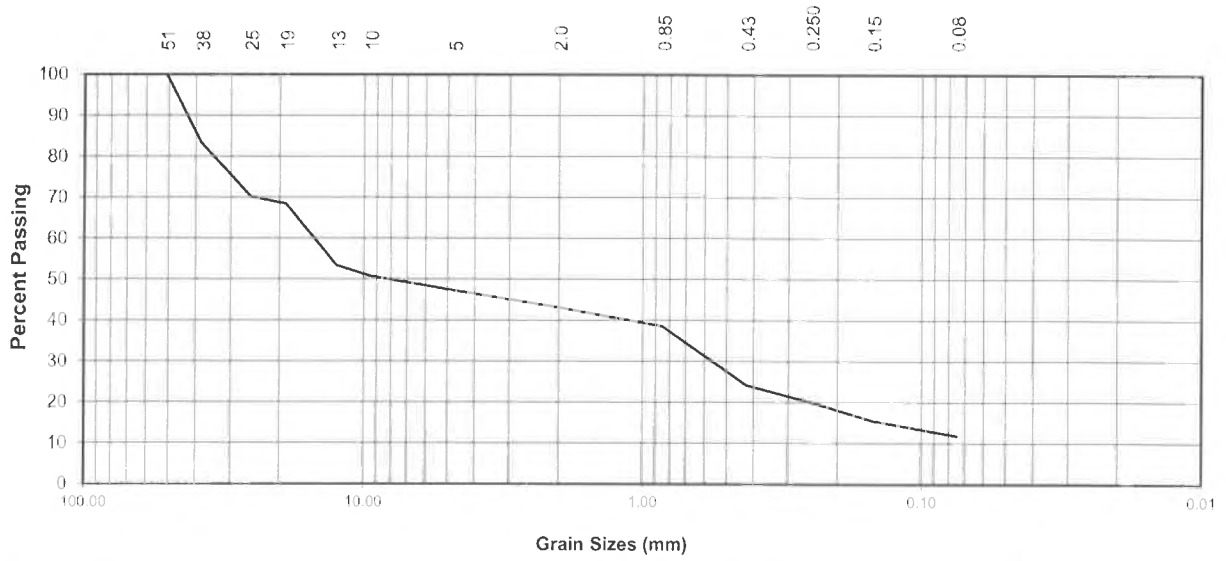
Project: Hawrelak Park Rehabilitation

Project No.: 31566

Date: 16-Jul-21

Sample Source: TH21-32 G5 @ 6.0 ft
Material Type:
Specification:
Unified Class:

Date Tested: 14-Jul-21
Sampled by: N/A
Date Sampled: N/A
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
2.0 ins	50.8	100.0		
1.5 ins	38.1	83.2		
1.0 ins	25.4	70.1		
3/4 ins	19	68.4		
1/2 ins	12.5	53.4		
3/8 ins	9.5	50.8		
#4	4.75	47.3		
#10	2	43.1		
#20	0.85	38.6		
#40	0.425	24.2		
#60	0.25	20.1		
#100	0.15	15.5		
#200	0.075	11.8		

Total Sample Proportions	
Gravel:	52.7 %
Sand:	35.5 %
Fines:	11.8 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 5.8%

Percent Crush: -
Faces Counted:

Computer File : TH21-32 G5
Series No.: N/A

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

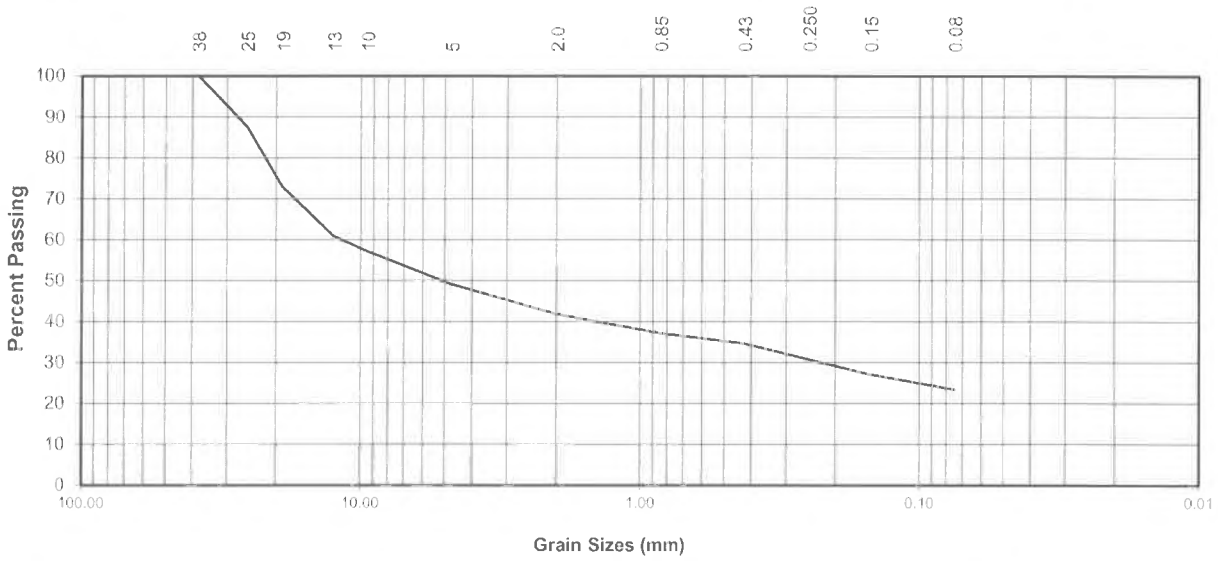
THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton **Project No.:** 31566

Project: Hawrelak Park Rehabilitation **Date:** 16-Jul-21

Sample Source: TH21-39 G5 @ 5.0 ft
Material Type:
Specification:
Unified Class:

Date Tested: 14-Jul-21
Sampled by: N/A
Date Sampled: N/A
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
1.5 ins	38.1	100.0		
1.0 ins	25.4	87.5		
3/4 ins	19	72.8		
1/2 ins	12.5	60.8		
3/8 ins	9.5	57.1		
#4	4.75	49.0		
#10	2	41.8		
#20	0.85	37.1		
#40	0.425	34.5		
#60	0.25	30.7		
#100	0.15	27.0		
#200	0.075	23.3		

Total Sample Proportions	
Gravel:	51.0 %
Sand:	25.7 %
Fines:	23.3 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 8.9%

Percent Crush: -
Faces Counted:

Computer File : TH21-39 G5
Series No.: N/A

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton

Project: Hawrelak Park Rehabilitation

Project No.: 31566

Date: 16-Jul-21

Sample Source: TH21-52 P5 @ 7.5 - 9.0 ft
Material Type:
Specification:
Unified Class:

Date Tested: 14-Jul-21
Sampled by: N/A
Date Sampled: N/A
Test Method: ASTM C 136

Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
1.5 ins	38.1	100.0		
1.0 ins	25.4	88.0		
3/4 ins	19	80.1		
1/2 ins	12.5	68.7		
3/8 ins	9.5	64.8		
#4	4.75	54.4		
#10	2	46.6		
#20	0.85	38.4		
#40	0.425	23.4		
#60	0.25	16.8		
#100	0.15	12.7		
#200	0.075	9.1		

Total Sample Proportions	
Gravel:	45.6 %
Sand:	45.3 %
Fines:	9.1 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 12.4%

Percent Crush: -
Faces Counted:

Computer File : TH21-52 P5
Series No.: N/A

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton

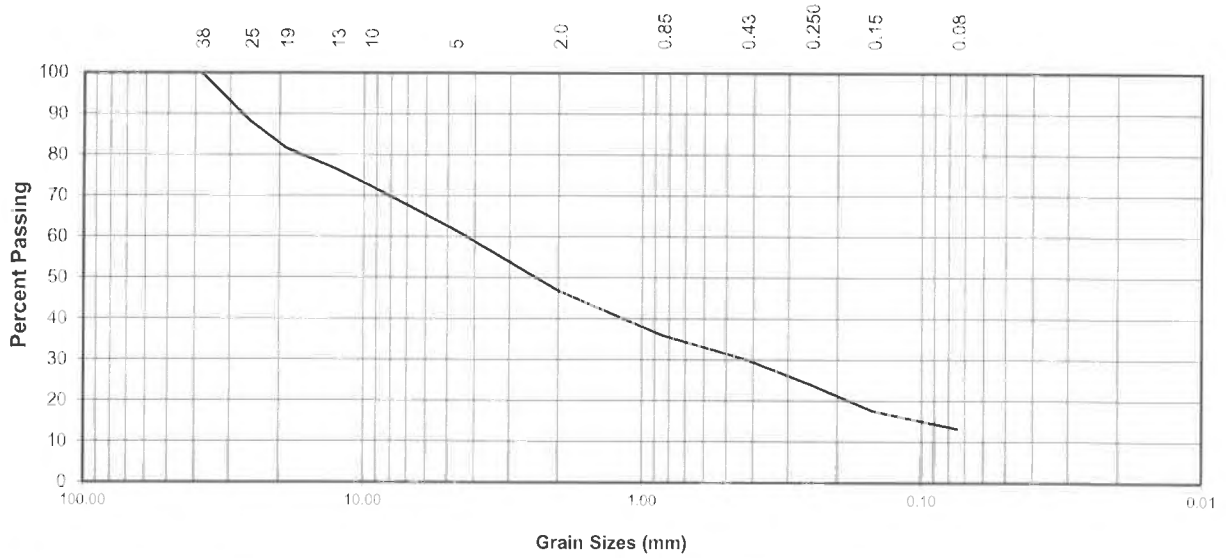
Project: Hawrelak Park Rehabilitation

Project No.: 31566

Date: 16-Jul-21

Sample Source: TH21-55 P11 @ 22.5 - 24.0 ft
Material Type:
Specification:
Unified Class:

Date Tested: 15-Jul-21
Sampled by: n/a
Date Sampled: n/a
Test Method: ASTM C 136



Sieve No	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
1.5 ins	38.1	100.0		
1.0 ins	25.4	88.0		
3/4 ins	19	81.5		
1/2 ins	12.5	76.3		
3/8 ins	9.5	72.4		
#4	4.75	61.7		
#10	2	46.7		
#20	0.85	35.9		
#40	0.425	30.0		
#60	0.25	24.0		
#100	0.15	17.5		
#200	0.075	13.2		

Total Sample Proportions	
Gravel:	38.3 %
Sand:	48.5 %
Fines:	13.2 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 13.3%

Percent Crush: -
Faces Counted:

Computer File : TH21-55 P11
Series No.: n/a

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

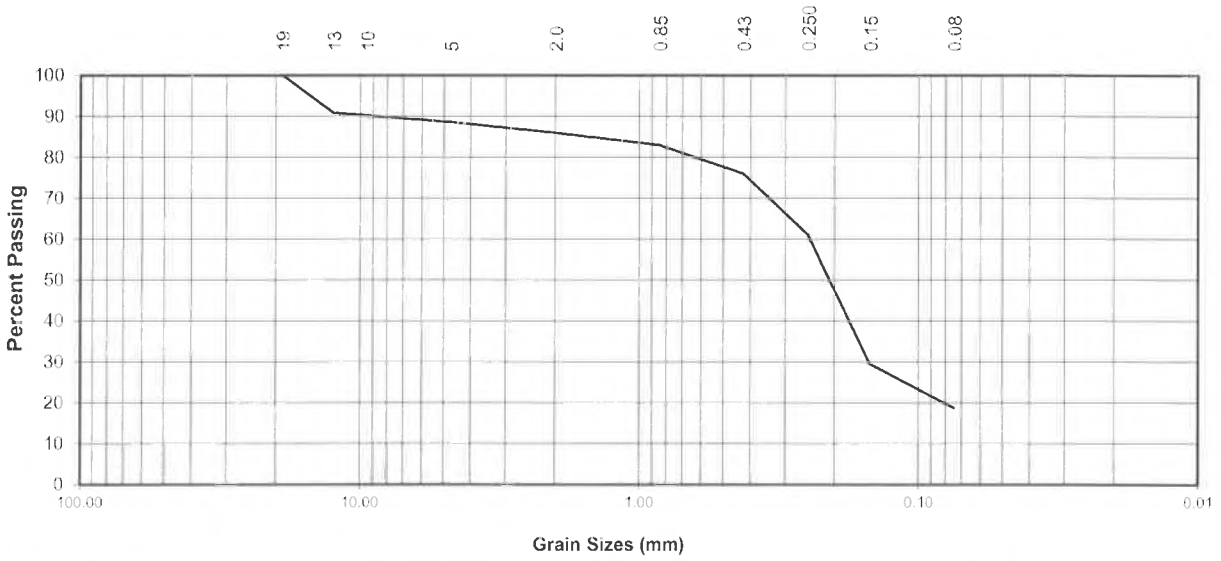
SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton **Project No.:** 31566

Project: Hawrelak Park Rehabilitation **Date:** 16-Jul-21

Sample Source: TH21-61 G6 @ 10.0 ft **Date Tested:** 15-Jul-21
Material Type: **Sampled by:** n/a
Specification: **Date Sampled:** n/a
Unified Class: **Test Method:** ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
3/4 ins	19	100.0		
1/2 ins	12.5	90.7		
3/8 ins	9.5	90.1		
#4	4.75	88.5		
#10	2	85.9		
#20	0.85	82.9		
#40	0.425	75.9		
#60	0.25	61.1		
#100	0.15	29.5		
#200	0.075	18.7		

Total Sample Proportions	
Gravel:	11.5 %
Sand:	69.8 %
Fines:	18.7 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 23.4%

Percent Crush: -
Faces Counted:

Computer File : TH21-61 G6
Series No.: n/a

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton

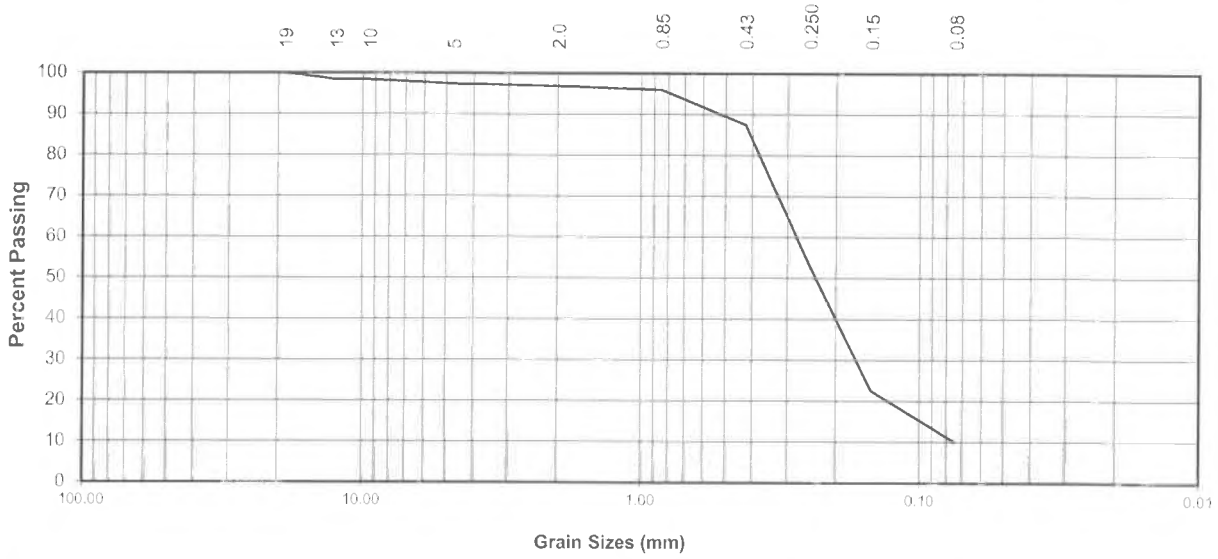
Project: Hawrelak Park Rehabilitation

Project No.: 31566

Date: 16-Jul-21

Sample Source: TH21-65 G8 @ 15.0 ft
Material Type:
Specification:
Unified Class:

Date Tested: 15-Jul-21
Sampled by: n/a
Date Sampled: n/a
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
3/4 ins	19	100.0		
1/2 ins	12.5	98.3		
3/8 ins	9.5	98.3		
#4	4.75	97.3		
#10	2	96.7		
#20	0.85	95.9		
#40	0.425	87.3		
#60	0.25	53.1		
#100	0.15	22.5		
#200	0.075	10.0		

Total Sample Proportions	
Gravel:	2.7 %
Sand:	87.3 %
Fines:	10.0 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 6.7%

Percent Crush: -
Faces Counted:

Computer File : TH21-65 G8
Series No.: n/a

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

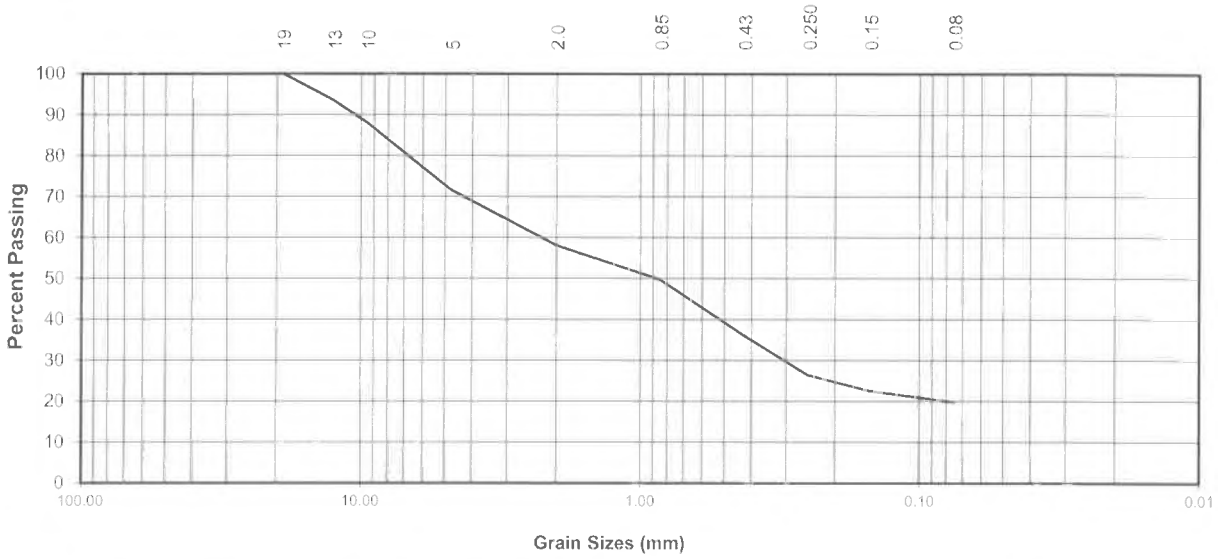
SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton **Project No.:** 31566

Project: Hawrelak Park Rehabilitation **Date:** 16-Jul-21

Sample Source: TH21-66 G5 @ 5.0 ft **Date Tested:** 15-Jul-21
Material Type: **Sampled by:** n/a
Specification: **Date Sampled:** n/a
Unified Class: **Test Method:** ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
3/4 ins	19	100.0		
1/2 ins	12.5	93.4		
3/8 ins	9.5	88.0		
#4	4.75	71.5		
#10	2	58.1		
#20	0.85	49.8		
#40	0.425	36.0		
#60	0.25	26.4		
#100	0.15	22.5		
#200	0.075	19.8		

Total Sample Proportions	
Gravel:	28.5 %
Sand:	51.7 %
Fines:	19.8 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 7.3%

Percent Crush: -
Faces Counted:

Computer File : TH21-66 G5
Series No.: n/a

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

SIEVE ANALYSIS REPORT

THURBER ENGINEERING LTD.
4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

Client: City of Edmonton

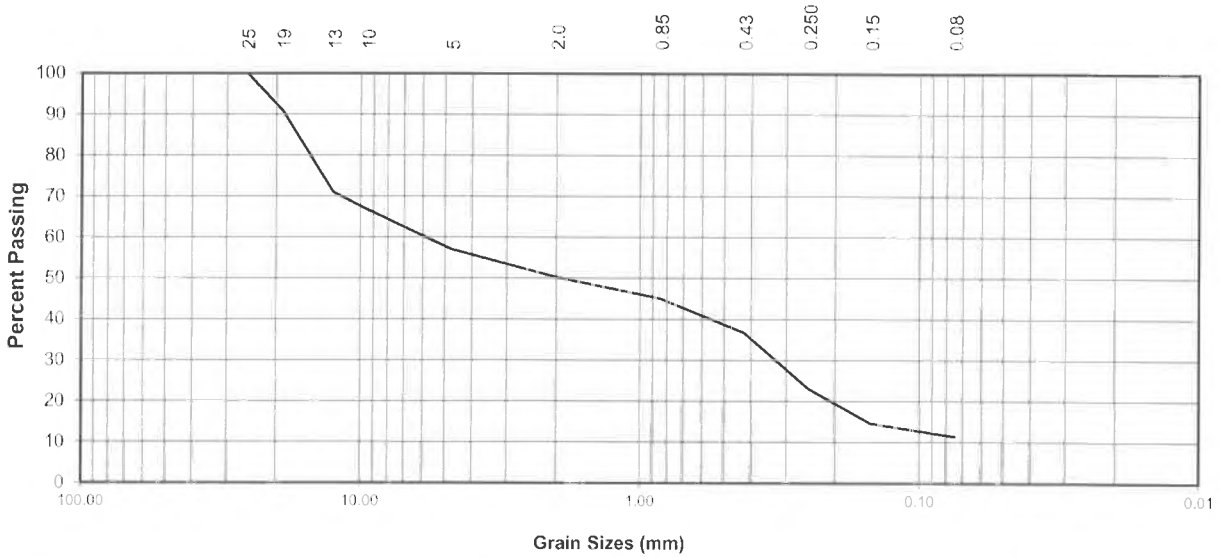
Project: Hawrelak Park Rehabilitation

Project No.: 31566

Date: 16-Jul-21

Sample Source: TH21-72 G6 @ 10.0 ft
Material Type:
Specification:
Unified Class:

Date Tested: 15-Jul-21
Sampled by: n/a
Date Sampled: n/a
Test Method: ASTM C 136



Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	Gradation Limits Min
1.0 ins	25.4	100.0		
3/4 ins	19	90.8		
1/2 ins	12.5	70.9		
3/8 ins	9.5	66.8		
#4	4.75	57.0		
#10	2	50.3		
#20	0.85	45.1		
#40	0.425	36.7		
#60	0.25	23.1		
#100	0.15	14.7		
#200	0.075	11.4		

Total Sample Proportions	
Gravel:	43.0 %
Sand:	45.6 %
Fines:	11.4 %

Silt and Clay	
Silt	-
Clay	-
Total Fines:	

Moisture Content
As Received: 15.6%

Percent Crush: -
Faces Counted:

Computer File : TH21-72 G6
Series No. : n/a

Comments:

Checked By:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

THURBER ENGINEERING LTD.

