Memo

Wastewater Treatment Project
Treated for a cleaner future

TO: Jas Paul, Assistant Director Engineering and Public Works, City of Victoria

FROM: Dave Clancy, CRD Wastewater Treatment Project, Project Director

DATE: December 8, 2017

SUBJECT: **Wastewater Treatment Project – Licence Obligations**

1. Purpose

The purpose of this memo is to present the City of Victoria with the Design Proposals for the Clover Point Pump Station Building exterior and Public Realm Improvements, and the Clover Forcemain and Cycle Track alignment in accordance with the licence agreements between the Capital Regional District ("CRD") and the City of Victoria ("City"). It also serves the purpose of presenting the findings of the geotechnical assessment for the Clover Forcemain in accordance with the Watewater Treatment Project Board's response to the May 11, 2017 City of Victoria Council Resolution.

2. Introduction

The Wastewater Treatment Project is being built to meet the provincial and federal regulations for treatment of the Core Area's wastewater by December 31, 2020 and consists of three main elements:

1. **McLoughlin Point Wastewater Treatment Plant**: Located at McLoughlin Point in Esquimalt, the treatment plant will provide tertiary treatment to the Core Area's wastewater. Tertiary treatment is one of the highest levels of treatment available and produces a higher quality of effluent than secondary treatment.

2. **Residuals Treatment Facility**: Residual solids from the wastewater treatment plant will be piped to the Residuals Treatment Facility at the Hartland Landfill, where they will be turned into what are known as "Class A" biosolids. These biosolids are a high quality by-product treated such that it is safe for further use.

3. **Conveyance System**: The conveyance system refers to the "pumps and pipes" of the Wastewater Treatment Project. This system will carry wastewater from across the Core Area to the treatment plant. It will also send residual solids from the wastewater treatment plant to the Residuals Treatment Facility.

The Wastewater Treatment Project is being funded by the Government of Canada, the Government of British Columbia, and the CRD.

3. Project Background

The Wastewater Treatment Project (the "Project") will provide the Capital Regional District's ("CRD") Core Area with tertiary treatment of wastewater that meets both provincial and federal wastewater regulations. The communities to be serviced by this Project include the City of Victoria, City of Langford, City of Colwood, District of Oak Bay, District of Saanich, Township of Esquimalt, Town of View Royal, and the Songhees and Esquimalt Nations.

Provincial Municipal Wastewater Regulations (MWR) under the Environment Management Act came into effect in 2012 to “protect public health and the environment”. The MWR prescribes the minimum standards of municipal wastewater quality for marine water, fresh water or groundwater discharge.

Federal Wastewater System Effluent Regulations under the Fisheries Act establish effluent quality performance standards. The objective is to decrease the level of deleterious and harmful substances discharged through wastewater effluent. Facilities with discharge effluent quality not equivalent to or better than the secondary treatment performance standards (such as Macaulay Point and Clover Point) are required to upgrade to conformance prior to December 31, 2020.

In May 2016, the CRD established the Core Area Wastewater Treatment Project Board (“Project Board”) to administer the Project. The CRD asked the Project Board to review the wastewater treatment issues and, by September 2016, recommend to the CRD and senior levels of government a plan to comply with the law and to preserve senior government funding.

In September 2016, the CRD Board approved the Wastewater Treatment Project, as recommended by the Project Board. The Wastewater Treatment Project meets all of the goals that were established for the Project Board by the CRD:

- meet federal requirements for secondary treatment by 2020[1] ;
- minimize costs to residents;
- optimize opportunities for resource recovery;
- reduce greenhouse gas emissions; and
- add value to the surrounding community and enhance livability of neighbourhoods.

The Wastewater Treatment Project Board has appointed a Project Team to manage the execution of the Project.

4. City of Victoria – Technical Working Group

The Project Team and the City of Victoria (“City”) have established a Technical Working Group (“TWG”) to provide a forum to ensure accurate technical information is available to City staff as project planning and construction proceeds, and to ensure technical issues are raised, discussed and addressed and, where possible, to coordinate municipal works with project construction.

The kick-off meeting for the TWG was held on April 24, 2017. The primary purpose was to review the Project with City staff, outline the scope of the facilities within the City, and identify the key touch-points between the City and the Project. There have been a number of TWG meetings since the kick-off meeting to review items such as establishing procedures to satisfy the obligations in the various licence agreements between the City and CRD. A separate meeting was also held to review the Design Proposal for the Clover Point Pump Station Building exterior and Public Realm Improvements, as well as the alignment of the Clover Forcemain and Cycle Track.

---

[1] The federal regulations require the region’s sewage undergo secondary treatment by December 31, 2020. The McLoughlin Point Wastewater Treatment Plant is designed to go further and will provide tertiary treatment for all wastewater flows from the Core Area. Tertiary treatment is one of the highest levels of treatment available and produces a higher quality of effluent than secondary treatment.

It is noted that one of the obligations in the licence agreements for both the Clover Point Pump Station and the Clover Forcemain is to invite the Songhees and Esquimalt Nations to nominate a representative to participate in the Design Workshops in order to provide meaningful opportunities for the Nations to contribute to the final design of the exterior of the Building and the Public Realm Improvements. The CRD WTP has completed this requirement drawing on the Project's Esquimalt and Songhees Liaisons to participate in the TWG to review the Design Proposal noted above. The CRD anticipates working further with the Esquimalt and Songhees Nations on the incorporation of Indigenous art into the Public Realm Improvements.

The Project Team will continue to hold regular meetings with the TWG throughout the course of the Project.

5. Clover Point Pump Station

The Clover Point Pump Station will be upgraded and expanded as part of the Wastewater Treatment Project. The existing station pumps sewage directly into the ocean. The expanded pump station will pump wastewater to the McLoughlin Point Wastewater Treatment Plant for tertiary treatment and provide bypass pumping to the existing outfall during storm events.

The CRD WTP Team held a competitive procurement, via a Reqeust for Proposals process, to secure the design-builder for the Clover Point Pump Station. The procurement phase included two (2) confidential collaborative meetings with each of the CRD's shortlisted design-build proponents. In accordance with the terms of the licence agreement, the City participated in these meetings to allow for their review and comment on each proponent's design proposal for the exterior of the Building and the Public Realm Improvements. Proposals were received in August 2017 and the contract was awarded to Kenaidan Contracting Ltd (Kenaidan) in November 2017.

The following sections summarize the obligations related to design of the Clover Point Pump Station, as defined in the licence agreement between the City and CRD. It also presents the Kenaidan Design Proposal for the Building exterior and Public Realm Improvements.

5.1 Licence Agreement (Clover Point Pump Station)

On February 22, 2017, the City and CRD entered into a licence agreement associated with the Clover Point Pump Station entitled "Licence of Occupation – Clover Point Pump Station". The agreement allows the CRD to install, entrench, construct, expand, upgrade, operate, maintain, repair, replace and relocate the existing wastewater pumping station. In return, the CRD agreed to:

- construct the Public Realm Improvements upon the Licence Area and the surrounding lands, including a Public Plaza, a Bike Node, two (2) public washrooms, intersection improvements at Clover Point Road and Dallas Road, new connecting walkways and pedestrian pathways, site furnishings, wayfinding signage, and landscaping.
- present to City Council, in a public meeting, the Design Proposal for the exterior of the Building and the Public Realm Improvements, and amend the Design Proposal as it relates to the Public Realm Improvements in accordance with any recommendations of City Council.
- hold three (3) Design Workshops at the 30%, 50% and 90% design completion stages for the City and CRD to work collaboratively on development and finalization of the design details related to the exterior of the Building and design of the Public Realm Improvements.

- invite the Songhees and Esquimalt Nations to nominate a representative to participate in the Design Workshops to provide meaningful opportunities to consider the Songhees and Esquimalt Nation's input in final design of the exterior of the Building and the Public Realm Improvements.
- at the 50% design stage, present the design to City Council at a public meeting and to the Fairfield-Gonzales Community Association in a separate presentation, and amend the 50% Design Proposal as it relates to the Public Realm Improvements in accordance with any recommendations of City Council.
- submit the final design of the exterior of the Building and the Public Realm Improvements for City approval.
- provide the City with a one-time payment of $75,000 for the maintenance of the public washrooms to be constructed as part of the Public Realm Improvements.
- provide the City a one-time payment of $100,000 toward the construction of additional capital improvements by the City.
- provide the Director of Engineering with a public engagement plan outlining how the CRD will manage inquiries, complaints and correspondence from the public.

Additionally, the licence agreement set out certain design requirements for the pump station, including a conceptual plan for the Building exterior, as well as a concept plan and design guidelines for the Public Realm Improvements. These design requirements are included in Appendix "A" of this memo. The Public Realm Improvements, as defined in Clause 7.1 of the agreement, are summarized below.

- construct and install the Public Plaza to be accessible to pedestrians and cyclists and replace the existing public parking lot located above the existing pump station;
- construct and install the Bike Node;
- interpretative signage and wayfinding signs at the Public Plaza;
- two replanted grassed open spaces to the west and east of the Public Plaza;
- install, as part of the Public Plaza, street furniture and bicycle facilities including benches, bike racks, a bike rack for maintenance and repair, and a drinking fountain;
- install two (2) public washrooms, each with one sink, one toilet and one urinal, including all necessary sanitary sewer, electrical, and water connections;
- construct intersection improvements at Clover Point Road and Dallas Road;
- construct a pedestrian path from Dallas Road alongside Clover Point Road and connecting to the existing Clover Point Path; and
- construct a new connecting walkway and bike path across Clover Point Road to the Dallas Road/Ross Bay Seawalk.

5.2 Design Proposal

This section presents the design basis for the Building exterior and Public Realm Improvements associated with the Clover Point Pump Station, as proposed by Kenaidan. Drawings illustrating the design of the Building exterior and Public Realm Improvements are included in Appendix "B".

5.2.1 Existing Conditions and Site Usage

The current Pump Station is well blended into the landscape and covered with a gently sloped grassed area. Several memorial benches have been located on prominent spots within this grassed area. The grassed area ends along the east end of the facility at the top of a structural wall featuring a beautiful natural stone finish. A small parking lot is currently in place just east of the Dallas Road/ Clover Point Road intersection. Currently there are no pathways on site and pedestrians generally walk down the Clover Point Park Road on the west side and around the base of the facility using the Dallas Road Waterfront Trail to the east. The site is heavily used by pedestrians from the surrounding neighbourhood as well as users of Clover Point and the Waterfront Trail. Worn pedestrian “desire line” paths are evident across the grassed area.

5.2.2 Design Approach

In addition to the public realm improvements outlined in the licence agreement, the Kenaidan team proposes further landscape improvements that they feel greatly improve the existing site experience, the efficiency of the surrounding pedestrian networks and the site safety for the future users of this popular vantage point. Key to all design decision making is the overall vision, and its resulting design strategies for the Building and Public Realm Improvements.

The Vision: Creation of a memorable destination public space designed to a level reflective of its prominent location in the city.

Design of the Buildiing and Public Realm Improvements focus on:

UNIQUE CONTEXT	Respond in a sensitive and complementing way to the sites unique coastal edge context
NEIGHBOURHOOD INTEGRATION	The design will respect and enhance its neighbourhood interface
MOBILITY	The design will create an enhanced public realm that provides multiple opportunities for pedestrians and cyclists, as well as being universally accessible
GREAT CONNECTIONS	The design will focus on creating connections that are responsive to current and planned pedestrian and bicycle routine.
AUTHENTICITY	The design will celebrate the rich culture heritage of the **Songhees** and **Esquimalt Nations**. Additionally, appropriate local materials will be used and opportunities for local art expression will be examined.
VITALITY SUSTAINABILITY	The public realm design will prioritize environmental sustainability and material performance.

From observations of the existing site, it was apparent how pedestrian routes (desire lines) had been worn into the ground as steep trails from the Dallas Road car park, down the grassy bank to the Seawalk below. Recognizing the intent to further invite people to this point of prospect, the Kenaidan team felt it necessary to go beyond the minimum design guidelines in the licence agreement and provide adequate trail improvements that offer safe, universally accessible routes to the lower Ross Bay Seawalk.

As this new trail traverses the site to connect with the existing ramp and stairs and also to connect with the proposed washroom, the opportunity arose to re-instate the current informal viewing area that exists above the facility, with a new improved and safer lookout area at this newly created pedestrian node. The design that arose out of these concepts is further described in Section 6.4.3.

5.2.3 Design Objectives

Key objectives of the design approach are summarized below.

1. Respond to client and project requirements
    - construct a 'Viewing Plaza' adjacent to the Dallas Road intersection and in proximity to the existing car park location
    - furnish plaza space with benches and drinking fountain
    - provide other specified park furnishings, such as trash/recycling receptacles in coordination with City Parks' staff
    - confine bike use to designated routes by way of bollard and/or signage
    - construct intersection improvements at the Clover Point Road and Dallas Road intersection
    - construct a Bike Node (with a bicycle maintenance station and bike racks), west of the improved intersection, and continue the Pedestrian/Bike path south, on the westerly side of Clover Point Road to the Clover Point Park Path
    - construct a new Pedestrian/Bike path across Clover Point Road to the Ross Bay Seawalk
    - locate public washroom facility in a safe, visually prominent and universally accessible area
    - maintain unobstructed views from higher vista points

2. Respond to site conditions, and make the site safe for all users
    - provide pedestrian connections where existing park-user desire lines are apparent (noticeable "goat trails" traversing site)
    - design these routes with the appropriate slopes and materiality and with guardrails where building code requires (locate these routes and guardrails to achieve the objective of improving site safety)
    - provide a safe viewing area in combination with the improved pedestrian connections
    - match the existing stone-faced retaining walls when building the new retaining wall system that flanks the lower seawall walkway, and repair the existing wall and stonework where necessary

3. Minimize design interventions and potential site impacts and employ sustainable practices
    - minimize the use of singular purpose site furnishings, integrate site design elements where possible such as retaining walls being designed also as seating elements
    - pathway surface treatments should be permeable such as crushed fines and permeable unit pavers in plaza spaces
    - proposed or altered topography should match or enhance the exiting site and context
    - select soft and hardscaping materials to minimize maintenance costs
    - use locally sourced materials where possible

5.2.4 Proposed Design

The presented design represents the Kenaidan/WSP team's interpretation of the guidelines and objectives in context of this very special site. The building expansion has been incorporated underneath a varied and vibrant public realm design.

The proposed design is highlighted by the provision of three prominent public gathering areas. The primary viewing plaza is located on the eastern side of Dallas Road and Clover Point Park Road. The design features in this area include permeable concrete brick pavers, four benches offering views out to Ross Bay, a drinking fountain and protective leaning railing.

The second plaza area, on the west side of the Dallas Road and Clover Point Road intersection, is seen as a transition area between the cycle track and new pedestrian sidewalk. The plaza also features permeable concrete pavers, bike racks and a bicycle “maintenance kitchen”.

The third plaza is a lower plaza gathering area that provides built-in concrete wall edge seating at the intersection of the multiple pathway connections. The surface of this area and adjacent walkways will be high permeability compacted granular. There will also be another protective “leaning” railing along the ocean side edge of this area.

The pathway system has been designed to ensure multiple connection points with the surrounding existing pathway networks including Dallas Road, the Dallas Road Waterfront Trail along Ross Bay and the Dallas Road waterfront trail through Clover Point Park.

The new public washroom has been strategically placed toward the south end of the pump station area at the intersection of a new pathway connection between Clover Point Park and the Waterfront Trail along Ross Bay. The washroom will be designed to be safety and security conscious and feature two universally accessible gender neutral washrooms and associated amenities.

The landscape treatment will be a shaping and creation of grass areas to respond to the hillside location and where possible, provide specific mounding to soften and integrate the new washroom into the landscape.

6. Clover Forcemain and Cycle Track

The Clover Forcemain will convey wastewater from the Clover Point Pump Station to Ogden Point. The forcemain will have a total length of approximately 3.4 km from the Clover Point Pump Station to the harbour crossing at Ogden Point.

The CRD engaged Stantec to prepare an indicative design of the Clover Forcemain and Cycle Track. The CRD then engaged Kerr Wood Leidal (KWL) to review the indicative design, prepare detailed design documents, and be responsible for fulfilling Engineer of Record duties as defined by the Association of Professional Engineers and Geoscientists of British Columbia. The indicative design was completed in July 2017, and KWL has completed their review of the alignment for the Forcemain and Cycle Track.

The following sections summarize the obligations related to design of the Clover Forcemain, as defined in the licence agreement between the City and CRD. It also presents the KWL Design Proposal for the alignment of the Forcemain and Cycle Track.

6.1 Licence Agreement

On February 22, 2017, the City and CRD entered into a licence agreement associated with the Clover Forcemain entitled “Licence of Occupation – Dallas Road Forcemain”. The agreement allows the CRD to install, entrench, construct, operate, maintain, repair and replace one or more systems of sanitary sewer works, i.e. the Clover Point Forcemain. In return, the CRD agreed to:

- construct a Cycle Track connecting Clover Point to Dock Street in accordance with the conceptual plans and Design Guidelines in the licence agreement.

- present the alignment of the Forcemain and Cycle Track and the Design Proposal to City Council in a public meeting prior to the commencement of detailed design and amend the Design Proposal in accordance with any recommendations of City Council.
- hold three (3) Design Workshops at the 30%, 50% and 90% design completion stages for the City and CRD to work collaboratively on development and finalization of the design details related to the Cycle Track.
- invite the Songhees and Esquimalt Nations to nominate a representative to participate in the Design Workshops to provide meaningful opportunities to consider the Songhees and Esquimalt Nation’s input in the final design of the Cycle Track.
- at the 50% design stage, present the design and alignment of the Cycle Track and alignment of the Forcemain to City Council at a public meeting and to the James Bay Neighbourhood Association and the Fairfield-Gonzales Community Assocation in a separate presentation, and amend the 50% Design Proposal with any recommendations of City Council.
- submit the final design and alignment of the Cycle Track for City approval.
- provide the Director of Engineering with a public engagement plan outlining how the CRD will manage inquiries, complaints and correspondence from the public.

Additionally, the licence agreement set out certain design requirements for the Forcemain and Cycle Track, including conceptual drawings of the alignment for the Forcemain and Cycle Track along Dallas Road, as well as the design guidelines for the Cycle Track. These design requirements are included in Appendix “C” of this memo.

6.2 Forcemain Alignment

The CRD engaged Stantec to prepare an indicative design of the Clover Forcemain. In developing the indicative design, Stantec evaluated route options, selected a preferred route for the forcemain, developed the basis of design, prepared indicative design alignment drawings, and presented a construction cost estimate. CRD then engaged KWL to review the indicative design, prepare detailed design documents, and be responsible for fulfilling Engineer of Record duties as defined by the Association of Professional Engineers and Geoscientists of British Columbia. The scope of KWL’s work includes a technical review of geotechnical factors affecting the indicative design.

To review the indicative design, KWL assembled an interdisciplinary team with expertise in the fields of conveyance system design, geotechnical engineering, terrain analysis, marine construction, environmental analysis, and civil engineering. On September 8, 2017, the KWL team, Stantec, and CRD Project Team staff held a workshop to review the indicative design. Extensive consideration was given to the geotechnical aspects of the design, as well as schedule, cost, archaeological, environmental, and community impacts.

The KWL team agreed with the selection of Dallas Road as the recommended corridor for the Clover Forcemain. The KWL team also concluded that the forcemain can be designed, constructed and operated in the Dallas Road alignment without affecting the Dallas Road Bluffs and without the bluffs affecting the forcemain. The alignment of the proposed Clover Forcemain is shown on the drawing included in Appendix “D”.

6.3 Cycle Track

The cycle track will extend from Dock Street to Clover Point along the south side of Dallas Road, with physical separation from motor vehicles and also separation from pedestrian sidewalks or paths. This section presents the design basis for the cycle track alignment, as proposed by the KWL team. Drawings illustrating the alignment are included in Appendix “E”.

6.3.1 Design Objectives

Key objectives of the design approach are:

- meet requirements per the Licence of Occupation.
- safety for all users.
- adhere to Victoria’s Official Community Plan; recognize that in the transportation hierarchy the priority is pedestrians highest, followed by cyclists, then motorists (in order from transit, commercial vehicles, to finally single occupancy vehicles).
- provide a continuous cycling facility that is suitable for all ages and abilities.

6.3.2 Design Criteria

In addition to the cycle track specifications, design criteria for all roadway features are a consideration to ensure appropriate accommodation of all users and modes as part of the design. The following are the design criteria used for establishing the cycle track alignment.

Cycle track width:

- 3.0m minimum (typical). Absolute minimum of 2.5m in short-segment pinch points.

Buffer width between cycle track and road

- Desirable minimum: 1.0m (or 1.5m min. for treed landscaping)
- Limited width / pinch-point areas: 0.6m adjacent to moving vehicles, 0.75m adjacent to parked cars

On-street parking

- 2.5m a suitable width for a typical parking lane

Drive lanes with buses

- 3.3m minimum where accommodating buses (typ.)

Sidewalks

- 1.5m minimum is typical in Victoria; 1.8m – 2.0m preferred

6.3.3 Design Constraints

In some areas the available width is constrained, which may require deviation from preferred criteria dimensions or alterations to alignments of sidewalks, the cycle track, on-street parking (width or angle of parking), and/or road lanes.

Specific design constraints include:

- north curb line is to remain undisturbed in most areas; this is the effective design limit for incorporating the design elements (cycle track plus south sidewalk, drive lanes, and on-street parking).
- south side constraints vary by segment. Specific constraints include:

  - Seawall (limiting available space) between Dock St and Lewis St.
  - Large mature trees adjacent to Dallas Road between Government St and Paddon Ave.
  - Space limitations at Paddon Avenue, between the north side of the road and retaining wall / concrete railing as well as the Dallas Road bluffs.
  - Space limitations at Douglas Street and the Dallas Road bluffs.
  - Above ground utilities (e.g. light standards, fire hydrants).

6.3.4 Proposed Alignment

Sheet CF-G00-C-702: Dock Street to San Jose Avenue
In this section the cycle track is adjacent to the existing south sidewalk that abuts the seawall. South side Dallas Road parking is switched to parallel parking from current angle parking, which is required to accommodate the cycle track and buffer. On-street parallel parking would remain along the north side of Dallas Road. This section has limited width overall, and dimensions are typically minimum for all features (1.8m sidewalk, 3.0m cycle track, 0.8m buffer, 3.3m drive lanes, 2.5m parking). The existing curb extension and crosswalk at Oswego Street is retained. Along the seawall (Dock Street to Lewis Street) the net impact on parking is an approximate reduction from 120 stalls to 70 stalls.

Sheet CF-G00-C-703: Boyd Street to Menzies Avenue
This section has two cycle track alignment zones: the seawall section west of Lewis Street, and a Holland Point Park section east of Lewis Street.

In the seawall section, the cycle track is adjacent to the existing south sidewalk that abuts the seawall. South side parking is switched to parallel parking from current angle parking, which is required to accommodate the cycle track and buffer. On-street parallel parking would remain along the north side of Dallas Rd. This section has limited width overall, and dimensions are typically minimum for all features (1.8m sidewalk, 3.0m cycle track, 0.8m buffer, 3.3m drive lanes, 2.5m parking).

In the park section, the cycle track will abut a relocated pedestrian sidewalk. The alignment is contained off-street in the existing boulevard area; there is no change to the road cross section in this area. The sidewalk is 1.5m, the cycle track is 3.0m, and the buffer is 2.25m.

Sheet CF-G00-C-704: South Turner Street to Government Street
This section is within Holland Point Park west of Government Street and adjacent to Harrison Yacht Pond east of Government Street. The cycle track will abut a relocated pedestrian sidewalk. The alignment is contained off-street in the existing boulevard area; there is no change to the road cross section in this area. The sidewalk is 1.5m wide, the cycle track is 3.0m and the buffer is generally 2.5m wide, except it is 1.0m along the angled parking frontage and 0.6m wide in narrow areas where required to avoid trees.

Adjacent to Harrison Yacht Pond there are two trees and at the east end of this section there are four large mature trees that necessitate horizontal curvature in the cycle track and sidewalk alignment in order to preserve the trees.

Sheet CF-G00-C-705: Paddon Avenue to Douglas Street
In this section, there are typical alignment segments and two segments with space limitations: one at Paddon Avenue and one at Douglas Street.

In the typical segments, the cycle track will abut a relocated pedestrian sidewalk. The alignment is contained off-street in the existing boulevard area; there is no change to the road cross section in these areas. The sidewalk is 1.5m wide, the cycle track is 3.0m and buffer is generally 1.0m wide, but 0.6m wide in narrow areas where required to avoid trees.

At Paddon Avenue, there is limited width and a geotechnical constraint that prohibits placement of fill on the bluffs. Additionally, a stand of trees immediately east of the east end of the concrete railing has been identified for preservation. Therefore the cycle track alignment through this section encroaches onto Dallas Road, which requires shifting of the drive lanes of Dallas Road to the north. This necessitates the elimination of on-street parking through the pinch point area (a reduction of 13 stalls in total, one of which is a passenger loading zone). A short section adjacent to the trees just east of Paddon Avenue requires narrowing the cycle track to 2.7m wide, with a 0.6m buffer and 3.3m drive lanes.

At Douglas Street, there is also limited width and the same geotechnical constraint. The cycle track alignment encroaches slightly onto Dallas Road, which requires a slight shift of the drive lanes. However no loss of on-street parking is anticipated in this area due to the available width and current parking extents. A minimum of 1.5m sidewalk, 3.0m cycle track, and 1.0m buffer are maintained in this section along with drive lane widths that exceed minimum criteria values.

East of Douglas Street, the cycle track alignment follows a route further south from Dallas Road through the brush area, in order to avoid the large mature trees that abut the south curb of Dallas Road in this area. The pedestrian path alignment shifts south and away from the cycle track at this point as well (and remains separated from the cycle track alignment all the way east to Clover Point).

Sheet CF-G00-C-706: East of Douglas Street / Beacon Hill Park
In the west section, the cycle track alignment is through the brush south of Douglas Street. At the east end, immediately beyond the mature trees, the cycle track approaches the south edge of Dallas Road, and is separated from the roadway and existing on-street perpendicular parking.

At the easterly limit of this section, the alignment encroaches into the existing angled parking to avoid a treed area. This will necessitate conversion to parallel parking for a portion of the area (losing approximately 6 stalls; overall this segment will see a parking reduction from from 92 to 86 stalls).

Sheet CF-G00-C-707: Circle Drive to Cook Street
The alignment is generally away from Dallas Road in this section and does not impact the roadway. It veers south and follows a utility corridor between two treed areas. A connection is proposed to the Circle Drive cycle track.

Sheet CF-G00-C-708: Cook Street to Wellington Avenue
The alignment is offset from Dallas Road in this section and follows the proposed forcemain alignment.

Sheet CF-G00-C-709: Wellington Avenue to Clover Point Pump Station
The alignment is offset from Dallas Road in this section and follows the proposed forcemain alignment up to Clover Point. At the east end the design will tie into the Clover Point Pump Station site design.

7. Geotechnical Assessment (Dallas Road Bluffs)

The City of Victoria, at the May 11, 2017 Council meeting, passed the following resolution related to Dallas Road Waterfront Geotechnical Monitoring.

> *Put in place risk mitigation measures to protect the Dallas Road Bluffs during construction including but not limited to:*
>
> *a. Assembling an interdisciplinary team to study and address the protection of the bluffs.*
>
> *b. As part of the detailed design of the conveyancing, include a plan for the preservation of the bluffs.*

> *And that the Project Board report out to the public at one of their regular community meetings, to the JBNA and to Victoria City Council on the measures outlined.*

In response, the Project Board and Project Team committed to the following:

> *Geotechnical investigations and monitoring will take place along Dallas Road with an enhanced focus on the shoreline and bluffs prior to, during and after the construction of the Clover Point Forcemain and related pipework. The geotechnical investigations will include a series of test holes drilled along the pipe alignment to establish existing geological conditions and to collect samples for laboratory testing and use in establishing geotechnical design parameters for the pipe and bluff stability analysis. The geotechnical monitoring will include the installation of instruments near the bluffs and along the pipe alignment. Recordings from these instruments will be used to monitor conditions during the construction and post-construction phase of the project.*
>
> *The design process for the conveyance system from Ogden Point to Clover Point (the Clover Forcemain) has begun. It includes the development of an indicative design and a final design. Stantec, as the owner's engineer, will undertake the indicative design. Another qualified engineering firm (which we will call the 'Second Engineering Firm') will review the indicative design and prepare the final design. Both firms will have input into the undertaking of, and access to the outcome of, geotechnical investigations and monitoring outlined above.*
>
> *Specifically, the Project Team will competitively-procure the Second Engineering Firm to review the indicative design and prepare the final design. This firm will have expertise in the fields of geotechnical, terrain analysis, environmental and civil engineering. The firm will be provided with the indicative design and the results of the geotechnical investigations undertaken to-date, and will be responsible for reviewing that work as part of developing the final design. They will also be responsible for fulfilling the duties of Engineer of Record as defined by the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC). Professional members of the firm and their qualifications will be noted as part of their work.*
>
> *As part of their scope of work, the Second Engineering Firm will prepare a plan to mitigate any impacts on the bluffs during construction. As noted, this plan will include post-construction monitoring for 12 months following completion of construction.*
>
> *Reports detailing the results of the geotechnical investigations and the indicative alignment will be complete in the fall of 2017. The Project Team will report on these to the public at one of their regular community information meetings, to the James Bay Neighbourhood Association and to Victoria City Council. Results will also be posted on the Project website.*

In keeping with the requirements of the May 11, 2017 resolution to report out to Victoria City Council, the following summarizes the progress that the Project Team has made regarding the plan outlined above.

1. Geotechnical investigations have been undertaken along Dallas Road with an enhanced focus on the shoreline and bluffs. The geotechnical investigations included:

  - twenty-four (24) boreholes drilled along the forcemain alignment, with samples sent for laboratory testing;
  - three (3) slope inclinometers (one near Paddon Avenue, and two near Douglas Street); and
  - one (1) standpipe piezometer with two nested groundwater monitoring wells near Douglas Street.

The results of the geotechnical investigations were used to establish existing geological conditions and geotechnical design parameters for the pipe and bluff stability analysis.

In preparation for geotechnical monitoring during and after construction of the Clover Forcemain, instruments have been installed near the bluffs and along the pipe alignment. Recordings from these instruments will be used to monitor conditions during the construction and post-construction phases of the Project.

2. Design of the Clover Forcemain has been advanced. As laid out above, the design process includes development of an indicative design by Stantec, as the owner’s engineer, and a final design by a second engineering firm.

   The Project Team has competitively-procured a design engineering team led by Kerr Wood Leidal (KWL), to undertake the responsibilities of the second engineering firm: namely, to review the indicative design, prepare the final design, and be responsible for fulfilling the duties of the Engineer of Record as defined by the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC).

3. The KWL team has assembled an interdisciplinary team with expertise in the fields of geotechnical, terrain analysis, environmental, and civil engineering. The KWL team has completed a geotechnical assessment of the Clover Forcemain. The assessment included a review of the indicative design and the results of the geotechnical investigations undertaken to-date, as well as a number of previous studies and technical reports.

   The KWL team agreed with selection of the Dallas Road alignment, and their geotechincal assessment concluded that the forcemain can be designed, constructed and operated in the Dallas Road alignment without having an adverse environmental or geotechnical impact on the bluffs (and without the bluffs affecting the forcemain).

   Details of the geotechnical assessment were documented in the KWL report entitled “Clover Forcemain Geotechnical Summary”, which is included in Appendix “F” of this memo. The report also includes a summary of the credentials and qualifications of the KWL interdisciplinary team of experts.

4. The KWL report outlining the results of the geotechnical assessment of the Clover Forcemain alignment, including the geotechnical investigations to-date, was posted to the Project website on November 27, 2017.

Additionally, the Project Team reported the results of the geotechnical assessment to the public at the November 27, 2017 community information meeting.

The Project Team remains committed to complete the following:

1. Reporting the results of the geotechnical investigations to-date and the geotechnical assessment to the James Bay Neighbourhood Assocation at a meeting on January 10, 2018.
2. Geotechnical monitoring along Dallas Road with an enhanced focus on the shoreline and bluffs during and after the construction of the Clover Forcemain, including post-construction monitoring for twelve (12) months following completion of construction.
3. As part of finalizing the design, the KWL led team will prepare a plan to mitigate any impacts that construction may have on the bluffs. KWL will monitor the construction contractor's adherence to the plan.

8. Next Steps

December 2017

The CRD will present to Council the refined concepts arising from November 2017 input, with a recommendation from staff to bring them forward to the community for consultation.

January 2018

1. CRD will present the 50% design for the exterior of the Clover Point Pump Station Building, the Public Realm Improvements, the Clover Forcemain alignment, and alignment of the Cycle Track, to obtain feedback for incorporation into the design. City of Victoria staff will attend two separate meetings, one with James Bay Neighbourhood Association (JBNA), and one with Fairfield Gonzales Community Association.
    a. Fairfield Gonzales Community Association: CRD presents the design for the exterior of the Clover Point Pump Station Building and the Public Realm Improvements (per Clause 11.5 of the Clover Point Pump Station licence agreement).
    b. Fairfield Gonzales Community Association and James Bay Neighbourhood Association (JBNA): CRD presents the design and alignment of the Cycle Track and alignment of the Clover Forcemain. (per Clause 9.5 of the Clover Forcemain licence agreement).
2. CRD hosts 50% Design Workshop with City and First Nations representation (per Clause 11.2 and 11.3 and 9.2. and 9.6 of the Clover Point Pump Station and Dallas Road (Clover) Forcemain licence agreements, respectively.

February 2018

1. CRD to refine concepts where possible based on previous input from Council (in December) and input from members of the community.
2. CRD presents at a Committee of the Whole Meeting the 50% Design Proposal for the exterior of the Clover Point Pump Station Building, the Public Realm Improvements, the Dallas Road (Clover) Forcemain alignment, and alignment of the Cycle Track, which will reflect input received from the community associations (per Clauses 11.4 and 11.5 and 9.4 and 9.5 of the Clover Point Pump Station and Clover Forcemain licence agreements, respectively).

3. CRD to proceed with detailed design of the exterior of the Clover Point Pump Station Building, the Public Realm Improvements, and the Clover Forcemain alignment and Cycle Track.
4. CRD hosts 90% Design Workshop with City and First Nations representation (per Clause 11.2 and 11.3 and 9.2. and 9.6 of the Clover Point Pump Station and Dallas Road (Clover) Forcemain licence agreements, respectively).

March 2018

Key activities include:

1. Final acceptance of the exterior of the Clover Point Pump Station Building and the Public Realm Improvements (per Clauses 6.8 and 11.6 of the licence agreement)
2. Final acceptance of the Clover Forcemain alignment and design and alignment of the Cycle Track (per Clauses 9.1 and 9.7 of the licence agreement).
3. Community Information Meeting, with City of Victoria staff in attendance, to provide:
    a. General status update, final construction impacts and mitigation, timing for implementation, and opportunity for the public to ask questions;

       Summary report of input received in Community Information Meetings.

    b. Presentation of the final design for the exterior of the Clover Point Pump Station Building, the Public Realm Improvements, and the Clover Forcemain alignment, and design and alignment of the Cycle Track; and
    c. Opportunity for City of Victoria to obtain public input re: specific improvements to be implemented under subsection 6.6 of the Clover Point Pump Station Licence Agreement (per Clause 6.8).

April 2018

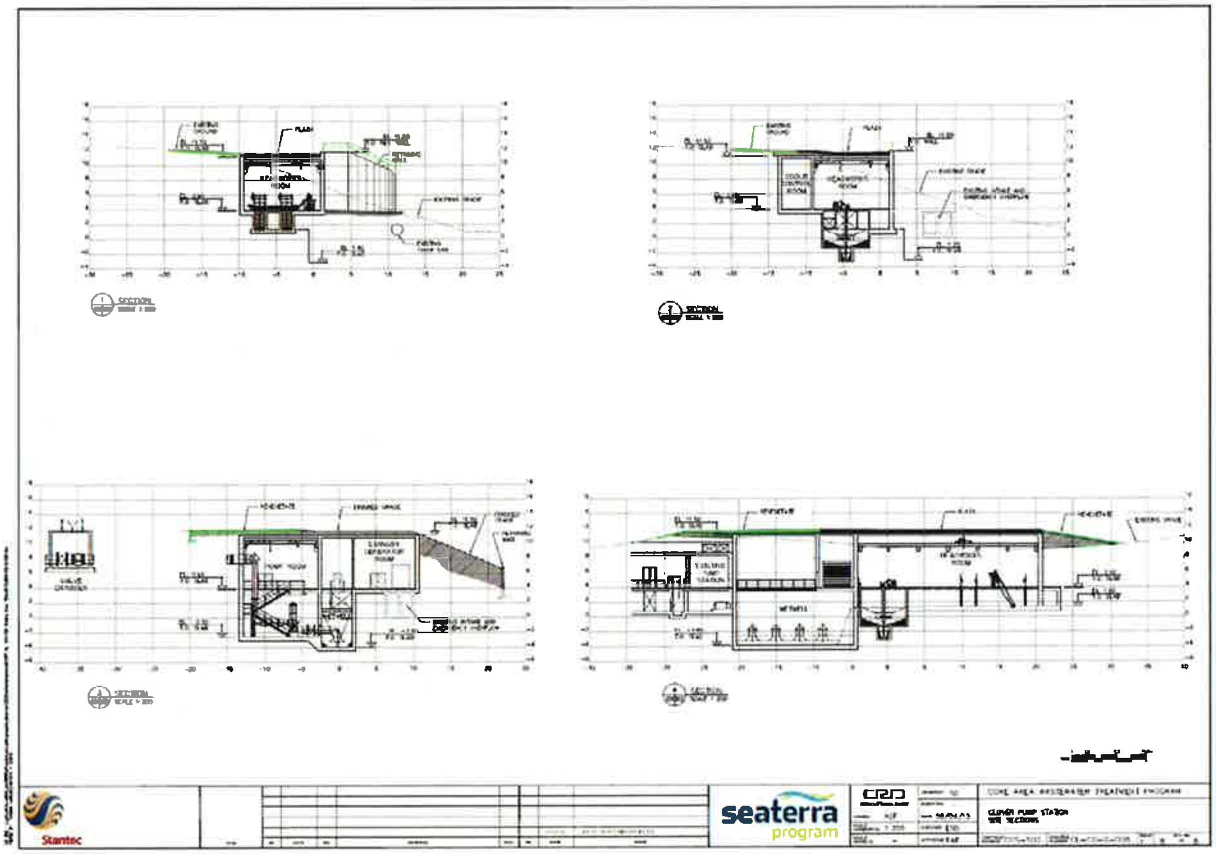
The CRD provides the City of Victoria's Director of Engineering a public engagement plan prior to commencing construction that outlines how the CRD will manage inquiries, complaints, and correspondence from the public that are directed to the City regarding the Project.

Appendix "A"

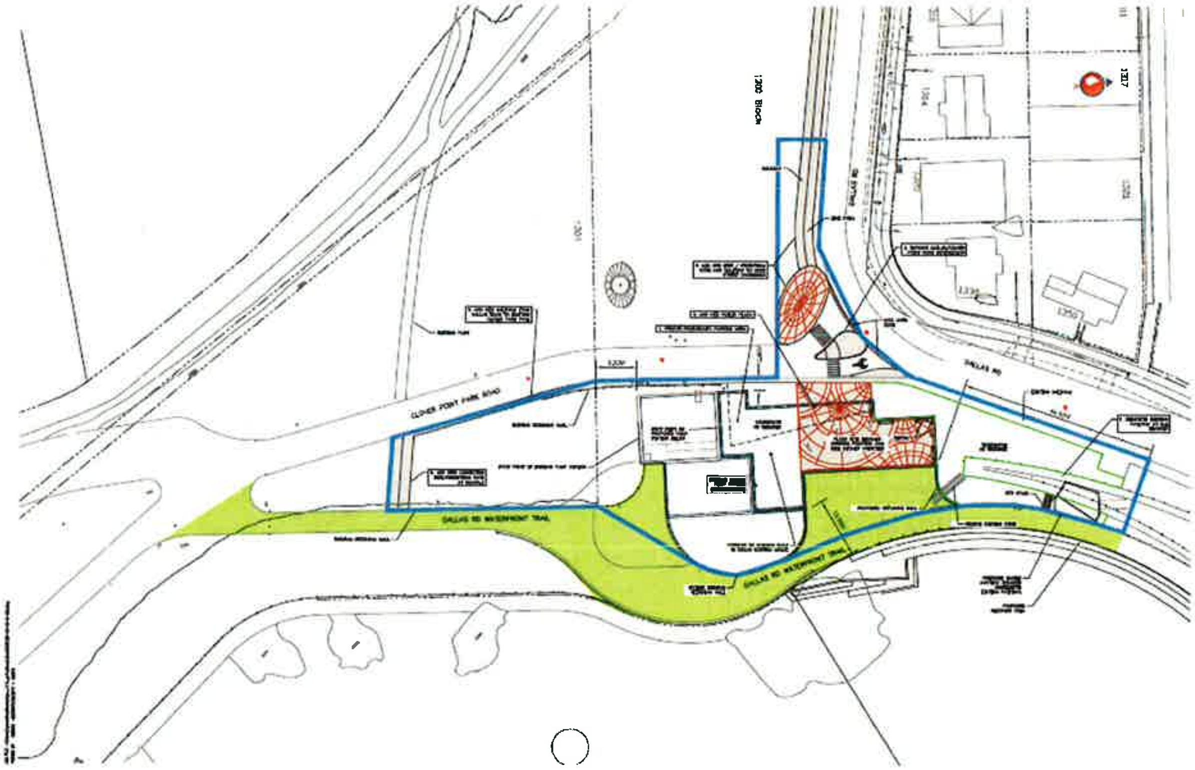
Clover Point Pump Station – Licence of Occupation Excerpts re: Design Concept and Design Guidelines

Schedule “B”

The Works (conceptual only)



Schedule "C"
The Lands



Schedule "D"

Conceptual Plan of the Public Realm Improvements

Schedule "E"

Design Guidelines for the Public Realm Improvements

The City's vision is that:

Clover Point Park should be reimagined as a "special place" of arrival and gathering and should acknowledge and reflect that the location is:

- the proposed beginning/terminus of the Trans Canada Trail and will form part of a future network of nationally significant "special places"
- a part of the Salish Sea Marine Trail
- a part of the federal Victoria Harbour Migratory Bird Sanctuary.

Public Realm Improvements

The public realm improvements will complement the City's vision by:

- functioning as a regional destination for multiple users to enjoy waterfront views, with a "rest area" linking to the proposed bikeway ("Cycle Track") and Ross Bay Greenway.
- encouraging architectural elements that contribute to creating a visual identity for the site, and include distinctive features, such as seating, or lighting.
- considering low cost of maintenance and weather resistance as important factors.
- recognizing and celebrating the heritage and culture of the Songhees First Nation and the Esquimalt First Nation.
- where respectful and appropriate, considering the Songhees First Nation and the Esquimalt First Nation heritage and culture in the Public Realm Improvements, more specifically in the development of public art, associated signage, and any additional exterior design of Public Realm Improvements that the parties may agree upon.

Site Furnishings and Amenities

- Pavement will be concrete, brick or pavers.
- All landscaping will be low maintenance, with no or low long term irrigation requirements.
- The design of the public realm improvements will include at minimum:
  - 4 benches
  - 2 garbage cans (in-ground cans to be installed where feasible)
  - 1 interpretive sign
  - 2 bicycle racks
  - 1 bicycle kitchen (i.e. a maintenance stand similar to those along Capital Regional District's Regional Trails)
  - 1 water fountain
- All site furnishings should be consistent in design, style and quality as the City's current Park's standard.

Public Art

- Consider the inclusion of public art in consultation with the City's artist and aboriginal artist in residence.

Bikeway and Pathway Connectivity

- The location is a key connecting point to bikeways and pathways, including the pathway along Clover Point Park towards Beacon Hill Park, and Ross Bay Greenway (combined bikeway and pathway).
- The final design will link these existing bikeways and pathways with the Cycle Track along Dallas Road, maintain pedestrian and cycling flows along Clover Point Road, and, minimize conflicts between existing park users and users of the Cycle Track and Public Realm Improvements.
- A gathering/dismount area for the Cycle Track will be incorporated on the west side of Clover Point Road at Dallas Road.
- Bike amenities will be included on the east side of Clover Point Road, near the new washroom, and upgraded pump station facility.

Public Washroom

- The washroom facility will contain two gender neutral, universally accessible single use washrooms, each with a sink, toilet, urinal and electric hand dryer and a mechanical/janitors room. The total building will have an approximate footprint size of 3.5m x 8.5 m.
- In determining washroom location, existing view sheds will be a consideration. Building form and massing need to minimize impacts to the views from public vantage points along Dallas Road, Clover Point Road, and from the water.
- The washroom must be distinctive in appearance, yet the function is integrated into the site's topography and overall landscape design.
- Proposed location and building design must respond to public safety considerations and consider Crime Prevention Through Environmental Design (CPTED) principles and the need for lighting.
- High-quality materials will be used for the exterior design, and interior finishes.
- Building will be constructed to LEED Silver at minimum and should strive for LEED Gold.

Universal Access

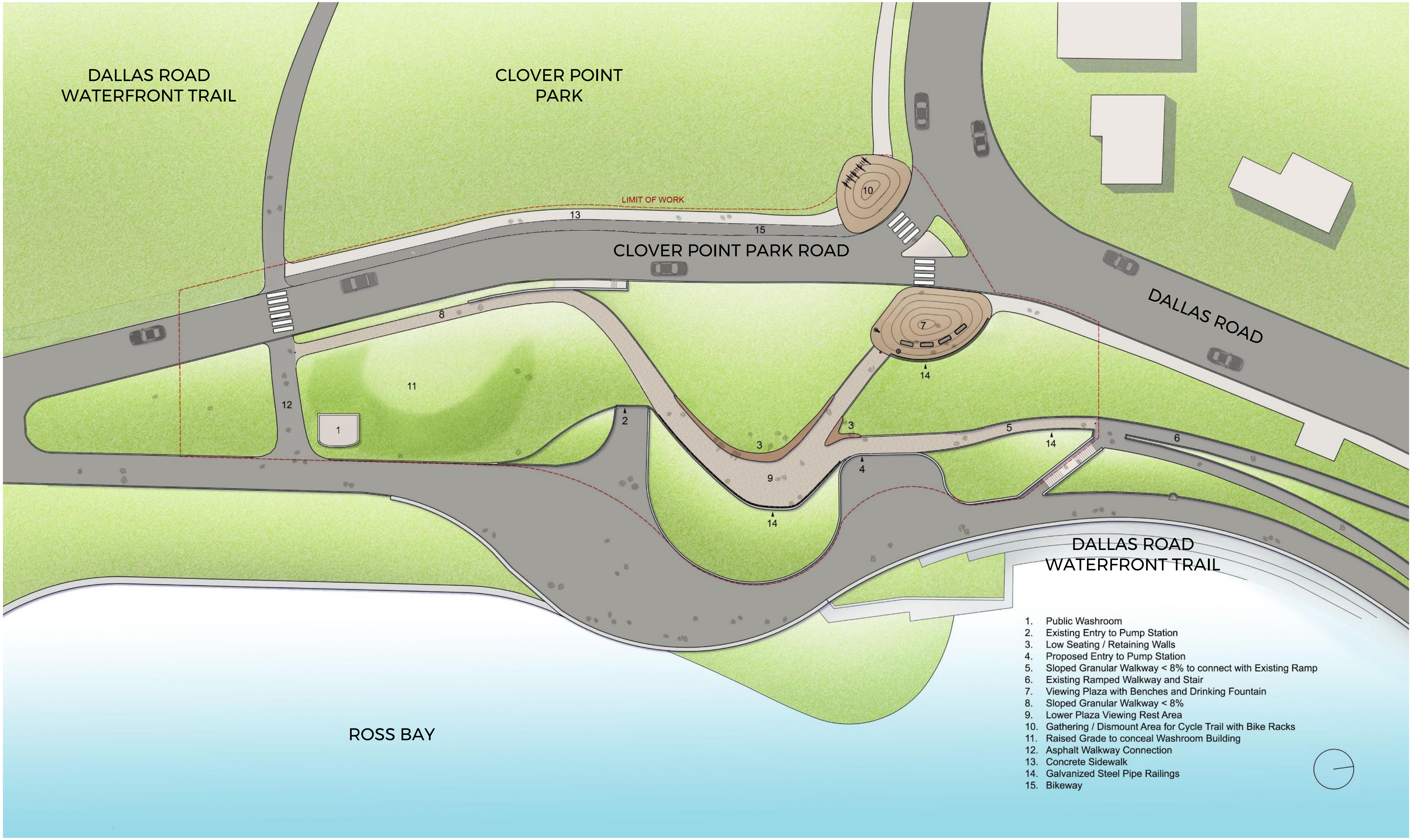
- Universal access (i.e. wheelchair access) will be provided to all plazas and washrooms.
- Pathways will be universally accessible wherever possible to City standards.

Construction Specifications

- To provide pedestrian priority over vehicle movements and reduce vehicle speeds, the intersections improvements at Dallas and Clover Point Road are to be constructed as a standard driveway crossing, consistent with the City's Subdivision and Development Servicing Bylaw No. 12-042.
- Intersection improvements, roadways, sidewalks, landscaping and any other works or services must be designed and constructed in accordance with the requirements and specifications in the City's Subdivision and Development Servicing Bylaw No. 12-042.

