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May 8, 2017
File: 1873-004.01

Alberta Environment and Parks
Suite 100, 3115 12 St. NE
Calgary, Alberta T2E 7J2

Attn: David DePape – FISHES Program Manager

Dear David,

Re: Final Design Report and Design Drawings for the Bioengineering Demonstration and Education Project

Hemmera Envirochem Inc. is pleased to provide you with this final copy of the Final Design Report and Design Drawings for the Bioengineering Demonstration and Education Project. We appreciate the feedback received from yourself and the City of Calgary on the Preliminary version of this report. We have addressed your comments and incorporated your requested changes in the attached report.

We have appreciated the opportunity to work with you on this project and trust that this report meets your requirements. Please feel free to contact the undersigned by phone or email regarding any questions or further information that you may require.

Regards,
Hemmera Envirochem Inc.

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Project Leader
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Bioengineering Demonstration and Education Project

Final Design Report

May 8, 2017
KWL Project No. 3552.004-300

Prepared for:

Hemmera Envirochem Inc.

HEMMERA

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1. Introduction

Alberta Environment and Parks (AEP) in conjunction with The City of Calgary (The City) retained a project team composed of Hemmera Envirochem Inc. (Hemmera), Kerr Wood Leidal Associates Ltd. (KWL), O2 Planning + Design Inc. (O2), Terra Erosion Control Ltd. (Terra), Polster Environmental Services Ltd. (Polster), RiverWatch, and Thurber Engineering Ltd. (Thurber) for the Bioengineering Demonstration and Education Project (BDEP). The main goals of the BDEP project are the following (AEP and City of Calgary, 2016):

- To achieve bank protection, fish habitat enhancement and riparian restoration at flood affected sites on the Bow River in the vicinity of the Cushing Bridge crossing using a variety of appropriate bioengineering techniques;
- To integrate education opportunities and objectives to facilitate and increase the understanding of a range of identified audiences that bioengineering techniques are an effective and ecologically valuable alternative to conventional bank erosion and riparian restoration practices; and
- To provide ongoing biophysical monitoring in order to compare and demonstrate the effectiveness of the various bioengineering techniques used to meet the projects slope stabilization, flood protection, and fish habitat and riparian area improvement.

A Conceptual Design Brief Document was provided to AEP and The City by Hemmera in October 2016 that summarized the site assessment and baseline condition characterization, the conceptual general arrangement of the proposed bioengineered bank protection and associated fish habitat enhancements, the results of the Concept Design Workshop, and the proposed education plan (Hemmera, 2016). This memorandum provides a summary of the analysis and final design of the works associated with bank protection, fish habitat enhancement and riparian restoration of the Bow River in the vicinity of the Cushing Bridge crossing in the historic community of Inglewood, Calgary.

1.1 Project Scope

The scope of the engineering and bioengineering design components of the BDEP included the following:

- Site assessment and issues identification including a riverbank and channel bathymetry survey,
- 1-D and 2-D hydraulic analysis,
- Geomorphic assessment,
- Conceptual Design Brief and Class 5 cost estimate,
- Geotechnical evaluation (desktop) and investigation (borehole drilling program),
- Preliminary Design Report (PDR) and Class 3 cost estimate,
- Erosion and Sediment Control Plan preparation,
- Detailed design and Class 1 cost estimate,
- Construction schedule preparation,
- Technical Report preparation,
- Contract Document preparation, and
- Construction inspections.

The extent of the scope of work originally covered five (5) sites on the Bow River near the Cushing Bridge crossing. The scope of work was subsequently amended by AEP and The City in December 2016 to only include Sites 1, 2, and 4 (see Section 1.2.1 Project Sites for site descriptions).

1.2 Project Setting

The BDEP is located on the Bow River in the community of Inglewood, Calgary as shown in Figure 1-1. The project includes 940 m of the right downstream bank of the Bow River and floodplain, and extends 250 m upstream to 640 m downstream of the Cushing Bridge. The 2013 flood event resulted in bank regression primarily at the downstream end of the project (Golder, 2014b; KWL, 2016), 240 m of the bank was reconstructed as part of the City of Calgary 2013 flood recovery efforts; however, the bank in the remainder of the site was left largely intact during the flood with the exception of local and surficial erosion due to vegetation loss (e.g., tree uprooting).

Key infrastructure located within the project extents includes the following as shown in Figure 1-1:

- Cushing Bridge,
- City of Calgary Fire Department Emergency Boat Launch (boat launch),
- Regional Pathway (3 m to 4 m wide asphalt pathway),
- Stormwater outfalls B-10A, B-10, B-9,
- Existing riprap bank protection and two (2) riprap groynes built in 2013- 2014,
- Sports fields and associated irrigation system and park lands,
- Underground infrastructure including water, sanitary and stormwater mains, gas lines, telecommunication lines,
- Overhead power lines, and
- Groundwater monitoring wells.

A new crossing of the Bow River is slated as part of the 17 AVE SE Bus Rapid Transit (SE BRT) Project (to be constructed by the City of Calgary under Code of Practice [CoP] No. 00388314). The bridge crossing will be located on the south side of the Cushing Bridge. Responsibility for the bridge and abutment design including bank armor will fall under the CoP and is out of scope of this application. Bioengineering treatments will be applied to the BRT works once in place. Only the bioengineering treatments fall under this application. Coordination between the SE BRT Project and the BDEP has been ongoing during the design phases and will continue into construction phases of the projects.

It should be noted that existing stormwater outfalls, existing riprap bank protection and two (2) riprap groynes built in 2013- 2014, and abutments and protection riprap for the proposed BRT bridge will not be altered or impacted as part of the BDEP project.

1.2.1 Project Sites

The BDEP includes the sites and sub-sites as shown in Figure 1-1 and described below. **Note that project sub-site extents have been modified slightly from the Concept Design Brief documentation for efficiency in communications for future phases of the project.**

- **Site 1:** The site is along the right downstream bank and adjacent to the main thalweg of the Bow River. It starts 250 m upstream of Cushing Bridge and ends at outfall B-9 at the location of an existing rock groyne. The total length of the site is 370 m. While the bank did not retreat appreciably during the 2013 flood, larger trees were uprooted exposing the existing concrete rubble riprap beneath. A deep scour hole is located at toe of the bank slightly upstream of the existing rock groyne.
    - Site 1-1: Begins at the upstream end of Site 1 and ends at the boat launch. The site is 75 m long.
    - Site 1-2: Begins at the boat launch and ends at Outfall B-10 and includes bioengineering treatments within the Cushing Bridge and the SE BRT Bridge corridors. The site is 70 m long.
    - Site 1-3: Begins at Outfall B-10 and ends at the end of the proposed vegetated timber crib wall 143 m downstream.
    - Site 1-4: Begins at the end of the proposed vegetated timber crib wall and ends at the existing riprap groyne at Outfall B-9. The site is 82 m long.

- **Site 2:** The site is along the right downstream bank of the Bow River 280 m downstream of the Cushing Bridge. It is located between existing rock groyne structures and adjacent to the main thalweg of the Bow River. The site is 120 m long. The bank receded 17 m during the 2013 flood event at this location (KWL, 2016).
    - Site 2-1: Begins at the existing riprap groyne at Outfall B-9 and ends downstream of the end of the existing bank swallow colony. The site is 65 m long.
    - Site 2-2: Begins at the end of the existing bank swallow colony and ends at an existing riprap groyne. The site is 70 m long.

- **Site 4**: Consists of existing riprap bank protection with a vegetated upper bank slope. The site is adjacent to a local road and residential housing. The site extends from the downstream groyne of Site 2 to a distance 360 m downstream where the existing bank protection ends. The vegetated upper bank slope consists of a grass mix, willow stakes, shrubs and tree plantings.
    - Site 4-1: Begins at an existing riprap groyne and ends 75 m downstream.
    - Site 4-2: Begins 75 m downstream of the existing riprap groyne and ends 145 m downstream. The site is 70 m long.
    - Site 4-3: Begins 145 m downstream of the existing riprap groyne and ends 215 m downstream. The site is 70 m long.
    - Site 4-4: Begins 215 m downstream of the existing riprap groyne and ends at the end of the existing riprap bank protection. The site is 40 m long and is considered the control site for Site 4 as there are no modifications proposed to the existing configuration.

PLAN
Scale: 1:2500

0 20 (1:2,500) 100m

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NOTE:

1. FOOTPRINT OF PROPOSED WORKS IS SHOWN. REFER TO DESIGN DRAWINGS FOR MORE DETAIL

LEGEND:

- PROPOSED EARTH WORKS SLOPE
- PROPOSED EARTH WORKS BENCH

Seal:

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP. 13/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	FEB. 07/2017	TWC	ROK	MG	UPDATED FOR PDR
C	APR. 19/2017	MG	ROK	MG	UPDATED FOR FDR

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

FIGURE 1 - 1
PROJECT SITE OVERVIEW

Project No. 3552-004 | Drawing No. | Rev. C
Group

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2. Design Considerations

2.1 Reference Information

Concept designs were advanced based on the following information:

- The site assessment and baseline characterization as described in the *Bioengineering Demonstration and Education Project Conceptual Design Brief* (Hemmera, 2016);
- Results from the fish and fish habitat assessment as described in the Qualified Aquatic Environment Specialist (QAES) Assessment (Hemmera, 2017);
- The conceptual general arrangement of the proposed bioengineered bank protection and fish habitat enhancements described in the *Bioengineering Demonstration and Education Project Conceptual Design Brief* (Hemmera, 2016);
- The results of the Concept Design Workshop as described in the *Bioengineering Demonstration and Education Project Conceptual Design Brief* (Hemmera, 2016);
- Hydrometric data recorded at Water Survey Canada Stations 05BH004 Bow River at Calgary, 05BJ001 Elbow River Below Glenmore Dam, and 05BH003 Nose Creek at Calgary;
- Peak flow estimates for the Bow River prepared by Golder Associates Ltd. (Golder) as described in the *Bow and Elbow River: Basin-Wide Hydrology Assessment and 2013 Post Flood Documentation* (Golder, 2014a) and adopted by The City;
- Design documentation for the City of Calgary 2013 Flood Recovery project in Inglewood prepared by Golder and summarized in *Bank Restoration Design for Bow River at Inglewood* (Golder, 2014b);
- 1-D (HEC-RAS) hydraulic modelling of the Bow River prepared by Golder as part of the *2015 Bow River and Elbow River Hydraulic Model* and adopted by The City (Golder, 2015);
- 2-D (River2D) hydraulic modelling of the Bow River within the project sites prepared by Golder and described in *Two-Dimensional Hydraulic Modelling of the Bow River at Inglewood* (Golder, 2014c);
- Bathymetric survey completed by KWL on July 28, 2016 and local survey (including riverbank) completed by KWL on September 26, 2016;
- Geomorphic assessment conducted by KWL and summarized in the memorandum *Bow River Bioengineering Demonstration Project Preliminary Geomorphology Assessment* (KWL, 2016);
- Preliminary geotechnical assessment conducted by Thurber and summarized in *Fisheries Habitat and Sustainability Program along the Bow River Preliminary Geotechnical Assessment* (Thurber, 2016);
- Geotechnical assessment conducted by Thurber and summarized in the draft memorandum *Fisheries Habitat and Sustainability Program along the Bow River, Calgary, AB Geotechnical Investigation – Lower Site 1 and Site 2* (Thurber, 2017);
- Wildlife corridor design recommendations as summarized by O2 in *Cushing Bridge Wildlife Corridor Design Guidelines* (O2, 2017).

- River ice processes and design considerations prepared by nhc summarized in *Implications of Ice on the Morphology of the Bow River within the City of Calgary* (nhc, 2016);
- Riparian planting recommendations provided by Rood et al. and summarized in *Analyzing and Projecting Post-Flood Vegetation Colonization along the Bow River through Calgary, Alberta* (Rood, et al., 2016)
- SE BRT Bridge hydrotechnical analysis and design by Stantec summarized in *Hydrotechnical Engineering Assessment and Recommendations for the SE BRT Transitway Extension Crossing of the Bow River* (Stantec, 2016a) and *Technical Memo 2 – SE BRT Transitway 2-Dimensional Model* (Stantec, 2016b) provided to KWL by Stantec;
- City of Calgary Floodway/Flood Fringe Maps: Section 12C-24-1-W5M and Section 13C-24-1-W5M (City of Calgary, 2014); and
- Spatial data including legal boundaries, transportation data, utility data, and aerial photographs provided by The City.

2.2 Design Basis

The design basis for the BDEP includes the considerations listed in Table 2-1.

Table 2-1: BDEP Design Basis

Design Consideration	Basis
Flood Protection	Provide the same level of flood protection or better than currently exists
Bow River Water Levels	No increase in Bow River water levels during the 100-year event. No increase in Bow River water levels during bank full conditions at the Inglewood Golf and Curling Club.
Bank Protection Top Elevation	Water level elevation for the 100-year flood event as generated by the existing, unaltered HEC-RAS model prepared by Golder for the Bow River and Elbow River
Bank Protection Design Velocity	Flow velocity for 100-year flood event as generated by the existing, unaltered River2D model prepared by Golder for the Bow River
Bank Protection Design Shear Stress	Shear stress from the 100-year flood event as generated by the existing, unaltered River2D model prepared by Golder for the Bow River
Freeboard	0.5 m as required
Bank Toe Protection Top Elevation	Vegetation trim line[1]
Bank Toe Protection Bottom Elevation	Minimum elevation down to: • Scour depth based on the 100-year flood event; or • Bedrock elevation.
Bioengineering Treatment Lowest Elevation	Vegetation trim line[1]
River Ice	Toe erosion protection to be designed to account for potential damage by ice action based on experience and observations working in the Bow River system. Vegetation to be placed above typical bank ice scour elevation.
Navigation	Avoid impacts to navigation by limiting encroachments into the Bow River to maximum 10% of the river width
Vegetation in Bioengineering Treatments	Selection of vegetation shall be native species by default unless site circumstances depict otherwise.

[1] The vegetation trim line is a naturally occurring observable line between granular bank material and vegetation that is typical of alluvial, ice-covered rivers. On the Bow River, the presence of high freeze-up levels that occur in some years tends to limit the growth of vegetation along the lower extents of the banks (nhc, 2016). Per Rood et al. (2016), the discharge threshold for perennial vegetation including small shrubs such as those used in bioengineering treatments is 250 m^3/s. Based on our experience and observations from Rood et al. (2016) , bioengineering measures typically do not survive well below the trim line. Based on the combination of site observation, survey data, and hydraulic modelling, it is estimated that the trim line corresponds to the modelled water level elevation from the Average Summer Flow (see Section 3.1.1).

Design Consideration	Basis
Live Cuttings Used in Bioengineering Treatments	Harvesting of live cuttings must occur while plants are dormant to ensure survivability when planted in bioengineering works. The dormancy period is typically from October 1 to March 31. Live cuttings can be placed in cold storage; however, harvested live cuttings must be installed by the third week of June if harvested before March 31 of the same year. Installation of live cuttings must occur while plants are dormant. Live cuttings must be harvested in the fall (after October 1) for fall construction the same year.
Fish Habitat	No net loss of fish habitat and no impacts to fish migration
Contaminated or Inappropriate Materials	Appropriate handling and disposal of contaminated or inappropriate materials such as concrete rubble.
Geotechnical	Well-draining, granular materials to be used as fill with slopes no greater than 2H:1V. Factor of safety (FOS) for deep seated failures of minimum 1.5 for long term stability per standard practice for geotechnical practitioners and the City.
Existing and Proposed Infrastructure	Infrastructure design and setbacks from underground infrastructure, roads, pathways, right-of-way's, outfalls, etc. per City of Calgary requirements and standards including the following: • The minimum cover for storm sewers shall be 1.2 meters from pipe crown to finish grade. Where minimum cover cannot be achieved, an adequate insulation design must be submitted with the DSSP for approval (City of Calgary, 2015). • Regional pathway with 4.0 m minimum for river pathways, where possible. Provide 1.0 m clear of all obstacles on both sides. Provide 3.0 m clear of all obstacles overhead. (City of Calgary, 2017) • Install a handrail where a trail is within 1 m of the top of a 2:1 slope or steeper, and the slope is greater than or equal to 1 m in depth (City of Calgary, 2017) • Apply topsoil at a minimum depth of 150 mm for seeded areas, measured at right angles to the subgrade after leveling with a tolerance of 25 mm over 2.4 m (City of Calgary, 2017). • Stormwater outfalls and function will not be impacted or altered as a result of the project. • Pre-existing riprap and groynes will not be removed, partially removed or altered with the exception of potential addition of "top dressing bioengineering materials" such as soil mix and plantings.

Design Consideration	Basis
Erosion and Sediment Control	Enable/enact erosion and sediment control (ESC) measures that limit sediment mobilization into the Bow River from construction activities. ESC measures must meet both AEP and The City of Calgary guidelines and standards. An ESC Plan is included in a separate report titled: Fish and Fish Habitat Assessment (FFHA) as the FFHA Appendix H - Erosion and Sediment Control Plan, (Hemmera, 2017) . The contractor will be required to provide their ESC Plan together with an EcoPlan prior to commencing work. In accordance with the requirements of the City of Calgary, an ESC drawing is prepared and included as Drawing G-040 of Appendix B.
Care of Water	Care of water and protection of watercourses are achieved by mitigation measures that include temporary site isolation and turbidity monitoring that must meet industry and regulatory practices, and be acceptable to AEP under the Water Act approval and DFO under the Fisheries Act approval. Included in the FFHA (a separate report) is Appendix F titled, “Environmental Monitoring Plan – Water Quality Monitoring Plan and Spawning Surveys”, provides the necessary mitigation, contingency, and response.
Existing City of Calgary Fire Department Boat Ramp	City of Calgary Fire Department requires unobstructed access to the boat ramp. Materials shall not be stockpiled and equipment shall not be stored in such a manner that may obstruct access to the boat launch. Equipment shall not be left unattended on the access road or near the boat launch in such a way that may obstruct access to the boat launch.

2.3 Bow River Floodway and Flood Fringe

The sites are located along the bank of the Bow River and within the floodway or the flood fringe as defined in The City of Calgary Floodway/Flood Fringe Mapping (City of Calgary, 2014). Relevant City of Calgary floodway/flood fringe maps are provided in Appendix A.

2.4 Bow River Restricted Access Period

Per the *Government of Alberta's Code of Practice for Watercourse Crossings* (Government of Alberta, 2013), the Bow River is a Class C watercourse with a restricted access period from May 1 to July 15 and September 16 to April 5.

2.5 Existing Vegetation Management

The approach to site demolition minimizes tree clearing and vegetation disturbance as much as possible. Tree removal is limited to only those that are necessary for the successful design and construction of the bioengineering demonstration elements. Existing trees located within or adjacent to laydown areas and access routes will be protected based on the City of Calgary Tree Protection Bylaws and a tree protection plan was prepared as part of this submission. Refer to Appendix D: Landscape Design Drawings.

2.6 Landscape Design Approach

The landscape design approach is based on natural vegetation community and colonization patterns that occur along the riparian zone of the Bow River, the natural interface between aquatic and upland habitats (Thompson & Hansen, 2002; Rood, et al., 2016). Typical vegetation patterns that exist in nearby riparian areas include shrublands adjacent to the river channel (i.e., below the water level elevation for the 5-year flood event) transitioning to balsam poplar/red-osier dogwood forest (i.e., above the water level elevation for the 5-year flood event). This natural mosaic of habitats combined with wildlife mobility requirements and the expected human use of the site formed the basis of the landscape design. Please refer to Appendix C: Wildlife Corridor Design Guidelines and Appendix D: Landscape Design Drawings.

3. Analysis

3.1 Hydrology

The sites for the BDEP are located on the Bow River downstream of the confluence with the Elbow River and Nose Creek and upstream of the confluence with Fish Creek – this reach of the Bow River is referred to as Bow River below Nose Creek (Golder, 2014a). The following Water Survey Canada (WSC) hydrometric stations are near the project sites:

- Bow River at Calgary – ID 05BH004: Located just downstream of the Reconciliation Bridge (formerly the Langevin Bridge) 3.5 km upstream of the project site, upstream of the Elbow River and Nose Creek. The available data record extends from 1911 to 2015.
- Elbow River Below Glenmore Dam – ID 05BJ001: Located 1.4 km downstream of the Glenmore Dam. The available data record extends from 1908 to 2013.
- Nose Creek at Calgary – ID 05BH003: Located near the Beddington Trail crossing. The available data record extends from 1911 to 1919 and 1972 to 1986.

The Western Irrigation District (WID) diverts flow from the Bow River upstream of the project site at Harvie Passage, but reduction in flows is not included in this assessment to be conservative.

The hydrograph for daily average flows in the Bow River below Nose Creek reach is shown in Figure 3-1. Average monthly flows for the Bow River below Nose Creek reach are shown in Figure 3-2. A flow exceedance curve based on daily average flows for the Bow River below Nose Creek reach is provided in Figure 3-3.

3.1.1 Design Low Flows

The key low flow statistics are provided in Table 3-1 and are based on daily average flow data for the Bow River, Elbow River and Nose Creek as prepared by WSC.

Table 3-1: Bow River Design Low Flows

Flow Statistic	Bow River below Nose Creek (m^3/s)
Average Summer Flow (Average of June, July and August flows)	195
Annual Average Flow	99
September Average Monthly Flow	96
99th Percentile Flow[1]	46.4

Note:
[1] Based on daily average flow data shown in Figure 3-1.

3.1.2 Design Peak Flows

Per guidance by AEP and The City, design peak flows for the BDEP are taken from the *Bow River and Elbow River Basin-Wide Hydrology Assessment and 2013 Flood Documentation* report by Golder Associates (Golder, 2014a). Design peak flows for several return periods are provided in Table 3-2.

Table 3-2: Bow River Design Peak Flows

Return Period (year)	Bow River below Nose Creek (m^3/s)
2	439
5	816
8	1060
10	1180
20	1540
35	1910
50	2210
75	2640
100	2910
200	3650
350	4330
500	4820
1000	5920

Note:
Source: Golder. 2014. Bow River and Elbow River Basin-Wide Hydrology Assessment and 2013 Flood Documentation

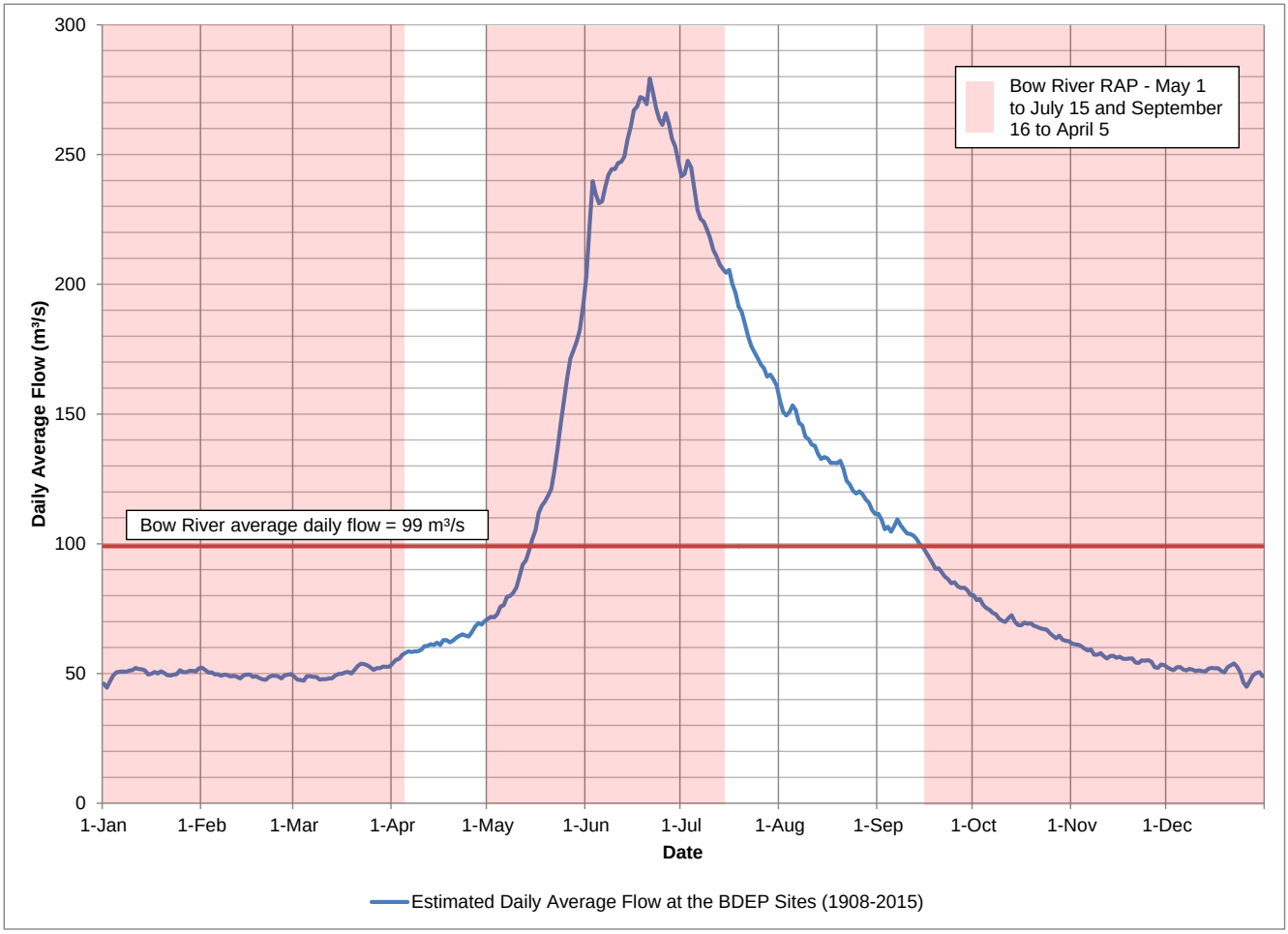


Figure 3-1: Daily Average Flow in the Bow River below Nose Creek
(Note: Daily Bow River below Nose Creek flows were generated by adding daily average flows for WSC stations 05BH004, 05BJ001, and 05BH003 for each calendar day)

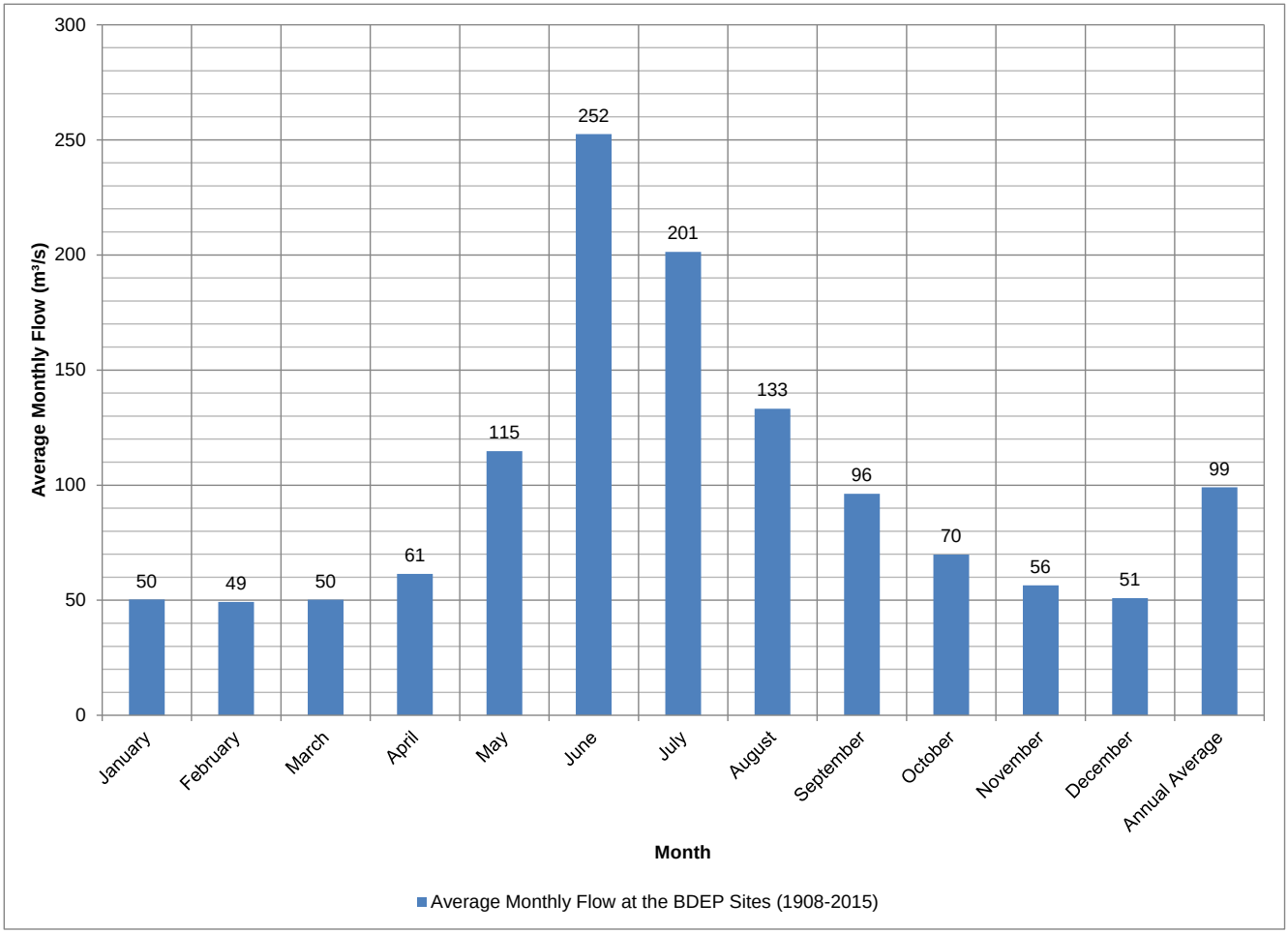


Figure 3-2: Average Monthly Flows for the Bow River below Nose Creek
(Note: Monthly Bow River below Nose Creek flows were generated by adding average monthly flows for WSC stations 05BH004, 05BJ001, and 05BH003 for each calendar month.)

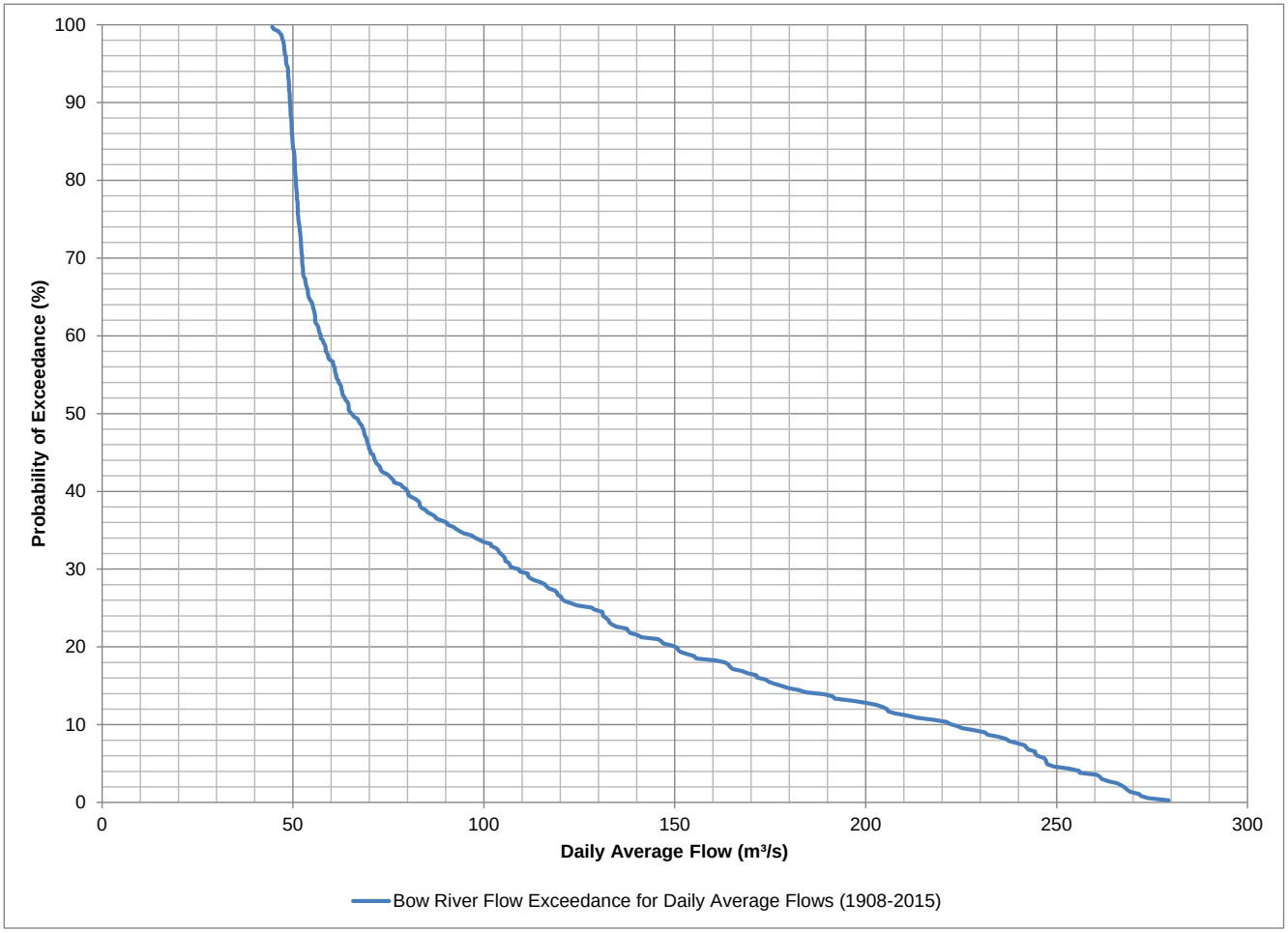


Figure 3-3: Flow Exceedance Curve for Daily Average Flows on the Bow River below Nose Creek
(Note: The flow exceedance curve was generated using the daily average flows for the Bow River below Nose Creek)

3.2 Hydraulic Modelling

3.2.1 Model Setup

Hydraulic modelling for the Bow River BDEP utilized a subset of the existing city-wide HEC-RAS model developed by Golder (2014c) to simplify modelling due to the large size of the existing model. The model subset extends from the Western Headworks Diversion Weir to 3.5 km downstream adjacent the Inglewood Bird Sanctuary as shown in Figure 3-4.

