Attachment 1

City of Edmonton
Valley Line Stage 1 – Light Rail Transit (LRT) Project
Environmental Impact Screening Assessment Update

Final Report

Prepared for:

LRT D and C
Transportation Services
City of Edmonton
Edmonton, Alberta

Prepared by:

Spencer Environmental
Management Services Ltd.
Edmonton, Alberta

Under Contract to:

AECOM
Connected Transit Partnership
Edmonton Alberta

Project Number EP - 576

February 2015

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23 February 2015
Our file: EP-576

Glinis Buffalo
Ecological Planner
Sustainable Development
City of Edmonton
1200 HSBC Bank Place
10250 - 101 Street NW
Edmonton, AB T5J 3P4

Dear Ms. Buffalo,

Re: City of Edmonton River Valley Light Rail Transit (LRT)
Environmental Impact Screening Assessment Update - Final Report
Your file: 131150741-011 | GB15-02

On behalf of LRT D and C and as part of ConnectEd Transit Partnership, enclosed please find nine (9) hard copy and five (5) electronic copies (CDs) of the above-mentioned report for your files. This final report reflects the draft report comments received from all city reviewers.

Please contact the undersigned if you require additional information.

Sincerely,

Spencer Environmental
Management Services Ltd.

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

Chris Rudge, B.Sc., B.A., EP, CPESC
Project Biologist

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

cc: Waqar Syed, LRT D and C, City of Edmonton
Mark Perry, AECOM, CTP

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2	**1**	Connected Transit Partnership – Mark Perry

EXECUTIVE SUMMARY

In 2013, pursuant to the City of Edmonton's *North Saskatchewan River Valley Area Redevelopment Plan* (*Bylaw 7188*), LRT Design and Construction prepared an Environmental Impact Screening Assessment (EISA) for the portion of the Valley Line Stage 1 that will be situated within the North Saskatchewan River Valley (NSRV). City Council approved that report in September 2013. Subsequent project planning, including ongoing community group consultation, has identified eight proposed changes to Valley Line, NSRV project components. Most of these changes are minor in nature and scale; one is more substantial. Assessment of these proposed changes is required because the changes involve previously unassessed activities or require adjustments to the approved 2013 Project Area. Consequently, LRT D and C has prepared this EISA Update to assess of the following eight proposed changes:

- Development of a temporary, primary construction access route through the west side of Louise McKinney Riverfront Park (LMRP). This access route will replace the use of Cameron Avenue and the future permanent portal maintenance access route (in the east side of LMRP), which will now be utilized only as a secondary construction access route.
- Modifications to the west boundary of the Project Area, within Henrietta Muir Edwards Park (HMEP). This will include the exclusion of two small parcels of land to reduce impacts on the abandoned Mill Creek channel, and the addition of one small parcel to include all lands occupied by an existing picnic shelter that, through consultation with Community Services, was identified in the 2013 EISA as available for demolition.
- Inclusion of a small parcel of land at the entrance to HMEP to allow for more flexibility in providing required temporary pedestrian access to the 98 Avenue Pedestrian Bridge during LRT construction.
- Explicit recognition of potential for installation of ground anchors as a means of supporting retaining walls at two locations, and, potential for those ground anchors to extend underground beyond the previously defined project boundaries but within City-owned lands.
- A minor extension of the Project Area to allow for local slope re-grading and relocation of ski hill infrastructure as mitigation for project impacts on one Edmonton Ski Club run.
- Closure/demolition of a 200 m long, one-way road connecting northbound Connors Road to the Muttart Access Road.
- Locating the replacement Muttart Conservatory storage building and associated yard slightly southeast of the previously-approved location. This new location will overlap with the 2013 Project Area boundary. This component is no longer part of the P3 project and will be undertaken by the City as early work.
- Construction of a temporary, short connecting trail in LMRP, outside the Project Area, to provide for improved internal pedestrian circulation during the LRT construction period. As mitigation, the trail will be constructed by the City, prior to Valley Line construction.

The EISA Update describes the above-noted changes and assesses their potential to affect river valley resources. This EISA Update identifies some new, component-specific impacts and sets out specific mitigation commitments that will also be City or Project Co requirements and will be incorporated into the Project Agreement. Important among these is the need for the City and Project Co to do some additional geotechnical investigations and to follow all resulting recommendations. Most new mitigation measures are directed at reducing impacts associated with the temporary, primary construction access route through the west side of LMRP. For that project component, despite application of mitigation measures, the presence of an active construction access route will temporarily and adversely affect park user experience, park visual resources, park vegetation and, to a lesser extent, wildlife habitat movement through the west park. With mitigation, these effects were rated as minor. All of these impacts are temporary, and most of them will be eliminated in short order upon completion of construction. The residual impact of clearing of woody vegetation in the park will be longer-lasting as mitigation will be a longer-term native forest restoration effort.

Finally, the EISA update also describes four other minor adjustments to the Project Area that are required to implement previously-approved activities and mitigation measures. These components are described for documentation purposes but not assessed.

Table of Contents

List of Figures

List of Tables

List of Plates

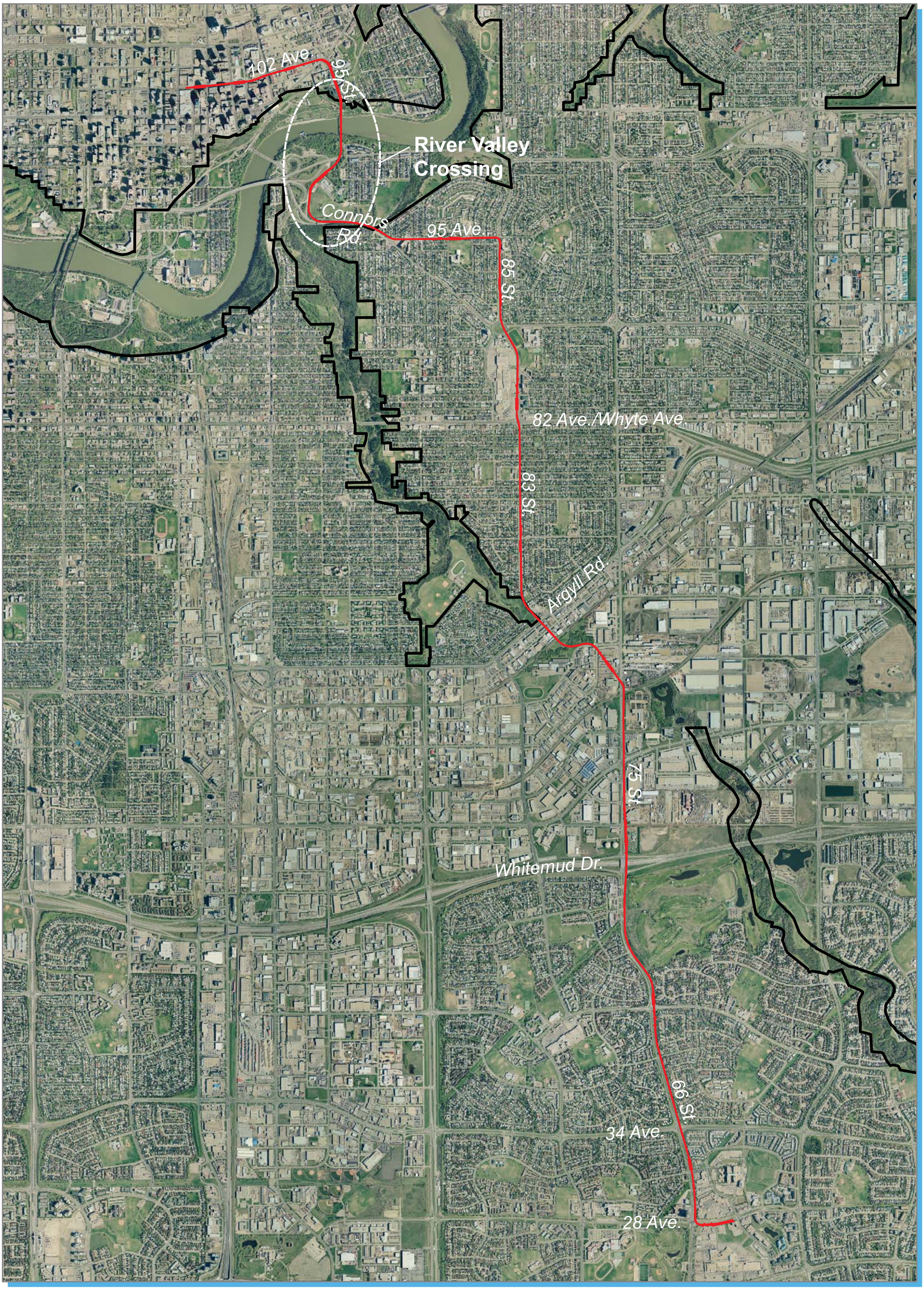
1.0 INTRODUCTION

1.1 Background and Need for an EISA Update

City of Edmonton (the City), led by Transportation Services LRT Design and Construction (LRT D and C), is expanding Edmonton's Light Rail Transit (LRT) network by constructing the Valley Line Stage 1, connecting Downtown to Mill Woods (Figure 1.1). This new line necessarily involves a crossing of the North Saskatchewan River Valley (NSRV) (Figure 1-1). Planning for the project began in 2008 and preliminary design was completed in 2013, culminating in a Reference Design for a new, urban-style, low-floor system. The project will be delivered through a Public Private Partnership (P3) and is now in the proponent procurement phase. The procurement schedule includes awarding a contract to the successful bidder, referred to as Project Co, in January 2016.

In 2012/2013, as part of the preliminary planning exercise and pursuant to the City of Edmonton's *North Saskatchewan River Valley Area Redevelopment Plan* (*Bylaw 7188*), LRT D and C prepared an Environmental Impact Screening Assessment (EISA) for the portion of the project situated within the NSRV. The report, City of Edmonton Valley Line-Stage 1 Light Rail Transit (LRT), Project Environmental Screening Impact Assessment (Spencer Environmental 2013), hereafter referred to as the 2013 EISA, addressed all identified Valley Line project components situated in the river valley, as described in the Reference Design. The 2013 EISA report acknowledged that the selected P3 delivery model influenced the level of design detail available for assessment and also the potential for some additional change to occur during the design and construction phase by Project Co. It was clear that the environmental review process must acknowledge some tolerance for minor, future design variance. To facilitate impact assessment and ensure that all unexplored potential project impacts were assessed moving forward, the 2013 EISA delineated an absolute boundary for construction-related activities, the "Project Area", and assessed the impact associated with disturbance of all of the Project Area. Included in the 2013 EISA was a commitment to subject any future proposed works that would require modification of the Project Area or facilities situated outside of the approved Project Area and within the Bylaw 7188 lands, to further Bylaw 7188 review. City Council approved the EISA in September 2013, but instructed LRT D and C to continue to work with select community groups into the next project phases to mitigate select impacts, particularly as they affect community groups.

Project planning, including ongoing community group consultation, refinement of select mitigation measures and preparation of P3 procurement documents, has progressed since summer of 2013. Through this planning, several changes to select river valley project components have been made that require adjustment of the Project Area shown in the 2013 EISA. Most changes are considered to be minor, both in terms of the nature of the change and the area affected; one is considered more substantial. Through summer of 2014, consultation with City of Edmonton Sustainable Development and Community Services determined that LRT D and C should prepare an amendment to the 2013 EISA addressing these known changes and that the amendment should be brought back to Council for approval.



Legend

Valley Line LRT Alignment (Reference Design)
Bylaw 7188 Boundary

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1:30,400

Figure 1.1 Valley Line Stage 1 Location

City of Edmonton LRT Valley Line - Stage 1
EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

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The proposed changes were grouped into two categories: 1) *Changed Project Components* – changes having potential to result in previously-unassessed impacts, in most cases by expanding an activity into newly added lands; and 2) *Spatial Clarification* – minor adjustments of work limits required either as a result of a closer examination of the components; or design refinement of previously-described and assessed activities; or advancement of mitigation measures. In essence, this is a clarification of previously described required lands. It was agreed that while changes of this nature should be included in the update exercise, treatment would be limited to documentation of changes in the update report, rather than assessment of impacts.

1.2 Changed Project Components

As of October 2014, LRT D and C have identified the following eight discrete project component changes that require adjustment of the previously-approved Project Area boundaries and have *potential* to result in previously-unassessed impacts

1) Designation of Cameron Avenue and the Shared Use Path (SUP) in east end of Louise McKinney Riverfront Park (LMRP) as the secondary rather than primary, north valley construction access route and identification of a temporary, primary construction access route through the west side of LMRP.
2) Modifications to the west boundary of the Project Area, within Henrietta Muir Edwards Park (HMEP). This will include the exclusion of two small parcels of land to reduce impacts on the abandoned Mill Creek channel, and the addition of one small parcel to include all lands occupied by an existing picnic area that, after consultation with Community Services, was identified in the 2013 EISA as available for demolition.
3) A minor expansion of the Project Area in HMEP to allow for more flexibility toward provision of temporary pedestrian access to the 98 Avenue Pedestrian Bridge during LRT construction.
4) Explicit recognition of potential for installation of ground anchors as a means of support for the previously identified retaining walls at two locations and potential for ground anchors to extend, below ground, beyond the previously-defined project boundaries but remaining within City-owned lands.
5) A minor expansion of lands at the top of Connors Hill to allow for slope re-grading for relocation of ski hill infrastructure as mitigation for project impacts on an existing Edmonton Ski Club run.
6) Removal of a one-way connector road between north Connors Road to the Muttart Access Road. (Note: This does not require a boundary adjustment but removal was not previously assessed).
7) Shifting the replacement Muttart Conservatory storage building to the southeast of the previously identified location and slightly beyond the 2013 Project Area boundary, and, having the City undertake construction prior to commencement of P3 work.
8) Construction of a temporary, connecting trail in the Chinese Gardens, in advance of the project, to provide for improved internal pedestrian circulation through LMRP during the Valley Line construction period.

Items seven and eight, construction of a new Muttart Conservatory storage building and a temporary connector pedestrian trail, are required to mitigate Valley Line project impacts and will be undertaken by City of Edmonton, Community Services prior to commencement of Valley Line construction to reduce the impact of LRT construction on park facilities and operation. This distinction is relevant to construction timing and development of mitigation measures since these components will not be governed by mitigation clauses included in the final Valley Line Project Agreement.

1.3 Spatial Clarifications

Adjustments to individual recreational trails and their reconnections to the larger network were one of the 'major facilities' approved by Council in 2013. The 2013 EISA identified the need to: restore disrupted trails within the Project Area; reconfigure some trails to accommodate new infrastructure and re-landscaping; and seamlessly tie realigned and restored trails into the existing, undisturbed trails at the project boundaries. All of these activities were discussed in the 2013 EISA in the context of mitigation of project impacts. Since then, as committed to, several specific mitigation measures have been refined or further developed, some to a relatively advanced state. Importantly, through consultation with Community Services, LRT D and C have developed 70% landscape drawings (known as River Valley Landscape Drawings) to ensure full mitigation of project impacts to park resources in a manner consistent with existing and future plans for these important public spaces. These drawings are intended to provide the City with more control and certainty over the post-construction landscaping of the Project Area in LMRP, HMEP and at Muttart Conservatory grounds by providing Project Co with detailed guidance. These landscaping plans represent a refinement of several mitigation measures that were previously only generally described in the 2013 EISA. Importantly, the plans explicitly acknowledge how Project Co is to tie the re-landscaped Project Area into surrounding, unaffected, existing park landscaping and how much land will be required to achieve a seamless tie-in at critical locations. For Project Co to implement those newly-developed plans, the 2013 Project Area must be adjusted in a minor way at three manicured park locations. Work in these specific areas will be restricted to that required to realize the landscaping plans. General construction use will not be allowed. The following are the three components:

- Tie-in of remnant World Walk and Rose Garden in LMRP to gardens and the SUPs that were re-landscaped by Project Co within the Project Area.
- Installing a new HMEP trail connecting to the SUP at 98A Avenue and HMEP parking lot.
- Reconfiguration of a trail connecting Muttart Gardens to 98 Avenue and Cloverdale Neighbourhood.

Since these trail activities are mitigation measures and were previously committed to in the 2013 EISA, further *assessment* of these activities is not warranted, but documentation is desirable.

In addition, planning during the last year identified a required modification of the Project Area in the vicinity of the HMEP parking lot at 96A Street. The 2013 EISA text identified that parking lot as included in the Project Area and available for use as a general construction area. The parking lot is critical to Project Co achieving feasible access from 98 Avenue to the south river bank work area. However, in 2013 the Project Area boundary drawn did not quite capture the entire parking lot as was intended. Accordingly, this boundary has now been adjusted slightly to follow the parking lot west boundary and include the whole of the parking lot. This adjustment is the fourth spatial clarification element.

Because undertaking the four above-noted components in this category requires an adjustment of the Project Area delineated in the 2013 EISA there is a need to document and explain these project aspects for record keeping purposes. To that end, each of these Spatial Clarification components is described in detail in Chapter 2 along with the rationale for the change and placement in the category of Spatial Clarification, but these components are not then further assessed.

1.4 EISA Amendment Objectives

Considering the above, following are the primary objectives of this EISA Update:

- Meet the commitment to ensure Bylaw 7188 review of Valley Line project changes affecting lands or facilities outside the Project Area.
- Document minor Project Area adjustments required to accommodate the refinement of previously-approved activities or mitigation measures.
- Prepare a publicly-available report for consideration by City Council.

1.5 Report Organization

This EISA Update consists of 13 chapters. Chapter 1 provides context and background on the need for the EISA Update and describes the focus of this report. Chapter 2 describes each project component addressed in this document, the motivation and rationale for the change, and the resulting changes to the previously-approved boundary. Chapter 2 also describes, in more detail, the spatial clarification components and the lands involved. Chapter 3 outlines the impact assessment methods specific to this EISA Update. Chapters 4 through 11 assess each of the described project components, describing specific methods used, existing conditions, impacts and mitigation, and includes a summary assessment for that component. Chapter 12 summarizes results from the public engagement process and major conclusions and commitments for all component changes. Chapter 13 provides all references and personal communications cited in the report.

This report includes the following appendices:

- Appendix A: Alternatives Analysis for North Valley Construction Access Route
- Appendix B: Temporary Construction Access Road – Geotechnical and Slope Stability Assessment (Thurber Engineering 2014)

- Appendix C: LMRP Vegetation Data
- Appendix D: Wildlife Species Potentially Found in the LMRP Study Area
- Appendix E: Special Status Wildlife Species Potentially Found in the LMRP Study Area
- Appendix F: LMRP Subsurface Utilities (T2 Utility Engineers 2013)

2.0 PROJECT DESCRIPTION

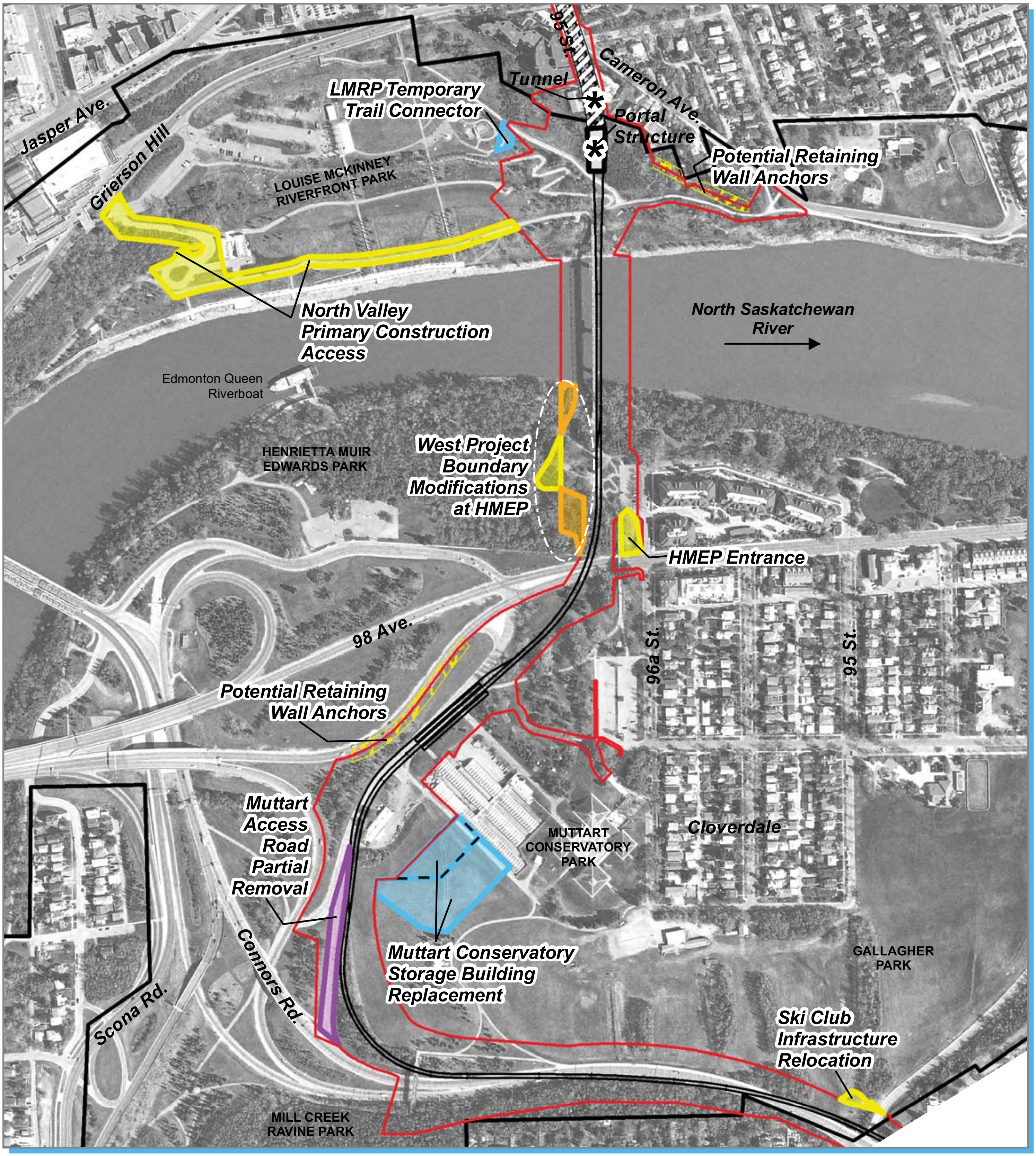
2.1 Changed Project Components

Figure 2.1a illustrates the location and spatial extent of the eight project components assessed in this update; Figures 2.1b through 2.1d show these components at a finer-scale. Six of these components will be included in the scope of work to be undertaken by Project Co, and two will be undertaken by the City of Edmonton as preparatory (early) works (see Figure 2.1a).

2.1.1 *North Valley Primary Construction Access - Project Co Component*

The 2013 EISA identified the primary north river valley construction access corridor as moving through the east side of LMRP. The identified route involved approaching the park along the edge of Riverdale Neighbourhood, following Cameron Avenue to its intersection with 94 Street and 99 Avenue, then moving west into LMRP using the Trans Canada Trail SUP. The 2013 Project Area included the lands along that SUP. This route was also identified as the required permanent emergency and maintenance access route to the portal and tunnel (Figure 2.1b). The 2013 EISA identified the possible need for a secondary construction access from the west, through LMRP, but a specific location was not discussed, nor was the specific purpose of a secondary access route discussed. Because of this, associated impacts were not described. At that time, it was assumed that any secondary access would be used only for select but unspecified activities and would not require physical modification of park lands. It was agreed that if a need to use lands in the western end of LMRP in this way emerged, the impacts would be assessed in later project planning.

Since that time, additional planning and community group consultation has determined that the designated primary construction access route will be through the west half of LMRP, entering the park from Grierson Hill Road and accessing the valley slope east to the west edge of the Project Area that was described in 2013 (Figure 2.1b). From there access would then continue within the approved 2013 Project Area. The original east park route using Cameron Avenue is now identified as the secondary access route, to be used only at select times during construction on an as-needed basis, when the west, primary access route is unavailable to Project Co. The proposed primary construction access road will be temporary only but present for the duration of construction in the north valley, a period lasting approximately five years; the east permanent emergency access and maintenance road will remain as described in the 2013 EISA and, as before, both roads will be designed and constructed by Project Co.



Legend

Additional Lands

🟨 Undertaken by Project Co

Excluded Lands

🟧 Areas Removed from Project Area

No Lands Change - *Undertaken by Project Co*

🟪 Road Removal/Landscaping

▨ Potential Retaining Wall Anchors (Sub-Surface Work Only)

Lands Involved in Preparatory (Early) Works

🟦 Undertaken by City of Edmonton

🟦 Lands Previously Assessed in 2013 EISA

— Project Area

— Valley Line LRT Alignment (Reference Design)

▭ Bylaw 7188 Boundary

* Indicative Location Only

0 25 50 100 Meters

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Figure 2.1a Project Components Assessed in EISA Update

City of Edmonton LRT Valley Line - Stage 1 EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

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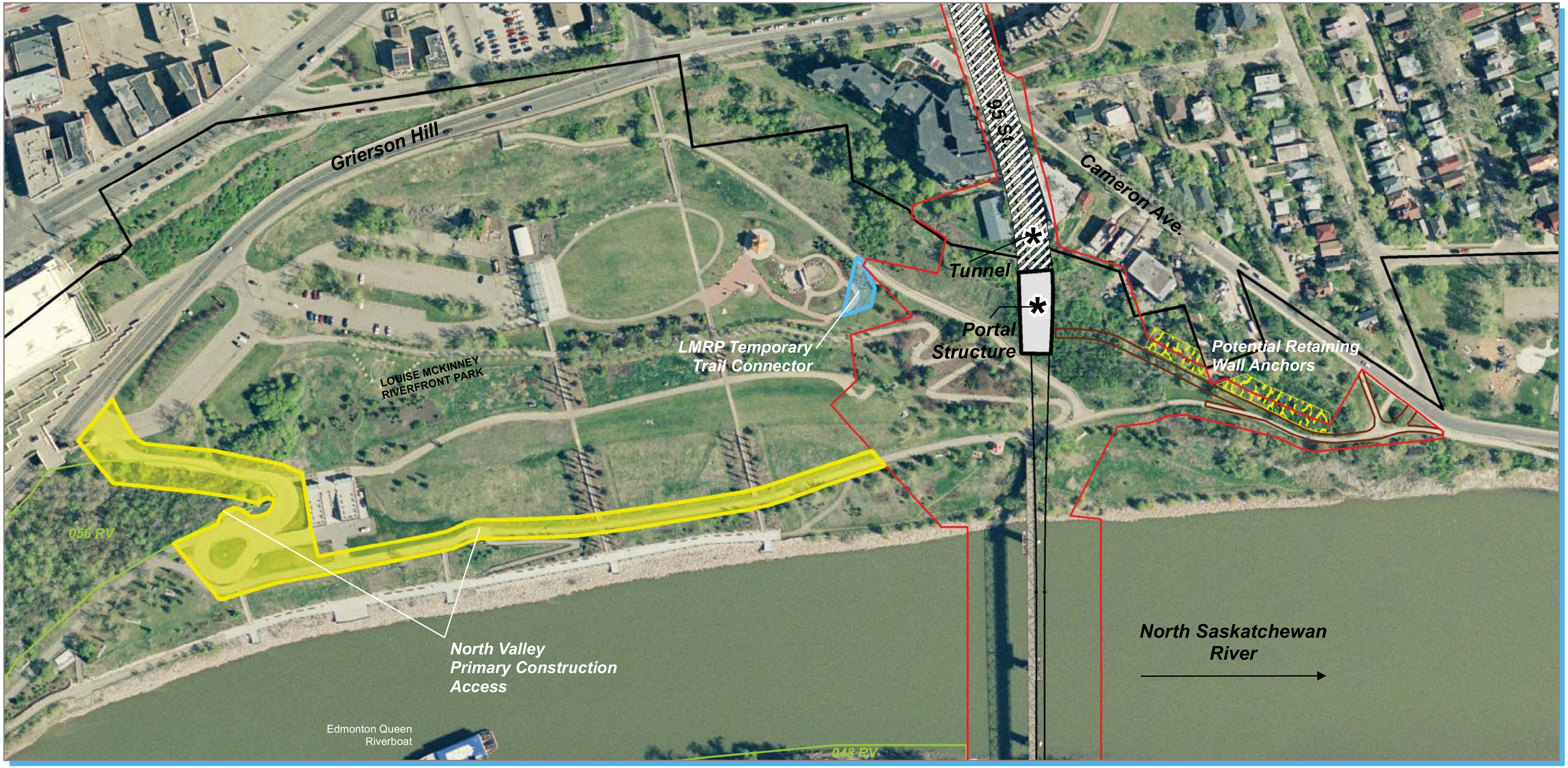

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Additional Lands

🟨 Undertaken by Project Co

Excluded Lands

🟧 Areas Removed from Project Area

No Lands Change - *Undertaken by Project Co*

🟪 Road Removal/Landscaping

▨ Potential Retaining Wall Anchors (Sub-Surface Work Only)

Lands Involved in Preparatory (Early) Works

🟦 Undertaken by City of Edmonton

▨ Lands Previously Assessed in 2013 EISA

— Project Area

— Valley Line LRT Alignment (Reference Design)

— Portal Access Route

☐ Bylaw 7188 Boundary

☐ City of Edmonton River Valley Natural Areas (2010)

* Indicative Location Only

0 50 100 200 Meters

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Figure 2.1b Project Components Assessed in EISA Update

City of Edmonton LRT Valley Line - Stage 1
EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

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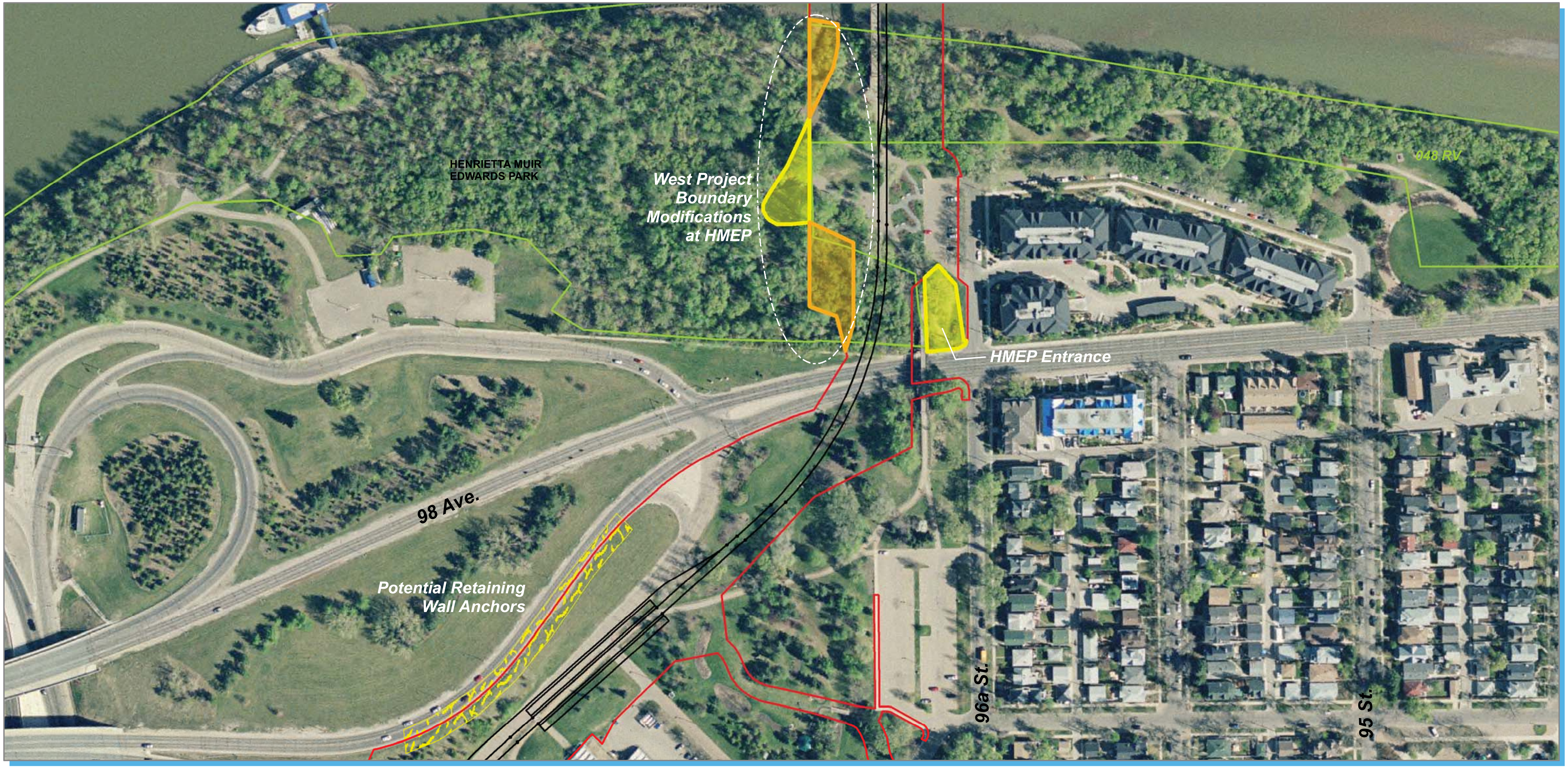

Legend

Additional Lands

🟨 Undertaken by Project Co

Excluded Lands

🟧 Areas Removed from Project Area

No Lands Change - *Undertaken by Project Co*

🟪 Road Removal/Landscaping

▨ Potential Retaining Wall Anchors (Sub-Surface Work Only)

Lands Involved in Preparatory (Early) Works

🟦 Undertaken by City of Edmonton

▭ Lands Previously Assessed in 2013 EISA

— Project Area

— Valley Line LRT Alignment (Reference Design)

— Portal Access Route

▭ Bylaw 7188 Boundary

🟩 City of Edmonton River Valley Natural Areas (2010)

* Indicative Location Only

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Figure 2.1c Project Components Assessed in EISA Update

City of Edmonton LRT Valley Line - Stage 1 EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Legend

Additional Lands

🟨 Undertaken by Project Co

Excluded Lands

🟧 Areas Removed from Project Area

No Lands Change - *Undertaken by Project Co*

🟪 Road Removal/Landscaping

▨ Potential Retaining Wall Anchors (Sub-Surface Work Only)

Lands Involved in Preparatory (Early) Works

🟦 Undertaken by City of Edmonton

▭ Lands Previously Assessed in 2013 EISA

— Project Area

— Valley Line LRT Alignment (Reference Design)

— Portal Access Route

⬛ Bylaw 7188 Boundary

🟩 City of Edmonton River Valley Natural Areas (2010)

* Indicative Location Only

N

0 50 100 200 Meters

1:2,100

Figure 2.1d Project Components Assessed in EISA Update

City of Edmonton LRT Valley Line - Stage 1 EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

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The proposed primary north valley construction access route enters LMRP from Grierson Hill Road near the Shaw Conference Centre, at the park main vehicle access point (Plate 2.1). From there, the access road travels southeast along the existing paved maintenance vehicle access, to the Riverfront Plaza, and then ties into an existing paved SUP (Figure 2.1b; Plate 2.2). The entire route follows existing asphalt, of variable width. Project Co will be required to design and construct the access road to the standard needed to carry out the work safely and without adversely affecting slope stability in the park. Based on the anticipated types of required construction equipment and the anticipated volume of traffic, Project Co is expected to upgrade the existing route. At a minimum, this is expected to involve some re-grading along the SUP to create a road base, and some preparatory work to assure a stable base. The road will have to accommodate two-way construction traffic and must fit within the corridor shown on Figure 2.1b. Temporary fencing may be installed to ensure safe separation of the route from public areas. The tight curves and narrow width of the existing access road from Grierson Hill to the Riverfront Plaza may be unable to accommodate large construction equipment. Thus, at this stage the City has not ruled out the need for Project Co to widen that route, which may require some clearing into adjacent natural vegetation.

Plate 2.1. Segment of proposed Louise McKinney Riverfront Park Construction Access Road using existing maintenance road, looking northeast.

Plate 2.2: Trans Canada SUP to be used as Primary construction Access Route in LMRP.

Only activities specific to construction and operation of this temporary access road will be permitted in the Project Area delineated for this component as shown in Figure 2.1b. Lands identified as part of the primary construction access road will not be available for general construction activities (i.e. staging and material storage) and the installation of permanent infrastructure associated with the Valley Line LRT will not be permitted. Once construction activities on the north valley wall and riverbank are completed, the temporary construction access road lands will be returned to the pre-disturbance grades and similar or better condition. All disturbed vegetation will be re-established.

The construction access road will support high volumes of traffic during select construction activities such as tunneling, fill placement, concrete pours, steel installation and bridge demolition and at least some of these activities will consist of numerous heavy loads for periods lasting many days. While in use as the Valley Line construction access, the existing vehicular access road must also remain available to others for servicing of the facilities at the Riverfront Plaza, including the holding tank and future lift station.

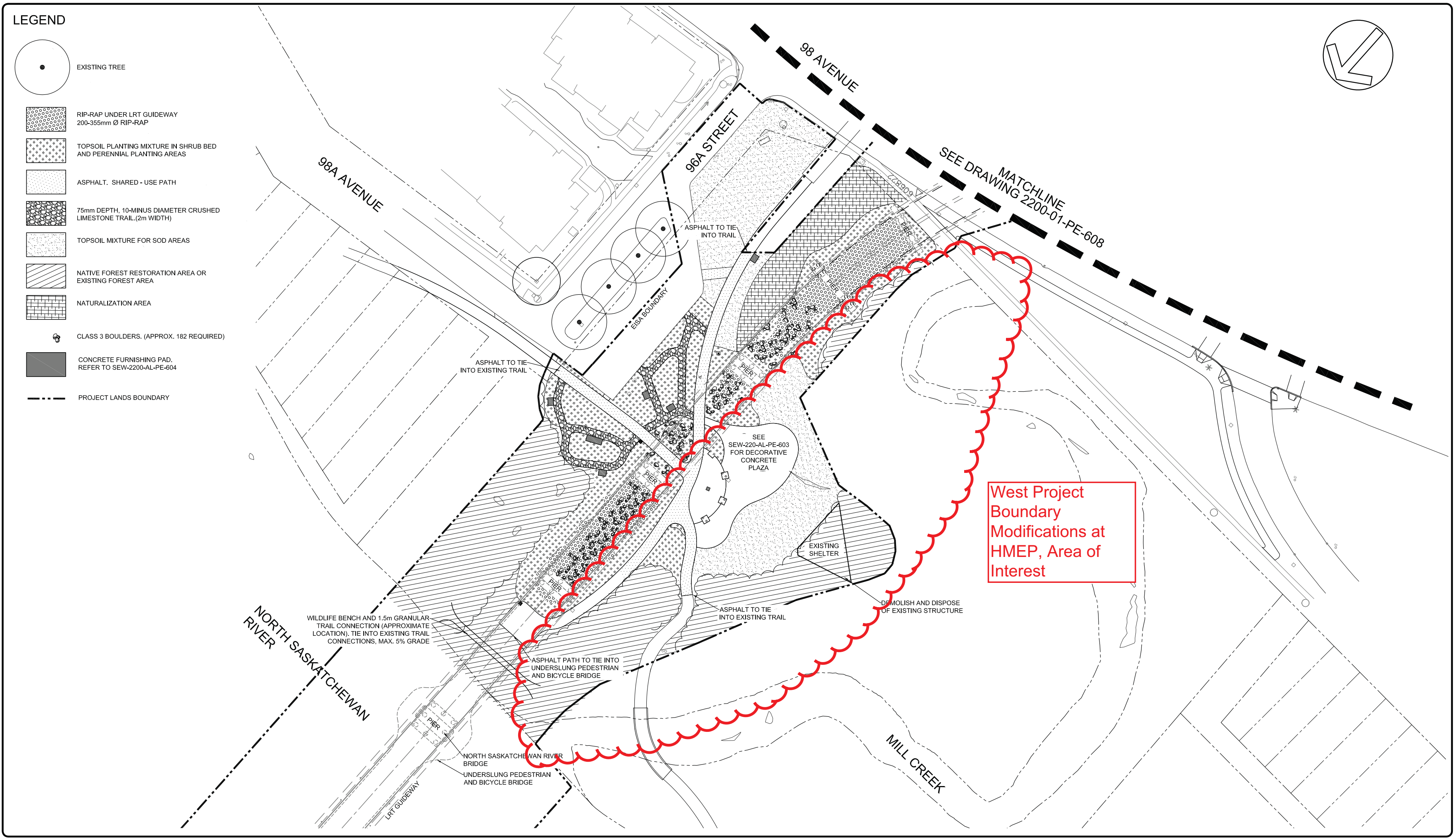
Alternatives Considered

When the City determined a need for a primary access route through west LMRP, LRT D and C identified three possible routes, consulted with Community Services and in November 2013 initiated an alternatives analysis exercise, considering in brief: constructability, slope issues, existing park conditions and impacts to park facilities and programming. The outcome of the route analysis was adoption of the route assessed here and shown on Figure 2.1b as the preferred alternative. The memo detailing this analysis is provided in Appendix A.

2.1.2 *West Project Boundary Modifications at HMEP - Project Co Component*

The City proposes to modify the western Project Area boundary, within HMEP, in two ways (Figure 2.1c) for two very different reasons. The 2013 EISA project description included demolition of a derelict picnic shelter near the west margin of the Project Area and use of those lands for general construction. The picnic area includes a shelter, benches and picnic tables (Plate 2.4). Closer inspection of the aerial photograph base overlain by the Project Area boundary revealed that, as drawn, the boundary cut through the shelter and thus did not allow for its demolition as part of the project. At the same time, LRT D and C continued to examine the impact of the Project on the Crown-owned bed and shore of the abandoned Mill Creek, north of 98 Avenue. It became evident that if the Project Area could be extended west to include the whole of the picnic area and be made available to Project Co for general construction use such as staging, lands encompassing the bed and shore of Mill Creek, and supporting native forest, could be removed from the Project Area, without adversely affecting constructability. Lands to be added to the Project Area, in support of picnic shelter demolition and used for general construction, total approximately 800 m^2. Lands to be removed from the Project Area include two parcels, approximately 539 m^2 and 1138 m^2 in area, totaling approximately 1677 m^2. Overall, the HMEP west project boundary modification represent a reduction of approximately 877 m^2 in land disturbed by construction activities. In combination, these proposed modifications, one extension and two reductions, were seen as a net gain in environmental protection. Furthermore, the subsequently developed 70% River Valley Landscape Drawings reflect the demolition of the picnic shelter, and show this area as re-landscaping of a portion of those lands and native forest restoration (Figure 2.2).

In summary, the proposed west boundary of the Project Area in HMEP involves an expansion in one location and a reduction in two locations. The boundary adjustment not only reduces impact on Mill Creek and the adjacent native balsam poplar forest, some lands currently supporting a hard-surfaced area would be returned to native forest.



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revisions

ISL Engineering and Land Services
Consultant

A1 bar scale 1:500 0 5 15 25m

drawn by S.P.
designed by L.K.
checked by L.K.
date 11-22-13

permit

consultant job no 13369

seal
The Alberta Association of Landscape Architects
22/08/2014
Jeff Schurek

consultant reviewed by J. SCHUREK

AECOM
Prime Consultant

THE CITY OF Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald
ISL Engineering and Land Services
DIALOG
gec architecture

PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by M. PERRY

drawing title
RIVER VALLEY LANDSCAPE DRAWINGS
HENRIETTA MUIR EDWARDS PARK
SOILS AND MATERIALS PLAN

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2200-01-AL-PE-601
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Figure 2.2

Plate 2.3. HMEP west project boundary modifications, looking west; picnic shelter and paving stone area (Sept. 2013).

Plate 2.4. Derelict picnic shelter and grounds in HMEP (April 2013).

2.1.3 *HMEP Entrance - Project Co Component*

The 2013 EISA Project Area deliberately excluded from the Project Area a small parcel of land situated between the 98 Avenue Pedestrian Bridge and 96A Street (Figure 2.1c; Plate 2.5). Subsequent planning has determined that inclusion of this approximate 763 m^2 area of land would create more flexibility for Project Co to provide continuous pedestrian access to 98 Avenue Pedestrian Bridge, as required in the contract. In earlier planning stages it was thought that excluding the lands would assist in assuring continuous access to the bridge, but by adding that small parcel, Project Co would have more flexibility to provide access to and from that bridge terminus, in a manner that best suits sequential construction stages. The contract will still require that pedestrian access to the bridge be maintained at all times. Post-construction, this area would be reclaimed through landscaping.

Plate 2.5. Area of proposed boundary changes at HMEP entrance (98 Ave and 96A St), looking northeast (June 2014).

2.1.4 *Retaining Wall Ground Anchors - Project Co Component*

The 2013 EISA identified the need for the installation of one or more retaining walls in the vicinity of Muttart Stop and along the permanent portal emergency and maintenance access route. The need for these retaining walls and the possible use of ground anchors as a means of providing wall support was acknowledged in the 2013 EISA. These robust, typically steel anchors are drilled or driven (pounded) at a downward angle into adjacent lands at increasing depth. The length of the anchor is, in part, a function of the height of the wall, and the anchor often extends as far as four times the height of the wall. Thus, at the two identified locations, ground anchors, should Project Co choose to use them, would extend beyond the previously identified Project Area, occupying an area coarsely depicted in Figure 2.1b and 2.1c. The installation of retaining wall anchors does not require surface disturbance. Such anchors are commonly used when new infrastructure is installed in built environments and installation without disturbing adjacent infrastructure is a proven procedure. Final design of the retaining walls and their support methods will be the responsibility of Project Co and, at these locations, ground anchors will be among the available options. The contract will not permit the anchors to extend past the limits of City-owned land and under privately-held lands. Following construction, anchor locations will be documented and registered and thus on record with Alberta First Call. There will be no post-construction restrictions on surface use of lands underlain by anchors.

Following is a technical description of ground anchors, their utility and the benefits of having this method remain available to Project Co. This description was developed for EISA Update purposes by Thurber Engineering. Permanent or temporary excavations in constrained sites are typically supported using non-gravity, cantilever or anchored/braced retaining walls. For both systems, support is provided through the shear and bending stiffness of the vertical wall elements and the passive resistance from the soil below the finished excavation grade. For anchored/braced walls, added support is provided by the lateral resistance of the ground anchors or internal bracing elements. Because of lack of lateral restraint, cantilever walls undergo larger lateral deformations than anchored/braced systems, and their use is often limited to supporting excavations shallower than about 5 m.

For deep excavations in certain design and soil conditions, ground anchors and anchored retaining systems offer some key technical and economic advantages over cantilever or internally braced walls. A summary of these advantages is noted below:

- Anchored walls can resist relatively large horizontal pressures without requiring a significant increase in wall cross section;
- The active forces applied by pre-stressed ground anchors are an effective way of limiting wall deformations, which is particularly important in design situations where strict control of lateral movement of retained ground is required (e.g. excavations of steep or marginally stable slopes, excavations near sensitive structures, etc.);
- The use of ground anchors can reduce the required embedment of vertical wall elements below the excavation grade line;

- The use of ground anchors offers unobstructed workspace inside the excavations.
- Typical industry practice involves verifying the actual performance of ground anchors via full scale field testing during construction.

Construction of a ground anchor involves the insertion of high strength steel element (bar or stand) into a predrilled hole that extends a certain design distance behind the excavation face. The hole is subsequently filled with cement grout (usually under pressure) and the steel member pre-tensioned. The pre-stressing force is transmitted to the retaining structure at the cut face via an anchorage system. Figure 2.3a shows a schematic diagram of the main components of a typical ground anchor. Figure 2.3b illustrates the construction sequence of one type of anchored retaining wall systems, namely, solider piles and lagging.

For ground anchors to be effective, they should be installed into competent soil or bedrock beyond any potential slip surfaces. Ground anchors are commonly installed at angles of 15 to 30 degrees below the horizontal, and can extend generally between 12 and 40 m behind the excavation face. An assessment of the feasibility of ground anchors at a given site should consider underground obstructions/utilities, soil and groundwater conditions, right-of-way and easement limitations and effects on adjacent structures.

In Edmonton, ground anchors have been used successfully on many projects, including the Shaw Conference Center, the south riverbank portal of the existing LRT line, and the widening of Fox Drive and Scona Road. Ground anchors in Edmonton are usually embedded into hard glacial till, dense Saskatchewan sand and gravel, or clay shale/sandstone bedrock.

Figure 2.3a

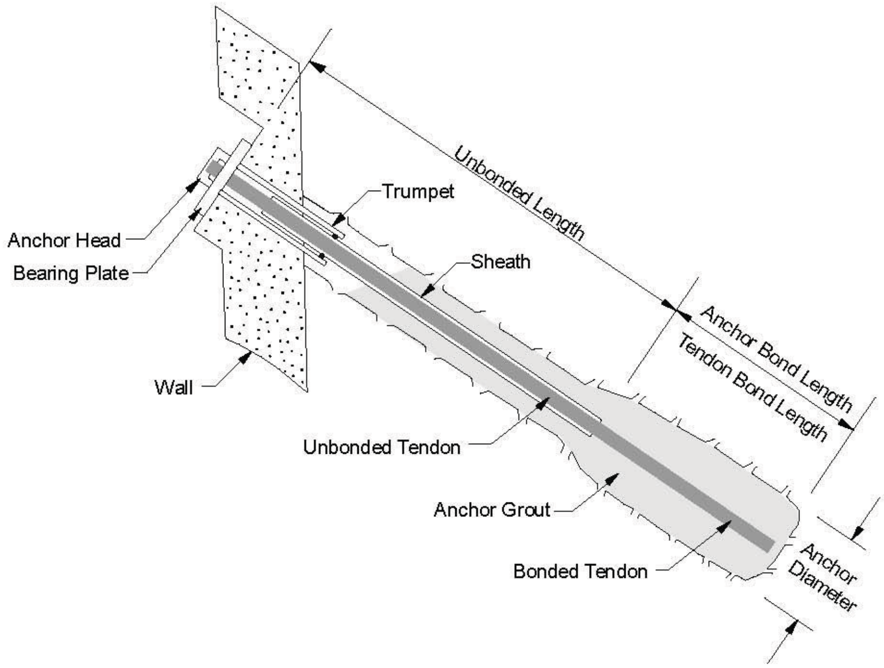
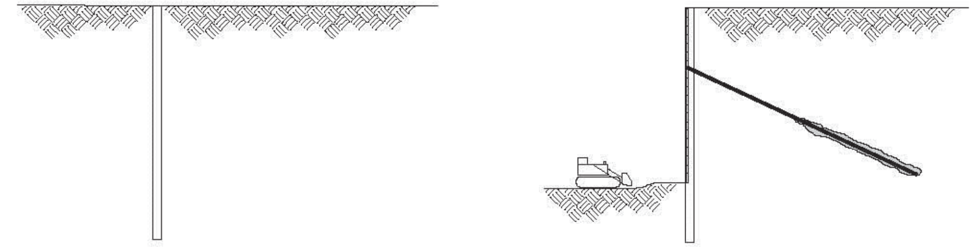


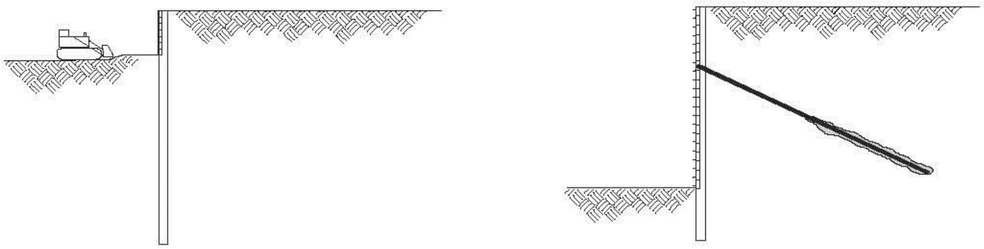
Figure 1 – Main Components of a ground anchor (FHWA, 1999)

Figure 2.3b



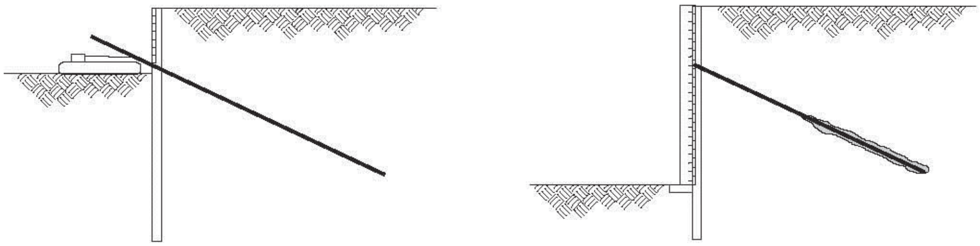
STEP 1: Install soldier beam

STEP 4: Complete excavation



STEP 2: Excavate and install lagging

STEP 5: Install headed studs and prefabricated drainage



STEP 3: Install and test ground anchor

STEP 6: Pour cast-in-place facing

Figure 2 – Construction sequence for permanent soldier beam and lagging wall (FHWA, 1999)

2.1.5 *Ski Club Infrastructure Relocation - Project Co Component*

The 2013 EISA indicated that up to three Edmonton Ski Club lift towers must be relocated to accommodate a wider transportation corridor and the resulting changed grades north of Connors Road. Since then, studies of the effect of the project on the nearby ski runs have refined the City's understanding of the impact and of available and required mitigation means. As anticipated in 2013, Ski club infrastructure requires relocation at three locations, all of which can be undertaken within the 2013 delineated Project Area. However, at the third location, near the intersection of Connors Road and Cloverdale Hill Road, relocation of the T-bar return terminal bullwheel has implications for the associated downslope run. According to a specialist's report prepared for the City (BHA 2014), to maintain the minimum recommended unloading distance of 25 m between the relocated return terminal bullwheel and the last T-Bar tower there is a need to move the T-Bar tower slightly downslope and re-grade a small area to create a new suitable landing area. The existing operator shack shown in Plate 2.6 will also have to move further downslope, to be near the relocated return terminal bullwheel. Re-grading falls slightly outside the 2013 boundary and thus requires a small extension of the Project Area (Figure 2.1d) adding approximately 362 m^2 of additional land (Plate 2.6).

Plate 2.6. Edmonton Ski Club return terminal bullwheel (foreground), operator shack (middle ground) and last tower (background) for the T-bar run, looking northwest (Jan. 2015)

For this scenario, a new tower may also have to be added to maintain passenger ropeway standards (BHA 2014). This will be finalized at a later date.

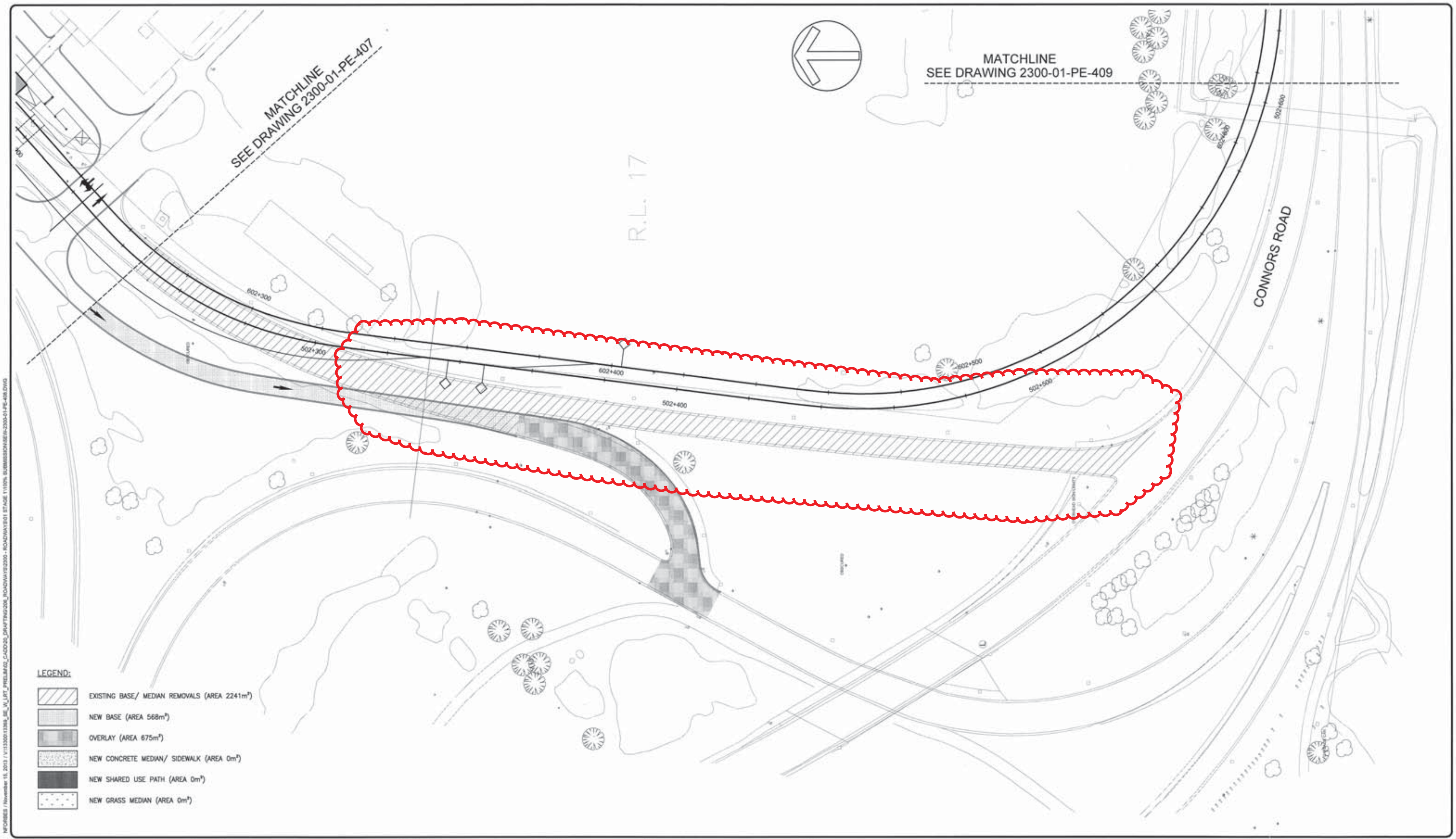
Any infrastructure removal/relocation and installation will be the responsibility of the Edmonton Ski Club, as funded and facilitated by LRT D and C. Project Co is responsible only for re-grading and the final condition of the affected lands. Project Co activities in this extended parcel will be restricted to site fencing and re-grading for ski club purposes. The re-grading between the return terminal bullwheel and last tower is mandated to occur between April 15 and August 20. This timing requirement now forms part of the contract, providing the ski club time to reinstall the equipment prior to the start of the following ski season.

2.1.6 *Muttart Access Road Partial Removal - Project Co Component*

As part of Valley Line LRT construction, the Muttart Access Road, connecting Connors Road northbound and 98 Avenue, and providing access to the conservatory grounds, will be permanently realigned to accommodate the LRT trackway and Muttart Stop. The need for realignment was covered in the 2013 EISA. As part of that realignment, closure/demolition of a 200 m long, one-way road connecting northbound Connors Road to the Muttart Access Road will be required (Figure 2.4). That connector road will be permanently removed as part of the Valley Line project. As 2013 EISA stated that the existing connector from Connors Road north would remain intact, this minor, permanent change in the road network was not fully assessed. The road removal involves approximately 2,070 m^2 of land. This project component differs from the others assessed in this update in that it requires no adjustments to the Project Area *and* most of the activities associated with removal would be the same as which these undertaken as part of the realignment of the access road, was covered in the 2013 EISA.

2.1.7 *Muttart Storage Building Replacement- City Component*

The 2013 EISA identified Project Co as responsible for constructing the replacement Muttart Conservatory Storage Building (MSCB) and ancillary facilities, required as a result of the location of the LRT trackway and Muttart Stop. The delineated Project Area included lands to accommodate the new facility, showed a conceptual building location and assumed that Project Co would construct the building at the time it staged construction of other facilities in that area. Subsequent planning has since refined that location, considering details such as how best to accommodate a like-for-like storage building, associated parking and delivery truck access requirements in a manner that also responds to the delivery needs of the Muttart greenhouses (Figure 2.5a – 2.5c). . The final building location then shifted another 5.8 m to the southwest so as not to foreclose on the potential for a future park access road and future SUP running between the greenhouses and the storage building. Specifically, the new facility location was affected by the need to ensure effective delivery service to both the working greenhouses and the storage building. The new location had to account for efficient delivery service to both these areas and *between* the storage building and working greenhouses for items such as soil storage. The changed location led to the decision to reassign this component from the larger project to early works by the City.



no.	description	date	appd
C	FINAL PRELIMINARY ENGINEERING	15-11-13	R.C.
B	ISSUED FOR 90% REVIEW	07-12-12	R.C.
A	ISSUED FOR 60% REVIEW	22-06-12	R.C.
	issue date		

no.	description	date	checked
	revisions		

ISL Engineering and Land Services
Consultant

A1 bar scale 1:500 0 5 15 25m

drawn by E. CHIU
designed by E. CHIU
checked by B. CAMPBELL
date 15-11-2013

permit
PERMIT TO PRACTICE
ISL Engineering and Land Services Ltd.
Signature
Date Nov 19/2013
PERMIT NUMBER: P 4741
The Association of Professional Engineers and Geoscientists of Alberta

seal
RUSSEL COULOMBE
11-19-2013

consultant job no 13369
consultant reviewed by R. COULOMBE

AECOM
Prime Consultant

The City of Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald
ISL Engineering and Land Services
DIALOG
gec architecture

PRELIMINARY ENGINEERING
DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by M. PERRY

drawing title
LRT CIVIL WORK
PAVEMENT DETAILS

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2300-01-PE-408
REV
SHT 129

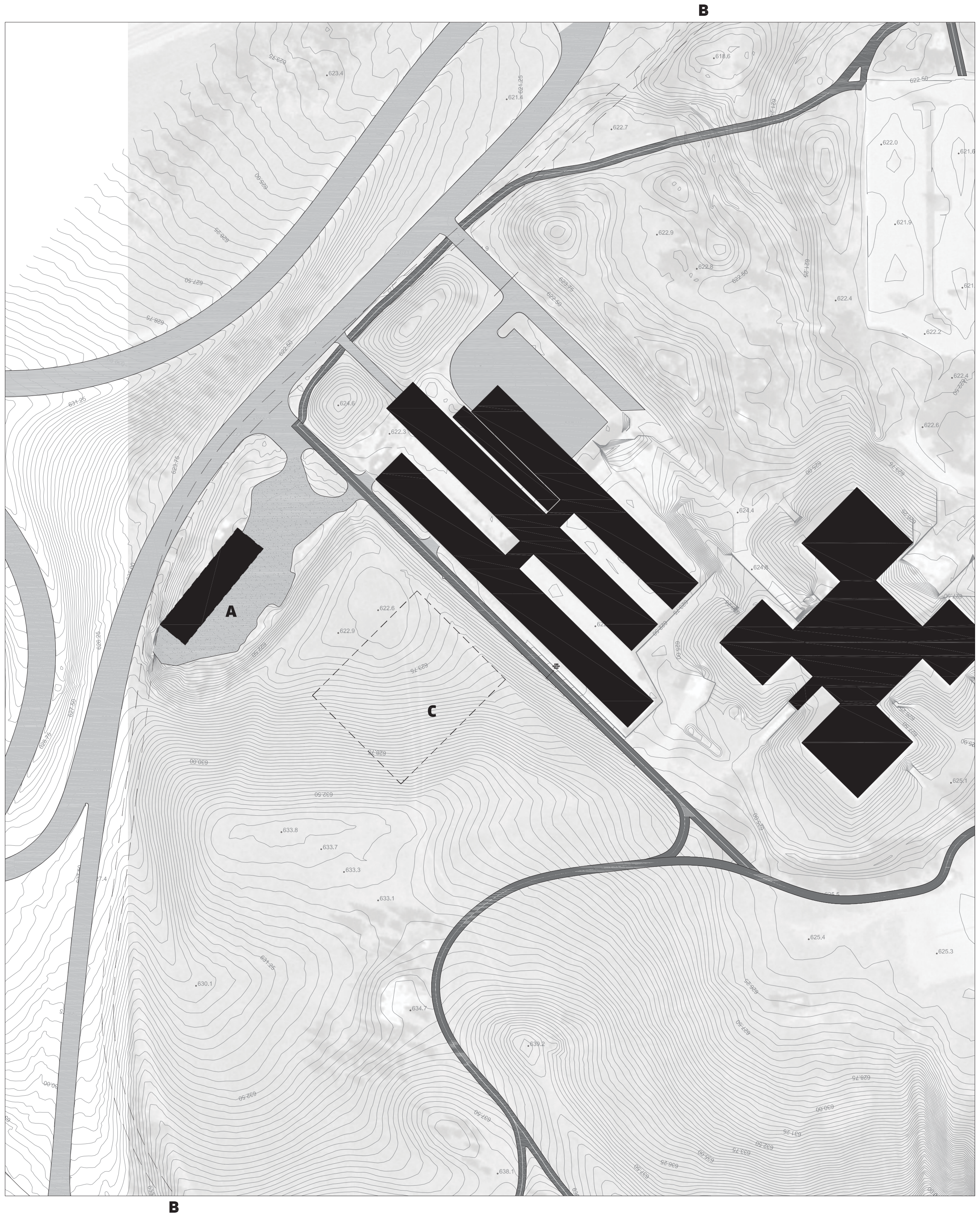
Figure 2.4 Muttart Access Road Partial Removal

The new building is close to identical in size, shape and function as the building it is to replace. The replacement project includes re-establishment of essential ancillary facilities (a small number of parking stalls and delivery truck turn around). Much of the disturbance footprint shown in Figure 2.1d is temporary, required to accommodate the necessary re-grading (Plate 2.7) and will be returned to parkland following construction. The total project component footprint is 8,795 m^2, of which approximately 5,966m^2 (68%) will be restored to turf and possibly other small landscaping features near the facility (i.e. planted beds). Lands to be disturbed consist entirely of manicured lawn and one SUP, situated along the existing west margin of the Muttart working greenhouses. Minor realignment of that SUP will be required. Construction activities associated with this project component will be undertaken by the City in summer and autumn of 2015, prior to commencement of general construction activities associated with the Valley Line.

Since construction of the proposed replacement building will be undertaken by the City of Edmonton, the footprint for the replacement structure has been removed from the Project Co lands, as shown in Figure 2.1d, and distinguished from those lands as a City component (shown in blue). Demolition of the existing storage building for the Muttart Conservatory will be undertaken by Project Co as was described in the 2013 EISA and the existing building remains within the original Project Area. In the event that construction is not complete by spring of 2016, when Project Co is anticipated to begin work in the river valley, arrangements will be made to ensure no conflicts arise with other contractors that may be working in the area.

This assessment assumes that certain construction protection measures will be built into the MCSB replacement construction contract, with the chief one being the need to remain compliant with City of Edmonton's ENVISO program. Thus, new facility construction is assumed to be governed by a project-specific, Environmental Construction Operations (ECO) Plan, prepared by the contractor in compliance with the City's Environmental Construction Operations (ECO) Plan Framework. This plan will include a comprehensive Temporary Erosion and Sedimentation Control Plan (TESCP) that meets or exceeds the standards of the City of Edmonton's *Erosion and Sedimentation Control Guidelines* (2005). Further, the contract will specify the need to address utilities, as required. Finally, it is expected that all appropriate fuel handling procedures and occupational health and safety requirements will be followed and all construction practices will be in compliance with all City environmental bylaws.

Figure 2.5a



PROJECT CONTEXT - EXISTING

SCALE 1:2000

PROJECT CONTEXT - FUTURE

SCALE 1:2000

PROJECT DESCRIPTION:

Build a new storage building to replace the existing (**A**) as a result of the new LRT line expansion (**B**).

The new building (**C**) will house 3 main functions; Soil and Material Storage, Prop Storage, and a workshop for Kinsmen Fitness Centre.

REPLACEMENT STRUCTURE CONSIDERATIONS:

- Incorporate efficiencies into the building and surrounding area (**C2**) along with managing the visual impact of the structure given its new location.
- It is expected that the TPSS building (**E**) and the Muttart Conservatory Storage Building will be complimentary relative to architectural expression.
- The design of the new building is to be respective of its surroundings in Edmonton's North Saskatchewan River Valley and the Muttart Conservatory grounds. (**D2**)

DRAWING LEGEND:

B	Anticipated Valley-Line LRT alignment.
B2	Valley Line LRT Stop.
C	New Storage Building, re-located next to existing greenhouses (**D**).
E	Traction power substation (T.P.S.S.) site, part of LRT.
E2	Potential storm water management pond, part of LRT.
▧	Shared-Use-Path (SUP)
▥	Potential Future Shared-Use-Path
■	Buildings
▒	Hard Surface (asphalt / pavement)
▒	Gravel Surface
▨	Topography (0.25m intervals)
▧	L.R.T. TRACK ALIGNMENT (at grade)

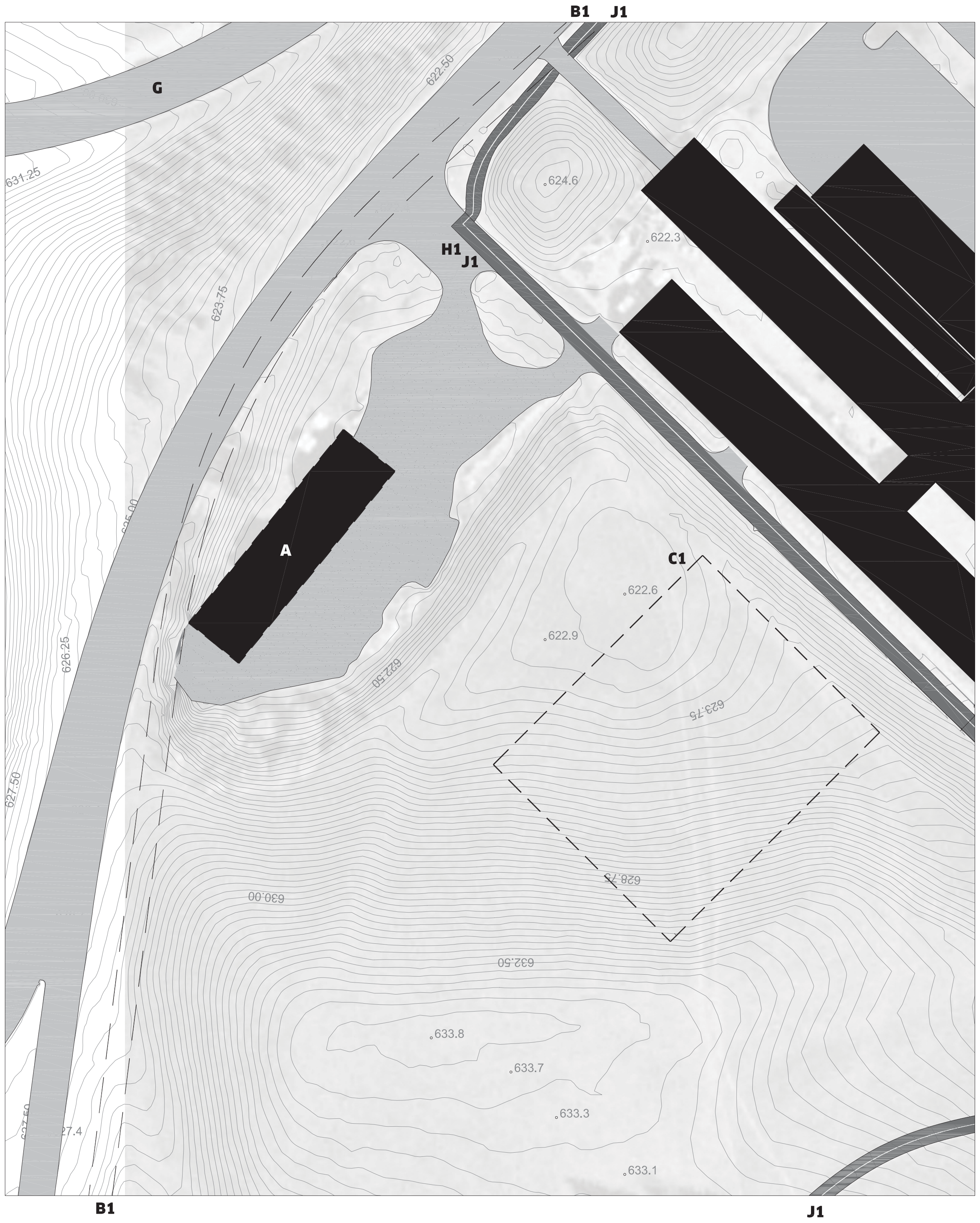
DIALOG

MUTTART CONSERVATORY STORAGE BUILDING

A001

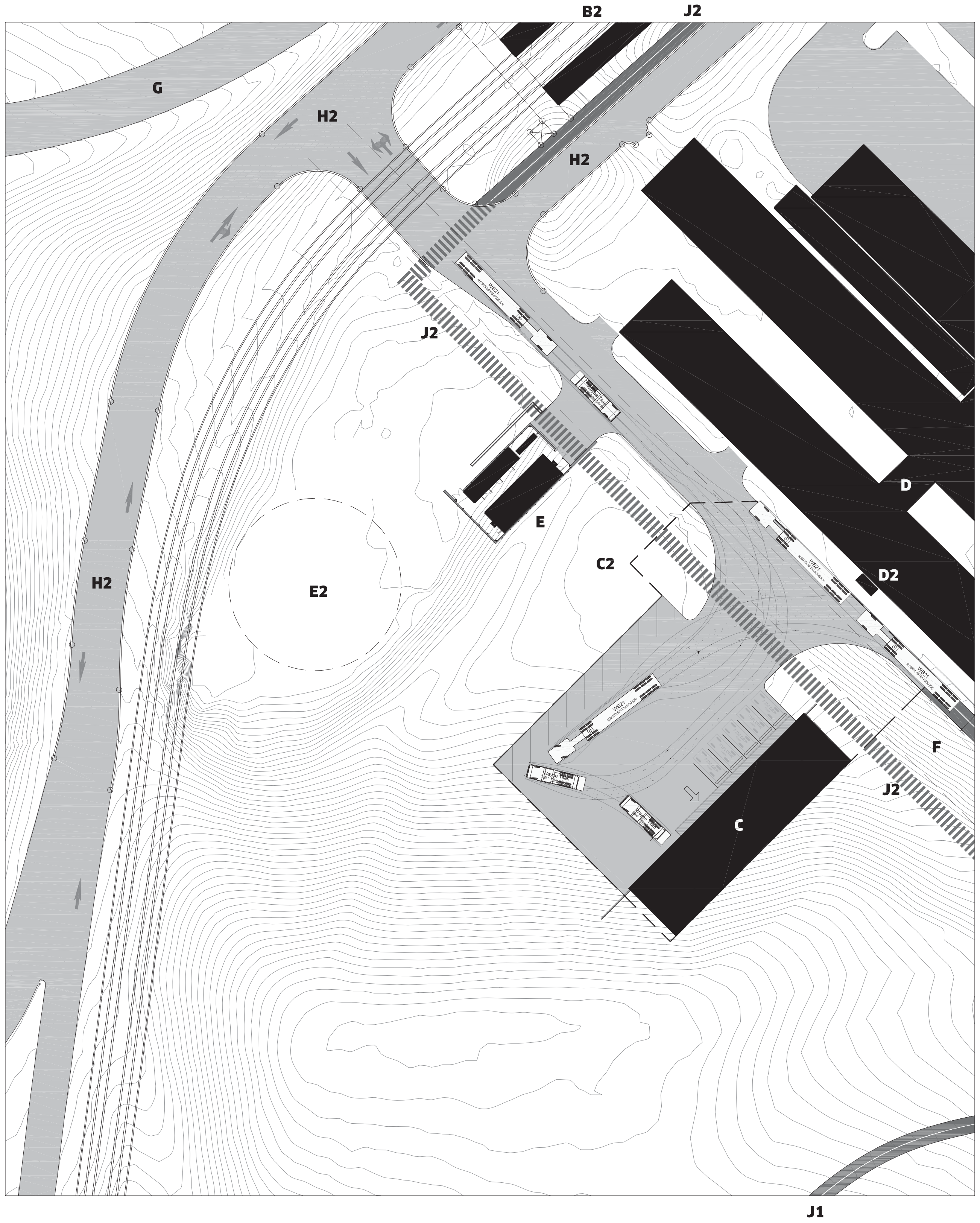
Prepared for Client review - Site Shift to SW
2014-09-22

Figure 2.5b



SITE CONTEXT PLAN - EXISTING

SCALE 1:1000



SITE CONTEXT PLAN - FUTURE

SCALE 1:1000

SITE CONTEXT DRAWING LEGEND:

A	Existing Storage Building.
B1	Anticipated Valley-Line LRT alignment.
B2	Valley Line LRT Stop.
C	New Storage Building. = 502.8 m² or 5412.6 s.f.
C1	Outline of Project Scope. (from RFP Figure 9.0) = 2288 m² or 0.57 acres
C2	Outline of Project Scope (including road work) = 3043 m² or 0.75 acres
D	Existing greenhouses.
D2	Potential future vestibule entrance into Greenhouses.
E	Traction power substation (T.P.S.S.) site, part of LRT.
E2	Potential storm water management pond, part of LRT.
G	Off-ramp from James MacDonald Bridge (98 AVE) Eastbound, one-way.
H1	Existing Service Road, currently shared with Shared-Use-Path (SUP).
H2	New road alignments.
J1	Existing Shared-Use-Path.
J2	Possible new alignment for 3.0 m Shared-Use-Path. Not part of this project scope.
F	9.0 m offset for Potential Future Access to Ski Club site.

▧	Shared-Use-Path (SUP)
▥	Potential Future Shared-Use-Path
■	Buildings
▒	Hard Surface (asphalt / pavement)
░	Gravel Surface
▨	Topography (0.25m intervals)
▧	L.R.T. TRACK ALIGNMENT (at grade)

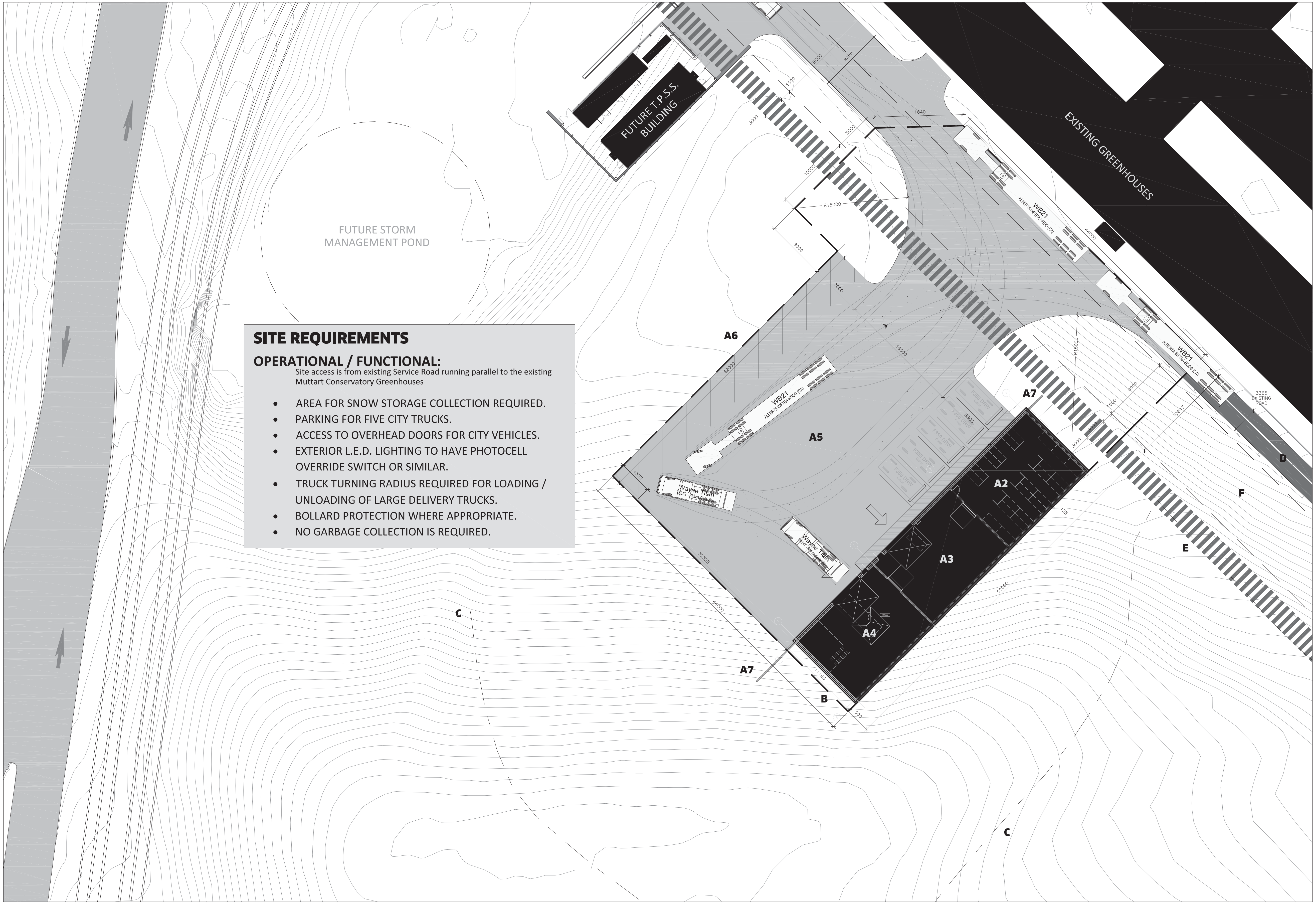
DIALOG

MUTTART CONSERVATORY STORAGE BUILDING

A002

Prepared for Client review - Site Shift to SW
2014-09-22

Figure 2.5c



SITE REQUIREMENTS

OPERATIONAL / FUNCTIONAL:

Site access is from existing Service Road running parallel to the existing Muttart Conservatory Greenhouses

- AREA FOR SNOW STORAGE COLLECTION REQUIRED.
- PARKING FOR FIVE CITY TRUCKS.
- ACCESS TO OVERHEAD DOORS FOR CITY VEHICLES.
- EXTERIOR L.E.D. LIGHTING TO HAVE PHOTOCELL OVERRIDE SWITCH OR SIMILAR.
- TRUCK TURNING RADIUS REQUIRED FOR LOADING / UNLOADING OF LARGE DELIVERY TRUCKS.
- BOLLARD PROTECTION WHERE APPROPRIATE.
- NO GARBAGE COLLECTION IS REQUIRED.

SITE PLAN DRAWING LEGEND:

New Storage Building .
= 502.8 m^2 or 5412.6 s.f.

A2	Prop Storage Bay
A3	Soils Material & Storage Bay
A4	Fitness Repair Workshop
A5	Outdoor yard
A6	Snow Storage Area
A7	Possible retaining wall
B	Outline of Project Scope (including road work) = 3043 m^2 or 0.75 acres
C	3:1 grading (slope towards building) from Figure 9.0 of RFP.
D	Existing Service Road, to remain.
E	Possible new alignment for 3.0 m Shared-Use-Path. Out of scope.
F	9.0 m offset for Potential Future Access to Ski Club site.

▨	Shared-Use-Path (SUP)
▥	Potential Future Shared-Use-Path
■	Buildings
▒	Hard Surface (asphalt / pavement)
░	Gravel Surface
▤	Topography (0.25m intervals)
▧	L.R.T. TRACK ALIGNMENT (at grade)

SITE PLAN
SCALE 1:500

DIALOG®

MUTTART CONSERVATORY STORAGE BUILDING

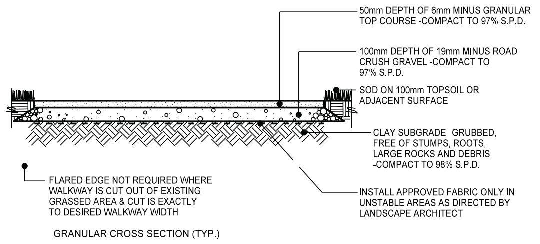
A003
Prepared for Client review - Site Shift to SW
2014-09-22

Plate 2.7. Manicured lawn of proposed MCSB replacement and parking area (hill to be re-graded in foreground, existing building will be situated mid-ground), view to northeast (Sept. 2014)

2.1.8 *LMRP Temporary Trail Connector - City Component*

Prior to commencement of Valley Line construction, to reduce the impact of the up to five years of construction on LMRP trails and facility use, the City will construct a short, temporary connector trail just west of the Project Area in the Chinese Gardens (Figure 2.1b; Plate 2.8). The temporary trail will connect the western portion of the primary north-south SUP to an established trail in the Chinese Garden, allowing pedestrians and cyclists to circulate through the broader network of park trails situated west of the main LRT project corridor and avoiding trail dead ends. The proposed temporary gravel trail will be approximately 1.5 m wide and 15 m in length. Design details and location are shown on Figure 2.6.

Construction drawings indicate that the trail will be sub-excavated to 150 mm depth, filled with compact clay and topped with gravel. Trail construction in this sloped area will involve grade changes. The grade adjacent to the existing trail will be raised using clay fill and will taper down to the existing grade with a maximum slope of 1:3 (Figure 2.6). Fill will be stabilized using 300-600 mm boulders installed at the bottom of the new embankment with one third of the boulders buried into the subgrade/topsoil. Topsoil and sod will be placed on disturbed soil adjacent to the new trail and positive drainage will be provided. The width of disturbed area will be approximately 2-3 m; total area of disturbance will be approximately 65 m^2.

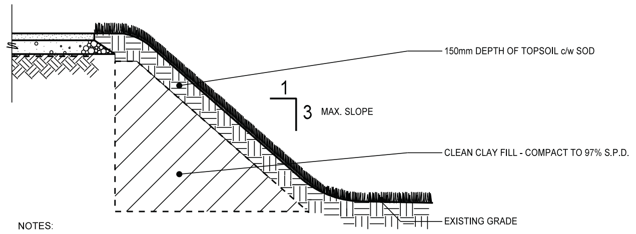


NOTES:

- DIMENSIONS OF GRANULAR WALKWAY AS PER LANDSCAPE DRAWINGS
- SET GRANULAR SURFACE FLUSH WITH ADJACENT GRADES
- ENSURE DRAINAGE OFF GRANULAR WALKWAY AT ALL LOCATIONS & IN COMPLIANCE WITH THE OVERALL SITE DRAINAGE PLAN
- 20mm MINUS GRANULAR - SECTION 2060 AGGREGATE DESIGNATION 3, CLASS 20A, COMPACT to 97% S.P.D.

THE CITY OF Edmonton GRANULAR WALKWAY

Drawing No. LA303



NOTES:

- HEIGHT AND WIDTH OF SLOPE VARIES
- SET GRANULAR SURFACE FLUSH WITH ADJACENT GRADES
- ENSURE DRAINAGE OFF GRANULAR WALKWAY AT ALL LOCATIONS & IN COMPLIANCE WITH THE OVERALL SITE DRAINAGE PLAN
- 20mm MINUS GRANULAR - SECTION 2060 AGGREGATE DESIGNATION 3, CLASS 20A, COMPACT to 97% S.P.D.

THE CITY OF Edmonton GRANULAR WALKWAY SLOPE

Drawing No. CUSTOM

Temporary Trail Connector
Louise McKinney Park
River Valley

(9529 Grierson Hill Road, Edmonton, AB)

BY CONTRACTOR

INCIDENTALS

1. Contractor is responsible for mobilization and demobilization of the site. See 'Special Provisions' section of tender document for detail.
2. Contractor is responsible for 'Warranty Period Maintenance' of the site. See 'Special Provisions' section of tender document for details.

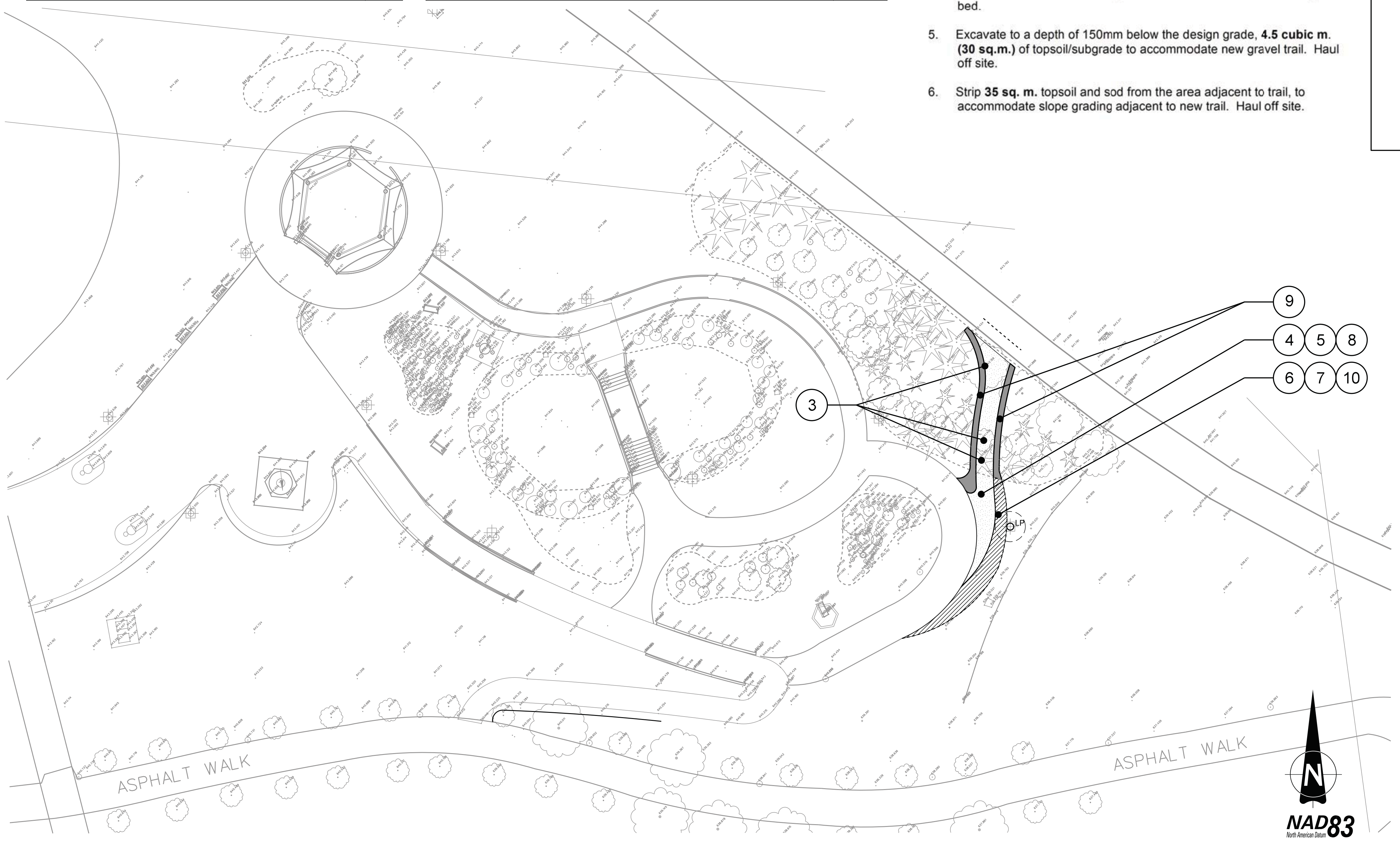
SITE PREPARATION / REMOVALS

3. Excavate **3** shrubs (1 horizontal juniper; 1.2m dia. approx., 1 multi-stemmed Sand cherry; 1.5m dia. approx., and 1 multi-stemmed maple; 2.0m dia. approx.) to accommodate new gravel trail alignment. Relocate on site as directed by project manager.
4. Strip **30 sq. m.** of shrub bed mulch to accommodate new gravel trail and reserve for re-use on site. Spread excavated mulch over existing shrub bed.
5. Excavate to a depth of 150mm below the design grade, **4.5 cubic m. (30 sq.m.)** of topsoil/subgrade to accommodate new gravel trail. Haul off site.
6. Strip **35 sq. m.** topsoil and sod from the area adjacent to trail, to accommodate slope grading adjacent to new trail. Haul off site.

NEW CONSTRUCTION

7. Build up the grade adjacent to existing trail to accommodate new trail construction. Construct **25.0 cubic m.** base with clay fill adjacent to trail tapering down to existing grade. Maximum slope is 1:3. Refer to custom detail on this drawing.
8. Construct **30 sq. m.** of 50mm depth granular paving c/w 150mm granular base on compacted clay sub-grade. Trail is 1.5m wide. Refer to detail LA302 on this drawing. Contact Community Project to arrange for compaction testing.
9. Install **10 sq. m.** 100mm depth mulch adjacent to new trail through existing shrub bed. Ensure positive drainage
10. Install **20 sq. m.** 150mm depth topsoil and sod adjacent to new trail. Ensure positive drainage.

NOTE:
THIS SITE SURVEY IS OUT OF DATE AND MAY NOT BE ACCURATE. LAYOUT AND GRADING OF EXISTING SITE IS APPROXIMATE. NEW TRAIL IS TO BE LAID OUT INTHE FIELD. QUANTITIES MAY NEED TO BE ADJUSTED ACCORDINGLY.



THE CITY OF Edmonton ASSET MANAGEMENT & PUBLIC WORKS PARKS BRANCH
PRELIMINARY DRAWING not for CONSTRUCTION

The Alberta Association of Landscape Architects
Gilbert Catabay

Revisions

THE CITY OF Edmonton
ASSET MANAGEMENT AND PUBLIC WORKS PARKS BRANCH

RIVER VALLEY (9529 Grierson Hill Road)
LOUISE MCKINNEY PARK

CHINESE GARDENS
TEMPORARY TRAIL

CONSTRUCTION DRAWINGS

Landscape Arch. GC		Date AUG. 2014	Drawing No. 1
Grading Drainage		Scale 1:200	
Drawn CR	Director	File No. CD–01–14	
Checked	— Date —	Design File Name loui acd.dgn	

Reference File Name(s) loui abs.dgn
construct.tbl

Figure 2.6

Plate 2.8. Approximate area of proposed LMRP temporary trail connector, looking south (Jan. 2015).

The trail will cut through an existing planting bed and, thus, will require some site preparation, including relocation of several shrubs from the planting bed; stripping approximately 30 m^2 of shrub bed mulch and topsoil, and, stockpiling for re-use in nearby sites. Post-construction, all disturbed lands will be returned to their pre-disturbance condition.

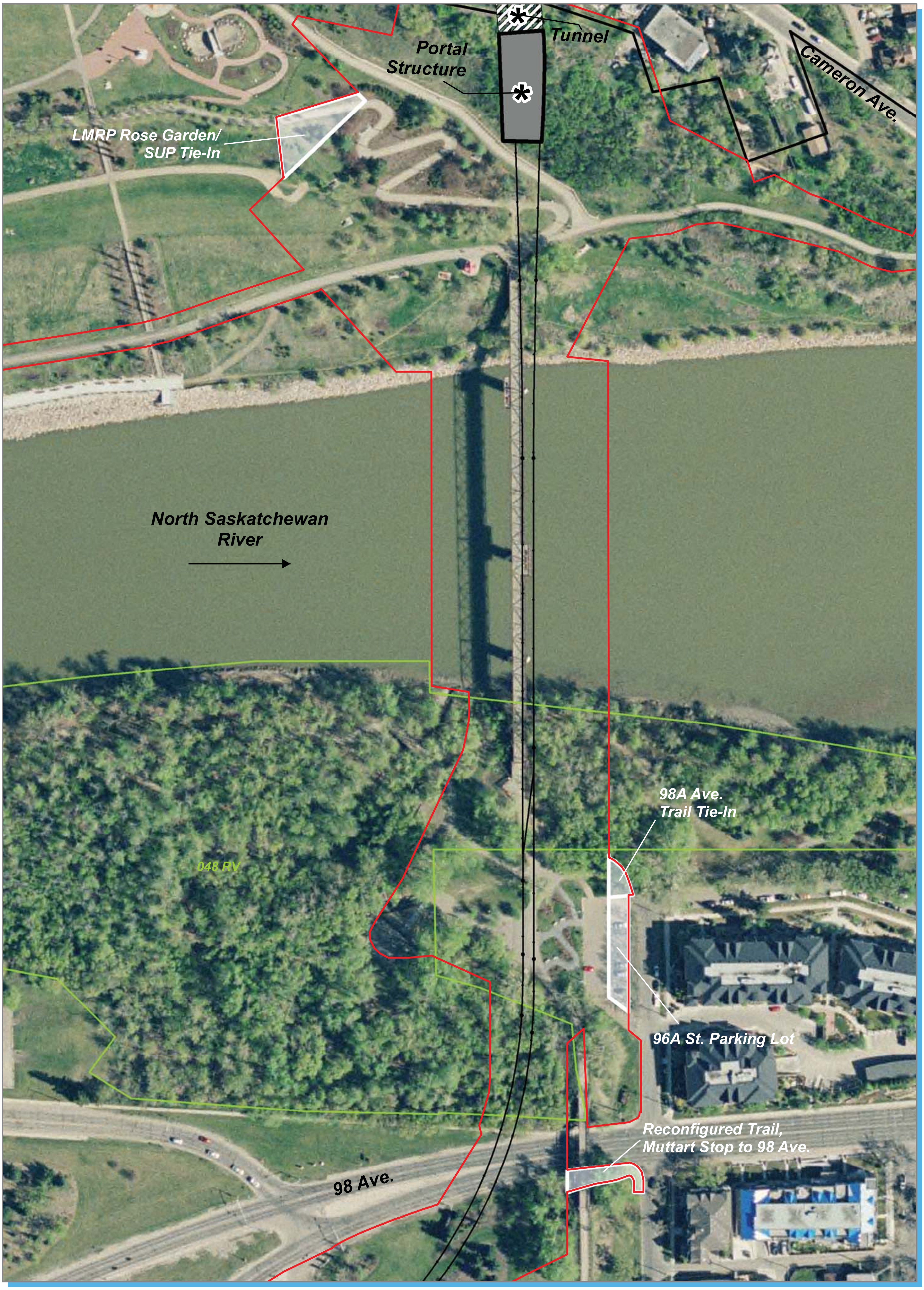
The connector trail will be constructed in late summer 2015, under a contract administered by Community Services. The contract will specify the need to prepare an ECO Plan, address utilities as required, and comply with all City bylaws and relevant environmental guidelines.

2.2 Spatial Clarifications

Figure 2.7 shows the location and relative extent of the four project components requiring spatial clarification. All of the activities associated with each of the four project components will be undertaken by Project Co.

2.2.1 *LMRP Rose Garden and SUP Tie-in*

As documented in the 2013 EISA, Valley Line construction will result in temporary disturbance to a portion of the "World Walk" SUP and associated Rose Garden in LMRP (Plate 2.9). The 2013 EISA noted that a portion of the Rose Garden was expected to be removed in support of construction and that it would either be restored at its current site



Legend

- ▭ Refinements to Project Co Project Lands
- 🟥 Project Area
- — Valley Line LRT Alignment (Reference Design)
- ▭ Bylaw 7188 Boundary
- 🟩 City of Edmonton River Valley Natural Areas (2010)
- * Indicative Location Only

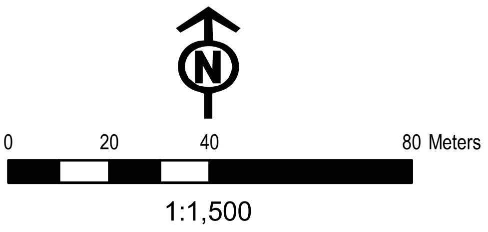


Figure 2.7 Spatial Clarifications

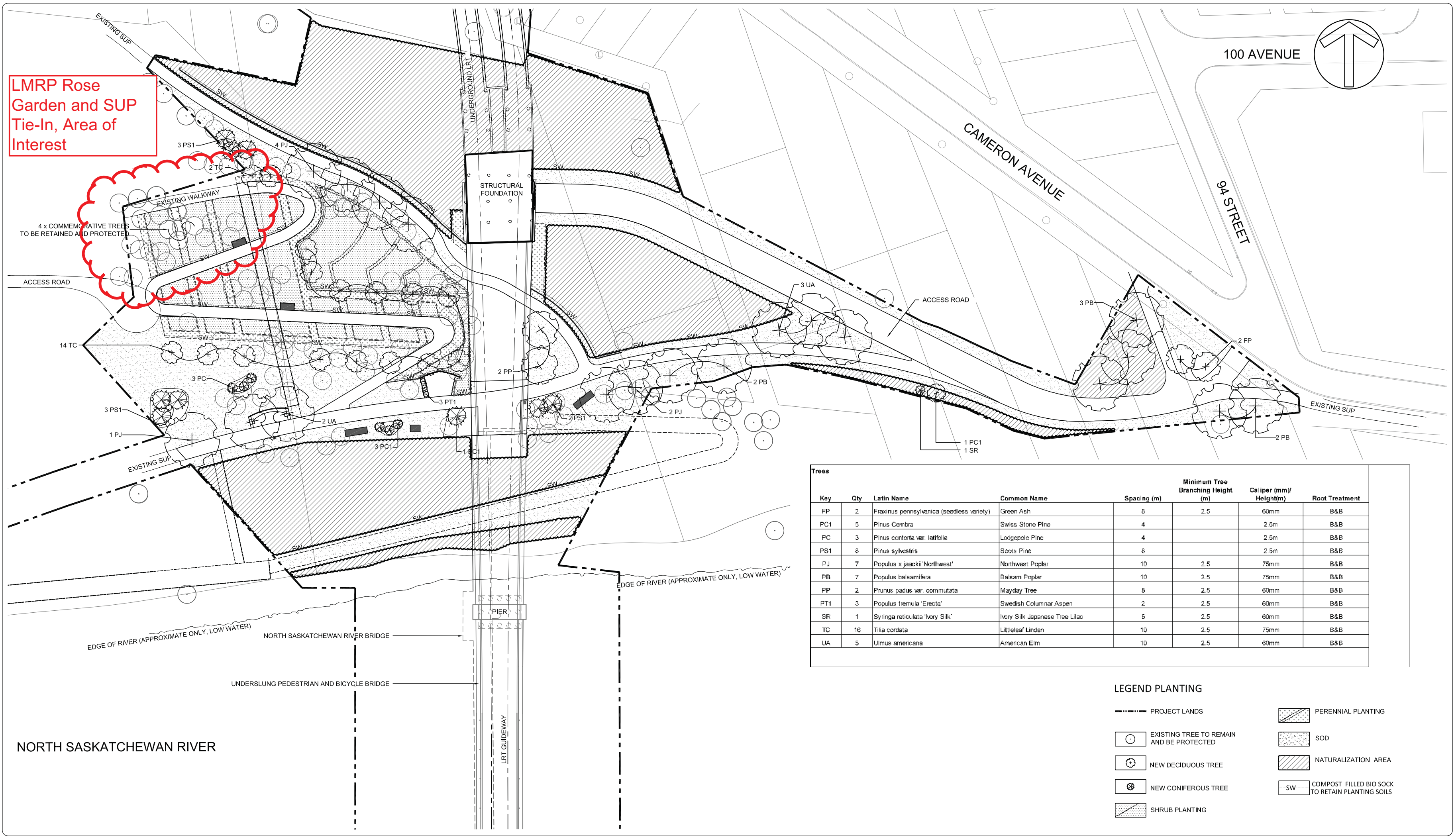
City of Edmonton LRT Valley Line - Stage 1
EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Plate 2.9. Existing "World Walk" SUP and Rose Garden (June 2014).

following construction, or relocated to a new, permanent site. The 70% River Valley Landscape Drawings and the Project Agreement now in place for the project require Project Co to install a revisioned Rose Garden within the original Project Area. The drawings also require that the new garden area properly tie-in to the remnant portions of the Rose Garden and SUP situated west of the Project Area (Figure 2.8a). These activities represent a refinement of a mitigation measure committed to in the 2013 EISA; however, the tie-in work requires a slight extension of the Project Area. The project contract documents restrict Project Co activities in this area to landscaping activities only (Figure 2.8b). The total area associated with the tie-in work for the SUP and Rose Garden is approximately 527 m^2 (Figure 2.7).



Trees

Key	Qty	Latin Name	Common Name	Spacing (m)	Minimum Tree Branching Height (m)	Caliper (mm)/ Height(m)	Root Treatment
FP	2	Fraxinus pennsylvanica (seedless variety)	Green Ash	8	2.5	60mm	B&B
PC1	5	Pinus Cembra	Swiss Stone Pine	4		2.5m	B&B
PC	3	Pinus contorta var. latifolia	Lodgepole Pine	4		2.5m	B&B
PS1	8	Pinus sylvestris	Scots Pine	8		2.5m	B&B
PJ	7	Populus x jaackii`Northwest'	Northwest Poplar	10	2.5	75mm	B&B
PB	7	Populus balsamifera	Balsam Poplar	10	2.5	75mm	B&B
PP	2	Prunus padus var. commutata	Mayday Tree	8	2.5	60mm	B&B
PT1	3	Populus tremula 'Erecta'	Swedish Columnar Aspen	2	2.5	60mm	B&B
SR	1	Syringa reticulata 'Ivory Silk'	Ivory Silk Japanese Tree Lilac	5	2.5	60mm	B&B
TC	16	Tilia cordata	Littleleaf Linden	10	2.5	75mm	B&B
UA	5	Ulmus americana	American Elm	10	2.5	60mm	B&B

LEGEND PLANTING

-·-·-	PROJECT LANDS
○	EXISTING TREE TO REMAIN AND BE PROTECTED
⊕	NEW DECIDUOUS TREE
⊗	NEW CONIFEROUS TREE
▨	SHRUB PLANTING
▨	PERENNIAL PLANTING
▒	SOD
▨	NATURALIZATION AREA
SW	COMPOST FILLED BIO SOCK TO RETAIN PLANTING SOILS

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A	ISSUED FOR 70%	22-08-14	J.S.

issue data

no.	description	date	checked

revisions

AECOM
Consultant

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drawn by B.N./K.V.
designed by B.N./L.K.
checked by L.K.
date 10-12-13

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gec architecture

PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by M. PERRY

drawing title
RIVER VALLEY LANDSCAPE DRAWINGS
LOUISE MCKINNEY PARK
TREE PLANTING

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2200-01-AL-PE-502
REV 0
SHT .