THURBER ENGINEERING LTD.
UNCONFINED COMPRESSION TEST REPORT

City of Edmonton
FILE NUMBER : 31566

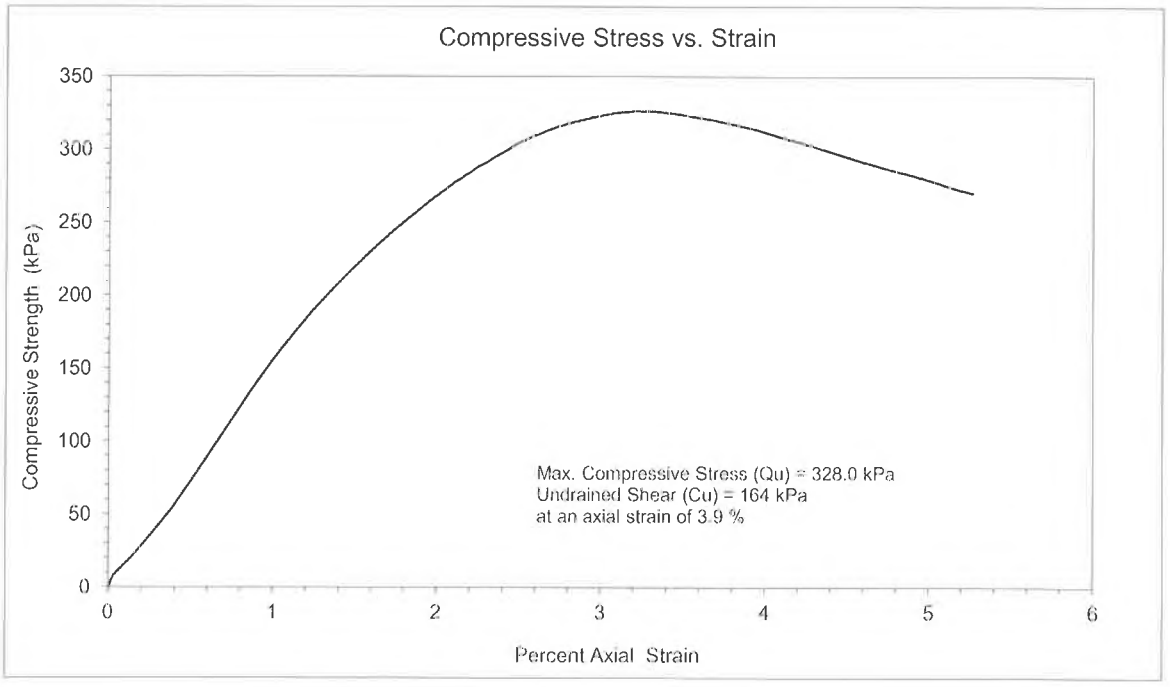
REPORT DATE: July 19/21
REPORT NUMBER: UC21-1

Hawrelak Park Rehabilitation Geo Inv

TEST DATE: July 16/21
SAMPLE: TH21-14 S5 @ 2.29 - 2.75m
DESCRIPTION: Clay (CL), some organics, trace rootlets, black

SPECIMEN DETAILS:

Wet Density (kg/m^3):	1862
Dry Density (kg/m^3):	1530
Moisture Content (%):	21.7
Liquid Limit (%):	-
Plastic Limit (%):	-
Plasticity Index (%):	-
Gravel (%):	-
Sand (%):	-
Silt (%):	-
Clay (%):	



THURBER ENGINEERING LTD.

THURBER ENGINEERING LTD.
UNCONFINED COMPRESSION TEST REPORT

City of Edmonton
FILE NUMBER : 31566

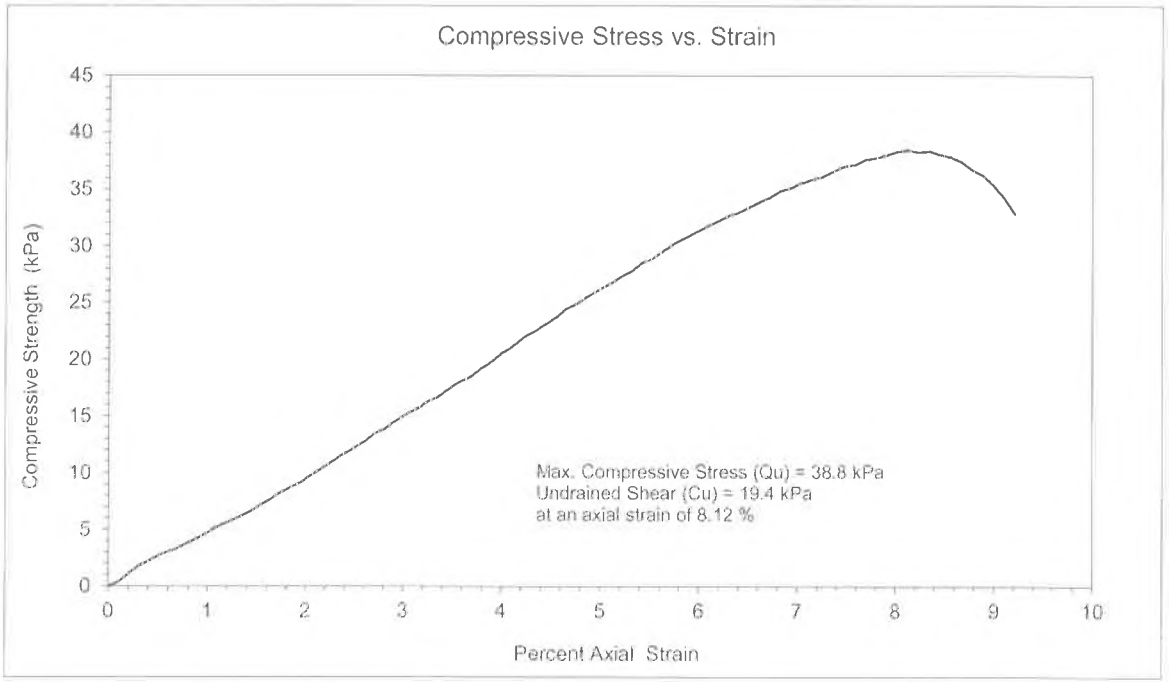
REPORT DATE: July 19/20
REPORT NUMBER: UC21-2

Hawrelak Park Rehabilitation Geo Inv

TEST DATE: July 16/21
SAMPLE: TH21-28 S5 @ 2.29 - 2.75m
DESCRIPTION: Clay (CL), silty, some sand, trace sand lenses, trace oxides, trace coal, CH pockets

SPECIMEN DETAILS:

Wet Density (kg/m^3):	1867
Dry Density (kg/m^3):	1435
Moisture Content (%):	30.1
Liquid Limit (%):	-
Plastic Limit (%):	-
Plasticity Index (%):	-
Gravel (%):	-
Sand (%):	-
Silt (%):	-
Clay (%):	



THURBER ENGINEERING LTD.

THURBER ENGINEERING LTD.
UNCONFINED COMPRESSION TEST REPORT

City of Edmonton
FILE NUMBER : 31566

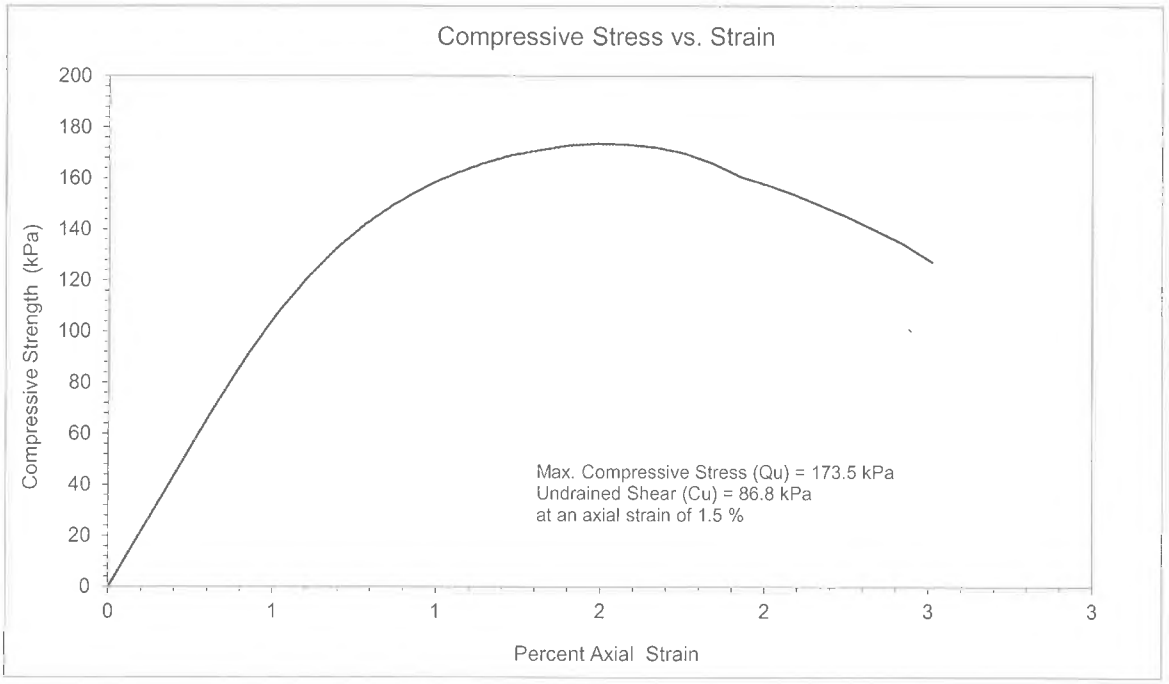
REPORT DATE: July 19/21
REPORT NUMBER: UC21-3

Hawrelak Park Rehabilitation Geo Inv

TEST DATE: July 16/21
SAMPLE: TH21-30 S5 @ 2.29 - 2.75m
DESCRIPTION: Clay (CH), Silty, trace sand, trace oxides, coal, brown

SPECIMEN DETAILS:

Wet Density (kg/m^3):	1847
Dry Density (kg/m^3):	1386
Moisture Content (%):	33.3
Liquid Limit (%):	-
Plastic Limit (%):	-
Plasticity Index (%):	-
Gravel (%):	-
Sand (%):	-
Silt (%):	-
Clay (%):	



THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-10	SAMPLE:	G8
DEPTH:	15.0 ft.	TECH:	JAP
DATE:	13-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: 11-15/3 CRUCIBLE NO: _____

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[X]	Clear Solution No Reaction	[ ]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	_____	g
WTt of Crucible Empty	_____	g
Wt of BaSO4 (ppt)	0	g
Wt of Soil Used (passing No. 40 sieve)	100	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0}{2.60} = 0.000 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.00}{20} = 0.00 \%$$

[ ]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-13	SAMPLE:	G4
DEPTH:	5.0 ft.	TECH:	JAP
DATE:	13-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: 11-17/D5 CRUCIBLE NO: 20-7

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	25.82	g
WTt of Crucible Empty	25.81	g
Wt of BaSO4 (ppt)	0.01	g
Wt of Soil Used (passing No. 40 sieve)	100	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.01}{2.60} = 0.004 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.38}{20} = 0.02 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-15	SAMPLE:	G7
DEPTH:	11.0 ft.	TECH:	NM
DATE:	13-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: R4 / 9 CRUCIBLE NO: 21-4

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	25.69	g
WTt of Crucible Empty	25.68	g
Wt of BaSO4 (ppt)	0.01	g
Wt of Soil Used (passing No. 40 sieve)	100	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.01}{2.60} = 0.004 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.38}{20} = 0.02 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-23	SAMPLE:	G4
DEPTH:	5.0 ft.	TECH:	NM
DATE:	13-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: R8 / 10 CRUCIBLE NO: 8

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	25.75	g
WTt of Crucible Empty	25.74	g
Wt of BaSO4 (ppt)	0.01	g
Wt of Soil Used (passing No. 40 sieve)	100	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.01}{2.60} = 0.004 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.38}{20} = 0.02 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-26	SAMPLE:	G4
DEPTH:	5.0 ft.	TECH:	NM
DATE:	13-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: 9 / 23 CRUCIBLE NO: 20-11

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	25.82	g
WTt of Crucible Empty	25.81	g
Wt of BaSO4 (ppt)	0.01	g
Wt of Soil Used (passing No. 40 sieve)	100	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.01}{2.60} = 0.004 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.38}{20} = 0.02 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-28	SAMPLE:	G7
DEPTH:	11.0 ft.	TECH:	NM
DATE:	13-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: 5 / D3 CRUCIBLE NO: 21-2

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	25.75	g
WTt of Crucible Empty	25.74	g
Wt of BaSO4 (ppt)	0.01	g
Wt of Soil Used (passing No. 40 sieve)	100	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.01}{2.60} = 0.004 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.38}{20} = 0.02 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-30	SAMPLE:	G4
DEPTH:	5.0 ft.	TECH:	LLK
DATE:	14-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: 2/11 CRUCIBLE NO: 19-1

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + $BaSO_4$ (ppt) (oven dried)	25.78	g
WTt of Crucible Empty	25.76	g
Wt of $BaSO_4$ (ppt)	0.02	g
Wt of Soil Used (passing No. 40 sieve)	100.03	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.02}{2.60} = 0.008 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.77}{20.006} = 0.04 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-32	SAMPLE:	G9
DEPTH:	15.0 ft.	TECH:	LLK
DATE:	14-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: 11-11/17 CRUCIBLE NO: 20-2

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	25.76	g
WTt of Crucible Empty	25.75	g
Wt of BaSO4 (ppt)	0.01	g
Wt of Soil Used (passing No. 40 sieve)	100.02	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.01}{2.60} = 0.004 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.38}{20.004} = 0.02 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER ENGINEERING LTD.

4127 Roper Road
Edmonton, Alberta T6B 3S5
Phone (780) 438-1460 | Fax (780) 437-7125

Job No:	31566		
Client:	City of Edmonton		
Project:	Hawrelak Park Rehabilitation		
HOLE/PIT:	TH21-35	SAMPLE:	GS
DEPTH:	6.0 ft.	TECH:	LLK
DATE:	14-Jul-21	CHECKED BY:	

SULPHATE TEST ON SOILS USING PFRA METHOD

BEAKER NO: 30/22 CRUCIBLE NO: R-27

1- Add 100 g of oven dried soil, passing No. 40 sieve.
2- Add 500 mL of distilled water - or ratio of 20 g of soil to 100 g of water.
3- Add 3 drops of concentrated HCL acid.
4- Place mixture in oven (110C, 250F) for 1 hour or allow to sit overnight.
5- Draw off or filter 100 mL clear liquid from mixture into 250 mL beaker.
6- Add 100 mL distilled water on 5 mL concentrated HCL acid.
7- Heat in oven for 1 hour.
8- Add 10 mL of 10% BACL2 solution, mix thoroughly, observe reaction.

[ ]	Clear Solution No Reaction	[X]	Slightly Milky No Precipitate	[ ]	Milky Solution With Precipitate

9- Filter mixture through crucible on vacuum setup, dry crucible thoroughly in oven

Wt of Crucible + BaSO4 (ppt) (oven dried)	25.55	g
WTt of Crucible Empty	25.54	g
Wt of BaSO4 (ppt)	0.01	g
Wt of Soil Used (passing No. 40 sieve)	100.02	g

CALCULATIONS

Gravimetric Factor

$$\text{Wt of Sulphate} = \frac{\text{Wt } BaSO_4 \text{ (ppt) gms}}{\text{Gravimetric Factor}} = \frac{0.01}{2.60} = 0.004 \text{ g}$$

$$\text{Percent Sulphate} = \frac{\text{Wt of } SO_4 \times 100\%}{\text{Wt of Soil Used (g)}} = \frac{0.38}{20.004} = 0.02 \%$$

[X]	0-0.1%	Clear Solution, No reaction
[ ]	0.1-0.5%	Slightly Milky, No Precipitation Dangerous if Water Table is Too High
[ ]	>0.5%	Milky with Precipitate Dangerous, use HS Cement

THURBER

APPENDIX D

William Hawrelak Park Rehabilitation

Main Pavilion Concrete Apron Slab Concrete Coring

Geotechnical Investigation

THURBER ENGINEERING LTD.

MEMORANDUM

To:	Ms. Christina Tatarniuk, P.Eng. (City of Edmonton)	**Date:**	September 7, 2021
From:	Thomas Vogt, P.Eng. (Reviewed by Robin Tweedie, P.Eng.)	**File:**	31566

CITY OF EDMONTON
WILLIAM HAWRELAK PARK REHABILITATION
MAIN PAVILION CONCRETE APRON SLAB CONCRETE CORING
GEOTECHNICAL INVESTIGATION

This memorandum presents a summary of the concrete apron slab investigation conducted by Thurber Engineering Ltd. (Thurber) at the William Hawrelak Park Main Pavilion.

The information will be presented in our final geotechnical report including any review comments received from the City.

1. FIELD INVESTIGATION

On July 15, 2021 Thurber Engineering Ltd. (Thurber) mobilized to William Hawrelak Park to initiate the Main Pavilion concrete apron slab investigation. CanWest Concrete Cutting and Coring Inc. (CanWest) provided ground penetrating radar (GPR) scanning for three core locations selected by Entuitive.

Utilities were cleared using the Alberta One Call system. A private utility locator (Hawkeye Line Locators Inc.) was also retained on July 22, 2021 to scan for utilities not registered with the Alberta One Call system.

A total of three, 75 mm diameter concrete cores were completed by CanWest on July 26, 2021. The concrete core samples were provided to Entuitive on site on July 26, 2021. The core locations were backfilled with grout by Thurber on July 27, 2021. Prior to coring, the tiles overlying the concrete slab were removed and they were subsequently placed back to their original locations prior to site demobilization on July 27, 2021.

Two concrete cores attempted near grid lines H.3 and 2.1 (Core 2) encountered epoxy coated steel reinforcing bars at approximately 100 mm below the top of concrete slab elevation. As soon as contact was made with the bars, the concrete cores were abandoned and backfilled with grout.

Additional GPR scanning was completed by CanWest and the as-drilled coring locations (Core 1 to 3) are provided on the attached foundation plan. The thicknesses of the concrete cores, void form and voids (if encountered) were recorded.

Camera inspections were completed at the core excavation locations and extended to locations underlying the concrete apron slab at the locations of Core 1 and Core 2. Camera inspections

were also completed under the concrete apron slab from grid lines F to J, 1 to 2. The camera inspections indicated that the void form has detached from the concrete apron slab within these areas.

A hand auger was used to collect disturbed soil samples of the underlying soils at core locations 1 to 3 (TH21-74 to 76). The test holes were extended to depths ranging from 1.0 m to 1.25 m below the top of the concrete slab elevation. The undrained shear strengths of cohesive soils were estimated using a pocket penetrometer at select depths. Geotechnical laboratory testing consisted of visual classifications and water content determination on all soil samples.

A description of the subsurface conditions at each test hole location is presented in the test hole logs in the attachments. An explanation of the symbols and terms used to describe observations in the test hole logs and the Modified Unified Soil Classification are also provided in the attachments.

In general, the concrete apron slab ranged in thickness from 165 mm 170 mm. The slab was underlain by 45 mm to 80 mm of voids or void form, overlying medium plastic clay fill to the test hole termination depths ranging between 1.0 m to 1.25 m below the top of the concrete slab elevation.