Flows from the appropriate reach of the original model were applied at the upstream end. Bow River low flow rates used in the model are summarized in Table 3-1. Bow River peak flow rates used in the model are summarized in Table 3-2. Upstream and downstream boundary conditions for the model subset were set to match the water level results from the original model.

Manning's roughness coefficients used in the original model within the project site were as shown in Table 3-3. These values were not changed in the model used for this project.

Table 3-3: Manning's Roughness Values from Original Model

Ground Cover Type	Manning's n
Active channel areas	0.0399
Developed/landscaped overbank areas	0.040002
Natural overbank areas	0.050001
Source: *2015 Bow River and Elbow River Hydraulic Model* (Golder, 2015)	

3.2.2 Model Scenarios

Two (2) scenarios were modelled to assess the cumulative hydraulic effects of the proposed changes to the riverbank geometry and roughness that are associated with the proposed works. For both scenarios, the cross-section geometry was updated within the footprint of the proposed constructed works to accurately represent the proposed finished ground bank geometry. There is no difference in proposed finished ground bank geometry between the two modelled scenarios. The two scenarios applied different Manning's roughness coefficients to the proposed bioengineering treatment areas to investigate the sensitivity of the model results to this parameter. The scenarios generally correspond with the following:

- Scenario 1 – represents conditions immediately after construction where there is little vegetation growth in the bioengineering treatments.
- Scenario 2 – represents long-term conditions where there is full growth of the vegetation included in the bioengineering treatments.

Roughness values used in the two model scenarios are summarized in Table 3-4.

Table 3-4: Manning's Roughness Values for Model Subset

Ground Cover Type	Manning's Roughness	
	Scenario 1[1]	Scenario 2[2]
Active channel areas (generally Class 2 riprap)	0.0399	0.0399
Overbank areas with proposed grass cover or hardscaping	0.040002	0.040002
Overbank areas with proposed bioengineering treatments	0.050001	0.055

Notes:
[1] This scenario represents conditions immediately after construction where there is little growth of the vegetation incorporated in the bioengineering treatments.
[2] This scenario represents some time in the future where there is full growth of the vegetation incorporated in the bioengineering treatments.

3.2.3 Model Results

Modelling results showing water level change from the existing conditions for the 100-year, 10-year, 5-year and 2-year flood flows are provided in Table 3-5, Table 3-6, Table 3-7, and Table 3-8 respectively. The 100-year flood event was selected as the design water level elevation. The 10-year event represents the situation where water levels are expected to exceed the bank elevation at the Inglewood Golf and Curling Club based on inundation mapping by Golder (Golder, 2014c). The 5-year event was selected to represent the bank full condition based on inundation mapping by Golder (Golder, 2014c). The water level elevation for the 2-year flood event is commonly used by regulators to define the high water mark. Results are provided for each of the two (2) scenarios described above (see Section 3.2.2).

The proposed works result in minimal water level change for either scenario over the range of flood flows modelled. Changes in water levels reach 0.02 m during the 100-year, 10-year and 5-year flood event at Site 1-2 or in the section(s) immediately upstream. Otherwise, where there is a change in water level, it is restricted to 0.01 m. No impact is expected to upstream or neighbouring properties due to the minor increase in water levels.

Also, it is expected that any minor change in water levels due to the proposed works will be overwhelmed by the changes in water levels due to the proposed SE BRT Bridge. Per the results from the hydraulic modelling for the SE BRT Bridge (Stantec, 2016a), water levels are expected to increase 0.07 m upstream of the proposed bridge and 0.02 m immediately downstream.

Table 3-5: Hydraulic Modelling Results - 100-Year Flood Event

Project Area	River Station (HEC-RAS)	Water Surface Elevation (m)			Difference from Original Model (m)[1]	
		Original Model	Scenario 1	Scenario 2	Scenario 1[2]	Scenario 2[3]
Upstream of project	45235.17	1039.02	1039.02	1039.02	0.00	0.00
	45190.07	1037.93	1037.93	1037.94	0.00	0.01
	45104.63	1037.82	1037.83	1037.83	0.01	0.01
	44792.97	1037.00	1037.00	1037.01	0.00	0.01
	44456.87	1036.45	1036.46	1036.47	0.01	0.02
Site 1-2	44309.26	1036.01	1036.02	1036.03	0.01	0.02
Cushing Bridge						
Site 1-2	44264.89[4]	1035.72	1035.73	1035.74	0.01	0.02
Site 1-3	44138.52[4]	1035.59	1035.60	1035.60	0.01	0.01
Site 2	43980.16[4]	1035.45	1035.46	1035.46	0.01	0.01
Site 4	43808.40[4]	1035.10	1035.10	1035.11	0.00	0.01
Downstream of project	43657.23[4]	1034.95	1034.95	1034.95	0.00	0.00
	43493.01[4]	1034.63	1034.63	1034.63	0.00	0.00
	43271.91[4]	1034.21	1034.21	1034.21	0.00	0.00
	43115.08[4]	1033.96	1033.96	1033.96	0.00	0.00

Notes:
[1] Underlined data show increases in water levels above the existing conditions based on the modelling parameters and channel geometry assigned for each scenario.
[2] This scenario represents conditions immediately after construction where there is little growth of the vegetation incorporated in the bioengineering treatments.
[3] This scenario represents some time in the future where there is full growth of the vegetation incorporated in the bioengineering treatments.
[4] This section cuts through the Inglewood Golf and Curling Club where water levels exceed the bank elevation during the 10-year flood event.

Table 3-6: Hydraulic Modelling Results – 10-Year Flood Event

Project Area	River Station (HEC-RAS)	Water Surface Elevation (m)			Difference from Original Model (m)[1]	
		Original Model	Scenario 1	Scenario 2	Scenario 1[2]	Scenario 2[3]
Upstream of project	45235.17	1037.45	1037.45	1037.45	0.00	0.00
	45190.07	1035.75	1035.75	1035.75	0.00	0.00
	45104.63	1035.54	1035.55	1035.55	0.01	0.01
	44792.97	1034.84	1034.84	1034.85	0.00	0.01
	44456.87	1034.39	1034.40	1034.41	0.01	0.02
Site 1-2	44309.26	1034.25	1034.26	1034.26	0.01	0.01
Cushing Bridge						
Site 1-2	44264.89[4]	1034.18	1034.19	1034.19	0.01	0.01
Site 1-3	44138.52[4]	1034.08	1034.09	1034.09	0.01	0.01
Site 2	43980.16[4]	1033.94	1033.95	1033.95	0.01	0.01
Site 4	43808.40[4]	1033.54	1033.54	1033.54	0.00	0.00
Downstream of project	43657.23[4]	1033.33	1033.33	1033.33	0.00	0.00
	43493.01[4]	1033.00	1033.00	1033.00	0.00	0.00
	43271.91[4]	1032.61	1032.61	1032.61	0.00	0.00
	43115.08[4]	1032.24	1032.24	1032.24	0.00	0.00

Notes:
[1] Underlined data show increases in water levels above the existing conditions based on the modelling parameters and channel geometry assigned for each scenario.
[2] This scenario represents conditions immediately after construction where there is little growth of the vegetation incorporated in the bioengineering treatments.
[3] This scenario represents some time in the future where there is full growth of the vegetation incorporated in the bioengineering treatments.
[4] This section cuts through the Inglewood Golf and Curling Club where water levels exceed the bank elevation during the 10-year flood event.

Table 3-7: Hydraulic Modelling Results - 5-Year Flood Event

Project Area	River Station (HEC-RAS)	Water Surface Elevation (m)			Difference from Original Model (m)[1]	
		Original Model	Scenario 1	Scenario 2	Scenario 1[2]	Scenario 2[3]
Upstream of project	45235.17	1036.93	1036.93	1036.93	0.00	0.00
	45190.07	1035.05	1035.05	1035.05	0.00	0.00
	45104.63	1034.86	1034.86	1034.87	0.00	0.01[5]
	44792.97	1034.15	1034.15	1034.15	0.00	0.00
	44456.87	1033.72	1033.73	1033.73	0.01	0.01
Site 1-2	44309.26	1033.60	1033.61	1033.62	0.01	0.02
Cushing Bridge						
Site 1-2	44264.89[4]	1033.55	1033.56	1033.56	0.01	0.01
Site 1-3	44138.52[4]	1033.48	1033.49	1033.49	0.01	0.01
Site 2	43980.16[4]	1033.37	1033.37	1033.37	0.00	0.00
Site 4	43808.40[4]	1033.01	1033.01	1033.01	0.00	0.00
Downstream of project	43657.23[4]	1032.76	1032.76	1032.76	0.00	0.00
	43493.01[4]	1032.45	1032.45	1032.45	0.00	0.00
	43271.91[4]	1032.10	1032.10	1032.10	0.00	0.00
	43115.08[4]	1031.77	1031.77	1031.77	0.00	0.00

Notes:
[1] Underlined data show increases in water levels above the existing conditions based on the modelling parameters and channel geometry assigned for each scenario.
[2] This scenario represents conditions immediately after construction where there is little growth of the vegetation incorporated in the bioengineering treatments.
[3] This scenario represents some time in the future where there is full growth of the vegetation incorporated in the bioengineering treatments.
[4] This section cuts through the Inglewood Golf and Curling Club where water levels exceed the bank elevation during the 10-year flood event.
[5] There are no project works at this section location. It is anticipated that the water level change shown here is a rounding error within the HEC-RAS software.

Table 3-8: Hydraulic Modelling Results - 2-Year Flood Event

Project Area	River Station (HEC-RAS)	Water Surface Elevation (m)			Difference from Original Model (m)[1]	
		Original Model	Scenario 1	Scenario 2	Scenario 1[2]	Scenario 2[3]
Upstream of project	45235.17	1039.02	1036.14	1036.14	0.00	0.00
	45190.07	1037.93	1034.12	1034.13	0.00	0.01[5]
	45104.63	1037.82	1033.94	1033.94	0.00	0.00
	44792.97	1037.00	1033.24	1033.24	0.00	0.00
	44456.87	1036.45	1032.81	1032.81	0.00	0.00
Site 1-2	44309.26	1036.01	1032.73	1032.73	0.00	0.00
Cushing Bridge						
Site 1-2	44264.89[4]	1035.72	1032.71	1032.71	0.01	0.01
Site 1-3	44138.52[4]	1035.59	1032.66	1032.66	0.00	0.00
Site 2	43980.16[4]	1035.45	1032.57	1032.58	0.00	0.01
Site 4	43808.40[4]	1035.10	1032.27	1032.27	0.00	0.00
Downstream of project	43657.23[4]	1034.95	1031.95	1031.95	0.00	0.00
	43493.01[4]	1034.63	1031.55	1031.55	0.00	0.00
	43271.91[4]	1034.21	1031.18	1031.18	0.00	0.00
	43115.08[4]	1033.96	1030.81	1030.81	0.00	0.00

Notes:
[1] Underlined data show increases in water levels above the existing conditions based on the modelling parameters and channel geometry assigned for each scenario.
[2] This scenario represents conditions immediately after construction where there is little growth of the vegetation incorporated in the bioengineering treatments.
[3] This scenario represents some time in the future where there is full growth of the vegetation incorporated in the bioengineering treatments.
[4] This section cuts through the Inglewood Golf and Curling Club where water levels exceed the bank elevation during the 10-year flood event.
[5] There are no project works at this section location. It is anticipated that the water level change shown here is a rounding error within the HEC-RAS software.

3.3 Scour

The bank protection design at Site 1 includes a toe apron to protect against toe scour, one of the most common mechanisms for bank protection failure (BC MELP, 2000). Estimated toe scour was calculated as described in the following sections.

3.3.1 Site 1

KWL bathymetry work confirmed the existence of a scour hole adjacent to Site 1-4. The Golder technical memorandum *Bank Protection Between Cushing Bridge and Outfall B09*, *Inglewood* (Golder, 2014b), indicated the scour hole lowered as much as 4.5 m during the 2013 flood. Other observations regarding the scour hole that Golder noted include the following (Golder, 2014b):

- The scour hole likely eroded to bedrock during the 2013 flood event[2].
- The scour hole is more likely to fill in with gravel sediment in the future during the next flood event where river sediment is mobilized. The 2013 flood produced a significant amount of movable sediment in the reach upstream of the Cushing Bridge.
- Expansion and migration of the scour hole is less likely after the removal of the gravel bar along the left bank and now that it is likely at bedrock.

Based on the above observations, the anticipated bed lowering (scour) at the toe of the bank where the channel has not already scoured to bedrock at Site 1 was taken to be 4.5 m, the actual event-based scour depth for the 100-year flood event on the Bow River. This is assumed to be a reasonable depth of scour given the uncertainty in the behaviour of the scour hole adjacent to the site and the change in hydraulics that will be imposed by the new SE BRT Bridge crossing.

3.3.2 Site 2

For Site 2, based on Golder's report and design results related to the riprap groynes (Golder, 2014b), it is expected that the riprap groynes will provide adequate sheltering from high flows and will minimize scour at the toe of the bank in Site 2. Based on the results presented in Golder's report (Golder, 2014b), it was deemed that toe scour protection was not required for the proposed works at Site 2.

3.3.3 Site 4

The existing riprap bank and toe scour protection will be left in place per Golder's design (Golder, 2014b). No additional analysis was conducted for Site 4.

[2] The top of the scour hole is located at elevation 1024 m based on a survey that Golder completed in 2014 and confirmed by a bathymetry survey by KWL on July 28, 2016. Thurber drilled a test hole on the top of the bank adjacent to the scour hole and reached top of bedrock at 1025.15 m; however, the bedrock that they encountered is moderately to highly weathered, extremely weak to very weak claystone (Thurber, 2017). If the bedrock elevation from the bank is projected to the scour hole location, it is possible that the top meter and a bit in the Bow River channel thalweg were eroded due the low competency of the bedrock and high turbulence and scour forces during the flood.

3.4 Rock Sizing

The following sizes/classes of rock are proposed as part of the BDEP design:

- **Class 2 Rock Riprap:** Forms the base of the wildlife corridor in Site 1-1 and Site 1-2 and the riprap apron for Site 1-3, Site 1-4, and as a bench for Site 4-1. Rock riprap is sized based on a factored maximum design velocity at Site 1 of 3.4 m/s for the 100-year flow event as generated from the existing River2D model (Golder, 2014c). Class 2 rock riprap (Alberta Transportation, 2013) was determined to be suitable using the average results from five (5) riprap sizing methods (Pilarczyk, 1990; USACE, 1991; Escarameia & May, 1992; BC MELP, 2000; Neill, 2004).
- **Riprap Bedding/Riprap Void Fill Material:** Fills the voids in the riprap to form a suitable surface for wildlife passage in the wildlife corridor at Site 1-1 and Site 1-2 and as a riprap bedding material at Site 2-2. The following available materials were checked against the proposed Class 2 rock riprap using the commonly-used Terzhagi approach (Mack, Slack & Associates, 2004) and found to be suitable to be used as riprap bedding or void-fill material:
    - Native river gravels (if approved for use by AEP Approvals, per Aggregate Policy), per grain size analysis provided by Thurber (2017) (this should be confirmed during construction as materials may change locally).
    - Native bank material (if approved for use by AEP Approvals, per Aggregate Policy), per grain size analysis provided by Thurber (2017) (this should be confirmed during construction as materials may change locally).
    - Alberta Transportation Designation 6 Class 125 mm (Alberta Transportation, 2013).
    - Alberta Transportation Designation 6 Class 80 mm (Alberta Transportation, 2013).

3.5 Ice Considerations

Based on site observations of existing conditions and recommendations in *Implications of Ice on the Morphology of the Bow River within the City of Calgary* prepared by nhc (2016), all vegetation proposed as part of the bioengineering bank protection and fish habitat enhancement measures is at or above the vegetation trim line to account for river ice processes. As discussed in Section 2.2, the vegetation trim line corresponds with the water level elevation for the Average Summer Flow of 195 m^3/s (see Section 3.1.1). Rock riprap that is sized to withstand ice processes on the Bow River is proposed for areas below the vegetation trim line.

3.6 Geotechnical Investigation

Thurber completed a site investigation for the detailed design effort. The key findings that influenced the design are as follows:

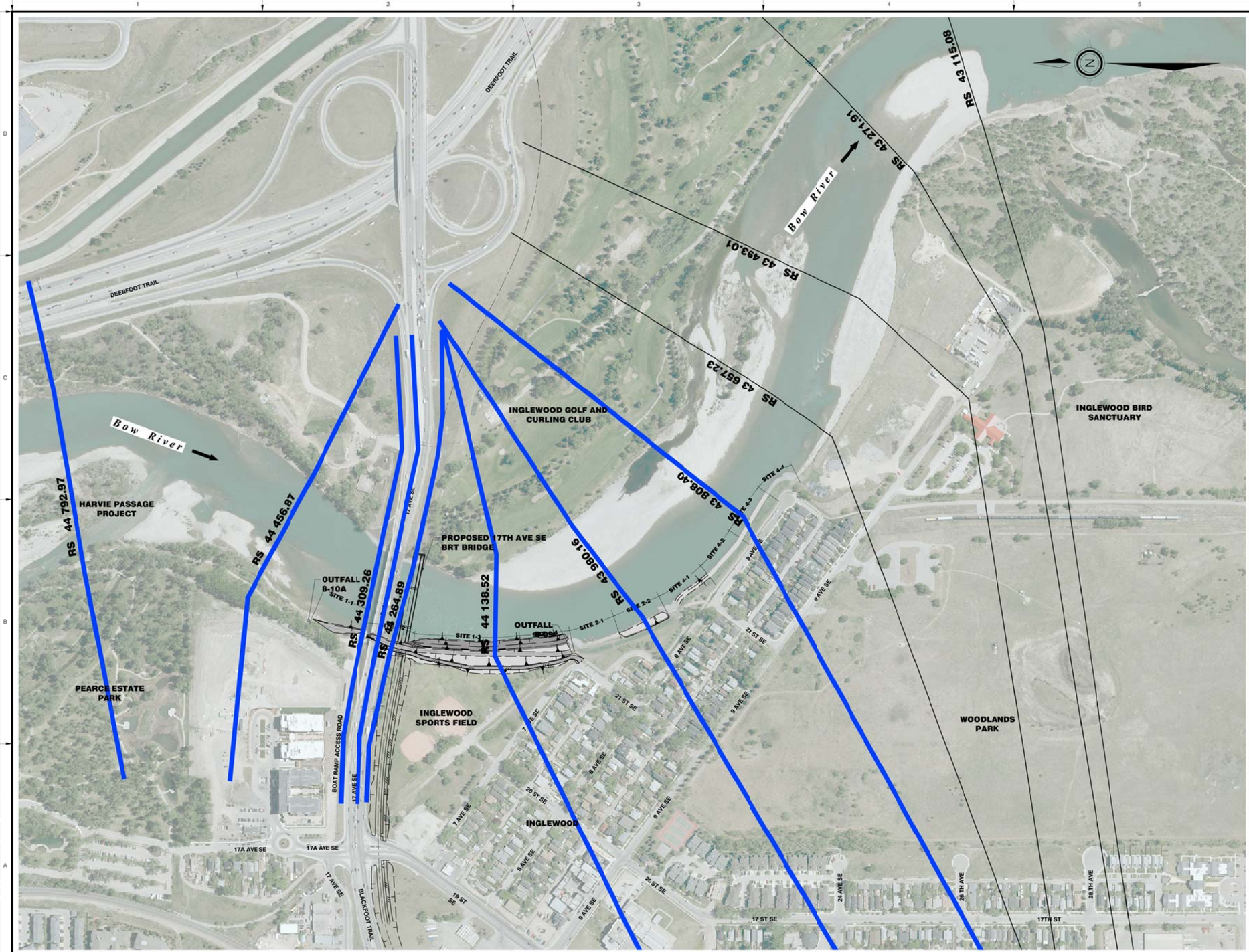
- Bank materials at Site 1 and Site 2 consisted of surficial topsoil (thickness ranging from 100 mm to 150 mm), overlying native silt or sand (thickness ranging from 0.6 m to 1.3 m), over native gravel layers (thickness ranging from 8.6 m to 12.7 m), and underlain by bedrock.
- Bedrock was observed at 12.2 m below surface at Site 1-4 (test hole no. TH16-1) (estimated by KWL to be at elevation 1025.15 m), and at 9.45 m below surface at Site 2 (test hole no. TH16-2) (estimated by KWL to be at elevation 1026.21 m).
- Grain size analysis of gravel bar materials was provided for five (5) samples. The samples have an average D_{50} of 20 mm.
- The results of slope stability analysis and global stability analysis showed that for all four (4) cases that were analyzed, a factor of safety for the terraced slope cut at Site 1-3 and Site 1-4 was above 1.5, the minimum required FOS required to ensure long term stability.

Borehole logs may be viewed on Drawing G-030 of Appendix B. Borehole locations are plotted on Drawings SW-100 and SW-200 of Appendix B.

3.7 Wildlife Passage Considerations

O2 has compiled wildlife passage considerations in the *Cushing Bridge Wildlife Corridor Design Guidelines* report (O2, 2017) that is included in Appendix C of this report. The key findings that influenced the design are as follows:

- Wildlife corridor design guidelines:
    - Minimum width of 6 m and minimum overhead clearance of 2.5 m.
    - Clear line of site through crossing.



PLAN
Scale: 1:2500

0 20 (1:2,500) 100m

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NOTES:

1. MODELING CROSS-SECTIONS SHOWN ARE FROM THE 1-D (HEC-RAS) HYDRAULIC MODEL PREPARED BY GOLDER AS PART OF THE 2015 BOW RIVER AND ELBOW RIVER MODELING PROJECT.
2. MINOR WATER LEVEL CHANGE (0.02m OR LESS) WAS OBSERVED AT THE MODELING CROSS SECTIONS HIGHLIGHTED IN BLUE DURING HYDRAULIC MODELING OF THE PROPOSED WORKS FOR THE 100-YEAR FLOOD EVENT
3. GENERAL ARRANGEMENT PRESENTED PER SITE AS IMPORTED FROM DRAWING G-010. (LEGEND OMITTED)

Seal:

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.13/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	FEB. 08/2017	TWC	ROK	MG	UPDATED FOR PDR
C	APR.19/2017	MG	ROK	MG	UPDATED FOR FDR

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

FIGURE 3-4
HEC-RAS MODEL SECTIONS

Project No. 3552-004 | Drawing No. | Rev. C
Group

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4. Proposed Design

The highest ranking concept options for each site were advanced to detailed design based on the information described in Section 2 (refer to the Concept Design Brief (Hemmera, 2016) for a detailed discussion on the process and concept design options) and the analysis described in Section 3.

The designs are based on providing rock armour extending to the vegetation trim line to protect against scour, bank erosion and ice abrasion, and various bioengineering treatments to the top of bank to provide bank protection and improve riparian, aquatic and terrestrial habitats while also improving aesthetics. Several bioengineering treatments have been included in the design to showcase a diversity of techniques applicable to each site. Human and wildlife passage are factored into the design and have highly influenced the final layout. All proposed vegetation such as live cuttings and container shrubs has been placed above the trim line.

Design drawings illustrating the design features summarized below are provided in Appendix B. More information regarding the proposed bioengineering techniques for the BDEP are provided in Section 5.

4.1 Site 1

The proposed design features for each Site 1 sub-site are described below.

4.1.1 Site 1-1

The proposed works at Site 1-1 begin immediately downstream of Outfall B-10A and end immediately upstream of the boat launch. Refer to Drawing SW-120 of Appendix B. The proposed works do not impact the existing outfall or boat launch. Key design features of Site 1-1 include the following:

- **Vegetated Wildlife Corridor**: 7 m to 8 m wide rock apron located along the river margin with a top elevation less than the water level elevation for the 2-year flood event. The vegetated wildlife corridor is necessary to facilitate 'line of sight' requirements for the restricted space available below Cushing Bridge. It is composed of Class 2 rock riprap that is covered with native river gravels to infill void-spaces between rocks and provides a surface that is suitable for wildlife passage. Live plantings are installed into the corridor surface to provide vegetation. Some excavation of native river gravels is required to maintain the apron thickness. All excavated native river gravels will be salvaged and maintained as available fish habitat through placement within the active river channel (below the 2-year flood level) as surface dressing for the placed riprap. The surface dressing provides a traversable surface for wildlife.

Typical sections for Site 1-1 are presented as Sections 1A and 1B on Drawing SW-140 of Appendix B.

4.1.2 Site 1-2

The proposed works at Site 1-2 begin at the boat launch and end at Outfall B-10. Site 1-2 is located under the Cushing Bridge and the proposed SE BRT Bridge. Proposed bioengineering design features were developed to transition to a new design surface imposed by the new BRT bridge. The BDEP design team collaborated with the SE BRT Bridge team to facilitate design integration. Items of collaboration between the teams include bridge abutment location, wildlife corridor, erosion protection design under the bridge, approach grading, and pathway alignment design.

The SE BRT Bridge will be constructed under CoP No. 00388314 and is not part of this application. The SE BRT Bridge abutment location, pathway and erosion protection design under the bridge, approach grading, and pathway alignment design fall under the responsibility of the BRT project and associated CoP notifications. Only bioengineering works (e.g. wildlife corridor) will be constructed in Site 1-2 under this application.

Refer to drawing SW-121 for the Plan-Profile. Please also refer to Typical Sections 1C and 1D on Drawings SW-140 and SW-141 of Appendix B, respectively.

Key design features of Site 1-2 include the following:

- **Vegetated Wildlife Corridor**: 6 m wide rock apron located along the river margin with a top elevation less than the water level elevation for the 5-year flood event. It is composed of a Class 2 rock riprap (Alberta Transportation, 2013) that is covered with native river gravels to infill void-spaces between rocks and provides a surface that is suitable for wildlife passage. The apron is planted with live cuttings. Much of the apron will be situated overbank as the BRT abutment has been moved inland to accommodate the wildlife corridor and regional pathway. The erosion protection works for the bridge were submitted under the CoP Notification 00388314 and are not included in the proposed works for the BDEP. Some sub-excavation may be required to provide the apron thickness and maintain 'zero' impacts. All excavated native river gravels will be salvaged and maintained as available fish habitat through placement within the active river channel (below the 2-year flood level) as surface dressing for the placed riprap.
- **Regional Pathway**: 4 m wide asphalt pathway and handrail where required under the Cushing Bridge. This portion of the regional pathway will be covered under CoP 00388314. The pathway ties into the existing pathway alignment under the Cushing Bridge and to the new alignment through Site 1-3 and Site 1-4.

4.1.3 Site 1-3 and Site 1-4

The proposed works for Site 1-3 and Site 1-4 begin immediately downstream of Outfall B-10 and end immediately upstream of the existing rock groyne at Outfall B-9. Refer to Drawing SW-121 of Appendix B. The proposed works do not impact the existing outfalls or rock groyne. Key design features of Site 1-3 and Site 1-4 include the following:

- **Riprap Toe Apron**: Self-launching apron composed of Class 2 rock riprap that varies in width from 8 m to 11 m. The apron is provided for bank toe scour protection and will be placed directly over existing riverbed materials.
- **Vegetated Timber Crib Wall**: 1.8 m wide by 1.8 m tall crib wall along the riverbank toe that is founded on Class 2 rock riprap. The top of the crib wall is designed to correspond with the water level for the 2-year flood event. The bottom of the timber crib wall corresponds to the water level elevation for the 99th percentile low flow and will most often be submerged. The timber cribs are backfilled with rock up to the water level elevation for the Average Summer Flow (corresponding to the vegetation trim line). Brush layers are then interspersed between layers of planting material wrapped in a biodegradable geotextile up to the top of the timber cribbing.
- **Vegetated Timber Crib Wall with Fish Shelters**: Same vegetated timber crib approach as above, with the exception that submerged fish habitat niches are provided below the cribbing by adding the following:
    - A continuous deck covered in non-woven geotextile along the bottom course of the cribbing to contain backfill.
    - The riprap platform for the wall is lowered and the cribs are founded on large rocks on the riverside and concrete blocks along the landside.
- **Fish Habitat Rock Spurs**: Located in front of rock boulders that support the timber crib wall. They are proposed to be 1 m high and to extend 2 m into the Bow River in a perpendicular direction to the timber crib wall.

- **Fish Habitat Boulder Clusters**: Located adjacent to the timber crib wall and habitat spurs. Consist of three (3) 1000 mm diameter boulders placed in a triangular pattern with 1000 mm spacing between boulders and pointing upstream. Proposed pacing between clusters is 10 m.
- **Vegetated Soil Wraps**: Two (2) layers of planting material wrapped in a biodegradable geotextile separated by brush layers are placed over the vegetated timber crib wall. The top of the vegetated soil wraps corresponds to the water level elevation for the 5-year flood event.
- **Brush Mattress**: Toe of live cuttings in brush mattress is keyed into a riprap toe with a top elevation set to the Average Summer Flow (corresponding to the vegetation trim line). Extends 2.0 m up the slope. Brush layers and contour fascines are placed on the cut slope above the brush mattress and below the wildlife corridor.
- **Vegetated Wildlife Corridor**: Terrace located above the vegetated soil wraps that varies in width from 6 m to 10 m. The corridor is planted with native shrubs and tree species and seeded with a native riparian seed mix per the landscape design by O2 mix (see Tables 5.2 and 5.3 for detailed species lists). Salvaged natural materials such as large woody debris are provided along the corridor as habitat for small mammals.
- **Regional Pathway**: 4 m wide asphalt pathway to follow new alignment through Site 1-3 and Site 1-4. Turf grass is proposed for the shoulder areas on either side of the pathway and the fill slope on the landside of the pathway.

For Typical Sections, refer to Sections 1-E, 1-F, 1-G, 1-H, and 1-I on Drawings SW-141 and SW-142. For the cribwell, fish shelter, and miscellaneous details, please refer to Drawings SW-143 and SW-144 of Appendix B.

4.2 Site 2

Site 2 is located between two (2) existing rock riprap groynes. Refer to Drawing SW-200 of Appendix B. The proposed design features for each Site 2 sub-site are described below.

4.2.1 Site 2-1

The proposed works at Site 2-1 begin at the existing rock groyne at Outfall B-9 and end downstream of the bank swallow colony. Refer to Drawing SW-220 of Appendix B. No bank trimming or other bioengineering measures will be placed on the bank along Site 2-1. The singular design features of Site 2-1 will include the following:

- **Box Fascine**: Placed along the toe of the bank to provide vegetated toe erosion protection. Ties into the existing riprap groyne at the upstream end of the site. The bottom elevation of the brush layer/fascine bundles corresponds with the water level elevation for the Average Summer Flow. The vegetation will not impede access and egress of swallows to the colony.

Refer to Typical Section 2A on Drawing SW-240 of Appendix B.

4.2.2 Site 2-2

The proposed works at Site 2-2 begin at the downstream limit of the bank swallow colony and end immediately upstream of the existing rock groyne. Refer to Drawing SW-220 of Appendix B. The proposed works do not impact the existing rock groyne. Key design features of Site 2-2 include the following:

- **Box Fascine**: Placed along the toe of the bank to provide vegetated toe erosion protection. Ties into the existing riprap groyne at the downstream end of the site. The bottom elevation of the brush layer/fascine bundles corresponds with 200 mm below the water level elevation for the Average Summer Flow.
- **Bank Regrade**: Regrading of the existing scoured and over-steepened slope to a uniform 2H:1V slope that is suitable for bioengineering treatments. Approved excavated materials from the bank slope flattening are also placed at the toe of the bank to raise the bank up on the landside of the box fascine. This will provide access to growing medium on the landside for the box fascine and provide a suitable planting surface for the slope treatments.
- **Slope Treatment A:** Consists of a brush mattress at the base of the slope with rows of contour fascine up the slope to the top of bank. The toe of the brush mattress is set to the water level elevation for the Average Summer Flow and abuts the live cuttings in the box fascine. The brush mattress extends 2.0 m up the slope. Spacing of contour fascine rows above the brush mattress is 2 m (slope distance). Contour fascines are provided up to the water level for the 100-year flood event. Exposed soils are covered with topsoil and seeded with native riparian species as shown in Table 5-2. The topsoil is then covered with biodegradable coir matting for the lower 2 m (corresponding with the water level for the 2-year flood event) and hydromulch for the remainder of the slope.