Appendix "B"

Kenaidan Contractin Ltd – Design Proposal
Clover Point PS – Building Exterior and Public Realm Improvements

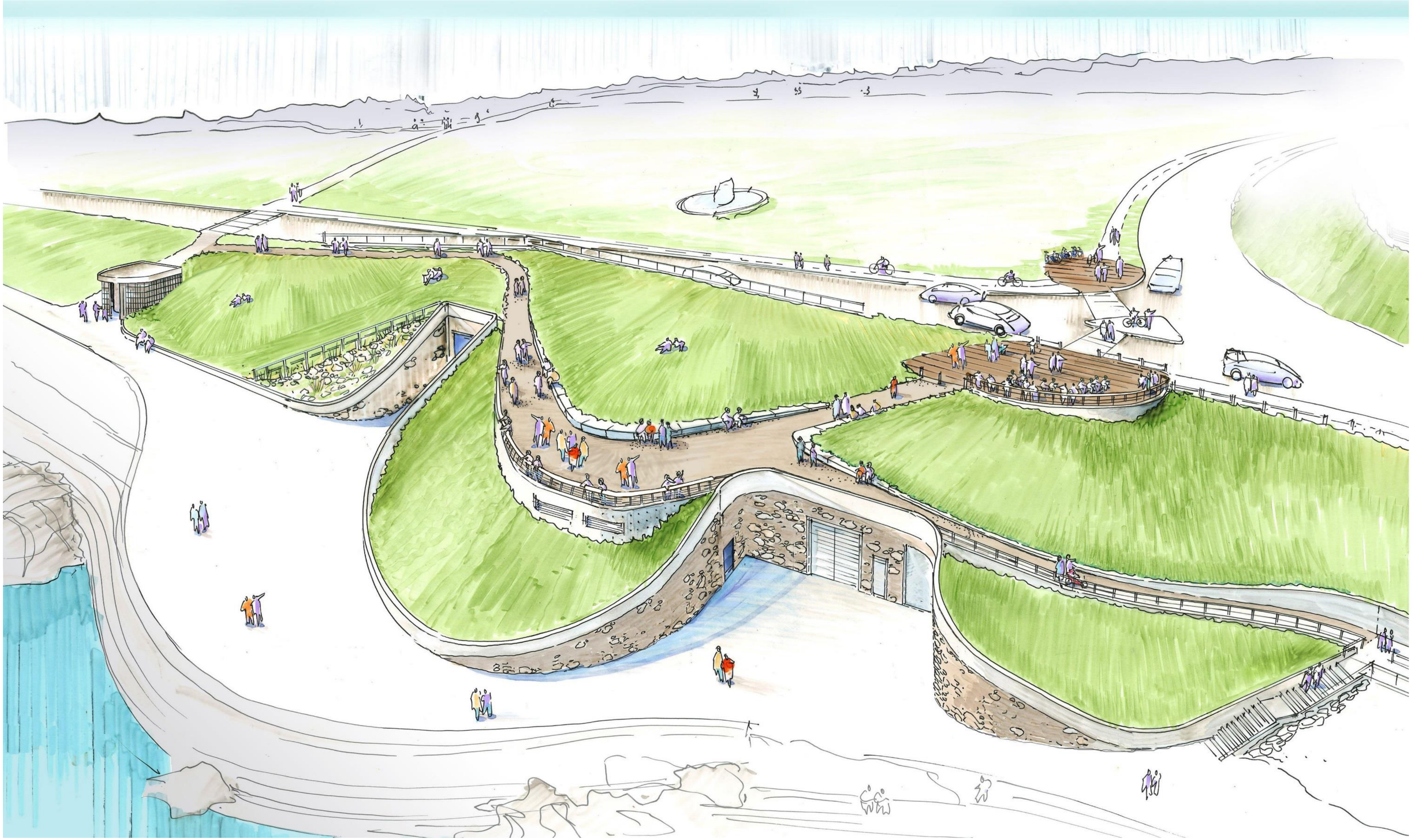


1. Public Washroom
2. Existing Entry to Pump Station
3. Low Seating / Retaining Walls
4. Proposed Entry to Pump Station
5. Sloped Granular Walkway < 8% to connect with Existing Ramp
6. Existing Ramped Walkway and Stair
7. Viewing Plaza with Benches and Drinking Fountain
8. Sloped Granular Walkway < 8%
9. Lower Plaza Viewing Rest Area
10. Gathering / Dismount Area for Cycle Trail with Bike Racks
11. Raised Grade to conceal Washroom Building
12. Asphalt Walkway Connection
13. Concrete Sidewalk
14. Galvanized Steel Pipe Railings
15. Bikeway

CLOVER PUMP STATION

City of Victoria 30% Design Presentation - December 2017

FIGURE 1 - CONCEPT PUBLIC REALM PLAN



CLOVER PUMP STATION

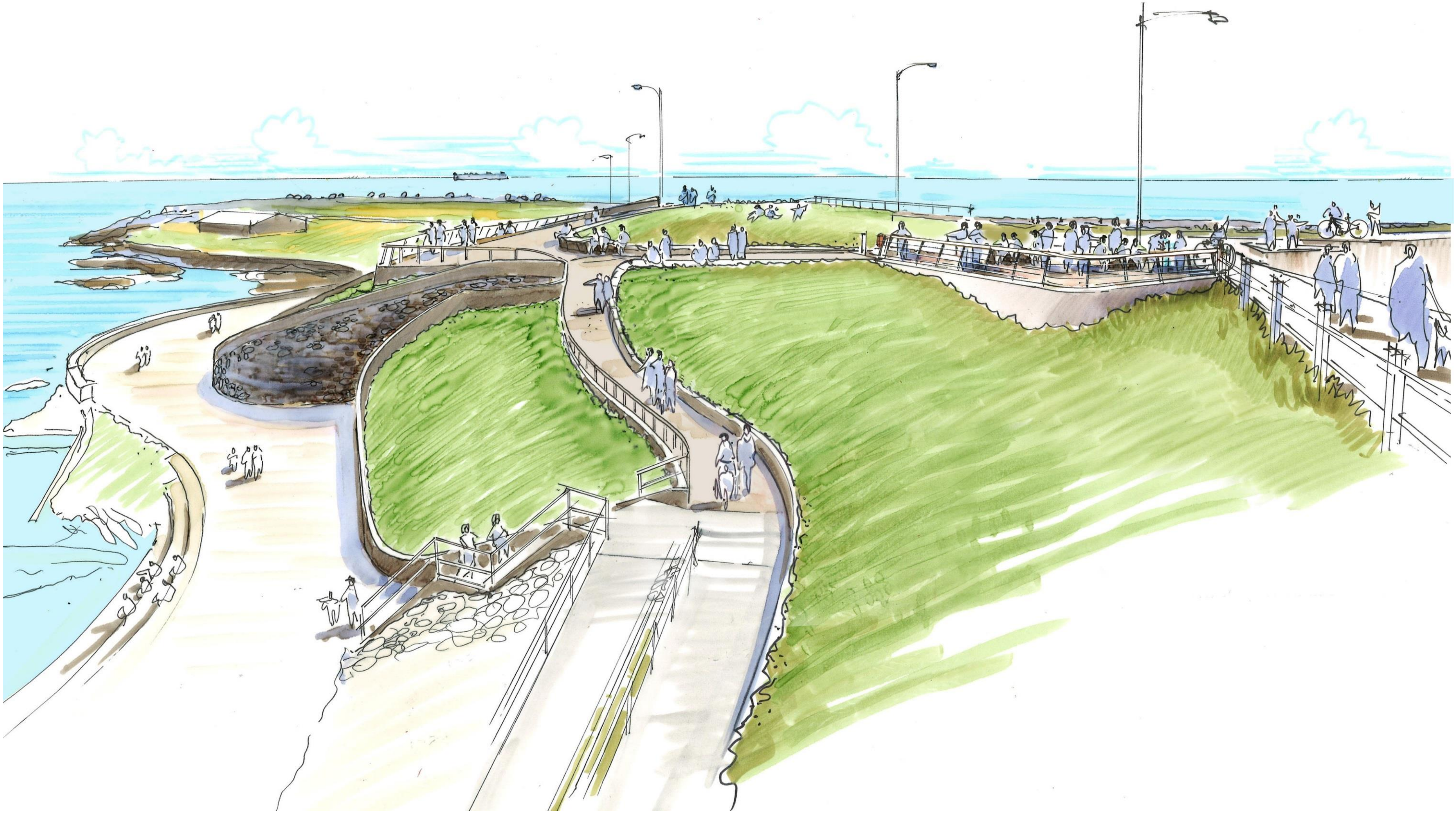
City of Victoria 30% Design Presentation - December 2017

FIGURE 2 - AERIAL PERSPECTIVE

CLOVER PUMP STATION

City of Victoria 30% Design Presentation - December 2017

FIGURE 3 - PERSPECTIVE LOOKING NORTH



CLOVER PUMP STATION

City of Victoria 30% Design Presentation - December 2017

FIGURE 4 - PERSPECTIVE LOOKING SOUTH

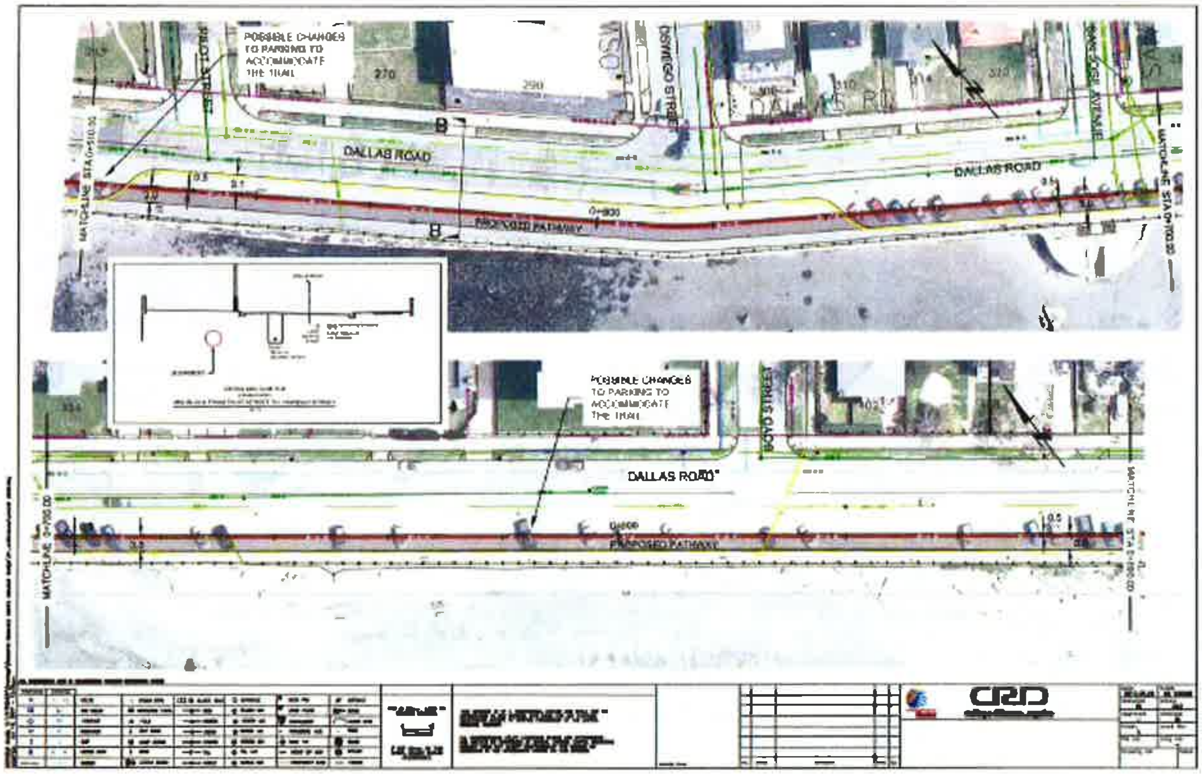
Appendix "C"

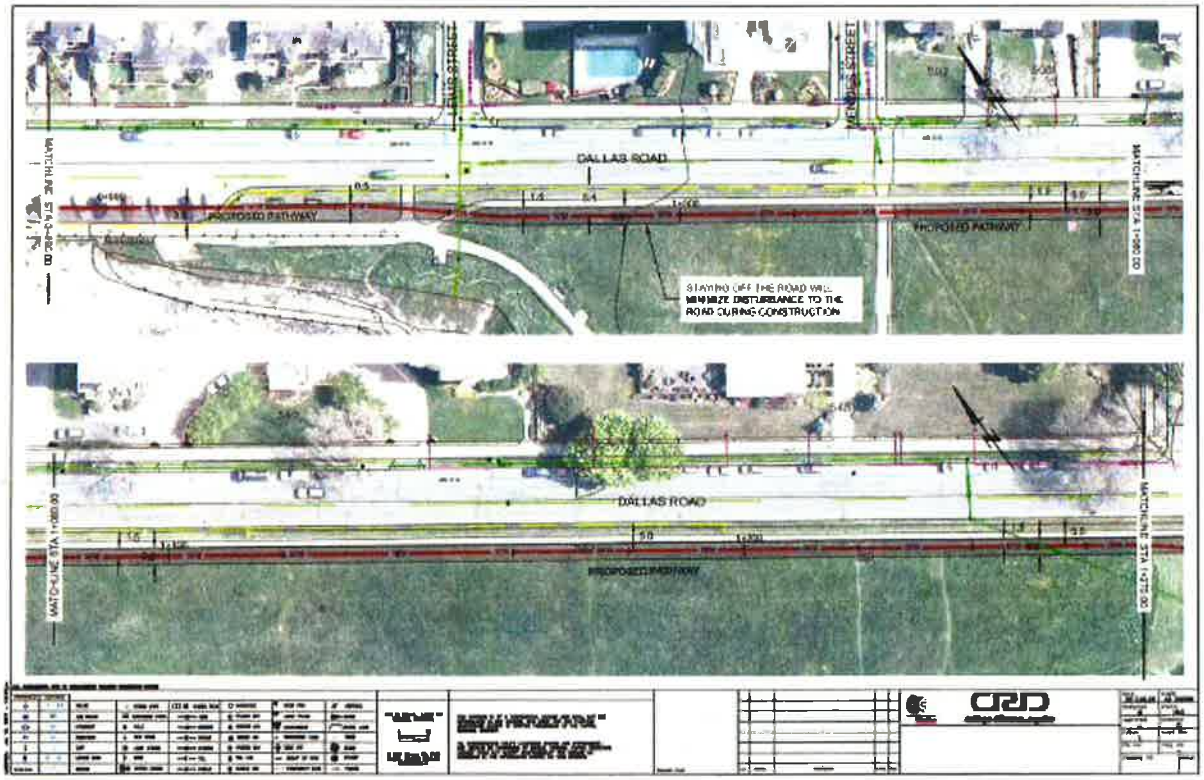
Dallas Road Forcemain Licence of Occupation
Excerpts re: Design Concept and Design Guidelines

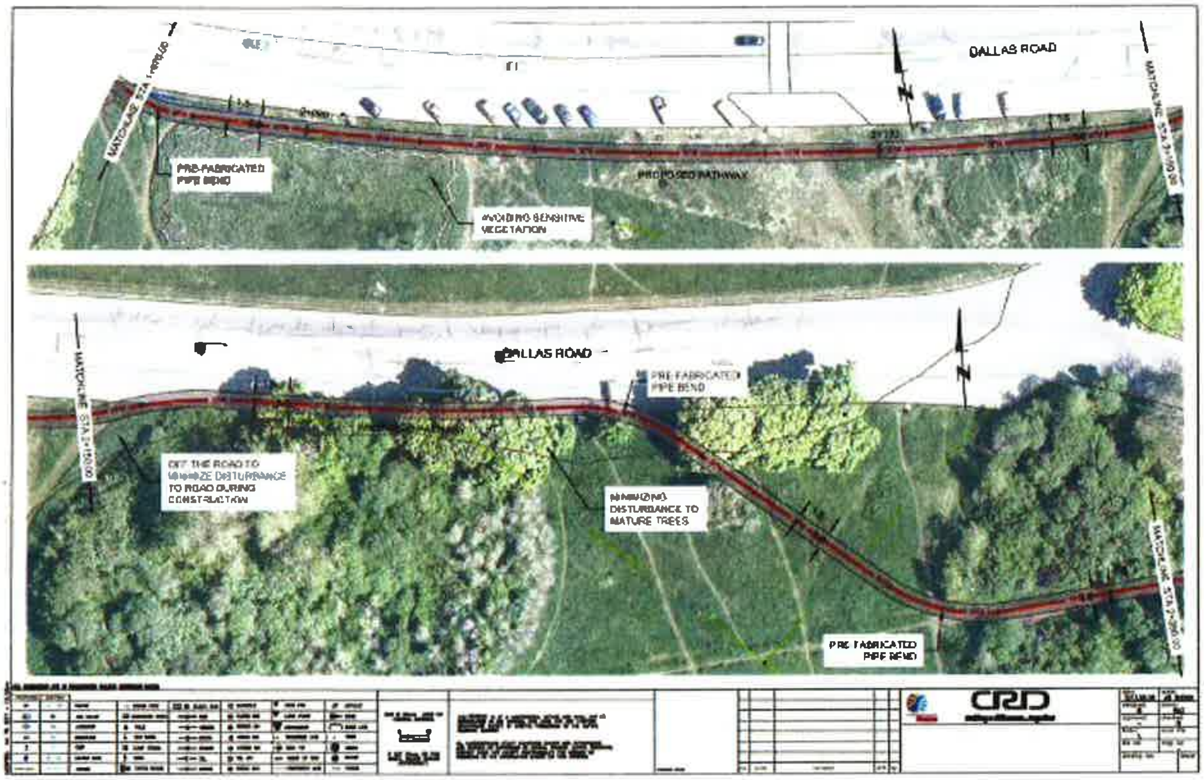
Schedule "B"

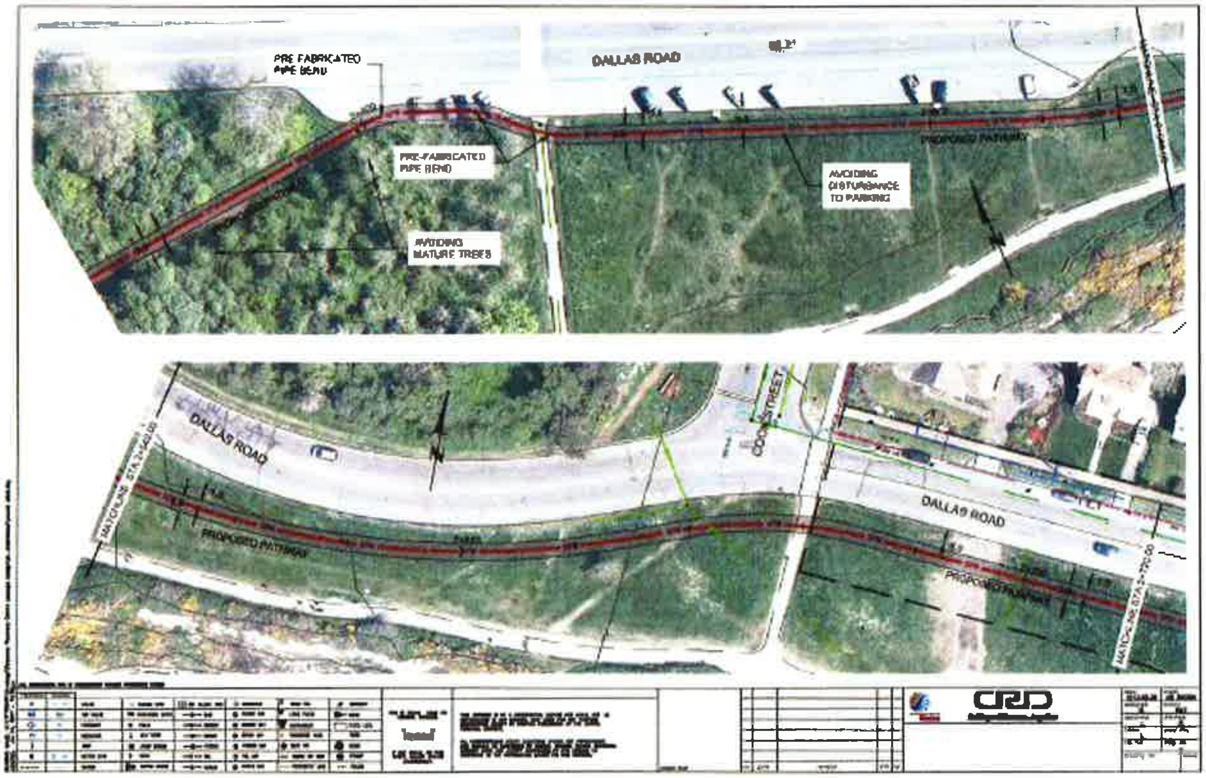
Conceptual Drawings of the Works

JUNE 2013


POSSIBLE CHANGES TO PARKING TO ACCOMMODATE THE TRAIL
PILOT STREET
OSWEGO STREET
MENZIES AVENUE
DALLAS ROAD
DALLAS ROAD
PROPOSED PATHWAY
MATCHLINE STA 0+510.00
MATCHLINE STA 0+700.00
0+600
270
290
B
B
POSSIBLE CHANGES TO PARKING TO ACCOMMODATE THE TRAIL
BOYD STREET
DALLAS ROAD
PROPOSED PATHWAY
MATCHLINE STA 0+700.00
MATCHLINE STA 0+890.00
CRD


DALLAS ROAD
PROPOSED PATHWAY
PROPOSED PATHWAY
STAYING OFF THE ROAD WILL MINIMIZE DISTURBANCE TO THE ROAD DURING CONSTRUCTION
MATCHLINE STA 0+890.00
MATCHLINE STA 1+080.00
DALLAS ROAD
PROPOSED PATHWAY
MATCHLINE STA 1+080.00
MATCHLINE STA 1+270.00
CRD


DALLAS ROAD
MATCHLINE STA 1+980.00
MATCHLINE STA 2+180.00
PRE-FABRICATED PIPE BEND
PROPOSED PATHWAY
AVOIDING SENSITIVE VEGETATION
DALLAS ROAD
MATCHLINE STA 2+180.00
PRE-FABRICATED PIPE BEND
OFF THE ROAD TO MINIMIZE DISTURBANCE TO ROAD DURING CONSTRUCTION
MINIMIZING DISTURBANCE TO MATURE TREES
MATCHLINE STA 2+380.00
PRE-FABRICATED PIPE BEND
CRD


PRE FABRICATED PIPE BEND
DALLAS ROAD
PRE-FABRICATED PIPE BEND
AVOIDING DISTURBANCE TO PARKING
PROPOSED PATHWAY
AVOIDING MATURE TREES
DALLAS ROAD
COOK STREET
MATCHLINE STA 2+540.00
PROPOSED PATHWAY
DALLAS ROAD
PROPOSED PATHWAY
MATCHLINE STA 2+770.00
CRD

Appendix “D”

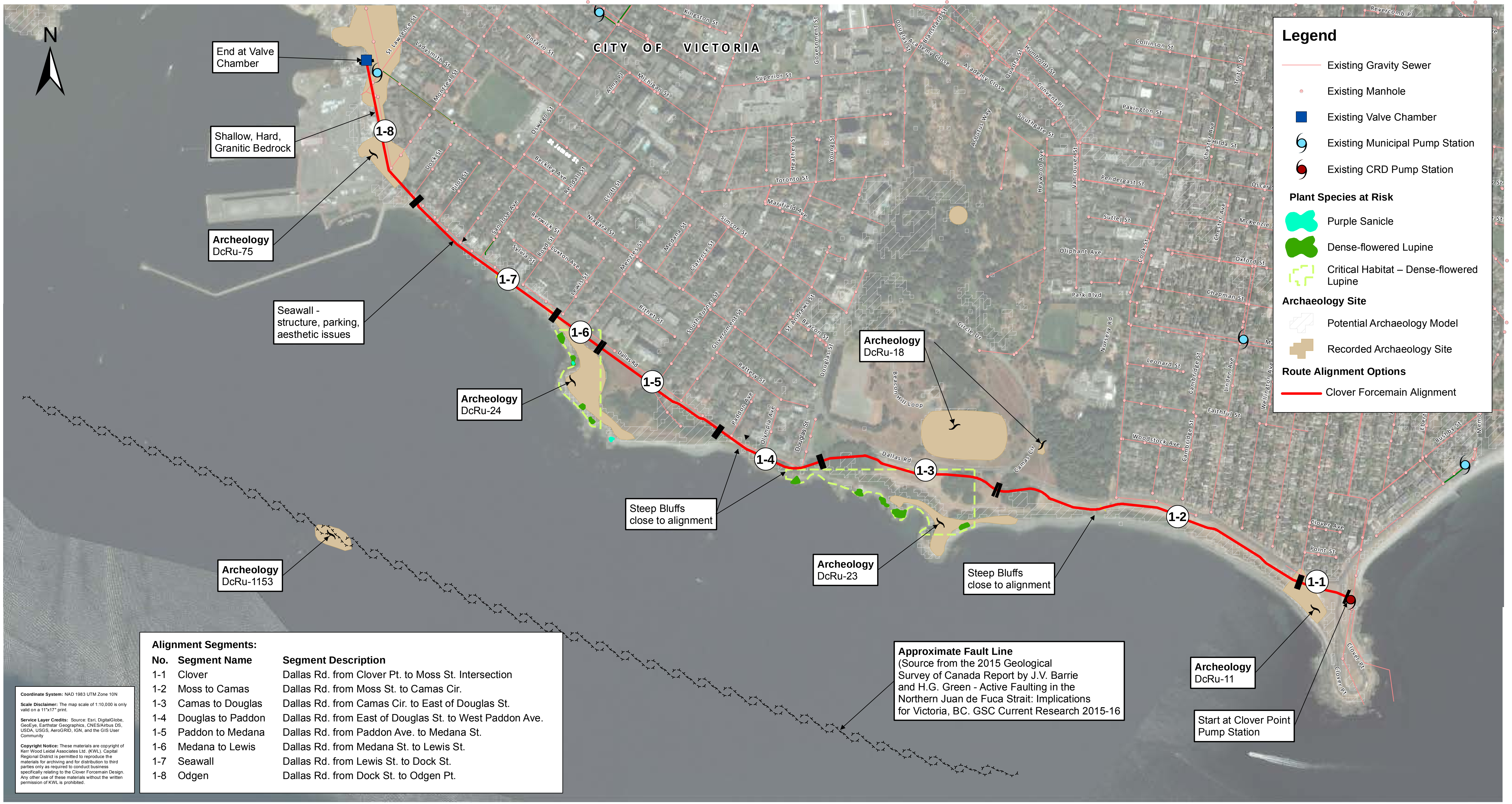
Kerr Wood Leidal Design Proposal Clover Forcemain Alignment

Path: O:\0200-0299\283-372\430-GIS\MXD-Rp\283372_Fig2_Option1.mxd Date Saved: 10/16/2017 10:27:14 AM | Author: jlau

Capital Regional District

Clover Forcemain Design

KERR WOOD LEIDAL
consulting engineers



End at Valve Chamber

Shallow, Hard, Granitic Bedrock

Archeology DcRu-75

Seawall - structure, parking, aesthetic issues

Archeology DcRu-24

Archeology DcRu-18

Steep Bluffs close to alignment

Archeology DcRu-1153

Archeology DcRu-23

Steep Bluffs close to alignment

Archeology DcRu-11

Start at Clover Point Pump Station

Approximate Fault Line
(Source from the 2015 Geological
Survey of Canada Report by J.V. Barrie
and H.G. Green - Active Faulting in the
Northern Juan de Fuca Strait: Implications
for Victoria, BC. GSC Current Research 2015-16

Legend

- Existing Gravity Sewer
- Existing Manhole
- 🟦 Existing Valve Chamber
- Existing Municipal Pump Station
- Existing CRD Pump Station

Plant Species at Risk

- Purple Sanicle
- Dense-flowered Lupine
- Critical Habitat – Dense-flowered Lupine

Archaeology Site

- Potential Archaeology Model
- Recorded Archaeology Site

Route Alignment Options

- Clover Forcemain Alignment

Alignment Segments:

No.	Segment Name	Segment Description
1-1	Clover	Dallas Rd. from Clover Pt. to Moss St. Intersection
1-2	Moss to Camas	Dallas Rd. from Moss St. to Camas Cir.
1-3	Camas to Douglas	Dallas Rd. from Camas Cir. to East of Douglas St.
1-4	Douglas to Paddon	Dallas Rd. from East of Douglas St. to West Paddon Ave.
1-5	Paddon to Medana	Dallas Rd. from Paddon Ave. to Medana St.
1-6	Medana to Lewis	Dallas Rd. from Medana St. to Lewis St.
1-7	Seawall	Dallas Rd. from Lewis St. to Dock St.
1-8	Odgen	Dallas Rd. from Dock St. to Odgen Pt.

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:10,000 is only valid on a 11"x17" print.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Project No.	283-372
Date	October 2017
Scale	1:10,000

Clover Forcemain Location Map and Site Considerations

Figure 1-1

Appendix “E”

Kerr Wood Leidal Design Proposal
Dallas Road Cycle Track Alignment

Schedule "E"

The Design Guidelines for the Cycle Track

Cycle Track Connectivity

- The Cycle Track will extend from Dock Street at the Ogden Point breakwater to Clover Point.
- A gathering/dismount area for the Cycle Track will be incorporated on the west side of Clover Point Road at Dallas Road as part of the Public Realm Improvements to be constructed under the Licence of Occupation for the Clover Point Pump Station.

Alignment

- The Cycle Track will be consistent with the alignment of the Works, subject to any variance required by the CRD due to design requirements or for geotechnical, archaeological and environmental reasons.

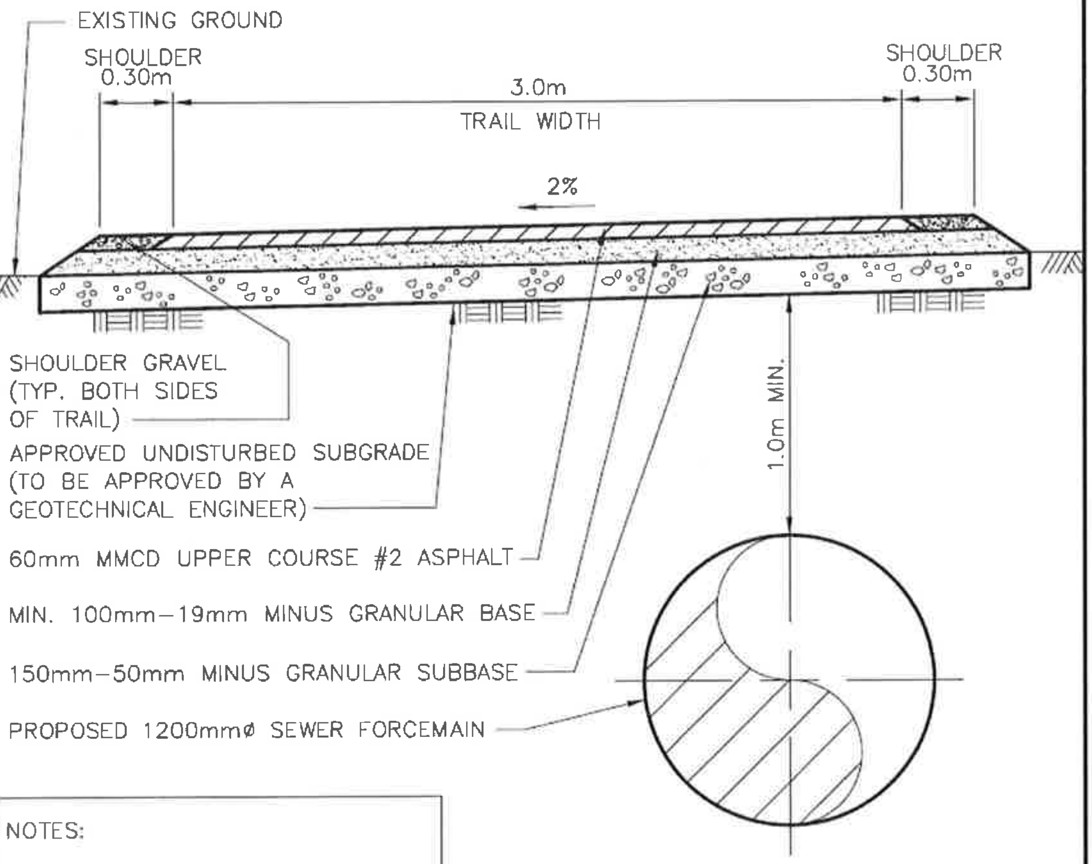
Pathway Design Specifications

- The Cycle Track must be:
    - three (3) metres wide;
    - physically separated from Dallas Road;
    - constructed in accordance with the attached Typical Trail Section Detail;
    - designed to mitigate public safety concerns and incorporate Crime Prevention Through Environmental Design (CPTED) principles, including lighting;
    - in compliance with Transportation Association of Canada geometric design standards for bikeways;
    - designed to incorporate safety improvements for pedestrian crossings, linkages to existing crosswalks and connections to the Dallas Road waterfront pathway; and
    - constructed in a manner that minimizes loss of parking spaces.

Site Furnishings

- All existing in-ground garbage cans located adjacent to Dallas Road must be replaced as part of the Project. Final locations will be determined in consultation with City of Victoria Parks staff.
- The Cycle Track must incorporate a bike rack and a bench at a minimum of six locations at key intersections.
- All site furnishings will be consistent in design, style and quality as the City's current Park's standard.
- Barrier-fencing will be located between the dog off-leash area and the Cycle Track east of Cook Street. The specific locations for fencing shall be determined in consultation with the City's Director of Parks and Director of Engineering during the detailed design process.

Capital Regional District | Parks & Environmental Services



NOTES:

1. TRAIL SURFACE TO SHED WATER AND DRAIN IN ACCORDANCE TO ENGINEERING DRAWINGS (SLOPE DIRECTION MAY VARY).
2. SEWER FORCEMAIN LOCATION MAY VARY.

ELEVATION

TYPICAL TRAIL SECTION

1:25

CRD
Making a difference...together

DALLAS ROAD FORCEMAIN

TYPICAL TRAIL SECTION DETAIL

DESIGNED	DRAWN	SCALE	CHECKED	APPROVED	DATE	DWG. NO.	REV.	SHT
M.C.	L.B.	AS SHOWN	M.C.	M.C.	02/05/14	**5–M110–1**		1 OF 1

SECTION A
N.T.S.

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:37PM

WATT
Consulting Group

SEAL

BY	DATE	No.	REVISION	ENG.

No.	DATE	ISSUE
A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District
Wastewater Treatment Project

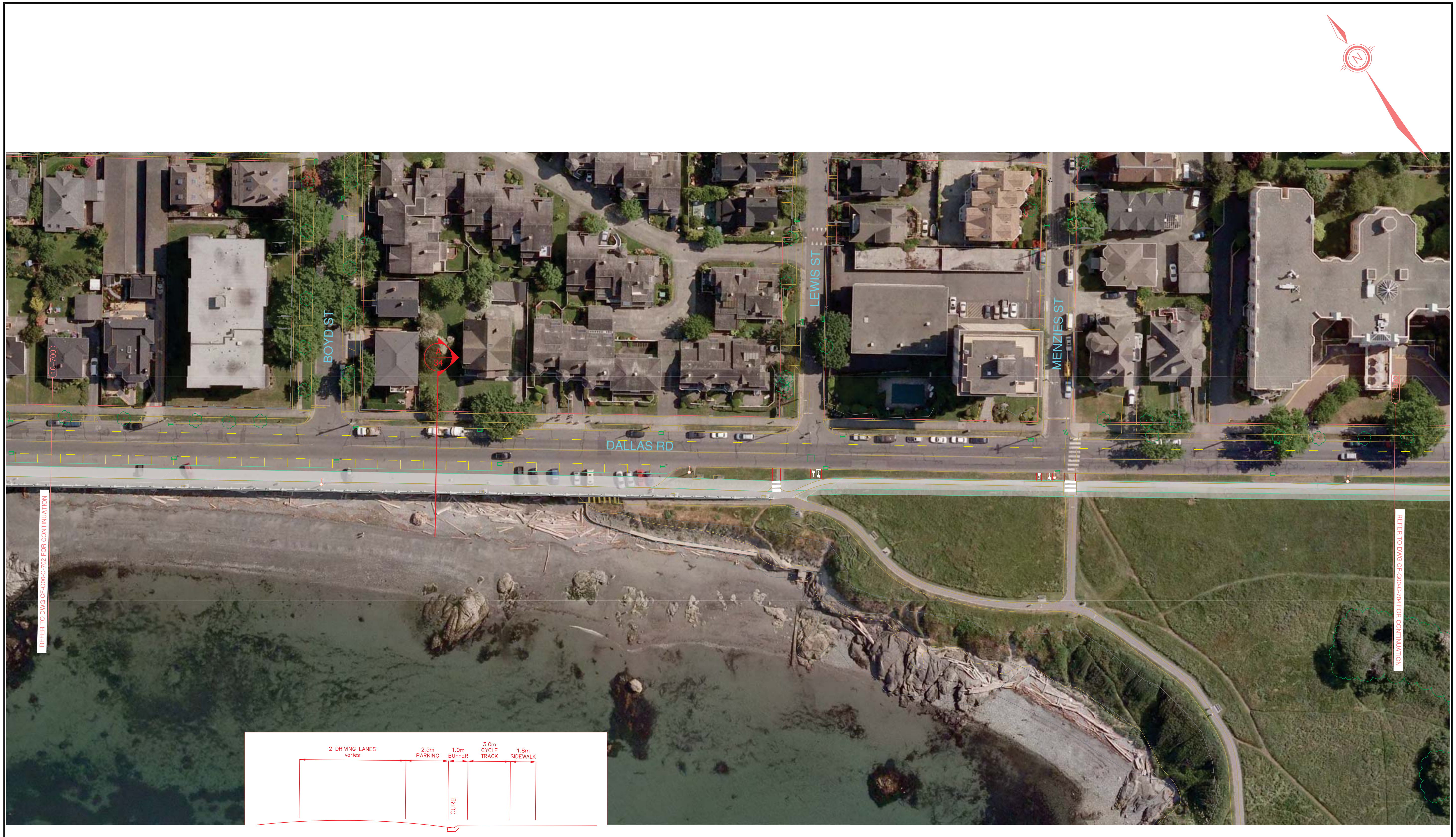
DESIGNED	M. JACOBSON	**SURVEYED**	
DRAWN	B. SOCH	**DATE**	2017.12.08
SCALE HORIZONTAL	1:500	**CHECKED**	M. JACOBSON
SCALE VERTICAL		**APPROVED**	

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 10+320 TO STA 10+700

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-702
ISSUE
33 **SHT. No. OF** 40



SECTION A
N.T.S.

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:38PM

WATT
Consulting Group

SEAL

BY	DATE	No.	REVISION	ENG.

No.	DATE	ISSUE
A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District Wastewater Treatment Project
DESIGNED M. JACOBSON
SURVEYED
DRAWN B. SOCH
DATE 2017.12.08
SCALE HORIZONTAL 1:500
CHECKED M. JACOBSON
SCALE VERTICAL
APPROVED

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 10+700 TO STA 11+080

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-703
ISSUE
34 **SHT. No. OF** 40

SECTION A
N.T.S.

1:500 0 5 15 25m

WATT Consulting Group

SEAL	BY	DATE	No.	REVISION	ENG.	No.	DATE	ISSUE
						A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District	Wastewater Treatment Project
DESIGNED M. JACOBSON	SURVEYED
DRAWN B. SOCH	DATE 2017.12.08
SCALE HORIZONTAL 1:500	CHECKED M. JACOBSON
SCALE VERTICAL	APPROVED

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 11+080 TO STA 11+440

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-704
ISSUE
SHT. No. 35 OF 40

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:39PM

SECTION A
N.T.S.

1:500 0 5 15 25m

WATT Consulting Group

SEAL	BY	DATE	No.	REVISION	ENG.	No.	DATE	ISSUE
						A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District Wastewater Treatment Project

DESIGNED M. JACOBSON
SURVEYED
DRAWN B. SOCH
DATE 2017.12.08
SCALE HORIZONTAL 1:500
CHECKED M. JACOBSON
SCALE VERTICAL
APPROVED

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 11+440 TO STA 11+820

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-705
ISSUE
SHT. No. 36 **OF** 40

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:41PM

SECTION A
N.T.S.

1:500 0 5 15 25m

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:42PM

WATT
Consulting Group

SEAL

BY	DATE	No.	REVISION	ENG.

No.	DATE	ISSUE
A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District Wastewater Treatment Project
DESIGNED M. JACOBSON
SURVEYED
DRAWN B. SOCH
DATE 2017.12.08
SCALE HORIZONTAL 1:500
CHECKED M. JACOBSON
SCALE VERTICAL
APPROVED

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 11+820 TO STA 12+200

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-706
ISSUE
37
SHT. No. OF 40

SECTION A
N.T.S.

1:500
0 5 15 25m

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:43PM

WATT
Consulting Group

SEAL

BY	DATE	No.	REVISION	ENG.

No.	DATE	ISSUE
A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District	Wastewater Treatment Project
DESIGNED M. JACOBSON	SURVEYED
DRAWN B. SOCH	DATE 2017.12.08
SCALE HORIZONTAL 1:500	CHECKED M. JACOBSON
SCALE VERTICAL	APPROVED

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 12+200 TO STA 12+580

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-707
ISSUE
SHT. No. 38 OF 40

SECTION A
N.T.S.

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:44PM

WATT
Consulting Group

SEAL

BY	DATE	No.	REVISION	ENG.

No.	DATE	ISSUE
A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District Wastewater Treatment Project

DESIGNED M. JACOBSON
SURVEYED
DRAWN B. SOCH
DATE 2017.12.08
SCALE HORIZONTAL 1:500
CHECKED M. JACOBSON
SCALE VERTICAL
APPROVED

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 12+580 TO STA 12+960

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-708
ISSUE
39 **SHT. No. OF** 40

SECTION A
N.T.S.

CAD FILE : V:\Project Files\2249 - Clover Forcemain Peer Review\Drawing\2249.B01 Dallas Rd_Cycle Track Alignment.dwg
PRINTED BY :BSOCH -DECEMBER/08/2017 - 1:46PM

WATT
Consulting Group

SEAL

BY	DATE	No.	REVISION	ENG.

No.	DATE	ISSUE
A	2017.12.08	PRELIMINARY ISSUED FOR 50% REVIEW

CRD
Making a difference...together

Capital Regional District	Wastewater Treatment Project
DESIGNED M. JACOBSON	SURVEYED
DRAWN B. SOCH	DATE 2017.12.08
SCALE HORIZONTAL 1:500	CHECKED M. JACOBSON
SCALE VERTICAL	APPROVED

CLOVER FORCEMAIN

A 2017.12.08 PRELIMINARY ISSUED FOR 50% REVIEW

DALLAS ROAD CYCLE TRACK ALIGNMENT
STA 12+960 TO STA 13+217.63

CONTRACT NUMBER CFM-001R
DRAWING NUMBER CF-G00-C-709
ISSUE
40
SHT. No. OF
40

Appendix "F"

Geotechnical Assessment and Investigation Reports

MEMORANDUM

Clover Forcemain
Geotechnical Summary

Prepared for

Capital Regional District

November 27, 2017

KERR WOOD LEIDAL
consulting engineers

THURBER ENGINEERING LTD.

ch2m

Rev 0– 11/27/2017

Contents

Figures

SECTION 1

Introduction

This memorandum summarizes geotechnical conditions along the Dallas Road alignment of the Clover Forcemain, reviews geotechnical conditions affecting design of the forcemain, and outlines the next steps for geotechnical work required to complete detailed design. This memorandum is based on Kerr Wood Leidal Consulting Engineers' (KWL) review of the indicative design prepared by Stantec Consulting Ltd (Stantec), results of geotechnical investigations and reference reports, information presented at meetings with Capital Regional District (CRD) and Stantec staff, and a site reconnaissance.

The KWL team concluded that with refinement of the indicative design, the Dallas road alignment is suitable for construction of the Clover Forcemain from a geotechnical perspective and that the forcemain can be constructed and operated without an adverse effect on the Dallas Road Bluffs and James Bay Seawall.

1.1 Project Background

The Clover Forcemain is an essential part of the CRD Wastewater Treatment Project, which will convey and treat wastewater from the CRD Core Area. On September 14, 2016, the CRD Board approved the Wastewater Treatment Project, including the proposed Clover Forcemain.

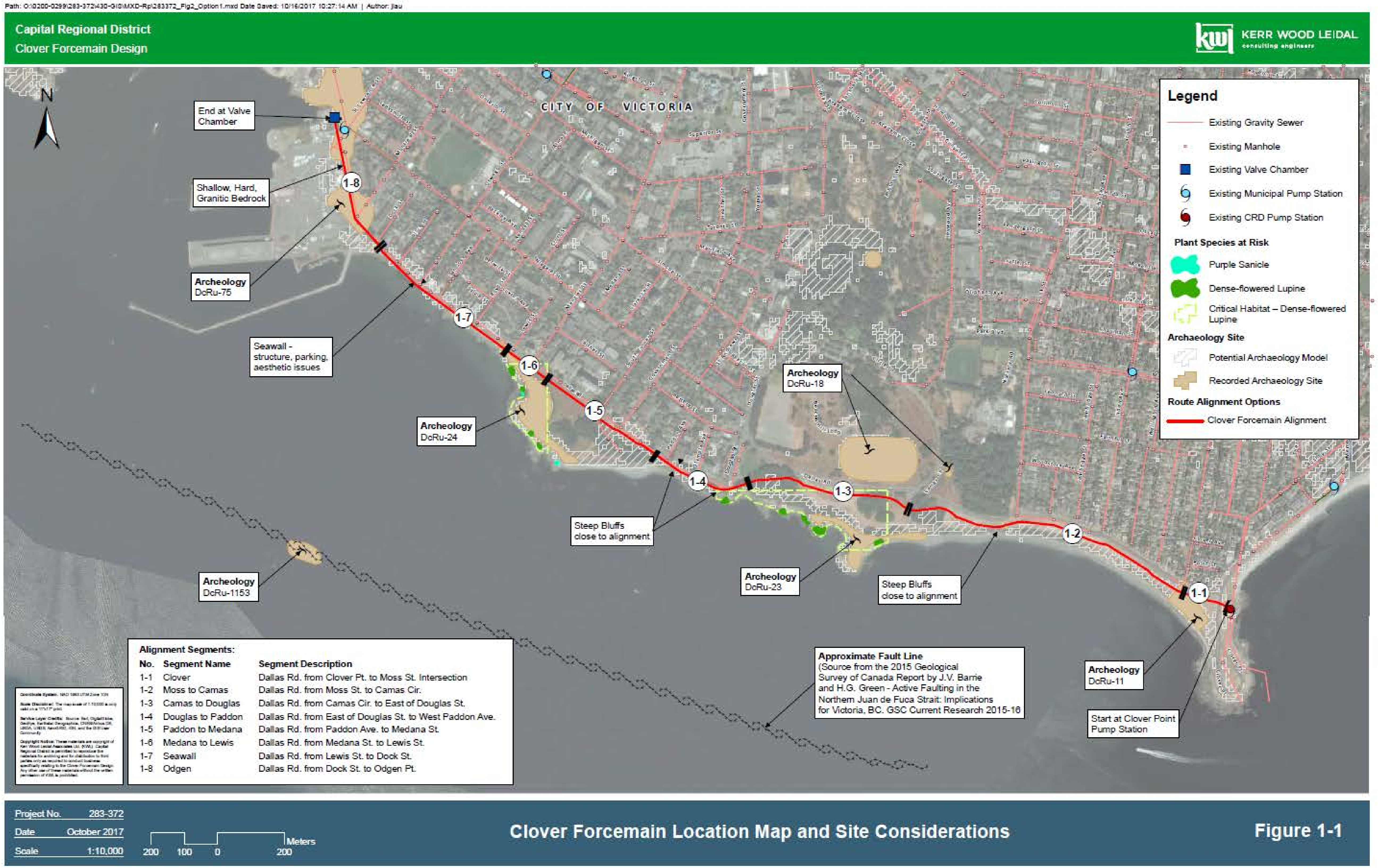
The Clover Forcemain will convey wastewater from the Clover Point Pump Station to Ogden Point. The alignment of the proposed Clover Forcemain is shown in Figure 1-1. At Ogden Point the forcemain will connect to the Harbour Crossing project, which consists of a pipe crossing under the entrance to the Victoria Harbour and conveying wastewater from the Clover Forcemain to the McLoughlin Point Wastewater Treatment Plant. The Clover forcemain will have a total length of approximately 3.4 km from the Clover Point Pump Station to Ogden Point.

CRD engaged Stantec to prepare an indicative design of the Clover Forcemain. In developing the indicative design, Stantec evaluated route options, selected a preferred route, developed the basis of design, prepared detailed alignment drawings, and estimated construction costs. CRD then engaged KWL to review the indicative design, prepare detailed design documents and be responsible for fulfilling Engineer of Record duties as defined by the Association of Professional Engineers and Geoscientist of British Columbia (APEGBC).

Figure 1-1 shows the alignment of the Clover Forcemain as developed by the indicative design.

CRD obtained a Licence of Occupation from the City of Victoria for the Clover Forcemain on February 22, 2017. CRD was granted a non-exclusive licence of occupation to install, entrench, construct, operate, maintain, and repair the forcemain. Construction of the Clover Forcemain will include mitigation of environmental, geotechnical, and archaeological impacts, as well as construction of a cycle track along Dallas Road from Clover Point to Dock Street.

This memorandum summarizes the geotechnical aspects of the Dallas Road alignment affecting design.



Alignment Segments:

No.	Segment Name	Segment Description
1-1	Clover	Dallas Rd. from Clover Pt. to Moss St. Intersection
1-2	Moss to Camas	Dallas Rd. from Moss St. to Camas Cir.
1-3	Camas to Douglas	Dallas Rd. from Camas Cir. to East of Douglas St.
1-4	Douglas to Paddon	Dallas Rd. from East of Douglas St. to West Paddon Ave.
1-5	Paddon to Medana	Dallas Rd. from Paddon Ave. to Medana St.
1-6	Medana to Lewis	Dallas Rd. from Medana St. to Lewis St.
1-7	Seawall	Dallas Rd. from Lewis St. to Dock St.
1-8	Odgen	Dallas Rd. from Dock St. to Odgen Pt.

Figure 1-1. Clover Forcemain Location Map and Site Considerations

1.2 Project Objectives

CRD developed the following objectives for the Clover Forcemain Project:

- Provide for safe construction and operation.
- Completion by March 2020 to allow for commissioning of the wastewater system to comply with federal law for secondary treatment by December 31, 2020.
- Convey 162 megalitres per day of wastewater from the proposed Clover Point Pump Station to the Harbour Crossing project at Ogden Point.
- Remain operational during and following a seismic event.
- Preserve the integrity of the sensitive ecosystem of the Dallas Road Bluffs.
- Mitigate construction and operational risks associated with environmentally sensitive areas, including those in close proximity to the Dallas Road Bluffs.
- Assess and mitigate risks associated with registered archaeological sites in proximity to forcemain.
- Address geotechnical challenges, including those associated with construction and operation of a forcemain in close proximity to the Dallas Road Bluffs and the Dallas Road Seawall. This includes possible impacts of the forcemain on the Bluffs and Seawall and possible impacts of the Bluffs and Seawall on the forcemain.
- Minimize construction and operational impacts to high-use areas by community users and tourists.
- Minimize total cost to regional taxpayers (including capital and life cycle costs).

1.3 Design Criteria

To implement the objectives established by CRD for the Clover Forcemain, Stantec developed the following design criteria:

- Seismic design loading is based on recurrence interval of 1 in 975 years and includes tsunami impacts and the effects of sea level rise
- Pipe material will be high density polyethylene (HDPE) with a dimension ratio of DR21
- Design for velocities no lower than 0.9 metres per second and not exceeding 1.5 metres per second.
- Where open cut construction is used, provide a minimum depth of cover of 1.0 metre

1.4 KWL Team Qualifications

Stantec prepared an indicative design for the Clover Forcemain. KWL has been engaged to complete the design of the forcemain. The scope of KWL's work includes a review of geotechnical factors affecting Stantec's indicative design.

KWL assembled an interdisciplinary team with expertise in the fields of conveyance system design, geotechnical engineering, terrain analysis, marine construction, environmental analysis, and civil engineering. On September 8, 2017, the KWL team, Stantec, and CRD Program Management Office staff held a workshop to review the entire Clover Forcemain along Dallas Road from Clover Point to Ogden Point, with a focus on assessing and refining design of the forcemain. Extensive consideration was given to the geotechnical aspects of the design, as well as schedule, cost, archeological impacts, environmental impacts, and community impacts.

The qualifications of the team are shown in Table 1-1.