2. PILE FOUNDATIONS

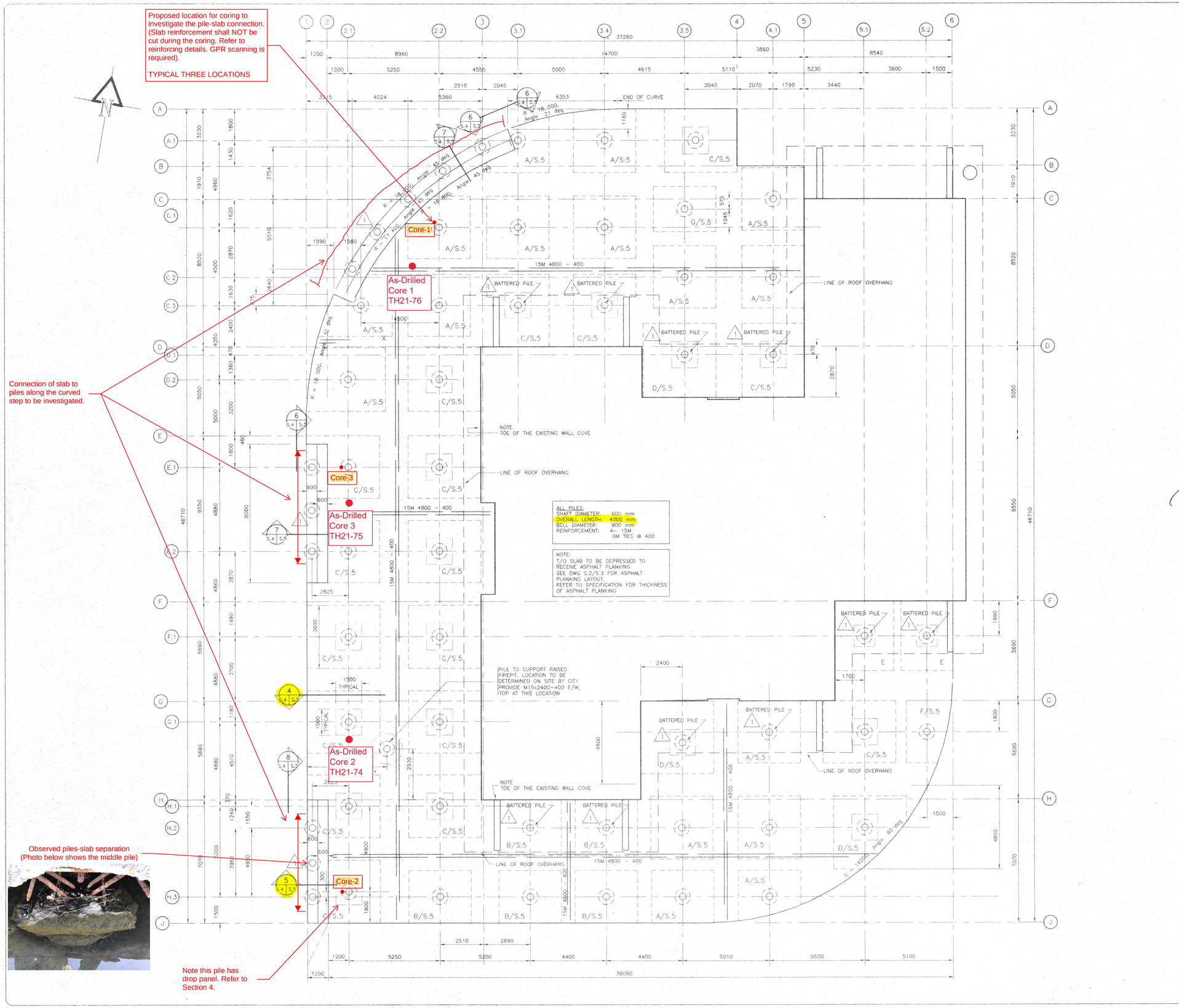
Test holes TH21-74 to -76 indicate that the near surface soils below the slab consist of medium plastic clay and the groundwater table is expected to be relatively high throughout most of the year. Hence, swelling of the soils is not expected to be a significant concern, particularly when compared to the potential for frost heaving.

Selected still images from the camera inspections are presented in Figures 1 and 2 included in the attachments. Figure 1 indicates a separation between the concrete apron slab and the pile foundation at grid lines C.1 and 2.2. Figure 2 indicates a separation between the concrete apron slab and the pile foundation at grid lines F.1 and 2.1.

We trust this meets with your present requirements. If you have any questions, please contact us at your convenience.

Attachments:

- Statement of Limitations and Conditions
- Main Pavilion Concrete Apron Slab Foundation Plan
- Modified Unified Soils Classification
- Symbols and Terms Used on Test Hole Logs
- Test Hole Logs
- Figures 1 and 2



notes

Recommendation for slab deck investigation

May 3, 2021

no.	description	date	checked
1	REVISED FOR THE RECORD	01-14-00	

revisions

issue date	date
ISSUED FOR CLIENT APPROVAL	
ISSUED FOR QUOTATION / TENDER	
ISSUED FOR CONSTRUCTION	

detail legend

A DETAIL NO.
B LOCATION DWG. NO.
C DETAIL DWG. NO.

DETAIL NUMBERS TO

seal

seal

permit

PERMIT TO PRACTICE
VENTURE ENGINEERING CONSULTANTS LTD.
Signature
Date FEB 3, 2000
PERMIT NUMBER: P 4526
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

consultants

VENTURE
ENGINEERING CONSULTANTS LTD.

#200, 10453 - 178 STREET, EDMONTON, ALBERTA TEL (780) 484-1974 FAX (780) 484-1975

consultant project no.

THE CITY OF Edmonton COMMUNITY SERVICES

project

HAWRELAK PARK
SKATING PAVILION
DECK SLAB UPGRADE
9330 GROAT ROAD, EDMONTON

drawing title

FOUNDATION PLAN
STRUCTURAL DECK SLAB

scale 1 : 100

drawn by AbS-ATL
date

checked by R.A.K.
date

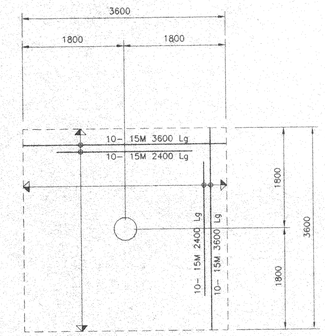
reviewed by
date

drawing no. S.4
sheet no. of

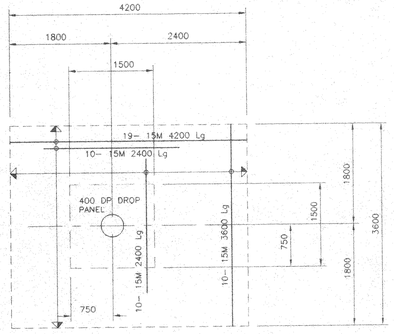
project no.

all dimensions are in millimetres

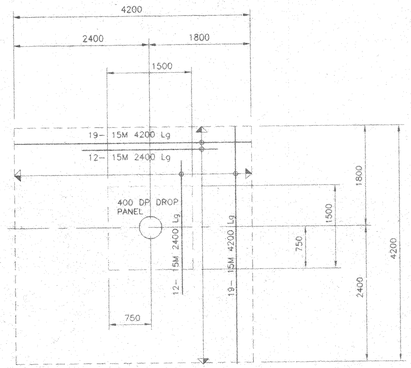
WIL101(xx)-00-S4



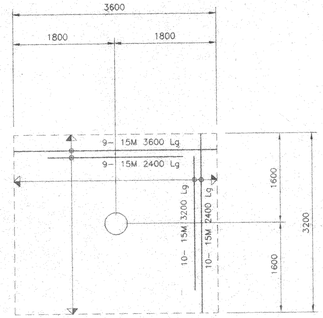
A S.4 S.5 PLAN DETAIL SCALE: 1:50



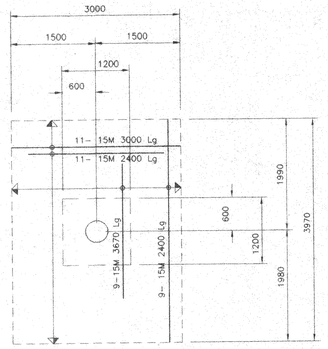
B S.4 S.5 PLAN DETAIL SCALE: 1:50



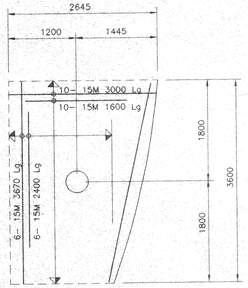
C S.4 S.5 PLAN DETAIL SCALE: 1:50



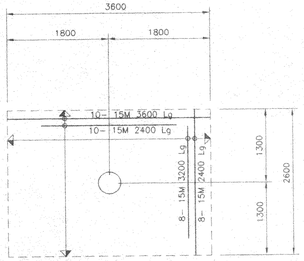
D S.4 S.5 PLAN DETAIL SCALE: 1:50



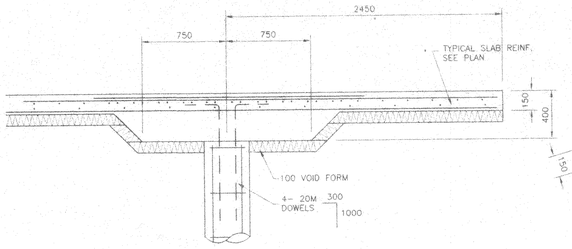
E S.4 S.5 PLAN DETAIL SCALE: 1:50



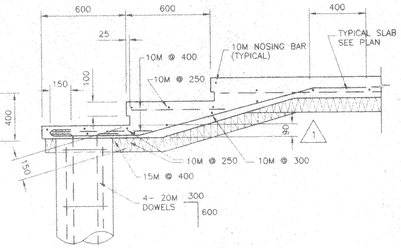
E S.4 S.5 PLAN DETAIL SCALE: 1:50



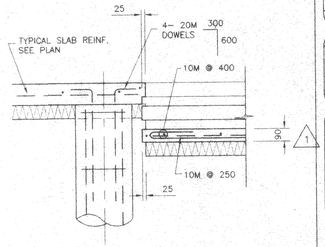
G S.4 S.5 PLAN DETAIL SCALE: 1:50



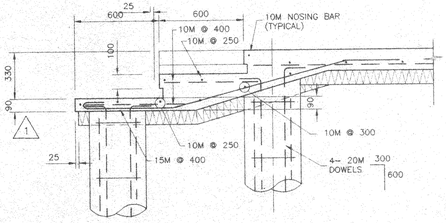
4 S.2 S.3 SECTION SCALE: 1 : 25



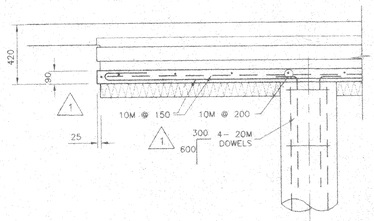
5 S.4 S.5 SECTION SCALE: 1 : 20



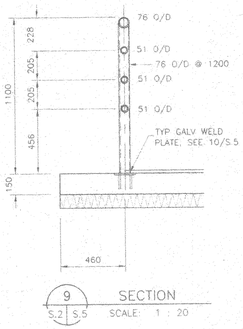
6 S.4 S.5 SECTION SCALE: 1 : 20



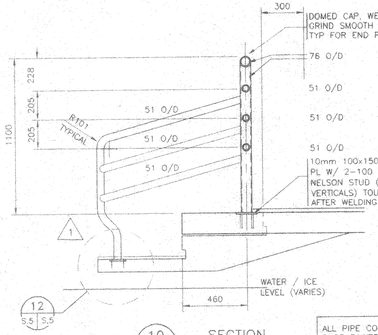
7 S.4 S.5 SECTION SCALE: 1 : 20



8 S.2 S.5 SECTION SCALE: 1 : 20



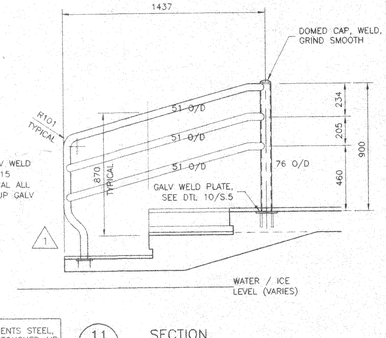
9 S.2 S.5 SECTION SCALE: 1 : 20



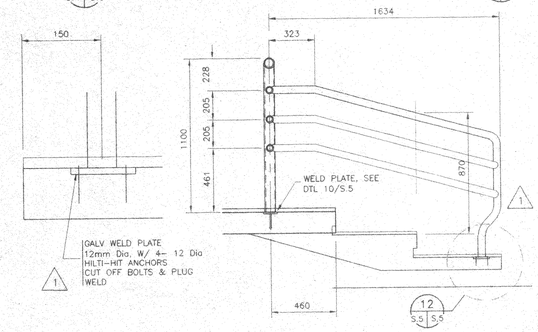
12 S.5 S.5

10 S.2 S.5 SECTION SCALE: 1 : 20

ALL PIPE COMPONENTS STEEL, SHOP PAINTED & TOUCHED–UP IN FIELD AFTER INSTALLATION

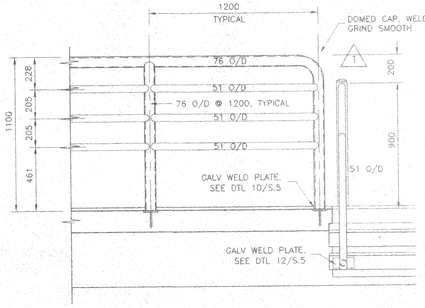


11 S.4 S.5 SECTION SCALE: 1 : 20



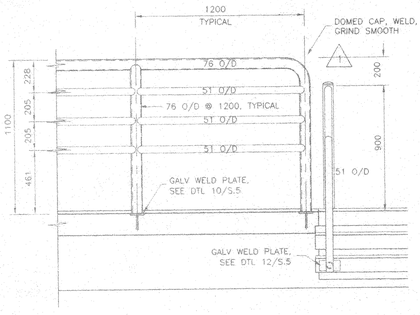
12 S.5 S.5

12 S.2 S.5 DETAIL SCALE: 1 : 5

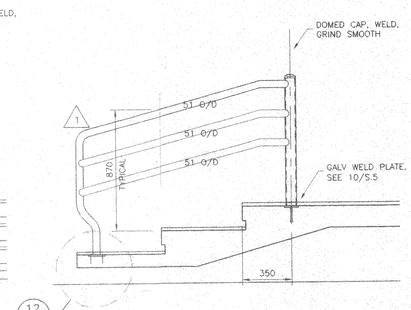


13 S.2 S.5 ELEVATION SCALE: 1 : 20

14 S.2 S.5 ELEVATION SCALE: 1 : 20



15 S.2 S.5 ELEVATION SCALE: 1 : 20



12 S.5 S.5

16 S.2 S.5 ELEVATION SCALE: 1 : 20

notes

no.	description	date	checked
1	REVISED FOR THE RECORD	01–14–00	

revisions

issue data	date
ISSUED FOR CLIENT APPROVAL	
ISSUED FOR QUOTATION / TENDER	
ISSUED FOR CONSTRUCTION	

detail legend

A DETAIL NO.
B LOCATION DWG. NO.
C DETAIL DWG. NO.

DETAIL NUMBERS TO

seal

PROFESSIONAL ENGINEER ALBERTA TERRY A. KALMANSON

Feb 8/2000

seal

permit

PERMIT TO PRACTICE
VENTURE ENGINEERING CONSULTANTS LTD.
Signature
Date FEB 8, 2000
PERMIT NUMBER: P 5526
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

consultants

VENTURE
ENGINEERING CONSULTANTS LTD.
#200, 10453 – 178 STREET, EDMONTON, ALBERTA TEL (780) 484–1974 FAX (780) 484–1975

consultant project no.

THE CITY OF Edmonton COMMUNITY SERVICES

project

HAWRELAK PARK
SKATING PAVILION
DECK SLAB UPGRADE
9330 GROAT ROAD, EDMONTON

drawing title

DETAILS, SECTIONS

scale 1 : 100

drawn by AbS–ATL date

checked by R.A.K. date

reviewed by date

drawing no. S.5 sheet no. of

project no. WIL101(xx)–00–S5

all dimensions are in millimetres

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	15 to 30
Hard	200 - 300 kPa	National Building	Greater than 30
Very Hard	Greater than 300 kPa	Code	

* 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
Dense	30 - 50	National Building
Very Dense	Over 50	Code

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

Shelby Tube SPT No Recovery A-Casing Grab 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

TERMS DESCRIBING QUANTITIES

'and'	35% to 50% of each size group
'sandy'	20% to 35%
'some'	10% to 20%
'trace'	Less than 10%
'mixture'	Soils containing three or more size groups within 20% of each other and each group greater than 10%

THURBER ENGINEERING LTD.

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: CanWest Concrete Cutting and Coring Inc.	BOREHOLE NO: **TH21-74 (Core2)**
CLIENT: City of Edmonton	DRILLING METHOD: Hand Auger	PROJECT NO: 31566
START DATE: 2021-7-26	LOCATION: Refer to Foundation Plan	ELEVATION:

SAMPLE TYPE: Shelby Tube | Drive Sample | Auger Sample | No Recovery | A Casing | Cored Sample

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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0							CONCRETE SLAB (165mm)	
							VOID (45mm)	
					CI		CLAY (FILL)	
					CI		firm, grey, brown streaks, trace sand	
1					CI			
					CI			
							END OF TEST HOLE AT 1.2m	
							UPON COMPLETION:	
							Backfilled with sand, void foam spray, and grout	
2								
3								
4								
5								
6								
7								
8								
9								
10								

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 1.2 m

COMPLETION DATE: 21-7-26

LOGGED BY: JH | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: CanWest Concrete Cutting and Coring Inc.	BOREHOLE NO: **TH21-75 (Core3)**
CLIENT: City of Edmonton	DRILLING METHOD: Hand Auger	PROJECT NO: 31566
START DATE: 2021-7-26	LOCATION: Refer to Foundation Plan	ELEVATION:

SAMPLE TYPE: Shelby Tube | Drive Sample | Auger Sample | No Recovery | A Casing | Cored Sample

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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0							CONCRETE SLAB (170mm)	
							VOID FORM, styrofoam (50mm)	
					CI		CLAY (FILL), firm, grey - brown, silty, trace sand	
					CI		-grey, sand lenses, trace oxides	
1					CI		-brown - grey, silty, sandy, trace oxides and gravel	
					CI		-coal	
							END OF TEST HOLE AT 1.2m	
							UPON COMPLETION:	
							Backfilled with sand, void foam spray, and grout	
2								
3								
4								
5								
6								
7								
8								
9								
10								

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

COMPLETION DEPTH: 1.2 m

COMPLETION DATE: 21-7-26

LOGGED BY: JH | REVIEWED BY: TGV / RWT

PROJECT: William Hawrelak Park Rehab	DRILLING COMPANY: CanWest Concrete Cutting and Coring Inc.	BOREHOLE NO: **TH21-76 (Core1)**
CLIENT: City of Edmonton	DRILLING METHOD: Hand Auger	PROJECT NO: 31566
START DATE: 2021-7-26	LOCATION: Refer to Foundation Plan	ELEVATION:

SAMPLE TYPE: Shelby Tube | Drive Sample | Auger Sample | No Recovery | A Casing | Cored Sample

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

Depth (m)	▲Headspace (ppmv)▲ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	◆Soil Sulphates (%)◆ 0.02 0.04 0.06 0.08 ▲CPEN (kPa)▲ 50 100 150 200 ■Standard Penetration (N)■ 10 20 30 40	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0							CONCRETE SLAB (170mm)	
							VOID (80mm)	
					CI		CLAY (FILL)	
					CI		firm to stiff, grey, silty, sandy	
1					CI		-grey, brown streaks, trace organics, sand, and gravel	
					CI			
							END OF TEST HOLE AT 1.2m	
							UPON COMPLETION:	
							Backfilled with sand, void foam spray, and grout	
2								
3								
4								
5								
6								
7								
8								
9								
10								

STANDPIP 31566-CITY OF ED.GPJ CITY OF EDMONTON.GDT 21-7-30

THE CITY OF Edmonton — Transportation Engineeering Services Section

THURBER ENGINEERING LTD.