- **Slope Treatment B:** Consists of rows of hedge brush layers up the slope from the box fascine to the water level for the 100-year flood event. Spacing of rows is 2 m (slope distance). Exposed soils are covered with topsoil and seeded with native riparian species. The topsoil is then covered with biodegradable coir matting for the first two (2) rows of hedge brush layer (corresponding with the water level for the 2-year flood event) and hydromulch for the remainder of the slope.
- **Slope Treatment C:** Consists of dense live staking as shown in Table 5-2 (spacing of 300 mm to 400 mm) up the slope from the box fascine to the water level for the 100-year flood event. Exposed soils are covered with topsoil and seeded with native riparian species. The topsoil is then covered with biodegradable coir matting for the lower 2 m (corresponding with the water level for the 2-year flood event) and hydromulch for the remainder of the slope.

Refer to Typical Section 2B on Drawing SW-240. For Slope Treatment details, refer to Drawing SW-241 and Drawing SW-242. All drawings are in Appendix B.

4.3 Site 4

Site 4 is located at the existing riprap bank protection. Refer to Drawing SW-400 of Appendix B. Proposed design features for each Site 4 sub-site are described below.

4.3.1 Site 4-1

The proposed works at Site 4-1 tie into the existing rock groyne and end 55 m downstream. Refer to Drawing SW-420 of Appendix B. The proposed works will not impact the existing rock groyne and the existing restoration planting. Key design features of Site 4-1 include the following:

- **Soil-Covered Riprap**: Consists of a 450 mm layer of topsoil over a layer of approved general backfill placed as bedding on the existing riprap slope and on a new Class 2 riprap bench. The topsoil is planted with container shrubs, seeded with native riparian seed mix, and covered with a biodegradable erosion control blanket. A compost sock is placed at the toe of the planting area to arrest erosion of the planting medium. Planting extends down to the water level elevation for the Average Summer Flow on the riverside and up to the edge of existing vegetation on the landside.

Refer to Typical Section 4A on Drawing SW-440 of Appendix B.

4.3.2 Site 4-2

The proposed works at Site 4-2 begin at the end of Site 4-1 and end 70 m downstream. Refer to Drawing SW-420 of Appendix B. Key design features of Site 4-2 include the following:

- **Void-Filled Riprap Method A**: Consists of mechanically vibrating planting medium into the existing riprap to a depth of 1.5 m. A layer of topsoil is placed over the void-filled riprap that is seeded with native riparian seed mix and covered with hydromulch. Shrub plugs are inserted into favourable planting locations in the void-filled riprap. A compost sock is placed at the toe of the planting area to arrest erosion of the planting medium. A gravel filter is placed at the toe of the void-fill material to reduce migration of planting medium out of the riprap. Planting extends down to the water level elevation for the Average Summer Flow on the riverside and up to the edge of existing vegetation on the landside. This method is placed over 35 m of the site.
- **Void-Filled Riprap Method B**: Consists of placing a planting medium slurry into the existing riprap to a depth of 1.5 m. A layer of topsoil is placed over the void-filled riprap that is seeded with native riparian seed mix and covered with hydromulch. Shrub plugs are inserted into favourable planting locations in the void-filled riprap. A compost sock is placed at the toe of the planting area to arrest erosion of the planting medium. A gravel filter is placed at the toe of the void-fill material to reduce migration of planting medium out of the riprap. Planting extends down to the water level elevation for the Average Summer Flow on the riverside and up to the edge of existing vegetation on the landside. This method is placed over 35 m of the site.

Refer to Typical Section 4B on Drawing SW-440 of Appendix B.

4.4 Site 4-3

The proposed works at Site 4-3 begin at the downstream end of Site 4-2 and end 70 m downstream. Refer to Drawing SW-420 of Appendix B. Key design features of Site 4-3 include the following:

- **Void-Filled Riprap Method C**: Consists of mechanically vibrating mixed pitrun and topsoil into the existing riprap to a depth of 1.5 m. A layer of topsoil is placed over the void-filled riprap that is seeded with native riparian seed mix and covered with hydromulch. Live cuttings are inserted into prepared planting holes in the void-filled riprap at favourable locations. A compost sock is placed at the toe of the planting area to arrest erosion of the planting medium. A gravel filter is placed at the toe of the void-fill material to reduce migration of mixed pitrun and topsoil out of the riprap. Planting extends down to the water level elevation for the Average Summer Flow on the riverside and up to the edge of existing vegetation on the landside. This method is placed over 35 m of the site.
- **Void-Filled Riprap Method D**: Consists of placing a mixed pitrun and topsoil slurry into the existing riprap to a depth of 1.5 m. A layer of topsoil is placed over the void-filled riprap that is seeded with native riparian seed mix and covered with hydromulch. Live cuttings are inserted into prepared planting holes in the void-filled riprap at favourable locations. A compost sock is placed at the toe of the planting area to arrest erosion of the planting medium. A gravel filter is placed at the toe of the void-fill material to reduce migration of mixed pitrun and topsoil out of the riprap. Planting extends down to the water level elevation for the Average Summer Flow on the riverside and up to the edge of existing vegetation on the landside. This method is placed over 35 m of the site.

Refer to Typical Section 4C on Drawing SW-440 of Appendix B.

4.4.1 Site 4-4

Site 4-4 is proposed to be a comparison site to monitor long term changes and differences amongst the sites. No treatment is proposed for Site 4-4.

4.5 Proposed Landscape Design

The landscape design drawings are provided in Appendix D. Specific plant species were chosen based upon *Classification and Management of Riparian and Wetland Sites of Alberta's Prairie Biome* (Thompson & Hansen, 2002) and an approved planting list provided by the City of Calgary. It is expected that the landscape design will significantly improve the habitat quality of the site and improve wildlife mobility in the area.

Mature plant height was considered in the design of the wildlife corridor in order to maintain clear passage and sightlines for wildlife and humans. Shrubs adjacent to the bridge underpass will allow cover for animals approaching the structure and no large vegetation (i.e., trees) will be planted directly under or adjacent to the structure so wildlife can see through the structure to suitable habitat on the other side. Microhabitat complexity was maximized using materials salvaged from site clearing (i.e., logs, root wads, rocks, etc.) to encourage use by smaller wildlife. Vegetation, logs, stumps, rocks and elevation changes will act as barrier to separate human-use along the regional pathway from wildlife.

4.6 Proposed Laydown and Stockpile Areas

The proposed laydown and stockpile areas for the project are shown on design drawing G-040 (Appendix B) and are summarized as follows:

- Site 1 laydown and stockpile area is in an existing City of Calgary park at 616 20 ST SE that is accessed from 7 AVE SE. The park is located outside of the floodway/flood fringe area as shown in The City's Floodway/Flood Fringe Mapping (City of Calgary, 2014) (see Section 2.3). This location is also proposed for the SE BRT Project laydown and stockpile area. Ongoing coordination is occurring between the project teams with respect to parcelling the available space between the construction projects.
- A temporary laydown area for Site 1-1 is proposed to be located adjacent to the regional pathway and boat launch areas. This location is subject to the City of Calgary Fire Department requirements for access to the boat launch described in Section 2.2.
- Site 2 and 4 laydown and stockpile area is in an existing City of Calgary park at 2122 8 AVE SE that is accessed at the corner of 7 AVE SE and 21 ST SE. This park is located in the flood fringe area as shown in The City's Floodway/Flood Fringe Mapping as a result of overland flow from the 9 AVE SE/CPR underpass (City of Calgary, 2014). The construction is scheduled to occur after the flood season has passed so flood conditions at the site should not be encountered.

Laydown and stockpile areas are to be reclaimed to pre-construction or better condition.

4.7 Proposed Isolation Construction Sequence

Isolation techniques will be used at each site to protect the aquatic environment of the Bow River. Each site and technique used for isolation is described below.

4.7.1 Site 1 Isolation

Construction of Site 1 is scheduled to commence in the late summer of 2017 outside the Bow River RAP (see Section 2.4). The RAP period is September 16 to April 5 and May 1 to July 15 inclusive and is in place to protect fall spawning and eggs incubating through the winter, and spring spawning.

Instream construction activities will be targeted to be initiated outside of the RAP and as much instream work as possible will be completed outside of the RAP. Actual timing of the start of work will largely depend on the timing of the receipt of project approvals. It is, however, anticipated that some or potentially all instream construction work will extend into the RAP and therefore, appropriate mitigation measures to protect fish and fish habitat, including isolation, will be implemented. These mitigation measures are described in Appendix F of the Fish and Fish Habitat Assessment (FFHA), in the format of a separate report titled: "Environmental Monitoring Plan - Water Quality Monitoring Plan and Spawning Surveys" (Hemmera, 2017).

The method of isolation presented on the design drawings (see Appendix B) will not create fully dry conditions due to the permeability of substrates but will be designed to prevent or limit sediment from entering the Bow River. The isolation in Site 1 will involve the use of bulk bags (refer to Drawing D-102 in the design drawings) with a plastic sheeting liner and a turbidity curtain installed at the downstream extent of the bulk bag isolation wall. The bulk bags will be filled with clean granular material to prevent sediment entering the river in the event of a bag breach.

Figure 4-1 provides a sequence of construction to install and remove the proposed isolation. The figure presents two unique cross sections. The first cross-section involves a vegetated timber crib wall with fish shelters; adjacent the deep scour hole. The second cross-section involves a shallower arrangement of the same vegetated timber crib wall but without incorporated fish shelters.

The sequence of construction is described below:

Step 1 – Excavation:

- A turbidity curtain will be installed as a contingency measure extending from Outfall B-10 to the first rock groyne.
- Fish salvage operations behind the turbidity curtain will be carried out per the measures identified in the FFHA report separate from this one (Hemmera, 2017).
- Excavation of the right bank (limited to the dimensions shown on the design drawings) will be controlled by the contractor for the equipment selected[3].
- Initial excavation of the river bed outside of the RAP to the design subgrade lines shown on the drawings.

[3] The tender process can only commence following receipt of the required approvals, and the selected equipment by the contractor will only be known following receipt of tenders.

Step 2 – Construct Riprap Platform:

- Place Class 2 riprap to support initial bulk bag placement.
- Bulk bag placement will include the use of a plastic liner that will be anchored together with the bulk bag structure or held in place using clean sand bags (refer to design drawings). The turbidity curtain will remain installed.

Step 3 – Excavation of Riverbank:

- A fish salvage operation will take place prior to any further bank excavation.
- Seepage or inflow of water is anticipated during attempts to dewater or control water level behind the isolation.
- Water pumped from the excavation, as required, will be discharged to the designated contingency isolation dewatering sediment control area located immediately south of the contractor laydown/stockpile area as shown in the design drawings. Clean water will be permitted to flow back to the Bow River. Refer to Appendix B, Drawing G-040 for details.
- With the isolation in place, and under-watered conditions, excavation of the bank material will be completed.

Step 4 – Place Riprap Apron:

- Placement of Class 2 riprap to be completed:
    - First behind the isolation to permit equipment mobilization, and
    - Secondly on the river side of the isolation.
- Placement of riprap on the river side of the isolation will take place inside the RAP. Isolation cannot practically be achieved without creating a larger impact to fish and fish habitat from isolation efforts than the Project works themselves. This is due to the depth and water velocity. The turbidity curtain will be required to be removed to permit riprap placement (refer to the section below titled 'Supplemental' for proposed removal procedure). Mitigations other than isolation are proposed if work proceeds within the RAP. These mitigations measures are outlined in the FFHA report – separate from this submission - (Hemmera, 2017) and include temporarily displacing fish via a "fish scare", installing clean Class 2 riprap, carefully placing riprap by individual bucket dumps, turbidity monitoring and associated temporary work shut downs if turbidity levels exceed thresholds, spawning surveys, and having a QAES on site during all instream works within the RAP. A turbidity monitoring plan is included in the FFHA.
- The turbidity curtain will be reinstalled immediately following waterside riprap placement
- A fish salvage operation will take place after the turbidity curtain is re-established.

Step 5 – Bioengineering Bank Construction and Removal of Isolation:

- Complete the construction of bioengineering treatments.
- Once all construction is completed below the normal water level, the isolation will be removed. Appropriate sediment and erosion control measures will be implemented so that sediment and runoff from the construction site does not enter the Bow River.
- Removal of the isolation and turbidity curtain will take place inside the RAP. Given ice conditions in the winter through Site 1 adjacent to the isolation area, it is not recommended to leave the isolation in place until freeze-up due to the likelihood of failure from ice damage. As with the installation, if removal of the isolation must be done inside the RAP, additional mitigation measure will be implemented to avoid or minimize impacts to fish and fish habitat.

Supplemental:

The contractor will be required to submit a suitable Care of Water Plan detailing the construction procedure and include the following mitigation measures that are outlined in detail in the Fish and Fish Habitat Assessment (Hemmera, 2017) but will be based on the following:

- A turbidity curtain will be deployed in the Bow River along the downstream end of the isolation.
- Turbidity monitoring will occur in the Bow River during all instream activities with associated temporary work shut-downs if turbidity levels exceed thresholds. Refer to the FFHA submitted separately from this document.
- A QAES will be on site during all critical instream works outside the RAP, and onsite during all instream works within the RAP.
- Spawning surveys with implementation of additional mitigations (e.g. work stoppage) if spawning fish are observed in or adjacent to the work area. Refer to the FFHA submitted separately from this document.
- Sediment that may have been deposited within the isolated area is expected to be buried below the clean riprap and the timber crib structure during Step 4 work. Residual sediments remaining on the bulk bags will be removed by suction induced by a dewatering hose, and will be discharged to the dewatering sediment control area (see Drawing D-040 in Appendix B) until any visual evidence of sediment on the bulk bags is removed.
- Immediately prior to removal of the isolation, water within the isolation area will be tested for turbidity. If water quality is below threshold levels, then the removal will proceed. If turbidity exceeds thresholds, the area within the isolation will be dewatered by pumping and discharged to the designated contingency isolation dewatering sediment control area located immediately south of the contractor laydown/stockpile area (see Drawing D-040 in Appendix B) above the top of bank with water returning to the Bow River passing through a sediment control area. It is expected that water infiltrating the area will meet release requirements and return to the Bow River. Isolation will be removed when the water within the isolation area is within threshold levels.
- The bulk bags will be removed starting from the downstream extent and working to the upstream extent. The removal process will be temporarily halted if turbidity levels exceed thresholds.

- The turbidity curtain will be removed by first controlling the removal of the upstream anchor point so that the weighted bottom remains vertical as the upstream curtain end is transported downstream to the downstream anchor point. This is expected to result in a 'belly' developing in the curtain, being pushed to the edge of the watercourse. Then, with both ends being removed at the same time (with both top and bottom lines being secured), the turbidity curtain will be dragged on shore like a seine net. This would retain the trapped sediment through removal, which could then be placed overtop bioengineering elements as a supplemental soil amendment.
- Turbidity monitoring will be ceased once all isolation (including the turbidity curtain), has been removed.

4.7.2 Site 2 – Isolation

Site 2 is located between two existing riprap groynes. Prior to commencing construction, a turbidity curtain will be deployed to isolate the work area from river flows and prevent sediment from entering the Bow River. The turbidity curtain will be installed parallel to flow and anchored to the inside edges of the groynes, and weighted to the channel bed of the Bow River. A fish salvage will be completed prior to initiation of any works.

Turbidity monitoring in the Bow River will be completed during instream activities.

All bank trimming work is anticipated to be carried out outside the RAP including installation of box fascine posts. Installation of fascine bundles, brush layers and brush mattresses located below the normal water level will be carried out within the RAP after October 1 when the source plant materials are confirmed in dormancy (see Section 2.2). Any sediments are anticipated to concentrate at the shoreline and will be buried under bioengineering treatments including the fascine bundles, brush layers, and brush mattresses.

Additional mitigations during this period will include:

- Turbidity monitoring in the Bow River during all instream activities with associated temporary work shut downs if turbidity levels exceed thresholds.
- A QAES will be on site during all critical instream works outside the RAP and onsite during all instream works within the RAP.
- Immediately prior to removal of the turbidity curtain, water within the isolation area will be tested for turbidity. The removal will not proceed until water within the curtain (work area) is within turbidity thresholds.

Once all instream work is completed, and provided water quality readings are confirmed at background levels, the turbidity curtain will be removed.

The turbidity curtain will be removed by first controlling the removal of the upstream anchor point so that the weighted bottom remains vertical as the upstream curtain end is transported downstream to the downstream anchor point. This is expected to result in an 'belly' developing in the curtain, being pushed to the edge of the watercourse. Then, with both ends being removed at the same time (with both top and bottom lines being secured), the turbidity curtain will be dragged on shore like a seine net. This would retain the trapped sediment through removal, which could then be placed overtop bioengineering elements as a supplemental soil amendment.

4.7.3 Site 4 - Isolation

Site 4 will not involve instream work. However, as a precaution, a turbidity curtain will be deployed. The upstream end of the turbidity curtain will be anchored to the riprap groyne located between Site 2 and 4. The downstream end of the turbidity curtain will be anchored to the farthest downstream portion of the proposed works at Site 4. The turbidity curtain will be weighted to the channel bed of the Bow River between the anchor points and at appropriate intervals along the length of the isolation. A fish salvage will be completed prior to initiation of any works.

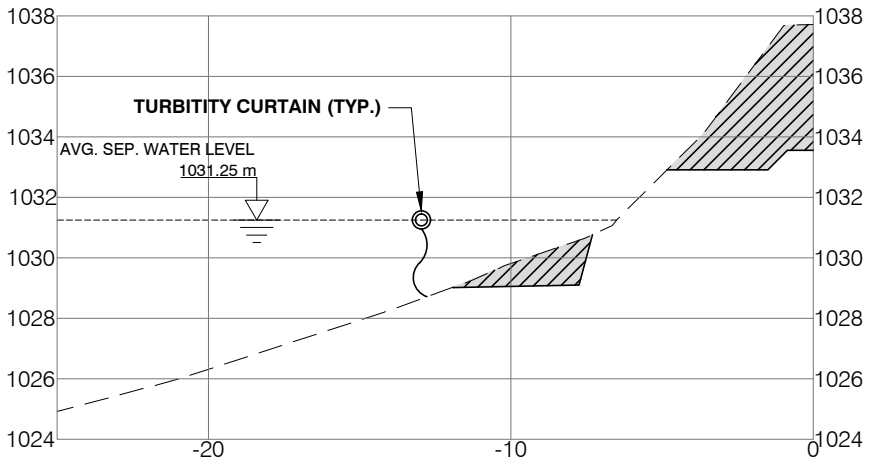
Most of Site 4 work will be completed outside the RAP; however, as mentioned above, this work is not instream. A portion of the work will be carried out inside the RAP because of the need to source and install live cuttings while the cuttings are confirmed to be in dormancy. This is anticipated to be after October 1 and installations are expected out of water.

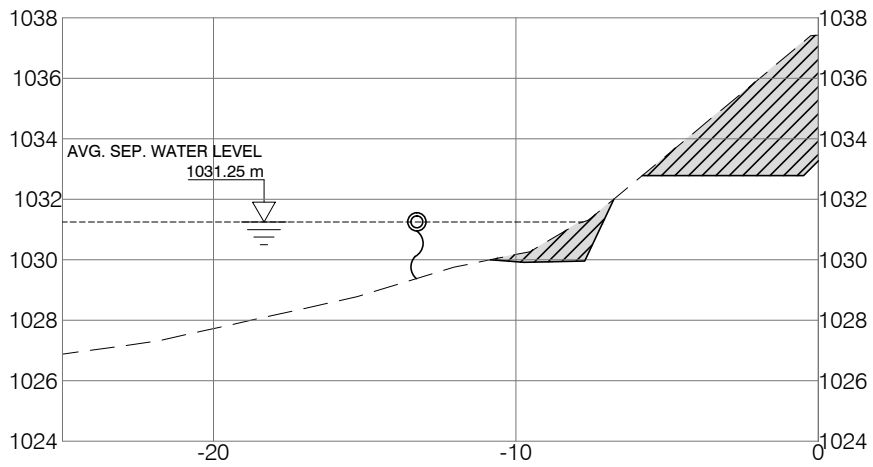
Since removal of the precautionary isolation will occur within the RAP, additional mitigations during this period will include:

- Immediately prior to removal of the turbidity curtain, water within the isolation area will be tested for turbidity. T he removal will not proceed until water within the curtain (work area) is within turbidity thresholds.
- Turbidity monitoring in the Bow River during removal activities with associated temporary work shut downs if turbidity levels exceed thresholds.
- A QAES will be on site during all critical instream works outside the RAP and onsite during all instream works within the RAP.

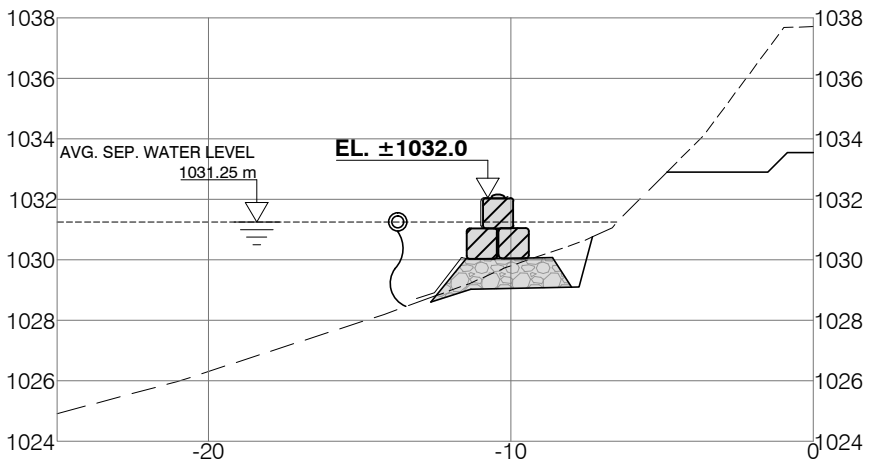
Once all work at Site 4 is completed and provided water quality readings are confirmed at background levels, the turbidity curtain will be removed.

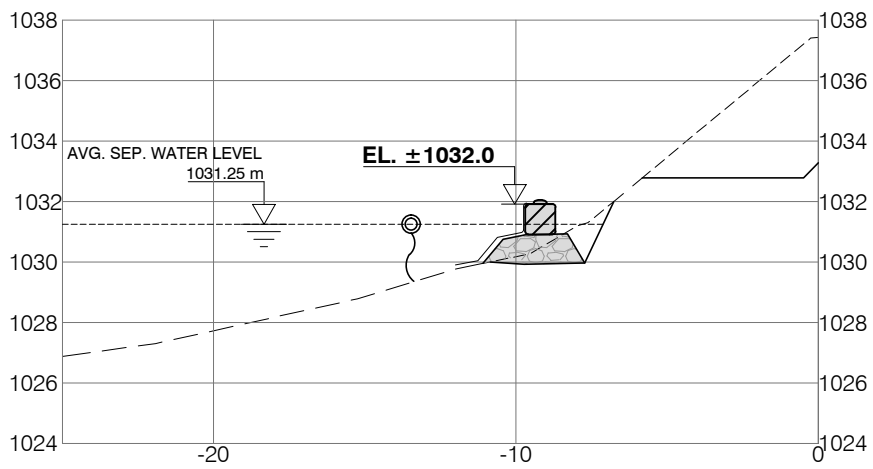
The turbidity curtain will be removed by first controlling the removal of the upstream anchor point so that the weighted bottom remains vertical as the upstream curtain end is transported downstream to the downstream anchor point. This is expected to result in an ‘belly’ developing in the curtain, being pushed to the edge of the watercourse. Then, with both ends being removed at the same time (with both top and bottom lines being secured), the turbidity curtain will be dragged on shore like a seine net. This would retain the trapped sediment through removal, which could then be placed overtop bioengineering elements as a supplemental soil amendment.



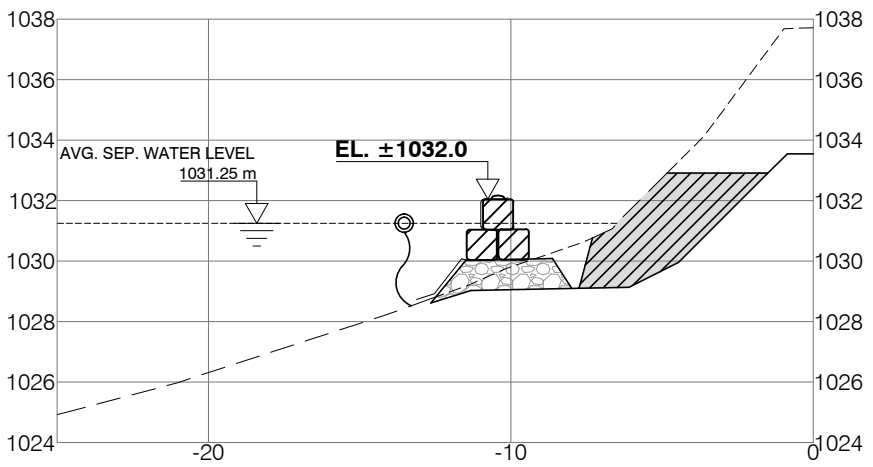


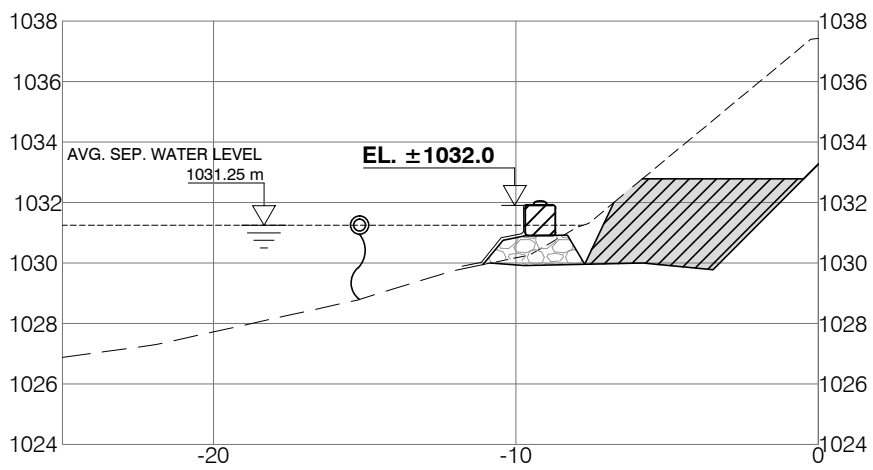
STEP 1: EXCAVATE HATCHED AREAS



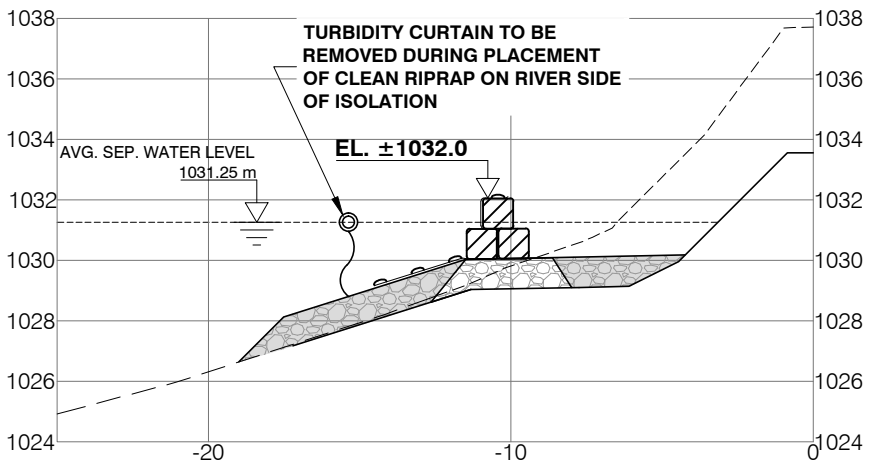


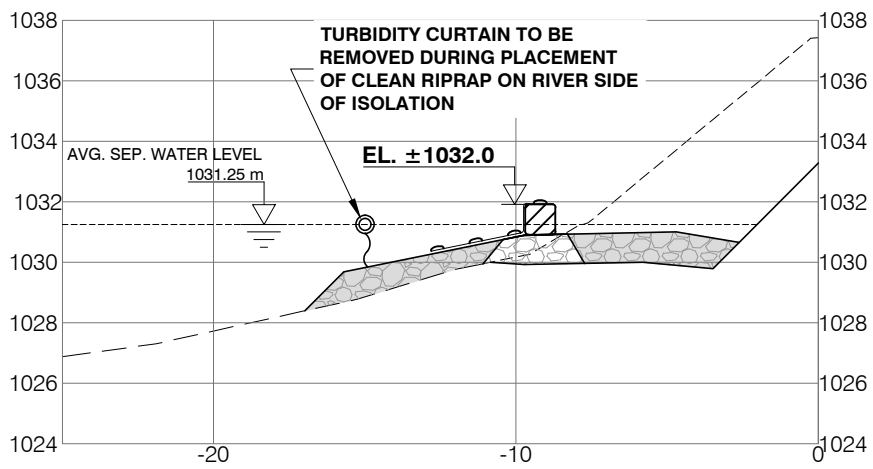
STEP 2: CONSTRUCT RIPRAP PLATFORM AND PLACE BULK BAGS ON TOP



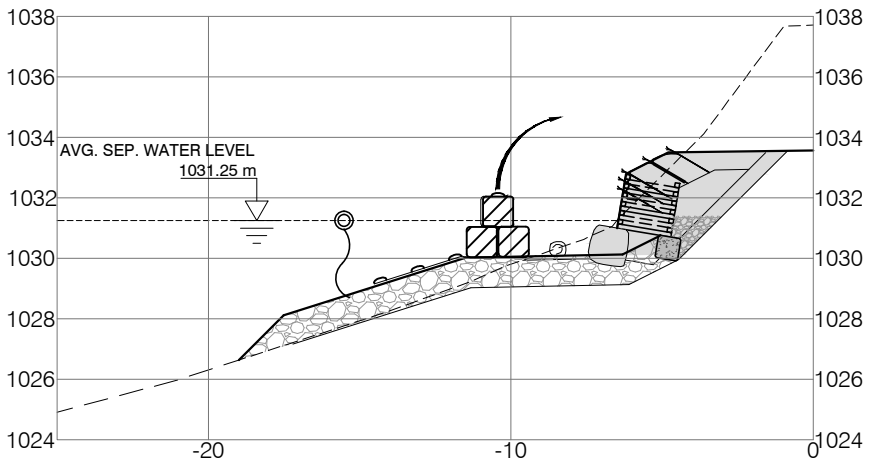


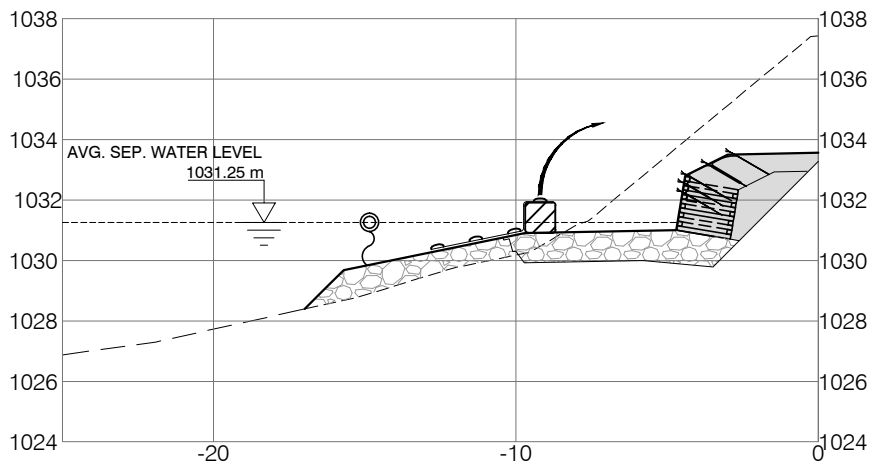
STEP 3: EXCAVATE HATCHED AREAS





STEP 4: PLACE RIPRAP ON LAND SIDE OF BULK BAGS. THEN WORKING OVER THE BULK BAGS PLACE RIPRAP APRON ON WATER SIDE





STEP 5: COMPLETE BIOENGINEERING BANK TREATMENT STRUCTURE AND THEN REMOVE BULK BAGS

ISOLATION DETAILS
VEGETATED TIMBER CRIB WALL WITH FISH SHELTERS

N.T.S.