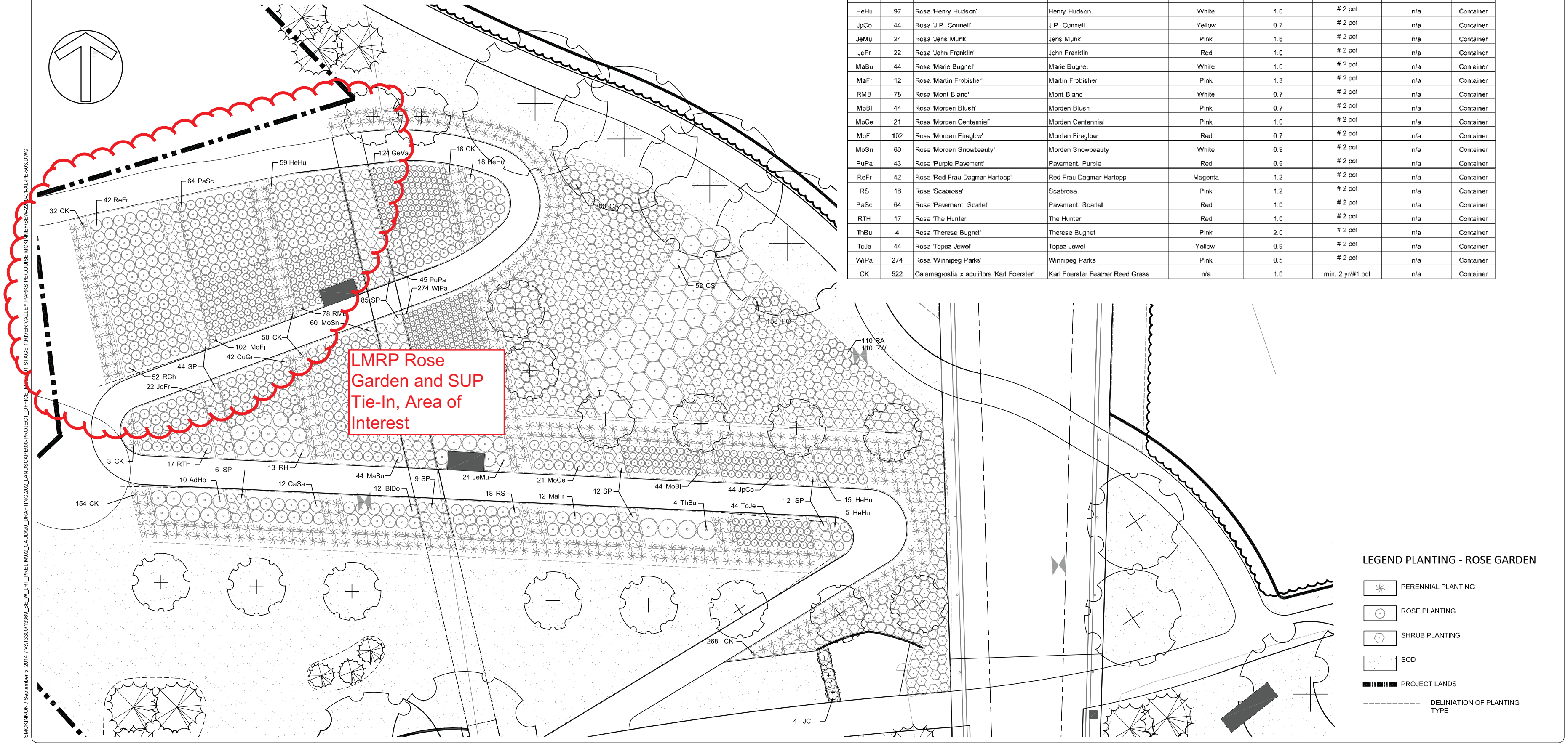
Figure 2.8a

Shrub Planting Beds

Key	Qty	Latin Name	Common Name	Spacing (m)	Plant Age /Container Size	Height/Spread at Planting (mm)	Root Treatment
CA	300	Cornus alba 'Siberica'	Siberian Coral Dogwod	1.0	#2 pot	min. 450mm height	Container
CS	52	Cornus sericea 'Flaviramea'	Golden Twig Dogwood	2.0	#2 pot	min. 450mm height	Container
JC	4	Juniperus communis 'Alpine Carpet'	Alpine Carpet Juniper	1.2 (min)	#2 pot	min. 300mm spread	Container
PO	138	Physocarpus opulifolius 'Dart's Gold'	Dart's Gold Ninebark	1.0	#2 pot	min. 450mm height	Container
RA	110	Rosa acicularis	Prickly Wild Rose	1.0	#2 pot	min. 450mm height	Container
RW	110	Rosa woodsii	Wood's Rose	1.0	#2 pot	min. 450mm height	Container
SP	168	Salix purpurea nana	Dwarf Basket Willow	1.0	#2 pot	min. 450mm height	Container

Rose Planting Beds

Key	Qty	Latin Name	Common Name	Colour	Spacing (m)	Plant Age / Container Size	Height/Spread at Planting (mm)	Root Treatment
AdHo	10	Rosa 'Adelaide Hoodless'	Adelaide Hoodless	Red	1.6	# 2 pot	n/a	Container
BlDo	12	Rosa 'Blanc Double de Courbert'	Blanc Double de Coubert	White	1.3	# 2 pot	n/a	Container
CaSa	12	Rosa 'Captain Samuel Holland'	Captain Samuel Holland	Red	1.3	# 2 pot	n/a	Container
RCh	52	Rosa 'Champlain'	Champlain	Red	1.0	# 2 pot	n/a	Container
CuGr	42	Rosa 'Cuthbert Grant'	Cuthbert Grant	Red	1.0	# 2 pot	n/a	Container
GeVa	124	Rosa 'George Vancouver Rose '	George Vancouver Rose	Red	0.6	# 2 pot	n/a	Container
RH	13	Rosa 'Hansa'	Hansa	Mauve red	1.6	# 2 pot	n/a	Container
HeHu	97	Rosa 'Henry Hudson'	Henry Hudson	White	1.0	# 2 pot	n/a	Container
JpCo	44	Rosa 'J.P. Connell'	J.P. Connell	Yellow	0.7	# 2 pot	n/a	Container
JeMu	24	Rosa 'Jens Munk'	Jens Munk	Pink	1.6	# 2 pot	n/a	Container
JoFr	22	Rosa 'John Franklin'	John Franklin	Red	1.0	# 2 pot	n/a	Container
MaBu	44	Rosa 'Marie Bugnet'	Marie Bugnet	White	1.0	# 2 pot	n/a	Container
MaFr	12	Rosa 'Martin Frobisher'	Martin Frobisher	Pink	1.3	# 2 pot	n/a	Container
RMB	78	Rosa 'Mont Blanc'	Mont Blanc	White	0.7	# 2 pot	n/a	Container
MoBl	44	Rosa 'Morden Blush'	Morden Blush	Pink	0.7	# 2 pot	n/a	Container
MoCe	21	Rosa 'Morden Centennial'	Morden Centennial	Pink	1.0	# 2 pot	n/a	Container
MoFi	102	Rosa 'Morden Fireglow'	Morden Fireglow	Red	0.7	# 2 pot	n/a	Container
MoSn	60	Rosa 'Morden Snowbeauty'	Morden Snowbeauty	White	0.9	# 2 pot	n/a	Container
PuPa	43	Rosa 'Purple Pavement'	Pavement, Purple	Red	0.9	# 2 pot	n/a	Container
ReFr	42	Rosa 'Red Frau Dagmar Hartopp'	Red Frau Dagmar Hartopp	Magenta	1.2	# 2 pot	n/a	Container
RS	18	Rosa 'Scabrosa'	Scabrosa	Pink	1.2	# 2 pot	n/a	Container
PaSc	64	Rosa 'Pavement, Scarlet'	Pavement, Scarlet	Red	1.0	# 2 pot	n/a	Container
RTH	17	Rosa 'The Hunter'	The Hunter	Red	1.0	# 2 pot	n/a	Container
ThBu	4	Rosa 'Therese Bugnet'	Therese Bugnet	Pink	2.0	# 2 pot	n/a	Container
ToJe	44	Rosa 'Topaz Jewel'	Topaz Jewel	Yellow	0.9	# 2 pot	n/a	Container
WiPa	274	Rosa 'Winnipeg Parks'	Winnipeg Parks	Pink	0.5	# 2 pot	n/a	Container
CK	522	Calamagrostis x acutiflora 'Karl Foerster'	Karl Foerster Feather Reed Grass	n/a	1.0	min. 2 yr/#1 pot	n/a	Container



LEGEND PLANTING - ROSE GARDEN

✳	PERENNIAL PLANTING
⊙	ROSE PLANTING
⬡	SHRUB PLANTING
⋯	SOD
▬▮▬▮	PROJECT LANDS
- - - - -	DELINIATION OF PLANTING TYPE

SMCKINNON / September 5, 2014 / V:\13300\13369_SE_W_LRT_PRELIM\02_CADD\20_DRAFTING\202_LANDSCAPE\00-PROJECT_OFFICE_FILES\01 STAGE 1\RIVER VALLEY PARKS PELOUSE MCKINNEY\SEW-2200-01-AL-PE-503.DWG

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A	ISSUED FOR 70%	22-08-14	J.S.

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AECOM
Consultant

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drawn by B.N./K.V.

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checked by L.K.

date 14-11-13

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ISL Engineering and Land Services
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gec architecture

PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by M. PERRY

drawing title
RIVER VALLEY LANDSCAPE DRAWINGS
LOUISE MCKINNEY PARK
SHRUB AND PERENNIAL
PLANTING

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2200-01-AL-PE-503
REV 0
SHT .

Figure 2.8b

2.2.2 98A Avenue Trail Tie-in to SUP

The 2013 EISA noted that LRT construction will disrupt portions of trails situated in HMEP in the vicinity of the south end of the new Tawatina Bridge crossing the NSR. It acknowledged the need to redevelop that area of the park and committed to providing a seamless tie-in to adjacent existing trails. During development of the 70% River Valley Landscape Drawings it became evident that the full area required for this work, particularly to appropriately tie-in to the existing east-west SUP at the north end of the HMEP parking lot, near 98A Avenue, was not captured by the 2013 EISA Project Area (Figure 2.9) (Plate 2.10, 2.11). This area has now been captured by both the landscape drawings that guide Project Co and by the revised Project Area boundary (Figure 2.7). The work area for this SUP tie-in will total 108 m^2 (Figure 2.9). Valley Line contract documents include specifications that limit Project Co work in this area to the work described in the landscape drawings; the added area will not be permitted to function as a general construction area.

Plate 2.10. Site of trail tie-in work required at HMEP and 98A Avenue, behind the no-stopping sign, see in the foreground (Jan. 2015).

LEGEND

EXISTING TREE

NEW TREES

NEW SHRUBS

SOD

NATIVE FOREST RESTORATION AREA OR EXISTING FOREST AREA

NATURALIZATION AREA

BOULDERS

PROJECT LANDS BOUNDARY

NOTES

1. PLANT LIST ON THIS SHEET INCLUDES THE PLANTS INDICATED ON SHEET SEW-2200-01-AL-PE-606.

Trees

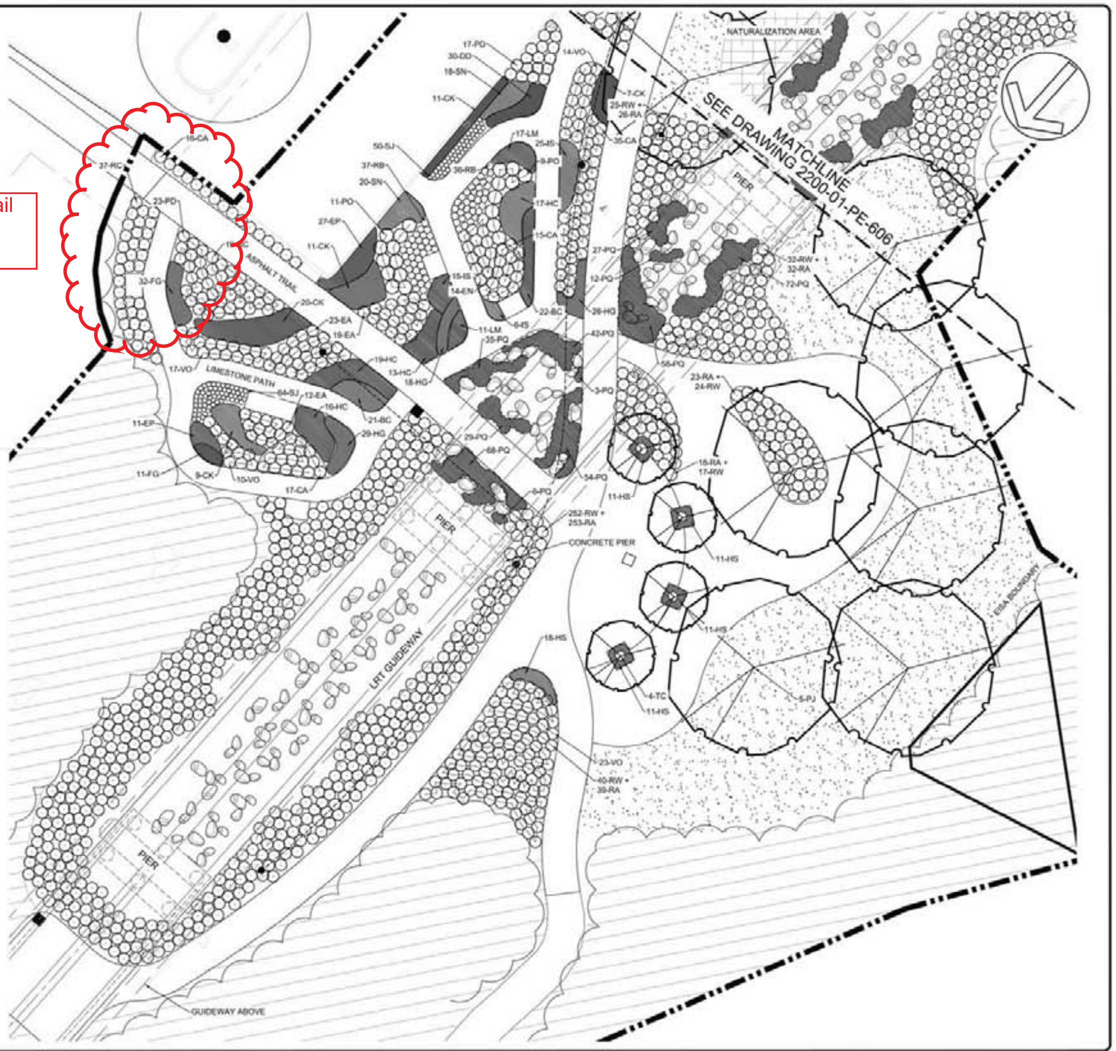
Key	Qty	Latin Name	Common Name	Spacing (m)	Minimum Tree Branching Height	Caliper/Height at Planting	Root Treatment
PJ	12	Populus x jackii 'Northwest'	Northwest Poplar	15	2.5m	60mm	B&B
TC	4	Tilia cordata	Little-leaf Linden	6	2.5m	60mm	B&B

Ornamental Planting Beds

Key	Qty	Latin Name	Common Name	Spacing (m)	Plant Age /Container Size	Height/Spread at Planting (mm)	Root Treatment
CA	83	Cornus alba 'Ivory Halo'	Ivory Halo Dogwood	1	#2 pot	min. 450mm height	Container
EA	54	Euonymous alatus 'compacta'	Dwarf burning bush	1	#2 pot	min. 450mm height	Container
EN	14	Euonymous nana 'Turkestanica'	Turkestan burning bush	1	#2 pot	min. 450mm height	Container
PD	55	Physocarpus opulifolia 'Dart's Gold'	Dart's Gold Ninebark	1	#2 pot	min. 300mm height	Container
PO	20	Physocarpus opulifolia 'Summer Wine'	Summer Wine Ninebark	1.2	#2 pot	min. 300mm height	Container
RC	56	Rosa 'Cuthbert Grant'	Cuthbert Grant Rose	1	#2 pot	min. 450mm height	Container
RB	73	Rosa 'Morden Blush'	Morden Blush Rose	0.6	#2 pot	min. 450mm height	Container
SJ	170	Spiraea japonica 'Little Princess'	Little Princess Spiraea	0.4	#2 pot	min. 450mm height	Container
VO	74	Viburnum opulus 'nana'	Dwarf European Cranberry	1	#2 pot	min. 450mm height	Container
BC	43	Bergenia cordifolia	Elephant Ears	0.6	min. 2 yr/#1 pot	n/a	Container
CK	58	Calamagrostis x acutiflora 'Karl Foerster'	Karl Foerster Feather Reed Grass	1	min. 2 yr/#1 pot	n/a	Container
DD	30	Dianthus deltoides	Maiden Pinks	0.5	min. 2 yr/#1 pot	n/a	Container
EP	38	Echinacea purpurea	Coneflower	0.6	min. 2 yr/#1 pot	n/a	Container
FG	43	Festuca glauca	Blue Fescue	0.5	min. 2 yr/#1 pot	n/a	Container
HS	62	Hemerocallis 'Stella d'Oro'	Stella d'Oro Daylily	0.5	min. 2 yr/#1 pot	n/a	Container
HC	65	Hemerocallis 'Catherine Woodbury'	Catherine Woodbury Daylily	0.8	min. 2 yr/#1 pot	n/a	Container
HG	73	Hosta spp 'Gold Standard'	Gold Standard Hosta	0.5	min. 2 yr/#1 pot	n/a	Container
IS	46	Iris sibericia	Siberia Iris	0.6	min. 2 yr/#1 pot	n/a	Container
LM	28	Lamium malculatum	Silver Deadnettle	0.6	min. 2 yr/#1 pot	n/a	Container
SN	38	Salvia nemorosa	Blue Sage	0.6	min. 2 yr/#1 pot	n/a	Container

Guideway Areas

Key	Qty	Latin Name	Common Name	Spacing (m)	Plant Age /Container Size	Height/Spread at Planting (mm)	Root Treatment
RW	575	Rosa woodsii	Wood's Rose	1	#2 pot	min. 450mm height	Container
RA	576	Rosa acicularis	Prickly Wild Rose	1	#2 pot	min. 450mm height	Container
PQ	611	Parthenocissus quinquefolia	Virginia Creeper	0.5	min. 2yr/#1 pot	min 600mm length stems	Container



98A Avenue Trail Tie-In, Area of Interest

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designed by L.K.

checked by L.K.

date 11-22-13

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PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by M. PERRY

drawing title
RIVER VALLEY LANDSCAPE DRAWINGS
HENRIETTA MUIR EDWARDS PARK
PLANTING PLAN

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2200-01-AL-PE-605
REV 0
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Figure 2.9

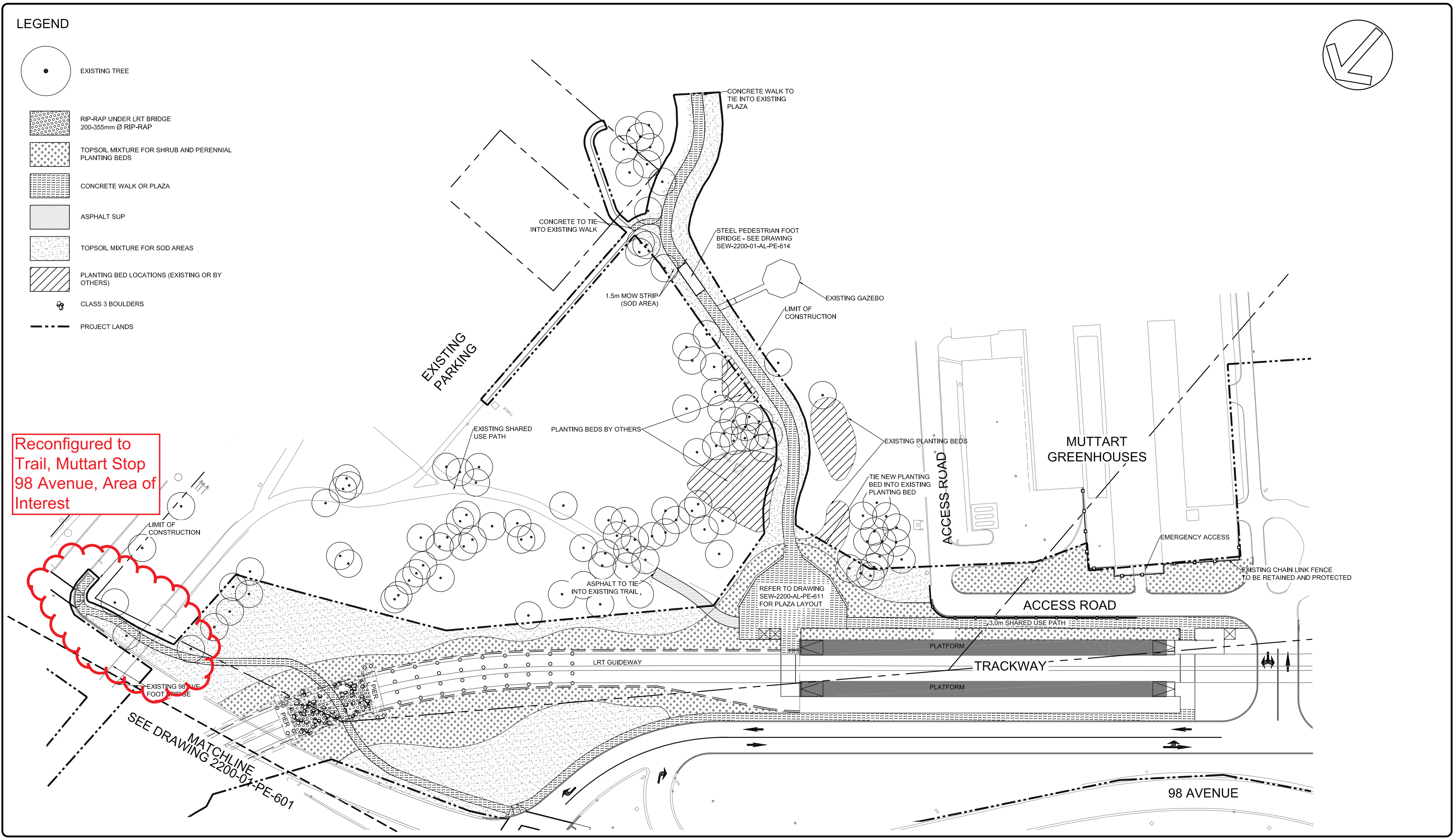
Plate 2.11. Site of trail tie-in work required at HMEP and 98A Avenue, looking north from within HMEP (April 2013).

2.2.3 *Reconfigured Trail, Muttart Stop to 98 Avenue*

The 2013 EISA describes LRT work required in the vicinity of the Muttart Conservatory and the Muttart Stop as temporarily and adversely affecting river valley trails in the Muttart grounds. Built-in mitigation measures included installation of a new entrance plaza connecting the Conservatory grounds to the new LRT stop and reconfiguration of trails in that area to provide appropriate access to both north and south bound platforms and the larger local path network, as needed. The trail or pathway connections in this area have now been refined as part of development of the 70% River Valley Landscape Drawings. Those plans show a realigned trail connecting the south (northbound) platform to the Muttart Conservatory grounds and local trail network, and, a new trail connecting the north (southbound) platform to the Muttart grounds and Cloverdale Neighbourhood at 96A Street, thus providing access to the south terminus of the 98 Avenue Pedestrian Bridge. The new trail moves under the bridge to connect with 96A Street. That connection requires a narrow extension of the Project Area in that locality, parallel to 98 Avenue (Figure 2.10; Plate 2.12, 2.13) totaling an additional 227 m^2. The Valley Line contract includes specifications that limit Project Co work in this area to trail construction only; the area will not be permitted to function as a general construction area.

Plate 2.12: Lands extension for the new tie-in trail south of 98 Avenue, looking east (June 2014).

Plate 2.13: Lands extension for new tie-in trail, south of 98 Avenue, west of 96A Street, looking northwest (June 2014).



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designed by L.K.
checked by L.K.
date 18-08-14

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PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by M. PERRY

drawing title
RIVER VALLEY LANDSCAPE DRAWINGS
MUTTART STOP
SOILS AND MATERIALS PLAN

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2200-01-AL-PE-608
REV 0
SHT .

Figure 2.10

2.2.4 *96A Street Parking Lot*

The 2013 EISA described the temporary loss of a small trailhead parking lot situated in HMEP, immediately west of 96A Street (Figure 2.4; Plate 2.14). The parking lot was described as within the Project Area and available to Project Co for general construction purposes. Post-construction re-establishment of the parking lot was included in EISA mitigation commitments. While the 2013 EISA narrative identified this small parking lot as part of the Project Area, the Project Area boundary presented in that report included only the western half of the parking lot. As the full parking lot would necessarily be affected during parking lot re-establishment, the Project Area boundary has now been shifted approximately 10 m to the east to include the entire parking lot, adding 364 m^2 to the Project Area. As had been intended all along, the full parking lot will be available to Project Co for general construction activities.

Plate 2.14: Trailhead parking lot at HMEP; lands will include up to the far side of the treed median shown mid-photograph.

3.0 ASSESSMENT METHODS

3.1 General Methods

This update differs from the 2013 EISA in that it builds on information provided in that EISA. Therefore, to varying degrees for each project component, an abbreviated impact assessment process was adopted based on the methods used in 2013. The disparate locations, size and nature of the eight assessed project components lent themselves to treatment in separate report chapters, with the level of assessment and the aspects assessed commensurate with the proposed change. That the City is undertaking two of the eight project components also favours the separate treatment of components, particularly with respect to mitigation development.

For each component, impact assessment examined specific key issues, for select Valued Environmental Components (VECs), used known design information and construction practices specific to that proposed change and did not consider those impacts that had already been addressed in the 2013 EISA. For this update, only new impacts were examined in detail.

3.2 Issue Identification

For each component, key project issues were identified by considering project component activities, issues raised for the overall Valley Line project, issues raised by the public through review of the released RFP documents, issues raised at the EISA Update open house held in February 2015 (see *Section 3.7*) and applying professional judgement. Each key issue was examined during impact assessment. The resolution of each identified key issues is described at the end of each component chapter.

3.3 Selection of Valued Environmental Components

VECs for this EISA Update were selected separately for each assessed project component. For each component, VECs from the 2013 EISA and the *Bylaw 7188* environmental review guidelines were reviewed to assess relevance. If no potential existed for the project component to interact with that VEC in a manner that resulted in additional or unique issues, no further consideration was given to that VEC. In instances where it was determined that some potential existed for additional or unique issues, that VEC was then examined with respect to relative abundance/status, public concerns, professional judgement, economic importance, and regulatory concerns to more specifically justify the inclusion of the VEC. This selection process is documented individually for each project component in subsequent sections of this report.

3.4 Assessment Spatial and Temporal Scope

The spatial boundaries, or discrete study areas, used for individual project components are shown in Figure 2.1a – 2.1d. For each component, the study area was generally defined by the lands to be directly affected by that component. For some component, for a select few VECs, a component's study area was expanded to fully account for all potential interactions. Such expansions are detailed in Chapters 4 through 11.

For Project Co components, the construction period is anticipated to be 2016 to 2020. For City components, construction is anticipated to occur in 2015, possibly extending to 2016. As the Project Co components are not integral to LRT operation, this update covers only the construction period. All of the lands supporting the assessed components will be handed back to the City at Service Commencement or in the very early operations phases, once reclamation and landscaping work is fully complete. For the City components, the assessment focuses only on construction, including reclamation because 1) park connector trail operation is a known entity subject to standard maintenance practices and 2) a Muttart Storage building has been operating in the valley for many years, thus this is not a new activity.

3.5 Description of Existing Conditions

The description of existing conditions provides a current snapshot of the individual project component areas as documented by investigations during the period 2012 to 2014. Methodologies employed to describe existing conditions generally followed those used in the 2013 EISA and component-specific methods are specifically described in each project component chapter.

3.6 Impact Analysis

3.6.1 Potential Impacts

Where it was determined that the potential existed for *new or unique impacts* to individual VECs specific to a project component, impacts were investigated, described and classified using the same methodology as employed in the 2013 EISA.

Potential impacts were addressed based on the information presented in the component project description (in Chapter 2). Sound project planning involves incorporating best management practices and mitigation measures into early planning, and this has been done for these components. This initial assessment assumes that built-in mitigation measures noted in the project descriptions, such as compliance with all laws and best management practice guidelines are all effectively implemented. Additionally, previously-developed Project Agreement clauses (contractual obligations) specific to the Valley Line LRT were also considered in assessments for all project components to be undertaken by Project Co.

All identified impacts were described and classified as to their direction (positive, adverse), magnitude (negligible, minor, or major), and duration (short-term, long-term, or permanent) and our confidence in impact prediction (predictable or uncertain effect) noted. These descriptors were defined as follows:

Direction:

Positive Impact: An interaction that enhances the quality or abundance of natural or historical resources, or social pursuits or opportunities.

Adverse Impact: An interaction that diminishes the abundance or quality of natural or historical resources, or social pursuits or opportunities.

Magnitude:

Negligible Impact: An interaction that is determined to have essentially no appreciable effect on the resource. Such impacts are not characterized with respect to direction, duration or confidence.

Minor Impact: An interaction that has an appreciable effect but does not affect local or regional populations, natural or historical resources beyond a defined critical threshold (where that exists) or beyond normal limits of natural perturbation; or, an interaction that slightly alters existing or future recreational pursuits at established facilities or well-used areas.

Major Impact: An interaction that affects local or regional populations, natural or historical resources beyond a defined critical threshold (where that exists) or beyond the normal limits of natural perturbation; or, an interaction that changes the character or precludes existing or future social pursuits at established facilities or well-used areas.

Duration:

Short-term Impact: An interaction resulting in measurable change that does not persist for longer than two years.

Long-term Impact: An interaction resulting in measurable change that persists longer than two years, but at some point dissipates completely.

Permanent Impact: An interaction resulting in measurable change that persists indefinitely.

Confidence:

Predictable Impact: Effects on VEC are well understood through experience in projects of a similar nature.

Uncertain Impact: Effects on VEC are not well understood owing to lack of knowledge of the VEC and/or its response to disturbance.

3.6.2 *Residual Impacts*

In the next step of the assessment, mitigation measures were developed to address identified adverse, minor and major potential impacts. Residual impacts were then characterized. Residual impacts are impacts predicted to remain *after* application of mitigation measures. Residual impacts were characterized according to the above impact descriptors, with one exception:

Predictable Residual Impact: Efficacy of proposed mitigation measures is well understood through application in similar projects or circumstances.

Uncertain Residual Impact: Efficacy of mitigation measure is not well understood because of lack of previous experience in similar circumstances or lack of knowledge about the VEC.

3.7 Public Engagement Process

The 2013 EISA required that the public be engaged regarding any proposed changes to the Valley Line. Additionally, the City's Guide to Environmental Review Requirements in the North Saskatchewan River Valley requires public participation appropriate to the scope and scale of the proposed project. Taking this into consideration, LRT D and C developed a supplementary public engagement plan for the EISA Update which included the following objectives:

- Satisfy the requirements of Bylaw 7188 by:
    - Creating awareness of the project adjustments.
    - Providing an opportunity for public input.
- Ensure project adjustments and the context of EISA Update are understood.
- Exhibit responsiveness to public issues and concerns.
- Demonstrate process transparency.

Implementation of the public engagement plan took the form of a drop-in public open house, held from 17:00 to 20:30 hours on 03 February 2015 at the Old Timer's Cabin at 9430 Scona Road in Edmonton. Stakeholders were notified in advance of the open house through a variety of methods, including web/email notification, direct mail, roadside signs and social media. Representatives from LRT D and C and Spencer Environmental were present to discuss the update and receive public input. Display panels covering the 2013 EISA and Update, its purpose and objectives, the proposed changes being assessed and other supplementary information not directly related to the Update (i.e. trail detours and ongoing engagement) were presented to members of the public during the open house. Hard copy comment forms were provided to attendees and online comments were also accepted.

4.0 NORTH VALLEY PRIMARY CONSTRUCTION ACCESS

4.1 Context

The proposed primary construction access road for all north valley construction activity will be temporary in nature but in place for the duration of construction in the north valley, estimated at five years. The proposed access road will support high volumes of traffic during select construction activities, for periods lasting many days. The route will follow the corridor shown in Figure 2.1b and Plate 2.2. Project Co will be required to design and construct the access road to the standard needed to carry out the work safely and without adversely affecting slope stability in the park. Project Co is expected to upgrade the SUP portion of the route to accommodate two-way construction traffic. At this stage, the City has not ruled out the need for Project Co to widen the existing maintenance vehicle road leading from Grierson Hill. While in use for Valley Line construction, that road must also remain available to others for servicing of the facilities at the Riverfront Plaza. The access route may not be used for general construction purposes.

4.2 Assessment Methods

As this project component was not assessed in 2013 and involves a significant boundary adjustment, the VECs selected for this assessment are very similar to those included in the 2013 EISA (Table 4.1).

The spatial boundaries, or study area, for this assessment, are shown in Figure 2.1b. The assessment recognizes that project access routes will extend beyond these boundaries along established City roads, but this aspect was not covered in the assessment. For a select few VECs the study area was expanded. Expansions are noted in VEC-specific sections.

Specific studies undertaken for this assessment in 2014 included the following:

- Reconnaissance-level site inspections on 20 June and 15 September 2014, focusing on general vegetative characteristics.
- A rare plant survey on 07 July 2014.
- Breeding bird surveys on 17 and 27 June 2014.
- Site-specific geotechnical and slope stability assessment of lands traversed by the proposed road (Thurber Engineering 2014) (Full report provided in Appendix B).

Table 4.1. Justification for the selection of VECs – North Valley Primary Construction Access

Valued Environmental Components	Potential for Additional or Unique Issues[1]	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Relevant Legislation/Bylaw/Policy
Valued Ecosystem Components							
Geology/Geomorphology	**Yes**			✓		✓	• Bylaw 7188
Soils	**Yes**			✓		✓	• Bylaw 7188 • Drainage Bylaw 16200
Hydrology Surface Water/ Groundwater	**Yes**			✓		✓	• Bylaw 7188 • Drainage Bylaw 16200 • Alberta *Water Act*
Fish and Fish Habitat	**No**						
Vegetation	**Yes**	✓	✓	✓		✓	• Bylaw 7188 • Alberta *Weed Control Act*
Wildlife	**Yes**	✓	✓	✓		✓	• Bylaw 7188 • Federal *Species at Risk Act* • Federal *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Habitat Connectivity	**Yes**	✓	✓	✓		✓	• Bylaw 7188
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Residential Land Use	**No**						
Recreational Land Use	**Yes**		✓	✓		✓	• Bylaw 7188
Utilities	**Yes**		✓	✓	✓	✓	• Bylaw 7188
Worker and Public Safety	**No**						
Visual Resources	**Yes**		✓	✓		✓	• Bylaw 7188
Valued Historic Components							
Historical Resources	**Yes**		✓	✓		✓	• Alberta *Historical Resources Act* • Bylaw 7188

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

4.3 Key Issues

Key issues were identified by: 1) examining the project component location, known conditions and potential project activities; 2) considering concerns raised by the public and City services departments; and 3) applying professional judgement. Following are the key issues identified in association with the proposed primary construction access road:

- **Will construction of the access road adversely impact slope stability on the north valley wall or riverbank?**
- **Will the landfill present challenges to road stability or performance and lead to more disturbance?**
- **Do contaminated soils occur within the project component area? Could the work result in mobilization of contaminants from contaminated soils?**
- **Will construction of the access road lead to surface erosion?**
- **Does contaminated groundwater occur within the project component area? Could the work result in mobilization of contaminated groundwater?**
- **Will vegetation in recognized Natural Areas be affected?**
- **Does the work have potential to affect rare, threatened or endangered plants or plant communities?**
- **Will any special status wildlife species be affected by access road construction?**
- **Will local pathway disruptions be suitably mitigated for all users, including those requiring a fully accessible pathway?**
- **Will access to River Valley Adventures/Urban Green Café or washrooms be disrupted as a result of the access road?**
- **Will use of the construction access interfere with park programming or special events?**
- **Does this project component have potential to affect known historical resources?**

4.4 Existing Conditions by VEC

4.4.1 Geology/Geomorphology

4.4.1.1 Methods

Thurber Engineering (2014; Appendix B) conducted a site-specific geotechnical investigation and preliminary slope assessment in support of the proposed construction access road through the west side of LMRP. Their investigation comprised a desktop analysis of existing geotechnical information available for LMRP and a field program conducted on 17-24 March 2014. The field program comprised drilling eight test holes for the installation of geotechnical instruments - six holes along the proposed access road alignment to depths ranging between 6 m and 10 m below existing ground surface, and two deep holes upslope of the road alignment to depths 45.6 m and 33.3 m below existing ground surface. Also, five additional test holes were drilled to depths ranging from 5.2 m to 11.9 m below existing ground surface near the eastern end of the road alignment, for a separate study characterizing the thickness of waste material present in the area.

Standpipe piezometers were installed in the boreholes along the proposed access road alignment, to monitor groundwater levels. Soils and bedrock collected in boreholes were subject to laboratory investigations to assess physical, chemical and mechanical properties such as moisture content, strength, and grain size. The full suite of parameters examined, and results for individual samples, are presented in Thurber Engineering 2014 (Appendix B).

As part of this study, Thurber Engineering examined antecedent and new data from six inclinometers, including two inclinometers installed along the proposed access road alignment and four previously installed inclinometers at the eastern end of the access road alignment. All newly and previously installed instruments were monitored several times each year following installation.

In addition, slope stability assessments were carried out on four cross sections of two bentonite seams ("A" and "B") and also at the riverbank, using the software SLOPE/W (Thurber Engineering 2014). The intent of the stability analyses was to compare existing slope stability and factor of safety (prior to construction) with predicted slope stability and factor of safety following access road construction. Composition of bedrock and depositional layers, shear strength of material and groundwater conditions were all incorporated into assessments of slope stability. Further details are provided in Thurber Engineering 2014 (Appendix B).

For the purposes of their assessment, Thurber Engineering (2014) assumed that fills associated with construction of the proposed access road would be placed up to 1 m high and that the road would be approximately 8 m wide to accommodate two-way traffic.

4.4.1.2 Description

Slope Stability

The cross-slope, proposed primary construction access road would be located near the toe of the Grierson Hill Slide, a major deep-seated landslide that occurred on the north slope of the North Saskatchewan Valley in 1901 (Thurber Engineering 2014). The landslide measures approximately 600 m east-west along the riverbank in LMRP extending from the Shaw Conference Centre in the west to the Cloverdale Pedestrian Bridge to the east. The northern limits of the slide are bounded by Grierson Hill Road and the south limits by the north bank of the NSR (Figure 4.1) (Thurber Engineering 2014). Since the initial slope failure in 1901, the Grierson Hill slope has been modified by extensive dumping and backfilling, mainly on the upper portions of the slope, including using the area as a City landfill (Grierson Nuisance Grounds – see below). Movement of the valley slope has been monitored since the 1950's and movement rates have been noted as very sensitive to changes in slope condition (e.g., grading works, toe erosion, precipitation, etc.). Various slope stabilization measures have been implemented over the years, which have considerably improved overall slope stability. Slope inclinometers, installed in 2000, 2010 and 2011, and monitored regularly since November 2010, have detected no noticeable slope movements since their installation (Thurber Engineering 2014; Appendix B).

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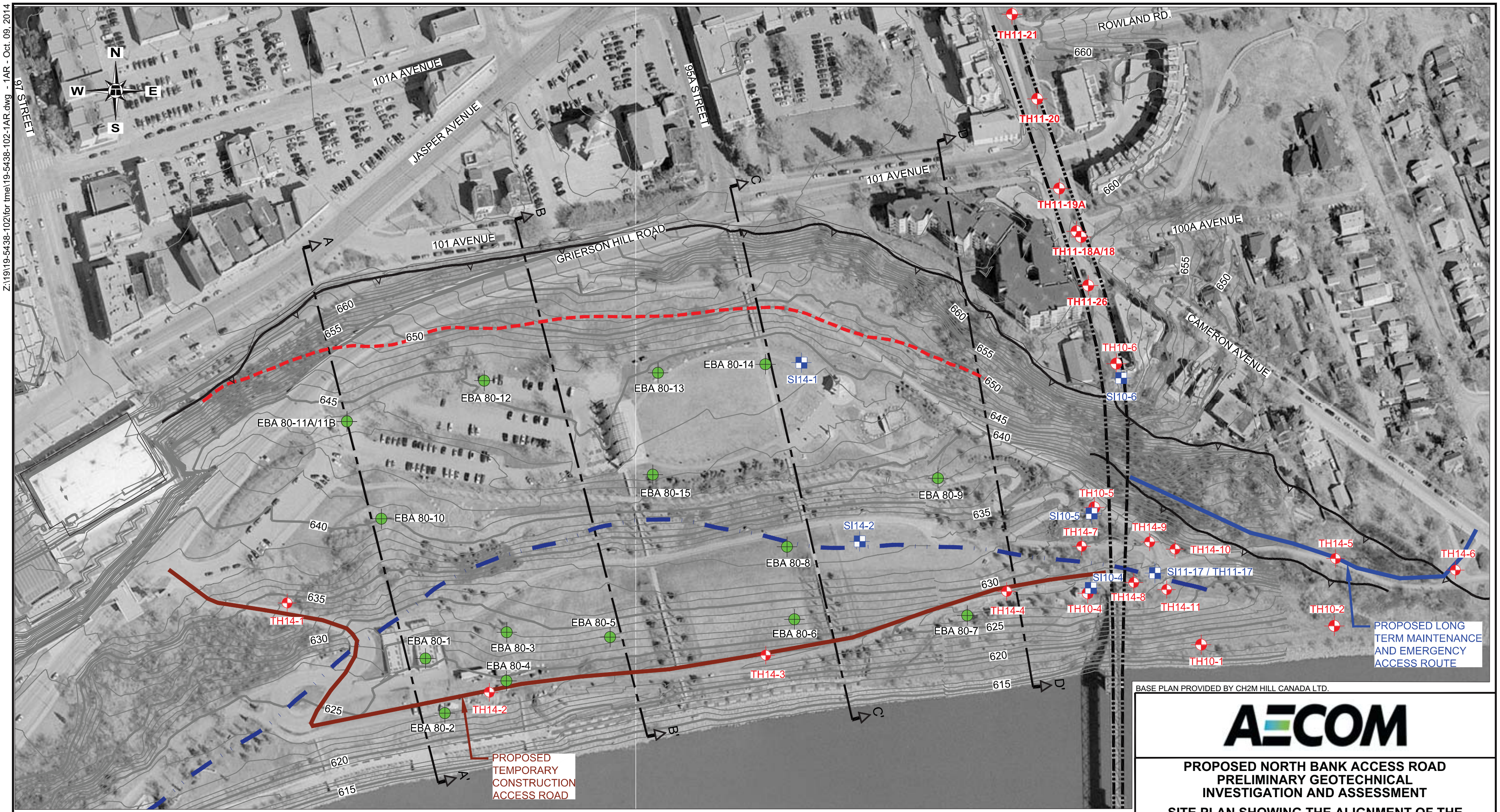

BASE PLAN PROVIDED BY CH2M HILL CANADA LTD.

LEGEND

⊕	TEST HOLE LOCATION BY THURBER
⊕	PREVIOUS TEST HOLE LOCATION BY OTHERS
▨	TEST HOLE LOCATION WITH EXISTING SLOPE INCLINOMETER BY THURBER
▽▽	CURRENT SLOPE CREST / SCARP (APPROXIMATE)
- - -	APPROXIMATE SLOPE CREST IN 1887 (BEFORE FAILURE)
— · —	APPROXIMATE TOE OF RIVERBANK IN 1887 (BEFORE FAILURE)
— · · —	PROPOSED LRT ALIGNMENT

0 20 40 60 80 100 120m

SCALE 1:2000

AECOM

PROPOSED NORTH BANK ACCESS ROAD PRELIMINARY GEOTECHNICAL INVESTIGATION AND ASSESSMENT

SITE PLAN SHOWING THE ALIGNMENT OF THE PROPOSED CONSTRUCTION ACCESS ROAD AND APPROXIMATE TEST HOLE LOCATIONS

DWG No. 19-5438-102-1AR

DRAWN BY	ML
DESIGNED BY	TME
APPROVED BY	HER
SCALE	1:2000
DATE	OCTOBER 2014
FILE No.	19-5438-102

THURBER ENGINEERING LTD.

Figure 4.1

Landfill

As noted above, the site of the Grierson Hill landslide was used as a landfill (Grierson Nuisance Grounds) for several decades in the early 20th century. Since then, the landfill has been covered with soil fills and landscaped for the creation of LMRP. The approximate boundaries of the landfill have been identified as shown in Figure 4.2 and the 2013 EISA documented the overlap with the proposed LRT infrastructure. The proposed construction access road will intersect with the southern edge of the landfill. Based on their test hole data, Thurber Engineering (2014) noted that landfill materials were up to 20 m thick in the central area of LMRP, approximately 200 to 300 m west of the LRT alignment. Fill encountered during drilling included brick fragments, pieces of glass and wood. Some waste has also been documented close to the surface. For example, waste was evident at 30 cm below existing ground surface at Testhole 14-1, in the vicinity of the construction access road.

As noted in the 2013 EISA, a Phase II ESA undertaken in early 2013 (Connected Transit Partnership 2013b) included two test holes at the former landfill location, yielding soils with significant metals exceedances including arsenic, boron, lead, copper nickel, tin, zinc, and boron.

4.4.2 *Soils*

4.4.2.1 Methods

Thurber Engineering (2014) also provided some information on soil depth and additional information on sub-surface conditions along the proposed construction access alignment.

4.4.2.1 Description

Subsurface conditions in the proposed primary construction access road corridor comprised topsoil and fills of varying composition and thickness overlying colluvium (lacustrine clay, clay till and sand) (Thurber Engineering 2014). Conversely, clay shale and sandstone bedrock were encountered directly beneath the topsoil or below a limited thickness of fill at the east end of the proposed alignment. Topsoil was encountered in all test holes and ranged in thickness between 0.15 m to 0.3 m. The fill ranged from 1.6 to 2.9 m in thickness at the western and eastern ends of the proposed road alignment, which coincided with the flanks of the Grierson Hill slide. Fill was approximately 5.8 m thick along the central part of the alignment. Overall, fill comprised clay or clay shale with intermittent gravelly and sandy horizons and included coal, peat, organic soils, brick fragments, pieces of glass and wood (Thurber Engineering 2014).

4.4.3 *Hydrology*

4.4.3.1 Methods

Hydrology investigations specific to this component focused on groundwater as there are no surface water features in the study area. The NSR, previously discussed in the 2013 EISA, is situated downslope from the proposed road, approximately 40 m at its closest point.

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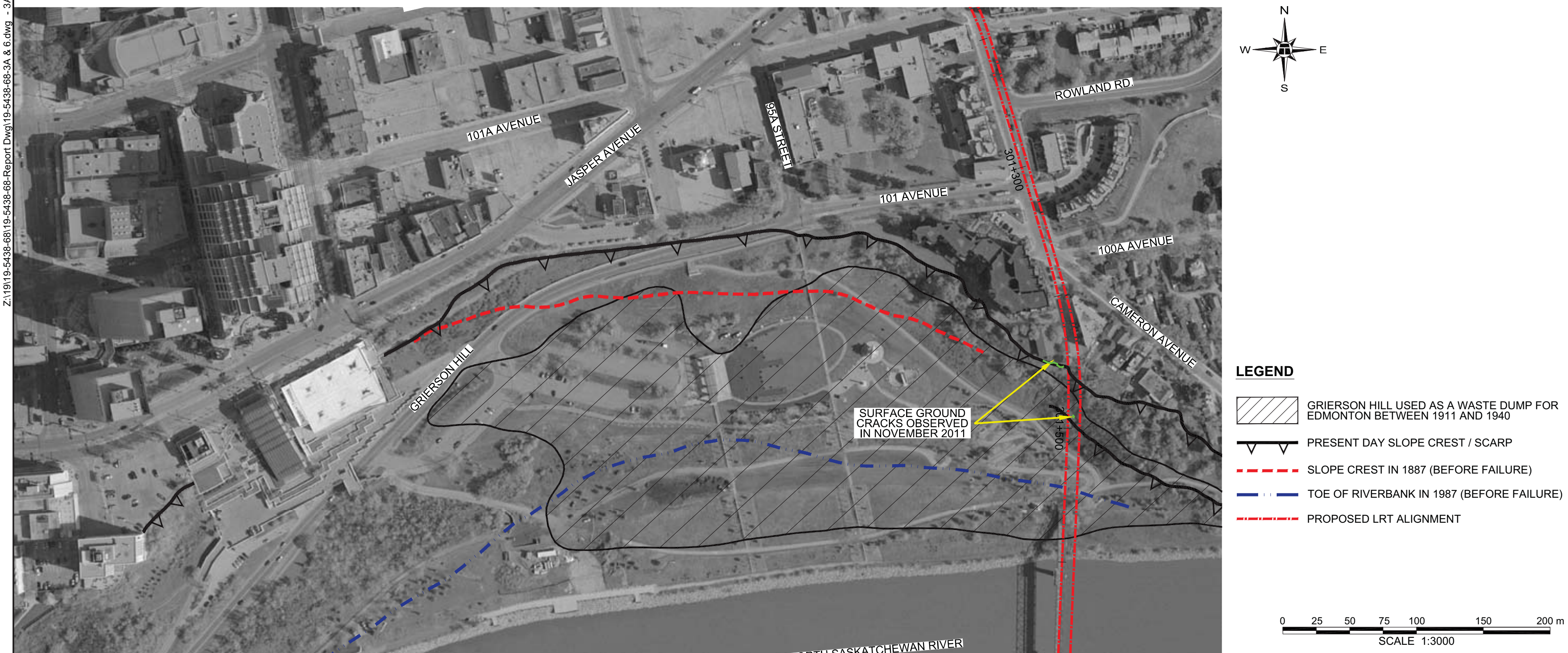


AIR PHOTO PROVIDED BY CH2M HILL CANADA LTD.

AECOM

EDMONTON SOUTHEAST LRT EXTENSION
PRELIMINARY GEOTECHNICAL INVESTIGATION

GRIERSON HILL SLIDE - PLAN VIEW

DWG No. 19-5438-68-3A

DRAWN BY	KLW
DESIGNED BY	MB
APPROVED BY	HER
SCALE	1:3000
DATE	MARCH 2012
FILE No.	19-5438-68

THURBER ENGINEERING LTD.

Figure 4.2

To assess groundwater conditions, Thurber Engineering (2014) installed standpipe piezometers in six of the boreholes drilled along the proposed access road alignment for groundwater level monitoring.

4.4.3.2 Description

Groundwater Depth

Short-term groundwater levels measured by Thurber Engineering in 2014 along the proposed road alignment ranged from 4.6 m to 8.1 m below existing ground surface, with two piezometers recording no groundwater (Thurber Engineering 2014). As these are short-term results, they may not represent stabilized long-term groundwater levels.

Landfill

Contaminated groundwater is known to exist within the boundaries of the former landfill. This was not further examined for this project component, as the proposed work does not involve deep excavation. In support of other Valley Line components, a landfill groundwater monitoring program has been established further east, closer to the permanent Valley Line infrastructure. Results are not yet available.

4.4.4 *Vegetation*

4.4.4.1 Methods

A rare plant and plant community survey was undertaken by a professional plant ecologist in LMRP on 07 July 2014 in support of this proposed construction access road assessment. For this VEC, the study area was expanded to encompass most of LMRP west of the Project Area previously surveyed for the 2013 EISA. Both natural plant communities and manicured areas occur in the west portion of the park. The focus of the plant surveys was to map and characterize natural vegetation; however, manicured areas were also coarsely characterized.

Plant Communities

First, all plant communities in the study area were delineated on an aerial photograph as a desktop exercise, then field investigations were undertaken to ground truth and refine community boundaries, develop descriptions of plant community character and floristics, and document rare plant occurrences. Each natural plant community was surveyed via meandering transects. All species observed were documented and their relative abundances ranked as dominant, abundant, frequent, occasional, or rare (meaning uncommon in that community). Plant species that could not be identified in the field were collected and identified with the aid of a dissecting scope and various keys and botanical manuals. Following field surveys, species were classified as native or exotic based on data in the Alberta Conservation Information Management System (ACIMS), which provides a comprehensive database of species known to occur in the province (Alberta Environment and Sustainable Resource Development 2014). Species nomenclature followed ACIMS. Common species names are used throughout this document with scientific names provided in brackets. Complete plant community data, including species scientific names, are provided in Appendix C.

Plant communities were delineated based on aerial photographs during field surveys, and later classified according to the system developed by Westworth and Associates (*In:* EPEC Consulting Western Ltd. 1981) specific to Emonton in the NSRV, but adjusted as necessary. This classification system focuses largely on forest types, as the majority of natural communities found in the river valley are treed, and classification is primarily based on canopy composition. Spencer Environmental has found it necessary in the past to include separate classifications for caragana (*Caragana arborescens*) and Manitoba maple (*Acer negundo*) dominated communities, as those communities do not fit within the system developed by Westworth and Associates but are present throughout the river valley.

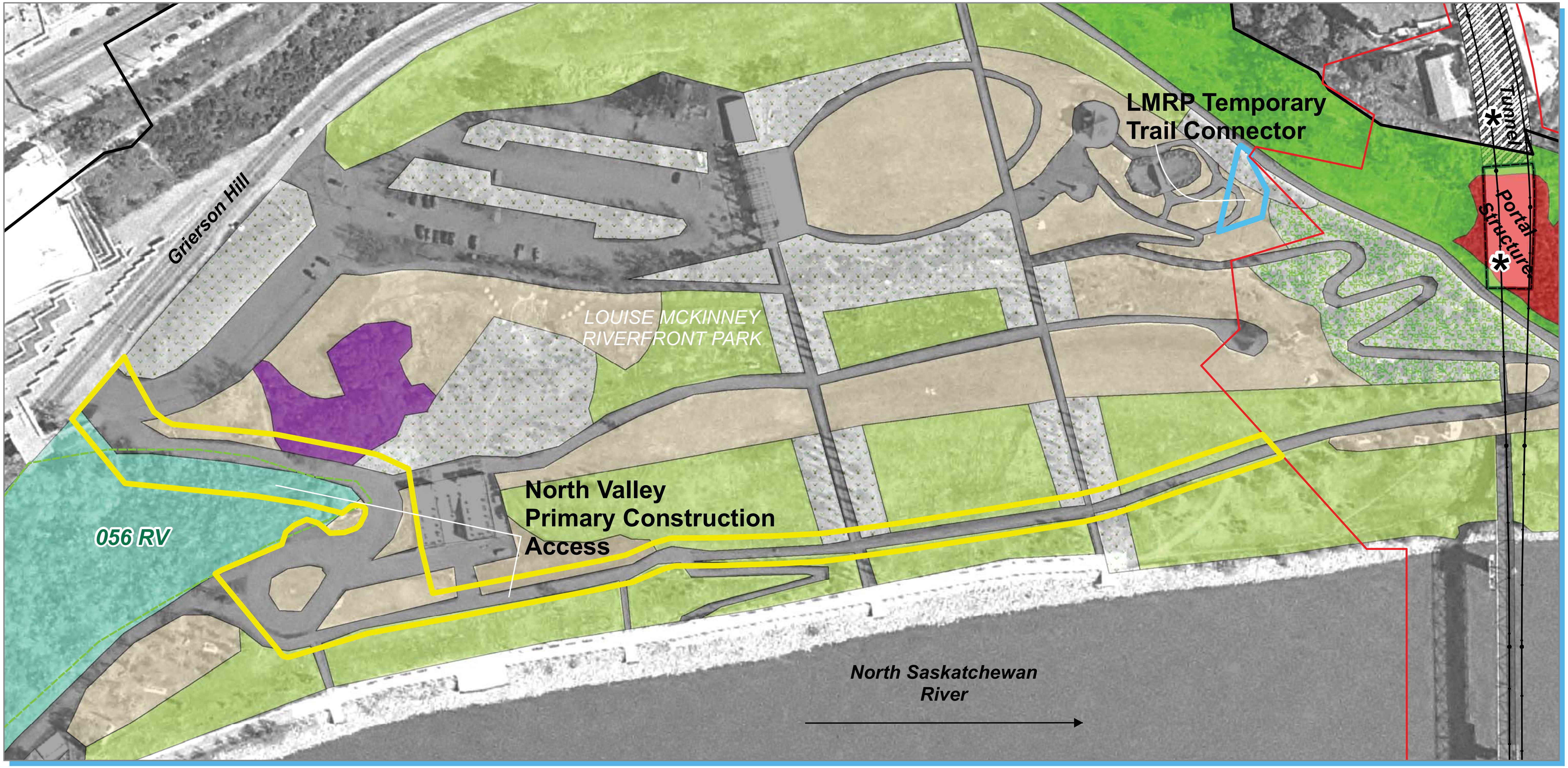
Manicured areas were classified as lawns, gardens, and planted beds. Lawns were defined for the purpose of this assessment as areas dominated by grass and regularly mowed, that may also contain scattered, planted trees. Gardens were discrete beds dominated by ornamental flowers and shrub species. Planted beds were characterized by concentrations of planted, native or exotic shrubs and trees and having definite boundaries. Gardens and planted beds were coarsely surveyed, gathering only the data necessary to characterize them broadly. Lawns were mapped but not surveyed; therefore, individual planted trees are not identified. Reconnaissance level investigations showed that all manicured areas were typically dominated by ornamental cultivars and non-native plants.

Rare Plant Survey

All plant communities were surveyed at an intensity that was deemed sufficient to capture the diversity of habitats within the site and to encounter any rare species present. Prior to conducting the rare plant survey, the ACIMS database was consulted to identify any existing records of rare plants within or near the study area, as this was last done for this general area in 2012. The rare plant survey was carried out via meandering transects in all natural plant communities. Rarity was defined by subnational ranks (S-ranks) based on up-to-date data from ACIMS. For the purposes of this report, S1, S2, and S3 species were considered rare, as is the stated practice of City of Edmonton Urban Ecology (Young *pers. comm.).*

4.4.4.2 Description

Vegetation in the west portion of LMRP is characterized by landscaped parkland, including manicured lawns and several types of formal gardens, and is traversed by several paved pathways (Plate 4.1). Non-manicured, natural communities in this area are relatively small and, at the time of our survey, consisted of grassland (G), Manitoba maple (MM) and a portion of one larger, poplar-Manitoba maple (PMM) forest community on the west edge of the study area (Figure 4.3). Detailed descriptions of each community are provided below. A full list of species observed in each community is provided in Appendix C.



Legend

Additional Lands

🟨 Undertaken by Project Co

Lands Involved in Preparatory (Early) Works

🟦 Undertaken by City of Edmonton

— Project Area

— Valley Line LRT Alignment (Reference Design)

☐ Bylaw 7188 Boundary

🟩 City of Edmonton River Valley Natural Areas (2010)

⬛ Pathway/Structure

Natural Communities

🟩 Balsam Poplar/Manitoba Maple (PMM)

🟪 Manitoba Maple (MM)

🟥 Caragana (C)

🟩 Grassland/Shrub (G/S)

🟩 Grassland (G)

Manicured Communities

🟨 Lawn

▨ Garden

▨ Planted Bed

* Indicative Location Only

0 25 50 100 Meters

1:1,400

Figure 4.3 North Valley Primary Construction Access & LMRP Temporary Trail Connector, Existing Plant Communities

City of Edmonton LRT Valley Line - Stage 1
EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Plate 4.1. The west portion of LMRP is characterized by landscaped parkland, including manicured lawn, gardens and paved pathways (July 2014)

Grassland (G)

Small naturalized grasslands (G) communities were located throughout the park including parallel to the SUP that will form the proposed construction access road and were commonly dominated by exotic grass species, including smooth brome, quack grass, and crested wheatgrass (Plate 4.2). Reed canary grass (*Phalaris arundinacea*) and slender wheatgrass (*Elymus trachycaulus*), both native grasses, were also dominant or abundant in some areas; Kentucky bluegrass (*Poa pratensis*) and western wheatgrass (*Agropyron smithii*) were frequently observed. Other common species included wild vetch (*Vicia americana*), alsike clover (*Trifolium hybridum*), common goat's-beard (*Tragopogon dubius*), prickly rose (*Rosa acicularis*), and buckbrush (*Symphoricarpos occidentalis*). A total of 52 species was detected in grassland communities, 20 (38%) of which were native. The remaining 32 species (62%) were exotic, with five of those species listed as noxious under the Alberta *Weed Control Act*.

Plate 4.2. Naturalized (unmanicured) grassland communities on the slopes of Louise McKinney Riverfront Park (July 2014)

Manitoba Maple (MM)

One naturalized Manitoba maple (MM) community was located in the west end of the park bordering the maintenance vehicle access road (Figure 4.3). That community was dominated by Manitoba maple, with occasional balsam poplar (*Populus balsamifera*) and red-osier dogwood (*Cornus stolonifera*). The understorey was typically open, comprising reed canary grass, smooth brome (*Bromus inermis*), and quack grass (*Elytrigia repens*) (Plate 4.3). A total of 11 species was detected in this community, 7 (64%) of which were native. The remaining four species (36%) were exotic, with one noxious weed species observed. Manitoba maple is not native to this region of Alberta but has naturalized and commonly occurs in the NSRV and is often found as a sub-dominant tall shrub or tree species.

Plate 4.3. Open understorey in a Manitoba maple community in Louise McKinney Park (July 2014)

Poplar-Manitoba Maple (PMM)

A densely-forested balsam poplar-Manitoba maple (PMM) community was located on the slope below the Shaw Conference Centre at the west margin of LMRP and bordering much of the maintenance vehicle access road (Figure 4.2). This community is part of a larger area that is mapped by the City as Natural Area 056 RV. The canopy of this forest community was dominated by Manitoba maple and balsam poplar, and had occasional aspen (*Populus tremuloides*). The dense shrub layer consisted of buckbrush, prickly rose, red-osier dogwood, Saskatoon (*Amelanchier alnifolia*), and bracted honeysuckle (*Lonicera involucrate*).

The margins of the PMM community, adjacent to along the existing access road were characterized as a typical edge community (Plate 4.4) that graded into the more mature stand interior. The margins consisted of shrubbery and young trees, with few mature trees. In particular, Manitoba maple formed dense populations with red osier-dogwood and prickly rose shrubs comprising the majority of the shrub layer. Together, these trees and shrubs formed a dense band, limiting the space available for low-growing shrubs or forbs to establish. The understorey along the edge was dominated by exotic species: smooth brome and quack grass were widespread, as were alfalfa and white sweet-clover. Occasional creeping thistle, a noxious weed, was also observed along the edge, near the bottom of the slope. In contrast, the interior of this stand was characterized by a patchy canopy of balsam poplar and Manitoba maple, where the trees tended to be taller, with larger DBHs than closer to the edge (Plate 4.5). More space between trees promoted heterogeneity and facilitated the establishment of diverse shrub and herbaceous layers. Red-osier dogwood and prickly rose were common shrubs in the interior of the stand, as they were along the edges; however, snowberry and species of honeysuckle and currant were also frequently observed in the interior. Interior understorey was characterized by a variety of native forbs, such as wild sarsaparilla, northern bedstraw, star-flowered Solomon's-seal, and species of aster. Exotic and noxious weed species occurred throughout the stand, but they tended to be rare in the interior.

A total of 58 species was detected in this community, 36 (62%) of which were native. The remaining 22 species (38%) were exotic, with three of those species listed as noxious weeds.

Plate 4.4. The margins of the PMM community, adjacent to along the existing access road typified Edmonton river valley forest edge communities, view looking south (July 2014)

Plate 4.5. Dense understorey in the interior of the PMM community along the west edge of LMRP (July 2014)

Manicured Areas

Manicured lawns, gardens, and planted beds occupied most of the park including some occurances in the vicinity of the SUP portion of the proposed access road. Planted beds in the park supported ornamental perennial forbs as well as trees and shrubs; common species included oleaster (*Elaeagnus sp.*), ornamental columnar poplar (*Populus sp.*), pine (*Pinus sp.*), and larch (*Larix sp.*). Planted beds comprising oleaster, pine, and columnar poplar were located along the staircases intersecting with the SUP to be upgraded (Plates 4.6 and 4.7).

Special Status Species

No rare plant species (i.e., ranked S1, S2 or S3) were detected within the construction access road corridor during the July 2014 survey. One rare plant species, smooth sweet cicely (*Osmorhiza longistylis*), was found at the edge of the vegetation survey area, within Natural Area 056 RV, but his was approximately 175 m southwest of the access road corridor.

Plate 4.6. Manicured areas and paths, including columnar poplar, adjacent to the proposed access road alignment (July 2014)

Plate 4.7. A typical planted bed along a staircase intersecting with the to the proposed access road alignment (July 2014)

4.4.5 *Wildlife*

4.4.5.1 Methods

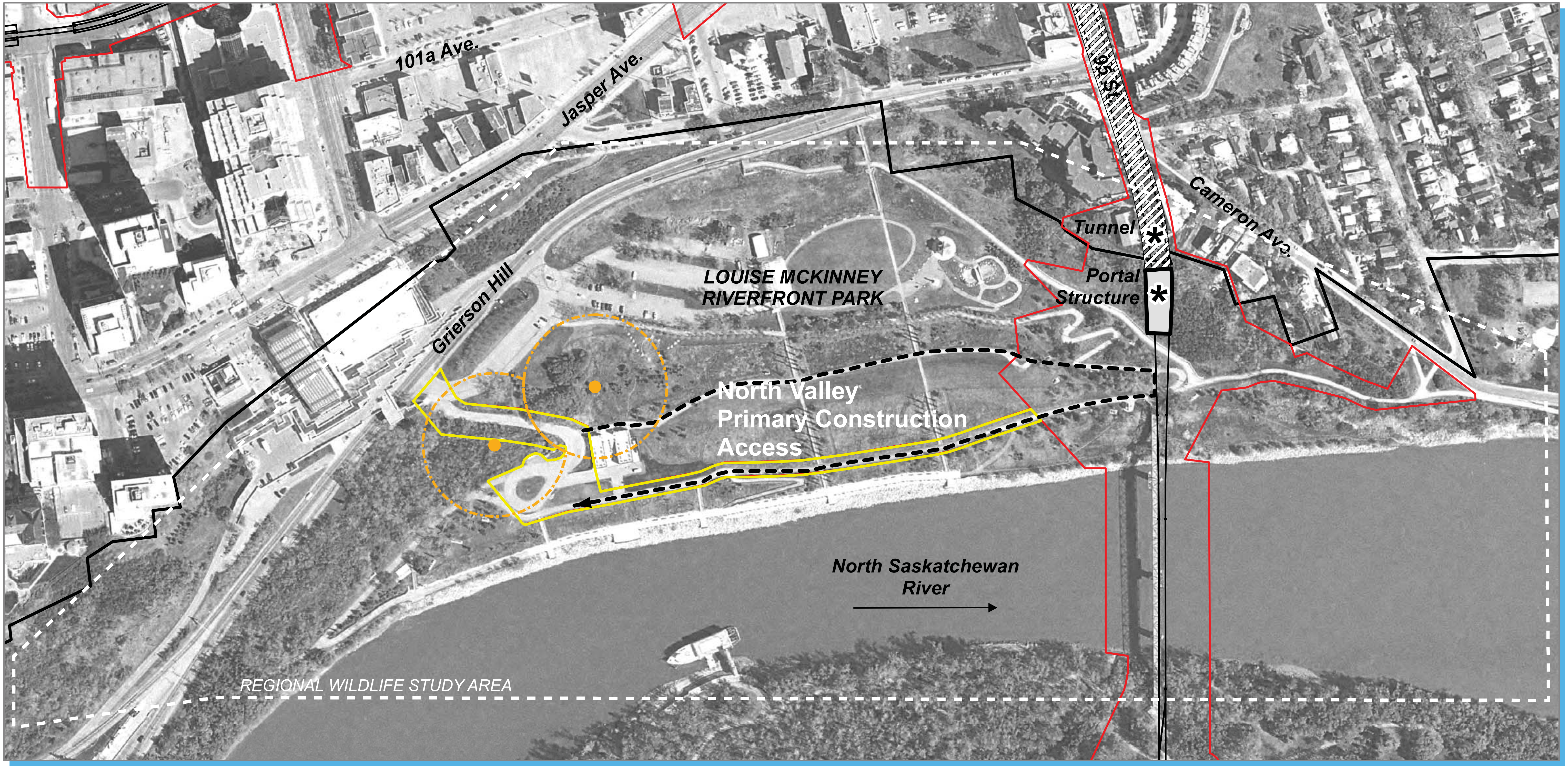
As the western portion of LMRP was not described in detail in the 2013 EISA, wildlife communities within the proposed primary construction access road area were described using a combination of literature review (including the 2013 EISA) and field investigations. Analysis of existing wildlife conditions was completed to a level commensurate with the scale of the project component area and the habitat potential, to enable a description of commonly occurring species and habitat quality, and a brief discussion of potential for the area to support special status species. Species nomenclature followed ACIMS. Common names are used throughout the report; scientific names are provided in Appendix D and E.

Literature Review

Several resources were consulted to determine wildlife species previously recorded in the area. The Fisheries and Wildlife Internet Mapping Tool (FWMIT) (Alberta Environment and Sustainable Resource Development 2014) was searched on 04 September 2014 for information regarding special status species recorded in the area. eBird, a publicly available database of citizen-scientist bird observations, was searched on 04 September 2014 for observations of bird species within the project area (Sullivan *et al.* 2009). To determine wildlife species potentially present in LMRP, information was compiled through a review of previous studies conducted within the NSRV. As was the case for the 2013 EISA, Westworth & Associates (1980) provided preliminary information. More recent and local supplemental information was provided by the 2013 EISA and an earlier study centered on LMRP (Spencer Environmental 2005). In addition, a number of scientific papers and field guides were consulted to determine species ranges and behavior.

Field Investigations

Wildlife field investigations were limited to the spring and comprised breeding bird surveys. No suitable amphibian breeding habitat was identified in the park. For bird surveys, the study area was expanded to include natural habitat adjacent to the proposed road corridor. A breeding bird survey was conducted on 17 June 2014 and repeated on 27 June 2014, to characterize breeding bird richness and abundance. Each bird survey consisted of a point count at each of two stations located within areas of natural vegetation (i.e., the PMM and MM plant communities) and a meandering search of areas supporting manicured vegetation (Figure 4.4). Each point count was an eight-minute survey, wherein all birds detected (seen or heard) within a 50 m radius were recorded. The meandering survey consisted of walking SUPs in the vicinity of the proposed primary construction access road at a rate of approximately 40 m/s and recording all birds detected using habitat in that area. Data from the bird surveys were reported as the maximum number of individuals of each species detected on 17 or 27 June 2014, and the total number of surveys that each species was detected in (out of four point counts and two meandering surveys). All other animal observations or signs were documented and described in terms of presence and habitat use. All habitat types present were briefly described and qualitatively assessed with respect to habit potential.



Legend

- ● Bird Point Count Survey Location (with 50m radius plot)
- * Indicative Location Only
- ▪ ▪ ▪ Bird Survey Transect

Addition to Lands

- 🟨 Undertaken by Project Co
- — Project Area
- — Valley Line LRT Alignment (Reference Design)
- ☐ Bylaw 7188 Boundary

N

0 50 100 200 Meters

1:2,700

Figure 4.4 North Valley Primary Construction Access, Wildlife Survey Locations

City of Edmonton LRT Valley Line - Stage 1
EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

4.4.5.2 Description

The manicured character of LMRP and its location in the center of Edmonton makes the habitat within the project area most suitable for urban-adapted species (e.g., coyotes, several small mammals, commonly-occurring, disturbance-tolerant bird species), although some less tolerant wildlife species may be present on an irregular basis. Please refer to the 2013 EISA for a more complete discussion of wildlife habitat and communities within this reach of the NSRV.

Wildlife Habitat

Of the habitat present within LMRP, there are three types of natural vegetation that are not manicured and experience lower levels of human use. These areas are assumed to provide the highest quality wildlife habitat within the west part of LMRP. The first is a patch of poplar-Manitoba maple (PMM) along the steep slope at the western edge of LMRP (Figure 4.3). The second is a patch of large Manitoba maple (MM) trees on the east side of the existing paved maintenance vehicle access road. The third habitat type is naturalized grassland (G), which occurs as several discrete patches scattered around the west part of LMRP. All of these habitats likely support a small variety of small animals. The existing buildings and structures within LMRP also offer suitable nesting habitat for avian species such as eastern phoebes and some swallows species. Finally, manicured lawns offer some foraging habitat to commonly-occurring species, such as American robins, and ornamental trees can provide perching and nesting habitat for several urban-tolerant bird species. The NSR, located outside of our survey area, but possibly influencing bird use in the park, comprises aquatic habitat suitable for foraging and loafing by a number of waterbird species. It is possible that some urban-tolerant waterbird species at times nest, graze, or loaf in the park.

Avifauna

A total of eight bird species was observed during point count and meandering surveys (Table 4.2; Appendix D). The most common species observed within the naturally vegetated areas in LMRP was the black-billed magpie, which was the most abundant species and was observed at both survey stations and during both visits (17 June and 27 June 2014). Yellow warblers were also abundant during the 17 June 2014 survey. Along the meandering search transect, clay-coloured sparrows were abundant in the shrubs along the NSR, south of the paved SUP. Song sparrows were also frequently observed in this area. All of the species observed are common, urban-adapted species that typically occupy deciduous woodland, shrubby habitat, or manicured areas, the common natural habitat types in the study area. No special status species were observed.

Table 4.2. Bird species recorded during point count and meandering surveys conducted during the breeding season of 2014 in LMRP

Species	**Point Count Survey**		**Meandering Survey**	
	Total Count	**% of Surveys Present (n=4)**	**Total Count**	**% of Surveys Present (n=2)**
Gray catbird (*Dumetella carolinensis*)	1	25	1	50
Yellow warbler (*Setphaga petechia*)	3	25	1	50
Black-billed magpie (*Pica pica*)	3	75	0	0
Clay-coloured sparrow (*Spizella pallida*)	1	50	4	100
American robin (*Turdus migratorius*)	1	75	0	0
Chipping sparrow (*Spizella passerina*)	0	0	2	100
House finch (*Haemorhous mexicanus*)	0	0	1	0
Song sparrow (*Melospiza melodia*)	0	0	3	100
Total # Species	**8**			

Bird abundance was greatest in the poplar-Manitoba maple (PMM) forest (Figure 4.3). During the survey on 17 June 2014, three yellow warblers were observed singing in response to each other on either side of the paved SUP, indicating that this is good yellow warbler breeding habitat. Black-billed magpies were detected in this area on both visits. Fewer birds were detected in the Manitoba maple plant (MM) community. One clay-coloured sparrow was heard singing from the planted pine trees to the east of that community. Only black-billed magpies and American robins were observed to be using the Manitoba maples, suggesting this habitat is only suitable for highly urban-adapted species and reflecting the lack of vertical habitat structure present in the community due to the sparse understorey. During the meandering survey, clay-coloured sparrows and song sparrows were frequently detected in the shrubs adjacent to the river and one gray catbird was also seen and heard moving through the shrubs in the study area. The two final species detected, house finch and chipping sparrow, are urban-adapted species that were detected in the manicured areas surrounding the parking lots.

Mammals

Of the mammal species that may occur within LMRP, small- and medium- sized urban-adapted species are the most likely to occur (Appendix D). White-tailed jackrabbits and red squirrels were observed in LMRP during field investigations. Ground-squirrels and skunks have previously been observed within the project area (City of Edmonton Animal Care and Control Centre 2011, Spencer Environmental 2005). Several larger mammals are also present. Coyote movement monitoring conducted by the Edmonton Urban Coyote Project has documented coyotes moving within the park (Murray and Cassidy St Clair unpublished data). Both white-tailed and mule deer have been observed in the NSRV, primarily outside the downtown core, but smaller populations and transients also occur closer to the city center, usually not far from the NSRV. Deer have been documented in Mill Creek Ravine and Gallagher Park less than 1 km across the NSR (Spencer Environmental unpublished data) and they are anecdotally reported in LMRP.

The high level of human activity and lack of natural vegetation in LMRP likely discourages regular use by deer and other large ungulates and carnivores. .

Amphibians & Reptiles

No suitable breeding amphibian habitat is available in LMRP; however, two reptile species may occur year round within more natural habitat in the project area (Appendix D). The project area is within the range of red-sided and plains garter snakes; however, garter snakes generally prefer natural habitat with ample ground cover (Russell and Bauer 2000), and so if present in the project area are likely to be generally confined to the naturally vegetated areas (e.g., poplar-Manitoba maple habitat on west margin of LMRP).

Special Status Species

Based on habitat requirements, habitat availability and provincial distributions, two special status species were considered to have at least a moderate probability of occurring in the north valley access study area: peregrine falcon, ranked provincially as *At Risk,* and little brown bat, ranked federally as *Endangered* under the *Species at Risk Act* (SARA) (Table 4.3; Appendix E).

Table 4.3. Select special status species with a moderate probability of occurrence in the study area

Common Name	**Provincial Status***	**Wildlife Act Designation and New Species Assessed by ESCC**[1]	**COSEWIC Designation**[2]	**SARA Designation**[3]	**Recorded in Study Area**	**Potential Habitat Use**	**Likelihood of Occurrence**
Peregrine Falcon (*Falco peregrinus anatum*)	At Risk	Threatened	Special Concern	Schedule 1 (Threatened)	FWMIS	Foraging	High
Little Brown Bat (*Myotis lucifugus*)	Secure		Endangered	Endangered	No	Foraging/ Roosting	Moderate

*According to General Status of AB Wild Species (date)

[1] ESCC- Alberta's Endangered Species Conservation Committee

[2] COSEWIC -

[3] SARA – Committee on the Status of Endangered Wildlife in Canada

[4] Fish and Wildlife Information Management System

Peregrine falcons prefer to nest in rocky cliffs, or tall buildings in cities (White *et al.* 2002) and are known to nest on office buildings in Edmonton's downtown core, approximately 1 km northeast of the Cloverdale Pedestrian Bridge, and within 5 km at the University of Alberta. Peregrine falcons are also known to have nested in recent years on the High Level Bridge approximately 3 km upstream from the study area. Peregrine falcons often hunt in the NSRV and are recorded in FWMIS as foraging within 1 km of the local study area. Considering this information, Peregrine falcons are considered to have a high likelihood of foraging in the study area.

The most commonly occurring bat species in Edmonton, the little brown bat, may be present in the park as it is most often seen foraging around water bodies such as the NSR (Alberta Sustainable Resource Development 2001). Suitable roosting snags occur within the poplar-Manitoba maple community. The little brown bat has recently been listed under the federal *Species at Risk Act* as *Endangered* due to extreme rates of mortality in the eastern United States caused by white-nose syndrome (WNS) (COSEWIC 2012). Although WNS has not yet been reported in western Canada, a similar event is expected, and this could severely reduce this species abundance. At present, the little brown bat remains common in the Edmonton area (ASRD 2001). Little brown bats roost in old nest cavities or under the bark of trees, and could make diurnal use of old snags in the poplars in the forest at the west end of LMRP and thus are considered to have a moderate potential to roost and forage in LMRP, and possibly breed in suitable trees or buildings. They do not overwinter in the Edmonton area. Within the areas subject to potential vegetation clearing, the potential for little brown bat breeding and roosting is considered low because the trees in these areas are relatively small, and little brown bats prefer larger than average diameter tree snags for cavity roosts (Crampton and Barclay 1998, Olson and Barclay 2013).

4.4.6 *Habitat Connectivity*

4.4.6.1 Methods

Study Area

Habitat connectivity was considered at two scales: locally and regionally. A regional wildlife study area was delineated to account for the fact that the local project area in LMRP comprises only a small portion of the home range for some species in that area and to facilitate the discussion of the NSR system as a wildlife movement corridor. A reduced regional study area used in the 2013 EISA was suitable because it included ecological boundaries relevant to potentially occurring wildlife species with large home range requirements, and considered the topographic NSRV features in the vicinity of the local project component study area.

Habitat connectivity was assessed based on the quality and distribution of habitat in the local and regional study areas; consideration of local topography; a review of an existing report on landscape linkages and connectivity in the City of Edmonton (Spencer Environmental 2006); preliminary data from the University of Alberta urban coyote project (Murray and Cassidy St. Clair, unpublished data); and wildlife collision data from City of Edmonton Animal Care and Control Centre (2011).

4.4.6.2 Description

When juxtaposed with natural areas, highly developed lands, such as those supporting residential, commercial and recreational land uses, pose barriers to wildlife attempting to move through the lands to the adjacent more suitable natural habitat patches beyond them. In such cases, wildlife corridors within the developed areas play a key role in successful wildlife movement between the disjunct, natural habitat patches. They provide a necessary link between larger habitat areas, accommodating daily, seasonal or dispersal movements that enable genetic exchange and access to other resources (Paquet et al. 2004). The viability of an area as a wildlife corridor is a function of the continuity in its vegetation structure, its width, the amount and type of surrounding disturbance and the quality of the habitat it connects. Major wildlife corridors provide cover and resources, connecting large areas of habitat at a regional scale. River valleys and their associated riparian strips are widely recognized as major wildlife corridors (Vermont Agency of Natural Resources 2005). The Edmonton NSRV is the longest continuous urban green space in North America, has abundant natural cover, links much wilder habitat on either end of the City, and is viewed as an important regional biological corridor (Spencer Environmental 2006). For those reasons, the NSRV serves as the foundation of Edmonton's ecological network.

Within the regional study area, the presumed general direction of dispersal movement is east-west, following the river alignment and the quality of the corridor is variable. At the west end a relatively narrow strip of naturally wooded valley lines the riverbank and provides a nearly continuous corridor for movement through that part of the city core. This segment is assumed to be used regularly by species that are tolerant of the adjacent residential areas and valley recreational use and to also be important for intermittent use by species attempting to follow the valley through the city. The existing paved maintenance vehicle access and the Riverfront Plaza likely deflect movement of animals leaving the east and south edges of that natural habitat patch. The proposed primary construction access corridor, while mostly paved, is currently embedded in a mosaic of naturalized grassland habitat on the valley slopes. The slope bottom comprises landscaped manicured habitat. The lack of forested area within this construction corridor does not provide the protective cover preferred by many species such as deer or fox and weasel. This highly developed and manicured park area is an exposed portion of the longer north valley corridor. There is some more continuous habitat cover along the riverbank within the local study area that may facilitate the movement of smaller wildlife species through the area, but the value is diminished by the presence of the riprapped bank and the concrete promenade. The Cloverdale Pedestrian Bridge spanning that narrow band of habitat is a further limitation for the largest mammals (i.e., moose and deer). Coyotes, which tend to be less wary and more willing to travel through open areas, have been documented to travel through the area, including the open park space (Murray and Cassady St Clair unpublished data) and across the river in winter, proving the connectivity within the wider valley corridor. East of the future Valley Line LRT, lands offer more cover, but the suitable area is only approximately 60 m wide (between residential property boundaries and the shores of the river). And then, further east, wildlife movement is assumed to be further impeded but not prohibited, by a pinch point of very steep slopes. Overall, the quality of the wildlife movement corridor on the north valley slopes in the regional study area is considered low to moderate because of the lack of protective cover, the presence of a pinch point, and the area's more limited suitability for larger mammals, with the lands to be occupied by the proposed primary construction access road ranking among the lowest quality locales.

4.4.7 *Recreational Land Use*

4.4.7.1 Methods

Recreational land use was described based on information and supporting investigations presented in the 2013 EISA (Spencer Environmental 2013), new LMRP event information generated in 2014 and reconnaissance site visits on 20 June and 15 September 2014. The recreation study area was expanded to include lands surrounding the project component area in order to capture indirect effects on recreational activities.

4.4.7.2 Description

Due to its central location and high quality amenities within the NSRV, LMRP supports numerous programmed and un-programmed activities, including passive and active uses (Plate 4.8), some commercial activities, and two major events, the annual Edmonton Dragon Boat Festival and the inaugural Edmonton 2015 Red Bull Crashed Ice event.

The 2013 EISA documented the recreational value of LMRP in general and the facilities present. In the more limited area of the proposed primary construction access road alignment, park facilities include an important service road, recreational pathways and facilities as follows:

- A paved maintenance/service vehicle road and turn-around that connects to the gravel east-west park maintenance road and recreational businesses and public washrooms. It also facilitates regular holding tank service. This road does not provide vehicular park access or parking for the general public (Plate 4.9)
- Situated along both the SUP and the vehicle access road is the Riverfront Plaza – which includes public washrooms and two businesses (River Valley Adventures/Urban Green Café). River Valley Adventures operates a Segway rental service that relies on their connection to the paved Trans Canada Trail and the broader river valley SUP network (Plate 4.10).
- The SUP within the proposed project area is one of two SUPs travelling through LMRP. This SUP forms part of the main spine of east-west trails through the longer river valley and is part of the Trans Canada Trail. Within the park, the west section of this SUP connects with the aforementioned maintenance access road and continues west, outside the park, towards the Low Level Bridge; the east section of this SUP connects with the Cloverdale Pedestrian Bridge and continues east, outside the park, towards Riverdale and Dawson Park.
- Within the footprint of the proposed primary construction access road, this SUP intersects with four stairways and one paved path: two bisecting downhill staircases connect uphill trails and amenities to the Riverfront Promenade; two intersecting staircases lead south to the Riverfront Promenade, one paved, fully accessible trail leads south to the promenade (Plate 4.11). Through the promenade, these routes also lead to the public boat launch/dock just west of the promenade; however, the dock can also be accessed from trails further west.

Plate 4.8. LMRP supports numerous programmed and un-programmed activities, including passive and active uses.

Plate 4.9. Maintenance/service vehicle road turn-around, looking north (July 2014). This road does not provide vehicular park access or parking for the general public.

Plate 4.10. Riverfront Plaza, looking northwest: River Valley Adventures operates a Segway rental service that relies on the connection to the paved Trans Canada Trail and the broader river valley SUP network (July 2014).

Plate 4.11. Paved fully accessible trail leading south to the Riverfront Promenade, looking east (July 2014).

- An additional, fully accessible north-south pathway is planned for construction in 2015 by City of Edmonton Community Services (Figure 4.5), to provide increased accessibility to the Riverfront Plaza, the SUP and the Riverfront Promenade and to replace the accessible trail in the east park that will be temporarily closed by LRT construction. Since trail construction is scheduled to be undertaken prior to Valley Line LRT construction, this assessment assumes this trail to be an operating park facility that must be accounted for by the proposed primary construction access road.

- An additional staircase connecting the above-mentioned accessible path to the Riverfront Plaza is also anticipated to be constructed by Community Services in 2015 (Figure 4.5).

The Dragon Boat Festival occurs in LMRP annually during August. The festival is centered on the water but also involves land-based activities in the west part of LRMP, within the proposed primary construction access road corridor. In March 2015, Edmonton's inaugural Red Bull Crashed Ice event will take place in the west part of LMRP, making use of the maintenance vehicle access road, Riverfront Plaza and adjacent lands. This event is expected to repeat in 2017 and 2019.

Other Park Infrastructure

Within the boundaries of the proposed primary construction access study area, other park infrastructure is limited. There are no light standards, benches or other recreational infrastructure situated within the area. In autumn 2014, the entrance path connecting to the east part of the Riverfront Plaza included two portable bike racks, one portable picnic bench and decorative planters.

4.4.8 *Visual Resources*

4.4.8.1 Methods

Visual resources were described based on information and supporting investigations presented in the 2013 EISA (Spencer Environmental 2013) and subsequent reconnaissance site visits on 20 June and 15 September 2014.

4.4.8.2 Description

The role of LMRP as an important visual resource in Edmonton, aesthetically linking the downtown urban environment with the natural environment of the NSRV, is well documented in the 2013 EISA. This assessment focuses on the smaller area of LMRP that would be traversed by the proposed primary construction access road (Plate 4.12). The western part of LMRP is highly visible from several in-valley and top-of-bank west-facing vantage points, including the Cloverdale Pedestrian Bridge, higher points of land across the NSR, the Shaw Conference Centre (Plate 4.13) and LMRP parking lot and the Riverfront Plaza (rooftop views) (Plate 4.14), (looking east and west), and several residential properties at the top of the river valley west of Cameron Avenue.

Site Plan - Louise McKinney Riverfront Park

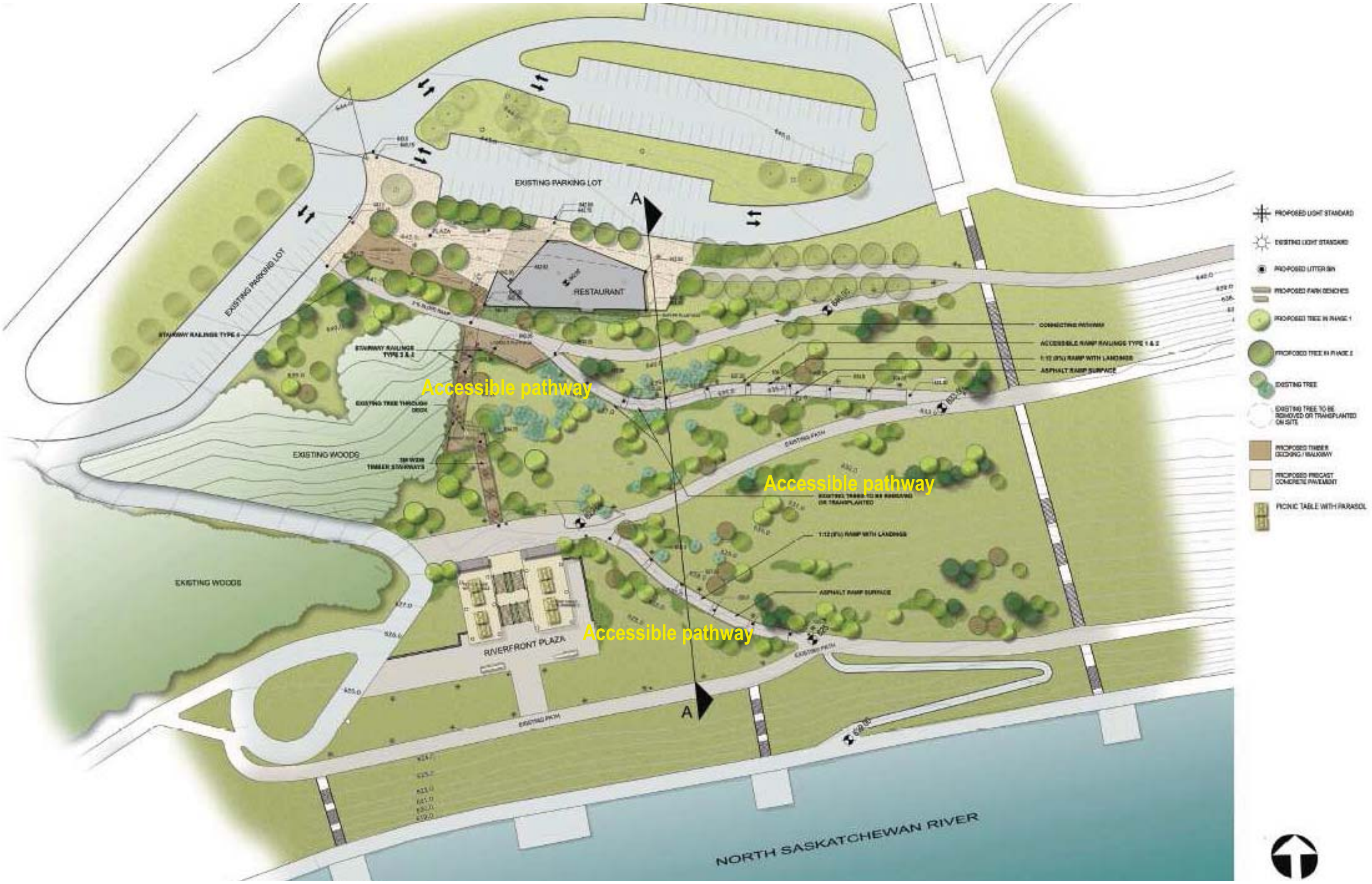


Figure 4.5

Plate 4.12. West End of proposed primary construction access road, looking southeast along the maintenance vehicle access road, from the Shaw Conference Centre (June 2014).

Plate 4.13. West End of proposed primary construction access road, looking northeast towards the maintenance vehicle access road and the Shaw Conference Centre, from the Riverfront Plaza (June 2014).

Plate 4.14. Rooftop view from the Riverfront Plaza, looking east (June 2014).

4.4.9 *Utilities*

Utility information was derived from detailed LRMP utility maps provided by Community Services to LRT D and C. It is possible that not all utilities have currently been located. Prior to beginning work on the site, Project Co will need to confirm all utilities and their locations within the designated Project Area.

Multiple buried utility lines (and associated surface components) are present in the proposed construction access road project area (Appendix F). Several buried EPCOR electrical lines are within the project area including one running parallel with the Trans Canada SUP at the base of the slope, which terminates at an electrical panel near the east end of the Promenade. EPCOR lines also travel north, east and south and intersect with the project component area. Several utility panels/boxes are located along the vehicle access road turnaround (Plate 4.15). Two storm sewer lines are located across and adjacent to the entrance to the maintenance access road to the Riverfront Plaza building and two additional storm sewer lines are documented as running north/south across the valley slope east of the plaza building. A subsurface holding tank, an associated sanitary line and a monitoring cable are located west of the Riverfront Plaza building, with surface connections and the majority of the tank located in the grassed centre of the vehicle turn-around (Plate 4.16). This holding tank is anticipated to be replaced with a lift station and associated sanitary lines in 2015. One north-south water main and fire hydrant are situated immediately west of the Riverfront Plaza. An ATCO gas line is located under the west side of the vehicle access road to LMRP, within the project component lands. There are no identified overhead utilities. While some of the utility relocations required for the Valley Line are already underway, no relocation work has been undertaken in support of the proposed primary construction access road in LMRP.

Plate 4.15. Several utility panels/boxes are located along the vehicle access road turnaround, looking north.

Plate 4.16. A subsurface holding tank, an associated sanitary line and a monitoring cable are located west of the Riverfront Plaza building.

4.4.10 *Historical Resources*

The entire project has been granted Clearance under the *Historic Resources Act*, in the form of two Clearance letters issued by the Province. The second letter, issued on 01 December 2014, accounted for the lands affected by the proposed construction access road. The Province has indicated that the abandoned landfill, the Grierson Nuisance Grounds, is in their inventory of known historic sites and is designated as site FjPj-166. Portions of the proposed construction access road would intersect with site FjPj-166.

4.5 Potential Impacts and Mitigation Measures

4.5.1 *Geology/Geomorphology*

4.5.1.1 Slope Stability

Impact

While a history of slope stabilization measures has improved the overall slope stability in LMRP, it is recognized that excavation and fill activities associated with construction of the proposed primary construction access road along the toe of the former Grierson Hill Slide may have potential to result in slope instability. Thus, to assess this, Thurber Engineering (2014) compared pre- and post-construction use factors of safety. They found that construction of the proposed access road would have no effect on the slope factor of safety for Bentonite Seams “A” and “B” (Thurber Engineering 2014). Thurber Engineering attributed this finding to the relatively minute height/volume of road fill, 1 m high embankments, compared to the volume of the slide mass.

At the riverbank, the pre-construction factor of safety was estimated to be in the range of 1.15 to 1.25 while the post-construction factor of safety was estimated to be reduced by 2 to 7 percent, to a factor of safety ranging from 1.1 to 1.2 (Thurber Engineering 2014). While the percent reduction was not considered large, it reduces the already low factors of safety for the riverbank.

Overall, Thurber Engineering found that construction of the proposed construction access road is expected to have a minimal adverse impact on the stability of the overall valley slope (Thurber Engineering 2014; Appendix B), but could adversely affect the stability of the shallow bank along the NSR. Although such a failure would impact a limited portion of the valley slope, instabilities along the toe of the sensitive Grierson Hill slide may trigger slope movements on a wider scale, if not repaired on a timely basis. The above potential is, therefore, rated as an adverse, major, permanent and predictable impact.

Mitigation Measures and Residual Impact

Thurber Engineering (2014) recommended the following measures be incorporated into construction and operation of the portion of the proposed primary construction access road situated along the existing SUP, as built-in mitigation:

- Placement of additional fill (greater than 1 m in height) should be avoided during construction of the primary construction access road.

- The footprint of the primary construction access road (to accommodate an 8 m wide road) should be kept as far north as practical from the rest of the riverbank.
- Limited cuts may be used to achieve the required road width. To limit the extent of excavation, cuts could be supported using temporary retaining systems (e.g. lock-block walls).
- Several slope inclinometers should be installed along the proposed alignment and monitored on a regular basis to help detect and assess any slope movements.
- Visual inspections of the river valley slope in the general area of the access road should also be carried out regularly during road and Valley Line LRT construction to identify any signs of ground movement (e.g., cracks, bulging, tilted trees or posts, etc.)
- Should the slope monitoring or visual inspections indicate any ground movement, a review of the slope condition should be carried out immediately by a geotechnical engineer and measures to arrest the movement should be implemented as soon as possible.

Project Co will be required to comply with all geotechnical and slope stability recommendations by Thurber Engineering for the design and construction and use of the portion of the proposed primary construction access road situated along the existing SUP. For the portion of the proposed primary construction access road situated along the existing maintenance access road (leading from Grierson Road), the City will undertake a geotechnical assessment of road upgrading in this area and develop recommendations required to ensure slope stability. LRT D and C will submit any geotechnical report to Transportation Services for review and sign-off. Project Co will be required to implement all recommendations and abide by all limitations. Should the City report recommend no clearing of native vegetation or re-grading, Project Co will be required to use the road in its current horizontal and vertical alignment.

With such recommendations in place, residual impacts to slope and riverbank stability from construction of the proposed primary construction access road are anticipated to be negligible.

4.5.2 *Soils*

Construction and operation of the proposed primary construction access road has the potential to interact with surface water from precipitation and snow melt. As identified in the 2013 EISA and carried forward into the Project Agreement, Project Co will be required to develop an EMS and an associated ECO Plan and ESC Plan. The ESC Plan will conform to the City of Edmonton Erosion and Sedimentation Control Guidelines and Erosion and Sedimentation Control Field Manual and must provide for measures commensurate with the sensitivities of the site conditions a location within the landscape. Thus, no *new* impacts relating to erosion and sedimentation and no *new* mitigation measures are required.

Construction and operation of the proposed primary construction access road does, however, have the potential to interact with soils in several other ways.

4.5.2.1 Disturbance of Contaminated Soils during Construction

Construction of the primary construction access will follow existing grades but will likely involve some minor cuts and fills. In certain areas, minor cuts along the base of the slope may encounter landfill materials, as debris has been noted close to the ground surface, particularly in the center of the project area (Thurber Engineering 2014). A Phase II ESA (Connected Transit Partnership 2013b) confirmed that the former Grierson Nuisance Grounds appear to have contributed to heavy metals contamination in soils upgradient of the river. The 2013 EISA determined that for lands in LMRP along the new LRT track, excavation activities in support of permanent infrastructure installation must unavoidably occur within the boundaries of the abandoned landfill and will therefore interface with contaminated soils. Because of this, the proposed access road poses no impacts relating to contaminated soils over and above those associated with the permanent LRT infrastructure.

Project-wide mitigation measures developed for the Valley Line LRT project require Project Co to abide by all environmental laws and include specific protocols and other requirements to ensure suitable handling of all contaminated soils and no exacerbation of soil contamination within the park. All project-wide mitigation measures developed to date are now included in the Project Agreement and will be applied to any activities associated with the construction access road. In addition, the City is developing a Valley Line risk management strategy for soil and groundwater contamination in this area, and will be consulting with the Province. This is a work in progress and Project Co will be required to comply with all Provincial recommendations.

4.5.3 *Hydrology*

Construction and operation of the proposed primary construction access road has the potential to interact with both surface and groundwater in several ways.

4.5.3.1 Road Surface Drainage Impacts

Impact

Construction of the primary construction access road will include limited site grading and creation of a road bed, which will require draining surface water off the access roadway. Negative drainage could affect road integrity and increase the disturbance footprint. This would be a minor, adverse, long-term, predictable impact.

Mitigation Measures and Residual Impact

Thurber Engineering (2014) recommended that permanent site drainage be developed at the early stages of access road construction. They recommended ensuring a 2% slope to the subgrade towards side ditches. The purpose of this is to drain surface water from the subgrade and thereby prevent ponding of water which could result in swelling, softening, and/or possible frost heave of the subgrade. Project Co will also be required to develop a dewatering plan and an ESC plan for all works associated with the project component. The ESC Plan will conform to the City of Edmonton *Erosion and Sedimentation Control Guidelines* and *Erosion and Sedimentation Control Field Manual* and must account for surface drainage associated with the construction access roadway. With these mitigation measures, residual impacts should be negligible.

4.5.3.2 Disturbance of Contaminated Groundwater during Construction

Impact

Construction of the proposed primary construction access road will involve some minor cuts. While this is required in an area with known groundwater contamination, groundwater levels recorded in piezometers suggest it is unlikely that excavation would be deep enough to interact with contaminated groundwater. In the unlikely event that contaminated groundwater is encountered during excavation activities, project wide mitigation measures have already been developed for the Valley Line LRT and are included in the Project Agreement. For example, Project Co must have an approved plan in place for testing, containment, handling and disposal of contaminated water. These protocols account for all LRT work on the landfill. Because of this, the proposed access road poses no additional or unique impacts with respect to interacting with contaminated groundwater.

Mitigation Measures and Residual Impact

Project-wide mitigation measures developed for the Valley Line LRT project require Project Co to abide by all environmental laws and include specific protocols and other requirements to ensure suitable handling of contaminated groundwater and no exacerbation of contamination within the park. All project-wide mitigation measures developed to this end are now included in the Project Agreement and will be applied to any activities associated with the construction access road. In addition, the City is undertaking a groundwater monitoring program at the former Grierson Hill landfill in the vicinity of the permanent Valley Line infrastructure and will be developing a risk management strategy for soil and groundwater contamination and consulting with the Province. These measures will ensure no residual impacts to park resources.

4.5.3.3 Surface Drainage and Contaminated Soils

Construction of the proposed primary construction access road will involve some minor cuts and re-grading and these activities may expose contaminated soils for brief periods. During precipitation events, surface drainage may interact with such contaminated soils, flow off site, and potentially contaminate nearby lands. Suitable project wide mitigation measures have already been developed for other Valley Line LRT components and are included in the Project Agreement. This includes the development of site dewatering plans that include measures appropriate for the handling of all potentially contaminated surface runoff. Because of this, the proposed access road poses no additional or unique impacts with respect to interacting with contaminated groundwater.

4.5.4 *Vegetation*

4.5.4.1 Impacts to Native and Naturalized Vegetation

Impact

It will be the responsibility of Project Co to determine the final design of the proposed primary construction access road. If the geotechnical assessment undertaken by the City recommends that vegetation clearing and re-grading is acceptable at the portion of the access route along the existing maintenance road, Project Co may elect to clear portions of the poplar-Manitoba maple (PMM) and/or Manitoba maple (MM) communities. If the road is widened to the east, a relatively small area of the MM community would be lost, totaling approximately 168 m^2.

Of greater vegetation consequence would be a widening or realignment to the west, which would involve clearing into the PMM community. This is a more diverse and more native stand and is also part of Natural Area 056 RV. The largest area that could be cleared of this community is captured in the Project Area overlap shown on Figure 4.3 and measures approximately 1,036 m^2. The overlap shown in the figure allows only for widening/upgrading of the existing road. This would permit a disturbance corridor approximately 10 m wide into the PMM community. Vegetation impacts resulting from this would include the edge and potentially the transitional area from edge to more interior habitat of the PMM community. This is considered to be the worst-case scenario and the actual area required for widening/upgrading may be smaller.

Widening the portion of the access road that follows the SUP to support the movement of heavy equipment, would also require removing portions of several naturalized grassland (G) communities, clearing a total of approximately 1,305 m^2. This community is the result of park naturalization and is relatively fast growing and thus, easily restored in a relatively short time.

If realized, the additional loss of native vegetation as described above is rated as adverse, minor, long-term and predictable. It is minor, even though some native vegetation would be removed, because of the relatively small areas involved.

Importantly, the City has adopted a project wide strategy to ensure compliance with the City's Corporate Tree Policy. This strategy will also apply to this project component.

Mitigation Measures and Residual Impact

Mitigation for clearing in the Manitoba maple (MM) and poplar-Manitoba maple (PMM) communities will take the form of avoidance, followed by restoration for unavoidable clearing. If road upgrading proposed by Project Co requires clearing in either of these areas, Project Co will be required to submit a detailed request to the City, justifying the clearing by indicating why other options could not be used and demonstrating that a suitable alternative that does not require clearing of trees cannot be achieved. Clearing of the MM community would be the first acceptable alternative. Clearing of the PMM community would be considered as a last resort. If clearing of the MM and/or PMM communities is approved, restoration will be governed by native forest restoration requirements already noted in the Project Agreement for any clearing of forest communities, as part of this project component change. Establishment of Manitoba maple will not be an acceptable part of restoration.