		COMPLETION DEPTH: 1.2 m
		COMPLETION DATE: 21-7-26
LOGGED BY: JH	REVIEWED BY: TGV / RWT	Page 1 of 1

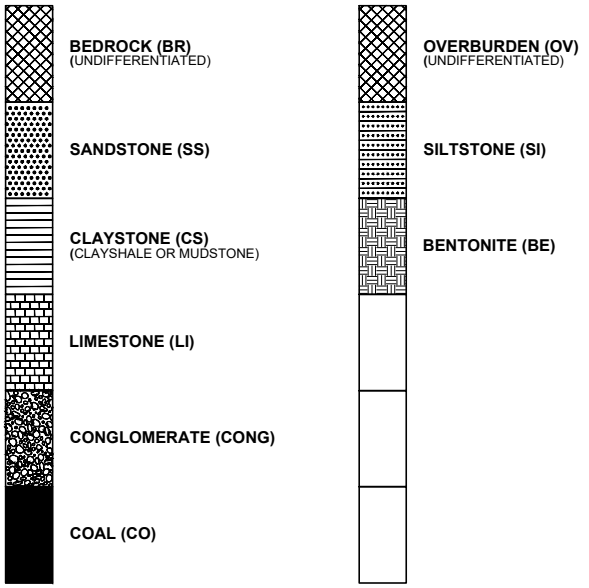
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

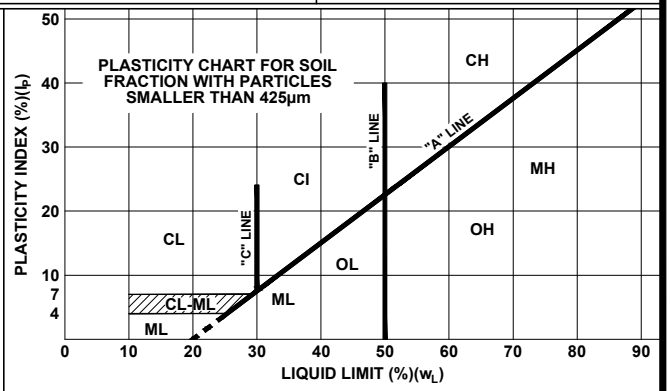
(MODIFIED BY PFRA, 1985)

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 4.75mm	CLEAN GRAVELS (LITTLE OF NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ 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
			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 4.75mm	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
			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

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





THURBER ENGINEERING LTD.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(MODIFIED BY PFRA, 1985)

Revised October 22, 2019

Figure 1: Pile location at Grid Lines C.1 and 2.2

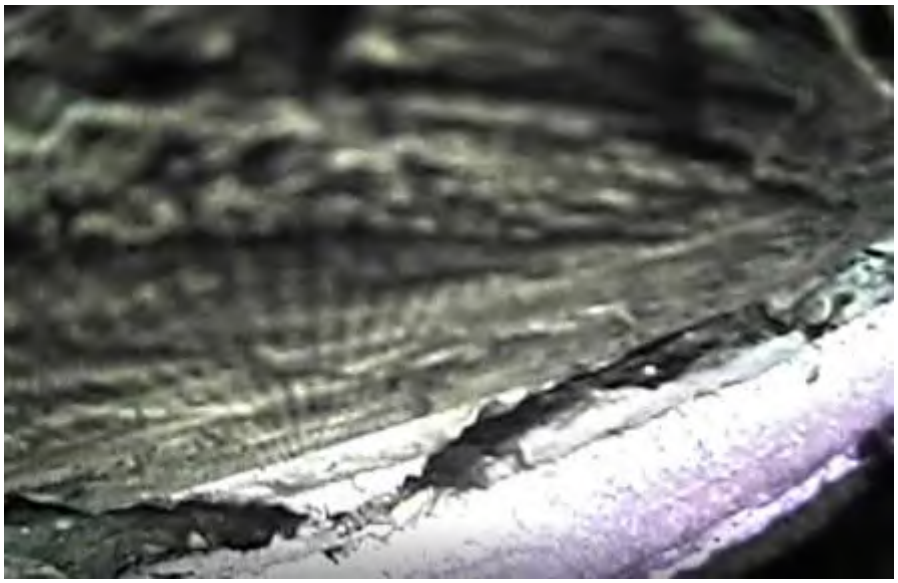


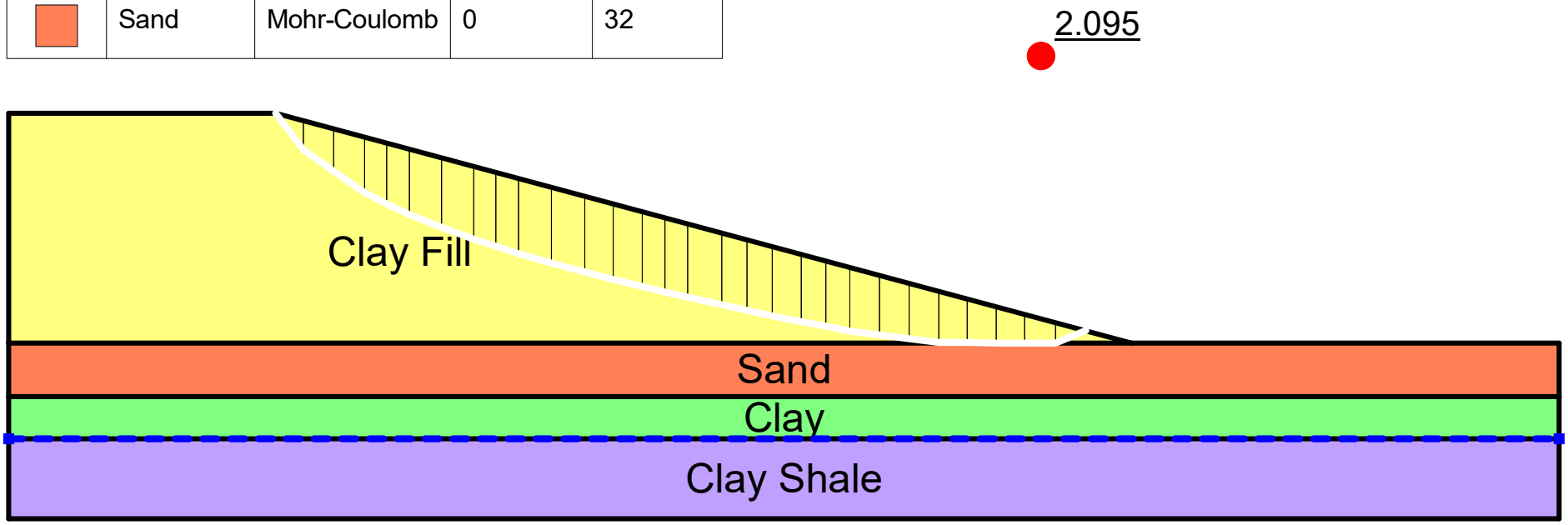
Figure 2: Pile Location at Grid Lines F.1 and 2.1

THURBER

APPENDIX E

Playground Mound Stability Analysis

Color	Name	Model	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clay	Mohr-Coulomb	5	23
	Clay Fill	Mohr-Coulomb	2	23
	Clay Shale	Mohr-Coulomb	15	18
	Sand	Mohr-Coulomb	0	32



Hawrelak Park - Playground Mound Preliminary Stability Analysis

THURBER

APPENDIX F

Recommended Construction Procedures

THURBER

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. EXCAVATED FOUNDATIONS

1.1 Excavation close to foundation level should be done carefully to avoid disturbance of the soil. It is essential to prevent the soil at foundation level from deterioration due to excessive drying or becoming wet from surface or seepage water. Good drainage both during and after construction is essential.

1.2 Sumps, if required, should be located well away from the foundation area. Softened or overdried soil must be removed and replaced by lean mix concrete or by extending the foundations.

1.3 The foundation must be kept from freezing both during and after construction. Foundation concrete should not be placed on or against frozen soil.

2. PROOF ROLLING

2.1 Proof rolling is a method of detecting soft areas in a subgrade for fill, pavement, floors, or foundations. The intent is to detect softened areas not revealed by the boreholes or visual examination of the site surface and is used where normal scarification and compacting procedures would not be successful in detecting and eliminating soft areas. It is usually accomplished with the use of heavy 130 to 220 kN (15-25 ton) compaction equipment with high contact wheel pressures on independent axles, although heavily loaded single axle trucks will provide the equivalent result.

2.2 The procedure requires two complete passes with the heavy equipment in one direction and then a second series of two passes made at right angles to the first series.

2.3 While the passes are being made, any softened, rutted, or displaced areas detected should be examined and either recompacted with additional fill or the existing material removed and replaced with better quality material.

THURBER

3. BACKFILLING

3.1 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.

3.2 Backfill should not be placed until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction.

3.3 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 nor organic material should be incorporated into the fill. All lumps of material must be broken down or squeezed together during placing and compaction.

3.4 The final grade (allowing for some settlement of the backfill) should shed water away from the structure.

3.5 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.

4. BORED CAST-IN-PLACE CONCRETE PILES

4.1 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.

4.2 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.

4.3 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.

THURBER

4.4 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.

4.5 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.

4.6 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.

Appendix G. Stairway Replacement Geotechnical Desktop Study (Thurber 2021b)

THURBER ENGINEERING LTD.

November 18, 2021 File No.: 31556

City of Edmonton
11004 190 Street NW
Edmonton, Alberta
T5S 0G9

Attention: Ms. Christina Tatarniuk, M.Sc., P.Eng.

WILLIAM HAWRELAK PARK REHABILITATION
STAIRCASE REPLACEMENT ON EAST SIDE OF PARK
EDMONTON, ALBERTA
GEOTECHNICAL DESKTOP STUDY

Dear Ms. Tatarniuk:

1. INTRODUCTION

This letter presents the results of a geotechnical assessment carried out by Thurber Engineering Ltd. (Thurber) for the staircase replacement on the east side of the park. The staircase replacement is part of the larger William Hawrelak Park rehabilitation project, located at 9330 Groat Road in Edmonton, Alberta.

The scope of the original geotechnical investigation was outlined in our proposal to Ms. Christina Tatarniuk, M.Sc., P.Eng., of the City of Edmonton (City) on May 6, 2021 and the results were presented in a geotechnical report to the City dated September 7, 2021.

The City has subsequently requested Thurber to undertake a geotechnical assessment for the Hawrelak Park staircase replacement via email on September 20, 2021. The additional scope of work for the Hawrelak Park staircase replacement geotechnical assessment was outlined in our scope change letter dated September 28, 2021. Authorization to proceed with the assessment was received from Ms. Tatarniuk via email on October 6, 2021. This assessment is based on a review of existing geotechnical information and did not include a drilling investigation for the staircases.

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

We understand that the City is planning the replacement of the Hawrelak Park staircase located on the east side of the park as part of the Hawrelak Park upgrades and rehabilitation project. We also understand that the City plans to use the existing staircase alignment for the staircase replacement unless the geotechnical assessment indicates concerns from a slope stability aspect with the existing alignment.

Thurber carried out a geotechnical investigation at Hawrelak Park for the park upgrades and rehabilitation plans in the summer of 2021 (File No. 31566). However, this investigation did not include drilling any geotechnical test holes near the existing staircase location.

The City's Standard Drawing No. 5201 for wooden stairs and support structure shows that these stairs are typically supported on 76 mm x 127 mm pressure treated timber posts embedded at least 600 mm below grade. Other types of foundations including helical steel (screw) piles and concrete piles are frequently used to enhance the long-term performance of the staircase foundations.

3. SCOPE OF WORK

Thurber's scope of work consisted of the following tasks:

- Review available geotechnical and geological information and LIDAR data to check for existing slope stability conditions at the staircase location
- Undertake a site reconnaissance to inspect and assess the existing slope conditions at the staircase location
- Prepare a geotechnical report which summarizes the field observations, overall site assessment, and providing recommendations for proposed foundation option(s), and any future work if required.

4. SITE DESCRIPTION

4.1 Site Geology

A desktop review of local geological mapping and reports from Thurber's files at Hawrelak Park near the exiting staircase indicates that the general site geology on the valley slopes bordering the southeast corner of the park consists of surficial colluvium deposit overlying, glacial till with interbedded sand and gravel deposits, overlying Upper Cretaceous clay shale and sandstone bedrock of the Horseshoe Canyon Formation.

The colluvium deposits are expected to consist of a mixture of clay and clay till deposits resulting from previous slope movements. It is also possible that fills were placed on the slope during the original Groat Road construction.

The expected depth to bedrock, based on Kathol and McPherson (1975), is expected to range from about 10 m to 30 m below existing grade. It is expected that the bedrock underlies the base of the slope at the staircase location.

4.2 Aerial Photograph Interpretation

A recent aerial photograph from 2019 is provided on Drawing No. 31566-S1, included in Appendix A. A review of aerial photographs between 1948 and 1978 are shown on Drawing No. 31566-S2, included in Appendix A.

The aerial photograph from 1948 indicates that a former road alignment connected the west end of Saskatchewan Drive with the east end of Hawrelak Park. Signs of gravel extraction from within Hawrelak Park appear by 1952.

The construction of Groat Road and the development of the Windsor Park subdivision is ongoing in the 1952 airphoto. A stormwater line that crosses Groat Road approximately 40 m north of the existing staircase appears to have been installed before 1952.

In 1965, the development of the Windsor Park subdivision is completed. The construction of Groat Road, including the road embankment grading, surface pavement, curb and gutter on its current alignment was completed.

In 1965, a shallow landslide is visible on the valley slope at the existing Hawrelak Park staircase alignment. The landslide is believed to be located within the fill slope on the west side of Groat Road. The limits of the slide extend from the stormwater line crossing located at the northern slide limits to the dormant colluvium deposits located at the southern slide limits. The scarp of the landslide appears to be located approximately 15 m west from the west curb of Groat Road.

By 1978, the footprint of the landslide appears to be vegetated with a scarp that is less pronounced. The construction of the existing staircase that appears to be at the south end of the landslide block was completed after 1978.

In the recent aerial photograph from 2019, there are no signs of recent instability within the existing staircase footprint.

4.3 Surface Conditions

The location of the staircase is shown on Drawing 31566-S1 included in Appendix A and is displayed with a recent aerial photograph from 2019. The staircase connects Groat Road south to the gravel trail that eventually links with the circular asphalt roadway around Hawrelak Park.

Based on the available survey data provided by the City, the staircase is estimated to be about 71 m long (east to west), 23 m high, and with an average overall slope of 19 degrees (2.9H:1V).The approximate elevation at the top of the staircase is approximately 659 m.

The staircase terminates at the upslope end on a concrete sidewalk on the west side of Groat Road. The roadway has curb and gutter which diverts the majority of surface water away from the staircase. Hence the slopes were noted to be dry and well drained at the time of our site visit. The lower gravel trail is relatively flat, level, and slopes slightly downwards to the North Saskatchewan River.

4.3.1 Site Reconnaissance

A site reconnaissance was conducted by Mr. Robin Tweedie, M.Sc., P.Eng., and Mr. Thomas Vogt, M.Eng., P.Eng., of Thurber on October 18, 2021. Selected photographs of the site (Photos C1 to C6) are provided in Appendix C.

The Hawrelak Park staircase consists of six flights of raised timber steps descending the river valley slope (Photo C1). The numbers of stairs per each flight is provided below in Table 3.1.

TABLE 3.1
WILLIAM HAWRELAK PARK STAIRCASE
STAIRS PER STAIRCASE FLIGHT (FROM STAIRCASE BOTTOM)

STAIRCASE FLIGHT	NO. OF STAIRS
Bottom, No. 1	10
No.2	21
No. 3	34
No. 4	29
No. 5	26
Top, No. 6	14
TOTAL	134

The adjacent slopes are well vegetated with no signs of active slope movement (Photos C1 to C4). There were no visible signs of cracking at the crest of the slope. The site is currently graded to divert the majority of surface water runoff at the top of the staircase to the catch basins located on Groat Road.

Evidence of historical landside activity was observed to the north of the staircase. However, no visible signs of recent active instability were observed in the slopes adjacent to the staircase, and there was no evidence of slope movements affecting the alignment or foundations of the staircase. The scarp identified in the aerial photograph interpretation located to the north from the middle of the staircase appeared to be eroded and subdued (Photos C3 and C4).

A tree located south from the middle of the existing staircase was tilted eastward towards the crest of the slope (Photo C5). However, the existing foundations under the stairs appear to have performed well (Photo C6), and little distress or differential settlement of the staircase was observed. Drainage conditions at the site appear to be performing well and there were no significant signs of erosion near the existing staircase.

Based on LiDAR data, aerial photographs, and site observations, it appears that the staircase was constructed over a pre-existing landslide block that slid sometime between 1952 and 1965. Fill was likely placed on the top of the landslide block to grade the surface for the construction of the Groat Road roadway embankment. This additional weight may have resulted in movement of the fill and/or underlying colluvium on the west side slope of the roadway embankment.

4.4 Subsurface Conditions

As outlined in the scope of work, no test holes have been drilled at the staircase location.

Based on available geological information (ref. Kathol and McPherson, 1975), the sub-surface conditions at the staircase location is anticipated to consist of colluvium of variable thickness underlain by clay till over bedrock.

The bedrock consists of interbedded clay shale and sandstone of variable quality and strength. The upper meters of the bedrock are generally weathered, and the thickness of this weathered zone varies.

One test hole (S5-04) drilled by AMEC for the EPCOR transmission cable replacement is described on the test hole log included in Appendix B. The location of the test hole in relation to the staircase is presented on Drawing No. 31566-S1, in Appendix A. The test hole was advanced through the lower trail near the bottom of the staircase and indicated a stratigraphy consisting of topsoil, overlying clay, silt, sand and gravel and bedrock in descending order.

The test hole log S5-04 indicates that the bedrock was at approximate elevation 627 m and the groundwater level upon completion of drilling was 9.5 m below ground surface (approximate elevation of 622.5 m).

5. GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

5.1 General Considerations

Based on the results of the desktop study and visual site observations, the existing Hawrelak Park staircase alignment appears to be a relatively favourable location for the staircase replacement. The slopes are relatively uniform, well drained and there are no signs of recent slope instability or slope erosion.

There is evidence of an old shallow landslide at the staircase location; however, this appears to have resulted from the original Groat Road grading and appears to have either stabilized naturally or by slope reconstruction, such that there is little evidence of the landslide at the current staircase location.

The following general comments regarding foundations should be considered during design and construction for the staircase replacement.

- The staircase should generally follow the existing alignment to avoid additional clearing of vegetation or grading. Any additional clearing and grading should be limited to the minimum required to provide construction access.
- Access for equipment to install the piles and reconstruct the stairs should be carried out in a manner where there is no load added to the slope at any construction stage. Access, preparation, and restoration plans should be submitted to the Consultant for review and approval.
- The Contractor should establish and maintain positive site drainage away from the slope areas and avoid discharge of any surface water, runoff, or pumped water into the slope areas.
- Re-constructed slopes should not be steeper than the current grades. If it is required to change grades, consideration should be given to flattening the slopes or to offload the top of the slope and place excavated material at the toe of the slope to enhance slope stability. Site specific stability analysis should be conducted if slope grades are altered.

- Grading work to re-construct the stairs should be undertaken in a manner which does not create concentrated flow paths below and/or adjacent to the stairs.
- All disturbed areas below and adjacent to the slope should be revegetated with native species that require limited irrigation. Bio-engineering techniques may also be considered to revegetate all disturbed areas.
- No stockpiling of fill or heavy construction equipment should be permitted on the slopes.
- The Contractor shall continuously monitor construction to observe any impact on slope stability, ground subsidence, and erosion. Construction should be immediately halted if cracks or movements are noted on slope.

5.2 Preliminary Design Recommendations for Staircase Foundations

The existing staircase is founded on timber posts which appear to have performed relatively well over the lifetime of the staircase. On this basis, timber posts are considered a feasible foundation type for the reconstructed staircase.

Timber post foundations should typically be designed and constructed in accordance with the most recent version of the City of Edmonton Standard Drawing No. 5201 – Wooden Stairs and Support Structure provided in Appendix D.

Helical piles may also be considered for foundation support. No information on the existing soil conditions is currently available. However, it is expected that the screw piles will be relatively lightly loaded both vertically and laterally and hence screw pile designs may be based on similar projects and confirmed by torque measurements during screw pile installations.

The uppermost helix of a screw pile and the tip of a timber pile should be embedded at least 3.5 m below final grade (i.e., about one metre below an anticipated frost depth) to reduce frost heave effects.

Screw piling contractors should be pre-qualified, and an experienced contractor should be retained to design and install screw piles.

Further geotechnical investigation should be undertaken if soil strength parameters are required for screw pile design.

6. LIMITATIONS

This desktop study is based on review of available information and a general knowledge of subsurface conditions in the study area. The evaluations and recommendations presented within are preliminary in nature since no site-specific geotechnical investigation/stability analyses have been conducted for this project.

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before final design or construction details have been prepared or issued. Therefore, differences may exist between the report recommendations and

the final design, contract, or construction documents. 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.

7. REFERENCES

- C.P. Kathol and R.A. McPherson. Urban Geology of Edmonton. Bulletin 32. Alberta Research Council. Published 1975.
- Aerial photographs from 1948 to 1978.
- Reports provided by the City.

8. CLOSURE

We trust this report meets with your requirements. Should you have any questions, please contact the undersigned at your convenience.

Yours very truly,
Robin Tweedie, M.Sc., P.Eng.
Principal | Senior Geotechnical Engineer

Thomas Vogt, M.Eng., P.Eng.
Geotechnical Engineer
/sls

Attachments:

- Statement of Limitations and Conditions
- Appendix A: Drawing No. 31566-S1: Site Plan Showing Approximate Staircase and Test hole Locations
  Drawing No. 31566-S2: Aerial Photographs 1948 to 1978 and LIDAR
- Appendix B: Nearby Test Hole Log from AMEC 2002 Geotechnical Investigation
- Appendix C: Selected Site Photographs
- Appendix D: City of Edmonton – Wooden Stairs and Support Structure

THURBER

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.

THURBER

APPENDIX A

Drawing No. 31566-S1 – Site Plan Showing Approximate Staircase and Test hole Locations

Drawing No. 31566-S2 – Aerial Photographs 1948 to 1978 and LIDAR

H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566 S1 OCTOBER 28, 2021.dwg - 1 - Nov. 02, 2021

N
W E
S

LEGEND

APPROXIMATE STAIR CASE ALIGNMENT

APPROXIMATE GRAVEL TRAIL ALIGNMENT

APPROXIMATE TEST HOLE LOCATION (DRILLED BY OTHERS)

DRAFT

0 5 10 15 20 25 30m

SCALE 1:500

2019 AIR PHOTO AND 2018 TOPOGRAPHY PROVIDED BY THE CITY OF EDMONTON

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

SITE PLAN SHOWING APPROXIMATE STAIRCASE AND TEST HOLE LOCATIONS

DWG No. 31566-S1

DRAWN BY	ML
DESIGNED BY	TGV
APPROVED BY	RWT
SCALE	1:500
DATE	NOVEMBER 2021
FILE No.	31566

THURBER ENGINEERING LTD.

H:\31000\31566 William Hawrelak Park Rehabilitation\Drafting\31566 S2.dwg - 2 - Nov. 02, 2021

1948

1952

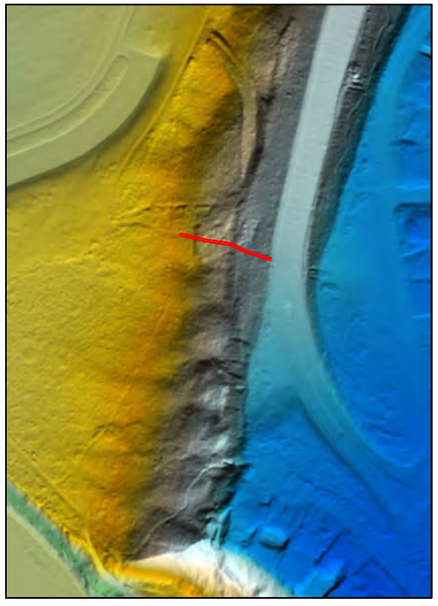
1965

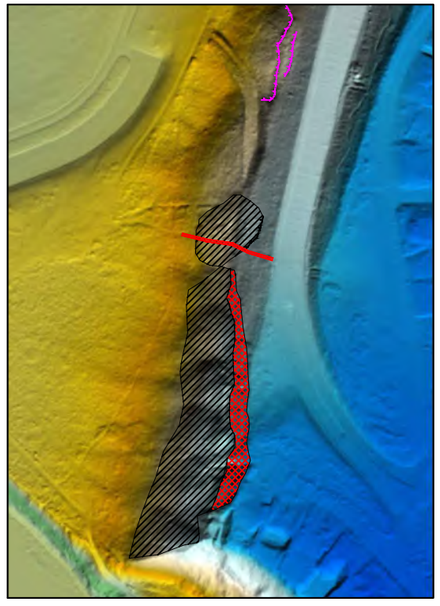
1978

N

W E

S





LEGEND

FRACTURE-ACTIVE

MAIN SCARP-DORMANT-CRUMBLING AND EROSION

DORMANT-SLOW MOVEMENT -COLLUVIUM

EXISTING STAIRCASE ALIGNMENT

DRAFT

0 50 100 150 200 250m

SCALE 1:4000

THE CITY OF Edmonton

WILLIAM HAWRELAK PARK REHABILITATION
EDMONTON, ALBERTA

WILLIAM HAWRELAK PARK EDMONTON, ALBERTA
AERIAL PHOTOGRAPHS 1948 TO 1978 AND LIDAR

DWG No. 31566-S2

DRAWN BY	ML
DESIGNED BY	TGV
APPROVED BY	RWT
SCALE	1:4000
DATE	NOVEMBER 2021
FILE No.	31566

THURBER ENGINEERING LTD.