ISOLATION DETAILS
VEGETATED TIMBER CRIB WALL

N.T.S.

KERR WOOD LEIDAL
consulting engineers

FIGURE 4-1: PROPOSED ISOLATION CONSTRUCTION SEQUENCE

5. Summary of Proposed Bioengineering Techniques

Bioengineering is the use of live materials, i.e., seeds, plants, parts of plants, and plant communities, to stabilize and protect eroded areas. A summary of the proposed bioengineering techniques incorporated into the BDEP design is provided in Table 5-1. Design drawings illustrating the bioengineering techniques summarized below are provided in Appendix B.

Table 5-1: Summary of Proposed Bioengineering Techniques in the BDEP Design

Technique Name	Description	Proposed Location
Box Fascine	Fascine bundles placed at the toe of an eroding bank and secured between wooden poles[1].	Site 2-1, Site 2-2
Brush Layer	Row(s) of live cuttings placed in a criss-cross or overlapping manner between layers of soil, with tips protruding beyond the face of the fill[2].	Site 1-3, Site 1-4 Site 2-1, Site 2-2
Brush Mattress	A layer of interlaced/adjacent live cuttings placed on the face of the riverbank[3].	Site 1-4 Site 2-2
Container Shrub Planting	Planting of container stock seedling species that are selected for beneficial attributes such as fast-growing, natural colonizer, deep rooting, nitrogen fixing, and food production[4].	Site 1-2, Site 1-3, Site 1-4 Site 2-2 Site 4-1, Site 4-2
Contour Fascine	Fascines are live cuttings that are tied together in long bundles. Contour fascines are installed in shallow trenches constructed on contour, and anchored in the trench using stakes[5].	Site 1-3, Site 1-4 Site 2-2
Live Staking	Insertion of live cuttings into the ground in such a manner as to promote root growth and leaf-out[6].	Site 1-1, Site 1-2 Site 2-2 Site 4-3
Hedge Brush Layer	A layer of interlaced/adjacent live cuttings and rooted stock placed on the face of the riverbank[7].	Site 2-2
Joint Planting	Live staking of existing riprap to improve riparian, aquatic and terrestrial habitats while also improving aesthetics[8].	Site 4-3
Native Species Seeding	Planting of native streambank/riparian species that are selected for beneficial attributes such as fast-growing, natural colonizer, deep rooting, nitrogen fixing, and food production[9].	Site 1-2, Site 1-3, Site 1-4 Site 2-2 Site 4-1, Site 4-2, Site 4-3
Soil Amendment	Application of soil amendments within bioengineering techniques will address deficiencies in soil chemistry (e.g., soil salinity, available nitrogen, phosphorus, potassium, pH, soil toxins) and will enhance the soil moisture retaining capacity[10].	All

Technique Name	Description	Proposed Location
Soil-Covered Riprap	Covering existing riprap bank protection with soil and vegetation to improve riparian, aquatic and terrestrial habitats while also improving aesthetics[11].	Site 4-1
Vegetated Soil Wraps	Consists of brush layers interspersed between layers of soil wrapped in natural geotextile materials that provides reinforcement[12].	Site 1-3, Site 1-4
Vegetated Timber Crib Wall	Consists of a hollow, box-like interlocking arrangement of structural timber, filled with suitable backfill material and layers of live cuttings[13].	Site 1-3, Site 1-4
Void-filled Riprap	Planting material inserted into void-spaces in existing riprap bank protection and planted with live cuttings or container shrub plantings to improve riparian, aquatic and terrestrial habitats while also improving aesthetics [14].	Site 4-2, Site 4-3

Sources:
[1] Streambank Erosion and Potential Remedial Measures – Guideline A (AMEC, 2012)
[2] Gray & Sotir, Biotechnical & Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control (1996); Streambank Erosion and Potential Remedial Measures – Guideline I1 (AMEC, 2012)
[3] Streambank Erosion and Potential Remedial Measures – Guideline I5 (AMEC, 2012)
[4] Streambank Erosion and Potential Remedial Measures – Guideline H and Guideline L (AMEC, 2012)
[5] Streambank Erosion and Potential Remedial Measures – Guideline I2 (AMEC, 2012)
[6] Gray & Sotir, Biotechnical & Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control (1996); Streambank Erosion and Potential Remedial Measures – Guideline H (AMEC, 2012)
[7] Schiechtl & Stern, Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection (Schiechtl & Stern, 1997); Alaska Department of Fish and Game, Streambank Revegetation and Protection: A Guide for Alaska (2005)
[8] Streambank Erosion and Potential Remedial Measures – Guideline F (AMEC, 2012)
[9] Streambank Erosion and Potential Remedial Measures –Guideline L (AMEC, 2012)
[10] Streambank Erosion and Potential Remedial Measures –Guideline M (AMEC, 2012)
[11] McCullah & Gray, Environmentally Sensitive Channel- and Bank-Protection Measures - NCHRP Report 544 (2005)
[12] Gray & Sotir, Biotechnical & Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control (1996); McCullah & Gray, Environmentally Sensitive Channel- and Bank-Protection Measures - NCHRP Report 544 (2005)
[13] Gray & Sotir, Biotechnical & Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control (1996); Streambank Erosion and Potential Remedial Measures – Guideline E (AMEC, 2012)
[14] Wulliman & Johns. Demonstration Project Illustrating Void-Filled Riprap Applications in Stream Restoration (2011)

5.1 Bioengineering Plant Species

A summary of the plant species proposed to be used in the bioengineering techniques are listed in Table 5-2. Design drawings illustrating the plant species summarized below are provided in Appendix B.

Table 5-2: Proposed Plant Species Used in the BDEP Design

Latin Name	Common Name	Stock Type	Bioengineering Technique	Implementation Location[1]
Alnus tenuifolia	River alder	#2 Container 1 Litre container 415D plug	Container Shrub Planting Hedge Brush Layer	Site 1-3, Site 1-4 Site 4-1, Site 4-2
Amelanchier alnifolia	Saskatoon	#2 Container 1 Litre container	Container Shrub Planting Hedge Brush Layer	Site 1-3, Site 1-4
Betula occidentalis	Water birch	#2 Container 415D plug	Container Shrub Planting	Site 1-3, Site 1-4 Site 4-1, Site 4-2
Cornus stolonifera	Red osier dogwood	Live Cutting 1 Litre container	Brush Layer Brush Mattress Container Shrub Planting Live staking	Site 1-1, Site 1-2, Site 1-3, Site 1-4 Site 2-1, Site 2-2 Site 4-1, Site 4-3
Lonicera spp.	Honeysuckle	#2 Container	Container Shrub Planting	Site 1-2, Site 1-3, Site 1-4
Populus Balsamifera	Balsam poplar	Live cutting	Brush Layer Contour Fascine Hedge Brush Layer Live Staking	Site 1-1, Site 1-2, Site 1-3, Site 1-4 Site 2-2
Prunus virginiana	Choke cherry	#2 Container	Container Shrub Planting	Site 1-2, Site 1-3, Site 1-4
Rosa woodsii	Wood's rose	#2 Container	Container Shrub Planting	Site 1-2, Site 1-3, Site 1-4
Salix bebbiana	Beaked willow	Live Cutting	Box Fascine Brush Mattress	Site 1-4 Site 2-1, Site 2-2
Salix exigua	Sandbar willow	Live Cutting 1 Litre Container 415D plug	Box Fascine Brush Layer Brush Mattress Contour Fascine Container Shrub Planting Hedge Brush Layer Live staking	Site 1-1, Site 1-2, Site 1-3, Site 1-4 Site 2-1, Site 2-2 Site 4-1, Site 4-2, Site 4-3

Latin Name	Common Name	Stock Type	Bioengineering Technique	Implementation Location[1]
Salix lutea	Yellow willow	Live Cutting 1 Litre Container	Box Fascine Brush Layer Brush Mattress Contour Fascine Container Shrub Planting Hedge Brush Layer Live Staking	Site 1-3, Site 1-4 Site 2-1, Site 2-2 Site 4-3
Symphoricarpus albus	Common snowberry	#2 Container	Container Shrub Planting	Site 1-2, Site 1-3, Site 1-4

Notes:
[1] Refer to design drawings in Appendix B

5.2 Seed Mixes

The following seed mixes are proposed for the BDEP design:

- Table 5-3 provides the proposed seed mix for areas below the water level elevation for the 5-year flood event.
- Table 5-4 provides the proposed seed mix for areas above the water level elevation for the 5-year flood event.
- Table 5-5 provides the proposed seed mix for the wildlife corridor at Site 1-1 and Site 1-2. Note that seed mixes may be refined during the contract document preparation phase of the project.

Table 5-3: Seed Mix for Areas Below the Water Level Elevation for the 5-year Flood Event*

Botanical Name	Common Name	Percent by Weight
Agrostis scabra	Rough Hairgrass	5%
Calamagrostris expansa or C. stricta	Northern Reed Grass	10%
Deschampsia caespitosa	Tufted Hairgrass	5%
Elymus trachycaulus	Slender Wheatgrass	15%
Glyceria striata	Fowl Manna Grass	15%
Juncus balticus	Baltic/Wire Rush	10%
Nassella viridula	Green Needle Grass	20%
Pascopyrum smithii	Western Wheatgrass	10%
Poa palustris	Fowl Bluegrass	10%
*Note: (except for wildlife corridor in Site 1-1 and Site 1-2)		

Table 5-4: Seed Mix for Areas Above the Water Level Elevation for the 5-year Flood Event

Botanical Name	Common Name	Percent by Weight
Agropyron subsecundum	Awned wheatgrass	15%
Elymus lanceolatus ssp. lancelolatus	Northern Wheatgrass	10%
Festuca campestris	Foothills rough fescue	20%
Festuca hallli	Plains rough fescue	15%
Gaillaria aristata	Gaillarida	2%
Koeleria macrantha	June grass	5%
Linum lewisii	Wild Blue Flax	6%
Nassella viridula	Green Needlegrass	15%
Pascopyrum smithii	Western Wheatgrass	10%
Petalostemon purpureum	Purple prairie clover	2%

Table 5-5: Wet Meadow Seed Mix for Wildlife Corridor in Site 1-1 and Site 1-2

Botanical Name	Common Name	Percent by Weight
Calamagrostris canadensis	Canada Reedgrass	5%
Carex aquatilis	Water Sedge	20%
Carex utriculata	Beaked Sedge	20%
Eleocharis palustris	Spike Rush	20%
Elymus canadensis	Canada Wild Rye	5%
Elymus innovatus	Hairy Wildrye	5%
Festuca saximontana	Rocky Mountain fescue	5%
Juncus balticus	Wire Rush	20%

6. Proposed Habitat Enhancements

A summary of the proposed fish habitat enhancements that are incorporated into the BDEP design is provided in Table 6-1 on the following page. A summary of the proposed wildlife habitat enhancements that are incorporated into the BDEP design is provided in Table 6-2. Design drawings illustrating the fish and wildlife habitat enhancements summarized below are provided in Appendix B.

Table 6-1: Summary of Fish Habitat Enhancement Techniques in the BDEP Design

Technique Name	Description	Proposed Location
Fish Shelters	Constructed overhead cover niche under the vegetated timber crib wall that provides fish habitat below the mean annual water level[1].	Site 1-3, Site 1-4
Habitat Rock Spurs	A structure that projects from the bank into the stream for a short distance to deflect flowing water away from the streambank. They typically are used to direct the flow towards the centre of the channel and protect the streambank against erosion. The habitat rock spurs are used in this application to create habitat complexity and diversity through hydraulic complexity, overhead cover (depth and turbulence), and food source habitat for fish[2].	Site 1-3, Site 1-4
Habitat Boulder Clusters	Boulders are placed in clusters on the stream substrate and provide instream cover by creating small scour holes and providing velocity shelter below the boulders. They create habitat complexity and diversity through hydraulic complexity and overhead cover (depth and turbulence). Instream boulders are used by juvenile and adult fish for resting, refuge from predators and feeding[3].	Site 1-3, Site 1-4 Site 2-1, Site 2-2
Scour Apron – Juvenile Fish Refuge	Large rock placed in a rough, irregular profile that creates interstitial spaces and habitat niches for juvenile fish. Can allow increased habitat use over natural cobble-boulder banks[4].	Site 1-3, Site 1-4 Site 2-1, Site 2-2
Overhanging Vegetation	The live cuttings installed as part of the bioengineering treatments will grow into overhanging vegetation, and will provide cover along the bank. Cover provides individual fish with areas of refuge from predators, competitors and periods of high flow. Overhanging vegetation also provides a food source by providing habitat for insects. Young or small fish are especially dependent on areas with cover to feed, and to avoid predators or physical displacement downstream.[5]	All

Sources:
[1] Studer & Zeh, Soil Bioengineering: Construction Type Manual (2014); Streambank Erosion and Potential Remedial Measures – Guideline Q (AMEC, 2012)
[2] Alberta Transportation, Fish Habitat Manual - Guidelines and Procedures for Watercourse Crossings in Alberta – Factsheet M6 (Alberta Transportation, 2009)
[3] Alberta Transportation, Fish Habitat Manual - Guidelines and Procedures for Watercourse Crossings in Alberta – Factsheet C10 (Alberta Transportation, 2009)
[4] Lister, Field Evaluation of Rip-Rap Effects on Juvenile Salmonid Habitat (Lister, 2004)
[5] Alberta Transportation, Fish Habitat Manual - Guidelines and Procedures for Watercourse Crossings in Alberta (Alberta Transportation, 2009)

Table 6-2: Summary of Wildlife Habitat Enhancement Techniques in the BDEP Design

Technique Name	Description	Proposed Location
Vegetated Wildlife Corridor	A vegetated corridor provided to encourage wildlife passage that serves two main functions: 1) to maintain connectivity between habitats and wildlife populations and 2) increase motorist safety and reduce mortality of wildlife on highways[1].	Site 1- 1, Site 1-3
Large Woody Debris in Wildlife Corridor	Provides cover and habitat for small mammals and various insects and assists in revegetation[2].	Site 1-1, Site 1-2, Site 1-3, Site 1-4
Protection of Bank Swallow Colony	Preserves existing habitat for a bird species listed as threatened by COSEWIC[3]	Site 2-1
Provision of Native Species and Riparian Planting	Enhances the riparian zone as nesting habitat for birds, cover for small mammals, and habitat for various insects. Increases biodiversity through healthy diverse riparian habitat[4].	All

Sources:
[1] Alberta Transportation, Planning Considerations for Wildlife Passage in Urban Environments - Best Practice Guideline (Alberta Transportation, 2011)
[2] Best Management Practices Handbook: Hillslope Restoration in British Columbia (Atkins, et al., 2001)
[3] http://www.registrelep-sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=1233
[4] Design Guidelines for Erosion and Flood Control Projects Streambank and Riparian Stability Restoration (AMEC, 2012)

7. Proposed Construction Schedule

The main milestones for the proposed construction schedule are provided in Table 7-1. A detailed proposed construction schedule is provided in Appendix E.

Funding availability and construction logistics with the City of Calgary's SE BRT Bridge construction resulted in schedule modifications. Site 1 construction will take place in 2017 (minus Site 1-2 <BRT> bioengineering treatments), and construction of Site 2, Site 4 and Site 1-2 be completed in 2018.

As discussed in Section 2.4, the Bow River is a Class C watercourse with a restricted access period from May 1 to July 15 and September 16 to April 5. The RAP provides windows of April 6 to April 30 (spring window) and July 16 to September 15 (summer window) for instream construction. Given anticipated regulatory approval and procurement timelines for the BDEP, the end of the 2017 summer window will be targeted for instream construction at Site 1. Mitigation measures are provided as it is anticipated instream construction will extend beyond the summer window (see Section 4.7). It is proposed that construction of Site 2, Site 4 and bioengineering treatments of the Site 1-2 be scheduled to coincide with the 2018 spring window. Mitigation measures are as described in the FFHA report that is submitted separately from this one (Hemmera, 2017). See also Section 4.7.

It is expected that construction of the proposed bank protection and fish habitat enhancement measures at Site 1 will take 3 ½ months to complete and at Site 2, Site 4, and completion of bioengineering treatments to Site 1-2 will take an estimated 2 ½ months to complete including mobilization and demobilization.

Table 7-1: Key Milestones for the Proposed Construction Schedule

Activity[1]	Approx. Start Date	Approx. End Date
Regulatory Approvals Submission and Anticipated Approval	April 28, 3017	July 21, 2017
Tender	July 21, 2017	August 18, 2017
Tender Award and Contract Negotiation	August 18, 2017	September 8, 2017
Site 1 Mobilization	September 8, 2017	September 14, 2017
Site 1 Earthworks	September 8, 2017	October 15, 2017
Site 1 Isolation and Instream Construction	September 8, 2017	October 15, 2017
Site 1 Live Cutting Harvest	October 1, 2017	November 15, 2017
Site 1 Bioengineering Measures Installation	October 1, 2017	November 30, 2017
Site 1 Demobilization	December 1, 2017	December 8, 2017
Site 2, Site 4 and Site 1-2 Mobilization	March 26, 2018	April 5, 2018
Site 2, Site 4 and Site 1-2 Earthworks	April 6, 2018	April 30, 2018
Site 2, Site 4 and Site 1-2 Isolation and Instream Construction[1]	April 6, 2018	April 30, 2018
Site 2, Site 4 and Site 1-2 Live Cutting Harvest	March 1, 2018	April 15, 2018
Site 2, Site 4 and Site 1-2 Bioengineering Measures Installation	April 15, 2018	May 31, 2018
Site 2, Site 4 and Site 1-2 Demobilization	June 1, 2018	June 8, 2018
Monitoring and Maintenance Period (See Section 8)[2]	December 15, 2017	October 15, 2020

Notes:
[1] Construction for Site 1-2 will occur in 2018 due to required coordination with SE BRT construction activities.
[2] The construction contract will include a monitoring and maintenance period that is required to be fulfilled by the contractor. It does not include environmental monitoring (i.e. water quality) as no construction is taking place. Please refer to Section 8.

7.1.1 Schedule Assumptions and Risks

The following assumptions were made in the preparation of the proposed construction schedule:

- Regulatory windows:
  - Bow River Restricted Activity Period: May 1 to July 15 and September 16 to April 5, and
  - Bird/raptor/bat migration and nesting restricted period: April 15 to July 15.
- Conceptual SE BRT Bridge construction schedule (subject to change without notice):
  - East berm – April 2017 window in RAP,
  - West berm – July to September 2017 window in RAP, and
  - Piers – July to September 2017 window in RAP and onwards as required.
- Live cuttings harvesting schedule (per Table 2-1 in Section 2.2):
  - Harvesting of live cuttings must occur while plants are dormant. The dormancy period is typically from October 1 to March 31.
  - Live cuttings can be placed in cold storage; however, harvested live cuttings must be installed by the third week of June if harvested before March 31 of the same year.
  - Installation of live cuttings must occur while plants are dormant.
  - Live cuttings must be harvested in the fall (after October 1) for fall construction the same year.
- Earthworks and land based construction schedule prepared by the contractor not available at the time of schedule preparation.
- In-stream construction within RAP subject to approval and implemented mitigations as Documented in the Fish and Fish Habitat Assessment (QAES Assessment) Report (Hemmera, 2017) and isolation details (Section 4.6).
- The City will assume ownership of the construction contract for Construction Completion Certificate (CCC), warranty period monitoring and maintenance, and Final Acceptance Certificate (FAC).
- The proposed works located within the construction area for the SE BRT Bridge at Site 1-2 must be constructed in 2018 according to discussions with Stantec, as a result of SE BRT Bridge construction activities in 2017 (subject to negotiations).

8. Monitoring and Maintenance Period

The designed bioengineering bank protection and fish habitat enhancement measures are based on the information, design basis, and analysis presented above and are designed to withstand the assumed river and ice forces described in this report. They are also meant to be somewhat self-healing as rock riprap shifts and self-launches in response to river and ice forces. In this manner, the proposed works are meant to avoid a catastrophic loss of integrity but are otherwise categorized as perpetual maintenance structures.

The success of the works depends significantly on regular monitoring and maintenance including weeding, watering, mulching, mowing, and minor repairs. Inspection of these works is critical to identify any damage to the works as early as possible so that the structures are repaired in a timely manner. The works should be inspected at key intervals and mitigation applied as required. The construction contract will require a 3-year monitoring and maintenance period.

Appendix F contains the Monitoring and Maintenance Plan (Table F-1). The Monitoring and Maintenance Plan provides a means to identify issues early enough to affect mitigation and ensure the establishment of healthy vegetation and structure for bank stability. The table provides key observations points, and provides contingency measures, and responses.

9. Closure and Next Steps

This memorandum provides a summary of the background information, design basis, analysis, and proposed detailed design of bioengineering bank protection and fish habitat enhancement measures for the BDEP. Following acceptance of this memorandum and the attached detailed design drawings, and schedule by AEP and The City, the design team will submit the deliverables to the appropriate regulatory agencies for approval.

We trust that this report meets your needs at this time. Please contact the undersigned with any questions or if additional information is required.

9.1 Report Submission

KERR WOOD LEIDAL ASSOCIATES LTD.
APEGA Permit to Practice No. P07929

Prepared by:

Mike Gallant, M.Sc.E., P.Eng.
Water Resources Engineer

This document is a copy of the sealed and signed original retained on file. The content of the electronically transmitted document can be confirmed by referring to the filed original.

Reviewed by:

Andrew Szojka, P.Eng.
Component Lead

Malcolm Smith, M.Sc., P.Biol.
Project Leader

References

AEP and City of Calgary. (2016). *Project Charter - Bioengineering Demonstration and Education Project.*

Alaska Department of Fish and Game. (2005). *Streambank Revegetation and Protection: A Guide for Alaska .*

Alberta Transportation. (2009). *Fish Habitat Manual - Guidelines and Procedures for Watercourse Crossings in Alberta.*

Alberta Transportation. (2011). *Planning Considerations for Wildlife Passage in Urban Environments - Best Practice Guideline.*

Alberta Transportation. (2013). *Standard Specifications for Bridge Construction.* Edition 15.

AMEC. (2012). *Design Guidelines for Erosion and Flood Control Projects Streambank and Riparian Stability Restoration.* Report submitted to The City of Calgary .

Atkins, R., Leslie, M., Polster, D., Wise, M., & Wong, R. (2001). *Best Management Practices Handbook: Hillslope Restoration in British Columbia.* BC Ministry of Forests, Watershed Restoration Program, Resource Tenures and Engineering Branch.

BC MELP. (2000). *Riprap Design and Constriction Guide.* British Columbia Ministry of Environment, Lands and Parks, Public Safety Section, Water Management Branch.

City of Calgary. (2014). *Floodway/Flood Fringe Maps.*

City of Calgary. (2015). *Design Guidelines for Development Site Servicing Plans.*

City of Calgary. (2017). *Development Guidelines and Standard Specifications: Landscape Construction.*

Escarameia, M., & May, R. (1992). *Channel Protection Downstream of Structures.* HR Wallingford, London: Report SR 313.

Golder. (2014a). *Bow and Elbow River: Basin-Wide Hydrology Assessment and 2013 Post Flood Documentation.* Golder Associates Ltd.

Golder. (2014b). *Bank Restoration Design for Bow River at Inglewood.*

Golder. (2014c). *Two-Dimensional Hydraulic Modelling of the Bow River at Inglewood.* Technical Memorandum submitted to The City of Calgary.

Golder. (2015). *2015 Bow River and Elbow River Hydraulic Model .*

Government of Alberta. (2013). *Government of Alberta's Code of Practice for Watercourse Crossings.*

Gray, D., & Sotir, R. (1996). *Biotechnical & Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control.* John Wiley & Sons.

Hemmera. (2016). *Bioengineering Demonstration and Education Project Conceptual Design Brief.* Report to Alberta Environment and Parks.

Hemmera. (2017). *Fish and Fish Habitat Assessment - QAES Assessment.*

KWL. (2016). *Bow River Bioengineering Demonstration Project Preliminary Geomorphology Assessment.* Technical Memorandum submitted to Hemmera Envirochem Inc.

Lister, D. (2004). Field Evaluation of Rip-Rap Effects on Juvenile Salmonid Habitat. In J. Quigley, & D. Harper, *Streambank Protection with Rip-rap: An Evaluation of the Effects on Fish and Fish Habitat - Canadian Manuscript Report of Fisheries and Aquatic Sciences 2701* (pp. 21-72). Habitat and Enhancement Branch Fisheries and Oceans Canada.

Mack, Slack & Associates. (2004). *Water Control Structures - Selected Design Guidelines.* Alberta Transportation and Alberta Environment.

McCullah, J., & Gray, D. (2005). *Environmentally Sensitive Channel- and Bank-Protection Measures - NCHRP Report 544.* Washington, DC: National Cooperative Highway Research Program.

Neill, C. (2004). *Guide to Bridge Hydraulics.* Thomas Telford, London, UK: Transportation Association of Canada.

nhc. (2016). *Implications of Ice on the Morphology of the Bow River within the City of Calgary.* Report submitted to Klohn Crippen Berger.

O2. (2017). *Cushing Bridge Wildlife Corridor Design Guidelines.* Calgary, Alberta: Report submitted to Hemmera Envirochem Inc.

Pemberton, E., & Lara, J. (1984). *Computing Degradation and Local Scour.* Denver, CO: Bureau of Reclamation, Engineering and Research Centre.

Pilarczyk, K. (1990). *Stability Criteria for Revetments.* Proceedings of the 1990 National Conference, Chang, H.H., and Hill, J.C. (eds.),Hydraulic Division of the ASCE, San Diego, CA.

Rood, S., Kaluthota, S., Philipsen, L., & Zanewich, K. (2016). *Analyzing and Projecting Post-Flood Vegetation Colonization along the Bow River through Calgary, Alberta.* University of Lethbridge.

Schiechtl, H., & Stern, R. (1997). *Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection.* London, UK: Blackwell Science.

Stantec. (2016a). *Hydrotechnical Engineering Assessment and Recommendations for the SE BRT Transitway Extension Crossing of the Bow River.* Internal Memo.

Stantec. (2016b). *Technical Memo 2 - SE BRT Transitway 2-Dimensional Model.* Internal Memo.

Studer, R., & Zeh, H. (2014). *Soil Bioengineering: Construction Type Manual .* vdf Hochschulverlag AG, an der ETH Zurich.

Thompson, W., & Hansen, P. (2002). *Classification and Management of Riparian and Wetland Sites of Alberta's Prairie Biome.* Corvallis, Montana: Bitterroot Restoration Inc.

Thurber. (2016). *Fisheries Habitat and Sustainability Program along the Bow River Preliminary Geotechnical Assessment .* Memorandum submitted to Hemmera Envirochem Inc.

Thurber. (2017). *Fisheries Habitat and Sustainability Program along the Bow River, Calgary, AB Geotechnical Investigation – Lower Site 1 and Site 2.* Memorandum submitted to Hemmera Envirochem Inc.

USACE. (1991). *Hydraulic Design of Flood Control Channels.* Washington, D.C.: Engineering Manual No. 1110-2-1601.

Wulliman, J., & Johns, D. (2011). *Demonstration Project Illustrating Void-Filled Riprap Applications in Stream Restoration .* Denver, CO: Prepared for Urban Drainage and Flood Control District .

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Revision History

Revision #	Date	Status	Revision	Author
2	May 8, 2017	FINAL	Incorporated Hemmera comments, Issued for Use	MG
1	April 28, 2017	FINAL	Incorporated Hemmera comments, Issued for Use	MG
0	April 20, 2017	FINAL	Issued for Use	MG
A	February 8, 2017	DRAFT	Original prepared	MG

OQM | Organizational Quality Management Program

APEGA Permit # PO7929

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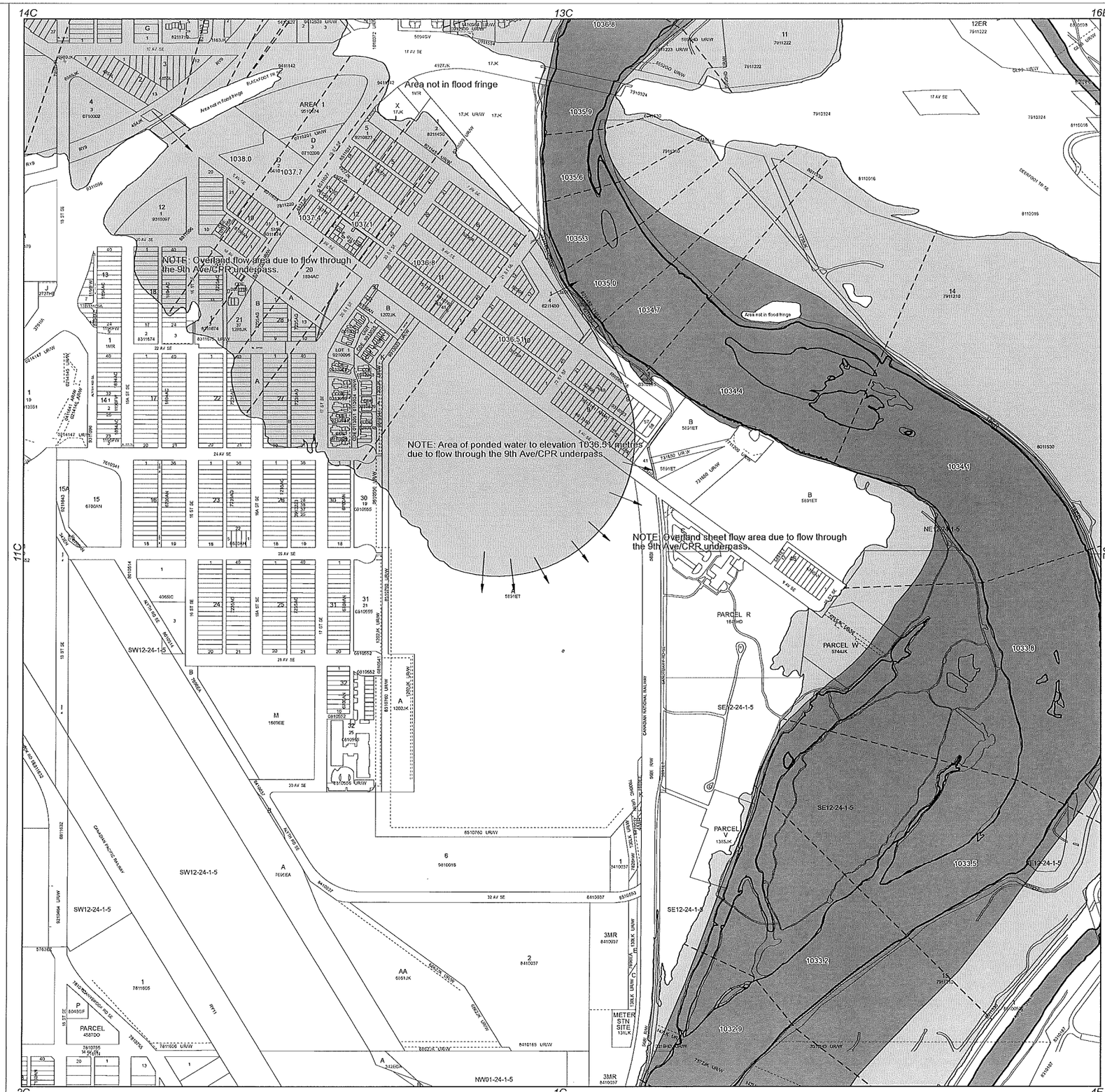
Appendix A

City of Calgary Floodway/Flood Fringe Maps



THE CITY OF
CALGARY
PLANNING, DEVELOPMENT & ASSESSMENT

Floodway / Flood Fringe

1:100 Floodway / Flood Fringe Delineation

Legend

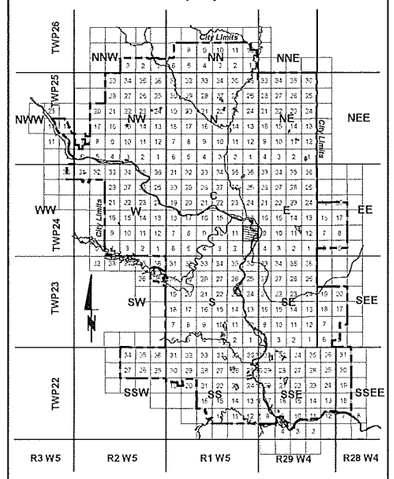
- Floodway
- Flood Fringe
- Overland Flow
- Step Line (Bow/Elbow River)
- 1050.2 — Water Elevation Between Step Lines
- Cross-Section Line (Nose/West Nose Creek)
- *1050.2* — Water Elevation at Cross-Section Lines
- Tentative Plan
- Legal Base
- 9 AV SE — Street Names
- City Limits

Notes:

This map forms part of the Calgary Land Use By-law 1P2007 as indicated in Part 3, Division 3 of the Bylaw. The Floodway / Flood Fringe is subject to amendment by by-law of City Council and the maps are updated as soon as possible following Council's decision.