Finally, to ensure compliance with the Corporate Tree Management Policy, the City of Edmonton commits to updating the Valley Line tree inventory to cover the lands included for this project component.

Any loss of naturalized grassland (G) communities will be mitigated by requiring Project Co to restore all affected grasslands to their original condition, according to an approved plan. Use of clean imported topsoil will be required to ensure that re-use of any soils affected by landfill debris is avoided.

The above mitigation measures will ensure that impacts to native and natural communities will be negligible; however full restoration of the native community would be a long-term process.

4.5.4.2 Impacts to Manicured Vegetation

Impact

Construction activities associated with the proposed construction access road are anticipated to impact a small area of manicured vegetation within LMRP, totaling approximately 1,622 m^2 associated with widening the existing SUP to support construction traffic. Impacts to manicured vegetation will include lawn (approximately 1,338 m^2), some planted trees and portions of planted beds (approximately 284 m^2) situated along the existing SUP. The additional loss of manicured vegetation is rated as adverse, minor, long-term and predictable. It is rated as minor because of the small patches involved and ease of restoration in comparison to naturalized communities.

Mitigation Measures and Residual Impact

Any manicured park areas disturbed by this project component will be reclaimed to the existing landscaped condition. Project Co will be required to include this area in their project landscaping plans that demonstrate that full reclamation will be achieved. Any removal of trees within this project component will be subject to the City's Corporate Tree Management Policy and, more specifically, to the process and tree inventory that the City has established for the Valley Line LRT to ensure compliance with that policy. These measures should result in a negligible residual impact to manicured vegetation, in the long-term, allowing for time for plantings to mature.

4.5.5 *Wildlife*

4.5.5.1 Loss of Terrestrial Habitat Due to Clearing Activities

Impact

Construction activities associated with the proposed primary construction access road have potential to remove some small areas of the park's unmanicured and comparatively better quality wildlife habitat. Those losses will only be required if it is determined that the existing maintenance/service vehicle access road in LMRP would require some realignment to accommodate construction vehicles.

Because the potentially affected areas are small, not of the highest quality, would not be fully removed, are found in abundance in the NSRV and support commonly-occurring species, and must be replaced as part of mitigation efforts, this potential loss of habitat is rated as a minor, long-term adverse and predictable impact.

Mitigation Measures and Residual Impact

Because Project Co will be required to re-establish all lost native or naturalized plant communities, as described in the previous section, the long-term residual impact to wildlife habitat within the project component area is rated as negligible.

4.5.5.2 *Special Status Species*

Impact

None of the project components are thought to have potential to adversely influence peregrine falcons because falcons do not now regularly occur in the area. Construction activity may alienate some potential peregrine avian prey species from the park, thereby further reducing the potential for peregrines to use the area. An abundance of foraging opportunities exist elsewhere in the NSRV. The potential impact to peregrine falcons is considered negligible.

Because the areas subject to potential clearing are not suited to little brown bat roosting, the project has negligible potential to affect little brown bat habitat or to result in direct mortality to little brown bats as a result of clearing. Potential for direct mortality is further reduced by the Project Agreement clause that prohibits all clearing in vertically complex forest (which applies to the PMM community) between 10 May and 10 August. In the Edmonton area, little brown bats *can* return to cavity roosts in early May; however, their numbers in early May are generally low (Schowalter *et al.* 1979, Alberta Fish and Wildlife Division *n.d.*). Females do not give birth until June, their young fledge in late July and most roosts are free of little brown bats by the second week of August (Schowalter *et al.* 1979). If bats happen to be present in early May or after 10 August, and are disturbed during roosting, they would be mobile enough to fly away.

Mitigation Measures and Residual Impact

Additional mitigation measures are not required.

4.5.6 *Habitat Connectivity*

Impact

Although the manicured west portion of LMRP is not considered to be a high quality movement corridor, the construction and use of the proposed primary construction access road is likely to further reduce its suitability for use as a wildlife corridor. Conversely, as the access road is to be oriented parallel and not perpendicular to the riverbank and because construction activity will typically occur between the hours of 07:00-22:00 hours Monday to Saturday and 09:00-21:00 hours on Sundays and holidays, the potential effect of this project component on wildlife movement through the western part of the park is reduced. During working hours the noise and visible traffic may deter some animal movement through this area; impacts during these periods are anticipated to be adverse but only minor, short-term, and predictable.

Mitigation Measures and Residual Impact

The 2013 EISA required Project Co to develop several measures to accommodate wildlife movement through the valley, the main ones being to ensure that during construction, a corridor remains present in the north river valley and to address any wildlife-worker conflicts. Such requirements have been incorporated into the Project Agreement for the Valley Line LRT. These measures are anticipated to reduce the impact but because it may not eliminate all adverse impacts, it does not change the impact severity rating.

4.5.7 *Recreational Land Use*

Use of the proposed north valley primary construction access road will impact recreational land use within the western part of LMRP. The 2013 EISA addressed the impacts of partial closure of this east-west SUP, as it was recognized that further east this same SUP intersects with the LRT alignment and main construction zone. This update is, therefore, specific to the impacts of closure of the additional (western) portion of the SUP and use of the existing maintenance/service vehicle access road and SUP as the primary construction access road.

4.5.7.1 Impacts to the Pathway Network

Impact

West Park Pathway Use

Closure of the east-west SUP to the public and use of it as the proposed primary construction access road has the following implications for public use of the greater west LMRP pathway network:

- The four north-south wooden staircases intersections with the SUP must either be controlled for safety reasons or closed, limiting access to the Riverfront Promenade.
- Ensure that all businesses located in LMRP remain accessible to recreationalists and service vehicles.
- The new accessible pathway to be constructed in 2015, and remain open during Valley Line LRT construction, will intersect with the proposed primary construction access road, creating a need to ensure safe access across this area to the existing accessible path south of the SUP that leads to the promenade.
- Segway renters will have more limited access to the greater SUP network to the east and west.

- There is potential for construction traffic to pose a safety hazard to members of the public using available shared use routes and where pathways intersect with the vehicle access route (Plates 4.17 and 4.18).

Unmitigated, potential impacts to the pathway network are rated as adverse, major, long-term and predictable.

Plate 4.17. An informal trail that connects to the maintenance access road from the LMRP parking lot, looking north (July 2014).

Plate 4.18. Three pathways (from west, south and east) connect to vehicle maintenance access road (July 2014).

Mitigation Measures and Residual Impact

To mitigate the limitations that the construction access route will have on existing pathways that currently access the east-west SUP and the Riverfront Promenade to the south, Project Co will be required to undertake the following:

- Provide and maintain barrier-free and safe access across the primary construction access road at the two wooden staircases leading south to the Riverfront Promenade and at the connection with the accessible pathway to the north and to the south.
- Post-construction, re-establish all affected pathways and staircases will be re-established to the pre-disturbance condition, alignment and width, restoring the trail network in the local area.
- During the construction period, all works associated with the primary construction access road will be subject to the contractual obligations of the Valley Line LRT, which includes requirements and protocols pertaining to trail detours, signage and communications.
- Ensure safe and effective shared use of the existing or upgraded maintenance/service vehicle access route with vehicular traffic servicing the existing facilities.
- Provide a safe crossing of the existing maintenance/service vehicle access route for all recreationists accessing the formal pathway network to the west, south and northeast.

Implementing these measures should ensure that residual adverse impacts to trail users are minimized, reducing the adverse effect of the proposed route to minor, long-term and predictable.

4.5.7.2 General Park Use

Impact

The use of the proposed primary construction access for all activities in the north river valley will result in the daily flow of numerous trucks and various types of heavy equipment through the area, with intermittent periods of peak activity each lasting up to several months. This has potential to create noise and dust and be a very noticeable project component in the lower, western portion of LMRP. Therefore, there is some potential for this to adversely affect unprogrammed uses in that part of the park, such as use of the Riverfront Plaza roof top patio, grassed areas for picnicking and nature appreciation. Vehicles servicing the Riverfront Plaza and associated businesses may be inconvenienced by the volume and nature of the construction traffic. There is also potential for construction traffic through the park to pose a safety hazard to members of the public using adjacent manicured areas of the park, if public access is uncontrolled.

Unmitigated, the potential impact to park users is rated as adverse, minor, long-term and predictable. The severity is minor because of the relatively low passive use in this park locale.

Mitigation Measures and Residual Impact

To mitigate the impact of construction traffic on unprogrammed park uses the City will ensure the following:

- Project Co will be required to continuously control dust emanating from the road surface using acceptable protocols as set out in the Project Agreement.
- Project Co will make available to the café any printed project update information generated through the public communications plan, so as to allow patrons using the plaza and rooftop to interpret visible construction activities.
- Effective barriers are present along the construction route to clearly delineate the route and protect the safety of nearby park users.
- Project Co will ensure continuous access for vehicles servicing facilities at the Riverfront Plaza, including the holding tank and future lift station.

Implementing these measures should ensure that residual adverse impacts are minimized, reducing the adverse effect of the proposed route on the quality of recreation experiences to minor, long-term and predictable. It remains minor because of the anticipated traffic noise that will be incompatible with most park uses.

4.5.7.3 Special Events

Impact

Programmed uses in this part of the park include the annual Dragon Boat Festival and the inaugural Edmonton 2015 Red Bull Crashed Ice event (with anticipated future events in 2017 and 2019) both of which have considerable spatial overlap with the construction access route, involve installation of temporary infrastructure, attract hundreds of spectators and rely on good visual sightlines and broadcasting acoustics for a successful event. In addition, the Dragon Boat Festival requires direct access for spectators to the Riverfront Promenade. None of these event requirements are compatible with an active construction access route, and thus, unmitigated, this project component has potential to create significant conflict with these events.

Overall, the potential impact to special events, prior to mitigation is rated as adverse, major, long-term and predictable. It is rated as major because these are major events that rely on public attendance and draw people from across the City.

Mitigation Measures and Residual Impact

To mitigate the effects of this project component on the Dragon Boat Festival, the City will implement the following protocols and measures:

- For the period of 4 days before to 2 days after the event, Project Co must provide unimpeded access to the Edmonton Dragon Boat Festival site from Grierson Hill Road to allow for festival set-up and tear-down and for emergency evacuation.
- Valley Line construction access via the north valley primary access route will be suspended from noon on the Friday of the Edmonton Dragon Boat Festival event to midnight on the Sunday of the event, during which time construction access will be via the portal maintenance access road from Cameron Avenue.
- The City will reserve the right to modify these measures as informed by the experience gained during the first occurrence of the event after project initiation, assumed to be 2016.

To mitigate the effects of this project component on Red Bull Crashed Ice, the City will implement the following protocols and measures for the period spanning 28 days prior to, and until 14 days following the, Red Bull Crashed Ice event:

- Use of the construction access road will cease and unimpeded access from Grierson Hill will be granted to event organizers for activities associated with set-up, tear down and emergency evacuation related to the event.
- Construction equipment vehicle access will be by way of Cameron Avenue and the north portal permanent access road.
- Grierson Hill Road will not be used for construction access and the road will be fully closed for the four day event.
- All Project Co construction fencing, temporary structures, equipment and materials will be removed from the Red Bull Crashed Ice Site.

- Within the entire river valley, all Project Co construction activity will be suspended during the four-day event. Specific activities having no potential to be audible may be allowed at the discretion of the City.
- Red Bull Crashed Ice organizers may erect temporary fencing on their site, as needed.
- The City will reserve the right to modify these measures as informed by the experience gained during the 2015 event.

Implementing these measures should ensure that residual adverse impacts on special events are reduced to negligible.

4.5.8 *Visual Resources*

Impact

The North Valley Primary Construction Access will be highly visible within the NSRV, including from in-valley and top-of-bank vantage points. Activities associated with this project component will, however, be undertaken concurrently with other extensive construction associated with the Valley Line PRT including the north valley portal and the Tawatina Bridge, and this portion is expected to be relatively minor although one of the longer lasting components. Visual impacts will include the temporary conversion of vegetated areas to construction zones, some fencing and the frequent presence of numerous construction vehicles and heavy equipment. Based on these considerations, impacts to visual resources are considered to be adverse, minor to major, long-term and predictable.

Mitigation Measures and Residual Impact

During construction, all works associated with the North Valley Primary Construction Access project component will be subject to the contractual obligations of the Valley Line LRT, which includes requirements to provide aesthetically suitable fence and/or visual screening. Despite the implementation of such measures, works associated with this project component are anticipated to increase the overall visual impact within the local area, thus, impacts are still rated as adverse, minor, long-term and predictable.

4.5.9 *Utilities*

Impact

Use of the park maintenance access road as the construction access road has some potential to affect several buried utilities situated underneath the access route, including but potentially not limited to, a subsurface holding tank, an associated sanitary line and monitoring cable located west of the Riverfront Plaza building, several EPCOR lines connecting to the electrical panels to the immediate northwest of the Riverfront Plaza, and an ATCO gas line located under the west side of the vehicle access road to LMRP. Even if subsurface work or road widening is not required in that section of the construction access route, there is some uninvestigated potential for these underlying utilities to be damaged by the heavy loads that will use this road. Should the road require straightening this also has potential to affect buried and surface utilities. The SUP corridor will also carry heavy loads and constructing the access road will require some subsurface work, including cuts. Utilities in that corridor may also require protection and/or relocation. Should any utility relocations be necessary, it would be the utility owner that would undertake the work, in cooperation with Project Co.

Although not at present anticipated, since utility locates and road design are still in the future, it is possible that temporary or permanent relocations will be required and may involve lands outside the Project Area, affecting other park resources. This impact is rated as adverse, minor, and uncertain. It is minor based on the assumption that relocations would affect very small areas only.

Mitigation Measures and Residual Impact

Project Co will need to confirm utility locations prior to commencing construction and will then implement suitable mitigation, which may be protection in place through proven measures such as temporary bridging over the utility, or may be temporary or permanent relocation. Protection of such utilities should also include the holding tank or lift station and associated sanitary line. Continued accessibility for maintenance vehicles servicing the tank/lift station will also be required. Relocation within the Project Area would be subject to all of the environmental protection measures included in the contract agreement and any impacts would thus be mitigated. Should it become evident that utility relocation or new utility installation is required on lands outside the Project Area, the work would be undertaken by the utility owner. The work would be subject to review under Bylaw 7188, would most likely take the form of an Initial Project Review (IPR) and would be the responsibility of the utility owner. An approved Bylaw 7188 review is expected to ensure no attendant long-term impacts to park resources.

4.5.10 *Historical Resources*

The second Clearance Letter issued by the Province covers the construction access road component and all conditions and associated reporting requirements stipulated in the *Historic Resource Act* Clearance letter are included in the Valley Line Project Agreement. Because there is some potential for the construction access road to affect historical artifacts in the Grierson Landfill, the Provincial Clearance includes a condition requiring archaeological monitoring of all excavations at site FjPj-166. This includes any excavation work associated with the construction access road. The Provincial conditions ensure that any uncovered historical resources will be documented and brought to the attention of the Province. On that basis, there should be no residual impacts on Historical Resources.

4.6 Summary Assessment

4.6.1 *Summary of Residual Impacts*

Five residual adverse impacts were identified after the application of mitigation measures. The assessment determined that during construction, even with mitigation, there will be adverse minor impacts to native vegetation, habitat connectivity during construction, the recreational pathway network, general park use and visual resources.

With the exception of some vegetation, these residual impacts will be eliminated very shortly after construction. Impacts associated with any removal of woody vegetation will be much longer-lasting, but not permanent, as forest restoration and planted trees will take time to mature.

4.6.2 *Monitoring Requirements*

The Province requires monitoring of excavation work within site FjPj-166, at the former Grierson Landfill.

4.6.3 *Resolution of Key Environmental Issues*

The following are brief answers to the questions initially posed in *Section 4.3*.

Will construction of the access route adversely impact slope stability on the north valley wall or river bank?

No. Project Co will be required to comply with all geotechnical and slope stability information and recommendations by Thurber Engineering for the design and construction and use of the portion of the proposed primary construction access road situated along the existing SUP. For the portion of the proposed primary construction access road situated along the existing maintenance access road (leading from Grierson Road), the City will undertake a geotechnical assessment of road upgrading in this area and develop recommendations required to ensure slope stability. LRT D and C will submit any geotechnical report to Transportation Services for review and sign-off. Project Co will be required to implement such recommendations. Should the City report recommend no clearing of native vegetation or re-grading, Project Co will be required to use the road in its current horizontal and vertical alignment.

Will the landfill present challenges to road stability or performance and lead to more disturbance?

No, not if Thurber Engineering (2014) recommendations and subsequent recommendations from the City's additional geotechnical assessment are incorporated into construction and operation of the proposed primary construction access road. These measures took into consideration the presence of the existing landfill. Project Co will be required to comply with all geotechnical and slope stability information and recommendations by both reports for the design and construction of the temporary construction access road through Louise McKinney Riverfront Park.

Do contaminated soils occur within the project component area?

Yes.

Could the project result in mobilization of contaminants or contaminated soils?

Unlikely. Project-wide mitigation measures developed for the Valley Line LRT project require Project Co to abide by all environmental laws and include specific protocols and other requirements to ensure suitable handling of all contaminated soils and no exacerbation of soil contamination within the park. All project-wide mitigation measures developed to date are now included in the Project Agreement and will be applied to any activities associated with the construction access road. In addition, the City is developing a Valley Line risk management strategy for soil and groundwater contamination in this area, and is consulting with the Province. Project Co will comply with any resulting provincial requirements.

Will construction of the access road lead to surface erosion?
Construction and operation of the proposed primary construction access road has the potential to interact with surface water from precipitation and snow melt. As identified in the 2013 EISA and carried forward into the Project Agreement, Project Co will be required to develop an EMS and an associated ECO Plan and ESC Plan. The ESC Plan will conform to the City of Edmonton Erosion and Sedimentation Control Guidelines and Erosion and Sedimentation Control Field Manual and must provide for measures commensurate with the sensitivities of the site conditions a location within the landscape.

Does contaminated groundwater occur within the project component area?
Yes.

Could construction access route activities result in mobilization of contaminants or contaminated groundwater?
Not likely. Project-wide mitigation measures developed for the Valley Line LRT project require Project Co to abide by all environmental laws and include specific protocols and other requirements to ensure suitable handling of contaminated groundwater and no exacerbation of contamination within the park. All project-wide mitigation measures developed to this end are now included in the Project Agreement and will be applied to any activities associated with the construction access road. In addition, the City is undertaking a groundwater monitoring program at the former Grierson Hill landfill in the vicinity of the Valley Line permanent infrastructure and will be developing a risk management strategy for soil and groundwater contamination and consulting with the Province. Project Co will have to comply with any resulting requirements.

Do construction access road activities have the potential to affect rare, threatened or endangered plants or plant communities?
No. No rare, threatened or endangered plants or plant communities are present within the project component area.

Will vegetation in recognized Natural Areas be affected?
Possibly. Such an impact would occur only if it is determined that the existing maintenance vehicle access road into LMRP would require widening/upgrading to support construction vehicle access. Clearing would be contingent on the results of the City's geotechnical assessment for the portion of the access route situated at the existing maintenance road. In a worst case scenario, this would result in the disturbance of up to approximately 1,036 m^2 (or approximately 1.5%) of Natural Area 056 RV. If Project Co determines that such a widening/upgrading required and if geotechnical assessments undertaken by the City support such works, Project Co will adhere to the requirements governing native forest restoration in the river valley noted in the Project Agreement for any clearing of the MM or PMM communities. Establishment of Manitoba maple will not be an acceptable part of restoration. All plans will be subject to approval by the City.

Will any special status wildlife species be affected by access road construction?
No. Both special status species within the potential to occur in the project area are highly mobile and wide ranging and can avoid the area during construction.

Will local pathway disruptions during construction activities be suitably mitigated for all users, including those availing themselves of wheelchair accessibility?
Yes. Numerous measures will be incorporated into the Project Agreement to mitigate effects on pathway use. In addition, the City has developed several other measures, such as provision of fully accessible routes.

Will access to River Valley Adventures/Urban Green Café or washrooms be disrupted as a result of the access road?
No. River Valley Adventures, the Urban Green Café and public washrooms at the Riverfront Plaza will remain accessible during project activities. It is anticipated, however, that closure of the nearby east-west SUP will result in a more limited access for Segway renters to the greater SUP network to the west.

Will construction activities interfere with park programming or special events?
No. Programmed uses in this part of the park include the annual Dragon Boat Festival and inaugural Edmonton 2015 Red Bull Crashed Ice event (with anticipated future events in 2017 and 2019), both of which have considerable spatial overlap with the construction access route. To mitigate the effects of this project component on these events, the City has developed event-specific mitigation measures to ensure that construction does not impact the accessibility and operation of these events in LMRP.

Will project activities occur in an area where the Province requires historical resources monitoring of subsurface construction activities?
Yes. There is some potential for the construction access road to affect historical artifacts in the Grierson Landfill, thus, the Provincial Clearance includes a condition requiring archaeological monitoring of all excavations at site FjPj-166. This includes any excavation work associated with the construction access road.

5.0 WEST PROJECT BOUNDARY MODIFICATIONS AT HMEP

5.1 Context

The proposed west project boundary modifications at Henrietta Muir Edwards Park (HMEP) are the result of further planning at a finer scale that better reflects the resources present. The changes protect the valued natural features present, better align with natural topography and better accommodate the previously approved removal of aging picnic area infrastructure that has been deemed to be of low value and available for demolition. The modifications involve exclusion of two small parcels, totaling approximately 1,677 m^2, from, the Project Area, thus reducing the effect of the project on the abandoned Mill Creek reach. The modifications also include the expansion of one area, totaling approximately 800 m^2, to fully include an aging picnic area that is no longer a desirable park feature. The expanded lands will be available for general construction activities. Post-construction, all lands disturbed in this area will be subject to native forest restoration efforts. Overall, the west project boundary modifications at HMEP represent a net reduction of approximately 877 m^2 in land disturbed by construction activities.

5.2 Assessment Methods

Valued Ecosystem Components

Several VECs were selected for this assessment, as newly affected lands supporting numerous resources are involved (Table 5.1).

Study Area

The study area for assessment of this project component is shown in Figure 2.1c. Because some lands affected by this project component were included in the 2013 EISA field work, specific studies undertaken for this assessment in 2014 were limited to reconnaissance-level site inspections on 20 June and 15 September 2014 and an examination of site-specific contours to assist in boundary delineation.

Table 5.1. Justification for the selection of VECs – West Project Boundary Modifications at HMEP

Valued Environmental Components	Potential for Additional or Unique Issues[1]	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Relevant Legislation/Bylaw/Policy
Valued Ecosystem Components							
Geology/Geomorphology	**Yes**			✓		✓	• Bylaw 7188
Soils	**Yes**			✓		✓	• Bylaw 7188 • Drainage Bylaw 16200
Hydrology Surface Water/ Groundwater	**Yes**			✓		✓	• Bylaw 7188 • Drainage Bylaw 16200 • Alberta *Water Act*
Fish and Fish Habitat	**No**						
Vegetation	**Yes**		✓	✓		✓	• Bylaw 7188 • Alberta *Weed Control Act*
Wildlife	**Yes**		✓	✓		✓	• Bylaw 7188 • Federal *Species at Risk Act* • Federal *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Habitat Connectivity	**Yes**		✓	✓		✓	• Bylaw 7188
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Residential Land Use	**No**						
Recreational Land Use	**Yes**		✓	✓		✓	• Bylaw 7188
Utilities	**Yes**		✓	✓	✓	✓	• Bylaw 7188
Worker and Public Safety	**No**						
Visual Resources	**Yes**		✓	✓		✓	• Bylaw 7188
Valued Historic Components							
Historical Resources	**No**						

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

5.3 Key Issues

Key issues were identified by: 1) examining the project component location, known conditions and potential project activities; 2) considering concerns raised by the public and city services departments; and 3) applying professional judgement. Following are the key issues identified in association with the west project boundary modifications at HMEP:

- **Will project activities impact the abandoned channel of Mill Creek?**
- **What changes to assessed vegetation impacts, identified in the 2013 EISA, will result from the proposed project boundary modifications?**
- **Will project activities adversely impact recreational infrastructure in the local area?**
- **Will project boundary modifications result in additional impacts to visual resources in the local area?**

5.4 Existing Conditions

5.4.1 Geology/Geomorphology and Soils

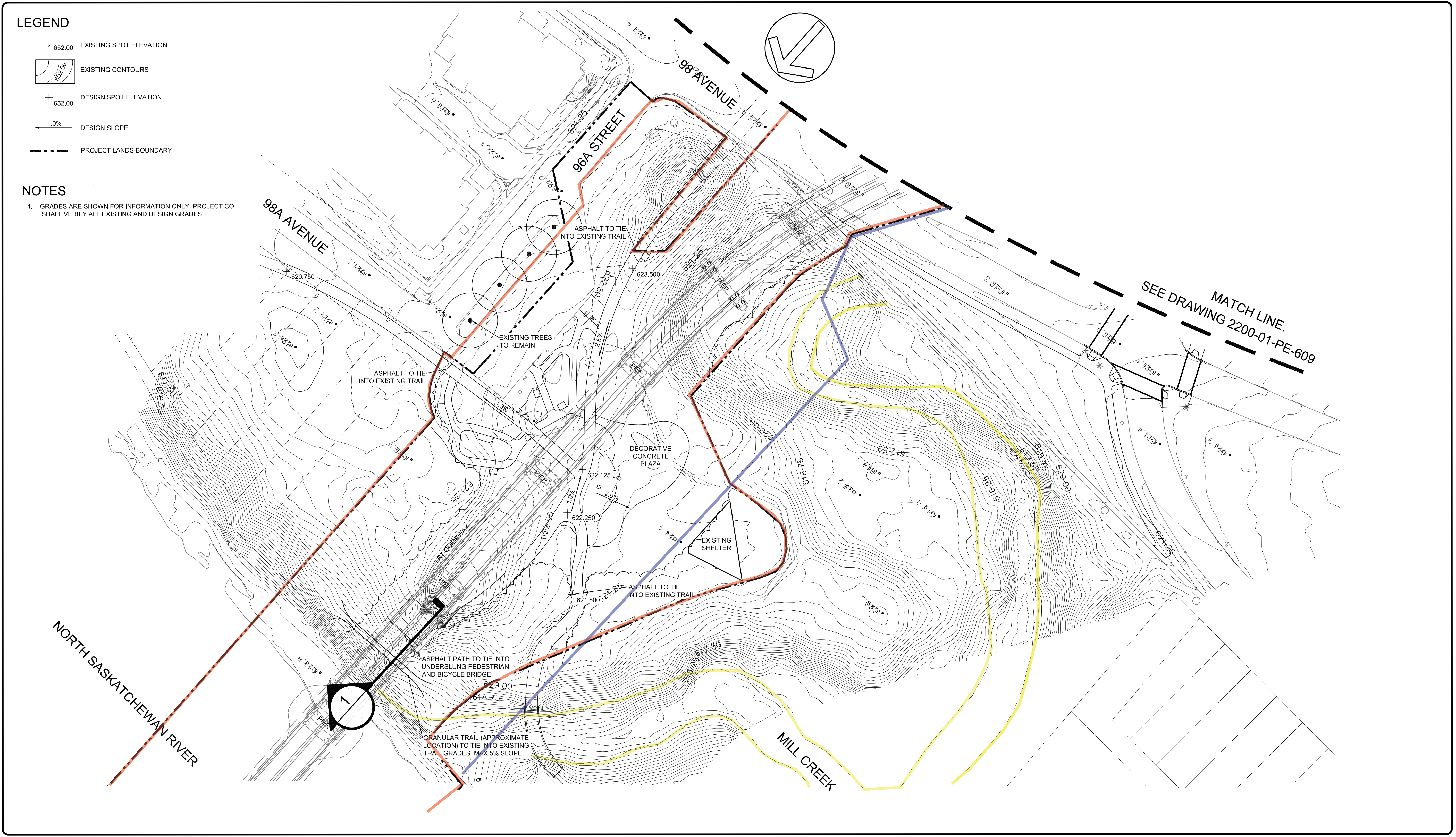
The Project Area situated in HMEP forms part of a wide, low-lying, relatively flat terrace along the south river bank. This project component is bounded on the west by an abandoned reach of Mill Creek and on the north by the bank of the NSR. No known slope stability issues have been documented for these lands by the numerous studies associated with this part of the river valley for the Valley Line project. The geology is well described in the 2103 EISA.

Lands to be removed from the Project Area support mature native forest, suggesting native soils with no recent history of disturbance. These lands slope to the west toward an abandoned reach of Mill Creek (Figure 5.1), and show some slight terracing. This reach of Mill Creek, north of 98 Avenue, was isolated from upstream reaches as a result of a full creek diversion in the 1960s and significant road development. Nevertheless, the abandoned channel remains evident and short sections intersect with these small parcels.

The picnic shelter area, to be added to the Project Area, is much flatter and borders steeper, creek-influenced topography. Development of the park amenities in the 1970s, as evidenced by park plaques, likely require some minor re-grading to flatten the area and assure positive drainage. The modified outer boundaries of this area were drawn with a view to excluding the steeper slopes leading to the creek.

No soil survey or environmental drilling was undertaken for these small areas, but a Phase I ESA undertaken for the Valley Line LRT (ConnectEd Transit Partnership 2013a) did not flag any known soil contamination issues within these particular areas.

*Adapted by Spencer Environmental from base information provided by CTP.



LEGEND

- 652.00 EXISTING SPOT ELEVATION
- EXISTING CONTOURS
- 652.00 DESIGN SPOT ELEVATION
- 1.0% DESIGN SLOPE
- PROJECT LANDS BOUNDARY

NOTES

1. GRADES ARE SHOWN FOR INFORMATION ONLY. PROJECT CO SHALL VERIFY ALL EXISTING AND DESIGN GRADES.

SMCKINNON / September 5, 2014 / V:\13300\13369_SE_W_LRT_PRELIM\02_CADD\20_DRAFTING\202_LANDSCAPE\00-PROJECT_OFFICE_FILES\01 STAGE 1\RIVER VALLEY PARKS PE\HENRIETTA MUIR EDWARDS\SEW-2200-01-AL-PE-602.DWG

no.	description	date	appd
A	ISSUED FOR 70%	22-08-14	J.S.

issue data

no.	description	date	checked

revisions

ISL Engineering and Land Services
Consultant

A1 bar scale 1:500 0 5 15 25m

drawn by K.W.
designed by L.K.
checked by L.K.
date 22-11-13

permit

seal
The Alberta Association of Landscape Architects
22/08/2014
Jeff Schurek

consultant job no 13369
consultant reviewed by J. SCHUREK

AECOM
Prime Consultant

THE CITY OF Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald
ISL Engineering and Land Services
DIALOG
gec architecture

PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by M. PERRY

drawing title
RIVER VALLEY LANDSCAPE DRAWINGS
HENRIETTA MUIR EDWARDS PARK
GRADING PLAN

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2200-01-AL-PE-602
REV 0
SHT .

—	Lands (2013), approx.
—	Lands (14Jan15), approx.
—	Mill Creek Channel

Figure 5.1 Boundary Changes to Exclude Mill Creek

5.4.2 *Vegetation*

Lands involved in the west project boundary modifications at HMEP support manicured and native vegetation (Figure 5.2). Lands to be added to the Project Area are largely manicured and include lawn, large planted trees, hard surfaces (paving stones) and passive recreational infrastructure including a picnic shelter, benches and tables. Within manicured areas, site reconnaissance indicated that in the small parcel to be expanded, vegetation is characterized by manicured lawn with large mature planted poplars interspersed throughout (Plate 5.1). Several planted choke cherry (*Prunus virginiana*) trees are also located in this area (Plate 5.2). Numerous mature Manitoba maple are situated on the edge of the proposed boundary expansion, adjacent to terrain influenced by Mill Creek (Plate 5.3).

Lands to be removed from the Project Area support native balsam poplar communities, surveyed in July 2012. Balsam poplar was the dominant community tree species, with Manitoba maple along the stand edges, adjacent to lawn. In 2012, the shrub layer consisted of red-osier dogwood, European mountain-ash (*Sorbus acuparia*), and snowberry (*Symphoricarpos alba*), while common understory species included wild lily-of-the-valley (*Maianthemum canadense*), Canada anemone (*Anemone canadensis*), and wild sarsaparilla (*Aralia nudicaulis*) and there was no evidence of disturbance in 2014. The northernmost area is immediately adjacent to the south bank of the NSR and the east bank of abandoned Mill Creek (Plate 5.4). The abandoned creek channel supports little vegetation, as it is still influenced by flowing water during periods of snowmelt and precipitation. The southern parcel also contains a section of abandoned Mill Creek, similarly scarcely vegetated (Plate 5.5).

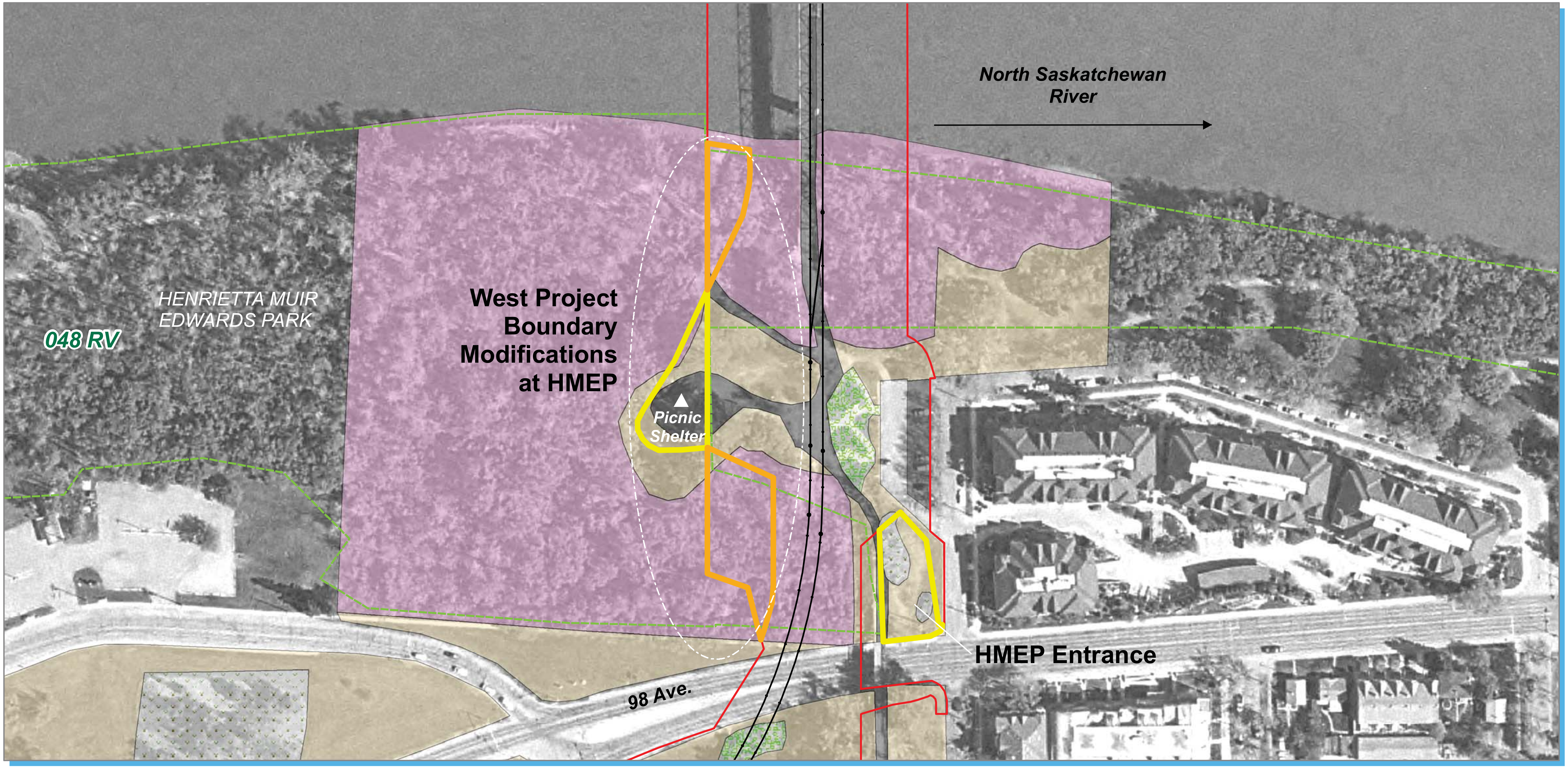
Plate 5.1. HMEP west project boundary modifications looking west; manicured lawn and mature poplars dominate this area, looking west (Sept. 2014).

Plate 5.2. HMEP west project boundary modifications looking east; several planted choke cherry are situated in this area, looking east (Sept. 2014).

Plate 5.3. HMEP west project boundary modifications looking southwest; Manitoba maple borders the west edge of the project component area and transitions to balsam poplar forest (Sept. 2014).

Plate 5.4. The northernmost area is immediately adjacent to the east bank of abandoned Mill Creek (June 2013).

Plate 5.5. The southern parcel also contains a section of abandoned Mill Creek, with a sparse understory (April 2013).



Legend

Additional Lands

🟨 Undertaken by Project Co

Reduced Lands

🟧 Areas Removed from Project Lands

— Project Area

— Valley Line LRT Alignment (Reference Design)

⬜ Bylaw 7188 Boundary

🟩 City of Edmonton River Valley Natural Areas (2010)

Natural Communities

🟪 Balsam Poplar (P1)

Manicured Communities

🟨 Lawn

▨ Garden

▨ Planted Bed

⬛ Pathway/Structure

N

0 25 50 100 Meters

1:1,400

Figure 5.2 HMEP West Project Boundary Modifications, Existing Plant Communities

City of Edmonton LRT Valley Line - Stage 1
EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

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5.4.3 *Wildlife Habitat and Connectivity*

The wildlife habitat potential of the Project Area to be expanded is limited by its small size, hard surface and frequent human traffic, but would still provide good canopy habitat for birds. The vast majority of lands within the parcels to be excluded from the Project Area are dominated by a native vegetation (balsam poplar forest community), providing excellent breeding habitat for songbirds. This forested area likely also provides some cover and foraging habitat for small and medium-sized mammals. Larger mammals such as coyote and deer and smaller mammals and birds, almost certainly periodically pass through the area while moving through the NSRV. Coyote have recently been documented moving through the project component area (Murray and Cassidy St Clair, unpublished data). Connectivity of lands in this area was assessed in the 2013 ESIA and was identified as part of an important riparian wildlife corridor within the City's central biological corridor.

5.4.4 *Recreational Land Use*

Lands involved in the west project boundary modifications at HMEP include a formerly-important picnic area whose amenities include a large picnic shelter, several benches, picnic tables, garbage cans and one drinking fountain (Plates 5.6, 5.7). A commemorative sign is installed at the entrance to the picnic shelter area. The picnic shelter and hard surfaces (paving stones) appear to be in disrepair and public fireplaces installed as part of the picnic shelter structure have been boarded over (Plate 5.8). According to Community Services, the area is not a bookable space and has no heritage value (S. Buchanan, *pers. comm.*). All of these facilities are situated in the Project Area to be expanded. There are no recreational facilities in the two areas proposed to be excluded from the Project Area.

Plate 5.6. Picnic Shelter situated in the proposed changes to the west boundary of the project area, looking southwest (Sept. 2014).

Plate 5.7. Benches, picnic tables, garbage cans and a drinking fountain are also situated in this area (Sept. 2014).

Plate 5.8. The picnic shelter and hard surface appear to be in disrepair and public fireplaces installed as part of the picnic shelter structure have been boarded over (April 2013).

5.4.5 *Utilities*

The 2013 EISA did not identify any major utility lines within the boundaries of this project component. It is anticipated, however, that subsurface electric cables for light standards and a water line for the existing drinking fountain are situated in the manicured portion of the park that will be added to the Project Area. Utilities will be confirmed prior to initiation of work in the area.

5.4.6 *Visual Resources*

All lands within the HMEP west project boundary modifications provide minimal views of the NSR and the north bank of the NSR, including downtown and LMRP, as their views come from a lower angle and are largely screened by forest vegetation, even in winter. Lands to be removed from the Project Area are naturally vegetated and, thus, contribute to visual resources for the NSRV as a “Ribbon of Green”. For lands to be excluded from the Project Area, the picnic shelter area is highly visible to users of the main spine trail to the Cloverdale Pedestrian Bridge. Nearby residents living at the west end of the condominium complex along 96A Street, with western exposures look out into this park area.

5.5 Potential Impacts and Mitigation Measures

5.5.1 *Soils and Geotechnical Stability*

5.5.1.1 Erosion and Sedimentation of the Abandoned Mill Creek Channel

Impact and Mitigation Measures

Lands to be added to the Project Area are situated adjacent to the east channel bank of abandoned Mill Creek. General construction activities within this area, assuming cleared vegetation, have the potential to result in some soil erosion and therefore also have potential to result in release of sediment to the abandoned creek channel. Because the channel carries water intermittently, such sediments could then flow into the NSR. If realized, sedimentation would be rated as an adverse, minor short or long-term and predictable impact.

Any construction activities undertaken within these lands in west HMEP will be subject to the contractual obligations of the Valley Line LRT project. For any works within the Project Area, Project Co will be required to develop an EMS and an associated ECO Plan and ESC Plan. The ESC Plan will conform to the City of Edmonton *Erosion and Sedimentation Control Guidelines* and *Erosion and Sedimentation Control Field Manual* and must provide for measures commensurate with the sensitivities of the site conditions a location within the landscape. Effectively developing and implementing these programs will ensure that impacts associated with erosion and sedimentation are reduced to negligible.

Exclusion of the two parcels from the Project Area that contain sections of abandoned Mill Creek has the effect of mitigating impacts on geomorphology and soils. With the exception of a very small area at the east half of the former confluence of the creek and the river (see Figure 5.1), there will be no need to fill or re-contour Mill Creek channel to allow for working areas or transit nor to get permission from Public Lands, the bed and shore owner. This will greatly reduce potential for sediments to be carried into the NSR. To protect the small intersection with the creek channel at the river confluence, Project Co will be prohibited from re-contouring the bed and shore and required to protect those existing contours.

5.5.2 *Vegetation*

5.5.2.1 Native Vegetation

Impact and Mitigation Measures

The west project boundary modifications at HMEP include a reduction of Lands dominated by native vegetation, totaling approximately 1,632 m^2. Areas to be added to the Project Area, and allowed to be cleared, include a very small area of native vegetation, totaling approximately 66 m^2. These Project Area modifications represent an overall reduction of approximately 1,566 m^2 of disturbance to native vegetation in the NSRV. Additionally, any lands disturbed within the expanded Project Area will be subject to native forest restoration efforts (Figure 2.2). Such lands will include all manicured and hard surfaces within this project component, totaling approximately 778 m^2. Based on these considerations, on balance, this boundary modification represents an overall reduction in native vegetation loss to the project and replacement of non-native forest to a native forest. This replacement will in the long-term result in a positive, minor, permanent and predictable vegetation impact.

5.5.2.2 Manicured Vegetation

Impact and Mitigation Measures

The west project boundary modifications at HMEP include approximately 351 m^2 of area covered by manicured vegetation that will be added to the Project Area and allowed to be cleared. Modifications will also include a very small area of manicured vegetation to be removed from the project area, totaling approximately 36 m^2. These Lands modifications represent an overall addition of approximately 315 m^2 of manicured vegetation that will be impacted as part of construction activities.

Much of area to be added to the Project Area is covered in paving stones (Plate 5.4), thus, no impacts to manicured vegetation was calculated for such areas. The 351 m^2 of manicured vegetation that will be added to the Project Area includes manicured lawn with numerous mature planted poplars and some planted choke cherry. These trees and lawns will be removed for construction. The loss of the trees will be addressed through the City's Corporate Tree Management Policy. Measures to ensure compliance with this policy are already included in the Project Agreement for the entire Project Area, which will include this project component change.

Post-construction, all lands disturbed as part of this project component will be subject to native forest restoration efforts, in a manner similar to that already applied to other affected forested areas of HMEP, and as shown on the 70% Landscape Drawings (Figure

2.2). Within this area, a native balsam poplar riparian forest will be restored on lands previously dominated by manicured vegetation. While the permanent loss of manicured vegetation would typically be considered an adverse impact, its long-term replacement with a native forest community negates such a rating.

5.5.3 *Wildlife Habitat and Connectivity*

The west project boundary modifications at HMEP will result in an overall reduction in adversely affected wildlife habitat, in the amount of approximately 1,566 m^2, as it reduces the loss of native forest in the NSRV. Additionally, long-term native forest restoration efforts will result in the addition of approximately 778 m^2 of native balsam poplar riparian forest habitat to the local area. Based on these considerations, no new or unique impacts to wildlife habitat and connectivity have been identified, and the earlier assessment of loss in this area has been mitigated.

5.5.4 *Recreational Land Use*

Work associated with the west project boundary modifications at HMEP will disturb manicured park areas and an existing picnic area.

5.5.4.1 Loss of Recreational Infrastructure

Impact and Mitigation Measures

The expansion of the Project Area to accommodate construction activities will result in the permanent removal of the HMEP picnic shelter, several benches, picnic tables, garbage cans and one drinking fountain. The loss of this picnic area has been sanctioned by Community Services and was assessed in the 2013 EISA and rated as a negligible impact because of the derelict nature of the area. Post-construction, all lands disturbed within this parcel will be subject to native forest restoration efforts; no recreational infrastructure will be re-installed in this area.

The net result in the expanded Project Area will be a more pleasing, regenerating natural environment. The open park space to the immediate east will be enhanced according to the 70% Landscape Drawing (Figure 2.2). Construction activity in this area will not result in additional temporary or permanent disruptions to the pathway network in the local area, thus, no new or unique impacts have been identified.

5.5.5 *Utilities*

Removal of the picnic shelter and associated recreational infrastructure by Project Co will include decommissioning or removal of associated power and water connections. Any such utility works will be subject to the contractual obligations of the Valley Line LRT project. Based on these considerations, no new or unique impacts as a result of utility removal have been identified.

5.5.6 Visual Resources

The west project boundary modifications at HMEP will result in the retention of approximately 1,566 m^2 of naturally vegetated lands within the NSRV and the removal of approximately 315 m^2 of manicured park lands and numerous, leafy mature planted trees. Although disturbances to this specific area of manicured park areas may be visible to nearby residents situated at the west end of the condominium complex along 96A Street with western exposures, this impact was addressed in the 2013 EISA, as part of the general construction activity visible in this area.

On a longer term basis and from more distant vantage points, the reduction of disturbance to native vegetation will also reduce the overall impact of the project to visual resources in HMEP. This project change does not, therefore, represent any short-term new or unique impacts to visual resources during construction activities. As works will ultimately result in increased natural vegetation in the NSRV "Ribbon of Green", long-term impacts related to this boundary change are considered to be positive and minor.

5.6 Summary Assessment

5.6.1 Summary of Residual Impacts

This assessment identified no residual adverse impacts or outstanding issues and two positive impacts. Positive residual impacts were related to overall improvements to visual resources and the net small increase in native balsam poplar forest . Furthermore, the proposed reduction of the Project Area would serve to avoid disturbance native forest and the abandoned Mill Creek channel.

5.6.2 Monitoring Requirements

There are no monitoring requirements unique to this project component. Monitoring requirements specific to erosion and sediment control, general construction activities and the native forest restoration efforts were committed to in the 2013 EISA and are now well described in the general Project Agreement.

5.6.3 Resolution of Key Environmental Issues

The following are brief answers to the questions initially posed in *Section 5.3*.

Will works impact the abandoned channel of Mill Creek?

No. Construction activities will be undertaken immediately adjacent to the abandoned east channel bank of Mill Creek, but not within the creek bed itself. Any construction activities undertaken within these lands in west HMEP will be subject to the contractual obligations of the Valley Line LRT project. For all Lands, Project Co will be required to develop an ECO Plan and ESC Plan. The ESC Plan will conform to the City of Edmonton *Erosion and Sedimentation Control Guidelines* and *Erosion and Sedimentation Control Field Manual* and must provide for measures commensurate with the sensitivities of the site conditions at the location within the larger landscape.

What changes to assessed vegetation impacts, identified in the 2013 EISA, will result from the proposed project boundary modifications?

Modifications to the project boundaries will result in the retention of approximately 1,566 m^2 of natural vegetation and the removal of approximately 351 m^2 of manicured vegetation, including some planted mature trees. Additionally, any lands disturbed as part of this project component will be subject to native forest restoration efforts that will result in the creation of approximately 778 m^2 of native balsam poplar riparian forest.

Will project activities adversely impact recreational infrastructure in the local area?

Yes. The expansion of lands to accommodate construction activities will result in the permanent removal of the HMEP picnic shelter, several benches, picnic tables, garbage cans and one drinking fountain. The loss of these picnic facilities has been sanctioned by Community Services and was assessed in the 2013 EISA and rated as a negligible impact because of the derelict nature of the area. No recreational infrastructure will be re-installed in this area. Any lands disturbed as part of this project component will be subject to native forest restoration efforts, the net result of which will be a more pleasing, regenerating natural environment.

Will project boundary modifications impact visual resources in the local area?

Yes. Although disturbances to manicured park areas may be visible to nearby residents situated at the west end of the condominium complex along 96A Street with western exposures, this impact was addressed in the 2013 EISA, as part of the general construction activity visible in this area. On a longer term basis and from more distant vantage points, the reduction of disturbance to native vegetation will reduce the overall impact to visual resources in HMEP. As works will ultimately result in increased natural vegetation in the NSRV "Ribbon of Green", long-term impacts related to this boundary change are considered to be positive and minor.

6.0 HMEP ENTRANCE

6.1 Context

Adding the small parcel at Henrietta Muir Edwards Park (HMEP) entrance, totaling approximately 763 m^2 in area, represents a minimal addition to the overall river valley project area for the Valley Line LRT. This small project component is bordered by the previously approved Project Area to the north, east and west, with 98 Avenue situated to the south (Figure 2.1c). This area consists of manicured and un-manicured lawn, one manicured planted bed and one naturalized planted bed which includes planted trees. These lands will be available to Project Co for general construction activities and may be used to access or egress the Lands north to the river.

6.2 Assessment Methods

Table 6.1 details the few VECs selected for this project component.

The spatial boundaries, or study area, for this assessment are shown in Figure 2.1c. Although this area was not included in the 2013 EISA, all surrounding lands were assessed. This fact, combined with the small area involved and the manicured nature of the lands, meant that detailed field studies were not warranted for the 2014 assessment. Investigations were limited to reconnaissance-level site inspections on 20 June and 15 September 2014 which included characterization of vegetation at an appropriate scale and documentation with photographs. Previous studies relied on for site-specific information includes a Phase I ESA covering all Valley Line river valley lands (ConnectEd Transit Partnership 2013a).

Table 6.1. Justification for the selection of VECs – HMEP Entrance

Valued Environmental Components	Potential for Additional or Unique Issues[1]	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Relevant Legislation/Bylaw/Policy
Valued Ecosystem Components							
Soils/Geotechnical	**Yes**			✓		✓	• Bylaw 7188 • Drainage Bylaw 16200
Hydrology Surface Water/ Groundwater	**No**						
Fish and Fish Habitat	**No**						
Vegetation and Wildlife	**Yes**		✓	✓		✓	• Bylaw 7188 • Federal *Species at Risk Act* • Alberta *Weed Control Act* • Federal *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Habitat Connectivity	**No**						
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Residential Land Use	**No**						
Recreational Land Use	**Yes**		✓	✓		✓	• Bylaw 7188
Utilities	**Yes**		✓	✓	✓	✓	• Bylaw 7188
Worker and Public Safety	**No**						
Visual Resources	**Yes**		✓	✓		✓	• Bylaw 7188
Valued Historic Components							
Historical Resources	**No**						

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

6.3 Key Issues

Key issues were identified by: 1) examining the project component location, known conditions and potential project activities; 2) considering concerns raised by the public and city services departments; and 3) applying professional judgement. Following are the key issues identified in association with the small parcel at HMEP entrance:

- **Will re-grading activities potentially occur in this area? If so, could it have adverse impacts on the 98 Avenue Pedestrian Bridge or lead to erosion?**

- **Will additional manicured vegetation or planted trees require removal?**
- **Will works result in disruptions to the local pathway network?**
- **Will the entrance sign to HMEP be impacted by construction activities?**
- **Will works adversely impact visual resources in the local area?**

6.4 Existing Conditions by VEC

6.4.1 *Soils and Geotechnical Stability*

Soils in this parcel have likely been subject to past disturbance associated with the construction of the existing 98 Avenue Pedestrian Bridge and associated landscaping. The soils present appear to be fill material. A constructed embankment associated with the bridge abutment occupies much of the area (Plate 6.1). The Phase 1 ESA undertaken for the Valley Line LRT did not identify issues pertaining to soil contamination or slope stability for these lands (ConnectEd Transit Partnership 2013a). Geotechnical studies have not been undertaken as there is no intended infrastructure in this area.

6.4.2 *Vegetation & Wildlife Habitat*

Vegetation within the proposed parcel includes manicured and non-manicured areas (Figure 5.2). Two planted beds are present: the first, in the southeast corner of the area, is manicured and includes junipers and pine shrubs (Plate 6.2), the second, in the north ends of the area, has naturalized and includes mature poplars with Manitoba maple shrubs interspersed throughout (Plate 6.3). Lands immediately around the planted beds consist of manicured lawns. Immediately west of the manicured planted bed is the constructed embankment associated with the 98 Avenue Pedestrian Bridge. No mowing appears to be conducted in this area likely due to the steep slope; vegetation consists of a mix of grass and weedy species with some small shrub saplings (Plate 6.4).

The wildlife habitat potential of this project component is low due to its small size, largely manicured nature, and adjacency to frequent anthropogenic disturbance. Manicured areas may provide foraging habitat for highly urban-adapted ground-foraging species (e.g., deer mice, black-billed magpies). The shrubs and poplar trees may provide limited breeding habitat for some disturbance-tolerant bird species, but are too small to provide an entire breeding territory for most species. Urban-adapted mammal species may use the lands as a stepping stone through the area on occasion.

Plate 6.1: Bridge abutment fill in the parcel to be added to the Project Area, looking northeast (June 2014).

Plate 6.2. HMEP near the north end of the 98 Avenue Pedestrian Bridge looking northeast; planted bed with park entrance sign, looking southwest (Sept 2014).

Plate 6.3. HMEP entrance looking northeast; mature poplar and Manitoba maple stand, (Sept. 2104).

Plate 6.4. HMEP entrance looking northeast; unmowed grasses on the pedestrian bridge embankment (Sept. 2014).

6.4.3 *Residential Land Use*

This proposed parcel, at the north end of the 98 Avenue Pedestrian Bridge, is located directly across the road from a condominium complex, situated along 96A Street that forms part of the Cloverdale neighbourhood.

6.4.4 *Recreational Land Use*

The proposed parcel is the landscaped entrance to HMEP and is signed as such (Plate 6.1); however no active recreational use occurs on the parcel. There is no trail access through the parcel to the 98 Ave Pedestrian Bridge; access to the bridge is from the parking lot and trails further north. The pedestrian bridge is an important recreational facility but it is excluded from this parcel and will remain open to the public during construction activities associated with the Valley Line LRT.

6.4.5 *Visual Resources*

Lands in this parcel provide no views of the NSR, or downtown across the river, as a result of low elevation and the screening provided by the bridge embankment and mature trees. The 98 Avenue Pedestrian Bridge is visible to the west. Residents of the condominium complex across 96A Street with western exposures look out directly on to this park entrance, including the pedestrian bridge. Motorists on 98 Avenue also have clear views of this area.

6.4.6 *Utilities*

Utilities have not been fully identified; however, this work is in progress. One above-surface power line and one light standard for 98 Avenue are situated on the southern edge of the project component boundary and a buried transmission line lies along the north edge of 98 Avenue.

6.5 Potential Impacts and Mitigation Measures

6.5.1 *Soils*

Impacts to soils resulting from construction activities in this parcel should be no different from impacts to soil resources in manicured areas further north in the park. If Project Co chooses to use the parcel for construction, soils are expected to be affected. In the most extreme scenario, Project Co would elect to re-grade this parcel to allow for a wider array of uses, shoring up the bridge abutment in a new way. This would be allowed, provided that measures were employed to protect the integrity of the bridge. The general Project Agreement clauses require Project Co to protect existing City infrastructure and to repair in the event of accidental damage. In this way, the infrastructure integrity will be achieved. Project-wide mitigation measures already detailed in the 2013 EISA and developed in the Project Agreement, are designed to minimize erosion, topsoil/subsoil mixing, compaction, contamination of or other degradation to soil resources will also be applied to any activities within this project component area. Thus, no new mitigation measures are required and the overall impact on soils, following mitigation, should be negligible.

6.5.2 *Vegetation, Wildlife Habitat and Connectivity*

6.5.2.1 Loss of Manicured Vegetation and Planted Beds/Trees

Impacts and Mitigation Measures

Construction activity in this parcel may result in the removal of some or all of the vegetation within the parcel. Vegetation potentially impacted includes two planted beds including several mature balsam poplars and Manitoba maple shrubs, in a naturalized bed and manicured and un-manicured lawn. If all of the parcel were disturbed, approximately 474 m^2 of lawn and 228 m^2 of planted beds would be disturbed, totaling approximately 702 m^2.

Any removal of trees within this project component will be subject to the City's Corporate Tree Management Policy and all contractual obligations already developed for all Project Works. Post-construction, any areas disturbed within this project component will be reclaimed through landscaping, as identified in the Project Agreement. This will include replacement of the planted bed and trees in a new arrangement but roughly the same location. Such landscaping would be conducted as part of the overall planned landscaping in HMEP. Based on these considerations, long-term impacts to vegetation are considered to be negligible.

6.5.3 *Recreational Land Use*

The addition of this parcel to the Project Area is required to provide flexibility for Project Co with respect to required continuous pedestrian access to the north terminus of the 98 Avenue Pedestrian Bridge, for the duration of the construction period. To realize this, Project Co will likely create one or more temporary routes to the bridge through HMEP. Any change in access to the north end of the bridge, including through this parcel will be subject to the SUP/Pathway closure and detour plan that Project Co will be required to develop as part of the Valley Line LRT. Based on these considerations, no additional or unique impacts to the pathway network have been identified as part of this project component.

6.5.3.1 Temporary Removal of HMEP Entrance Sign

Impacts and Mitigation Measures

The entrance sign to HMEP, situated within the planted bed, will require temporary removal in support of construction activities within the project component area. Prior to the initiation of construction, the City has committed to removing the above-ground portion of the sign. Project Co will then be responsible for removing and replacing the sign base. The original entrance sign to HMEP would then be reinstalled by the City on the new base. Project Co will notify the City at least 90 days prior to the planned removal of the sign base to permit adequate time for the City to remove the sign. Implementation of these measures will ensure that any long-term impacts will be mitigated and, therefore, negligible. The short-term loss of a park entrance sign is considered be negligible given the construction that will be occurring in this area of the park and the temporary unavailability of the trailhead parking lot.

6.5.4 *Visual Resources*

Impacts and Mitigation Measures

Any activities to be undertaken in this small (approximately 763 m^2) parcel will be highly visible to motorist and local residents. The Project Agreement contains conditions around visual screening of works in the river valley. The City will include this area in their review of areas to be adequately screened during construction to prevent unmitigated, chronic exposure to active construction. Post-construction, any areas disturbed within this project component will be reclaimed through landscaping. Project Co will be required to design and install a replacement bed slightly larger in area than the existing bed. The bed will be in the same general location and will accommodate the park sign and some trees. In the long-term, residents and motorists will have a view similar to existing views. Considering this, the long-term residual impacts to visual resources is considered to be negligible.

6.5.5 *Utilities*

No utility removals or relocations are currently planned as part of the work in the lands at the HMEP entrance. Project Co. will, however, be required to protect all existing utilities during construction activities. No additional or unique impacts to utilities have been identified.

6.6 Summary Assessment

6.6.1 *Summary of Residual Impacts*

This assessment identified no residual impacts or outstanding issues.

6.6.2 *Monitoring Requirements*

No monitoring requirements unique to this project component will be required. Monitoring requirements specific to erosion and sediment control, general construction activities and landscaping are defined through the general Project Agreement.

6.6.3 *Resolution of Key Environmental Issues*

The following are brief answers to the questions initially posed in *Section 6.3*.

Will re-grading activities potentially occur in this area? If so, could it have adverse impacts on the 98 Avenue Pedestrian Bridge or lead to erosion?

In the most extreme scenario for this project component, Project Co would elect to re-grade this parcel to allow for a wider array of uses, shoring up the bridge abutment in a new way. The general Project Agreement clauses require Project Co to protect existing City infrastructure and to repair in the event of accidental damage. In this way, the infrastructure integrity will be achieved. Project-wide mitigation measures already approved in the 2013 EISA and designed to minimize erosion, topsoil/subsoil mixing, compaction, contamination of or other degradation to soil resources will also be applied to any activities within this project component area.

Will additional manicured vegetation or planted trees require removal?

Yes. Construction activity in this parcel may result in the removal of some or all of the vegetation within the parcel. If all of the parcel were disturbed, approximately 474 m^2 of lawn and 228 m^2 of planted beds would be disturbed, totaling approximately 702 m^2. Post-construction, any areas disturbed within this project component will be reclaimed through landscaping, with specific requirements made of Project Co. This will include replacement of the planted bed and lost trees. Therefore, in the long-term all lost resources will be replaced.

Will works result in disruptions to the local pathway network?

No. Work associated with this project component is required to provide flexibility for Project Co to provide the required continuous pedestrian access to the 98 Avenue Pedestrian Bridge for the duration of the construction period.

Will the entrance sign to HMEP be impacted by construction activities?

Yes. The entrance sign will be temporarily removed by the City prior to construction activities in the project area. Project Co would then be responsible for removing, and ultimately reinstalling, the sign base as part of post-construction landscaping. The City would then reinstall the sign on the new base.

Will works adversely impact visual resources in the local area?

Yes. Any activities to be undertaken in this small (approximately 763 m^2) area will be highly visible to motorist and a few local residents. The City will require that this area be adequately screened during construction to prevent unmitigated chronic exposure to active construction. Post-construction, any areas disturbed within this project component will be reclaimed through landscaping. This will include replacement of the planted bed and trees such that the end result will be similar to present landscaping.

7.0 RETAINING WALL GROUND ANCHORS

7.1 Context

Retaining walls are required in the vicinity of the Muttart Stop and along the portal access road and, at these two locations, ground anchors are among the options available to Project Co for retaining wall stabilization. The areas where anchors may potentially be used and the potential subsurface extent are coarsely shown in (Figure 2.1b and 2.1c). Anchors would be installed by drilling into adjacent lands and will extend down and away from the wall through the subsurface at an angle. There would be no surface disturbance in the lands shown in yellow stipling outside the Project Area and anchor use will be limited to lands owned by the City.

7.2 Assessment Methods

Valued Ecosystem Components

Considering that the need for retaining walls and some form of support was identified in the 2013 EISA, and the limited activities that are required in support of the installation of ground anchors, VECs selected for this project component are few (Table 7.1).

Study Area

The study areas, for this assessment are shown in yellow in Figure 2.1b and 2.1c. As surface disturbance is not involved, no field investigations were required.

Table 7.1. Justification for the selection of VECs – Retaining wall ground anchors

Valued Environmental Components	Potential for Additional or Unique Issues[1]	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Relevant Legislation/Bylaw/Policy
Valued Ecosystem Components							
Geology/Geomorphology	**Yes**			✓		✓	• Bylaw 7188
Soils	**No**						
Hydrology Surface Water/ Groundwater	**No**						
Fish and Fish Habitat	**No**						
Vegetation	**No**						
Wildlife	**No**						
Habitat Connectivity	**No**						
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Residential Land Use	**Yes**			✓		✓	• Bylaw 7188
Recreational Land Use	**No**						
Utilities	**No**						
Worker and Public Safety	**No**						
Visual Resources	**No**						
Valued Historic Components							
Historical Resources	**No**						

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

7.3 Key Issues

Key issues were identified by: 1) examining the project component location, known conditions and potential project activities; 2) considering concerns raised by the public and city services departments; and 3) applying professional judgement. Following are the key issues identified in association with retaining wall ground anchors:

- **Will subsurface works adversely impact slope stability?**
- **Will local residents be adversely affected by anchor installation?**

7.4 Existing Conditions

7.4.1 Geomorphology and Geotechnical Stability

As this part of the river valley has a history of slope instability and fill placement, any subsurface works should be premised with geotechnical investigations to ensure local and global slope stability and retaining wall integrity. Thurber Engineering has indicated that for ground anchors to be effective, they should be installed into competent soil or bedrock beyond any potential slip surfaces. No site-specific studies have been undertaken to date but these are planned.

7.4.2 Residential Land Use

There are no residences in the immediate vicinity of the retaining walls expected to be installed at Muttart Stop. Several Riverdale residences border LMRP in the vicinity of the walls anticipated to be installed along the portal access road and, in one point location, the private property boundary abuts the park boundary and the Project Area boundary, as reflected by the “notch” shown in the boundary in Figure 2.1b.

7.5 Potential Impacts and Mitigation Measures

7.5.1 Geomorphology and Geotechnical Stability

Prior to the installation of the retaining walls Project Co will undertake a detailed site-specific geotechnical investigation and assessment for retaining walls and associated support methods, this will include an analysis of ground anchor installation if they wish to use them. The report will be submitted to the City for approval and all approved recommendations will be implemented.

7.5.2 Residential Land Use

7.5.2.1 Impacts to Local Residents during Construction Activities

Impacts and Mitigation Measures

Several Riverdale residences bordering east LMRP are situated immediately upslope from the planned retaining wall and potentially associated ground anchors. Anchor installation will respect private property boundaries and the Project Agreement will restrict anchors to beneath City-owned lands. Anchor installation can be achieved using several techniques, at least one of which, pounding, can be a significant, temporary source of noise. To reduce potential for noise disturbance to local residents at both locations, the Project Agreement will specify installation by drilling. Drilling is not anticipated to generate noise levels more noticeable than the general construction activities. Based on these considerations, ground anchors are not anticipated to worsen impacts on residents or residences any more than general construction noise will.

7.6 Summary Assessment

7.6.1 Summary of Residual Impacts

This assessment identified no residual impacts or outstanding issues.

7.6.2 *Monitoring Requirements*

No monitoring requirements unique to this project component will be required. Monitoring requirements specific to noise and general construction activities are already defined in the general Project Agreement.

7.6.3 *Resolution of Key Environmental Issues*

The following are brief answers to the questions initially posed for this project component

Will ground anchors adversely impact slope stability?
No. Project Co will undertake geotechnical investigations prior to retaining wall installation and will only install ground anchors if they will be effective and will have no adverse impact on slope stability.

Will local residents be adversely affected by anchor installation?
Unlikely. Construction activities will be undertaken in accordance with the *Community Standards Bylaw* and to reduce potential for noise disturbance to local residents, the Project Agreement will specify ground anchor installation by drilling at both locations. Drilling is not anticipated to generate noise levels more noticeable than that from general construction activities. Anchors will not extend underneath privately-held lands.

8.0 SKI CLUB INFRASTRUCTURE RELOCATION

8.1 Context

The extension of the Project Area in this location, as shown in Figure 2.1d, totals approximately 362 m^2. The proposed work for this project component is part of the mitigation for impacts to Edmonton Ski Club facilities associated with widening the Connors Road corridor. The proposed extension of lands is required to mitigate effects on the T-Bar run, specifically to accommodate re-grading fora new T-bar landing area. The proposed work involves removal of existing ski club infrastructure (by the club), re-grading the extended parcel (by Project Co.) and reinstallation of equipment (by the club) on those lands. Lands within this parcel will only be used for purposes of mitigating ski club impacts and not for general construction purposes.

Plate 8.1. Sloping terrain of existing T-bar run to be re-graded. (Jan. 2015).

8.2 Assessment Methods

VECs selected for this assessment were based on the limited range of activities required in support of the ski club infrastructure relocation and the very small area affected (Table 8.1).

The study area for this assessment is shown in Figure 2.1d. For habitat connectivity the study area was expanded to consider the south valley wall. Field investigations for this component were limited to reconnaissance-level site inspections in September of 2014 and on 05 January 2015.

Table 8.1. Justification for the selection of VECs – Ski club infrastructure relocation

Valued Environmental Components	**Potential for Additional or Unique Issues**[1]	**Relative Abundance or Status**	**Public Concern**	**Professional Concern**	**Economic Importance**	**Regulatory Concern**	**Relevant Legislation/Bylaw/Policy**
Valued Ecosystem Components							
Geomorphology/ Geotechnical Stability	**Yes**			✓		✓	• Bylaw 7188
Soils	**Yes**			✓		✓	• Bylaw 7188 • Drainage Bylaw 16200
Hydrology Surface Water/ Groundwater	**No**						
Fish and Fish Habitat	**No**						
Vegetation, Wildlife and Habitat Connectivity	**Yes**		✓	✓		✓	• Bylaw 7188 • Alberta *Weed Control Act* • Federal *Species at Risk Act* • Federal *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Residential Land Use	**No**						
Recreational Land Use	**Yes**		✓	✓		✓	• Bylaw 7188
Utilities	**No**						
Worker and Public Safety	**No**						
Visual Resources	**Yes**		✓	✓		✓	• Bylaw 7188
Valued Historic Components							
Historical Resources	**No**						

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

8.3 Key Issues

Key issues were identified by: 1) examining the project component location, known conditions and potential project activities; 2) considering concerns raised by the public and city services departments; and 3) applying professional judgement. Following are the key issues identified in association with ski club infrastructure relocation:

- **Will re-grading activities adversely affect slope stability?**
- **Will the operation of the Edmonton Ski Club be adversely affected?**
- **Will the installation/new location of ski lift infrastructure affect visual resources in the local area?**

8.4 Existing Conditions

8.4.1 Geomorphology/Geotechnical Stability and Soils

Slope Stability

Lands required to accommodate the ski run re-grading and infrastructure relocation are situated along sloping terrain immediately west of Cloverdale Hill Road, slightly north of Connors Road (Plate 8.2). Thurber Engineering's (2012) appraisal of geotechnical conditions along Connors Road determined that it is possible that existing fills associated with the grading of the ski hill slopes were placed in a somewhat uncontrolled manner. Slope instability associated with the loading of these fills and any underlying disturbed colluvium is a concern. This was also noted in the 2013 EISA.

Soils

These lands fall outside the boundaries of lands used for the former Cloverdale Incinerator landfill activities and are not identified as contaminated. These lands were, however, subject to past minor fill and grading (Thurber Engineering 2012) and are landscaped to turf and planted trees, thus the soils are not native. Thurber Engineering (2012) indicates that the stratigraphic profile of the local area is expected to consist of man-made fills, colluvium materials, native lacustrine and glacial deposits overlaying bedrock. Fills in the local area range from 0.8 m to 4.6 m in depth and consist of silty clay with pockets of organic matter and wood in some places (Thurber Engineering 2012).

Plate 8.2. Southeastern portion of lands required for ski club infrastructure relocation, looking west from Cloverdale Hill Road. Mature planted spruce on right are within the original Project Area. Deciduous stand of native vegetation shown on right is situated outside of the Project Area and will be undisturbed (Jan. 2015).

8.4.2 *Vegetation, Wildlife Habitat and Connectivity*

Lands involved in this project component consist entirely of manicured lawn and are not high quality wildlife habitat. Mature planted spruce are situated immediately south of the existing T-bar terminus and a linear stand of native vegetation is situated immediately north of the project component, both are outside of the lands to be disturbed (Plate 8.3). The 2013 EISA identified this locale as part of the larger Mill Creek-to-Cloverdale Ravine wildlife movement corridor. Existing infrastructure and ski club activity likely already compromise wildlife movement to some degree but wildlife are likely drawn to the cover offered by the adjacent linear tree stand and the area is thought to be most often used at night. The cover would be particularly useful to wildlife attempting to cross Cloverdale Hill Road. Available wildlife movement data specific to this locality are limited to preliminary coyote movement data from the University of Alberta urban coyote project (Murray and Cassidy St. Clair, unpublished data); and wildlife collision data from City of Edmonton Animal Care and Control Centre (2011). These data show movement through Gallagher Park and Cloverdale Ravine, but not preferentially at the corner occupied by this project component.

8.4.3 *Recreational Land Use*

Lands required for this project component form part of the existing lease held by the Edmonton Ski Club. These lands are situated on sloping terrain, near the top of the club's T-bar run. These project component lands are also part of Gallagher Park, which is not permanently fenced at the bounding roads and the lands are therefore currently accessible for other uses and to pedestrians in summer. These lands fall outside of the lands utilized for the annual Edmonton Folk Music Festival. No other recreational activities are facilitated on these lands.

8.4.4 *Visual Resources*

This project component area is dominated by manicured lawn; the small parcel is screened by planted spruce at the corner of Connors and Cloverdale Road and a linear natural tree stand descending the hill. Nearby residents along Strathern Drive, to the immediate east and residences along 95 Avenue, to the south have views of this area. Motorists along Connors Road and Cloverdale Hill Road also have views of this area. The existing T-bar terminus is clearly visible from Connors Road, dominating views at the crest of the hill (Plate 8.4)

Plate 8.4. The existing T-bar terminus is clearly visible from Connors Road, dominating views at the crest of the hill, looking northwest (Jan. 2015).

8.5 Potential Impacts and Mitigation Measures

8.5.1 Soils

No unique impacts to soil resources associated with the ski infrastructure relocation component were identified as part of this analysis. Project-wide mitigation measures designed to minimize erosion, topsoil/subsoil mixing, compaction, contamination or other degradation to soil resources will be applied to any activities within this project component area and currently form part of the Project Agreement.

8.5.2 Impacts to Slope Stability

Impacts and Mitigation Measures

Soils and subsoils/fill in these lands will be removed by Project Co to approximately 1 m depth to adjust the run's landing area. All Project Co re-grading activities associated with this component will be subject to the broader contractual obligations of the Valley Line LRT project that recognize the sensitivity of slope stability in this area. These contractual obligations include the requirement for Project Co to prepare a geotechnical report demonstrating the slope stability measures needed to attain the required improvements to the slope stability factor of safety. As such, detailed site-specific geotechnical investigation(s) and assessment(s) will be undertaken in support of any re-grading activities.. Adhering to such requirements will ensure that potential impacts of ski run re-grading to slope stability are negligible.

Funded by the City, the Edmonton Ski Club will be responsible for installation of all existing or new structures within this area, including subsurface foundations or pilings. Once the desired infrastructure (existing or replacement) has been identified and new locations have been finalized, the club must ensure that all geotechnical concerns have been addressed. This may require a new geotechnical study for review by the City's Transportation Services. Any geotechnical study by the club would require completion of an Initial Project Review (IPR) pursuant to Bylaw 7188. If infrastructure relocation were ultimately planned for lands downslope of the parcel covered in this EISA update, a more comprehensive IPR may be required. Geotechnical work and IPRs required for reinstallation will be funded by LRT D and C as part of the mitigation for impacts to ski club operations.

8.5.3 Vegetation, Wildlife Habitat and Connectivity

8.5.3.1 Loss of Manicured Vegetation

Impacts and Mitigation Measures

Work associated with the ski club facilities grading and relocation will include the disturbance of manicured lawn, covering approximately 362 m^2. Contractual obligations of the Valley Line LRT project contain clauses to ensure that no disturbance to adjacent trees situated just outside the Lands occurs. Impacts to vegetation are, therefore, rated as negligible. Post-construction, all lands disturbed as part of construction activities will be returned to their pre-disturbance vegetation, ensuring that impacts remain negligible.

The re-grading work and greater LRT project is expected to temporarily affect wildlife use of the area because of fencing requirements and general activity levels and the Project Agreement includes mitigation measures. After the work is done, the newly located infrastructure is not expected to alter current movement patterns as post-construction conditions are not seen to be substantially different and there will be no associated loss of vegetation cover.

8.5.4 *Recreational Land Use*

8.5.4.1 Disruption of Edmonton Ski Club Operations

Impacts and Mitigation Measures

The proposed ski run re-grading and the associated equipment relocation will ensure that T-Bar run at the Edmonton Ski Club remains functional. Contractual obligations for the work include a restriction of Project Co activities to just the required re-grading. These obligations also include specifications for final slopes, areas, elevations and gradients for the new landing area. The work has been defined by extensive consultation with the ski club executive. All construction activities associated with this project component will be undertaken during months when the Edmonton Ski Club is non-operational and provide time for the club to re-install equipment before the ski season begins. Based on these considerations, impacts to the operation of the ski club are considered to be negligible.

8.5.5 *Visual Resources*

This project component and the relocation of the T-bar terminus and operator shack, as discussed in the 2013 EISA, will result in the shifting of equipment a short distance to the northeast of its existing location. As equipment is currently very visible, this change is not anticipated to have an adverse impact on viewscapes. Equipment may be less visible to motorists, however, but all relocated infrastructure will be visible from trains as they passes through the area. From the east, the relocated equipment may be better screened by existing vegetation. This changed view is rated as a negligible impact for pedestrians, motorists and local residents.

8.6 Summary Assessment

8.6.1 *Summary of Residual Impacts*

This assessment identified no residual impacts or outstanding issues. However, LRT D and C will continue to work with the ski club to ensure that all details of infrastructure relocation and run adjustments are addressed. Should the club be asked to prepare an IPR for subsurface structure components, LRT D and C are willing to collaborate.

8.6.2 *Monitoring Requirements*

No monitoring requirements unique to this project component will be required. Monitoring requirements specific to broader erosion and sediment control, slope stability and general construction activities are defined through the general Project Agreement.

8.6.3 *Resolution of Key Environmental Issues*

Following are brief answers to the questions initially posed for this project component.

Will re-grading activities adversely affect slope stability?
No. While some slope re-grading will be done, as for the work in the larger adjacent area, Project Co will be required to undertake site-specific geotechnical work prior to re-grading activities must be preceded by and demonstrate that suitable slope stability measures will be implemented to attain the required improvements to the slope stability factor of safety.

Will the operation of the Edmonton Ski Club be adversely affected?
No. Regarding, relocation of ski club infrastructure and any other associated equipment will ensure that this run remains functional. Detailed re-grading specifications have been developed to ensure a functional landing area. All construction activities associated with this project component will be undertaken during periods when the Edmonton Ski Club is non-operational.

Will the installation of new ski life infrastructure affect visual resources in the local area?
Somewhat, as the elements visible may change; however, overall, negligible changes to in the quality of views are anticipated.

9.0 MUTTART ACCESS ROAD PARTIAL REMOVAL

9.1 Context

Realignment of the Muttart Access Road to accommodate the LRT trackway and Muttart Stop was covered in the 2013 EISA; however, the permanent removal of a one-way road connecting northbound Connors Road to the Muttart Access Road was not acknowledges. This component differs from the others assessed in this update in that it requires no additional Lands *and* most of the activities associated with removal would be undertaken as part of road realignment, which was already assessed. This assessment therefore focusses tightly on the potential impacts associated with the permanent removal of this river valley roadway. The road to be removed is ~200m long and the road and verge covers a total of approximately 2,070 m^2 (0.2 ha).

9.2 Assessment Methods

Very few VECs were selected for this assessment because the component does not involve any change in Lands and the majority of activities involved have already been captured by the 2013 EISA. VECs selected pertain to those potentially affected by the outcome of the road removal (Table 9.1). The study area for this assessment is shown in Figure 2.1d and was limited to directly affected lands.

Table 9.1. Justification for the selection of VECs –Muttart Access Road Partial Removal

Valued Environmental Components	Potential for Additional or Unique Issues[1]	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Relevant Legislation/Bylaw/Policy
Valued Ecosystem Components							
Geology/Geomorphology	**No**						
Soils	**No**						
Hydrology	**No**						
Fish and Fish Habitat	**No**						
Vegetation	**Yes**			✓			• Bylaw 7188
Wildlife	**No**						
	No						
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Transportation Land Use	**Yes**		✓	✓		✓	• Bylaw 7188
Recreational Land Use	**No**						
Utilities	**No**						
Worker and Public Safety	**No**						
Visual Resources	**No**						
Valued Historic Components							
Historical Resources	**No**						

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

9.3 Key Issues

Key issues were identified by considering the project component location, known conditions, potential project activities not already assessed, concerns raised by the public and city services departments and then applying professional judgement. Many potential issues associated with this component were adequately detailed and mitigated through the 2013 EISA. The following are the key VEC issues identified for this assessment of road removal:

- **How will removal of the connector road affect traffic circulation?**
- **What will the final condition of these lands be?**

9.4 Existing Conditions

9.4.1 Vegetation

Project component lands comprise an existing roadway with a mowed turf verge.

9.4.2 Transportation Land Use

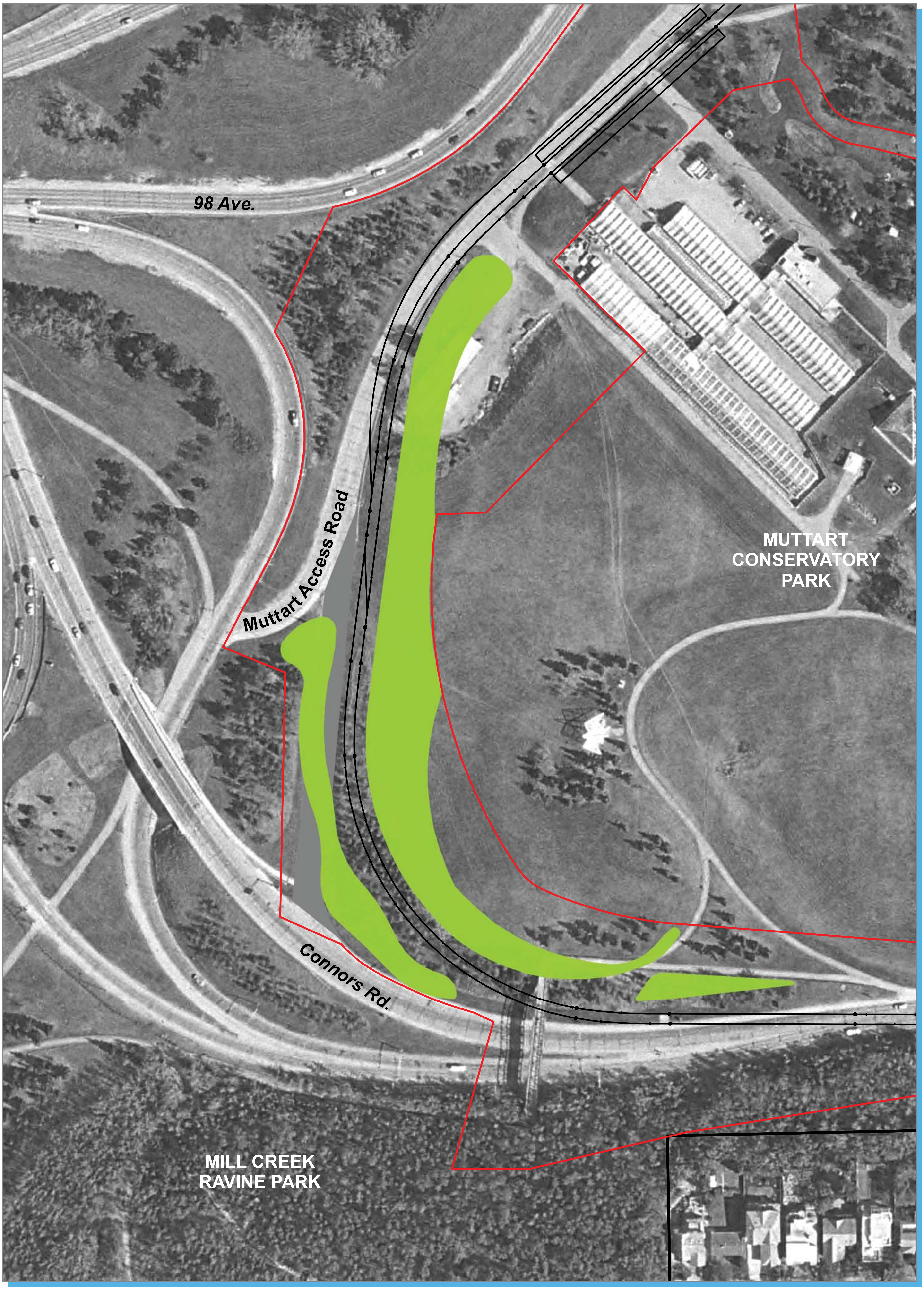
The connector road is a one-lane, one-way roadway that carries relatively low volumes of traffic (Perry, *pers. comm.*) and currently provides direct access for Connors Road northbound traffic to the Muttart Access Road and Muttart Conservatory storage building, staff parking lot and working greenhouses. The route is therefore useful to commercial vehicles delivering goods to the conservatory and conservatory staff commuting by personal vehicle along this route. The route also serves as a convenient shortcut for motorists travelling from Connors Road northbound to 98 Avenue eastbound. It is possible that this connector road route is used by cyclists travelling north on Connors Road; however, bicycle traffic is assumed to be rare considering that the sidewalk paralleling Connors Road north terminates further south just before the pedestrian bridge and veers into a dedicated SUP, leading through Gallagher Park. It is assumed that few cyclists instead choose to travel north along Connors Road sharing the vehicle lane and from there turn onto the access road connector, over using the SUP.

9.5 Potential Impacts and Mitigation Measures

9.5.1 Vegetation

9.5.1.1 Impacts to Vegetation

Lands occupied by the connector road to be removed will be reclaimed to green space by Project Co as part of the larger landscaping efforts in the river valley. The vast majority of the right-of-way to be removed has been identified as a naturalization area (Figure 9.1), the remainder will be reclaimed to manicured lawn. Naturalization efforts will include installation of trees and shrubs and will be governed by the Naturalization requirements that are currently set out in the Project Agreement. The planned naturalization will assist in reducing the total hard surface area in the LRT/road right-of-way and will screen the LRT trackway from the realigned Muttart Access Road. Based on this, impacts to vegetation associated with this project component are rated as positive, minor, permanent and predictable.



Legend

🟩 Naturalization Areas
🟥 Project Area
— Valley Line LRT Alignment (Reference Design)
☐ Bylaw 7188 Boundary

Figure 9.1 Naturalization at Former Road Location

City of Edmonton LRT Valley Line - Stage 1
EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

9.5.2 *Transportation Land Use*

9.5.2.1 Impacts to Local Traffic Circulation

Removal of the connector road between Connors Road northbound and the Muttart Access Road has been reviewed and agreed to by City of Edmonton Transportation (Perry, *pers. comm*.). This route comprises a secondary access to Muttart Conservatory facilities. The primary route, continuing approximately 500 m to the northwest on Connors Road to the existing intersection at 98 Avenue and then crossing south to connect to the Muttart Access Road, will remain available to all motorists following construction of the Valley Line. Cyclists who use this connecting road have access to an alternate (and safer route) through the SUP that connects Connors Road northbound to the Muttart Access Road by following the SUP route past the working greenhouses. The removal of this short road is part of the overall advancement in transportation options that is represented by the Valley Line project. Based on these balancing of considerations, the impact of this project component on local traffic circulation is considered to be negligible.

9.6 Summary Assessment

9.6.1 *Summary of Residual Impacts*

The proposed road removal is rated as a positive, minor, permanent and predictable impact on park greenspace.

9.6.2 *Resolution of Key Environmental Issues*

The following are brief answers to the questions initially posed for this project component.

How will removal of the connector road affect traffic circulation?
Removal of the connector road will eliminate one point of access between Connors Road northbound and 98 Avenue; however, an alternate connection to the realigned Muttart Access Road will remain available by continuing north approximately 500 m on Connors Road and crossing south over 98 Avenue. An alternative bicycle route is also available through the local SUP network.

What will the final condition of these lands be?
This project component will result in the replacement of approximately 2,070 m^2 of impermeable road surface with naturalized and manicured vegetation, much of which will be treed. The net effect of added green space will contribute to balancing the introduction of more infrastructure (LRT trackway) into this densely-roaded river valley locale.

10.0 MCSB REPLACEMENT

10.1 Context

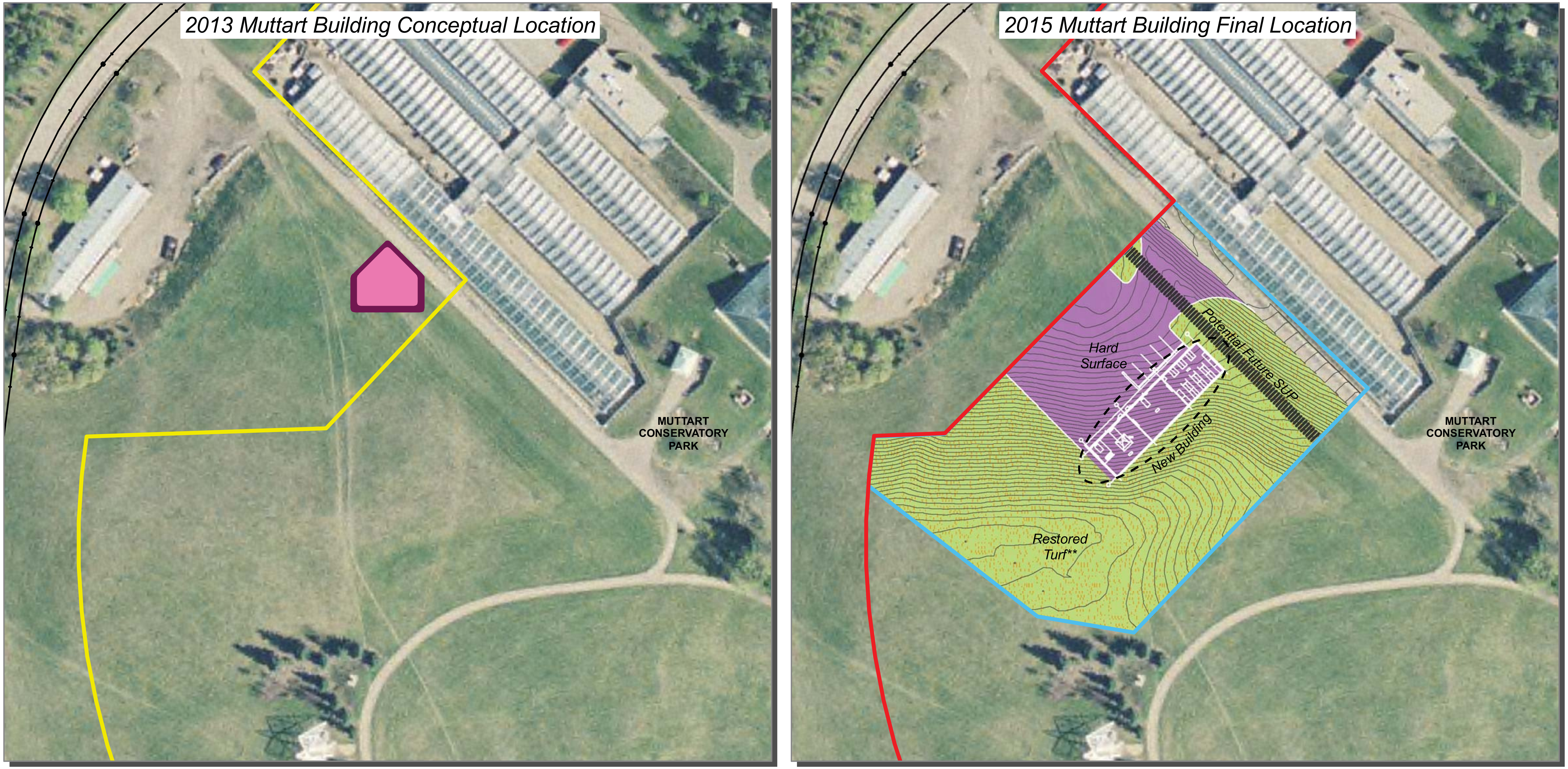
The location of the replacement Muttart Conservatory Storage Building (MCSB) has shifted approximately 40 m to the southeast of its previously approved location (Figure 10.1). The new building, ancillary facilities (parking and access) plus the necessary site re-grading will disturb an additional area totaling 6,353 $m^{2,}$ (0.64 ha). Lands to be disturbed consist entirely of manicured lawn and one SUP situated along the existing west margin of the Muttart working greenhouses. Minor realignment of the SUP will be required. Construction activities associated with this project component are planned to be undertaken by the City in summer and autumn of 2015.

10.2 Assessment Methods

Table 10.1 lists the VECs selected for this project component. For some VECs, this study area was expanded - these instances are noted in VEC-specific sections. The spatial boundaries, or study area, for this assessment are shown in Figure 2.1d and encompasses all land supporting new infrastructure and all lands expected to be temporarily disturbed by construction. Field investigations undertaken specifically for this project component were limited to reconnaissance-level site inspections on 20 June and 15 September 2014.

Previous studies relied on for site-specific information includes the following:

- A Phase I Environmental Site Assessment (ESA) covering all Valley Line river valley lands (ConnectEd Transit Partnership 2013a).
- A Phase II ESA covering all Valley Line river valley lands (ConnectEd Transit Partnership 2013b).
- A preliminary draft of a Phase II ESA undertaken specifically for the MCSB replacement project (ConnectEd Transit Partnership 2014).



2013 Muttart Building Conceptual Location

2015 Muttart Building Final Location

**Potential for some additional landscaping features near new building

Figure 10.1 Muttart Storage Building Replacement Site Plan

City of Edmonton LRT Valley Line - Stage 1 EISA Update

Aerial Photograph Date: May 2012
Date Map Created: 10 February 2015

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MANAGEMENT SERVICES LTD.

Table 10.1. Justification for the selection of VECs – MCSB replacement

Valued Environmental Components	Potential for Additional or Unique Issues[1]	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Relevant Legislation/Bylaw/Policy
Valued Ecosystem Components							
Geology/Geomorphology	**Yes**			✓		✓	• Bylaw 7188
Soils	**Yes**			✓		✓	• Bylaw 7188
Hydrology Surface Water/ Groundwater	**Yes**			✓		✓	• Bylaw 7188 • Alberta *Water Act*
Fish and Fish Habitat	**No**						
Vegetation	**Yes**		✓	✓		✓	• Bylaw 7188 • Alberta *Weed Control Act*
Wildlife and Habitat Connectivity	**Yes**		✓	✓		✓	• Bylaw 7188 • Federal *Species at Risk Act* • Federal *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Residential Land Use	**No**						
Recreational Land Use	**Yes**		✓	✓		✓	• Bylaw 7188
Utilities	**Yes**		✓	✓	✓	✓	• Bylaw 7188
Worker and Public Safety	**No**						
Visual Resources	**Yes**		✓	✓		✓	• Bylaw 7188
Valued Historic Components							
Historical Resources	**No**						

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

10.3 Key Issues

Key issues were identified by considering the project component location, known conditions, potential project activities, concerns raised by the public and city services departments and applying professional judgement. The following are the *key* VEC issues identified for exploration in this assessment:

- **Will re-grading activities adversely affect slope stability?**
- **Do contaminated soils occur within the project component area? Could the project result in mobilization of contaminated soils?**
- **Does contaminated groundwater occur within the project component area? Could the project result in mobilization of contaminated groundwater?**
- **Will the project adversely impact the local trail network?**
- **Will the project adversely impact recreational opportunities in the local area?**
- **Will the project adversely impact the Edmonton Folk Music Festival?**
- **Will the project adversely impact the operation of the Edmonton Ski Club?**
- **Will the presence of the new MCSB adversely affect views of the area?**

10.4 Existing Conditions by VEC

10.4.1 Geology/Geomorphology and Soils

The new MCSB site is situated on an existing bench and extends south into a shallow slope situated in Gallagher Park (Plate 10.1). The area has experienced a variety of former land uses and the grades and soils are not native. Thurber Engineering (2012) documented historical land uses as including the Cloverdale Incinerator, which was situated on lands, within the footprint of the new MCSB site. The incinerator was active on this site from the 1930s to 1971. Following that, in the 1970s, the local area was used to stockpile silt and clay materials from building excavations in the downtown area and construction of the James MacDonald Bridge Limited grading and park landscaping were undertaken in the local area in the 1980s.

Historical land uses led to concerns that soil contamination may be present in the area and, as recommended by a Phase I ESA completed for the Valley Line (ConnectEd Transit Partnership 2013a), in 2013, Phase II drilling was conducted along the LRT alignment, curving around the Muttart Conservatory to provide additional delineation of the former incinerator footprint. Drilling results documented the presence of buried waste material in all holes, with ash, traces of coal and wet coal seams observed in some locations (ConnectEd Transit Partnership 2013b). These Phase II drilling sites were, however, outside the footprint of the proposed new MCSB, thus in support of this project and others at the Muttart grounds, 14 additional soil test holes were drilled in October 2014, two of which were within the footprint of the proposed replacement MCSB. Both of those test holes showed exceedances of metals including selenium, copper, lead, molybdenum, tin and zinc (ConnectEd Transit Partnership 2014). It was also noted that the composition of soils within those test holes largely consisted of incinerator waste (ConnectEd Transit Partnership 2014).

Plate 10.1. MCSB replacement lands are situated on an existing bench and extend south into a shallow hill situated in Gallagher Park, looking southeast (July 2014).

Slope Stability

The proposed building site has a history of surface and subsurface disturbance, fill placement, and on a larger scale and to the south, slope instability. Site-specific geotechnical drilling is underway for this project component, focusing on local slope stability and building integrity. In addition, Thurber Engineering is preparing a statement regarding the potential effects of this proposed project component on global slope stability. The statement will be available in the near future.

10.4.2 *Hydrology – Surface Water/Groundwater*

The MCSB replacement project component is situated on the south river terrace, approximately 475 m south of the NSR and outside of City of Edmonton mapped floodplain limits (City of Edmonton 2013). There are no surface water features within the component study area. As noted above, lands within the project component area are situated within the boundaries of the former Cloverdale Incinerator site (ConnectEd Transit Partnership 2013b). In 2013, groundwater sampling conducted along the LRT alignment at Muttart Conservatory indicated groundwater exceedances of metals and PAH (ConnectEd Transit Partnership 2013b). As these sampling sites were outside the footprint of the proposed MCSB replacement one additional groundwater sampling hole was drilled in October 2014, within the footprint of the proposed new MCSB. That test hole yielded exceedances of PAH, and some other routine water chemistry parameters (ConnectEd Transit Partnership 2014). Groundwater levels were also measured in both testholes: one well had a groundwater depth of approximately 8.5 m while the other well was dry (ConnectEd Transit Partnership 2014). It was also noted that groundwater flow is likely northeast, towards the North Saskatchewan River (ConnectEd Transit Partnership 2014).

10.4.3 *Vegetation, Wildlife Habitat and Connectivity*

Vegetation

Vegetation within the study area consists entirely of manicured lawn (Plate 10.1 and 10.2). No trees or planted beds are situated within the project component area.

Wildlife & Habitat Connectivity

The manicured lawn at the site provides minimal wildlife habitat. Ground-squirrels, mice and voles may reside in the area from on occasion and some highly urban-adapted species of birds (e.g., black-billed magpie, American robin and American crow) likely forage in the grass, however, the lack of nearby perching sites limits even this use, but all other wildlife use of this area is likely to be transient. Habitat connectivity through this area is considered moderately high because it is a greenspace with relatively few barriers to wildlife passage; however, the complete lack of vegetative cover likely limits the use of this area to highly urban-adapted species and nocturnal use. Coyote movement through here has been documented but less frequently than in areas supporting security cover (Murray and Cassidy St Clair unpublished data). The connectivity this area provides between the NSR and Mill Creek Ravine may increase the likelihood of its use by species such as white-tailed deer and skunk, but there are several vegetated corridors that are likely used more often for wildlife passage by most mammalian species.

Plate 10.2. Vegetation in the MCSB replacement site consists entirely of manicured lawn, looking north (09 July 2014).

10.4.4 *Recreational Land Use*

One SUP is situated within the study area, directly adjacent to the existing working greenhouses, connecting SUPs running along the front and the back of the Muttart grounds. There are no other recreational facilities in the study area and no programmed uses. The eastern portion of the component area overlaps with lands that have recently been the site of a temporary bike compound serving Edmonton Folk Music Festival patrons. Is it possible that the hill within the project component area provides for passive recreation activities including sightseeing, photography, picnicking and tobogganing but these are undocumented uses (Plate 10.3). One informal trail is situated along the slope, from the northwest to southeast suggesting use of the area as a shortcut between formal trails (Plate 10.2). This area is not situated within lands leased by the Edmonton Ski Club.

10.4.5 *Visual Resources*

The project component is situated in a manicured lawn area, with rolling terrain that provides a vantage point within Gallagher Park, with a view of the Muttart Conservatory and downtown Edmonton. The site is visible to nearby recreationists at the Edmonton Ski Club, those using the upslope SUP path, and motorists on the Muttart Access Road. Current views from the hill include the existing storage building, which is slightly dilapidated, and grounds around the building, which are unpaved and only thinly graveled. Neither are considered aesthetically appealing (Plates 10.3 and 10.4).

Plate 10.3. View of MCSB Replacement site (in foreground) looking northwest; the existing slope provides passive recreation and one informal trail. Views from the site currently include the existing building (July 2014).

Plate 10.4. Alternative view of existing storage building and surrounding grounds (July 2014).

10.4.6 *Utilities*

One gas line and several water main lines are situated adjacent to the south boundary of the working greenhouses. The gas line travels in parallel line to the greenhouses and is partially situated within the project component footprint. Water main lines intersect with the project component boundary in three locations and include three manholes, also within the boundaries of the project component.

10.5 Potential Impacts and Mitigation Measures

10.5.1 *Geology/Geomorphology and Soils*

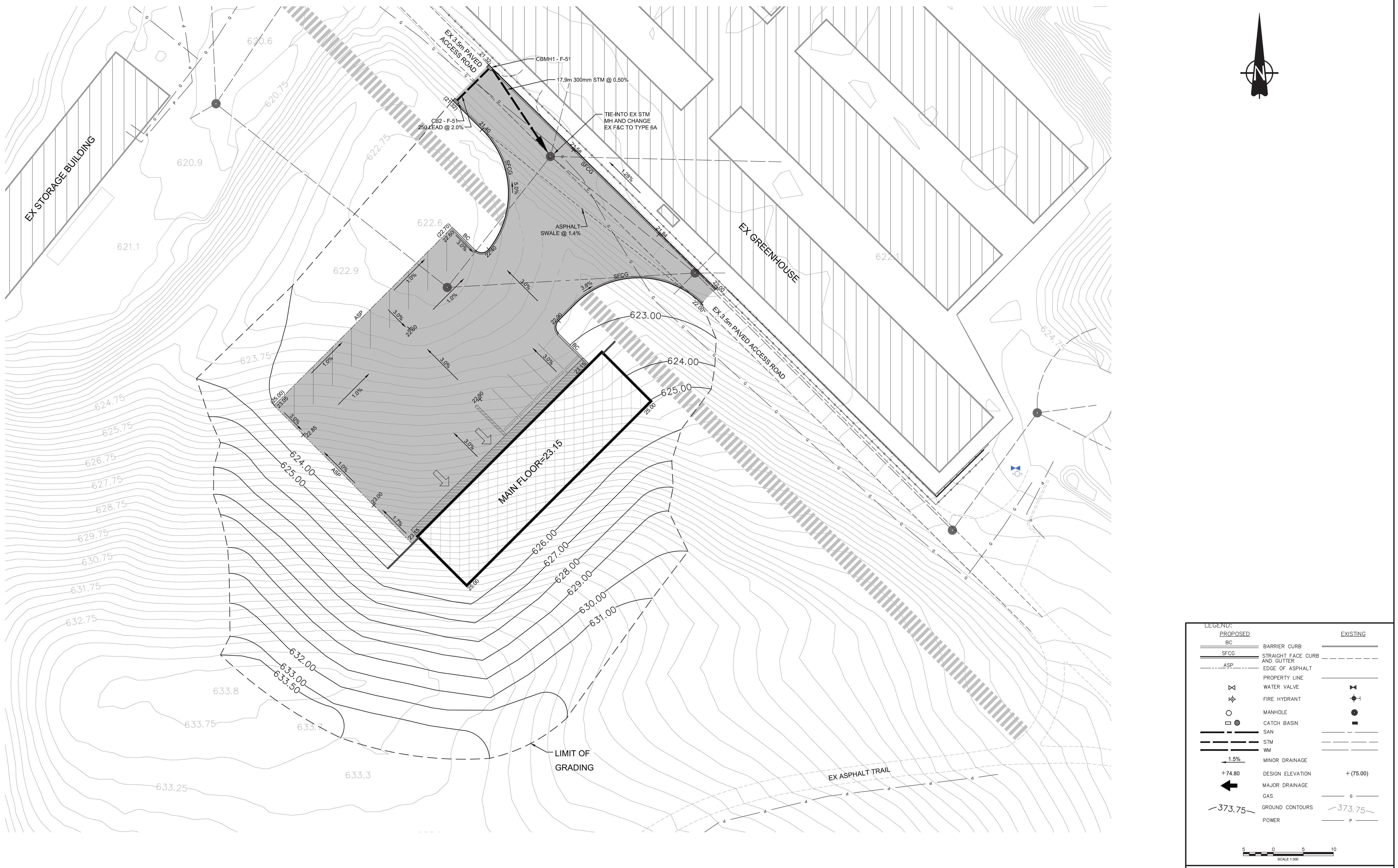
Slope stability and local geotechnical conditions were not known at the time of this report; however, investigations are currently underway. The City has commissioned a desktop analysis of the potential for this project component to affect global slope stability in Gallagher Park. Community Services, as the project proponent and contract manager, will be required to ensure that project design and construction complies with the global study's findings and recommendations and also the local study findings and recommendations. Community Services will be responsible for ensuring local geotechnical stability.