Table 1-1
KWL Team Qualifications

Company	Relevant Qualifications	Member	Role/Specialty	Years of Experience	Degrees
Kerr Wood Leidal	Extensive familiarity with the Dallas Road Bluffs, including preparation of a conservation plan for the bluffs that considered vegetation impacts, geotechnical assessments, climate change impacts and an archaeological overview.	Colin Kristiansen, P. Eng.	Project Manager	26	BASc, MBA
		Dave Murray, P.Eng.	Civil Engineering Specialist	28	BSCE, Dip. Civil
CH2M Hill	Expertise in design of large diameter forcemains with specialists in seismic design and resiliency of large diameter forcemains including ground improvements and trenchless technology.	Joe Broberg, P.Eng. (1)	Large Diameter Forcemain Specialist	43	BSCE, MSCE, MBA
		Donald Anderson, P.E.	Seismic Specialist	43	BSCE, MSCE, PhD, D.GE
		Andrew Finney, P.Eng	Trenchless Technology	24	BSCE, MSCE
Thurber Engineering	Geotechnical specialists having extensive local experience that includes the Dallas Road Bluffs, with specialists in the field of slope stability and terrain hazard assessments.	Stephen Bean, P.Eng.	Geotechnical Specialist	31	BASc, M.Eng
Plan Dynamics Ltd.	Environmental specialists, having extensive local experience in terrestrial and aquatic habitat, species at risk, ecology, etc.	David Harper CPESC, MCIP, RPP	Environmental Specialist	43	B.A., M.A., Ph.D.
Millennia Research	Archaeological expertise with extensive experience in local archaeological assessments and impact studies.	D'Ann Owens, (2) RPCA	Archaeology Specialist	23	BA (Hons)

(1) Joe Broberg is the Technical Review Leader.

(2) Millennia Research was retained directly by the Project Team to provide archaeological services for the Project. D'Ann Owens participated in the review of archaeological issues for the Clover Forcemain.

1.5 Previous Work

The KWL team reviewed extensive information regarding CRD's Project, indicative design of the Clover Forcemain, and geotechnical factors affecting design of the pipeline, as well as archaeological and environmental considerations. This information was reviewed during KWL's assessment and included results of previous geotechnical investigations and reference documents, meetings, and a site reconnaissance. The project team provided a summary of public feedback and comments that were considered in the preparation of this memorandum.

KWL also has extensive experience with the Dallas Road Bluffs, including preparation of a conservation plan. This plan included an overview of coastal geomorphology and past geotechnical studies, a geotechnical inspection and inventory, a detailed vegetation inventory and proposed restoration prescriptions, and a review of plant species at risk. This information was used to develop an overall bluff restoration plan which included identification of priority areas, removal of invasive species, cultivation of rare species and restoration of the bluffs with native species in a phased approach. Drainage issues and future coastal erosion protection projects were also identified including the use of beach nourishment along the Dallas Bluffs. Subsequent to the study, KWL has provided engineering design and construction services for some minor erosion sites that required immediate action, some using bioengineering solutions.

Table 1-2 provides a list of reference documents that the KWL team consulted during review of the indicative design.

Table 1-2
Reference Documents

Document Name	Date	Author
Dallas Road Shoreline Erosion Maps	1977	Thurber Consultants Ltd.
Waterfront Erosion Benchmark Study	June 10, 1997	R.D. Gillie
Quaternary Geological Map of Greater Victoria *Geoscience Map 2000-2*	2002	BC Ministry of Energy and Mines, Monahan and Levson
Vegetation, Wildlife and Habitat Evaluation Survey for Proposed Capital Regional District Wastewater Treatment Facility Sites	May 2013	TERA Environmental Consultants
Geotechnical Data Report *Core Area Wastewater Treatment Program*	April 12, 2013	Stantec Consulting Ltd.
Dallas Road Archaeological Impact Assessment *Progress Report*	2015	Millennia Research Ltd.
Licence of Occupation – Dallas Road Force Main	February 22, 2017	The City of Victoria and Capital Regional District
Seabed Pipeline Route for Clover Point Forcemain	March 13, 2017	Stantec Consulting Ltd.
Protection of Dallas Road Bluffs During Wastewater Construction Letter	May 4, 2017	City of Victoria
Wastewater Treatment Project Schedule	April 2017	Capital Regional District
Basis of Design Report *Cross Harbour Force Main*	June 26, 2017	AECOM
Scoping of Environmental Issues related to the Marine Option for a Clover Point to Forcemain Design *Project Memo*	September 18, 2017	Archipelago Marine Research Ltd (Brian Emmett)

SECTION 2

Physical and Geological Setting

This section summarizes the physical and geological setting of the Clover Forcemain, shoreline conditions, previous geotechnical investigations and a summary of the findings of the geotechnical assessment conducted by the KWL team.

2.1 Physical Setting

The ground surface along the length of the Clover Forcemain alignment ranges from flat to moderately sloping. The west third of the alignment, between St. Lawrence Street and Boyd Street is gently sloping. The middle third of the alignment is moderately sloping. The eastern third of the alignment is gently to moderately sloping, with a minor undulation near Linden Avenue but a general decrease in ground surface elevation from Beacon Hill Park to the Clover Point Pump Station. The ground surface perpendicular to the forcemain is generally flat to gently sloping, and is at least 15 m from the edge of slopes leading down to the beach, except near the James Bay Seawall, near Paddon Avenue, and near Douglas Street. The James Bay seawall spans approximately 500 m from Dock Street to Lewis Street and has a height of approximately 6 m measured from the ground surface behind the wall to the ground surface in front of the wall. Existing underground utilities run underneath Dallas Road along much of the alignment. There is a higher concentration of utilities between Ogden Point and Beacon Hill Park near Douglas Street. Overhead power and communication lines also run along the south edge of Dallas Road near Ogden Point, between St. Lawrence Street and Montreal Street.

2.2 Geological Setting

The forcemain alignment is located at the southern tip of Vancouver Island along the Dallas Road shoreline. The geology of the area consist of bedrock overlain by glacial deposits and recent fill. The bedrock in this area consists of highly irregular, glacially scoured granitic and metamorphosed granitic rock. The rock is typically hard, with unconfined compressive strengths in the 50 MPa to 250 MPa range and is crossed with numerous joints and shears. The surface of the bedrock is very irregular and often steeply sloping with granular tills filling in the bedrock valleys. As the ice from the last glaciation retreated, it deposited a layer of dense gravelly, silty sand beneath the ice (lodgement till) and submerged layers of less dense gravelly, silty sand (ablation and flow till). These tills are exposed along much of the current Dallas Road bluffs, particularly between Holland Point and Clover Point. As the ice retreated, large quantities of rock flour were deposited that formed a thick layer of Victoria marine clay. This clay is typically near normally consolidated (grey clay) with a desiccated crust (brown clay) up to about 5 m thick that has resulted from glacial rebound. In some areas, anthropogenic fills and beach lag deposits overly the marine clay.

2.3 Shoreline along Dallas Road

The shoreline along Dallas Road consists of bedrock points and steep south facing bluffs of glacial deposits up to about 20 m high. The bluffs are subject to a number of processes including toe erosion from storm waves, rotational landslides, colluvial creep and sloughing, wind, groundwater discharge, spalling by frost action and human activity that lead to slope regression. Over the last 100 years or so the City of Victoria has attempted to reduce the rate of natural regression through the construction of seawalls, revetments, stairways, retaining walls, drainage improvements, bioremediation (vegetation), off shore reefs and other methods. These bluffs are a prominent feature of the Victoria landscape, requiring that the forcemain be designed and constructed such that the rate of natural regression is unaffected by the forcemain project, and at locations where the existing risk of bluff instability is too high, stabilized to protect the forcemain from the natural regression of the bluff.

2.4 Subsurface Investigation

In June and July 2017, Stantec drilled 24 test holes and installed three slope inclinometers and a nested standpipe piezometer to investigate the soil conditions along the proposed Dallas Road alignment. The geotechnical exploration program was designed to identify:

- Areas which may be underlain by shallow bedrock.
- Areas potentially underlain by significant amounts of fill placed for road widening or pedestrian walkways.
- Areas where the stability of existing slopes could be impacted.
- Required instrumentation for geotechnical monitoring during and after construction of the forcemain.

The geotechnical exploration work included drilling using percussive air rotary and solid stem auger techniques; sampling by means of split spoon and grab sampling; in-situ testing by means of standard penetration testing (SPT's) and dynamic cone penetration tests and laboratory testing, including moisture content, Atterberg Limits, particle size, fines content, pH, conductivity, and sulphate content testing. A copy of the geotechnical factual report is appended.

Stantec also conducted preliminary slope stability analyses and estimated seismic ground displacements to assist in the indicative design.

2.5 Analysis of Geological Data

After reviewing available geotechnical data, the KWL team confirmed that the forcemain can be designed, constructed and operated within the Dallas Road corridor without impacting the bluffs and without the bluffs impacting the forcemain. The assessment identified the following geotechnical considerations affecting design of the Clover Forcemain.

2.5.1 James Bay Seawall Stability

The James Bay Seawall was constructed in 1912. The seawall is about 6 m in height and is believed to consist of a cast-in-place concrete gravity wall structure that has undergone numerous upgrades and modifications over the last 100 years or so. The geological conditions along this section of the alignment consist of fill materials and wall backfill overlying thick marine clay deposits. The wall backfill appears to be mixed clay and granular backfill in a relatively loose state. The marine clay deposit is known to become firm to soft beneath the wall. The geotechnical risk to the forcemain in this area would be a collapse of the seawall due to a seismic event, tsunami, or excessive wave erosion (undermining).

In the opinion of the KWL team, there is a strong likelihood that the seawall will undergo significant deformation during the design seismic event. However, there is sufficient space within the Dallas Road corridor to shift the forcemain alignment far enough away from the seawall to protect the forcemain from the seawall.

2.5.2 Bluff Stability

Along the bluffs to the east of the James Bay Seawall, there are three locations (described below) that appear to create a potential risk to the forcemain from bluff instability due to the proximity of the forcemain to slopes with existing stability problems. Bluff instability from natural processes, such as seismic loading and erosion, could endanger the forcemain at these locations even though the forcemain will be designed and constructed to not affect bluff stability. At other bluff locations, the setback of the forcemain to the bluff is believed to be such that the risk of bluff instability to the forcemain is minimal , and this will be confirmed through the development of the detailed design.

At other bluff locations, the setback of the forcemain to the bluff is believed to be such that the risk of bluff instability to the forcemain is acceptable, and this will be confirmed through the development of the detailed design.

- ***Paddon Avenue*** - There is a long history of slope movement at the foot of Paddon Avenue. Since the 1950s, numerous attempts to improve the stability of this section of the bluffs have been carried out by the City. These include dumping fill over the edge of the slope, beach nourishment and various retaining walls at the base, mid-slope and crest of the slope. It appears that toe erosion has been reduced at this location; however, extensive cracking currently observed around the crest of the slope indicates that slope movement is still occurring.
- ***Douglas Street*** – At the foot of Douglas Street there is a small pocket beach named “Fonyo Beach” at the base of an oversteepened bluff. This beach has no significant toe protection and active erosion on the slope can be observed. The indicative design recommended that the forcemain be located at least 9 m away from the crest of the slope to reduce the risk of ground movements during a seismic event. Further setback beyond 9 m is recommended to protect against natural toe erosion and slope regression during the service life of the forcemain.
- ***Cook Street*** – At Cook Street, the bluff is near the proposed forcemain alignment and there is a concern about groundwater flowing along the pipe trench and adversely affecting the bluffs.

2.5.3 Presence of Granitic Rock at Ogden Point

An open trench in the Ogden Point area will encounter bedrock in some areas. The rock consists of hard, metamorphosed granitic rock which will require blasting for economic removal. The proximity to structures will require controlled blasting techniques and vibration monitoring. The proximity to structures will require mechanical removal or controlled blasting techniques and vibration monitoring. Additional investigation may be required in this area to better define the location and consistency of bedrock and the potential for poor quality fill..

2.5.4 Possibility of Liquefaction Near Ogden Point

The area of Ogden Point is known to contain large quantities of man-made fill materials used to construct the current cruise ship terminal area. These fills may extend to Dallas Road. The soils west of Dallas Road could be liquefiable and may require widespread ground improvement to protect the pipeline from flotation, settlement and lateral loading from liquefaction-induced lateral spreading. Along the current alignment of Dallas Road, only localized areas of ground improvement for liquefaction are envisaged.

2.5.5 Trench Water Management

The KWL team identified a need for design features that address management of water in the trench, including preventing uncontrolled flow of water in forcemain backfill. This will be addressed in detailed design.

SECTION 3

Conclusions and Recommendations

The KWL Team developed the following geotechnical conclusions and recommendations:

1. **No impact on Dallas Road Bluffs** - The Clover Forcemain can be designed, constructed, and operated in the Dallas Road alignment without: affecting the Dallas Road Bluffs, and without natural forces affecting the forcemain.
2. **KWL will design solutions addressing concerns with the Dallas Road Bluffs** - KWL will develop design solutions for locations where the forcemain is near the bluffs to achieve the goals of protecting the bluffs and the forcemain. These design solutions will address refinement of the forcemain alignment within the right of way of Dallas Road and inclusion of features to manage the flow of water in the forcemain trench.
3. **James Bay Seawall** – Refinement in the alignment of the forcemain will avoid destabilizating the James Bay Seawall, and protect the forcemain from failure of the seawall.
4. **Investigations and analyses during detailed design** - Further investigations and analyses will be completed during detailed design to develop design details and refine the indicative design.

Next Steps

Additional geotechnical information and analyses will be completed during detailed design to develop design details protecting the forcemain, bluffs, and seawall at the following four locations:

- James Bay Seawall
- Paddon Avenueand specifications, and will be responsible for fulfilling
- Douglas Street
- Cook Street

Details of the geotechnical investigations are provided below. Once the investigations have been completed, KWL will prepare detailed design drawings and will be responsible for fulfilling the duties of Engineer of Record as defined by APEGBC.

The additional geotechnical information and analyses will be used to develop design details refining the indicative design to assure protection of the bluffs and seawall from construction and operation of the forcemain and to protect the forcemain from natural forces affecting the bluffs. As part of completing the detailed design, KWL will prepare a plan to mitigate impacts of construction on the bluffs, including post-construction monitoring for 12 months following completion of construction. KWL will monitor the construction contractor's compliance to that plan.

4.1 Additional Test Holes and Laboratory Tests

It is proposed to drill an additional test hole at each of the 4 sites using a track-mounted sonic drill rig. The sonic rig will be used to advance the test holes from the roadway to approximately 15 m to 20 m depth unless refusal is encountered at a shallower depth. Periodic Standard Penetration Tests (SPT) will be completed at selected depths to allow an estimate of the relative density of the soil.

Soil and groundwater conditions will be logged in the field by experienced geotechnical personnel, the sonic core will be photographed, and disturbed samples will be collected from the core and returned to a soils laboratory in Victoria. All soil samples will be subjected to routine moisture content and visual classification testing in the laboratory. Fines content (% passing 75 μm sieve) and Atterberg limit testing will be carried out on select representative samples.

4.2 Downhole Seismic Testing

Upon completion of drilling, downhole seismic testing (DST) will be conducted to provide an in-situ shear wave velocity (V_s) profile at each test hole location. A 63.5 mm (2.5" ID) PVC pipe will be grouted into each test hole location to facilitate insertion of the downhole seismic geophone. The geophone will take shear wave velocity measurements at 1 m intervals that will be used to estimate the small-strain shear modulus. The small-strain shear modulus is required to carry out a seismic site-specific response analysis (SSRA), which is used in the assessment of liquefaction potential and for numerical seismic deformation modelling.

4.3 Site-Specific Seismic Response Analysis, Limit Equilibrium Analysis, and Numerical Deformation Analysis

After drilling and laboratory testing is complete seismic assessments will be completed at each of the four areas of concern using both limit equilibrium and numerical analyses. The seismic assessment will be based on the 1 in 975 year return period earthquakes (design criteria) using seismic hazard values available from Natural Resources Canada. Seismic ground deformations will direct design of the forcemain.

Both the limit equilibrium and numerical analyses will require site-specific seismic response analyses (SSRAs) to be carried out. SSRAs will be completed based on the shear wave velocities obtained from the DSTs. The SSRAs will result in a more precise estimation of ground motion amplifications than using the factors provided in the B.C. Building Code (BCBC).

The limit equilibrium analysis will be used to quantify horizontal seismic displacements of the force main at its preferred alignment. This analysis will use the software program Slope/W to identify the critical slip surface that intersects the forcemain and the corresponding seismic slope yield acceleration at each area of concern. The slope stability models will follow the ground surfaces and subsurface soil profiles. The horizontal displacements will be estimated based on an empirical correlation to Newmark’s method using the peak ground accelerations (pgas) determined from the SSRAs, slope yield accelerations and slope geometries.

The results from the limit equilibrium analysis will be used to prioritize the areas for numerical deformation analyses. A numerical deformation analyses will be performed. The numerical deformation analysis will be carried out using the earthquake time-histories obtained from the SSRAs. Deformation contours will be generated at each of the four sites. This will assist in design of the forcemain at each of the four areas of concern.

Appendix A

Geotechnical Factual Data Report – Stantec Consulting Ltd

Geotechnical Factual Data Report

Clover Point Forcemain

Prepared for:
Capital Regional District
625 Fisgard Street
Victoria, BC V8W 1R7

Prepared by:
Stantec Consulting Ltd.
500-4730 Kingsway
Burnaby, BC V5H 0C6

Project No.: 111700431

DRAFT

July 27, 2017

Revision	Description	Author		Quality Check		Independent Review	
0	Draft	C. Hajen	S. Tsang	B. Huynh		U.M. Uthayakumar	

Sign-off Sheet

This document entitled Geotechnical Factual Data Report was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Capital Regional District (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on the conditions and information that existed at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

The component of the report describing the geological setting (Section 2.2) was written by Sidney Tsang, P.Geo. The remainder of the report, including the description of the physical setting (Section 2.1), geotechnical investigation scope (Section 3.0) and description of laboratory testing (Section 4.0) was written by Christian Hajen, EIT, reviewed by Ben Huynh, P.Eng., and independently reviewed by (Uthaya) M. Uthayakumar, Ph.D., P.Eng.

Prepared by ____________________Draft____________________

(signature)

Christian Hajen, EIT

Prepared by ____________________Draft________________

(signature)

Sidney Tsang, P.Geo.

Reviewed by ____________________Draft________________

(signature)

Ben Huynh, P.Eng.,

Approved by ____________________Draft________________

(signature)

(Uthaya) M. Uthayakumar, Ph.D., P.Eng.

Table of Contents

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

Stantec Consulting Ltd. (Stantec) presents this Geotechnical Factual Data report in support of Capital Regional District's (CRD) Clover Point Forcemain project. The preliminary Clover Point Forcemain alignment is located along Dallas Road in Victoria, BC and will run approximately 3.3 km from the existing Clover Point pump station to Ogden Point. However, the extent of Stantec's scope is for about 3.2 km of the alignment. A site plan showing the preliminary alignment is presented on Drawing 1 in Appendix B. The design and construction of the Clover Point Pump Station, as well as an approximate 100 m long section of the forcemain west of the pump station, will be completed by others during a different stage. At Ogden Point, the forcemain crosses the entrance to Victoria Harbour via a subsea horizontal directional drill (HDD) to the new McLoughlin Point WWTP. The design and construction of HDD crossing and of the WWTP are currently underway, and is being completed by others.

This report describes the physical setting and geological setting of the project, outlines the scope of the geotechnical exploration completed by Stantec and presents the results of the borehole exploration work, in-situ testing, instrumentation, and laboratory testing.

For ease of understanding, Stantec has split the preliminary Clover Point Forcemain alignment into three zones represented by common soil characteristics and engineering properties based on published surficial geology mapping (Monahan and Levson, 2000). The three geotechnical zones are presented on Drawing 1, in Appendix B, and summarized as follows:

Zone 1 – Ogden Point (10+000 to 0+450 m)

Zone 2 – James Bay Seawall (10+450 to 10+900 m)

Zone 3 – Holland Point to near Clover Point (10+900 to 13+200 m)

1.2 PURPOSE AND SCOPE

The purpose of the geotechnical exploration was to obtain information on the subsurface conditions beneath the preliminary Clover Point forcemain alignment to characterize the soil conditions to support the indicative design. In addition, borehole locations were selected to target specific areas along the preliminary alignment where key geotechnical considerations/issues were identified by Stantec during our terrain assessment of the Dallas Road cliffs (Reference "Dallas Road Cliffs, Historic Foreshore Erosion Assessment" prepared by Stantec Consulting Ltd., dated May 30, 2017).

The types of test holes for the geotechnical exploration, as well as the locations and type of testing were selected based the following considerations:

- Areas which may be underlain by shallow bedrock;
- Areas potentially underlain by significant amounts of fill placed for road widening or pedestrian walkways; and
- Areas where the stability of existing slopes and could be impacted

The resulting execution strategy of the Clover Point Forcemain geotechnical exploration work consisted of the following:

- Geotechnical drilling using percussive air rotary (ODEX) and solid stem auger techniques, with sampling by means of split spoon, and grab sampling;
- In-situ testing by means of standard penetration testing (SPT's) and dynamic cone penetration tests (DCPT's);
- Installation of three (3) slope inclinometers;
- Installation of a nested standpipe piezometer; and,
- Laboratory testing, including moisture content, Atterberg Limits, particle size, fines content, pH, conductivity, and sulphate content testing.

1.3 PROJECT DESCRIPTION

Some portions of the preliminary Clover Point Forcemain alignment will be located within the existing Dallas Road roadway. The majority of the alignment will be located within adjacent grassy park areas, and asphalt paved parking areas and walkways along Dallas Road.

We understand that the Clover Point Forcemain will be 1350 mm diameter and that the pipe invert depth will generally range from 2.5 to 3.8 m below the existing ground surface. At select locations, including the Clover Point tie-in, the pipe will be founded deeper, with a pipe invert depth of up to 5.4 m below the existing ground surface.

The project chainage of the forcemain for this report begins at the west end of the alignment at 10+000 m near the intersection of Dallas Road with St. Lawrence Street, and terminates at approximately 13+220 m near Clover Point at the east end of the alignment. The chainage notation is opposite to the forcemain's flow direction, which runs from east to west. For the purpose of this report, the alignment will be described from west to east, in accordance with the chainage notation.

2.0 SITE DESCRIPTION

2.1 PHYSICAL SETTING

The ground surface along the length of the preliminary alignment ranges from flat to moderately sloping. The west third of the alignment, between St. Lawrence Street (chainage 10+000 m) and Boyd Street (chainage 10+800 m) is gently sloping, increasing in elevation from 4 m near St. Lawrence Street, to 7 m near Boyd Street along an 800 m lineal span.

The middle third of the alignment is moderately sloping, with a general increase in ground surface elevation from 7 m near Boyd Street, to 23 m in front of Beacon Hill Park (chainage 11+960) along a 1160 m lineal span.

The eastern third of the alignment is gently to moderately sloping, with a minor undulation near Linden Avenue but a general decrease in ground surface elevation from 23 m in front of Beacon Hill Park, to 13 m near the proposed Clover Point Pump Station (chainage 13+200 m) along a 1240 m lineal span.

The slope of the ground surface orthogonal to the preliminary forcemain alignment is generally flat to gently sloping, and is at least 15 m from the edge of slopes leading down to the beach, except for three spans: near the James Bay seawall, near Paddon Avenue and near Douglas Street. The James Bay seawall spans approximately 500 m from Dock Street to Lewis Street and has a height of approximately 6 m measured from the ground surface behind the wall to the ground surface in front of the wall. Based on the preliminary alignment, the forcemain would be located approximately 3.7 m behind the edge of the seawall. At Paddon Avenue and Douglas Street, the preliminary alignment would position the forcemain a distance of approximately 5 m from the edge of a slope which leads down to the beach at a slope of approximately 30 to 35 degrees, and 35 to 40 degrees, respectively.

Existing underground utilities run underneath and/or across Dallas Road along much of the preliminary forcemain alignment, but with a higher concentration of utilities between Ogden Point and Beacon Hill Park near Douglas Street. Overhead power and communication lines also run along the south edge of Dallas Road near Ogden Point, between St. Lawrence Street and Montreal Street.

2.2 GEOLOGICAL SETTING

2.2.1 Setting and Bedrock Geology

The preliminary forcemain alignment is located within the Nanaimo Lowland physiographic subdivision, a strip of low-lying country, extending along the northeast, east and southwest coasts of Vancouver Island from Sayward to Jordan River, west of Victoria (Holland 1976).

The bedrock underlying the preliminary forcemain alignment is Jurassic-age Westcoast Crystalline Complex comprising quartz diorite, tonalite, horneblende-plagioclase gneiss, quartz-feldspar gneiss, amphibolite, diorite, agmatite, gabbro, marble and metasediments, including the Wark-Colquitz Complex (Clapp 1913, Cui 2015). Bedrock outcrops along the shoreline between Finlayson Point to Holland Park. Fault-zone mylonites in the Jurassic-age gneiss have been identified on the west side of Clover Point (Johnston et al. 2013). The active Leech River Fault Zone is located approximately 5 km west of Ogden Point (Morell et al. 2017) and the Devil's Mountain Fault Zone lies approximately 2.5 km south and offshore of the Clover Point Forcemain (Barrie and Greene 2015).

2.2.2 Quaternary History

During the last major glaciation (25,000-10,000 ybp) glaciers formed in the Vancouver Island Mountains and Coast Mountains and advanced down the Strait of Georgia to southeastern Vancouver Island after 19,000 ybp. During the glacial maximum (~15,000 ybp) southern Vancouver Island was completely covered by an ice sheet that flowed south-southwesterly across Juan de Fuca Strait and deposited Cordilleran till (Alley and Chatwin 1979). As the climate began to ameliorate, deglaciation was by downwasting and southern Vancouver Island was ice-free by 12,500 ybp (Clague 1981). During this period, the coastline was depressed due to glacio-isostatic effects such that marine waters invaded lowland areas below 75 meters elevation and glaciomarine sediments were deposited (Mathews et al. 1970). However, present sea level was attained as early as 11,700 ybp at Victoria (Clague 1981).

2.2.3 Surficial Geology

Regional (1:25,000) scale surficial geology mapping of the Victoria area provides an overview of surficial materials underlying the preliminary forcemain alignment (Monahan and Levson 2000). The alignment is underlain by areas of thin soil, with bedrock near or at the surface, interspersed with deposits of Victoria Clay. Victoria Clay is a glaciomarine sediment deposited when the coastline was depressed, at the end of the last glaciation. Four distinct units were mapped underlying the preliminary forcemain alignment. These units are summarized in **Table 1**; unit descriptions are from Geoscience Map 2000-2 (Monahan and Levson 2000).

Table 1 Surficial Geology Units along the Preliminary Forcemain Alignment

Unit	Description	Project Chainage(1)
UNIT C1	VICTORIA CLAY - INTERMEDIATE BETWEEN UNITS R2 AND C2, INCLUDING UNDIFFERENTIATED AREAS This unit mainly includes areas where soil profiles typical of units R2 and C2 occur together on a scale that is not mappable with the data available. This unit also includes areas where there is greater than 5 metres of Victoria clay, but where the thickness of the lower grey clay facies is less than 3 metres.	Sta. 10+000 to Sta. 10+150
UNIT R2	AREAS WITH BEDROCK AT OR NEAR THE SURFACE - THIN SOIL COVER WITH SCATTERED BEDROCK OUTCROP Generally consists of shallow soils over bedrock. In much of Greater Victoria, this unit includes areas with less than 5 metres of Victoria Clay, mainly the brown clay facies, overlying thin older Pleistocene deposits or bedrock. Scattered outcrops occur throughout the unit, and bedrock is commonly found in the upper five metres (e.g. in utility line excavations). The thickness of older Pleistocene deposits in most places is less than a few metres, but may locally be up to 10 metres. - UNIT R2a consists of those areas of unit R2 where thicknesses of older Pleistocene deposits between 5 and 10 metres can be mapped.	Sta. 10+150 to Sta. 10+500 Sta. 10+800 to Sta. 11+350 Sta. 11+450 to Sta. 11+800 Sta. 12+200 to Sta. 12+600
UNIT C2	VICTORIA CLAY – THICK SOFT CLAY Areas with more than 3 metres of the grey clay facies of the Victoria clay. The thickness of the grey clay facies is commonly greater than 10 metres and locally exceeds 20 metres. In this unit, the grey clay facies is overlain by the brown clay facies, which is generally 2 to 5 metres thick. The thickness of older Pleistocene deposits underlying the Victoria clay is generally less than a few metres, but may be greater adjacent to drumlinoid ridges. The unit occupies low-lying and gently sloping ground, and where borehole data are not available, this unit is assigned to such areas below 60 metres elevation.	Sta. 10+500 to Sta. 10+800 Sta. 11+350 to Sta. 11+450 Sta. 11+800 to Sta. 12+200 Sta. 12+600 to Sta. 12+750
UNIT C3	VICTORIA CLAY – THIN CLAY OVER THICK OLDER PLEISTOCENE DEPOSITS Occurs in areas with less than 5 metres of Victoria clay overlying older Pleistocene deposits greater than 10 metres thick. It generally occurs on the upper flanks of drumlinoid ridges	Sta. 12+750 to Sta. 13+200

NOTES:

(1) For project chainage, refer to Drawings 2-1 to 2-9 in Appendix B

3.0 GEOTECHNICAL SUBSURFACE EXPLORATION

3.1 SUMMARY

Stantec carried out a geotechnical subsurface exploration for the Clover Point Forcemain between June 19 and July 4, 2017 in order to support indicative design for the routing and installation of the forcemain.

The scope of the geotechnical exploration work consisted of the following:

- Seven (7) percussive air rotary (ODEX) boreholes;
- Seventeen (17) solid-stem auger boreholes;
- Three (3) slope inclinometer casing installations;
- One (1) nested standpipe piezometer installation

Test hole coordinates were recorded with a handheld Global Positioning System (GPS) device with an accuracy of approximately +/-3 m, with additional measurements taken in the field referenced to fixed landmarks (roadway intersections, curb returns, etc.). Upon plotting the GPS coordinates onto the drawings, if substantial error was noted when compared with the additional measurements to the fixed landmarks, the test hole location was adjusted on the drawing in accordance with the additional field measurements. Test hole elevations were approximated using LiDAR elevation contours provided by the CRD, as well as a topographic survey of the preliminary forcemain alignment sub-contracted by Stantec to McElhanney Surveys. Contour lines are shown on plan drawings included in Appendix B.

Soil samples were collected from boreholes by means of grab sampling and/or split spoon sampling. Standard Penetration Tests (SPTs) or Dynamic Cone Penetration Tests were completed in the ODEX and solid-stem auger boreholes.

The auger and ODEX drilling was performed using a Mobile B54, truck-mounted drill rig. The drill rig and associated support vehicles, equipment and tooling (including the 200 psi, 300 ft^3/min ODEX air compressor) are owned and operated by Geotech Drilling Services Ltd. (Geotech Drilling), located in Delta, BC.

Full-time review of the subsurface exploration work was carried out by a Stantec geotechnical field engineer, who classified the soils encountered, recorded borehole coordinates and SPT/DCPT blow counts, and collected representative soil samples. The soil samples were returned to the Stantec geotechnical laboratory in Burnaby, BC for classification and index testing.

3.2 GEOTECHNICAL DRILLING EXPLORATION

Descriptions of the percussive air rotary (ODEX) and solid stem auger drilling methodologies used for the boreholes are provided in the following sub-sections.

Detailed borehole logs describing the soil and groundwater conditions encountered, and results of the laboratory classification and index testing are included in Appendix C.

Soil descriptions presented on the borehole logs are based on the grab samples and split spoon samples collected at discrete intervals and are in general accordance with ASTM D2487 and D2488 for the Unified Soil Classification System (USCS) and the information presented on the "Symbols and Terms Used in Borehole and Test Pit Records" in Appendix C. Where the quantity of a soil type is sufficiently small, less than 5% and 15% for fine grained (passing the No. 200 sieve) and coarse grained (retained on the No. 200 sieve) soils, respectively, it is not reported on the borehole logs, in accordance with the USCS classification method.

3.2.1 Percussive Air Rotary (ODEX) Drilling

Seven (7) percussive, downhole hammer air rotary (ODEX) boreholes were completed using 125 mm diameter steel casing. **Table 2** presents a summary of the ODEX boreholes, and includes borehole coordinates, elevations, depths, and methods for sampling and in-situ testing.

In the ODEX drilling method, an eccentric, convex drill bit covered with carbide buttons penetrates overburden and rock formations via a reciprocating, jackhammer-like action. The downhole hammer is pneumatically driven via a constant stream of air, which also lifts drill cuttings away from the drill bit and up the casing to the surface.

In general, the ODEX drilling method was used to drill select deep boreholes near Paddon Avenue and Douglas Street for slope stability analyses and for permanent casing installations (i.e., slope inclinometers and standpipe piezometer). The ability to penetrate through very dense granular material (including cobbles and boulders) to target depth (into glacial till or into the underlying bedrock) allowed successful completion of boreholes BH17-12a to BH17-14, BH17-16 and BH17-24.

Sampling of both coarse-grained soils (i.e., sands and gravels) and fine-grained soils (i.e., silts and clays) in the ODEX boreholes was completed with split spoons and occasionally via grab sampling from drill cuttings collected from the air return. Samples were placed in plastic bags and transported to the Stantec laboratory in Burnaby, BC for further classification and index testing. SPT blow counts were recorded during split-spoon sampling. Further details regarding the SPTs are provided in Section 3.3.1.

Table 2 Summary of ODEX Boreholes

Borehole ID	Project Chainage[1]	UTM Coordinates		Ground Elevation, Geodetic	Drilled Depth	Sampling Methods	In-Situ Testing	Installs
		Northing	Easting					
BH17-03	10+188	5362737	471502	6.0 m	3.7 m	Grab Sampling	None	None
BH17-04	10+380	5362561	471561	6.0 m	3.4 m	Split Spoon, Grab Sampling	SPT	None
BH17-12a	11+559	5361845	472488	17.1 m	10.9 m	Split Spoon, Grab Sampling	SPT	Slope Inclino-meter
BH17-13	11+739	5361781	472659	20.3 m	17.7 m	Split Spoon, Grab Sampling	SPT	None
BH17-14	11+760	5361793	472676	21.2 m	19.7 m	Split Spoon, Grab Sampling	SPT	Slope Inclino-meter
BH17-16	11+792	5361800	472707	22.0 m	26.9 m	Split Spoon, Grab Sampling	SPT	Slope Inclino-meter
BH17-24	11+794	5361802	472709	22.0 m	22.9 m	Grab Sampling	DCPT	Stantpipe piezo-meter

NOTES:

[1] For project chainage, refer to Drawings 2-1 to 2-9 in Appendix B

Boreholes BH17-03 and BH17-04 were originally planned as auger boreholes, but upon attempting to drill at these locations, it was discovered that a layer of concrete underlay the surficial asphalt and impeded the auger from advancing. Accordingly, the ODEX method was used to drill through the concrete and complete these two shallow boreholes.

Borehole BH17-24 was not originally planned, but was added to supplement the subsurface information near the intersection of Dallas Rd with Douglas Street via additional sampling and SPT testing, and the installation of a standpipe piezometer.

Boreholes BH17-12a, BH17-13, BH17-14, BH17-16 and BH17-24 were advanced through overburden soils and into bedrock as planned.

Due to the installation of slope inclinometer casings in boreholes BH17-12a, BH17-14 and BH17-16, a combination of cement-bentonite grout and silica sand was used to backfill these holes, which were each capped with a steel casing cover concreted to match the surrounding grade. Similarly, the standpipe piezometer at BH17-24 was backfilled using a combination of bentonite chips and silica sand, and also capped with a steel casing cover concreted to match the surrounding grade. Boreholes BH17-03, BH17-04 and BH17-13 were backfilled using a combination of drill cuttings and silica sand. Bentonite seals were placed in compliance with the BC *Groundwater Protection Regulation* at the bottom of each borehole, at 6 m intervals, and below the surficial concrete plug.

3.2.2 Auger Drilling

Seventeen (17) auger boreholes were advanced using 140 mm diameter solid-stem, continuous flight auger drill rods. **Table 3** presents a summary of the auger boreholes, and includes borehole coordinates, elevations, depths, and methods for sampling and in-situ testing.

The solid stem drilling method was used to drill the majority of the boreholes along the preliminary Clover Point Forcemain alignment. In general, auger boreholes were advanced to a depth of 4.6 m (15 ft.) or practical refusal, to evaluate the soil conditions in the vicinity of the forcemain invert. At the James Bay seawall, the auger boreholes were advanced to depths of up to 7.6 m (25 ft.) in order to determine the composition of the native soil at the approximate subgrade level immediately below the inferred foundation depth of the concrete retaining wall.

Sampling of soils from the auger boreholes was completed mostly by collection of grab samples, with occasional split spoon sampling. Grab samples and split spoon samples were placed in plastic bags and transported to the Stantec laboratory for further classification and index testing. SPT and DCPT blow counts were recorded on borehole logs and used to characterize the compactness or consistency of the soils. Further details regarding the SPTs and DCPTs are provided in Sections 3.3.1 and 3.3.2.

Table 3 Summary of Solid Stem Auger Boreholes

Borehole ID	Project Chainage[1]	UTM Coordinates		Ground Elevation, Geodetic	Drilled Depth	Sampling Methods	In-Situ Testing
		Northing	Easting				
BH17-01	10+053	5362877	471488	4.0 m	5.2 m	Split Spoon, Grab Sampling	SPT
BH17-02	10+138	5362786	471492	4.4 m	4.6 m	Grab Sampling	DCPT
BH17-05	10+496	5362476	471639	4.6 m	7.6 m	Grab Sampling	DCPT
BH17-06	10+576	5362419	471696	4.5 m	7.6 m	Grab Sampling	DCPT
BH17-07	10+666	5362363	471767	6.1 m	5.3 m	Grab Sampling	DCPT
BH17-08	10+851	5362254	471916	7.0 m	8.5 m	Grab Sampling	DCPT
BH17-09	11+020	5362155	472052	11.0 m	4.6 m	Grab Sampling	DCPT
BH17-10	11+222	5362037	472216	14.0 m	4.3 m	Grab Sampling	DCPT
BH17-11	11+388	5361943	472348	16.1 m	None (DCPT only)	None	DCPT
BH17-12b	11+564	5361842	472490	16.6 m	5.5 m (DCPT to 7.0 m)	None	DCPT
BH17-15	11+765	5361817	472672	21.9 m	1.2 m	Grab Sampling	DCPT
BH17-17	12+022	5361783	472927	22.1 m	6.7 m	Split Spoon, Grab Sampling	SPT
BH17-18	12+291	5361734	473184	18.5 m	4.6 m	Grab Sampling	None
BH17-19	12+517	5361680	473396	14.4 m	1.5 m	Grab Sampling	None
BH17-20	12+793	5361664	473665	14.1 m	4.1 m	Grab Sampling	DCPT
BH17-21	13+004	5361578	473856	14.7 m	4.6 m	Grab Sampling	DCPT
BH17-22	13+287	5361455	474106	12.3 m	4.6 m	Grab Sampling	DCPT
BH17-23	11+507	5361876	472449	16.4 m	7.2 m	Grab Sampling	DCPT

NOTES:

(1) For project chainage, refer to Drawings 2-1 to 2-9 in Appendix B

All auger boreholes were completed to their targeted depth with the exception of boreholes BH17-07, BH17-10, BH17-11, BH17-15 and BH17-19. Boreholes BH17-07, BH17-10, BH17-15 and BH17-19 were terminated prior to reaching the target depth due to auger refusal on dense granular soils, hard clay soils, cobbles or bedrock. Drilling of borehole BH17-11 was abandoned due to mechanical breakdown of the auger drill head following a successful DCPT test to target depth at this location.

Borehole BH17-23 was not originally planned, but was added in order to further evaluate the fill thickness near the intersection of Dallas Road with Paddon Avenue. Borehole BH17-12b was also not originally planned, but was added to obtain DCPT blow counts in the native soils adjacent to borehole BH17-12a.

The auger boreholes were backfilled with drill cuttings, and bentonite seals were placed in compliance with the BC *Groundwater Protection Regulation*. Boreholes completed within the existing roadways, sidewalks or parking stalls were reinstated with a concrete patch.

3.3 IN-SITU TESTING

3.3.1 Standard Penetration Testing

SPTs were performed using 50.8 mm outside diameter, un-lined split spoon samplers driven with automatic safety hammers and in general accordance with ASTM D1586. Specifically, the SPTs involved driving the split spoon sampler connected by AWJ-rods with 63.5 kg hammers, falling from a height of 760 mm. Blow counts were recorded over four 150 mm intervals during the testing. The SPT blow counts are the cumulative blows for the second and third 150 mm penetration (total 300 mm or less than 300 mm in cases of refusal for further penetration) are reported on the borehole logs in Appendix C. Split spoon samples were placed in plastic bags and transported to the Stantec laboratory for further visual classification and index testing.

SPTs were generally performed on ODEX boreholes except for the tests in two auger boreholes. The steel drill casing of the ODEX boreholes remained in the ground during the SPT testing. The two auger boreholes in which SPT testing were carried out (BH17-01 and BH17-17) remained clean and open during the test.

3.3.2 Dynamic Cone Penetration Testing

DCPTs were performed using the same automatic safety hammer for SPTs to drive a conical tip at the end of the AWJ-rod string in lieu of an open soil sampler. Unlike SPTs, a soil sample is not retrieved. Instead, the DCPT is driven until either target depth or practical refusal is encountered, thereby generating an approximate, near-continuous profile of the soil compactness/consistency. The cone has a 30 mm diameter blunt tip and tappers at 45 degrees to 60 mm diameter, followed by a sleeve length of 150 mm.

Blow counts for the DCPT were recorded in 150 mm intervals and reported in the borehole logs in terms of total blows per 300 mm penetration.

DCPTs were generally performed starting from the upper 1.5 m in the auger borehole locations prior to drilling.

3.4 INSTRUMENTATION

3.4.1 Slope Inclinometers

A total of three (3) slope inclinometers were installed at select locations along the preliminary forcemain alignment. The slope inclinometer locations were selected in areas which were considered to be in close proximity of the adjacent slopes. One (1) slope inclinometer was installed near Paddon Avenue in borehole BH17-12a, and two (2) slope inclinometers were installed near Douglas Street in boreholes BH17-14 and BH17-16. The purpose of the slope inclinometers is to establish infrastructure that will allow for the monitoring of potentially deep seated slope movements of the cliffs during and after the construction of the forcemain.

The slope inclinometer installation consisted of boring through surficial fills and overburden soils, and advancing into the underlying bedrock. The 70 mm (2.75 inch) outer diameter ABS plastic snap seal inclinometer casing was then installed within the steel drill casing. As the steel drill casing was extracted, the annulus between the slope inclinometer casing and the borehole sidewalls was backfilled with a cement-bentonite grout.

The casings for the slope inclinometers were extended into the bedrock, as presented in **Table 4**, in order to allow for reference points for lateral movements above the bedrock surface.

Table 4 Summary of Slope Inclinometers

Slope Inclinometer ID	Project Chainage[1]	UTM Coordinates		Ground Elevation, Geodetic	Top of Bedrock Elevation, Geodetic	Slope Inclino-meter Depth
		Northing	Easting			
SI17-12	11+559	5361845	472488	17.1 m	8.6 m	10.0 m
SI17-14	11+760	5361793	472676	21.2 m	4.0 m	19.0 m
SI17-16	11+792	5361800	472707	22.0 m	-2.4 m	26.0 m
NOTES: [1] For project chainage, refer to Drawings 2-1 to 2-9 in Appendix B						

The slope inclinometer casings are monitored using a Digital Inclinometer monitoring system, model IC3205, supplied by RST Instruments Ltd., Maple Ridge, BC. The RST Digital Inclinometer monitoring system consists of an inclinometer probe, a graduated cable system, and a portable readout and data storage device. For monitoring, the probe is first inserted to the bottom of the inclinometer casings, then slowly drawn upwards, with measurements taken at 0.5 m intervals. The first survey establishes the baseline readings for the casing, with subsequent monitoring intervals compared to the baseline monitoring event to reveal changes in the lateral profile if movement occurs. Readings are recorded and stored in a handheld PC and subsequently downloaded into computer software for processing. Subsequent monitoring of the inclinometers shows movement in the A-Axis (parallel to the slope face) and the B-Axis (perpendicular to the slope face).

The data from the field is collected containing the field readings for A0 (A+, or downslope), A180 (A-, or upslope), B0 (B+) and B180 (B-) by depth. The data is imported into a database and the displacement at each discrete reading depth is calculated by taking the difference between the latest reading and the base-line reading. The displacement is then summed along the length of the pipe to create a cumulative displacement graph for both the "A" and "B" axes. If lateral movement was observed below the known bedrock level, a bias correction is applied to the data.

Baseline slope inclinometer readings were collected from the three slope inclinometer casings in the days following their installation. Additional readings are required to determine the degree of movement at each borehole location. As previously noted, borehole coordinates- including those for the three slope inclinometers- were recorded in the field using a handheld GPS. We are currently awaiting surveyed coordinates of the slope inclinometer casing covers, which will be collected by a BC Land Surveyor. Additional survey readings should be collected in conjunction with each subsequent slope inclinometer reading during construction and should be the responsibility of the contractor.

3.5 STANDPIPE PIEZOMETER

At borehole BH17-24, a standpipe piezometer consisting of two nested 25 mm diameter PVC pipe casings were installed to enable groundwater level readings.

Installation details for the standpipe piezometer are presented in **Table 5** below.

Table 5 Summary of Standpipe Piezometer Installation

Standpipe Piezometer ID	Project Chainage[1]	UTM Coordinates		Ground Elevation, Geodetic	Depth of screen	Backfill Details	Water Level (meters below ground surface)		
		Northing	Easting				June 29, 2017	July 4, 2017	July 18, 2017
MW17-24_1	11+794	5361802	472709	22.0 m	Solid: 0.0 - 17.7 m Screen: 17.7 - 22.2 m	Casing: 0.0 - 0.3 m Sand: 0.3 - 4.6 m Bentonite: 4.6 - 6.1 m Sand: 6.1 - 11.0 m Bentonite: 11.0 - 13.7 m Sand: 13.7 - 22.9 m	13.1	13.1	13.9
MW17-24_2					Solid: 0.0 - 7.6 m Screen: 7.6 - 10.7 m		dry	dry	dry

NOTES:

[1] For project chainage, refer to Drawings 2-1 to 2-9 in Appendix B

Water level readings were recorded on June 29, July 4 and July 18, 2017, or three, eight and 22 days, respectively, after the completion of the well installation. The readings indicate an equilibrium water level of 13.9 m below the existing ground surface.

4.0 LABORATORY TESTING

4.1 SUMMARY

Laboratory testing was conducted on split spoon samples and grab samples obtained during the geotechnical subsurface exploration work. A summary of the laboratory testing is presented in **Table 6**.

Natural moisture content, Atterberg limits, particle size analyses tests and fines content measurements were performed at the Stantec laboratory in Burnaby, BC. Testing of pH, conductivity and sulphate content were carried at the Maxxam Analytics laboratory in Burnaby, BC.

Table 6 Summary of Laboratory Testing

Laboratory Test	Number of Test Completed
Natural Moisture Content	130
Atterberg Limits	13
Particle Size Distribution	11
Fines Content Measurement (Particles less than 0.075 mm in size, passing sieve No. 200)	38
pH Testing	6
Electrical Conductivity Testing	6
Soluble Sulphate Testing	6

4.2 LABORATORY TESTING PROCEDURES

4.2.1 Natural Moisture Content

The Natural Moisture Content (w) of soil is defined as the ratio of the mass of water contained in the pore spaces of the soil to the mass of solids in the soil, expressed as a percentage. Measurement of moisture content was performed in general accordance with ASTM D2216. Natural moisture content measurements are presented on the borehole logs in Appendix C.

4.2.2 Atterberg Limits

Atterberg limits describe the consistency and plasticity of fine-grained soils with varying degrees of moisture. Atterberg limits tests are used to determine the moisture contents at which soil behavior becomes liquid or brittle. The Liquid Limit (LL) represents the moisture content at which the soil begins to flow like a liquid, and the Plastic Limit (PL) represents the moisture content at which it ceases to be plastic and becomes brittle. Subtracting the plastic limit from the liquid limit yields the Plasticity Index (PI). The PI defines the typical range of moisture contents for a soil.

The Atterberg limits were measured using the multi-point method (Method A), described in ASTM D4318. The PI is defined as follows:

$$PI = LL - PL$$

The Liquidity Index (LI) is defined as follows:

$$LI = (w - PL) / PI$$

Where “w” is the natural moisture content of the soil sample.

Atterberg limits test results are presented in Appendix D.1 and on the borehole logs in Appendix C.

4.2.3 Particle Size Distribution and Fines Content

Tests for particle size distribution were performed in general accordance with ASTM D421 and ASTM D422. In some cases, only the amount of material in the soil samples finer than 0.075 mm nominal diameter was measured. In these cases, testing was completed in general accordance with ASTM D1140 (Method A). Particle size distribution test results are presented in Appendix D.2, and summary of particle size and fines content test results are presented on the borehole logs in Appendix C.

4.2.4 pH, Conductivity and Sulphate Content

Testing of pH, conductivity and sulphate content for selected soil samples was completed at the Maxxam Analytics laboratory in Burnaby, BC, in general accordance with SM 22 4500-H+B, SM 22 2510 B, and SM 22 4500-SO42- E m respectively. The results are presented in Appendix D.3.

5.0 CLOSURE

This report was prepared for the exclusive use of the CRD and its agents for specific application to the Clover Point Forcemain Indicative Design Project. Any use of this report or the material contained herein by third parties, or for other than the intended purpose, should first be approved in writing by Stantec.

Use of this report is subject to the Statement of General Conditions included in Appendix A. It is the responsibility of the Capital Regional District, who is identified as "the Client" within the Statement of General Conditions, and their agents to review the conditions and notify Stantec should any of them not be satisfied.

We trust that this report meets your present requirements. If you have any questions or require additional information, please do not hesitate to contact the undersigned.

Respectfully submitted,

STANTEC CONSULTING LTD.

Reviewed by:

DRAFT

Christian Hajen, EIT
Geotechnical Engineer in Training
Phone: (604) 412-3215
Fax: (604) 436-3752
Christian.Hajen@stantec.com

DRAFT

(Uthaya) M. Uthayakumar, Ph.D., P.Eng.
Senior Principal Engineer, Geotechnical
Phone: (604) 678-3076
Fax: (604) 436-3752
Uthaya.Uthayakumar@stantec.com

DRAFT
Sidney Tsang, P.Geo.
Senior Associate, Geohazards and Geomorphology
Phone: (604) 235-1873
Fax: (604) 436-3752
Sid.Tsang@stantec.com

DRAFT
Ben Huynh, P.Eng.
Senior Associate, Geotechnical
Phone: (604) 331-0215
Fax: (604) 436-3752
Ben.Huynh@stantec.com

6.0 REFERENCES

Alley, N.F. and Chatwin, S.C. 1979. Late Pleistocene history and geomorphology, southwestern Vancouver Island, British Columbia. Canadian Journal of Earth Sciences, Vol. 16, No.9, pp. 1645-1657.

Barrie, J.V. and Greene, H.G. 2015. Active faulting in the northern Juan de Fuca Strait: implications for Victoria, British Columbia. Geological Survey of Canada, Current Research 2015-6.