Adopted by Council: 2014 June 9
Bylaw Number: 1P2007

Key Map



SECTION 12C

T.24R. 1 W5

200 0 200 400 Feet

50 0 50 100 Meters

1:4000

Sources: Land Information & Mapping, Alberta Environment

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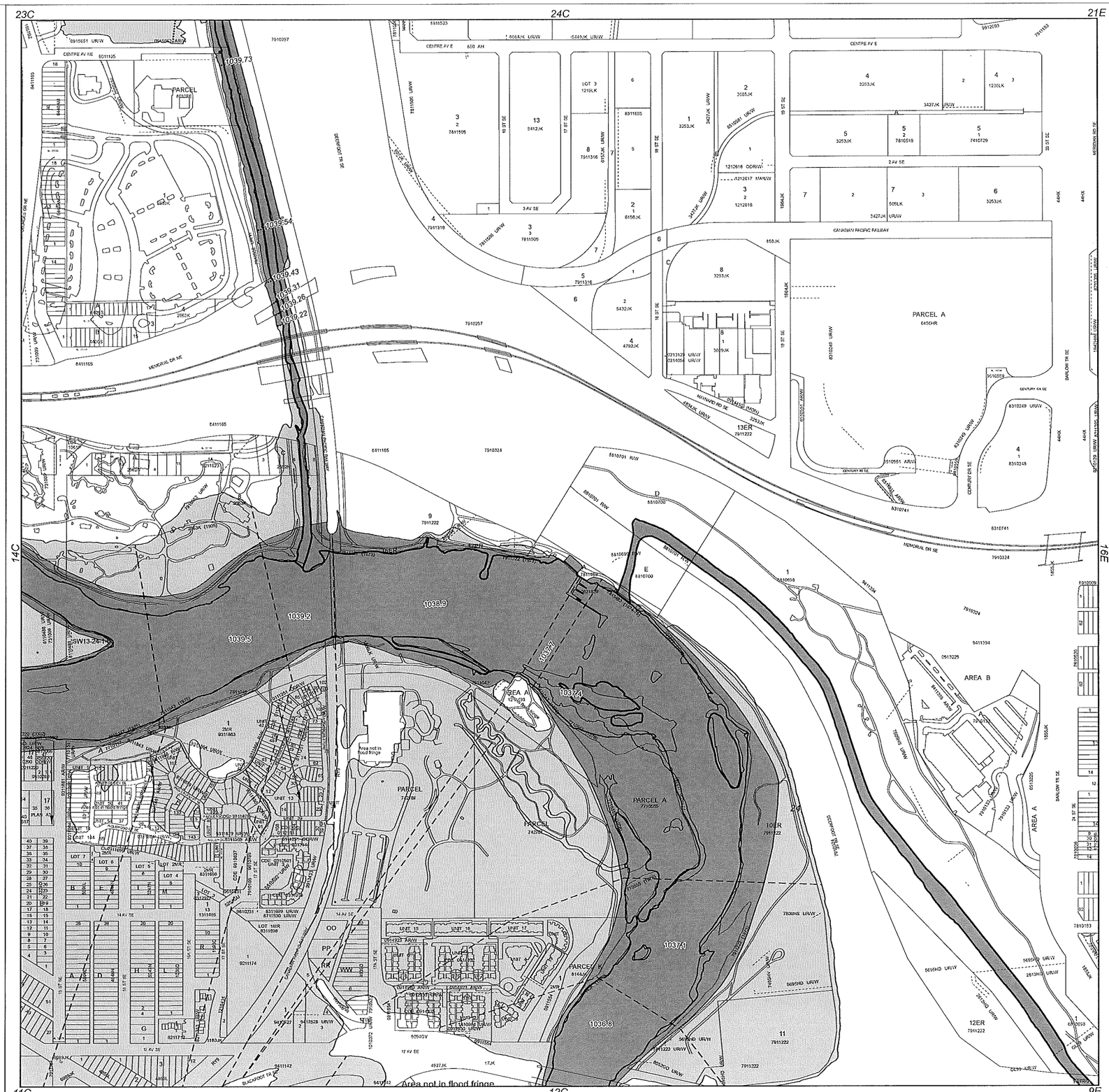
Date Plotted: Thursday, June 05, 2014 *SECTION 12C*



THE CITY OF CALGARY
PLANNING, DEVELOPMENT & ASSESSMENT

Floodway / Flood Fringe

1:100 Floodway / Flood Fringe Delineation

Legend

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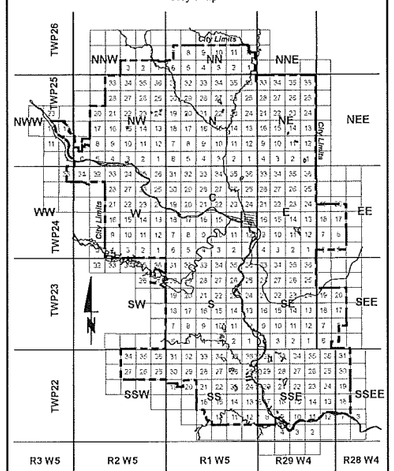

SECTION 13C

T.24 R. 1 W.5

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Sources: Land Information & Mapping, Alberta Environment

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Date Plotted: Thursday, June 05, 2014

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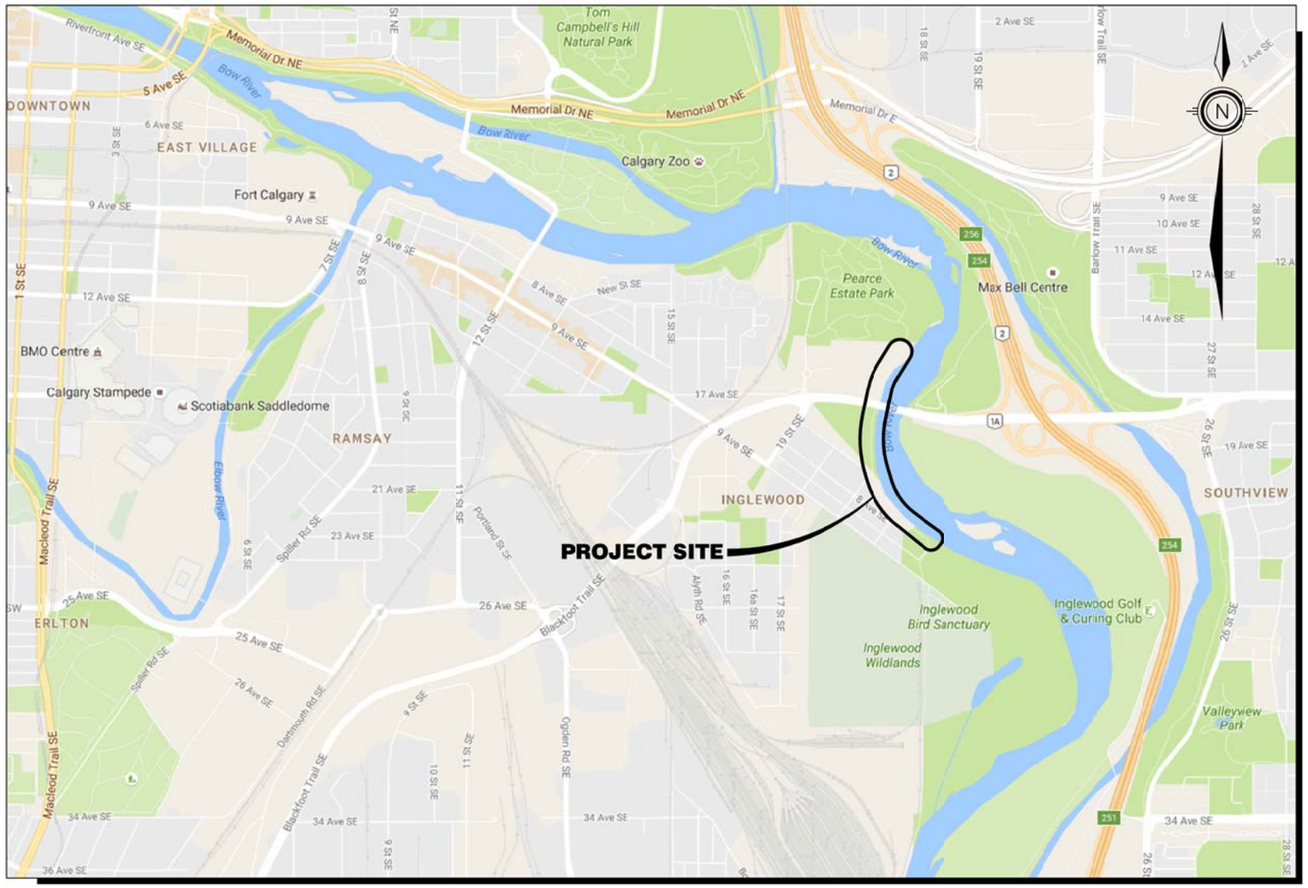
Appendix B

Design Drawings



LOCATION PLAN
Scale: N.T.S.

DRAWINGS LIST		
SHEET NO.	DRAWING NO.	DRAWING TITLE
1	G-000	LOCATION PLAN AND DRAWINGS LIST
2	G-010	KEY PLAN AND GENERAL ARRANGEMENT
3	G-020	LEGEND AND GENERAL NOTES
4	G-030	BOREHOLE LOGS
5	G-040	EROSION AND SEDIMENT CONTROL PLAN
6	SW-100	SITE 1 - EXISTING CONDITIONS PLAN
7	SW-110	SITE 1 - DEMOLITION PLAN
8	SW-120	SITE 1 - WILDLIFE TRAIL PLAN AND FROFILE STATION 10+000 TO 10+100
9	SW-121	SITE 1 - WILDLIFE TRAIL PLAN AND FROFILE STATION 10+080 TO 10+380
10	SW-122	SITE 1 - REGIONAL PATHWAY PLAN AND PROFILE STATION 11+000 TO 11+300
11	SW-130	SITE 1 - SECTIONS STATION 10+000 TO 10+180
12	SW-131	SITE 1 - SECTIONS STATION 10+200 TO 0+380
13	SW-140	SITE 1 - TYPICAL SECTIONS SHEET 1
14	SW-141	SITE 1 - TYPICAL SECTIONS SHEET 2
15	SW-142	SITE 1 - TYPICAL SECTIONS SHEET 3
16	SW-143	SITE 1 - CRIB WALL AND FISH SHELTER DETAILS
17	SW-144	SITE 1 - MISCELLANEOUS DETAILS
18	SW-200	SITE 2 - EXISTING CONDITIONS PLAN
19	SW-220	SITE 2 - PLAN AND PROFILE
20	SW-230	SITE 2 - SECTIONS STATION 0+550 TO 0+700
21	SW-240	SITE 2 - TYPICAL SECTIONS
22	SW-241	SITE 2 - SLOPE TREATMENT DETAILS
23	SW-242	SITE 2 - TYPICAL DETAILS
24	SW-400	SITE 4 - EXISTING CONDITIONS PLAN
25	SW-420	SITE 4 - PLAN AND PROFILE
26	SW-430	SITE 4 - SECTIONS STATION 0+690 TO 0+920
27	SW-440	SITE 4 - TYPICAL SECTIONS
28	D-100	STANDARD DETAILS
29	D-101	PLANTING SPECIES LISTS
30	D-102	ISOLATION DETAILS

ALBERTA ENVIRONMENT AND PARKS
BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

KERR WOOD LEIDAL
consulting engineers
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Terra Erosion Control Ltd.
308 Hart St. Nelson, B.C. V1L 5N5
Tel: 250 352 2757
www.terraerosion.com

Issued for Approval
Not for Construction
APRIL,19/2017

Seal: PROFESSIONAL ENGINEER ALBERTA
19 April 2017

APEGA PERMIT TO PRACTICE NO. P07929

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.23/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.30/2016	TWC	TWC	AKS	UPDATED DRAWINGS LIST
C	JAN.18/2017	TWC	TWC	AKS	UPDATED DRAWINGS LIST
D	JAN.31/2017	TWC	TWC	AKS	UPDATED DRAWINGS LIST
E	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT
LOCATION PLAN AND DRAWINGS LIST

Project No. 3552-004
Group CIVIL
Drawing No. G-000
Rev. E

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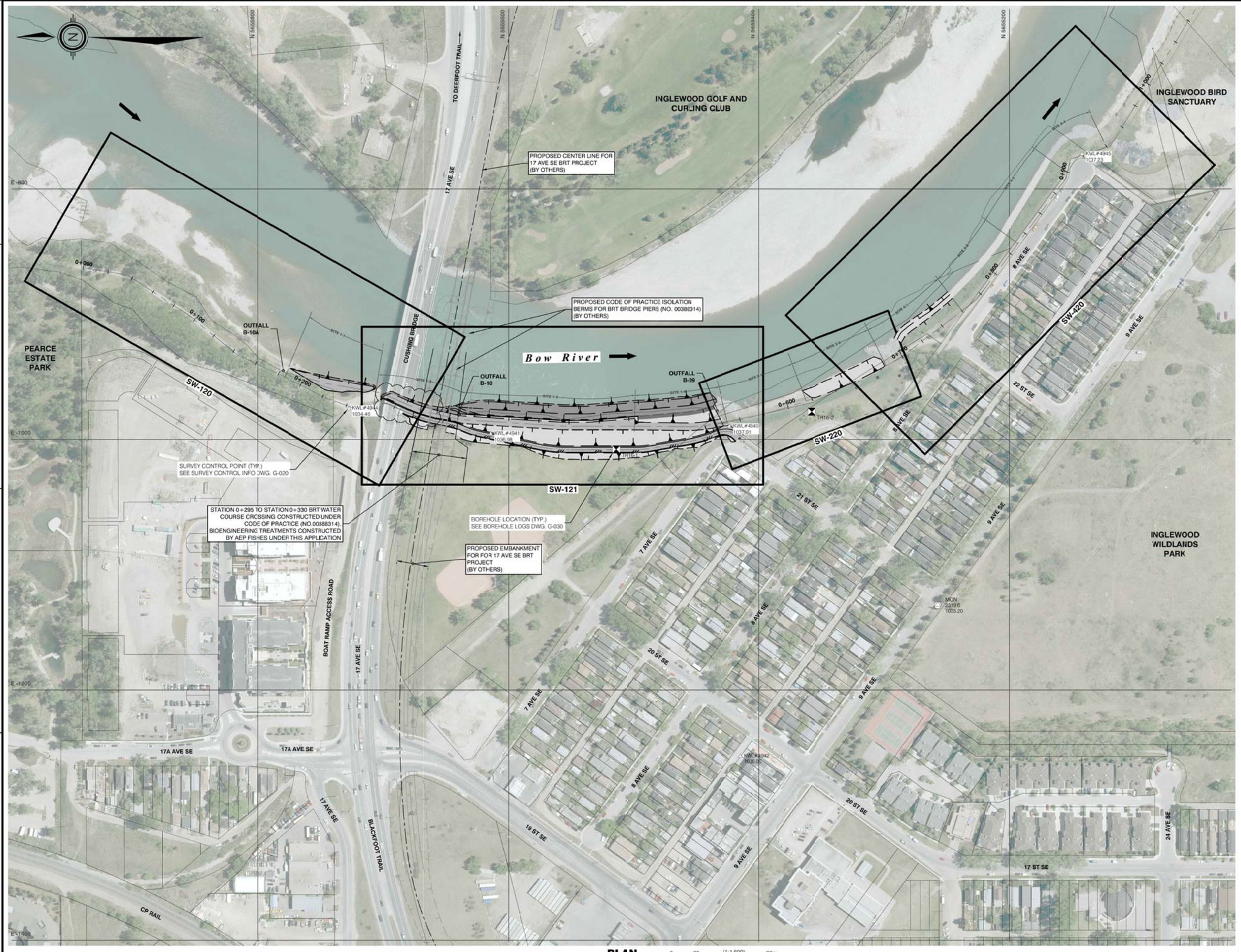

PLAN
Scale: 1:1500

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www.terraerosion.com

NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES.

Issued for Approval
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APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

Seal: ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF ALBERTA
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.14/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.17/2017	TWC	TWC	AKS	UPDATED OUTFALL B-10A LABEL
C	JAN.10/2017	TWC	PAC	AKS	REVISED DRAWING EXTENTS
D	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT
KEY PLAN AND GENERAL ARRANGEMENT

Project No.	Drawing No.	Rev.
3552-004	G-010	D
Group: CIVIL		

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LEGEND

1034	EXISTING GROUND CONTOJR
X X X X	EXISTING FENCE
	EXISTING EDGE OF ASPHALT
	EXISTING EDGE OF GRAVEL PATH
	EXISTING CURE AND GUTTER
	EXISTING TOP OF SLOPE
	EXISTING TOE OF SLOPE
	EXISTING LEGAL BOUNDARY
D	EXISTING STORM SEWER MAIN
S	EXISTING SANITARY SEWER MAIN
W	EXISTING WATER MAIN
G	EXISTING GAS MAIN
T	EXISTING BURIED TELECOMMUNICATIONS DUCT
E	EXISTING BURIED ELECTRICAL DUCT
LS	EXISTING LIGHT STANDARD
	EXISTING TEL MANHOLE
	EXISTING ELECTRICAL JUNCTION BOX
	EXISTING UTILITY POLE
	EXISTING CATCH BASIN
	EXISTING STORM MANHOLE
	EXISTING SANITARY MANHOLE
	EXISTING HYDRANT
	EXISTING WATER VALVE
TH16-1	BORE HOLE LOCATION
	GROUND WATER MONITORNG WELL
△ KWL# EL	SURVEY CONTROL POINT
△ MON# EL	ALBERTA SURVEY CONTROL POINT
	EXISTING VEGETATION

	PROPOSED PATHWAY
	PROPOSED WALL
	PROPOSED TOE OF SLOPE
	PROPOSED TOP OF SLOPE
	PROPOSED EARTHWORKS SLOPE
	PROPOSED EARTHWORKS BENCH

GENERAL NOTES:

1. ELEVATIONS AND STATIONS IN METRES, AND DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. COORDINATES ARE BASED ON CITY OF CALGARY 3TM NAD 1983 W114 GEODETIC DATUM
3. CONTOUR INTERVAL IS 1.0m UNLESS OTHERWISE NOTED.
4. EXISTING UTILITY LOCATIONS, ALIGNMENTS, AND BURIAL DEPTHS MAY NOT BE EXACTLY AS SHOWN ON THE DRAWINGS. CONTRACTOR TO CONFIRM LOCATIONS, ALIGNMENTS AND BURIAL DEPTHS PRIOR TO COMMENCING CONSTRUCTION.
5. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH CONTRACT SPECIFICATIONS, ADDENDA, AND DRAWINGS. IN THE EVENT OF CONFLICT BETWEEN DRAWINGS AND SPECIFICATIONS, THE MORE STRINGENT REQUIREMENTS SHALL APPLY.
6. THE BOW RIVER SUPPORTS SENSITIVE HABITAT. ALL WORK SHALL BE CARRIED OUT IN ACCORDANCE WITH REGULATORY APPROVALS.
7. CONTRACTOR IS RESPONSIBLE FOR ALL CONSTRUCTION LAYOUT OF THE WORKS AND FOR REVIEW WITH THE ENGINEER PRIOR TO STARTING WORK. DIGITAL DRAWINGS FOR THE PURPOSE OF SITE LAYOJT CAN BE PROVIDED AT THE REQUEST OF THE CONTRACTOR.
8. CONTRACTOR IS RESPONSIBLE FOR EROSION & SEDIMENT CONTROL, PROTECTION OF TREES, AND PROTECTION OF SURVEY MONUMENTS, INCLUDING ENVIRONMENTAL AND GEOTECHNICAL MONITORING WELLS.
9. ALL BIOENGINEERING TREATMENTS SUBJECT TO THREE (3) YEAR MAINTENANCE AND MONITORING PERIOD.

REFERENCES

1. BASE DATA, INCLUDING LEGAL BOUNDARIES, TRANSPORTATION DATA, AND UTILITY DATA, PROVIDED BY THE CITY OF CALGARY.
2. EXISTING TOPOGRAPHY CONTOURS GENERATED FROM 2015 20cm RESOLUTION LIDAR PROVIDED BY THE CITY OF CALGARY, CHANNEL BATHYMETRY SURVEY CONDUCTED BY KWL ON JULY 28, 2016, AND RIVERBANK TOPOGRAPHY SURVEY CONDUCTED BY KWL ON SEPTEMBER 26, 2016.
3. AERIAL PHOTOGRAPH TAKEN ON MAY 22, 2015 AND PROVIDEC BY THE CITY OF CALGARY.
4. 100-YEAR (Q100) WATER LEVEL CORRESPONDS TO A FLOW RATE OF 2190m³/s, 5-YEAR (Q5) WATER LEVEL TO 816m³/s, AND 2-YEAR (Q2) WATER LEVEL TO 439 m³/s PER THE *BOW RIVER AND ELBOW RIVER BASIN-WIDE HYDROLOGY ASSESSMENT AND 2013 FLOOD DOCUMENTATION REPORT* BY GOLDER ASSOCIATES LTD.
5. AVERAGE JUNE/JULY/AUGUST (AVG JUN/JUL/AUG) WATER LEVEL CORRESPONDS TO A FLOW RATE OF 195m³/s, AVERAGE SEPTEMBER (AVG. SEP.) WATER LEVEL TO 96m³/s, AND 99TH PERCENTILE LOW FLOW WATER LEVEL TO 46m³/s BASED ON FLOW RECORDS FROM THE WATER SURVEY OF CANADA HYDROMETRIC GAUGES 05BH004 BOW RIVER AT CALGARY, 05BJ001 ELBOW RIVER BELOW GLENMORE DAM, AND 05BH003 NOSE CREEK AT CALGARY.
6. WATER LEVELS WERE GENERATED USING THE *BOW RIVER AND ELBOW RIVER HYDRAULIC MODEL* DEVELOPED BY GOLDER ASSOCIATES LTD. IN 2015.

SURVEY CONTROL INFORMATION

COORDINATES ARE TO NAD83(CSRS) / ALBERTA 3TM REFERENCE MERIDIAN 114W DATJM. ELEVA"IONS ARE GEODETIC TO CGVD28 W/ GSD95 GEOID.

SURVEY CONTROL ORIGIN AT MON#405357 (S.W. COR 9TH AVE. S.E. & 16 ST. S.E.).

ADDITONAL SURVEY CONTROL POINT COORDINATES AND E.EVATIONS DERIVED USING TRIMBLE R10 GPS RCEIVER ON CAN-NET SYSTEM, WITH SITE CALIBRATION TO PUBLISHED 3TM-114 COORDS AND GEODETIC ELEVATIONS FOR MON#405357 AND MON#2319.6.

MULTIFLY LOCALLY MEASURED GROUND LEVEL DISTANCES BY COMBINED SCALE FACTOR OF 0.999739 TO CONVERT TO THIS COORDINATE SYSTEM.

POINT	NORTHING	EASTNG	ELEVATION	DESCRIPTON
465357	5655545.410	-1646.654	1011.675	MON#405357 (ASCM NO. 405357)
23196	5655257.218	-1132.344	1035.197	MON#23196 (ASCM NO. 163527)
4940	5655423.416	-989.542	1037.012	KWL#4940
4941	5655614.114	-995.363	1036.980	KWL#4941
4942	5655415.072	-1252.660	1036.046	KWL#4942
4944	5655727.619	-975.403	1034.471	KWL#4944
4945	5655141.916	-771.660	1037.230	KWL#4945

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APEG PERMIT TO PRACTICE NO. P07929

Seal:
PROFESSIONAL ENGINEER ALBERTA
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	JAN.17/2017	MG	ROK	AKS	ORIGINAL PLAN PREPARED
B	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

LEGEND AND GENERAL NOTES

Project No. 3552-004 | Drawing No. G-020 | Rev. B
Group CIVIL

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CLIENT: Hemmera Envirochem Inc. | PROJECT: Fisheries Habitat Enhancement and Sustainability Program | TEST HOLE NO: **TH16-1**
PROJECT NO: 13155 | 3TM 114° NAD 83, Northing: 5655514 m, Easting: -1008 m | ELEVATION:
SAMPLE TYPE: Grab Sample
BACKFILL TYPE:

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	Becker Blow Count/300 mm (20 40 60 80)	PL W.C. (%) LL (10 20 30 40)	REMARKS	MUDCS / ISRM	SOIL SYMBOL	DESCRIPTION	DEPTH (m)
0		G-1				TPS		TOPSOIL, approximately 150mm thick	0
						ML		SILT, some sand, trace gravel, brace clay, non to low plastic, very stiff, brown, damp	
1		G-2						GRAVEL sandy, trace silt, poorly graded, compact, grey, damp, trace cobbles	1
2		G-3							2
3		G-4							3
4		G-5						- compac to dense	4
5		G-6							5
		G-7						- possible boulder	
6		G-8							6
7		G-9			Sieve Analysis Gravel = 69.9% Sand = 22.3% Silt & Clay = 7.8%			- moist, brown to grey - compac	7
		G-10							
8		G-11							8
		G-12							
9		G-13			Seepage			- wet	9
10									10

THURBER ENGINEERING LTD.
DRILLING CO.: Earth Drilling Co. Ltd.
RIG TYPE: Becker Hammer | COMPILED BY: VB | COMPLETION DEPTH: 13.7 m
DRILL METHOD: Becker Hammer | REVIEWED BY: CKK | COMPLETION DATE: 22/11/2016
INSPECTOR: VB
Page 1 of 2

CLIENT: Hemmera Envirochem Inc. | PROJECT: Fisheries Habitat Enhancement and Sustainability Program | TEST HOLE NO: **TH16-1**
PROJECT NO: 13155 | 3TM 114° NAD 83, Northing: 5655514 m, Easting: -1008 m | ELEVATION:
SAMPLE TYPE: Grab Sample
BACKFILL TYPE:

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	Becker Blow Count/300 mm (20 40 60 80)	PL W.C. (%) LL (10 20 30 40)	REMARKS	MUDCS / ISRM	SOIL SYMBOL	DESCRIPTION	DEPTH (m)
10		G-14						GRAVEL (continue)	10
11		G-15							11
12		G-16							12
		G-17							
13		G-18			100/ 75	CS		CLAYSTONE (BEDROCK), moderately to highly weathered, extremely weak to very weak, grey, damp	13
14								END OF HOLE at 11.7 m - seepage at 9.1 m - slough to 4.0 m - backfill with bentonite from 13.7 m to 11.5 m - backfilled with drillcuttings - bentonite seal at surface - water level = 9 m below ground surface upon completion	14
15									15
16									16
17									17
18									18
19									19
20									20

THURBER ENGINEERING LTD.
DRILLING CO.: Earth Drilling Co. Ltd.
RIG TYPE: Becker Hammer | COMPILED BY: VB | COMPLETION DEPTH: 13.7 m
DRILL METHOD: Becker Hammer | REVIEWED BY: CKK | COMPLETION DATE: 22/11/2016
INSPECTOR: VS
Page 2 of 2

CLIENT: Hemmera Envirochem Inc. | PROJECT: Fisheries Habitat Enhancement and Sustainability Program | TEST HOLE NO: **TH16-2**
PROJECT NO: 13155 | 3TM 114° NAD 83, Northing: 5655358 m, Easting: -978 m | ELEVATION:
SAMPLE TYPE: Grab Sample
BACKFILL TYPE:

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	Becker Blow Count/300 mm (20 40 60 80)	PL W.C. (%) LL (10 20 30 40)	REMARKS	MUDCS / ISRM	SOIL SYMBOL	DESCRIPTION	DEPTH (m)
0		G-1				TPS		TOPSOIL, approximately 150mm thick	0
						ML		SILT, sandy, trace gravel, trase clay, non to low plastic, stiff, brown, damp	
1		G-2						GRAVEL, sandy, trace silt, poorly graded, compact, grey, damp, trace cobbles	1
2		G-3							2
3		G-4							3
4		G-5			Sieve Analysis Gravel = 76.8% Sand = 16.5% Silt & Clay = 4.8%			- some sand to sandy - dense	4
5		G-6							5
		G-7						- moist, bown to grey	
6		G-8				GP		- sand layr approximately 300 mm thick	6
7		G-9			Seepage			- wet	7
		G-10							
8		G-11						- compact	8
		G-12							
9		G-13							9
10						CS		CLAYSTONE (BEDROCK), moderately to highly weathered, extremely weak to very weak, grey, damp	10

THURBER ENGINEERING LTD.
DRILLING CO.: Earth Drilling Co. Ltd.
RIG TYPE: Becker Hammer | COMPILED BY: VB | COMPLETION DEPTH: 9.8 m
DRILL METHOD: Becker Hammer | REVIEWED BY: CKK | COMPLETION DATE: 22/11/2016
INSPECTOR: VB
Page 1 of 2

CLIENT: Hemmera Envirochem Inc. | PROJECT: Fisheries Habitat Enhancement and Sustainability Program | TEST HOLE NO: **TH16-2**
PROJECT NO: 13155 | 3TM 114° NAD 83, Northing: 5655358 m, Easting: -978 m | ELEVATION:
SAMPLE TYPE: Grab Sample
BACKFILL TYPE:

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	Becker Blow Count/300 mm (20 40 60 80)	PL W.C. (%) LL (10 20 30 40)	REMARKS	MUDCS / ISRM	SOIL SYMBOL	DESCRIPTION	DEPTH (m)
10								END OF HOLE at 9.8 m - seepage at 5.8 m - slough to 4.5 m - backfill with bentonite from 9.8 m to 9 m - backfill with drill cuttings - bentonite seal at surface - water level = 6 m below ground surface upon completion	10
11									11
12									12
13									13
14									14
15									15
16									16
17									17
18									18
19									19
20									20

THURBER ENGINEERING LTD.
DRILLING CO.: Earth Drilling Co. Ltd.
RIG TYPE: Becker Hammer | COMPILED BY: VB | COMPLETION DEPTH: 9.8 m
DRILL METHOD: Becker Hammer | REVIEWED BY: CKK | COMPLETION DATE: 22/11/2016
INSPECTOR: VS
Page 2 of 2

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NOTES:

1. REFER TO DWG.D-020 FOR LEGEND AND GENERAL NOTES.
2. GEOTECHNICAL BORE HOLE LOGS PROVIDED BY THURBER ENGINEERING LTD. NOV. 2016.

Issued for Approval
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APRIL,19/2017

APEG PERMIT TO PRACTICE NO. P07929

Seal:
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS OF ALBERTA
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	APR.19/2017	MG	FOK	AKS	ORIGINAL PLAN PREPARED

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

BOREHOLE LOGS

Project No.	Drawing No.	Rev.
3552-004	G-030	A
Group: CIVIL		

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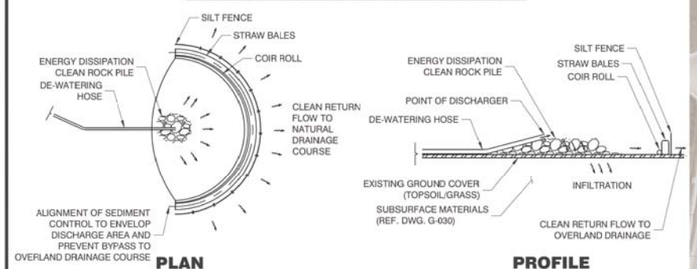
DETAIL 1 - SEDIMENT CONTROL AREA



PLAN
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0 20 (1:1,500) 80m

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES.

GOOD HOUSEKEEPING PRACTICES ITEMS:

1) PROPER PLACEMENT AND PROTECTION OF STOCKPILE SOILS AND MATERIALS. PLACEMENT OF MATERIALS ON A CITY OF CALGARY STREET OR WHERE WIND/WATER COULD TRANSPORT MATERIAL OFF-SITE IS PROHIBITED UNDER THE CITY OF CALGARY STREET BYLAW. STOCKPILES ARE TO BE PROPERLY PLACED AND PROTECTED ON SITE SO MATERIAL WILL NOT BE ERODED TO OFF-SITE AREAS, INCLUDING STORM INLETS.

2) CONTROL OF MUD TRACK OUT DURING CONSTRUCTION, USUALLY BY MEANS OF A WELL MAINTAINED CONSTRUCTION ENTRANCE/EXIT ON ALL ACCESS LOCATIONS, SUPPLEMENTED WITH PERIODIC STREET SWEEPING IF REQUIRED.

3) DUST CONTROL MUST BE IMPLEMENTED ON SITE, WHEN REQUIRED.

4) INSTALL DOWN-GRADIENT PERIMETER PROTECTION (SUCH AS SILT FENCE, COMPOST SOCKS OR FIBER ROLLS) TO PROTECT OFF-SITE AREAS FROM STORMWATER RUNOFF AND SEDIMENTATION DURING CONSTRUCTION.