THURBER

APPENDIX B

Nearby Test Hole Log from AMEC – EPCOR Transmission Line River Crossing Geotechnical Investigation (March 2002)

STANTEC CONSULTING Ltd.	EPCOR TRANSMISSION LINE RIVER CROSSING	BOREHOLE NO: S5-04
EDMONTON, ALBERTA	SITE 5: HAWRELAK PARK	PROJECT NO: EG08822
M-5 TRACK MOUNT - SOLID STEM	EDMONTON, ALBERTA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; CORE SAMPLE

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

Depth(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	INSTRUMENTATION DATA	OTHER TESTS COMMENTS	ELEVATION(m)
0.0			ORGANICS, topsoil, rootlets, root fibres, dark brown, frozen		G1				0.0
			CLAY, silty, trace sand, frozen, medium plastic, brown		G2				
1.0			SILT, some sand, trace clay, stiff, low plastic, brown		G3			Hard drilling Frost depth at 1.1 m	-1.0
2.0					G4				-2.0
3.0			GRAVEL AND SAND, silty, cobbles to 100 mm size, gravel sizes, brown, damp, rust staining		G5				-3.0
			...below 3.7 m, cobbles to 150 mm sizes		G6			Hard drilling	
4.0			...below 4.0 m, gravelly, clay till like, low to medium plastic, brown to dark brown, coal pieces, rust stained pockets		G7			Difficult to log exact location of interface	-4.0
5.0			CLAY, silty, bentonitic, high plastic, brown, rust stained lenses		G8 G9			pp > 450 kPa off auger	-5.0
			CLAY SHALE, silty, hard, high plastic, grey ...below 5.3 m, greenish tint, bentonitic		G10				
6.0									-6.0
7.0			...below 6.9 m, dark brown, scattered green inclusion		G11			Hard drilling	-7.0
8.0			...below 7.7 m, brown						-8.0

AMEC Earth & Environmental Limited Edmonton, Alberta	LOGGED BY: DD REVIEWED BY: CF	COMPLETION DEPTH: 9.9 m COMPLETE: 02/03/06
		Page 1 of 2

02/04/15 02:26PM (BMWE)

STANTEC CONSULTING Ltd.	EPCOR TRANSMISSION LINE RIVER CROSSING	BOREHOLE NO: S5-04
EDMONTON, ALBERTA	SITE 5: HAWRELAK PARK	PROJECT NO: EG08822
M-5 TRACK MOUNT - SOLID STEM	EDMONTON, ALBERTA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; CORE SAMPLE

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

Depth(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	INSTRUMENTATION DATA	OTHER TESTS COMMENTS	ELEVATION(m)
8.0			...below 8.1 m, grey						-8.0
9.0									-9.0
10.0			END OF BOREHOLE AT 9.9 m SLOUGH AT 9.5 m AT COMPLETION WATER LEVEL AT 9.5 m AT COMPLETION BACKFILLED WITH BENTONITE TO SURFACE						-10.0
11.0									-11.0
12.0									-12.0
13.0									-13.0
14.0									-14.0
15.0									-15.0
16.0									-16.0

AMEC Earth & Environmental Limited
Edmonton, Alberta

LOGGED BY: DD
REVIEWED BY: CF

COMPLETION DEPTH: 9.9 m
COMPLETE: 02/03/06

02/04/15 02:26PM (BMWE)

THURBER

APPENDIX C

Selected Site Photos

Photo C1: Top of Staircase Looking West – Vegetated Adjacent Slopes

Photo C2: Middle of Staircase Looking East – Vegetated Adjacent Slopes

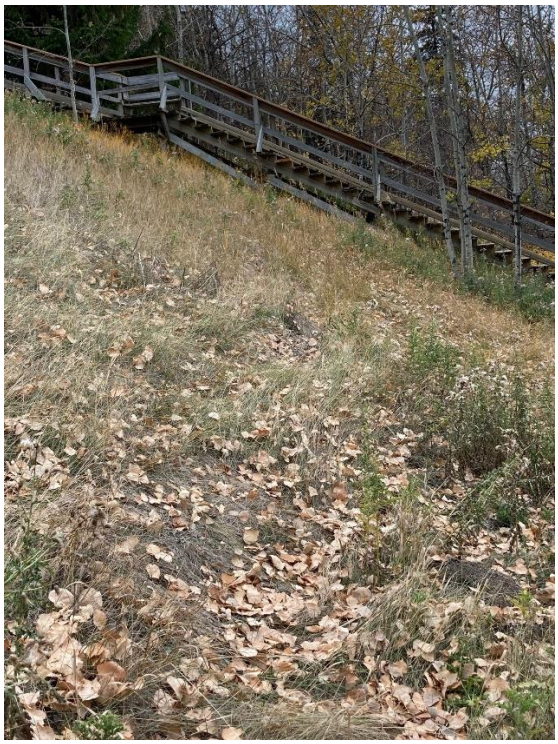


Photo C3: North from the Middle of the Staircase Looking South – Eroded Scarp

Photo C4: Middle of Staircase Looking North - Vegetated Adjacent Slopes, Eroded Scarp

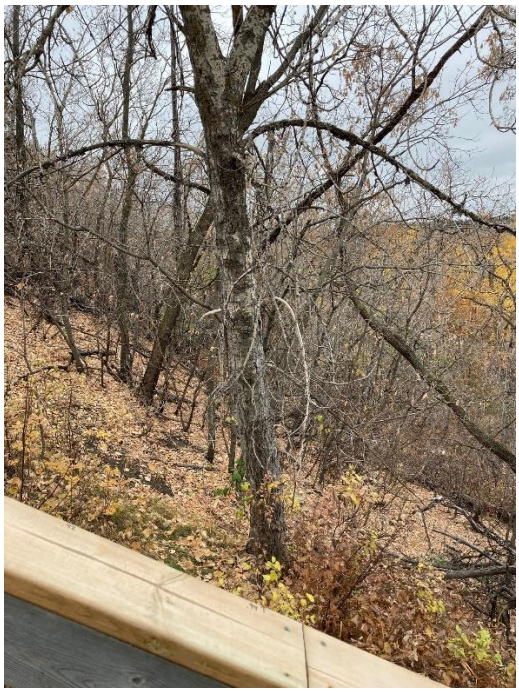


Photo C5: Middle of Staircase Looking South – Tilting Tree

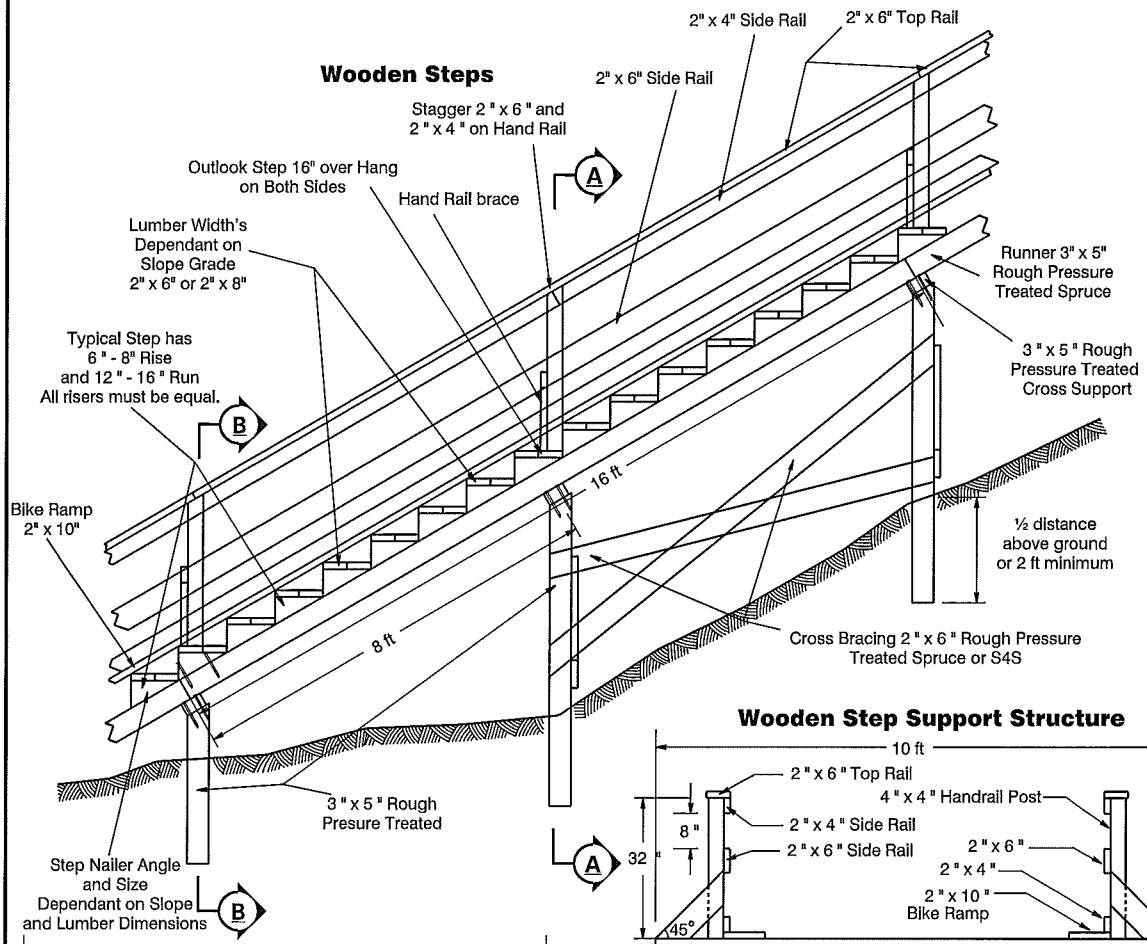
Photo C6: Middle of Staircase Looking East – Existing Foundations

THURBER

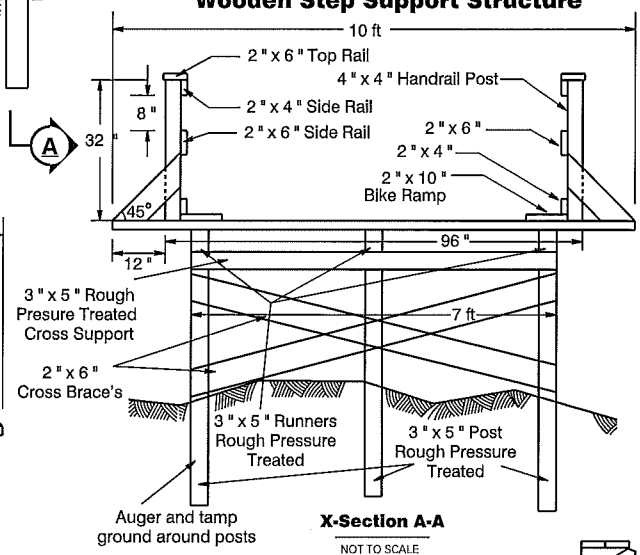
APPENDIX D

City of Edmonton – Wooden Stairs and Support Structure

Wooden Steps



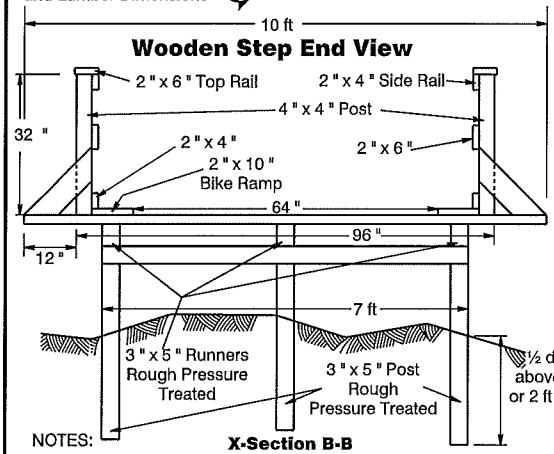
Wooden Step Support Structure



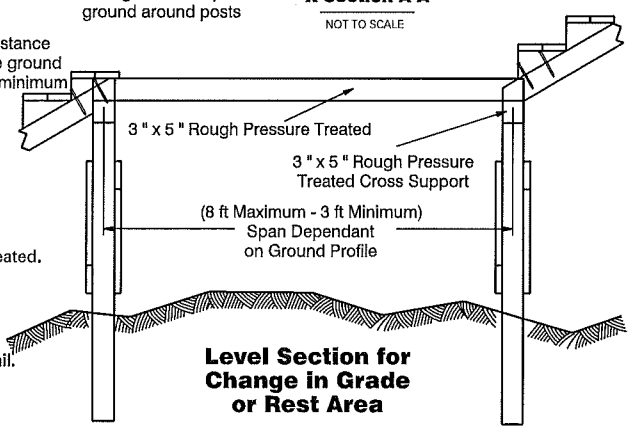
X-Section A-A

NOT TO SCALE

Wooden Step End View



X-Section B-B



Level Section for Change in Grade or Rest Area

NOTES:

1. Stringers Are 3 " x 5 " x 16 ' Rough Pressure Treated.
2. Base Plate:
   a: 2 " x 8 " x 64 " Rough Pressure Treated.
   b: 2⅜" x 5½" Plastic Wood"
   c: 6 " x 8 " x 64 " Pressure Treated.
3. Top Boards or Walking Surface 2 " x 8 " x 64 " Rough Pressure Treated.
4. Hand Rail:
   a: 2 " x 4 " x 16 ' S/4/S Pressure Treated (Side Rail).
   b: 2 " x 6 " x 16 ' S/4/S Pressure Treated (Top Rail).
   c: 4 " x 4 " x 32 " S/4/S Pressure Treated (Handrail Post).
5. Braces 2 " x 8 " Rough Pressure Treated Outlook to Hold Hand Rail.
6. Use 4 " Spiral Nails.
7. All Dimensions are nominal imperial units to correspond to standard lumber sizes.

THE CITY OF Edmonton
STANDARD DRAWING

WOODEN STAIRS AND SUPPORT STRUCTURE

Date Approved:	Drawn By:	Approved	Revision #	Drawing #
FEB., 2011	JW			5201
Scale: NTS	Checked By:			

Appendix H: Hawrelak Park Plant Community Inventory (July 2021)

Hawrelak Park Renewal Plant Species Inventory (21 July 2021)

Species*				Plant Community**			
Scientific Name	**Common Name**	**Origin**	**ACIMS Rank*** **	**Deciduous Mixedwood Mixed Shrubs (DLM.1)**	**Mixed Deciduous Mixed Shrubs (MD.1)**	**Mixed Deciduous Red-Osier Dogwood (MD.2)**	**Riparian (R)**
Trees							
Acer ginnala	amur maple	Exotic	SNA		R	R	O
Acer negundo	Manitoba maple	Native	SU	O	F	F	
Betula papyrifera	white birch	Native	S5			O	R
Cedrus sp.	cedar	Exotic	SNA			R	
Picea glauca	white spruce	Native	S5	O	O	O	
Picea pungens	blue spruce	Exotic	SNA		R	R	
Pinus ponderosa	ponderosa pine	Exotic	SNA		R	R	
Populus balsamifera	balsam poplar	Native	S5	F	F	F	O
Populus tremuloides	aspen	Native	S5	A	F	F	
Salix alba	white willow	Exotic	SNA			R	
Salix sp.	willow					R	O
Sorbus aucuparia	European mountain-ash	Exotic	SNA	O		O	
Ulmus americana	American elm	Exotic	SNA	R	R	R	
Shrubs							
Amelanchier alnifolia	saskatoon	Native	S5	O	O	O	
Caragana arborescens	common caragana	Exotic	SNA			O	
Cornus stolonifera	red-osier dogwood	Native	S5	O	O	A	O
Corylus cornuta	beaked hazelnut	Native	S5	O		F	
Cotoneaster sp.	Cotoneaster	Exotic	SNA	R		O	

Species*				Plant Community**			
Scientific Name	**Common Name**	**Origin**	**ACIMS Rank*** **	**Deciduous Mixedwood Mixed Shrubs (DLM.1)**	**Mixed Deciduous Mixed Shrubs (MD.1)**	**Mixed Deciduous Red-Osier Dogwood (MD.2)**	**Riparian (R)**
Crataegus mordensis	morden hawthorn	Exotic	SNA		O	O	
Lonicera sp.	honeysuckle	Exotic	SNA		O	O	
Malus baccata	Siberian crab apple	Exotic	SNA		O	O	
Prunus pensylvanica	pin cherry	Native	S5			R	
Prunus virginiana	choke cherry	Native	S5	O	O	O	R
Prunus virginiana 'Schubert'	Schubert choke cherry	Exotic	SNA			R	
Quercus macrocarpa	burr oak	Exotic	SNA	R		O	O
Rhamnus catharticus	common buckthorn	Prohibited Noxious	SNA	R	O	O	
Rosa acicularis	prickly rose	Native	S5	O	O	O	O
Rosa woodsii	common wild rose	Native	S5	O	O	O	
Rubus idaeus	wild red raspberry	Native	S5	O	O	O	
Salix bebbiana	beaked willow	Native	S5				O
Salix exigua	narrow-leaf willow	Native	S5				F
Sambucus racemosa	red elderberry	Native	S4	O	R	R	R
Symphoricarpos occidentalis	buckbrush	Native	S5	O	A	F	
Syringa sp.	lilac	Exotic	SNA	R			R
Viburnum edule	low-bush cranberry	Native	S5	R		O	

Species*				Plant Community**			
Scientific Name	**Common Name**	**Origin**	**ACIMS Rank*** **	**Deciduous Mixedwood Mixed Shrubs (DLM.1)**	**Mixed Deciduous Mixed Shrubs (MD.1)**	**Mixed Deciduous Red-Osier Dogwood (MD.2)**	**Riparian (R)**
Viburnum opulus	high-bush cranberry	Native	S3S4		O	O	
Forbs							
Actaea rubra	red and white baneberry	Native	S5	O			
Agrimonia striata	agrimony	Native	S4	R		R	R
Ambrosia artemisiifolia	common ragweed	Native	S3				R
Anemone canadensis	Canada anemone	Native	S5	R	R	R	
Apocynum androsaemifolium	spreading dogbane	Native	S5			O	
Aralia nudicaulis	wild sarsaparilla	Native	S5	O	O	O	
Arctium tomentosum	woolly burdock	Noxious	SNA	R	R	R	R
Artemisia absinthium	absinthe wormwood	Exotic	SNA				R
Capsella bursa-pastoris	shepherd's-purse	Exotic	SNA				R
Chamerion angustifolium	common fireweed	Native	S5		O	O	
Cirsium arvense	creeping thistle	Noxious	SNA	O	F	F	F
Epilobium ciliatum	northern willowherb	Native	S5				F
Equisetum pratense	meadow horsetail	Native	S5	R			
Erigeron sp.	fleabane					R	
Eurybia conspicua	showy aster	Native	S5			O	

Species*				Plant Community**			
Scientific Name	**Common Name**	**Origin**	**ACIMS Rank*** **	**Deciduous Mixedwood Mixed Shrubs (DLM.1)**	**Mixed Deciduous Mixed Shrubs (MD.1)**	**Mixed Deciduous Red-Osier Dogwood (MD.2)**	**Riparian (R)**
Fagopyrum esculentum	common buckwheat	Exotic	SNA				R
Galeopsis tetrahit	hemp-nettle	Exotic	SNA			O	O
Galium boreale	northern bedstraw	Native	S5		O	O	
Galium triflorum	sweet-scented bedstraw	Native	S5	O			
Geranium pratense	meadow crane's-bill	Exotic	SNA				O
Geum aleppicum	yellow avens	Native	S5	R	R	R	
Geum sp.	avens						R
Hackelia virginiana	Stickseed	Exotic	SNA	R	R	R	
Heracleum maximum	cow parsnip	Native	S5	R	O	O	
Lactuca serriola	prickly lettuce	Exotic	SNA			R	
Linaria dalmatica	Dalmatian toadflax	Noxious	SNA			O	
Lycopus uniflorus	northern water-horehound	Native	S3				R
Lysimachia ciliata	fringed loosestrife	Native	S4			R	
Lythrum salicaria	purple loosestrife	Prohibited Noxious	SNA				O
Maianthemum canadense	wild lily-of-the-valley	Native	S5	O	O	O	
Maianthemum stellatum	star-flowered Solomon's-seal	Native	S5	O	O	O	