10.5.1.1 Soil Loss and Poor Handling during Construction

Impacts and Mitigation Measures

This project component will involve soil stripping and grading, including cutting into a hill and the project therefore has potential to adversely affect soils (Figure 10.2).

Figure 10.2



SUBSTRUCTURE TABLE

AREA	MATERIAL	DEPTH	COMPACTION
HEAVY DUTY PAVEMENT ▨	Asphalt Concrete Pavement (ACF-HT)	100mm	97% M.D
	Crushed Gravel Base Course (20 mm)	300mm	100% S.P.D
	Subgrade with 10kg/m² cement	150mm	100% S.P.D

Al-Terra

GRADING & UNDERGROUND SERVICES PLAN

Mitigation measures designed to minimize erosion, subsoil compaction, contamination from spills or other degradation to soil resources will be developed as part of the contractor's site-specific ECO Plan and TESCP, to be prepared in compliance with City bylaws and guidelines. Considering there will be cuts into the hill, implementation of effective erosion control will be important.

10.5.1.2 Mobilization of Contaminated Soils

Impacts

Borehole drilling results indicated that topsoils and subsoils on site are contaminated (ConnectEd Transit Partnership 2014). The re-use or redistribution of contaminated soils on site could adversely affect reclamation and may, over time, lead to further mobilization of contamination. If realized, this would be an adverse, minor, long-term, and predictable impact.

Mitigation Measures and Residual Impacts

The following mitigation measures will be implemented:

- All contaminated topsoils and subsoils excavated within the project area will be hauled off site and disposed of at a Class II landfill, following all applicable environmental laws.
- Following excavation, any remaining underlying or adjacent soils will be capped or otherwise lined with a non-permeable layer to prevent further exposure or migration of contamination.
- The City will present this approach to contaminated soils to Alberta Environmental and Sustainable Resource Development (AESRD) for any regulatory approvals that may be necessary.

With such mitigation measures in place, the presence of contaminated soils in the local area will be reduced and the residual effect will be positive, minor, permanent and predictable. It is minor because of the relatively small area involved.

10.5.2 *Hydrology – Surface Water/Groundwater*

10.5.2.1 Alteration of Surface Drainage

Impacts

This project component includes construction of a new storage building and associated paved surfaces for parking and maintenance/delivery vehicle access. The footprint of this project component, although small, will be impermeable and surface runoff must therefore be managed. Project design has included stormwater management during operation. Minor drainage (stormwater events below approximately a 1:5 storm event) will be intercepted through a newly installed catch basin. A sump design to capture grit will be included in the catch basin. Major drainage (stormwater events at or exceeding approximately a 1:5 storm event) will ultimately flow overland towards a planned stormwater facility that will be constructed in the vicinity of the existing storage building, as part of the Valley Line LRT project. Prior to the commissioning of the Valley Line stormwater facility, any major drainage from the new site will flow overland to that area, where it will percolate into the ground. Based on the above, the long-term impact of surface drainage is considered to be negligible as runoff can be accommodated into existing and planned conditions.

The project must also considered stormwater management during construction of this project component. The project cuts into a hill that will funnel runoff onto the site and potentially off the site. There is some potential here for minor, adverse, short-term impacts to off-site lands.

The project must also consider stormwater management for the period between completion of this project and completion of the Project Co Valley Line work on adjacent receiving lands. The adjacent lands will be under construction for a period of one to four years and, for that period, that site may not be an acceptable receiving area. Uncontrolled surface runoff to that site during major events could lead to adverse, minor, long-term, predictable impacts on vegetation and aesthetics.

Mitigation Measures and Residual Impacts

The following mitigation measures will be implemented:

- The City will ensure that the contractor develops a temporary erosion and sediment control plan that specifically addresses site runoff during construction, in order to avoid affecting downslopes lands and facilities.
- The City will also make provision to appropriately manage runoff associated with major events until such time as the Valley Line LRT stormwater management facility can accept these flows.

With the above mitigation measures in place, residual impacts associated with surface drainage should be negligible.

10.5.2.2 Mobilization of Contaminated Groundwater

Impacts

Groundwater at the project component area is documented as contaminated. Although groundwater at this site may be deep, interception during excavation activities could result in migration of contaminated groundwater off the project area, and potentially into the stormwater system and then then NSR. These potential effects are rated as adverse, minor, long-term and predictable.

Mitigation Measures and Residual Impacts

The following mitigation measures will be implemented:

- The City will require the contractor to develop an appropriate dewatering plan. That plan will include provisions to contain exposed groundwater or surface water

that enters excavated areas having exposed contaminants, and to dewater such that there is no further mobilization of contaminants.
- Following excavation, any remaining contaminated soils will be capped or lined with a non-permeable layer to prevent further collection of contaminated groundwater.
- The City will ensure that no buried utilities are situated within the water table, creating potential migration pathways.

With these measures in place, the project should not result in exacerbation of contaminated groundwater conditions.

10.5.3 *Vegetation, Wildlife and Habitat Connectivity*

10.5.3.1 Loss of Manicured Vegetation/Habitat

Impacts and Mitigation Measures

Work associated the MCSB replacement will result in the removal of approximately 8,206 m^2 of manicured lawn, 2,211 m^2 of which was considered in the 2013 EISA. Post-construction, approximately 5,966 m^2 (68%) of the disturbed footprint will be restored to turf. Other landscaping features (i.e. planted beds) may be installed near the new building. The new storage building has roughly the same dimensions as the existing building so does not represent a net loss of green space. The new paved parking lot is approximately one fifth larger than the existing unpaved parking lot, and therefore does represent a slight net loss of green space. Within Gallagher Park, manicured lawn is abundant, even dominant. This slight loss is therefore, not considered significant. Manicured lawn provides low quality wildlife habitat. The proposed new site also represents a slight decrease in site permeability for wildlife but the area is not currently a high quality corridor. Based on these considerations, the impacts to vegetation, wildlife habitat and habitat connectivity, are considered to be negligible.

10.5.4 *Recreational Land Use*

10.5.4.1 Impacts to the Trail Network

Impacts

Construction activities will require temporary closure of the on-site SUP. Such a closure would reduce trail connectivity between the north Muttart Conservatory and the pathway network south and along Connors Road. The closure will last approximately 18 months. This will reduce options available to local pedestrians, cyclists etc. and some patrons of the Edmonton Folk Music Festival (EFMF). Nearby alternative routes are, however, available to the immediate east of the Muttart Conservatory that connects with Gallagher Park, Edmonton Ski Club and EFMF grounds. Cloverdale Hill Road will also be available as a detour link. Impacts of the SUPs temporary inaccessibility are rated as adverse, minor, short-term and predictable.

Post-construction approximately 110 m of the existing SUP will be replaced with a paved maintenance/delivery vehicle access, along the existing alignment. That access will become a link in the SUP, connecting to the existing path at both ends. Since the paved maintenance/delivery vehicle access will not provide public vehicle access, it is anticipated that vehicular traffic will be minimal and will not disrupt recreational passage.

Mitigation Measures

To minimize impacts to trail users, temporary detours and closures will be implemented in compliance with the City's River Valley Trail Closure protocols. Warning signs will be posted in advance of trail closures and detours. Those signs will provide park trail users with adequate notification of the timing and duration of the closures and advise them of detours and alternate trails. For safety reasons, temporary fencing will be installed at key locations at the construction site to prevent public access into active construction areas and the trail detour signs will assist with alerting the public to the temporary construction activities. Implementation of these measures will reduce the residual impacts to negligible.

10.5.4.2 Loss of Recreational Opportunities

Impacts and Mitigation Measures

Construction of the new MCSB facilities will require re-grading into the adjacent hill. Such activities will permanently alter the grades to a 3:1 slope towards the building and result in the removal of approximately 8,206 m^2 of manicured lawn that may be used for unprogrammed recreation. Re-grading will occupy only part of the hill and the west half of the hill's peak will remain unaffected. Based on these considerations, and the presence of other similar hills and slopes in the local area, and the large area of manicured lawn throughout adjacent lands and no programmed use, it is not anticipated that re-grading activities will have a significant impact on recreational opportunities in the local area. Impacts to recreation are, thus, considered to be negligible.

In addition, as noted above, temporary fencing will be installed at key locations to prevent public access into active construction areas and the trail detour signs will assist with alerting the public to the temporary construction activities.

10.5.4.3 Temporary Bike Storage during the Edmonton Folk Music Festival (EFMF)

Impacts and Mitigation

Construction will require the EFMF to move or reconfigure their secure bike storage area as the project area overlaps with roughly half of the bike compound used last year. This represents an inconvenience but is not anticipated to render festival organizers without options as the bike storage location has varied over time, thus appears not to be the only available choice. Nearby alternative locations may be available within Gallagher Park or Cloverdale Neighbourhood. Based on these considerations, impacts to temporary bike storage during the EFMF are considered to be minor and short-term. Mitigation will comprise informing festival organizers, as soon as possible, which lands will be unavailable to them. The residual impacts should be negligible.

10.5.5 *Visual Resources*

Impacts and Mitigation

The potential impacts to visual resources consist of the visibility of construction activities such as site grading, material stockpiling and building erection from several vantage points. During construction activities, impacts are expected to be adverse and minor, but short-term and predictable.

Permanent adverse effects to visual resources are not anticipated, for the following reasons. Post-construction, replacement of turf will be undertaken in all disturbed areas and some other landscaping features (i.e. planted beds) may be installed. In addition, the replacement building has been designed to be compatible with the surroundings including the look of other Muttart Conservatory structures the building will be integrated into the hill, through grading and backfill placement (Figure 10.3) and the new building will have a largely flat roof, reducing its visibility from a distance In comparison to the existing storage building, the new building is anticipated to be an aesthetic improvement or, at least. The above effects are predicted to result in no adverse, long-term visual impacts.

10.5.6 *Utilities*

Construction of the MCSB replacement will not require the removal or realignment of any existing utilities, but may require some on-site utility protection. New power and gas utilities will be installed, connecting to nearby existing services. Based on these considerations, no impacts to utilities have been identified and impacts to other park resources are not expected.

10.6 Summary Assessment

10.6.1 *Summary of Residual Impacts*

This assessment identified no adverse residual impacts. One positive residual impact was noted associated with the removal and appropriate disposal of contaminated soils during excavation activities, resulting in a reduction of contamination in the local area.

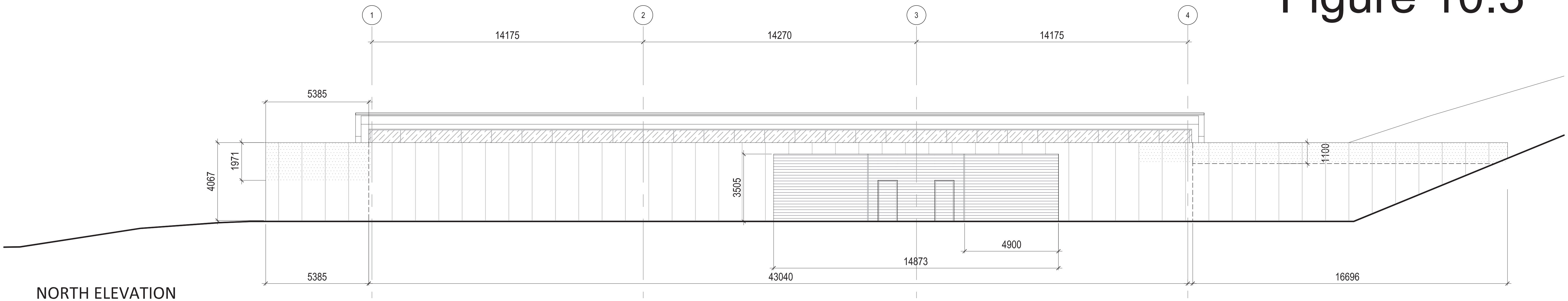
10.6.2 *Resolution of Key Environmental Issues*

Following are brief answers to the questions initially posed for this project component.

Will re-grading activities adversely affect slope stability?

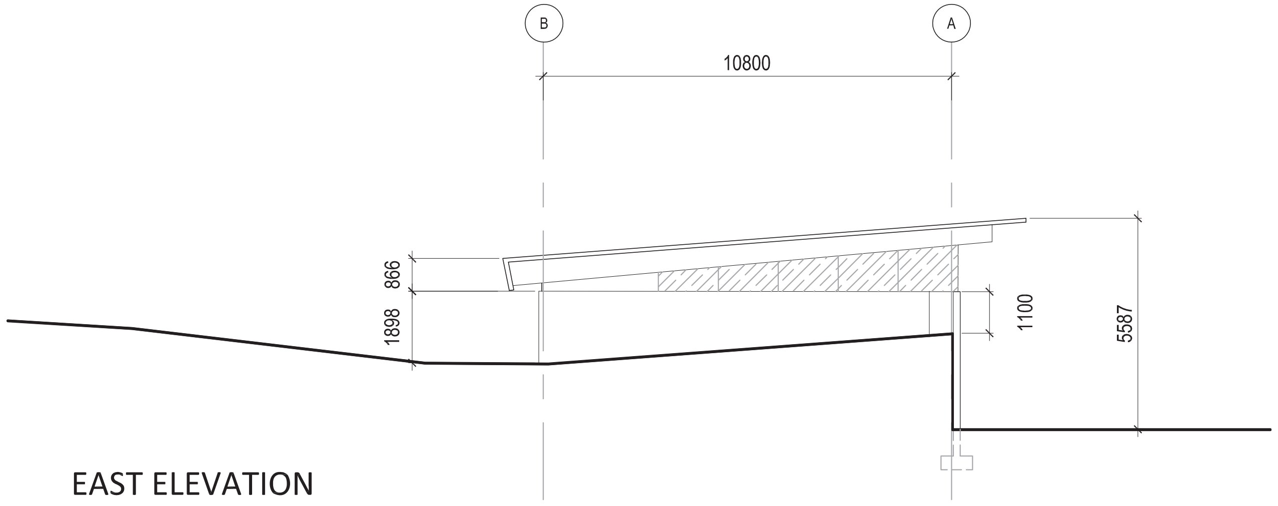
Slope stability conditions were not known at the time of this report; however, global and local investigations are currently underway. The project proponent will be required to adhere to any findings and recommendations of such geotechnical assessments and this will ensure slope stability.

Figure 10.3



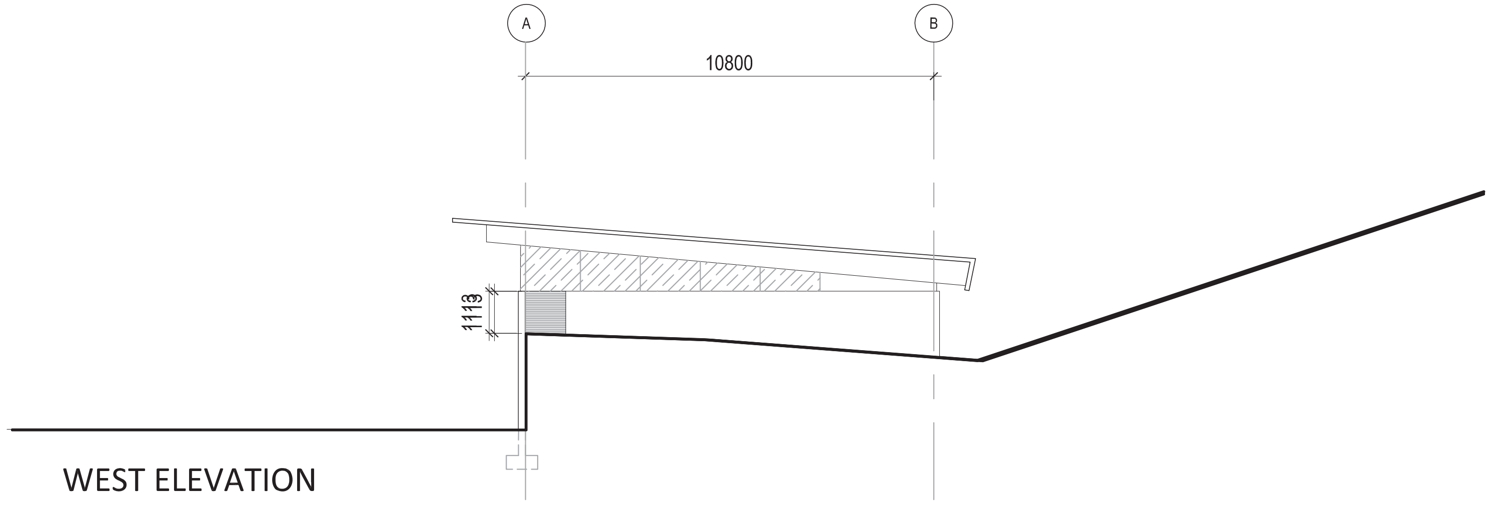
NORTH ELEVATION

SCALE 1:200



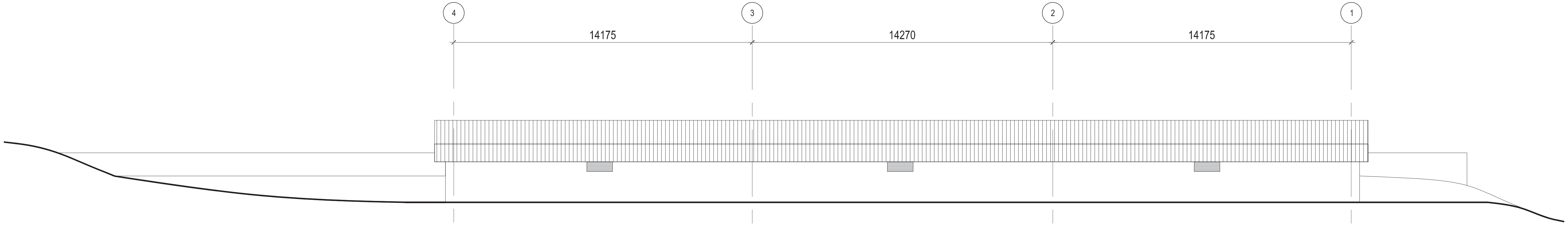
EAST ELEVATION

SCALE 1:200



WEST ELEVATION

SCALE 1:200



SOUTH ELEVATION

SCALE 1:200

MUTTART CONSERVATORY STORAGE BUILDING

CURRENT BUILDING ELEVATIONS
prepared for Valley Line LRT - P3 proponents
2014-11-05

Do contaminated soils occur within the project component area?
Yes.
Could the project result in mobilization of contaminated soils?
Unlikely. All contaminated soil excavated within the project area will be hauled off site and disposed of at a Class II landfill, following all applicable environmental laws. During construction activities, provisions will be made to contain seepage into, and drainage from, excavated areas and to dewater appropriately to minimize contaminants being released off-site into the stormwater system. Following excavation any remaining contaminated soils will be capped with clean clay material to prevent further exposure. Furthermore, the City will investigate the need to have the aforementioned approach to contamination approved by the Province.

Does contaminated groundwater occur within the project component area?
Yes.
Could the project result in mobilization of contaminated groundwater?
No. During construction activities, provisions will be made to contain seepage into, and drainage from, excavated areas and to dewater appropriately to minimize contaminants being released off-site into the stormwater system.

Will additional manicured vegetation be removed?
Yes. Construction of the MCSB replacement will require the removal of approximately 8,206 m^2 of manicured lawn, 2,211 m^2 of which was considered in the 2013 EISA. Within Gallagher Park, manicured lawn is abundant, even dominant. Post-construction, approximately 5,966 m^2 (68%) of the disturbed footprint will be restored to turf and possibly other landscaping features (i.e. planted beds). The slight loss is not, therefore considered significant.

Will the project adversely impact the local trail network?
Construction activities will require temporary closure of the SUP in the project area, lasting approximately 18 months. Nearby alternative routes are, however, available to the immediate east of the Muttart Conservatory that connects with Gallagher Park, Edmonton Ski Club and EFMF grounds. Cloverdale Hill Road will also be available as a detour link. Post-construction approximately 110 m of affected paved SUP will be replaced with a paved maintenance/delivery vehicle access, along the existing alignment. That access will become a link in the SUP, connecting to the existing path at both ends. To minimize impacts to trail users, temporary detours and closures will be implemented.

Will the project adversely impact passive recreational opportunities in the local area?
No. Construction of the MCSB Replacement will require re-grading of an existing hill adjacent to the planned structure. Such activities will permanently alter the grade of a section of this hill to a 3:1 slope towards the building and result in the removal of approximately 8,206 m^2 of manicured lawn that may be used for unprogrammed recreation. Re-grading will, however, occupy only part of the slope and the west half of the hill's peak will remain unaffected.

Will the project adversely impact the Edmonton Folk Music Festival?
Construction will require the EFMF to move or reconfigure their secure bike storage area as the project area overlaps with roughly half of the bike compound used last year. This represents an inconvenience but is not anticipated to render festival organizers without options as the bike storage location has varied over time, thus appears not to be the only available choice.

Will the project adversely impact the existing or future operation of the Edmonton Ski Club?
No. Lands within the project component area are situated outside the lease boundaries for the Edmonton Ski Club.

Will shifting of the MCSB replacement location adversely affect visual resources?
The replacement building has been designed to be compatible with the surroundings including look of other Muttart Conservatory structures. The building is concrete like other Muttart structures and the dominant cladding will be polished aluminum, enhancing its aesthetic appeal. In comparison to the existing storage building, the new building is anticipated to be an improvement.

11.0 LRMP TEMPORARY TRAIL CONNECTOR

11.1 Context

The proposed temporary trail will be 15 m in length and 1.5 m wide, situated within the project component area shown in Figure 2.1b. Construction will disturb a 3 m wide corridor for a total disturbance footprint of approximately 45-50 m^2. Trail construction involves excavation to a depth of 150 mm and the placement of compacted clay and gravel. The connector trail will not be paved. Trail design and construction drawings have accounted for provision of slope stability, impacts to manicured vegetation and mitigation (Figure 2.6). Post-construction, the connector trail will be removed and landscaping will return the area to its pre-disturbance condition. This work will be undertaken directly through Community Services and not by Project Co, in late summer or autumn of 2015.

11.2 Assessment Methods

Valued Environmental Components

Works associated with the temporary connector trail will be undertaken by the City prior to general Valley Line LRT construction and this work has never been assessed. As such, most VECs associated with terrestrial and park resources have been selected (Table 11.1).

Study Area

The study area for this assessment is shown in Figure 2.1b. Because of the manicured nature of the site, field investigations were limited to reconnaissance-level inspections on 15 September 2014 and 06 January 2015.

Table 11.1. Justification for the selection of VECs – LRMP temporary connector trail

Valued Environmental Components	Potential for Additional or Unique Issues[1]	Relative Abundance or Status	Public Concern	Professional Concern	Economic Importance	Regulatory Concern	Relevant Legislation/Bylaw/Policy
Valued Ecosystem Components							
Geology/Geomorphology	**Yes**			✓		✓	• Bylaw 7188
Soils	**Yes**			✓		✓	• Bylaw 7188
Hydrology - Surface Water	**Yes**						• Bylaw 7188 • Drainage Bylaw 16200 • Alberta *Water Act*
Fish and Fish Habitat	**No**						
Vegetation and Wildlife	**Yes**		✓	✓		✓	• Bylaw 7188 • Alberta *Weed Control Act* • Federal *Species at Risk Act* • Federal *Migratory Birds Convention Act* • Alberta *Wildlife Act*
Valued Socio-economic Components							
Land Disposition and Land Use Zoning	**No**						
Residential Land Use	**No**						
Recreational Land Use	**Yes**		✓	✓		✓	• Bylaw 7188
Utilities	**Yes**		✓	✓	✓	✓	• Bylaw 7188
Worker and Public Safety	**No**						
Visual Resources	**Yes**		✓	✓		✓	• Bylaw 7188
Valued Historic Components							
Historical Resources	**No**						

[1] In instances where it was determined that no potential existed for additional or unique issues to arise, no further consideration to that VEC was given

11.3 Key Issues

Key issues were identified by considering the project component location, known conditions, potential project activities not already assessed, concerns raised by the public and city services departments and then applying professional judgement. Many potential issues associated with this component were adequately detailed and mitigated through the

2013 EISA. The following are the key VEC issues identified for this assessment of the LMRP temporary trail connector:

- **Do excavation activities have the potential to result in slope stability concerns or interact with landfill debris?**

11.4 Existing Conditions

11.4.1 *Soils and Geotechnical Stability*

Slope Stability

Slope stability is addressed here because this location is part of the larger valley slope that has been well documented to be unstable as a result of several intrinsic factors (Thurber Engineering 2012). To date, no discussions of trails in this park have suggested surface instability in this locale.

Soils

Within the project component area, soils have been historically disturbed by previous land use, including the Grierson Nuisance Grounds and the subsequent placement of fill and landscaping of LMRP.

Landfill

As noted above, the site of the Grierson Hill landslide was used as a landfill (Grierson Nuisance Grounds) for several decades in the early 20th century and this and the subsequent reclamation is well documented in the 2013 EISA. The approximate boundaries of the landfill were identified in the 2013 EISA and are shown in Figure 4.2. The LMRP connector trail project component is situated within the centre east area of the Grierson Nuisance Grounds. Thurber Engineering (2014) indicates that waste materials remain present in subsurface layers near the ground surface and to depths up to 20 m in the middle of the landfill. Holes were not drilled in lands for this project component but holes drilled slightly east for the Valley Line LRT did intersect with landfill waste (Thurber Engineering 2014). Of the holes drilled by Thurber Engineering in the park, the shallowest waste encountered was at 30 cm depth.

11.4.2 *Hydrology – Surface Water*

The LMRP temporary connector trail project component is situated on terrain sloping towards the NSR, which is located approximately 140 m to the south. As such, surface drainage in the local area is expected to be south, towards the NSR, however, most surface runoff is assumed to percolate into the slope before it reaches the river, except during extreme events.

11.4.3 *Vegetation and Wildlife Habitat*

Vegetation within the lands affected by the temporary trail connector is entirely manicured and consists of lawn and a portion of a planted bed of horticultural shrubs including juniper, cherry and maple. Wildlife habitat is minimal in both scale and quality.

11.4.4 *Recreational Land Use*

The project component is situated in a highly-used manicured area of LMRP. The area currently supports no programmed recreational opportunities, but us close to several trails and the Chinese Gardens.

11.4.5 *Visual Resources*

The LMRP temporary connector trail project component area forms one small component of the overall park landscape and includes planted shrubs and manicured lawn. It serves as a backdrop to the nearby Chinese Garden infrastructure.

11.4.6 *Utilities*

One buried electric street light cable, associated with light standards, is situated in the northern half of the project component area, very close to the portions of the new trail. One more distant water line is situated on the south boundary of the project component area. Please refer to Appendix F for maps of all subsurface utilities within the project component area.

11.5 Potential Impacts and Mitigation Measures

11.5.1 *Geotechnical Stability and Soils*

11.5.1.1 Slope Stability and Landfill Debris

Impacts and Mitigation Measures

Construction of the LMRP temporary connector trail will include some sub-excavation, but only to a depth of 150 mm. Although slope stability is considered to be marginal in the local area, slope stability is not anticipated to be a concern for this project, considering the shallow nature of the excavation, which essentially involves stripping the topsoil layer. Similarly, this shallow excavation is viewed as unlikely to intersect landfill materials. The ECO Plan to be developed by Community Services, or their contractor, will note measures to be taken in the event that landfill debris is uncovered during excavation activities. Disposal will comply with all environmental standards and laws. Implementing such measures will ensure that impacts are negligible.

11.5.1.2 Impacts to Soils during Construction

Impacts and Mitigation Measures

Mitigation measures designed to minimize erosion, topsoil/subsoil stripping and stockpiling, compaction, contamination or other degradation to soil resources will be developed as part of the site-specific ECO Plan, to be prepared by Community Service, or their contractor, as required by the City of Edmonton's ENVISO program and guideline documents. Construction drawings include placement of riprap at the downslope edge as an erosion and sedimentation control measure. Implementing such measures, and associated notes developed for the construction drawings, will ensure that impacts to soils are negligible.

11.5.2 *Hydrology – Surface Water*

Construction of the LMRP temporary connector trail will include excavation, the placement of backfill materials and associated grading activities. Such activities have the potential to alter local surface drainage patterns, although in this case, on a very local scale. Temporary trail connector work will include the installation of topsoil and sod on all disturbed grounds adjacent to the new trail; once installed, positive drainage will be confirmed. The trail will be granular, with a granular base, allowing some runoff to percolate into subsoils. There are currently no drainage issues on the trails to be connected by this temporary trail, further suggestion that this will not be an issue. Based on these considerations, no impacts to hydrology have been identified.

11.5.3 *Vegetation, Wildlife Habitat and Connectivity*

11.5.3.1 Loss of Manicured Vegetation

Work associated with the LMRP temporary connector trail will result in the removal of manicured vegetation, including lawn and approximately 30 m^2 of an existing planted bed. All potential vegetation impacts have already been addressed by specifications included in the construction drawings. Shrubby vegetation within the planted bed, including one juniper, one cherry and one maple, will be transplanted prior to disturbance activities. Sod and soils are to be re-used on site. Post-construction landscaping will return the project component area to its pre-disturbance condition ensuring that no residual impacts to manicured vegetation will occur as part of this work.

11.5.4 *Recreational Land Use*

11.5.4.1 Impacts to the Pathway Network

The construction of this connector trail, prior to on-site disturbance by Valley Line construction, will connect the western portion of the primary north-south SUP to an established trail in the Chinese Gardens, allowing pedestrians and cyclists to circulate through the broader network of park trails situated west of the LRT project and avoiding trail dead ends. This project component is proposed as part of the City’s mitigation measures for Valley Line impacts on LMRP. The connector trail will be shown on all communication and way-finding tools associated with detour plans to be developed by Project Co in support of the Valley Line LRT. Based on these considerations, no additional or unique impacts have been identified.

11.5.5 *Utilities*

Utility locations will be confirmed in the field closer to construction and required protection provided, likely focusing on the electrical subsurface and surface utilities. There is no reason to anticipate that utility work has potential to result in additional impacts to park resources within or outside the component study area.

11.5.6 *Visual Resources*

Any construction activities to be undertaken in this small (303 m^2) project component area will be present for only a few weeks and because of the small scale will resemble routine park landscaping. For those reasons, this is not expected to adversely affect larger park viewscapes. Post-construction, all lands associated with this project component will be returned to their pre-disturbance conditions.

11.6 Summary Assessment

11.6.1 *Summary of Residual Impacts*

This assessment identified no residual impacts or outstanding issues.

11.6.2 *Monitoring Requirements*

There are no monitoring requirements for this project component.

11.6.3 *Resolution of Key Environmental Issues*

One issue was identified for this component:

Do excavation activities have the potential to result in slope stability concerns or interact with existing debris?

Very little potential exists. Excavation in support of the temporary trail connector will be shallow (150 mm depth) and is not expected to impact slope stability or interact with landfill debris in the local area. The contractor's ECO Plan will include a plan for dealing with the eventuality of unearthing debris.

12.0 CONCLUSIONS

12.1 Summary of Public Engagement Response

Approximately 108 participants took part in the 03 February 2015 drop-in open house. The open house was also covered by several media outlets. In total, 22 comment forms were completed and submitted at the open house, followed by three online submissions. The majority of comments received extended beyond the focus of the EISA Update and its proposed project component changes, focusing instead on previously-established design elements (i.e. LRT alignment, replacement of Cloverdale Bridge). Overall, those responding were almost evenly divided in their views on the value of the changes, with nine of 21 responses to a specific question on this matter indicating that the changes were positive and nine indicating they would not help address concerns. Three others were unsure. No new issues related to the project components were identified in written responses. Conversation with attendees indicated that the location of the river valley facilities, the desire to limit the number of facilities in the river valley and the ability to provide for wildlife movement through the valley particularly during construction remains of interest to attendees.

As the Valley Line project proceeds through procurement and preliminary design to construction, public involvement will continue to be a high priority. Methods of engagement will include five new community-based Citizen Working Groups, which will provide a platform for ongoing information-sharing and dialogue.

12.2 New Potential Impacts and Mitigation Commitments

Few new mitigation measures, over and above those specified in the 2013 EISA, are required in response to the proposed project components and associated Project Area adjustments. This is partly because many of the assessed project components are themselves mitigation measures committed to in the 2013 EISA and most affected lands are small areas. Moreover, the Valley Line contract (Project Agreement) already contains clauses that ensure application of standard mitigation measures and all commitments made in the 2013 EISA. This pre-emptively covered many potential impacts associated with the new components. Project components identified in this update to be undertaken by Project Co will be governed by the Valley Line LRT Project Agreement. Project components identified the responsibility of the City of Edmonton will be administered through separate contracts tendered by Community Services. All new mitigation measures committed to in this EISA Update will be incorporated into the relevant contracts or implemented directly by the City, as appropriate. Following is a brief summary list of key new mitigation measures committed to for the two larger component projects - the north valley access road and the MCSB Replacement.

Primary North Valley Access

- The Project Agreement will incorporate all of Thurber Engineering's recommendations with respect to site preparation, road design, drainage and monitoring during construction and operation of the portion of the access route situated along the existing SUP.

- LRT D and C will undertake and submit a geotechnical report specific to the portion of the access route located at the existing maintenance vehicle road to Transportation Services for review and sign-off.
- Project Co will implement all recommendations from that geotechnical assessment and abide by the limitations; should the City report recommend no clearing or grading, Project Co will be required to use the road in its current horizontal and vertical alignment.
- LRT D and C will ensure that all trees and shrubs located in the project area are accounted for in the Valley Line Corporate Tree Management Policy inventory. The City will discuss their approach to contaminated soils and groundwater with the Province.
- Project Co will be required to undertake the following:
    - Justify clearing of native vegetation along the maintenance vehicle access road.
    - Restore any disturbed native or naturalized forest communities.
    - Implement specified vehicle and pedestrian access and safety measures.
    - Continuously manage dust and safety measures.
    - Implement specified measures to accommodate the Red Bull Crashed Ice and Dragon Boat Festival, respecting all periods where use of the road must cease.
    - Have a qualified archaeologist monitor all excavation activities within the Grierson Landfill.

Muttart Conservatory Storage Building

- LRT D and C will commission a desktop study of the potential for this component to affect global slope stability.
- Community Services will continue with a site-specific geotechnical study and implement recommendations.
- The City will discuss their approach to contaminated soils with the Province.
- The Contractor will develop a plan to control runoff during construction.
- The City will develop a plan to control runoff during major events prior to commissioning of new receiving stormwater management facility.
- The City will implement an SUP detour and appropriate notifications.
- The City will inform EFMF of the impact on the festivals temporary bike compound.

With the above measures implemented, the proposed project components and associated Project Area adjustments should result in few residual impacts.

12.3 Summary of Changed Project Components

The following sections provide concise summaries of the main points and conclusions reached for each assessed component.

12.3.1 *North Valley Primary Construction Access Road*

Recent planning has designated west LMRP as the new north valley primary construction access. As a consequence, the original primary access through the east park is now identified as the secondary construction access route. The proposed primary construction access road will be temporary, but present for the duration of construction in the north valley, a period lasting approximately four years. The proposed access road will support high volumes of traffic. Project Co will be required to design and construct the access road to the standard needed to carry out the work safely and without adversely affecting slope stability in the park. The route will follow a mainly paved corridor in LMRP, but will require upgrading and, possibly, some realignment. As this project component involves a significant boundary adjustment, VECs selected for this assessment were comprehensive and very similar to those included in the 2013 EISA. The assessment determined that during construction, even with mitigation, there will be adverse minor impacts to native vegetation, habitat connectivity during construction, the recreational pathway network, general park use and visual resources. In addition, impacts associated with any removal of woody vegetation will be evident until restoration efforts realize mature vegetation leading to a long-term, but not permanent, vegetation impact.

12.3.2 *West Project Boundary Modifications at HMEP*

This component redresses the need to include enough lands around the picnic shelter to allow for demolition and restoration to a native forest. It also reduces the 2013 Project Area to avoid disturbance of the bed and shore of abandoned Mill Creek associated impacts to native balsam poplar forest. This project component represents a net gain in environmental protection. Overall, the HMEP west project boundary modification represent a reduction of approximately 877 m^2 in land disturbed by construction activities. There are no identified residual adverse impacts or outstanding issues. The long-term establishment of a native balsam poplar forest in an area previously dominated by manicured vegetation was considered a minor positive impact for vegetation and visual resources.

12.3.3 *HMEP Entrance – Project Co Component*

Inclusion of a parcel of land at the 96A Street entrance to HMEP, covering approximately 763 m^2, is proposed to afford flexibility to Project Co when providing the required continuous access to the 98 Avenue pedestrian bridge during LRT construction activities. This parcel represents a minimal addition to the overall river valley project area for the Valley Line and consists of manicured vegetation, including planted trees and the HMEP entrance sign. These lands will be available to Project Co for general construction activities and may be used as part of the access and egress to the south riverbank. Post-construction, any areas disturbed within this project component will be reclaimed through landscaping, and this will be specified in the Project Agreement. This will include replacement of the planted bed and trees. No residual impacts were identified.

12.3.4 *Retaining Wall Ground Anchors – Project Co Component*

Project Co is expected to propose use of retaining walls in the vicinity of the Muttart Stop and along the portal access road, to retain cut slopes. At these two locations, ground anchors are among the options available to Project Co for retaining wall stabilization. Final design of the retaining walls and their stabilizing methods will be the responsibility of Project Co. At these two locations, ground anchors, should Project Co choose to use them, would likely extend beyond the previously identified Project Area, underground and at depth. The installation of retaining wall anchors does not require surface disturbance. To assure no impact to residents, the contract will not permit the anchors to extend past the limits of City-owned land (avoiding privately-held lands) and will not allow installation by pounding. Prior to the installation of the retaining walls a detailed site-specific geotechnical investigation and assessment will be undertaken in support of retaining wall construction. This will include investigation of the use of ground anchors. No residual impacts were identified.

12.3.5 *Ski Club Infrastructure Relocation – Project Co Component*

Near the intersection of Connors Road and Cloverdale Hill Road, the project will adversely affect the Edmonton Ski Club T-Bar run. As a result of ski club infrastructure relocation, there also is a need to re-grade lands to provide a safe and appropriately graded and -sized landing area downslope of the return terminal bullwheel This re-grading falls slightly outside the 2013 boundary and requires an extension of the Project Area by approximately 362 m^2. It is also possible that additional infrastructure will be required to meet new safety standards. These lands are covered entirely with manicured lawn. The Project Agreement includes detailed specifications for final elevations and gradients at the new landing area, which have been defined through extensive consultation with the ski club executive. All construction activities will be undertaken during months when the Edmonton Ski Club is non-operational and the timing will allow the club to re-install equipment before the ski season begins. Any re-grading work will be subject to site-specific geotechnical investigations and measures must be implemented to ensure that the slope stability called for in the Project Agreement is attained.

Funded by the City, the Edmonton Ski Club will be responsible for (re-) installation of all structures within this area, including required subsurface foundations or pilings. For this, the club must also ensure that all geotechnical concerns have been addressed; therefore, site-specific geotechnical investigation(s) and assessment(s) will be undertaken in support of installation of relocated ski club infrastructure. Drilling for this would require an IPR pursuant to *Bylaw 7188*. Should any equipment require installation outside of these assessed lands, a more comprehensive IPR may be required. Required studies will be funded by LRT D and C. No other residual impacts or outstanding issues were identified.

12.3.6 *Muttart Access Road Partial Removal – Project Co Component*

The 2013 EISA identified the need to realign Muttart Access Road, which connects Connors Road and 98 Avenue and provides access to the conservatory grounds. The 2013 EISA did not, however, capture the need to permanently close and remove a one-lane, one-way, ~ 200m long connector road which handles northbound Connors Road traffic connecting to the Muttart Conservatory just west of the existing Muttart storage building. The planned road removal is fully situated with the 2013 Project Area, thus no extension of Lands is required. Once removed, this section of roadway will be subject to landscaping and naturalization efforts. Overall, the removal of the connector road is rated as a positive impact on park greenspace, while potential impacts to transportation are considered to be negligible. There are no required mitigation measures associated with this project component.

12.3.7 *Muttart Storage Building Replacement – City Component*

The 2013 Project Area included lands to accommodate the new MCSB, but at that time it was only conceptually conceived and located. During subsequent planning, the City decided to undertake construction of the replacement building prior to LRT construction; detailed design identified the space required for a new building of the same dimensions as the existing building. To accommodate this, the footprint of the new building shifted by approximately 40 m to the southeast and the eastern portion of the proposed facility is now situated outside the 2013 Project Area. Lands within the affected area consist entirely of manicured vegetation and one SUP and may support some unprogrammed recreation. After the application of mitigation measures, one positive residual impact was identified which related to the removal of known contaminated soils during excavations. No other residual impacts or outstanding issues were identified; however, additional geotechnical investigations are underway and all recommendations must be implemented.

12.3.8 *LMRP Temporary Trail Connector – City Component*

As a mitigation measure for Valley Line impacts on LMRP recreation and prior to commencement of Valley Line construction, the City will construct a short (approximately 15 m), temporary connector trail just west of the 2013 Project Area in the Chinese Gardens of LMRP. The temporary trail will connect the western portion of a primary north-south SUP to an established trail in the Chinese Garden, allowing pedestrians and cyclists to circulate through the broader network of west park trails during the up to four years of construction in LMRP. Mitigation measures for physical disturbance have been incorporated into the trail plans. The contractor will be required to comply with all City policies and guidelines, ensuring no residual impacts.

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Appendix A: Alternative Analysis for Construction Access Route

connectEd
TRANSIT PARTNERSHIP

Memorandum

AECOM
ConnectEd Transit Partnership
10235 101 Street, Suite 1200, Edmonton, AB, Canada T5J 3E9

To Brad Griffith Page 1

CC File, Jeff Ward, Gordon Menzies, Lynn Maslen, Josh Jones, Russ Coulombe

Subject Valley Line LRT – North Bank Access Route

From Mark Perry

Date December 19, 2013 Project Number 60222337

This memo summarizes the options regarding the short term construction and long term maintenance and emergency access to the Valley Line tunnel portal and Tawatinâ Bridge on the north bank of the North Saskatchewan River.

Short term construction access could include bringing in material and equipment required to build the tunnel, portal, bridge and any landscaping or pathway reconstruction. There is also the potential the access could be used for removal of excavated material from the tunnel. Long term access would be for regular maintenance of the tunnel and Tawatinâ Bridge and any emergency services required in the tunnel or on the bridge.

The current design shows both the short term and long term access from Cameron Avenue. A potential minor secondary access was identified through Louise McKinney Park in the Environmental Impact Screening Assessment (EISA) in this way:

> *"Construction access for the portal structure is designated as from the east, via Cameron Avenue but, as planning proceeds, the need for a secondary access from the west, through Louise McKinney Park, may also be identified. For this reason, this environmental assessment assumes an as yet unidentified secondary access from the west but also assumes that this access will be limited and will not require physical modification. Therefore, secondary access is not shown on figures, is considered to be outside of the study area and is only assessed qualitatively."*

For an access through Louise McKinney Park to be used for construction would require some upgrading and therefore further review and approval to be compliant with Bylaw 7188 (North Saskatchewan River Valley Area Redevelopment Plan)

Access from Cameron Avenue, although feasible, has some inherent issues. The primary issue is that the main contractor access, which would include large heavy loads and equipment, would travel down a fairly steep road through a residential neighbourhood. CTP was asked to evaluate other potential access options including through Louise McKinney Park to mitigate some of these concerns.

Potential Access Alignments

In addition to the Cameron Avenue access 3 alternate alignments were identified for access from the west. The alignments are shown on Figure 1.

West Access Alignment 1 is from Grierson Hill past the Riverfront Plaza along the existing SUP to the bridge site on the north bank. Access to the tunnel portal site would follow the same route as the new portion of the Cameron Access route.

West Access Alignment 2 is from Grierson Hill along the existing maintenance road through Louise McKinney Park. At the east end of the existing maintenance road the access route would cross through the World Walk and over a Shared Use Path (SUP) on sufficient fill to meet the elevation of the tunnel portal. Access to the bridge site on the north bank would need to go through the portal site or use the Cameron Avenue access. Figure 2 shows the profile of the Alignment 2.

West Access Alignment 3 is from a SUP connection on Grierson Hill modified to accommodate construction vehicles. The route would follow the existing SUP to a point where a new connection would be provided to the tunnel portal site. To access the bridge site vehicles could either continue along the SUP or cross the tunnel portal site and access along the Cameron Avenue access connection. Figure 3 shows the profile of the Alignment 3.

All of the alternate alignments would require upgrading of the SUPs or maintenance roads to accommodate construction loads. In some cases this will be building up the road structure and widening the existing structure.

Alternative Comparison

The attached summary identifies some of the items of consideration for the alternate alignments.

It should be noted that the existing access shown in the Preliminary Design has been approved via the EISA and any substantial work that is in additional to what is discussed in the EISA may trigger a new EISA.

LRT D&C has agreed that the long term access can be maintained via Cameron Avenue as this would be used only sporadically for regular maintenance and emergencies. The biggest concern and impact on the adjacent residents would be the short term access during the construction phase.

The Cameron Avenue alignment provides the best long term routing for maintenance and emergency access since the anticipated frequency is relatively low, therefore not expecting to impact residents significantly, and sharing less SUPs than the west alignments. The short term construction access will have significant impact on the adjacent residents.

West Access Alignment 1 does not improve on the Cameron Avenue Alignment for maintenance and emergency access since the vehicles would need to be routed along more than 600 metres of SUP before getting to the same new access road that would be needed for the Cameron route. The main advantage to Alignment 1 is that the route skirts the former dump site and since it runs along the base of the slope, appears to be the most geotechnically stable. This route also does not require any more significant retaining walls or structures than identified in the Cameron Avenue route. Alignment 1 does have a significant impact on the use of the Riverside Plaza and Promenade. A major event planned for the winters of 2015, 2017, and 2019 would require closure of this route for approximately 6 weeks. There is the potential to access the site using Alternative 1 and exit through Cameron Avenue during construction.

West Access Alignment 2 would require significant grading over the existing World Walk in Louise McKinney Park to have vehicles access the tunnel portal site. This additional loading on the sensitive side slope and crossing the former dump site make this route less desirable geotechnically and therefore not recommended for short or long term access. As with Alignment 1 this route will be closed for approximately 6 weeks for the major event planned for the winters of 2015, 2017, and 2019.

West Access Alignment 3 does not provide good maintenance and emergency access for the long term since the connection to Grierson Hill will be restricted to a right turn onto the access road and therefore become a one way road only. For construction access Alignment 3 would require building up the connection of the SUP to Grierson Hill. This could be incorporated into the proposed park viewpoint at this location. However there is concern that this connection would add load to the top of a historic slide area. As well additional work and retaining walls would be required to connect the SUP to the tunnel portal site. Upgrading the SUP to reach the bridge site would be likely, even for a construction access only, since the existing slope does not allow for an access road to be built adjacent to the existing path. Similar to Alignment 1 this alignment would need to be used as a one way in access for construction traffic with Cameron Avenue as the exit from site.

Recommendation

Due to the relatively low frequency of maintenance vehicles and the expectation that the maintenance vehicles will not be large vehicles the permanent maintenance and emergency access should come off of Cameron Avenue. This will minimize the amount of trails and park space that will have the maintenance vehicles cross through for the long term.

For the short term construction access, impact on the residents needs to be weighed against the impact on Louise McKinney Park. To balance the impact consideration can be given to using West Access Alignment 1 as the access to the site and Cameron Avenue as the exit from site. This would mean that the heavier loads of construction materials such as concrete and bridge equipment would access along the SUP that would need structural upgrading instead of along Cameron Avenue. This route will need to be reviewed with Parks and event organizers to determine if it is feasible considering businesses and events planned along this route. Costs should be comparable to using the Cameron Avenue alignment as a 2 way route since there should be no significant additional retaining walls required for the construction access and the use of Cameron as a one way route only would reduce the rehabilitation costs of Cameron Avenue. As with all the alignments, additional geotechnical investigation will be required to confirm the need for structural stability, the ability to build a construction access adjacent to the SUP, or, where needed, the upgrading of the SUP to support construction loads.

If West Access Alignment 1 is determined to be unfeasible due to park and event restrictions than West Access Alignment 3 should be considered as a one way access to the site with the exit to Cameron Avenue. There is a higher geotechnical risk with this option due to placing the route along the top of the slope. The slope stabilizing and additional required retaining walls to access the portal site increase the costs of the option substantially.

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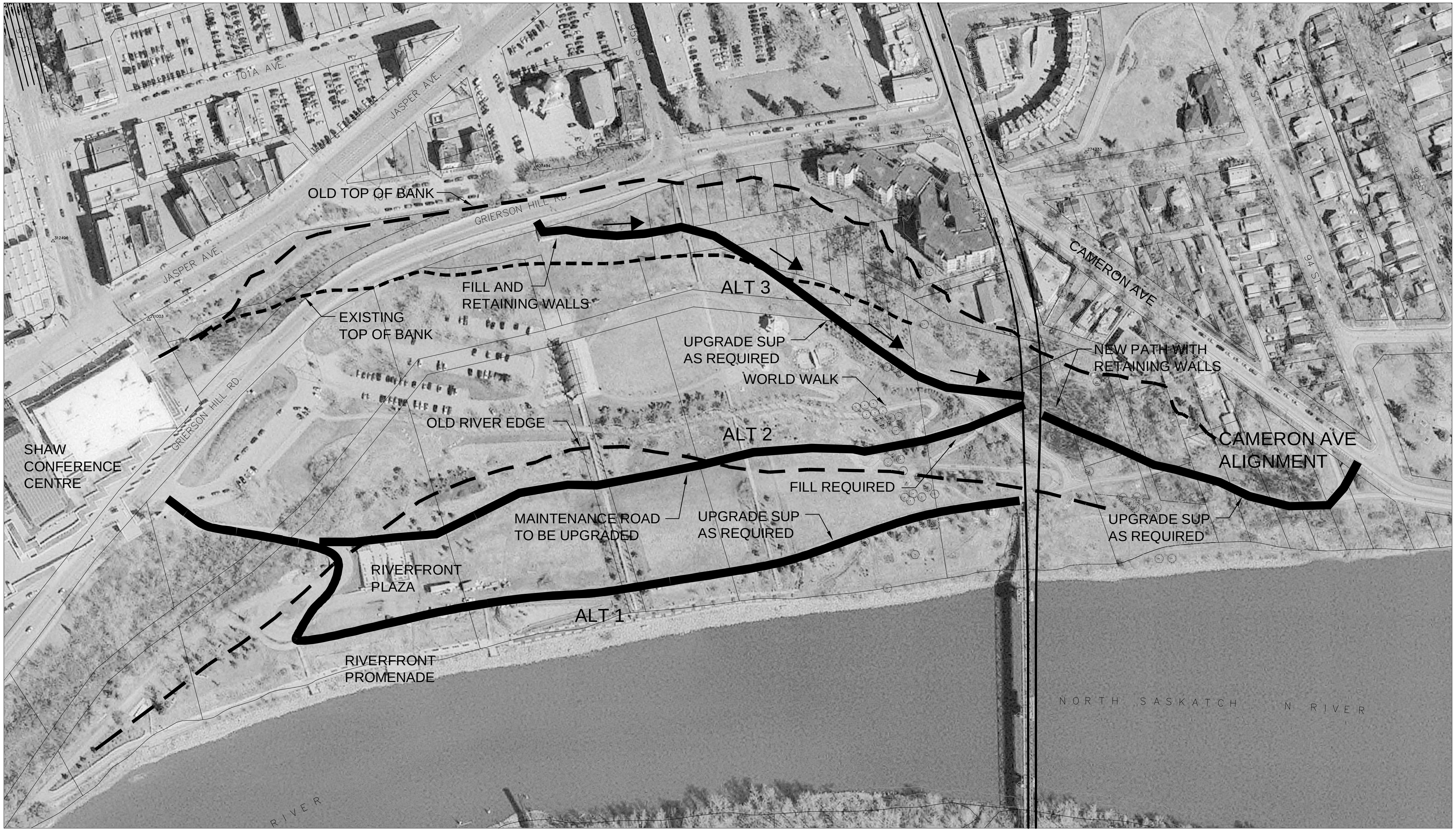

VALLEY LINE LRT

connectEd
TRANSIT PARTNERSHIP

THE CITY OF Edmonton
TRANSPORTATION
SERVICES

Date Issued: 29-11-2013
Drawing No: Figure 1

NORTH RIVER BANK ACCESS OPTIONS

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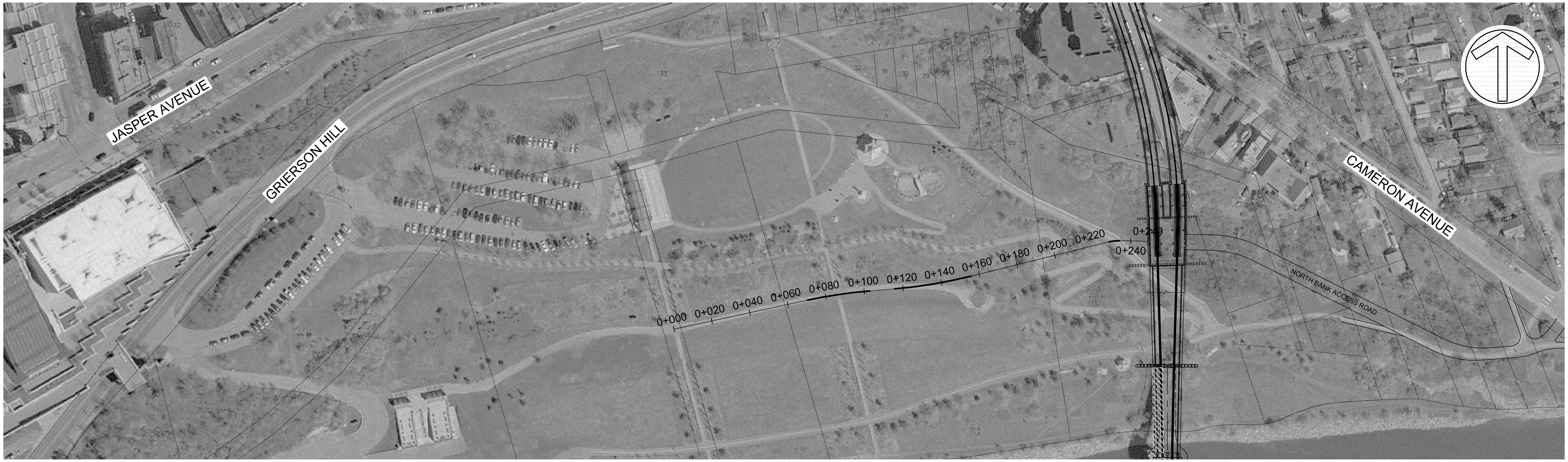

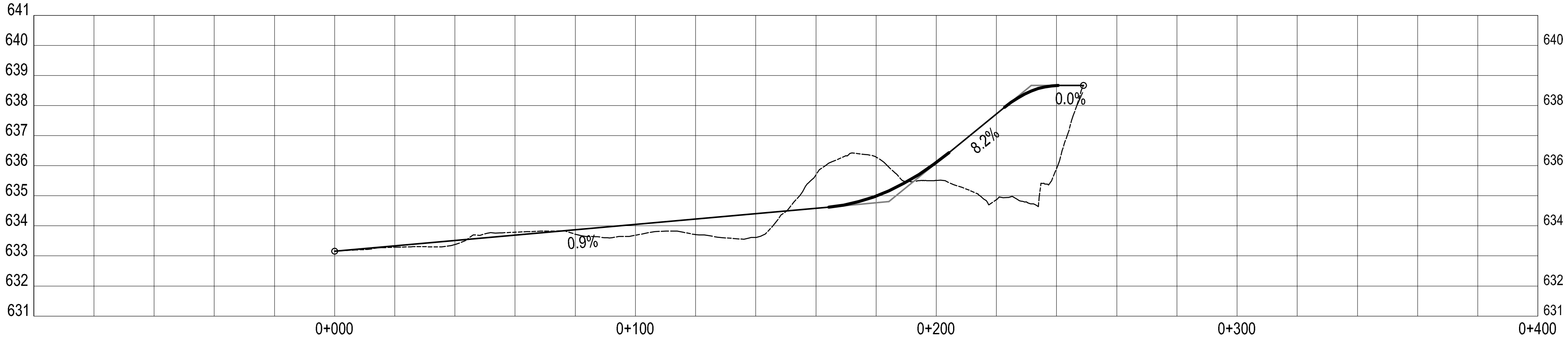

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Prime Consultant

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ISL Engineering and Land Services

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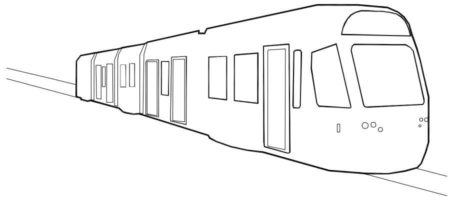
gec architecture

Associate Consultants



SOUTHEAST TO WEST LRT

Drawn By: B.C.
Designed By: B.C.
Checked By: R.C.
Date Issued: 12-09-2013

NORTH BANK
WEST ACCESS ROAD
OPTION 2

FIGURE 2

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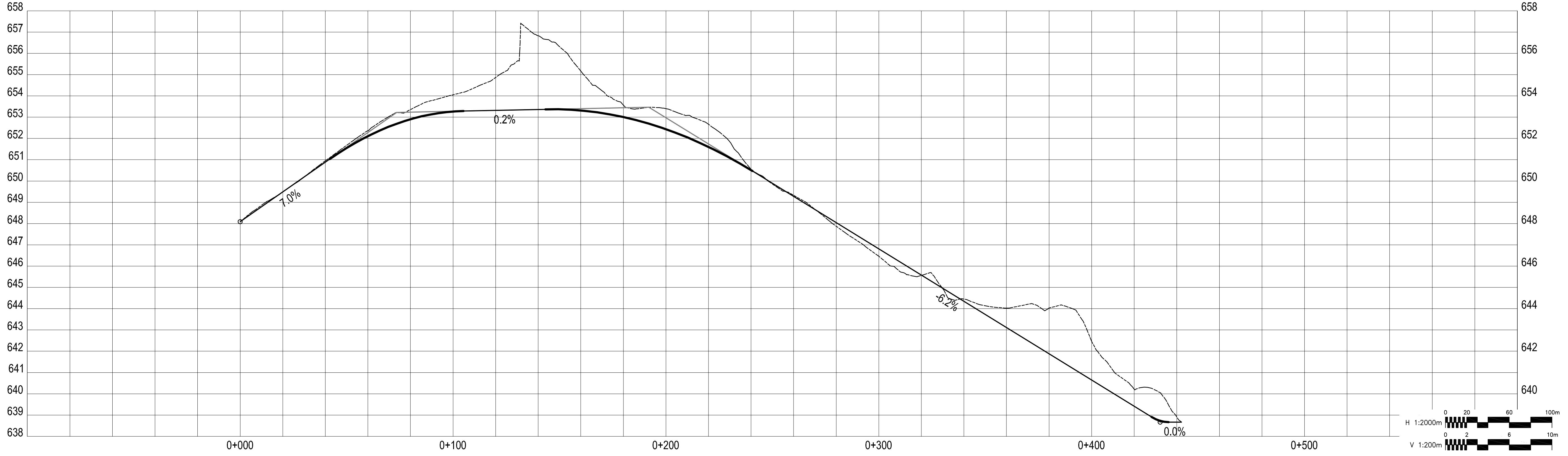

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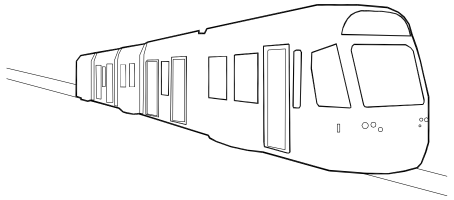


SOUTHEAST TO WEST LRT

Drawn By: B.C.
Designed By: B.C.
Checked By: R.C.
Date Issued: 12-09-2013

NORTH BANK
WEST ACCESS ROAD
OPTION 3

FIGURE 3

Summary of Valley Line LRT West River Bank Access Alignments

Criteria	Cameron Avenue Alignment	West Alignment 1	West Alignment 2	West Alignment 3
Geometric Considerations	Steepest Grades approx. 12%	Steepest grades approx. 15%	Steepest grades approx. 15%	Steepest grades approx. 15%
Connecting Road	Cameron Avenue is a local collector road providing access to/from Riverdale community.	Grierson Hill is a arterial road designated as 24 hour truck route	Grierson Hill is a arterial road designated as 24 hour truck route	Grierson Hill is a arterial road designated as 24 hour truck route
Residential Impacts	-Cameron Avenue on street parking would be banned -Private Property access would be impacted -Construction traffic adjacent to curb walks -Noise, vibration, dust, saftey concerns for adjacent residents	None if used as 2 way access. Similar, yet less, impacts if to Cameron Avenue Alignment if Cameron Ave is used as as an exit.	None if used as 2 way access. Similar, yet less, impacts if to Cameron Avenue Alignment if Cameron Ave is used as as an exit.	None if used as 2 way access. Similar, yet less, impacts if to Cameron Avenue Alignment if Cameron Ave is used as as an exit.
Access Considerations	Parking ban would be required on Cameron Avenue with a tight corner to make at bottom of Cameron Ave.	Traffic Signal may be needed on Grierson Hill	Traffic Signal may be needed on Grierson Hill	Geometry may only allow right turns off of Grierson Hill. May require additional route to exit site.
Route Upgrade and Restoration	Pavement damage leading to repaving/reconstruction of Cameron Avenue following construction. Approximately 170 m of SUP would then need post-construction restoration. Some tree removal may be required.	Potentially 370 m of SUP along north river bank would require upgrading to accommodate construction vehicles and would then need post-construction restoration. Potential accomodation of a contruction access along the SUP would require potential grading, road preparation, and restoration. Some tree removal may be required.	Approximately 310 m of maintenance access road would require upgrading and would then need post-construction restoration. Use as permanent access would mean that World Walk and rose garden would need to be relocated.	SUP would require upgrading for construction access and would then then need post-construction restoration. Constructing adjacent to SUP is unlikely due to steep side slopes. Some temporary retaining structures may be required. Some tree removal may be required.
Tunnel Portal Construction Access	Via new access road	Via same new access road as Cameron Avenue alignment (This option does not provide permanent access to Tunnel)	Via new access connection through World Walk site (This option does not provide permanent access to Tunnel)	Via new connection from SUP
Bridge Site Construction Access	Via existing SUP	Along existing SUP	Via additional access road through World Walk area or along West Alignment 1	Via existing SUP or new access road similar to Cameron Avenue alignment
Retaining Walls	Required for new access road	Required for new access road	Potentially needed through park site to accommodate final access road configuration	Required at access to Grierson Hill and along access to portal site
Known restrictions on route use	None	Would not be able to use route for 6 weeks during winter of 2015, 2017, & 2019 due to major park event.	Would not be able to use for 6 weeks during winter of 2015, 2017, & 2019 due to major park event.	Would be closed for 4 days for major park event during winter of 2015, 2017, & 2019.
Snow Clearing	Coordination with Road Maintenance for Cameron Ave clearing	Contractor Responsibility for snow clearing route through park	Contractor Responsibility for snow clearing route through park	Contractor Responsibility for snow clearing route through park
EISA	Included in EISA. No further approval required.	Indentified as potential secondary access in EISA. Would require additional submission and approval.	Indentified as potential secondary access in EISA. Would require additional submission and approval.	Indentified as potential secondary access in EISA. Would require additional submission and approval.
Louise McKinney Park:				
Impact to Trail Users	Approxmately 170 m of SUP, the only existing trail access from the east, would be closed to users during construction	Potentially additional 370m of SUP would be closed to use during construction	Approximately 310 m of maintenance access road would be unavailable to park management but this route is not a designated pathway so there would be no impact to formal trail system	Additional 450m of SUP would be closed to users during construction.
Impact to Programmed and Unprogrammed Park Uses	Does not affect programmed use; adjacent lands do not support unprogrammed use, therefore no impact.	Interrupts access to Riverside Promenade which supports programmed and unprogrammed use; impacts two businesses at the Riverfront Plaza. Indirect impact on quality of unprogammed use of adjacent lands.	Does not directly impact programmed use but indirectly impacts quality of unprogrammed use of adjacent lands.	No impact on programmed use but indirectly affects quality of unprgrammed use on adjacent lands.

Summary of Valley Line LRT West River Bank Access Alignments

Criteria	Cameron Avenue Alignment	West Alignment 1	West Alignment 2	West Alignment 3
Geotechnical:				
Decommissioned Landfill (limits approximated)	Within the landfill but very near the NE limits.	Eastern half is within the landfill. Test holes indicated the presence of uncontrolled fill soils mixed with waste materials. Depths are not confirmed in this location. The existing fill/waste subgrade could be unsuitable to support construction traffic.	Majority of this route is through the centre of the landfill. Test holes indicated the presence of uncontrolled fill soils mixed with waste materials up to 25 m thick. The existing fill/waste subgrade could be unsuitable to support construction traffic.	Eastern two-thirds descends into the landfill. Test holes indicated the presence of uncontrolled fill soils mixed with waste materials. Depths are not confirmed in this location. The existing fill/waste subgrade could be unsuitable to support construction traffic.
Construction Route Structure	The existing SUP structure is unknown, but unlikely to have been designed to support heavy construction traffic. SUP structure assessment/upgrading will be required.	The existing SUP structure is unknown, but unlikely to have been designed to support heavy construction traffic. SUP structure assessment/upgrading will be required. Access Road adjacent to the SUP would also need confirmation of suitable structure.	The condition of the existing maintenance access road structure is unknown, but unlikely to have been designed to support heavy construction traffic. Road structure assessment/upgrading will be required.	The existing SUP structure is unknown, but unlikely to have been designed to support heavy construction traffic. SUP structure assessment/upgrading will be required.
Slope Stability/Grierson Hill Slide	This option will have the least impact on the stability of the Grierson Hill slide		Fill embankment woud be required across the World Walk and SUP to get from maintenance road to tunnel portal site. Embankment fills will exert additional loading on the Grierson Hill and, depending on their height, can trigger slope movement. Will require geotechnical evaluations to determine the impact of the proposed fills on the stability of the valley slope.	This route (particularly the northern section) is close to the scarp/crest of the Grierson Hill slide. Fills, and to a lesser extent cuts, near the scarp of the slide could be detrimental to the stability of the slope (the worst location to add fills is at/near the crest of the slide). This option will require geotechnical evaluations to determine the impact of the proposed earth works on the stability of the valley slope. Fill and retaining wall required to access portal and therfore would be placing loading on the slope.

Appendix B: Temporary Construction Access Road – Geotechnical and Slope Stability Assessment (Thurber Engineering 2014) – Appended at the end of document

Appendix C: Vegetation Data

Appendix C - LMRP Vegetation Data

Species				**Louise McKinney Riverfront Park**				
Scientific Name	**Common Name**	**Origin**	**ACIMS Status**	**Grassland**	**Grass-Shrub**	**Manitoba Maple**	**Poplar-Manitoba Maple**	**Planted Beds**
Achillea millefolium	common yarrow	Native	S5	O				
Actaea rubra	red and white baneberry	Native	S5				F	
Aralia nudicaulis	wild sarsaparilla	Native	S5			R	A	
Arctium sp.	burdock	Noxious	SNA	F	O		R	
Artemisia absinthium	absinthe wormwood	Exotic	SNA	F	O		O	
Artemisia ludoviciana	prairie sagewort	Native	S5	O	O		R	
Brassica sp.	canola cultivar	Exotic	SNA	R	R			
Chenopodium album	lamb's-quarters	Exotic	SNA	F	A			
Cirsium arvense	creeping thistle	Noxious	SNA	F		O	R	
Cosmos sp.	cosmos cultivar	Exotic	SNA					
Dianthus sp.	pink cultivar	Exotic	SNA					
Epilobium angustifolium	common fireweed	Native	S5	R				
Erigeron sp.	fleabane	Native					R	
Erysimum cheiranthoides	wormseed mustard	Native	S5	O				
Euphorbia esula	leafy spurge	Noxious	SNA	R	R			
Eurybia conspicua	showy aster	Native	S5				F	
Galeopsis tetrahit	hemp-nettle	Exotic	SNA	R				
Galium boreale	northern bedstraw	Native	S5		R	R	A	
Kochia scoparia	summer-cypress	Exotic	SNA				R	
Lactuca serriola	prickly lettuce	Exotic	SNA	O	O		O	
Lappula squarrosa	bluebur	Exotic	SNA	R				
Lathyrus ochroleucus	cream-colored vetchling	Native	S5	F			F	
Lavatera sp.	lavatera cultivar	Exotic	SNA					
Linaria vulgaris	common toadflax	Noxious	SNA	O	F			

Appendix C - LMRP Vegetation Data

Species				Louise McKinney Riverfront Park				
Scientific Name	**Common Name**	**Origin**	**ACIMS Status**	**Grassland**	**Grass-Shrub**	**Manitoba Maple**	**Poplar-Manitoba Maple**	**Planted Beds**
Lotus corniculatus	bird's-foot trefoil	Exotic	SNA	R			O	
Maianthemum canadense	wild lily-of-the-valley	Native	S5				O	
Matricaria matricarioides	pineappleweed	Exotic	SNA		O			
Medicago sativa	alfalfa	Exotic	SNA	O	F		R	
Melilotus alba	white sweet-clover	Exotic	SNA	O	O		O	
Melilotus officinale	yellow sweet-clover	Exotic	SNA	O	F			
Mertensia paniculata	tall lungwort	Native	S5					
Osmorhiza longistylis	smooth sweet cicely	Native	S2				R	
Plantago major	common plantain	Exotic	SNA	O	x			
Polygonum convolvulus	wild buckwheat	Exotic	SNA	R				
Portulaca sp.	portulaca cultivar	Exotic	SNA					
Rumex occidentalis	western dock	Native	S5	R				
Senecio vulgaris	common groundsel	Exotic	SNA				O	
Silene pratense	white cockle	Noxious	SNA	O				
Smilacina racemosa	false Solomon's-seal	Native	S5				O	
Smilacina stellata	star-flowered Solomon's-seal	Native	S5		R		F	
Solidago canadensis	Canada goldenrod	Native	S5				O	
Sonchus sp.	sow-thistle	Exotic	SNA	O			R	
Spiraea sp.	meadowsweet	Exotic	SNA					
Symphyotrichum ciliolatum	Lindley's aster	Native	S5				F	
Symphyotrichum puniceum	purple-stemmed aster	Native	S4				O	
Tanacetum vulgare	common tansy	Noxious	SNA				R	
Taraxacum officinale	common dandelion	Exotic	SNA	F	R		O	

Appendix C - LMRP Vegetation Data

Species				Louise McKinney Riverfront Park				
Scientific Name	**Common Name**	**Origin**	**ACIMS Status**	**Grassland**	**Grass-Shrub**	**Manitoba Maple**	**Poplar-Manitoba Maple**	**Planted Beds**
Thlaspi arvense	stinkweed	Exotic	SNA	O	O		R	
Tragopogon dubius	common goat's-beard	Exotic	SNA	O				
Trifolium hybridum	alsike clover	Exotic	SNA	A			O	
Trifolium pratense	white clover	Exotic	SNA				O	
Trifolium repens	red clover	Exotic	SNA	F				
Urtica dioica	common nettle	Native	S5				R	
Veronica peregrina	hairy speedwell	Native	S5	R				
Vicia americana	wild vetch	Native	S5	A	O		A	
Vicia cracca	tufted vetch	Exotic	SNA	O			R	
Viola canadensis	western Canada violet	Native	S5				O	
Agropyron pectiniforme	crested wheatgrass	Exotic	SNA	A	F		O	
Agropyron sp.	wheatgrass	Exotic	SNA					
Avena sp.	oat cultivar	Exotic	SNA	R	R			
Bromus inermis	smooth brome	Exotic	SNA	D	D	A	D	
Elymus lanceolatus	northern wheatgrass	Native	S5	A				
Elymus trachycaulus	slender wheatgrass	Native	S5	A	A		O	
Elytrigia repens	quack grass	Exotic	SNA	A	A	F	F	
Hordeum jubatum	foxtail barley	Native	S5	O	O		O	
Leymus innovatus	hairy wild rye	Native	S5				R	
Phalaris arundinacea	reed canary grass	Native	S5	D	O	A		
Phleum pratense	timothy	Exotic	SNA	R				
Poa pratensis	Kentucky bluegrass	Native	S5	A	A	F	O	
Alnus viridis							O	
Amelanchier alnifolia	saskatoon	Native	S5				F	
Caragana arborescens	common caragana	Exotic	SNA	O	A/D			

Appendix C - LMRP Vegetation Data

Species				**Louise McKinney Riverfront Park**				
Scientific Name	**Common Name**	**Origin**	**ACIMS Status**	**Grassland**	**Grass-Shrub**	**Manitoba Maple**	**Poplar-Manitoba Maple**	**Planted Beds**
Cornus sp.	variegated dogwood	Exotic	SNA					x
Cornus stolonifera	red-osier dogwood	Native	S5			O	A	
Corylus cornuta	beaked hazelnut	Native	S5				x	
Crataegus sp.	hawthorn cultivar	Exotic	SNA		O			
Elaeagnus sp.	oleaster	Exotic	SNA	O				x
Lonicera dioica	twining honeysuckle	Native	S5				R	
Lonicera involucrata	bracted honeysuckle	Native	S5				O	
Lycium sp.	goji berry	Exotic	SNA		R		R	
Prunus pensylvanica	pin cherry	Native	S5				O	
Prunus sp.	cherry	Exotic	SNA					
Prunus virginiana	chokecherry	Native	S5	R			F	
Ribes hirtellum	wild gooseberry	Native	S4				O	
Ribes triste	wild red currant	Native	S5				F	
Rosa acicularis	prickly rose	Native	S5	A			D	
Rosa sp.	rose	Exotic	SNA					x
Sorbus acuparia	European mountain-ash	Exotic	SNA				R	
Symphoricarpos alba	snowberry	Native	S5				A	
Symphoricarpos occidentalis	buckbrush	Native	S5	A	F			
Syringa vulgaris	common lilac	Exotic	SNA		O/A			
Viburnum edule	low-bush cranberry	Native	S5				F	
Acer negundo	Manitoba maple	Exotic	SNA	O	F	D	D	
Acer sp.	maple	Exotic	SNA					
Aesculus glabra	Ohio buckeye	Exotic	SNA					
Fraxinus pensylvanicus	green ash	Exotic	SNA					

Appendix C - LMRP Vegetation Data

Species				Louise McKinney Riverfront Park				
Scientific Name	**Common Name**	**Origin**	**ACIMS Status**	**Grassland**	**Grass-Shrub**	**Manitoba Maple**	**Poplar-Manitoba Maple**	**Planted Beds**
Larix laricina	tamarack	Native	S5	R				
Larix sp.	larch	Exotic	SNA					x
Picea pungens	blue spruce	Exotic	SNA					x
Pinus banksiana					F	r		
Pinus contorta	lodgepole pine	Native	S5	O				x
Pinus sp.	pine	Exotic	SNA					
Populus balsamifera	balsam poplar	Native	S5	O	F	O	D	
Populus sp.	columnar poplar	Exotic	SNA					x
Populus tremuloides	aspen	Native	S5	O			F	
Quercus sp.	oak	Exotic	SNA					x
Number of Species				52	34	11	58	8

Appendix D: Wildlife Species Potentially Found in the Study Areas

Appendix D - Wildlife Species Potentially Found in the LMRP Study Area

Common Name	Scientific Name	Species Group	Provincial Status (General Status of AB Wild Species)	Wildlife Act Designation and New Species Assessed by ESCC (see Comments)	COSEWIC Designation	SARA Designation	EDMONTON AREA (within 100 km)	Species Recorded in Study Area	Potential Habitat Use	Likelihood of Occurrence
Canadian Toad	*Anaxyrus hemiophrys*	A	May Be At Risk	Data Deficient	Not at Risk / HP Candidate (SSC)		R	FWMIS (1914, 1950, 1957)	Wintering	Low
Alder Flycatcher	*Empidonax alnorum*	B	Secure				B			
American Crow	*Corvus brachyrhynchos*	B	Secure				B	eBird		
American Goldfinch	*Spinus tristis*	B	Secure				B			
American Kestrel	*Falco sparverius*	B	Sensitive		LP Candidate (SSC)		B		Foraging	Low
American Redstart	*Setophaga ruticilla*	B	Secure				B			
American Robin	*Turdus migratorius*	B	Secure				B	BBS, eBird		
American White Pelican	*Pelecanus erythrorhynchos*	B	Sensitive		Not at Risk		B	eBird	Foraging	High
Bald Eagle	*Haliaeetus leucocephalus*	B	Sensitive		Not at Risk		B		Foraging	Moderate
Baltimore Oriole	*Icterus galbula*	B	Sensitive				B		Breeding	Moderate
Bank Swallow	*Riparia riparia*	B	Secure		Threatened		B	eBird, personal obs	Foraging	High
Barn Swallow	*Hirundo rustica*	B	Sensitive		Threatened		B		Foraging	Low
Belted Kingfisher	*Megaceryle alcyon*	B	Secure		LP Candidate (SSC)		B			
Black Tern	*Chlidonias niger*	B	Sensitive		Not at Risk		B		Foraging	Moderate
Black-and-white Warbler	*Mniotilta varia*	B	Secure				B			
Blue-winged Teal	*Anas discors*	B	Secure				B			
Bonaparte's Gull	*Chroicocephalus philadelphia*	B	Secure				B			
Brewer's Blackbird	*Euphagus cyanocephalus*	B	Secure				B			
Broad-winged Hawk	*Buteo platypterus*	B	Sensitive				B		Foraging	Low
Brown-headed Cowbird	*Molothrus ater*	B	Secure				B			
Bufflehead	*Bucephala albeola*	B	Secure				B			
California Gull	*Larus californicus*	B	Secure				B	eBird		
Canada Goose	*Branta canadensis*	B	Secure				B			
Cedar Waxwing	*Bombycilla cedrorum*	B	Secure				B	eBird		
Chipping Sparrow	*Spizella passerina*	B	Secure				B	BBS, eBird		
Clay-colored Sparrow	*Spizella pallida*	B	Secure				B	BBS, eBird		
Cliff Swallow	*Petrochelidon pyrrhonota*	B	Secure				B			
Common Goldeneye	*Bucephala clangula*	B	Secure				B			
Common Grackle	*Quiscalus quiscula*	B	Secure				B			
Common Loon	*Gavia immer*	B	Secure		Not at Risk		B			
Common Merganser	*Mergus merganser*	B	Secure				B	eBird		
Common Nighthawk	*Chordeiles minor*	B	Sensitive		Threatened (see Status Report)	Schedule 1 (Threatened)	B		Foraging	Low
Common Tern	*Sterna hirundo*	B	Secure		Not at Risk		B			
Common Yellowthroat	*Geothlypis trichas*	B	Sensitive				B		Foraging	Low
Connecticut Warbler	*Oporornis agilis*	B	Secure		LP Candidate (SSC)		B			
Cooper's Hawk	*Accipiter cooperii*	B	Secure		Not at Risk		B			
Dark-eyed Junco	*Junco hyemalis*	B	Secure				B			
Double-crested Cormorant	*Phalacrocorax auritus*	B	Secure		Not at Risk		B			
Eastern Kingbird	*Tyrannus tyrannus*	B	Secure		LP Candidate (SSC)		B			
Eastern Phoebe	*Sayornis phoebe*	B	Sensitive				B		Breeding	Moderate
European Starling	*Sturnus vulgaris*	B	Exotic/Alien				B	eBird		
Forster's Tern	*Sterna forsteri*	B	Sensitive		Data Deficient		B		Foraging	Low
Franklin's Gull	*Leucophaeus pipixcan*	B	Secure				B	eBird		
Golden-crowned Kinglet	*Regulus satrapa*	B	Secure				B			
Gray Catbird	*Dumetella carolinensis*	B	Secure				B	BBS		
Great Blue Heron	*Ardea herodias*	B	Sensitive				B		Foraging	Moderate
Greater Yellowlegs	*Tringa melanoleuca*	B	Secure				B			

Green-winged Teal	*Anas crecca carolinensis*	B	Sensitive				B		Foraging	Moderate
Hermit Thrush	*Catharus guttatus*	B	Secure				B			
Herring Gull	*Larus argentatus*	B	Secure				B	eBird		
House Wren	*Troglodytes aedon*	B	Secure				B			
Killdeer	*Charadrius vociferus*	B	Secure		LP Candidate (SSC)		B			
Least Flycatcher	*Empidonax minimus*	B	Sensitive		LP Candidate (SSC)		B		Breeding	Moderate
Lesser Yellowlegs	*Tringa flavipes*	B	Secure				B			
Lincoln's Sparrow	*Melospiza lincolnii*	B	Secure				B			
Magnolia Warbler	*Setophaga magnolia*	B	Secure				B			
Mallard	*Anas platyrhynchos*	B	Secure				B	eBird		
Merlin	*Falco columbarius*	B	Secure		Not at Risk		B			
Mountain Bluebird	*Sialia currucoides*	B	Secure				B			
Mourning Dove	*Zenaida macroura*	B	Secure				B			
Northern Flicker	*Colaptes auratus*	B	Secure				B			
Northern Harrier	*Circus cyaneus*	B	Sensitive		Not at Risk		B		Foraging	Low
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	B	Secure				B			
Orange-crowned Warbler	*Oreothlypis celata*	B	Secure				B			
Osprey	*Pandion haliaetus*	B	Sensitive				B		Foraging	Moderate
Ovenbird	*Seiurus aurocapilla*	B	Secure				B			
Peregrine Falcon	*Falco peregrinus anatum*	B	At Risk	Threatened	Special Concern (see Comments	Schedule 1 (Special Conce	B	FWMIS	Foraging	High
Purple Finch	*Carpodacus purpureus*	B	Secure				B			
Purple Martin	*Progne subis*	B	Sensitive				B		Migrating	Moderate
Red-eyed Vireo	*Vireo olivaceus*	B	Secure				B	eBird		
Red-tailed Hawk	*Buteo jamaicensis*	B	Secure		Not at Risk		B			
Red-winged Blackbird	*Agelaius phoeniceus*	B	Secure				B			
Ring-billed Gull	*Larus delawarensis*	B	Secure				B	eBird		
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	B	Secure				B			
Ruby-crowned Kinglet	*Regulus calendula*	B	Secure				B			
Ruby-throated Hummingbird	*Archilochus colubris*	B	Secure				B			
Savannah Sparrow	*Passerculus sandwichensis*	B	Secure				B	eBird		
Sharp-shinned Hawk	*Accipiter striatus*	B	Secure		Not at Risk		B			
Short-eared Owl	*Asio flammeus*	B	May Be At Risk		Special Concern		B		Breeding	Low
Solitary Sandpiper	*Tringa solitaria*	B	Secure				B			
Song Sparrow	*Melospiza melodia*	B	Secure				B	BBS, eBird		
Spotted Sandpiper	*Actitis macularius*	B	Secure				B	eBird		
Swainson's Hawk	*Buteo swainsoni*	B	Sensitive				B	eBird	Foraging	High
Swainson's Thrush	*Catharus ustulatus*	B	Secure				B			
Swamp Sparrow	*Melospiza georgiana*	B	Secure				B			
Tennessee Warbler	*Oreothlypis peregrina*	B	Secure				B			
Tree Swallow	*Tachycineta bicolor*	B	Secure				B			
Veery	*Catharus fuscescens*	B	Secure				B			
Vesper Sparrow	*Pooecetes gramineus*	B	Secure				B			
Warbling Vireo	*Vireo gilvus*	B	Secure				B			
Western Tanager	*Piranga ludoviciana*	B	Sensitive				B		Foraging	Low
Western Wood-pewee	*Contopus sordidulus*	B	Sensitive				B		Foraging	Moderate
White-throated Sparrow	*Zonotrichia albicollis*	B	Secure				B			
Yellow Warbler	*Setophaga petechia*	B	Secure				B	BBS, eBird		
Yellow-bellied Sapsucker	*Sphyrapicus varius*	B	Secure				B			
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	B	Secure				B			
Yellow-rumped Warbler	*Setophaga coronata*	B	Secure				B			
American Tree Sparrow	*Spizella arborea*	B	Secure				M			
Bay-breasted Warbler	*Setophaga castanea*	B	Sensitive	In Process (see Comments)			M		Migrating	Low

Appendix D - Wildlife Species Potentially Found in the LMRP Study Area

Cape May Warbler	*Setophaga tigrina*	B	Sensitive	In Process (see Comments)			M		Migrating	Low
Glaucous Gull	*Larus hyperboreus*	B	Secure				M			
Harris's Sparrow	*Zonotrichia querula*	B	Secure		HP Candidate (SSC)		M			
Mew Gull	*Larus canus*	B	Secure				M			
Northern Waterthrush	*Parkesia noveboracensis*	B	Secure				M			
Sabine's Gull	*Xema sabini*	B	Secure				M			
Thayer's Gull	*Larus thayeri*	B	Secure				M			
White-crowned Sparrow	*Zonotrichia leucophrys*	B	Secure				M	eBird		
Wilson's Warbler	*Cardellina pusilla*	B	Secure				M			
Barred Owl	*Strix varia*	B	Sensitive	Special Concern			R		Foraging	Low
Black-billed Magpie	*Pica hudsonia*	B	Secure				R	BBS, eBird		
Black-capped Chickadee	*Poecile atricapillus*	B	Secure				R	eBird		
Blue Jay	*Cyanocitta cristata*	B	Secure				R			
Boreal Chickadee	*Poecile hudsonicus*	B	Secure				R			
Common Raven	*Corvus corax*	B	Secure				R			
Downy Woodpecker	*Picoides pubescens*	B	Secure				R			
Evening Grosbeak	*Coccothraustes vespertinus*	B	Secure				R			
Gray Partridge	*Perdix perdix*	B	Exotic/Alien				R			
Great Horned Owl	*Bubo virginianus*	B	Secure				R			
Hairy Woodpecker	*Picoides villosus*	B	Secure				R			
House Finch	*Carpodacus mexicanus*	B	Secure				R	BBS		
House Sparrow	*Passer domesticus*	B	Exotic/Alien				R	eBird		
Northern Goshawk	*Accipiter gentilis atricapillus*	B	Sensitive		Not at Risk (see Comments)		R		Foraging	Moderate
Northern Saw-whet Owl	*Aegolius acadicus*	B	Secure				R			
Pileated Woodpecker	*Dryocopus pileatus*	B	Sensitive				R		Foraging	Moderate
Pine Siskin	*Spinus pinus*	B	Secure				R			
Red-breasted Nuthatch	*Sitta canadensis*	B	Secure				R			
Rock Pigeon	*Columba livia*	B	Exotic/Alien				R	eBird		
White-breasted Nuthatch	*Sitta carolinensis*	B	Secure				R			
Bohemian Waxwing	*Bombycilla garrulus*	B	Secure				W			
Common Redpoll	*Acanthis flammea*	B	Secure				W			
Hoary Redpoll	*Acanthis hornemanni*	B	Secure				W			
Red Crossbill	*Loxia curvirostra*	B	Secure				W			
Snow Bunting	*Plectrophenax nivalis*	B	Secure				W			
White-winged Crossbill	*Loxia leucoptera*	B	Secure				W			
Hoary Bat	*Lasiurus cinereus*	M	Sensitive				B	FWMIS	Foraging	High
American Beaver	*Castor canadensis*	M	Secure				R			
Arctic Shrew	*Sorex arcticus*	M	Secure				R			
Big Brown Bat	*Eptesicus fuscus*	M	Secure				R			
Common Porcupine	*Erethizon dorsatum*	M	Secure				R			
Coyote	*Canis latrans*	M	Secure				R	Murray 2014		
Deer Mouse	*Peromyscus maniculatus*	M	Secure				R			
Dusky Shrew	*Sorex monticolus*	M	Secure				R			
Ermine	*Mustela erminea*	M	Secure				R			
House Mouse	*Mus musculus*	M	Exotic/Alien				R			
Least Chipmunk	*Tamias minimus*	M	Secure				R			
Little Brown Bat	***Myotis lucifugus***	M	Secure		**Endangered**	**Endangered**	R		Foraging, roo	Moderate
Long-tailed Weasel	*Mustela frenata*	M	May Be At Risk		Not at Risk (see Comments)		R		Foraging	Low
Masked Shrew	*Sorex cinereus*	M	Secure				R			
Meadow Jumping Mouse	*Zapus hudsonius*	M	Secure				R			
Meadow Vole	*Microtus pennsylvanicus*	M	Secure				R			
Mink	*Neovison vison*	M	Secure				R			

Appendix D - Wildlife Species Potentially Found in the LMRP Study Area

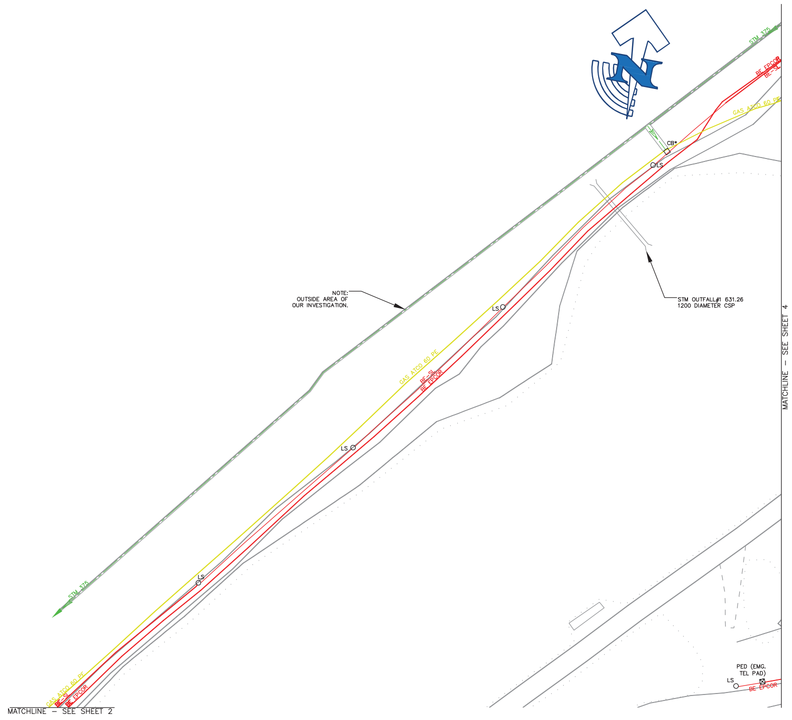
Moose	*Alces alces*	M	Secure				R			
Mule Deer	*Odocoileus hemionus*	M	Secure				R			
Muskrat	*Ondatra zibethicus*	M	Secure				R			
Northern Bat	***Myotis septentrionalis***	M	May Be At Risk	Data Deficient	**Endangered**		R		Foraging	Low
Northern Flying Squirrel	*Glaucomys sabrinus*	M	Secure				R			
Northern Pocket Gopher	*Thomomys talpoides*	M	Secure				R			
Prairie Shrew	*Sorex haydeni*	M	Secure				R			
Pygmy Shrew	*Sorex hoyi*	M	Secure				R			
Red Fox	*Vulpes vulpes*	M	Secure				R			
Red Squirrel	*Tamiasciurus hudsonicus*	M	Secure				R	BBS		
Richardson's Ground Squirrel	*Spermophilus richardsonii*	M	Secure				R	Spencer 2005		
Snowshoe Hare	*Lepus americanus*	M	Secure				R			
Southern Red-backed Vole	*Clethrionomys gapperi*	M	Secure				R			
Striped Skunk	*Mephitis mephitis*	M	Secure				R			
Western Jumping Mouse	*Zapus princeps*	M	Secure				R			
White-tailed Deer	*Odocoileus virginianus*	M	Secure				R			
White-tailed Jack Rabbit	*Lepus townsendii*	M	Secure				R	BBS		
Common Garter Snake	*Thamnophis sirtalis*	R	Sensitive	LP Candidate	LP Candidate (SSC)		R		Foraging	Moderate
Plains Garter Snake	*Thamnophis radix*	R	Sensitive	MP Candidate	MP Candidate (SSC)		R		Foraging	Low

Appendix E: Special Status Wildlife Species Potentially Found in the Study Areas

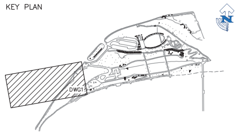
Appendix E - Special Status Wildlife Species Potentially Found in the LMRP Study Area

Common Name	**Scientific Name**	**Provincial Status (General Status of AB Wild Species)**	**Wildlife Act Designation and New Species Assessed by ESCC (see Comments)**	**COSEWIC Designation**	**SARA Designation under Schedule 1**	EDMONTON AREA (within 100 km)	Species Recorded in Study Area	Potential Habitat Use	Likelihood of Occurrence
Bank Swallow	*Riparia riparia*	Secure		Threatened		B	eBird, personal obs	Foraging	High
Peregrine Falcon	*Falco peregrinus anatum*	At Risk	Threatened	Special Concern	Special Concern	B	FWMIS	Foraging	High
Little Brown Bat	*Myotis lucifugus*	Secure		Endangered	Endangered	R		Foraging, roosting	Moderate

Appendix F: LMRP Subsurface Utilities (T2 Utility Engineers 2013)



KEY PLAN



NOT TO SCALE

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LEGEND

GAS	GAS
G.S.	GAS SERVICE
WM	WATER
W.S.	WATER SERVICE
SAN	SANITARY SEWER
SAN LAT.	SANITARY LATERAL
STM	STORM SEWER
STM LAT.	STORM LATERAL
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BE–SL	BURIED ELECTRIC STREET LIGHT
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TV	CABLE TV
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– – – –	QUALITY LEVEL "C"
— · — ·	QUALITY LEVEL "D"
⌖	TEST HOLE (QL–A)
►	CONTINUATION ARROW
▷	FLOW ARROW
[	END CAP
*	NOT SURVEYED, LOCATION BASED ON FIELD OBSERVATION
#	NOT SURVEYED, LOCATION BASED ON RECORD INFORMATION

TEST HOLE INFORMATION

Utility Type

BE	Buried Electric	CATV	Cable Television
G	Gas	FM	Force Main
BT	Buried Telecom	RW	Reclaimed Water
FOC	Fibre Optic Cable	SL	Street Light
W	Water	TS	Traffic Signal
SAN	Sanitary	EXP	Exploratory
STM	Storm	UNK	Unknown

Utility Material

DBC	Direct Buried Cable	CNP	Concrete Pipe
UNK	Unknown	CMP	Corrugated Metal Pipe
MET	Metallic	CC	Concrete/Clay Cap
CP	Clay Pipe	PL	Plastic
AC	Asbestos Cement (Transite)	CD	Concrete Duct
CP	Copper Pipe	HDPE	Heavy Duty Polyethylene
PE	Poly Ethylene		

Surface Type

A	Asphalt	C	Concrete	[illegible]	[illegible]	NG	Natural Ground

Test #	Test Date (MM/DD/YY)	Station	Utility Type	Utility Material	Utility Size (Dia.) mm	Ref. Point Elev. m	Bottom of Utility Elev. m	Top of Utility Elev. m	Manual Depth From Grade Bottom m	Manual Depth From Grade Top m	Cross Sectional View	N	[illegible]	Surface Type	Pavement Thickness mm
1	3/4/13	–	G	PE	40	638.84	–	637.89	–	0.95	○	↘	Rod & Cap	NG	–
2*	3/4/13	–	EXP	–	–	638.87	–	–	2.97	–	–	–	Rod & Cap	NG	–
3*	3/4/13	–	EXP	–	–	636.13	–	–	2.93	–	–	–	Rod & Cap	NG	–
4*	3/4/13	–	EXP	–	–	629.79	–	–	1.98	1.98	–	–	Rod & Cap	NG	–
5	3/4/13	–	G	PE	40	628.26	–	627.33	–	0.93	○	↘	Rod & Cap	NG	–
6*	3/4/13	–	EXP	–	–	628.46	–	–	1.58	–	–	–	Rod & Cap	NG	–
7*	3/4/13	–	EXP	–	–	628.56	–	–	–	1.83	–	–	Rod & Cap	NG	–
8*	3/4/13	–	EXP	–	–	628.42	–	–	3.68	–	–	–	Rod & Cap	NG	–
9*	3/4/13	–	W	PL	300	628.93	–	625.61	–	3.32	▭	–	Rod & Cap	NG	–
10*	3/4/13	–	EXP	–	–	641.61	–	–	2.45	–	–	–	Rod & Cap	NG	–
11	3/4/13	–	W	HDPE	150	646.81	–	637.85	–	1.98	○	↘	Rod & Cap	NG	–
12*	3/4/13	–	EXP	–	–	646.70	–	–	4.59	–	–	–	Rod & Cap	NG	–
13*	3/4/13	–	EXP	–	–	641.01	–	–	3.38	–	–	–	Rod & Cap	NG	–

NOTES:

TH2 - Went down 1.30m looking for gas until a hard layer was hit. Then went over 1.0m in each direction from ref. pin in center of hole. Poor signal, previous pipe may have been removed. Went down 2.97m total to make sure it was not there. No sign of anything.

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REVISIONS

△	
△	
△	

DISCLAIMER.

PREPARED BY.

T2 utility engineers
1-855-222-T2UE | WWW.T2UE.COM

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LAWRENCE E. ARCAND

		DATE (MM/DD/YY)
DRAWN	A. JACKSON–WYATT	03/28/13
CHECKED	R. GRINTON	03/28/13
APPROVED	L. ARCAND	03/28/13
SCALE	1:500	0 5 10 15 20m

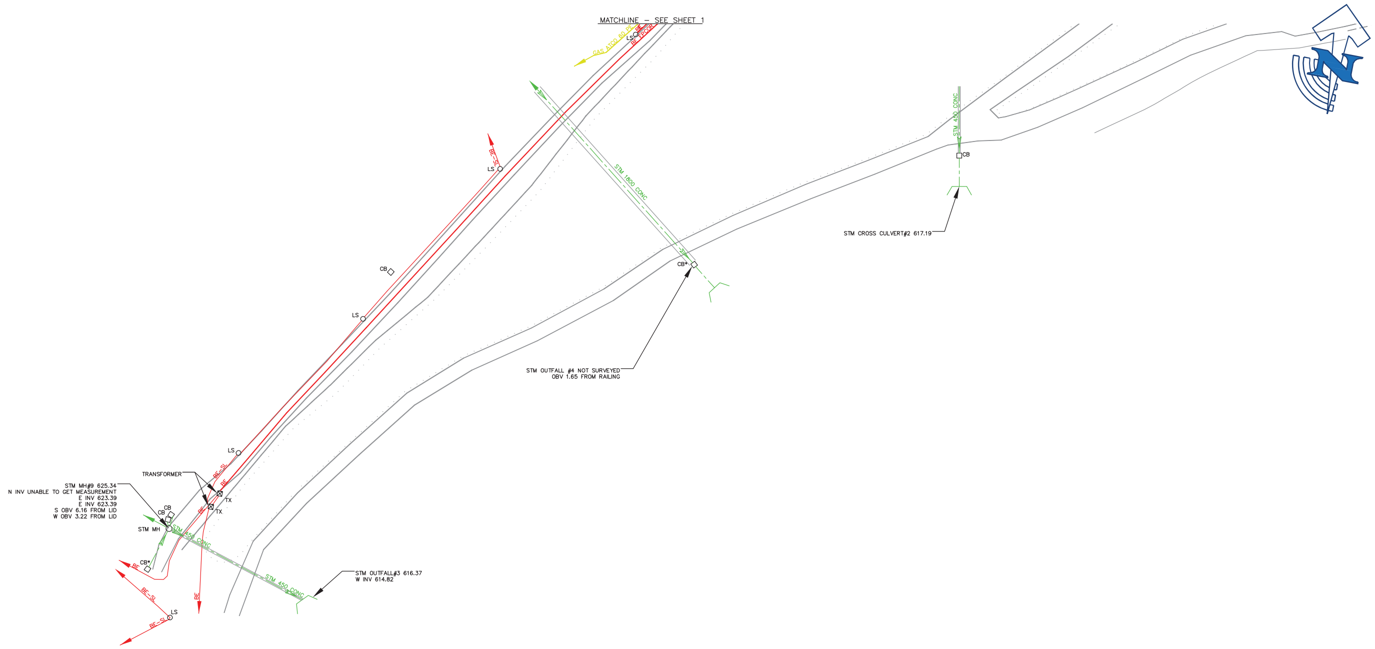
PROJECT.
LOUISE McKINNEY RIVERFRONT PARK
EDMONTON, AB

DRAWING.
SUBSURFACE UTITLITY ENGINEERING
MAPPING SERVICES

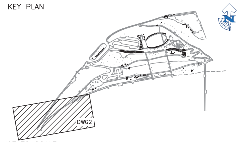
CLIENT.
AECOM

PROJECT NO.
61000100

SHEET NO.
01 OF 06



KEY PLAN



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TEST HOLE INFORMATION

REVISIONS

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PREPARED BY.