Clague, J.J. 1981. Late Quaternary geology and geochronology of British Columbia, Part 2: Summary and discussion of radio-carbon-dated Quaternary history. Geological Survey of Canada, Paper 80-35. 41 pages.

Clapp, C.H. 1913. Geology of the Victoria and Saanich Map-areas, Vancouver Island, B.C. Canada Department of Mines, Geological Survey. Memoir 36, Geological Series No. 33. Including maps 1251-70A and 1252-71A, map scale 1:62,500.

Cui, Y., Miller, D., Nixon, G., and Nelson, J., 2015. British Columbia digital geology. British Columbia Geological Survey, Open File 2015-2. May 31, 2016 version.

ASTM D421-85(2007), Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants (Withdrawn 2016), ASTM International, West Conshohocken, PA, 2007, www.astm.org.

ASTM D422-63(2007)e2, Standard Test Method for Particle-Size Analysis of Soils (Withdrawn 2016), ASTM International, West Conshohocken, PA, 2007, www.astm.org.

ASTM D1140-14, Standard Test Methods for Determining the Amount of Material Finer than 75-μm (No. 200) Sieve in Soils by Washing, ASTM International, West Conshohocken, PA, 2014, www.astm.org.

ASTM D1452-09, Standard Practice for Soil Exploration and Sampling by Auger Borings, ASTM International, West Conshohocken, PA, 2009, www.astm.org.

ASTM D1586-11, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils, ASTM International, West Conshohocken, PA, 2011, www.astm.org.

ASTM D2216-10, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass, ASTM International, West Conshohocken, PA, 2010, www.astm.org.

ASTM D2487-11, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM International, West Conshohocken, PA, 2011, www.astm.org.

ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), ASTM International, West Conshohocken, PA, 2011, www.astm.org.

ASTM D4220 / D4220M-14, Standard Practices for Preserving and Transporting Soil Samples, ASTM International, West Conshohocken, PA, 2014, www.astm.org.

ASTM D4318-10e1, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM International, West Conshohocken, PA, 2010, www.astm.org.

Holland, S. S. (1976). Landforms of British Columbia: A Physiographic outline. BC Department of Mines and Petroleum Products. Bulletin No. 48. p. 138.

Johnston, S.T., Canil, D., McEwen, G., and Pope, M. 2013. A transect of the Pacific Rim – Wrangellia terrane boundary. 2013 BCGS Open House Canadian Tectonics Group Meeting. School of Earth and Ocean Sciences, University of Victoria.

Mathews, W.H., Fyles, J.G. and Nasmith, H.W. 1970. Postglacial crustal movements in southwestern British Columbia and adjacent Washington state. Canadian Journal of Earth Sciences, Vol. 7, pp. 690-702.

Monahan, P. A. and Levson, V.M. 2000. Quaternary Geological Map of Greater Victoria. Geoscience Map 2000-2. Scale 1:25,000. Geological Survey Branch.

Morell, K.D., Regalla, C., Leonard, L.J., Amos, C. and Levson, V. 2017. Quaternary rupture of a crustal fault beneath Victoria, British Columbia, Canada. GSA Today, Vol. 27.

Appendix A STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec's present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec will not be responsible to any party for damages incurred as a result of failing to notify Stantec that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec cannot be responsible for site work carried out without being present.

Appendix B DRAWINGS

Sources

Project Information
Project No.: 111700431
Scale: 1:7500
Date: 2017-JUL-11
Drawn by: G. HUYNH
Checked by: C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE
BOREHOLE LOCATION PLAN
OVERVIEW

Dwg No.
1

Stantec

\\Cd1183-f03\workgroup\1232\projects\111700431\clover_point\factual_report\111700431_001_overview.dwg
2017/07/27 1:37 PM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

Sources

Project Information

Project No.:	111700431
Scale:	1:1000
Date:	2017-JUL-11
Drawn by:	G. HUYNH
Checked by:	C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE

BOREHOLE LOCATION PLAN
SHEET 1

Dwg No.
2-1

S:\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 11:37 AM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

S:\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 11:38 AM By: Huynh, Gordon

Stantec

ORIGINAL SHEET - ANSI B

Sources

Project Information

Project No.:	111700431
Scale:	1:1000
Date:	2017-JUL-11
Drawn by:	G. HUYNH
Checked by:	C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE
BOREHOLE LOCATION PLAN
SHEET 2

Dwg No.
2-2

LEGEND

— — SFM —	PROPOSED FORCEMAIN
— - - —	LOTLINE
——	MAJOR CONTOUR (5 m)
——	MINOR CONTOUR (1 m)
●	BOREHOLE LOCATION

SCALE IN METRES
0 10 20 30 40 50
1:1000

Stantec

S:\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 11:38 AM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

Sources

Project Information

Project No.:	111700431
Scale:	1:1000
Date:	2017-JUL-11
Drawn by:	G. HUYNH
Checked by:	C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE
BOREHOLE LOCATION PLAN
SHEET 3

Dwg No.
2-3

Stantec

Sources

Project Information

Project No.:	111700431
Scale:	1:1000
Date:	2017-JUL-11
Drawn by:	G. HUYNH
Checked by:	C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE
BOREHOLE LOCATION PLAN
SHEET 4

Dwg No.
2-4

S:\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 11:38 AM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

Stantec

Sources

Project Information

Project No.:	111700431
Scale:	1:1000
Date:	2017-JUL-11
Drawn by:	G. HUYNH
Checked by:	C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE

BOREHOLE LOCATION PLAN
SHEET 5

Dwg No.
2-5

S:\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 11:40 AM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

Sources

Project Information

Project No.: 111700431
Scale: 1:1000
Date: 2017-JUL-11
Drawn by: G. HUYNH
Checked by: C. HAJEN

Project Location

DALLAS ROAD
VICTORIA, BC

Client/Project

CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE

BOREHOLE LOCATION PLAN
SHEET 6

Dwg No.

2-6

Stantec

Sources

Project Information

Project No.: 111700431
Scale: 1:1000
Date: 2017-JUL-11
Drawn by: G. HUYNH
Checked by: C. HAJEN

Project Location

DALLAS ROAD
VICTORIA, BC

Client/Project

CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE

BOREHOLE LOCATION PLAN
SHEET 7

Dwg No.

2-7

S:\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 11:40 AM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

Stantec

Sources

Project Information

Project No.:	111700431
Scale:	1:1000
Date:	2017-JUL-11
Drawn by:	G. HUYNH
Checked by:	C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE
BOREHOLE LOCATION PLAN
SHEET 8

Dwg No.
2-8

S:\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 11:41 AM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

Sources

Project Information

Project No.:	111700431
Scale:	1:1000
Date:	2017-JUL-11
Drawn by:	G. HUYNH
Checked by:	C. HAJEN

Project Location
DALLAS ROAD
VICTORIA, BC

Client/Project
CAPITAL REGIONAL DISTRICT

CLOVER POINT FORCEMAIN
GEOTECHNICAL ASSESSMENT

TITLE
**BOREHOLE LOCATION PLAN
SHEET 9**

Dwg No.
2-9

\\Cd1183-f03\workgroup\1232\projects\111700431\drawings\clover_point\factual_report\111700431_002.dwg
2017/07/27 1:39 PM By: Huynh, Gordon

ORIGINAL SHEET - ANSI B

Appendix C BOREHOLE LOGS

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

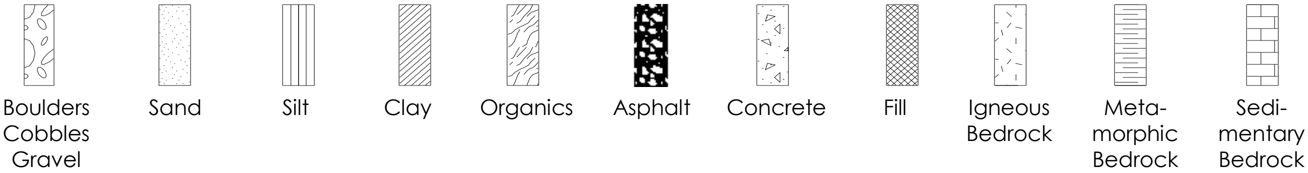
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PT	Piston tube sample
GS	Grab sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

▼	measured in standpipe, piezometer, or well
▽	inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_U	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

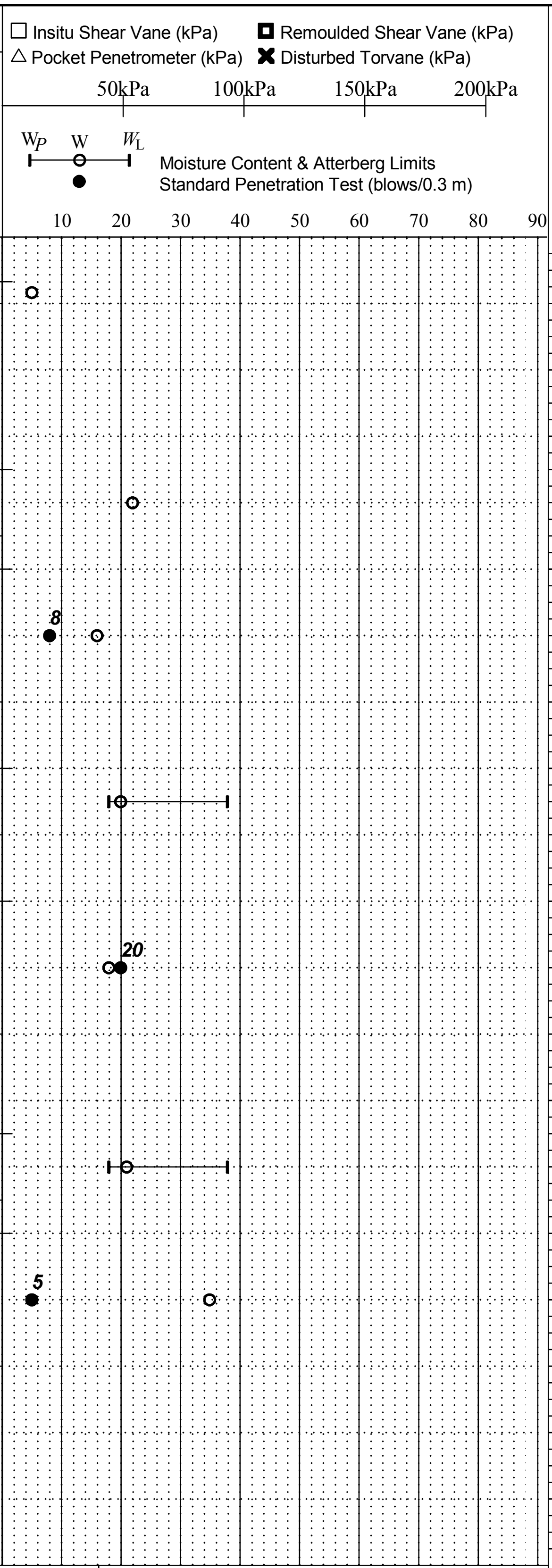
	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

BOREHOLE RECORD

BH17-01

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362877
LOCATION Dallas Road, Victoria, BC
ELEVATION 4.0 m
EASTING 471488
DRILLING DATE 06/29/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	TYPE	NUMBER	MOISTURE CONTENT (%)
AS	■	ASPHALT				
FL	☒	FILL: grey well-graded gravel with sand		GS	1	5
FL	☒	FILL: dark brown midden with high organic content - traces of sand and gravel - occasional seashell fragments - fines at 1.2 m= 19.0%		GS SPT	2 3	22 16
ML		Grey SILT (ML) with sand - mottled with brown - fines at 2.0 m= 62%				
CL		Grey lean CLAY (CL) - traces of sand and gravel - mottled with light grey and brown - lower drilling resistance below 3.8 m		GS SPT GS SPT	4 5 6 7	20 18 21 35
		End of Borehole BH17-01 at 5.2 m Target depth reached Groundwater not encountered in open borehole				



DEPTH (m): 0, 1, 2, 3, 4, 5, 6

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁛ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

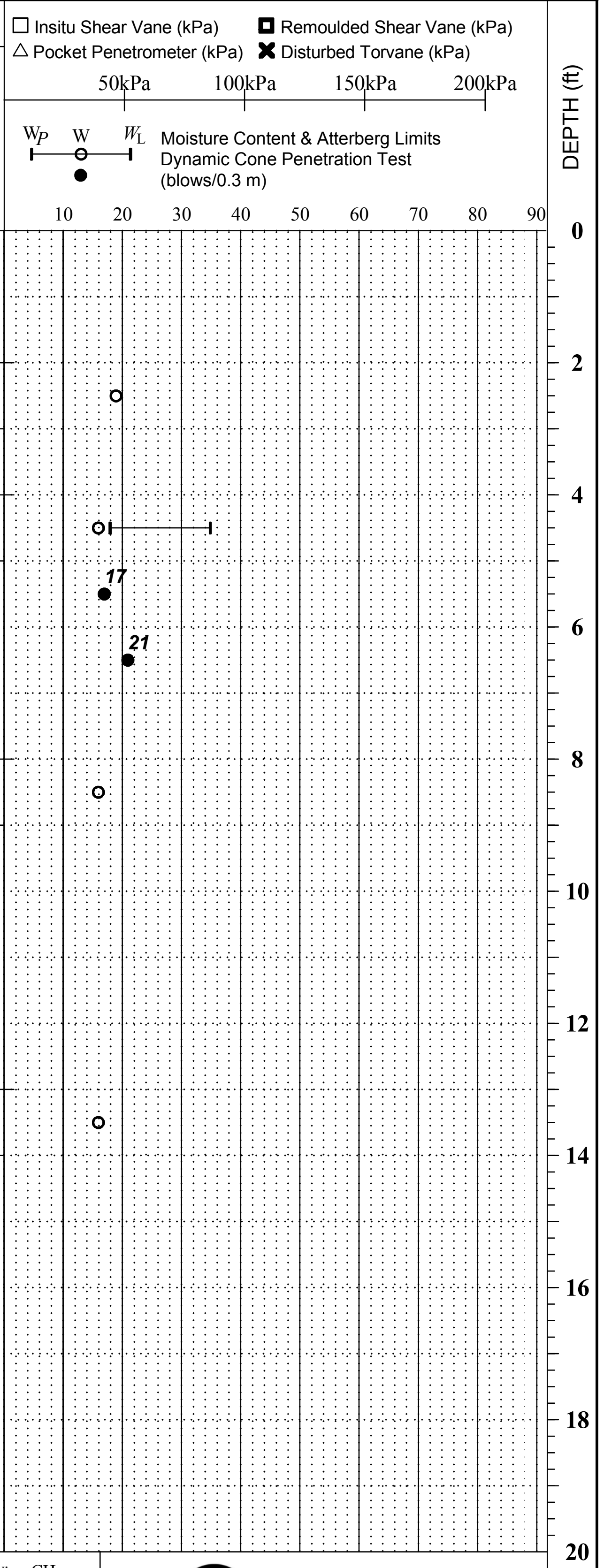
Stantec

BOREHOLE RECORD

BH17-02

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362786
LOCATION Dallas Road, Victoria, BC
ELEVATION 4.4 m
EASTING 471492
DRILLING DATE 06/28/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
0	AS		ASPHALT				
	CO		CONCRETE				
	FL		FILL: grey and brown mottled lean clay with sand - traces of gravel and organics - crumbly		GS	1	19
1			Grey and brown mottled lean CLAY (CL) with sand - traces of gravel		GS	2	16
2			- with sand and gravel from 2.1 m to 2.7 m				
					GS	3	16
	CL		- traces of sand and no gravel below 2.7 m				
3							
4					GS	4	16
			End of Borehole BH17-02 at 4.6 m Target depth reached Groundwater not encountered in open borehole DCPT conducted from 1.5 m to 2.1 m				
5							
6							



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ⊠ Drill Cuttings ⁘ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-03

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362737
LOCATION Dallas Road, Victoria, BC
ELEVATION 6.0 m
EASTING 471502
DRILLING DATE 06/28/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

☐ Insitu Shear Vane (kPa) ▣ Remoulded Shear Vane (kPa)
△ Pocket Penetrometer (kPa) ✖ Disturbed Torvane (kPa)
50kPa 100kPa 150kPa 200kPa
W_P W W_L Moisture Content & Atterberg Limits
● Standard Penetration Test (blows/0.3 m)
10 20 30 40 50 60 70 80 90

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)	DEPTH (ft)
0	AS	ASPHALT					0
	CO	CONCRETE					
	FL	FILL: grey well-graded gravel with sand					
	BR	Dark grey BEDROCK - advanced using ODEX hammer - angular and/or powdered cuttings observed from air return - high drilling resistance		GS GS	1 2		
		End of Borehole BH17-03 at 3.7 m Termination upon confirmation of bedrock Groundwater not encountered in open borehole					

DEPTH (m): 0 1 2 3 4 5 6
DEPTH (ft): 0 2 4 6 8 10 12 14 16 18 20

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core
Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

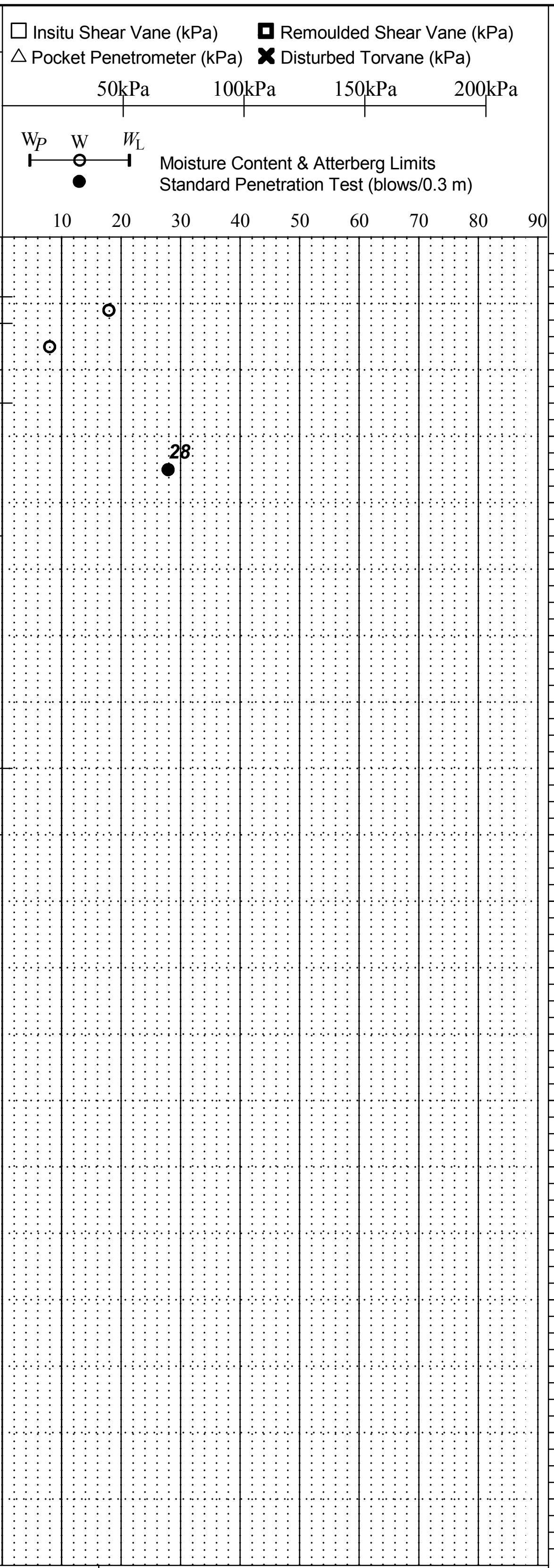
Stantec

BOREHOLE RECORD

BH17-04

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362561
LOCATION Dallas Road, Victoria, BC
ELEVATION 6.0 m
EASTING 471561
DRILLING DATE 06/28/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)
AS	ASPHALT			
CO	CONCRETE			
FL	FILL: brown sandy silt with gravel and organics	GS	1	18
FL	FILL: grey well-graded sand	GS	2	8
FL	FILL: grey well-graded gravel with sand	SPT	3	
BR	Dark grey BEDROCK - advanced through bedrock using ODEX hammer - angular and/or powdered cuttings observed from air return - high drilling resistance	GS	4	
	End of Borehole BH17-04 at 3.4 m Termination upon confirmation of bedrock Groundwater not encountered in open borehole			



DEPTH (m): 0 1 2 3 4 5 6
DEPTH (ft): 0 2 4 6 8 10 12 14 16 18 20

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core
Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

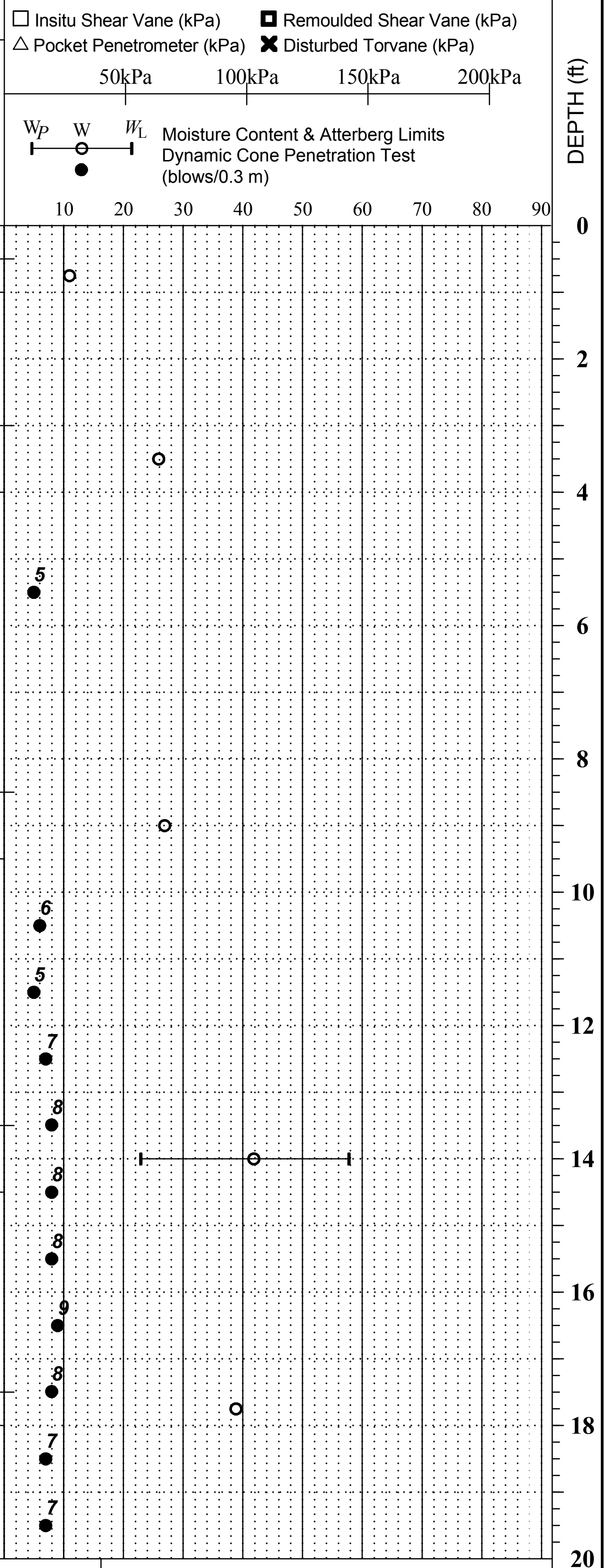
Stantec

BOREHOLE RECORD

BH17-05

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362476
LOCATION Dallas Road, Victoria, BC
ELEVATION 4.6 m
EASTING 471639
DRILLING DATE 06/29/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	TYPE	NUMBER	MOISTURE CONTENT (%)
0	AS	ASPHALT				
	FL	FILL: grey silty sand with gravel and organics		GS	1	11
1 2	FL	FILL: grey lean clay - mottled with brown - traces of gravel and organics - fines at 1.1m= 92% - auger and DCPT refusal at 2.0 m on inferred boulder - re-drilled 1.5 m east and advanced beyond 2.0 m depth		GS	2	26
	FL	FILL: dark brown silty sand - traces of gravel and organics - fines at 2.7 m= 44%		GS	3	27
3 4 5 6	CH	Brown-grey fat CLAY (CH) - grey below 4.6 m		GS GS	4 5	42 39



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ▨ Drill Cuttings ⁚ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

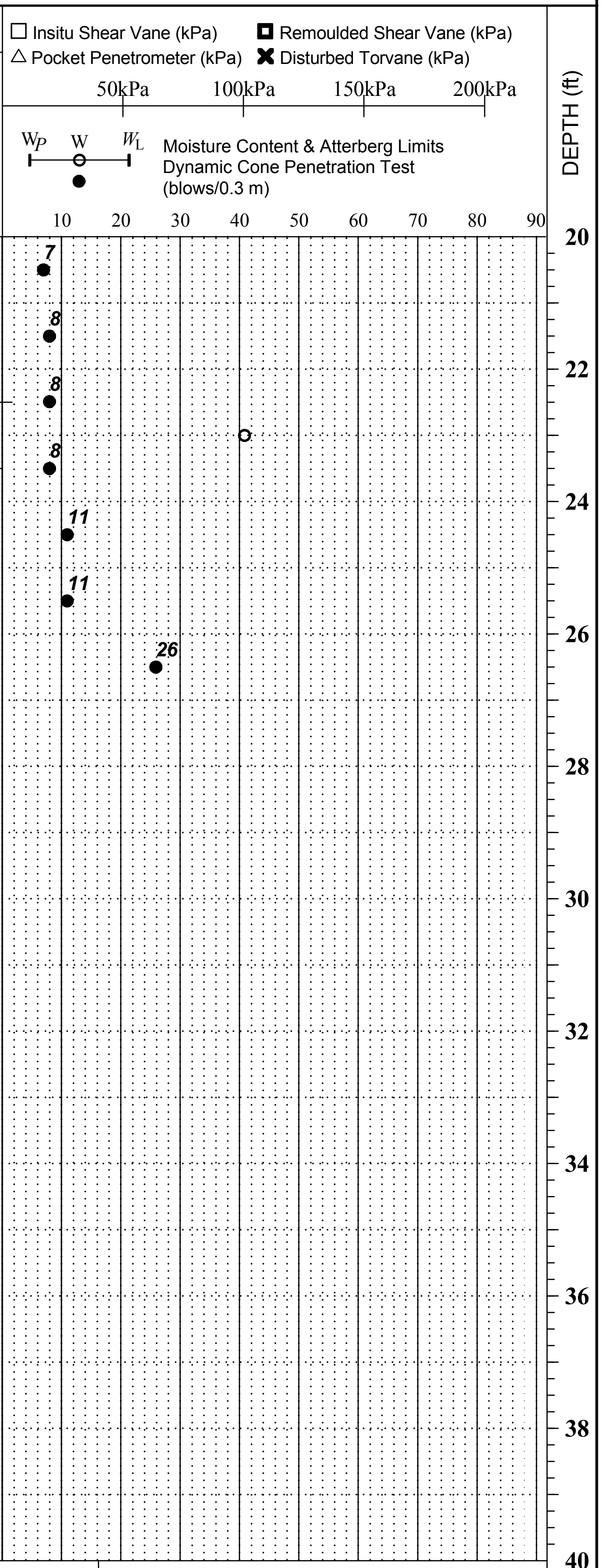
Stantec

BOREHOLE RECORD

BH17-05 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362476
LOCATION Dallas Road, Victoria, BC
ELEVATION 4.6 m
EASTING 471639
DRILLING DATE 06/29/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
	CH	▨	Brown-grey fat CLAY (CH)				
7					GS	6	41
			End of Borehole BH17-05 at 7.6 m Target depth reached Groundwater not encountered in open borehole DCPT conducted at 1.5 m, and 3.0 to 8.2 m				
8							
9							
10							
11							
12							



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

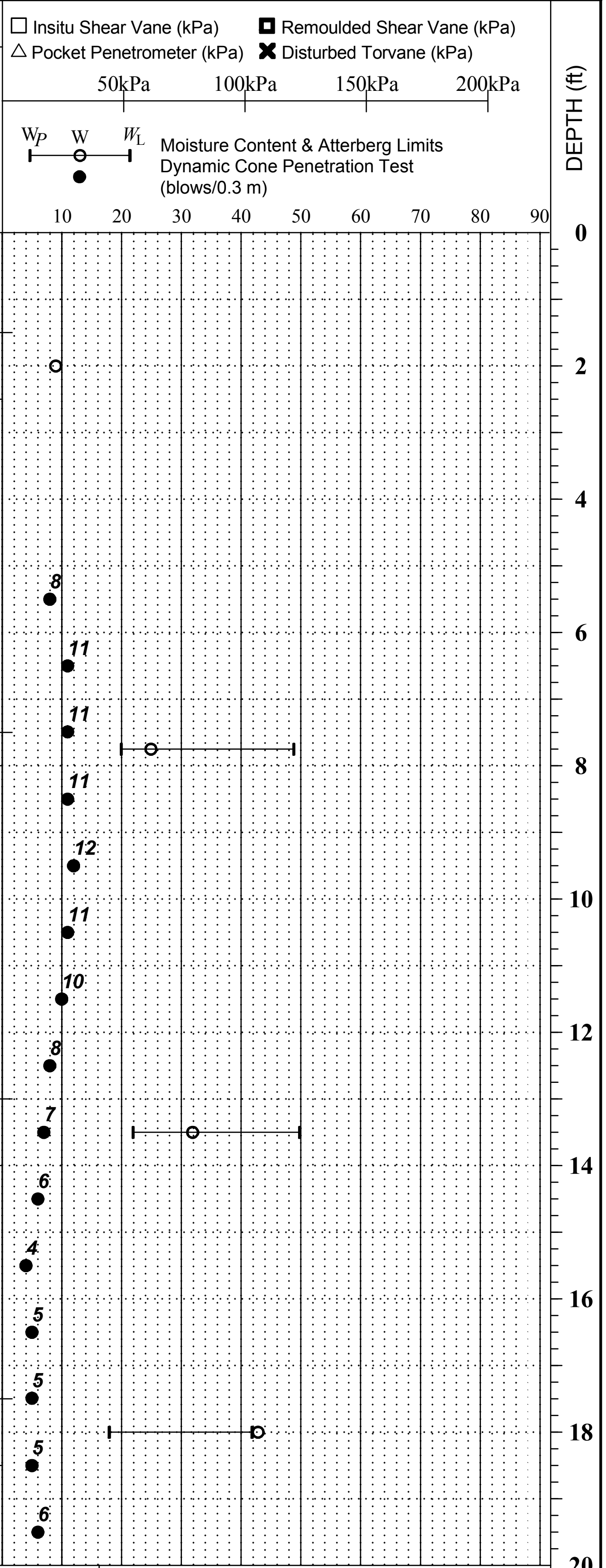
Stantec

BOREHOLE RECORD

BH17-06

CLIENT Capital Regional District
PROJECT Clover Point Forcemain
LOCATION Dallas Road, Victoria, BC
DRILLING DATE 06/29/2017
DRILLING CO. Geotech Drilling Ltd.
DATUM Geodetic
ELEVATION 4.5 m
PROJECT No. 111700431
NORTHING 5362419
EASTING 471696
DRILLING METHOD Solid-Stem Auger

USC	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)
AS	ASPHALT				
FL	FILL: dark brown silty sand - traces of gravel and organics - fines at 0.7 m= 18%		GS	1	9
ML	Reddish-light brown SILT (ML) with sand				
CH	Grey-brown fat CLAY (CH) - DCPT conducted from 1.5 to 7.6 m		GS	2	25
CL	Grey-brown lean CLAY (CL) - grey below 4.6 m		GS GS	3 4	32 43



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

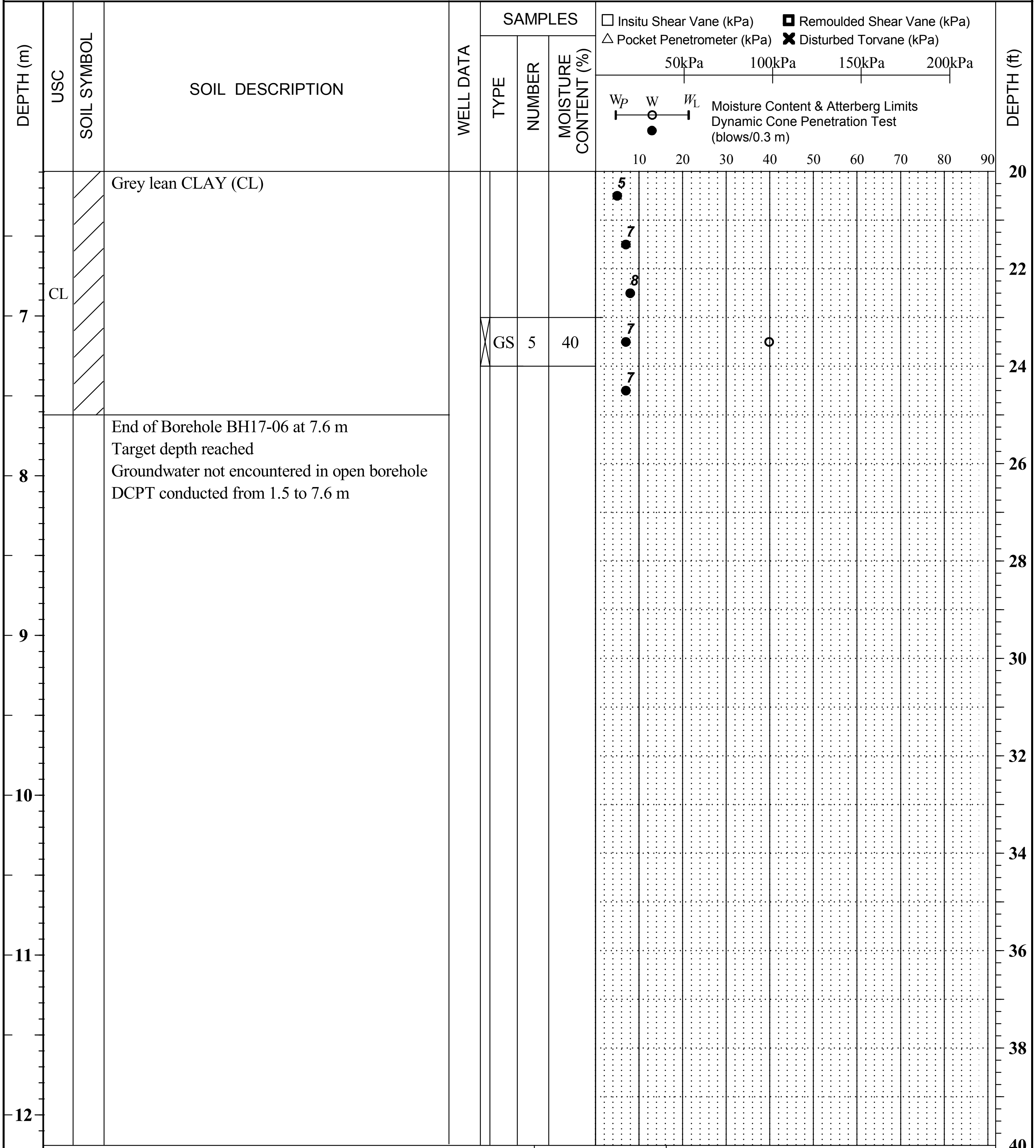
Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-06 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362419
LOCATION Dallas Road, Victoria, BC
ELEVATION 4.5 m
EASTING 471696
DRILLING DATE 06/29/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger



USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)
CL	Grey lean CLAY (CL)	GS	5	40
	End of Borehole BH17-06 at 7.6 m Target depth reached Groundwater not encountered in open borehole DCPT conducted from 1.5 to 7.6 m			

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁚ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

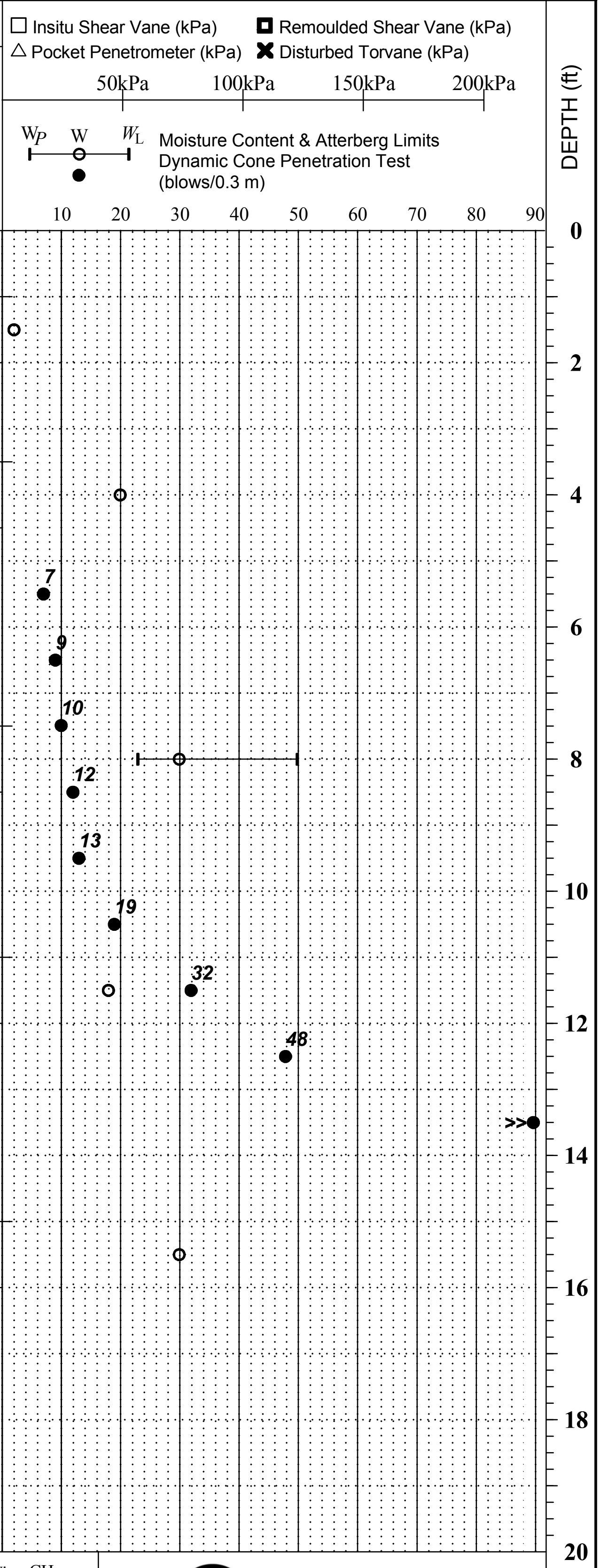
Stantec

BOREHOLE RECORD

BH17-07

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362363
LOCATION Dallas Road, Victoria, BC
ELEVATION 6.1 m
EASTING 471767
DRILLING DATE 06/29/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
0	AS	■	ASPHALT				
	FL	⊠	FILL: grey well-graded sand with gravel		GS	1	2
1	CL	▨	Light brown sandy lean CLAY (CL) - mottled with grey and brown		GS	2	20
2		▨	Grey-brown lean to fat CLAY (CL/CH)		GS	3	30
3	CL	▨	- traces of gravel from 3.4 to 4.6 m		GS	4	18
4		▨	- sandy gravelly clay lens from 3.8 to 4.1 m - DCPT bouncing refusal at 4.0 m				
5		▨			GS	5	30
6			End of Borehole BH17-07 at 5.3 m Sudden auger refusal at 5.3 m Groundwater not encountered in open borehole DCPT conducted from 1.5 to 4.0 m				



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ⊠ Drill Cuttings ⁘ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

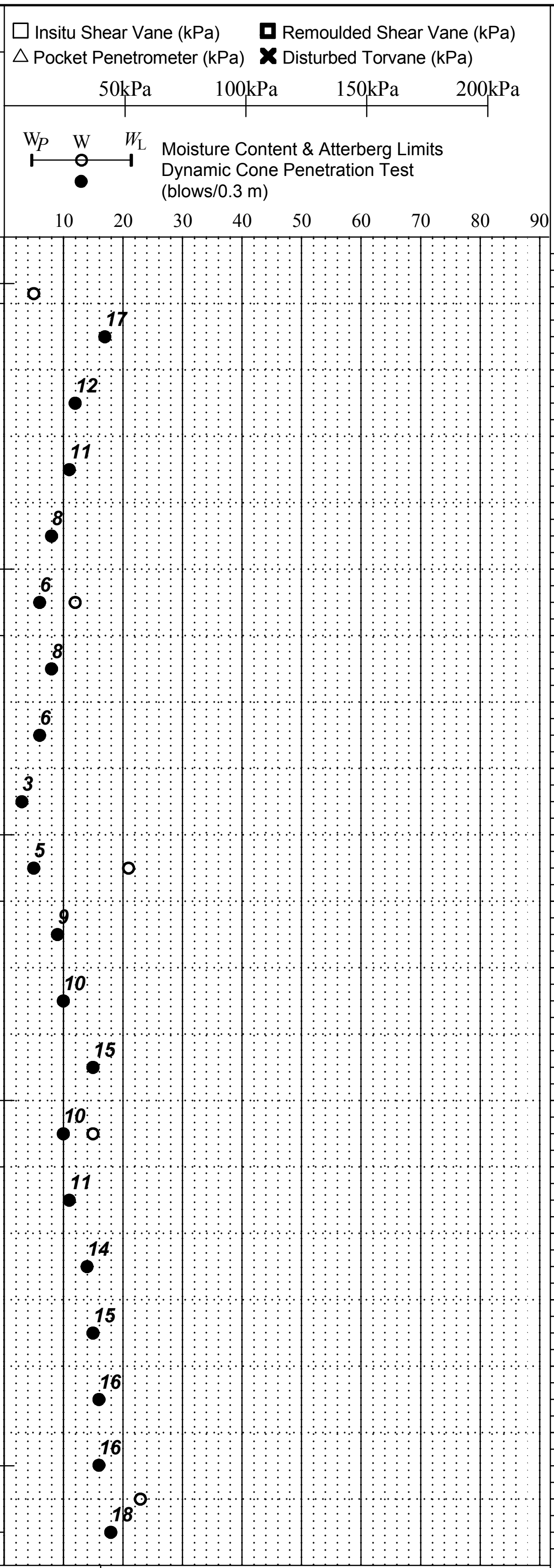
Stantec

BOREHOLE RECORD

BH17-08

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362254
LOCATION Dallas Road, Victoria, BC
ELEVATION 7.0 m
EASTING 471916
DRILLING DATE 06/30/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)
AS	ASPHALT			
FL	FILL: grey well-graded sand with silt and gravel	GS	1	5
FL	FILL: brown silty sand - traces of gravel and organics - sieve at 1.7 m: gravel= 13.0%; sand= 51.4%; fines= 35.6%	GS	2	12
FL	FILL: brown silt with sand - traces of gravel and organics	GS	3	21
	- grey-brown below 5.3 m - fines at 4.1 m= 95%	GS	4	15
CL	Grey lean CLAY (CL)	GS	5	23



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

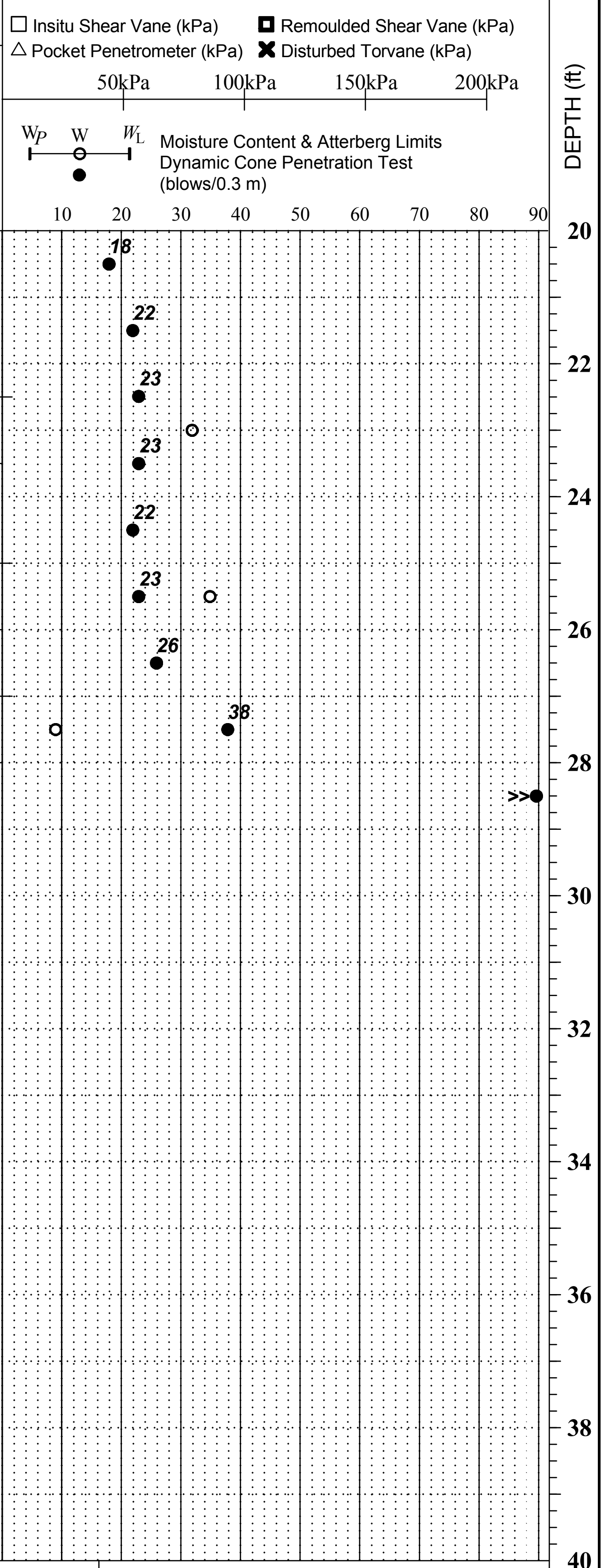
Stantec

BOREHOLE RECORD

BH17-08 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362254
LOCATION Dallas Road, Victoria, BC
ELEVATION 7.0 m
EASTING 471916
DRILLING DATE 06/30/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
			Grey lean CLAY (CL)				
7	CL				GS	6	32
∇							
					GS	7	35
8							
	TL		Grey sandy silt (ML) with gravel TILL - high drilling resistance		GS	8	9
			End of Borehole BH17-08 at 8.5 m Practical auger refusal Groundwater measured at 7.3 m in open borehole DCPT conducted from 0.3 to 8.7 m DCPT refusal at 8.7 m				
9							
10							
11							
12							



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ⊠ Drill Cuttings ⁘ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

BOREHOLE RECORD

BH17-09

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5362155

LOCATION Dallas Road, Victoria, BC

ELEVATION 11.0 m

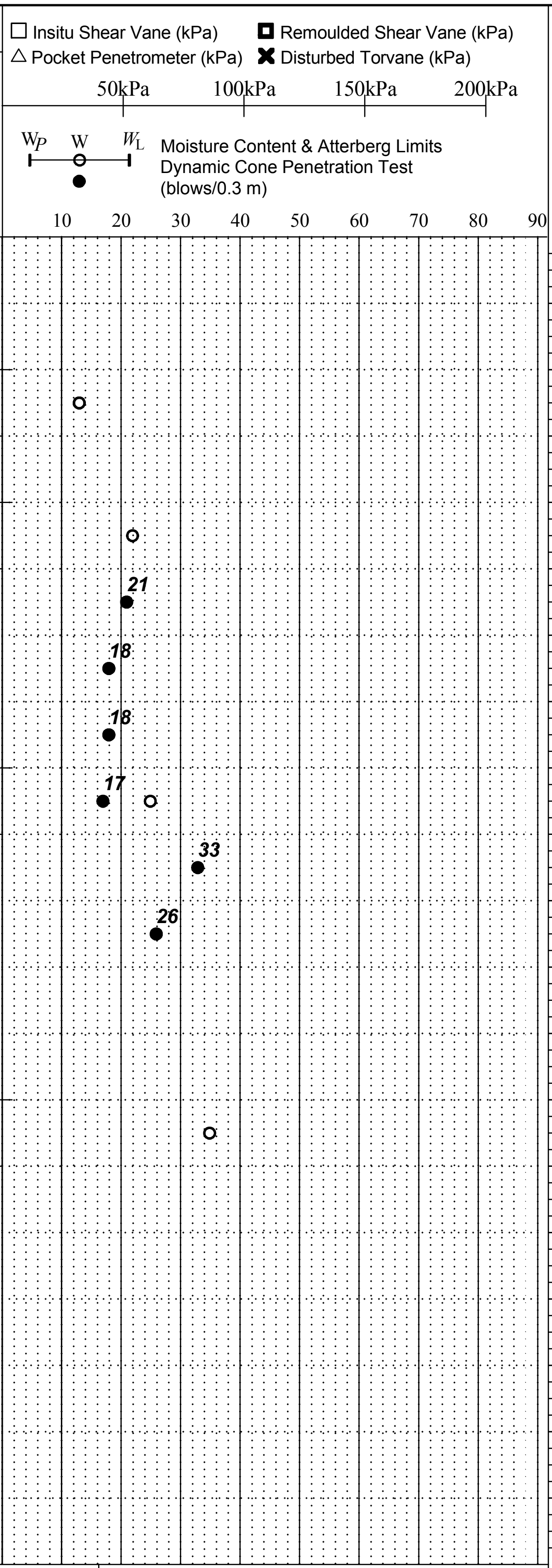
EASTING 472052

DRILLING DATE 06/30/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	NUMBER	MOISTURE CONTENT (%)
0	TP	TOPSOIL				
	ML	Grey and brown mottled sandy SILT (ML) with gravel		GS	1	13
1	CL	Grey-brown lean CLAY (CL) with sand - traces of gravel to 3.0 m		GS	2	22
				GS	3	25
4				GS	4	35
		End of Borehole BH17-09 at 4.6 m Target depth reached Groundwater not encountered in open borehole DCPT conducted from 1.5 to 3.4 m				



DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

Logged by: CH

Reviewed by: BH

Date: July 13, 2017

Stantec

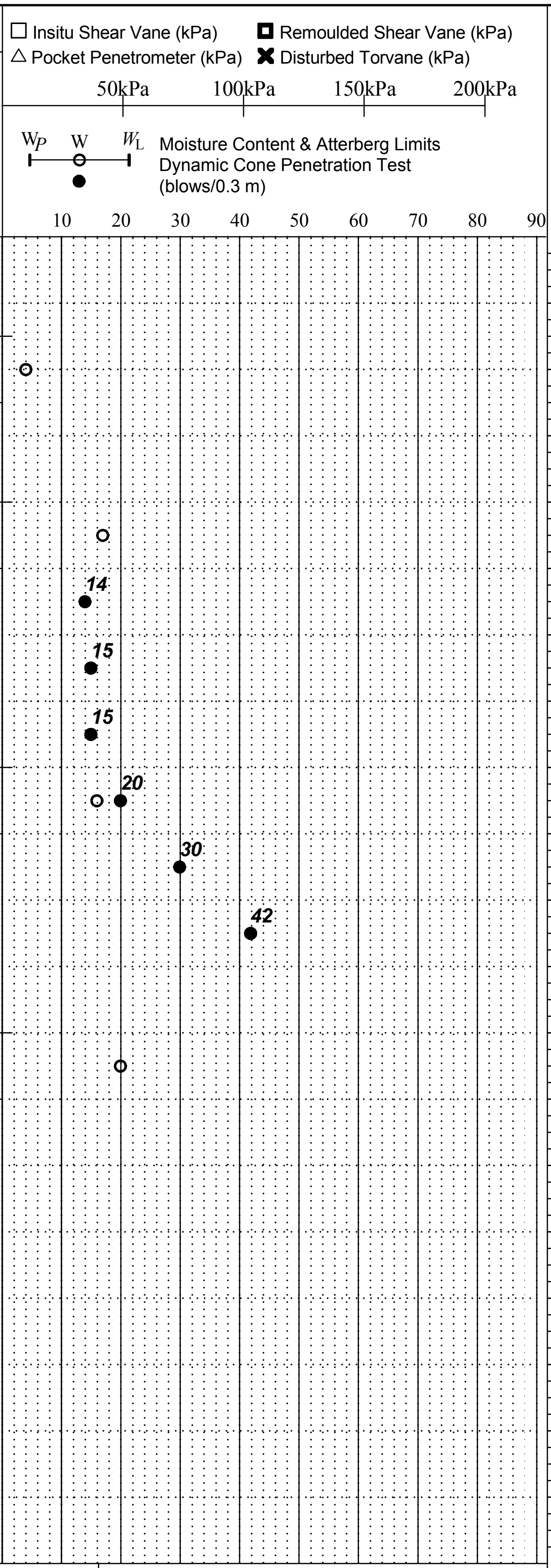
BOREHOLE RECORD

BH17-10

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5362037
LOCATION Dallas Road, Victoria, BC
ELEVATION 14.0 m
EASTING 472216
DRILLING DATE 06/30/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL DESCRIPTION
0	TP	TOPSOIL
	SM	Brown SILTY SAND (SM) - traces of gravel
1	CL	Grey lean CLAY - traces of sand - gravelly from 1.5 m to 1.8 m - traces of gravel below 1.8 m
		End of Borehole BH17-10 at 4.3 m Target depth reached Groundwater not encountered in open borehole DCPT conducted from 1.5 to 3.4 m

SAMPLES TYPE	NUMBER	MOISTURE CONTENT (%)
GS	1	4
GS	2	17
GS	3	16
GS	4	20



DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

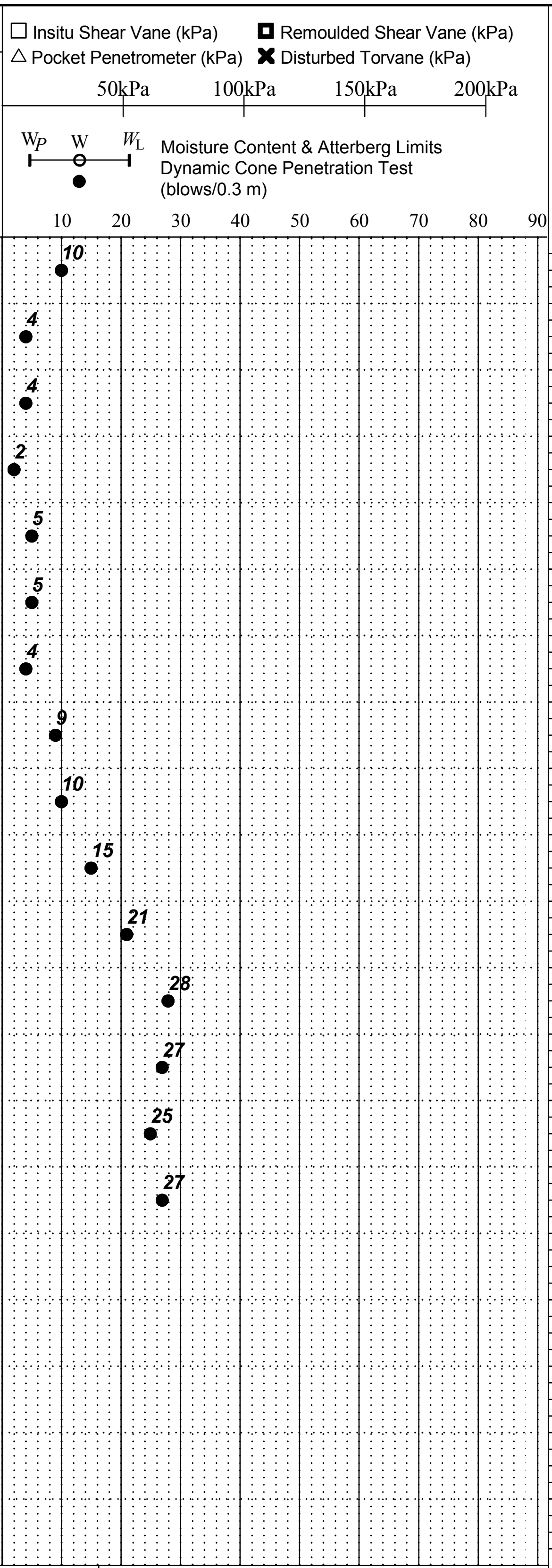
Stantec

BOREHOLE RECORD

BH17-11

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361943
LOCATION Dallas Road, Victoria, BC
ELEVATION 16.1 m
EASTING 472348
DRILLING DATE 06/30/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
0			Auger head breakdown, DCPT blow counts performed to target depth; no drilling					0
4.6			End of DCPT at 4.6 m Target depth reached					



Depth (m): 0, 1, 2, 3, 4, 5, 6

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁛ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

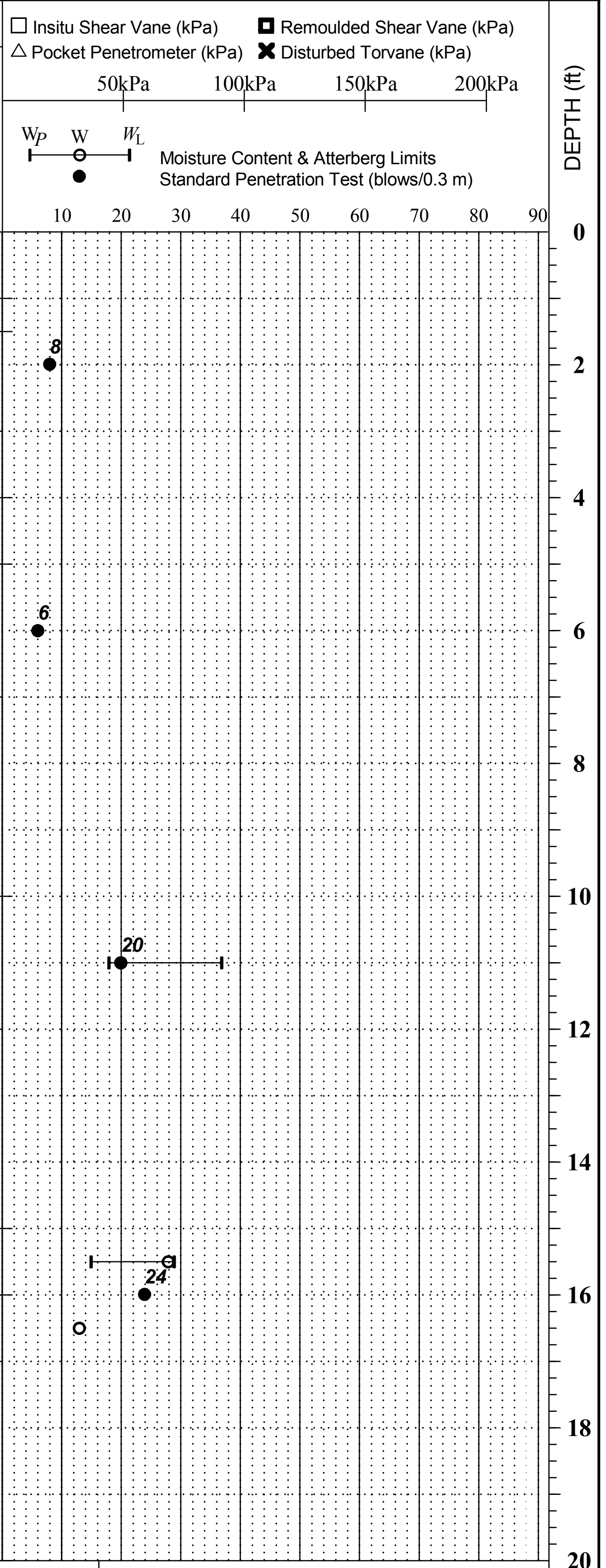
BOREHOLE RECORD

BH17-12a

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361845
LOCATION Dallas Road, Victoria, BC
ELEVATION 17.1 m
EASTING 472488
DRILLING DATE 06/27/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

DEPTH (m)	USC	SOIL DESCRIPTION
0	AS	ASPHALT
	FL	FILL: grey-brown poorly graded gravel with sand - traces of organics
	FL	FILL: brown silt with sand - traces of organics
1	FL	FILL: dark brown to black organic soil with sand and gravel
2	CL	Grey-brown lean CLAY (CL) - traces of sand and gravel - grey and brown mottling - fines at 3.4 m= 85.7% - fines at 4.7 m= 88.8% - silty sand lens from 4.9 to 5.2 m

SAMPLES TYPE	NUMBER	MOISTURE CONTENT (%)
SPT	1a	
SPT	1b	
GS	2	
SPT	3	
SPT	4	20
SPT	5a	28
SPT	5b	13



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

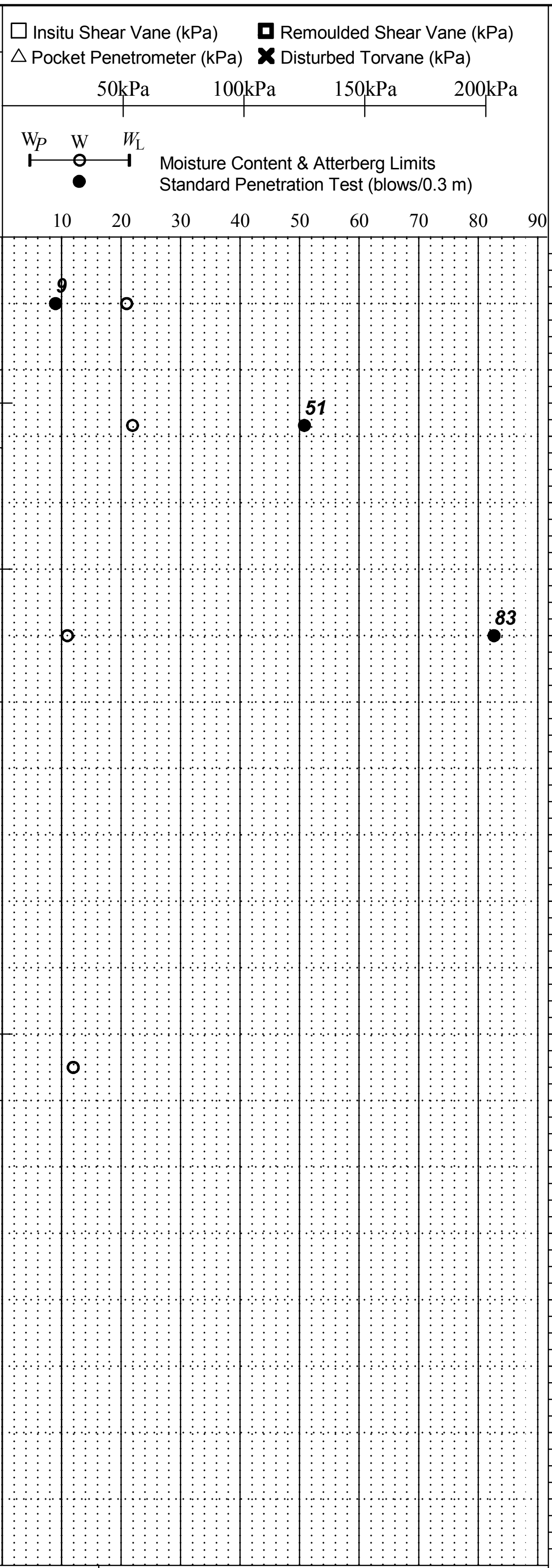
Stantec

BOREHOLE RECORD

BH17-12a cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361845
LOCATION Dallas Road, Victoria, BC
ELEVATION 17.1 m
EASTING 472488
DRILLING DATE 06/27/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
	CL		Grey-brown sandy lean CLAY (CL)		SPT	6	21	20
7	TL		Grey silty sand (SM) with gravel TILL - sieve at 6.9 m: gravel= 20.9%; sand=47.6%; fines= 31.5%		SPT	7	22	22 24
8					SPT	8	11	26
9 10	BR		Dark grey BEDROCK - advanced using ODEX hammer - angular and/or powdered cuttings observed from air return		GS	9	12	28 30 32 34
11 12			End of Borehole BH17-12a at 10.9 m Practical refusal Slope inclinometer installed. Casing set in bedrock Groundwater not encounterd in open borehole					36 38 40



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core
Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

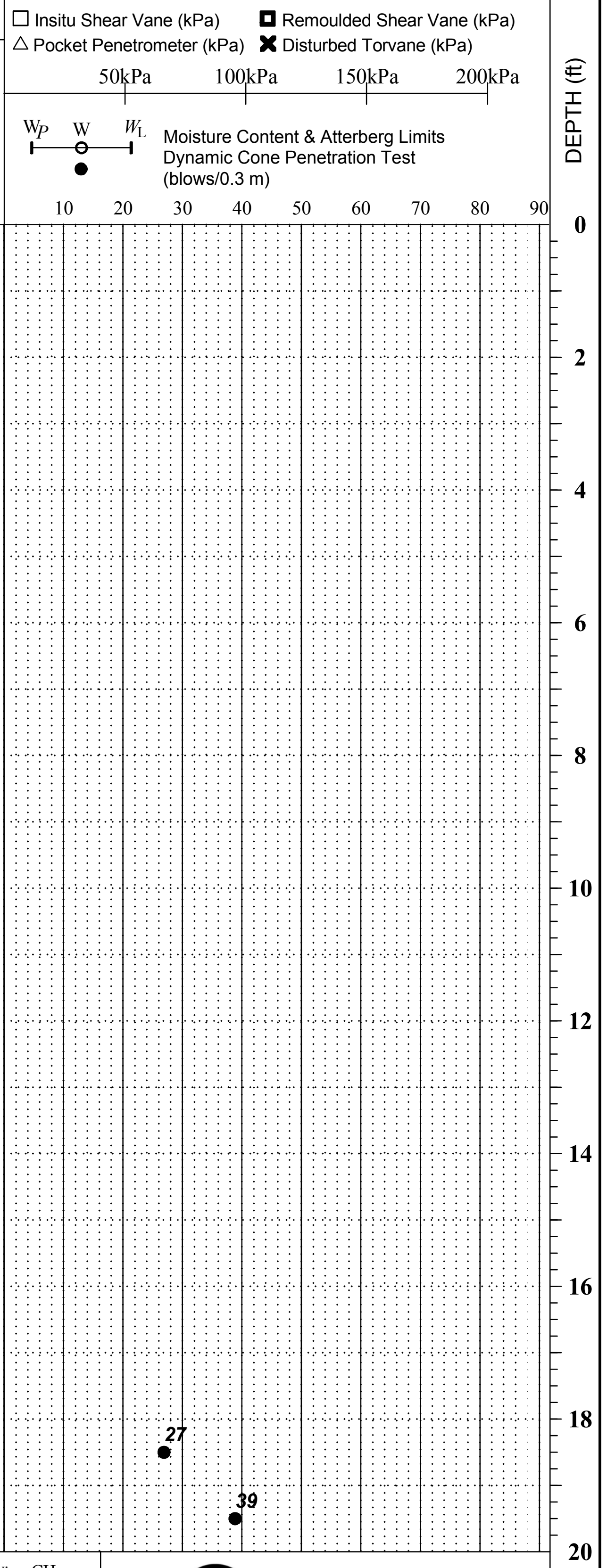
Stantec

BOREHOLE RECORD

BH17-12b

CLIENT: Capital Regional District
PROJECT No.: 111700431
PROJECT: Clover Point Forcemain
DATUM: Geodetic
NORTHING: 5361842
LOCATION: Dallas Road, Victoria, BC
ELEVATION: 16.6 m
EASTING: 472490
DRILLING DATE: 06/27/2017
DRILLING CO.: Geotech Drilling Ltd.
DRILLING METHOD: Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)	DEPTH (ft)
0			DCPT conducted from 5.5 m to 7.0 m to supplement BH17-12a					0



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

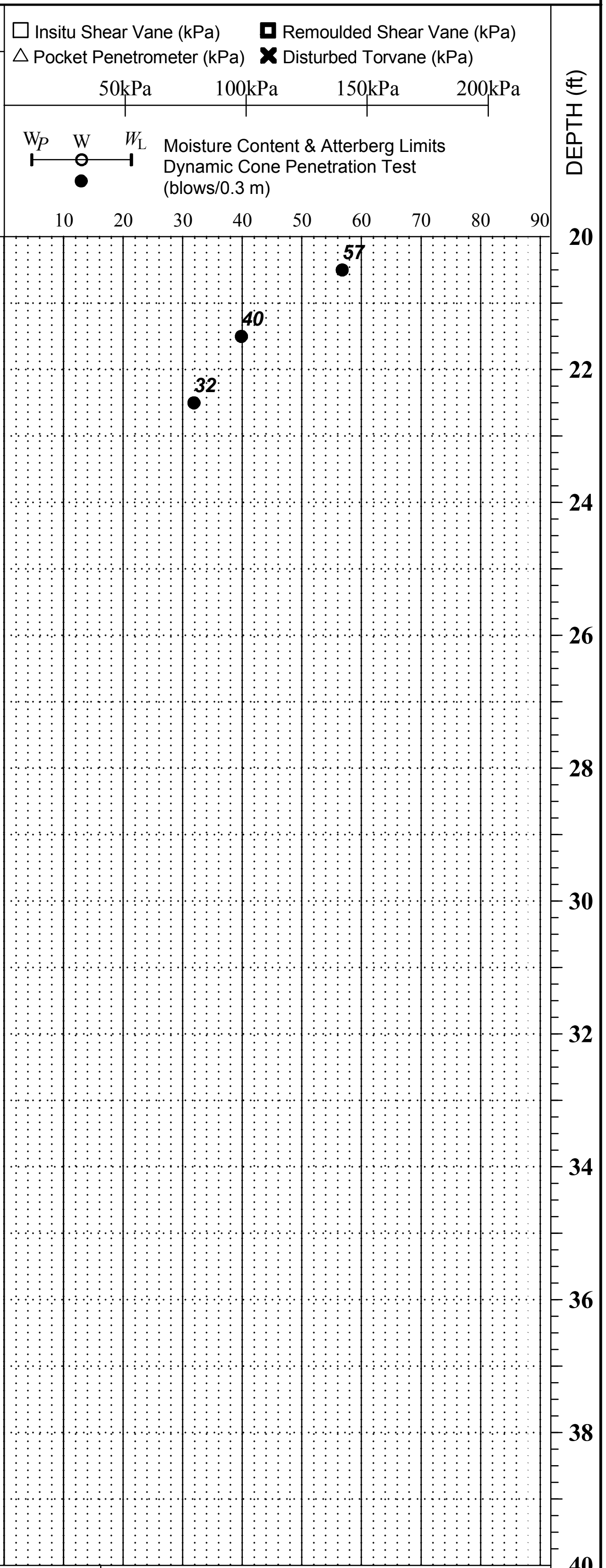
Stantec

BOREHOLE RECORD

BH17-12b cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361842
LOCATION Dallas Road, Victoria, BC
ELEVATION 16.6 m
EASTING 472490
DRILLING DATE 06/27/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
			DCPT conducted from 5.5 m to 7.0 m to supplement BH17-12a				
7			End of Borehole DCPT at 7.0 m Target depth reached				
8							
9							
10							
11							
12							



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

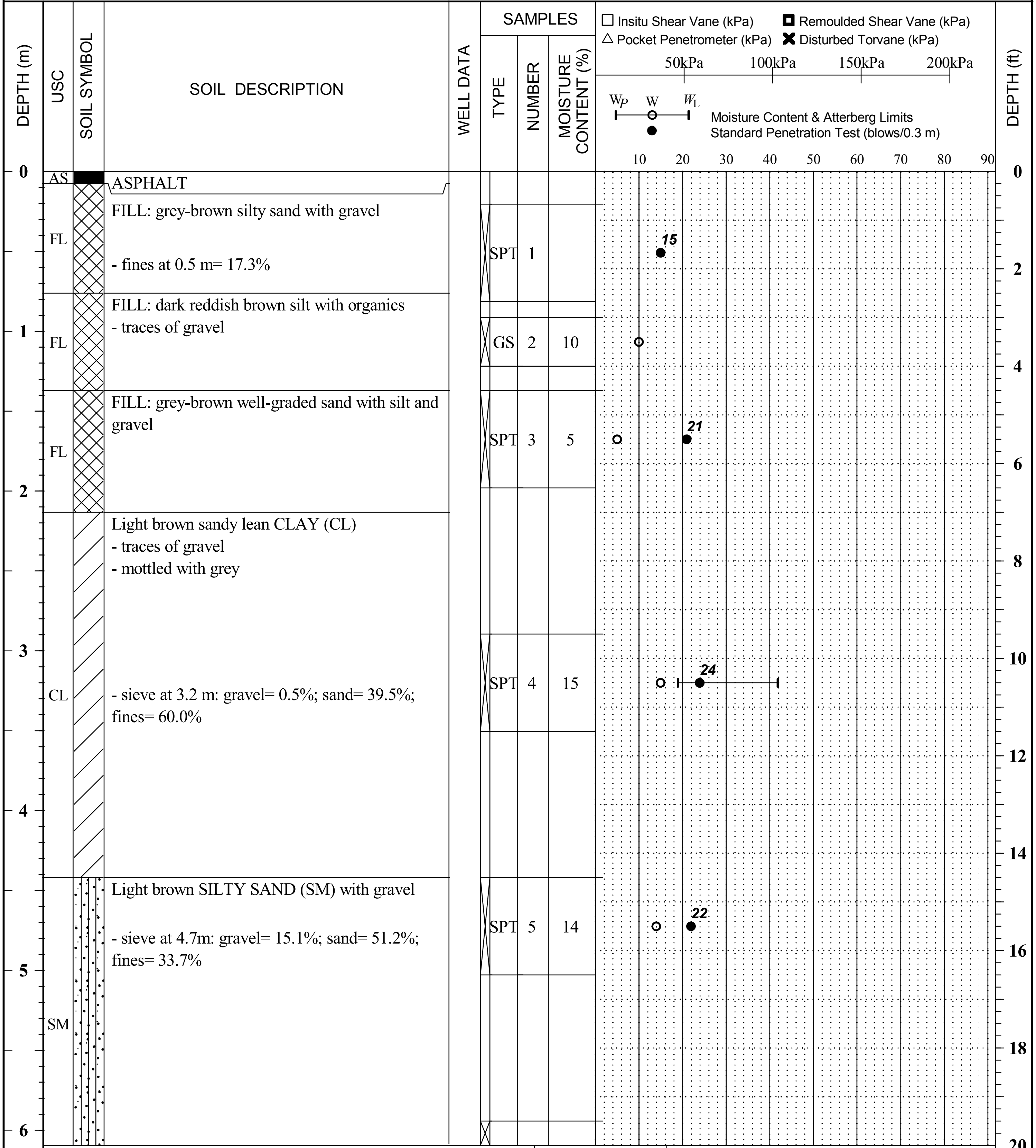
Stantec

BOREHOLE RECORD

BH17-13

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361781
LOCATION Dallas Road, Victoria, BC
ELEVATION 20.3 m
EASTING 472659
DRILLING DATE 06/19/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

USC	SOIL DESCRIPTION	WELL DATA	TYPE	NUMBER	MOISTURE CONTENT (%)
AS	ASPHALT				
FL	FILL: grey-brown silty sand with gravel - fines at 0.5 m= 17.3%		SPT	1	
FL	FILL: dark reddish brown silt with organics - traces of gravel		GS	2	10
FL	FILL: grey-brown well-graded sand with silt and gravel		SPT	3	5
CL	Light brown sandy lean CLAY (CL) - traces of gravel - mottled with grey - sieve at 3.2 m: gravel= 0.5%; sand= 39.5%; fines= 60.0%		SPT	4	15
SM	Light brown SILTY SAND (SM) with gravel - sieve at 4.7m: gravel= 15.1%; sand= 51.2%; fines= 33.7%		SPT	5	14



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ⊠ Drill Cuttings ⁙ Sand

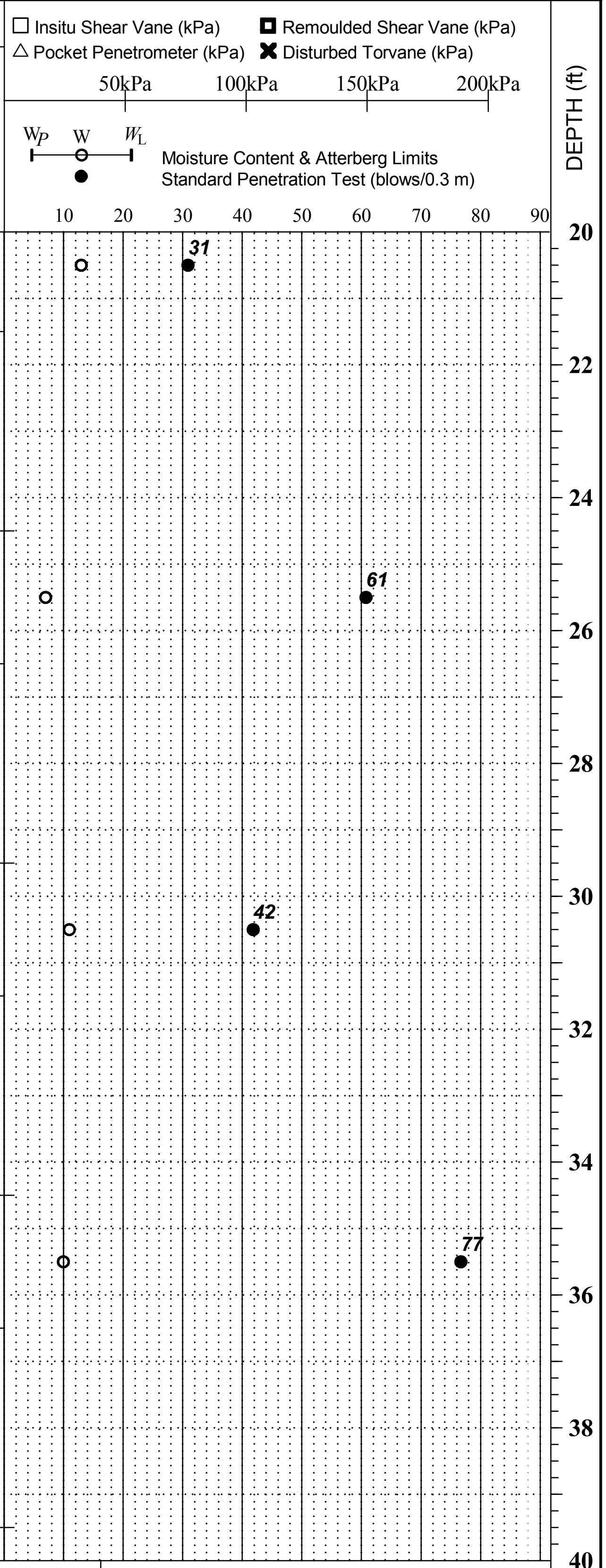
Logged by: CH
Reviewed by: BH
Date: July 13, 2017

BOREHOLE RECORD

BH17-13 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361781
LOCATION Dallas Road, Victoria, BC
ELEVATION 20.3 m
EASTING 472659
DRILLING DATE 06/19/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
			Light brown silty sand (SM) with gravel TILL - fines at 6.2 m= 48.7%		SPT	6	13
7							
∇			- with gravel, and mottled with grey and brown below 7.5 m - sieve at 7.7 m: gravel= 20.5%; sand= 65.4%; fines= 14.1%		SPT	7	7
8							
9	TL		- grey-brown below 8.9 m		SPT	8	11
10							
			- grey below 10.5 m - sieve at 10.8 m: gravel= 11.7%; sand= 58.1%; fines= 30.2%		SPT	9	10
11							
12							



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

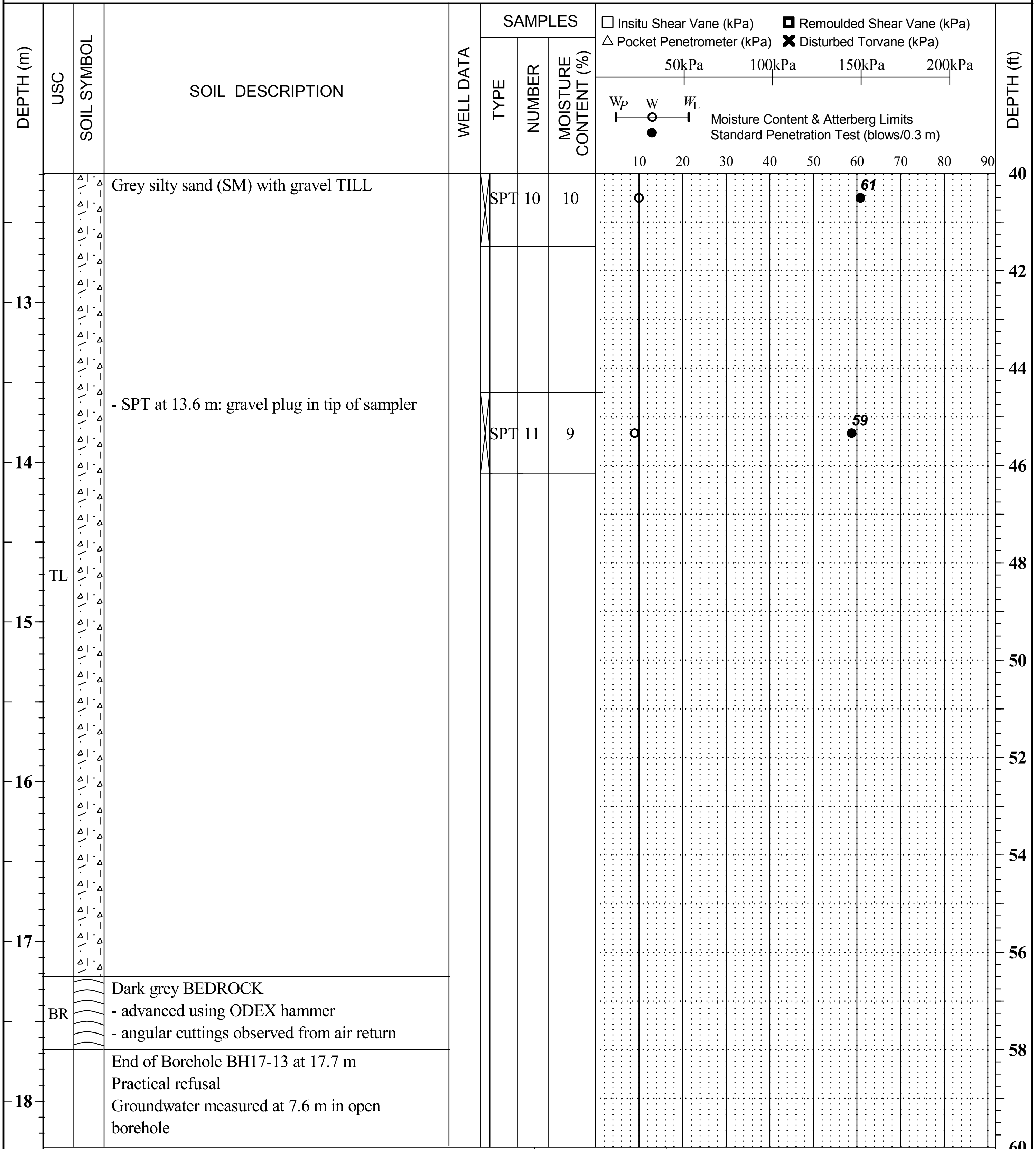
Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-13 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361781
LOCATION Dallas Road, Victoria, BC
ELEVATION 20.3 m
EASTING 472659
DRILLING DATE 06/19/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX



USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)
TL	Grey silty sand (SM) with gravel TILL	SPT	10	10
	- SPT at 13.6 m: gravel plug in tip of sampler	SPT	11	9
BR	Dark grey BEDROCK - advanced using ODEX hammer - angular cuttings observed from air return			
	End of Borehole BH17-13 at 17.7 m Practical refusal Groundwater measured at 7.6 m in open borehole			

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

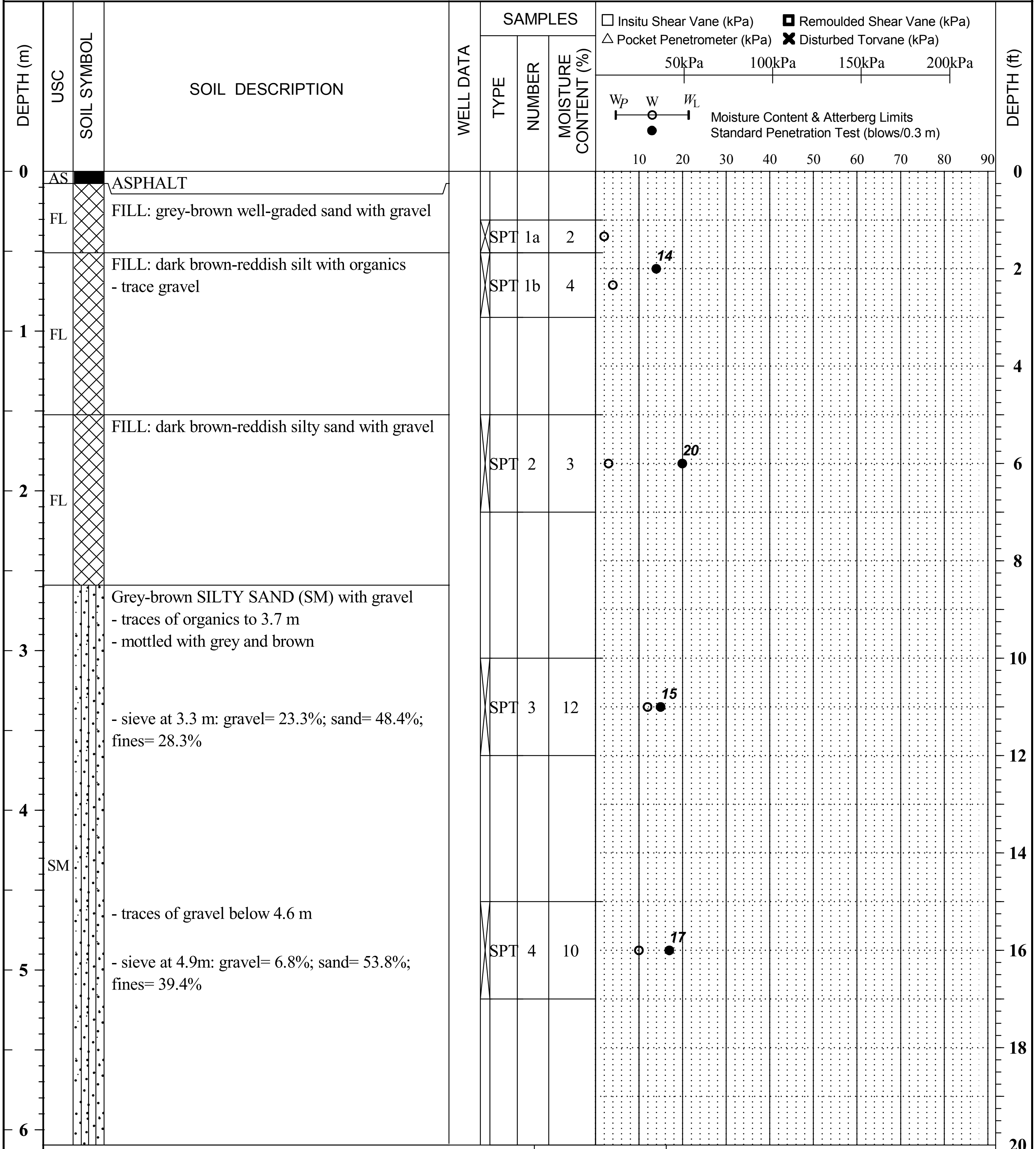
Logged by: CH
Reviewed by: BH
Date: July 13, 2017

BOREHOLE RECORD

BH17-14

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361793
LOCATION Dallas Road, Victoria, BC
ELEVATION 21.2 m
EASTING 472676
DRILLING DATE 06/20/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

USC	SOIL DESCRIPTION	WELL DATA	TYPE	NUMBER	MOISTURE CONTENT (%)
AS	ASPHALT				
FL	FILL: grey-brown well-graded sand with gravel		SPT	1a	2
FL	FILL: dark brown-reddish silt with organics - trace gravel		SPT	1b	4
FL	FILL: dark brown-reddish silty sand with gravel		SPT	2	3
SM	Grey-brown SILTY SAND (SM) with gravel - traces of organics to 3.7 m - mottled with grey and brown - sieve at 3.3 m: gravel= 23.3%; sand= 48.4%; fines= 28.3%		SPT	3	12
	- traces of gravel below 4.6 m - sieve at 4.9m: gravel= 6.8%; sand= 53.8%; fines= 39.4%		SPT	4	10



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁚ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

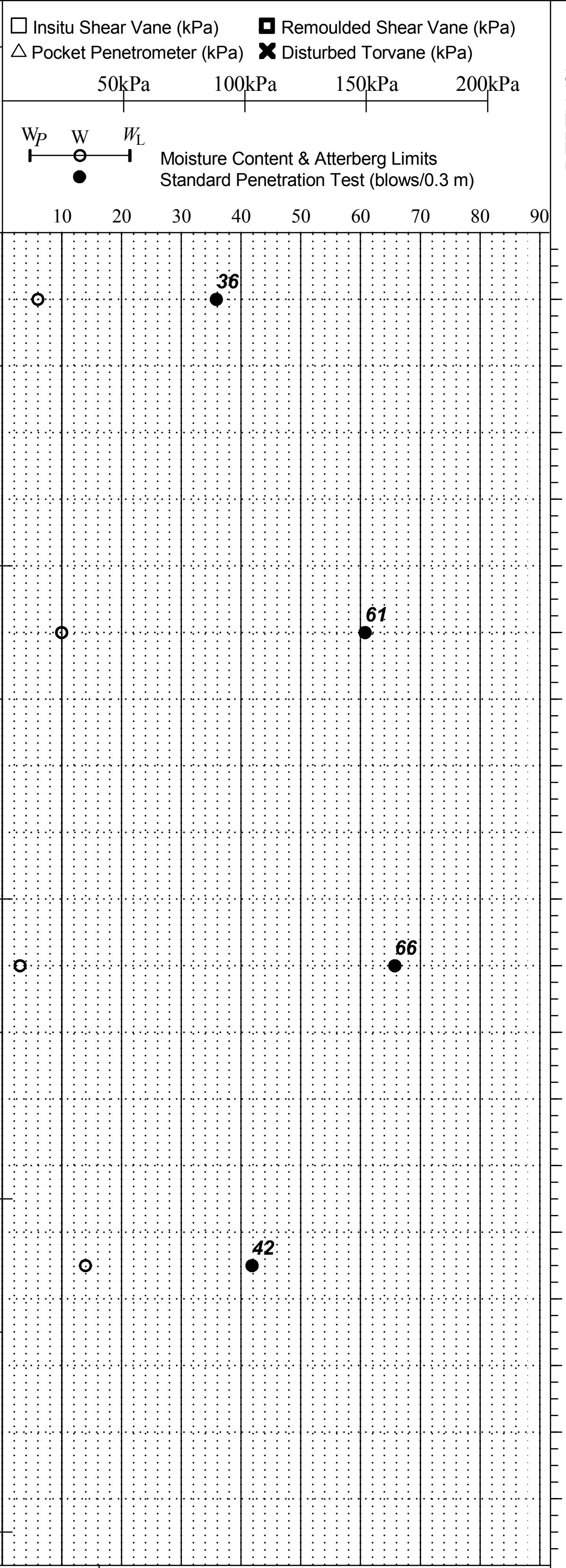
Stantec

BOREHOLE RECORD

BH17-14 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361793
LOCATION Dallas Road, Victoria, BC
ELEVATION 21.2 m
EASTING 472676
DRILLING DATE 06/20/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
	SM	Grey-brown SILTY SAND (SM) with gravel					20
	TL	Grey-brown silty sand (SM) with gravel TILL		SPT	5	6	
7							22 24
8		- coal inclusions at 7.9 m - sieve at 7.9 m: gravel= 15.0%; sand= 56.2%; fines= 28.8%		SPT	6	10	26 28
9				SPT	7	3	30 32
10							34
11		- traces of gravel below 10.5 m - sieve at 10.5 m: gravel= 5.5%; sand= 53.2%; fines= 41.3% - inferred boulder or cobble at 11.1 m based on drilling reaction		SPT	8	14	36 38
12							40



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-14 cont'd

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5361793

LOCATION Dallas Road, Victoria, BC

ELEVATION 21.2 m

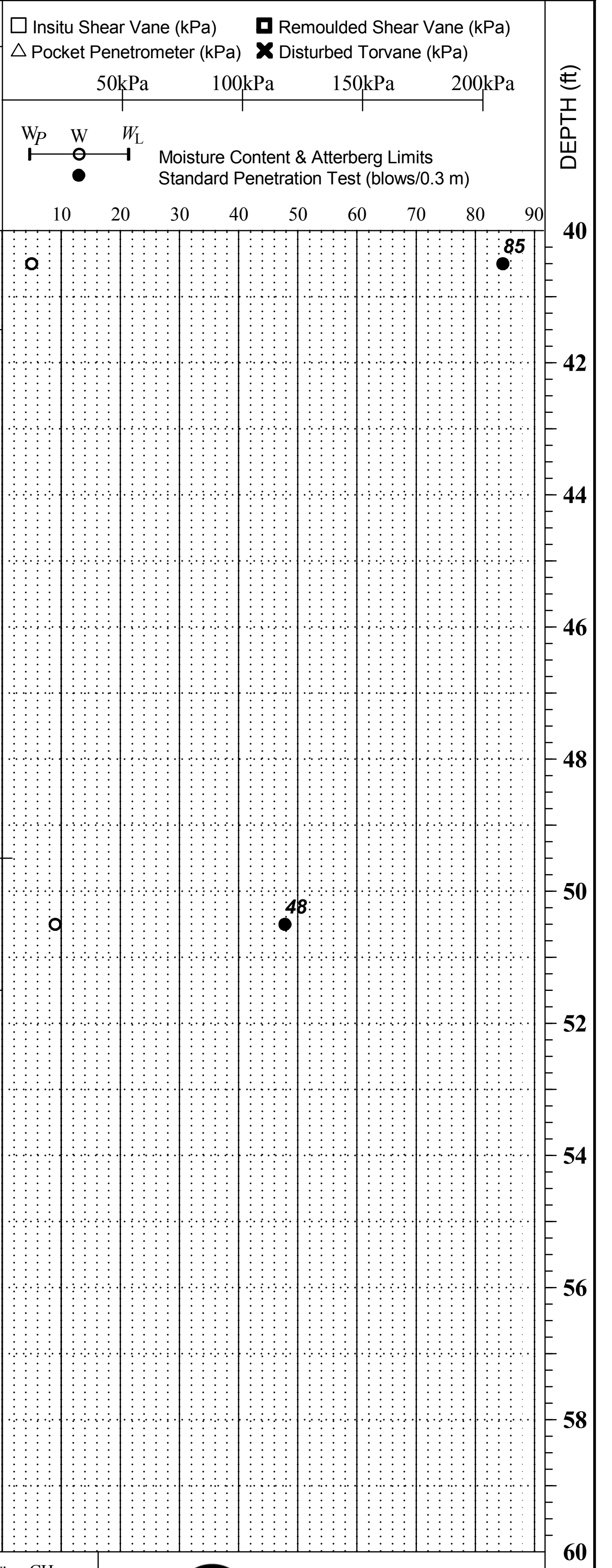
EASTING 472676

DRILLING DATE 06/20/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD ODEX

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
13 14 15 16 17	TL		Grey-brown, silty sand (SM) TILL - traces of gravel		SPT SPT	9 10	5 9
18	BR		Dark grey BEDROCK - advanced using ODEX hammer - angular and/or powdered cuttings observed from air return - slow advancement rate				



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁚ Sand

Logged by: CH

Reviewed by: BH

Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-14 cont'd

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5361793

LOCATION Dallas Road, Victoria, BC

ELEVATION 21.2 m

EASTING 472676

DRILLING DATE 06/20/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD ODEX

☐ Insitu Shear Vane (kPa)
△ Pocket Penetrometer (kPa)
◘ Remoulded Shear Vane (kPa)
✖ Disturbed Torvane (kPa)

50kPa 100kPa 150kPa 200kPa

W_P W W_L Moisture Content & Atterberg Limits

● Standard Penetration Test (blows/0.3 m)

10 20 30 40 50 60 70 80 90

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
19	BR		Dark grey BEDROCK - advanced using ODEX hammer - angular and/or powdered cuttings observed from air return - slow advancement rate					60 62 64
20 21 22 23 24			End of Borehole BH17-14 at 19.7 m Practical refusal Slope inclinometer installed. Casing set in bedrock Groundwater not encountered in open borehole					66 68 70 72 74 76 78 80

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH

Reviewed by: BH

Date: July 13, 2017

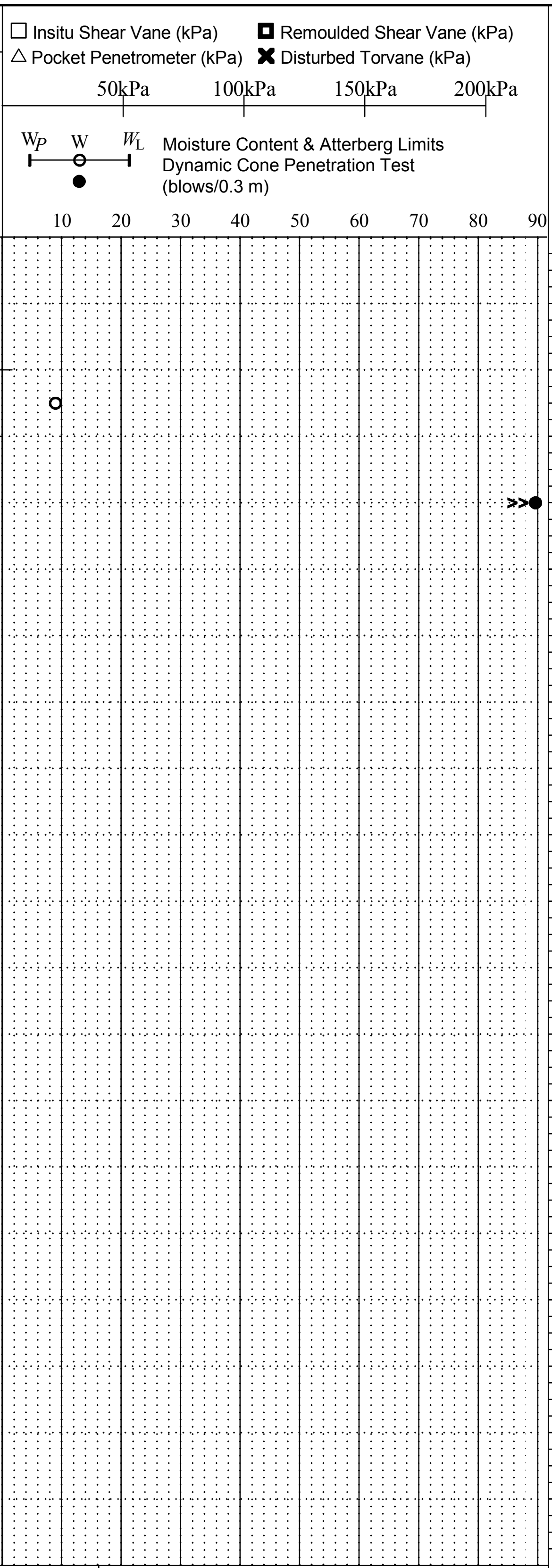
Stantec

BOREHOLE RECORD

BH17-15

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361817
LOCATION Dallas Road, Victoria, BC
ELEVATION 21.9 m
EASTING 472672
DRILLING DATE 07/04/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
0	AS	ASPHALT					0
	FL	FILL: grey-brown well-graded sand with gravel					
	ML	Grey-brown sandy SILT (ML) with gravel - very dense based on drill reaction - occasional to frequent inferred cobbles		GS	1	9	2
1		- DCPT refusal at 1.2 m					4
		End of Borehole BH17-15 at 1.2 m Practical auger refusal Groundwater not encountered in open borehole Second borehole drilled 1.2 m east of BH17-15 and encountered refusal at same depth					
2							6
							8
3							10
							12
4							14
							16
5							
							18
6							20



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-16

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5361800

LOCATION Dallas Road, Victoria, BC

ELEVATION 22.0 m

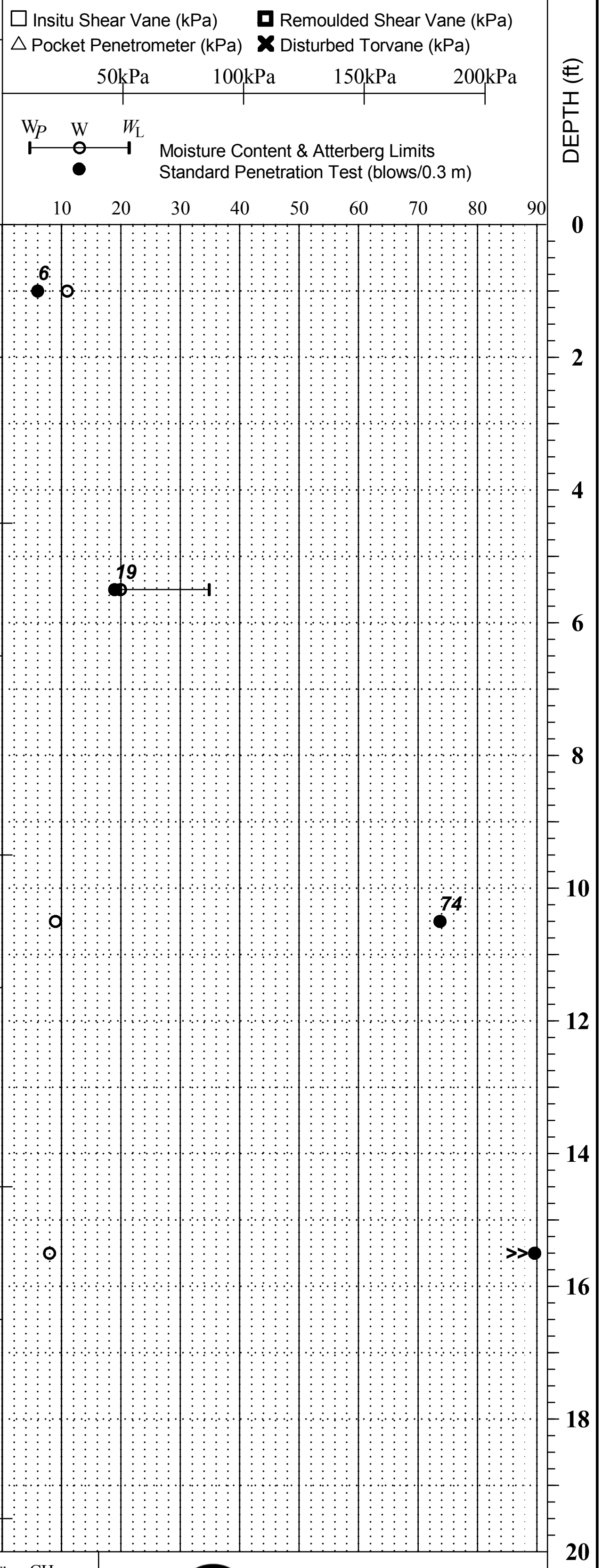
EASTING 472707

DRILLING DATE 06/21/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD ODEX

USC	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	NUMBER	MOISTURE CONTENT (%)
TP	TOPSOIL - frequent rootlets from 0.0 m to 0.3 m - trace rootlets below 0.3 m - light brown and sandy below 0.5 m		SPT	1	11
CL	Light brown lean CLAY (CL) with sand - fines at 1.7 m= 82.0%		SPT	2	20
SM	Grey-brown SILTY SAND (SM) - traces of gravel - mottled with brown and grey				
TL	Grey-brown silty sand (SM) TILL - traces of gravel - mottled with brown and grey to 3.5 m - fines at 3.2 m= 39.4%		SPT SPT	3 4	9 8