Species*				Plant Community**			
Scientific Name	**Common Name**	**Origin**	**ACIMS Rank*** **	**Deciduous Mixedwood Mixed Shrubs (DLM.1)**	**Mixed Deciduous Mixed Shrubs (MD.1)**	**Mixed Deciduous Red-Osier Dogwood (MD.2)**	**Riparian (R)**
Matricaria discoidea	pineappleweed	Exotic	SNA				O
Melilotus alba	white sweet-clover	Exotic	SNA		R	R	O
Mentha arvensis	wild mint	Native	S5				O
Persicaria lapathifolia	pale persicaria	Native	S5				F
Pimpinella saxifraga	Burnet-saxifrage	Exotic	SNA		R	R	
Plantago major	common plantain	Exotic	SNA				O
Potentilla norvegica	rough cinquefoil	Native	S5				R
Ranunculus sceleratus	celery-leaved buttercup	Native	S5				R
Rumex fueginus	American Golden Dock	Native	S5				O
Sanicula marilandica	snakeroot	Native	S4S5	R			
Silene latifolia	white cockle, bladder campion	Noxious	SNA				R
Solidago altissima	tall goldenrod	Native	S5		O	O	
Sonchus arvensis	perennial sow-thistle	Noxious	SNA		O	O	O
Sonchus oleraceus	annual sow-thistle	Exotic	SNA		O	O	O
Tanacetum vulgare	common tansy	Noxious	SNA				O
Taraxacum officinale	common dandelion	Exotic	SNA	O		O	F
Thalictrum venulosum	veiny meadow rue	Native	S5	O	O	O	

Species*				Plant Community**			
Scientific Name	**Common Name**	**Origin**	**ACIMS Rank*** **	**Deciduous Mixedwood Mixed Shrubs (DLM.1)**	**Mixed Deciduous Mixed Shrubs (MD.1)**	**Mixed Deciduous Red-Osier Dogwood (MD.2)**	**Riparian (R)**
Thlaspi arvense	stinkweed	Exotic	SNA		R	R	R
Tragopogon dubius	common goat's-beard	Exotic	SNA			R	
Trifolium hybridum	alsike clover	Exotic	SNA			O	
Trifolium repens	white clover	Exotic	SNA				R
Tripleurospermum inodorum	scentless chamomile	Noxious	SNA				R
Urtica dioica	common nettle	Native	S5		R	R	
Vicia americana	wild vetch	Native	S5			O	R
Viola canadensis	western Canada violet	Native	S5	O	O	O	
Graminoids							
Bromus inermis	smooth brome	Exotic	SNA	O	F	F	
Carex aquatilis	water sedge	Native	S5				O
Carex atherodes	awned sedge	Native	S5				O
Carex bebbii	Bebb's sedge	Native	S5				R
Carex sp.	sedge						O
Carex utriculata	small bottle sedge	Native	S5				O
Echinochloa crusgalli	barnyard grass	Exotic	SNA				R
Eleocharis palustris	creeping spike-rush	Native	S5				R
Elymus repens	quackgrass	Exotic	SNA		O	O	
Glyceria grandis	common tall manna grass	Native	S5				R

Species*				Plant Community**			
Scientific Name	**Common Name**	**Origin**	**ACIMS Rank*** **	**Deciduous Mixedwood Mixed Shrubs (DLM.1)**	**Mixed Deciduous Mixed Shrubs (MD.1)**	**Mixed Deciduous Red-Osier Dogwood (MD.2)**	**Riparian (R)**
Hordeum jubatum	foxtail barley	Native	S5				O
Juncus balticus	wire rush	Native	S5				R
Phalaris arundinacea	reed canary grass	Native	S5				O
Poa palustris	fowl bluegrass	Native	S5				R
Poa pratensis	Kentucky bluegrass	Native	S5			O	F
Schoenoplectus tabernaemontani	common great bulrush	Native	S5				O
Scirpus microcarpus	small-fruited bulrush	Native	S5				R
Typha latifolia	common cattail	Native	S5				O
Species Richness				**38**	**43**	**67†**	**57†**
Native Species Richness				**27**	**25**	**35**	**31**
Exotic Species Richness				**8**	**14**	**25**	**16**
Prohibited Noxious/Noxious Species Richness				**3**	**4**	**5**	**7**

*Scientific nomenclature, common names and rank follow ACIMS (2018)

**Species abundance abbreviations per location are as follows: D=dominant, A=abundant, F=frequent, O=occasional, R=rare

***ACIMS Rank definitions are as follows: S5=Secure, S4=Apparently Secure, S3=Known from 100 or fewer occurrences in the province, S2=Known from 20 or fewer occurrences in the province, S1= Known from 5 or fewer occurrences in the province.

†Total number of species does not add up as some species were not fully identified to species and, therefore, could not be labelled as native, exotic or noxious.

Appendix I: Wildlife List

Hawrelak Park Wildlife List

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
Wood Frog	*Lithobates sylvaticus*	Amphibian	Secure		LP Candidate (SSC)		Spencer 2021		
Boreal Chorus Frog	*Pseudacris maculata*	Amphibian	Secure		LP Candidate (SSC)		Spencer 2021		
Western Tiger Salamander	*Ambystoma mavortium*	Amphibian	Secure		Special Concern	Schedule 1 (Special Concern)	CoE Observation	Breeding, foraging	High
Common Garter Snake	*Thamnophis sirtalis*	Reptile	Sensitive		MP Candidate (SSC)				
Canada Goose	*Branta canadensis*	Bird	Secure				Spencer 2021, eBird		
Wood Duck	*Aix sponsa*	Bird	Secure						
Gadwall	*Mareca strepera*	Bird	Secure						
American Wigeon	*Mareca americana*	Bird	Secure				Spencer 2021, eBird		
Mallard	*Anas platyrhynchos*	Bird	Secure				Spencer 2021, eBird		
Blue-winged Teal	*Spatula discors*	Bird	Secure				Spencer 2021		
Cinnamon Teal	*Spatula cyanoptera*	Bird	Secure						
Northern Shoveler	*Spatula clypeata*	Bird	Secure						
Northern Pintail	*Anas acuta*	Bird	Secure						
Green-winged Teal	*Anas crecca carolinensis*	Bird	Secure						
Canvasback	*Aythya valisineria*	Bird	Secure						
Redhead	*Aythya americana*	Bird	Secure						
Ring-necked Duck	*Aythya collaris*	Bird	Secure						
Lesser Scaup	*Aythya affinis*	Bird	Secure				Spencer 2021, eBird		
Bufflehead	*Bucephala albeola*	Bird	Secure						
Common Goldeneye	*Bucephala clangula*	Bird	Secure				Spencer 2021, eBird		
Ruddy Duck	*Oxyura jamaicensis*	Bird	Secure						
Gray Partridge	*Perdix perdix*	Bird	Exotic/Alien				eBird		
Horned Grebe	*Podiceps auritus*	Bird	Sensitive		Special Concern	Schedule 1 (Special Concern)	Spencer 2021		
Red-necked Grebe	*Podiceps grisegena*	Bird	Secure				Spencer 2021		
Rock Pigeon	*Columba livia*	Bird	Exotic/Alien				eBird		
Mourning Dove	*Zenaida macroura*	Bird	Secure				eBird		
Common Nighthawk	*Chordeiles minor*	Bird	Sensitive		Special Concern	Schedule 1 (Threatened)	eBird	Foraging	Low
Ruby-throated Hummingbird	*Archilochus colubris*	Bird	Secure				eBird		
Sora	*Porzana carolina*	Bird	Sensitive				Spencer 2021, eBird		
American Coot	*Fulica americana*	Bird	Secure		Not at Risk		Spencer 2021		
Black-bellied Plover	*Pluvialis squatarola*	Bird	Secure				eBird		
Killdeer	*Charadrius vociferus*	Bird	Secure		HP Candidate (SSC)		eBird		
Spotted Sandpiper	*Actitis macularius*	Bird	Secure				eBird		
Solitary Sandpiper	*Tringa solitaria*	Bird	Secure				eBird		
Greater Yellowlegs	*Tringa melanoleuca*	Bird	Secure				eBird		
Lesser Yellowlegs	*Tringa flavipes*	Bird	Secure		Threatened		eBird	Foraging	Low
Wilson's Snipe	*Gallinago delicata*	Bird	Secure						
Bonaparte's Gull	*Chroicocephalus philadelphia*	Bird	Secure				eBird		
Franklin's Gull	*Leucophaeus pipixcan*	Bird	Secure		LP Candidate (SSC)		Spencer 2021		
Ring-billed Gull	*Larus delawarensis*	Bird	Secure				Spencer 2021, eBird		
California Gull	*Larus californicus*	Bird	Secure				eBird		
Common Tern	*Sterna hirundo*	Bird	Secure		Not at Risk				

Hawrelak Park Wildlife List

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
Forster's Tern	*Sterna forsteri*	Bird	Sensitive						
Great Blue Heron	*Ardea herodias*	Bird	Sensitive				eBird		
Black-crowned Night Heron	*Nycticorax nycticorax*	Bird	Sensitive				eBird		
Osprey	*Pandion haliaetus*	Bird	Sensitive						
Bald Eagle	*Haliaeetus leucocephalus*	Bird	Sensitive		Not at Risk				
Sharp-shinned Hawk	*Accipiter striatus*	Bird	Secure		Not at Risk				
Cooper's Hawk	*Accipiter cooperii*	Bird	Secure		Not at Risk				
Swainson's Hawk	*Buteo swainsoni*	Bird	Secure						
Red-tailed Hawk	*Buteo jamaicensis*	Bird	Secure		Not at Risk				
Great Horned Owl	*Bubo virginianus*	Bird	Secure				eBird		
Snowy Owl	*Bubo scandiacus*	Bird	Secure		MP Candidate (SSC)				
Barred Owl	*Strix varia*	Bird	Sensitive	Special Concern			FWMIS, eBird	Breeding, foraging	High
Great Grey Owl	*Strix nebulosa*	Bird	Sensitive		Not at Risk				
Short-eared Owl	*Asio flammeus*	Bird	May Be At Risk		Special Concern	Schedule 1 (Special Concern)	FWMIS	Foraging	Low
Boreal Owl	*Aegolius funereus*	Bird	Secure		Not at Risk				
Northern Saw-whet Owl	*Aegolius acadicus*	Bird	Secure				eBird		
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Bird	Secure				eBird		
Downy Woodpecker	*Dryobates pubescens*	Bird	Secure				Spencer 2021, eBird		
Hairy Woodpecker	*Dryobates villosus*	Bird	Secure				Spencer 2021, eBird		
Black-backed Woodpecker	*Picoides arcticus*	Bird	Sensitive				eBird		
Northern Flicker	*Colaptes auratus*	Bird	Secure				eBird		
Pileated Woodpecker	*Colaptes pileatus*	Bird	Sensitive				Spencer 2021, eBird		
American Kestrel	*Falco sparverius*	Bird	Sensitive		LP Candidate (SSC)				
Merlin	*Falco columbarius*	Bird	Secure		Not at Risk		eBird		
Gyrfalcon	*Falco rusticolus*	Bird	Secure		Not at Risk				
Peregrine Falcon	*Falco peregrinus anatum/tundrius*	Bird	At Risk	Threatened	Not at Risk	Schedule 1 (Special Concern)		Foraging	Low
Prairie Falcon	*Falco mexicanus*	Bird	Sensitive	Special Concern	Not at Risk				
Olive-sided Flycatcher	*Contopus cooperi*	Bird	May Be At Risk		Special Concern	Schedule 1 (Threatened)	eBird	Foraging	Low
Alder Flycatcher	*Empidonax alnorum*	Bird	Secure				eBird		
Least Flycatcher	*Empidonax minimus*	Bird	Sensitive		LP Candidate (SSC)		eBird		
Eastern Phoebe	*Sayornis phoebe*	Bird	Sensitive				eBird		
Western Kingbird	*Tyrannus verticalis*	Bird	Secure						
Eastern Kingbird	*Tyrannus tyrannus*	Bird	Sensitive				eBird		
Northern Shrike	*Lanius excubitor*	Bird	Secure				eBird		
Blue-headed Vireo	*Vireo solitarius*	Bird	Secure				eBird		
Warbling Vireo	*Vireo gilvus*	Bird	Secure				eBird		
Philadelphia Vireo	*Vireo philadelphicus*	Bird	Secure				eBird		
Red-eyed Vireo	*Vireo olivaceus*	Bird	Secure				Spencer 2021, eBird		
Canada Jay	*Perisoreus canadensis*	Bird	Secure						
Blue Jay	*Cyanocitta cristata*	Bird	Secure				Spencer 2021, eBird		
Black-billed Magpie	*Pica hudsonia*	Bird	Secure				Spencer 2021, eBird		
American Crow	*Corvus brachyrhynchos*	Bird	Secure				Spencer 2021, eBird		

Hawrelak Park Wildlife List

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
Common Raven	*Corvus corax*	Bird	Secure				eBird		
Tree Swallow	*Tachycineta bicolor*	Bird	Secure				eBird		
Barn Swallow	*Hirundo rustica*	Bird	Sensitive		Special Concern	Schedule 1 (Threatened)	eBird	Breeding, Foraging	Moderate
Black-capped Chickadee	*Poecile atricapillus*	Bird	Secure				Spencer 2021, eBird		
Boreal Chickadee	*Poecile hudsonicus*	Bird	Secure				eBird		
Red-breasted Nuthatch	*Sitta canadensis*	Bird	Secure				Spencer 2021, eBird		
White-breasted Nuthatch	*Sitta carolinensis*	Bird	Secure				Spencer 2021, eBird		
Brown Creeper	*Certhia americana*	Bird	Sensitive				eBird		
House Wren	*Troglodytes aedon*	Bird	Secure				eBird		
Winter Wren	*Troglodytes hiemalis*	Bird	Secure						
Sedge Wren	*Cistothorus platensis*	Bird	Sensitive		Not at Risk				
Marsh Wren	*Cistothorus palustris*	Bird	Secure				eBird		
Golden-crowned Kinglet	*Regulus satrapa*	Bird	Secure				eBird		
Ruby-crowned Kinglet	*Regulus calendula*	Bird	Secure				Spencer 2021, eBird		
American Robin	*Turdus migratorius*	Bird	Secure				eBird		
Gray Catbird	*Dumetella carolinensis*	Bird	Secure				eBird		
European Starling	*Sturnus vulgaris*	Bird	Exotic/Alien				eBird		
Bohemian Waxwing	*Bombycilla garrulus*	Bird	Secure				eBird		
Cedar Waxwing	*Bombycilla cedrorum*	Bird	Secure				eBird		
House Sparrow	*Passer domesticus*	Bird	Exotic/Alien				eBird		
Pine Grosbeak	*Pinicola enucleator*	Bird	Secure				eBird		
Purple Finch	*Haemorhous purpureus*	Bird	Secure				eBird		
Cassin's Finch	*Haemorhous cassinii*	Bird	Secure						
House Finch	*Haemorhous mexicanus*	Bird	Secure				eBird		
Red Crossbill	*Loxia curvirostra*	Bird	Secure				eBird		
White-winged Crossbill	*Loxia leucoptera*	Bird	Secure				eBird		
Common Redpoll	*Acanthis flammea*	Bird	Secure				eBird		
Hoary Redpoll	*Acanthis hornemanni*	Bird	Secure				eBird		
Pine Siskin	*Spinus pinus*	Bird	Secure				eBird		
American Goldfinch	*Spinus tristis*	Bird	Secure				eBird		
American Tree Sparrow	*Spizelloides arborea*	Bird	Secure				eBird		
Chipping Sparrow	*Spizella passerina*	Bird	Secure				Spencer 2021, eBird		
Clay-colored Sparrow	*Spizella pallida*	Bird	Secure				eBird		
Savannah Sparrow	*Passerculus sandwichensis*	Bird	Secure				eBird		
Le Conte's Sparrow	*Ammodramus leconteii*	Bird	Secure						
Fox Sparrow	*Passerella iliaca*	Bird	Secure				eBird		
Song Sparrow	*Melospiza melodia*	Bird	Secure				Spencer 2021, eBird		
White-throated Sparrow	*Zonotrichia albicollis*	Bird	Secure				Spencer 2021, eBird		
Dark-eyed Junco	*Junco hyemalis*	Bird	Secure				Spencer 2021, eBird		
Red-winged Blackbird	*Agelaius phoeniceus*	Bird	Secure				Spencer 2021, eBird		
Common Grackle	*Quiscalus quiscula*	Bird	Secure				eBird		
Brown-headed Cowbird	*Molothrus ater*	Bird	Secure				eBird		

Hawrelak Park Wildlife List

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
Baltimore Oriole	*Icterus galbula*	Bird	Sensitive				eBird		
Tennessee Warbler	*Oreothlypis peregrina*	Bird	Secure				eBird, Spencer 2021		
Orange-crowned Warbler	*Oreothlypis celata*	Bird	Secure				eBird		
Nashville Warbler	*Oreothlypis ruficapilla*	Bird	Secure				eBird		
Yellow Warbler	*Setophaga petechia*	Bird	Secure				Spencer 2021, eBird		
Chestnut-sided Warbler	*Setophaga pensylvanica*	Bird	Secure				eBird		
Magnolia Warbler	*Setophaga magnolia*	Bird	Secure				eBird		
Cape May Warbler	*Setophaga tigrina*	Bird	Sensitive	Special Concern			eBird	Migrating, foraging	Low
Yellow-rumped Warbler	*Setophaga coronata*	Bird	Secure				Spencer 2021, eBird		
Black-Throated Green Warbler	*Setophaga virens*	Bird	Sensitive	Special Concern			eBird	Migrating, foraging	Low
Palm Warbler	*Setophaga palmarum*	Bird	Secure				eBird		
Bay-breasted Warbler	*Setophaga castanea*	Bird	Sensitive				FWMIS, eBird		
Blackpoll Warbler	*Setophaga striata*	Bird	Secure				eBird		
Black-and-white Warbler	*Mniotilta varia*	Bird	Secure				eBird		
American Redstart	*Setophaga ruticilla*	Bird	Secure				eBird		
Ovenbird	*Seiurus aurocapilla*	Bird	Secure				eBird		
Northern Waterthrush	*Parkesia noveboracensis*	Bird	Secure				eBird		
Connecticut Warbler	*Oporornis agilis*	Bird	Secure		LP Candidate (SSC)		eBird	Migrating, foraging	Low
Mourning Warbler	*Geothlypis philadelphia*	Bird	Secure				eBird		
Common Yellowthroat	*Geothlypis trichas*	Bird	Sensitive				eBird		
Wilson's Warbler	*Cardellina pusilla*	Bird	Secure				eBird		
Canada Warbler	*Cardellina canadensis*	Bird	At Risk		Special Concern	Schedule 1 (Threatened)	eBird	Migrating, foraging	Low
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Bird	Secure				eBird		
Snowshoe Hare	*Lepus americanus*	Mammal	Secure				Spencer 2021		
White-tailed Jack Rabbit	*Lepus townsendii*	Mammal	Secure						
Least Chipmunk	*Neotamias minimus*	Mammal	Secure				Spencer 2021		
Richardson's Ground Squirrel	*Urocitellus richardsonii*	Mammal	Secure						
Red Squirrel	*Tamiasciurus hudsonicus*	Mammal	Secure				Spencer 2021		
Northern Flying Squirrel	*Glaucomys sabrinus*	Mammal	Secure						
Northern Pocket Gopher	*Thomomys talpoides*	Mammal	Secure						
American Beaver	*Castor canadensis*	Mammal	Secure				CoE, Spencer 2021		
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				Spencer 2021		
House Mouse	*Mus musculus*	Mammal	Exotic/Alien						
Common Porcupine	*Erethizon dorsatum*	Mammal	Secure						
Masked Shrew	*Sorex cinereus*	Mammal	Secure						
Water Shrew	*Sorex palustris*	Mammal	Secure						
Little Brown bat	*Myotis lucifugus*	Mammal	May Be At Risk		Endangered	Schedule 1 (Endangered)		Roosting, foraging	High

Hawrelak Park Wildlife List

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
Northern Bat	*Myotis septentrionalis*	Mammal	May Be At Risk	Data Deficient	Endangered	Schedule 1 (Endangered)	FWMIS	Roosting, foraging	Moderate
Big Brown Bat	*Eptesicus fuscus*	Mammal	Secure						
Coyote	*Canis latrans*	Mammal	Secure				CoE, Spencer 2021		
Red Fox	*Vulpes vulpes*	Mammal	Secure						
Long-tailed Weasel	*Mustela frenata*	Mammal	May Be At Risk		Not at Risk			Breeding, foraging	Low
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						
Mule Deer	*Odocoileus hemionus*	Mammal	Secure						
White-tailed Deer	*Odocoileus virginianus*	Mammal	Secure				CoE Observation		

* 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).

** Sources of species records: Spencer 2021 = 2021 field investigations (BBS, waterbird survey, amphibian surveys, etc.) and site visit incidental observations, FWMIS = fish and wildlife Management Information System (Accessed 15 January 2021, observation dates not known), eBird = The Cornell Lab of Ornithology eBird (Accessed 29 September 2021, observation dates range from 2000 to 2021)

Appendix J: *Historical Resources Act* Approval with Conditions

Alberta

HRA Number: 4725-21-0034-001
July 14, 2021

Historical Resources Act Approval with Conditions

Proponent: City of Edmonton
12 Floor Civic Tower, 10111 - 104 Avenue, Edmonton, AB T5J 0J4
Contact: Rachel Dumont

Agent: Circle CRM Group Inc.
Contact: Alexandra Burchill

Project Name: **Hawrelak Park Renewal**

Project Components: Park Development

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 the following conditions.

David Link
Assistant Deputy Minister
Heritage Division
Alberta Culture and Status of Women

SCHEDULE OF CONDITIONS

ARCHAEOLOGICAL RESOURCES

Historical Resources Act approval is granted in relation to archaeological resources, subject to the conditions outlined below.

SCHEDULE OF CONDITIONS (continued)

1. Development plans for individual renewal components that are located within or immediately adjacent to archaeological site FjPj-65, or within less disturbed areas bordering the river bank, as illustrated in the attached figure, and that will result in substantial subsurface disturbance must be submitted for review by Alberta Culture and Status of Women. These project components include, but are not limited to, rehabilitation of the storm sewer system, upgrades to buried power, gas and telecommunication utilities, addition of new pathways, and any site grading. The plans for these individual components must be submitted in a new Historic Resources Application prior to the onset of development activities. The application must be accompanied by GIS shapefiles.