T2 utility engineers
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SCALE	1:500	0 5 10 15 20m

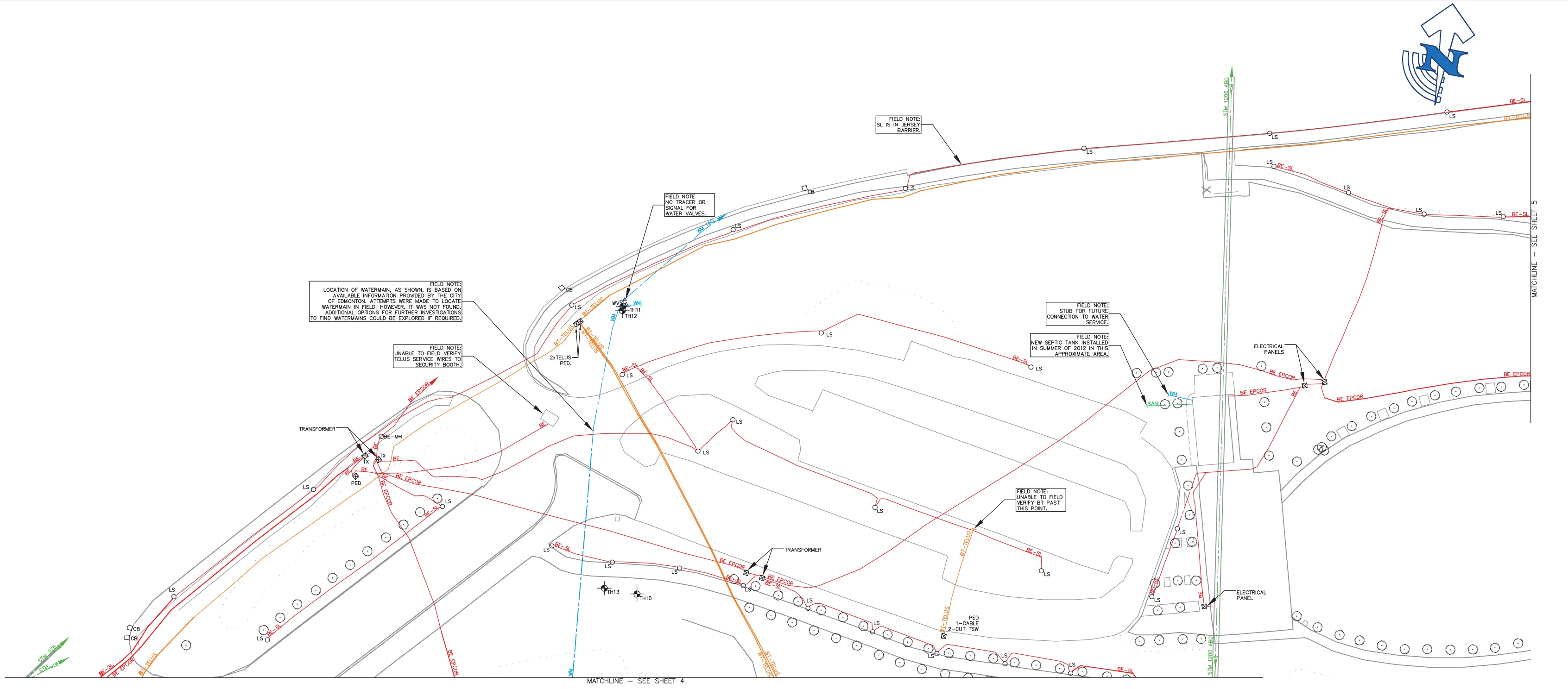
PROJECT.
LOUISE McKINNEY RIVERFRONT PARK
EDMONTON, AB

DRAWING.
SUBSURFACE UTITLITY ENGINEERING
MAPPING SERVICES

CLIENT.
AECOM

PROJECT NO.
61000100

SHEET NO.
02 OF 06



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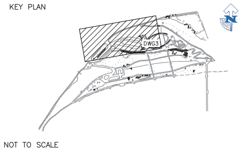

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STM	Storm	UNK	Unknown	PE	Poly Ethylene		

Surface Type

A Asphalt C Concrete G Gravel NG Natural Ground

Hole	Test Date (MM/DD/YY)	Station	Utility Type	Utility Material	Utility Width (Dim)	Ref. Point Elev.	Bottom of Utility Elev.	Top of Utility Elev.	Manual Depth From Grade		Cross Sectional Type	N	[illegible]	Surface Type	Pavement Thickness
									Bottom	Top					
					mm	m	m	m	m	m					mm
1	3/4/13	–	G	PE	40	638.84	–	637.89	–	0.95	○	↘	Rod & Cap	NG	–
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NOTES:

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		DATE (MM/DD/YY)
DRAWN	A. JACKSON–WYATT	03/28/13
CHECKED	R. GRINTON	03/28/13
APPROVED	L. ARCAND	03/28/13

SCALE 1:500 0 5 10 15 20m

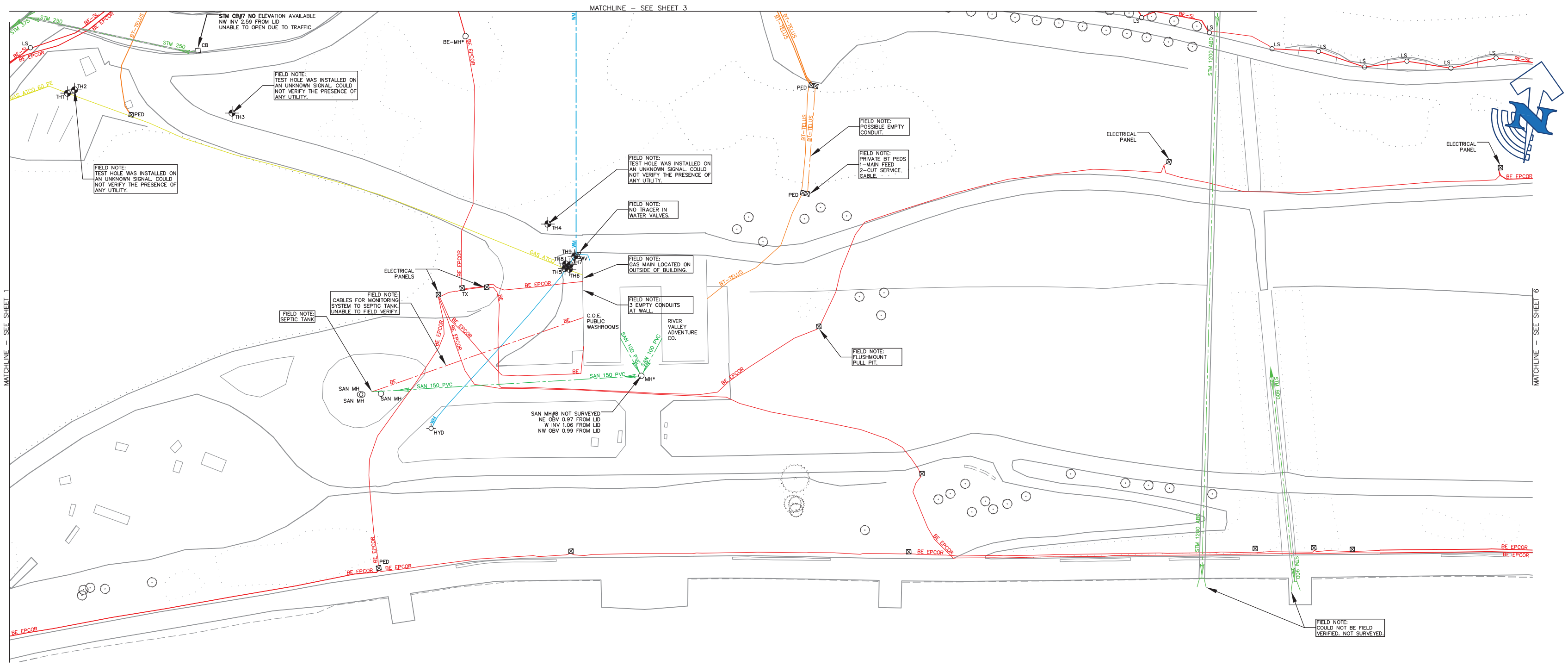
PROJECT.
LOUISE McKINNEY RIVERFRONT PARK
EDMONTON, AB

DRAWING.
SUBSURFACE UTITLITY ENGINEERING
MAPPING SERVICES

CLIENT.
AECOM

PROJECT NO.
61000100

SHEET NO.
03 OF 06



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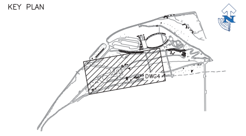

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GAS	GAS
G.S.	GAS SERVICE
WM	WATER
W.S.	WATER SERVICE
SAN	SANITARY SEWER
SAN LAT.	SANITARY LATERAL
STM	STORM SEWER
STM LAT.	STORM LATERAL
BE	BURIED ELECTRIC
BE–SL	BURIED ELECTRIC STREET LIGHT
BE–TL	BURIED ELECTRIC TRAFFIC LIGHT
UNK	UNKNOWN
FOC	FIBRE OPTIC CABLE
TV	CABLE TV
BT	BURIED TELECOMMUNICATIONS
——O/H——	OVERHEAD WIRE
————	QUALITY LEVEL "B"
– – – –	QUALITY LEVEL "C"
—— - ——	QUALITY LEVEL "D"
⊕	TEST HOLE (QL–A)
►	CONTINUATION ARROW
▷	FLOW ARROW
[	END CAP
*	NOT SURVEYED, LOCATION BASED ON FIELD OBSERVATION
#	NOT SURVEYED, LOCATION BASED ON RECORD INFORMATION

TEST HOLE INFORMATION

REVISIONS

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△

DISCLAIMER.

PREPARED BY.

T2 utility engineers
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LAWRENCE E. ARCAND

		DATE (MM/DD/YY)
DRAWN	A. JACKSON–WYATT	03/28/13
CHECKED	R. GRINTON	03/28/13
APPROVED	L. ARCAND	03/28/13

SCALE 1:500

0 5 10 15 20m

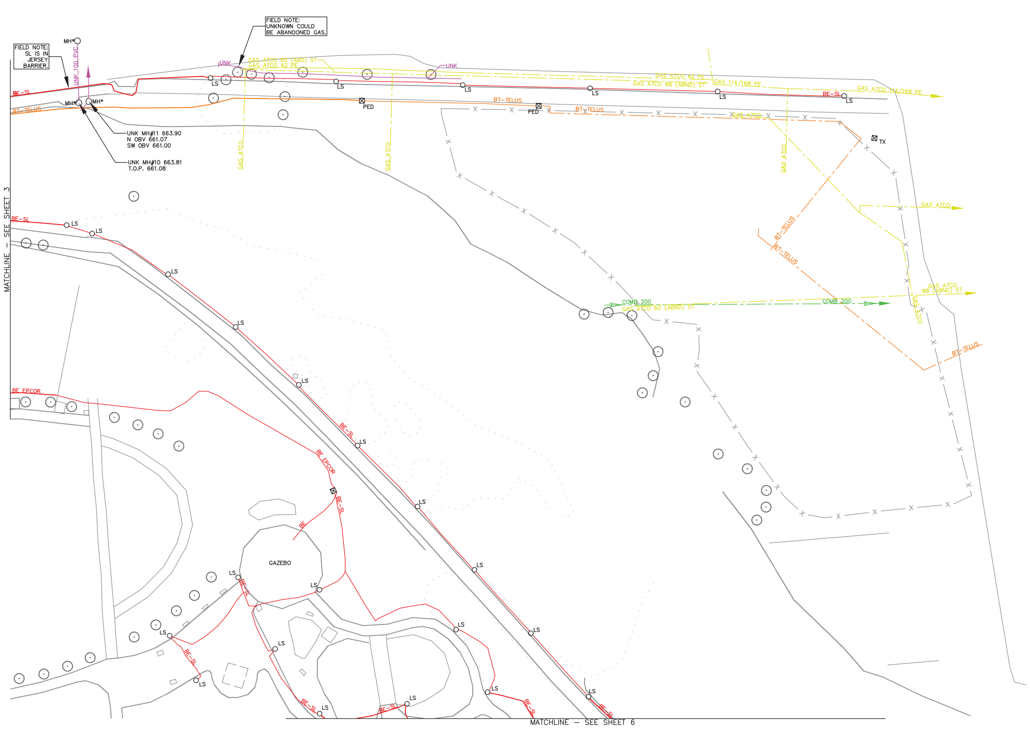
PROJECT.
LOUISE McKINNEY RIVERFRONT PARK
EDMONTON, AB

DRAWING.
SUBSURFACE UTITLITY ENGINEERING
MAPPING SERVICES

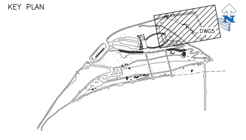
CLIENT.
AECOM

PROJECT NO.
61000100

SHEET NO.
04 OF 06



KEY PLAN



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W.S.	WATER SERVICE
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SAN LAT.	SANITARY LATERAL
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STM LAT.	STORM LATERAL
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BE–SL	BURIED ELECTRIC STREET LIGHT
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UNK	UNKNOWN
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O/H	OVERHEAD WIRE
———	QUALITY LEVEL "B"
– – – –	QUALITY LEVEL "C"
—— - ——	QUALITY LEVEL "D"
⊕	TEST HOLE (QL–A)
▶	CONTINUATION ARROW
➢	FLOW ARROW
[	END CAP
*	NOT SURVEYED, LOCATION BASED ON FIELD OBSERVATION
#	NOT SURVEYED, LOCATION BASED ON RECORD INFORMATION

TEST HOLE INFORMATION

Utility Type

BE	Buried Electric	CATV	Cable Television
G	Gas	FM	Force Main
BT	Buried Telecom	RW	Reclaimed Water
FOC	Fibre Optic Cab	SL	Street Light
W	Water	TS	Traffic Signal
SAN	Sanitary	EXP	Exploratory
STM	Storm	UNK	Unknown

Utility Material

DBC	Direct Buried Cable	CNP	Concrete Pipe
UNK	Unknown	CMP	Corrugated Metal Pipe
MET	Metallic	CC	Concrete/Clay Cap
CP	Clay Pipe	PL	Plastic
AC	Asbestos Cement (Transite)	CD	Concrete Duct
CP	Copper Pipe	HDPE	Heavy Duty Polyethylene
PE	Poly Ethylene		

Surface Type

A Asphalt C Concrete [illegible] [illegible] NG Natural Ground

TH #	TH Date (MM/YY)	[illegible]	Utility Type	Utility Material	Utility Width (mm)	Ref Point Elev (m)	Bottom of Utility Elev (m)	Top of Utility Elev (m)	Manual Depth From Grade Bottom (m)	Manual Depth From Grade Top (m)	Cross Sectional View	N	[illegible]	Surface Type	Pavement Thickness (mm)
1	3/4/13	–	G	PE	40	638.84	–	637.89	–	0.95	○	↘	Rod & Cap	NG	–
2*	3/4/13	–	EXP	–	–	638.87	–	–	2.97	–	–	–	Rod & Cap	NG	–
3*	3/4/13	–	EXP	–	–	636.73	–	–	2.33	–	–	–	Rod & Cap	NG	–
4*	3/4/13	–	EXP	–	–	629.75	–	–	1.56	1.90	–	–	Rod & Cap	NG	–
5	3/4/13	–	G	PE	40	628.26	–	627.33	–	0.93	○	↘	Rod & Cap	NG	–
6*	3/4/13	–	EXP	–	–	628.46	–	–	1.58	–	–	–	Rod & Cap	NG	–
7*	3/4/13	–	EXP	–	–	628.58	–	–	–	1.85	–	–	Rod & Cap	NG	–
8*	3/4/13	–	EXP	–	–	628.42	–	–	3.63	–	–	–	Rod & Cap	NG	–
9*	3/4/13	–	W	PL	300	628.93	–	625.61	–	3.32	○□	–	Rod & Cap	NG	–
10*	3/4/13	–	EXP	–	–	641.61	–	–	2.45	–	–	–	Rod & Cap	NG	–
11	3/4/13	–	W	HDPE	150	646.81	–	637.85	–	1.98	○	↘	Rod & Cap	NG	–
12*	3/4/13	–	EXP	–	–	646.70	–	–	4.59	–	–	–	Rod & Cap	NG	–
13*	3/4/13	–	EXP	–	–	641.51	–	–	3.38	–	–	–	Rod & Cap	NG	–

NOTES:

TH2 - Went down 1.30m looking for gas until a hard layer was hit. Then went over 1.0m in each direction from ref. pin in center of hole. Poor signal, previous pipe may have been removed. Went down 2.97m total to make sure it was not there. No sign of anything.

TH3 - Vacced down looking for unknown and found hard U/R type ground at approximately 1.0m down. Able to break through on south end but unable to find anything. 2.3m depth, trench was 2.10m long.

TH4 - Looking for unknown. Made a hole 0.80m long, went down 1.56m, and was unable to find anything.

TH6 - Found concrete at 1.58m in hole. Began trenching SE to 1.20m.

TH7 - Got down to 1.85m and then hit asphalt. Went over 0.40m NE and still hit asphalt.

TH8 - Went down 3.63m with a 0.80m long trench. Unable to feel or see WM.

TH9 - Test hole was completed at the point where the service line to the public washrooms ties into the water main. It was measured at approximately 300mm, which is likely due to the tee fitting.

TH10 - EXP hole based on possible alignment of main. 2.45m down and 0.80m long trench.

TH12 - Searched for WM based on alignment of valves and proper entry into park area. Went down 4.59m across front of valve. Unable to find main, must be on a strange angle.

TH13 - Vacced out a 0.75m by 3.38m deep trench. Looking for watermain location based off probable position of main going from WV's in road. WV's at washroom building and survey. Unable to locate WM.

REVISIONS

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PREPARED BY.

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SCALE 1:500 0 5 10 15 20m

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DRAWING.
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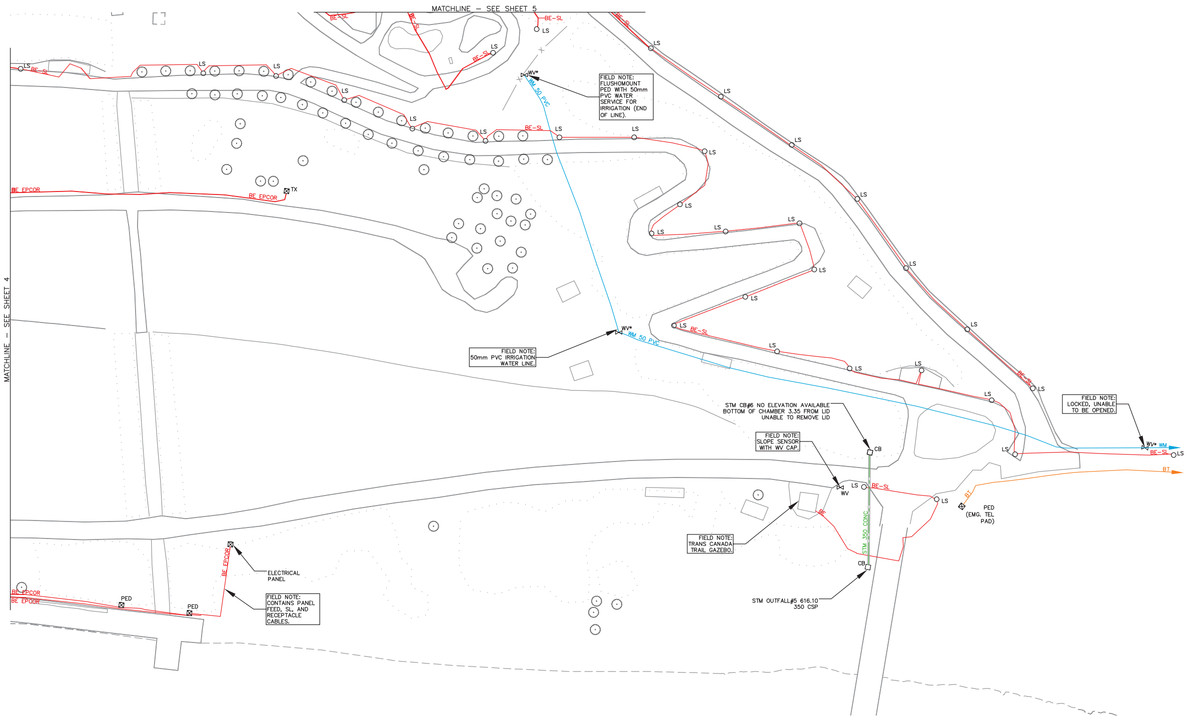
MAPPING SERVICES

CLIENT.
AECOM

PROJECT NO. 61000100

SHEET NO. 05 OF 06



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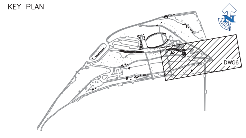

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CP	Copper Pipe	HDPE	Heavy Duty Polyethylene
PE	Poly Ethylene		

Surface Type

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TH #	Test Date (mm/dd/yy)	Station	Utility Type	Utility Material	Utility Size (Dia.)	Ref Point Elev.	Bottom of Utility Elev.	Top of Utility Elev.	Manual Depth From Grade		Cross Sectional Type	N	ID Info	Surface Type	Pavement Thickness
					mm	m	m	m	Bottom m	Top m					mm
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SCALE 1:500
0 5 10 15 20m

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DRAWING.
SUBSURFACE UTITLITY ENGINEERING
MAPPING SERVICES

CLIENT.
AECOM

PROJECT NO.
61000100

SHEET NO.
06 OF 06

APPENDIX B: TEMPORARY CONSTRUCTION ACCESS ROAD – GEOTECHNICAL AND SLOPE STABILITY ASSESSMENT

THURBER ENGINEERING LTD.

October 9, 2014 File: 19-5438-102

AECOM
#1200, 10235 - 101 Street
Edmonton, AB, T5J 3E9

Attention: Mr. Josh Jones, PMP

EDMONTON LIGHT RAIL TRANSIT – VALLEY LINE STAGE 1 SHORT TERM CONSTRUCTION ACCESS ROAD ON NORTH RIVERBANK PRELIMINARY GEOTECHNICAL INVESTIGATION AND SLOPE ASSESSMENT

Dear Sir,

This letter presents the results of a geotechnical investigation and a preliminary slope assessment for the proposed construction access road along the north riverbank that is being considered to facilitate the erection of Stage 1 of the Valley Line of Edmonton's Light Rail Transit system (LRT- VL).

The geotechnical investigation and the slope stability assessment presented herein were carried out in general accordance with our proposal letter to AECOM dated February 7, 2014. Authorization to proceed with the study was given by Mr. Josh Jones of AECOM.

Use of this report is subject to the Statement of Limitations and Conditions which is included at the end of the text of this report. The reader's attention is specifically drawn to these conditions as it is considered essential that they be followed for the proper use and interpretation of this report.

1. BACKGROUND

As part of the LRT-VL development, the design includes a long term maintenance and emergency access road to the north riverbank portal via Cameron Avenue. To minimize the impact of construction on the residential neighbourhood along Cameron Avenue, a separate, short term construction access road from the west through Louise McKinney Park is being considered. In November 2013, three alternate alignments of the construction access road were proposed by the design team. A high level, multi-disciplinary review of the three options (including a geotechnical review by Thurber) concluded that a west access from the Grierson Hill Road past the Riverfront Plaza along the existing southern Shared Use Path (SUP) seemed to be the least disruptive alternative. The findings of the review were presented to the City of Edmonton (the City) in a memorandum by ConnectEd Transit Partnership on December 19, 2013. In early 2014, the City requested ConnectEd to carry out a preliminary geotechnical investigation to evaluate the impact of the preferred construction access road on the overall stability of the north river valley slope in the project area.

Drawing No. 19-5438-102-1AR in Appendix A shows the preferred alignment of the construction access road. The topographic contours of the valley slope in the project area are also shown on the drawing. As discussed, upgrading of the existing SUP (both in terms of geometry and pavement structure) could be required to accommodate the anticipated construction traffic. No vertical alignment of the proposed construction access road was available at the time of this report. It is our understanding, however, that only minor grading works may be required to upgrade the access road to the required geometry.

From a geotechnical perspective, the temporary access road runs across the Grierson Hill slide which is only marginally stable. Depending on the extent of the required grading works and associated slope disturbances, construction of the access road could potentially impact the stability of the north river valley slope. An assessment of the potential impacts of the access road on the stability of the river valley slope is presented in this report.

As discussed in previous Thurber reports, the Grierson Hill slope was used as a waste dump for the City in the early 1900’s and random thick fills mixed with various municipal waste materials were encountered near the ground surface. As such, the condition of subgrade soils may be poor. Preliminary recommendations for a pavement structure more suited to supporting construction traffic on the access road are also provided.

2. SCOPE OF WORK

Given the objectives of the study (outlined earlier), our scope of work consisted of the following:

- Compile and review existing geological and geotechnical information pertaining to the Grierson Hill slide.
- Undertake a field drilling program to identify the subsurface conditions along the proposed access road alignment.
- Install geotechnical instruments to monitor slope movement and pore water pressure conditions.
- Undertake geotechnical assessment of the impact of the proposed access road on the overall stability of the north valley slope and provide preliminary recommendations on access road development.
- Carry out preliminary design for a pavement structure suitable for supporting anticipated construction traffic.

It should be mentioned that environmental assessments pertaining to the impacts of the proposed road on the Louise McKinney Park and the historic waste dump were not part of our scope of work.

3. AVAILABLE INFORMATION

The following documents were obtained and reviewed as part of this study:

- EBA Engineering Consultants Ltd., and Norbert R. Morgenstern Consultants Ltd., 1978. Edmonton Convention Centre geotechnical evaluation. Report submitted to the City of Edmonton, Department of Real Estate and Housing.

- EBA Engineering Consultants Ltd., 1981. Grierson Hill stabilization study. Report submitted to the City of Edmonton, Engineering Department/Parks and Recreation.

- EBA Engineering Consultants Ltd., 1989. Riverbank slope protection measures, Grierson Hill, Edmonton. Report submitted to the City of Edmonton Transportation Department.

- City of Edmonton, 2000. Slope indicator installation, Grierson Hill Road bike path.

- Hardy, R.M. & Associates Ltd. 1961. Third Report Re Grierson Hill, City of Edmonton, Alberta. Report submitted to the City of Edmonton.

- Martin, R.L., Williams, D.R., Balanko, L.A., and Morgenstern, N.R. 1984. The Grierson Hill slide, Edmonton, Alberta. Proceedings, 4th International Symposium on Landslides, Toronto, Canada Day Volume, pp. 125-133.

- Martin, R.L., Lewycky, D.M., and Ruban A.F., 1998. Long term movement rates in a large translational landslide. Proceedings, 51th Canadian Geotechnical Conference, Edmonton. Volume 1, pp. 23-30.

- Thurber Engineering Ltd., 2005. Louise McKinney park Riverfront Plaza - geotechnical investigation. Report submitted to the City of Edmonton. Project No. 14-31-212.

- Thurber Engineering Ltd., 2010. SE LRT expansion, North Saskatchewan river valley crossing, geotechnical data gathering. Report submitted to the City of Edmonton. Project No. 14-31-303.

- Thurber Engineering Ltd., 2011. Louise McKinney park Millennium Plaza phase 1 - geotechnical investigation. Report submitted to the City of Edmonton. Project No. 14-31-203A.

- Thurber Engineering Ltd., 2012. Edmonton southeast LRT extension Quarters to Connors road - an overall appraisal of geotechnical conditions along the LRT alignment. Report submitted to AECOM. Project No. 19-5438-68.

- Thurber Engineering Ltd., 2012. Edmonton southeast LRT transit expansion: preliminary study of the stability of the north valley slope – Grierson Hill slide area. Report submitted to AECOM. Project No. 19-5438-68C.

- Thurber Engineering Ltd., 2012. Edmonton's southeast light rail transit – Quarters to Cloverdale: preliminary assessment of stabilization piles for the north valley slope. Report submitted to AECOM. Project No. 19-5438-68C.

4. GEOLOGIC SETTING

The geologic conditions underlying the project area have been established based on published studies (Kathol and McPherson, 1975; Andriashek, 1988) and the results of recent and previous geotechnical investigations. The subsurface conditions along the alignment of the proposed access road are expected to consist of fill and colluvium material, overlying bedrock. The man-made fills at surface were associated with the waste disposal activities in the area up until about 1940, the grading works related to the development of Louise McKinney Park in the seventies, and the stabilization of the valley slope in the eighties. The underlying colluvium material consists of a mixture of till, clay, silt, sand, and gravel that were displaced and re-located downslope by the Grierson Hill Slide. The bottom horizons of the colluvium comprise, generally, bedrock that has been disturbed and weakened by the slide. The combined thickness of fill and colluvium in the Grierson Hill area varied significantly from one location to the other, and was up to about 23 m in one test hole.

The undisturbed bedrock underlying the project area is of the Upper Cretaceous Edmonton Formation, which consists of interbedded layers of clay shale, sandstone, and siltstone. Coal layers and bentonite seams of variable thickness are frequently encountered throughout the bedrock. The bentonite seams represent weak layers along which sliding of the valley slopes has occurred. The Grierson Hill slide is a result of sliding along some of these bentonite seams. Coal layers within the bedrock were mined extensively in the Grierson Hill area. Disturbance caused by mining activities has also contributed to weakening of the river valley slopes.

5. GRIERSON HILL LANDSLIDE

The proposed access road is located near the toe of the Grierson Hill Slide; a major deep-seated landslide that encompassed the north slope of the North Saskatchewan River valley. The slide has been the subject of several studies (e.g. Hardy & Associates, 1961; EBA, 1981; EBA, 1989; Martin et al, 1984; and Martin et al, 1998). A brief description of the slide and its history is presented below as it could impact the proposed development.

The Grierson Hill slide first occurred in 1901 and was reportedly attributed to toe erosion from river action, weakening of the bedrock in the backslope area caused by coal mining activities, and a prolonged period of precipitation. The landslide measures about 600 m east-west along the riverbank and has a total slope height of about 55 m, with an average slope angle of 11 degrees. It extends from the Shaw Convention Centre at the west end to the Cloverdale pedestrian bridge at the east end; and from Grierson Hill Road at the north end to the river's edge at the south end (see Drawing 19-5438-102-1AR).

The slide mechanism was translational, with the failure mass sliding towards the river on planar near-horizontal shear surfaces that developed along distinct bentonite seams within the bedrock. A schematic diagram of the slide mechanism is shown on Drawing No. 19-5438-102-2AR. Since 1901, the slide scarp has retrogressed more than 35 m and the toe has moved out some 120 m into the river from its original pre-slide location (refer to Drawing 19-5438-102-1AR).

Since the initial failure in 1901, the Grierson Hill slope has been modified by extensive dumping and backfilling, mainly on the upper portions of the slope. Between 1911 and 1940, the graben feature created by the slide was used as a waste dump for the City of Edmonton. Between 1950 and 1961, nearly 50,000 m^3 of fill were placed in the graben area for the construction of the Grierson Hill Road. In 1978, the Grierson Hill slope was graded and landscaped into a city park; the Louise McKinney Park. Construction of the Shaw Convention Centre at the west end of the slide was undertaken in the early 1980’s, and a portion of the Grierson Hill Road was relocated slightly to the north in the late 1980’s.

Monitoring the movement of the valley slope in the area dates back to the early 1950’s during the initial attempts to construct the Grierson Hill Road. Since then, slope movements have occurred periodically, sometimes at rates as fast as several meters per year in the central portion of the slide. It has been observed that the movement rates were very sensitive to changes in slope condition (e.g. grading works, toe erosion, precipitation, etc.). Over the years, various stabilization measures have been implemented to slow the slope movement. In the late 1950’s and early 1960’s, dewatering wells and drainage galleries were installed to drain the coal seams and abandoned mine openings. In 1987, a toe berm was constructed to improve the stability of the slope after a major flood removed up to 8 m of the river bank in 1986. In 1991, a 4 m wide outer berm of concrete rubble and rock riprap was installed along the north bank of the river channel. The outer berm was deemed necessary following a rapid drawdown failure of a 50 m long section of the riverbank in July of 1990.

The stabilization measures noted above have considerably improved the overall slope stability. Two slope inclinometers were installed in March 2000 by the City of Edmonton along the Grierson Hill Road. Available readings of these slope inclinometers (between April and June, 2000) did not indicate any significant slope movements. Four additional slope inclinometers were installed in 2010 and 2011 at the eastern flank of the slide near the LRT-VL alignment. The instruments have been monitored regularly since November, 2010. No noticeable slope movements have been detected to date.

6. GEOTECHNICAL INVESTIGATION

6.1 Field Drilling Program

Six test holes (TH14-1 to TH14-6) were drilled along the preferred road alignment to depths ranging between 6 and 10 m below existing ground surface. Upon the completion of drilling, 25 mm diameter standpipe piezometers were installed in all six holes for future monitoring of groundwater levels.

Two deep test holes, SI14-1 and SI14-2, were also drilled upslope of the road alignment to depths of 45.6 and 33.3 m, respectively, for the installation of geotechnical instruments. A total of 2 slope inclinometers and 5 pneumatic piezometers were installed in these two holes.

Five test holes (TH14-7 to TH14-11) were drilled to depths ranging from 5.2 m to 11.9 m below existing ground near the eastern end of the road alignment. These test holes were part of a different study aimed at characterizing the thickness of waste material within the anticipated LRT-VL construction zone (Thurber report dated July 23, 2014).

The locations of recent and previous test holes advanced in the project area are presented on Drawing No. 19-5438-102-1AR in Appendix A.

The current field program was conducted between March 17 to 24, 2014, using two different drill rigs; a small auger rig and a large rig with both auger and wet rotary/coring capabilities. The shallow holes and overburden soils in the two deeper holes were drilled using solid stem augers while continuous coring was used in the bedrock. Both rigs were owned and operated by Mobile Augers and Research Ltd. of Edmonton, Alberta. The field work was conducted under the supervision of Thurber personnel. The test hole locations were surveyed by Opus Stewart Weir after the drilling program was completed.

For overburden soils, disturbed soil samples were obtained from the auger flights and Standard Penetration Tests (SPTs) were carried out at selected depths. The undrained shear strength (Cpen value) of cohesive samples was estimated using a pocket penetrometer. For bedrock, continuous core samples were recovered.

Water and slough levels were noted during and immediately after the completion of drilling, before backfilling the test holes.

The results of the drilling, field observations, and the details of the installed instruments are summarized on the test hole logs in Appendix B.

6.2 Laboratory Testing

Laboratory testing included visual classification and the determination of the natural moisture content of all soil samples. Bedrock core samples were also logged in the laboratory and the percent recovery and the Rock Quality Designation (RQD) were recorded. The moisture content of select bedrock specimens were determined. Atterberg Limits tests were carried out on selected representative soil and bedrock samples.

The results of laboratory testing are summarized on the test hole logs in Appendix B. An explanation of the symbols and terms used to describe observations on the test hole logs and the Modified Unified Soil Classification System are also provided in Appendix B.

7. SUBSURFACE CONDITIONS

7.1 Soil Conditions

7.1.1 General

The subsurface conditions encountered in test holes drilled along the proposed road alignment comprised, in descending order, topsoil, fills of varying composition and thickness, overlying colluvium (lacustrine clay, clay till and sand). In TH14-5 and TH14-6 at the east end of the alignment (which coincides with the eastern flank of the Grierson Hill slide), clay shale and sandstone bedrock were encountered directly beneath the topsoil or below a limited thickness of fill.

Similar stratigraphy was observed at the locations of the two deep test holes drilled upslope of the road alignment. The primary difference was that the fill soils were much thicker.

Brief descriptions of the main soil layers are provided in the following sections. Detailed soil descriptions are presented on the test hole logs attached in Appendix B.

7.1.2 Topsoil

Topsoil was encountered in all test holes. The topsoil extended to depths ranging from about 0.15 m to 0.3 m below existing ground surface. It should be noted that the thickness of topsoil could vary between test holes and it may be thicker or thinner at other locations along the road alignment.

7.1.3 Fill

Fill soils were encountered in all test holes except TH14-6. The fill ranged from 1.6 to 2.9 m in thickness at the western and eastern ends of the road alignment which coincide with the flanks of the Grierson Hill Slide. Along the central part of alignment, the fill extended to the termination depths of test holes TH14-2 through TH14-4 at 5.8 m below ground surface. At the locations of SI14-1 and SI14-2, the fill was 12.8 and 10.2 m thick, respectively.

The fill comprised clay or clay shale with intermittent gravelly and sandy horizons. Coal, peat, organic soils, brick fragments, pieces of glass, and wood were encountered within the fill.

The moisture contents of fill samples varied widely, ranging from 4 percent up to about 60 percent. The lower values were associated with sand and gravel fills near the ground surface whereas the higher values were characteristic of peat layers. SPT ‘N’ values in the fill ranged generally from 2 to 17 blows per 300 mm penetration indicating soft to very stiff consistencies. The results of four Atterberg Limits tests conducted on samples of the clay and clay shale fills indicated plastic limits between 17 and 27 percent and liquid limits between 44 and 72 percent. The results indicate that fill soils were generally of medium to high plasticity.

7.1.4 Clay (Possible Colluvium)

A clay layer was encountered beneath the clay fill in TH14-1 at a depth of about 1.5 m below ground surface and had a thickness of about 2.3 m. The clay was brown, silty, contained trace oxides and was classified as high plastic. The natural moisture content of clay samples ranged from 28 to 43 percent. One SPT ‘N’ value of 7 blows per 300 mm penetration was recorded in the clay, indicating firm consistency.

7.1.5 Clay Till (Possible Colluvium)

Layers of clay till were encountered beneath the clay in TH14-1 and beneath the fill in SI14-1. The thickness of till layers varied from 0.8 to 2.3 m. The clay till was medium plastic, silty, sandy, and contained traces of gravel, coal, and occasional sand lenses. The natural moisture content of clay till samples varied between 17 and 22 percent. The clay till was of very stiff consistency with SPT ‘N’ values between 18 and 29 blows per 300 mm of spoon penetration.

7.1.6 Bedrock

Bedrock consisting of interbedded layers of clay shale and sandstone was encountered in test holes TH14-5, TH14-6, SI14-1 and SI14-2. Coal seams, 0.2 to 0.5 m thick, and thin layers of siltstone, 0.1 to 0.2 m thick, were encountered within the bedrock. The elevation of top of bedrock varied between 623.3 and 633.1 m, depending on the test hole location on the valley slope. The corresponding depth to top of bedrock below existing ground ranged between 0.3 m (TH14-6) and 13.6 m (SI14-1).

The moisture content of bedrock samples ranged generally from 15 to 30 percent. Higher moisture contents, up to 60 percent, were recorded at a few locations and were typically associated with bentonitic horizons or coal seams within the bedrock. SPT ‘N’ values in the bedrock ranged from 14 to over 100 blows per 300 mm penetration, indicating a stiff to hard consistency in soil mechanics terminology. The results of one Atterberg Limits test conducted on a clay shale sample indicated high plastic material with a liquid limit of 63 percent and a plastic limit of 27 percent.

7.2 Groundwater Conditions

Groundwater measurements taken in the standpipe piezometers installed in test holes advanced along the road alignment are presented in Table 7.1. A summary of the groundwater levels recorded in the pneumatic piezometers installed in SI14-1 and SI14-2 is presented in Table 7.2.

TABLE 7.1
SHORT TERM GROUNDWATER OBSERVATIONS AND SLOUGHING CONDITIONS

TEST HOLE	DRILL DEPTH B.G.S. [1] (m)	DEPTH OF STANDPIPE PIEZOMETER B.G.S. [1] (m)	LEVEL BELOW GROUND SURFACE AT END OF DRILLING [2] (m)		WATER LEVEL IN STANDPIPE PIEZOMETER B.G.S. [1] (m)	
			SLOUGH LEVEL	WATER LEVEL	June 11, 2014	July 31, 2014
TH14-1	6.1	6.1	none	none	4.6	4.6
TH14-2	5.8	5.6	5.5	5.3	5.4	5.1
TH14-3	5.8	5.8	none	none	Dry	Dry
TH14-4	5.8	5.8	none	none	Dry	Dry
TH14-5	10.1	9.6	9.7	none	8.1	8.2
TH14-6	10.4	10.2	9.9	9.7	6.7	6.6

[1] Below ground surface.

[2] Test holes were drilled on March 24, 2014.

TABLE 7.2
SHORT TERM GROUNDWATER LEVELS IN PNEUMATIC PIEZOMETERS

TEST HOLE	TIP OF PNEUMATIC PIEZOMETER		GROUNDWATER LEVEL ON			
			11-JUN-2014		20-AUG-2014	
	DEPTH [1] (m)	ELEVATION (m)	DEPTH [1] (m)	ELEVATION (m)	DEPTH [1] (m)	ELEVATION (m)
SI14-1	12.0	632.5	3.50	641.0	3.1	641.4
	21.6	622.9	16.2	628.3	17.7	626.9
	35.3	609.2	27.3	617.2	27.1	617.4
SI14-2	5.8	627.7	5.1	628.4	4.2	629.3
	27.3	606.2	19.0	614.5	19.2	614.3

[1] Below ground surface.

It should be noted that the water level measurements taken during this field investigation program are short term levels and may not represent the stabilized long term groundwater conditions. In addition, groundwater levels may vary between test hole locations. Groundwater levels are also expected to vary in response to seasonal factors and precipitation. Hence, the actual groundwater conditions at the time of construction could vary from those recorded during this investigation.

8. SLOPE MOVEMENT MONITORING

As noted earlier, slope inclinometers SI14-1 and SI14-2 were installed during the current investigation (refer to Drawing 19-5438-102-1AR) to monitor the movement of the Grierson Hill slide. Previously, four slope inclinometers were installed at the eastern end of the proposed construction access road as part of the geotechnical investigation for the LRT-VL project.

All instruments have been monitored a number times each year since they were installed. The monitoring results, in terms of the observed cumulative and incremental slope movements, are presented on the attached plots in Appendix C. As shown on the plots, the slope inclinometer data did not indicate any noticeable slope movements.

It should be noted, however, that the monitoring period, 2011 to 2014, is relatively short and may not necessarily reflect the long term performance of the slope, particularly if changes to the slope conditions (e.g. caused by construction) were to occur.

9. PRELIMINARY GEOTECHNICAL SITE EVALUATION

9.1 General

As discussed earlier, the preferred alignment of the construction access road runs along the toe of the Grierson Hill slide. It is our understanding that construction of the access road will involve minor grading works. For the purposes of this assessment, it was assumed that fills up to 1 m high may be placed for road construction. It was also assumed that the width of the road will be in the order of 8 m to accommodate two way traffic.

Because of disturbances caused by the Grierson Hill slide and subsequent grading works, the subsurface conditions in the project area are complex. The stratigraphy, characteristics of fill and colluvium materials, and groundwater conditions vary significantly from one location to the other. Considering the uncertainty in subsurface conditions, the intent of the stability analyses presented herein was not to estimate the absolute values of the factor of safety, but rather to quantify the change in the slope factor of safety as a result of access road construction. On that basis, slope stability analyses were carried out for four different cross-sections (Sections A-A′, B-B’, C-C’ and D-D’ shown on Drawing No. 19-5438-102-1AR) to assess the impact of road construction on the factor of safety of the existing valley slopes. Deep-seated translational failure modes along weak bentonite seems within the bedrock were considered in the analyses. Both large scale failures encompassing the majority of the valley slope and small failures encompassing the 10 m high bank along the river channel were investigated. Potential rotational failures of the latter shallow bank were also analyzed. They were found less critical and the results of these stability analyses are not reported herein.

9.2 Assessment of Slope Stability

9.2.1 Stratigraphy and Soil and Groundwater Parameters

The soil/bedrock stratigraphy used in the stability analyses was inferred from available test hole information from both the current and previous geotechnical investigations (Appendix B). The slope profiles along cross-sections A-A′, B-B’, C-C’ and D-D’ were estimated from the survey data provided by AECOM.

Soil and bedrock strength parameters used in the stability analyses were estimated from the results of various geotechnical studies and are presented in Table 9.1. They are also shown on the figures of slope stability analyses in Appendix D.

TABLE 9.1
SOIL AND BEDROCK STRENGTH PARAMETERS USED IN STABILITY ANALYSES

SOIL TYPE	UNIT WEIGHT (kN/m^3)	EFFECTIVE FRICTION ANGLE ϕ' (°)	EFFECTIVE COHESION c' (kPa)
Colluvium and Fill	18	23	2
Clay Till (Weathered)	18	25	5
Clay Till	18	25	20
Previous Slip Zone (Bentonite seams at residual strength)	20	9	0
Potential Slip Zone (Bentonite seams at peak strength)	20	14	0
Bedrock Units A and B	20	25	80
Bedrock Unit C	20	25	60
Bedrock Units D and E	20	25	50
Disturbed Bedrock	20	25	15 - 30

From a slope stability perspective, the shear strength of bentonite seams within the bedrock is a governing factor in the global stability assessment of the Grierson Hill slope. In the analyses, the peak strength parameters (ϕ' = 14°, c = 0) were used along the relatively undisturbed sections of the bentonite layers behind (i.e. north of) the old scarp area. The residual strength parameters (ϕ' = 9°, c = 0) were assigned to the disturbed sections of the bentonite seams near the slope toe, where significant slope movements have occurred in the past.

The shear strength of the disturbed horizons of bedrock was varied between cross-sections. For Sections A-A', B-B' and C-C', ϕ' = 25° and c = 15 kPa were used in the analyses. For Section D-D' near the eastern flank of the slide where slope movement and ground disturbance would have been less severe, higher shear strength parameters (ϕ' = 25°, c = 30 kPa) were used.

The groundwater levels used in the stability analyses were primarily based on historic and some recent groundwater monitoring data. They varied from elevations of about 654 m below the crest of the valley slope to 614 m at the toe of the slope near the North Saskatchewan River.

9.2.2 Analysis Results

The slope stability analyses were performed using the SLOPE/W software, based on the method of limit equilibrium. Stability analyses were first performed for the existing slope condition prior to access road construction. The slope profiles were modified to approximate possible changes in ground surface topography associated with road construction (i.e. possible fills and cuts). A surcharge pressure of 16 kPa was applied on the road surface to account for loading induced by construction traffic. The stability analyses were then repeated to assess the change in the slope factor of safety as a result of road construction. The results of the stability analyses are presented on Figures D1 through D24 in Appendix D, and are also summarized in Table 9.2.

TABLE 9.2
SUMMARY OF RESULTS OF SLOPE STABILITY ANALYSES

CROSS SECTION [1]	**SLOPE FACTOR OF SAFETY**					
	BENTONITE SEAM 'A' [2]		**BENTONITE SEAM 'B'** [2]		**RIVERBANK** [3]	
	EXISTING CONDITION	**ACCESS ROAD** [4]	**EXISTING CONDITION**	**ACCESS ROAD** [4]	**EXISTING CONDITION**	**ACCESS ROAD** [4]
A – A'	1.33	1.34	1.23	1.24	1.23	1.23
B – B'	1.31	1.31	1.20	1.21	1.24	1.22
C – C'	1.30	1.30	1.24	1.25	1.15	1.07
D – D'	1.23	1.23	1.23	1.23	1.20	1.17

[1] Refer to Drawing 19-5438-102-1AR for cross-section locations.

[2] Refer to the slope stability figures in Appendix D for soil/bedrock stratigraphy, including the depth of bentonite seams.

[3] Factor of safety of the ~10 m high bank along the river channel.

4 Factor of safety following construction of the access road in accordance with the approximate geometry shown on the stability figures in Appendix D.

As shown on the stability figures in Appendix D, possible translational failures along bentonite Seams 'A' and 'B' are large slides that encompass the majority of the valley slope. For the deep Bentonite Seam 'A' below riverbed, the pre-construction factor of safety ranged between 1.2 and 1.3. Construction of the access road had practically no effect on the slope factor of safety. For Bentonite Seam 'B' above the elevation of the riverbed, the preconstruction factor of safety was in the order of 1.2. Similarly, construction of the access road had practically no impact on the slope factor of safety. These findings are attributed to the minute size of road fill, 1 m high embankments, compared to the volume of the slide mass (refer to Figures D2 and D4, for example).

For potential failures encompassing the riverbank (i.e. the shallow bank along river channel), the preconstruction factor of safety was estimated to be in the range of 1.15 to 1.25. The placement of access road fill, albeit very limited, could potentially result in a 2 to 7 percent reduction in the slope factor of safety. While the percent reduction in the factor of safety is not large, it reduces the already low factors of safety even further to a 1.1 to 1.2 range. As noted in Section 5, a 50 m long section of the riverbank failed in July 1990 following a rapid drawdown of the river level. A 4 m wide outer berm of concrete rubble and riprap was constructed in 1991 (EBA, 1989; and Martin et al, 1998) to improve the marginal stability of the riverbank.

9.2.3 Conclusions and Recommendations

The proposed alignment of the temporary construction access road runs along the toe of the valley slope. It was assumed that road construction could involve the placement of up to 1 m high fills. Limited cuts could also be required to accommodate an 8 m wide road for two-way traffic.

The analysis results in Section 9.2.2 suggest that road construction will have minimal impact on the stability of the overall valley slope. It could, however, adversely affect the stability of the shallow bank along the river channel. Although any such failure would impact a limited portion of the valley slope, instabilities along the toe of the sensitive Grierson Hill slide may trigger slope movements on a wider scale, if not repaired on a timely basis. As such, it is recommended that the placement of additional fill be avoided during construction of the temporary access road. The footprint of the access road (to accommodate an 8 m wide road) should be kept as far north as practical from the crest of the riverbank. Limited cuts may be used to achieve the required road width. To limit the extent of excavations, cuts could be supported using temporary retaining systems (e.g. lock-block walls).

A number of slope inclinometers should be installed along the alignment of the access road and monitored on a regular basis to help detect and assess any slope movements. Visual inspections of the river valley slope in the general area of the access road should also be carried out regularly during road and LRT-VL construction to identify any signs of ground movement (e.g. cracks, bulging, tilted trees or posts, etc.). Should the slope monitoring or visual inspections indicate any ground movement, a review of the slope condition should be carried out immediately and measures to arrest the movement should be implemented as soon as possible.

9.3 Subgrade Assessment and Pavement Design

The evaluation and recommendations provided in the following sub-sections were based on limited information and concept level drawings provided by AECOM. They are considered preliminary and should be reviewed by the contractor's geotechnical engineer based on actual design and construction requirements.

9.3.1 General

The design grades of the temporary construction access road through Louis McKinney Park were unknown at the time of preparation of this report. However, it is understood that the road grades will follow the existing grades with possibly some minor cuts and fills.

Based on available test hole information, it is expected that the subgrade conditions would vary along the alignment of the subject access road. In some areas, the subgrade conditions would be adequate while in others poor unsuitable fills would be present at the subgrade level. The removal and replacement of unsuitable soils will be required in such areas and remedial measures will need to be determined at the time of construction on a case by case basis.

Recommendations for site grading and subgrade preparation are provided in Section 9.3.2. Preliminary design recommendations for alternate pavement structures are provided in Section 9.3.3.

9.3.2 Grading and subgrade preparation

All topsoil/peat, organics, and fill soils containing significant organic content or municipal waste materials should be removed from the proposed roadway areas. The thickness of topsoil at the test hole locations ranged from 0.15 m to 0.3 m below existing ground surface, however stripping requirements will be largely governed by the presence of organic/waste materials and the overall stability of existing fill soils that form the majority of the near-surface stratigraphy.

The exposed surface (after stripping) should be proof rolled and inspected by qualified geotechnical personnel to identify weak areas and to confirm that all deleterious material has been removed. Weak zones or pockets of deleterious material at surface should be locally removed and replaced with suitable fill compacted to at least 97 percent of Standard Proctor Maximum Dry Density (SPMDD).

Where the pavement subgrade will be located in cut or in fill of less than 150 mm, the finished subgrade should be subcut to a depth of 300 mm. The removed material (if suitable) should be reworked, then placed in lifts and compacted to 100 percent of the SPMDD.

The natural water content of existing fill soils varied widely ranging from 4 to 60 percent. It is, therefore, expected that poor subgrade conditions will be encountered in areas where the moisture contents of in-situ soils are significantly higher than the Optimum Moisture Content (OMC). In such areas, moisture conditioning will be required in order to meet the subgrade compaction requirements. Depending on the weather at the time of construction, it may be preferable to modify wet subgrades using cement. The use of cement modification offers improved field workability, quicker drying, and the formation of a working platform suitable for placing and compacting the pavement materials. A minimum application rate of 10 kg/m^2 of cement would be required per 150 mm lift of soil. Additional cement to deeper depths may be required if weaker soils are encountered.

The following additional recommendations also apply:

- Subgrade areas that become softened as a result of construction traffic or weather conditions should also be subexcavated and replaced with low to medium plastic clay or clean granular fill prior to the installation of pavement structure.

- Fill soils required to achieve the design subgrade level should consist of inorganic low to medium plastic clay placed in 150 mm thick lifts (compacted thickness) and compacted to at least 97 percent of the SPMDD at placement moisture contents within ±2 percent of the OMC. The upper 300 mm of subgrade should be compacted to 100 percent of the SPMDD.

- Uniformity of compaction is essential to reduce the potential for differential settlement. It is recommended that fill placement be inspected and tested by qualified geotechnical personnel to ensure adequate compaction.

Permanent site drainage should be developed at early stages of construction in order to improve site trafficability and reduce future frost effects in the subgrade. It is recommended that the finished subgrade surface be sloped at a minimum of 2 percent towards side ditches. The purpose of this is to drain surface water from the subgrade and thereby prevent ponding of water which could result in swelling, softening, and/or possible frost heave of the subgrade. The final compacted subgrade surface should be proof-rolled to confirm that surface deflections are minimal under the influence of construction traffic.

9.3.3 Pavement Structure

It is understood that the temporary construction access road will be required to accommodate wheel loads from typical construction equipment such as; dump trucks, concrete trucks, tracked equipment, and trailers. Although the expected number of trips per day is not available, we understand that the traffic through the construction access road is expected to be typical for a project of this scope with large quantities of earth moving expected. We further understand that the subject access road could either be asphalt concrete pavement (ACP) or gravel surfaced and would be in use for about 4 years.

Due to the frequent use of the construction access road by heavy trucks and construction equipment, and the relatively short service life, it is recommended that consideration be given to construction of a gravel pavement structure as opposed to an ACP pavement structure.

The design of pavement thickness will depend on the magnitude, frequency, and distribution of traffic loading anticipated on the access road. In the absence of this information, one of the preliminary pavement sections presented in Table 9.1 below may be considered for the design and construction of the subject temporary access road. Once the actual construction traffic loads and frequencies are known, the contractor’s pavement engineer should review and confirm the adequacy of these proposed pavement sections.

The pavement design has been based on an assumed subgrade CBR value of 3 and a design period of 4 years.

TABLE 9.3
ALTERNATE PAVEMENT STRUCTURES (GRAVEL PAVEMENTS)

UNREINFORCED STRUCTURE	REINFORCED STRUCTURE
550 mm Crushed Granular Base over Woven geotextile (Nilex 2004) over 300 mm of prepared subgrade	350 mm Crushed Granular Base over Geogrid (Tensar TX 160 or equivalent) over Non-Woven geotextile (Nilex 4551) over 300 mm prepared subgrade

On-going grading and maintenance of the roadway gravel surface should be anticipated, particularly where vehicles are turning and braking. In addition, some maintenance may also be required to repair localized structurally damaged areas and/or to fill and level rutted areas. Additional gravel may be required to restore the gravel section at damaged or rutted areas. Prior to placing the gravel, any surficial contamination or loosed material should be removed. The replacement gravel should comprise suitable crushed gravel compacted to the specified compaction level.

Pavement materials should be supplied and constructed in accordance with the latest edition of the City of Edmonton Design Standards and Construction Specifications.

10. CLOSURE

We trust the above provides the information you require at this time. If you have any questions regarding the contents of this report, please contact the undersigned at your convenience.

Yours truly,
Thurber Engineering Ltd.
Robin Tweedie, M.Sc., P. Eng
Review Principal

HASSAN EL-RAMLY
Oct. 9, 2014

Hassan El-Ramly, Ph.D., P. Eng
Senior Project Engineer

Donald W. Stefanyk
October 9, 2014

Don Stefanyk, P.Eng.
Senior Pavement Engineer
/lg

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
Signature H. El Ramly
Date 9 Oct. 2014
PERMIT NUMBER: P 5186
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Attachments

- Appendix A
  - Drawing No. 19-5438-102-1AR – Site Plan Showing the Alignment of the Proposed Construction Access Road and Approximate Test Hole Locations
  - Drawing No. 19-5438-102-2AR – Schematic Diagram of Failure Mechanism of Grierson Hill Slide

- Appendix B
  - Modified Unified Soils Classification System
  - Symbols and Terms Used on the Test Hole Logs
  - Test hole Logs

- Appendix C
  - Plots of Slope Inclinometer Readings

- Appendix D
  - Figures of Slope Stability Analyses

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is 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 us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which 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. WE CANNOT BE 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 us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document, subject to the limitations provided herein, are only valid to the extent that this Report expressly addresses proposed development, design objectives and purposes, and then only to the extent there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation or to consider such representations, information and instructions.

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 OUR WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS WE MAY EXPRESSLY APPROVE. The contents of the Report remain our copyright property. The Client may not give, lend or, sell the Report, or otherwise make the Report, or any portion thereof, available to any person without our prior written permission. Any use which a third party makes of the Report, are the sole responsibility of such third parties. Unless expressly permitted by us, no person other than the Client is entitled to rely on this Report. We accept no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without our 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 this report is delivered on 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. Where 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 us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot 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 us. We are entitled to rely on such representations, information and instructions and are not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

(see over …)

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

d) Construction Services: During construction we must be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions 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. RISK LIMITATION

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause an accidental release of those substances. In consideration of the provision of the services by us, which are for the Client's benefit, the Client agrees to hold harmless and to indemnify and defend us and our directors, officers, servants, agents, employees, workmen and contractors (hereinafter referred to as the "Company") from and against any and all claims, losses, damages, demands, disputes, liability and legal investigative costs of defence, whether for personal injury including death, or any other loss whatsoever, regardless of any action or omission on the part of the Company, that result from an accidental release of pollutants or hazardous substances occurring as a result of carrying out this Project. This indemnification shall extend to all Claims brought or threatened against the Company under any federal or provincial statute as a result of conducting work on this Project. In addition to the above indemnification, the Client further agrees not to bring any claims against the Company in connection with any of the aforementioned causes.

7. SERVICES OF SUBCONSULTANTS AND CONTRACTORS

The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. We may arrange the hiring of these services as a convenience to our Clients. As these services are for the Client's benefit, the Client agrees to hold the Company harmless and to indemnify and defend us from and against all claims arising through such hirings to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

8. CONTROL OF WORK AND JOBSITE SAFETY

We are responsible only for the activities of our employees on the jobsite. The presence of our personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that we never occupy a position of control of the site. The Client undertakes to inform us of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general. These procedures may well involve additional costs outside of any budgets previously agreed to. The Client agrees to pay us for any expenses incurred as the result of such discoveries and to compensate us through payment of additional fees and expenses for time spent by us to deal with the consequences of such discoveries. The Client also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the Client agrees that notification to such bodies by us will not be a cause of action or dispute.

9. INDEPENDENT JUDGEMENTS OF CLIENT

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

APPENDIX A

Drawing No. 19-5438-102-1AR – Site Plan Showing the Alignment of the Proposed Construction Access Road and Approximate Test Hole Locations

Drawing No. 19-5438-102-2AR – Schematic Diagram of Failure Mechanism of Grierson Hill Slide

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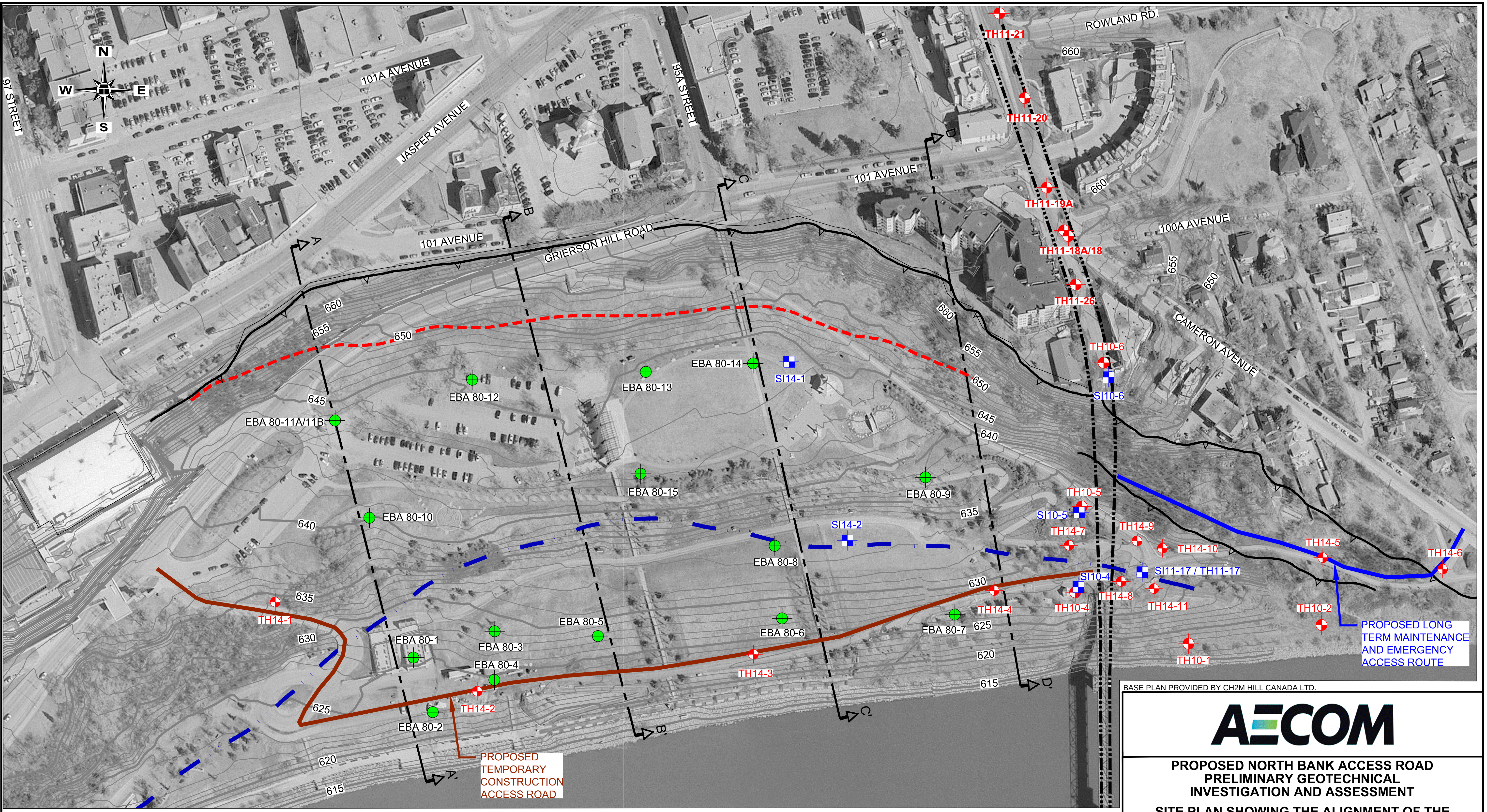

BASE PLAN PROVIDED BY CH2M HILL CANADA LTD.

LEGEND

- TEST HOLE LOCATION BY THURBER
- PREVIOUS TEST HOLE LOCATION BY OTHERS
- TEST HOLE LOCATION WITH EXISTING SLOPE INCLINOMETER BY THURBER
- CURRENT SLOPE CREST / SCARP (APPROXIMATE)
- APPROXIMATE SLOPE CREST IN 1887 (BEFORE FAILURE)
- APPROXIMATE TOE OF RIVERBANK IN 1887 (BEFORE FAILURE)
- PROPOSED LRT ALIGNMENT

0 20 40 60 80 100 120m

SCALE 1:2000

AECOM

PROPOSED NORTH BANK ACCESS ROAD
PRELIMINARY GEOTECHNICAL
INVESTIGATION AND ASSESSMENT

SITE PLAN SHOWING THE ALIGNMENT OF THE PROPOSED CONSTRUCTION ACCESS ROAD AND APPROXIMATE TEST HOLE LOCATIONS

DWG No. 19-5438-102-1AR

DRAWN BY	ML
DESIGNED BY	TME
APPROVED BY	HER
SCALE	1:2000
DATE	OCTOBER 2014
FILE No.	19-5438-102

THURBER ENGINEERING LTD.

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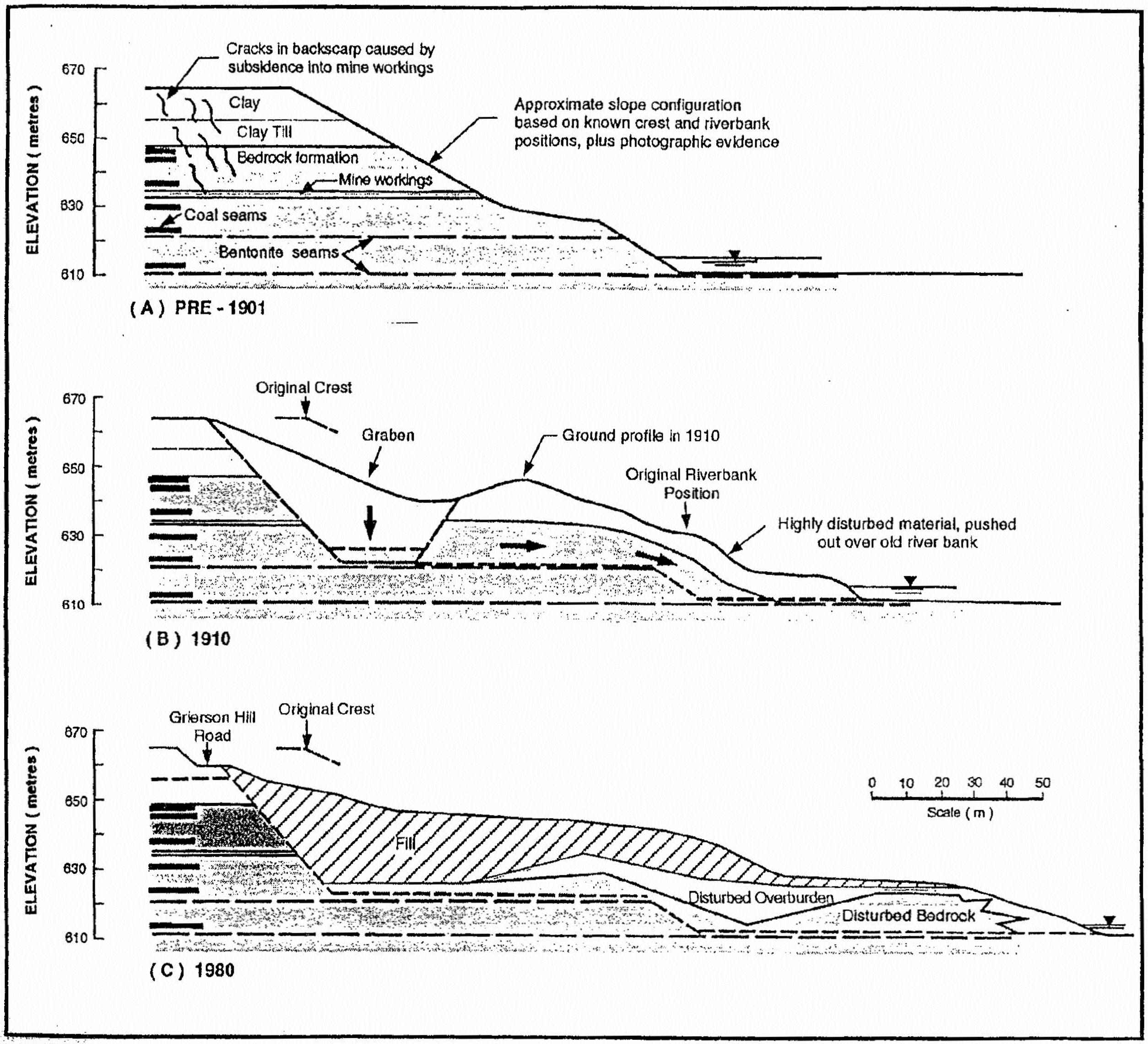


FROM MARTIN et. al., 1998

CROSS-SECTION SHOWING
SLIDE DEVELOPMENT

PROPOSED NORTH BANK ACCESS ROAD
GEOTECHNICAL INVESTIGATION AND ASSESSMENT

SCHEMATIC DIAGRAM OF FAILURE MECHANISM
OF GRIERSON HILL SLIDE

DWG No. 19-5438-102-2AR

AECOM

DRAWN BY	ML
DESIGNED BY	TME
APPROVED BY	HER
SCALE	N.T.S.
DATE	OCTOBER 2014
FILE No.	19-5438-102

THURBER ENGINEERING LTD.

THURBER

APPENDIX B

Test hole Logs

THURBER

Test Holes by Thurber (2014)

Z:_Edmonton office\Soil_Rock classification\Symbols & Terms-2012.dwg

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

1. VISUAL TEXTURAL CLASSIFICATION OF MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200 mm	Greater than 200 mm
Cobbles	75 mm to 200 mm	75 mm to 200 mm
Gravel	4.75 mm to 75 mm	5 mm to 75 mm
Sand	0.075 mm to 4.75 mm	Visible particles to 5 mm
Silt	0.002 mm to 0.075 mm	Non-Plastic particles, not visible to the naked eye
Clay	Less than 0.002 mm	Plastic particles, not visible to the naked eye

2. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	APPROXIMATE UNDRAINED SHEAR STRENGTH		APPROXIMATE SPT * 'N' VALUE
Very Soft	Less than 10 kPa		Less than 2
Soft	10 - 25 kPa		2 to 4
Firm	25 - 50 kPa		4 to 8
Stiff	50 - 100 kPa		8 to 15
Very Stiff	100 - 200 kPa	Modified from National Building Code	15 to 30
Hard	200 - 300 kPa		Greater than 30
Very Hard	Greater than 300 kPa		

* SPT 'N' Value Standard Penetration Test 'N' Value - refers to the number of blows from a 63.5 kg hammer free falling a height of 0.76m to advance a standard 50mm outside diameter split spoon sampler for 0.3m depth into the undrilled portion of the test hole.

3. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	STANDARD PENETRATION TEST (SPT) (Number of Blows per 300 mm)	
Very Loose	0 - 4	
Loose	4 - 10	
Compact	10 - 30	Modified from National Building Code
Dense	30 - 50	
Very Dense	Over 50	

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

◩	Shelby Tube	▤	A-Casing
⧄	SPT	▥	Grab
☒	No Recovery	◨	Core

SYMBOLS USED FOR TEST HOLE LOGS

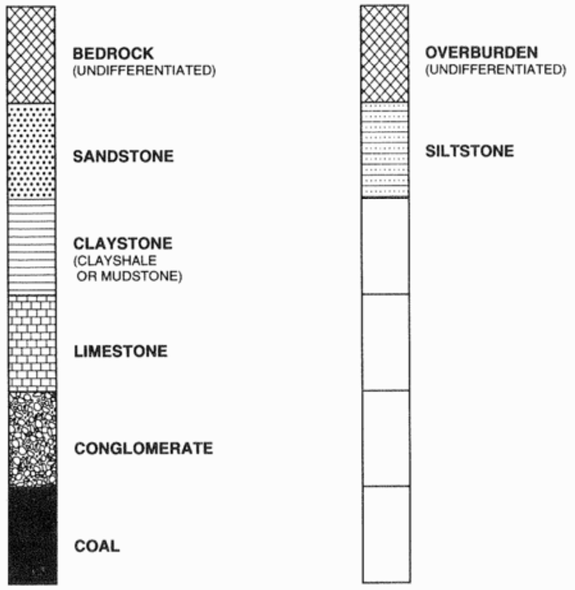
●		MC - Moisture Content (% by weight) of soil sample
▼		Water Level
■	SPT	Standard Penetration Test 'N' Value (Blows/300mm)
▲	CPen	Shear Strength determined by pocket penetrometer
	CVane	Shear Strength determined by pocket vane
	Cu	Undrained Shear Strength determined by unconfined compression test
	SO_4%	Percent (%) of water soluble sulphate ions

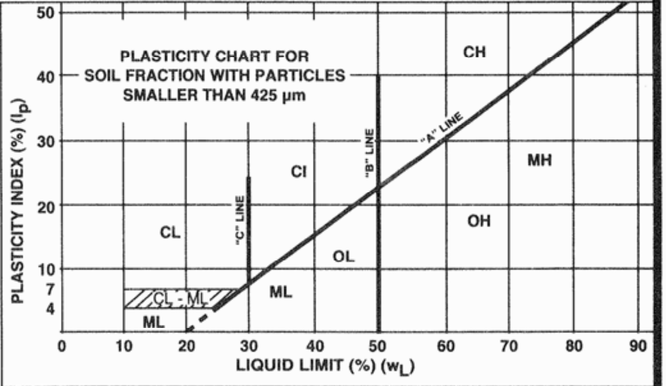
THURBER ENGINEERING LTD.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

MAJOR DIVISION			GROUP SYMBOL	THURBER LOG SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	**GRAVELS** MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm	**CLEAN GRAVELS** (LITTLE OR NO FINES)	GW	△▽△	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75µm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}} > 4 ; C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP	▲▼▲	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR GW	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	▲▼▲	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	▨	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
	SANDS MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm	**CLEAN SANDS** (LITTLE OR NO FINES)	SW	⁘	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		$C_U = \frac{D_{60}}{D_{10}} > 6 ; C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP	oooo	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		NOT MEETING ALL GRADATION REQUIREMENTS FOR SW	
		SAND WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	▦	SILTY SANDS, SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	▨	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	**SILTS** BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 50\%$	ML	‖‖	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)		
		$w_L > 50\%$	MH	‖‖‖	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS			
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 30\%$	CL	▨	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS			
		$30\% < w_L < 50\%$	CI	▨	INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS			
		$w_L > 50\%$	CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS			
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$w_L < 50\%$	OL	¦¦¦	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW AND MEDIUM PLASTICITY			
		$w_L > 50\%$	OH	▨	ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS			
HIGHLY ORGANIC SOILS			Pt	〰	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE		

SPECIAL SYMBOLS





THURBER ENGINEERING LTD.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

ROCK MATERIAL DESCRIPTION

Descriptions should follow the form "Colour, grain size, textural fabric, weathering, alteration, strength, type". Example: Dark bluish grey, fine-grained, crystalline, slightly weathered, moderately strong basalt.

COLOUR

Shade	Secondary	Primary
light	pinkish	pink
dark	reddish	red
	yellowish	yellow
	brownish	brown
	olive	olive
	greenish	green
	bluish	blue
		white
	greyish	grey
		black

GRAIN SIZE

Term	Particle Size	Retained on Sieve Size	Equivalent Soil Grade
Very coarse-grained	>60 mm	2 inch	Coarse gravel, cobbles, boulders
Coarse-grained	2 - 60 mm	No. 8	Gravel
Medium-grained	60 microns - 2 mm	No. 200	Sand
Fine-grained	2 - 60 microns		Silt
Very fine-grained	<2 microns		Clay

Note: grains >60 microns are visible to the naked eye.

TEXTURE/ FABRIC

crystalline
granular
glassy

WEATHERING / ALTERATION

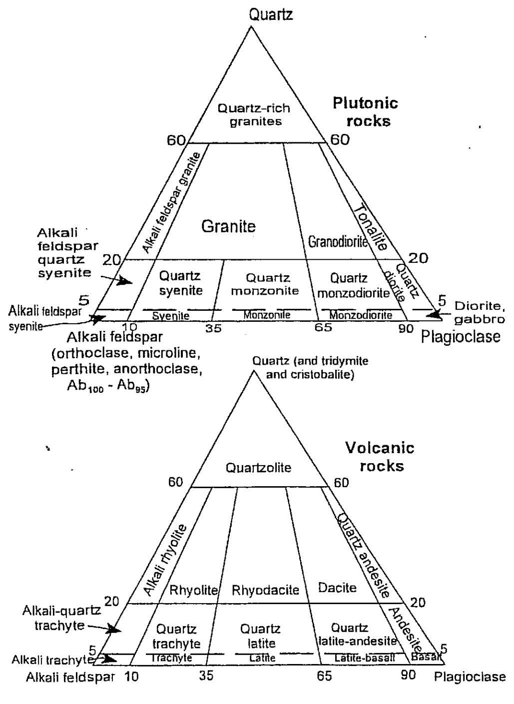
Term	Description
Fresh	No visible sign of rock material weathering.
Faintly weathered	Discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than in its fresh conditon.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as corestones.
Highly weathered	More than half the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

ROCK STRENGTH

Term	Grade	Unconfined compressive strength (MPa)	Unconfined compressive strength (psi)	Field estimation of strength
Extremely strong rock	R6	>250	>36,000	Specimen can only be chipped with a geological hammer.
Very strong rock	R5	100 - 250	15,000 - 36,000	Specimen requires many blows of a geological hammer to fracture it.
Strong rock	R4	50 - 100	7,500 - 15,000	Specimen requires more than one blow of geological hammer to fracture it.
Medium strong rock	R3	25 - 50	3,500 - 7,500	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.
Weak rock	R2	5 - 25	750 - 3,500	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.
Very weak rock	R1	1 - 5	150 - 750	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.
Extremely weak rock	R0	.25 - 1	35 - 150	Indented by thumbnail.
Hard clay[1]	S6	>.50	>70	Indented with difficulty by thumbnail.
Very stiff clay[1]	S5	0.25 - 0.50	35 - 70	Readily indented by thumbnail.
Stiff clay[1]	S4	0.10 - 0.25	15 - 35	Readily indented by thumb but penetrated only with great effort.
Firm clay[1]	S3	0.05 - 0.10	7 - 15	Can be penetrated several inches by thumb with moderate effort.
Soft clay[1]	S2	0.025 - 0.05	4 - 7	Easily penetrated several inches by thumb.
Very soft clay[1]	S1	<0.025	<4	Easily penetrated several inches by fist.

[1] These soil strengths are as recommended by ISRM but should only be used to describe highly weathered rock, residual soils or rock discontinuity filling; they do not correspond to ASTM D2488 consistency criteria.

ROCK TYPE

Genetic group			Detrital sedimentary			Pyroclastic	Chemical organic	Metamorphic		Igneous
Usual Structure			BEDDED			BEDDED		FOLIATED	MASSIVE	MASSIVE
COMPOSITION	Grain size (mm)		Grains of rock, quartz. feldspar and minerals	At least 50% of grains are of carbonate		At least 50% of grains are of fine-grained volcanic rock		Quartz, feldspars, micas, acicular dark minerals		
Very coarse grained Coarse grained	60 2	RUDACEOUS	Grains are of rock fragments Rounded grains: CONGLOMERATE Angular grains: BRECCIA	LIMESTONE (undifferentiated)	CALCI-RUDITE	Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	SALINE ROCKS Halite Anhydrite Gypsum	MIGMATITE GNEISS	HORNFELS MARBLE	
Medium grained	0.06	ARENACEOUS	SANDSTONE Grains are mainly mineral fragments QUARTZ SANDSTONE: 95% quartz, voids empty or cemented ARKOSE: 75% quartz, up to 25% feldspar: voids empty or cemented ARGILLACEOUS SANDSTONE: 75% quartz, 15% + fine detrital material		CALC-ARENITE	TUFF		Alternate layers of granular and flakey minerals SCHIST PHYLLITE	GRANULITE QUARTZITE AMPHIBOLITE	
Fine grained Very fine grained	0.002	ARGILLACEOUS or LUTACEOUS	MUDSTONE SHALE: fissile mudstone SILTSTONE: 50% fine-grained particles CLAYSTONE: 50% very fine-grained particles CALCAREOUS MUDSTONE		CALCI-SILTITE CALCI-LUTITE	Fine-grained TUFF Very fine-grained TUFF	CHERT FLINT COAL OTHERS	SLATE MYLONITE		
GLASSY										

References:

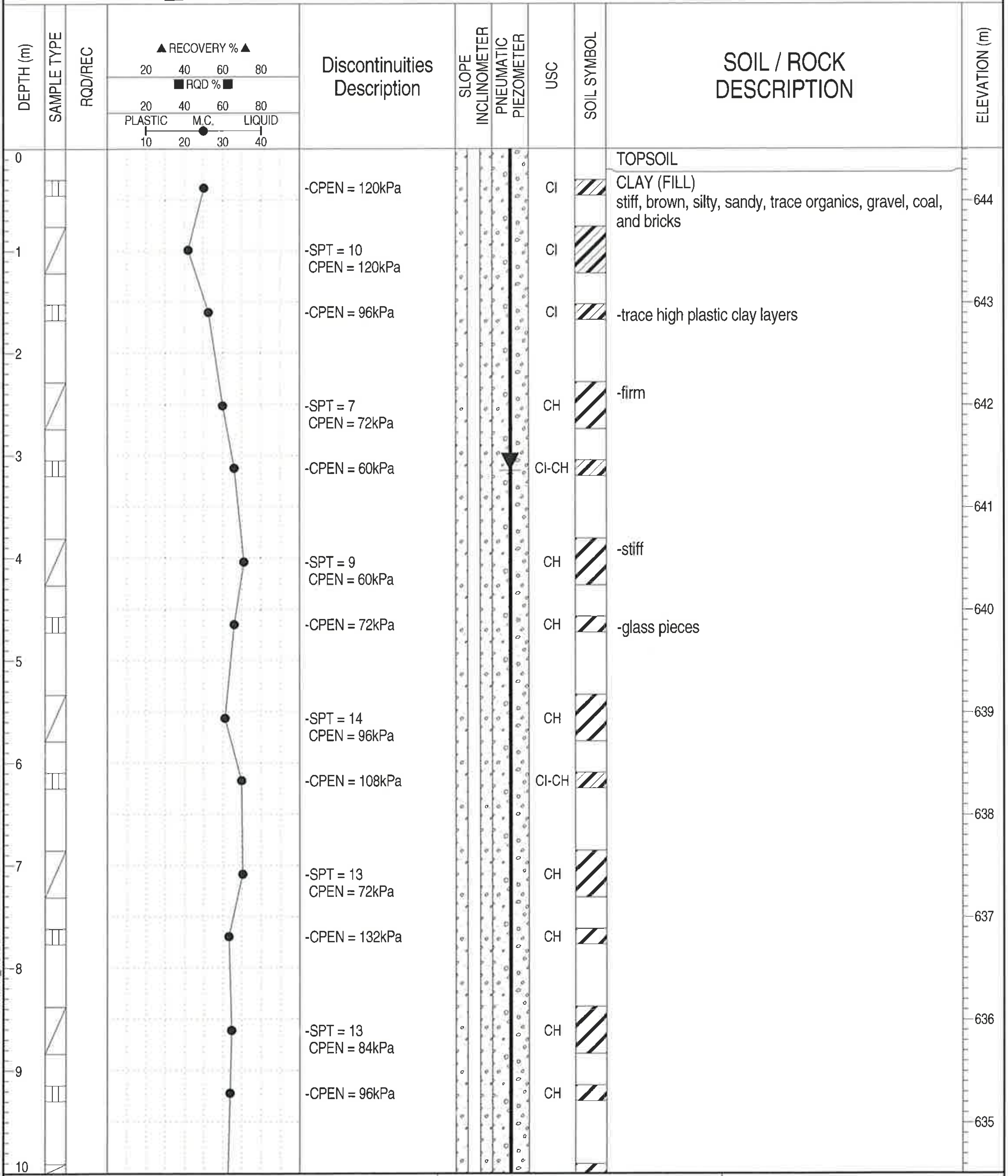
Geological Society Engineering Group Working Party (1977), The Description of Rock Masses For Engineering Purposes, Quaterly Journal of Engineering Geology, Vol. 10; Rock Chracterization Testing and Monitoring, ISRM Suggested Methods, E. Brown, Pergamon Press; Manual of Mineralogy, 20th Edition, C. Klein and C. Hurlbut, Wiley; Canadian Foundation Engineering Manual, 2nd Edition, 1985, Canadian Geotechnical Society; Foundations on Rock, D. Wyllie, E & FN Spon.

THURBER

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ▮ CORE

BACKFILL TYPE ⬚ GROUT



Discontinuities Description	USC	SOIL / ROCK DESCRIPTION
		TOPSOIL
-CPEN = 120kPa	CI	CLAY (FILL) stiff, brown, silty, sandy, trace organics, gravel, coal, and bricks
-SPT = 10 CPEN = 120kPa	CI	
-CPEN = 96kPa	CI	-trace high plastic clay layers
-SPT = 7 CPEN = 72kPa	CH	-firm
-CPEN = 60kPa	CI-CH	
-SPT = 9 CPEN = 60kPa	CH	-stiff
-CPEN = 72kPa	CH	-glass pieces
-SPT = 14 CPEN = 96kPa	CH	
-CPEN = 108kPa	CI-CH	
-SPT = 13 CPEN = 72kPa	CH	
-CPEN = 132kPa	CH	
-SPT = 13 CPEN = 84kPa	CH	
-CPEN = 96kPa	CH	

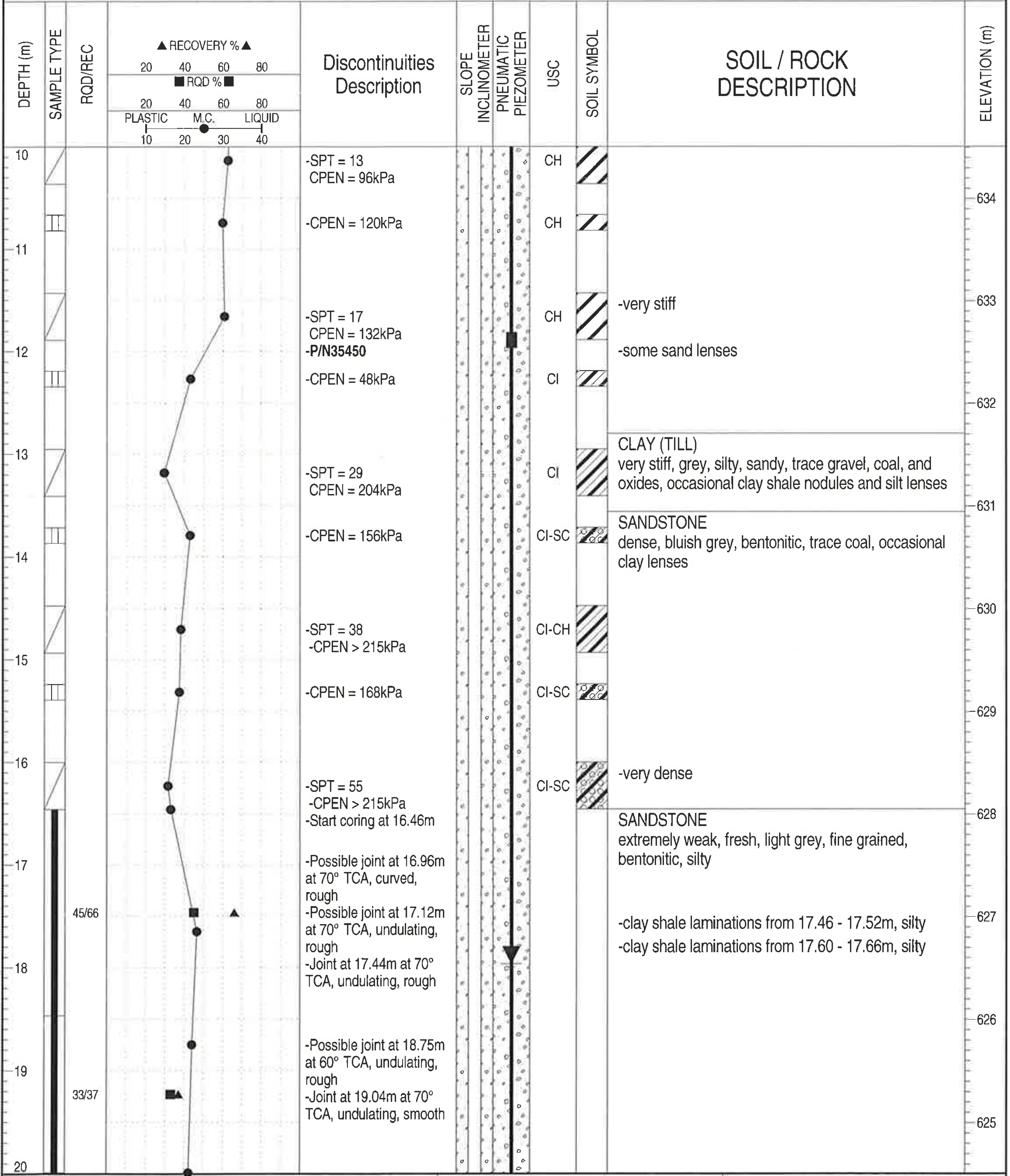
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ▮ CORE

BACKFILL TYPE ⬚ GROUT



RQD/REC	Discontinuities Description	USC	SOIL / ROCK DESCRIPTION
	-SPT = 13 CPEN = 96kPa	CH	
	-CPEN = 120kPa	CH	
	-SPT = 17 CPEN = 132kPa **-P/N35450**	CH	-very stiff -some sand lenses
	-CPEN = 48kPa	CI	
			CLAY (TILL) very stiff, grey, silty, sandy, trace gravel, coal, and oxides, occasional clay shale nodules and silt lenses
	-SPT = 29 CPEN = 204kPa	CI	
			SANDSTONE dense, bluish grey, bentonitic, trace coal, occasional clay lenses
	-CPEN = 156kPa	CI-SC	
	-SPT = 38 -CPEN > 215kPa	CI-CH	
	-CPEN = 168kPa	CI-SC	
	-SPT = 55 -CPEN > 215kPa -Start coring at 16.46m	CI-SC	-very dense
			SANDSTONE extremely weak, fresh, light grey, fine grained, bentonitic, silty
45/66	-Possible joint at 16.96m at 70° TCA, curved, rough -Possible joint at 17.12m at 70° TCA, undulating, rough -Joint at 17.44m at 70° TCA, undulating, rough		-clay shale laminations from 17.46 - 17.52m, silty -clay shale laminations from 17.60 - 17.66m, silty
33/37	-Possible joint at 18.75m at 60° TCA, undulating, rough -Joint at 19.04m at 70° TCA, undulating, smooth		

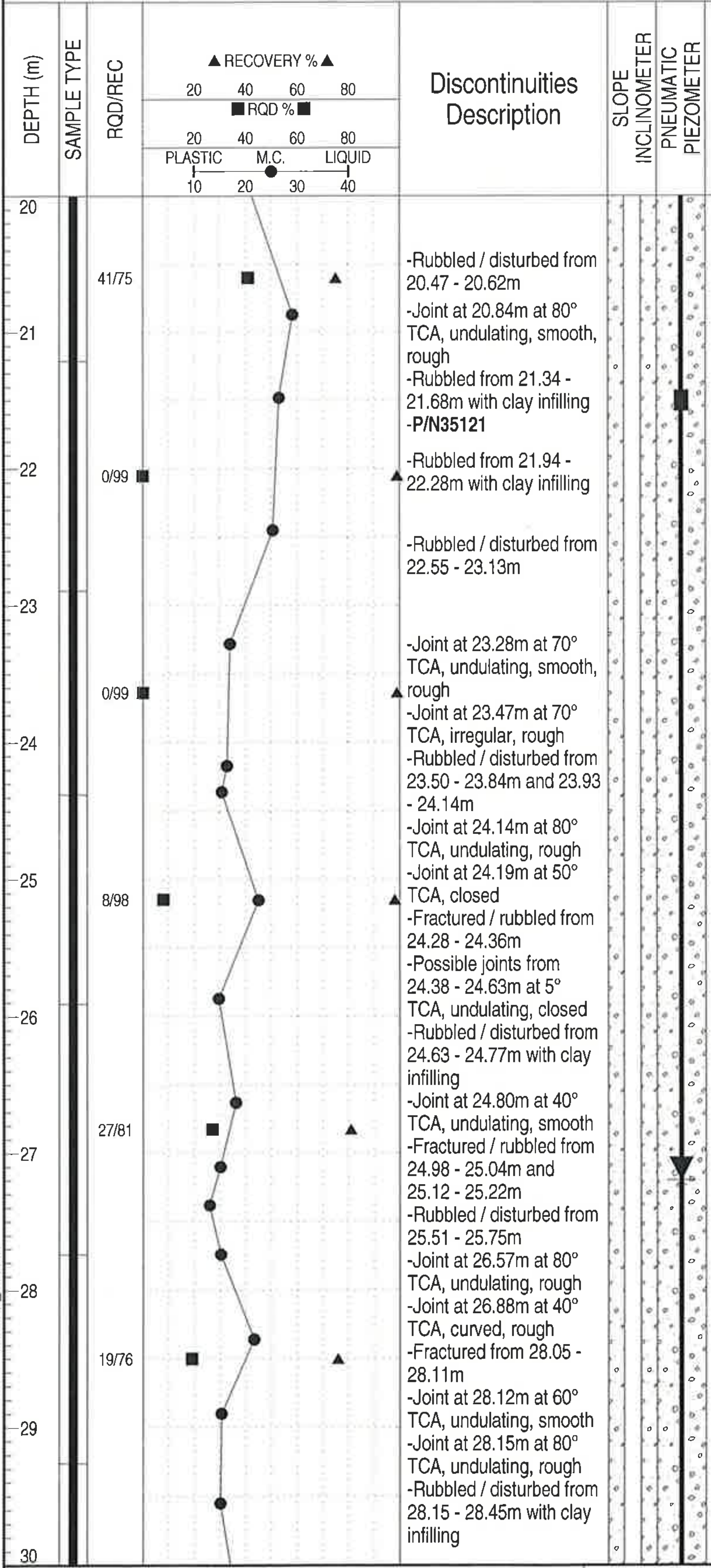
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▧ SPT ▮ CORE

BACKFILL TYPE ⊡ GROUT



RQD/REC:

41/75

0/99

0/99

8/98

27/81

19/76

Discontinuities Description

-Rubbled / disturbed from 20.47 - 20.62m

-Joint at 20.84m at 80° TCA, undulating, smooth, rough

-Rubbled from 21.34 - 21.68m with clay infilling

-P/N35121

-Rubbled from 21.94 - 22.28m with clay infilling

-Rubbled / disturbed from 22.55 - 23.13m

-Joint at 23.28m at 70° TCA, undulating, smooth, rough

-Joint at 23.47m at 70° TCA, irregular, rough

-Rubbled / disturbed from 23.50 - 23.84m and 23.93 - 24.14m

-Joint at 24.14m at 80° TCA, undulating, rough

-Joint at 24.19m at 50° TCA, closed

-Fractured / rubbled from 24.28 - 24.36m

-Possible joints from 24.38 - 24.63m at 5° TCA, undulating, closed

-Rubbled / disturbed from 24.63 - 24.77m with clay infilling

-Joint at 24.80m at 40° TCA, undulating, smooth

-Fractured / rubbled from 24.98 - 25.04m and 25.12 - 25.22m

-Rubbled / disturbed from 25.51 - 25.75m

-Joint at 26.57m at 80° TCA, undulating, rough

-Joint at 26.88m at 40° TCA, curved, rough

-Fractured from 28.05 - 28.11m

-Joint at 28.12m at 60° TCA, undulating, smooth

-Joint at 28.15m at 80° TCA, undulating, rough

-Rubbled / disturbed from 28.15 - 28.45m with clay infilling

USC

SOIL SYMBOL

SOIL / ROCK DESCRIPTION

-trace coal inclusions

CLAY SHALE
extremely weak, fresh, dark brown, carbonaceous, trace coal

-trace coal inclusions

Coal, very weak, fresh

-extremely weak to very weak, brown, silty

-extremely weak

-sandstone laminations from 23.28 - 23.37m

-siltstone laminations from 24.16 - 24.28m

-very weak, trace siltstone inclusions

Sandstone, extremely weak, fresh, light grey, fine grained, slightly bentonitic, silty, trace thin clay shale laminations at 80° TCA

Sandstone, extremely weak, fresh, light grey, medium to fine grained, bentonitic

SANDSTONE, extremely weak, fresh, medium to fine grained, bentonitic, silty, trace coal and siltstone inclusions

CLAY SHALE
extremely weak to very weak, fresh, slightly carbonaceous

-very weak to weak

-very weak, trace coal inclusions

Siltstone, very weak, fresh, trace coal inclusions

ELEVATION (m)

624
623
622
621
620
619
618
617
616
615

THURBER ENGINEERING LTD.

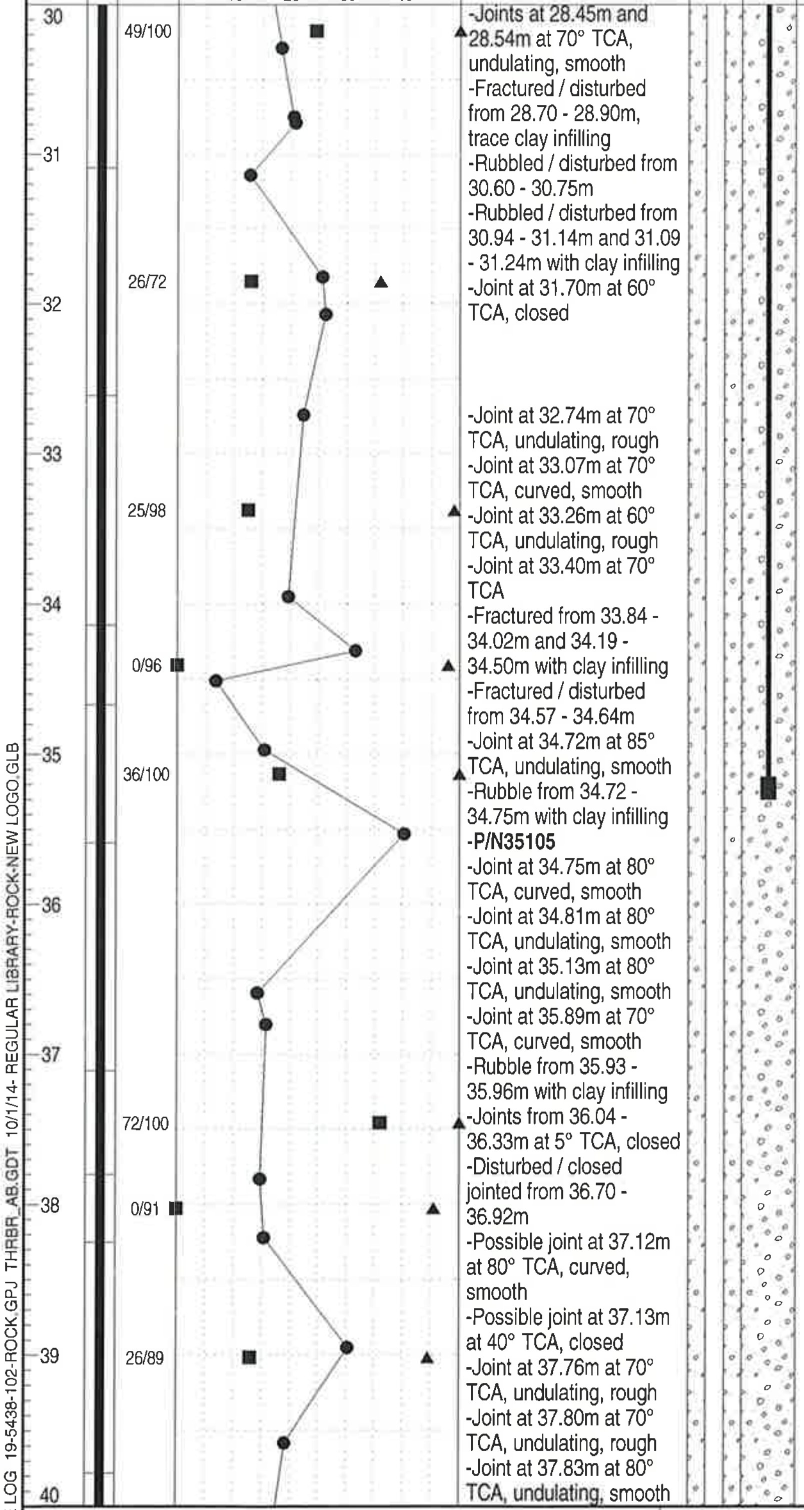
FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ▮ CORE

BACKFILL TYPE ▫ GROUT

DEPTH (m)	SAMPLE TYPE	RQD/REC	▲RECOVERY %▲ / ■RQD %■ / PLASTIC M.C. LIQUID	Discontinuities Description	SLOPE INCLINOMETER	PNEUMATIC PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)



RQD/REC:
49/100
26/72
25/98
0/96
36/100
72/100
0/91
26/89

Discontinuities Description

-Joints at 28.45m and 28.54m at 70° TCA, undulating, smooth
-Fractured / disturbed from 28.70 - 28.90m, trace clay infilling
-Rubbled / disturbed from 30.60 - 30.75m
-Rubbled / disturbed from 30.94 - 31.14m and 31.09 - 31.24m with clay infilling
-Joint at 31.70m at 60° TCA, closed
-Joint at 32.74m at 70° TCA, undulating, rough
-Joint at 33.07m at 70° TCA, curved, smooth
-Joint at 33.26m at 60° TCA, undulating, rough
-Joint at 33.40m at 70° TCA
-Fractured from 33.84 - 34.02m and 34.19 - 34.50m with clay infilling
-Fractured / disturbed from 34.57 - 34.64m
-Joint at 34.72m at 85° TCA, undulating, smooth
-Rubble from 34.72 - 34.75m with clay infilling
-P/N35105
-Joint at 34.75m at 80° TCA, curved, smooth
-Joint at 34.81m at 80° TCA, undulating, smooth
-Joint at 35.13m at 80° TCA, undulating, smooth
-Joint at 35.89m at 70° TCA, curved, smooth
-Rubble from 35.93 - 35.96m with clay infilling
-Joints from 36.04 - 36.33m at 5° TCA, closed
-Disturbed / closed jointed from 36.70 - 36.92m
-Possible joint at 37.12m at 80° TCA, curved, smooth
-Possible joint at 37.13m at 40° TCA, closed
-Joint at 37.76m at 70° TCA, undulating, rough
-Joint at 37.80m at 70° TCA, undulating, rough
-Joint at 37.83m at 80° TCA, undulating, smooth

SOIL / ROCK DESCRIPTION

-fine sandstone laminations from 30.23 - 30.30m

SILTSTONE, very weak, fresh, thin clay shale and coal laminations at 85° TCA

CLAY SHALE, very weak, fresh, silty, trace coal inclusions

SILTSTONE, very weak, fresh, some clay shale laminations
-sandstone laminations from 30.79 - 30.87m, trace coal inclusions

CLAY SHALE, very weak, fresh, silty

SILTSTONE, medium strong, fresh, cemented, trace calcite stringers, calcareous

CLAY SHALE, very weak to weak, fresh, brown, silty
-extremely weak, bentonitic, trace coal inclusions from 31.70 - 31.83m
-highly carbonaceous from 31.88 - 31.98m

Coal, very weak, fresh
-very weak, trace coal inclusions, siltstone laminations from 32.64 - 32.86m
-weak to very weak

Siltstone, weak, fresh, cemented
-carbonaceous

-extremely weak, green, bentonitic from 35.31 - 35.55m
-weak

SANDSTONE, weak, fresh, some clay shale laminations
-very weak, fine grained, silty

CLAY SHALE
weak, fresh, brown, silty

very weak, carbonaceous, trace coal inclusions

-extremely weak
-very weak, highly carbonaceous from 38.44 - 38.60m

COAL, very weak, fresh, black

CLAY SHALE, extremely weak to very weak, fresh, carbonaceous, trace coal inclusions

SANDSTONE, very weak, fresh, fine grained, silty, bentonitic, trace clay shale laminations

ELEVATION (m): 614, 613, 612, 611, 610, 609, 608, 607, 606, 605

BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

THURBER ENGINEERING LTD.