DEPTH (m): 0 1 2 3 4 5 6

Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH

Reviewed by: BH

Date: July 13, 2017

Stantec

BOREHOLE RECORD

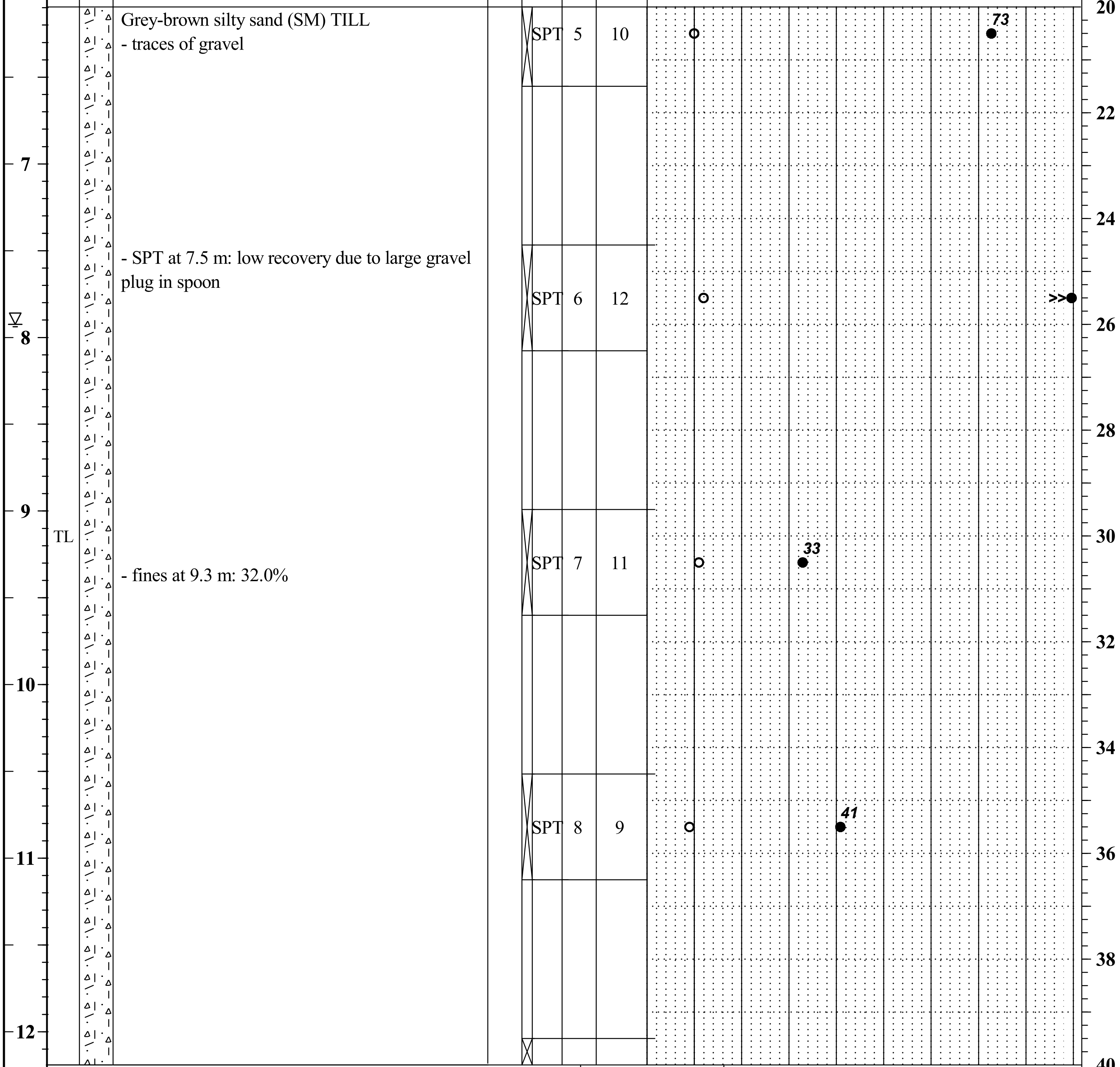
BH17-16 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361800
LOCATION Dallas Road, Victoria, BC
ELEVATION 22.0 m
EASTING 472707
DRILLING DATE 06/21/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

☐ Insitu Shear Vane (kPa) ◘ Remoulded Shear Vane (kPa)
△ Pocket Penetrometer (kPa) ✖ Disturbed Torvane (kPa)

W_P W W_L Moisture Content & Atterberg Limits
● Standard Penetration Test (blows/0.3 m)

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	TYPE	NUMBER	MOISTURE CONTENT (%)
	TL	Grey-brown silty sand (SM) TILL - traces of gravel		SPT	5	10
		- SPT at 7.5 m: low recovery due to large gravel plug in spoon		SPT	6	12
		- fines at 9.3 m: 32.0%		SPT	7	11
				SPT	8	9



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

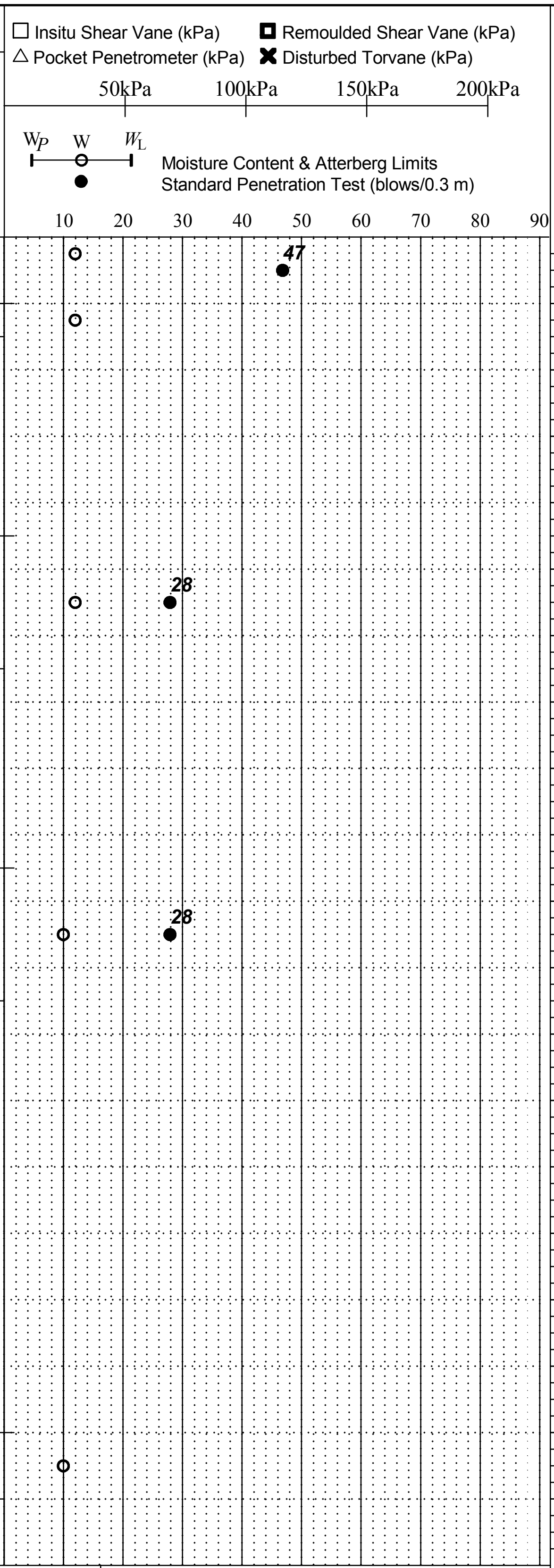
Stantec

BOREHOLE RECORD

BH17-16 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361800
LOCATION Dallas Road, Victoria, BC
ELEVATION 22.0 m
EASTING 472707
DRILLING DATE 06/21/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

DEPTH (m)	USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)	DEPTH (ft)
	TL	Grey-brown silty sand (SM) TILL - traces of gravel	SPT	9a	12	40
			SPT	9b	12	
13						42
						44
			SPT	10	12	
14						46
						48
15						50
		- with gravel below 15.1 m - fines at 15.4 m= 36.5%	SPT	11	10	
16						52
						54
17						56
						58
			GS	12	10	
18						60



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

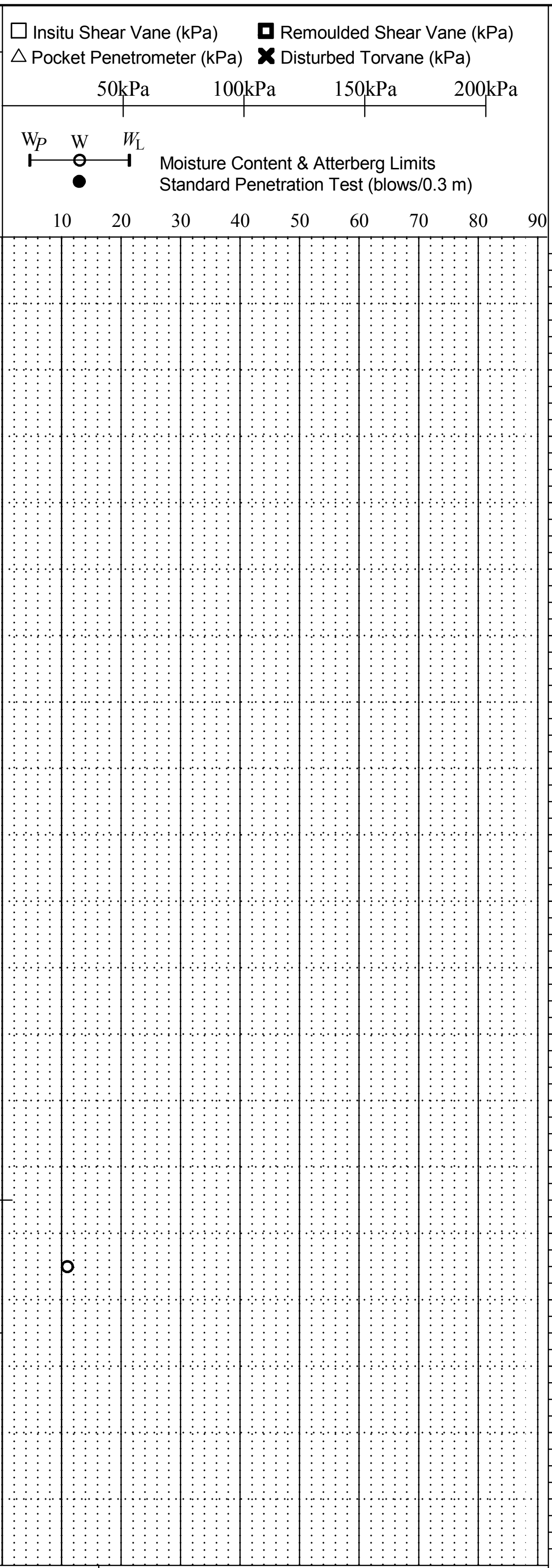
Stantec

BOREHOLE RECORD

BH17-16 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361800
LOCATION Dallas Road, Victoria, BC
ELEVATION 22.0 m
EASTING 472707
DRILLING DATE 06/21/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD ODEX

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	TYPE	NUMBER	MOISTURE CONTENT (%)	DEPTH (ft)
	TL	Grey-brown silty sand (SM) with gravel TILL					60
19							62
							64
20							66
							68
21							
	TL	Grey sandy silt (ML) with gravel TILL					70
22							72
							74
23				GS	13	11	76
							78
24							80



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⛶ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-16 cont'd

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5361800

LOCATION Dallas Road, Victoria, BC

ELEVATION 22.0 m

EASTING 472707

DRILLING DATE 06/21/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD ODEX

☐ Insitu Shear Vane (kPa) ▣ Remoulded Shear Vane (kPa)
△ Pocket Penetrometer (kPa) ✖ Disturbed Torvane (kPa)
50kPa 100kPa 150kPa 200kPa
W_P W W_L Moisture Content & Atterberg Limits
● Standard Penetration Test (blows/0.3 m)
10 20 30 40 50 60 70 80 90

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)	DEPTH (ft)
	BR		Dark grey BEDROCK - angular and/or powdered cuttings observed from air return - grab sample at 24.7 m obtained from ODEX air return		GS	14		80
25								82
								84
26								86
								88
27			End of Borehole BH17-16 at 26.9 m Practical refusal Slope inclinometer installed. Casing set in bedrock Groundwater measured at 7.9 m in open borehole during first day of drilling on June 21; re-measured morning of June 22 and at termination depth and found no groundwater in open borehole					90
28								92
								94
29								96
30								98
								100

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-17

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5361783

LOCATION Dallas Road, Victoria, BC

ELEVATION 22.1 m

EASTING 472927

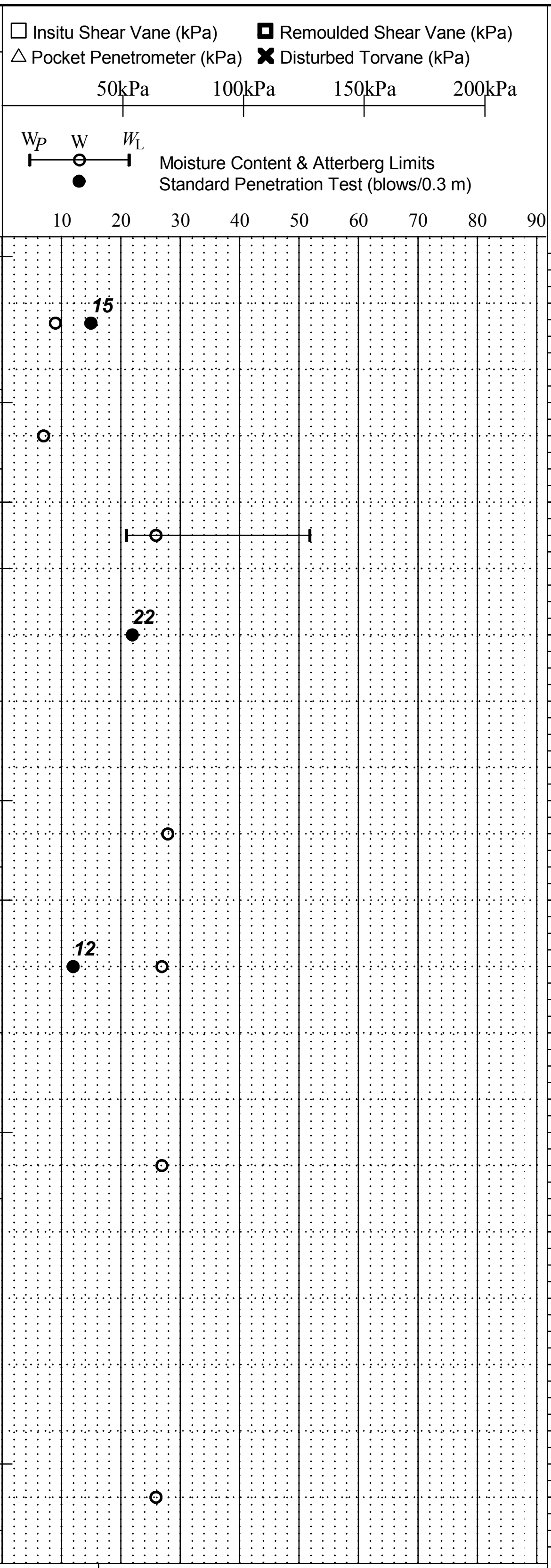
DRILLING DATE 06/23/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD Solid-Stem Auger

USC	SOIL DESCRIPTION
TP	TOPSOIL
FL	FILL: brown well-graded sand with silt and gravel - trace organics
CL	Grey-brown lean to fat CLAY (CL/CH) - mottled with grey and brown - traces of sand and gravel - fines at 1.4 m= 87.9% - grey below 4.4 m

TYPE	NUMBER	MOISTURE CONTENT (%)
SPT	1	9
GS	2	7
GS	3	26
SPT	4	
GS	5	28
SPT	6	27
GS	7	27
GS	8	26



DEPTH (m): 0, 1, 2, 3, 4, 5, 6

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH

Reviewed by: BH

Date: July 13, 2017

Stantec

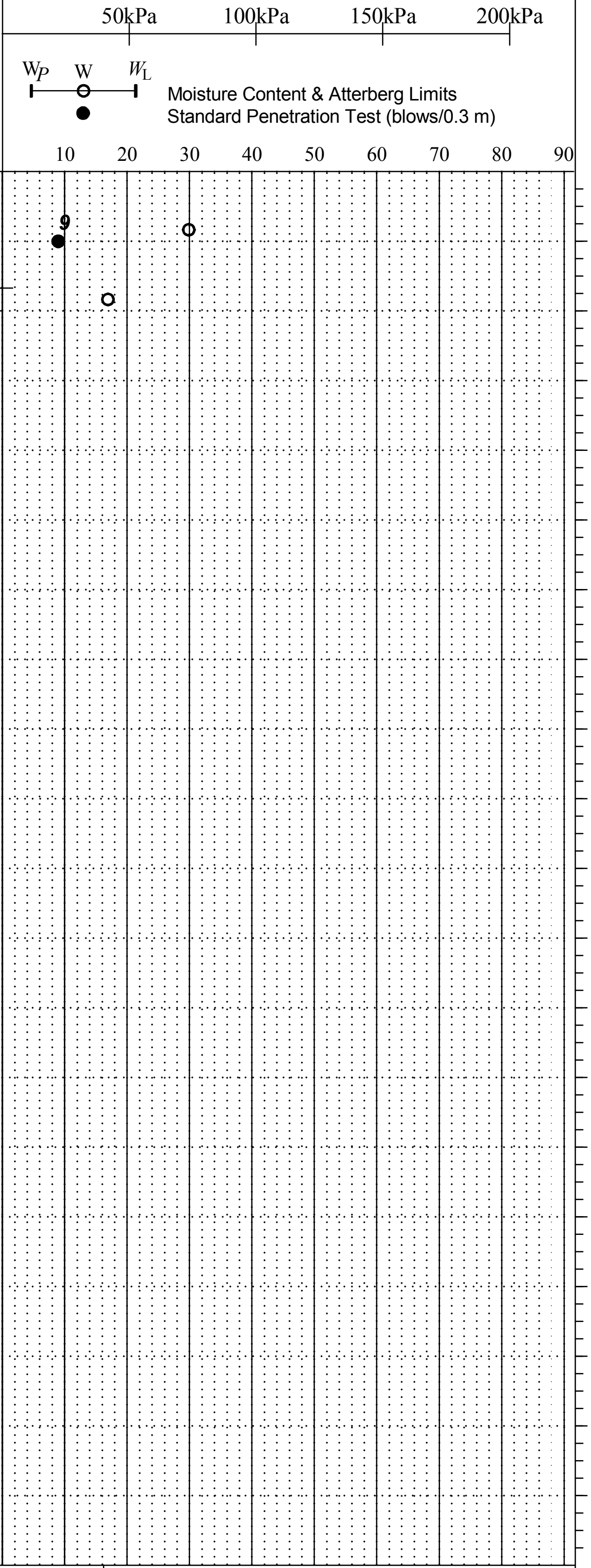
BOREHOLE RECORD

BH17-17 cont'd

CLIENT Capital Regional District PROJECT No. 111700431
PROJECT Clover Point Forcemain DATUM Geodetic NORTHING 5361783
LOCATION Dallas Road, Victoria, BC ELEVATION 22.1 m EASTING 472927
DRILLING DATE 06/23/2017 DRILLING CO. Geotech Drilling Ltd. DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
	CL	▨	Grey lean to fat CLAY (CL/CH) - traces of sand and gravel		SPT	9a	30	20
	ML	▥	Grey sandy SILT (ML)		SPT	9b	17	22
7			End of Borehole BH17-17 at 6.7 m Target depth reached Groundwater not encountered in open borehole					24
8								26
								28
9								30
								32
10								34
11								36
								38
12								40

☐ Insitu Shear Vane (kPa) ◘ Remoulded Shear Vane (kPa)
△ Pocket Penetrometer (kPa) ✖ Disturbed Torvane (kPa)



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▩ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

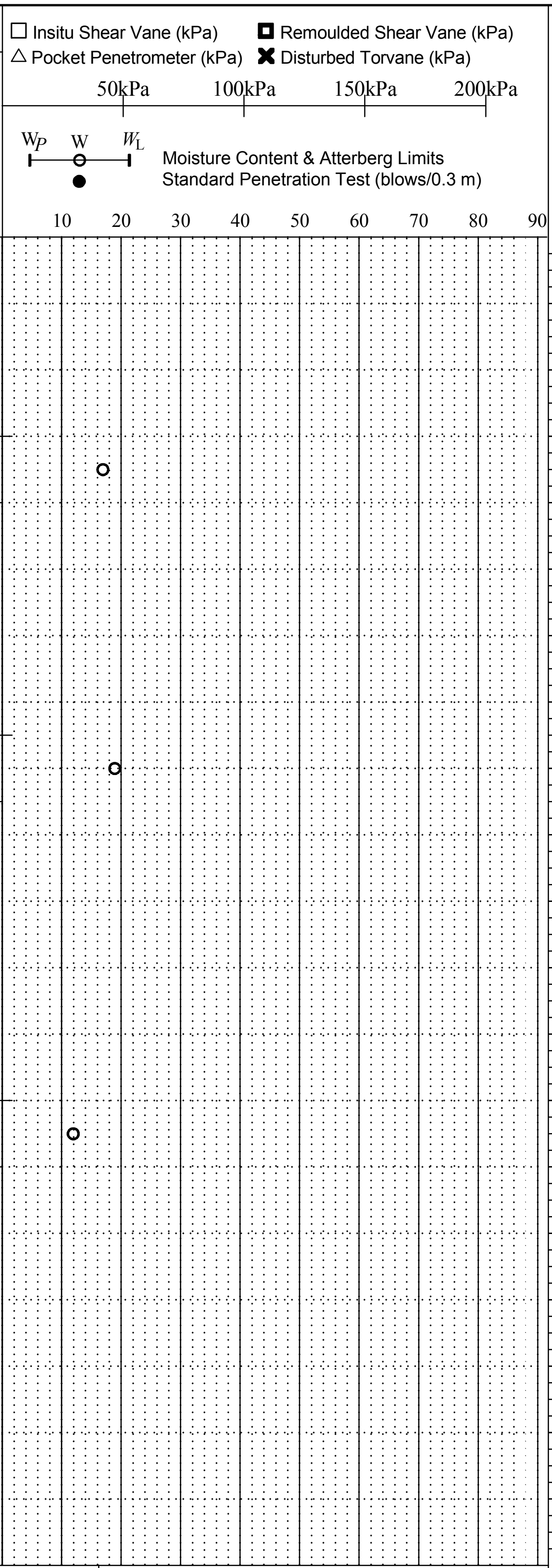
Stantec

BOREHOLE RECORD

BH17-18

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361734
LOCATION Dallas Road, Victoria, BC
ELEVATION 18.5 m
EASTING 473184
DRILLING DATE 06/23/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
0	TP	TOPSOIL					0
	FL	FILL: brown silty sand with gravel					2
1				GS	1	17	4
	FL	FILL: grey poorly-graded sand with silt - traces of gravel					6
2		- fines at 2.4 m= 13.1%		GS	2	19	8
∇ (2.7)							
3	ML	Grey sandy SILT (ML) with gravel					10
4				GS	3	12	12 14
		End of Borehole BH17-18 at 4.6 m Target depth reached Groundwater measured at 2.7 m in open borehole					16
5							18
6							20



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

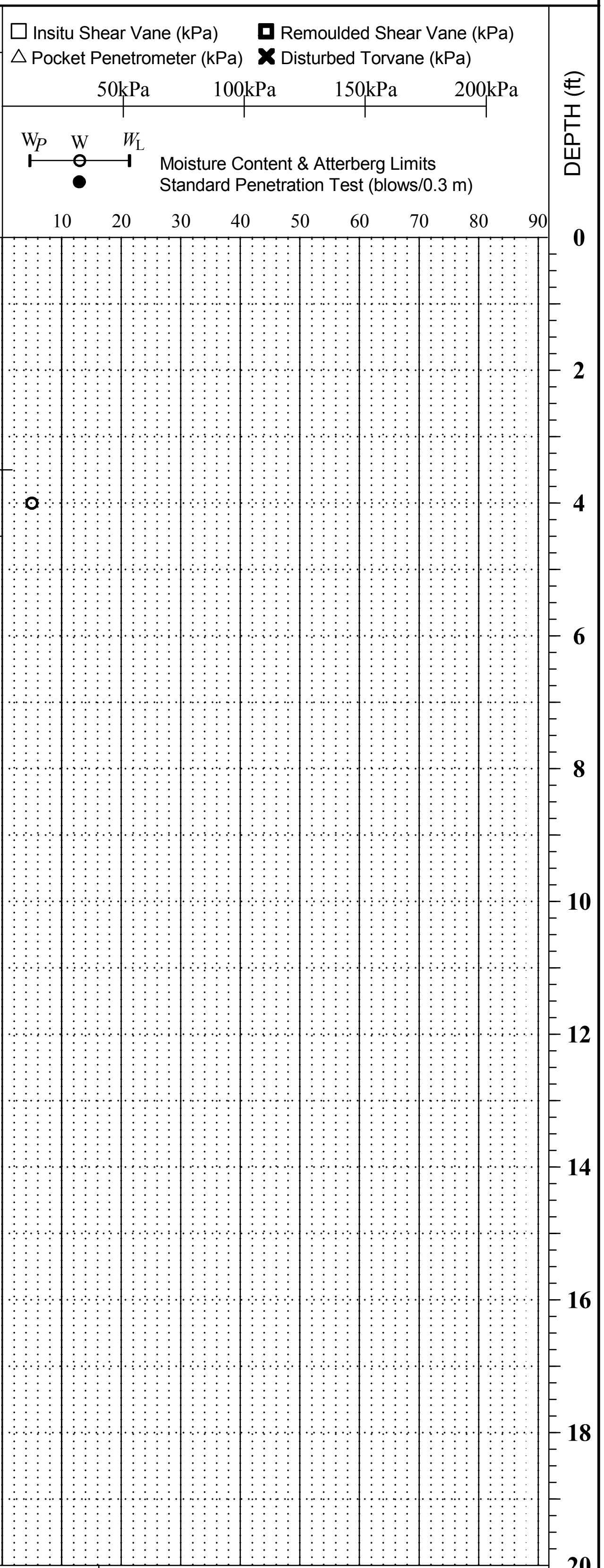
Stantec

BOREHOLE RECORD

BH17-19

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361680
LOCATION Dallas Road, Victoria, BC
ELEVATION 14.4 m
EASTING 473396
DRILLING DATE 06/23/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)
0	TP		TOPSOIL				
	FL		FILL: brown poorly-graded sand with silt - traces of gravel				
1			- with gravel and cobbles below 1.0 m		GS	1	5
			End of Borehole BH17-19 at 1.5 m Practical refusal on cobbles Groundwater not encountered in open borehole				
2							
3							
4							
5							
6							



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

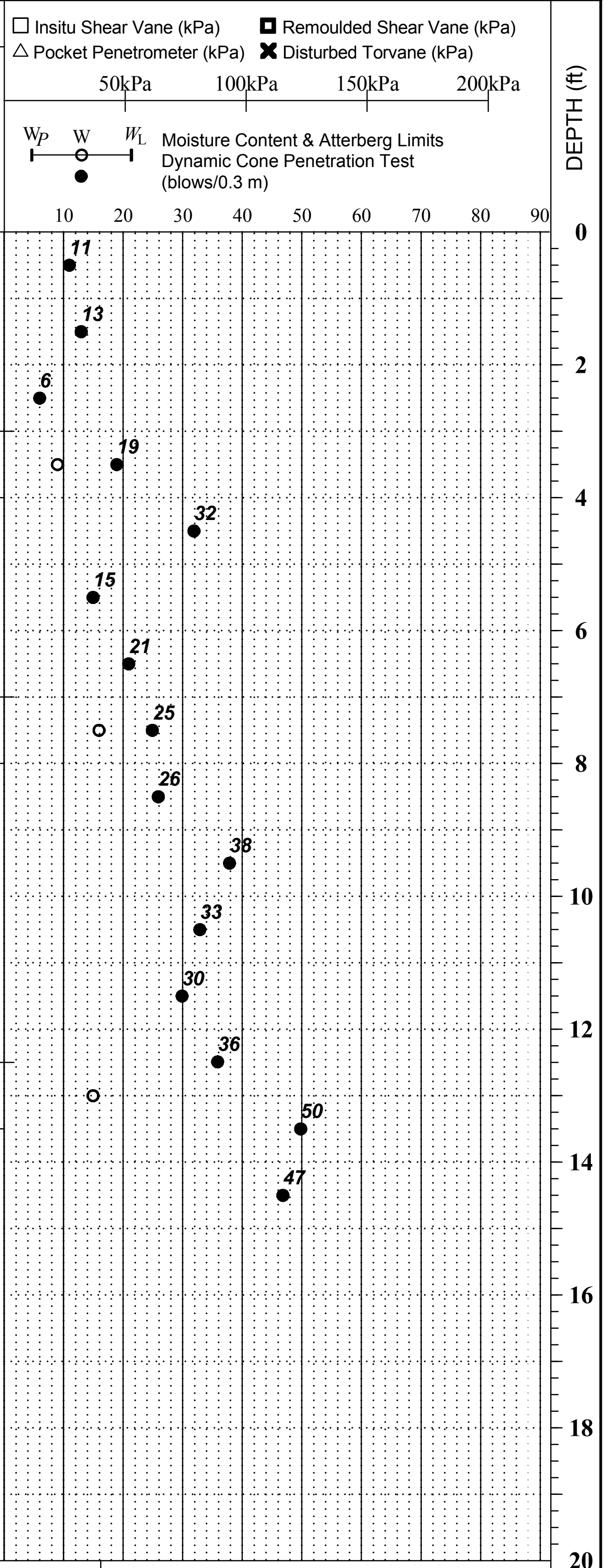
Logged by: CH
Reviewed by: BH
Date: July 13, 2017

BOREHOLE RECORD

BH17-20

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361664
LOCATION Dallas Road, Victoria, BC
ELEVATION 14.1 m
EASTING 473665
DRILLING DATE 07/04/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	MOISTURE CONTENT (%)
0	TP		TOPSOIL				
	FL		FILL: dark brown poorly graded sand with silt and gravel - traces of organics				
1			- fines at 1.1 m= 11.1%		GS	1	9
	CL		Grey-brown lean CLAY (CL) with sand and gravel - mottled with grey and brown to 3.0 m				
2					GS	2	16
3							
4					GS	3	15
			End of Borehole BH17-20 at 4.1 m Practical auger refusal Groundwater not encountered in open borehole DCPT conducted from surface to 4.6 m				
5							
6							



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core
Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ⊠ Drill Cuttings ⁙ Sand

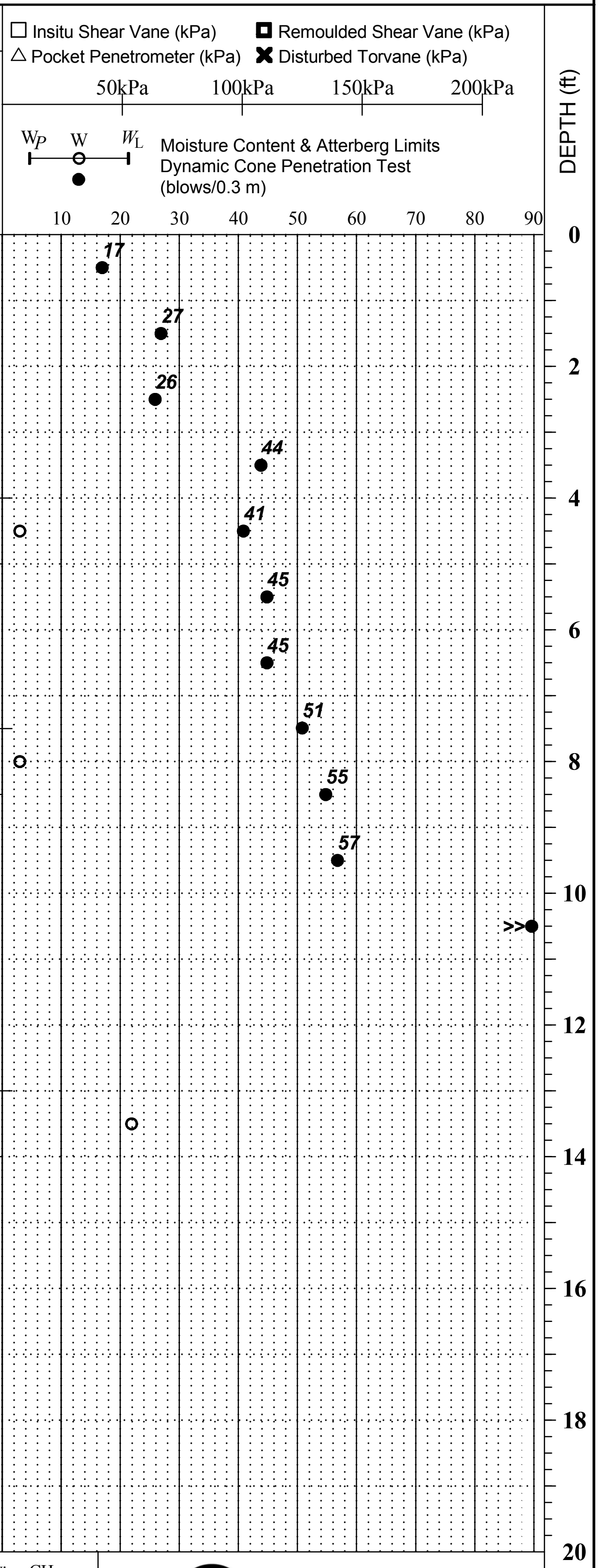
Logged by: CH
Reviewed by: BH
Date: July 13, 2017

BOREHOLE RECORD

BH17-21

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361578
LOCATION Dallas Road, Victoria, BC
ELEVATION 14.7 m
EASTING 473856
DRILLING DATE 07/04/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL DESCRIPTION	WELL DATA	TYPE	NUMBER	MOISTURE CONTENT (%)
0	TP	TOPSOIL				
	FL	FILL: brown well-graded sand with silt and gravel - frequent inferred cobbles				
1		- sieve at 1.4m: gravel= 44.2%; sand= 49.6%; fines= 6.2%		GS	1	3
2		- wet below 2.6 m		GS	2	3
∇						
3		- inferred cobble at 3.0 m - DCPT practical refusal at 3.1 m: 50 mm in 50 blows				
	CL	Grey lean CLAY (CL) - traces of sand and gravel				
4				GS	3	22
		End of Borehole BH17-21 at 4.6 m Target depth reached Groundwater measured at 2.6 m in open borehole DCPT from surface to 3.1 m				
5						
6						



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁚ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-22

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5361455

LOCATION Dallas Road, Victoria, BC

ELEVATION 12.3 m

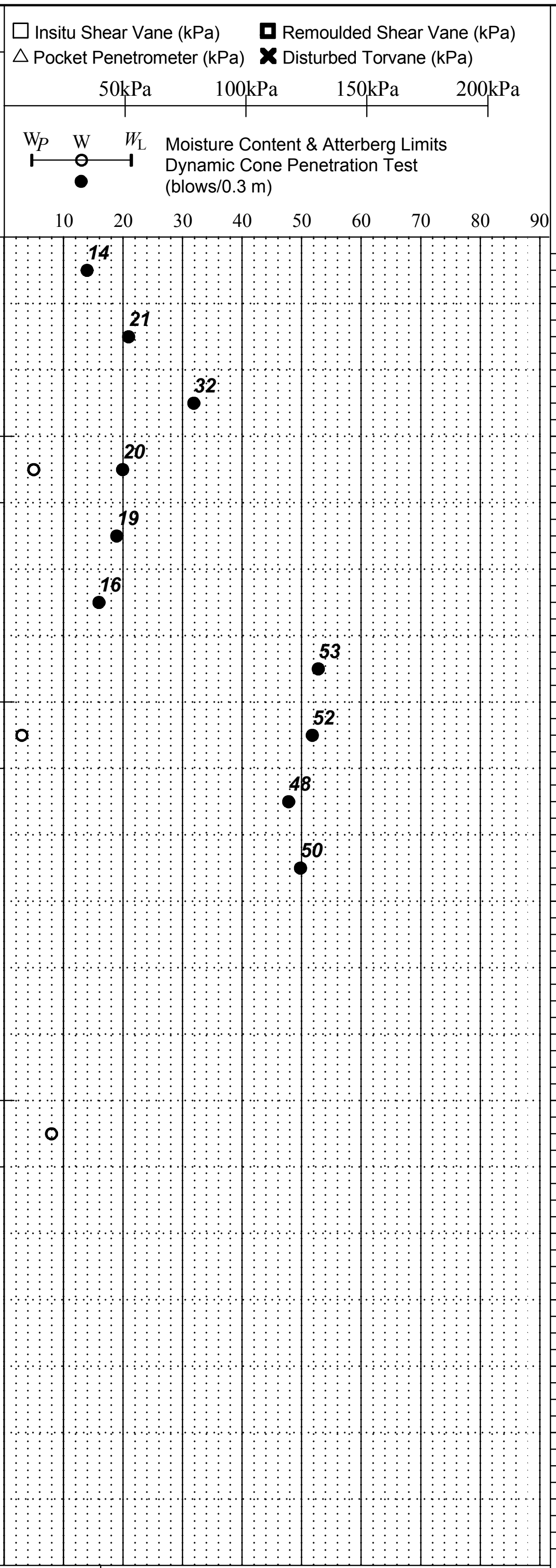
EASTING 474106

DRILLING DATE 07/04/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
0	FL	☒	FILL: dark brown silty sand - traces of gravel and organics - occasional inferred cobbles to 4.6 m					0
1			- fines at 1.1 m= 26.9%		GS	1	5	
2	FL	☒	FILL: brown, poorly-graded sand with silt and gravel - occasional inferred cobbles - fines at 2.1 m= 10.9%		GS	2	3	
4	TL		Grey silty sand (SM) with gravel TILL - high drilling resistance - occasional inferred cobbles		GS	3	8	
5			End of Borehole BH17-22 at 4.6 m Target depth reached Groundwater not encountered in open borehole DCPT conducted from surface to 3.0 m					



Depth (m): 0, 1, 2, 3, 4, 5, 6

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

Logged by: CH

Reviewed by: BH

Date: July 13, 2017

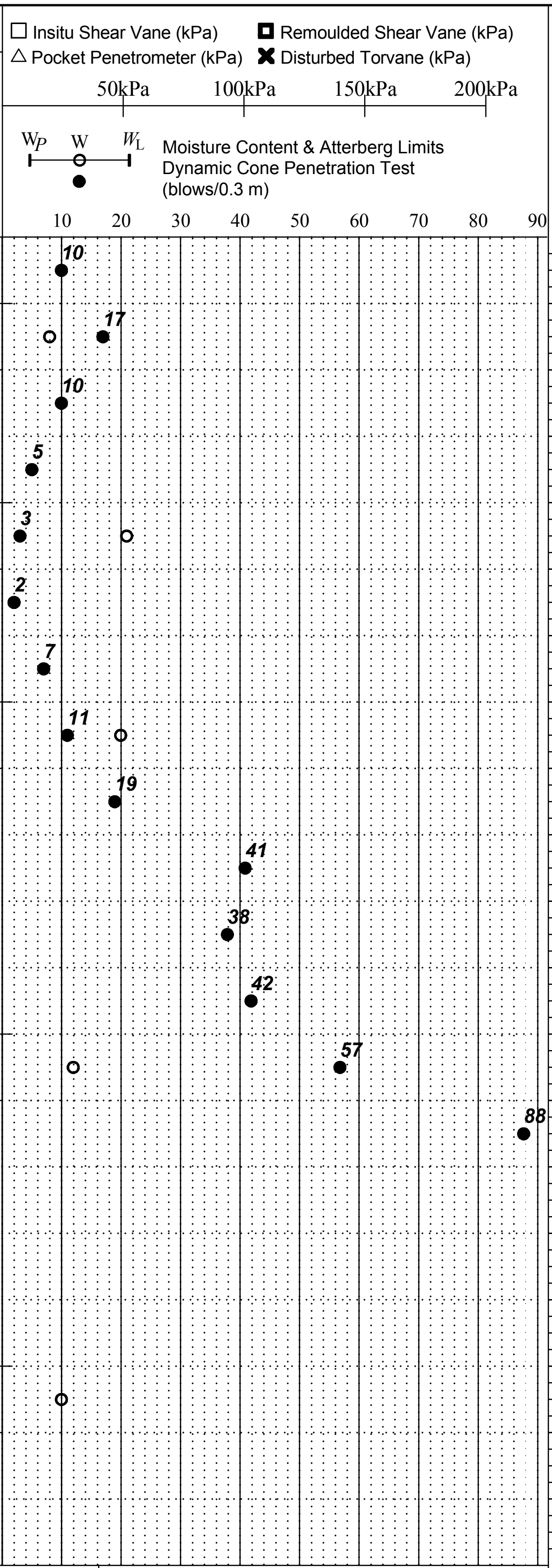
Stantec

BOREHOLE RECORD

BH17-23

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361876
LOCATION Dallas Road, Victoria, BC
ELEVATION 16.4 m
EASTING 472449
DRILLING DATE 07/04/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
0	TP		TOPSOIL					0
	FL		FILL: brown sandy silt - traces of gravel and organics		GS	1	8	2
1	FL		FILL: dark brown organic soil with sand and gravel - fines at 1.4 m= 20.7%		GS	2	21	4 6
2 3 ∇	ML		Grey SILT (ML) with sand - extensively mottled with reddish-brown - 100 mm of brown silty sand at 2.0 m - fines at 2.3 m= 76.8%		GS	3	20	8 10
4 5 6	TL		Grey-brown silty sand with gravel TILL - high drilling resistance - inferred occasional to frequent cobbles - fines at 3.8 m= 20.4% - grey below 4.6 m		GS GS	4 5	12 10	12 14 16 18 20



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

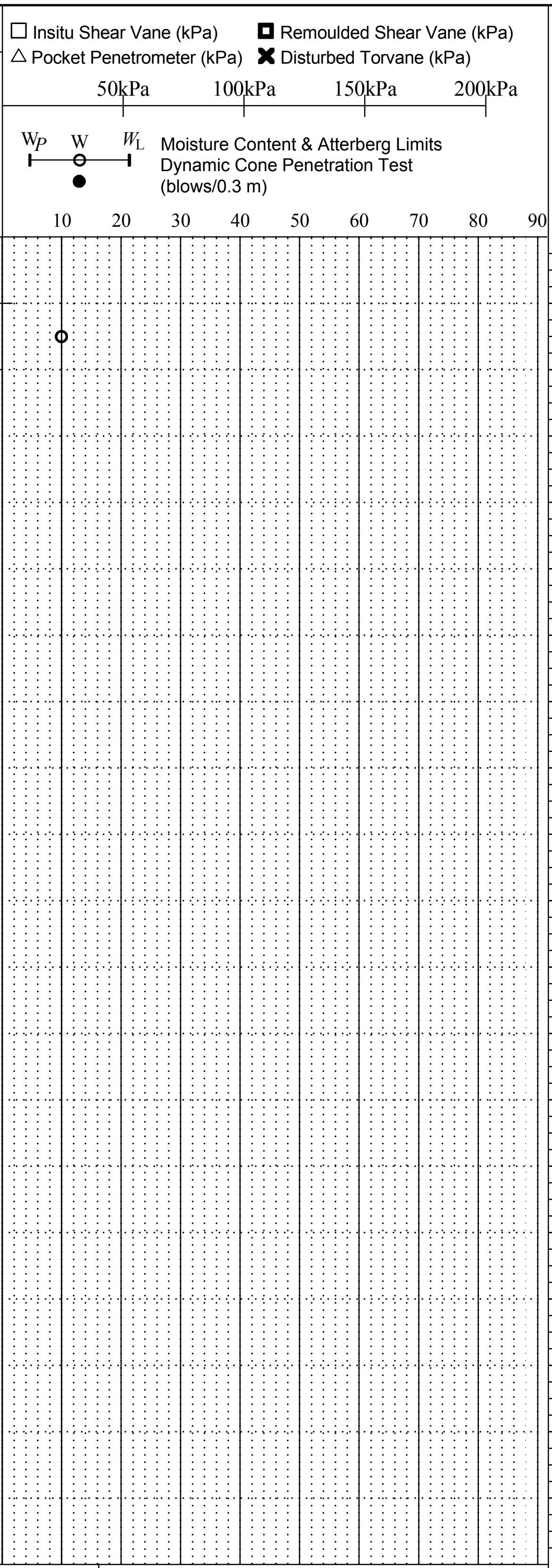
Stantec

BOREHOLE RECORD

BH17-23 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361876
LOCATION Dallas Road, Victoria, BC
ELEVATION 16.4 m
EASTING 472449
DRILLING DATE 07/04/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Solid-Stem Auger

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL DATA	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES MOISTURE CONTENT (%)	DEPTH (ft)
								20
	TL	△	Grey silty sand with gravel TILL - high drilling resistance - inferred occasional to frequent cobbles		GS	6	10	22
7								
			End of Borehole BH17-23 at 7.2 m Practical auger refusal Groundwater measured at 3.7 m in open borehole DCPT conducted from surface to 4.3 m					24
8								26
9								28
								30
10								32
								34
11								36
								38
12								40



Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁚ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

BOREHOLE RECORD

BH17-24

CLIENT Capital Regional District

PROJECT No. 111700431

PROJECT Clover Point Forcemain

DATUM Geodetic

NORTHING 5361802

LOCATION Dallas Road, Victoria, BC

ELEVATION 22.0 m

EASTING 472709

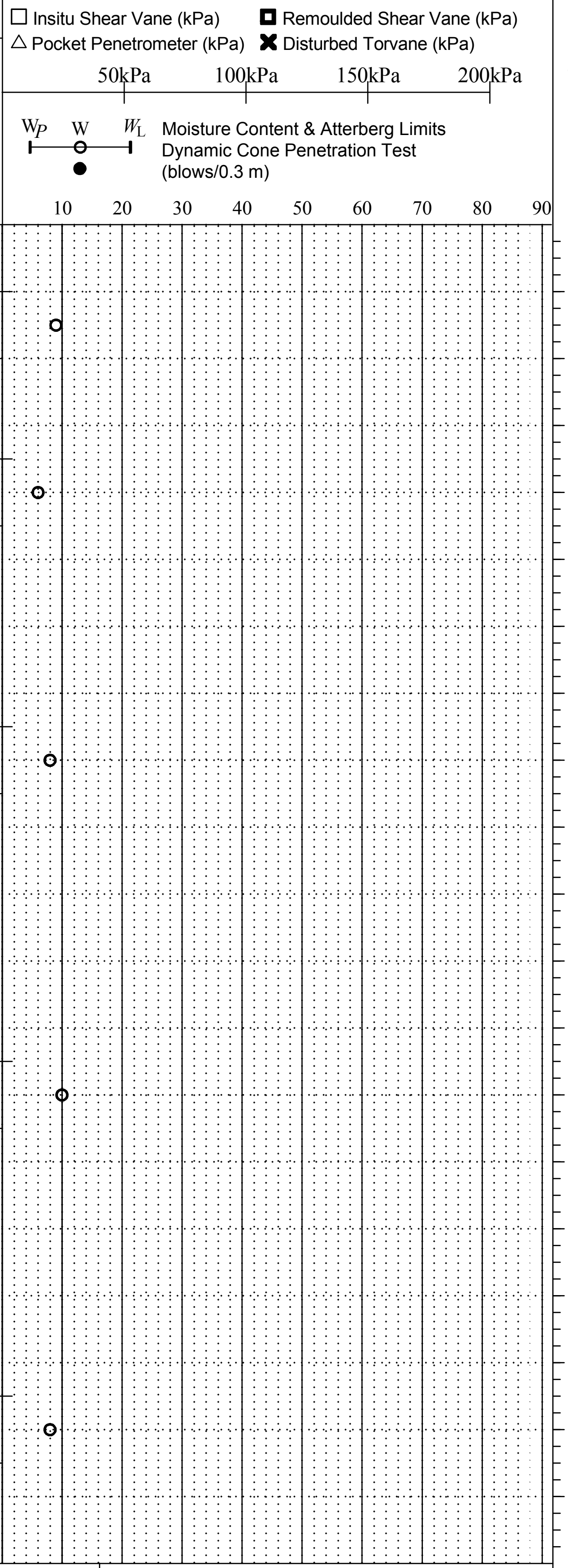
DRILLING DATE 06/26/2017

DRILLING CO. Geotech Drilling Ltd.