   Depending on the nature and location of specific project components, a Historic Resources Impact Assessment for archaeological resources may be required prior to development proceeding in these areas.

   Two maps illustrating the areas of concern are attached to facilitate project planning.

2. Archaeological site FjPj-65 must be avoided during all development activities. A map and shapefiles of the site location are attached to facilitate site avoidance. These files contain sensitive information about historic resources that are protected under provisions of the *Historical Resources Act*. This information is provided to your organization to be used in planning the proposed project only. It is not to be shared for any other purpose without permission from the Historic Resources Management Branch, Alberta Culture and Status of Women.

   If avoidance is not feasible, then further archaeological studies at site FjPj-65 may be required, as outlined below.

3. All other development activities that occur outside the area of concern and site FjPj-65 may proceed as planned without further concerns for archaeological resources.

4. Site-specific conditions and approvals are itemized below.

SITE	HRV	SITE DESCRIPTION	CONDITIONS/APPROVAL
FjPj-65	4	campsite, scatter >10	This site requires avoidance or additional studies relative to all proposed components associated with the Hawreluk Park renewal project. If avoidance is not feasible, then development plans for individual renewal components that are located within or that cross site FjPj-65 must be submitted for review by Alberta Culture and Status of Women. Depending on the nature of and anticipated impact of specific project components, a Historic Resources Impact Assessment may be required prior to development proceeding in the area of site FjPj-65.

PALAEONTOLOGICAL RESOURCES

Conditional *Historical Resources Act* approval is granted on the understanding that a Historic Resources Impact Assessment for palaeontological resources in the form of a monitoring program will be conducted, as outlined below.

1. The monitoring program is required for areas of undisturbed fluvial deposits that sit outside the margins of the existing ring road where significant subsurface disturbance (>1m below surface) will occur.

SCHEDULE OF CONDITIONS (continued)

2. No excavation activities greater than one (1) metre below surface are to take place in the above-mentioned areas until a professional consulting palaeontologist is on site to monitor construction activities. Should significant palaeontological resources be encountered during the conduct of the monitoring program, the Royal Tyrrell Museum of Palaeontology must be contacted. It may then be necessary for Alberta Culture and Status of Women to issue further instructions regarding these resources.

3. The Historic Resources Impact Assessment for palaeontological resources is to be conducted on behalf of the proponent by a palaeontologist qualified to hold a palaeontological research permit within the Province of Alberta. A permit must be issued by Alberta Culture and Status of Women prior to the initiation of any palaeontological field investigations. Please allow ten working days for the permit application to be processed. To obtain contact information for consultants qualified to undertake this work, please consult the list of Alberta Historic Resource Consultants.

ABORIGINAL TRADITIONAL USE SITES

There are no *Historical Resources Act* requirements associated with Aboriginal traditional use sites of a historic resource nature; however, the proponent must comply with Standard Requirements under the Historical Resources Act: Reporting the Discovery of Historic Resources, which are applicable to all land surface disturbance activities in the Province.

HISTORIC STRUCTURES

There are no *Historical Resources Act* requirements associated with historic structures; however, the proponent must comply with Standard Requirements under the *Historical Resources Act*: Reporting the Discovery of Historic Resources, which are applicable to all land surface disturbance activities in the Province.

PROVINCIALLY DESIGNATED HISTORIC RESOURCES

There are no *Historical Resources Act* requirements associated with Provincially Designated Historic Resources; however, the proponent must comply with Standard Requirements under the *Historical Resources Act*: Reporting the Discovery of Historic Resources, which are applicable to all land surface disturbance activities in the Province.

ADDITIONAL COMMENTS

1. In addition to any specific conditions detailed above, the proponent must abide by all Standard Conditions under the *Historical Resources Act*.

Lands Affected: All New Lands

Proposed Development Area:

MER	RGE	TWP	SEC	LSD List
4	25	52	36	1-3,6-8
4	24	52	30	13
4	24	52	31	4

SCHEDULE OF CONDITIONS (continued)

4	25	52	25		9,15-16

Documents Attached:

Document Name	Document Type
4725-21-0034-001_Archaeological site FjPj65_for_avoidance	Review
4725-21-0034-001_Areas_of_Archaeological Concern for CMSW Review	Review
Proposed park space configuration	Miscellaneous
Shapefiles SiteFjPj-65 for avoidance	GIS Data File

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

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

1.0 REPORTING THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

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

2.0 REPORTING THE DISCOVERY OF PALAEONTOLOGICAL RESOURCES

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

3.0 REPORTING THE DISCOVERY OF HISTORIC PERIOD SITES

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

4.0 REPORTING THE DISCOVERY OF ABORIGINAL TRADITIONAL USE SITES

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

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

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

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

5.0 FURTHER SALVAGE, PRESERVATIVE OR PROTECTIVE MEASURES

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

Appendix K: Project Activities and VECs Matrix

Project Activities and Valued Ecosystem Components Matrix

Project Activity	Valued Ecosystem Components										
	Surface Water Quality	Groundwater	Fish and Fish Habitat (Direct Interaction)	Geo-morphology	Soils	Vegetation - Natural	Vegetation - Open Space Trees and Shrubs	Wildlife			Historical Resources
								Herptiles	Birds	Habitat Connectivity	
Open Space, Outdoor Amenities, Wayfinding											
Regrade and/or repair turf areas to address compacted areas and areas experiencing poor surface drainage	✓				✓						
Regrade picnic sites to improve drainage; increase the number of accessible picnic sites that include an asphalt connection	✓				✓						
Enhance/augment select perimeter forest edges						✓			✓	✓	
Add plantings around the park's entrance to create a 'gateway'							✓				
Identify and remove invasive plant species						✓	✓				
Improve the playground, including providing accessible circulation, updating equipment and providing more diverse play features					✓		✓				
Potentially repair or replace the Hawrelak Lake dock with a removable option	✓				✓			✓	✓		
Install new boardwalk on the eastern lakefront	✓				✓			✓	✓		
Replace existing 3m wide bridge at the creek/lake interface with a 3.0 m wide vehicle rated bridge	✓					✓					
Enhance native vegetation on margins of constructed wetland and creek						✓			✓	✓	
Circulation											
Rehabilitate existing trails/paths; add new paths in manicured areas	✓				✓	✓	✓				
Replace wooden stairway on east park slope				✓	✓	✓			✓		
Increase vehicle outbound lanes from two to three lanes and expand the turning movement toward the south to a double right-turn lane					✓		✓				
Remove existing D-loop road to the service yard and replace with a southbound lane on the main circulation road up to the southern most entrance to the service yard					✓						
Repave all roads based on usage and replace curbing	✓										
Circulation Lighting Strategy											
Install lighting that clearly defines routes of travel through the park (lighting design will comply with Light Efficiency Guidelines)									✓	✓	

Project Activities and Valued Ecosystem Components Matrix

Project Activity	Valued Ecosystem Components										
	Surface Water Quality	Groundwater	Fish and Fish Habitat (Direct Interaction)	Geo-morphology	Soils	Vegetation - Natural	Vegetation - Open Space Trees and Shrubs	Wildlife			Historical Resources
								Herptiles	Birds	Habitat Connectivity	
Install new lighting at access to existing Buena Vista/Hawrelak Park pedestrian bridge									✓	✓	
Heritage Amphitheatre											
Reconfigure parking, road entry, turnaround and addition of pedestrian pathway					✓		✓				
Potentially renew or replace outdoor seating					✓						
Add lighting to support pedestrian access from the parking lot									✓	✓	
Reconfigure the fence around the facility using a slatted system					✓		✓				
Add plantings along new fence							✓				
Regrade the slope coming up to the main entry to 1:20 slope to create a more accessible path					✓		✓				
Boat Pavilion											
Potentially replace/repair washed-out fill below the boat pavilion and the potentially displaced column/beam support	✓	✓			✓			✓			
Replace concrete surrounding the facility	✓							✓			
Install additional lighting for security									✓	✓	
Picnic Shelters											
Add gender inclusive washrooms to Shelter #1 and 2, and redevelop Shelter #3 to incorporate the gender inclusive concept. Add universal/family room, possibly expanding the footprint					✓		✓				
Service Yard											
Demolish the existing aggregate and fuel sheds and replace them with a new aggregate and fuel facility along the west side of the service yard					✓						
Remove the existing road on the west side of the yard and replace with a new gravel road located further west					✓						
Expand staff parking and the main entrance to include 8 m two-way circulation, expand yard footprint by 40 m^2					✓		✓				
Pumphouse											
Potentially replace or rehabilitate building facade and pump						✓					
Remove surrounding chainlink fence					✓			✓		✓	

Project Activities and Valued Ecosystem Components Matrix

Project Activity	Valued Ecosystem Components										
	Surface Water Quality	Groundwater	Fish and Fish Habitat (Direct Interaction)	Geo-morphology	Soils	Vegetation - Natural	Vegetation - Open Space Trees and Shrubs	Wildlife			Historical Resources
								Herptiles	Birds	Habitat Connectivity	
Potentially repair or replace river intake pipe - insteam work	✓		✓	✓	✓	✓					✓
Underground Utilities											
Rehabilitate the entire water distribution system within the park and expand the system as required to provide fire coverage at Washroom/Shelter #2, the Service Yard, Heritage Amphitheatre and Main Pavilion	✓	✓			✓		✓				
Rehabilitate the sanitary and storm systems	✓	✓	✓		✓	✓	✓	✓			✓
Relocate the road storm sewer network and associated catch basins if parking and road realignments are made	✓				✓						
Repair riverbank storm outfalls (3 or 4)	✓	✓	✓	✓	✓	✓		✓			✓
Abandon and replace the irrigation line layout	✓	✓			✓		✓				
Hawrelak Lake											
Dredge the lake to remove accumulated sediment, to the original lake bottom elevation	✓	✓			✓	✓		✓	✓		
Dredging may require lake dewatering, possibly to the river, depending on dredging method selected	✓		✓			✓		✓	✓		
Goose nesting management - may be required									✓		
Install an 8 m wide planted buffer around the majority of Hawrelak Lake to deter geese (as a water quality improvement measure)						✓		✓	✓	✓	
Establish woody vegetation in open areas on islands to deter goose nesting						✓		✓			
Establish deep marsh emergent vegetation along shoreline segments						✓		✓	✓		
Potentially replace lake outfall mechanical system	✓		✓		✓						
Install a control structure (or two) on the existing park stormwater lines so that if and when lake elevation gets too high, water would automatically discharge into the North Saskatchewan	✓		✓								

** Assumes BMPs regarding soil handling when working in turf areas.*

**Assumes soil erosion and water quality are only a concern when working near water bodies.*

Appendix L: Public Engagement - Reporting Back (City of Edmonton 2018)

PUBLIC ENGAGEMENT

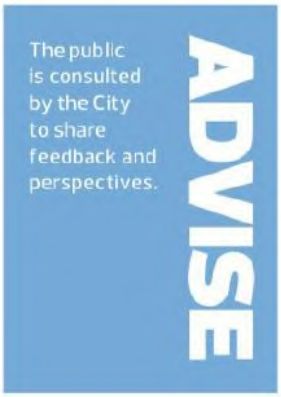
SHARE YOUR VOICE SHAPE OUR CITY

Reporting Back

2018 William Hawrelak Park Rehabilitation Plan

Project/Initiative Background

William Hawrelak Park is the most intensively used park in Edmonton. A wide variety of festivals, events, performances and casual users visit the Park annually from across the City as well as visitors to Edmonton. This 68-hectare manicured park in the river valley features a five -hectare lake and open grassy areas. The park supports five bookable picnic sites, a playground and access to walking and bike trails. A pavilion adjacent to the lake provides year-round access to washrooms, food service and in winter skate rentals. An outdoor patio provides seating, viewing areas, and a gas fire feature for those enjoying outdoor activities. In summer another building supports paddle boat operation. The park is also home to the Heritage Amphitheatre, Western Canada's largest outdoor amphitheatre. The park opened in 1967 and much of the infrastructure is original to the park and now in need of replacement. The 10-year William Hawrelak Park Rehabilitation Plan will guide the future capital investment of the park.

Name	**2018 William Hawrelak Park Rehabilitation Plan Public Engagement**
Date	A series of public engagements took place from June to October 2018.
Location	The engagements were held online through www.edmonton.ca, at William Hawrelak Park through Intercept and Drop Box surveys, at a Neighbourhood In-Person Session, and through Festival and Event Organizer Group sessions.
Level of public engagement	

Description	The public engagement was held to advise on the rehabilitation of William Hawrelak Park.

1. Executive Summary

The **10-year William Hawrelak Park Rehabilitation Plan** will guide the future capital investment of the park; addressing renewal of park infrastructure and improving the functionality of infrastructure to better support the existing programs and services of the park. The intent of the rehabilitation plan is aligned with the Community and Recreation Facility Branch Mandate to extend the life of William Hawrelak Park so that it continues to enhance the liveability and vibrancy of our city by providing places and opportunities for all Edmontonians to gather, connect, create and celebrate.

The **2018 William Hawrelak Park Rehabilitation Public Engagement Plan** supports the development of the Rehabilitation Plan by contributing to the understanding of how the park is currently functioning. Engagement of various audiences on the **rehabilitation** of William Hawrelak Park was completed in June and July of 2018.

Audiences
A broad audience was invited to engage with the City through an online survey, intercept and drop-box surveys at the park, and a neighbourhood in-person event. Targeted festival and event organizers were invited to engage through a focus group session. A communications plan that supported the public engagement plan ensured that these audiences were invited to the engagement events.

Key findings
In general, respondents in the engagements are proud of William Hawrelak Park, are passionate that the green space is not compromised, and the main features of the park remain the same. They believe the park is "getting old" and needs a shape-up to get it back to more modern standards. This shape-up consists mainly of aesthetic upgrades to the aspects of the park that already exist with the washrooms being the main aspect requiring attention.

Overall improvements
The **washrooms** in the park were clearly identified as the priority rehabilitation aspect for respondents. Other areas pinpointed for improvement (not in priority order):

- More seating areas
- Better picnic sites
- Better walking pathways
- Better signage inside the park
- Better trails for walking
- Parking
- Improved playground

How does your input impact the decision or next steps?
Your input will be used to help develop the rehabilitation plan and eventual implementation plans for the rehabilitation of William Hawrelak Park. The plan will be implemented over 10 years to extend the life of the park.

2. Engagement Techniques

The public engagement was held to advise on the rehabilitation of William Hawrelak Park.

The following public engagements were held:

Online
The **broad and open audience** was invited to engage through an **open link online survey** and through the **City of Edmonton's Online Insight Community**. A comprehensive set of questions and input opportunities were designed to cover the various aspects of the park to be considered for rehabilitation. A total of 1194 respondents started the survey process.

Intercept Surveys (William Hawrelak Park)
A team of City of Edmonton-affiliated survey takers approached users at William Hawrelak Park on the dates of July 15, 16, and 17. The locations were the Buena Vista footbridge/Hawrelak Park entrance, main entrance, playground/trail area towards the south pavilion, the main pavilion, open spaces. parking lot, picnic sites, and amphitheatre.

The intercept survey team completed 850 short surveys in-person with park users asking users to provide input on a short list of questions related to park rehabilitation. The questions are covered further in this report.

The 850 surveys were culled to 236 surveys for the purpose of this report. The criteria: a singular neighbourhood identified and 50% of each neighbourhood randomly selected as a sample of the audience.

Drop-Box Surveys (William Hawrelak Park)
Two drop boxes were also placed at William Hawrelak Park during the dates of July 11 – 20, 2018. The locations were the Main Pavilion and the picnic shelter at the Buena Vista Footbridge/Hawrelak Park entrance.

Park users completed 250 short surveys answering the same questions used with the Intercept Survey. The questions are covered further in this report.

Neighbourhood In-Person Event
An open public engagement session for all audiences was held July 11, 2018 at the Windsor Park Community League. An open invitation was available to all audiences though various communications channels and a targeted, mailed invitation was delivered to Windsor Park community residents. Twenty-one (21) Edmontonians attended this session.

Targeted Festival and Event Organizers Focus Group
Focus group sessions were held in June 2018 with two main Festival and Event Organizer Groups. The groups and representatives invited to the focus groups were identified by the City of Edmonton project team, based on historical interactions. Eleven people participated.

3. What was said?

In general, respondents in the engagements are **proud of William Hawrelak Park**, **are passionate that the green space is not compromised**, **and the main features of the park remain the same.** People stated that they believe the park is "getting old" and needs a shape-up to get it back to more modern standards. This shape-up consists mainly of aesthetic upgrades to the aspects of the park that already exist with the washrooms being the main aspect requiring attention.

The **online audiences** were asked a number of questions regarding the specific aspects of the park resulting in a wide range of responses to level of satisfaction with the park.

The **intercept survey and drop box survey participants** answered a much shorter survey focussing on pinpointing areas requiring the most attention.

The **neighbourhood in-person session** resulted in many general conversations regarding possible improvements for the park. One common theme was the surrounding neighbours desire to have access to a safe and convenient access point to the park by foot.

The **festival and event organizer groups** participated in detailed discussions around what could be improved at the park to help them stage their events. The group consisting of organizers whose events use a wide area of the park focussed on multiple aspects of the park. The group consisting of organizers who use the Heritage Amphitheatre focussed on possible improvements to that venue.

4. **What did we hear?**

Overall Improvements
The **washrooms** in the park were clearly identified as the priority rehabilitation aspect for respondents. Other areas pinpointed for improvement (not in priority order):

- More seating areas
- Better picnic sites
- Better walking pathways
- Better signage inside the park
- Better trails for walking
- Parking
- Improved playground

Getting around the Park
The majority of respondents **walk or run** to get around the park. **The majority of responders had no issues moving through the park**. The main issues the respondents had with moving through the park are: Need for a paved, multi-use pathway around the park that would support moving pedestrians and bikes from the road where traffic congestion and safety were a concern due to the variety of users. The majority of respondents **use the pathways in the park**.

Safety
In general, people feel safe in the park. There is some consensus in comments that the lighting could be updated throughout the park to increase safety. Users felt that there needs to be **better separation between competing users of the roadway**.

Washrooms
Clearly identified as the priority rehabilitation aspect for respondents. **Having more washrooms** was the most repeated comment online. Secondly, survey participants felt that the **washrooms were outdated and could be updated to a more modern aesthetic.**

Pavilion
Respondents **felt like the concession was the part of the pavilion that was lacking**. Respondents also stated that an **aesthetic update to modernize the facility was a priority** and **seating is limited and uncomfortable.**

Heritage Amphitheatre
Online respondents agree that the **seating meets their needs.** The Festival and Event Organizers provided detailed feedback on many aspects of the amphitheatre which are being considered in the development of the rehabilitation plan.

Bookable Picnic Shelters
The data would suggest that little rehabilitation is required for the picnic shelters except for the washrooms attached to specific shelters.

Bookable Picnic Sites

Most of the data in respect to bookable picnic sites was inconclusive. The data would suggest that little rehabilitation is required for the picnic sites.

Playground
Most respondents agreed that the **playgrounds in the park could be updated**.

Winter Use
Respondents asked to see **winterized washrooms, various locations to warm up** and **service providers** that could assist with rentals and healthy, regular access to concession items.

5. **How did citizen input affect the project/initiative with this engagement?**

Citizen input helped provide a greater understanding of how the park is currently used and how it could better support programs and services, safety and security and access and circulation. The input was consistent with the findings from the functional and physical assessments completed by the project team and supports the development of the rehabilitation plan in identifying projects to address the aging infrastructure. Prioritization of projects will be completed using a set of principles with a focus on addressing major infrastructure items like the utilities in the park but also enhancing aging facilities with the washrooms being the main focus. How people get around and move through the park is another area of focus with plans being developed to enhance user experience.

6. **What's next?**

The next step in the development of the plan is the establishment of priorities for the renewal of the park and development of an implementation plan including phasing options, costing and a schedule.
Citizens can continue to stay informed on this project: https://www.edmonton.ca/HawrelakParkRehabilitation

For more information on City of Edmonton public engagement, please visit www.edmonton.ca/publicengagement

Thank you for participating in sharing your voice and shaping our city.

Appendix M: Public Engagement - What We Heard Report (City of Edmonton 2021)

What We Heard Report

William Hawrelak Park Rehabilitation Pathway Design

Facility Planning and Design
FacilityPlanningand Design@edmonton.ca

SHARE YOUR VOICE
SHAPE OUR CITY

Edmonton

TABLE OF CONTENTS

A. Project Overview PG 3
B. Public Engagement PG 4
C. How and Who We Engaged PG 6
D. What We Asked PG 7
E. What We Heard PG 7
F. What Happens Next? PG 12

A. Project Overview

William Hawrelak Park opened in 1967 and is one of Edmonton's largest and most well-used parks. At over 50 years old, much of the infrastructure within Hawrelak Park is aging and requires repair and/or replacement. Investing in the park's infrastructure allows the City to maintain what is already here and support increased park use as the City grows.

The rehabilitation plan guides the renewal of the park in areas that affect public services and programs, safety, accessibility and circulation. A key objective of the project is to provide a new pathway system in the heart of the park that improves safety and provides accessible connections to amenities.

The goals for a new pathway system in Hawrelak Park are to:

- make use of existing paths where possible;
- provide access to the street, trails and bus stops;
- balance the needs of service vehicles and park users;
- provide a paved bicycle commuter connection which is also part of the Trans-Canada Trail;
- provide an enhanced pathway along the lake's edge; and
- ease vehicle congestion and pedestrian-vehicle conflicts by reconfiguring the road and trail near the main entrance.