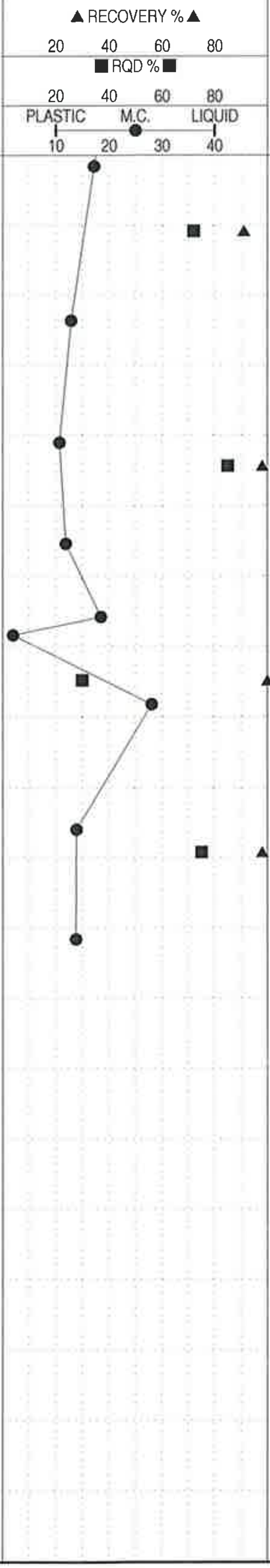
FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ▮ CORE

BACKFILL TYPE ⁘ GROUT

DEPTH (m)	SAMPLE TYPE	RQD/REC
40	CORE	
		72/91
41		
42		85/98
43		
		30/100
44		
45		75/98
46		
47		
48		
49		
50		



SLOPE INCLINOMETER | PNEUMATIC PIEZOMETER | USC | SOIL SYMBOL

Discontinuities Description

-Fractured from 37.93 - 37.97m
-Joint at 38.08m at 40° TCA, planar, smooth
-Joint at 38.30m at 60° TCA, undulating, rough
-Joints from 38.68 - 38.83m at 10° TCA, planar, rough, fractured
-Fractured / jointed from 38.83 - 39.16m with clay infilling
-Joint at 39.95m at 70° TCA, undulating, smooth
-Joint at 40.07m at 80° TCA, undulating, smooth
-Joint at 40.43m at 80° TCA, undulating, smooth
-Joint at 40.78m at 85° TCA, undulating, smooth
-Possible joint at 41.48m at 80° TCA
-Joint at 41.89m at 80° TCA, planar, smooth
-Joint at 42.09m at 40° TCA, curved, rough
-Joint at 42.47m at 80° TCA, planar, rough
-Joint at 42.94m at 80° TCA, curved, rough
-Joint at 43.32m at 85° TCA, undulating, smooth
-Joint at 43.35m at 80° TCA, undulating, rough
-Fractured from 43.38 - 43.59m
-Possible joints at 43.87m and 43.89m at 80° TCA, undulating, rough
-Joint at 44.15m at 80° TCA, curved, smooth
-Joint at 44.41m at 70° TCA, curved, rough
-Joint at 44.80m at 70° TCA, planar, smooth
-Joint at 45.11m at 70° TCA, curved, smooth
-Joint at 45.21m at 85° TCA, undulating, rough
-Rubble from 45.36 - 45.38m

SOIL / ROCK DESCRIPTION

-medium to fine grained
-some clay shale laminations from 40.14 - 40.43m

-fine grained, slightly bentonitic, trace coal inclusions

-trace cemented siltstone clasts

CLAY SHALE
extremely weak, fresh, brown, silty
-medium strong, calcareous, cemented siltstone from 43.30 - 43.59m

SANDSTONE, extremely weak, fresh, fine grained, bentonitic, trace coal inclusions
-weak, silty, slightly cemented, calcareous

CLAY SHALE, very weak, fresh, carbonaceous, trace coal inclusions

END OF TEST HOLE AT 45.6m
UPON COMPLETION:
Slope indicator (casing at 45.5m) installed
Three pneumatic piezometers installed (P/N35450, P/N35121, and P/N35105)
WATER LEVEL BELOW GROUND SURFACE:
P/N35450:
-July 9, 2014 = 3.1m
-July 31, 2014 = 3.4m
-September 29, 2014 = 3.1m
P/N35121:
-July 9, 2014 = 16.8m
-July 31, 2014 = 17.1m
-September 29, 2014 = 18.0m
P/N35105:
-July 9, 2014 = 26.9m
-July 31, 2014 = 26.4m
-September 29, 2014 = 27.2m

ELEVATION (m): 604, 603, 602, 601, 600, 599, 598, 597, 596, 595

BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14 - REGULAR LIBRARY-ROCK-NEW LOGO.GLB

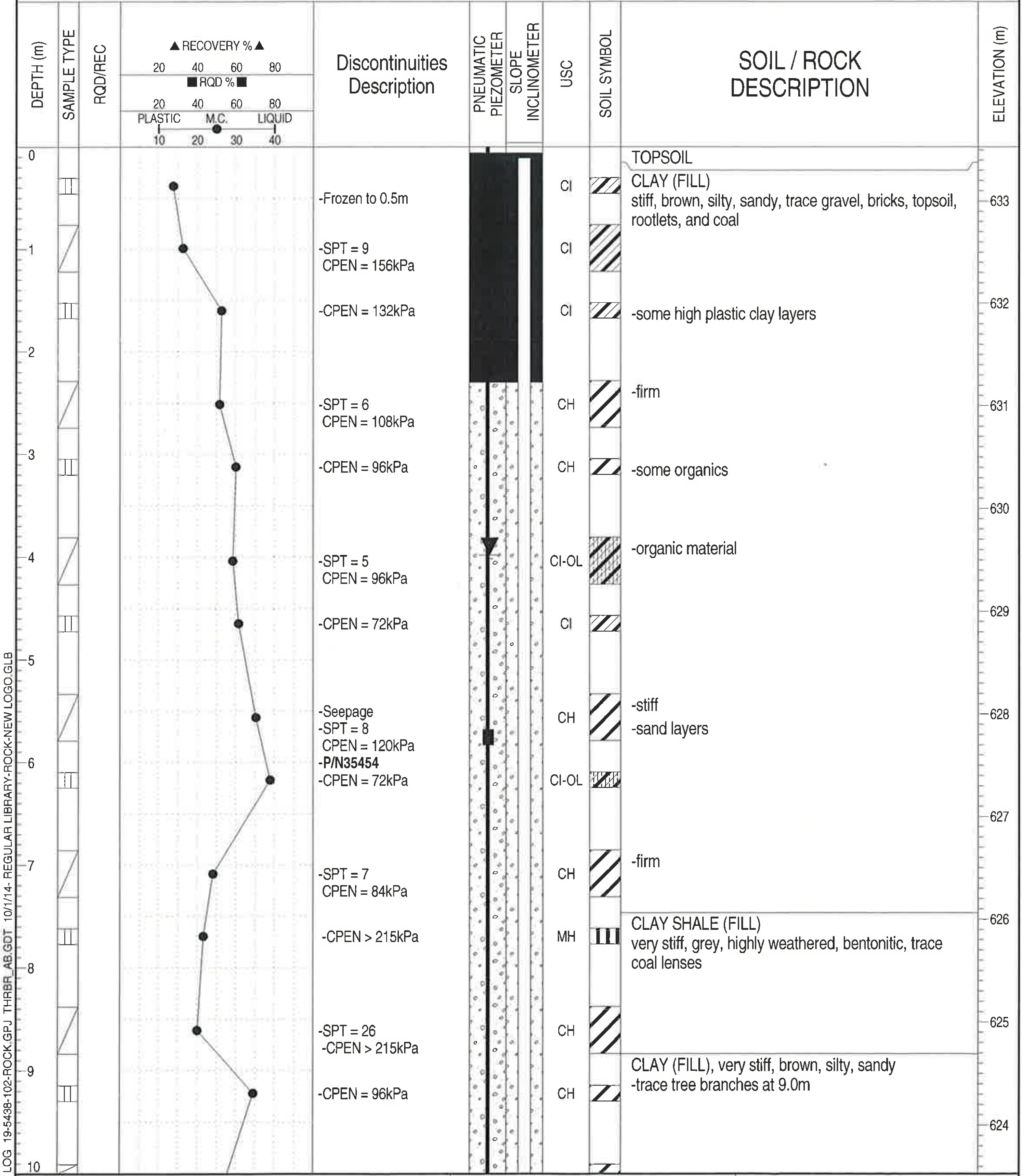
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ▮ CORE

BACKFILL TYPE ■ BENTONITE ▫ GROUT



Discontinuities Description	USC	SOIL / ROCK DESCRIPTION
		TOPSOIL
-Frozen to 0.5m	CI	CLAY (FILL) stiff, brown, silty, sandy, trace gravel, bricks, topsoil, rootlets, and coal
-SPT = 9 CPEN = 156kPa	CI	
-CPEN = 132kPa	CI	-some high plastic clay layers
-SPT = 6 CPEN = 108kPa	CH	-firm
-CPEN = 96kPa	CH	-some organics
-SPT = 5 CPEN = 96kPa	CI-OL	-organic material
-CPEN = 72kPa	CI	
-Seepage -SPT = 8 CPEN = 120kPa **-P/N35454**	CH	-stiff -sand layers
-CPEN = 72kPa	CI-OL	
-SPT = 7 CPEN = 84kPa	CH	-firm
-CPEN > 215kPa	MH	CLAY SHALE (FILL) very stiff, grey, highly weathered, bentonitic, trace coal lenses
-SPT = 26 -CPEN > 215kPa	CH	
-CPEN = 96kPa	CH	CLAY (FILL), very stiff, brown, silty, sandy -trace tree branches at 9.0m

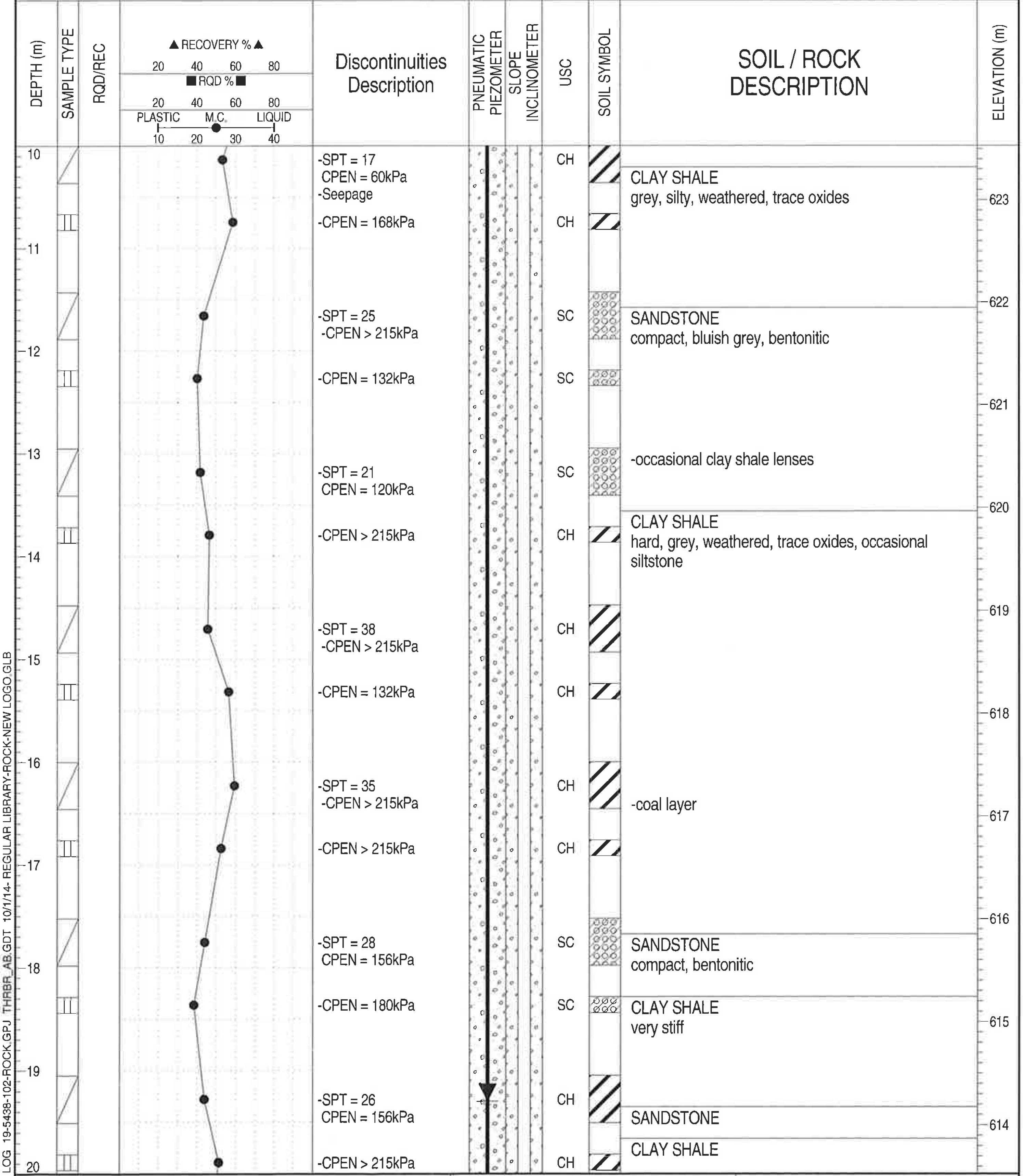
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
PREPARED BY: XW	COMPLETION DATE: 3/17/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ▮ CORE

BACKFILL TYPE ■ BENTONITE ⬚ GROUT



Discontinuities Description	USC	SOIL / ROCK DESCRIPTION
-SPT = 17 CPEN = 60kPa -Seepage	CH	CLAY SHALE grey, silty, weathered, trace oxides
-CPEN = 168kPa	CH	
-SPT = 25 -CPEN > 215kPa	SC	SANDSTONE compact, bluish grey, bentonitic
-CPEN = 132kPa	SC	
-SPT = 21 CPEN = 120kPa	SC	-occasional clay shale lenses
-CPEN > 215kPa	CH	CLAY SHALE hard, grey, weathered, trace oxides, occasional siltstone
-SPT = 38 -CPEN > 215kPa	CH	
-CPEN = 132kPa	CH	
-SPT = 35 -CPEN > 215kPa	CH	-coal layer
-CPEN > 215kPa	CH	
-SPT = 28 CPEN = 156kPa	SC	SANDSTONE compact, bentonitic
-CPEN = 180kPa	SC	CLAY SHALE very stiff
-SPT = 26 CPEN = 156kPa	CH	SANDSTONE
-CPEN > 215kPa	CH	CLAY SHALE

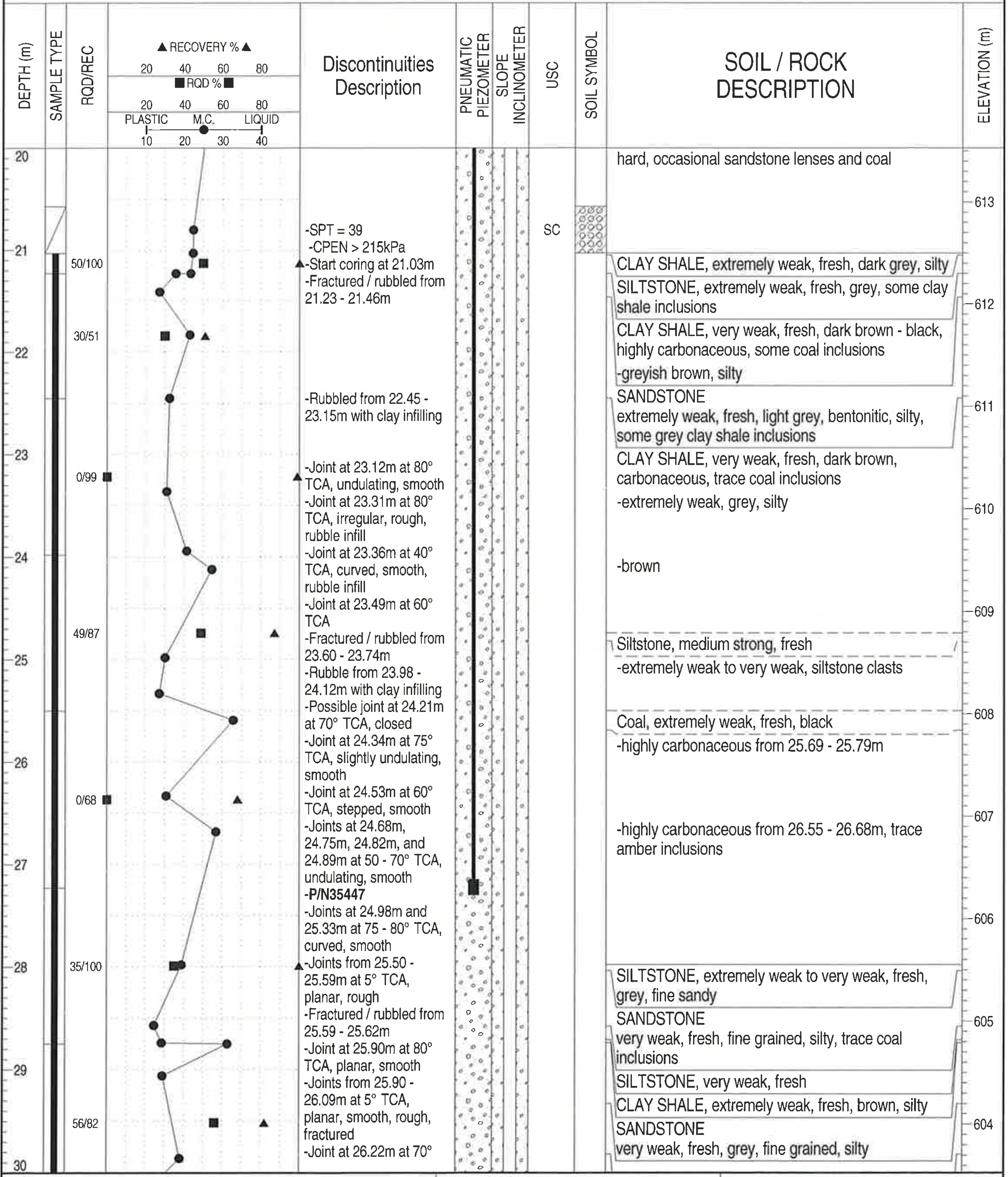
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
PREPARED BY: XW	COMPLETION DATE: 3/17/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ◧ CORE

BACKFILL TYPE ■ BENTONITE ⁘ GROUT



Discontinuities Description

-SPT = 39
-CPEN > 215kPa
-Start coring at 21.03m
-Fractured / rubbled from 21.23 - 21.46m
-Rubbled from 22.45 - 23.15m with clay infilling
-Joint at 23.12m at 80° TCA, undulating, smooth
-Joint at 23.31m at 80° TCA, irregular, rough, rubble infill
-Joint at 23.36m at 40° TCA, curved, smooth, rubble infill
-Joint at 23.49m at 60° TCA
-Fractured / rubbled from 23.60 - 23.74m
-Rubble from 23.98 - 24.12m with clay infilling
-Possible joint at 24.21m at 70° TCA, closed
-Joint at 24.34m at 75° TCA, slightly undulating, smooth
-Joint at 24.53m at 60° TCA, stepped, smooth
-Joints at 24.68m, 24.75m, 24.82m, and 24.89m at 50 - 70° TCA, undulating, smooth
-P/N35447
-Joints at 24.98m and 25.33m at 75 - 80° TCA, curved, smooth
-Joints from 25.50 - 25.59m at 5° TCA, planar, rough
-Fractured / rubbled from 25.59 - 25.62m
-Joint at 25.90m at 80° TCA, planar, smooth
-Joints from 25.90 - 26.09m at 5° TCA, planar, smooth, rough, fractured
-Joint at 26.22m at 70°

SOIL / ROCK DESCRIPTION

hard, occasional sandstone lenses and coal

CLAY SHALE, extremely weak, fresh, dark grey, silty

SILTSTONE, extremely weak, fresh, grey, some clay shale inclusions

CLAY SHALE, very weak, fresh, dark brown - black, highly carbonaceous, some coal inclusions
-greyish brown, silty

SANDSTONE
extremely weak, fresh, light grey, bentonitic, silty, some grey clay shale inclusions

CLAY SHALE, very weak, fresh, dark brown, carbonaceous, trace coal inclusions
-extremely weak, grey, silty

-brown

Siltstone, medium strong, fresh
-extremely weak to very weak, siltstone clasts

Coal, extremely weak, fresh, black
-highly carbonaceous from 25.69 - 25.79m

-highly carbonaceous from 26.55 - 26.68m, trace amber inclusions

SILTSTONE, extremely weak to very weak, fresh, grey, fine sandy

SANDSTONE
very weak, fresh, fine grained, silty, trace coal inclusions

SILTSTONE, very weak, fresh

CLAY SHALE, extremely weak, fresh, brown, silty

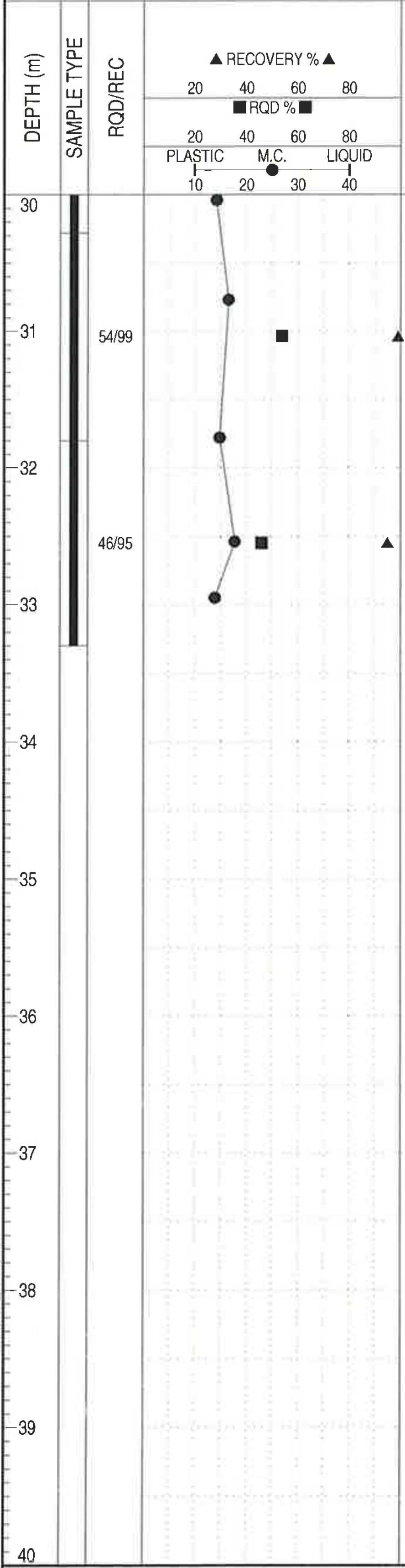
SANDSTONE
very weak, fresh, grey, fine grained, silty

THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
	PREPARED BY: XW	COMPLETION DATE: 3/17/14
	REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

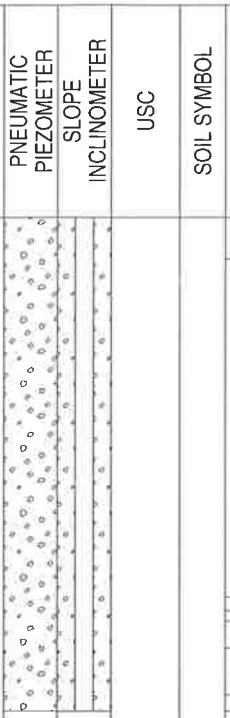
SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ GROUT



Discontinuities Description

TCA, undulating, rough
-Joint at 26.27m at 40° TCA, curved, smooth
-Joint at 26.28m at 80° TCA, planar, smooth
-Joint at 26.32m at 70° TCA, undulating, rough
-Fractured / rubbled from 26.55 - 26.68m and 27.23 - 27.98m
-Joint at 29.06m at 50° TCA, curved, smooth, rough
-Joint at 29.45m at 40° TCA, curved, rough
-Joint at 29.56m at 30° TCA, undulating, smooth
-Joint at 29.74m at 80° TCA, irregular, smooth
-Joints at 29.89m and 30.04m at 70 - 80° TCA, undulating, smooth
-Joint at 30.72m at 60° TCA, curved, rough
-Joint at 30.77m at 40° TCA, undulating, rough
-Joint at 32.54m at 60° TCA, undulating, rough
-Fractured from 32.54 - 33.29m



SOIL / ROCK DESCRIPTION

CLAY SHALE, extremely weak, fresh, brown, silty
-sandstone laminations from 29.49 - 29.51m

SILTSTONE, extremely weak, fresh, light grey, trace clay shale laminations / inclusions

SANDSTONE
extremely weak, fresh, fine grained, silty

-light grey, slightly bentonitic, trace siltstone inclusions

-trace thin coal laminations
-highly carbonaceous clay shale laminations from 32.44 - 32.51m

SILTSTONE, extremely weak to very weak, fresh

SANDSTONE, very weak, fresh, trace siltstone laminations

CLAY SHALE, very weak, fresh, highly carbonaceous

SILTSTONE, medium strong, fresh, cemented

CLAY SHALE, very weak, fresh

END OF TEST HOLE AT 33.3m
UPON COMPLETION:
Slope indicator (casing at 33.3m) installed
Two pneumatic piezometers installed (P/N35454and P/N35447)
WATER LEVEL BELOW GROUND SURFACE:
P/N35454:
-July 9, 2014 = 4.8m
-July 31, 2014 = 4.5m
-September 29, 2014 = 4.0m
P/N35447:
-July 9, 2014 = 19.1m
-July 31, 2014 = 19.3m
-September 29, 2014 = 19.3m

ELEVATION (m): 603, 602, 601, 600, 599, 598, 597, 596, 595, 594

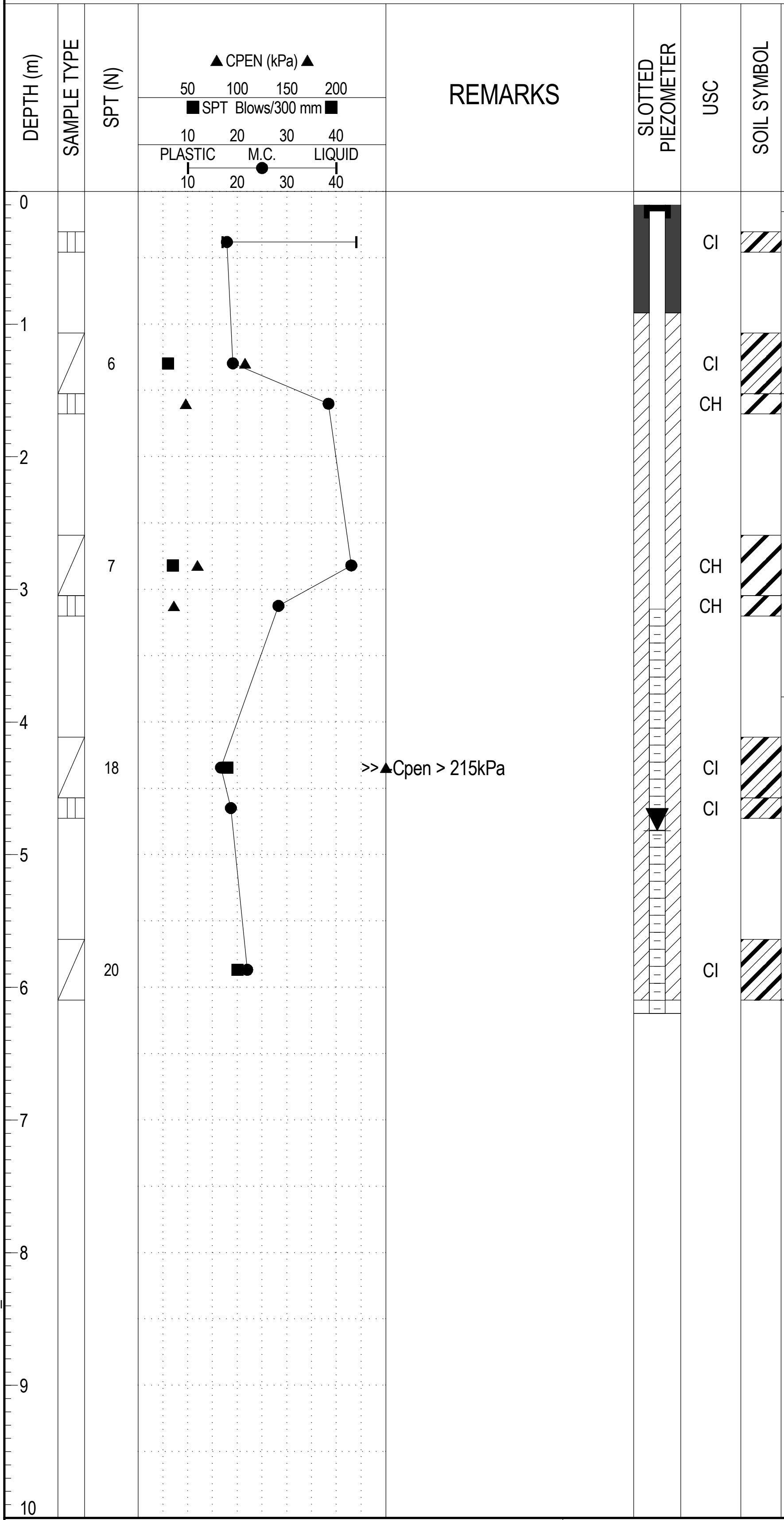
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
PREPARED BY: XW	COMPLETION DATE: 3/17/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934370.75, E34212.54 3TM	ELEVATION: 634.19 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◿ SPT

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS



SOIL DESCRIPTION

TOPSOIL

CLAY (FILL)
brown, silty, sandy, trace gravel, coal, roots, and bricks, occasional sand lenses

-firm

CLAY
firm, brown, silty, trace oxides

CLAY (TILL)
very stiff, brown - grey, silty, sandy, trace gravel, coal, and oxides, occasional sand lenses

END OF TEST HOLE AT 6.1m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 11, 2014 = 4.6m
-July 9, 2014 = 4.7m
-July 31, 2014 = 4.6m
-September 29, 2014 = 4.8m

ELEVATION (m)
634
633
632
631
630
629
628
627
626
625

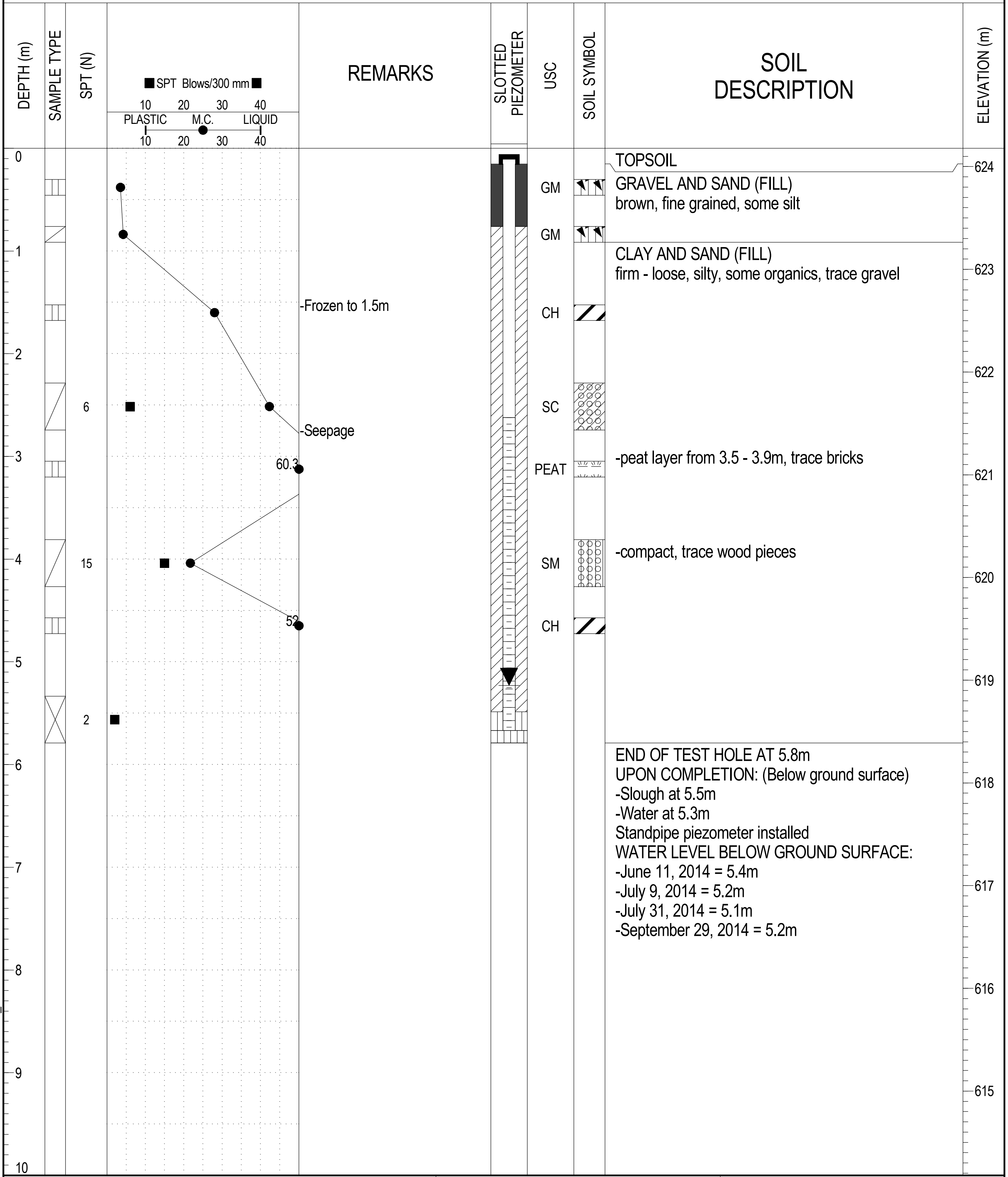
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 6.1 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 1 of 1

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934322.72, E34321.18 3TM	ELEVATION: 624.18 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



TOPSOIL

GRAVEL AND SAND (FILL)
brown, fine grained, some silt

CLAY AND SAND (FILL)
firm - loose, silty, some organics, trace gravel

-peat layer from 3.5 - 3.9m, trace bricks

-compact, trace wood pieces

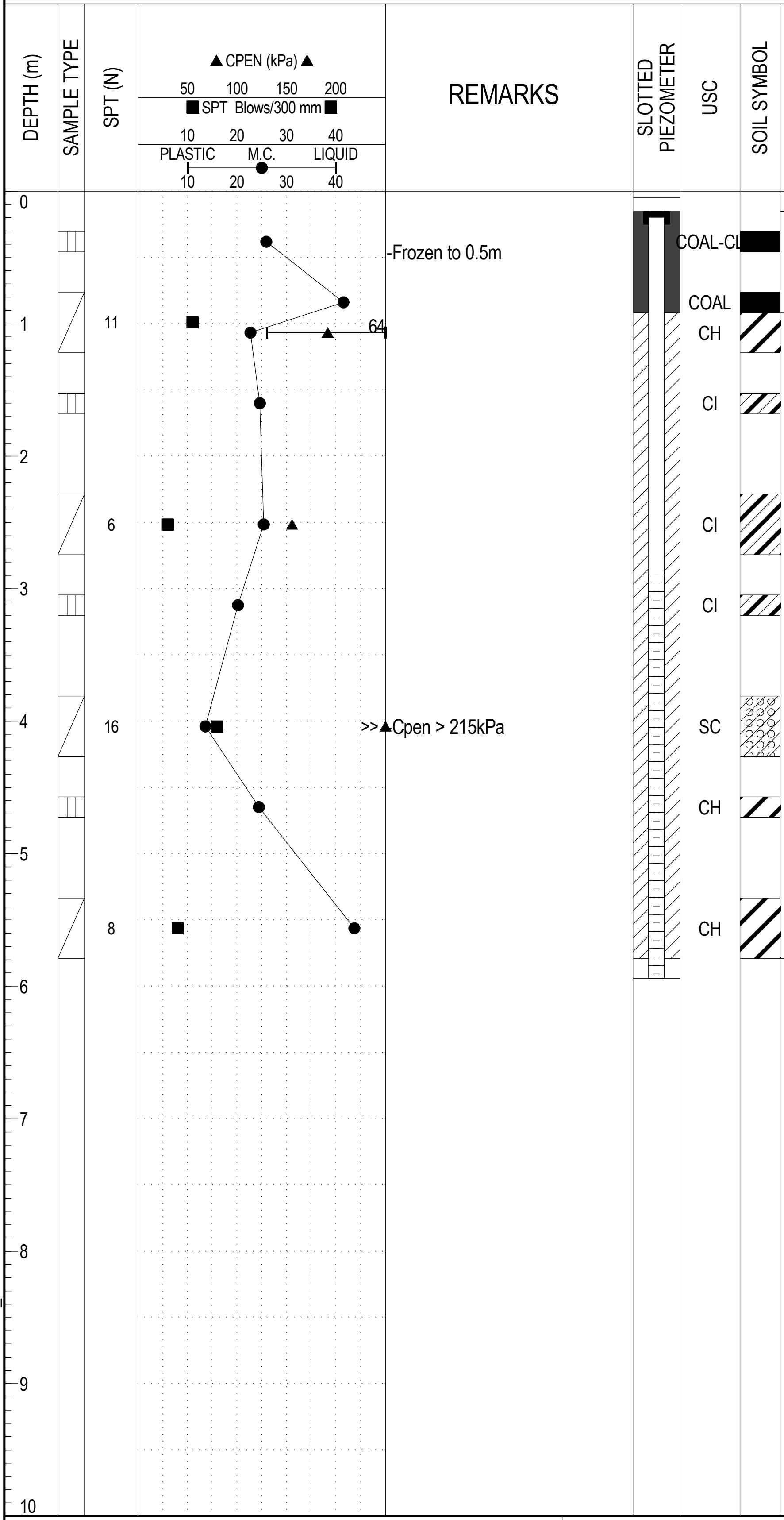
END OF TEST HOLE AT 5.8m
UPON COMPLETION: (Below ground surface)
-Slough at 5.5m
-Water at 5.3m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 11, 2014 = 5.4m
-July 9, 2014 = 5.2m
-July 31, 2014 = 5.1m
-September 29, 2014 = 5.2m

THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.8 m
	PREPARED BY: TME	COMPLETION DATE: 3/24/14
	REVIEWED BY:	Page 1 of 1

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-3**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934342.67, E34469.76 3TM	ELEVATION: 623.47 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



SOIL DESCRIPTION

TOPSOIL

CLAY AND COAL (FILL)
stiff, brown - black, trace rootlets

CLAY (FILL)
stiff, brown, silty, trace pebbles and oxides

-firm

-brown - grey, bentonitic, trace coal

-stiff, coal layer

END OF TEST HOLE AT 5.8m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 11, 2014 = Dry
-July 9, 2014 = Dry
-July 31, 2014 = Dry
-September 29, 2014 = Dry

ELEVATION (m)
623
622
621
620
619
618
617
616
615
614

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

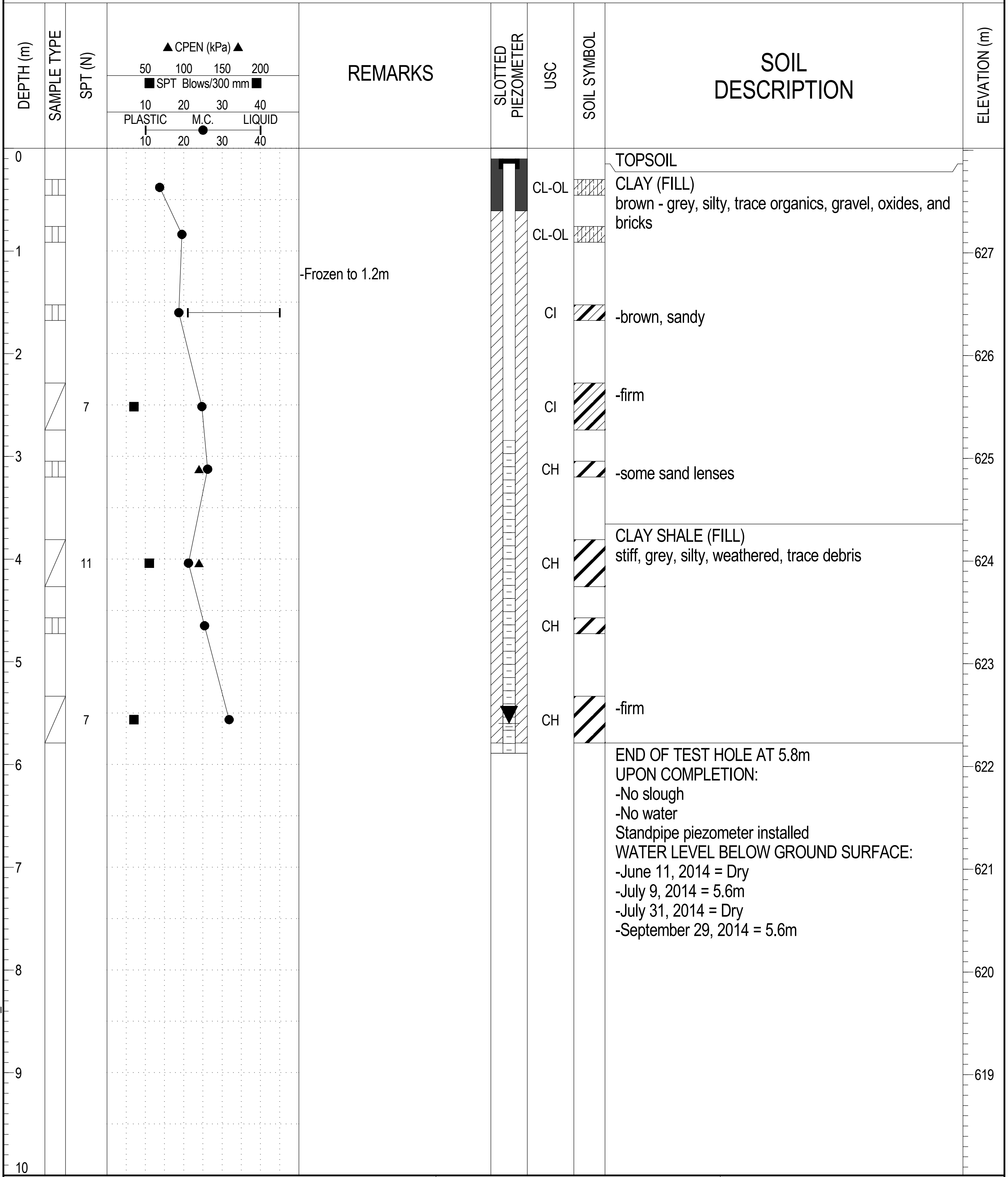
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.8 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-4**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934376.95, E34599.26 3TM	ELEVATION: 628.02 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



SOIL DESCRIPTION

TOPSOIL

CLAY (FILL)
brown - grey, silty, trace organics, gravel, oxides, and bricks

-brown, sandy

-firm

-some sand lenses

CLAY SHALE (FILL)
stiff, grey, silty, weathered, trace debris

-firm

END OF TEST HOLE AT 5.8m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 11, 2014 = Dry
-July 9, 2014 = 5.6m
-July 31, 2014 = Dry
-September 29, 2014 = 5.6m

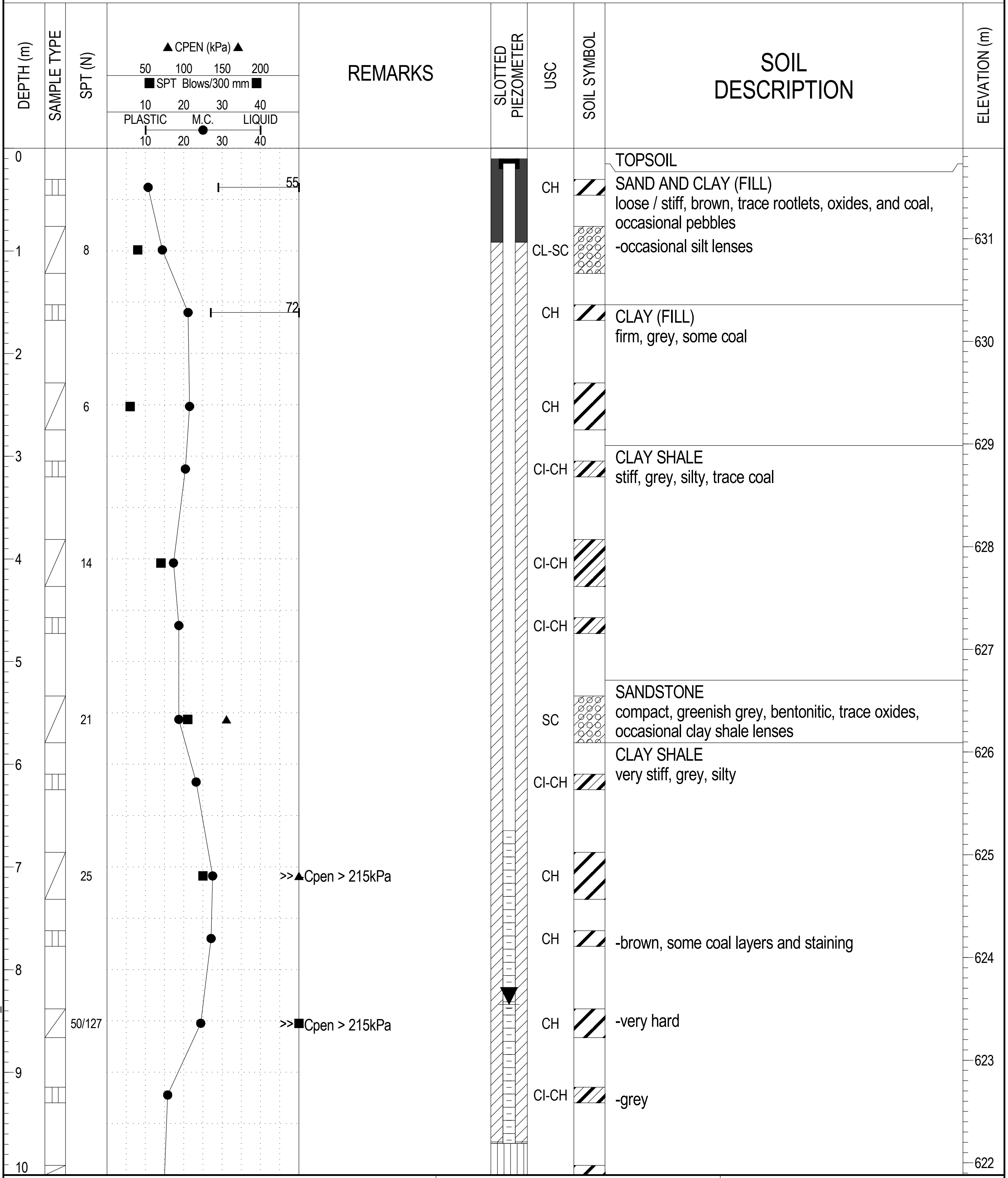
FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.8 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 1 of 1

THURBER ENGINEERING LTD.

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-5**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934394.61, E34775.98 3TM	ELEVATION: 631.88 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



TOPSOIL

SAND AND CLAY (FILL)
loose / stiff, brown, trace rootlets, oxides, and coal, occasional pebbles
-occasional silt lenses

CLAY (FILL)
firm, grey, some coal

CLAY SHALE
stiff, grey, silty, trace coal

SANDSTONE
compact, greenish grey, bentonitic, trace oxides, occasional clay shale lenses

CLAY SHALE
very stiff, grey, silty

-brown, some coal layers and staining

-very hard

-grey

THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.1 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 1 of 2

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-5**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934394.61, E34775.98 3TM	ELEVATION: 631.88 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH

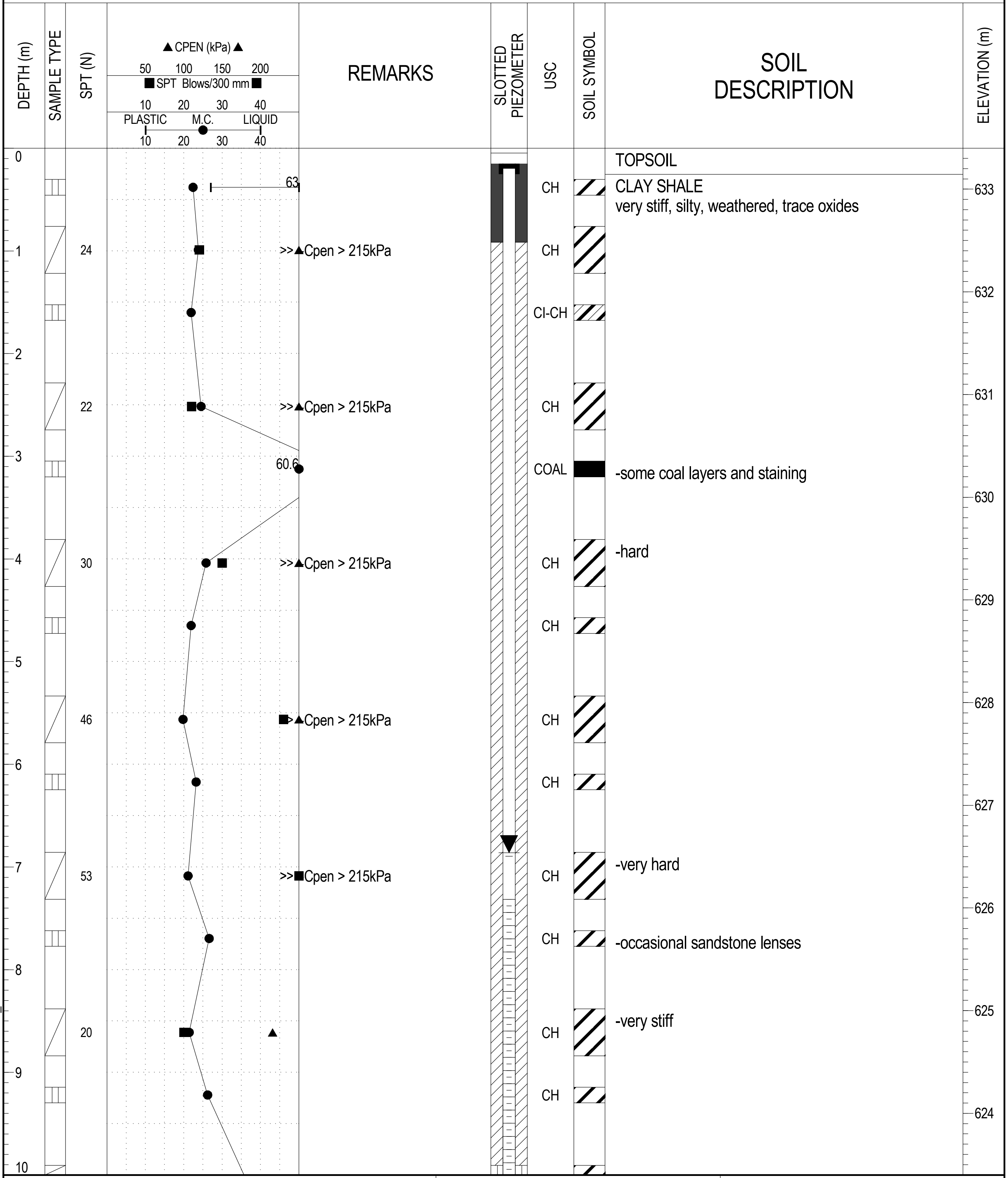
DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 ■SPT Blows/300 mm■ 10 20 30 40 PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10	▨	50/51	● >>■	-Cpen > 215kPa	▥	CH	▨	CLAY SHALE - CONTINUED END OF TEST HOLE AT 10.1m UPON COMPLETION: (Below ground surface) -Slough at 9.7m -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 11, 2014 = 8.1m -July 9, 2014 = 8.2m -July 31, 2014 = 8.2m -September 29, 2014 = 8.3m	
11									621
12									620
13									619
14									618
15									617
16									616
17									615
18									614
19									613
20									612

THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.1 m
	PREPARED BY: TME	COMPLETION DATE: 3/24/14
	REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-6**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934388.42, E34840.38 3TM	ELEVATION: 633.40 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



DEPTH (m)	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0				TOPSOIL
			CH	CLAY SHALE very stiff, silty, weathered, trace oxides
1	24	>>▲Cpen > 215kPa	CH	
			CI-CH	
	22	>>▲Cpen > 215kPa	CH	
3			COAL	-some coal layers and staining
				-hard
4	30	>>▲Cpen > 215kPa	CH	
			CH	
	46	■>▲Cpen > 215kPa	CH	
			CH	
				-very hard
7	53	>>■Cpen > 215kPa	CH	
			CH	-occasional sandstone lenses
				-very stiff
	20		CH	
			CH	

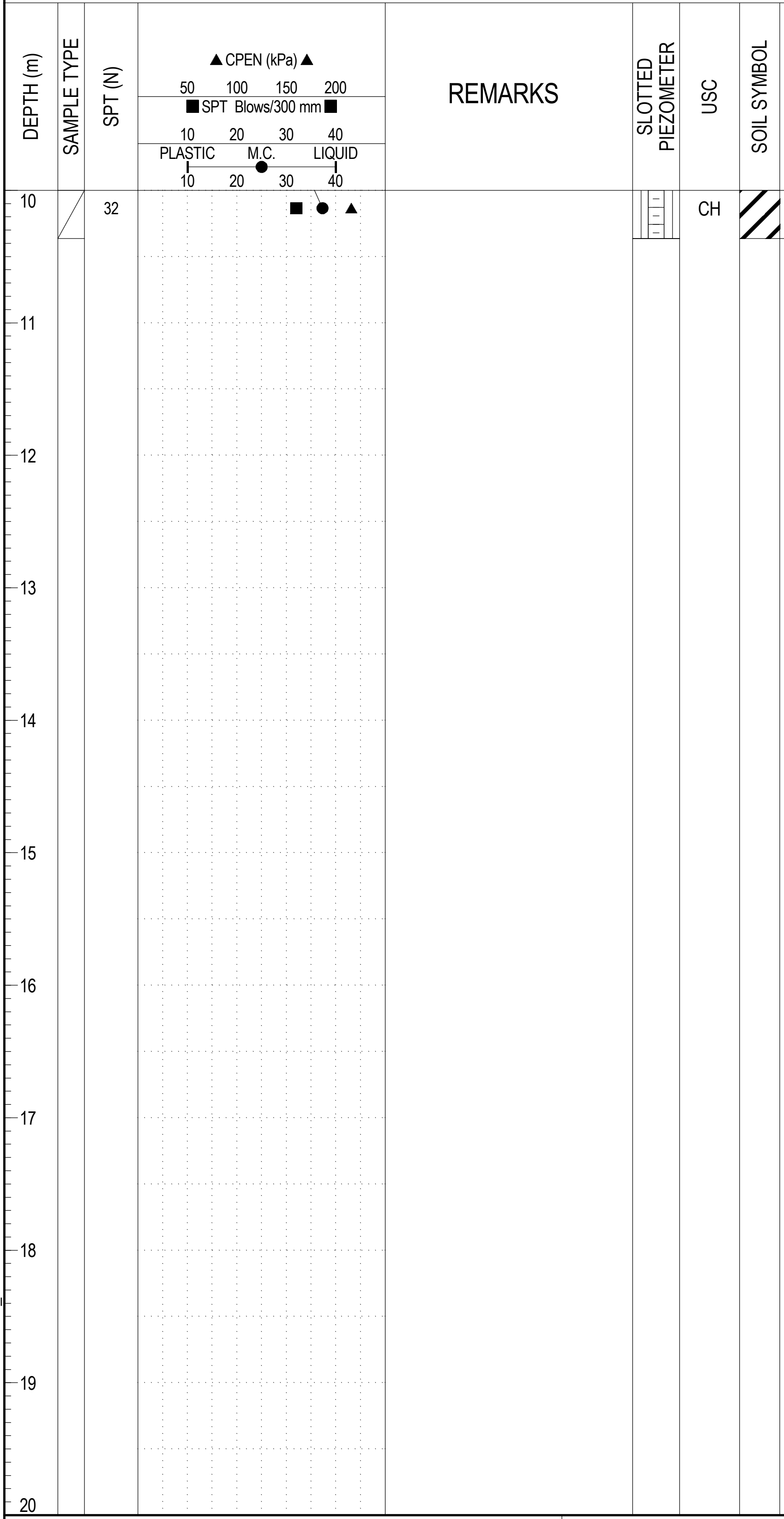
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-6**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934388.42, E34840.38 3TM	ELEVATION: 633.40 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SOIL DESCRIPTION

CLAY SHALE - CONTINUED
-hard
-coal layers

END OF TEST HOLE AT 10.4m
UPON COMPLETION: (Below ground surface)
-Slough at 9.9m
-Water at 9.7m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-June 11, 2014 = 6.7m
-July 9, 2014 = 6.8m
-July 31, 2014 = 6.6m
-September 29, 2014 = 6.9m

ELEVATION (m): 623, 622, 621, 620, 619, 618, 617, 616, 615, 614

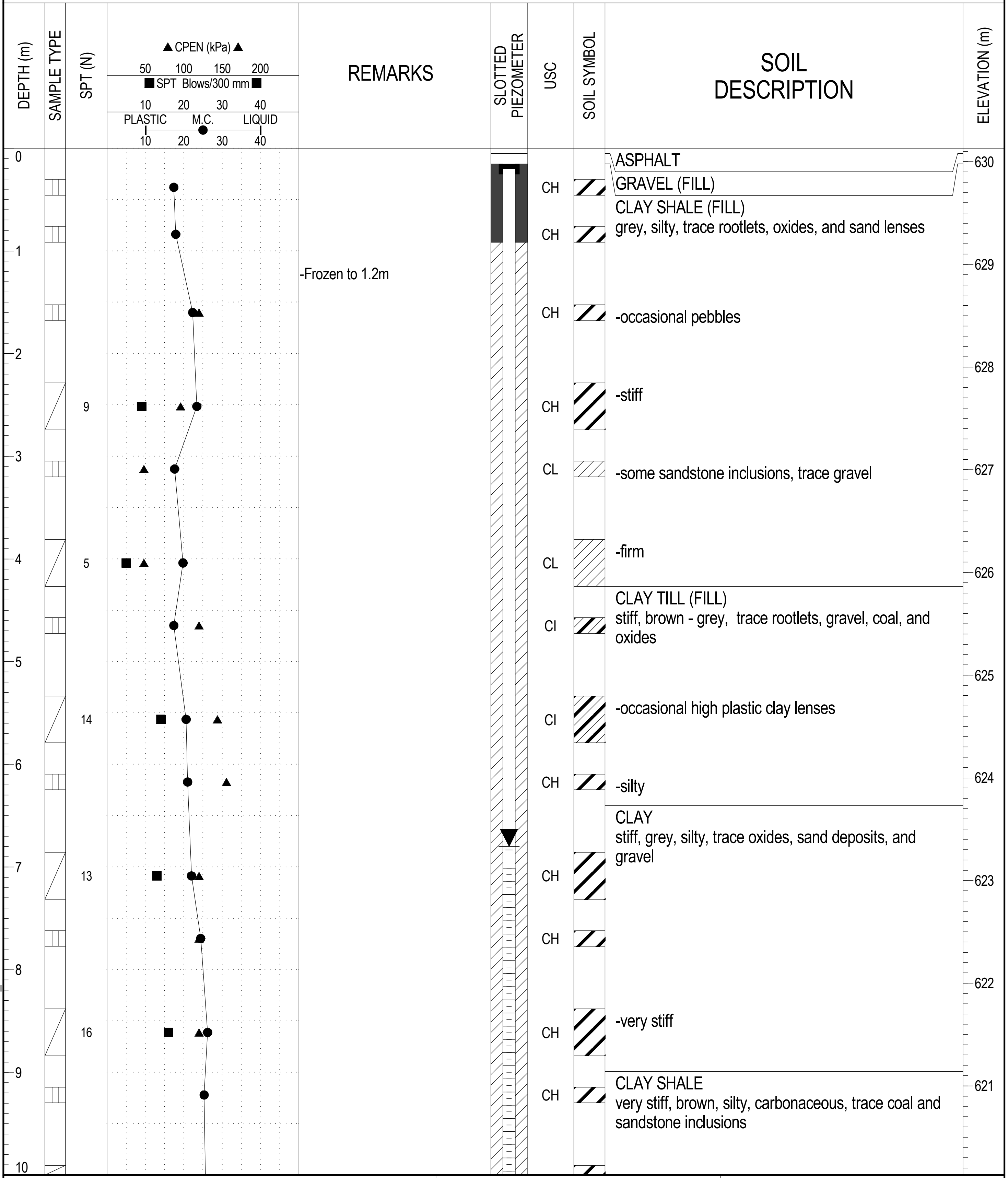
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 2 of 2

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-7**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934401.22, E34639.49 3TM	ELEVATION: 630.13 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



ASPHALT

GRAVEL (FILL)

CLAY SHALE (FILL)
grey, silty, trace rootlets, oxides, and sand lenses

-occasional pebbles

-stiff

-some sandstone inclusions, trace gravel

-firm

CLAY TILL (FILL)
stiff, brown - grey, trace rootlets, gravel, coal, and oxides

-occasional high plastic clay lenses

-silty

CLAY
stiff, grey, silty, trace oxides, sand deposits, and gravel

-very stiff

CLAY SHALE
very stiff, brown, silty, carbonaceous, trace coal and sandstone inclusions

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

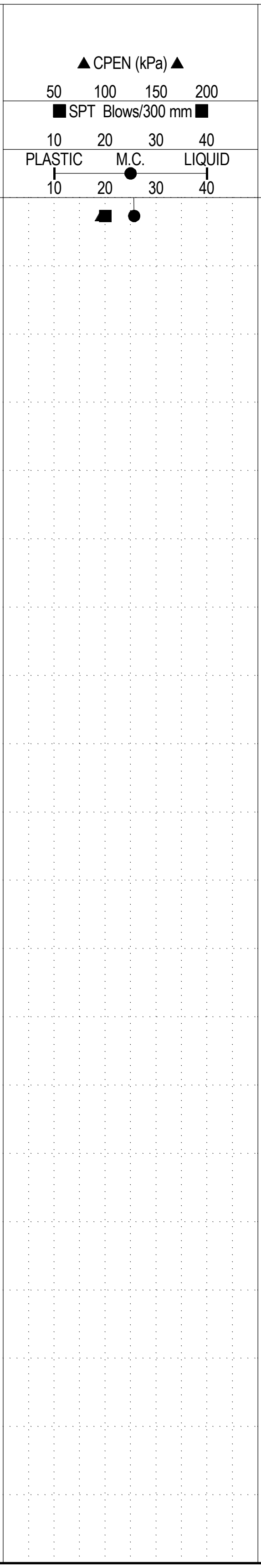
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-7**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934401.22, E34639.49 3TM	ELEVATION: 630.13 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



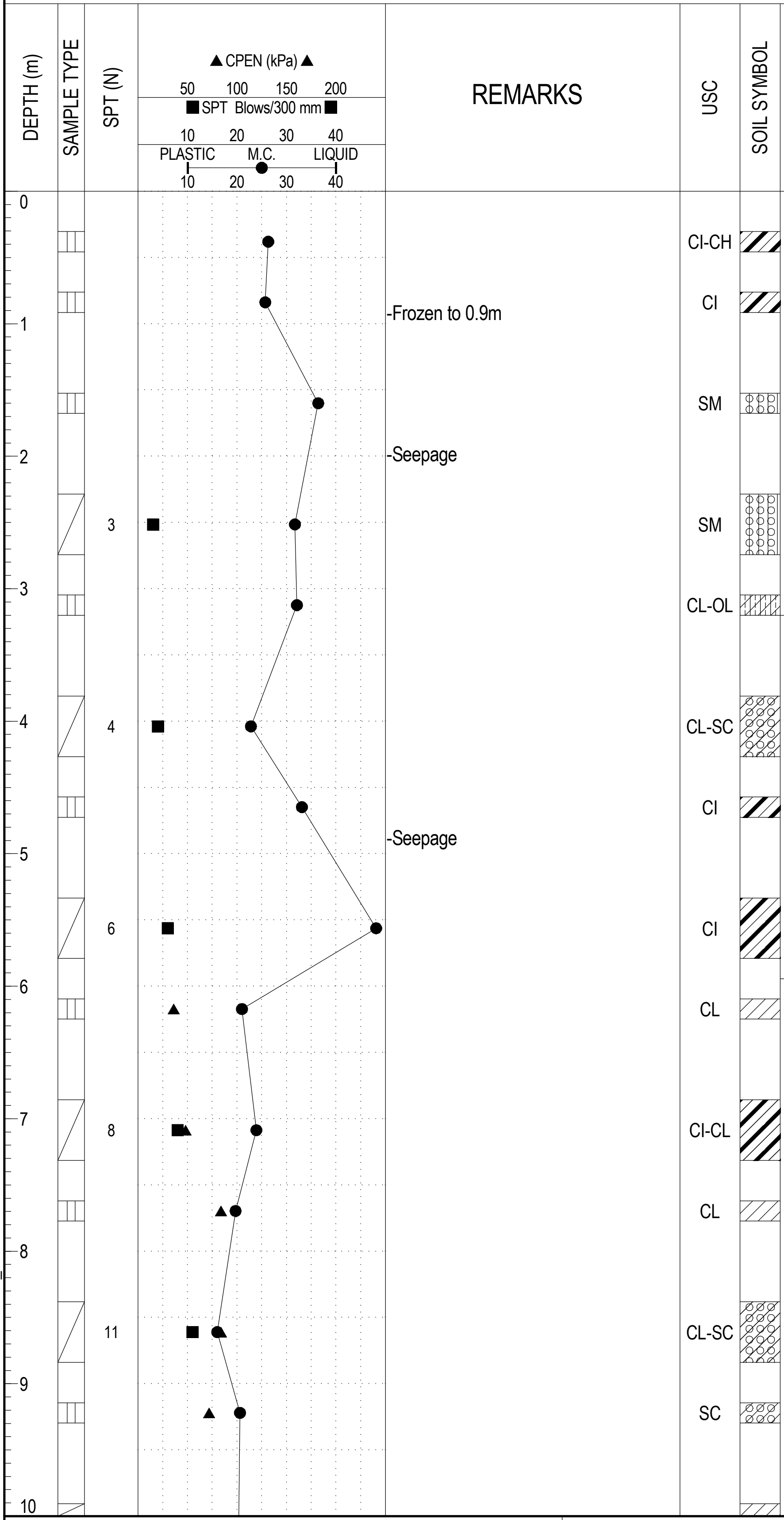
DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10	◸	20		▥	CH	▨	CLAY SHALE - CONTINUED -trace siltstone inclusions	620
							END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -Slough at 10.1m -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -May 5, 2014 = 7.0m -July 9, 2014 = 6.8m -July 31, 2014 = 6.8m -September 29, 2014 = 6.8m	
11								619
12								618
13								617
14								616
15								615
16								614
17								613
18								612
19								611
20								

THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	Page 2 of 2

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-8**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934381.75, E34667.58 3TM	ELEVATION: 627.74 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT ☒ NO RECOVERY



SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
		CI-CH	CLAY AND WASTE MATERIAL (FILL) dark brown, trace bricks, glass, roots, gravel, and organics	
	-Frozen to 0.9m	CI		627
		SM	-becomes sand and clay mixture, trace gravel, rubber, wood pieces, and asphalt	626
	-Seepage			
3		SM	-soft	625
		CL-OL	-sandy, trace metal pieces	
			BEDROCK (FILL) firm, brown, sandy, trace gravel and oxides	624
4		CL-SC		
		CI	-till - like, silty, some clay shale nodules	623
	-Seepage			
6		CI	-trace coal and sandstone nodules	622
		CL	CLAY TILL (FILL) stiff, silty, sandy, trace gravel	621
8		CI-CL	-some sandy lenses, trace gravel and coal	
		CL		620
11		CL-SC	-trace oxides and clay shale nodules	619
		SC	-sand pockets	618

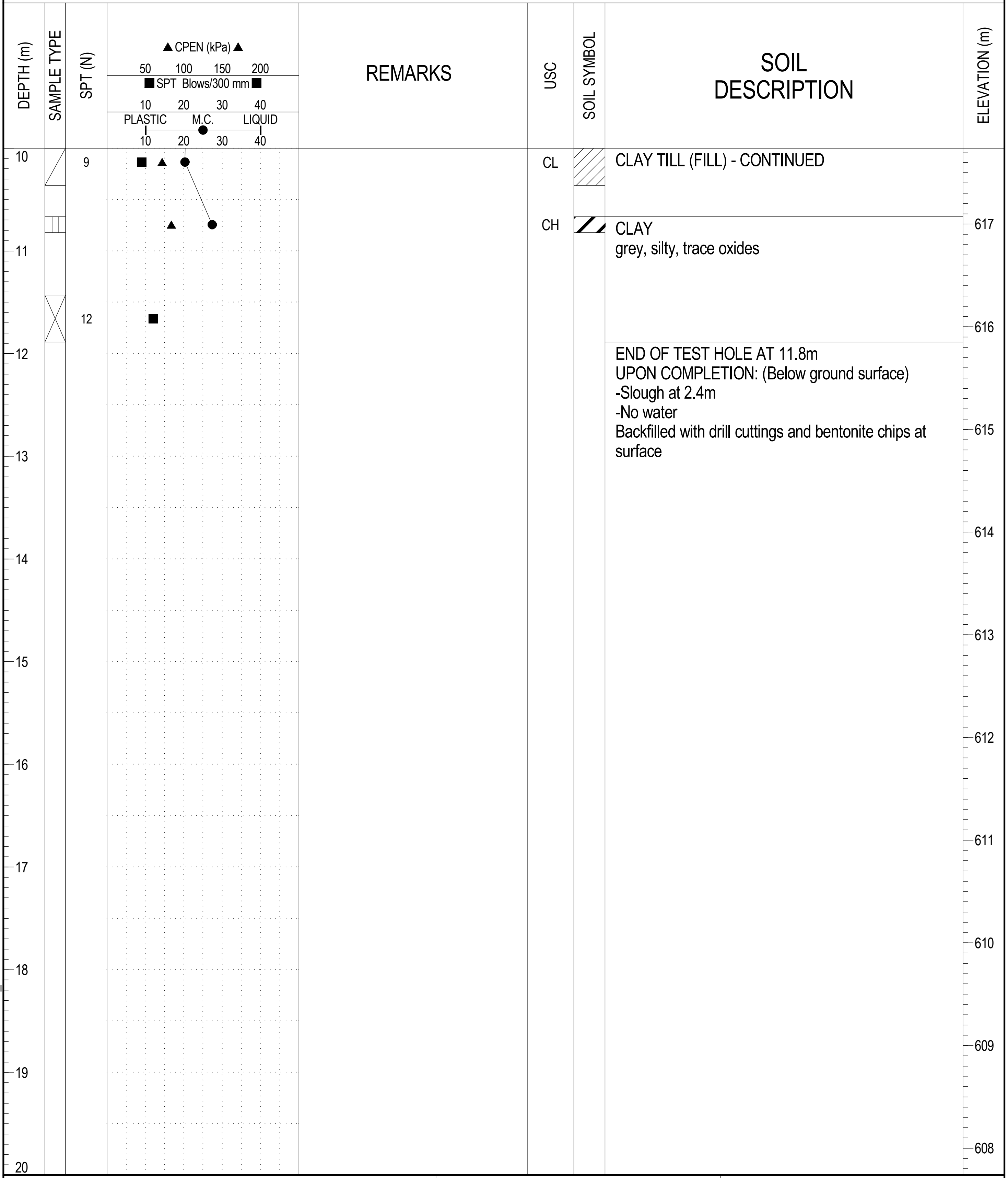
BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 11.9 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-8**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934381.75, E34667.58 3TM	ELEVATION: 627.74 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ☒ NO RECOVERY



CLAY TILL (FILL) - CONTINUED

CLAY
grey, silty, trace oxides

END OF TEST HOLE AT 11.8m
UPON COMPLETION: (Below ground surface)
-Slough at 2.4m
-No water
Backfilled with drill cuttings and bentonite chips at surface

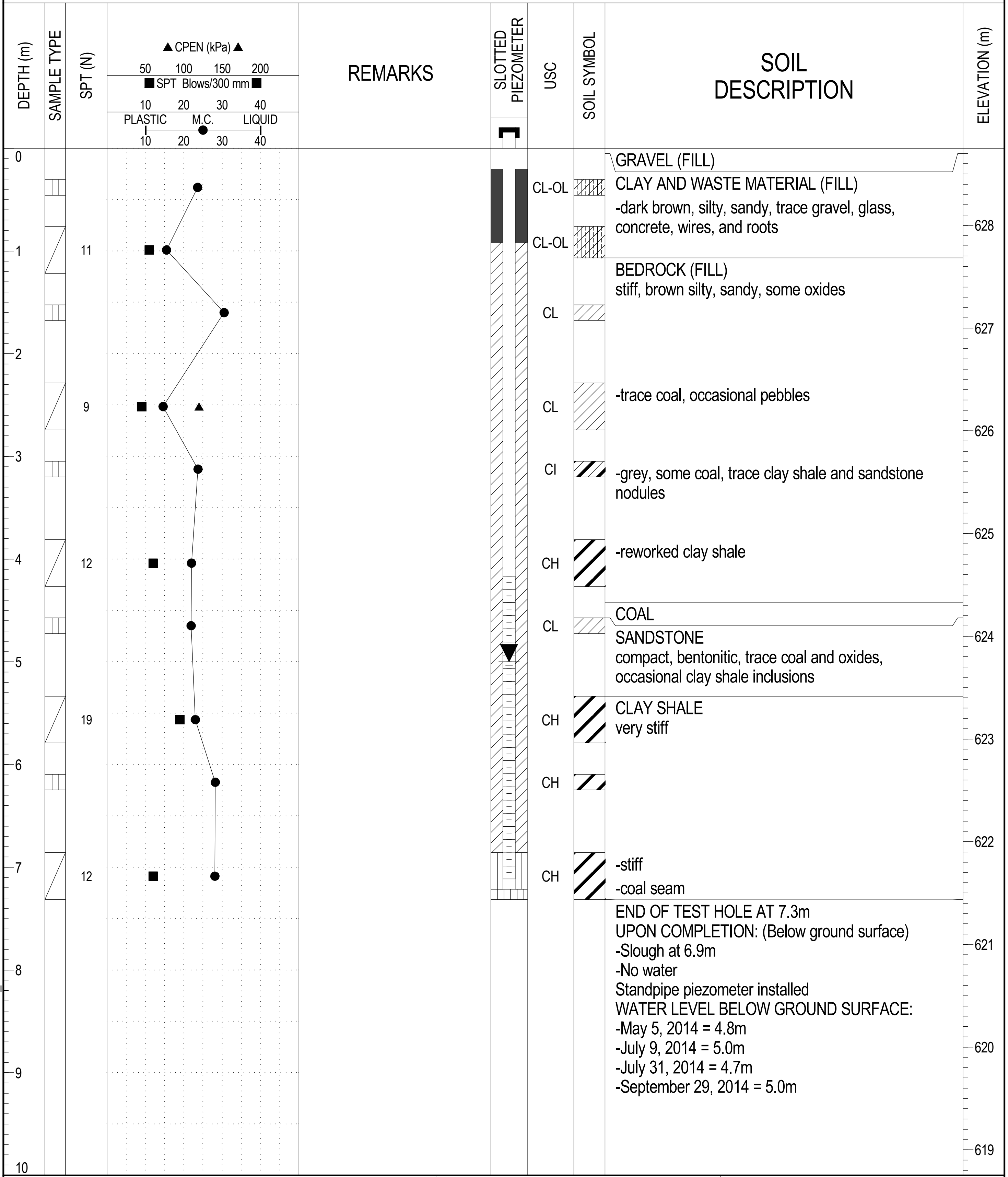
THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 11.9 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-9**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: N5934403.58, E34676.13 3TM	ELEVATION: 628.75 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◸ SPT

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SOIL DESCRIPTION

GRAVEL (FILL)

CLAY AND WASTE MATERIAL (FILL)
-dark brown, silty, sandy, trace gravel, glass, concrete, wires, and roots

BEDROCK (FILL)
stiff, brown silty, sandy, some oxides

-trace coal, occasional pebbles

-grey, some coal, trace clay shale and sandstone nodules

-reworked clay shale

COAL

SANDSTONE
compact, bentonitic, trace coal and oxides, occasional clay shale inclusions

CLAY SHALE
very stiff

-stiff

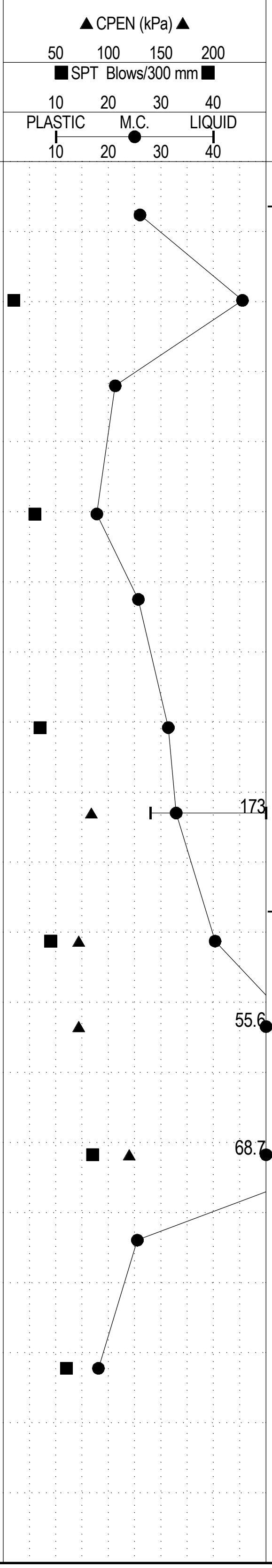
-coal seam

END OF TEST HOLE AT 7.3m
UPON COMPLETION: (Below ground surface)
-Slough at 6.9m
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-May 5, 2014 = 4.8m
-July 9, 2014 = 5.0m
-July 31, 2014 = 4.7m
-September 29, 2014 = 5.0m

THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 7.3 m
	PREPARED BY: XW	COMPLETION DATE: 3/25/14
	REVIEWED BY: HER	Page 1 of 1

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-10**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934399.65, E34689.76 3TM	ELEVATION: 628.75 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT



SAMPLE TYPE	SPT (N)	REMARKS	USC
▥		-Frozen to 0.3m	CL
◿	2		SC
▥			CI
◿	6		CH
▥			CI-CH
◿	7		CI-CH
▥			CH
◿	9	-Seepage	CH
▥			CH
◿	17	L.L. = 510% P.L. = 47%	CH
▥			CH
◿	12		CH

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

ELEVATION (m): 628, 627, 626, 625, 624, 623, 622, 621, 620, 619

SOIL DESCRIPTION

TOPSOIL

CLAY, SAND, AND WASTE MATERIAL (FILL)
brown, trace pebbles, organics, roots, and bricks

-soft / very loose, trace glass, gravel, and china pieces

MIXTURE OF BEDROCK AND CLAY TILL (POSSIBLE FILL)
firm, brown, sandy, trace clay shale nodules and oxides

-weathered clay shale inclusions

-silty

-some coal, trace gravel

-stiff, grey, silty, sandy, some bedrock inclusions

-trace bentonite

CLAY SHALE
very stiff, greenish white, BENTONITE seams

COAL

CLAY SHALE
stiff, silty, some coal fragments

-grey, some sandstone inclusions

END OF TEST HOLE AT 8.8m
UPON COMPLETION: (Below ground surface)
-Slough at 8.5m
-No water
Backfilled with drill cuttings and bentonite chips at surface

FIELD LOGGED BY: MW	COMPLETION DEPTH: 8.8 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	Page 1 of 1

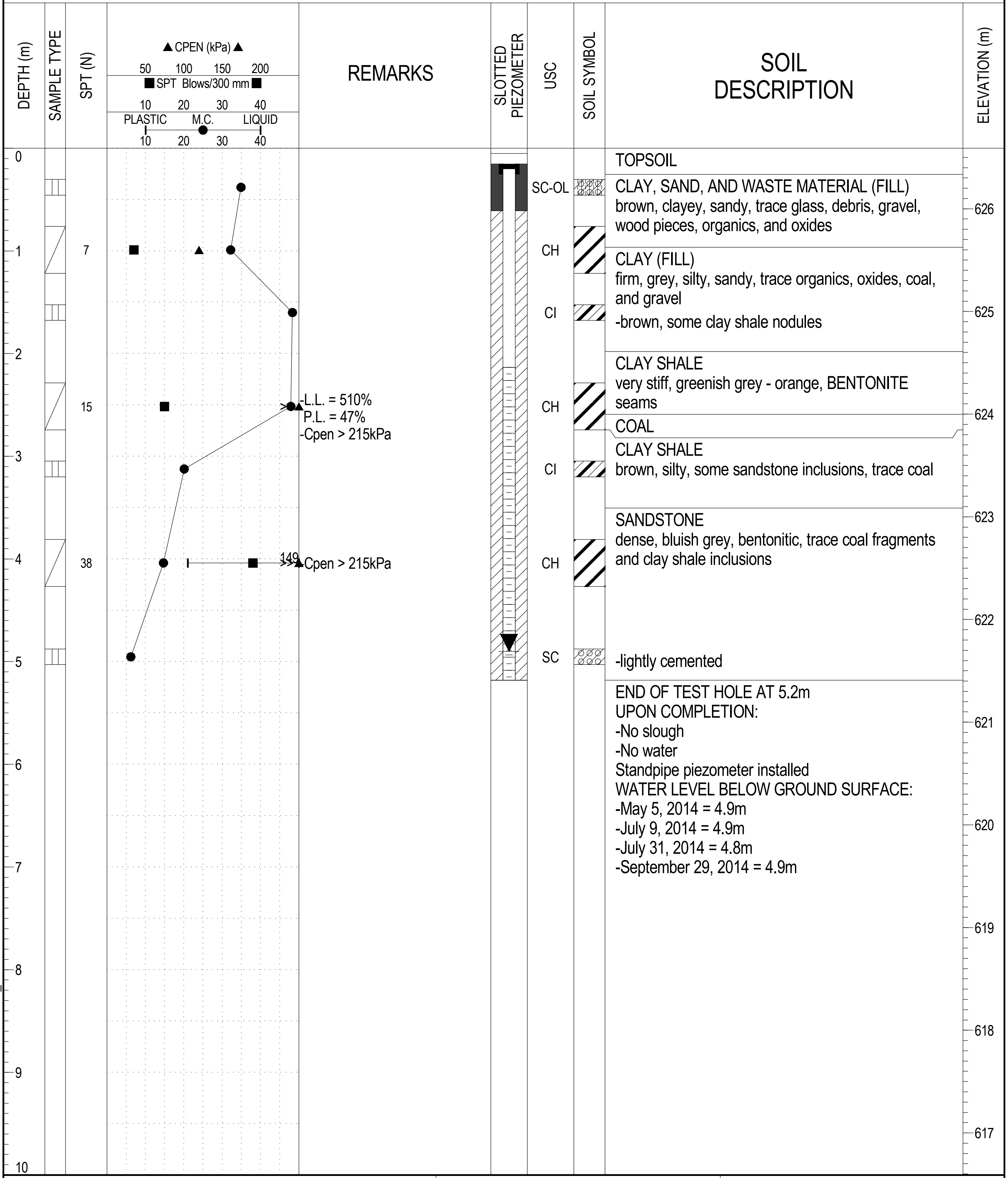
THURBER ENGINEERING LTD.

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-11**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 26, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: N5934377.92, E34685.20 3TM	ELEVATION: 626.59 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



-L.L. = 510%
P.L. = 47%
-Cpen > 215kPa

Cpen > 215kPa

TOPSOIL

CLAY, SAND, AND WASTE MATERIAL (FILL)
brown, clayey, sandy, trace glass, debris, gravel, wood pieces, organics, and oxides

CLAY (FILL)
firm, grey, silty, sandy, trace organics, oxides, coal, and gravel
-brown, some clay shale nodules

CLAY SHALE
very stiff, greenish grey - orange, BENTONITE seams

COAL

CLAY SHALE
brown, silty, some sandstone inclusions, trace coal

SANDSTONE
dense, bluish grey, bentonitic, trace coal fragments and clay shale inclusions

-lightly cemented

END OF TEST HOLE AT 5.2m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-May 5, 2014 = 4.9m
-July 9, 2014 = 4.9m
-July 31, 2014 = 4.8m
-September 29, 2014 = 4.9m

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.2 m
PREPARED BY: XW	COMPLETION DATE: 3/26/14
REVIEWED BY: HER	Page 1 of 1

Previous Test Holes (by others)

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON,
ALBERTA
Project Number 106-2672

Hole No. 80-1
Log Type Overburden/Rock Core
Surface Elevation 639.2 m (CITY)
Core Size 50 mm
Completion Depth 23.0 m
Drilling Contractor Mobile Augers
Date Drilled July 22, 1980
Drilling Method Hollow Stem Auger/ Wireline Coring
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
0		CLAY (FILL)								
3	1		- medium to dark grey, silty CLAY, hard, dry		▥		17.5		500	
4			- medium to dark brown, silty CLAY, hard lumps, loosely compacted, some sand, pebbles to 100 mm, coal particles, moist - some cinders, pieces of glass and coal							
5					☒	7	28.3		400	
8					▥		34.1			
10	3		- medium to dark brown, silty CLAY, stiff, some sand, pebbles, coal particles, moist		☒	12	28.9			
12		ORGANIC FILL	- black, very organic, silty, soft, some fibres, wood, cardboard, moist to wet, strong odour							
13.5					▥		40.9			
15					☒	N/A				
18.5			- very wet		▥		184.1			
20	6				☒	10	142.9			
23	7		- pieces of glass		▥		85.1			
25		SILT	- medium brown/grey, sandy, trace of clay, stiff, organic pockets, rootlets, moist		☒	13	27.4			
27.5		CLAY	- brown-grey, mottled, silty, stiff, pebbles to 15 mm oxide stains, trace of organics, moist		▥		25.6			
29	9									

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Drawing No. B-2

Sheet 1 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON,
ALBERTA
Project Number 106-2672

Hole No. 80-1
Surface Elevation 639.2 m (CITY)
Completion Depth 23.0 m
Date Drilled July 22, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method Hollow Stem Auger/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY	- brown-grey, mottled, silty, very stiff, pebbles to 15 mm, coal particles, moist		☒	17	21.0			
31										
32										
33	10				▥		20.6		250	
34			- moist sand pockets							
35		CLAY (TILL)	- grey brown, silty, very stiff, sand lenses, carbonaceous zones, pebbles to 10 mm, damp		☒	25	22.4			
36	11									
37										
38		CLAY SHALE	- dark brown to black, softened, K1 hardness, carbonaceous, damp - grey silt lenses		▥					
39	12						25.7		350	
40			- medium grey		☒	25	25.5			
41										
42	13	SANDSTONE								
43			- light grey, silty, fine-grained, uniform, K1 hardness, some coal particles, damp, compact to dense		▥					
44							21.3		300	
45			- compact		☒	31	23.0			
46	14									
47										
48			- light grey with light brown clay shale (K3 hardness) lenses		▥					
49	15						20.4			
50					☒	36	22.6			
51										
52	16	CLAY SHALE								
53			- dark brown, silty, carbonaceous, K1 to K3 hardness, fissile fabric, dry		▥					
54							16.7			
55	17				☒	37 (150mm)	18.3			
56			START ROCK CORING							

Project GRIERSON HILL STABILIZATION STUDY | **Project No.** 106-2672 | **Hole No.** 80-1 | **Depth Interval** 17.0-23.0m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		CLAY SHALE	- light to medium grey, silty, K3 hardness, brittle, dry	- fine horizontal bedding, slightly fractured (horizontal)	16.4			
57 58		SANDSTONE	- light to medium grey, silty, fine grained, uniform, K2 to K3 hardness, shale lenses (5 to 10mm) - coal stringers	- horizontal bedding, massive	18.8	95 1065 90	100	85
59	18	CLAY SHALE	- light to medium grey, silty, K3 to K4 hardness, brittle, dry	- slightly factured (horizontal), homogeneous fabric				
60 61 62	19		- K4 hardness, well indurated, trace of coal particles			35 105 55 110 195 250	100	66
63			- medium grey, bentonitic inclusions	- fractured (horizontal), blocky microstructure (15 mm)	15.6	60 90 25 80		
64 65	20		- dark brown, carbonaceous, fragmented, K2 to K3 hardness	- extremely fractured, blocky (10 mm)	16.4	225 45 185	81	56
66 67 68		COAL	- black, brittle - SHALE seam (75 mm)	- slightly factured, fissile fabric	34.9 34.6	65 350 80 65 90		
	21	BENTONITE	- 50mm thick, green, soft, moist	- homogeneous, non slickensided	40.6	70	34	12
69 70 71		CLAY SHALE	- dark brown, silty, K2 to K3 hardness, coal specks and stringers - medium to dark grey, sandstone pockets	- fractured (horizontal) - massive		40 35 110 55		
72 73 74 75	22 23		- medium grey SANDSTONE layer (350 mm), silty, fine grained, uniform, dry, some clay - bentonite pockets	- massive		1420	100	100
76			END OF BOREHOLE (23.0 metres)					

EBA Engineering Consultants Ltd. | **Drawing No.** B-2 | **Sheet** 3 **of** 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-2
Surface Elevation 637.2 m (CITY)
Completion Depth 13.6 m
Date Drilled July 23, 1980
Logged By RRH (field); (lab)
Log Type Overburden
Core Size
Drilling Contractor Mobile Augers
Drilling Method Hollow Stem Auger

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
0		SAND (FILL)								
3	1		- medium grey-brown, silty, fine to coarse grained, some clay pockets, pebbles to 25 mm, organic pockets, carbonaceous inclusions, damp		▥		21.8			
4			- dark brown to black, loose, dry		☒	5	12.4			
8			- medium grey-brown		▥		14.7			
9			- medium brown, medium grained							
10	3	CLAY (FILL)	- grey-brown, silty, firm, trace of organics, pebbles, some coal, moist		☒	7	28.6			
			- pieces of brick and glass							
13	4		- grey-brown, silty, organic pockets, damp		▥		21.3			
15			- stiff, moist		☒	10	27.7			
17		CLAY (TILL)	- medium brown-grey, silty, trace of sand, numerous coal particles, damp							
19	6				▥		30.2			
20			- very stiff, oxide stains		☒	18	25.3			
24	7	COAL	- black, powdery, moist, fractured		▥		25.8			
25		CLAY	- medium grey, silty, sandy, stiff, organic pockets, damp		☒	16	22.0			
26	8		- traces of organic material							
28			- medium brown, silty, pebbles to 10 mm, damp							
29	9	SILT			▥		23.0			

EBA Engineering Consultants Ltd.

Drawing No. B-3

Sheet 1 of 2

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-2
Log Type Overburden
Surface Elevation 637.2 m (CITY)
Core Size
Completion Depth 13.6 m
Drilling Contractor Mobile Augers
Date Drilled July 23, 1980
Drilling Method Hollow Stem Auger
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		SILT	- medium brown, sandy, very stiff, some oxide stains, damp to moist		☒	19	23.6			
32	10	CLAY (TILL)	- grey with brown silt lenses, very stiff, pebbles to 25 mm, coal particles, damp							
34			- medium brown SAND lens (150 mm thickness) well graded, moist		▥		15.6			
35	11		- medium brown SAND pocket, well graded		☒	27	16.7			
38	12	CLAY SHALE	- medium grey, silty, K1 hardness, blocky, micro-structure, damp		▥		31.9			
40		COAL	- black, hard, brittle, highly fractured, powdery lens (75 mm thickness) at 12.1 m		☒	22	37.6			
41		CLAY SHALE	- dark brown, silty, K1 hardness, carbonaceous, damp							
43	13		- medium to dark grey, extremely fractured, angular fragments to 10 mm, K4 to K5 hardness, moist to wet		▥		33.0			
44			- grey-brown, K1 to K2 hardness, dry		☒	56 (150mm)	25.6			
45	14		END OF BOREHOLE (13.6 metres)							

EBA Engineering Consultants Ltd.

Drawing No. B-3

Sheet 2 of 2

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-3
Surface Elevation 638.8 m (CITY)
Completion Depth 24.7 m
Date Drilled July 23, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method Hollow Stem Auger/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		SAND (FILL)	- sandy							
3	1		- black-brown, sandy, loose, some organic material, slightly carbonaceous, traces of white salts, brick, cinders, pebbles to 25 mm, dry		▥ ☒	 15	8.5 15.2			
6	2		- light to medium brown, moist		▥		36.4			
10	3		- dark grey, silty sand, fine-grained, some clay pockets, traces of coal		☒	5	31.1			
13	4		- dark brown, silty sand, loose, some clay, rock fragments, moist		☒	18	29.1			
16	5		- medium to dark brown, silty clay, some sand, organic material, rock fragments, coal							
		CLAY (TILL)	- medium to dark grey-brown, silty, some coal particles and pebbles, traces of brown oxides		▥		30.8			
		CLAY SHALE	- medium grey, softened (very stiff soil), highly fractured		☒	24	24.8			
23	7		- medium brown and grey, silty, stiff to very stiff, coal particles, moist, some hard inclusions at 7.4 m		▥		29.6			
		COAL	- black, brittle, highly fractured		☒	17	38.3			
		CLAY SHALE	- medium brown-grey, silty, K1 to K3 hardness, damp		▥		25.7			

Drawing No. B-4

Sheet 1 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-3
Surface Elevation 638.8 m (CITY)
Completion Depth 24.7 m
Date Drilled July 23, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method Hollow Stem Auger/

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		COAL	- black, brittle, highly fractured, wet		☒	27	28.6			
31										
32	10	CLAY SHALE	- medium grey, silty, K1 hardness, some sandstone pockets, damp							
33			- COAL lens (25 mm thickness), black, brittle, wet		▥		13.9			
34			- SANDSTONE layer (300 mm thickness), light to medium grey, fine-grained, uniform, compact, damp, some coal stringers		☒	17	26.0			
35										
36	11									
37										
38			- SANDSTONE layer (150 mm thickness), light to medium grey, fine grained, compact, damp		▥		27.9			
39	12		- COAL lens (50 mm thickness), black, brittle, highly fractured		☒	16	26.4			
40										
41										
42	13									
43			- SILT lens (120 mm thickness), medium grey, non-indurated, trace of sand, damp to moist		▥		28.7			
44			- SANDSTONE layer (75 mm thickness), light grey with brown patches		☒	18 (no recovery)				
45	14									
46										
47										
48			- light to medium brown CLAY SHALE, light grey sandstone inclusions of K3 hardness, massive		▥		28.7			
49	15									
50			- dark grey, K1 to K2 hardness		☒	18	29.2			
51										
52	16									
53			- finely layered		▥		31.5			
54		COAL	- black, brittle, highly fractured		☒	57	21.1			
			START ROCK CORING			(150mm)				

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Drawing No. B-4

Sheet 2 **of** 3

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-3

Depth Interval 16.2m-24.7m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
53			START ROCK CORING					
54		CLAY SHALE	- medium grey, silty, K4 hardness, thin coal stringers, dry	- massive, horizontal bedding				
55								
56	17					865 180 245 55	98	94
57			- thin siltstone lens, light grey					
58					17.8			
59	18			- slightly fractured (horizontal)				
60						400 190 306 80 140 175 75	100	88
61				- brecciated zone (25 mm)				
62	19		- medium to dark grey		14.8			
63				- brecciated zone				
64			- dark grey, K4 to K5 hardness, traces of coal particles		15.5			
65	20		- SILTSTONE layer (200 mm thickness), light to medium grey, well indurated, K7 hardness	- massive to slightly fractured, horizontal bedding - homogeneous fabric		370 50 65	87	78
66			- dark grey-brown K3 to K4 hardness			570		
67			- carbonaceous, K2 hardness		33.4			
		COAL	- black, brittle, K6 hardness	- blocky microstructure, massive				
68	21				23.9	60 35 55 100 100 25 65 20 70 480	78	56
69								
70		CLAY SHALE	- dark brown, silty, carbonaceous	- massive, homogeneous, non-slickensided				
		BENTONITE	- green, K1 hardness, traces of coal particles, dry to damp	- homogeneous fabric				
71		CLAY SHALE	- medium grey, silty, K1 to K2 hardness, coal particles, bentonitic	- massive, homogeneous fabric				
72	22				28.6	285 970	97	97
73			- medium to dark grey, K2 to K3 hardness - soft CLAY lens (50 mm thickness) - SILTSTONE layer (400 mm thickness), light grey, indurated, K3 to K4 hardness					
75	23			- massive, blocky microstructure (10 mm blocks)	14.5			
76								
77			- light to medium grey siltstone and sandstone laminations		14.4	1300	95	95
78	24	SANDSTONE	- light grey, fine grained, uniform, K2 to K3 hardness, cemented, thin medium grey silty laminations (20 mm thick), dry	- massive, laminated microstructure				
79								
80			- finer grained, K3 to K4 hardness	- homogeneous fabric				
81			- traces of coal particles	- laminated microstructure				
	25		END OF BOREHOLE (24.7 metres)					

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Drawing No. B-4

Sheet 3 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-4
Surface Elevation 638.3 m (City)
Completion Depth 15.6 m
Date Drilled July 28, 1980
Logged By RRH (field); (lab)
Log Type Overburden
Core Size
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		CLAY (FILL)	- dark brown, silty, sandy, pebbles to 20 mm, organic pockets, damp							
1										
2										
3	1				▥		13.8			
4			- dark brown to black, cinders, damp		☒	12	27.0			
5			- medium brown, silty, trace of organic material, moist							
6	2									
7		ORGANIC FILL								
8			- black, clayey, carbonaceous, pebbles to 25 mm		▥		32.5			
9	3		- wood chips, cinders		☒	15	24.6			
10										
11										
12										
13	4		- extremely organic, pieces of cardboard, moist to wet		▥		43.6			
14		CLAY SHALE	- medium grey, silty, slightly organic, wood fibres, damp							
15			- light grey and brown sandstone pockets, thin coal lenses		☒	22	24.9			
16	5									
17										
18			- dark grey, silty, K1 hardness with some K2 inclusions, blocky microstructure, damp		▥		37.6			
19	6	COAL	- black, brittle, fractured, blocky							
20					☒	23	54.1			
21										
22										
23	7	SANDSTONE	- light grey, silty, fine grained, K1 hardness, coal particles, clay shale inclusions, damp							
24		COAL	- black, K6 to K7 hardness, fractured, blocky, moist to wet		▥		39.1			
25					☒	16	53.1			
26	8									
27										
28		CLAY SHALE	- dark brown to black, K2 hardness, carbonaceous, damp		▥		29.8			
29	9		- greenish-grey, silty, K1 hardness, slightly bentoniti							

Drawing No. B-5

Sheet 1 of 2

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-4
Log Type Overburden
Surface Elevation 638.3 m (City)
Core Size
Completion Depth 15.6 m
Drilling Contractor Mobile Augers
Date Drilled July 28, 1980
Drilling Method B61 Hollow Stem
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY SHALE	- medium grey, K3 hardness, dry to damp		☒	37	24.3			
31										
32	10									
33			- medium brown-grey, K1 hardness, blocky microstructure, damp - CLAY SHALE layer (150 mm) dark brown to black, carbonaceous, K2 hardness		▥		30.7			
35	11		- silty, K2 hardness, coal particles		☒	18	28.8			
36										
37		SILTSTONE								
38			- medium grey/brown, clayey, K2 hardness, damp		▥		29.5			
39	12	CLAY SHALE	- dark brown-grey, silty, K3 hardness, blocky microstructure, dry, light grey sandstone lenses		☒	27	32.0			
41										
42	13									
43			- dark brown, carbonaceous, K2 hardness, damp		▥		34.7			
44		BENTONITE	- green-grey, K1 hardness, damp, (75 mm)							
44		CLAY SHALE	- medium to dark brown-grey, K3 to K4 hardness, damp							
45	14	SANDSTONE	- medium brown-grey, fine grained, uniform, softened, clay shale inclusions		☒	43 (150mm)	31.2			
46										
47		CLAY SHALE								
48	15		- dark brown to black, carbonaceous, K2 to K3 hardness, blocky microstructure - COAL layer (50 mm) fractured, K6 hardness		▥		24.5			
49			- dark grey-brown, K3 hardness, coal particles, dry		☒	78	24.3			
51			END OF BOREHOLE (15.6 metres)							
			Water level: 5.2 m on completion Slough level: 9.8 m on completion							

EBA Engineering Consultants Ltd.

Drawing No. B-5

Sheet 2 of 2

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-5
Surface Elevation 639.2 m (CITY)
Completion Depth 21.7 m
Date Drilled July 24-25, 1980
Logged By RRH (field); (lab)

Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/
Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1		SAND (FILL)								
2										
3	1		- dark brown, clayey, loose, some cinders, pieces of coal, brick and glass, pebbles to 10 mm, traces of red oxides, traces of organic material, dry to damp		▥		31.1			
4					☒	3	45.2			
5			- moist							
6	2									
7		CLAY								
8			- medium grey-brown, silty, firm, some oxides, traces of organic material, damp		▥		36.8		100	
9	3		- coal pocket							
10					☒	8	31.4			
11										
12										
13	4		- firm, soft grey inclusions - coal particles, dry		▥		29.9		175	
14										
15		COAL	- black, extremely fractured, wet		☒	12	50.8			
16	5	INTERBEDDED CLAY SHALE AND SANDSTONE	- CLAY SHALE, brown-black, stiff, carbonaceous, damp							
17			- medium to dark grey, silty, stiff, blocky							
18			- softened shale layer (150 mm thickness), clay-like, medium grey-brown, silty, stiff, some coal particles		▥		21.9			
19	6		- softened shale layer (150 mm thickness)							
20			- medium grey, silty, stiff, very fine coal stringers, traces of brown oxides, dry, blocky micro-structure		☒	18	23.7			
21										
22										
23	7		- SANDSTONE layer (300 mm thickness), light grey, silty, medium grained, compact, K1 hardness		▥		21.0			
24										
25			- CLAY SHALE, dark grey, silty, hard, extremely fractured - dark brown, carbonaceous - COAL layer		☒	40	25.8			
26	8									
27			- CLAY SHALE, dark brown, silty, K4 hardness, damp - COAL layer (10 mm thickness) - SANDSTONE layer (75 mm thickness), light to medium grey, fine-grained, uniform, K1 hardness, damp							
28					▥		20.1			
29	9									

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Drawing No. B-6

Sheet 1 of 3

Project	GRIERSON HILL STABILIZATION STUDY	Hole No.	80-5
Location	EDMONTON ALBERTA	Log Type	Overburden/Rock Core
Project Number	106-2672	Surface Elevation	639.2 m (CITY)
		Core Size	50 mm
		Completion Depth	21.7 m
		Drilling Contractor	Mobile Augers
		Date Drilled	July 24-25, 1980
		Drilling Method	B61 Hollow Stem/ Wireline Coring
		Logged By	RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		INTERBEDDED CLAY SHALE AND SANDSTONE	- CLAY SHALE, brown-grey, silty, K1 to K2 hardness, some coal particles, damp, blocky micro-structure		☒	34	21.3			
31										
32	10									
33			- SANDSTONE, light to medium grey, silty, fine grained, K1 to K2 hardness, laminated, coal stringers, damp		▥					
34			- CLAY SHALE layer (150 mm thickness), medium to dark grey, silty, K2 to K3 hardness, dry				21.1			
35					☒	42	18.9			
36	11									
37										
38			- laminated SANDSTONE/CLAY SHALE		▥		27.5			
39	12	COAL	- black, hard, brittle, highly fractured, moist to wet		☒	24	49.3			
40		CLAY SHALE	- medium grey, silty, K1 to K2 hardness, homogeneous fabric, damp							
41										
42	13									
43					▥					
44							26.7			
45			- SANDSTONE pocket, light grey, fine grained		☒	22	29.6			
46	14									
47										
48			- dark brown, silty, K2 hardness, carbonaceous, dry		▥					
49	15		- medium to dark grey, K3 hardness, coal particles,				24.6			
			blocky microstructure, dry		☒	46 (150mm)	19.6			
50			START ROCK CORING							

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
50		CLAY SHALE	- medium to dark brown, silty, K2 hardness, dry to damp	- massive, homogeneous fabric				
51					18.3	1170 80	100	94
52	16		- SANDSTONE layer (500 mm) light to medium grey, fine grained, uniform, K2 hardness, coal particles, fine clay shale laminations (5 to 10 mm), damp	- fine horizontal bedding				
53					17.7			
54			- medium greenish grey, CLAY SHALE, bentonitic, silty, K3 hardness, dry	- fine horizontal bedding				
55	17							

ROCK CORE LOG

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Drawing No. B-6

Sheet 2 of 3

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-5

Depth Interval 17.0-21.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56 57 58		CLAY SHALE	- medium grey, silty, K3 to K4 hardness, slightly bentonitic, coal particles, siltstone pocket at 17.1 m - dark brown-grey	- massive, blocky microstructure	16.7	960 150 100	100	100
59 60 61 62	18 19		- dark brown to black, carbonaceous, K4 to K5 hardness, brittle - K3 hardness	- massive, blocky microstructure - fractured - slightly fractured	16.7	115 315 20 80 65 250 95 190 120 85	109	81
63 64		COAL	- black, brittle, K6 hardness - CLAY SHALE lens (300 mm), black, carbonaceous	- fractured, blocky microstructure		80 50 20 120 30 50 10 100 25 205 240 80	83	55
65	20	BENTONITE	- greenish grey, K1 hardness, high plasticity (50 mm)	- homogeneous fabric	15.2			
66 67		CLAY SHALE	- dark brown, silty, K3 to K4 hardness, coal particles, dry to damp	- fractured, blocky, microstructure - massive, blocky microstructure	13.9	1190 140 40	100	97
68 69 70	21	INTERBEDDED CLAY SHALE AND SANDSTONE	- light to medium grey SANDSTONE, K3 hardness, some coal particles, slightly bentonitic, dark grey-brown CLAY SHALE laminaations (5 to 10 mm) - CLAY shale lens (100 mm) - siltstone pocket	- slightly fractured	14.4			
71 72 73 74 75	22		END OF BOREHOLE (21.7 metres)					

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Drawing No. B-6

Sheet 3 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-6
Surface Elevation 640.3 m (CITY)
Completion Depth 21.4 m
Date Drilled July 28, 1980
Logged By RRH (field); ______ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOPSOIL	- black, organic							
1		CLAY (FILL)	- dark brown, silty, some rootlets, dry							
3	1		- SAND layer (75 mm), orange-brown, silty, damp		▥					
4			- some organic material		▥		25.7			
5		SAND (FILL)	- medium brown, calcareous, some organic material		☒	8	22.5			
8		CLAY SHALE	- dark brown, silty, K1 hardness, coal stringers, some inclusions of K3 hardness, damp		▥					
9			- dark brown to black, carbonaceous		▥		26.9			
9	3	COAL	- black, brittle, K6 hardness, highly fractured, blocky		☒					
10			- powdery, dry		☒	13	37.1			
12		INTERBEDDED CLAY SHALE AND SANDSTONE	- CLAY SHALE, medium grey-brown, silty, K2 to K3 hardness, coal particles, blocky microstructure							
14					▥		19.7			
15			- fine sandstone laminations - SANDSTONE, medium grey, fine grained, softened, K1 hardness, damp		☒	17	22.5			
18			- alternating layers of CLAY SHALE, dark brown-grey, and SANDSTONE, medium grey (75-200 mm thickness), coal particles		▥		19.3			
20	6				☒	26	19.5			
21		CLAY SHALE	- dark brown-grey, silty, K2 to K3 hardness, damp							
23	7		- damp to moist		▥					
24			- green-grey, bentonitic, coal particles		▥		23.7			
25		COAL	- black, brittle, K6 hardness, highly fractured, blocky		☒	65	32.8			
29		CLAY SHALE	- dark brown-black, carbonaceous		▥		17.8			
29	9	SILTSTONE	- medium grey-brown, K3 to K4 hardness		▥					

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Drawing No. B-7

Sheet 1 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-6
Surface Elevation 640.3 m (CITY)
Completion Depth 21.4 m
Date Drilled July 28, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wirline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30 31 32	10	SANDSTONE	- light to medium grey, fine grained, uniform, softened, K1 to K2 hardness, damp		☒	53	17.5			
33 34			- K2 hardness, coal particles, horizontal bedding		▥		15.8			
35 36	11		- K2 to K3 hardness		☒	53	16.7			
37 38		CLAY SHALE	- dark brown-grey, silty, K3 hardness, dry, blocky		▥		18.5			
39 40 41	12	SANDSTONE	- light to medium grey, silty, fine grained, K2 to K3 hardness, fine shale laminations, horizontal bedding		☒	31 (150mm)	19.2			
42	13	CLAY SHALE	- dark brown-grey, silty, K3 hardness, some green-grey bentonite pockets, dry to damp							
43 44 45			- SANDSTONE layer (100 mm), damp		▥ ☒	60	23.3 21.1			

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
46	14	CLAY SHALE	- medium to dark grey, silty, K3 to K4 hardness, coal particles, dry	- fractured, blocky microstructure		40 155 610	59	56
47 48 49	15		- dark grey-brown, K2 to K3 hardness, slightly carbonaceous, dry to damp	- massive, blocky microstructure	14.8			
50		COAL	- black, brittle, K6 hardness	- highly fractured, blocky	19.7	25 60 190 80 750	85	73
51		CLAY SHALE	- dark brown to black, silty, K2 to K3 hardness, carbonaceous, siltstone seam (50 mm)	- fractured, blocky microstructure				
52	16		- slightly bentonitic	- massive	15.5			
53			- medium to dark grey, K3 hardness, coal stringers, trace of sandstone					
54			- siltstone inclusions	- massive, blocky microstructure	18.9	475 685	100	100
55	17		- slightly bentonitic					

ROCK CORE LOG

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Drawing No. B-7

Sheet 2 of 3

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-6

Depth Interval 17.0-21.4 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		CLAY SHALE						
57			- dark brown-grey, silty, K3 to K4 hardness, coal particles, lenses of softened material	- massive, block microstructure				
58			- SILTSTONE layer (100 mm) K7 hardness, indurated	- factured		110 70 615 190	81	75
59	18				15.2			
60			- K4 hardness	- extremely fractured zone, slickensided fracture surfaces				
61								
62	19		- some softened zones		17.5	710	95	84
63			- dark brown to black, carbonaceous	- massive		50 85 150 165		
64		COAL	- black, brittle, K6 hardness	- fractured, blocky microstructure	17.8			
65	20	CLAY SHALE	- dark brown, carbonaceous, K2 to K3 hardness, dry to damp	- massive				
66		BENTONITE	- grey-green, damp, coal stringers (130 mm)	- homogenous		1470	107	107
67		SANDSTONE	- light grey, medium grained, uniform, K4 hardness, coal stringers, siltstone laminations	- massive, horizontal bedding	13.5			
68								
69	21				12.5			
70			END OF BOREHOLE (21.4 metres)					

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Drawing No. B-7

Sheet 3 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-7
Log Type Overburden/Rock Core
Surface Elevation 637.8 m (City)
Core Size 50 mm
Completion Depth 22.0 m
Drilling Contractor Mobile Augers
Date Drilled July 31, 1980
Drilling Method B61 Hollow Stem/ Wireline Coring
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- dark brown to black, organic, damp, rootlets							
1		CLAY (FILL)	- dark brown, silty, pebbles, dry to damp							
2										
3	1		- rootlets, pieces of brick							
4			- wood fibres, some sand, organic pockets, soft, moist		▥		40.6		480	
5					☒	3	47.7			
6	2									
7		SILT (FILL)								
8			- dark brown, some clay and sand, firm, black organic pockets, pieces of glass, rust-coloured pockets, wood fibres		▥		41.0		90	
9	3		- dark grey/black, firm, very organic, moist		☒	5	30.9			
10										
11										
12										
13	4									
14			- brown/grey, firm, some sand, coal lenses, organic pockets		▥		31.1		110	
15			- dark brown to black, clay shale inclusions, coal particles, moist		☒	8	30.1			
16	5									
17		CLAY SHALE								
18			- medium grey-brown, silty, K1 hardness with K3 inclusions, blocky microstructure (1 mm), organic pockets, light grey sandstone inclusions		▥		28.1		100	
19	6									
20			- coal particles		☒	10	28.8			
21										
22										
23	7	COAL	- black, brittle, extremely fractured, blocky (2 to 3 mm), wet		▥		61.7			
24										
25		SANDSTONE	- light grey, silty, fine grained, K1 hardness, damp, some medium grey soft siltstone laminations		☒	16	25.8			
26	8									
27		CLAY SHALE	- medium to dark brown/grey, silty, K1 hardness with K3 inclusions, coal particles, damp, brecciated							
28										
29	9	COAL	- black, K6 hardness, extremely fractured, blocky (5mm), wet		▥		38.8			

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Drawing No. B-8

Sheet 1 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-7
Surface Elevation 637.8 m (CITY)
Completion Depth 22.0 m
Date Drilled July 31, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/
Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		COAL			☒	15	48.7			
31		CLAY SHALE	- dark brown/black, silty, carbonaceous, K1 hardness, damp							
33	10		- grey/rust-brown, silty, K1 to K2 hardness, brecciated, blocky, coal particles, damp - brownish grey with rust-brown pockets		▥		32.8			
35					☒	30	26.5			
37	11	COAL	- black, K6 hardness, extremely fractured, wet							
39	12	CLAY SHALE	- dark brown/black, K2 hardness, carbonaceous, bentonite pockets		▥		35.9			
40			- medium brown-grey, bentonitic - dark brown		☒	30	28.1			
43	13		- silty, coal particles, light grey bentonitic sandstone lenses		▥					
44		SANDSTONE	- medium grey-brown, fine grained, uniform, softened, K1 hardness, bentonite seams, coal particles				28.8			
45			START ROCK CORING		☒	69	19.1			

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
46	14	CLAY SHALE	- medium to dark grey, silty, K3 hardness, coal particles	- massive, horizontal layering	19.0			
47			- interbedded SANDSTONE and SILTSTONE layers (75 to 200 mm), coal particles - medium to dark grey, silty, K3 hardness	- some fractures	17.3	1365	100	100
50	15		- dark brown-grey, silty, K3 to K4 hardness - coal particles	- fractured, slickensided fracture surfaces	15.3 24.8	570 375 55 65 25 80 85	92	69
53	16	COAL	- black, brittle, K6 hardness	- highly fractured, blocky				
54	17	CLAY SHALE	- dark brown to black, carbonaceous, K2 hardness, coal particles - green-grey, slightly bentonitic	- massive - blocky microstructure (5to10mm)	18.7			

ROCK CORE LOG

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Drawing No. B-8

Sheet 2 of 3

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-7

Depth Interval 17.0-22.0 m

ROCK CORE LOG

Depth		Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
ft.	m.							
-56		CLAY SHALE	- medium to dark grey, silty K3 to K4 hardness, coal particles	- massive, blocky microstructure		1155	84	84
-57			angular fragments (3 mm)					
-58		INTERBEDDED SANDSTONE AND SILTSTONE	- SILTSTONE, medium to dark grey, K4 to K5 hardness, coal particles	- massive, homogeneous, fabric	14.4			
-59	18		SANDSTONE, light to medium grey, K3 hardness	- slickensided fractures	15.4	1375	100	100
-60			- softened CLAY SHALE lens(15 mm)	- horizontal bedding				
-61			- interbedded SILTSTONE and SANDSTONE					
-62	19							
-63					14.3			
-64			- SANDSTONE, medium grained, uniform, K4 hardness		16.0	1330	97	97
-65	20				14.0			
-66			- coal laminations					
-67			- K5 hardness	- bedding planes dip at 30°, fissile fabric				
-68	21		- K6 hardness, indurated, slightly bentonitic		8.6	130 120	90	77
-69						70 95		
-70						810		
-71			- SILTSTONE layer (50 mm), K3 to K4 hardness, coal particles					
-72	22							
			END OF BOREHOLE (22.0 metres)					

EBA Engineering Consultants Ltd.