DRILLING METHOD Auger & ODEX

DEPTH (m)	USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)
0	TP	TOPSOIL	GS	1	9
1	GW	Brown well-graded GRAVEL (GW) with sand - traces of organics	GS	2	6
2	SM	Grey-brown SILTY SAND (SM) - traces of gravel - high drilling resistance	GS	3	8
3	TL	Grey-brown silty sand (SM) TILL - traces of gravel - high drilling resistance			
4		- fines at 4.0 m= 34.9%	GS	4	10
5		- with gravel below 4.6 m	GS	5	8
6					

DEPTH (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

Logged by: CH

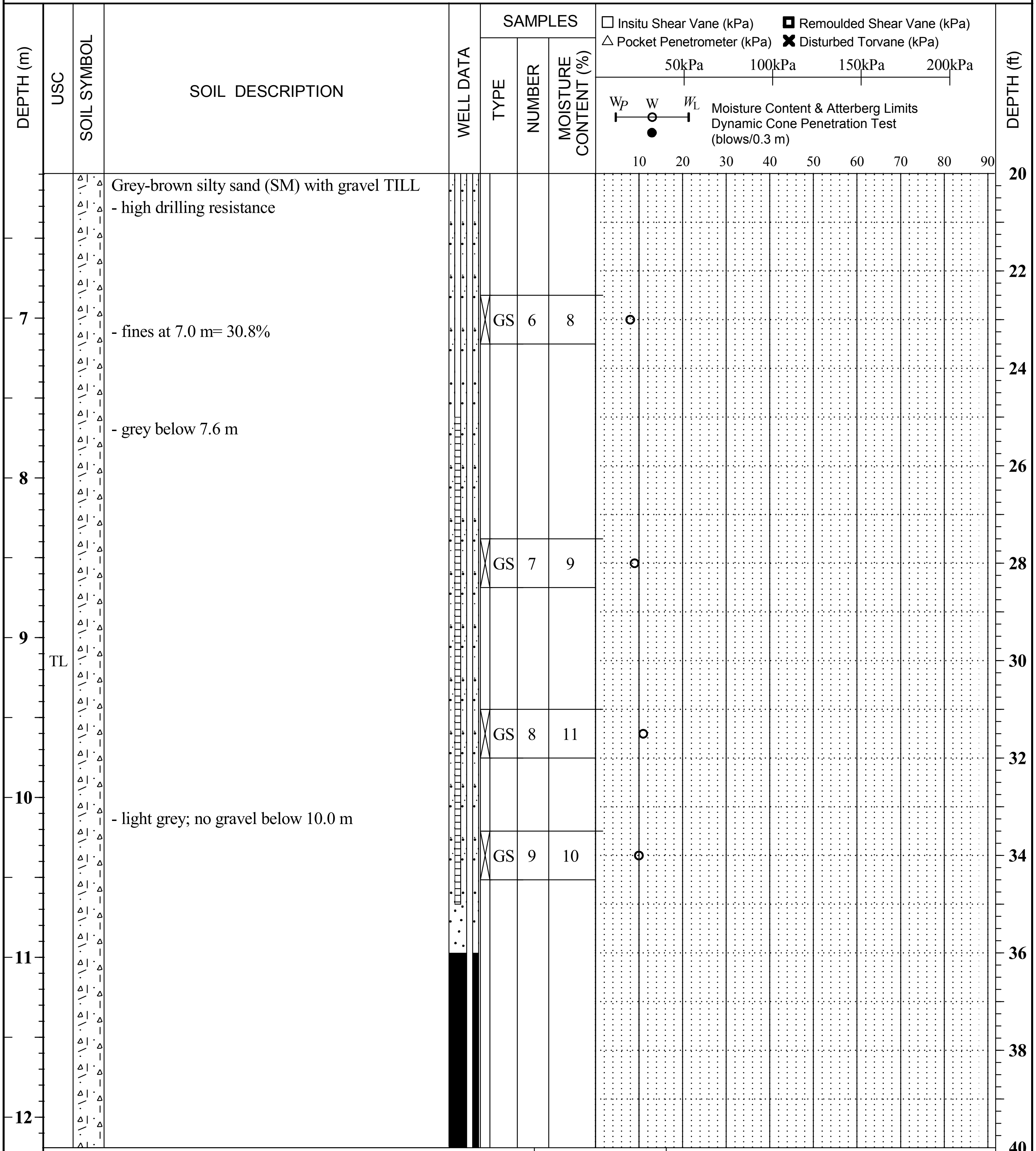
Reviewed by: BH

Date: July 13, 2017

BOREHOLE RECORD

BH17-24 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361802
LOCATION Dallas Road, Victoria, BC
ELEVATION 22.0 m
EASTING 472709
DRILLING DATE 06/26/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Auger & ODEX



Grey-brown silty sand (SM) with gravel TILL
- high drilling resistance
- fines at 7.0 m= 30.8%
- grey below 7.6 m
- light grey; no gravel below 10.0 m

TYPE	NUMBER	MOISTURE CONTENT (%)
GS	6	8
GS	7	9
GS	8	11
GS	9	10

Sample Type: GS - Grab Sample SPT - Split Spoon
ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁚ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

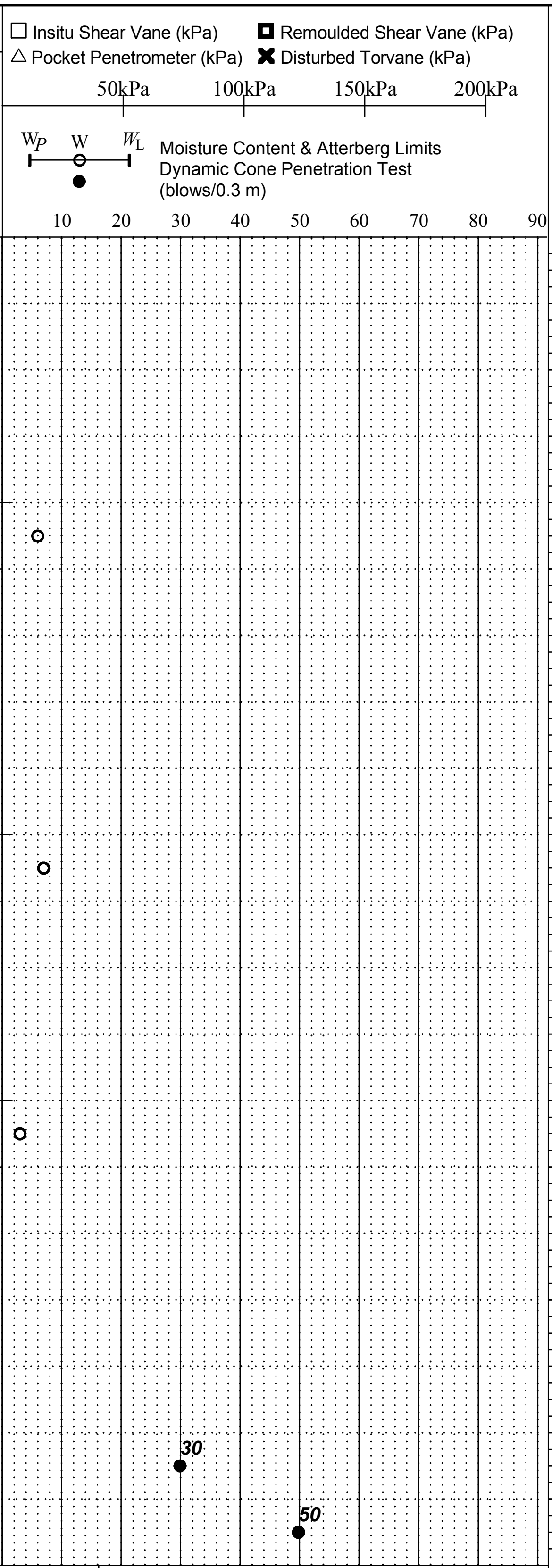
Stantec

BOREHOLE RECORD

BH17-24 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361802
LOCATION Dallas Road, Victoria, BC
ELEVATION 22.0 m
EASTING 472709
DRILLING DATE 06/26/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Auger & ODEX

DEPTH (m)	USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)	DEPTH (ft)
	TL	Grey silty sand (SM) with gravel TILL - high drilling resistance				40
13	TL	Grey, poorly-graded sand with silt (SP-SM) TILL				42
		- grab sample at 13.4 m taken from ODEX air return	GS	10	6	44
14	TL	Grey silty sand (SM) TILL - traces of gravel				46
15		- grab sample at 15.1 m taken from ODEX air return - fines at 15.1 m= 21.7%	GS	11	7	48 50
16	TL	- grab sample at 16.3 m taken from ODEX air return	GS	12	3	52 54
17						56
18						58 60



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁘ Sand

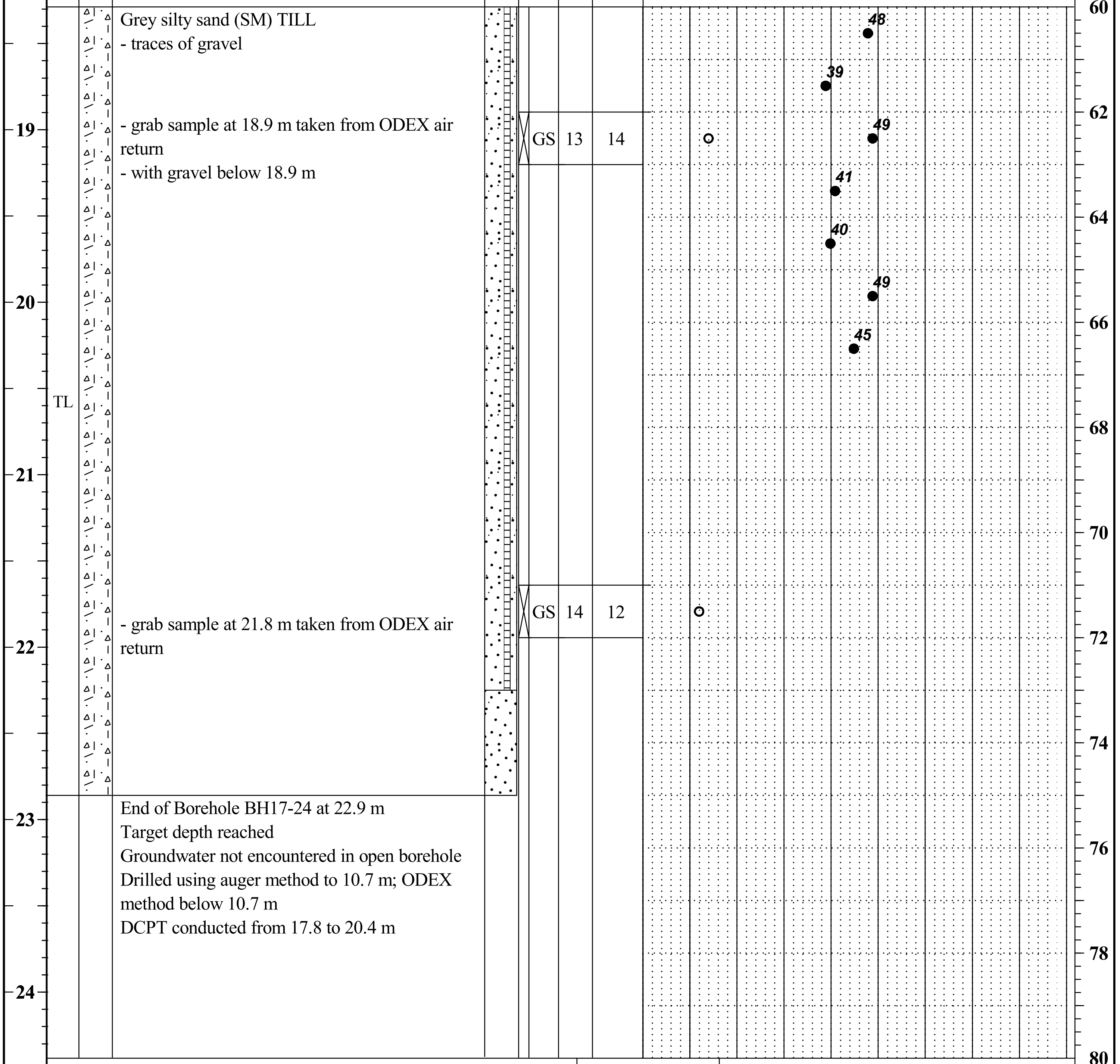
Logged by: CH
Reviewed by: BH
Date: July 13, 2017

BOREHOLE RECORD

BH17-24 cont'd

CLIENT Capital Regional District
PROJECT No. 111700431
PROJECT Clover Point Forcemain
DATUM Geodetic
NORTHING 5361802
LOCATION Dallas Road, Victoria, BC
ELEVATION 22.0 m
EASTING 472709
DRILLING DATE 06/26/2017
DRILLING CO. Geotech Drilling Ltd.
DRILLING METHOD Auger & ODEX

USC	SOIL DESCRIPTION	TYPE	NUMBER	MOISTURE CONTENT (%)
TL	Grey silty sand (SM) TILL - traces of gravel			
	- grab sample at 18.9 m taken from ODEX air return - with gravel below 18.9 m	GS	13	14
	- grab sample at 21.8 m taken from ODEX air return	GS	14	12
	End of Borehole BH17-24 at 22.9 m Target depth reached Groundwater not encountered in open borehole Drilled using auger method to 10.7 m; ODEX method below 10.7 m DCPT conducted from 17.8 to 20.4 m			



Sample Type: GS - Grab Sample SPT - Split Spoon ST - Shelby Tube PT - Piston Tube CC - Continuous Core

Piezometer Backfill Type: ■ Bentonite ▨ Sloughed ☒ Drill Cuttings ⁙ Sand

Logged by: CH
Reviewed by: BH
Date: July 13, 2017

Stantec

Appendix D LABORATORY TEST RESULTS

D.1 ATTERBERG LIMITS

Stantec

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 1, 2017
Date Tested: July 11, 2017
Tested By: JW

OFFICE	**LABORATORY**
4730 Kingsway	3711 North Fraser Way
Suite 500	Suite 400
Burnaby, BC	Burnaby, BC
Canada V5H 0C6	Canada V5J 5J2
Tel: (604) 436-3014	Tel: (604) 436-3014

Sample : BH17-1 GS-4

LIQUID LIMIT

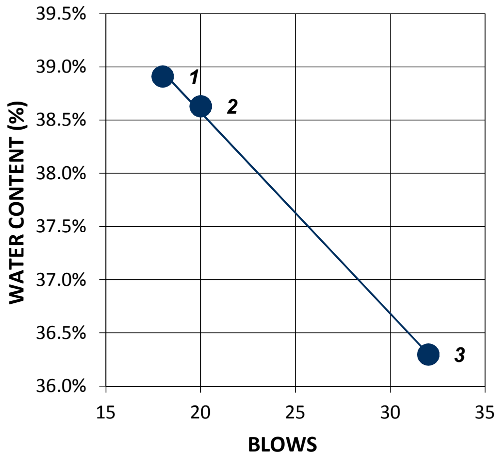
Trial	1	2	3
No. of Blows	18	20	32
Tare No.	NH-3	AB-1	AB-2
Wt. Sa. (wet+tare)(g)	45	40	38
Wt. Sa. (dry+tare)(g)	32	29	28
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	31.1	27.7	27.0
Wt. Water (g)	12.1	10.7	9.8
Water Content (%)	38.9%	38.6%	36.3%

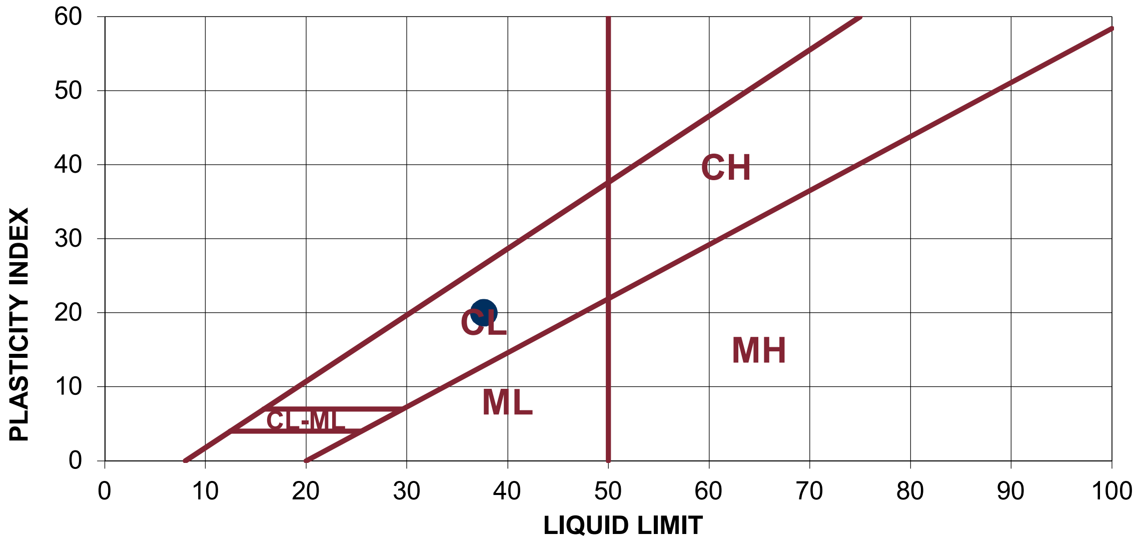
PLASTIC LIMIT

Trial	1	2
Tare No.	JK-11	NG-4
Wt. Sa. (wet+tare)(g)	21.10	21.6
Wt. Sa. (dry+tare)(g)	18.10	18.6
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	16.8	17.3
Wt. Water (g)	3.0	3.0
Water Content (%)	17.9%	17.3%

RESULTS

LL	**38**
PL	**18**
PI	**20**
Natural MC (%)	
20.1%	





Reviewed By: CH

Stantec

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 1, 2017
Date Tested: July 11, 2017
Tested By: JW

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-1 GS-6

LIQUID LIMIT

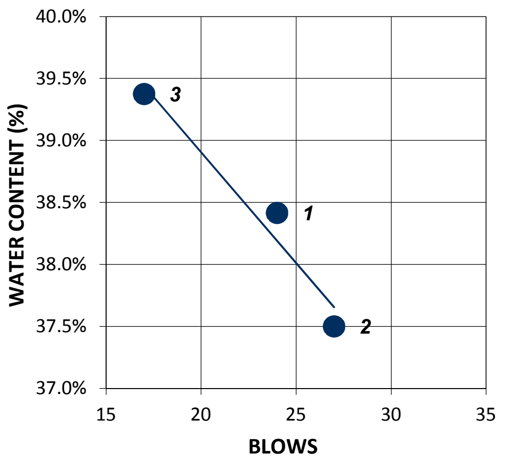
Trial	1	2	3
No. of Blows	24	27	17
Tare No.	JK-10	W-2	Z-4
Wt. Sa. (wet+tare)(g)	24	26	23
Wt. Sa. (dry+tare)(g)	18	19	17
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	16.4	17.6	16.0
Wt. Water (g)	6.3	6.6	6.3
Water Content (%)	38.4%	37.5%	39.4%

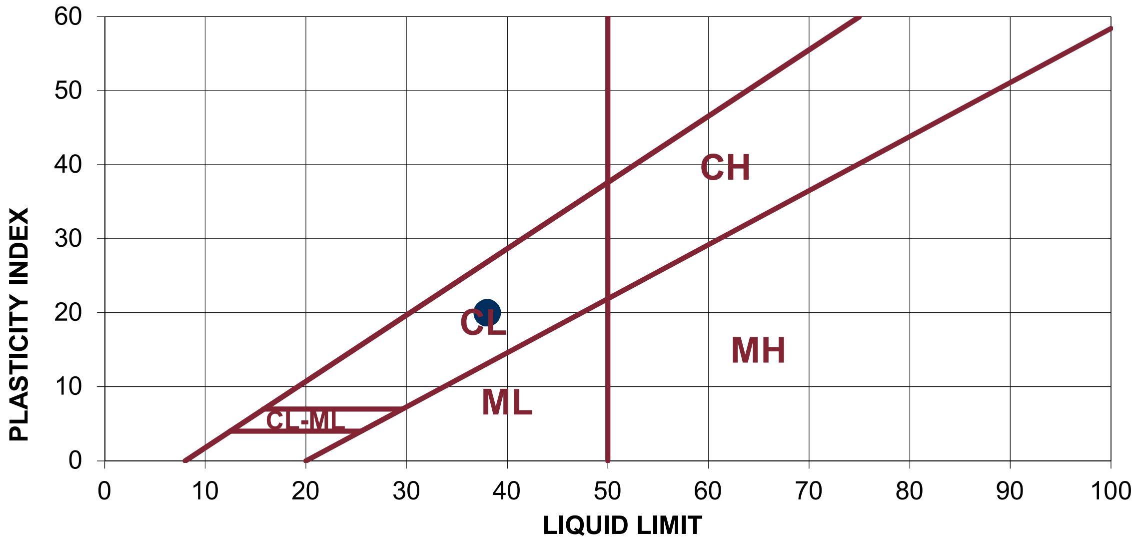
PLASTIC LIMIT

Trial	1	2
Tare No.	JW-2	JW-3
Wt. Sa. (wet+tare)(g)	23.10	21.8
Wt. Sa. (dry+tare)(g)	19.80	18.6
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	18.5	17.3
Wt. Water (g)	3.3	3.2
Water Content (%)	17.8%	18.5%

RESULTS

LL	**38**
PL	**18**
PI	**20**
Natural MC (%)	
20.6%	





Reviewed By: CH

Stantec

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 1, 2017
Date Tested: July 11, 2017
Tested By: JW

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-2 GS-2

LIQUID LIMIT

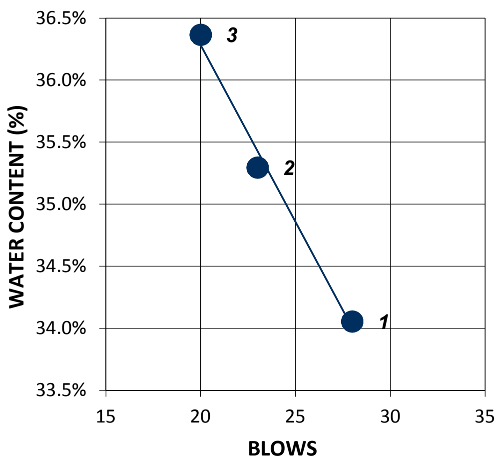
Trial	1	2	3
No. of Blows	28	23	20
Tare No.	JC-1	KJ-2	B-1
Wt. Sa. (wet+tare)(g)	26	24	27
Wt. Sa. (dry+tare)(g)	20	18	20
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	18.5	17.0	18.7
Wt. Water (g)	6.3	6.0	6.8
Water Content (%)	34.1%	35.3%	36.4%

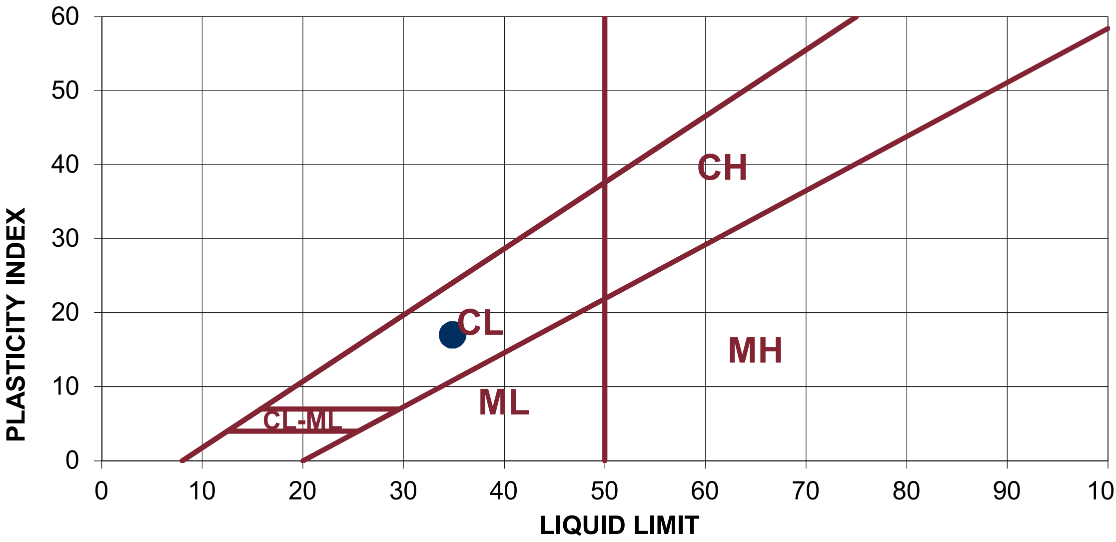
PLASTIC LIMIT

Trial	1	2
Tare No.	KJ-3	NG-4
Wt. Sa. (wet+tare)(g)	19.70	20.6
Wt. Sa. (dry+tare)(g)	16.90	17.7
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	15.6	16.4
Wt. Water (g)	2.8	2.9
Water Content (%)	17.9%	17.7%

RESULTS

LL	**35**
PL	**18**
PI	**17**
Natural MC (%)	
16.3%	





Reviewed By: CH

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 4, 2017
Date Tested: July 11, 2017
Tested By: JW

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-5 GS-4

LIQUID LIMIT

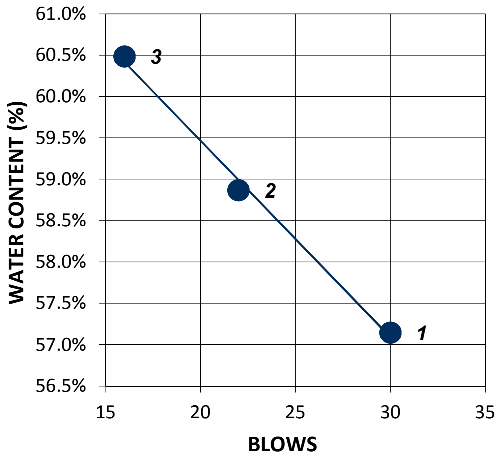
Trial	1	2	3
No. of Blows	30	22	16
Tare No.	D-1	D-3	D-2
Wt. Sa. (wet+tare)(g)	21	24	21
Wt. Sa. (dry+tare)(g)	14	15	14
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	12.6	14.1	12.4
Wt. Water (g)	7.2	8.3	7.5
Water Content (%)	57.1%	58.9%	60.5%

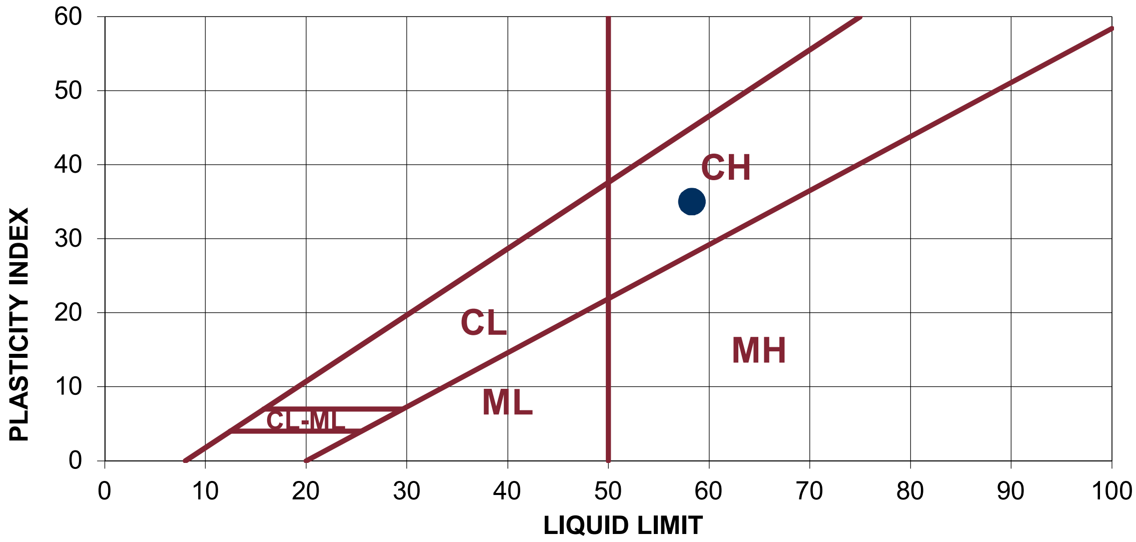
PLASTIC LIMIT

Trial	1	2
Tare No.	Z2	JN-5
Wt. Sa. (wet+tare)(g)	11.70	10.7
Wt. Sa. (dry+tare)(g)	9.70	8.9
Wt. Tare (g)	1.10	1.1
Wt. Dry Soil (g)	8.6	7.8
Wt. Water (g)	2.0	1.8
Water Content (%)	23.3%	23.1%

RESULTS

LL	**58**
PL	**23**
PI	**35**
Natural MC (%)	
42.2%	





Reviewed By: CH

Stantec

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 1, 2017
Date Tested: July 11, 2017
Tested By: JW

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-6 GS-2

LIQUID LIMIT

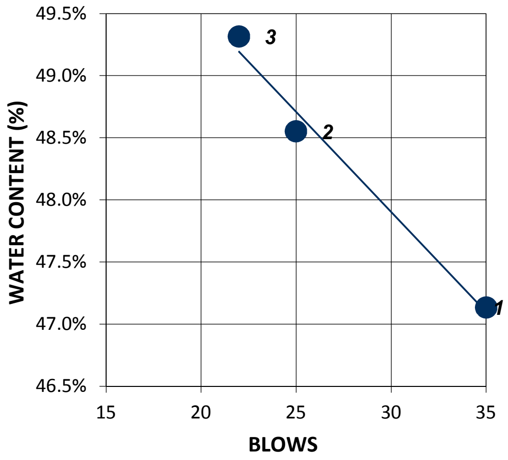
Trial	1	2	3
No. of Blows	35	25	22
Tare No.	AB-5	JK-9	JK-10
Wt. Sa. (wet+tare)(g)	24	22	23
Wt. Sa. (dry+tare)(g)	17	15	16
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	15.7	13.8	14.6
Wt. Water (g)	7.4	6.7	7.2
Water Content (%)	47.1%	48.6%	49.3%

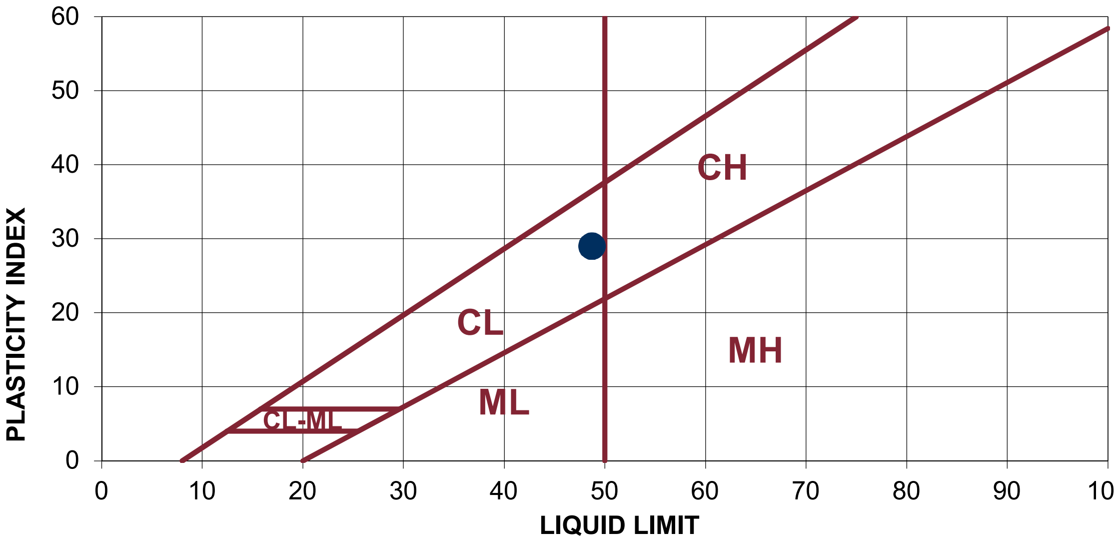
PLASTIC LIMIT

Trial	1	2
Tare No.	NG-1	KJ-4
Wt. Sa. (wet+tare)(g)	15.40	17.9
Wt. Sa. (dry+tare)(g)	13.00	15.1
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	11.7	13.8
Wt. Water (g)	2.4	2.8
Water Content (%)	20.5%	20.3%

RESULTS

LL	**49**
PL	**20**
PI	**29**
Natural MC (%)	
24.9%	





Reviewed By: CH

Stantec

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 1, 2017
Date Tested: July 11, 2017
Tested By: JW

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-6 GS-3

LIQUID LIMIT

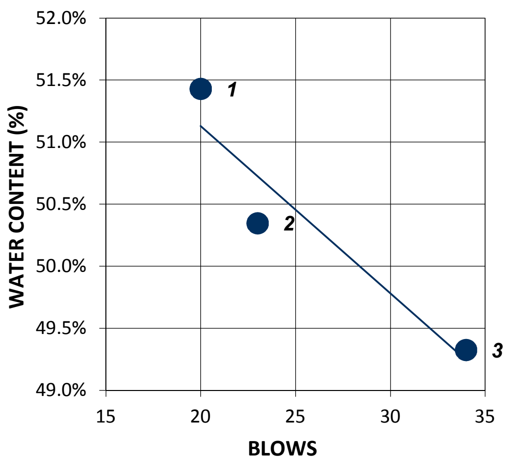
Trial	1	2	3
No. of Blows	20	23	34
Tare No.	JK-9	AB-1	JK-11
Wt. Sa. (wet+tare)(g)	23	23	23
Wt. Sa. (dry+tare)(g)	15	16	16
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	14.0	14.5	14.8
Wt. Water (g)	7.2	7.3	7.3
Water Content (%)	51.4%	50.3%	49.3%

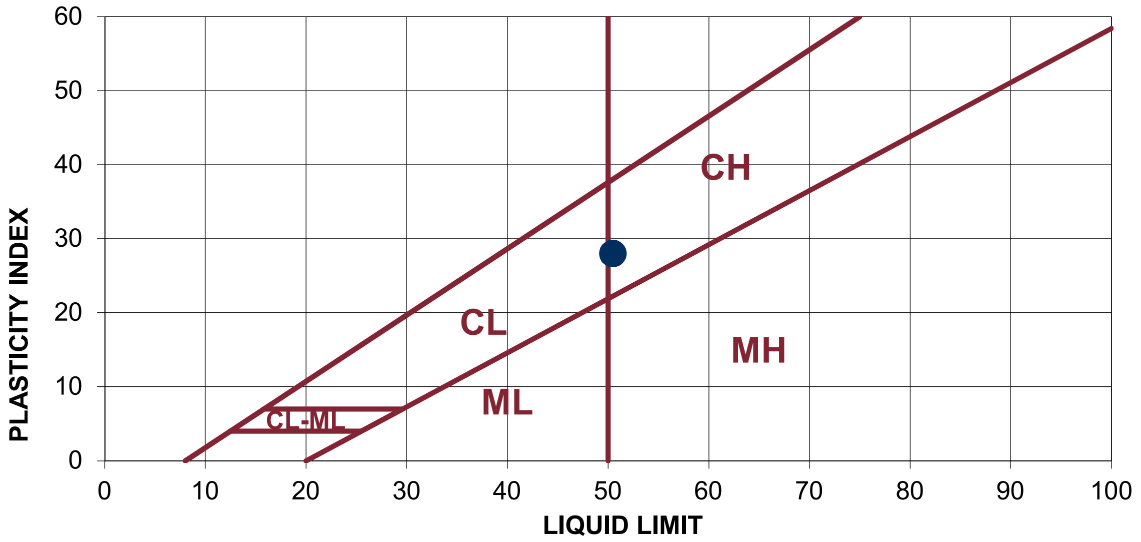
PLASTIC LIMIT

Trial	1	2
Tare No.	JW-1	AB-5
Wt. Sa. (wet+tare)(g)	20.90	21.1
Wt. Sa. (dry+tare)(g)	17.40	17.5
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	16.1	16.2
Wt. Water (g)	3.5	3.6
Water Content (%)	21.7%	22.2%

RESULTS

LL	**50**
PL	**22**
PI	**28**
Natural MC (%)	
31.8%	





Reviewed By: CH

Stantec

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 1, 2017
Date Tested: July 11, 2017
Tested By: JW

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-6 GS-4

LIQUID LIMIT

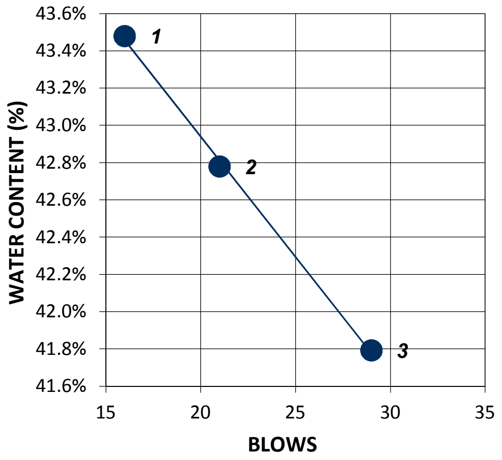
Trial	1	2	3
No. of Blows	16	21	29
Tare No.	JW-1	JW-2	JW-3
Wt. Sa. (wet+tare)(g)	28	27	20
Wt. Sa. (dry+tare)(g)	20	19	15
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	18.4	18.0	13.4
Wt. Water (g)	8.0	7.7	5.6
Water Content (%)	43.5%	42.8%	41.8%

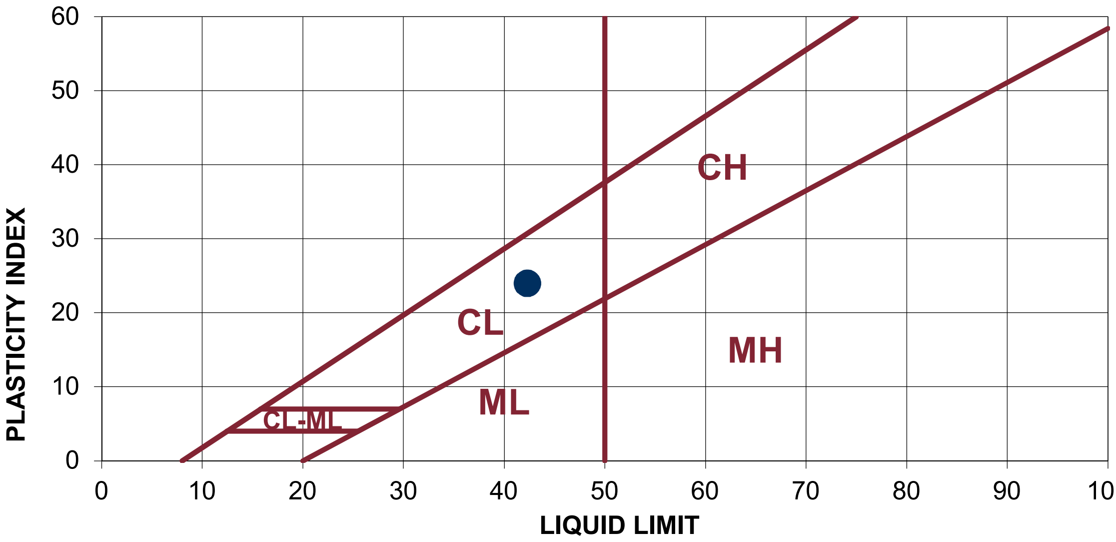
PLASTIC LIMIT

Trial	1	2
Tare No.	JK-1	J-6
Wt. Sa. (wet+tare)(g)	18.10	18.8
Wt. Sa. (dry+tare)(g)	15.50	16.1
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	14.2	14.8
Wt. Water (g)	2.6	2.7
Water Content (%)	18.3%	18.2%

RESULTS

LL	**42**
PL	**18**
PI	**24**
Natural MC (%)	
24.9%	





Reviewed By: CH

Atterberg Limits

ASTM D4318

Method A- Multi-Point

Client: CRD

Project Name: CRD Clover Point Forcemain

Project No: 111700431

Date Received: July 1, 2017

Date Tested: July 11, 2017

Tested By: JW

OFFICE	**LABORATORY**
4730 Kingsway	3711 North Fraser Way
Suite 500	Suite 400
Burnaby, BC	Burnaby, BC
Canada V5H 0C6	Canada V5J 5J2
Tel: (604) 436-3014	Tel: (604) 436-3014

Sample : BH17-7 GS-3

LIQUID LIMIT

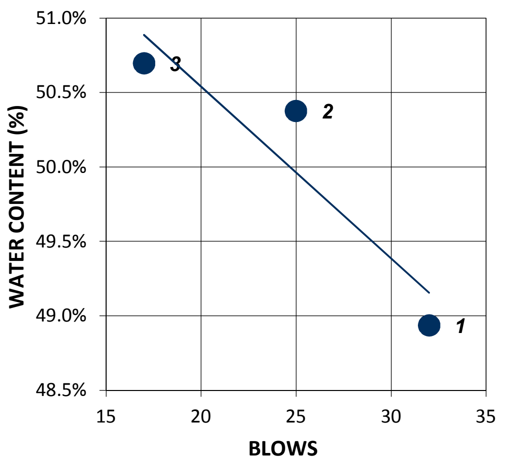
Trial	1	2	3
No. of Blows	32	25	17
Tare No.	JN-5	E2	Z1
Wt. Sa. (wet+tare)(g)	22	21	23
Wt. Sa. (dry+tare)(g)	15	14	16
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	14.1	13.3	14.4
Wt. Water (g)	6.9	6.7	7.3
Water Content (%)	48.9%	50.4%	50.7%

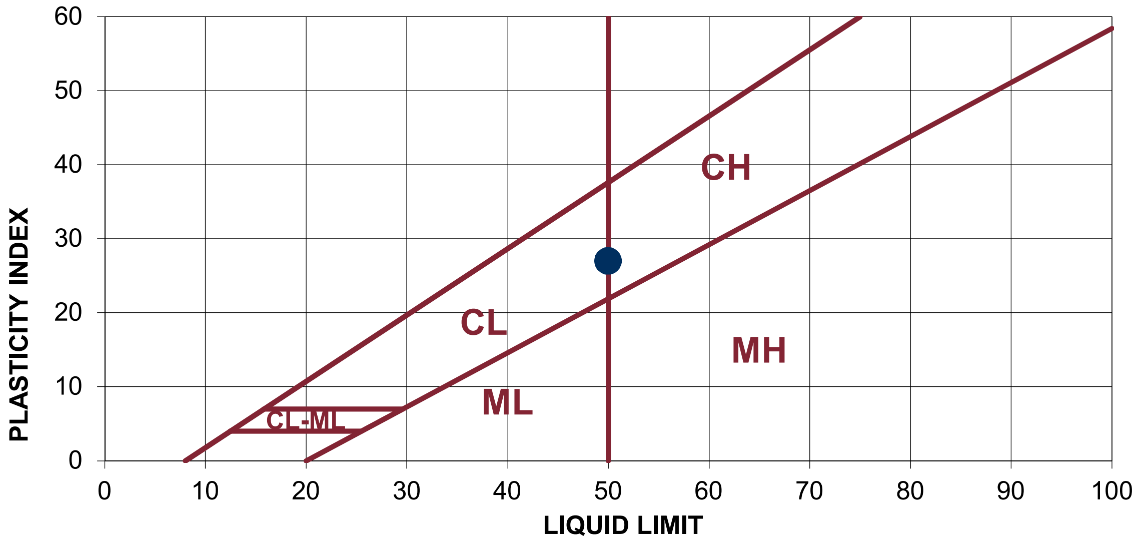
PLASTIC LIMIT

Trial	1	2
Tare No.	A10	C2
Wt. Sa. (wet+tare)(g)	11.00	7.8
Wt. Sa. (dry+tare)(g)	9.20	6.6
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	7.9	5.3
Wt. Water (g)	1.8	1.2
Water Content (%)	22.8%	22.6%

RESULTS

LL	**50**
PL	**23**
PI	**27**
Natural MC (%)	
30.1%	





Reviewed By: CH

Stantec

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: June 23, 2017
Date Tested: July 6, 2017
Tested By: KK

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH12-12 SS-04

LIQUID LIMIT

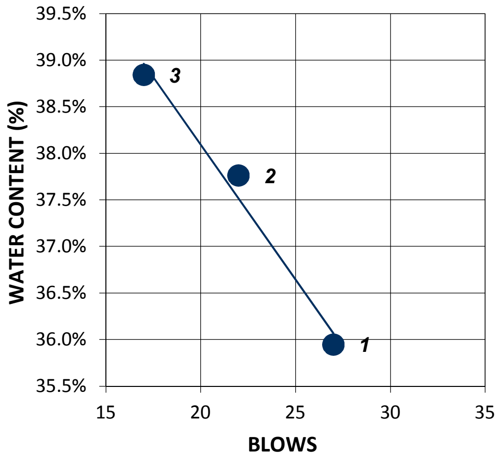
Trial	1	2	3
No. of Blows	27	22	17
Tare No.	NG-2	A4	A2
Wt. Sa. (wet+tare)(g)	31	35	32
Wt. Sa. (dry+tare)(g)	23	25	24
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	21.7	24.1	22.4
Wt. Water (g)	7.8	9.1	8.7
Water Content (%)	35.9%	37.8%	38.8%

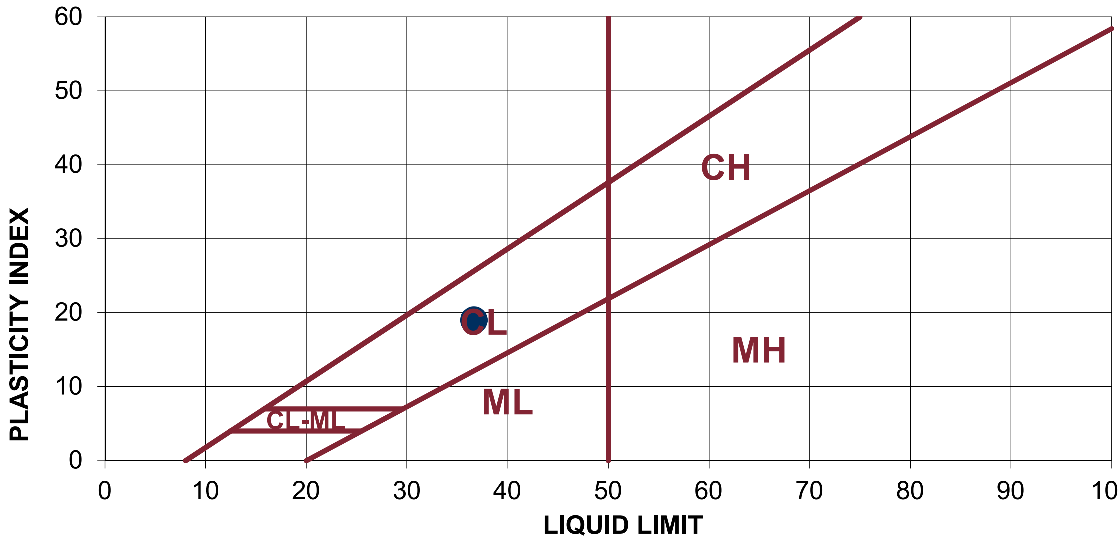
PLASTIC LIMIT

Trial	1	2
Tare No.	A28	H9
Wt. Sa. (wet+tare)(g)	13.10	11.8
Wt. Sa. (dry+tare)(g)	11.30	10.2
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	10.0	8.9
Wt. Water (g)	1.8	1.6
Water Content (%)	18.0%	18.0%

RESULTS

LL	**37**
PL	**18**
PI	**19**
Natural MC (%)	
20.3%	





Reviewed By: CH

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	CRD
Project Name:	CRD Clover Point Forcemain
Project No:	111700431
Date Received:	June 23, 2017
Date Tested:	July 6, 2017
Tested By:	KK

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH12-12 SS-05A

LIQUID LIMIT

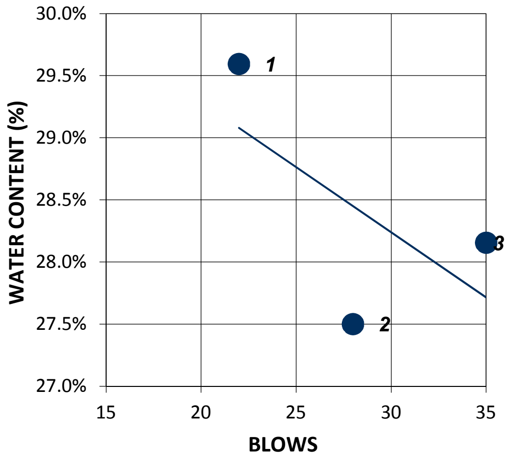
Trial	1	2	3
No. of Blows	22	28	35
Tare No.	D-1	D-2	D-3
Wt. Sa. (wet+tare)(g)	39	37	28
Wt. Sa. (dry+tare)(g)	31	29	22
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	29.4	28.0	20.6
Wt. Water (g)	8.7	7.7	5.8
Water Content (%)	29.6%	27.5%	28.2%

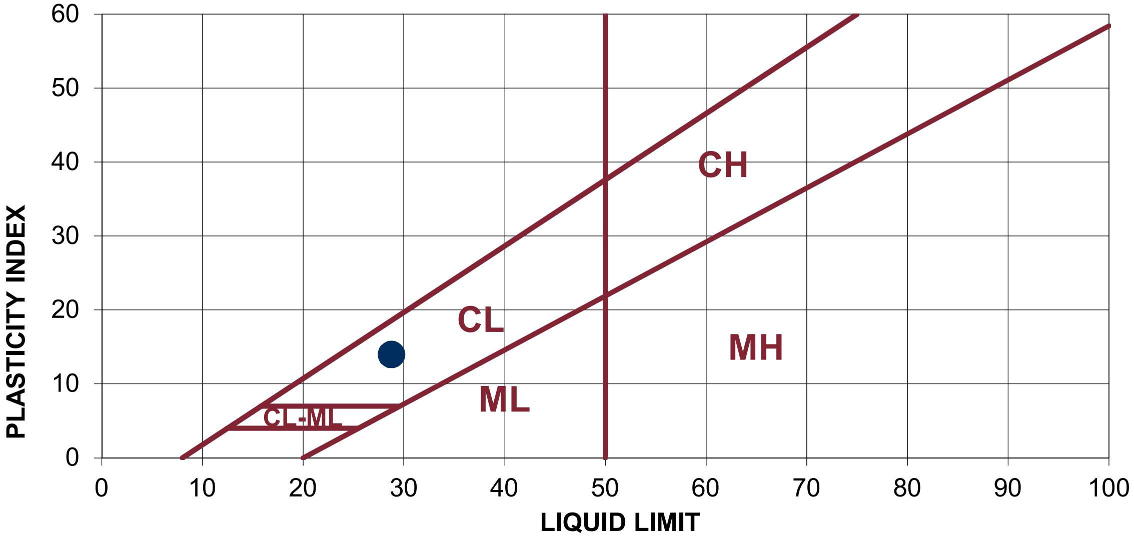
PLASTIC LIMIT

Trial	1	2
Tare No.	D-4	D-5
Wt. Sa. (wet+tare)(g)	16.30	13.7
Wt. Sa. (dry+tare)(g)	14.30	12.1
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	13.0	10.8
Wt. Water (g)	2.0	1.6
Water Content (%)	15.4%	14.8%

RESULTS

LL	**29**
PL	**15**
PI	**14**
Natural MC (%)	
20.3%	





Reviewed By: CH

Stantec

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: June 23, 2017
Date Tested: July 4, 2017
Tested By: KK

OFFICE	**LABORATORY**
4730 Kingsway	3711 North Fraser Way
Suite 500	Suite 400
Burnaby, BC	Burnaby, BC
Canada V5H 0C6	Canada V5J 5J2
Tel: (604) 436-3014	Tel: (604) 436-3014

Sample : BH17-13 SS-04

LIQUID LIMIT

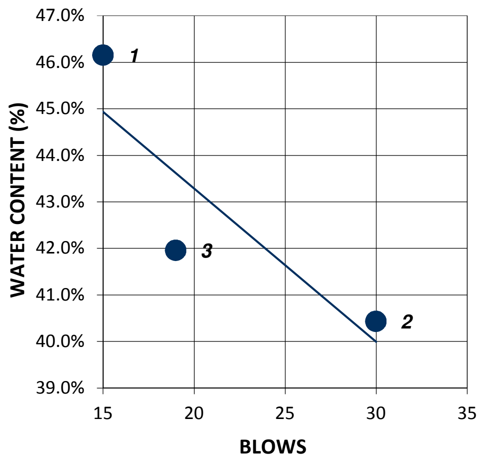
Trial	1	2	3
No. of Blows	15	30	19
Tare No.	A13	KK-7	KK-6
Wt. Sa. (wet+tare)(g)	24	34	38
Wt. Sa. (dry+tare)(g)	17	24	27
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	15.6	23.0	25.5
Wt. Water (g)	7.2	9.3	10.7
Water Content (%)	46.2%	40.4%	42.0%