5) TEMPORARY SEDIMENT CONTROL AT ANY STORM INLETS REQUIRES PRIOR WRITTEN APPROVAL BY THE CITY OF CALGARY. ONE OF THE FORMS OF WRITTEN APPROVAL IS APPROVED EROSION AND SEDIMENT CONTROL DRAWINGS. WHEN INSTALLING INLET PROTECTION MAKE SURE THAT THEY MATCH WHAT IS SHOWN ON THE APPROVED DRAWINGS. FOR MOST SITES, THE ONLY LOCATION WHERE INLET PROTECTION WOULD BE APPROVED IS DIRECTLY ADJACENT TO A GRAVEL PAD OR STOCKPILE. FAILURE TO OBTAIN APPROVAL CAN LEAD TO FINES UNDER THE CITY OF CALGARY DRAINAGE BYLAW. PLEASE CONTACT THE CITY OF CALGARY WATER SERVICES (CALL 3-1-1) FOR MORE INFORMATION IF YOU WISH TO USE INLET PROTECTION ON OR NEAR YOUR GOOD HOUSEKEEPING SITE.

GENERAL ITEMS:

1) INSPECTIONS OF ALL EROSION AND SEDIMENT CONTROL MEASURES BY THE CONTRACTOR DURING THE CONSTRUCTION PERIOD MUST BE COMPLETED AND DOCUMENTED DAILY AND DURING, OR WITHIN 24 HOURS OF, HEAVY SNOWMELT AND HEAVY AND/OR PROLONGED RAINFALL (DEFINED AS > 12 mm PRECIPITATION WITHIN ANY 24 HOUR PERIOD, OR PRECIPITATION OR SNOWMELT ON WET OR THAWING SOILS). INSPECTION DOCUMENTATION MUST CONTAIN NOTES REGARDING DAMAGE AND DEFICIENCIES OBSERVED.

2) IMMEDIATE ACTION MUST BE TAKEN BY THE CONTRACTOR WHEN THE NEED FOR MAINTENANCE OR REPAIR OF EROSION AND SEDIMENT CONTROL MEASURES IS IDENTIFIED FOR THE ONGOING PERFORMANCE OF THE MEASURES.

3) THE CONSULATANT SHOULD INSPECT THE EROSION AND SEDIMENT CONTROL MEASURES EVERY 7 DAYS AND FOLLOWING HEAVY RAINSTORMS OR SNOWMELT EVENTS ANDADVISE THE CONTRACTOR IMMEDIATELY OF ANY AREAS OF CONCERN.

4) ANY OFF-SITE RELEASES OF SEDIMENT-LADEN WATER OR OTHER CONTAMINANTS TO A STORM DRAINAGE SYSTEM OR THE ENVIRONMENT MUST BE IMMEDIATELY REPORTED BY CALLING 1-800-222-6514 AND 3-1-1.

5) PRIOR AUTHORIZATION (A DRAINAGE OR DEWATERING PERMIT) IS REQUIRED FROM THE CITY OF CALGARY PRIOR TO PUMPING OR DIRECTING IMPOUNDED SURFACE WATER AND/OR GROUNDWATER INTO A STORM SEWER. MORE INFORMATION ON PERMITS IS AVAILABLE AT WWW.CALGARY.CA/WQS OR BY CONTACTING 3-1-1.

6) LONGER TERM STOCKPILES (IN PLACE MORE THAN 30 DAYS) MUST BE COVERED OR STABILIZED WITH MULCH AND TACKIFIER, VEGETATION COVER OR OTHER SUITABLE MEASURES. STOCKPILES IN PLACE LESS THAN 30 DAYS MUST HAVE FUNCTIONAL SEDIMENT CONTROL PRACTICES ON THE DOWN-GRADIENT SIDE OF THE PILE THAT WILL CONTAIN SEDIMENT (SILT FENCE, FIBRE ROLLS, COMPOST SOCKS, ETC.). SOIL WINDROWED DURING UTILITY EXCAVATIONS SHOULD BE PLACED UP-GRADIENT OF THE TRENCH; IN THE ABSENCE OF OTHER SPECIFIC REGULATORY OR PROJECT REQUIREMENTS, MAXIMUM LENGTH OF OPEN EXCAVATION PRIOR TO BACKFILLING AND STABILIZATION IS 150 m.

7) DURING A CONSTRUCTION SHUTDOWN (DEFINED AS ANY EXTENDED PERIOD OF TIME DURING WHICH THE CONTRACTOR IS NOT ACTIVELY DEVELOPING THE PROJECT SITE AND MAY NO LONGER HAVE PERSONNEL OR EQUIPMENT ON SITE), EROSION AND SEDIMENT CONTROL MEASURES MUST STILL BE MAINTAINED, INCLUDING WINTER SHUTDOWNS AND SPRING FRESHET PRIOR TO CONSTRUCTION RE-START.

8) ALL CATCHBASIN INLET PROTECTION MUST BE REMOVED AT FINAL ACCEPTANCE CERTIFICATE.

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PROFESSIONAL ENGINEER ALBERTA
19 April 2017

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A	JAN.10/2017	MG	PAC	AKS	ORIGINAL PLAN PREPARED
B	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT
EROSION AND SEDIMENT CONTROL PLAN

Project No.	3552-004	Drawing No.	Rev.
Group	CIVIL	G-040	B

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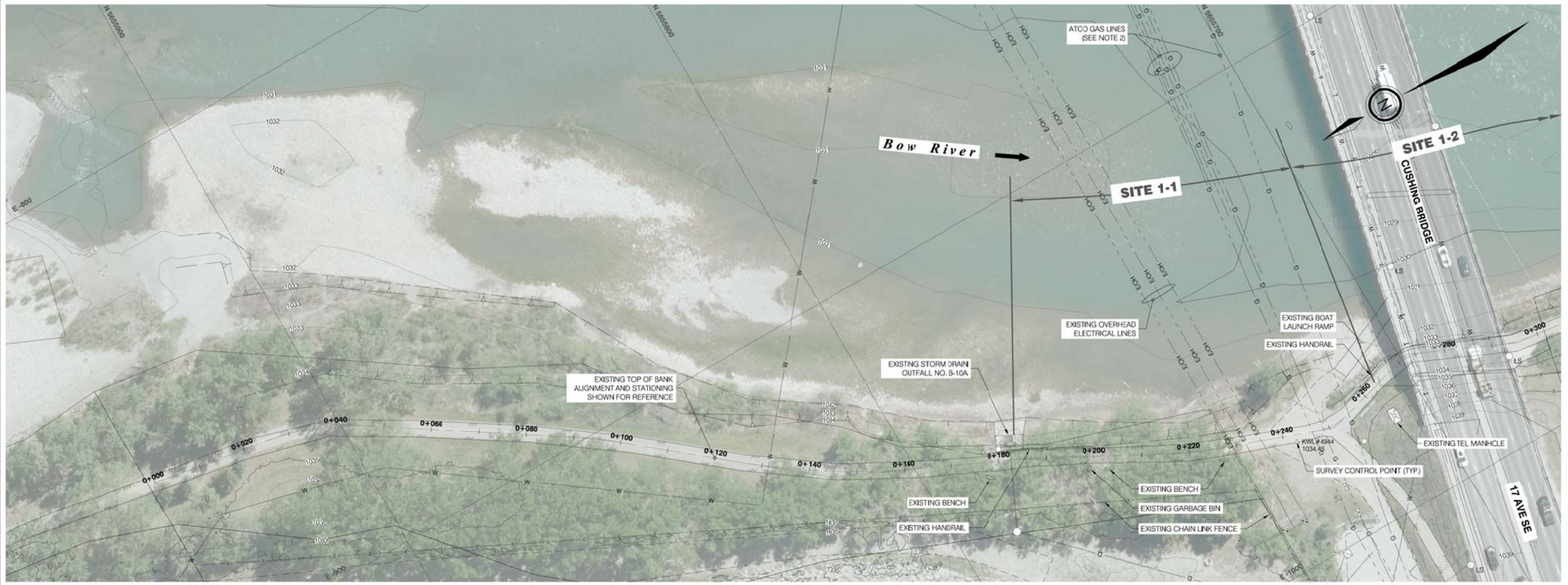

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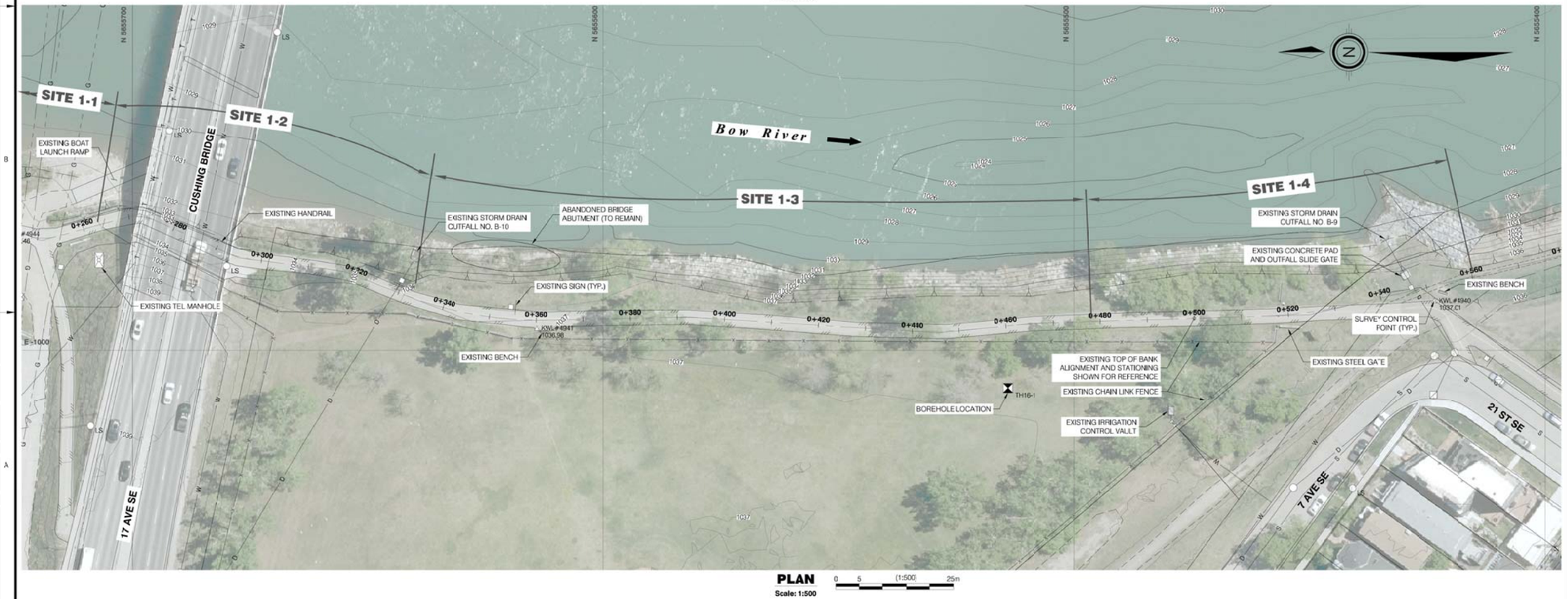

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NOTES:

1. REFER TO DWG G-320 FOR LEGEND AND GENERAL NOTES
2. ATCO GAS DISPOSITION (ROE1239)

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APEGA PERMIT TO PRACTICE NO. P07929

Seal:
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.14/2016	TWC	PAC	AKS	ORIGINAL PLAN PREPARED
B	NOV.14/2016	TWC	TWC	AKS	UPDATED CONTOURS & LINEWORK PER SEP 2016 SURVEY
C	JAN.09/2017	TWC	TWC	MG	BOREHOLES AND SURVEY CONTROL ADDED
D	JAN.31/2017	TWC	TWC	MG	UPDATED NOTES
E	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT
SITE 1
EXISTING CONDITIONS PLAN

Project No.	Drawing No.	Rev.
3552-004	SW-100	E
Group: CIVIL		

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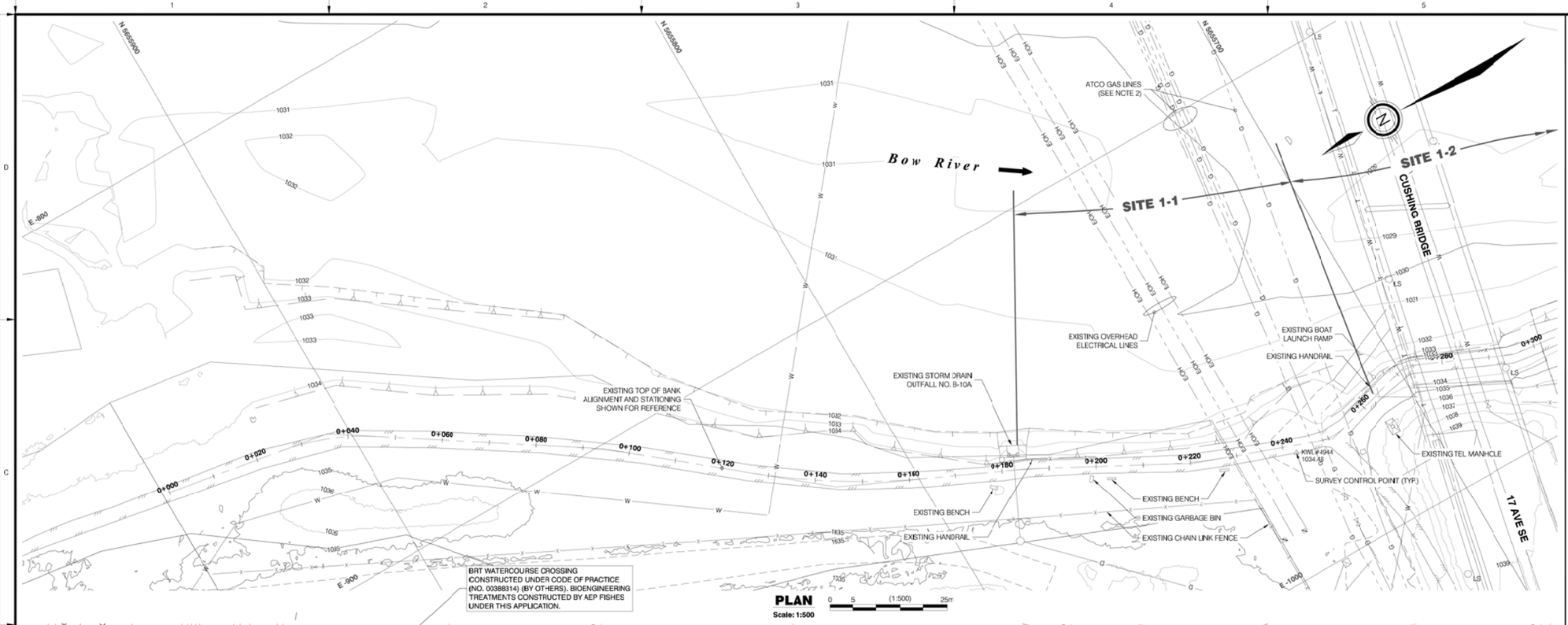

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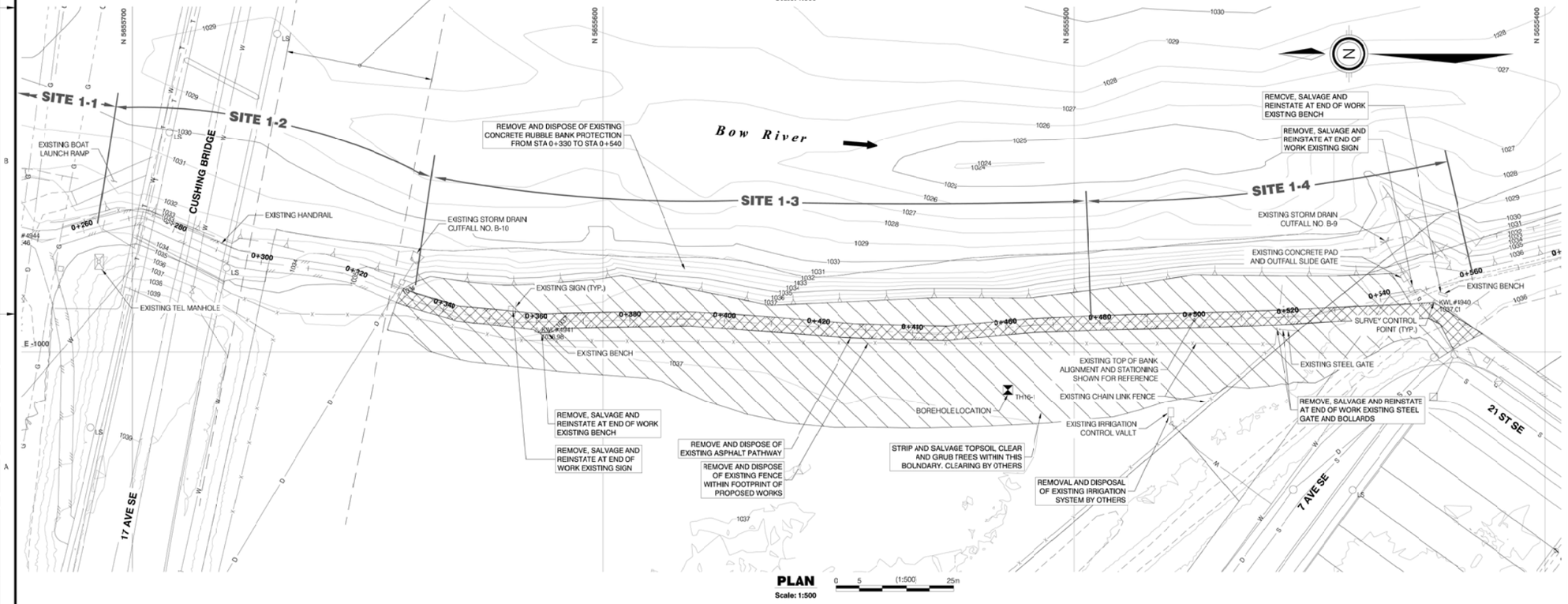

PLAN
Scale: 1:500

KERR WOOD LEIDAL
consulting engineers
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Terra Erosion Control Ltd.
308 Hart St. Nelson, B.C. V1L 5N5
Tel: 250 352 2757
www.terraerosion.com

NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES
2. ATCO GAS DISPOSITION (ROE1239)

LEGEND:

PATH REMOVAL

CLEARING, GRUBBING, STRIPPING BOUNDARY

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

Seal:
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	APR.19/2017	MG	MAR	AKS	ORIGINAL PLAN PREPARED

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT
SITE 1
DEMOLITION PLAN

Project No.	Drawing No.	Rev.
3552-004	SW-110	A
Group: CIVIL		

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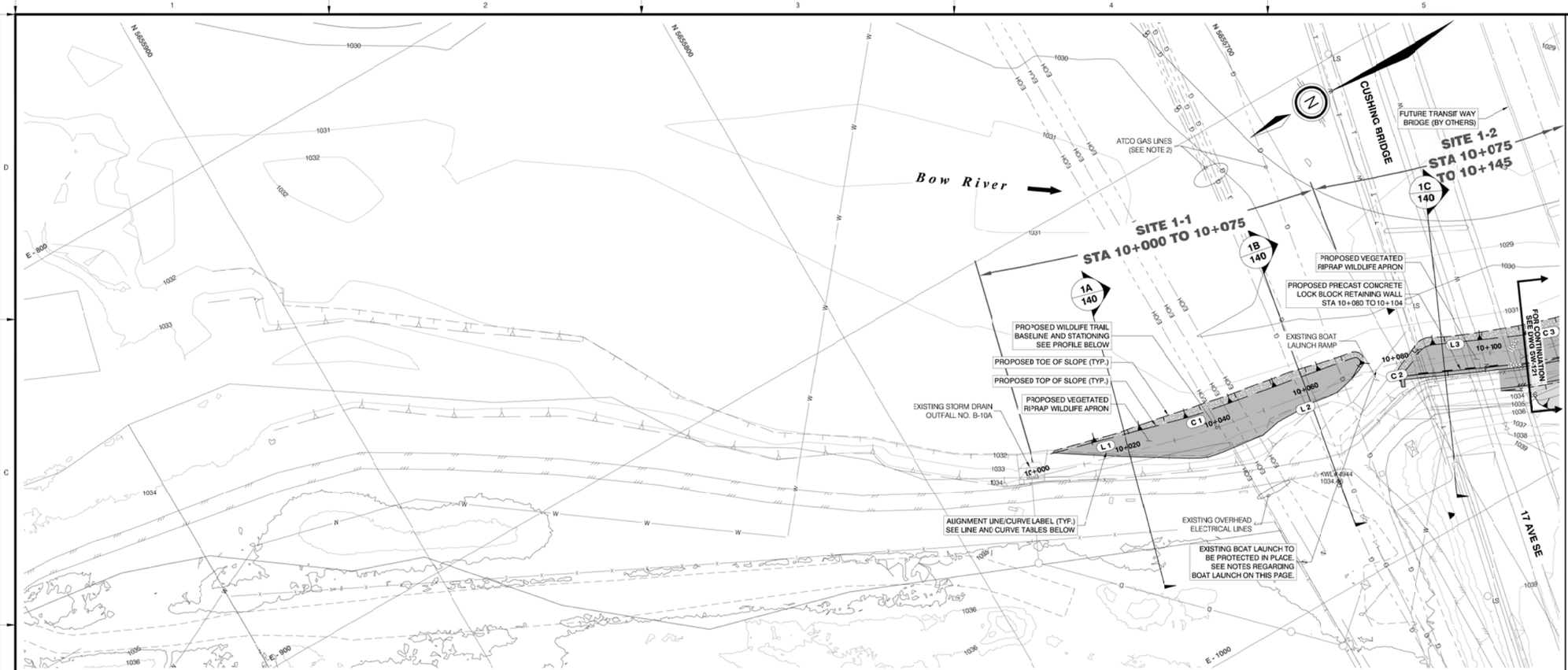


PLAN
Scale: 1:500

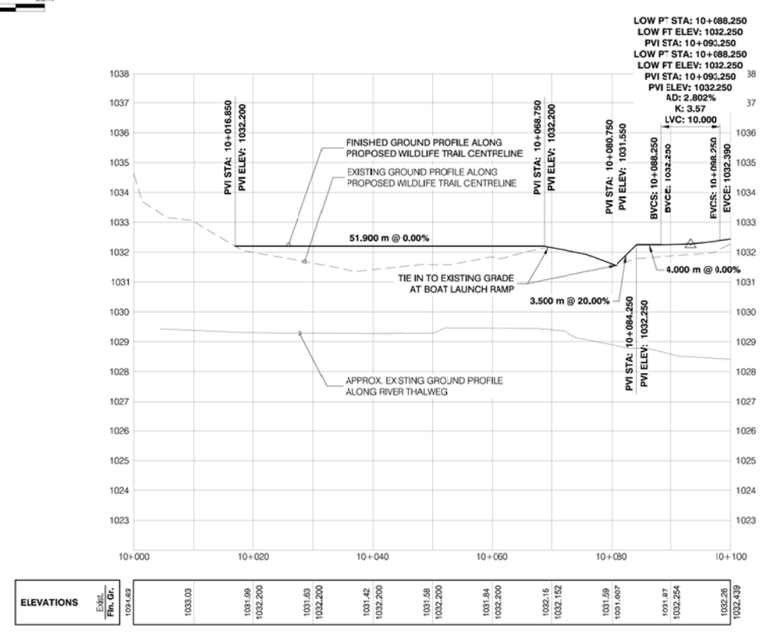
0 5 (1:500) 25m

ALIGNMENT LINE DATA

LINE #	START STATION	END STATION	LENGTH	AZIMUTH	START COORDINATES	END COORDINATES
L 1	10+000.000	10+030.928	30.928 m	195° 14' 04"	N=5655778.939 E=-946.200	N=5655749.098 E=-954.327
L 2	10+040.082	10+077.059	36.977 m	189° 59' 23"	N=5655740.167 E=-956.325	N=5655703.751 E=-962.740
L 3	10+081.953	10+103.720	21.767 m	204° 00' 34"	N=5655689.083 E=-964.167	N=5655679.199 E=-973.024
L 4	10+122.649	10+144.582	21.933 m	193° 09' 51"	N=5655661.284 E=-979.048	N=5655639.927 E=-984.043
L 5	10+146.250	10+228.517	82.266 m	183° 36' 25"	N=5655638.279 E=-984.286	N=5655556.176 E=-989.462
L 6	10+229.150	10+283.197	54.046 m	179° 58' 32"	N=5655555.542 E=-989.482	N=5655501.496 E=-989.458
L 7	10+283.320	10+326.557	43.236 m	180° 41' 07"	N=5655561.372 E=-989.459	N=5655458.139 E=-989.976
L 8	10+346.988	10+380.000	33.012 m	168° 58' 46"	N=5655437.827 E=-988.139	N=5655405.423 E=-981.829

ALIGNMENT CURVE DATA

CURVE #	RADIUS	DELTA	CURVE LENGTH	TANGENT LENGTH	BEG. CURVE STATION	END CURVE STATION	BEG. CURVE COORDINATES	END CURVE COORDINATES	PI COORDINATES	CENTER OF CURVE COORDINATES
C 1	100.000	5°14'42"	9.154	4.580	10+030.928	10+040.082	N=5655749.098 E=-954.327	N=5655740.167 E=-956.325	N=5655744.678 E=-955.531	N=5655722.821 E=-857.841
C 2	20.000	14°01'12"	4.694	2.459	10+077.059	10+081.953	N=5655703.751 E=-962.740	N=5655699.083 E=-964.167	N=5655701.329 E=-963.166	N=5655707.220 E=-982.436
C 3	100.000	10°50'43"	18.929	9.493	10+103.720	10+122.649	N=5655679.199 E=-973.024	N=5655661.284 E=-979.048	N=5655670.528 E=-976.886	N=5655638.510 E=-881.676
C 4	10.000	9°33'25"	1.668	0.836	10+144.582	10+146.250	N=5655639.927 E=-984.043	N=5655638.279 E=-984.286	N=5655639.113 E=-984.234	N=5655637.650 E=-974.306
C 5	10.000	3°37'54"	0.634	0.317	10+228.517	10+229.150	N=5655556.176 E=-989.462	N=5655555.542 E=-989.482	N=5655555.859 E=-989.482	N=5655555.547 E=-979.482
C 7	100.000	11°42'21"	20.431	10.251	10+326.557	10+346.988	N=5655458.139 E=-989.976	N=5655437.827 E=-988.139	N=5655447.889 E=-990.099	N=5655456.943 E=-889.983



ELEVATIONS	Exist. / Fin. Gr.	1034.63	1033.03	1031.99 / 1032.200	1031.63 / 1032.200	1031.42 / 1032.200	1031.58 / 1032.200	1031.84 / 1032.200	1032.15 / 1032.152	1031.59 / 1031.607	1031.87 / 1032.254	1032.26 / 1032.499

PROFILE
Scale: H 1:500 V 1:100

0 5 (H 1:500) 25m
0 1 (V 1:100) 5m

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EXISTING CITY OF CALGARY FIRE DEPARTMENT BOAT RAMP NOTES:

1. CITY OF CALGARY FIRE DEPARTMENT REQUIRES UNOBSTRUCTED ACCESS TO THE BOAT RAMP.
2. DO NOT STOCKPILE MATERIAL OR STORE EQUIPMENT IN SUCH A MANNER THAT MAY OBSTRUCT ACCESS TO THE BOAT LAUNCH.
3. DO NOT LEAVE EQUIPMENT UNATTENDED ON THE ACCESS ROAD OR NEAR THE BOAT LAUNCH THAT MAY OBSTRUCT ACCESS TO THE BOAT LAUNCH.

NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES
2. ATCO GAS DISPOSITION (ROE1239)

LEGEND:

-PROPOSED RIPRAP

-PROPOSED VEGETATED RIPRAP

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

Seal:
ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF ALBERTA
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.15/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.14/2016	TWC	TWC	AKS	CONTOURS AND LINEWORK UPDATED PER SEP.2016 SURVEY
C	NOV.25/2016	TWC	TWC	AKS	PROPOSED WORKS SHOWN
D	JAN.06/2017	TWC	TWC	MG	REVISED WILDLIFE APRON ALIGNMENT
E	JAN.31/2017	TWC	TWC	MG	ALIGNMENT LINE AND CURVE LAYOUT INFORMATION ADDED
F	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
WILDLIFE TRAIL PLAN AND PROFILE
STATION 10+000 TO 10+100

Project No.	3552-004	Drawing No.	SW-120	Rev.	F
Group	CIVIL				

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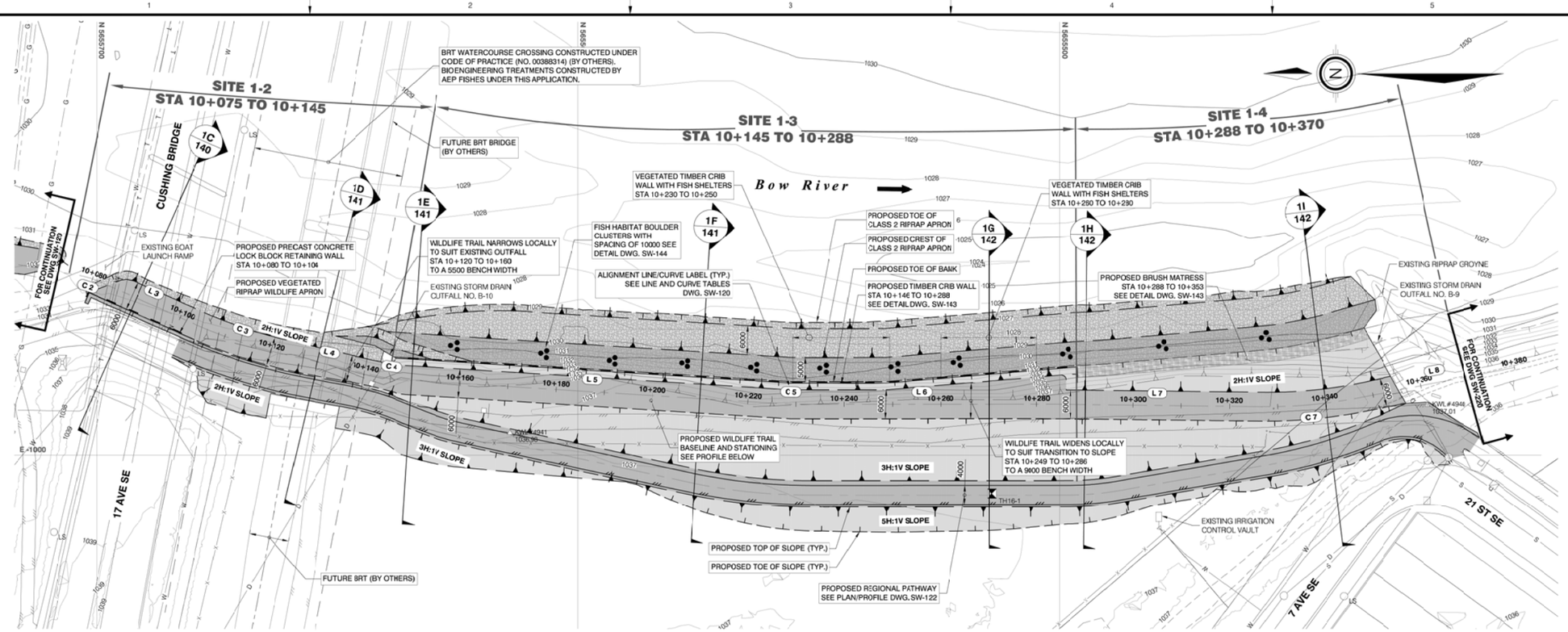
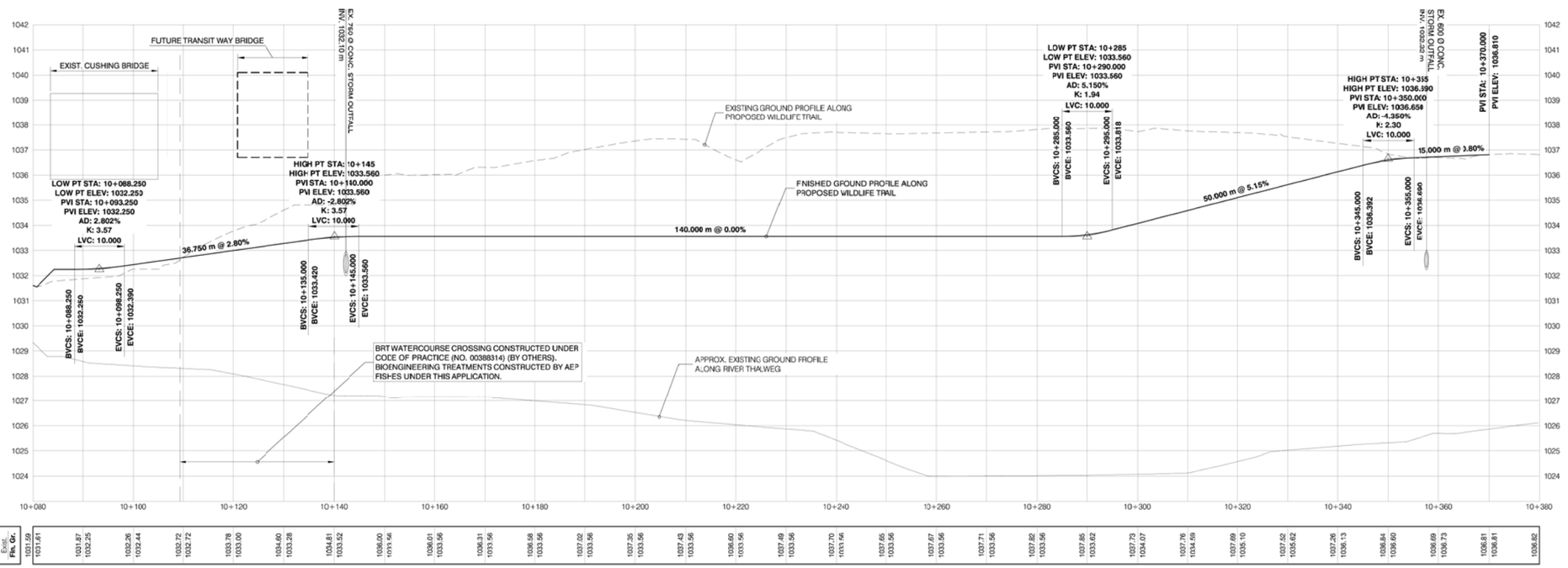


PLAN
Scale: 1:500



PROFILE
Scale: H 1:500 V 1:100

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Tel: 250 352 2757
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NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES

LEGEND:

- PROPOSED RIPRAP APRON BENCH
- PROPOSED RIPRAP APRON
- PROPOSED BRUSH MATTRESS

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

Seal:
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.15/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.14/2016	TWC	TWC	AKS	CONTOURS AND LINEWORK UPDATED PER SEP.2016 SURVEY
C	NOV.23/2016	TWC	TWC	AKS	PROPOSED WORKS SHOWN
D	JAN.09/2017	TWC	TWC	MG	ADJUSTED PATHWAY ALIGNMENT AND GRADING
E	JAN.17/2017	TWC	TWC	AKS	ADJUSTED TOE OF BANK GEOMETRY
F	JAN.31/2017	TWC	TWC	MG	ADJUSTED PATHWAY ALIGNMENT, ADDED LAYOUT INFO
G	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
WILDLIFE TRAIL PLAN AND PROFILE
STATION 10+080 TO 10+380

Project No. 3552-004
Group CIVIL
Drawing No. SW-121
Rev. G

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BRT WATERCOURSE CROSSING CONSTRUCTED UNDER CODE OF PRACTICE (NO. 00388314) (BY OTHERS). BIOENGINEERING TREATMENTS CONSTRUCTED BY AEP FISHES UNDER THIS APPLICATION.