Drawing No. B-8

Sheet 3 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-8
Surface Elevation 645.0 m (CITY)
Completion Depth 22.7 m
Date Drilled August 1, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOPSOIL	- black, organic, damp							
1 2		SILT (FILL)	- medium brown, clay pockets, some sand, pieces of glass, coal particles, damp, powdery, cohesionless							
3	1	CLAY (FILL)	- medium to dark brown, silty, hard, pebbles to 30 mm, pieces of glass, coal particles, damp, cohesive		▥		17.3		500	
4 5 6	2		- wood fibres, golf ball, traces of oxides		☒	24	11.7			
7 8 9		SAND	- olive-brown, silty, fine-grained, grey clay lenses, damp, mainly cohesionless		▥		14.6			
10	3				☒	15	15.9			
11 12		CLAY	- grey and brown, silty, stiff, trace of sand, oxide stains, coal particles, damp, cohesive							
13	4		- fine sand lenses, damp to moist, fairly cohesive							
14					▥		27.5		150	
		COAL	- black, brittle, K5 to K6 hardness, highly fractured, blocky (15 mm)							
15 16	5	CLAY SHALE	- dark brown to black, silty, K2 hardness, carbonaceous, dry to damp, massive		☒	22	25.8			
17 18 19	6		- medium brown-grey, K2 to K3 hardness, damp, fractured, blocky microstructure		▥		20.5		>500	
20					☒	24	21.9			
21 22	7	SANDSTONE	- light grey, fine-grained, uniform, K1 to K2 hardness, medium grey silt laminations, coal particles, damp, homogeneous fabric							
23 24		CLAY SHALE	- medium to dark brown-grey, silty, K3 hardness, fractured, block microstructure (5 mm), some slickensided		▥		16.8		>500	
25 26	8	COAL	- black, K6 hardness, highly fractured, (10 mm) free water		☒	30 (75mm)	45.2			
27 28		CLAY SHALE	- dark brown, silty, K3 hardness, coal particles, damp, blocky microstructure							
29	9		- grey-brown, K3 to K4 hardness, coal stringers		▥		24.3			

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Drawing No. B-9

Sheet 1 of 3

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-8

Depth Interval 9.0-19.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
30		CLAY SHALE	START ROCK CORING					
30		INTERBEDDED CLAY SHALE AND SANDSTONE	- SANDSTONE, light grey, silty, fine grained, K3 hardness, coal particles, light brown streaks, dry to damp	- slightly fractured, homogeneous fabric				
31					11.5	100 1285	100	100
32	10		- CLAY SHALE, dark brown-grey, silty, K3 hardness, oxides, coal stringers, dry to damp	- massive, blocky microstructure				
33			- SANDSTONE					
34			- CLAY SHALE, DRY	- horizontal bedding	15.2			
35			- fine SANDSTONE laminations					
36	11		- softened, clay-like, damp			535 130 280	69	69
			- brown-black, carbonaceous, black					
37		COAL	brittle, poor recovery	- extremely fractured (5 mm)				
		CLAY SHALE	- dark brown-grey, silty, K3 hardness	- slightly fractured				
38			- SILTSTONE layer, K6 to K7 hardness, indurated	- highly fractured	18.6			
39	12		- rust stains on fracture surfaces					
40		COAL	- black, brittle, K6 hardness	- extremely fractured (5 mm), blocky	25.2	460	34	34
42	13			- massive to slightly fractured, fissile fabric				
43								
44		INTERBEDDED CLAY SHALE, SILTSTONE AND SANDSTONE	- CLAY SHALE, dark brown-black, silty, K3 hardness, carbonaceous	- slightly fractured, fine horizontal bedding	18.0	170 1075	91	91
46	14				16.5			
47			- SANDSTONE, light grey, light brown, streaks, K3 hardness, coal particles, damp	- massive, homogeneous fabric				
48					16.3			
49	15		- SILTSTONE layer (150 mm), light grey, K5 hardness, dry to damp, indurated	- homogeneous fabric		1265	92	92
50			- SANDSTONE		17.1			
52	16		- CLAY SHALE, dark brown-grey, silty, K3 hardness, coal streaks dry to damp					
53			- carbonaceous layer (25 mm)	- fractured, blocky microstructure (5 mm)	23.2	60 1215	93	89
54			- fine light grey SANDSTONE/dark CLAY SHALE laminations, slightly bentonitic, K2 to K3 hardness, dry to damp	- inclined bedding (15°)				
56	17				22.3			
57			- SILTSTONE, dark grey, very fine grained, K2 to K3 hardness, some clay, dry	- massive, fissile fabric	21.9	40 700	54	51
59	18		- SANDSTONE layer (150 mm)					
			- SILTSTONE					
60			- CLAY SHALE, dark grey, K3 hardness	- slightly fractured, blocky microstructure				
61					18.6			
62	19			- extremely fractured, angular	22.1			

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Drawing No. B-9

Sheet 2 of 3

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-8

Depth Interval 19.0-22.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
63 64		**INTERBEDDED CLAY SHALE, SILTSTONE AND SANDSTONE**	- CLAY SHALE, dark brown-grey, K3 hardness, coal particles, siltstone inclusions	- slightly fractured, blocky microstructure (5 mm)	19.0	210 310 115 155 165	70	70
65	20		- SILTSTONE, medium brown-grey, K5 hardness, indurated	- extremely fractured, angular (10 mm)				
			- CLAY SHALE					
66 67		**COAL**	- black, brittle, bentonite inclusions	- fractured (poor recovery) blocky (10 mm)	16.8	50 290	25	21
68		**CLAY SHALE**	- dark brown to black, K2 hardness, carbonaceous	- massive				
	21		- BENTONITE layer (100 mm)					
69 70			- K3 hardness		13.9			
71			- SILTSTONE layer (200 mm), medium grey, K4 to K5 hardness, indurated	- massive				
72	22		- dark grey, K4 hardness, coal particles, slightly bentonitic	- massive, blocky microstructure (5 mm)	15.2	380 865	102	102
73 74			- dark brown to black, carbonaceous	- blocky microstructure (3 mm)				
75	23		END OF BOREHOLE (22.7 metres)					

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Drawing No. B-9

Sheet 3 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-9
Surface Elevation 652.7 m (CITY)
Completion Depth 28.5 m
Date Drilled August 5, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/
Wire line, coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- black, organic, rootlets, damp							
1		CLAY	- medium brown, silty, stiff, trace of rootlets, grey streaks, moist, cohesive						190	
2		SAND	- medium brown and grey, silty, fine grained, damp, cohesionless							
3					■				450	
4		CLAY	- medium to dark brown, silty, very stiff, some sand, pebbles to 20 mm, coal particles, damp, cohesive, impermeable		▥		14.1		330	
6			- dark grey		☒	13	16.0			
8			- damp to moist, stiff		▥		18.3		160	
9					■				180	
11		SAND	- medium brown, silty, compact, fine to medium grained, trace of clay, damp, cohesionless		☒	15	21.3			
13		CLAY (TILL)	- dark grey-brown, silty, very stiff, coal particles, pebbles, damp to moist, cohesive, impermeable		▥		18.0		270	
15					☒	15	18.5			
18			- dark grey, more silty		▥		17.6		300	
20		CLAY SHALE	- dark brown to black, silty, K1 hardness, coal particles, damp, fissile fabric		☒	23	21.5			
21		COAL	- black, brittle, K5 hardness, highly fractured, blocky (10 mm)							
23		CLAY SHALE	- medium grey, silty, K2 hardness, coal pockets, dry to damp, brecciated		▥		15.8		>500	
25			- light grey sandstone and siltstone inclusions, K2 hardness, brecciated		☒	42	14.6			
27		COAL	- black, highly fractured (10 mm), powdery		▥		17.5			

Project	GRIERSON HILL STABILIZATION STUDY
Location	EDMONTON ALBERTA
Project Number	106-2672

Hole No.	80-9	Log Type	Overburden/Rock core
Surface Elevation	652.7 m (CITY)	Core Size	50 mm
Completion Depth	28.5 m	Drilling Contractor	Mobile Auger
Date Drilled	August 5, 1980	Drilling Method	B61 Hollow Stem/ Wireline Coring
Logged By	RRH (field); ______ (lab)		

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30 31		COAL	- black, highly fractured (10 mm), powdery		☒	37	23.3			
32	10									
33 34 35		SANDSTONE	- light grey, fine grained, uniform, K1 hardness, coal particles, brown vertical streaks, damp, homogeneous fabric		☒	28	19.0			
36	11		- (high resistance to drilling)							
37 38		CLAY SHALE	- dark grey, silty, <K1 hardness, clay-like, damp, pieces of timber		☒	16	26.1			
39	12									
40 41		COAL	- black, K5 to K6 hardness, wet, fractured, blocky							
42	13									
43 44			- dark brown, silty, K2 hardness, fine horizontal bedding, occasional sandstone and softened shale (clay-like) layers - light grey-green BENTONITE layer (50mm), soft, damp - K3 hardness, coal stringers START ROCK CORING		▥ ☒	38 (100mm)	30.3 29.6		>500	
45										

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
	14	COAL	- black, K6 hardness	- fissile fabric		135	93	71
46 47 48 49	15	CLAY SHALE	- dark brown to black, silty, K3 hardness, carbonaceous, dry to damp - dark grey-brown - SILTSTONE layer (300mm), light grey, K7 hardness, indurated - dark grey-brown, K3 hardness	- fractured, fine horizontal bedding - slightly fractured, fine horizontal bedding - fractured	21.0 1.1	70 30 215 280 345 50 50 95		
50 51 52	16	SANDSTONE	- light to medium grey, silty, fine grained, K3 hardness, coal stringers, occasional SILTSTONE layers (100 to 300mm), fine CLAY SHALE laminations, dry to damp	- slightly fractured to massive, homogeneous fabric	9.7 11.3	210 1025 55 80	100	90
53 54 55	17		- CLAY SHALE layer (300 mm), dark brown-grey, silty, K3 hardness, dry - SANDSTONE, K3 to K4 hardness	- fractured, fine horizontal bedding - massive, homogeneous fabric		1220 130	99	99

ROCK CORE LOG

EBA Engineering Consultants Ltd.

Drawing No. B-10

Sheet 2 of 4

Project GRIERSON HILL STABILIZATION STUDY	Project No. 106-2672	Hole No. 80-9	Depth Interval 17.0-27.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56–57			- medium to fine grained, K3 hardness, coal particles	- slightly fractured, homogeneous fabric				
57–58			- light grey, K6 hardness, indurated, dry		11.3			
59	18					330	97	92
60–61			- K3 hardness, light brown horizontal lenses, damp	- slightly fractured to massive, horizontal bedding	12.5	140 690 100 65		
62	19		- medium to fine grained, K4 hardness, coal stringers					
63–64			- light grey, medium grained, dark brown-grey clay shale laminations	- massive, horizontal bedding		1280	93	93
65	20		light brown siltstone pocket, K4 to K5 hardness, indurated					
66–67			light grey, medium to fine grained, K3 hardness, damp		11.6			
68	21		- medium grey	- massive		645	103	94
69–70			- medium brown siltstone layer, (50mm), K6 to K7 hardness, indurated		12.2	512 125 95 40		
71	22		- fine to medium grained, K3 hardness	- fractured				
72–74			- CLAY SHALE, dark brown to black, K3 to K5 hardness, carbonaceous, with layers of COAL, black, highly fractured, (5mm) and SILTSTONE, medium grey, silty, indurated	- fractured, block microstructure, 100 to 200 mm layers	11.8	95 20 45 90 70	103	80
75	23		- light grey, silty, fine grained, K4 to K5 hardness	- massive, homogeneous fabric	11.3	785 305		
76			- CLAY SHALE lens (10mm)					
77–78	24		- coal stringers		14.9	1075 105 70 35	94	86
79–80			- dark brown-grey, silty, K3 to K4 hardness, coal particles, dry	- fractured, blocky microstructure (5mm)	11.7			
81	25		- dark brown to black, K5 hardness, carbonaceous, dry		13.7	25	89	72
82			- black, K6 hardness	- fissile fabric (10mm layers)	13.2	40 80		
83–85	26		- dark brown to black, carbonaceous - COAL lens (25mm) - medium to dark grey, K3 hardness slightly bentonitic	- massive, fine horizontal bedding	16.9 22.0	150 100 90 735		
86–88	27		- coal stringers - SILTSTONE layer (100mm) - dark brown-grey, silty, K3 to K4 hardness	- massive	19.0 18.5	970 65 40	79	71

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Drawing No. B-10

Sheet 3 of 4

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-9

Depth Interval 27.0-28.5 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
89		CLAY SHALE	- light grey siltstone laminations - SILTSTONE layer (150 mm), K7 hardness, indurated	- fractured, horizontal bedding				
90 91				- extremely fractured (very poor recovery)		-	0	
92 93	28		- dark brownish grey, K3 to K4 hardness - SILTSTONE inclusions	- extremely fractured (very poor recovery)	33.1	-	0	
94 95	29		END OF BOREHOLE (28.5 metres)					

EBA Engineering Consultants Ltd.

Drawing No. B-10

Sheet 4 of 4

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
Project Number 106-2672

Hole No. 80-10
Surface Elevation 653.1 m (City)
Completion Depth 29.0 m
Date Drilled August 9, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow stem/ Wireline coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- dark brown to black, clay pockets, damp, rootlets							
1		CLAY (FILL)	- dark brown, silty, some sand, stiff, pebbles to 20 mm, pieces of brick and coal, organics, damp, cohesive						160	
2										
3	1		- black organic layers, piece of wire, damp to moist		▥		21.7		140	
4					■				190	
5			- extremely organic silt layers - moist, firm, cohesionless		☒	5	23.1			
6	2									
7										
8		SILT (FILL)	- medium brown, sandy, organic pockets, firm to stiff, piece of glass, damp to moist, mainly cohesive		▥		28.5		100	
9					◣					
10	3	SAND (TILL)	- medium to dark brown, silty, some clay, fine to medium grained, compact, trace of pebbles and organics, damp, mainly cohesionless		☒	11	15.8			
11										
12										
13	4		- medium brown, moist to wet, cohesionless		▥		16.5		110	
14										
15		CLAY (TILL)	- dark brownish grey, silty, some sand, stiff, pebbles and coal specks, damp, cohesive		☒	14	16.0			
16	5									
17										
18			- CLAY SHALE, grey and brown, silty, K1 hardness, weathered, horizontal bedding, coal specks, damp(150mm)		▥		17.2		300	
19	6		- very stiff							
20		CLAY SHALE	- medium grey and brown, silty, K1 hardness, massive, damp, horizontal bedding		☒	29	22.3			
21			- SANDSTONE, light grey, fine grained, damp (150 mm)							
22										
23	7		- dark grey, K1 to K3 hardness, brecciated, blocky fragments (5-10 mm)		▥					
24			- medium brown layers				23.8			
25					☒	22	21.2			
26	8		- coal lenses							
27		SANDSTONE	- light grey, silty, fine grained, uniform, K1 to K2 hardness, medium grey clay laminations, brown iron streaks, damp, massive, homogeneous fabric							
28					▥		17.0	D	>500	
29	9									

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Drawing No. B-11

Sheet 1 of 4

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-10
Surface Elevation 653.1 m (CITY)
Completion Depth 29.0 m
Date Drilled August 9, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		SANDSTONE	- dry to damp, K2 hardness		☒	40	19.0			
31										
32	10									
33			- light grey and brown, thin medium grey clay laminations, slightly fractured, homogeneous fabric with faint horizontal bedding		▥					
34							16.8		>500	
35					☒	32(150mm)				
36	11		- K3 hardness, dry				16.9			
37										
38			- K1 to K2 hardness, dry to damp		▥					
39	12						15.2			
40			- thin medium grey clay shale lens (25 mm) START ROCK CORING		☒	55	16.6			

Depth ft.	Depth m	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
41			- light grey, silty, fine grained, uniform, coal, damp	- slightly fractured, homogeneous fabric, coal stringers and clay shale lenses @ horizontal and inclined @ 30°	17.6			
42	13		- loss of water pressure and poor recovery	- massive, homogenous fabric				
43					13.2	70 80 95 790	76	58
44								
45	14							
46								
47		CLAY SHALE	- medium to dark grey, silty, K2 hardness, subangular fragements, dry to damp	- slightly fractured, blocky microstructure (2 to 5 mm)	16.6		35	35
48						480		
49	15		- dark brown to black, carbonaceous, coal particles, dry to damp	- fractured, fissile fabric				
50		COAL	- black, fragmented, K6 hardness,	- highly fractured, blocky (20mm)				
51		CLAY SHALE	- medium grey, silty, K1 to K3 hardness, coal particles, damp	- brecciated fabric	17.1			
52	16		- SANDSTONE (100mm), light grey, fine grained, K1 to K2 hardness				37	37
53			- dark brownish grey, K3 hardness thin siltstone lenses, dry to damp	- fine horizontal bedding		110		
54		COAL	- black, fragmented, K6 hardness			400		
55	17	CLAY SHALE	- dark brownish grey, silty, K2 hardness, coal particles, damp	- fractured, brecciated - slightly fractured, blocky				

ROCK CORE LOG

EBA Engineering Consultants Ltd.

Drawing No. B-11

Sheet 2 of 4

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-10

Depth Interval 17.0- 27.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56			- light grey sandstone pockets					
57							12	12
58			- dark brown to black, carbonaceous, K1 hardness, damp to moist	- slightly fractured, brecciated		170		
59	18	CLAY SHALE	- med.green-grey, slightly bentonitic, layer (50 mm thick), K3 hardness	- fractured, fissile & blocky (20 mm)	31.2			
60			- dark brown to black, carbonaceous			90		
61		COAL	- black, brittle, subangular fragments, K6 hardness, wet	- fractured, blocky microstructure (5 mm)	28.6	415 65 40	53	30
62	19				23.1	50 70		
63								
64		CLAY SHALE	- dark brown to black, carbonaceous, K2 hardness, coal stringers, dry	- massive, fissile fabric				
65	20		- dark brownish grey, silty, K3 hardness, coal specks, dry	- massive, some horizontal fissures			100	99
66				- slickensided fracture plane at 45° to horizontal	20.1	20 1350		
67			- K3 to K4 hardness, siltstone inclusions					
68	21			- highly fractured, 25 mm subangular fragments (loss of water pressure)	12.9			
69		INTERBEDDED CLAY SHALE SANDSTONE AND SILTSTONE	- light grey sandstone/med. grey siltstone, K3 to K4 hardness, dry	- massive, horizontal bedding				
70					14.2	115 75 50 65 1060	100	86
71			- medium brown siltstone bonds, K6 hardness					
72	22		- dark brownish grey, silty, K3 to K4 hardness					
73			- numerous light grey sandstone lenses & pockets	- massive, blocky with fine horizontal bedding	15.1			
74					15.0		100	100
75	23							
76			- some sandstone & siltstone laminations, K4 hardness	- fine horizontal bedding - slickensided fracture planes		1375		
77								
78	24			- fractured	15.6			
79			- SILTSTONE layer (75 mm), K7 hardness, indurated				33	24
80			- SANDSTONE layer (800 mm), light grey, silty, uniform, some coal specks, K5 hardness, dry, medium to dark grey clay shale laminations	- massive, homogeneous fabric		40 10 75 330		
81	25							
82				- massive, homogeneous fabric, some vertical fissures	14.7			
83							100	100
84				- blocky microstructure (25 mm)	14.5			
85	26		- dark brown to black, carbonaceous, K4 hardness			1370		
86		COAL	- black, K6 hardness (poor recovery)	- highly fractured, blocky		80 130	46	29
87		SANDSTONE	- light to medium grey, silty, uniform, K4 hardness, some clay shale laminations	- massive, homogeneous fabric	13.1		100	100
88	27							

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Drawing No. B-11

Sheet 3 of 4

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2682

Hole No. 80-10

Depth Interval 27.0 - 29.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
89 90 91	28	**SANDSTONE**	- medium grained, K3 hardness, coal specks	- massive, homogeneous fabric	9.8	1360	100	100
92 93 94	29	**CLAY SHALE**	- dark brown-grey, silty, K4 to K5 hardness, coal specks, siltstone inclusions - dark brown to black, carbonaceous	- fractured to massive	12.6 12.3	195 225 85 65 135 230	68	57
95 96			END OF BOREHOLE (29.0 metres)					

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Drawing No. B-11

Sheet 4 of 4

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-11A
Surface Elevation 656.5 m (City)
Completion Depth 20.7 m
Date Drilled August 27, 1980
Logged By RRH (field); ______ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		GRAVEL	- dark brown, sandy, silty, pebbles to 35 mm, damp to moist, cohesionless							
1 2 3	1	CLAY (FILL)	- medium brown, black organic pockets, silty, very stiff, trace of rootlets, medium plasticity, damp, cohesive						200	
					▥					
4 5 6	2	CLAY (FILL) TILL	- dark brown-grey, silty, hard, sand pockets, pebbles, coal specks, oxide stains, damp, cohesive - pieces of brick, firm		■ ☒	5	13.3 14.6		480	
7 8 9	3		- SILT, (600 mm thick), medium brown-black, some clay and sand, very stiff, organics, trace of pebbles, damp, mainly cohesive		▥		19.4		280	
10 11 12	4		- dark greyish brown, stiff, some organics, rootlets, damp cohesive - black organic seams, pebbles to 10 mm		◣ ☒	8	18.1			
13			- SILT, (75mm thick), brown, very fine grained, damp, mainly cohesionless		▥		28.0		180	
14 15 16	5	CLAY (FILL)	- medium greyish brown, silty, stiff, high plasticity, moist - brown-grey, mottled, stiff, medium to high plasticity, damp to moist		■ ☒	10	25.7 33.7		110	
17 18 19	6		- medium to dark brown, very silty, sandy, stiff, pieces of shells and glass, organics, damp to moist, mainly cohesive		▥ ■		22.3 19.9		170 230	
20 21 22	7		- brown and grey, black organic silt pockets		☒	24	19.6			
23 24			- grey and black, silty, sandy, very stiff, pieces of coal, glass and bricks, calcareous, damp, mainly cohesive		▥		21.1		320	
25 26	8	CLAY (TILL)	- dark brownish grey, silty, hard, sand pockets, trace of pebbles and coal particles, damp, cohesive		☒	33	20.7			
27										
28 29	9	COAL	- black, brittle, highly fractured, K6 hardness, powdery, to blocky, (100 mm)		▥		28.0			

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Drawing No. B-12(a)

Sheet 1 of 3

Project	GRIERSON HILL STABILIZATION STUDY
Location	EDMONTON ALBERTA
Project Number	106-2672

Hole No.	80-11A	**Log Type**	Overburden/Rock Core
Surface Elevation	656.5 m (CITY)	**Core Size**	50 mm
Completion Depth	20.7 m	**Drilling Contractor**	Mobile Augers
Date Drilled	August 27, 1980	**Drilling Method**	B61 Hollow Stem/
Logged By	RRH (field); (lab)		Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30 31 32	10	CLAY SHALE	- thin dark brown carbonaceous layer (75 mm) - medium to dark grey, silty, K3 hardness, massive, homogeneous fabric, dry		☒	60 (225mm)	17.5			
33 34 35 36	11		- coal stringers, some brecciated zones - 25 mm thick, K1 to K3 hardness		▥ ☒	50 (100mm)	15.2			
37										
38 39	12	COAL	- black, brittle, highly fractured, K6 hardness, powdery to blocky, (max 10mm)		☒	54	44.5			
40										
41 42	13	CLAY SHALE	- medium to dark grey, silty, K1 to K3 hardness, massive, brecciated, damp to moist							
43 44		SANDSTONE	- SANDSTONE, light grey, silty, fine grained, friable, coal stringers, massive, homogeneous fabric (150 mm)		▥		21.3			
45			- light grey, silty, K2 hardness, clay shale laminations START ROCK CORING		☒		18.6			

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
46 47	14		- K1 to K2 hardness, coal particles - coal seams and clay shale laminations	- massive, homogeneous fabric, horizontal bedding	9.7		77	72
48 49	15	CLAY SHALE	- dark grey, silty, K3 hardness, coal specks, dry - dark brownish grey, K1 to K3 hardness, damp	- massive, irregular to blocky microstructure (5 to 10 mm) - slightly fractured, brecciated	18.8	980 80		
50 51 52	16		- SANDSTONE, light grey, silty, K3 hardness, siltstone seams (75mm) - dark grey, K3 hardness, coal stringers, horizontal siltstone laminations - SILTSTONE, light brown, K7 hardness (50 mm)	- massive, homogeneous fabric, slickensided fracture planes fractured	17.6	75 150 30 135 160 70	82	58
53 54 55	17		(No recovery - 16.35 to 16.65 m lost all water pressured and no resistance to coring - possible void, mine working?)				0	0

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Drawing No. B-12(a)

Sheet 2 of 3

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-11A

Depth Interval 17.0-20.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56								
57						50	28	20
58	18		- dark brown to black, silty, carbonaceous, K5 hardness, coal lenses	- fractured, homogeneous to fissile fabric	15.9	60 100 170		
59			- dark grey, K1 to K3 hardness - K3 hardness, siltstone laminations	- brecciated zone (50 mm) - slightly fractured, fine horizontal bedding				
60			- fractured zone	- extremely fractured, angular and subangular fragments (2 to 5mm), brecciated material			72	70
61			- K3 hardness	- brecciated zone (50 mm) - slickensided along fracture planes		30 160		
62	19		- dark brown to black, silty, K3 to K4 hardness, carbonaceous		19.2	135 205		
63			- COAL, poor recovery - dark grey, silty, K3 to K4 hardness	- massive, irregular blocky microstructure (2 to 5 mm)		275 185		
64			- dark brownish grey, coal streaks					
65	20		- SILTSTONE, medium grey, K3 hardness, clay shale laminations, coal streaks (400 mm)	- massive, homogeneous with fine horizontal bedding			77	74
66					17.7	40		
67			- dark brownish grey, K3 to K4 hardness - thin light grey sandstone lenses	- massive, blocky microstructure (5 to 10mm), fine horizontal bedding		325 695		
68	21		END OF BOREHOLE (20.7 metres)					
69								
70								
71								
72								
73								
74								
75								

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Drawing No. B-12(a)

Sheet 3 **of** 3

Project	GRIERSON HILL STABILIZATION STUDY
Location	EDMONTON ALBERTA
Project Number	106-2672

Hole No.	80-11B	Log Type	Rock Core
Surface Elevation	656.5 m	Core Size	75 mm
Completion Depth	34.7 m	Drilling Contractor	Garrity & Baker
Date Drilled	September 10, 1980	Drilling Method	Cyclone - Wireline
Logged By	RRH (field); ______ (lab)		

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
57 58 59	18		0 - 20.0 metres - This portion of Borehole 80-11B not logged. - See Borehole 80-11A					
60 61 62	19							
63 64 65	20							
66		CLAY SHALE	- dark grey, silty, K1 to K3 hardness, damp to moist	- slightly factured				
67 68	21		- dark brownish grey, K3 hardness, light grey, sandstone pockets, siltstone bands	- massive, some slickensided fracture planes at various angles		100 400	55	51
69 70						50 200		
71		BENTONITE	- (100mm),light greyish green, K1 hardness, coal streaks					
		CLAY SHALE	- dark brown to black, carbonaceous, K3toK4 hardness, coal lenses	- massive, homogeneous to fissile fabric				
72	22	COAL	- (225mm),black, fractured, K6 hardness	- fractured, blocky (≈25mm)				
73		CLAY SHALE	- thin carbonaceous zone - greenish grey, bentonitic, K3 to K4 hardness	- massive, homogeneous fabric		610 90	97	81
74			- SILTSTONE, (300mm), medium grey, clayey, K4 to K5 hardness, coal specks	- massive, blocky microstructure		50 260		
75	23		- SANDSTONE (450mm), light grey, silty, fine grained, K4 hardness	- massive, homogeneous fabric		45 70		
76 77			- dark brownish grey, silty, K4 to K5 hardness, thin coal lenses	- massive, blocky microstructure		60 40 50 270 700		
78	24		- dark grey, light grey sandstone laminations	- horizontal bedding		110 160		
79 80			- K1 to K3 hardness	- brecciated zone (150 mm)				
81				- fractured, blocky microstructure, slickensided fracture			100	98
82	25		- SILTSTONE, (225mm), dark greyish brown, K5 to K6 hardness	- massive, homogeneous fabric		70		
83			- SANDSTONE, (75 mm), light grey, silty, fine grained	- homogeneous fabric		115 245		
84			- dark brownish grey, K4 to K5 hardness	- massive, homogeneous fabric, fissures at various angles		1320 585		
85	26		- K1 to K3 hardness, siltstone inclusions	- brecciated zone		130		

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Drawing No. B-12(b)

Sheet 1 of 2

Project FESTIVAL PARK

Project No. 106-2672

Hole No. 80-11B

Depth Interval 26.0-34.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
86			- sandstone lenses, fine grained - slickensided fracture planes at 45° to horizontal	- horizontal bedding				
87 88	27	SANDSTONE	- light grey, silty, K4 hardness, fine grained, siltstone bands, coal streaks	- massive, homogeneous fabric				
89 90 91			- SILTSTONE, dark brown, clayey, K4 to K5 hardness, carbonaceous, coal particles (300mm)	- massive, homogeneous fabric		75 1070	73	65
92 93 94	28	INTERBEDDED CLAY, SHALE AND SANDSTONE	- dark brown, slightly carbonaceous clay shale, K4 to K5 hardness - light grey sandstone, K4 hardness - dark grey clay shale, K4 hardness - light grey sandstone - dark brown clay shale - light grey sandstone	- slightly brecciated		70 120		
95 96 97 98	29 30		- dark brownish grey, K4 to K5 hardness	- fractured, homogeneous, slightly blocky microstructure		145 40 100 40 55 105 185 60 1115	100	90
99 100 101	31		- SILTSTONE, (75mm), light brown, K6 hardness, well indurated	- fractured				
102		CLAY SHALE	- dark brown, slightly carbonaceous - greenish brown, slightly bentonitic, thin bentonite seams (2to5mm)	- massive, irregular, blocky		110 90	77	65
103		COAL	- black, brittle, K6 hardness	- fractured, blocky		140		
104	32	CLAY SHALE	- medium to dark grey, silty, K4 to K5 hardness, coal specks	- fractured, blocky microstructure (5 to 15mm)		185 55 100 215		
105			- SILTSTONE, (150mm), light brown, K6 hardness	- fractured, irregular		60		
106 107			- SANDSTONE, (450mm), light grey, K4 hardness, fine to medium grained, coal stringers	- massive, homogeneous fabric		95 185 230 525		
108	33		- medium to dark grey, silty, K4 to K5 hardness	- massive, irregular, blocky microstructure				
109 110			- thin light grey sandstone lenses, coal stringers	- massive, blocky microstructure (10-20mm) with horizontal bedding				
111	34		- medium grey, slightly bentonitic, K3 hardness, sandstone seams (100mm)				94	94
112 113			- medium to dark grey, K4 to K5 hardness, coal pockets - thin light brown siltstone lens, K7 hardness, calcareous - dark grey, silty, K5 hardness, coal specks	- massive, blocky, microstructure		1595 415		
114 115	35		END OF BOREHOLE (34.7 metres)					
	36							

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Drawing No. B-12(b)

Sheet 2 **of** 2

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-12
Surface Elevation 658.2 m (City)
Completion Depth 37.0 m
Date Drilled August 25, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		GRAVEL	- dark brown, silty, sandy, pebbles, wet, cohesionless, permeable							
1		CLAY (FILL)	- medium to dark brown, silty, organic pockets, stiff, pebbles, pieces of brick, cohesive						180	
2		SAND (FILL)	- medium brown, silty, clay pockets, fine grained, organic streaks, mainly cohesionless, permeable							
3	1				▥		16.3			
4					◣					
5		CLAY (FILL)	- brown-grey, silty, clay shale inclusions, firm, thin bentonite seams, sand pockets, damp to moist, mainly cohesive		☒	7	27.9			
6	2									
7										
8			- dark brown, silt pockets, stiff, pebbles to 20 mm, coal particles, wood fibres, organic seams, damp		▥		24.2		240	
9	3				■		24.1		110	
10			- medium brown, stiff, high plasticity, moist, cohesive		☒	8	33.1			
11										
12										
13	4		~~- medium brown, grey coarse grained sand lenses,~~ pebbles to 10mm, rootlets, mainly cohesive		▥		35.8		120	
14					◣					
15										
16	5				☒	8	28.4			
17										
18		CLAY TILL (FILL)	- medium brown and grey, very sandy, silty, very stiff, pebbles, coal particles, damp, mainly cohesive		▥		27.3		210	
19	6		- black, organic silt lens (75 mm), piece of leather, damp		◣					
20		CLAY (FILL)	- medium brown with grey streaks, silty, stiff, high plasticity, moist, cohesive		☒	11	31.7			
21										
22	7									
23			- siltier, very stiff, oxide stains, damp to moist							
24					▥		31.2		240	
25			- thin medium brown silt lenses (50 mm), damp to moist, mainly cohesionless		☒	13	25.3			
26	8									
27										
28			- SAND TILL (300 mm), medium brown, silty, fine grained pebbles and coal specks, damp, cohesionless		▥		11.3		480	
29	9		- CLAY TILL, dark greyish brown, silty, hard, damp							

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Drawing No. B-13

Sheet 1 of 5

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-12
Surface Elevation 658.2 m
Completion Depth 37.0 m
Date Drilled August 25, 1980
Logged By RRH (field); ______ (lab)

Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY SHALE	- brown-grey, mottled, silty, very stiff, coal particles, sand pockets, medium plasticity, moist, cohesive		☒	18	28.6			
31										
32										
33	10		- SILT (200 mm), black, extremely organic, trace of pebbles, damp, mainly cohesive		▥		24.0		260	
34			- medium brown, damp to moist							
35			- medium grey with brown streaks, very stiff		☒	21	25.7			
36	11									
37		CLAY TILL (FILL)								
38			- medium greyish brown, silty, some sand, very stiff, pebbles to 15 mm, coal particles, damp, cohesive		▥		29.7		360	
39	12	CINDERS (FILL)	- brown and black, some clay and silt, compact, coal particles, pieces of wood, calcareous, wet, cohesionless, permeable							
40			- free water in borehole at 12.0 m		☒	16	34.3			
41										
42										
43	13		- pieces of bricks and concrete, coal particles		▥					
44							25.7			
45			- rock fragments, pieces of ceramics		☒	13	30.8			
46	14	CLAY (TILL)	medium brown with grey streaks, silty, stiff, medium to high plasticity, coal pockets, moist, cohesive							
47										
48			(no recovery 14.0 - 16.0 m)							
49	15									
50										
51										
52	16									
53			- medium brown-grey, mottled, silty, very stiff, moist, cohesive		▥					
54			- thin wet sand pocket (25 mm)				27.6		230	
55			- SILT (300 mm), grey and black, siltstone inclusions, stiff, moist, mainly cohesive		☒	11	27.1			
56	17		- organic pockets, wood fibres							
57										
58			- SILT, dark brown, very sandy, pieces of glass, wood and ceramics, wet cohesionless		▥		45.4			
59	18									

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Drawing No. B-13

Sheet. 2 of 5

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-12
Surface Elevation 658.2 m (City)
Completion Depth 37.0 m
Date Drilled August 25, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
-60			- dark brown, black peat seams, pieces of wood and bricks		☒	15	46.8			
-61										
-62	19									
-63			- (No recovery - 18.6 m to 21.2 m)							
-64					▨					
-65	20									
-66										
-67										
-68		CLAY								
-69	21				▨					
-70			- medium brown and grey, silty, very stiff, some sand pockets, trace of pebbles, damp, cohesive		☒	23	23.1			
-71			- moist, high plasticity							
-72	22									
-73			- light and medium brown, silty, very stiff, high plasticity, moist, cohesive		▨					
-74		CLAY SHALE	- dark greyish brown, silty, thin bentonite seams, K1 to K2 hardness, massive, brecciated, moist				38.5		250	
-75	23	COAL	- black, brittle, highly fractured, blocky (1-10 mm), wet		☒	40	52.6			
-76		CLAY SHALE								
-77										
-78	24		- medium grey, silty, K3 hardness, coal specks, massive, homogeneous fabric, dry to damp		☒	50	(150 mm)			
-79							23.8			
-80			START ROCK CORING							

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-81			- medium to dark grey, silty, K3 hardness, coal specks, dry	- massive, fissile fabric				
-82	25		- K3 to K4 hardness, coal stringers	- massive, homogeneous fabric			62	62
-83			- light brown siltstone inclusions - K6 hardness		15.1	560 200		
-84								
-85	26							

ROCK CORE LOG

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Drawing No. B-13

Sheet 3 of 5

Project GRIERSON HILL STABILIZATION STUDY **Project No.** 106-2672 **Hole No.** 80-12 **Depth Interval** 27.0-36.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
86 87			- dark brownish grey, silty, K3 to K4 hardness, light brown siltstone inclusions	- massive, homogeneous fabric	18.1	365	27	27
88	27		- SANDSTONE, light grey, silty, fine grained, K3 hardness, dry	- massive, homogeneous fabric				
89 90		SILTSTONE	- light brownish grey, K7 hardness fractured zone (75mm) at 27.1m, lost water pressure	- highly fractured, homogeneous fabric	13.1			
91 92 93	28		- medium to dark grey, K4 hardness sandstone pockets, dry	- massive, homogeneous fabric		80 50 70 210	30	15
94 95	29	SANDSTONE	- light grey, silty, K3 to K4 hardness, fine grained, horizontal clay laminations, coal stringers, dry	- massive, homogeneous fabric	13.3			
			- fine to medium grained					
96 97		CLAY SHALE	- dark brownish grey, silty, K4 hardness, subangular fragments (≈10mm), siltstone inclusions, dry	- massive, blocky microstructure	14.8	950	69	69
98	30		- K4 to K5 hardness					
99 100 101	31		(No Recovery in core barrel - full run of core was left in the bottom of the borehole. Attempted to recover by overcoring but core was washed away).				0	0
102 103			- dark brown, silty, K3 hardness, carbonaceous, coal particles, dry	- slightly fractured, homogeneous fabric				
104	32		- medium to dark grey, K3 to K4 hardness, slightly bentonitic, siltstone inclusions	- massive, homogeneous fabric	13.3	90 30 205 100	85	71
105 106			- dark brownish grey, K4 hardness		15.3	310 105 90 205 160		
107 108	33		- dark brown to black, silty, K5 hardness, carbonaceous	- massive, homogeneous to fissile fabric				
109						40 60 65 195 40 180	42	27
110		BENTONITE	- greyish green, coal stringers, high plasticity		15.6			
111	34	CLAY SHALE	- medium grey, silty, K3 to K4 hardness, slightly bentonitic, coal stringers, dry	- massive, homogeneous fabric				
112 113			- SANDSTONE (150mm), light grey, silty, K3 hardness, fine grained dry	- massive, homogeneous fabric	19.1			
			- dark grey, coal patches, siltstone pockets					
114			- SILTSTONE, (50mm), light greyish brown, K7 hardness, calcareous stains	- slightly fractured, horizontal bedding	15.4	505 90 320	100	90
115	35		- dark grey, very silty, K3 to K4 hardness, dry					
116			- dark brownish grey, K4 hardness		17.1	75 40 40 95 60 85		
117			- SILTSTONE, (150mm), light greyish brown, K7 hardness, coal particles	- slightly fractured, some fissures	18.0			
118	36	BENTONITE	- light greyish green, clay lenses K1 hardness, high plasticity, damp		35.3			

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Drawing No. B-13

Sheet 4 of 5

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-12

Depth Interval

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
		BENTONITE	- as above			105		
119 120		CLAY SHALE	- dark brown to black, silty, K4 to K5 hardness, carbonaceous, coal lenses	- massive, homogeneous to fissile fabric		50 290 160 20 45	97	83
	37		- dark brownish grey, silty, K5 hardness, coal specks	- massive, homogeneous fabric	10.8	120 140 30 70 455		

END OF BOREHOLE (37.0 metres)

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Drawing No. B-13

Sheet 5 of 5

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-13
Surface Elevation 659.0 (CITY)
Completion Depth 33.7 m
Date Drilled August 14-16, 1980
Logged By RRH **(field);** ____ **(lab)**
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- dark brown to black, organic, damp, rootlets							
1		SILT (FILL)	- dark brown, clay pockets, trace of sand, rootlets, organic streaks, damp to moist, mainly cohesionless		☐					
2		CLAY TILL (FILL)	- medium and dark brown, silty, some sand, hard, pebbles to 25 mm, pieces of brick, organic seams, rootlets, damp, cohesive		☐					
3	1				▥		21.1		>500	
4					■				>500	
5			- medium brown, light grey sand pockets, very stiff, coal pieces, damp		☒	21	16.9			
7					☐					
8			- dark brown, black organic bands, numerous pebbles, damp		▥		26.3		210	
9	3	CLAY (FILL)	- medium brown, black organic silt pockets, very stiff, damp to moist, cohesive		■				200	
10					☒	22	26.2			
12					☐					
13	4		- medium brown-grey, mottled, very silty, stiff, trace of sand, damp to moist, cohesive		▥		28.9		190	
14					■				160	
15			- very stiff, coal particles, sand pockets, some pebbles		☒	15	27.0			
17		CLAY (FILL) TILL	- dark greyish brown, black organic silt seams, very stiff, calcareous, pebbles and coal specks, damp, cohesive		▥		18.2		250	
20			- very silty, very stiff, pebbles to 25 mm, organics, mainly cohesive		☒	25				
22					☐					
23			- dark greyish brown, black organic seams, silty, stiff, piece of concrete, nail, damp		▥		18.3		300	
25			- very stiff, pebbles to 25 mm		☒	19	14.5			
28			- sand pockets, organic layers, very stiff, cohesive		☐					
29	9	SILT (FILL)	- black, extremely organic, wood fibres, damp, mainly cohesionless		▥		20.9		200	

Project GRIERSON HILL STABILIZATION STUDY

Location EDMONTON ALBERTA

Project Number 106-2672

Hole No. 80-13

Surface Elevation 659.0 m

Completion Depth 33.7 m

Date Drilled August 14-16, 1980

Logged By RRH (field); (lab)

Log Type Overburden/Rock Core

Core Size 50 mm

Drilling Contractor Mobile Augers

Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		SILT (FILL)	- coal particles, cinders, damp, cohesionless		☒	33	32.3			
31			- pieces of brick							
33	10		- CINDERS, medium and dark brown, silty, angular fragments, piece of plastic, wet, cohesionless, free water in borehole at 10.0 m		▥		36.5			
35		CLAY (FILL)	- medium brown, black organic silt pockets, very stiff, wood fibres, damp to moist, mainly cohesive		☒	16	30.6			
37	11	CLAY (FILL)	- medium to dark greyish brown, silty, very stiff, trace of pebbles and coal specks, wood fibres, some organics, damp, cohesive							
38			- medium brown and grey, mottled, very silty, high plasticity, calcareous pockets, moist, cohesive		▥		34.5		2.7	
40	12		- thin organic seams, pieces of weathered concrete		☒	19	30.7			
43	13		- trace of pebbles, damp to moist - SILT, (200mm), black, organic, pieces of wood and brick, moist, mainly cohesionless		▥		27.7		3.1	
45			- medium brown and grey, very silty, very stiff, silt lenses, pebbles to 25 mm		☒	19	31.2			
48	14		- SILT, (600mm), dark grey to black, clayey, very stiff, organics, wood fibres, damp, mainly cohesive		▥		28.0		2.9	
50	15		- medium brown and grey, mottled, very silty, very stiff, some organics, damp, cohesive		☒	21	27.2			
53	16		- CLAY TILL, (200mm), medium to dark grey and brown, silty, some sand, very stiff, piece of weathered concrete, organic streaks, pebbles to 25 mm, damp, cohesive		▥		21.4		2.9	
55					☒	23	27.8			
58	17		- SILT, (200mm), light to medium grey, some sand, stiff, damp to moist, mainly cohesionless		▥				1.9	
	18									

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Drawing No. B-14

Sheet 2 of 4

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-13
Surface Elevation 659.0 m (CITY)
Completion Depth 33.7 m
Date Drilled August 14-16, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
-60 -61 -62	19	CLAY	- SILT, (300mm), grey and black, extremely organic, damp, mainly cohesionless - medium brown, silty, very stiff, high plasticity, moist, cohesive		▥ ⊠	20	20.7		2.7	
-63 -64 -65	20		- SILT, (100mm), medium grey, some sand, very stiff, trace of organics, damp to moist, mainly cohesionless - SILT, (250mm), medium grey, black organic bands, hard, damp, cohesive		▥ ⊠	31	25.9 23.1		2.7	
-66 -67 -68	21		- medium brown - as above - medium brown, grey silt lenses, very stiff, sand pockets, damp, cohesive		▥		26.1		3.7	
-69 -70 -71	22		- dark grey and black, very stiff, extremely organic lenses, pieces of wood, rootlets, damp - dark grey and black horizontal bedding, damp, cohesive		⊠	24	24.1			
-72 -73 -74 -75	23		- PEAT, dark brown, silty, clayey, extremely organic, very stiff, wood fibres and rootlets, damp - SAND, light to medium brown, very silty, dense, fine grained, damp, cohesionless		▥ ⊠	42	32.0 19.4		3.0	
-76 -77		CLAY SHALE	- dark brown to black, silty, carbonaceous, K3 hardness, slightly fractured, fissile fabric, dry to damp							
-78	24	COAL	- black, highly fractured, K5 hardness, blocky (5mm)							
			- dark brown - as above		⊠	42 (150mm)	23.6			
-79		CLAY SHALE	- dark brownish grey, silty, K3 hardness, slightly fractured START ROCK CORING							

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-80 -81 -82	25	CLAY SHALE	- dark brownish grey, silty, K3 to K4 hardness, coal stringers, dry	- massive, homogeneous fabric	18.7			
-83 -84 -85	26		- medium to dark grey, K4 hardness, slickensided fracture planes at 80° to horizontal	- massive, homogeneous fabric, slightly fissured		670	49	49

ROCK CORE LOG

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Drawing No. B-14

Sheet 3 of 4

Project

Project No. 106-2672

Hole No. 80-13

Depth Interval

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
					13.5			
86			- light brown siltstone pocket		13.1			
87			- SANDSTONE (300mm), light grey, very silty, fine grained, K3 hardness, dry to damp	- massive, homogeneous fabric			100	100
88	27		- medium to dark grey, silty, K4 hardness	- massive, blocky		975 395		
89			- SILTSTONE (200mm), light brownish grey, K6 hardness, coal stringers	- massive, homogeneous microstructure with some fissures				
90								
91	28		- medium to dark grey, silty, K3 to K4 hardness, coal pockets	- massive, blocky microstructure (10-15mm)	15.8		38	38
92		SANDSTONE	- light grey, silty, fine to medium grained, K5 hardness, grey clay shale laminations	- massive, homogeneous fabric with horizontal shale laminations				
93					7.2	520		
94			- coal stringers			300	100	100
95	29				11.8			
96								
97		CLAY SHALE	- dark grey, silty, K4 hardness, coal particles	- massive, homogeneous fabric		95	71	64
98	30				15.0	170 605		
99			- dark brownish grey, K1 to K3 hardness, angular fragments, damp	- fractured, brecciated	14.1			
100			- K3 to K4 hardness - dark brown to black, K4 to K5 hardness, carbonaceous, coal particles	- massive, blocky microstructure (≈10mm)				
101	31	SANDSTONE	- light grey, very silty, K3 hardness, fine grained, grey clay shale laminations	- massive, homogeneous fabric, faint horizontal bedding			100	100
102					10.3	1370		
103			- K5 hardness, fine to medium grained, coal specks	- homogeneous fabric	10.3			
104	32						66	66
105						475 120		
106			- SILTSTONE, medium grey with light grey streaks, very fine grained, K3 to K4 hardness, dry (100mm)	- fractured, horizontal bedding				
107			- K3 to K4 hardness, fine grained					
108	33	COAL	- black, brittle, fragmented, K6 hardness, some gold streaks, wet	- highly fractured, blocky microstructure (25mm) to fissile	11.5	25	71	67
109						30 280		
110		CLAY SHALE	- dark brown to black, K4 to K5 hardness, carbonaceous, coal lenses	- massive, homogeneous to fissile fabric	23.6	135 240 260		
111	34		END OF BOREHOLE (33.7 metres)					
	35							
	36							

EBA Engineering Consultants Ltd.

Drawing No. B-14

Sheet 4 of 4

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-14
Surface Elevation 659.0 m (CITY)
Completion Depth 35.1 m
Date Drilled August 6, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- black, organic, rootlets, damp							
1		SILT (FILL)	- medium to dark brown, some clay and sand, pieces of glass, coal particles, rootlets, damp, mainly cohesionless							
2										
3	1	CLAY (FILL)	- medium to dark brown, silty, sandy, hard, pebbles to 20 mm, pieces of brick, damp, cohesive		▥					
4					▥		15.0		>500	
5		CLAY TILL (FILL)	- medium to dark brown, silty, sand pockets, hard, pebbles to 25 mm, damp, cohesive		■				>500	
6	2		- medium brown, stiff, medium plasticity, damp, cohesive		☒	11	19.6			
7										
8			- dark greyish brown, stiff, low to medium plasticity, pieces of brick, calcareous, damp to moist, cohesive		▥		24.6		180	
9	3		- sand and silt pockets, pieces of concrete		■				210	
10			- organic, piece of coal to 30 mm		☒	11	25.2			
11										
12										
13	4	CLAY	- light to dark brown, sand lenses, stiff, medium to high plasticity, piece of steel, rootlets, moist, cohesive		▥		27.2		290	
14										
15					☒	12	28.7			
16	5									
17										
18			- light to medium brown, very silty, sand pockets, firm, organic silt pockets, moist, cohesive		▥		32.6		80	
19	6									
20					☒	11	32.0			
21										
22										
23	7		- medium brown, very silty, sandy clay pockets, stiff, trace of pebbles, piece of asphalt, moist, cohesive		▥		31.5		160	
24										
25					☒	13	33.5			
26	8									
27										
28			- light to medium brown, silty, stiff, pebbles to 5 mm, trace of organics, moist, cohesive		▥					
29	9				▥		30.3		180	

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Drawing No. B-15

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-14
Surface Elevation 659.0 m (CITY)
Completion Depth 35.1 m
Date Drilled August 6, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY	- light to medium brown, silty, very stiff, organic pockets		☒	19	28.8			
31										
32	10									
33			- medium brown, trace of organics, damp to moist, cohesive							
34		SILT	- dark grey to black, clayey, some sand, very stiff, organic, damp, mainly cohesive		▥		27.6		200	
35			- black, sandy, clay pockets, trace of pebbles, damp		☒	27	31.5			
36	11									
37		CLAY	- medium to dark grey, silty, hard, pebbles to 25 mm, damp, cohesive						410	
38			- light to medium brown, grey sand pockets, very stiff, damp, cohesive		▥		24.8		280	
39	12									
40			- light brown, silty clay pockets, very stiff, damp, cohesive		☒	19	24.1			
41			- greyish brown, black organic silt layers, cohesive							
42	13	CLAY (TILL)	- medium to dark brown, sandy, silty, very stiff, pebbles to 20 mm, pieces of coal, low to medium plasticity, damp, cohesive							
43					▥		20.3		310	
44			- pebbles to 15 mm, low plasticity							
45					☒	37	14.6			
46	14									
47		CLAY SHALE	- dark brownish grey, silty, K1 to K3 hardness, brecciated, damp							
48										
49	15		- dark grey to black, carbonaceous, K3 hardness, blocky		▥		25.7			
50					☒	40	21.8			
51										
52	16									
53			- dark grey, silty, K3 hardness, grey sandstone pockets, faint horizontal bedding							
54					▥		24.1		>500	
55	17	SANDSTONE	- light grey, silty, K3 hardness, fine grained, homogeneous		☒	52	16.0			
56			START ROCK CORING							
	18									

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Drawing No. B-15

Sheet 2 of 4

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-14

Depth Interval 17.0-27.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		SANDSTONE	- light grey, silty, K2 hardness, fine grained, grey clay pockets	- massive, homogeneous fabric				
57			- medium brown soft silt lens, rootlets, moist			75 180 45 180	67	57
58	18							
59								
60			- K2 hardness, grey clay laminations - light brown iron stains	- massive, homogeneous fabric with some horizontal bedding				
61							100	100
62	19		- K4 to K5 hardness, coal stringers	- massive, horizontal bedding				
63						895 325		
64			- SILTSTONE, light brownish grey, K2 hardness, very fine grained, coal stringers					
65	20		- light grey, very silty, K2 hardness, fine grained, coal stringers, clay laminations, siltstone inclusions	- massive, homogeneous fabric with bedding planes at 20° to horizontal		555	91	91
66								
67							0	0
68	21							
69			- light grey, K1 to K2 hardness, friable, fine grained, clay laminations	- massive				
70			- CLAY SHALE (100mm), brownish grey, K2 to K3 hardness	- massive, blocky microstructure (3-5 mm)		70	87	80
71						730		
72	22							
73							26	26
74		CLAY SHALE	- dark brownish grey, silty, K3 hardness	- massive, blocky microstructure (3-5 mm)				
75	23					130		
76				- brecciated zone (100 mm)		190		
77		COAL	- black, brittle, K6 hardness, wet fracture planes	- fractured, blocky (<10mm)			87	85
78	24	CLAY SHALE	- dark brownish grey, silty, K3 to K4 hardness, coal particles	- massive, homogeneous fabric with faint horizontal bedding		120 635 155 15		
79			- medium to dark grey, K4 hardness, slightly bentonitic, high plasticity	- massive, blocky microstructure				
80			- SILTSTONE, (150mm), light brownish grey, K7 hardness	- fractured irregular				
81			- siltstone bands	- faint horizontal bedding			22	17
82	25							
83						230 75		
84			- dark grey, silty, K3 to K4 hardness, siltstone inclusions	- massive, horizontal to slightly inclined bedding				
85	26							
86			- SILTSTONE, (150mm), medium grey, some clay and sand, K3 hardness, coal stringers	- massive, horizontal bedding				
87			- K4 to K5 hardness, coal lenses	- massive, homogeneous fabric with fine horizontal bedding		810 275	100	100
88	27		- thin coal lens (25mm), blocky to powdery			285		

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Drawing No. B-15

Sheet 3 of 4

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-14

Depth Interval ______

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
89		INTERBEDDED SANDSTONE AND SILTSTONE	- light grey sandstone, silty, K4 hardness/medium grey siltstone K4 to K5 hardness	- massive, horizontal bedding				
90								
91							100	100
92	28					1370		
93			- dark grey to black, carbonaceous zone (75 mm) - CLAY SHALE, (150mm), brownish grey, K4 to K5 hardness					
94								
95	29		- thin coal lens				101	101
96		CLAY SHALE	- dark brownish grey, silty, K4 to K5 hardness, trace of bentonite	- massive, homogeneous fabric				
97						1380		
98	30			- some slickensided fracture planes				
99			- SILTSTONE, (75mm), medium brown, K6 hardness			225 160 75 125 80	94	82
100		SANDSTONE	- light grey, silty, K5 hardness, fine grained, coal lenses	- massive, homogeneous fabric				
101	31		- fine to medium grained			620		
102								
103								
104	32		(no recovery below 31.1 m)				0	
105								
106							0	
107								
108	33							
109								
110								
111	34						0	
112								
113								
114								
115	35							

END OF BOREHOLE (35.1 metres)

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Drawing No. B-15

Sheet 4 **of** 4

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-15
Surface Elevation 656.3 m (CITY)
Completion Depth 32.3 m
Date Drilled August 12-13, 1980
Logged By RRH (field); ______ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- dark brown to black, organic, rootlets, dry to damp							
1		SILT (FILL)	- dark brown, some clay and sand, piece of glass, trace of rootlets, damp, mainly cohesionless							
3	1		- piece of wood							
			- CLAY, (100mm), medium brown-grey, silty, hard, pieces of coal and bricks, rootlets, dry to damp		▥		18.0		>500	
4			- SAND, (375mm), light brown, silty, pieces of coal and brick, rootlets, dry, cohesionless		■		8.3			
5		CLAY (FILL)	- medium brown, silty, firm, pebbles to 5 mm, pieces of glass, rootlets, dry to damp, cohesive		☒	6				
8			- medium to dark brown, silty, sandy, very stiff							
9					▥		21.8		260	
	3				■				250	
10			- SAND, (450mm), dark brown, silty, some clay, pieces of coal, steel and wood, trace of pebbles, dry to damp, cohesionless		☒	4	22.0			
13	4				▥		15.7			
14		SAND (FILL)	- dark brown, silty, fine grained, pieces of glass and coal, pebbles, dry to damp, cohesionless		◩					
16	5		- loose		☒	6	23.0			
17		CLAY (FILL)								
18			- SILT, (450mm), dark brown to black, organic, stiff, pieces of brick, damp, mainly cohesionless		▥		48.5		160	
19	6		- dark brown to black, silty, sandy, stiff, organics, trace of rootlets							
20					☒	9	36.8			
23	7		- grey pockets, very stiff, pieces of ceramics, moist, cohesive		▥		28.3		240	
24			- brownish grey, very sandy, stiff, slightly organic, piece of brick		☒	7				
28			- stiff, pieces of wood and glass, trace of rootlets		▥		36.9		180	
29	9		- large pieces of brick							

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Drawing No. B-16

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-15
Surface Elevation 656.3 m (CITY)
Completion Depth 32.3 m
Date Drilled August 12-13, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30			- wet cinders, pieces of coal, cohesionless - grey, stiff, medium plasticity, slightly organic, damp to moist, cohesive		☒	10	35.4			
33	10		- SILT, (50mm), black, extremely organic, rootlets, pieces of brick and wood, damp to moist							
34		CLAY	- medium greyish brown, silty, very stiff, pieces of coal, medium to high plasticity, moist		▥		32.7		210	
35					☒	16	28.1			
38			- high plasticity - brownish grey, sandy, stiff, trace of pebbles, wet		▥		29.0		180	
39	12		- SAND, (125mm), brownsih grey, silty, clayey, medium grained, wet							
40			- brownish grey, clayey sand pockets, very stiff, medium plasticity, moist, mainly cohesive		☒	22	18.6			
43			- SILT, medium grey, sand lenses, stiff, wet, mainly cohesive		▥				160	
44			- silty, very stiff, low to medium plasticity, pebbles to 5mm, damp to moist, cohesive				19.3		270	
45					☒	16				
47		CLAY (TILL)	- dark grey and brown, silty, very stiff, pebbles to 5mm, low to medium plasticity, damp							
48	15				▥		18.2		230	
49			- dark brownish grey, pebbles to 2 mm							
50			- numerous coal lenses		☒	21	22.3			
53			- dark grey, silt and sand lenses, very stiff, pebbles to 25 mm, low to medium plasticity, damp to moist, cohesive		▥		18.0		230	
55	17				☒	27				
58			- dark brownish grey, silty, hard, shale inclusions, damp		▥		25.1		400	
	18	COAL	- black, highly fractured, blocky fragments (1mm), powdery, wet							

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-15
Surface Elevation 656.3 m (CITY)
Completion Depth 32.3 m
Date Drilled August 12-13, 1980
Logged By RRH (field); ______ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
60 61 62	19	CLAY SHALE	- medium to dark grey, silty, K1 to K2 hardness, coal particles, massive, brecciated		▥ ☒	41	21.8			
63 64			- interbedded sandstone layers, thin organic seams, massive, horizontal bedding		▥		21.3			
65	20	SANDSTONE	- light grey, silty, K1 hardness, fine to medium grained, massive, homogeneous		☒	33	19.8			
66										
67 68	21	CLAY SHALE	- medium to dark grey, silty, K1 to K2 hardness - dark brown to black, K1 to K2 hardness, carbonaceous, coal lenses, fissile		▥		30.6			
69		COAL	- black, highly fractured, blocky fragments (2-5mm), K6 hardness, wet		☒	40 (100mm)	56.4			
70 71 72	22	CLAY SHALE								
73 74			- medium grey, silty, K1 to K2 hardness, fractured, brecciated, dry START ROCK CORING		☒	75 (125mm)	17.3			

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
75	23	INTERBEDDED CLAY SHALE SANDSTONE AND SILTSTONE	- CLAY SHALE, medium to dark grey, K1 to K2 hardness, damp to moist	- massive, brecciated				
76 77 78	24		- SANDSTONE, light grey, silty, K3 hardness, fine grained - CLAY SHALE, dark grey, K3 hardness - SILTSTONE, medium grey, K3 hardness - thin slickensided clay shale lens	- massive, homogeneous fabric - massive, fractured	13.6 17.5	900 460	99	99
79 80 81	25		- light grey sandstone lenses - CLAY SHALE, dark brownish grey, silty, K3 to K4 hardness	- massive, blocky microstructure	14.8	1380	101	101
82 83			- thin beds of siltstone and sandstone, K3 hardness		13.4			
84 85	26		- SILTSTONE, medium grey, K3 hardness, coal stringers - CLAY SHALE, dark grey, K3toK4 hardness	- massive, irregular	14.0			

ROCK CORE LOG

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Drawing No. B-16

Sheet 3 of 4

Project GRIERSON HILL STABILIZATION STUDY

Project No. 106-2672

Hole No. 80-15

Depth Interval 26.0-32.3 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-86 -87 -88	27	INTERBEDDED CLAY SHALE SANDSTONE AND SILTSTONE	- thin beds of siltstone and sandstone, K3 to K4 hardness, coal stringers - SANDSTONE, light grey, K4 hardness, medium grained, clay laminations	- massive, horizontal bedding - massive, homogeneous fabric	14.5 13.2	1355	99	99
-89 -90 -91	28	CLAY SHALE	- dark grey, silty, K3 to K4 hardness, coal specks - dark brown to black, silty, K5 hardness, carbonaceous, coal lenses	- massive, homogeneous fabric with some slickensided fracture planes - irregular, blocky microstructure, massive, homogeneous	14.3 15.1 12.6	90 35 540 210 55 400	97	84
-92 -93 -94 -95	29	SANDSTONE	- medium greyish brown, silty, K5 hardness, fine grained, coal streaks - light grey, K3 to K4 hardness, fine to medium grained	- massive, faint horizontal bedding			91	91
-96 -97 -98	30		- numerous coal laminations - SILTSTONE, medium grey, K4 hardness - CLAY SHALE, dark brown to black,	- massive, horizontal bedding	10.4 15.5	1240		
-99			K4 to K5 hardness, carbonaceous, coal lenses	- massive, fissile fabric		510	95	82
-100		COAL	- black, brittle, K6 hardness, subangular fragments	- highly fractured, blocky (5 to 10 mm)	22.8	85 90 140		
-101	31	CLAY SHALE	- dark brown, carbonaceous zone - dark greenish brown bentonitic, K3 to K4 hardness	- massive, blocky microstructure		475		
-102		BENTONITE	- greenish grey, K2 hardness, coal stringers		21.1			
-103 -104	32	INTERBEDDED CLAY SHALE SANDSTONE ANDSILTSTONE	- SILTSTONE, dark brownish grey, K3 to K4 hardness - SANDSTONE, light grey, K3 hardness, fine grained, bentonite bands - CLAY SHALE, dark brownish grey, silty, K4 hardness, coal particles	- massive, homogeneous fabric with horizontal bedding - massive, homogeneous fabric	20.6	1155 40	100	97
-105 -106			- siltstone inclusions, K6 hardness, calcareous stains			175		
			END OF BOREHOLE (32.3 metres)					

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Drawing No. B-16

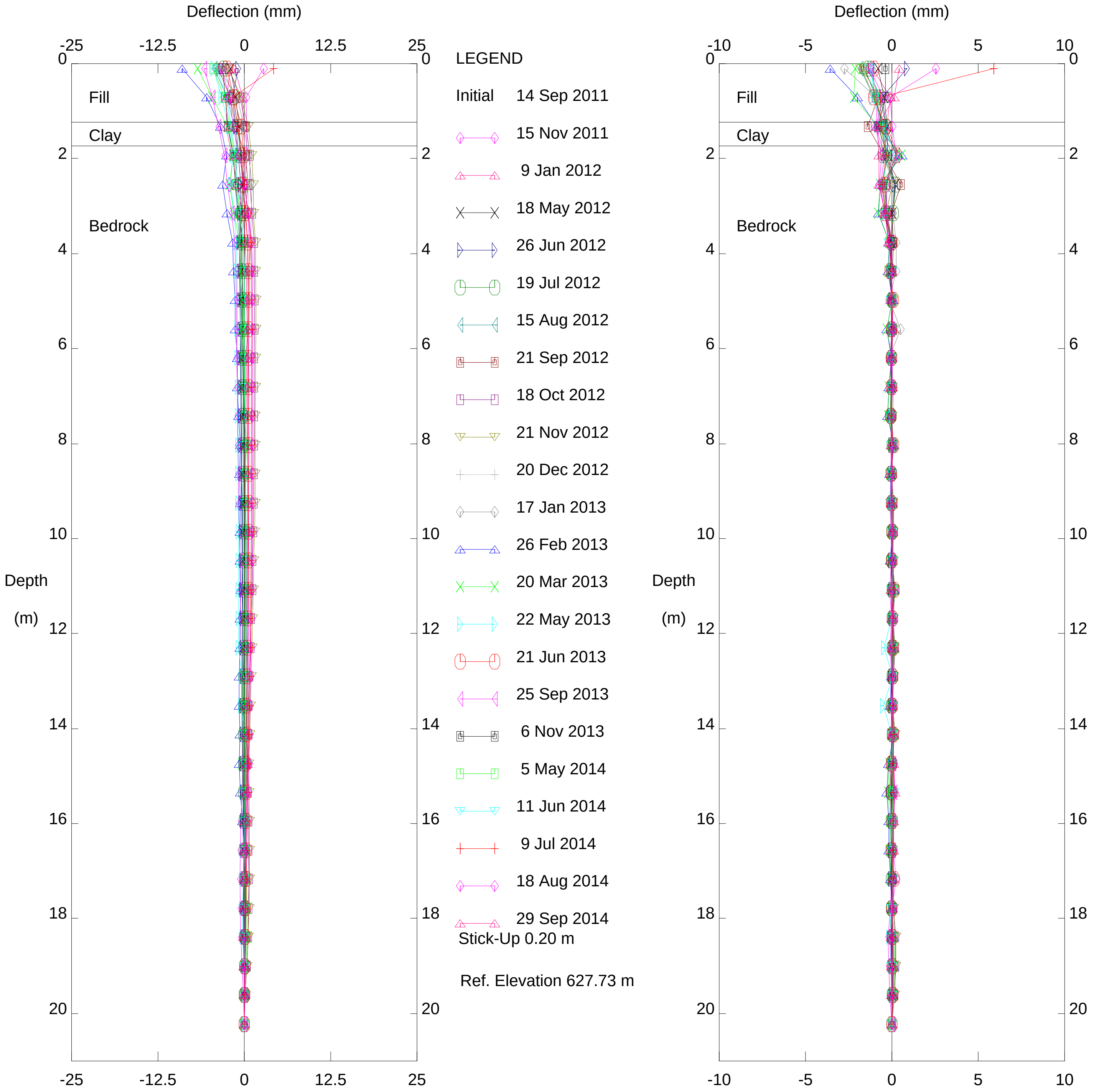
Sheet 4 of 4

THURBER

APPENDIX C

Plots of Slope Inclinometer Readings

Thurber Engineering Ltd.



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SE LRT Extension, Inclinometer SI10-4

N5934378.81 E34644.45

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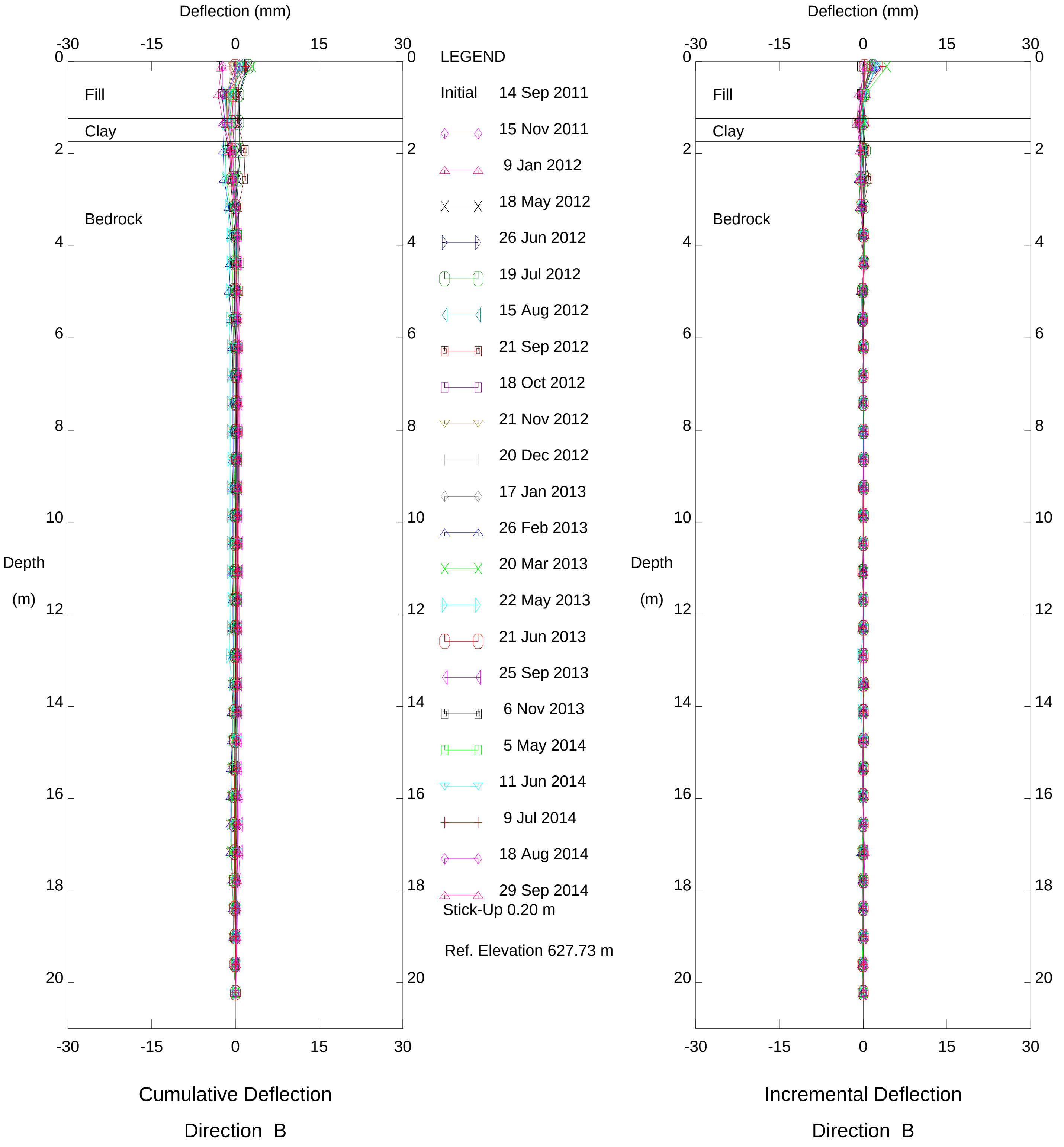
Thurber Engineering Ltd.



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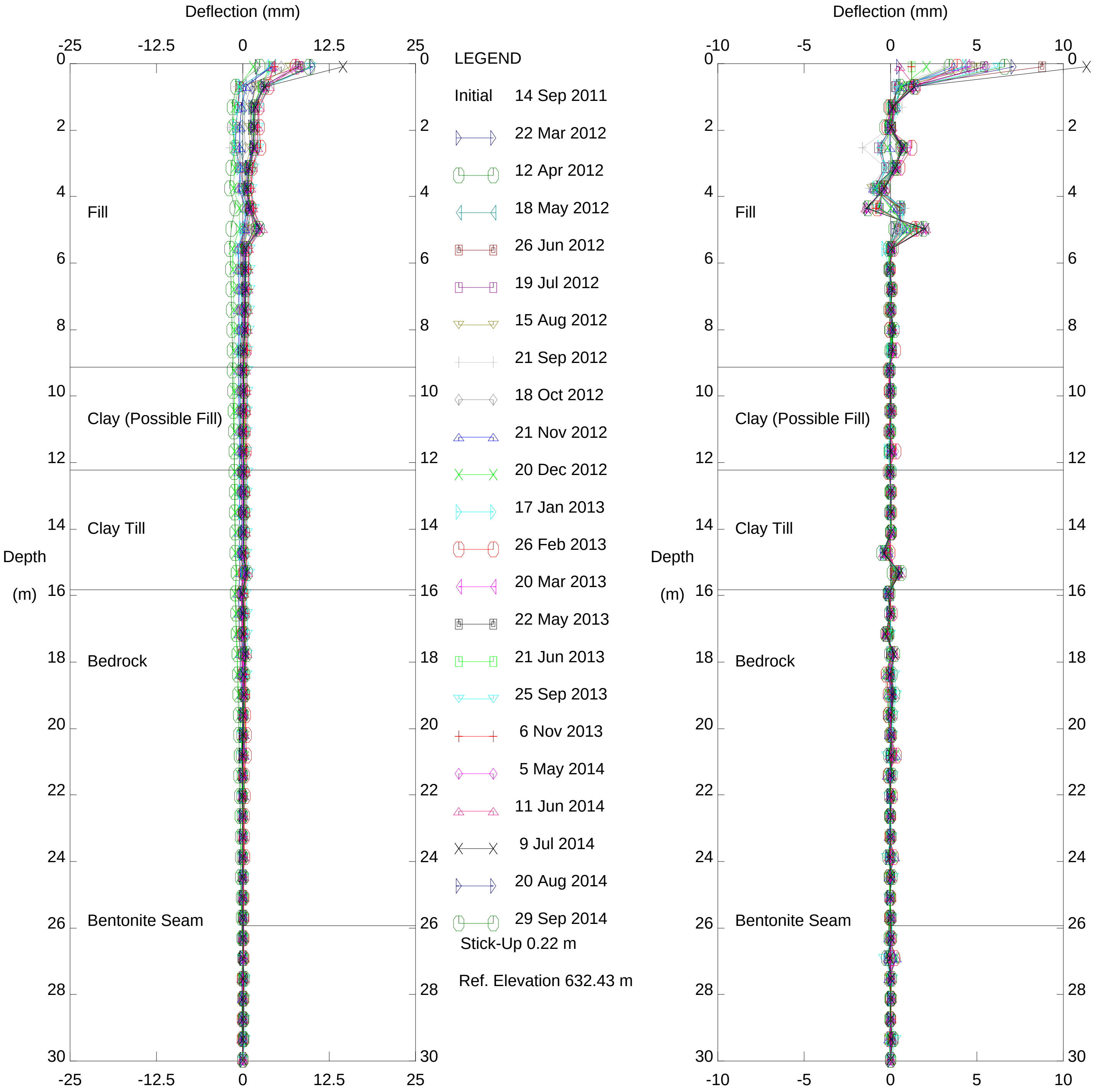

Cumulative Deflection

Direction A

Incremental Deflection

Direction A

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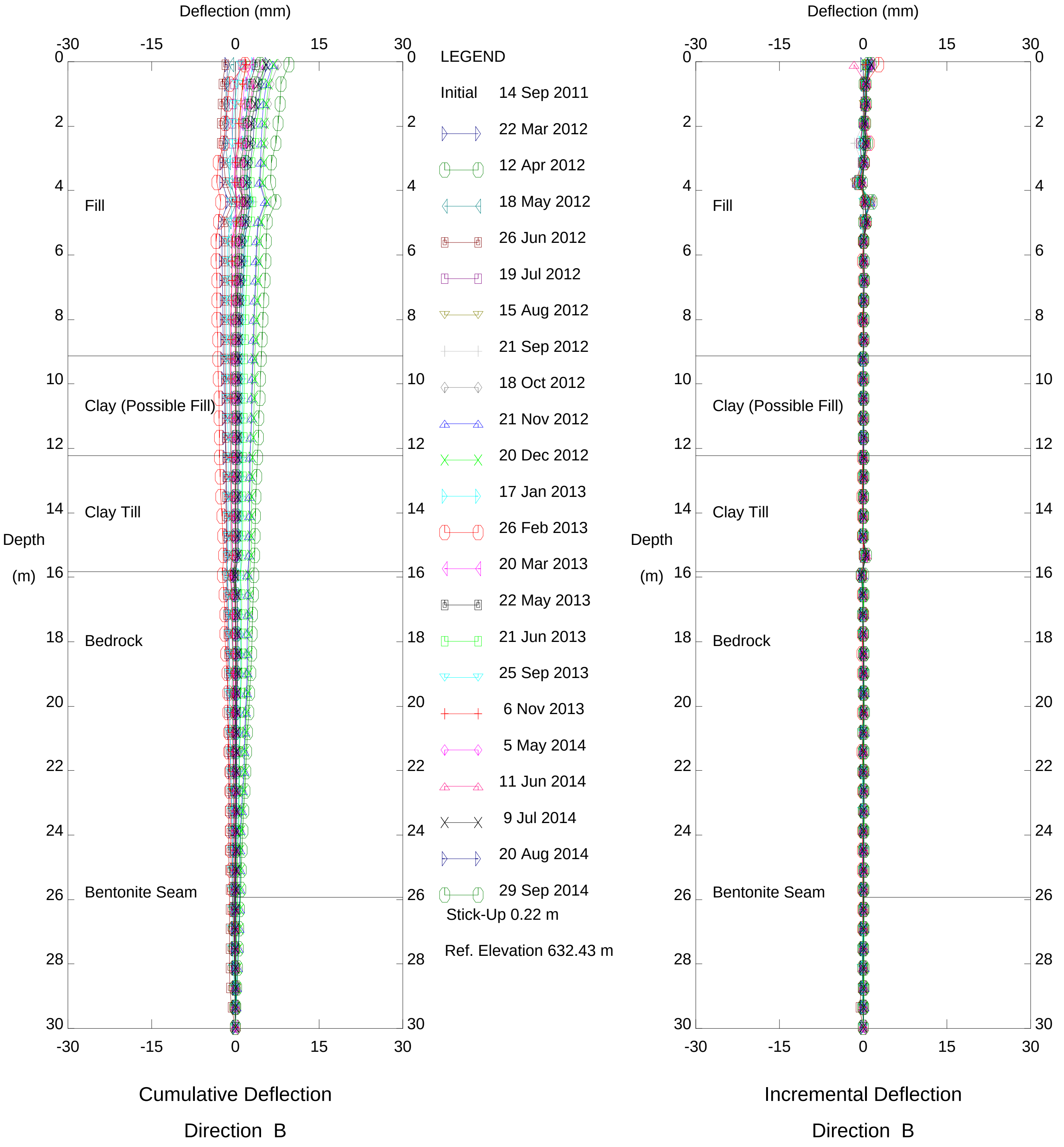
Thurber Engineering Ltd.



Stick-Up 0.22 m

Ref. Elevation 632.43 m

SE LRT Extension, Inclinometer SI10-5

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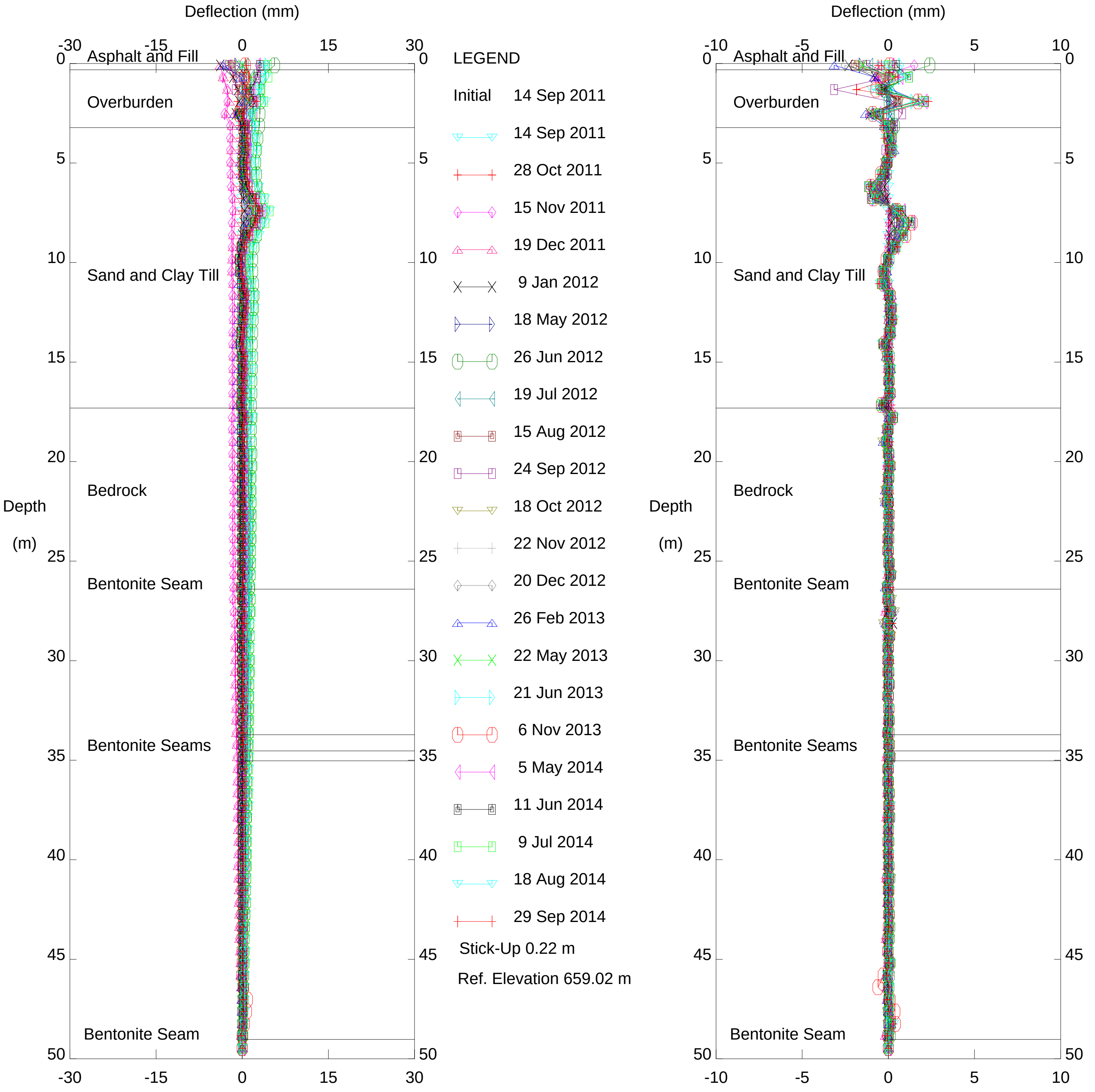

Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SE LRT Extension, Inclinometer SI 10-6

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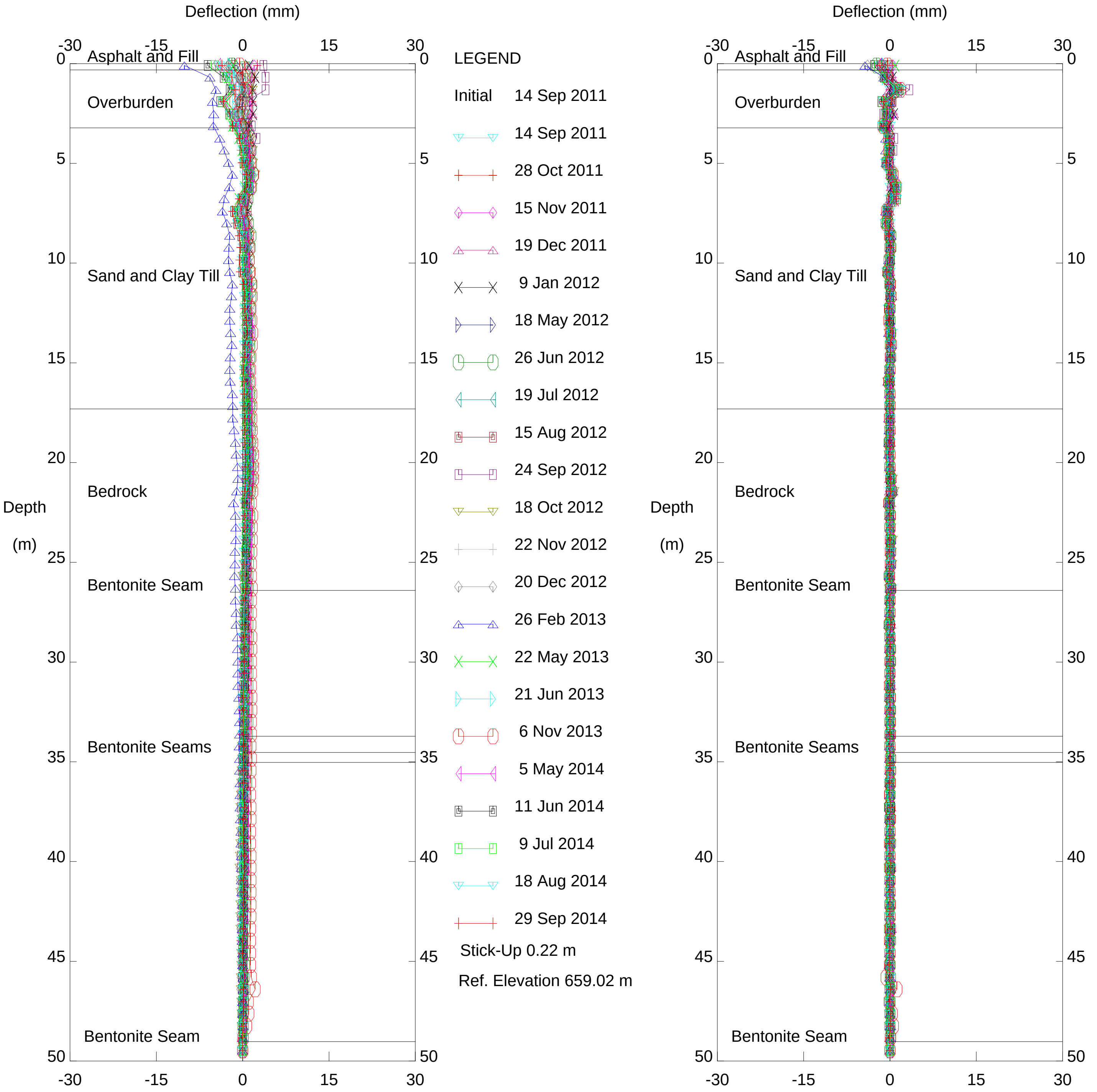

Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SE LRT Extension, Inclinometer SI 10-6

N5934491.68 E34660.77

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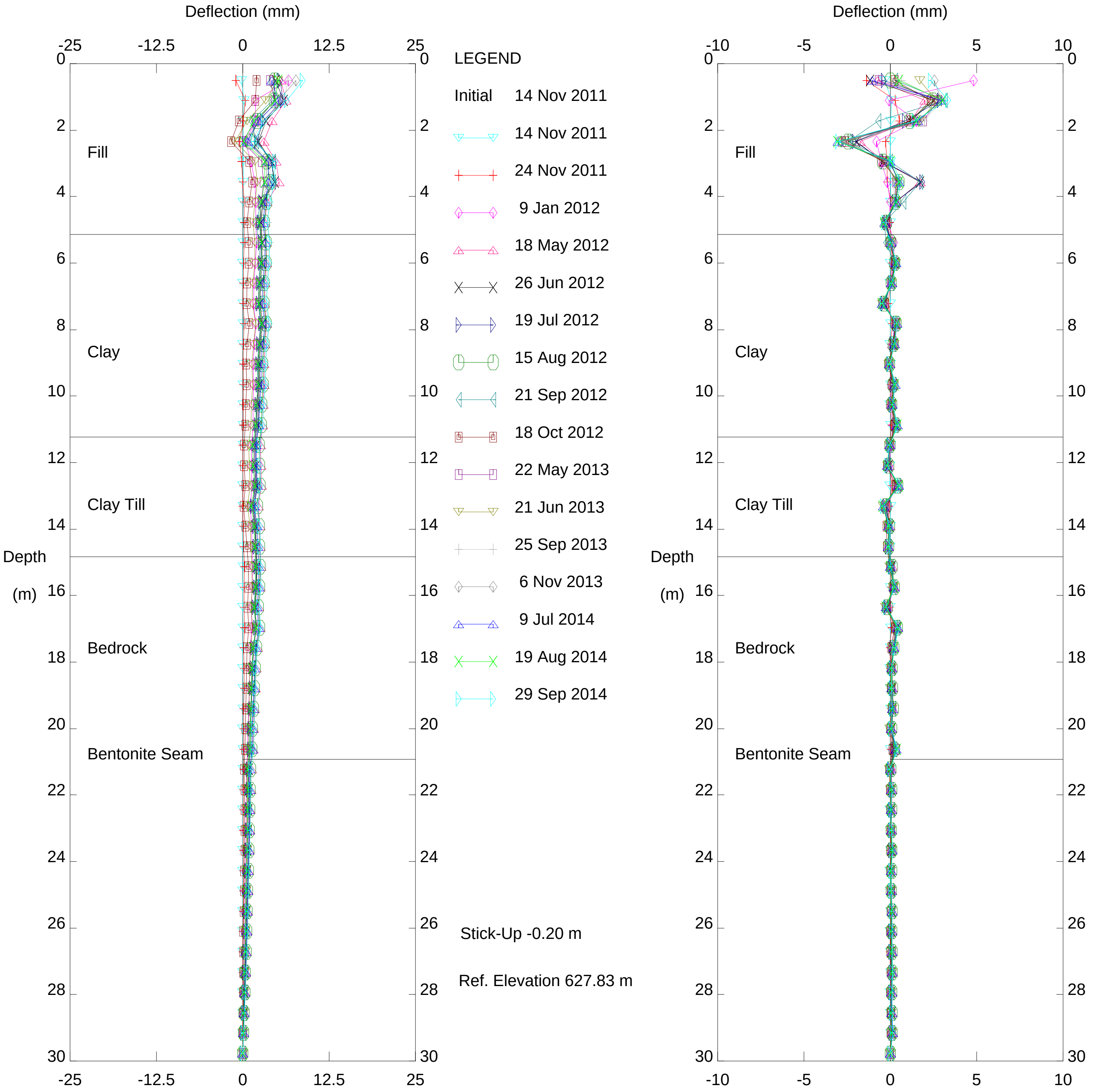
Thurber Engineering Ltd.



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SE LRT Extension, Inclinometer SI 11-17

N5934386.82 E34678.91

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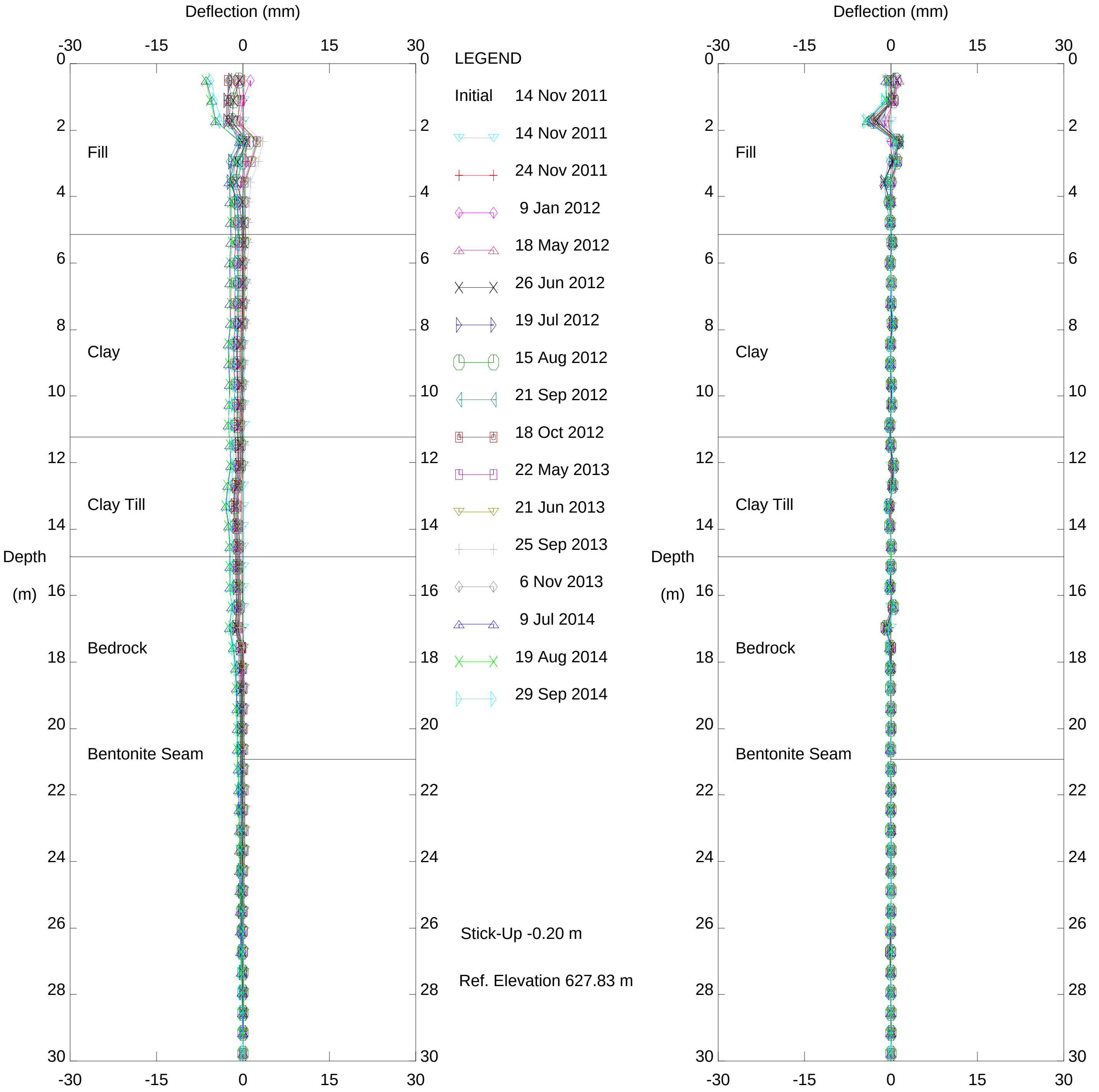
Thurber Engineering Ltd.



Stick-Up -0.20 m

Ref. Elevation 627.83 m

Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SE LRT Extension, Inclinometer SI 11-17

N5934386.82 E34678.91

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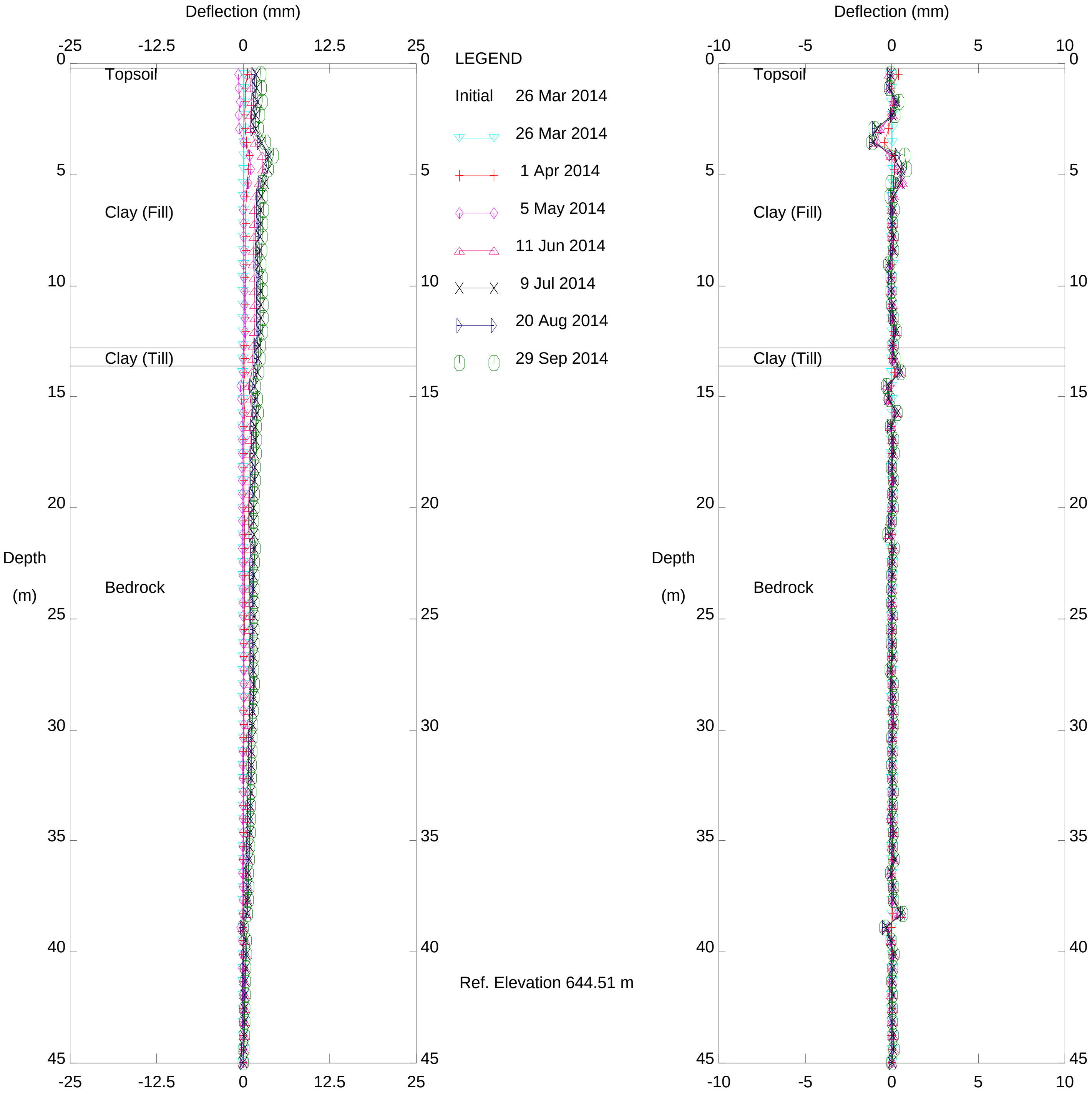
Thurber Engineering Ltd.



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SELRT, Inclinometer SI14-1

AECOM

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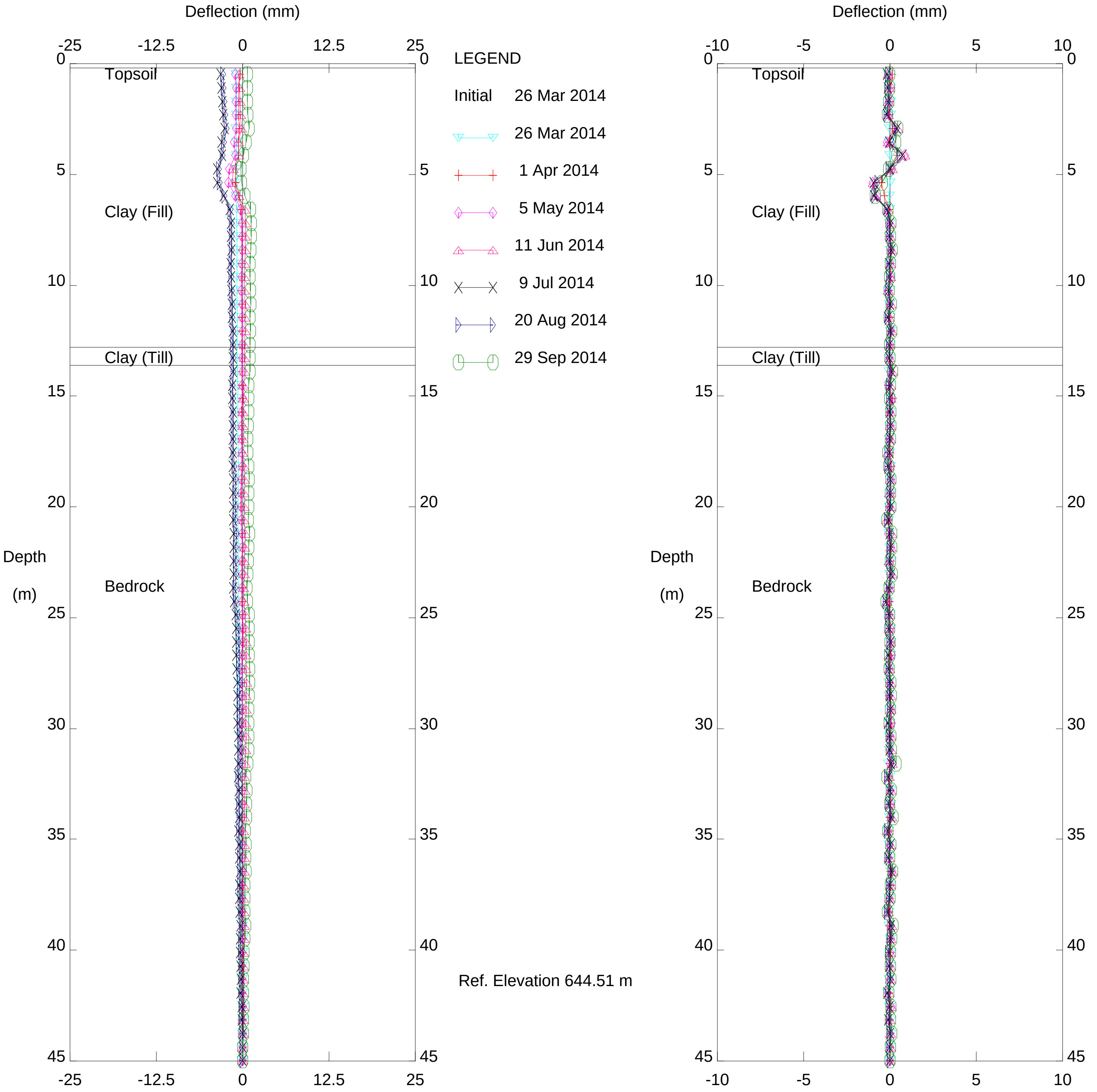
Thurber Engineering Ltd.



Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SELRT, Inclinometer SI14-1

AECOM

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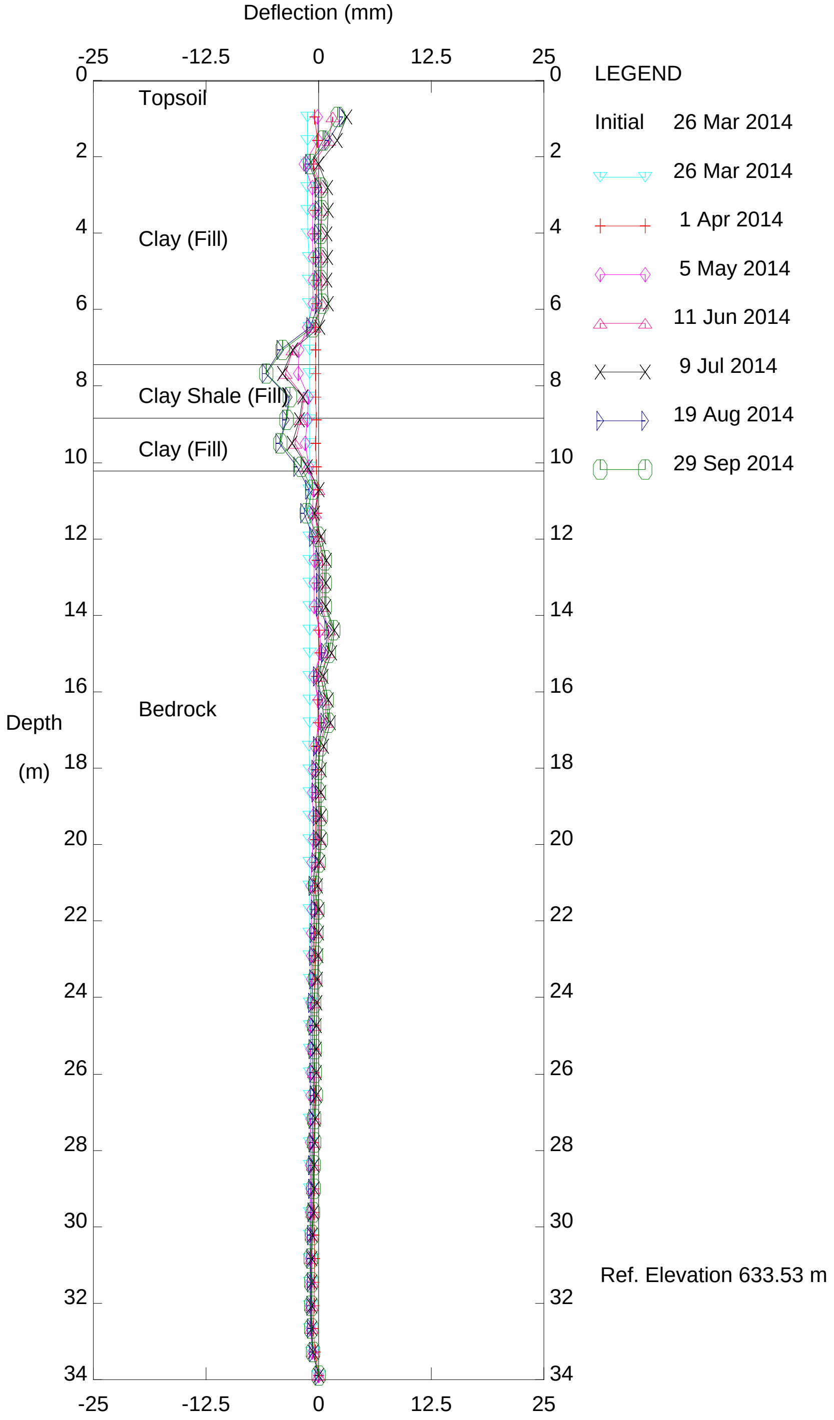
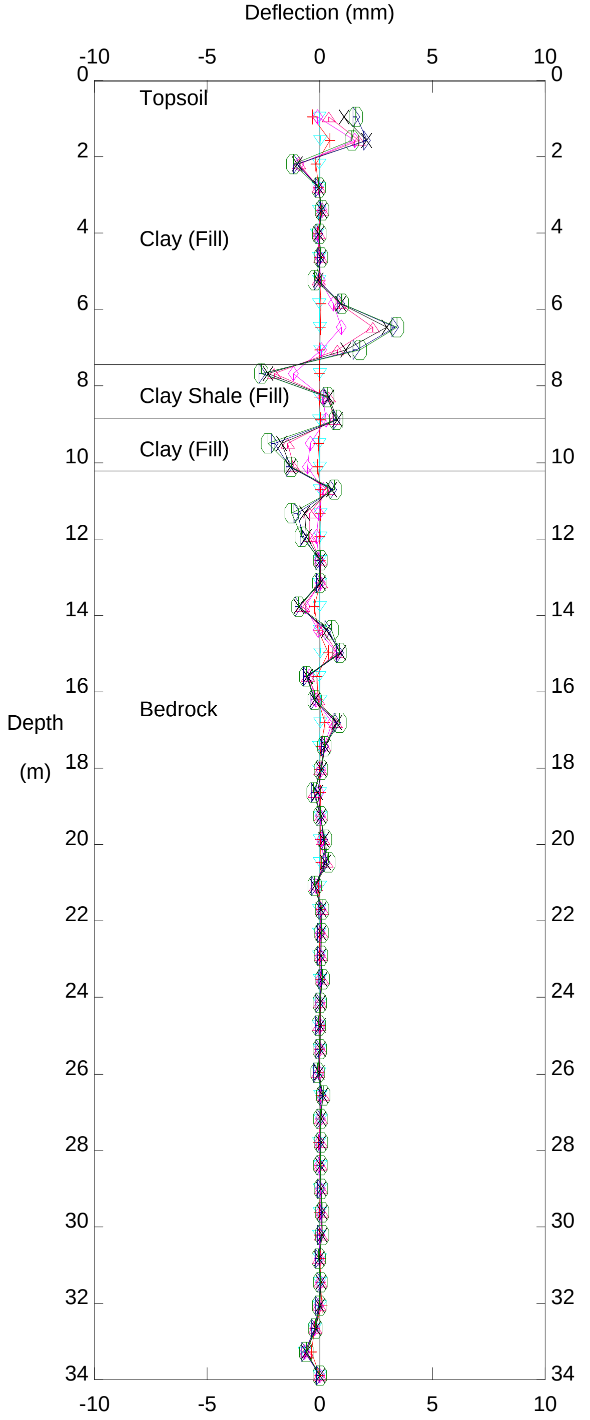
Thurber Engineering Ltd.



Ref. Elevation 633.53 m

Cumulative Deflection

Direction A



Incremental Deflection

Direction A

SELRT, Inclinometer SI14-2

AECOM

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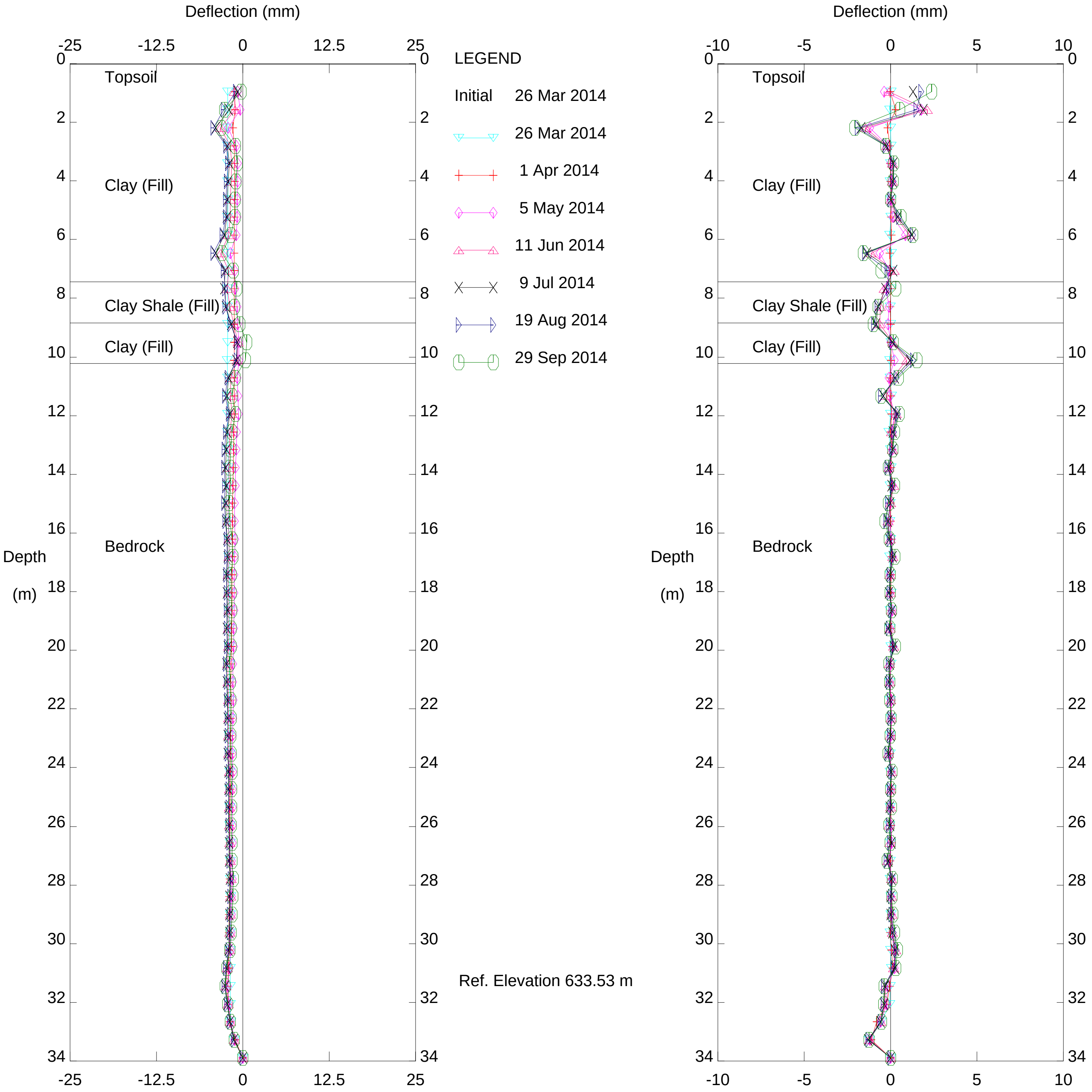
Thurber Engineering Ltd.



Ref. Elevation 633.53 m

Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SELRT, Inclinometer SI14-2

AECOM

H:\19\5438-68C Edm. SE LRT Extension - Geotech. Inv. - Slope\Instrument Readings\SI14-2.gtl

THURBER

APPENDIX D

Figures of Slope Stability Analyses

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

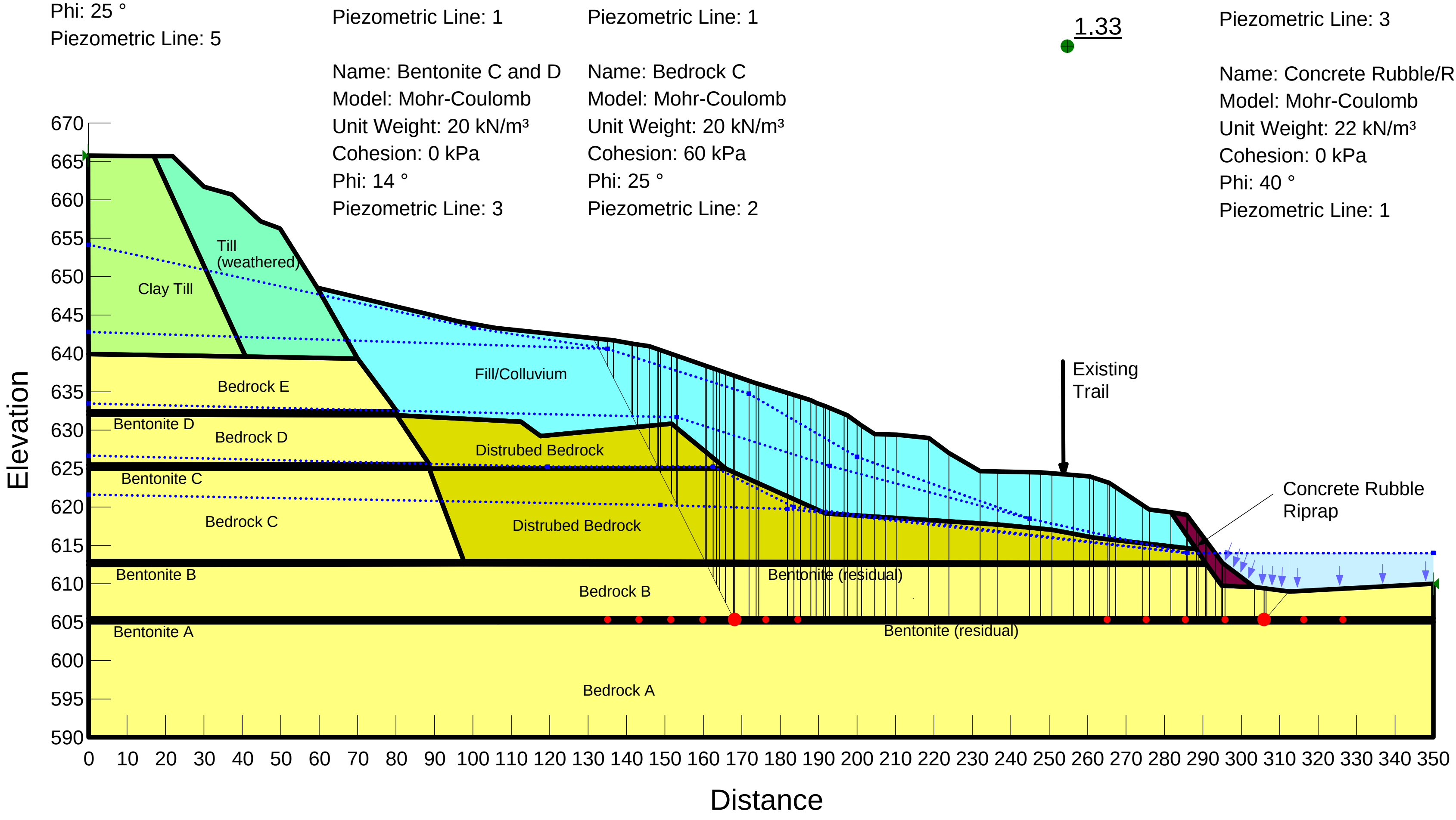
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section A-A_Current Conditions_Rev2_HER.gsz
Date: 9/6/2014 Time: 12:04:24 AM

SECTION A-A - FIGURE D1

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

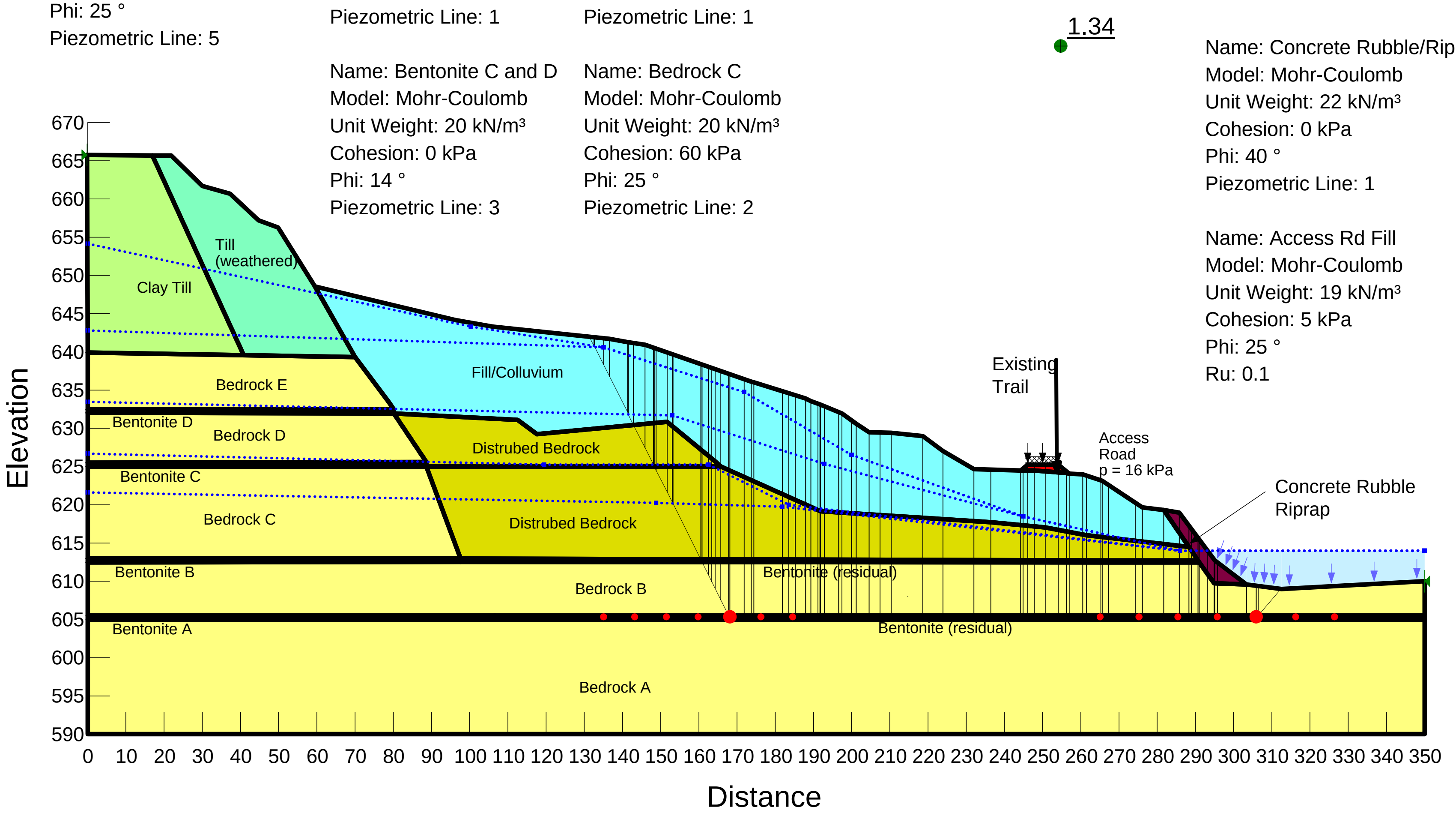
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section A-A_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/6/2014 Time: 12:16:09 AM

SECTION A-A - FIGURE D2

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

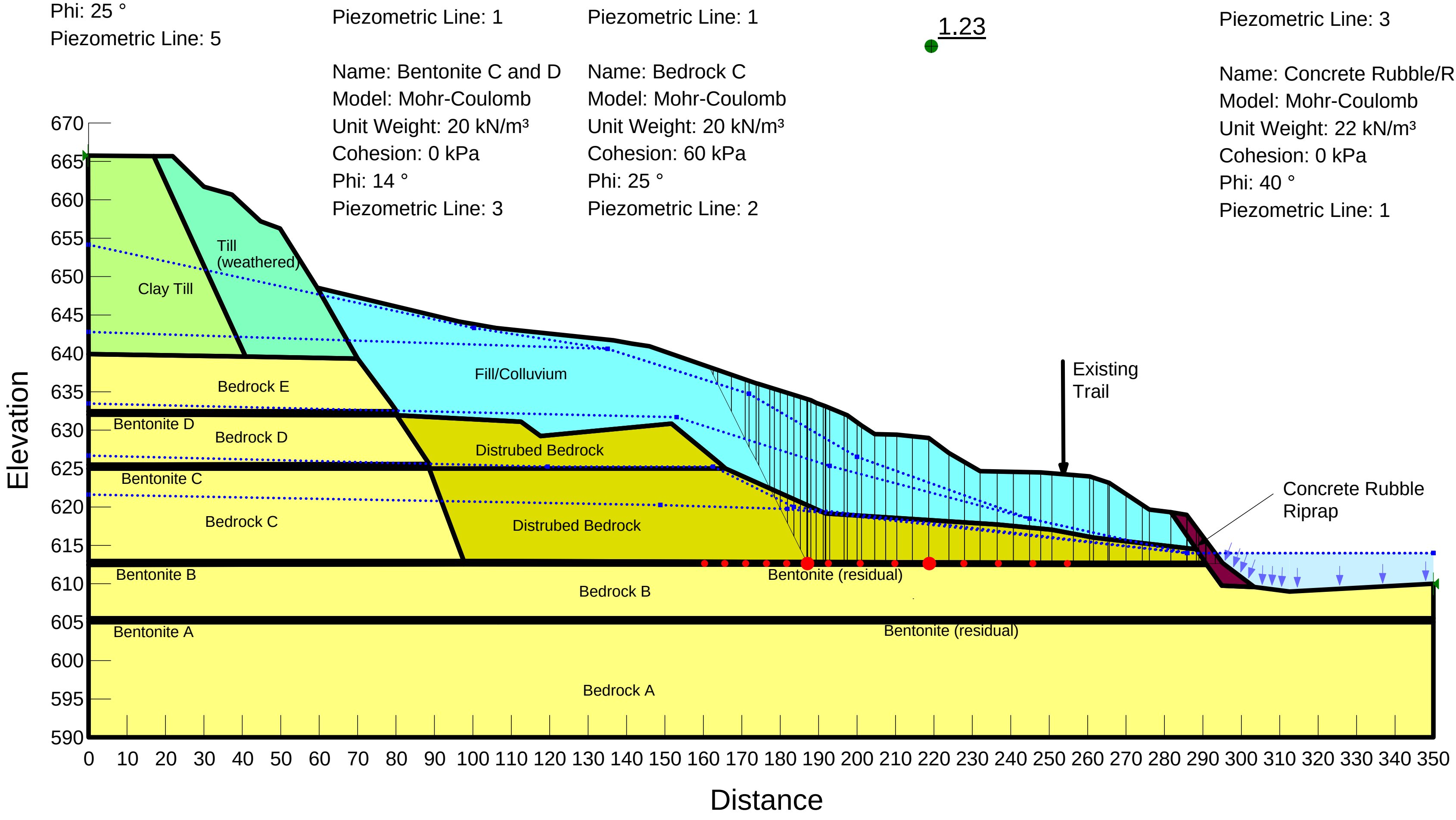
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m^3
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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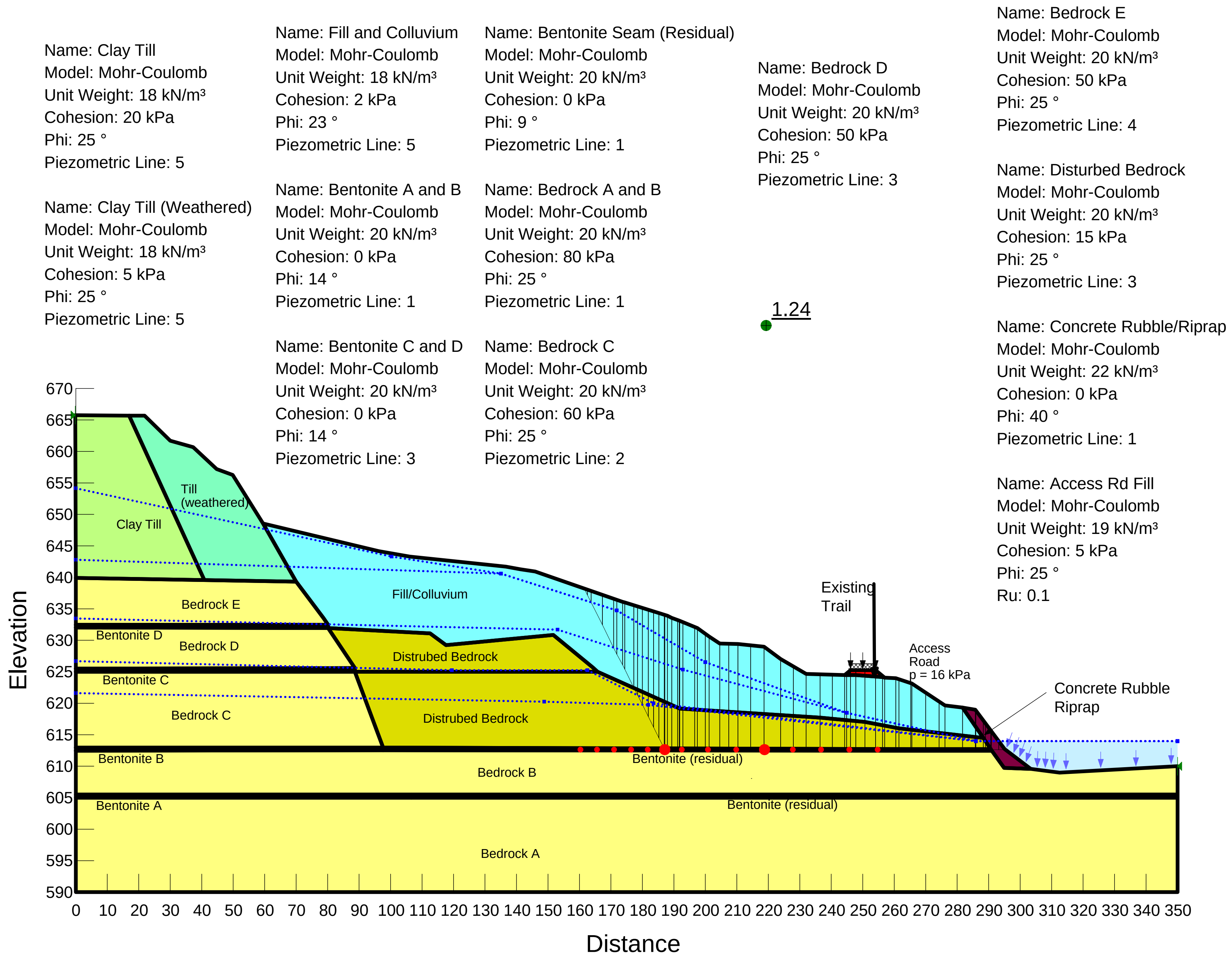
File Name: Section A-A_Current Conditions_Rev2_HER.gsz
Date: 9/6/2014 Time: 12:04:24 AM

SECTION A-A - FIGURE D3



Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1

Directory: H:\19\5438-102 Edmonton SE LRT Extention (Valley Line) - Procurement Stage\North Bank Access Road\Slope Stability Analysis\New Analysis_HER\Revision 2\
File Name: Section A-A_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/6/2014 Time: 12:16:09 AM

SECTION A-A - FIGURE D4

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

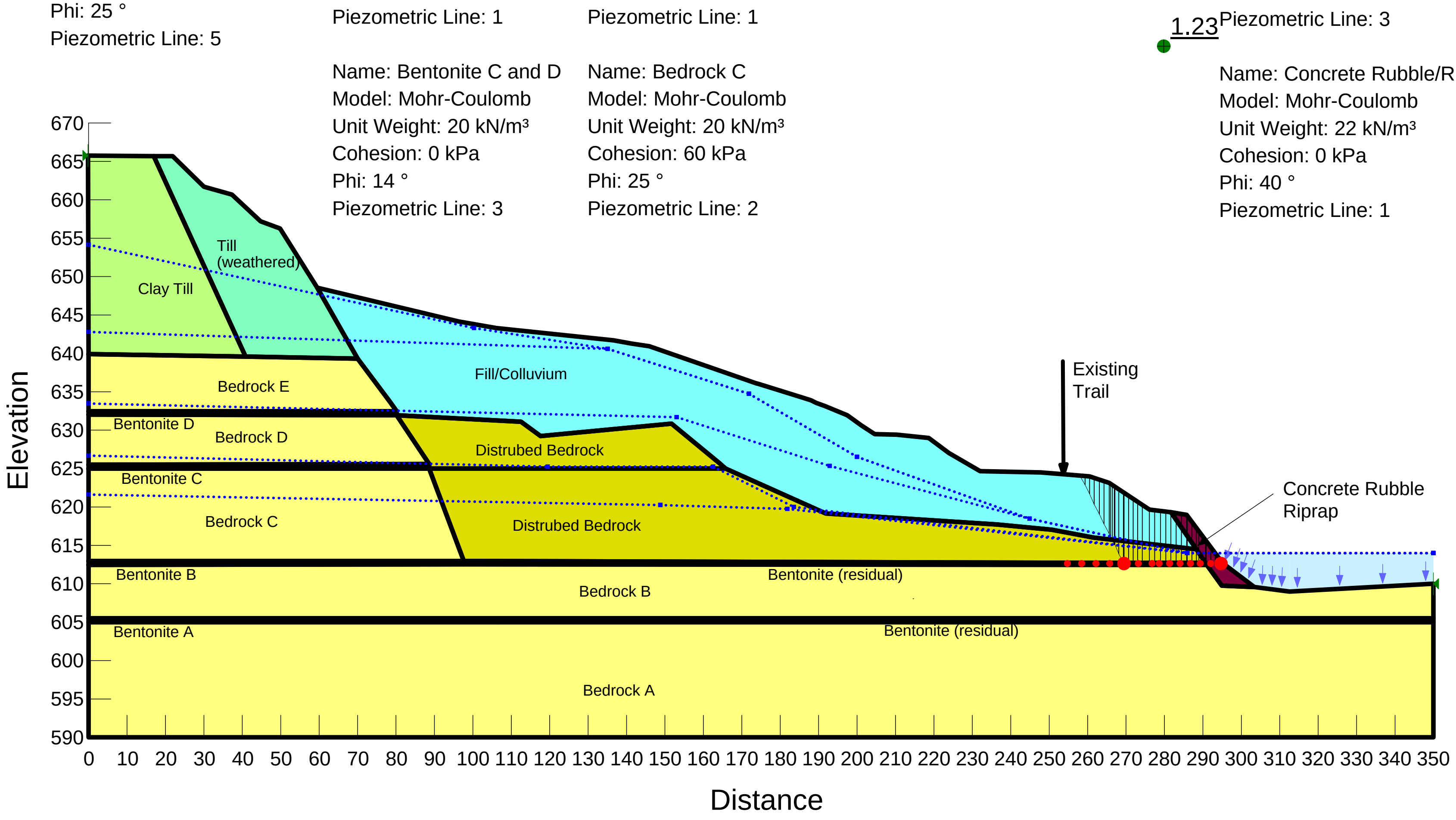
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m^3
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section A-A_Current Conditions_Rev2_HER.gsz
Date: 9/6/2014 Time: 12:04:24 AM

SECTION A-A - FIGURE D5

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

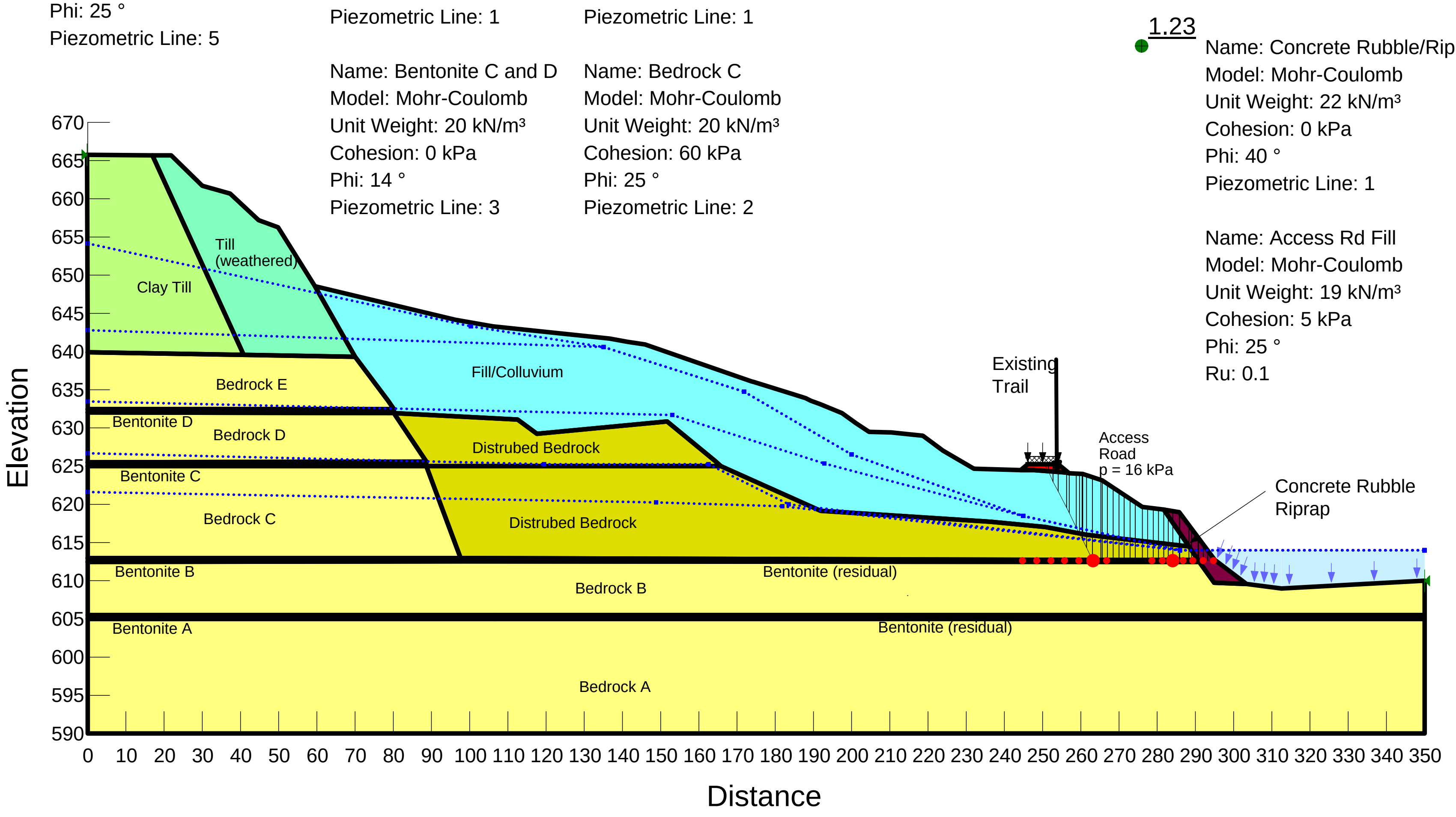
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m^3
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m^3
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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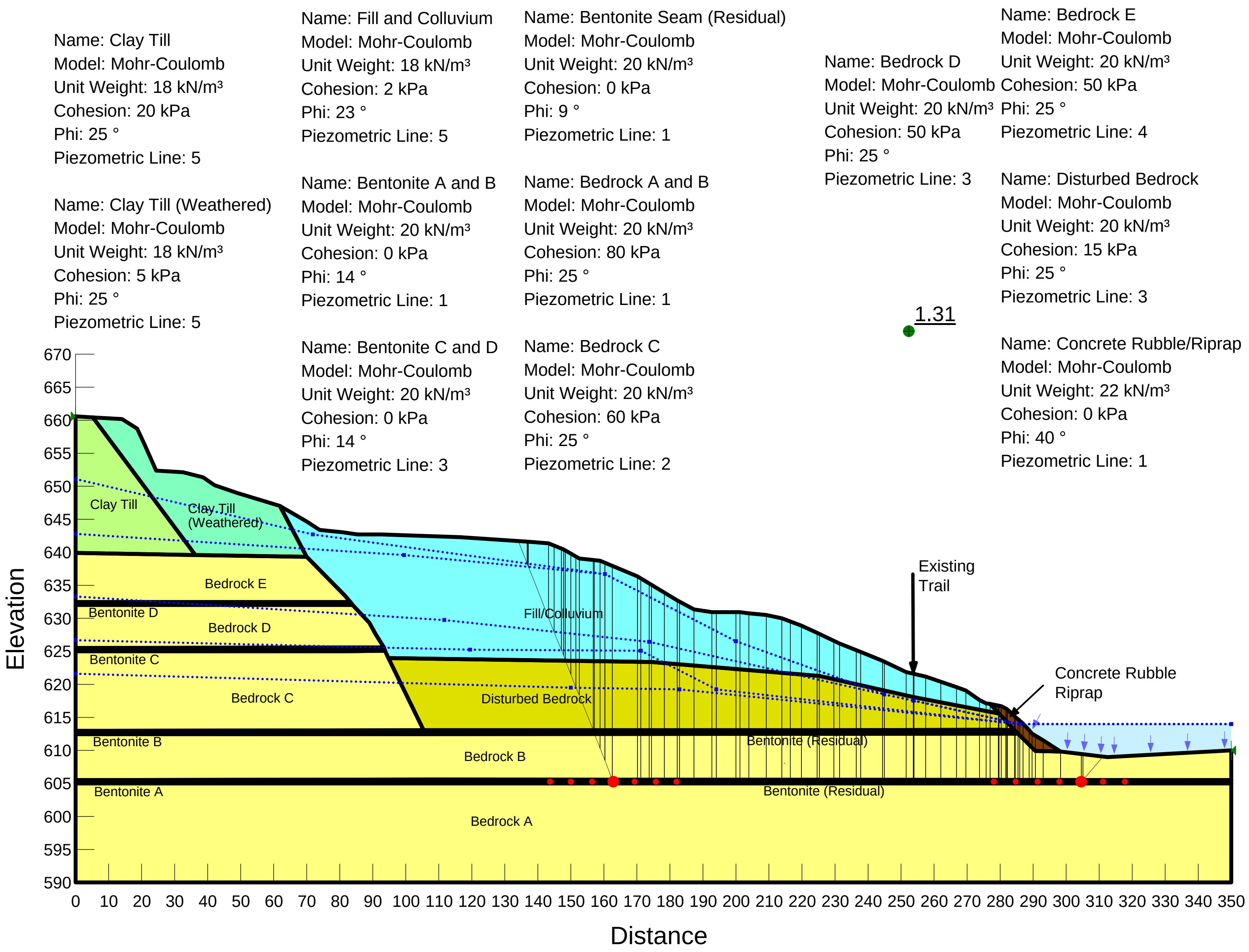
File Name: Section A-A_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/6/2014 Time: 12:25:11 AM

SECTION A-A - FIGURE D6



Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

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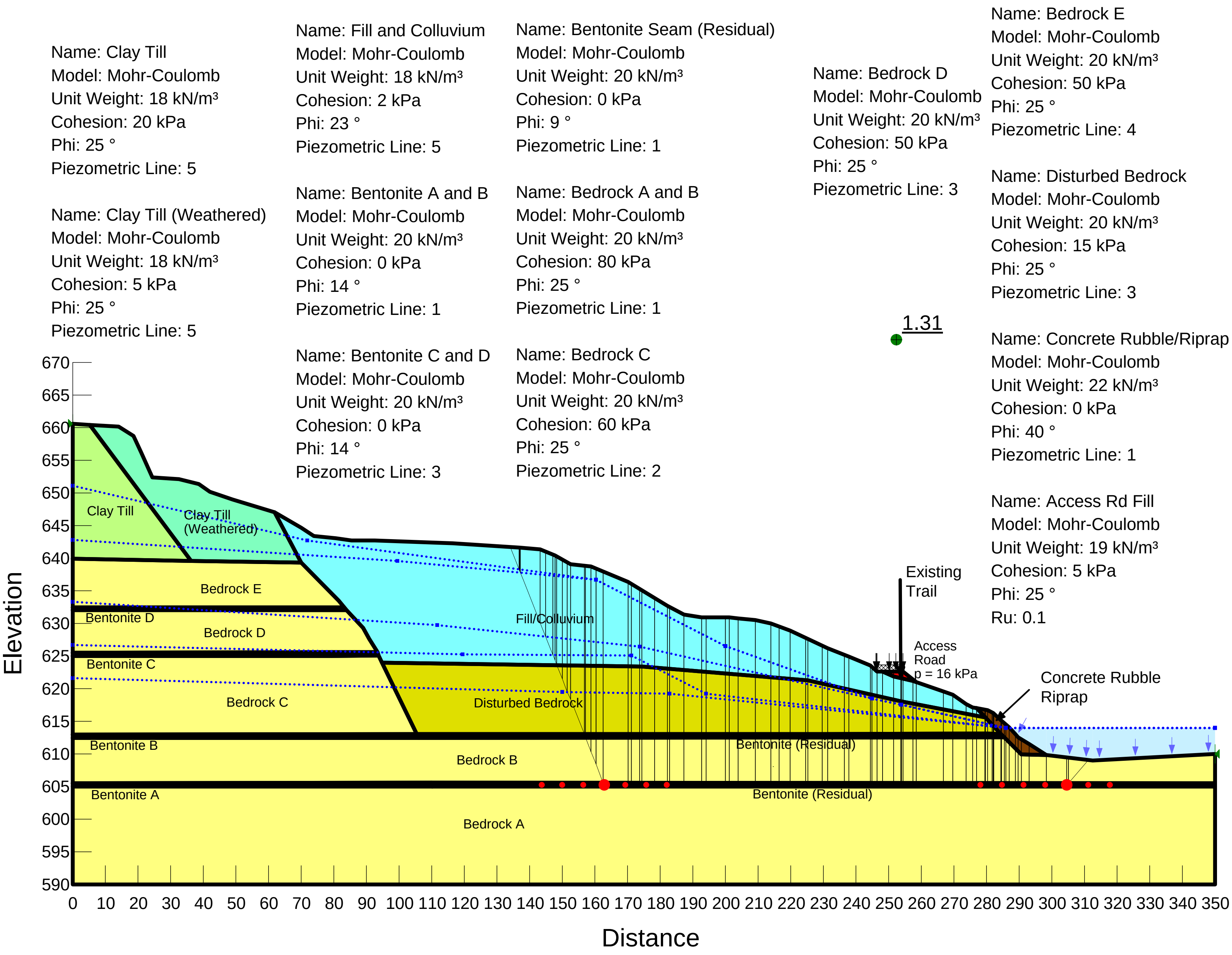
File Name: Section B-B_Current Conditions_Rev2_HER.gsz
Date: 9/5/2014 Time: 11:30:49 PM

SECTION B-B - FIGURE D7



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File Name: Section B-B_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/5/2014 Time: 11:37:02 PM

SECTION B-B - FIGURE D8

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m^3
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

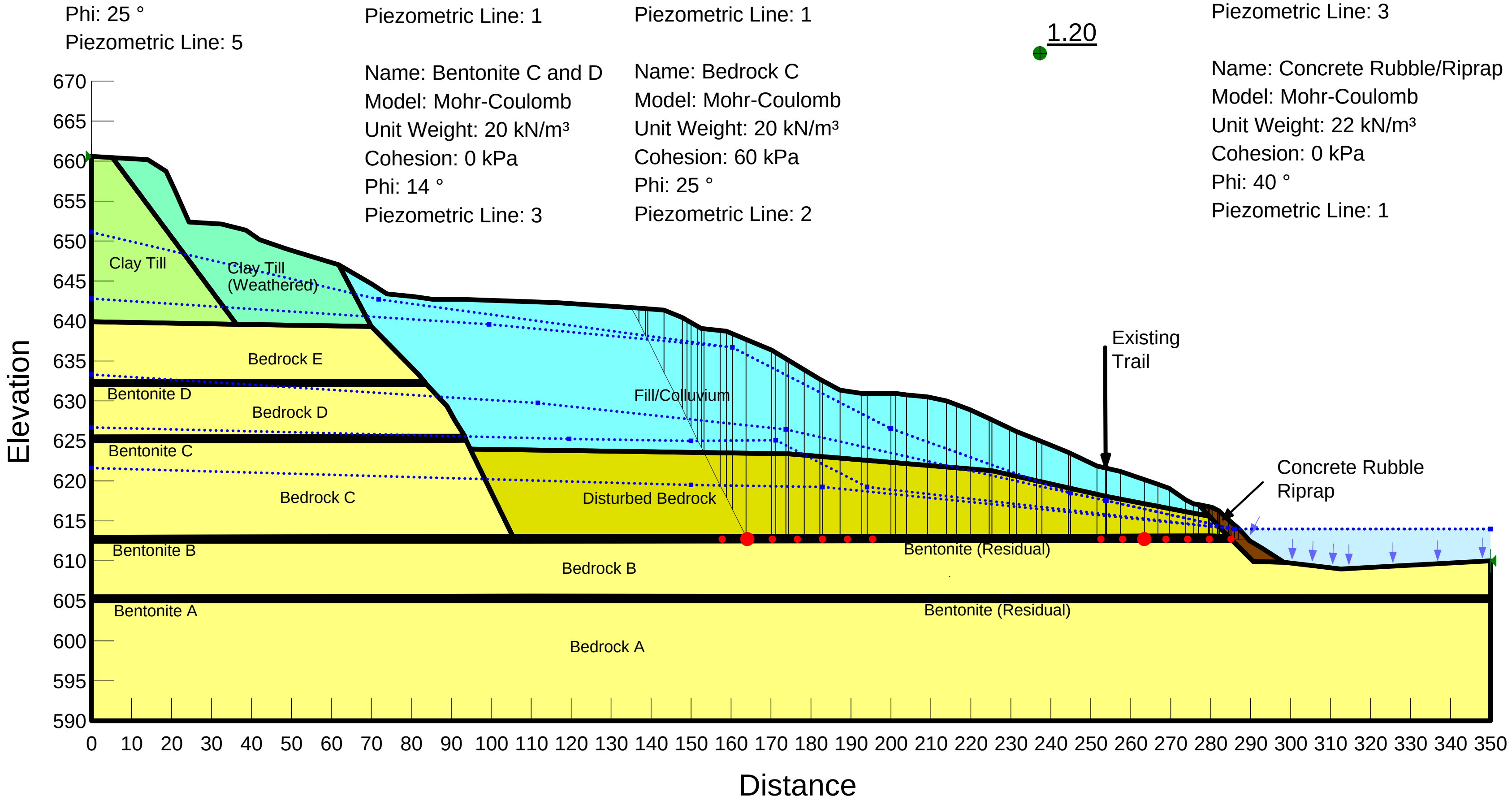
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m^3
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m^3
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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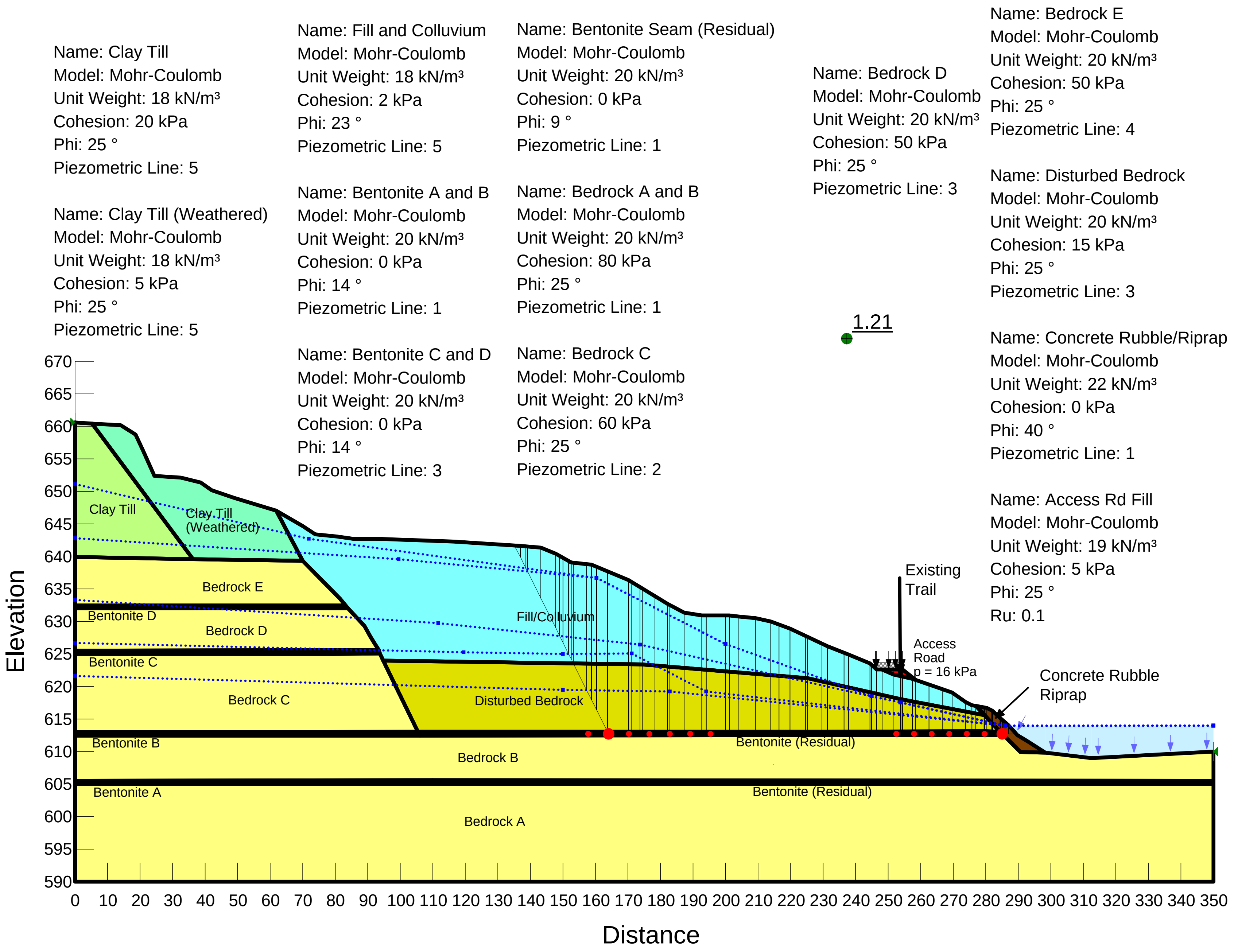
File Name: Section B-B_Current Conditions_Rev2_HER.gsz
Date: 9/5/2014 Time: 11:30:49 PM

SECTION B-B - FIGURE D9



Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1

Directory: H:\19\5438-102 Edmonton SE LRT Extention (Valley Line) - Procurement Stage\North Bank Access Road\Slope Stability Analysis\New Analysis_HER\Revision 2\
File Name: Section B-B_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/5/2014 Time: 11:37:02 PM

SECTION B-B - FIGURE D10

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

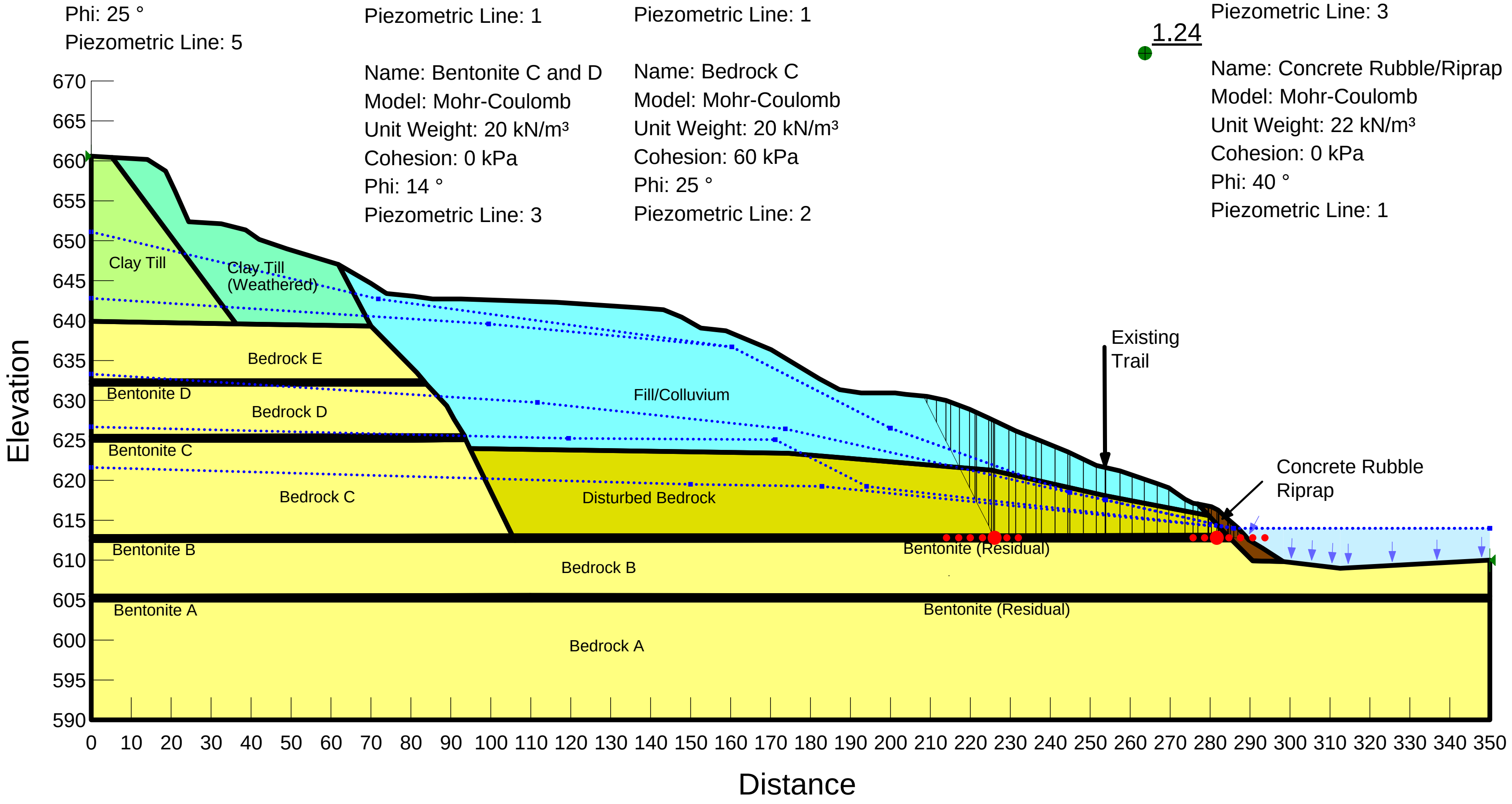
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section B-B_Current Conditions_Rev2_HER.gsz
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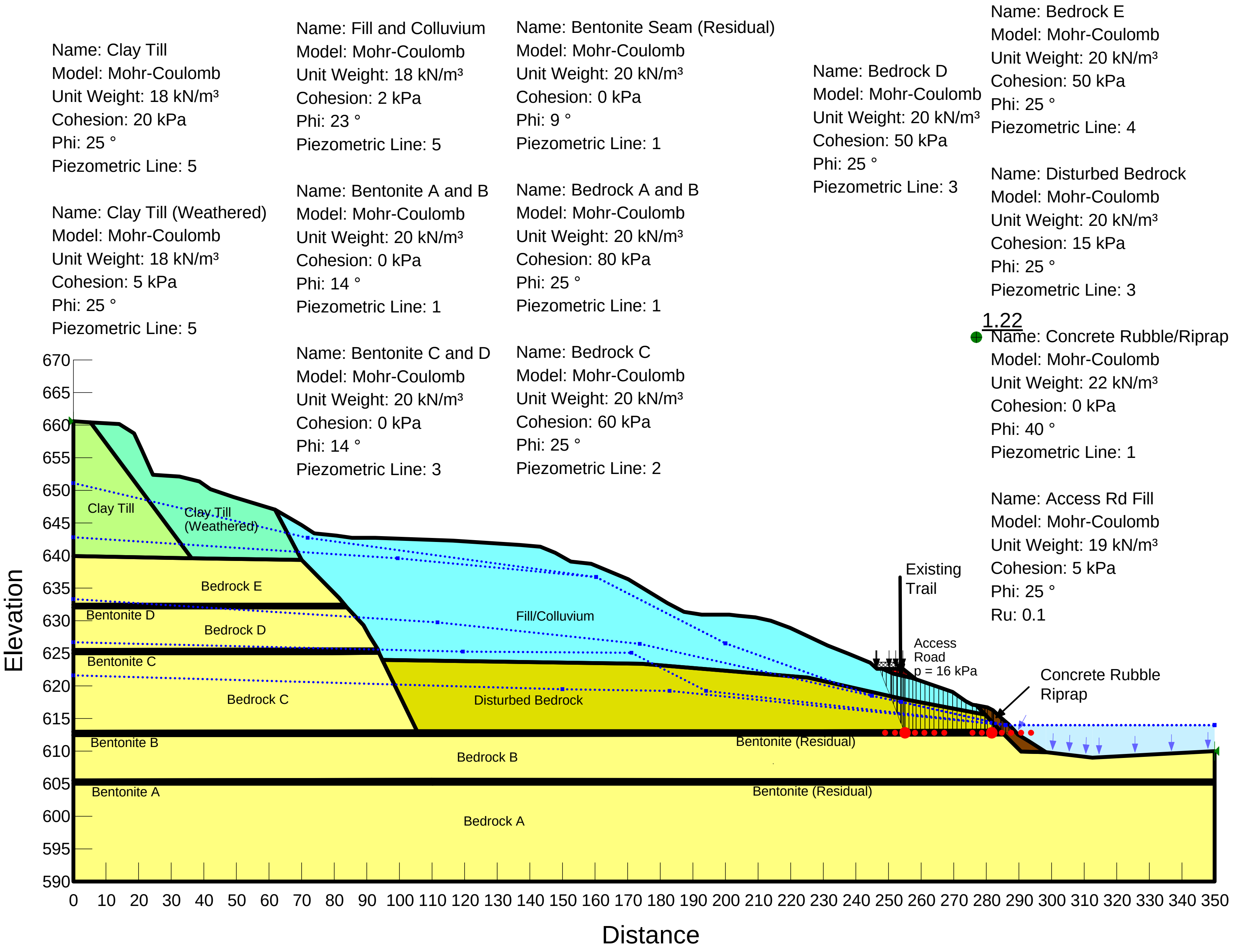
SECTION B-B - FIGURE D11



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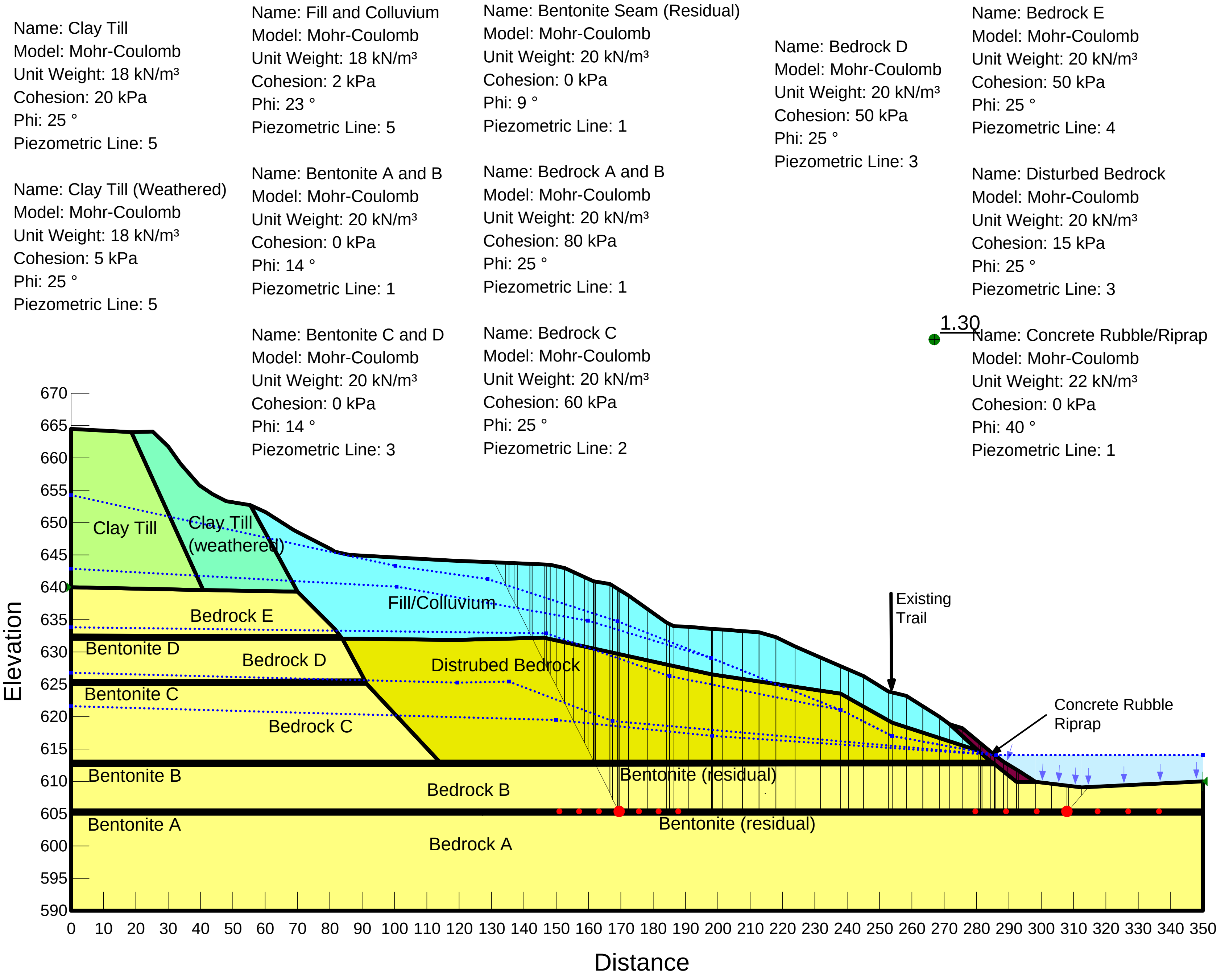
SECTION B-B - FIGURE D12



Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Directory: H:\19\5438-102 Edmonton SE LRT Extention (Valley Line) - Procurement Stage\North Bank Access Road\Slope Stability Analysis\New Analysis_HER\Revision 2\
File Name: Section C-C_Current Conditions_Rev2_HER.gsz
Date: 9/8/2014 Time: 7:47:11 AM

SECTION C-C - FIGURE D13

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

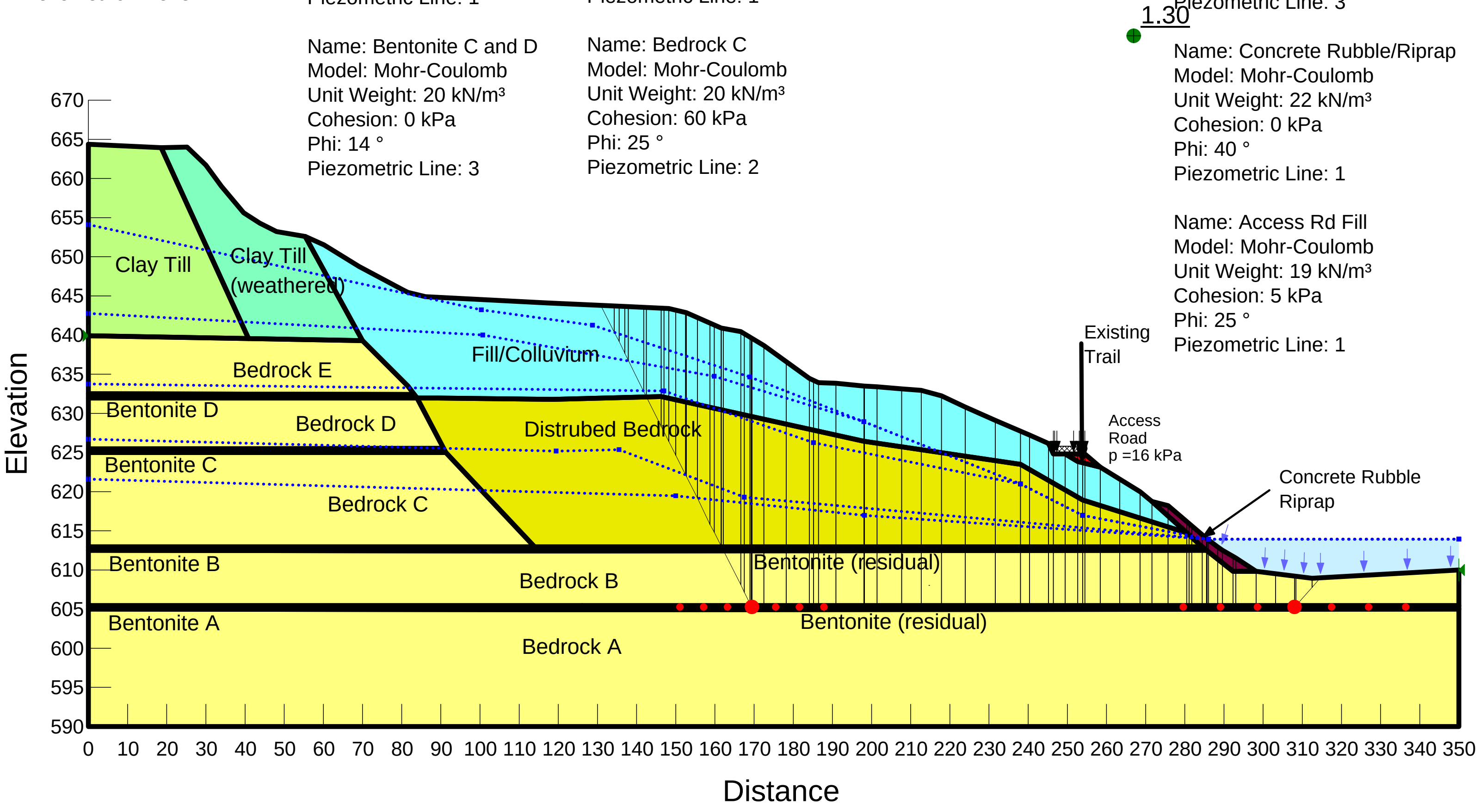
Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3



Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1

Directory: H:\19\5438-102 Edmonton SE LRT Extention (Valley Line) - Procurement Stage\North Bank Access Road\Slope Stability Analysis\New Analysis_HER\Revision 2\
File Name: Section C-C_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/5/2014 Time: 10:28:53 PM

SECTION C-C - FIGURE D14

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

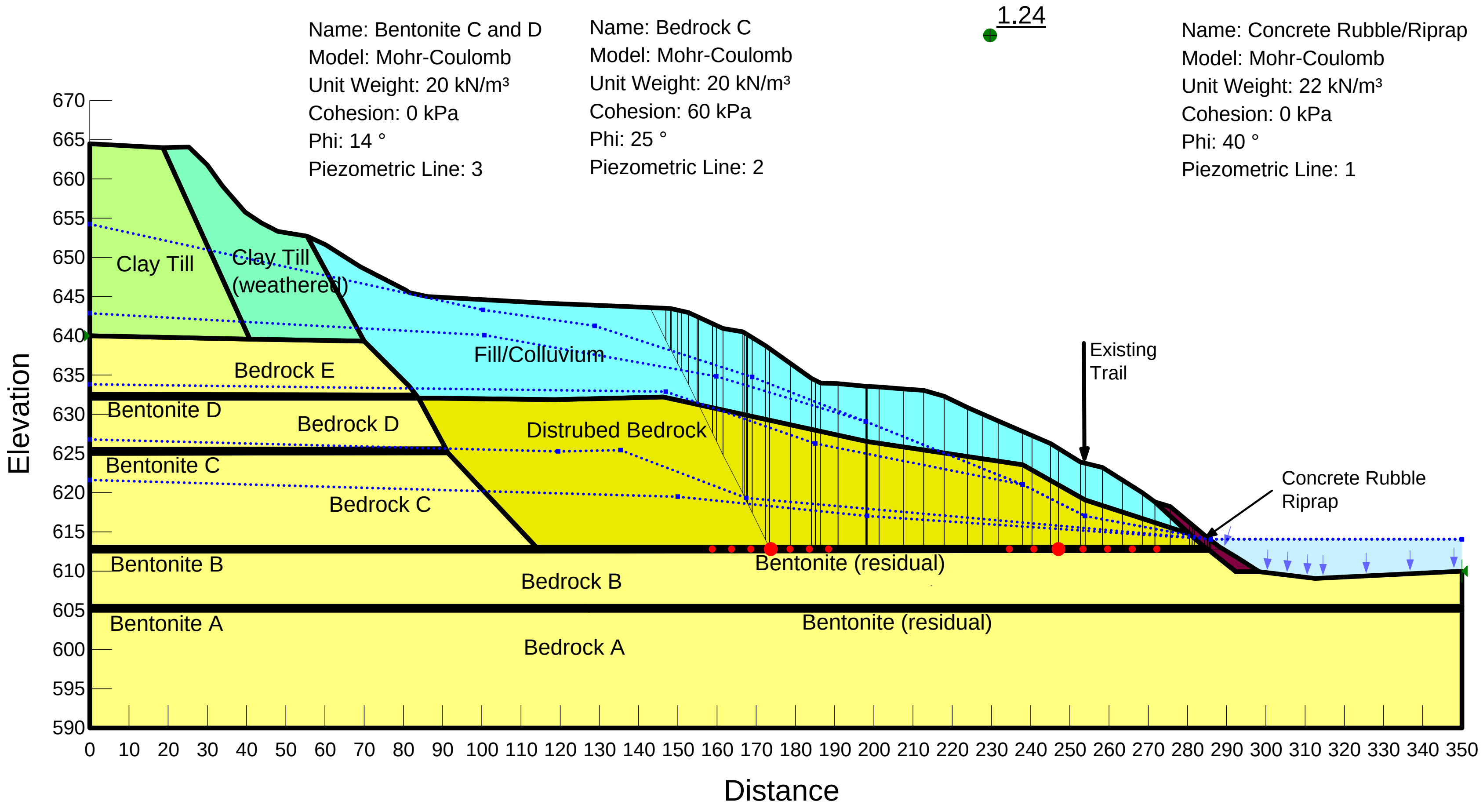
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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Date: 9/8/2014 Time: 7:47:11 AM

SECTION C-C - FIGURE D15

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

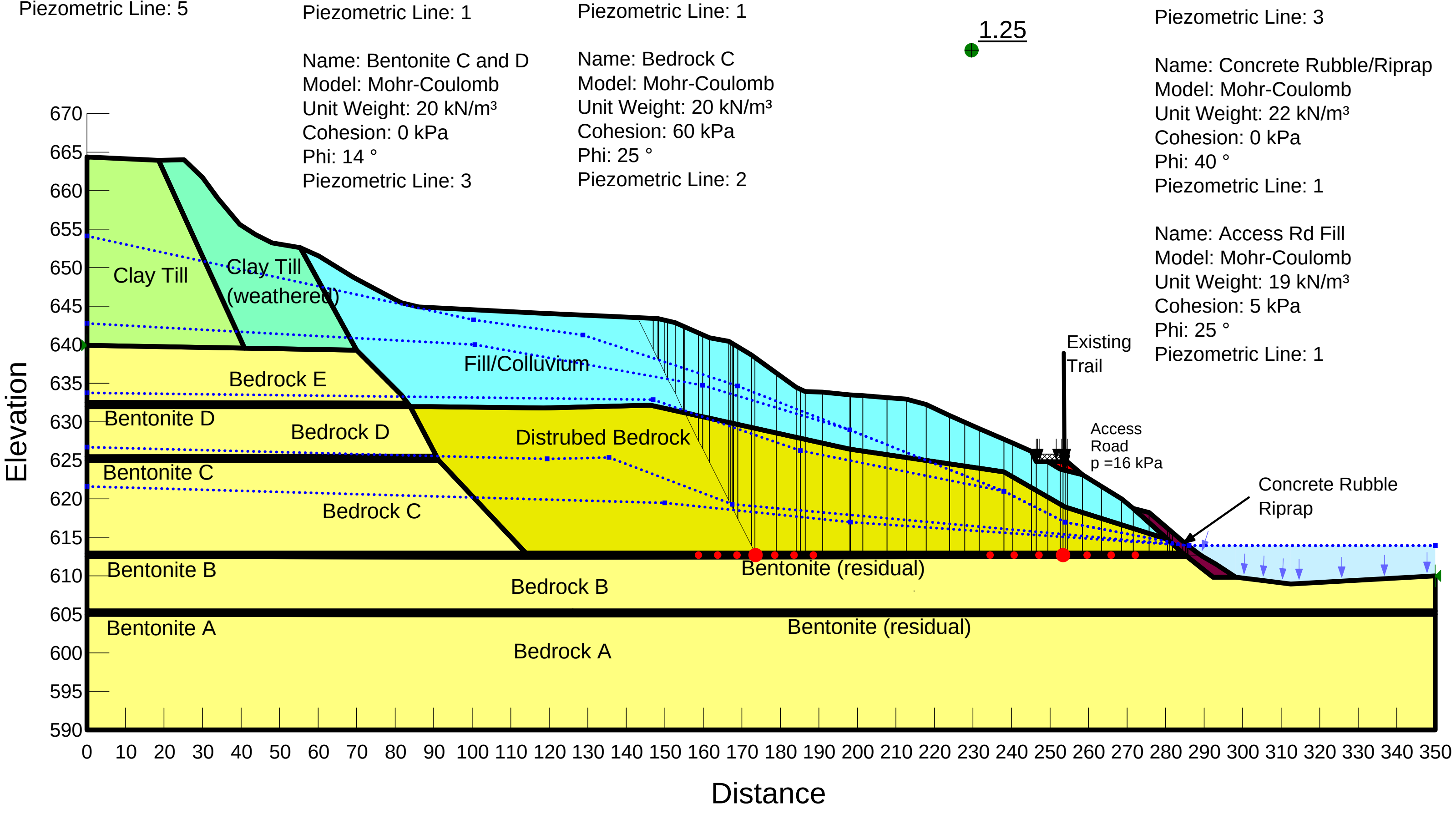
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1



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File Name: Section C-C_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/5/2014 Time: 10:28:53 PM

SECTION C-C - FIGURE D16

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

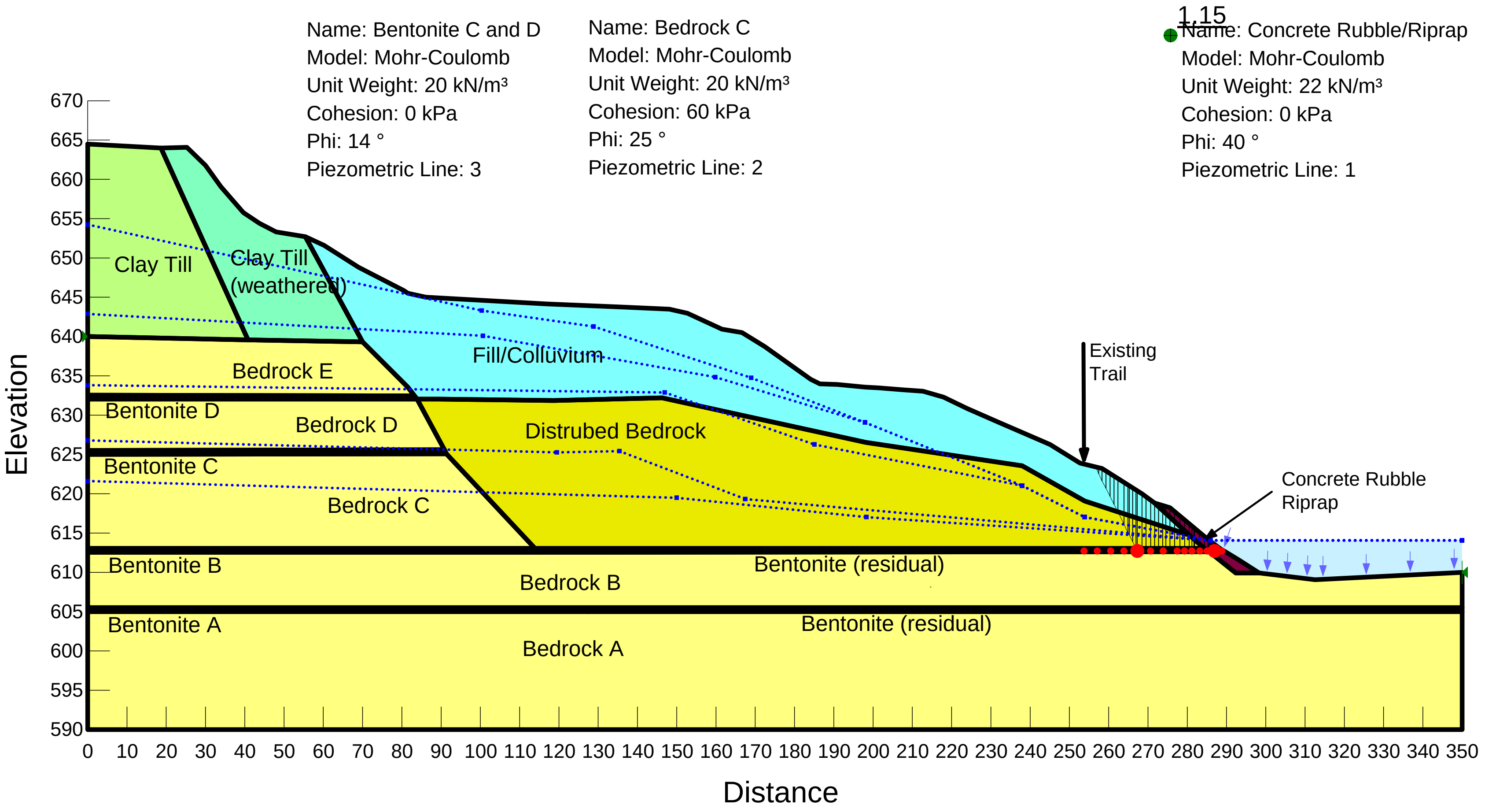
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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Date: 9/8/2014 Time: 7:47:11 AM

SECTION C-C - FIGURE D17

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

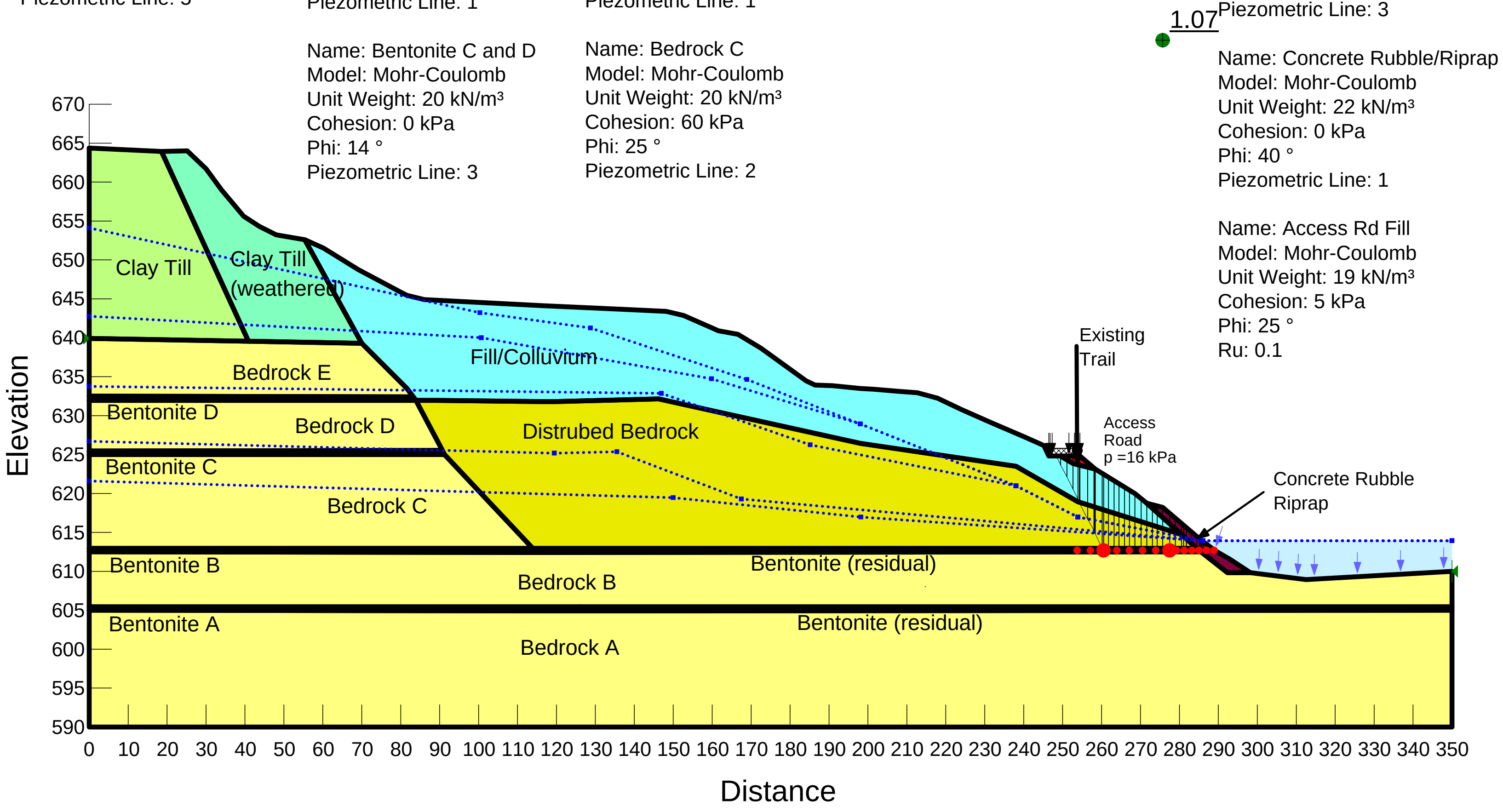
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section C-C_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/5/2014 Time: 10:28:53 PM

SECTION C-C - FIGURE D18

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

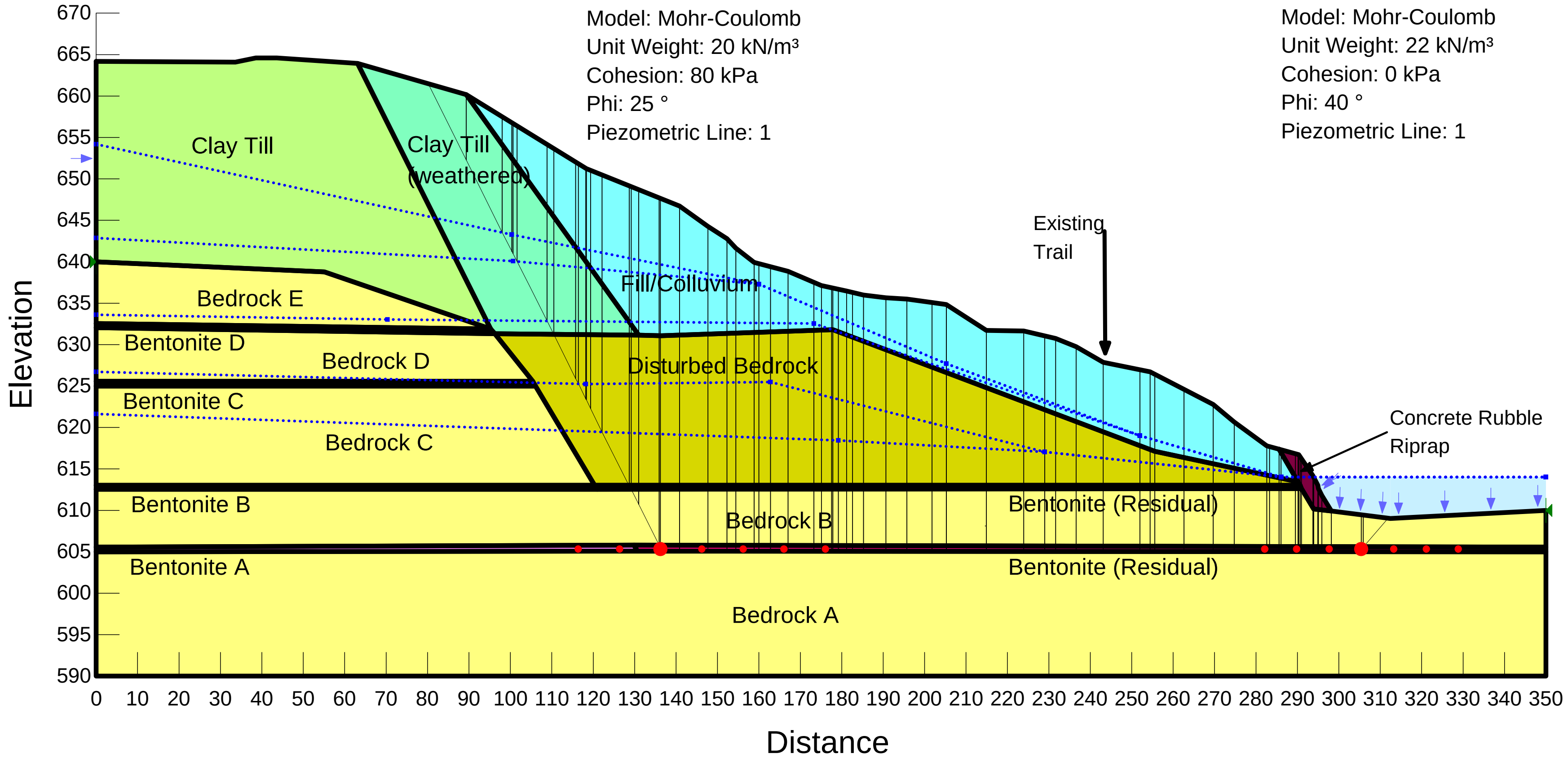
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

1.23

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section D-D_Current Conditions_Rev2_HER.gsz
Date: 9/5/2014 Time: 9:50:25 PM

SECTION D-D - FIGURE D19

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

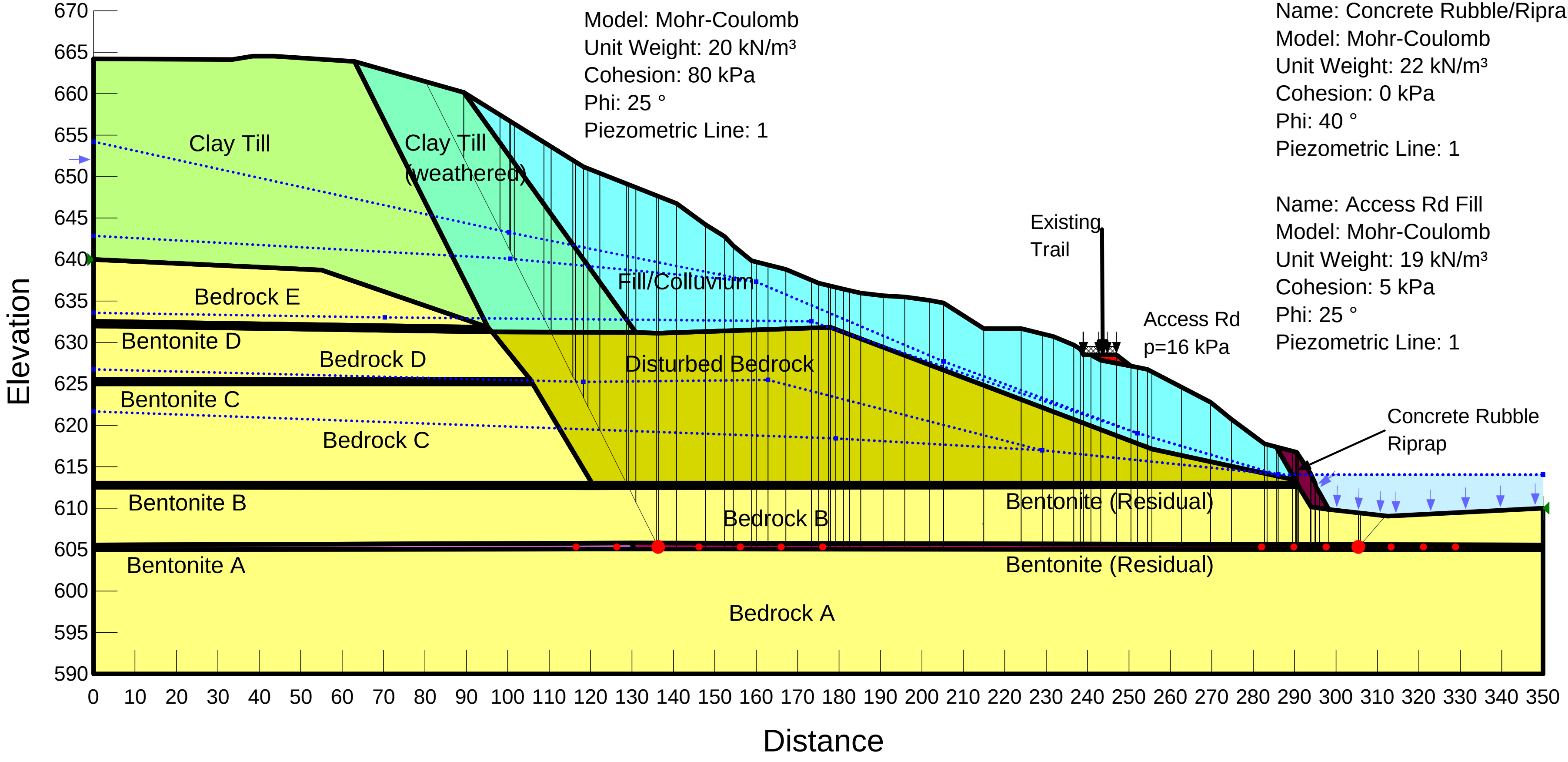
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1



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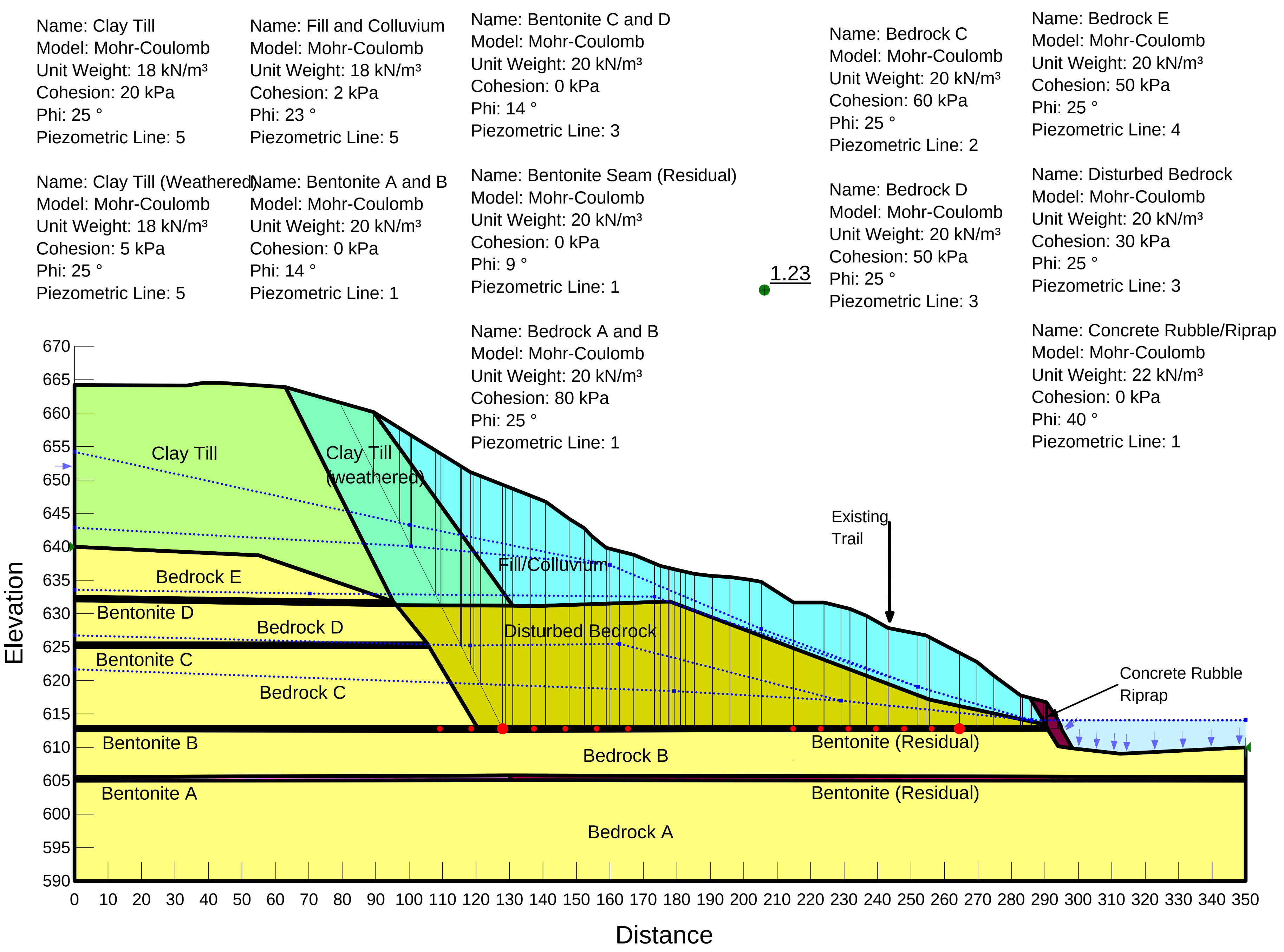
Date: 9/5/2014 Time: 10:14:55 PM

SECTION D-D - FIGURE D20



Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

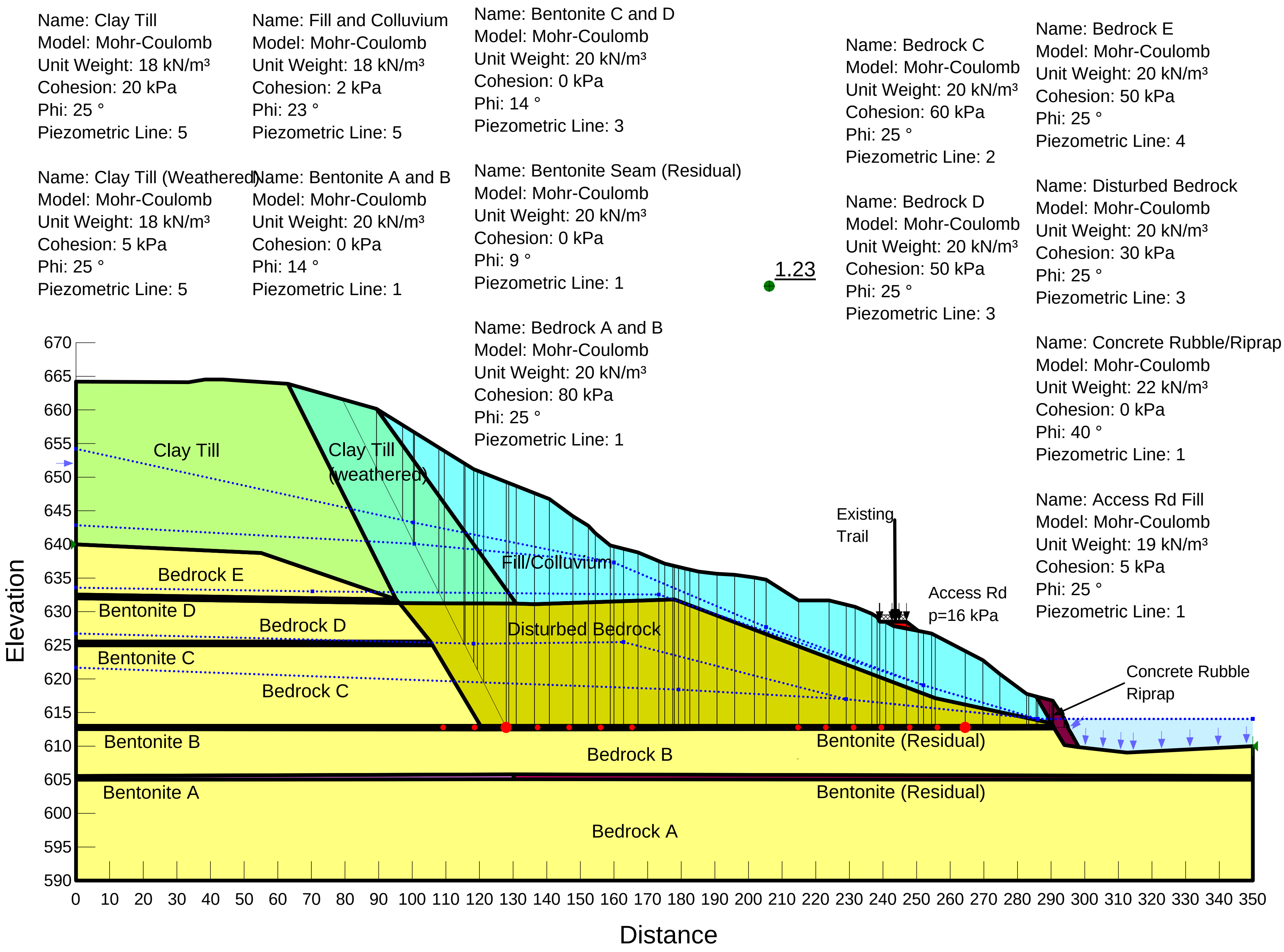
Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Directory: H:\19\5438-102 Edmonton SE LRT Extention (Valley Line) - Procurement Stage\North Bank Access Road\Slope Stability Analysis\New Analysis_HER\Revision 2\
File Name: Section D-D_Current Conditions_Rev2_HER.gsz
Date: 9/5/2014 Time: 9:50:25 PM

SECTION D-D - FIGURE D21



Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1

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File Name: Section D-D_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/5/2014 Time: 10:14:55 PM

SECTION D-D - FIGURE D22

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

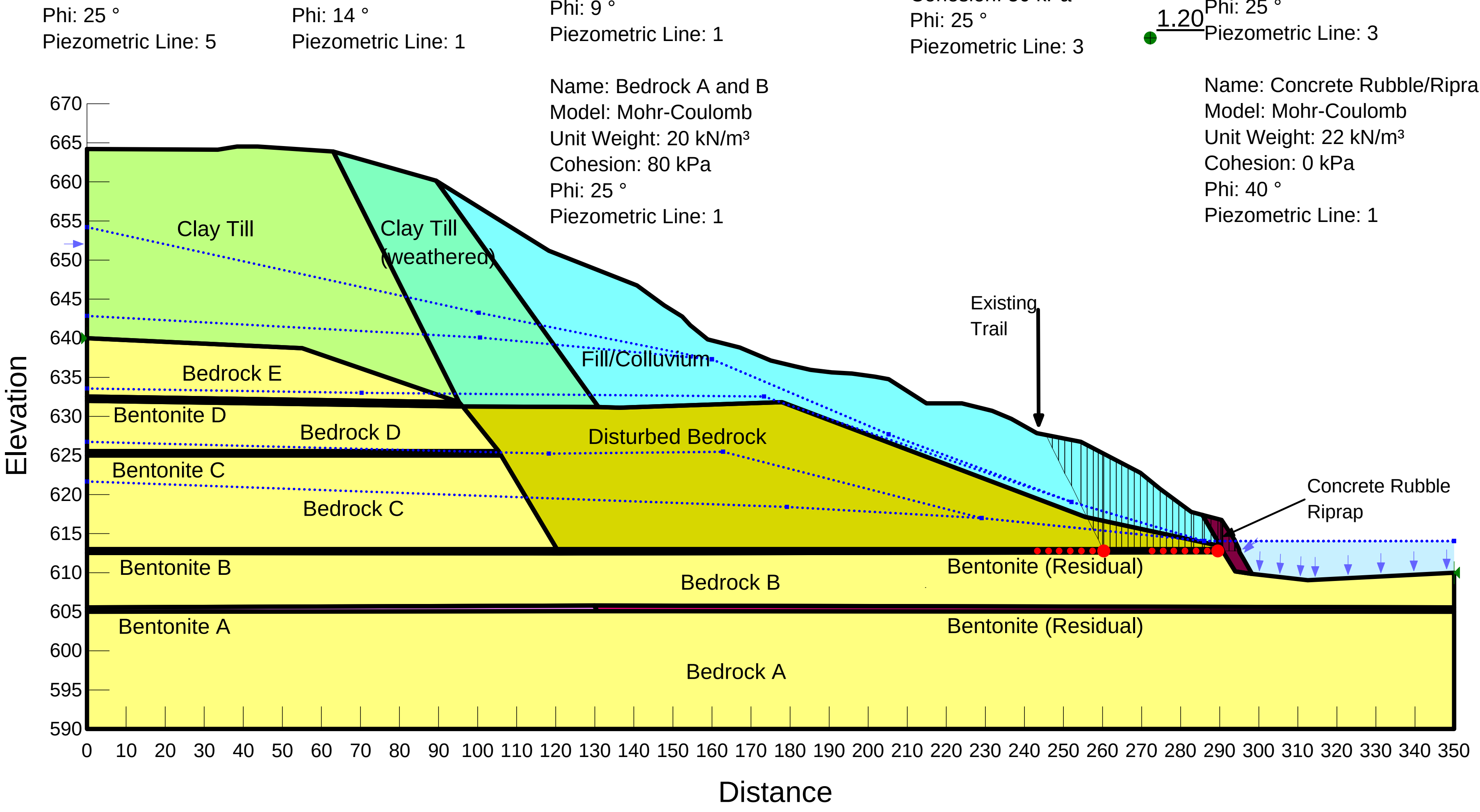
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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Date: 9/5/2014 Time: 9:50:25 PM

SECTION D-D - FIGURE D23

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

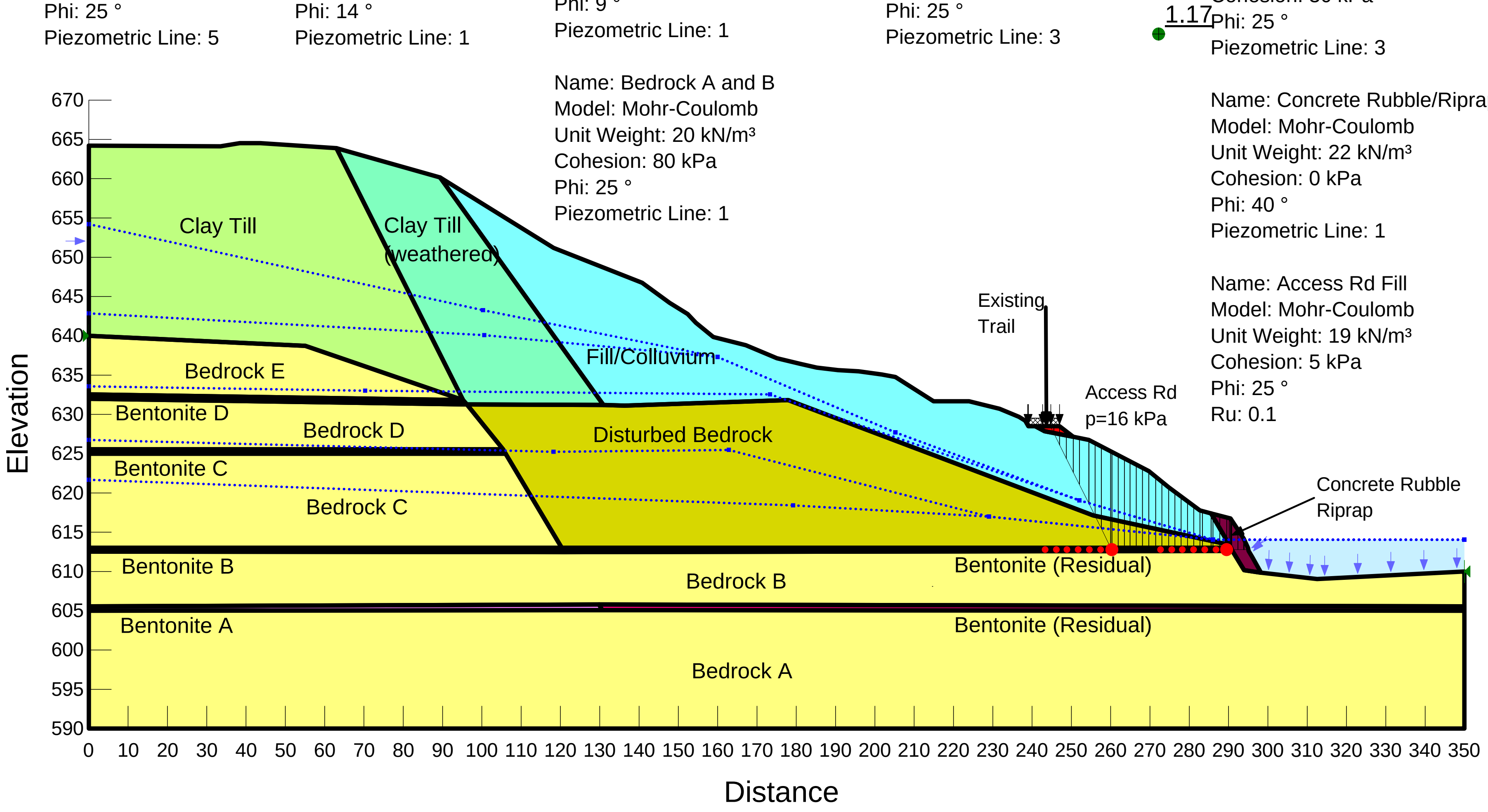
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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Date: 9/5/2014 Time: 10:14:55 PM

SECTION D-D - FIGURE D24