B. Public Engagement

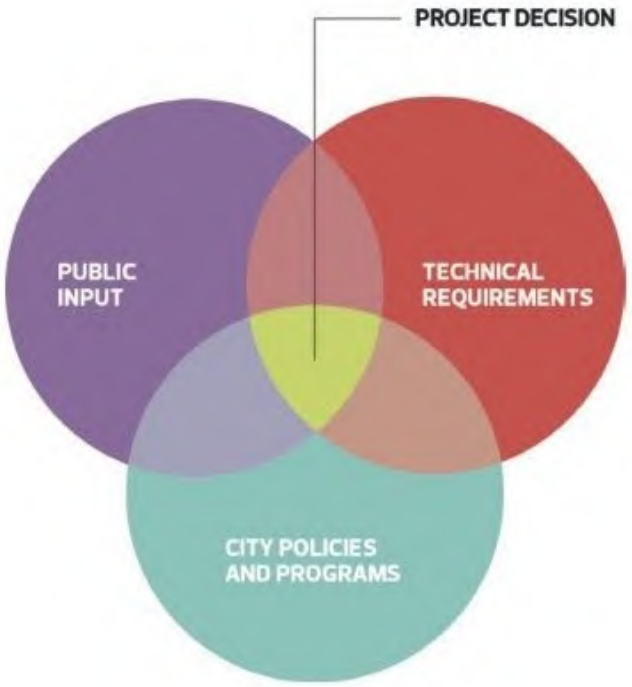
ADVISE

The public is consulted by the City to share feedback and perspectives.

Public and stakeholder engagement held in 2018 invited members of the public to advise on the rehabilitation of William Hawrelak Park through online, intercept and drop-box surveys and a neighbourhood in-person event. Festival and event stakeholders were also invited to engage through a focus group session.

When asked to share ideas about the pathway system, participants identified the need to create better connections, safer circulation and improve accessibility. Participants shared that the greenspace and main features of the park should be maintained and suggested the need for a paved, multi-use pathway around the park to support moving pedestrians and bikes from the road, where traffic congestion and safety are a concern.

The input received was consistent with the findings from the functional and physical assessment completed by the project team. This input, along with City policies, programs and technical requirements, was used to develop two options for pathway design to enhance how people get around and move through the park.

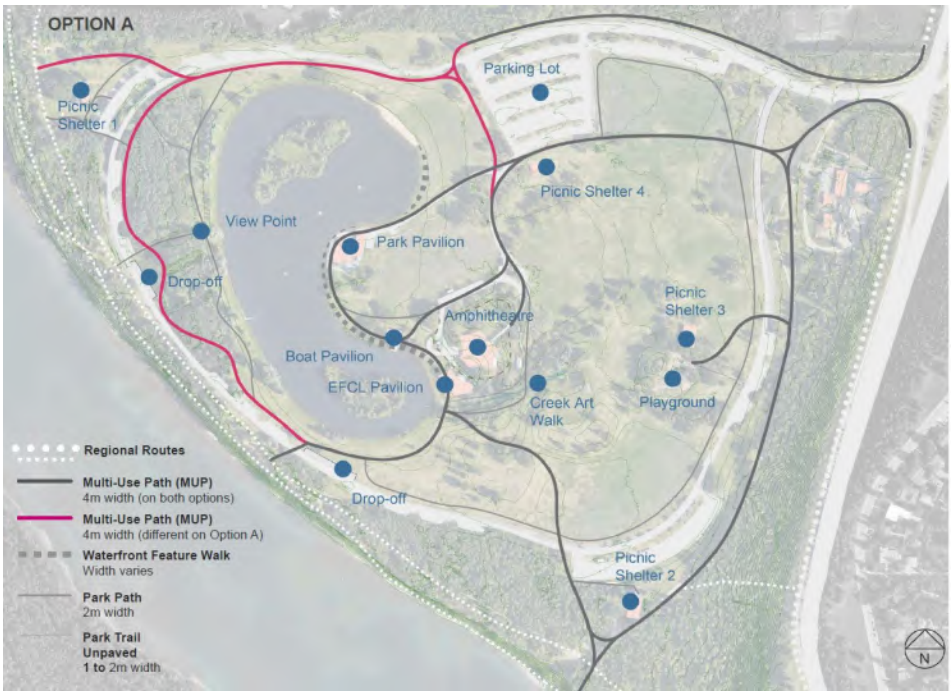


In consideration of the input received, both options were designed to:

- allow uninterrupted movement, minimizing conflict between vehicles and cyclists;
- provide connections to major park facilities;
- share the same circulation pattern on the east side, with the outer east loop doubling as a regional trail;
- create a commuter link between the pedestrian bridge and Groat Road;
- provide a new lake edge connection;
- create an enhanced pathway connecting the three waterfront facilities; and
- celebrate the distinct park centre core.

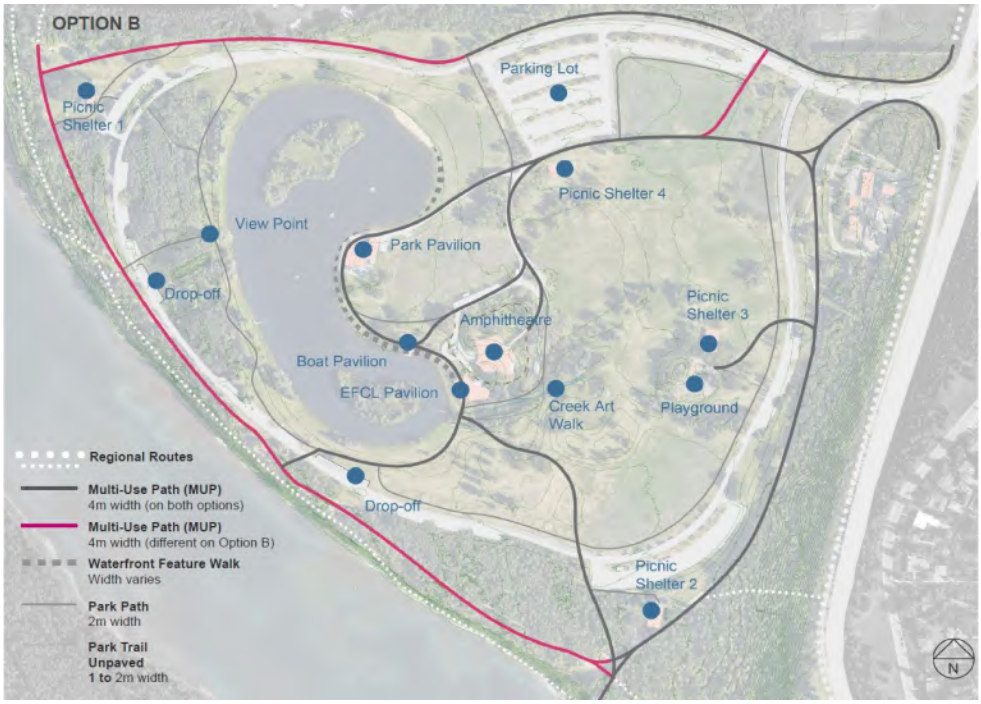
Option A: Internal Pathway Design

This option places the majority of the primary routes (four-metre shared-use paths) on the inside of the ring road, along with new two-metre park paths. This option allows for more direct connections and access to different areas and facilities. It includes a new pathway located in the forested area west of the lake that connects to the informal picnic area.



Option B: External Pathway Design

This option places all of the primary routes (four-metre shared use paths) on the outside of the ring road, along with new two-metre park paths. This option provides the required accessible connections to different areas and facilities. It provides a new pathway along the north-edge of the park that connects directly to the regional trail system.



C. How and Who We Engaged

While in-person public events are paused and physical distancing is a priority during COVID-19 pandemic, we remain committed to delivering project information and meaningful public engagement opportunities effectively and safely.

Between January 11 - 26, 2021, we invited the public to advise on the two pathway options using the Engaged Edmonton online platform. Road signs, social media, public service announcements and notifications to stakeholders were used to invite feedback. A total of 3,918 people visited or contributed to the Engaged Edmonton project page.

Engaged Edmonton Participation*

Description	Quantity
People who shared input	250
People who viewed a video or photo, downloaded a document, visited the key dates page, contributed input, and/or visited multiple project pages	729
People who visited the project page	2,939

***A single engaged participant could perform multiple actions.*

D. What We Asked

Better connections, safer circulation, and improved accessibility were important factors in the design of the two options. Participants were asked to contribute their ideas about what they liked about the designs, whether anything was missing and to suggest any changes to improve the designs.

Participants also had the option to like or share comments about ideas offered by other participants.

E. What We Heard

OPTION A: INTERNAL PATHWAY DESIGN

Participants indicated they liked:

- the visibility and sense of security of the internal pathway;
- the paved paths because they provide safer access and connection for those who currently use the road, especially in the winter;
- the direct connection points to the lake, amenities and routes in the park, especially for people with mobility challenges;
- how the internal path provides access to grassy areas and open spaces;
- the ability to interact with nature by travelling on pathways through the park; and
- the reduced impact on the natural landscape, river and wildlife in comparison to Option B.

Participants also offered suggestions on how Option A could be improved. These ideas involved:

- better connections to regional routes when travelling through the park;
- providing alternative regional routes for cyclists that avoid off-leash areas;
- having safe vehicle entry and exit to the park and making sure the right of way is given to pedestrians and cyclists when entering and exiting the park;
- adding blue emergency phones and improved lighting to increase personal safety;
- enhancing connections to park amenities, picnic sites and other paths in the park and adding pathways through the central east side of the park;
- enhancing the multi-use path that connects the wooden staircase on the southeast corner of the park;
- adding a path that circles the lake and connect it to the west path; and
- not adding the new western path along the lake to limit environmental impact.

OPTION B: EXTERNAL PATHWAY DESIGN

Participants indicated they liked:

- the circulation on the external multi-use path;
- the connection with existing pathways and regional routes;
- the limited road crossings to help reduce the interaction between pedestrians, cyclists and vehicles;
- how the external path helps people travel through and around the park, or connect with other regional routes;
- how paving the multi-use path provides safe access for people of all abilities;
- the addition of a multi-use path on the northside to create a full loop around the park;
- the limited impact to other park activities, vegetation, wildlife and the lake in comparison to Option A;
- how the external path gives a better view of the river and park; and
- the paved and expanded multi-use path because it allows more people to access and move around the park.

Participants also offered suggestions on how Option B could be improved. These ideas involved:

- putting in a physical barrier separating the road and external multi-use path to reduce interaction of cyclists, pedestrians, and vehicles.
- enhancing the pathway on the southeast side and northside so that cyclists and pedestrians do not have to use the road;
- considering how use of the external pathway might negatively impact the existing cross-country ski trails; and
- decreasing the multi-use path to a two or three metre width to limit the impact on the natural landscape.

FEEDBACK FOR BOTH OPTION A and B

Participants also shared feedback related to both Option A and B.

Designated Pathways

Participants advised that cyclists, pedestrians and vehicles should have their own path systems. They suggested that this would allow the pathway design to better address the needs of different users. They also suggested that this would provide:

- safer movement for people to access park amenities;
- better circulation for cyclists and pedestrians by having a continuous loop; and
- better connections to regional routes.

Participants suggested this could be done by:

- having the internal loop for pedestrian use only and the external loop for cyclist use only;
- requiring cyclists to use the roadway;
- considering different cycling needs of leisure riders, bike commuters, performance road cyclists and mountain bikers;
- requiring performance road cyclists to use the internal path;
- converting the road to divided multi-use paths; and
- limiting vehicle traffic to the main parking lot only, where people who travelled to the park in a vehicle would access the different types of pathways.

Pathway surface

Participants advised that both Option A and B should try to reduce the use of pavement to help limit the impact to the natural landscape, wildlife, and vegetation. They also suggested keeping the woodchip, gravel, and dirt paths instead of paving.

No changes

Participants suggested that the pathway system should not be rehabilitated at this time in order to:

- decrease impacts on the natural landscape;
- decrease costs for the City;
- preserve the park as an open space; and
- maintain the unique features and qualities of the park.

Participants also offered alternatives to pathway rehabilitation including:

- adding signs for way finding and to show the types of use allowed on the pathways;
- painting lines on the pathways or adding dividers;
- reducing vehicles on the roadway; and
- adding traffic calming techniques to support shared use of the road.

Winter Activities

Participants suggested the pathways design should consider:

- how to access existing Nordic cross-country ski trails and create interlocking circuits, double tracks and, meet grooming requirements;
- access to skating on the lake; and
- adding skating pathways throughout the park.

Maintenance

Participants advised of the need for ongoing maintenance and clearing of the pathways all year long specifically, making sure snow is cleared from Buena Vista Park bridge to the base of the stairs at Groat Road.

GENERAL REHABILITATION PROJECT FEEDBACK

Participants also shared feedback about the overall William Hawrelak Park Rehabilitation project.

Lake

Participants suggested making the lake available and safe for swimming, recreation and non-motorized sports and adding a public beach to encourage people to stay in the City during the summer months instead of travelling to lakes outside of Edmonton. They also shared the need to enhance the lake so it could support athletic training, particularly for swim clubs and the ITU World Triathlon. However, others suggested that the lake should not be transformed because it provides a natural space in an urban area and is a natural nesting habitat for geese and other migratory birds.

Bathrooms

Participants advised of the need for more bathrooms throughout the park. They suggested upgrades to the existing bathrooms to promote safety and adding things like lockers, air pumps and drinkable water stations where bathrooms are located.

Landscaping

Participants suggested adding gardens and different landscaping with plants and flowers throughout the park and along the pathways. They advised of a need for restoration and vegetation improvements, enhancing the wetland buffer, and increasing the tree canopy.

Transit

Participants advised of a need to improve bus service to and from the park. They suggested adding a new transit station at the park to enhance accessibility and decrease vehicle use. They also suggested that providing free transit use during major park events would help decrease vehicle use in the park.

Buildings

Participants suggested that the historic buildings in the park should be preserved, especially the amphitheatre because it is a unique landmark.

Park Activities and Amenities

Participants also offered ideas for activities and amenities that should be encouraged or added to the park such as:

- live music in the park
- increasing the use of the amphitheatre and other buildings
- adding more food and beverage vendors
- a winter light festival
- a fly fishing golf course
- a gondola ski chair ride from the top of hill to the pond
- a zip line
- tipi rentals
- more space for gathering between the amphitheatre and pavilion
- running distance markers
- disc golf course
- enhancing park features through lighting, lampposts and, garbage receptacles
- renaming the park to “Mayfair Park”
- annexing the Royal Mayfair Golf Club
- allowing on-leash dog walkers to use multi-use paths
- adding bike ramps to the staircases
- removing unnecessary lighting to reduce light pollution

G. What Happens Next?

The feedback received, along with technical requirements and City policies and programs, will be used to develop a final pathway design. This is scheduled to be completed in Fall 2021. As details progress through the design phase, more information will be posted to edmonton.ca/HawrelakParkRehabilitation.

Appendix N: Mitigation and Permitting Actions Summary

Hawrelak Park Renewal EIA
Permitting Requirements and Mitigation Measures,
by Project Phase

Project Phase	Permit or VEC	Required Permitting Action or Proposed Mitigation/Managem	Required to meet Regulations/Bylaw, i.e., Mandatory*	Completed or Outstanding
Design Development and Detailed Design				
	Permit - Approval	North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188) - acquire City Planning and then Council approval of the EIA & SLS	Yes	Outstanding
	Permit Acquistion	*Historical Resources Act* - ACMSW **conditional** approval received. Schedule of Conditions includes: Re: archaeological resources - submission of applications for individual renewal components invovling substantial subsurface disturbance and located within or immediately adjacent the known archaeological site, *and* , within less disturbed areas bordering the riverbank Re: palaeontological resources - monitoring all work at specified depths and in specified areas by a qualified palaeontologist	Yes	Outstanding
	Permit Acquistion	Outfall and river intake work*:* City to retain a QAES and prepare a fisheries assessment to support *Water Act* requirements *Water Act* - City to submit application(s) for approval for works in and adjacent to NSR not covered by Code of Pracitice (e.g., river intake replacement) - and for lake discharge to river	Yes	Outstanding
	Permit Acquistion	Outfall and river intake work: *Public Lands Act* - City to submit applications to AEP for appropriate dispositions (DLO's, Temporary Field Authorizations or similar) for proposed works in the NSR bed and shore - applies to outfall and river intake work	Yes	Outstanding
	Permit Acquistion	Outfall and river intake work*: Fisheries Act* - City to retain a QAES and prepare a fisheries assessment to satisfy *Water Act* requirements *and Fisheries Act* requirements. City to submit a Request for Review (RfR), to DFO and follow requirements determined by DFO	Yes	Outstanding
	Permit Acquistion	Outfall and river intake work: *Canadian Navigable Waters Act* - City to submit application based on detailed design and construction methodologies	Yes	Outstanding
	Riverbank Slope Stability	City to determine if riverbank slope stability investigations are needed to support access to riverbank work site and outfall repair works, implement as necessary and develop mitigation measures		Outstanding
	Riverbank Slope Stability	Investigate use of bio-engineering options for any required bank stablilization measures		Outstanding
	Vegetation	City Forestry to assess/value native forest communities and potentially affected open space trees/shrubs in project area, and City to integrate the values into design and construction planning to maxmize protection/retention of trees - Corporate Tree Management Policy C456C		Outstanding
	Vegetation	City to mandate directional drilling for underground utility work under select or all native forest communities		Outstanding
	Vegetation	City to mandate restoration of all native forest communities and to develop a forest restoration plan that meets City business partner requirements		Outstanding
	Vegetation	City to prepare a tree removal inventory per final design		Outstanding
	Wildlife	City to have qualified wildlife biologist prepare a Wildlife Management Plan in support of proposed invasive works at Hawrelak Lake		Outstanding
	Wildlife	Ensure detailed lighting design accounts for wildife impacts and new lighting regime reduces, or at worst, equals existing trespass lighting into sensitive park features		Outstanding
Construction				
	Permit Acquistion	City of Edmonton Parkland Bylaw (Bylaw 2202) – City or contractor	Yes	Outstanding
	Permit Acquistion	Outfall works: *Water Act* - City or Contractor to submit CoP for Outfall Structures on Water Bodies Notification at least 14 days prior to construction, requires QAES fisheries assessment	Yes	Outstanding
	Soils	City to require contractor to implement AECOM (2014) contaminated soil risk management recommendations		Outstanding
	Soils	City to require contractor to develop and implement a comprehensive lake dredging plan that includes environmental protection measures		Outstanding
	Surface Water	Contractor to implement effective ECO Plan and temporary ESC measures specific to all works near and in Hawrelak Lake and at/near the NSR	Yes - Enviso requirement	Outstanding
	Surface Water	Contractor to discharge all site surface water of poor quality to sanitary system	Yes	Outstanding
	Surface Water	Contractor to isolate Hawrelak Lake water during work at water's edge and during dewatering and dredging	Yes	Outstanding
	Surface Water	Contractor to prepare a Care of Water Plan, as an ECO Plan component	Yes - Enviso requirement	Outstanding
	Surface Water	Contractor to engage a CPESC to oversee temporary ESC plan design and implementation		Outstanding
	Surface Water	City to engage a CPESC to undertake QA monitoring of ESC		Outstanding
	Groundwater	City to require contractor to develop and implement a comprehensive lake dredging plan that includes measures to protect the lake clay liner and the environment		Outstanding
	Fish	Protected by above surface water quality measures		Outstanding
	Fish	Ensure contractor ECO Plan covers compliance with all QAES specifications and recommendations and all regulatory approvals. City to undertake QA monitoring of contractor performance.	Yes	Outstanding
	Vegetation	Contractor to ensure a rare plant specialist locates, flags and buffers all rare plant populations at Hawrelak Lake, priro to initiation of any work in or on margins of lake.		Outstanding
	Vegetation	Contractor to ensure rare plant specialist recommends means to suitably integrate rare plants into lakeshore naturalization plan.		Outstanding
	Vegetation	Require contractor to landscape with native tree species or ornamental trees comparable to those removed		Outstanding
	Vegetation	Contractor to prepare Tree Protection Plan	Yes	Outstanding
	Vegetation	Contractor to ensure ECO Plan that includes weed management measures for construction and during warranty period	Yes - Enviso requirement	Outstanding

	Wildlife	Contractor to propose amendments to Wildlife Management Plan for Hawrelak Lake, if needed, City to review		Outstanding
	Wildlife	If invasive activities are planned for the lake during the period 20 April to 30 August, City to engage wildlife specialist to monitor the contractor's implementation of wildlife management plan.		Outstanding
	Wildlife	Avoid tree and shrub clearing/removal during the period 15 February and 20 August.	Yes	Outstanding
	Wildlife	If clearing/removal must occur during this time period, nest sweeps by a qualified biologist will be required to identify active nests and appropriately buffer them until the nest is no longer active.	Yes	Outstanding
	Wildlife	Building exteriors should be inspected in the winter before exterior work is to occur for the presence of barn swallow/other bird species nests to enable nest disturbance avoidane	Yes	Outstanding
	Wildlife	ECO Plan to include appropriate wildlife/worker encounter protocols	Yes - Enviso requirement	Outstanding
	Historical Resources	In the event of Discovery of Historic Resources suspend all work and contact ACMSW as described in the project's *Historic Resources Ac* t Approval.	Yes	As needed
	General Environmental Management	Contractor to provide a spill prevention and emergency response plan and hazardous waste management plan. The plans must also include construction monitoring protocols and frequency.	Yes - Enviso requirement	Outstanding
	General Environmental Management	Contractor to prepare an ECO Plan compliant with current City of Edmonton requirements	Yes - Enviso requirement	Outstanding
Post-Construction				Outstanding
	Vegetation	Monitor the performance of the project's invasive weed removal program and implement remedial measures as required.		Outstanding

***** *if not identified as mandatory, proposed mitigation should be treated as a recommended project action that would meet guidelines or result in best management practice*
Monitoring requirements are summarized in the EIA Section 8.