CUSHING BRIDGE

Bow River

FUTURE BRT BRIDGE (BY OTHERS)

FUTURE BRT (BY OTHERS)

SITE 1-2
STA 10+075 TO 10+145
(WILDLIFE ALIGNMENT)

SITE 1-3
STA 10+145 TO 10+288
(WILDLIFE ALIGNMENT)

SITE 1-4
STA 10+288 TO 10+370
(WILDLIFE ALIGNMENT)

FOR CONTINUATION SEE DWG SW-120

FOR CONTINUATION SEE DWG SW-220

EXISTING BOAT LAUNCH RAMP

EXISTING STORM DRAIN OUTFALL NO. B-10

EXISTING STORM DRAIN OUTFALL NO. B-9

PROPOSED RIPRAP APRON
SEE PLAN/PROFILE DWG. SW-121

2H:1V SLOPE

3H:1V SLOPE

5H:1V SLOPE

PROPOSED WILDLIFE TRAIL
SEE PLAN/PROFILE DWG. SW-121

PROPOSED REGIONAL PATHWAY BASELINE AND STATIONING
SEE PROFILE BELOW (BY OTHERS)

ALIGNMENT LINE/CURVE LABEL (TYP.)
SEE LINE AND CURVE TABLES ABOVE

PROPOSED REGIONAL PATHWAY (BY OTHERS)
SEE TYP. SECTION DWG. SW-144

PROPOSED TOP OF SLOPE (TYP.)

PROPOSED TOE OF SLOPE (TYP.)

EXISTING IRRIGATION CONTROL VAULT

21 ST SE

7 AVE SE

KWL #4946
1037.01

ALIGNMENT LINE DATA

LINE #	START STATION	END STATION	LENGTH	AZIMUTH	START COORDINATES	END COORDINATES
L 10	11+000.000	11+001.839	1.839 m	168° 34' 57"	N=5655702.175 E=-971.872	N=5655700.374 E=-971.508
L 11	11+006.785	11+020.965	14.180 m	204° 00' 33"	N=5655695.535 E=-972.042	N=5655682.582 E=-977.811
L 12	11+048.640	11+057.534	8.894 m	190° 47' 43"	N=5655656.233 E=-986.070	N=5655647.496 E=-987.736
L 13	11+067.591	11+073.625	6.034 m	202° 19' 13"	N=5655637.872 E=-990.597	N=5655632.290 E=-992.889
L 14	11+082.441	11+130.128	47.687 m	192° 13' 07"	N=5655623.883 E=-995.502	N=5655577.276 E=-1005.595
L 15	11+155.725	11+209.461	53.735 m	179° 59' 49"	N=5655551.872 E=-1008.314	N=5655498.137 E=-1008.311
L 16	11+219.703	11+251.238	31.535 m	170° 12' 58"	N=5655487.944 E=-1007.438	N=5655456.868 E=-1002.079
L 17	11+273.640	11+275.269	1.629 m	157° 22' 51"	N=5655435.400 E=-995.842	N=5655433.897 E=-995.215
L 18	11+294.245	11+300.000	5.755 m	211° 44' 38"	N=5655415.683 E=-996.669	N=5655410.788 E=-999.696

ALIGNMENT CURVE DATA

CURVE #	RADIUS	DELTA	CURVE LENGTH	TANGENT LENGTH	BEG. CURVE STATION	END CURVE STATION	BEG. CURVE COORDINATES	END CURVE COORDINATES	PI COORDINATES	CENTER OF CURVE COORDINATES
C 10	8.000	35°25'36"	4.946	2.555	11+001.839	11+006.785	N=5655700.374 E=-971.508	N=5655695.535 E=-972.042	N=5655697.869 E=-971.002	N=5655698.790 E=-979.350
C 11	120.000	13°12'50"	27.675	13.899	11+020.965	11+048.640	N=5655682.582 E=-977.811	N=5655656.233 E=-986.070	N=5655669.886 E=-983.467	N=5655633.756 E=-868.194
C 12	56.000	11°31'30"	10.057	5.046	11+057.534	11+067.591	N=5655647.496 E=-987.736	N=5655637.872 E=-990.597	N=5655642.539 E=-988.681	N=5655656.881 E=-1036.851
C 13	56.000	10°06'05"	8.815	4.419	11+073.625	11+082.441	N=5655632.290 E=-992.889	N=5655623.883 E=-995.502	N=5655628.202 E=-994.567	N=5655613.301 E=-946.635
C 14	120.000	12°13'19"	25.597	12.847	11+130.128	11+155.725	N=5655577.276 E=-1005.595	N=5655551.872 E=-1008.314	N=5655564.719 E=-1008.314	N=5655551.879 E=-888.314
C 15	66.000	9°16'50"	10.242	5.134	11+209.461	11+219.703	N=5655498.137 E=-1008.311	N=5655487.944 E=-1007.438	N=5655493.063 E=-1008.310	N=5655498.140 E=-948.311
C 16	100.000	12°50'08"	22.402	11.248	11+251.238	11+273.640	N=5655456.868 E=-1002.079	N=5655435.400 E=-995.842	N=5655445.783 E=-1000.168	N=5655473.861 E=-903.534
C 17	26.000	54°21'47"	18.976	10.270	11+275.269	11+294.245	N=5655433.897 E=-995.215	N=5655415.683 E=-996.669	N=5655424.417 E=-991.265	N=5655426.205 E=-1013.677

PLAN
Scale: 1:500

0 5 (1:500) 25m

LOW PT STA: 11+035
LOW PT ELEV: 1033.258
PVI STA: 11+040.000
PVI ELEV: 1033.290
AD: 2.150%
K: 4.65
LVC: 10.000

LOW PT STA: 11+055
LOW PT ELEV: 1033.710
PVI STA: 11+050.000
PVI ELEV: 1033.850
AD: 2.200%
K: 4.55
LVC: 10.000

FUTURE TRANSIT WAY BRIDGE

EXIST. CUSHING BRIDGE

EX. 750 Ø CONC. STORM OUTFALL INV. 1032.10 m

EX. 600 Ø CONC. STORM OUTFALL INV. 1032.32 m

PVI STA: 11+020.000
PVI ELEV: 1033.160

BVCS: 11+035.000
BVCE: 1033.258

EVCS: 11+045.000
EVCE: 1033.400

BVCS: 11+055.000
BVCE: 1033.710

EVCE: 1034.100
EVCS: 11+065.000

BVCS: 11+120.000
BVCE: 1036.850

HIGH PT STA: 11+160
HIGH PT ELEV: 1037.850
PVI STA: 11+140.000
PVI ELEV: 1037.350
AD: -5.000%
K: 8.00
LVC: 40.000

EVCS: 11+160.000
EVCE: 1037.850

FINISHED GROUND PROFILE ALONG PROPOSED PATH CL

EXISTING GROUND PROFILE ALONG PROPOSED PATH CL

HIGH PT STA: 11+215
HIGH PT ELEV: 1037.850
PVI STA: 11+220.000
PVI ELEV: 1037.850
AD: -1.000%
K: 10.00
LVC: 10.000

BVCS: 11+215.000
BVCE: 1037.850

EVCS: 11+225.000
EVCE: 1037.800

HIGH PT STA: 11+255
HIGH PT ELEV: 1037.400
PVI STA: 11+270.000
PVI ELEV: 1037.350
AD: -2.700%
K: 3.70
LVC: 10.000

BVCS: 11+255.000
BVCE: 1037.400

EVCS: 11+275.000
EVCE: 1037.166

HIGH PT STA: 11+283
HIGH PT ELEV: 1036.869
PVI STA: 11+288.000
PVI ELEV: 1036.684
AD: -8.300%
K: 1.20
LVC: 10.000

BVCS: 11+283.000
BVCE: 1036.869

EVCS: 11+293.000
EVCE: 1036.084

PVI STA: 11+295.000
PVI ELEV: 1035.844

55.000 m @ 5.00%

15.000 m @ 0.65%

10.000 m @ 2.88%

55.000 m @ 0.00%

40.000 m @ -1.00%

8.000 m @ -3.70%

2.000 m @ -12.00%

BRT WATERCOURSE CROSSING CONSTRUCTED UNDER CODE OF PRACTICE (NO. 00388314) (BY OTHERS). BIOENGINEERING TREATMENTS CONSTRUCTED BY AEP FISHES UNDER THIS APPLICATION.

11+000 11+020 11+040 11+060 11+080 11+100 11+120 11+140 11+160 11+180 11+200 11+220 11+240 11+260 11+280 11+300

ELEVATIONS	Existing	Proposed
	1033.82	1033.10 / 1033.16 / 1033.16 / 1033.44 / 1033.22 / 1034.22 / 1033.32 / 1035.43 / 1033.57 / 1035.78 / 1033.88 / 1036.38 / 1034.35 / 1036.76 / 1034.85 / 1037.02 / 1035.35 / 1036.98 / 1035.85 / 1036.94 / 1036.35 / 1036.89 / 1036.85 / 1036.90 / 1037.29 / 1036.96 / 1037.60 / 1036.99 / 1037.79 / 1037.06 / 1037.85 / 1037.14 / 1037.85 / 1037.28 / 1037.85 / 1037.34 / 1037.85 / 1037.34 / 1037.85 / 1037.36 / 1037.85 / 1037.48 / 1037.84 / 1037.51 / 1037.75 / 1037.41 / 1037.65 / 1037.23 / 1037.55 / 1037.06 / 1037.45 / 1036.74 / 1037.32 / 1036.85 / 1036.98 / 1036.43 / 1036.41

PROFILE
Scale: H 1:500 V 1:100

0 5 (H 1:500) 25m
0 1 (V 1:100) 5m

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Tel: 250 352 2757
www.terraerosion.com

NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES

LEGEND:

- PROPOSED RIPRAP APRON BENCH
- PROPOSED RIPRAP APRON
- PROPOSED BRUSH MATTRESS
- PROPOSED VEGETATED SLOPE
- PROPOSED VEGETATED BENCH AND PATHWAY

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

Seal:
PROFESSIONAL ENGINEER ALBERTA
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	JAN.09/2017	TWC	TWC	MG	ORIGINAL PLAN PREPARED
B	JAN.17/2017	TWC	TWC	AKS	ADJUSTED TOE OF BANK GEOMETRY
C	JAN.31/2017	TWC	TWC	MG	ADJUSTED PATHWAY ALIGNMENT, ADDED LAYOUT INFO
D	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
REGIONAL PATHWAY PLAN AND PROFILE
STATION 11+000 TO 11+300

Project No.	Drawing No.	Rev.
3552-004	SW-122	D
Group: CIVIL		

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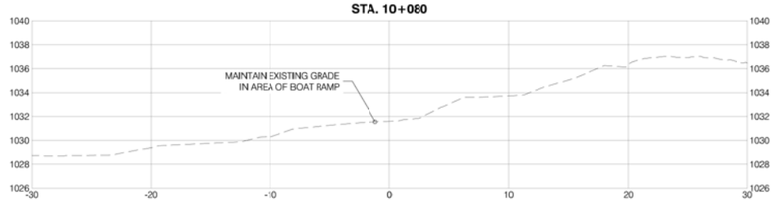
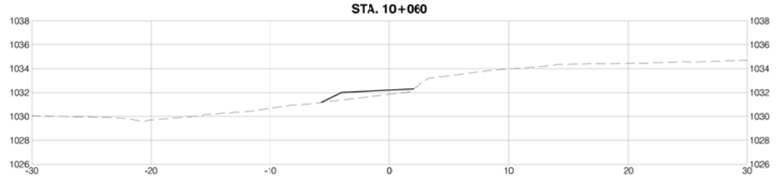
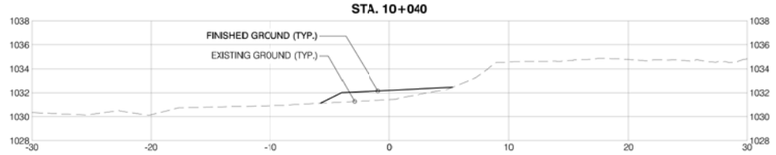
STA. 10+080



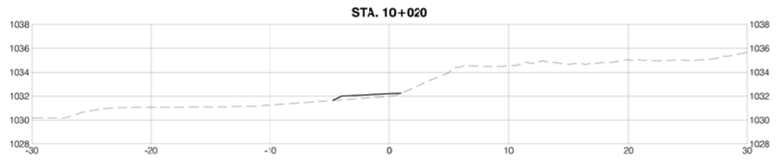
STA. 10+060



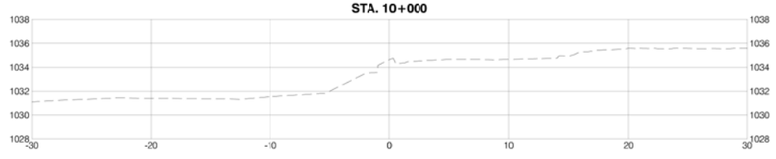
STA. 10+040



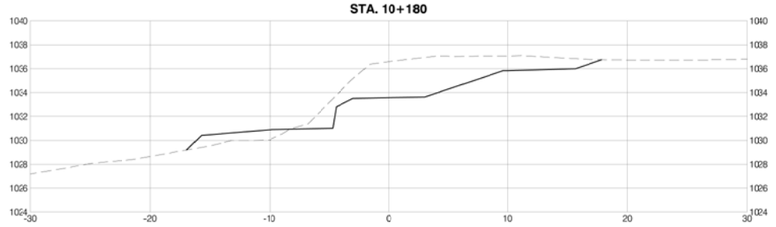
STA. 10+020



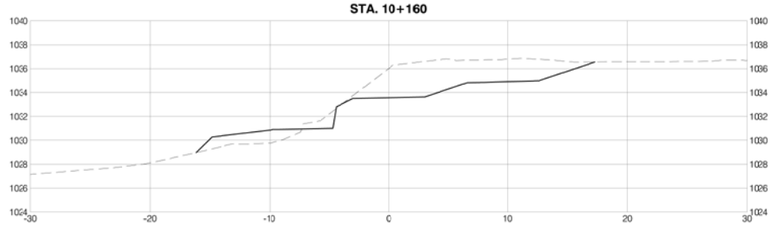
STA. 10+000



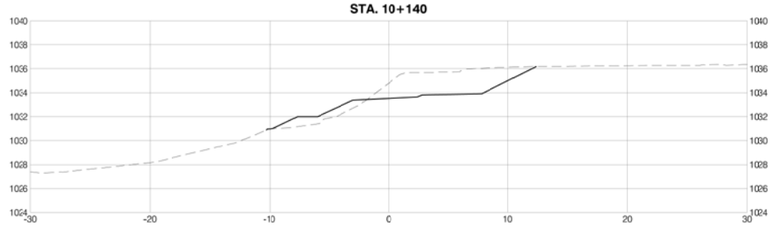
STA. 10+180



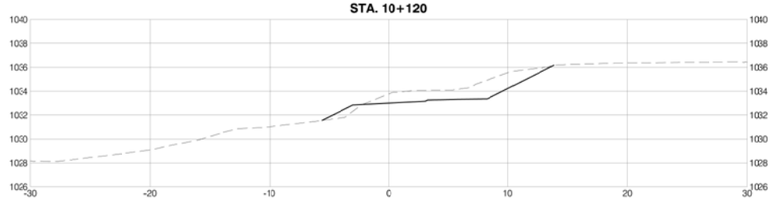
STA. 10+160



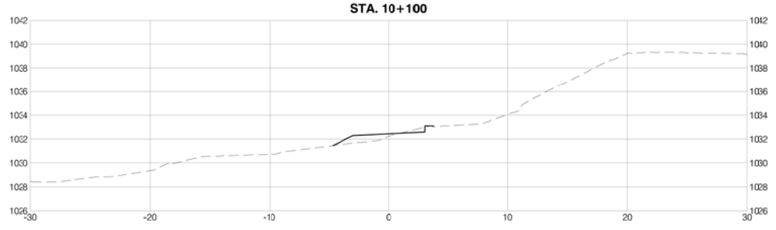
STA. 10+140



STA. 10+120



STA. 10+100



SECTIONS
Scale: 1:250

0 2 (1:250) 10m

KERR WOOD LEIDAL
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NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES
2. SECTIONS TAKEN ALONG WILDLIFE TRAIL ALIGNMENT. REFER TO DRAWING SW-120.
3. STATIONS 10+140 AND 10+120 ARE WITHIN BRT WATERCOURSE CROSSING CONSTRUCTED UNDER CODE OF PRACTICE (NO. 00388314) (BY OTHERS). BIOENGINEERING TREATMENTS BY AEP FISHES UNDER THIS APPLICATION.

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

Seal:
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.14/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
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F	JAN.31/2016	TWC	TWC	MG	ADJUSTED PATHWAY ALIGNMENT
G	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
SECTIONS
STATION 10+000 TO 10+180

Project No. 3552-004
Drawing No. SW-130
Rev. G
Group CIVIL

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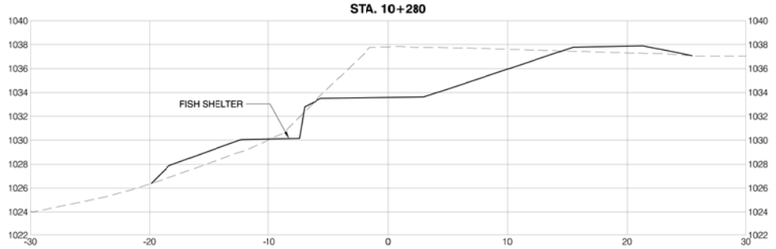
STA. 10+280



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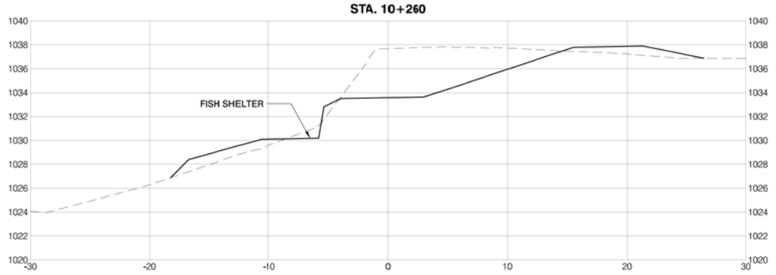
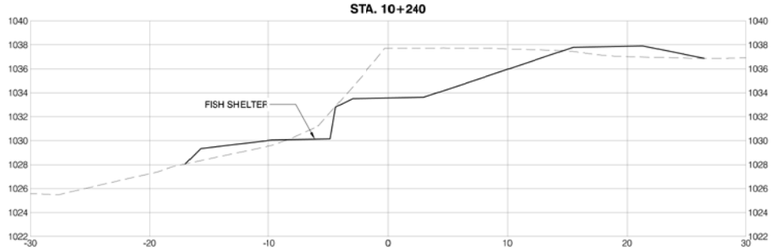
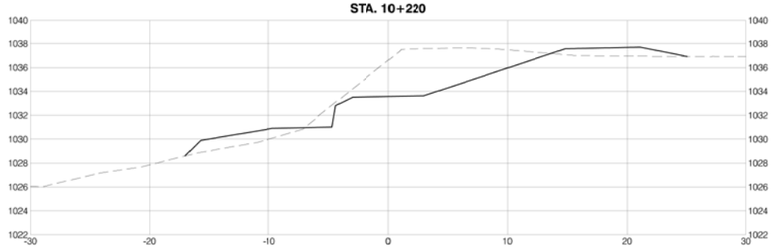


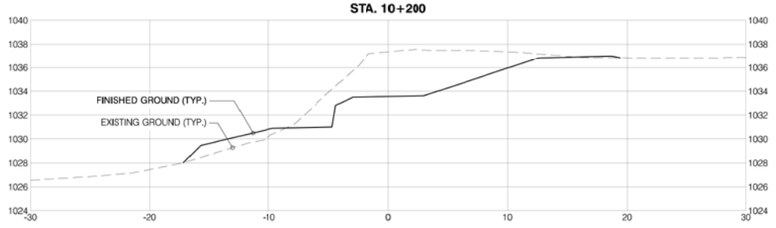
STA. 10+240



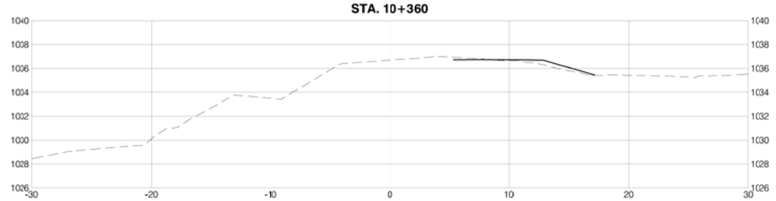
STA. 10+220



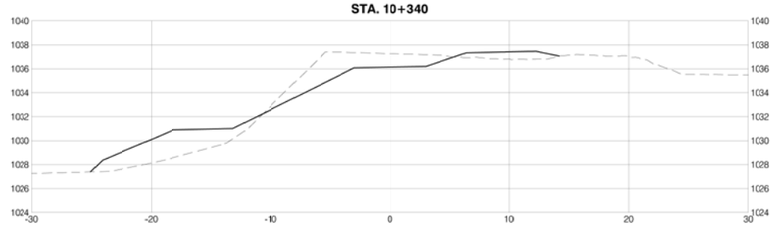
STA. 10+200



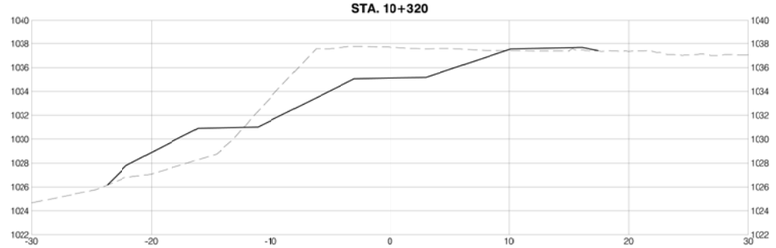
STA. 10+360



STA. 10+340



STA. 10+320



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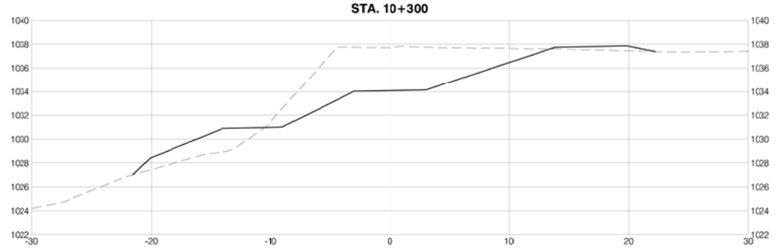

SECTIONS
Scale: 1:250

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NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES
2. SECTIONS TAKEN ALONG WILDLIFE TRAIL ALIGNMENT, REFER TO DRAWING SW-120.

Issued for Approval
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APEGA PERMIT TO PRACTICE NO. P07929

Seal:
PROFESSIONAL ENGINEER ALBERTA
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.14/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
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BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
SECTIONS
STATION 10+200 TO 10+380

Project No. 3552-004
Group CIVIL
Drawing No. SW-131
Rev. F

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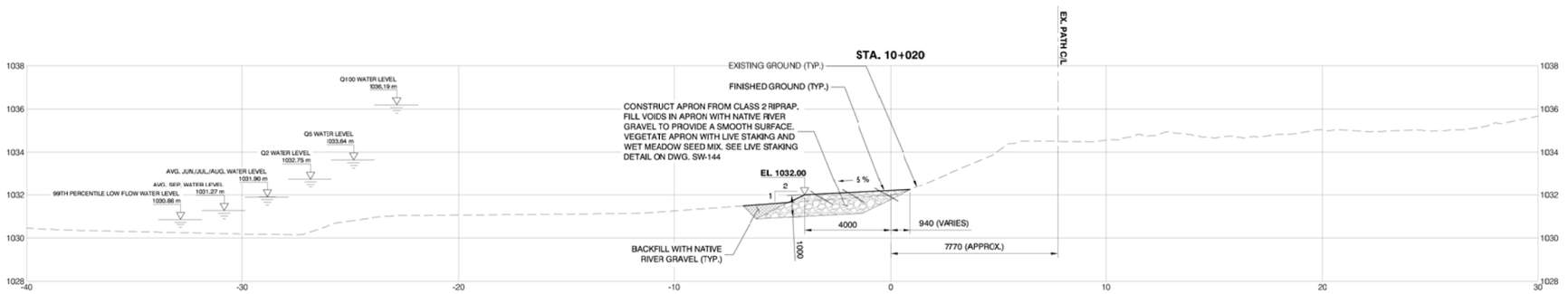

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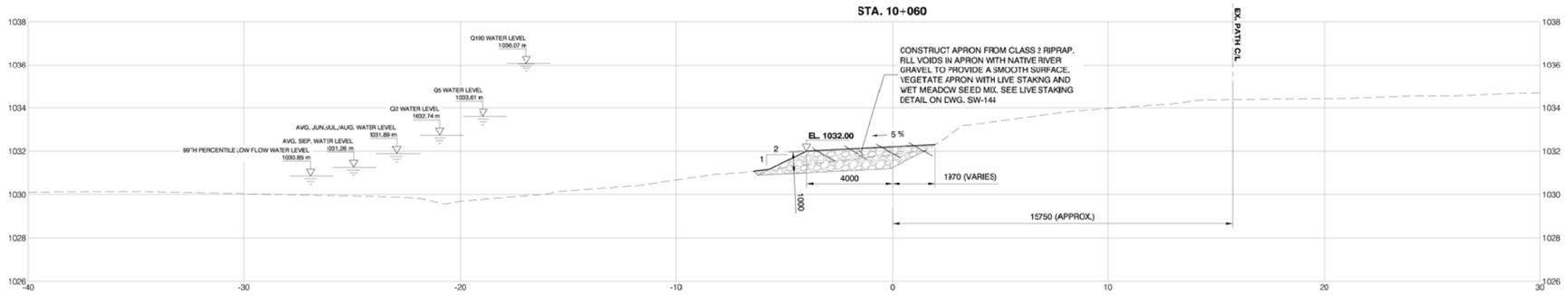

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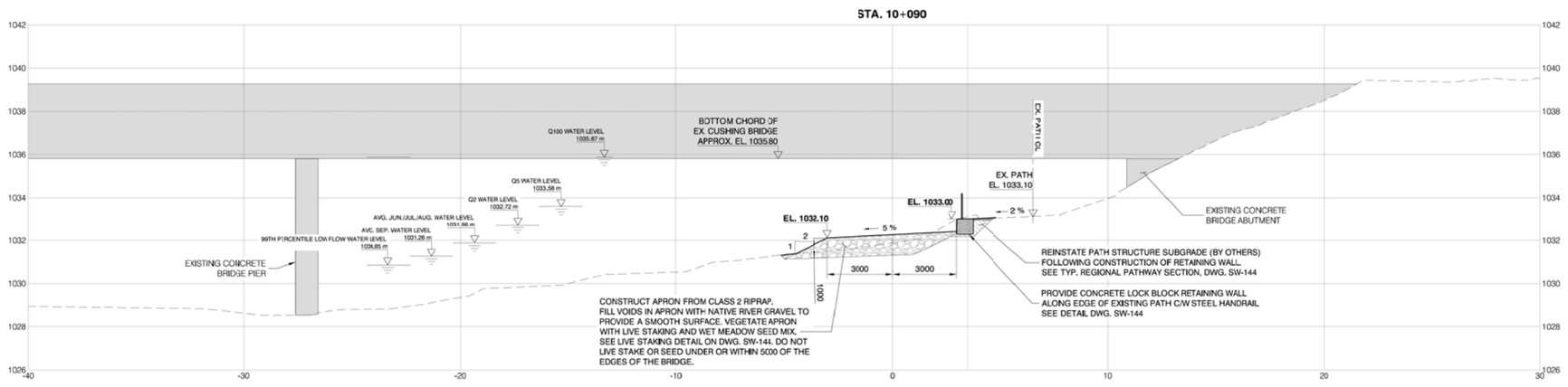

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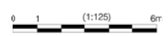

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NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES

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G	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
TYPICAL SECTIONS - SHEET 1

Project No.	Drawing No.	Rev.
3552-004	SW-140	G
Group: CIVIL		

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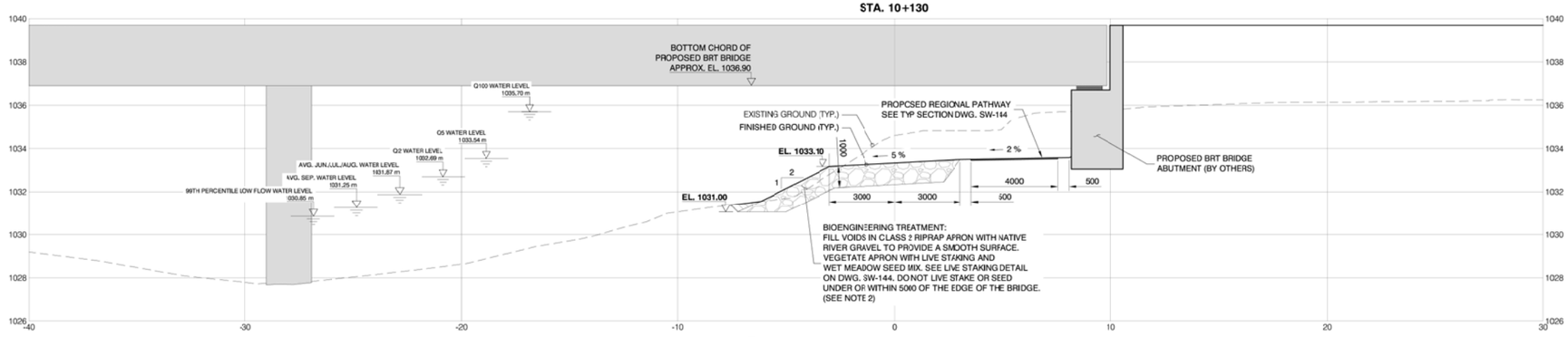
STA. 10+130



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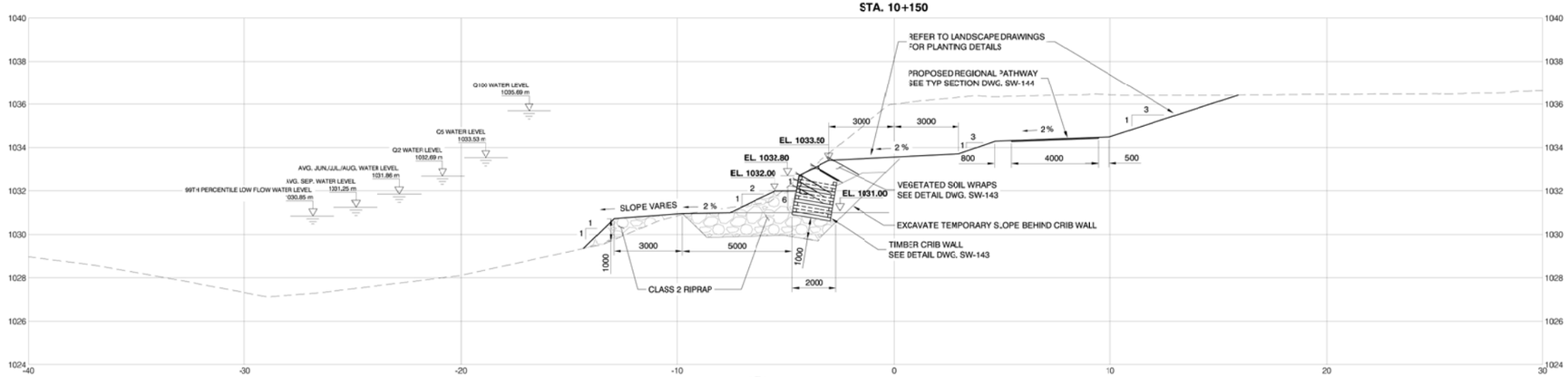
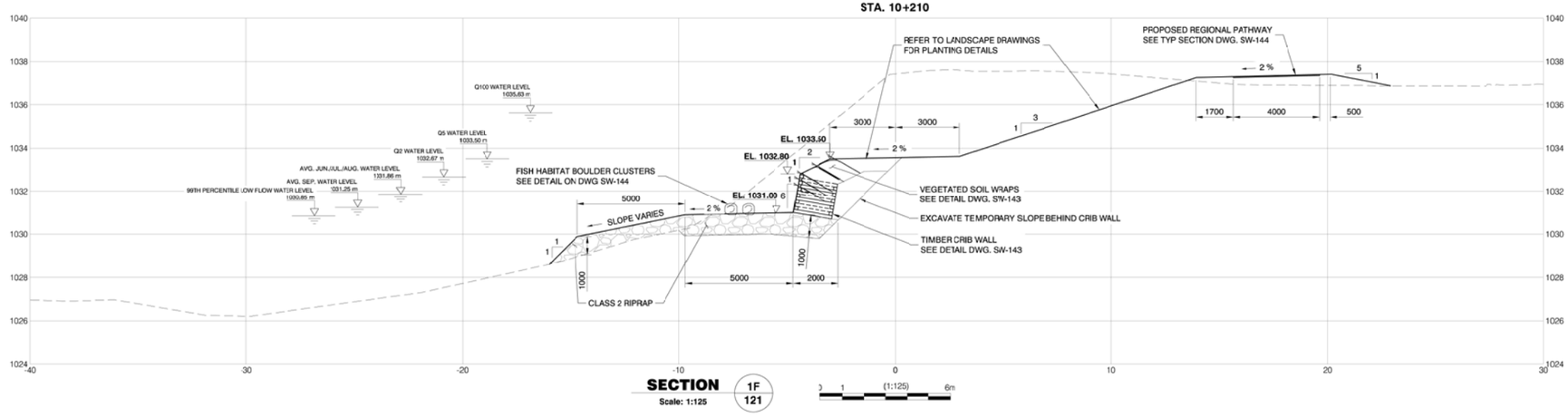
STA. 10+150



SECTION 1E / 121 — Scale: 1:125 (1:125) 6m

STA. 10+210



SECTION 1F / 121 — Scale: 1:125 (1:125) 6m

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NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES
2. BRT WATERCOURSE CROSSING CONSTRUCTED UNDER CODE OF PRACTICE (NO. 00388314) (BY OTHERS). BIOENGINEERING TREATMENTS CONSTRUCTED BY AEP FISHES UNDER THIS APPLICATION.