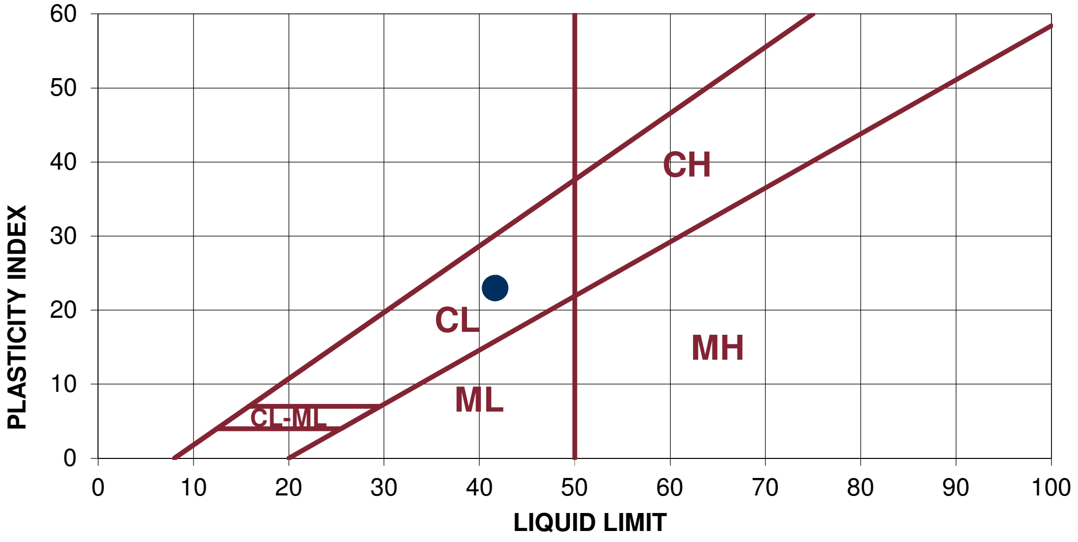
PLASTIC LIMIT

Trial	1	2
Tare No.	ZZ9	ZZ3
Wt. Sa. (wet+tare)(g)	12.70	19.3
Wt. Sa. (dry+tare)(g)	10.90	16.4
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	9.6	15.1
Wt. Water (g)	1.8	2.9
Water Content (%)	18.8%	19.2%

RESULTS

LL	**42**
PL	**19**
PI	**23**
Natural MC (%)	
15.4%	





Reviewed By: CH

Stantec

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: June 23, 2017
Date Tested: July 4, 2017
Tested By: KK

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-16 SS-02

LIQUID LIMIT

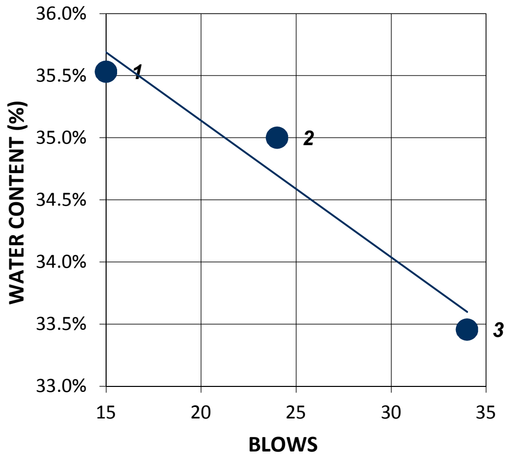
Trial	1	2	3
No. of Blows	15	24	34
Tare No.	RP1	ZZ6	ZZ4
Wt. Sa. (wet+tare)(g)	38	34	38
Wt. Sa. (dry+tare)(g)	29	25	29
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	27.3	24.0	27.2
Wt. Water (g)	9.7	8.4	9.1
Water Content (%)	35.5%	35.0%	33.5%

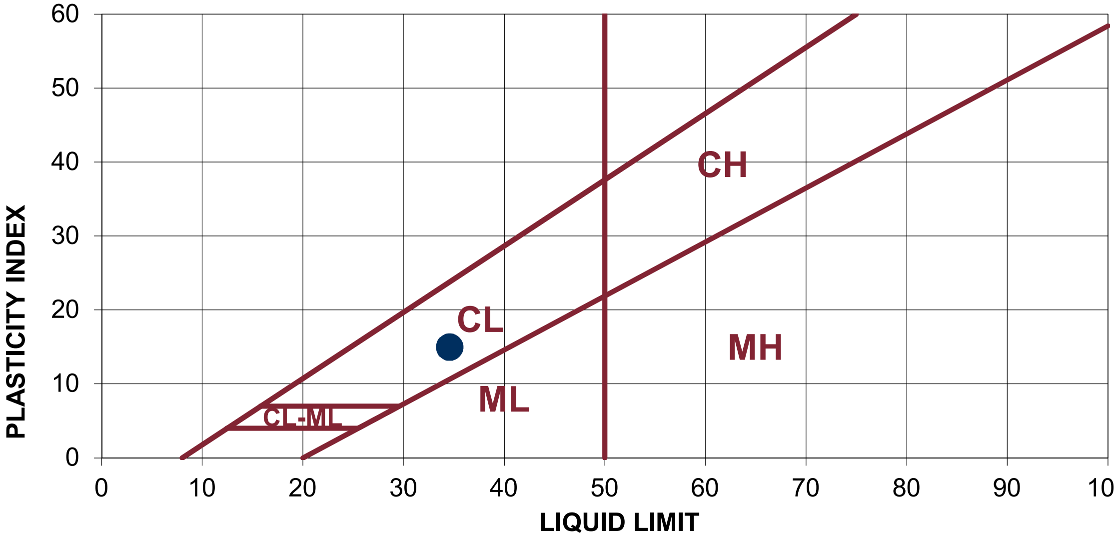
PLASTIC LIMIT

Trial	1	2
Tare No.	Z31	A12
Wt. Sa. (wet+tare)(g)	14.20	12.8
Wt. Sa. (dry+tare)(g)	12.10	10.9
Wt. Tare (g)	1.30	1.3
Wt. Dry Soil (g)	10.8	9.6
Wt. Water (g)	2.1	1.9
Water Content (%)	19.4%	19.8%

RESULTS

LL	**35**
PL	**20**
PI	**15**
Natural MC (%)	
19.6%	





Reviewed By: CH

Stantec

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431
Date Received: July 1, 2017
Date Tested: July 4, 2017
Tested By: JW

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

Sample : BH17-17 GS-3

LIQUID LIMIT

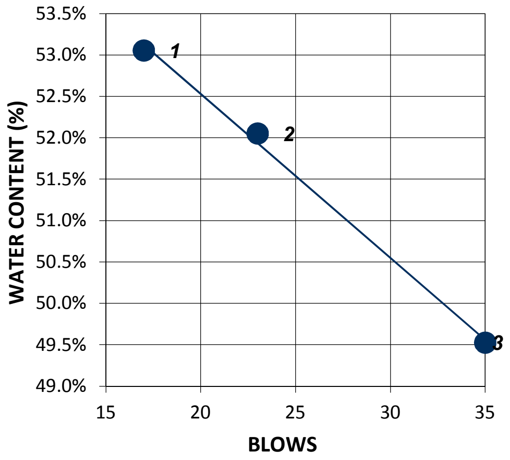
Trial	1	2	3
No. of Blows	17	23	35
Tare No.	E-1	E-2	E-3
Wt. Sa. (wet+tare)(g)	34	38	33
Wt. Sa. (dry+tare)(g)	23	26	22
Wt. Tare (g)	1	1	1
Wt. Dry Soil (g)	21.3	24.4	21.0
Wt. Water (g)	11.3	12.7	10.4
Water Content (%)	53.1%	52.0%	49.5%

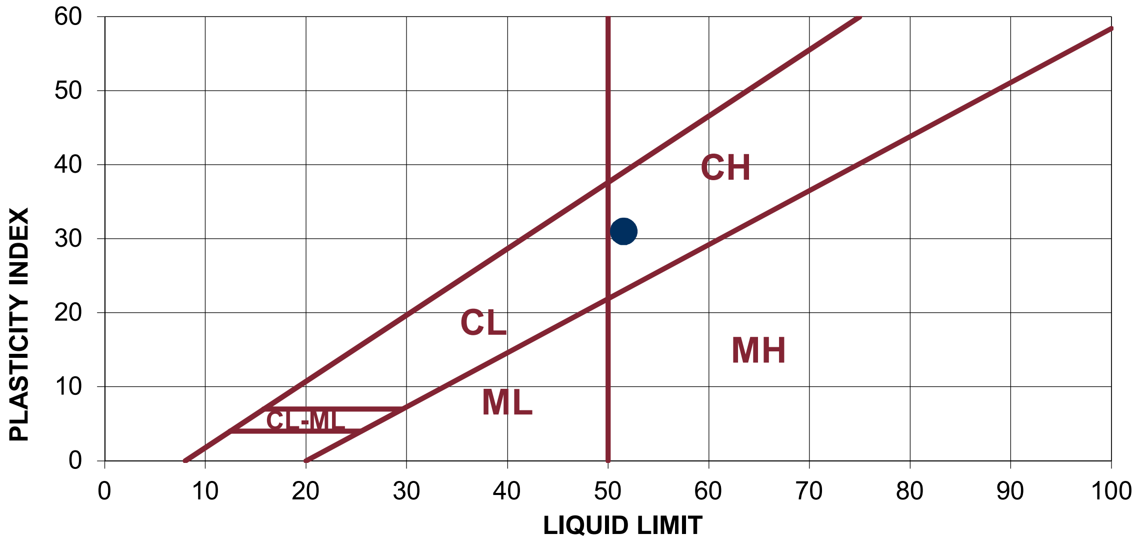
PLASTIC LIMIT

Trial	1	2
Tare No.	E4	
Wt. Sa. (wet+tare)(g)	15.70	
Wt. Sa. (dry+tare)(g)	13.20	
Wt. Tare (g)	1.30	
Wt. Dry Soil (g)	11.9	
Wt. Water (g)	2.5	
Water Content (%)	21.0%	

RESULTS

LL	**52**
PL	**21**
PI	**31**
Natural MC (%)	
26.4%	





Reviewed By: CH

D.2 GRAIN SIZE DISTRIBUTION

Stantec

Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

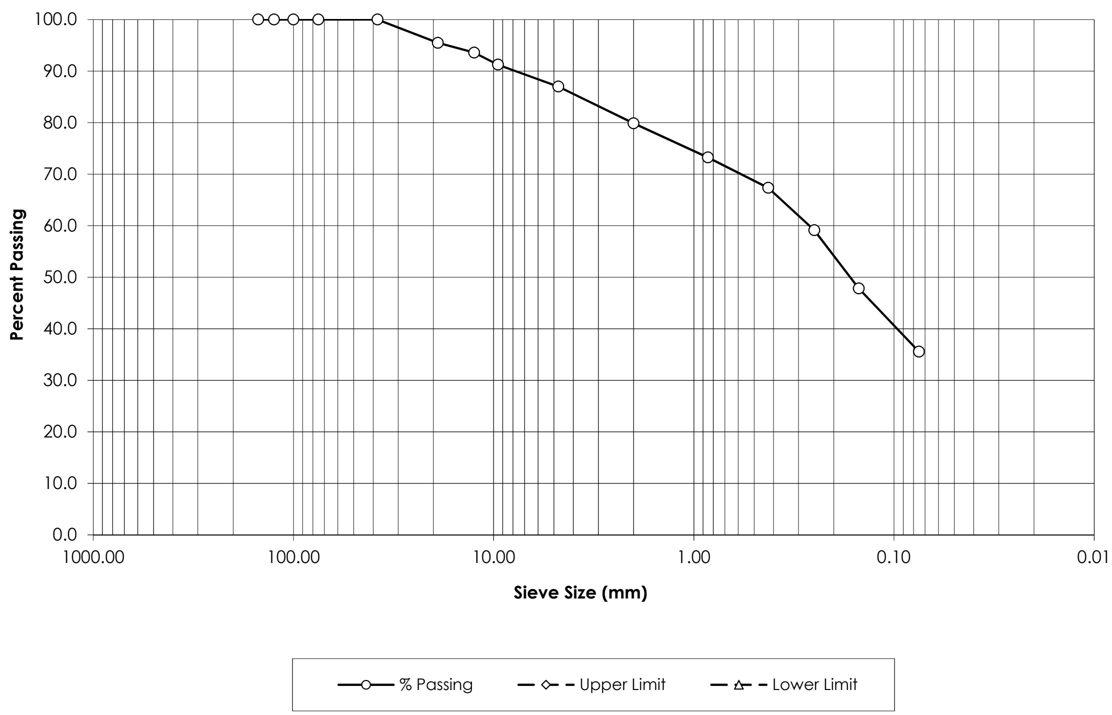
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: GS-2
SOURCE: BH17-8
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND



Sieve (mm)	Sample % Passing	Specifications Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**95.5**	-	-
12.5	**93.6**	-	-
9.5	**91.2**	-	-
4.75	**87.0**	-	-
2.00	**79.9**	-	-
0.85	**73.2**	-	-
0.425	**67.3**	-	-
0.250	**59.1**	-	-
0.150	**47.8**	-	-
0.075	**35.5**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	13.0%	D_{30}:	-
Sand:	51.4%	D_{60}:	0.2698
Fines:	35.6%	C_u:	-
		C_c:	-

Comments:

Reviewed by: CH

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided only on written request. The data presented above is for the sole use of the client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.

Stantec

Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

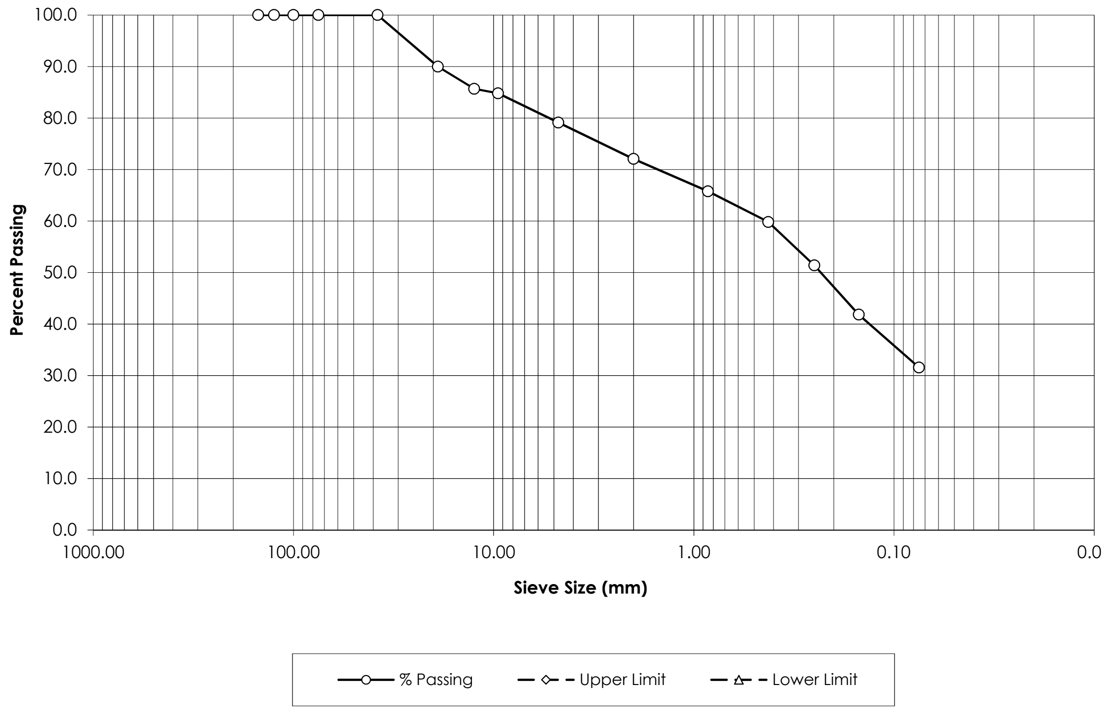
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: SS-7
SOURCE: BH17-12
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND with gravel



Sieve (mm)	Sample % Passing	Specifications	
		Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**90.0**	-	-
12.5	**85.7**	-	-
9.5	**84.8**	-	-
4.75	**79.1**	-	-
2.00	**72.1**	-	-
0.85	**65.8**	-	-
0.425	**59.8**	-	-
0.250	**51.4**	-	-
0.150	**41.8**	-	-
0.075	**31.5**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	20.9%	D_{30}:	-
Sand:	47.6%	D_{60}:	0.4389
Fines:	31.5%	C_u:	-
		C_c:	-

Comments:

Reviewed by: CH

Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

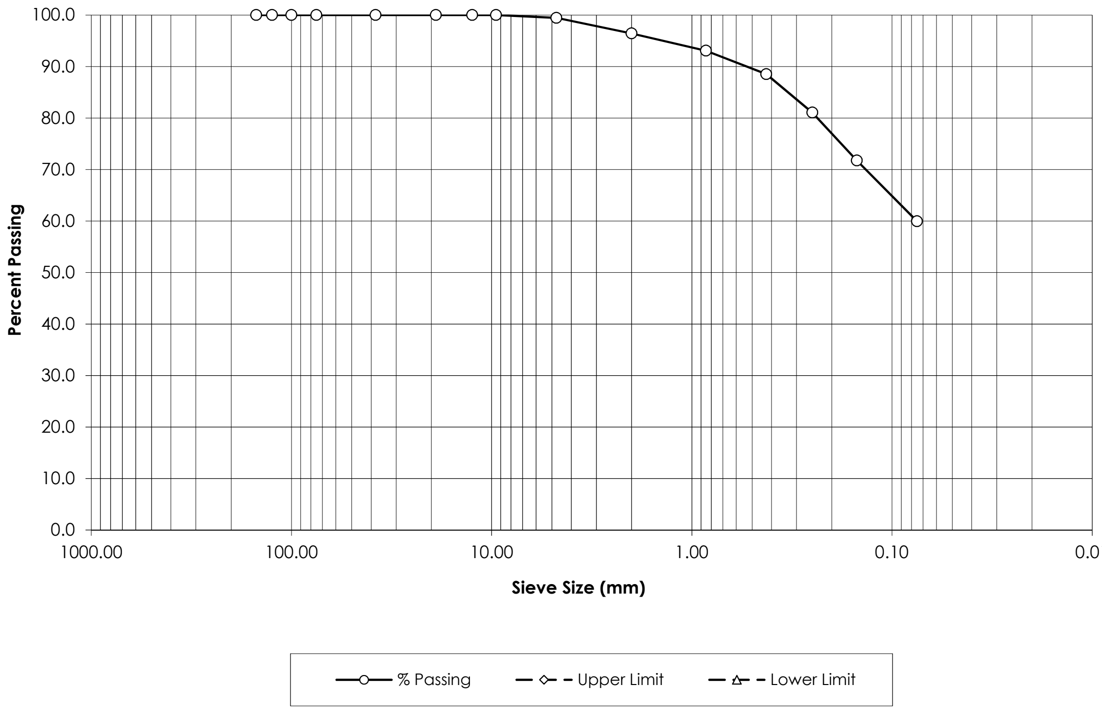
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: SS-4
SOURCE: BH17-13
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: Sandy lean CLAY



Sieve (mm)	Sample % Passing	Specifications Lower	Specifications Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**100.0**	-	-
12.5	**100.0**	-	-
9.5	**100.0**	-	-
4.75	**99.5**	-	-
2.00	**96.4**	-	-
0.85	**93.1**	-	-
0.425	**88.5**	-	-
0.250	**81.1**	-	-
0.150	**71.8**	-	-
0.075	**60.0**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	0.5%	D_{30}:	-
Sand:	39.5%	D_{60}:	0.0753
Fines:	60.0%	C_u:	-
		C_c:	-

Comments:

Reviewed by: CH

Stantec

Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

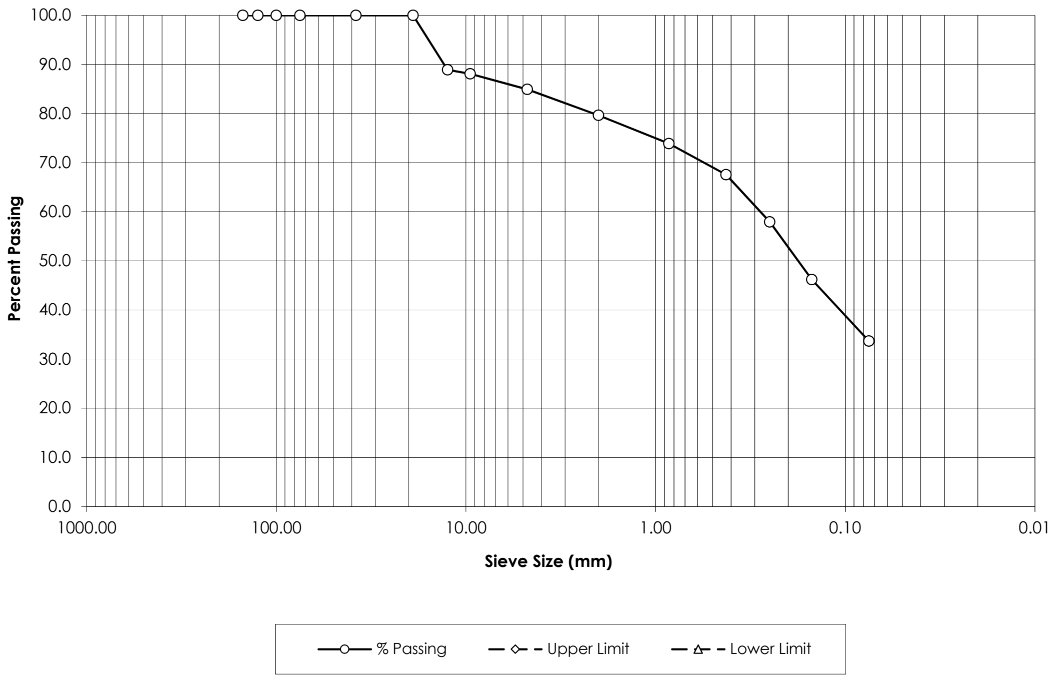
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: SS-5
SOURCE: BH17-13
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND with gravel



Sieve (mm)	Sample % Passing	Specifications	
		Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**100.0**	-	-
12.5	**88.9**	-	-
9.5	**88.1**	-	-
4.75	**84.9**	-	-
2.00	**79.6**	-	-
0.85	**73.9**	-	-
0.425	**67.5**	-	-
0.250	**57.9**	-	-
0.150	**46.2**	-	-
0.075	**33.7**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	15.1%	D_{30}:	-
Sand:	51.2%	D_{60}:	0.2901
Fines:	33.7%	C_u:	-
		C_c:	-

Comments:

Reviewed by: CH

Stantec

Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

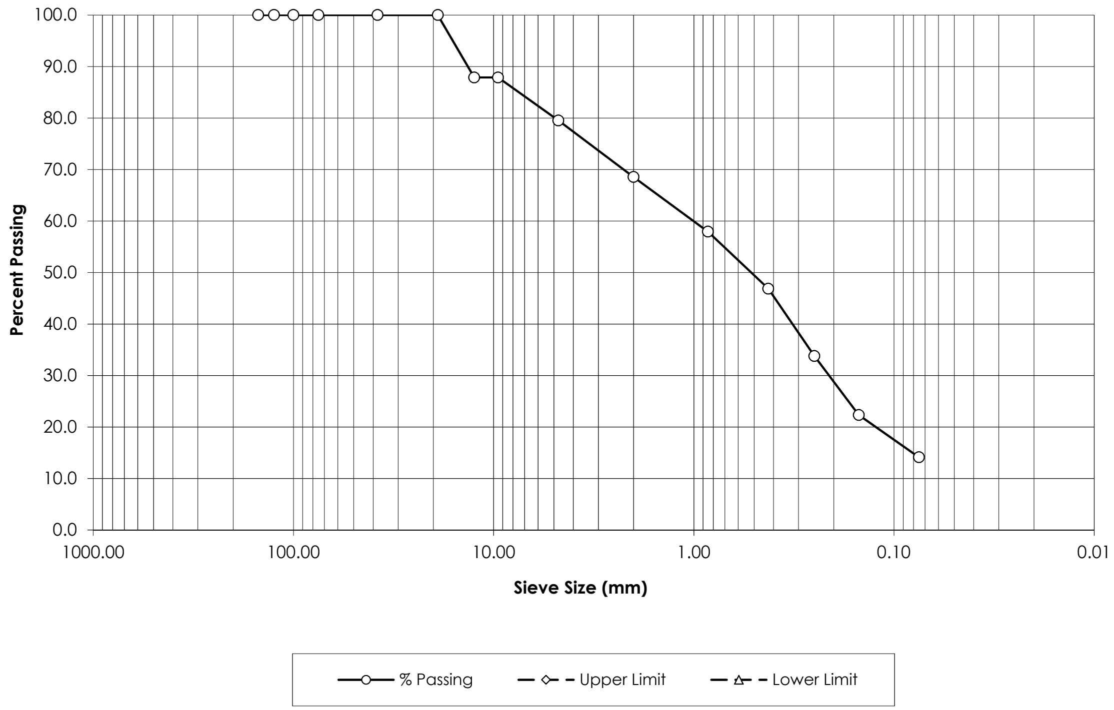
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: SS-7
SOURCE: BH17-13
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND with gravel



Sieve (mm)	Sample % Passing	Specifications	
		Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**100.0**	-	-
12.5	**87.9**	-	-
9.5	**87.9**	-	-
4.75	**79.5**	-	-
2.00	**68.6**	-	-
0.85	**57.9**	-	-
0.425	**46.9**	-	-
0.250	**33.8**	-	-
0.150	**22.3**	-	-
0.075	**14.1**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	20.5%	D_{30}:	0.2212
Sand:	65.4%	D_{60}:	1.0892
Fines:	14.1%	C_u:	-
		C_c:	-

Comments:

Reviewed by: CH

Stantec

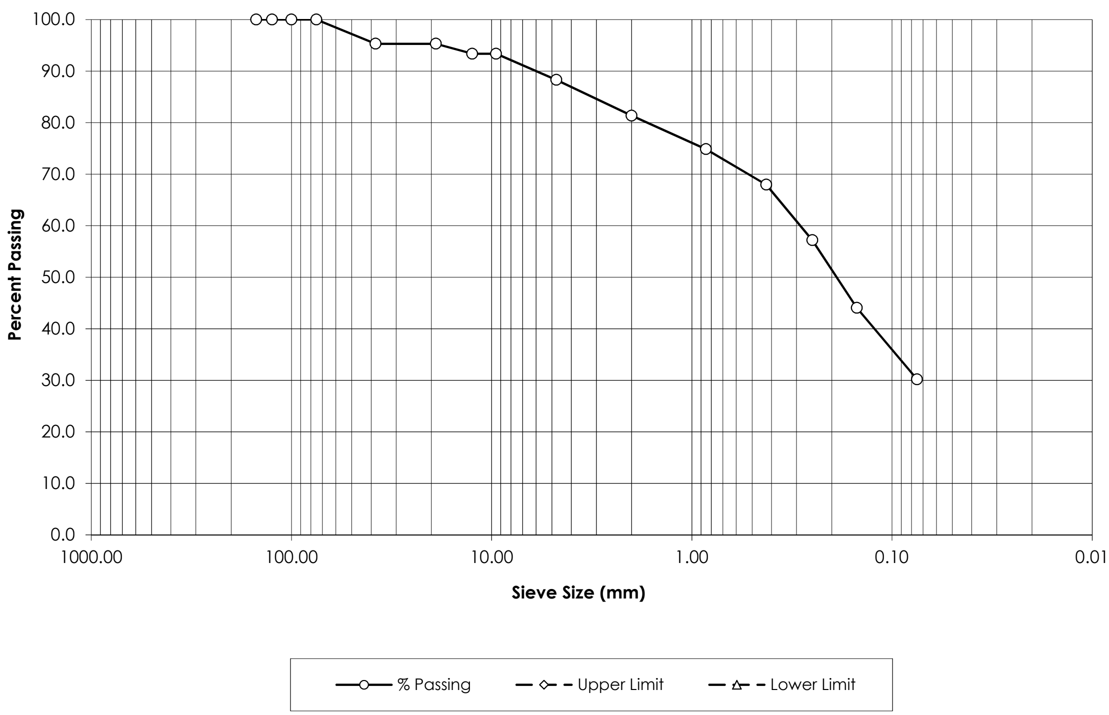
Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE	**LABORATORY**
4730 Kingsway	3711 North Fraser Way
Suite 500	Suite 400
Burnaby, BC	Burnaby, BC
Canada V5H 0C6	Canada V5J 5J2
Tel: (604) 436-3014	Tel: (604) 436-3014

SAMPLE No.: SS-9
SOURCE: BH17-13
TESTED BY: JN/JW
DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND



Sieve (mm)	Sample % Passing	Specifications	
		Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**95.3**	-	-
19.0	**95.3**	-	-
12.5	**93.4**	-	-
9.5	**93.4**	-	-
4.75	**88.3**	-	-
2.00	**81.4**	-	-
0.85	**74.9**	-	-
0.425	**68.0**	-	-
0.250	**57.2**	-	-
0.150	**44.1**	-	-
0.075	**30.2**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	11.7%	D_{30}:	-
Sand:	58.1%	D_{60}:	0.2986
Fines:	30.2%	C_u:	-
		C_c:	-

Comments:

Reviewed by: CH

Stantec

Grain S
Analysis
ASTM C1

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

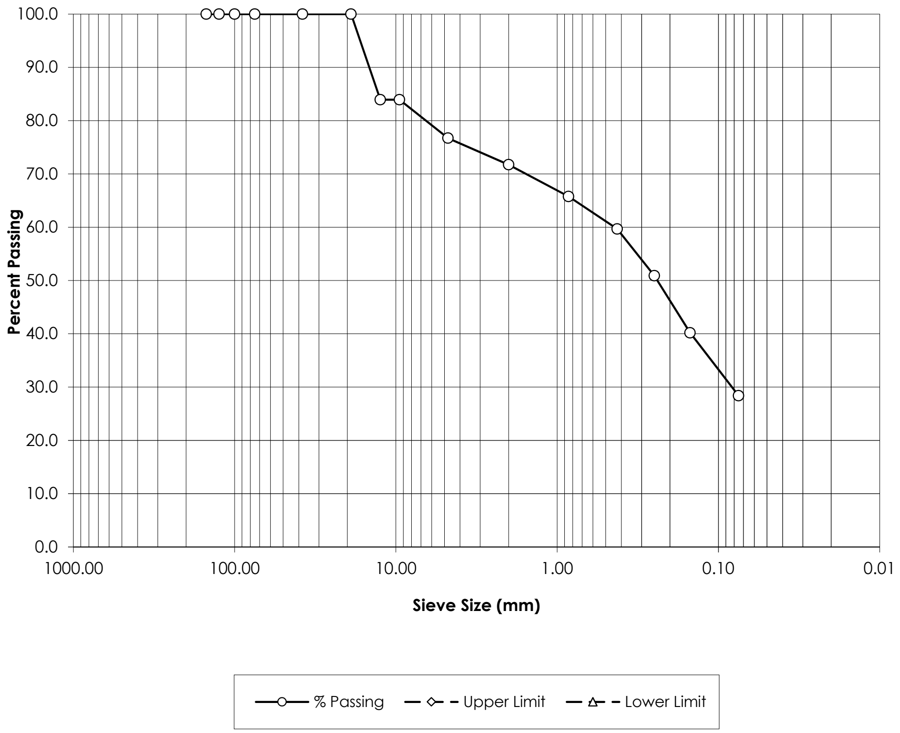
OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: SS-3
SOURCE: BH17-14
TESTED BY: JN/JW
DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND with gravel



Sieve (mm)	Sample % Passing	Specifications	
		Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**100.0**	-	-
12.5	**83.9**	-	-
9.5	**83.9**	-	-
4.75	**76.7**	-	-
2.00	**71.7**	-	-
0.85	**65.8**	-	-
0.425	**59.7**	-	-
0.250	**50.9**	-	-
0.150	**40.2**	-	-
0.075	**28.4**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	23.3%	D_{30}:	0.0870
Sand:	48.4%	D_{60}:	0.4481
Fines:	28.3%	C_U:	-
		C_C:	-

Comments:

Reviewed by: CH

Grain Size Analysis

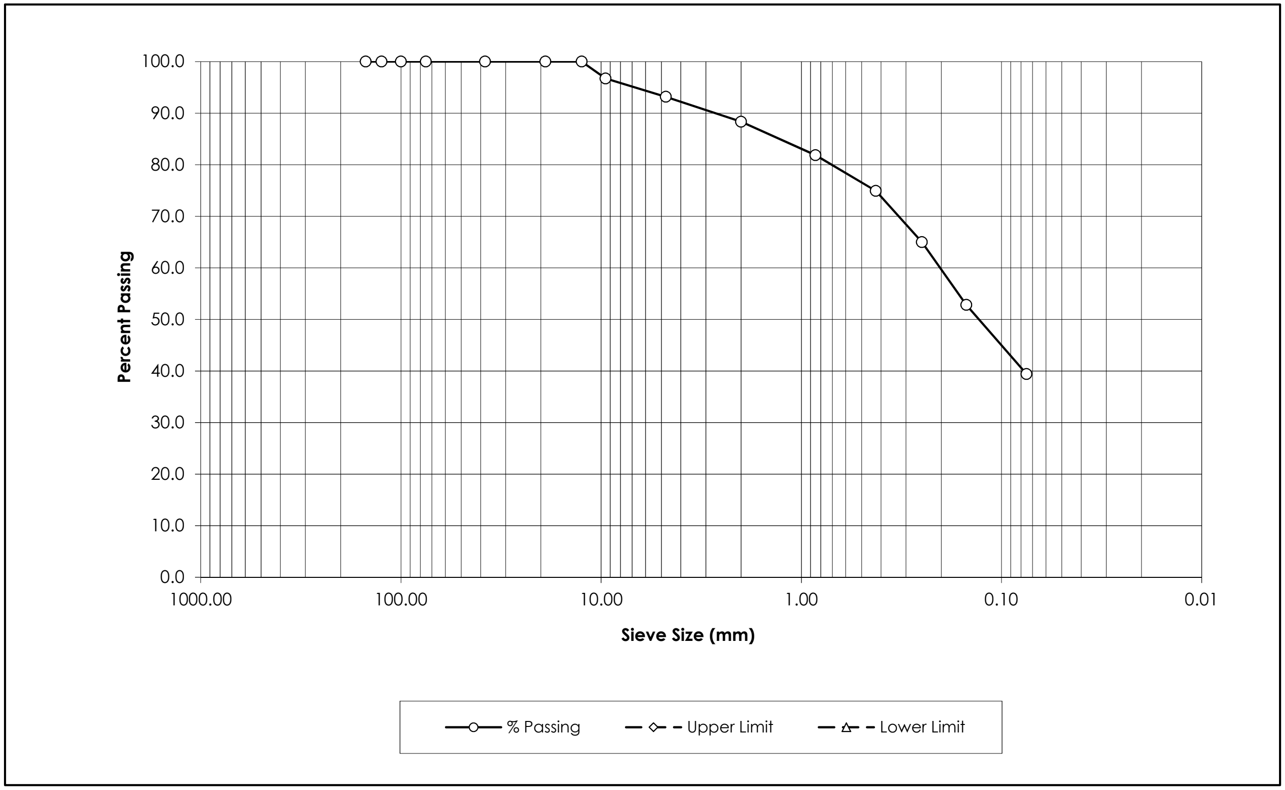
ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2
Tel: (604) 436-3014

SAMPLE No.: SS-4
SOURCE: BH17-14
TESTED BY: JN/JW
DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND



Sieve (mm)	Sample % Passing	Specifications Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**100.0**	-	-
12.5	**100.0**	-	-
9.5	**96.7**	-	-
4.75	**93.2**	-	-
2.00	**88.3**	-	-
0.85	**81.8**	-	-
0.425	**74.9**	-	-
0.250	**65.0**	-	-
0.150	**52.8**	-	-
0.075	**39.4**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	6.8%	D_{30}:	-
Sand:	53.8%	D_{60}:	0.2115
Fines:	39.4%	C_U:	-
		C_C:	-

Comments:

Reviewed by: CH

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided only on written request. The data presented above is for the sole use of the client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.

Stantec

Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

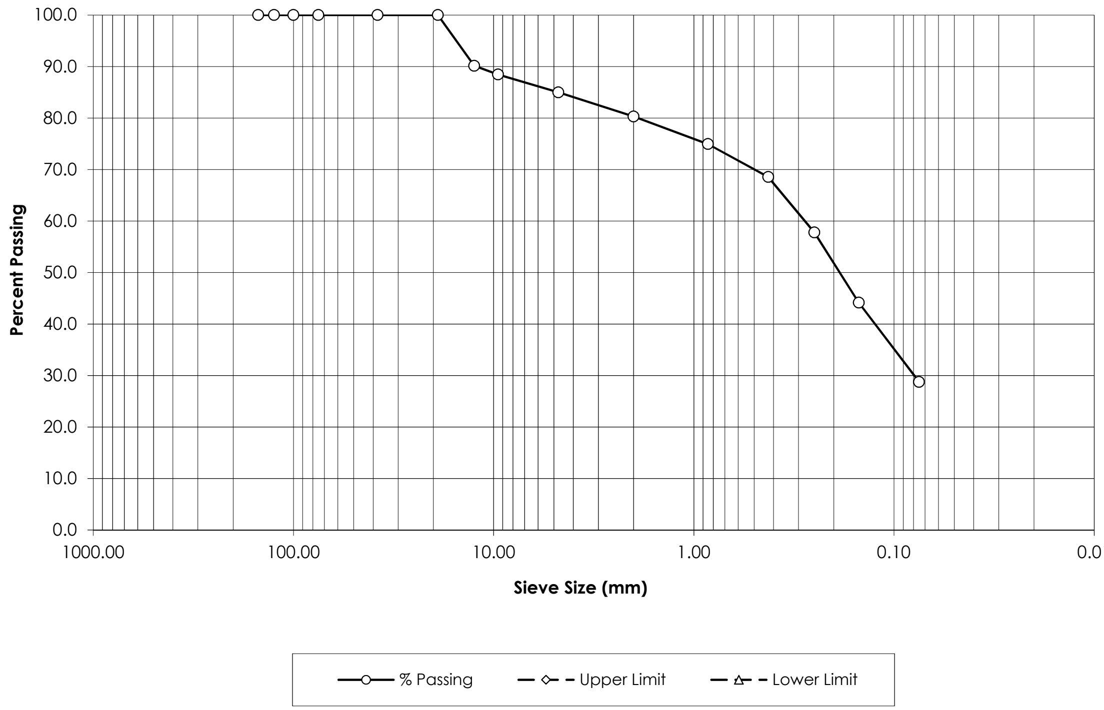
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: SS-6
SOURCE: BH17-14
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND with gravel



Sieve (mm)	Sample % Passing	Specifications Lower	Specifications Upper
150.0	100.0	-	-
125.0	100.0	-	-
100.0	100.0	-	-
75.0	100.0	-	-
38.0	100.0	-	-
19.0	100.0	-	-
12.5	90.2	-	-
9.5	88.5	-	-
4.75	85.0	-	-
2.00	80.3	-	-
0.85	75.0	-	-
0.425	68.6	-	-
0.250	57.8	-	-
0.150	44.2	-	-
0.075	28.8	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	15.0%	D_{30}:	0.0823
Sand:	56.2%	D_{60}:	0.2884
Fines:	28.8%	C_u:	-
		C_c:	-

Comments:

Reviewed by: CH

Stantec

Grain Size Analysis

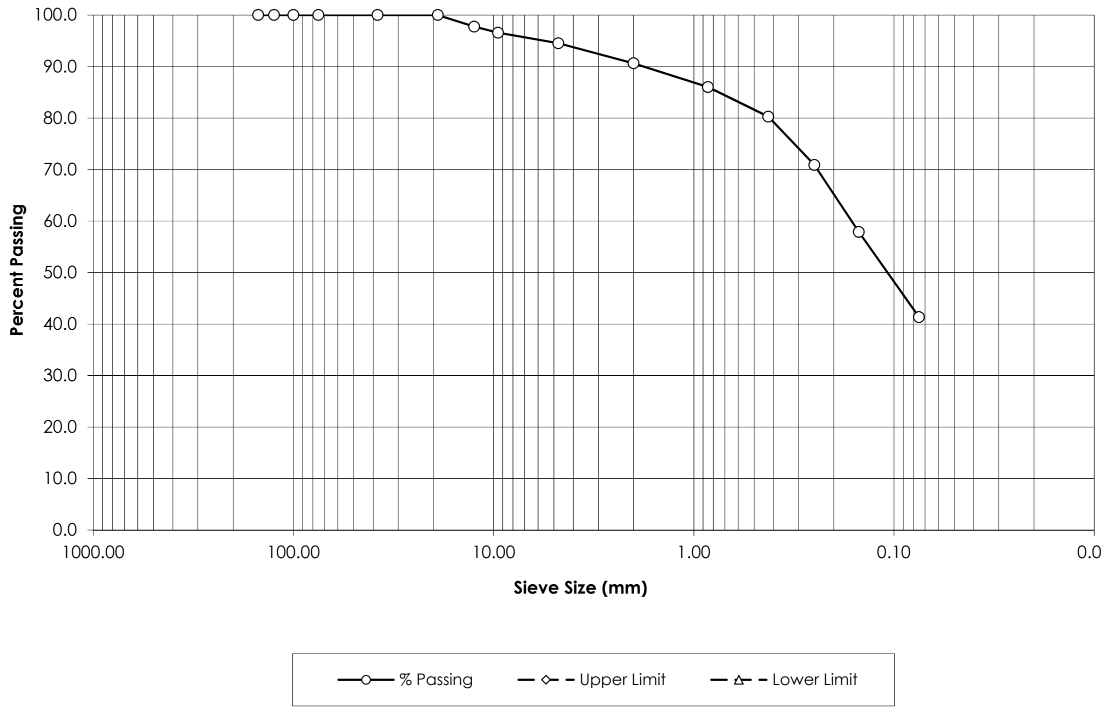
ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE	LABORATORY
4730 Kingsway	3711 North Fraser Way
Suite 500	Suite 400
Burnaby, BC	Burnaby, BC
Canada V5H 0C6	Canada V5J 5J2
Tel: (604) 436-3014	Tel: (604) 436-3014

SAMPLE No.: SS-8
SOURCE: BH17-14
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: silty SAND



Sieve (mm)	Sample % Passing	Specifications	
		Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**100.0**	-	-
12.5	**97.8**	-	-
9.5	**96.6**	-	-
4.75	**94.5**	-	-
2.00	**90.6**	-	-
0.85	**86.0**	-	-
0.425	**80.3**	-	-
0.250	**70.9**	-	-
0.150	**57.9**	-	-
0.075	**41.3**	-	-

Cobble:	0.0%	D_{10}:	-
Gravel:	5.5%	D_{30}:	-
Sand:	53.2%	D_{60}:	0.1677
Fines:	41.3%	C_U:	-
		C_C:	-

Comments:

Reviewed by: CH

Stantec

Grain Size Analysis

ASTM C136, ASTM C117

Client: CRD
Project Name: CRD Clover Point Forcemain
Project No: 111700431

OFFICE
4730 Kingsway
Suite 500
Burnaby, BC
Canada V5H 0C6

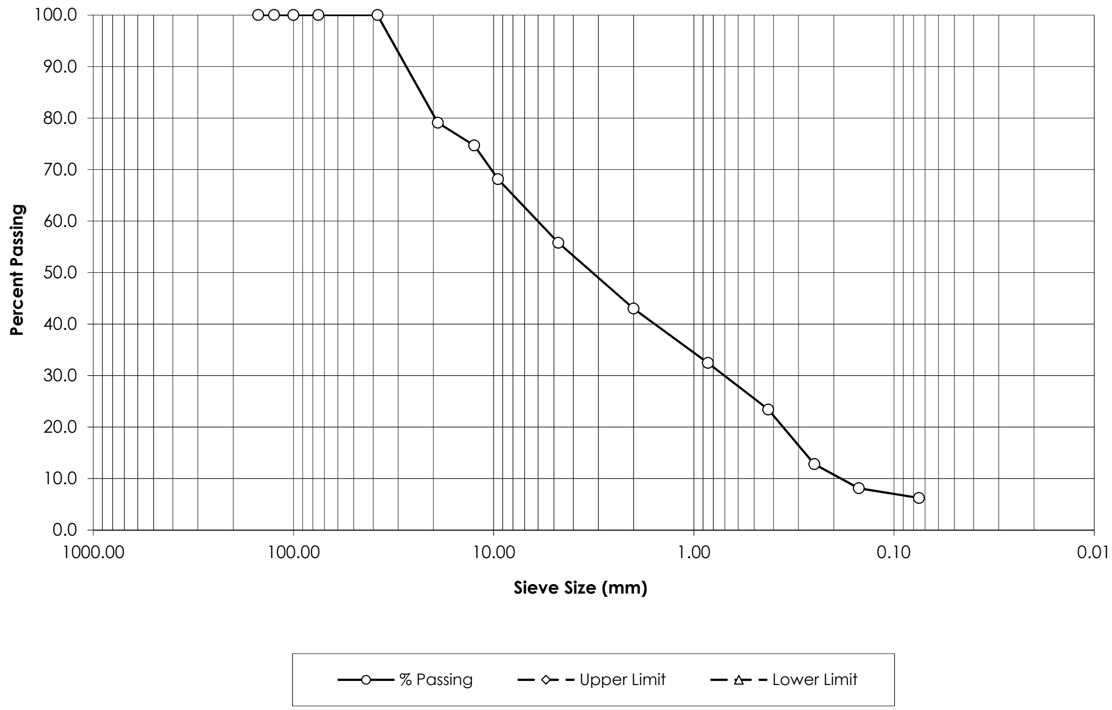
Tel: (604) 436-3014

LABORATORY
3711 North Fraser Way
Suite 400
Burnaby, BC
Canada V5J 5J2

Tel: (604) 436-3014

SAMPLE No.: GS-1
SOURCE: BH17-21
TESTED BY: JN/JW

DATE RECEIVED: July 1, 2017
DATE TESTED: July 12, 2017
SAMPLE DESCRIPTION: well-graded SAND with silt and gravel



Sieve (mm)	Sample % Passing	Specifications	
		Lower	Upper
150.0	**100.0**	-	-
125.0	**100.0**	-	-
100.0	**100.0**	-	-
75.0	**100.0**	-	-
38.0	**100.0**	-	-
19.0	**79.1**	-	-
12.5	**74.7**	-	-
9.5	**68.1**	-	-
4.75	**55.8**	-	-
2.00	**43.0**	-	-
0.85	**32.5**	-	-
0.425	**23.4**	-	-
0.250	**12.8**	-	-
0.150	**8.1**	-	-
0.075	**6.2**	-	-

Cobble:	0.0%	D_{10}:	0.1958
Gravel:	44.2%	D_{30}:	0.7478
Sand:	49.6%	D_{60}:	6.4836
Fines:	6.2%	C_u:	33.11
		C_c:	0.44

Comments:

Reviewed by: CH

D.3 PH, CONDUCTIVITY AND SULPHATE CONTENT

Your Project #: 111700431
Your C.O.C. #: 08441649

Attention:James Woo

STANTEC CONSULTING LTD
Metrotower III
Suite 500, 4730 Kingsway
BURNABY, BC
CANADA V5H 4M1

Report Date: 2017/07/21
Report #: R2416435
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B757836
Received: 2017/07/13, 17:03

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Conductivity (Soluble)	6	2017/07/20	2017/07/20	BBY6SOP-00029	SM 22 2510 B
pH (Soluble)	6	2017/07/20	2017/07/20	BBY6SOP-00025	SM 22 4500-H+ B
Saturated Paste	6	2017/07/20	2017/07/20	BBY6SOP-00030	BC Lab Manual 2015
Sulphate (soluble) (soil)	6	2017/07/20	2017/07/21	BBY6SOP-00017	SM 22 4500-SO42- E m
Soluble Sulphate (SO4) Ion Calc. (mg/kg)	6	N/A	2017/07/21	BBY WI-00033	Auto Calc

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 111700431
Your C.O.C. #: 08441649

Attention:James Woo
STANTEC CONSULTING LTD
Metrotower III
Suite 500, 4730 Kingsway
BURNABY, BC
CANADA V5H 4M1

Report Date: 2017/07/21
Report #: R2416435
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B757836
Received: 2017/07/13, 17:03

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
VJ Oco, Burnaby Project Manager
Email: VOco@maxxam.ca
Phone# (604)639-8422
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B757836
Report Date: 2017/07/21

STANTEC CONSULTING LTD
Client Project #: 111700431
Sampler Initials: CH

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		RM8872		RM8873	RM8873		RM8874		
Sampling Date									
COC Number		08441649		08441649	08441649		08441649		
	UNITS	**BH17-13, SS-04**	**RDL**	**BH17-22, GS-02**	**BH17-22, GS-02 Lab-Dup**	**RDL**	**BH17-17, GS-05**	**RDL**	**QC Batch**
ANIONS									
Soluble Sulphate (SO4)	mg/L	27	10	<10	<10	10	12	10	8702801
Calculated Parameters									
Soluble Sulphate (SO4)	mg/kg	15.7	5.8	<4.3		4.3	10.7	8.9	8694856
Soluble Parameters									
Soluble Conductivity	uS/cm	1060	1.0	165	163	1.0	130	1.0	8700722
Soluble pH	pH	6.58	N/A	7.64	7.63	N/A	7.46	N/A	8700721
Saturation %	%	57.9	N/A	42.6	42.6	N/A	89.0	N/A	8700710

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Maxxam ID		RM8875		RM8876		RM8877		
Sampling Date								
COC Number		08441649		08441649		08441649		
	UNITS	**BH17-08, GS-03**	**RDL**	**BH17-05, GS-03**	**RDL**	**BH17-02, GS-04**	**RDL**	**QC Batch**
ANIONS								
Soluble Sulphate (SO4)	mg/L	61	10	186	10	37	10	8702801
Calculated Parameters								
Soluble Sulphate (SO4)	mg/kg	41.0	6.7	120	6.4	22.9	6.1	8694856
Soluble Parameters								
Soluble Conductivity	uS/cm	613	1.0	1590	1.0	264	1.0	8700722
Soluble pH	pH	7.14	N/A	6.27	N/A	7.68	N/A	8700721
Saturation %	%	66.7	N/A	64.4	N/A	61.3	N/A	8700710

RDL = Reportable Detection Limit
N/A = Not Applicable

GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**% Recovery**	**QC Limits**
8700710	Saturation %	2017/07/20					0	%	0.017	30	107	75 - 125
8700721	Soluble pH	2017/07/20			100	97 - 103			0.13	N/A	102	97 - 103
8700722	Soluble Conductivity	2017/07/20			98	80 - 120	<1.0	uS/cm	1.2	35		
8702801	Soluble Sulphate (SO4)	2017/07/21	123	75 - 125	105	80 - 120	<10	mg/L	NC	30	116	75 - 125

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

Maxxam Job #: B757836
Report Date: 2017/07/21

STANTEC CONSULTING LTD
Client Project #: 111700431
Sampler Initials: CH

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Ph.D., P.Chem., Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.