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

Seal: ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF ALBERTA — 19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.15/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.15/2016	TWC	TWC	AKS	EG UPDATED PER SEP. 2016 SURVEY, WATER LEVELS SHOWN
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F	JAN.31/2017	TWC	TWC	MG	ADJUSTED PATHWAY ALIGNMENT, UPDATED NOTES
G	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
TYPICAL SECTIONS - SHEET 2

Project No. 3552-004
Group CIVIL
Drawing No. SW-141
Rev. G

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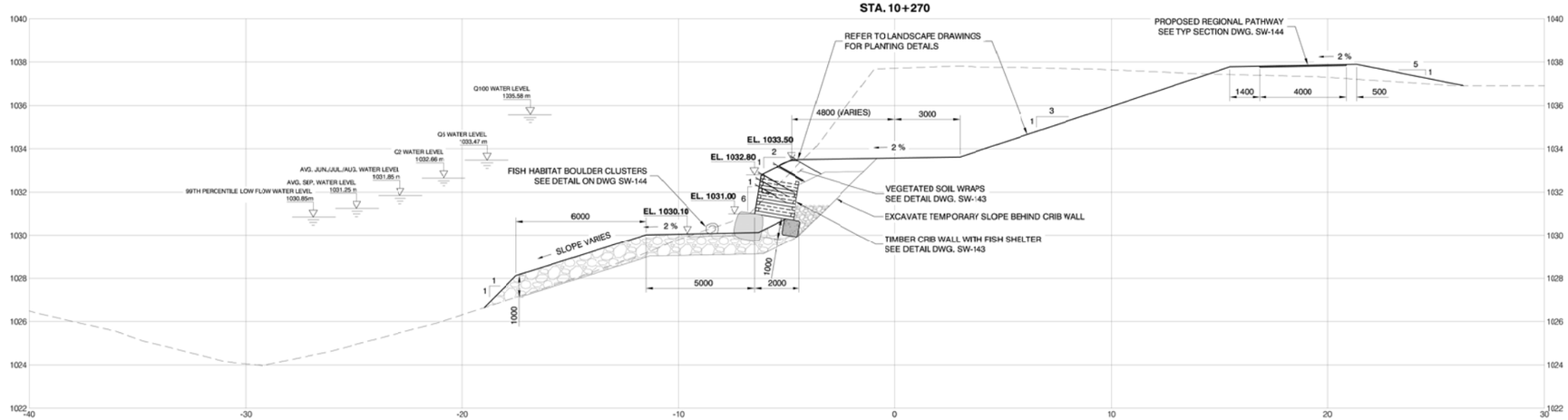
STA. 10+270



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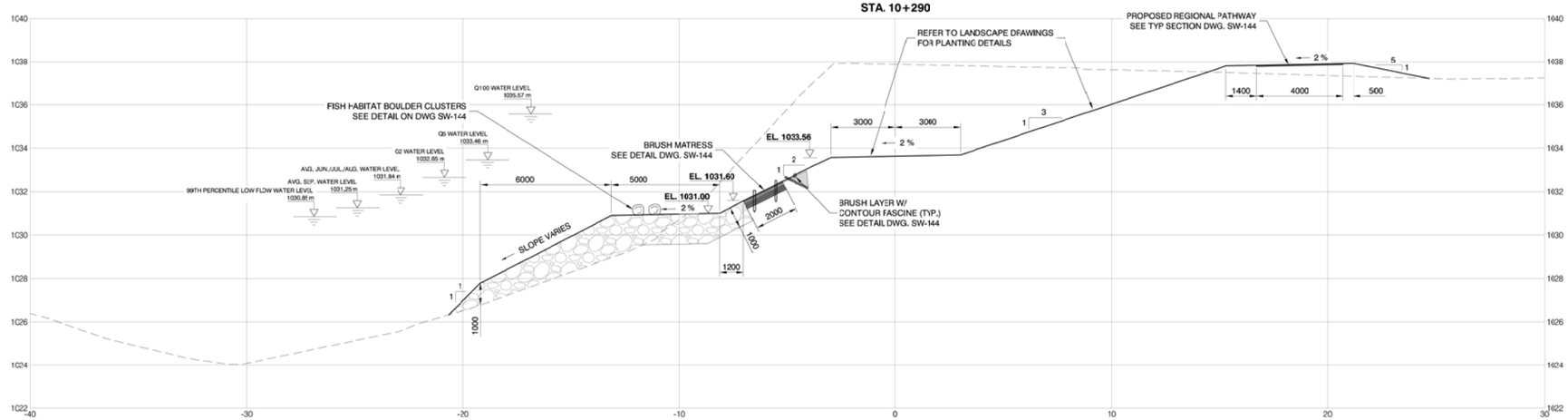
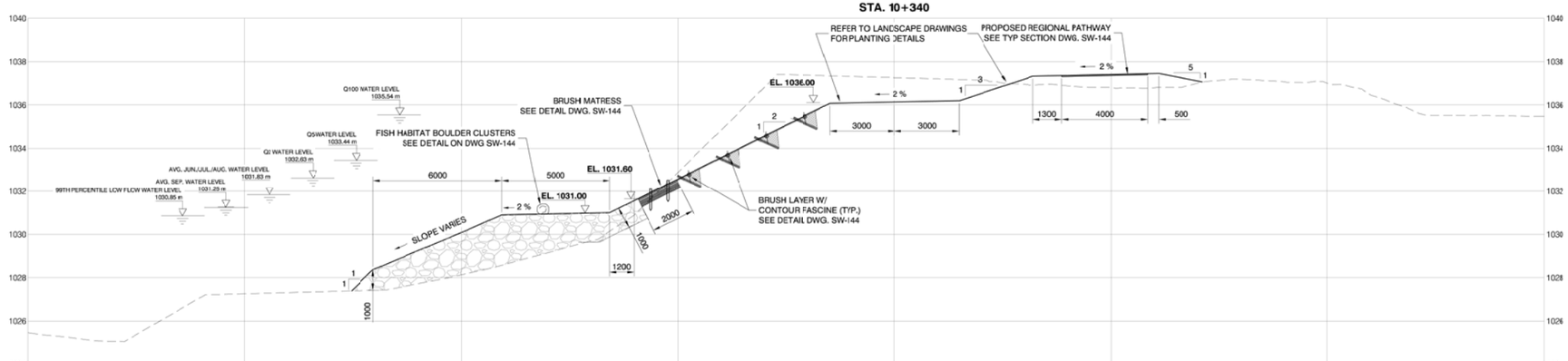
STA. 10+290



SECTION 1H / 121 — Scale: 1:125 — 0 1 (1:125) 6m

STA. 10+340



SECTION 1I / 121 — Scale: 1:125 — 0 1 (1:125) 6m

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NOTES:

1. REFER TO DWG G-C20 FOR LEGEND AND GENERAL NOTES

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Seal: PROFESSIONAL ENGINEER ALBERTA 19 April 2017

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BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
TYPICAL SECTIONS - SHEET 3

Project No. 3552-004
Group CIVIL
Drawing No. SW-142
Rev. G

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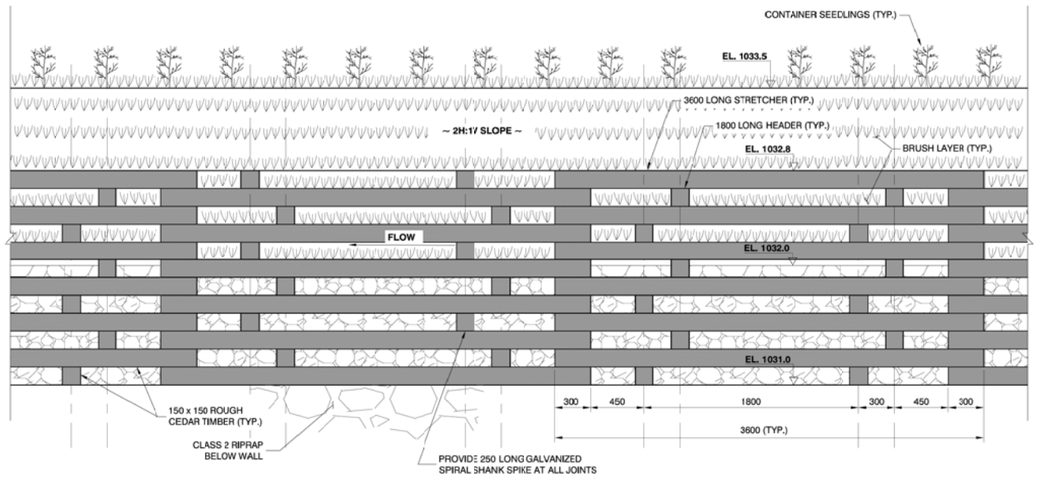

TIMBER CRIB WALL ELEVATION

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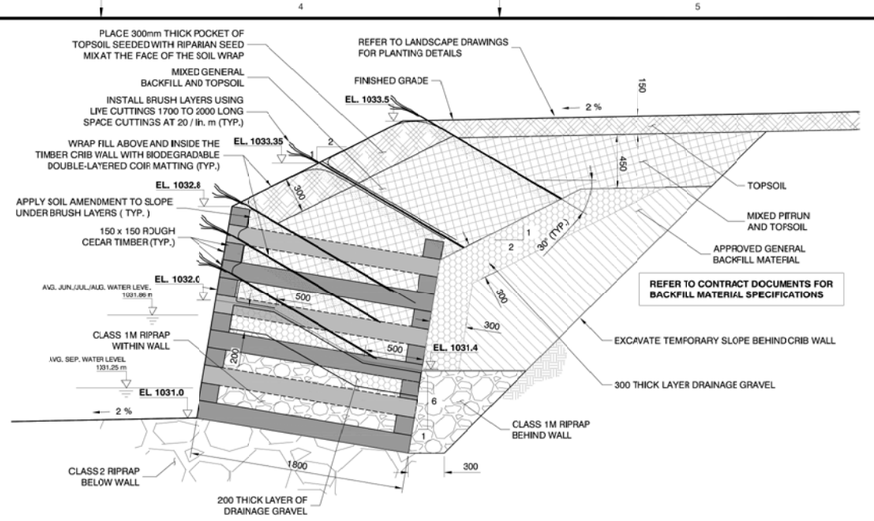

TIMBER CRIB WALL SECTION

Scale: 1:25

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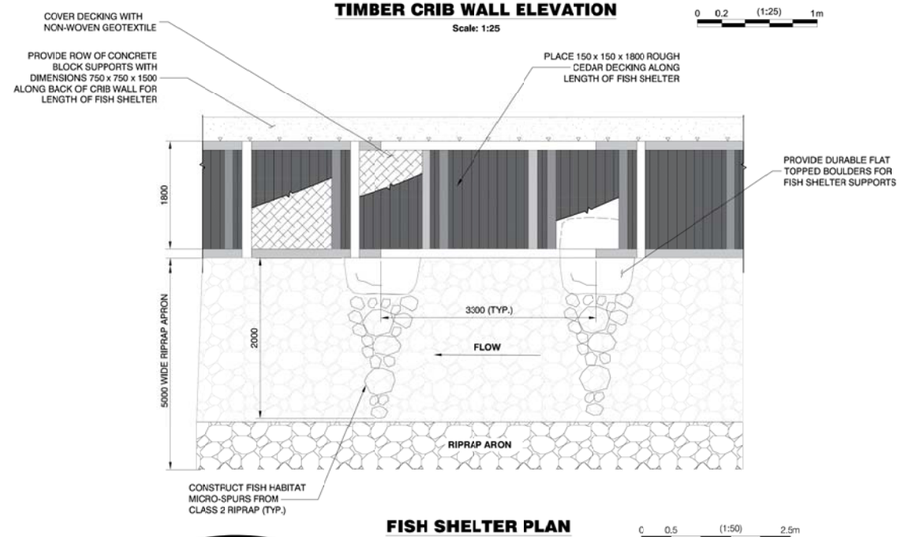

FISH SHELTER PLAN

Scale: 1:50

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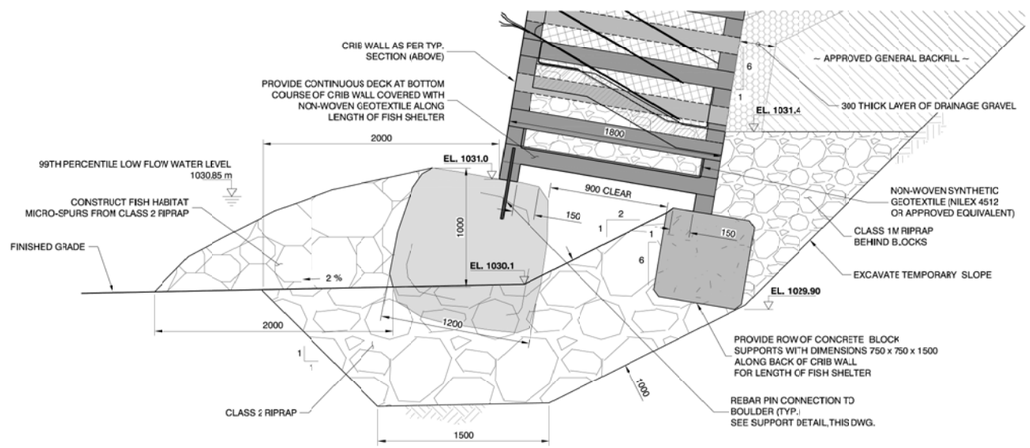

FISH SHELTER SECTION

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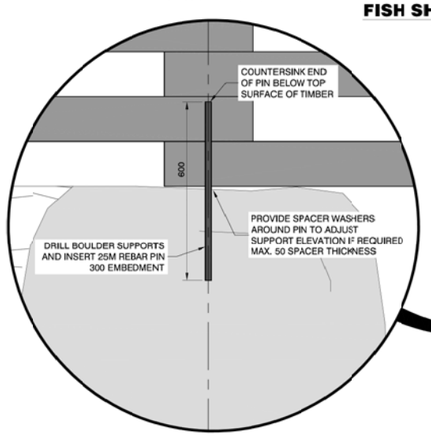

FISH SHELTER SUPPORT DETAIL

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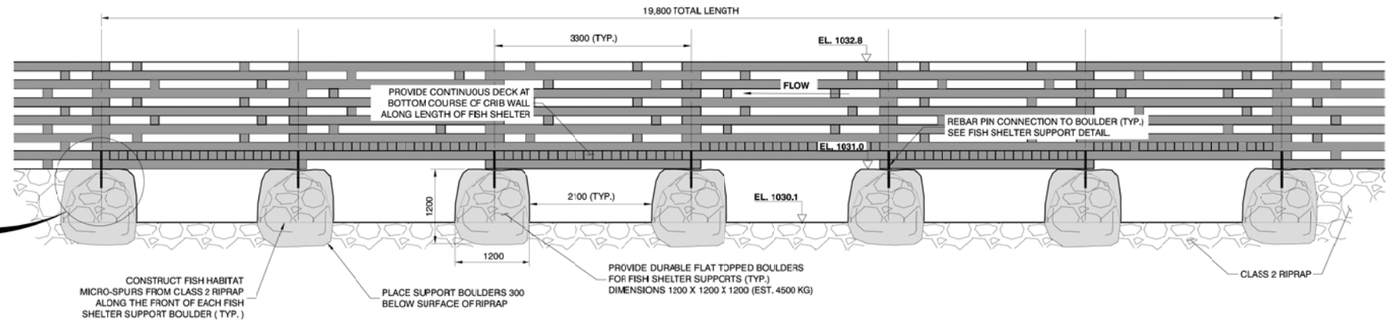

FISH SHELTER ELEVATION

Scale: 1:50

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NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES

LEGEND:

- APPROVED GENERAL BACKFILL
- PROPOSED DRAINAGE GRAVEL
- MIXED PITRUN AND TOPSOIL
- TOPSOIL
- CLASS 2 RIPRAP
- CLASS 1M RIPRAP

Issued for Approval
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APEGA PERMIT TO PRACTICE NO. P07929

Seal: ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS & GEOPHYSICISTS OF ALBERTA
19 April 2017

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B	JAN.13/2017	TWC	TWC	MG	FISH SHELTER DETAILS ADDED
C	JAN.31/2017	TWC	TWC	MG	UPDATED NOTES
D	APR.03/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
CRIB WALL AND FISH SHELTER DETAILS

Project No.	Drawing No.	Rev.
3552-004	SW-143	D
Group: CIVIL		

SAVED 2017-04-03 10:05 AM
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At Full Size, this border measures 520 mm x 800 mm
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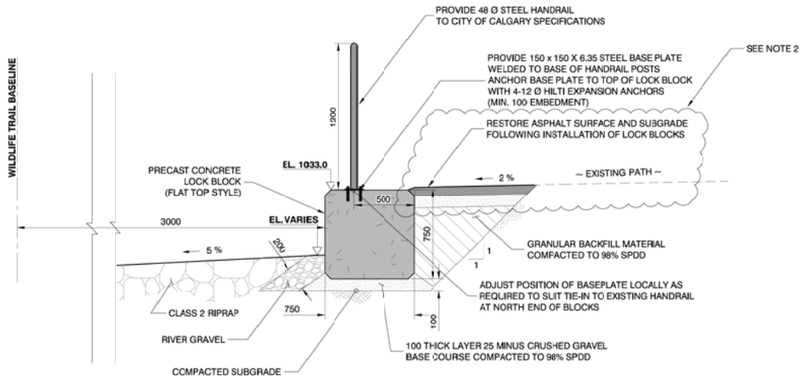
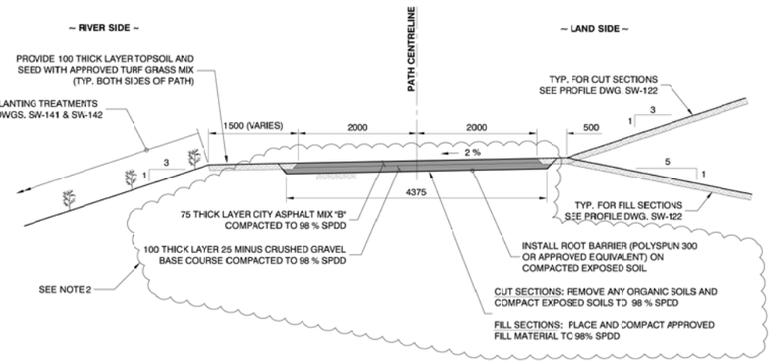


LOCK BLOCK WALL AND HANDRAIL DETAIL (CUSHING BRIDGE)

Scale: 1:25

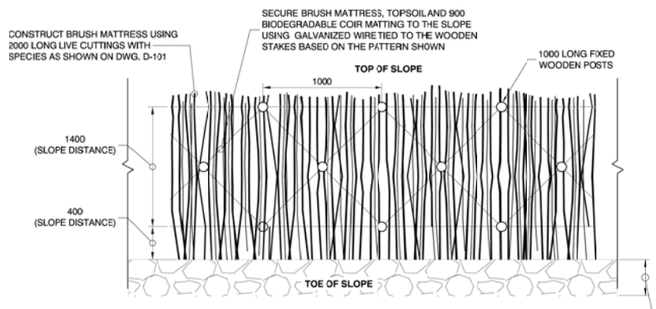
0 0.2 (1:25) 1m



REGIONAL PATHWAY TYP. SECTION

Scale: 1:50

0 0.5 (1:50) 2.5m

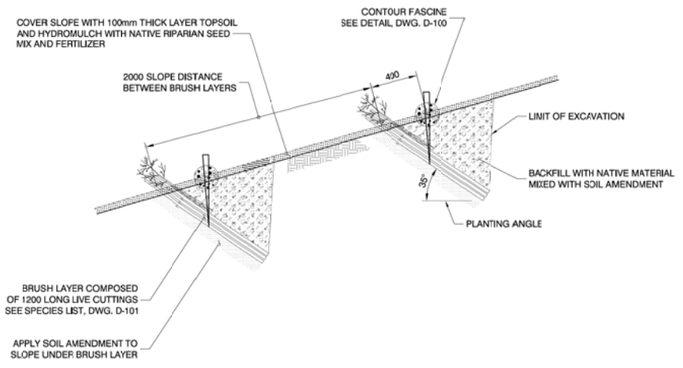


BRUSH MATTRESS WITH ROCK TOE DETAIL - PLAN

Scale: 1:25

0 0.2 (1:25) 1m

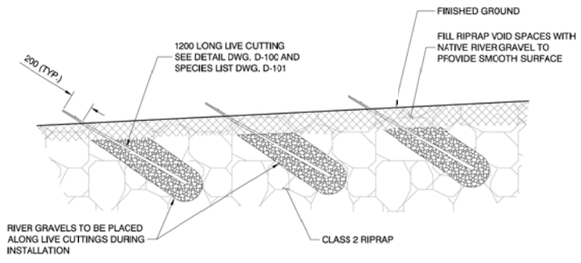
COVER BRUSH MATTRESS TOE
WITH 300 THICK LAYER OF RIPRAP



BRUSH LAYER W/ CONTOUR FASCINE DETAIL

Scale: 1:25

0 0.2 (1:25) 1m



APRON LIVE STAKING DETAIL

Scale: 1:25

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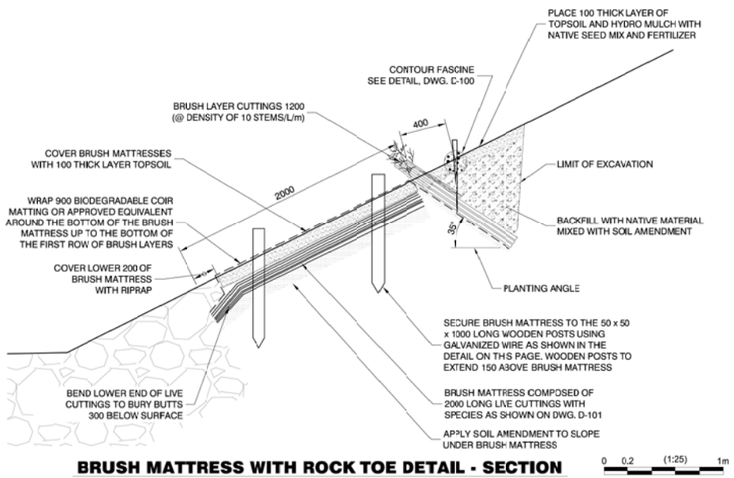

BRUSH MATTRESS WITH ROCK TOE DETAIL - SECTION

Scale: 1:25

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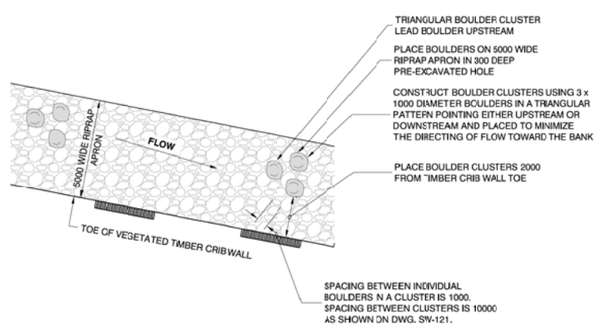
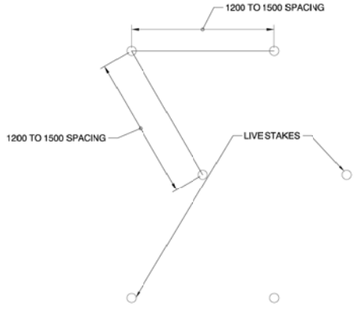


FISH HABITAT BOULDER CLUSTER DETAIL

Scale: 1:150

0 2 (1:150) 8m



APRON LIVE STAKING SPACING PLAN

Scale: 1:25

0 0.2 (1:25) 1m

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308 Hart St. Nelson, B.C. V1L 5N5
Tel: 250 352 2757
www.terraerosion.com

NOTES:

1. REFER TO DWG G-020 FOR LEGEND AND GENERAL NOTES
2. REGIONAL PATHWAY (ASPHALT AND BASE GRAVEL) TO BE CONSTRUCTED BY OTHERS AND DOES NOT FALL UNDER THIS APPLICATION.

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

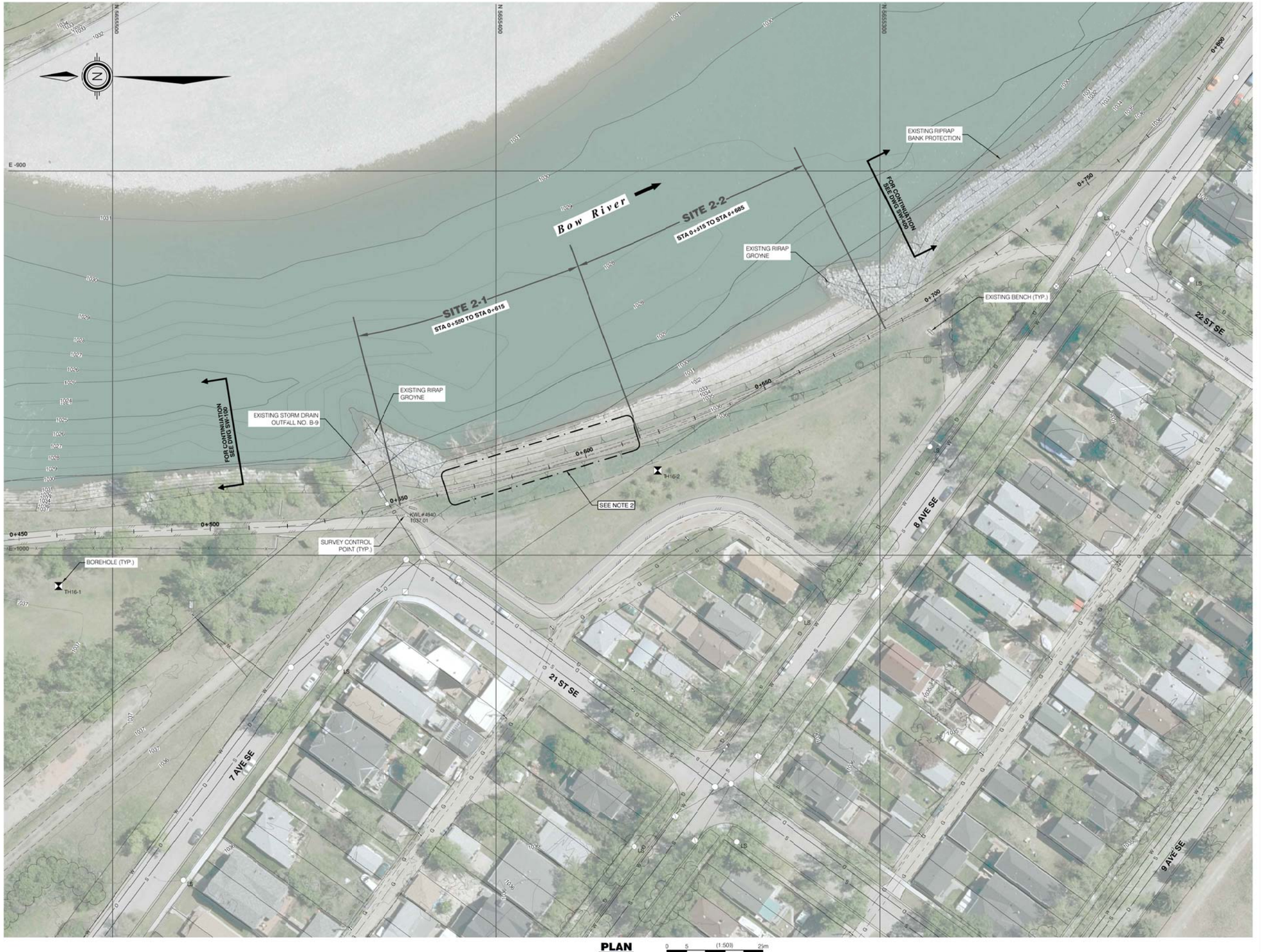
Seal: PROFESSIONAL ENGINEER ALBERTA
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	JAN.10/2017	TWC	TWC	MG	ORIGINAL PLAN PREPARED
B	JAN.23/2017	TWC	TWC	AKS	PLANTING DETAILS ADDED
C	JAN.31/2017	TWC	TWC	MG	REVISED PATHWAY WIDTH
D	APR.19/2017	MG	MAR	AKS	UPDATED PER COMMENTS FROM AEP/CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 1
MISCELLANEOUS DETAILS

Project No. 3552-004
Group CIVIL
Drawing No. SW-144
Rev. D



PLAN
Scale: 1:500

0 5 (1:50)) 25m

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES
2. EXISTING BANK SWALLOW COLONY STATION 0+560 TO STATION 0+610. NO SLOPE TREATMENT

Issued for Approval
Not for Construction
APRIL,19/2017

Seal:
PROFESSIONAL ENGINEER ALBERTA
19 April 2017

APEGA PERMIT TO PRACTICE NO. P07929

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.14/2016	TWC	PAC	AKS	ORIGINAL PLAN PREPARED
B	NOV15/2016	TWC	TWC	AKS	UPDATED CONTOURS & LINEWORK PER SEP. 2016 SURVEY
C	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 2
EXISTING CONDITIONS PLAN

Project No.	Drawing No.	Rev.
3552-004	SW-200	C
Group: CIVIL		

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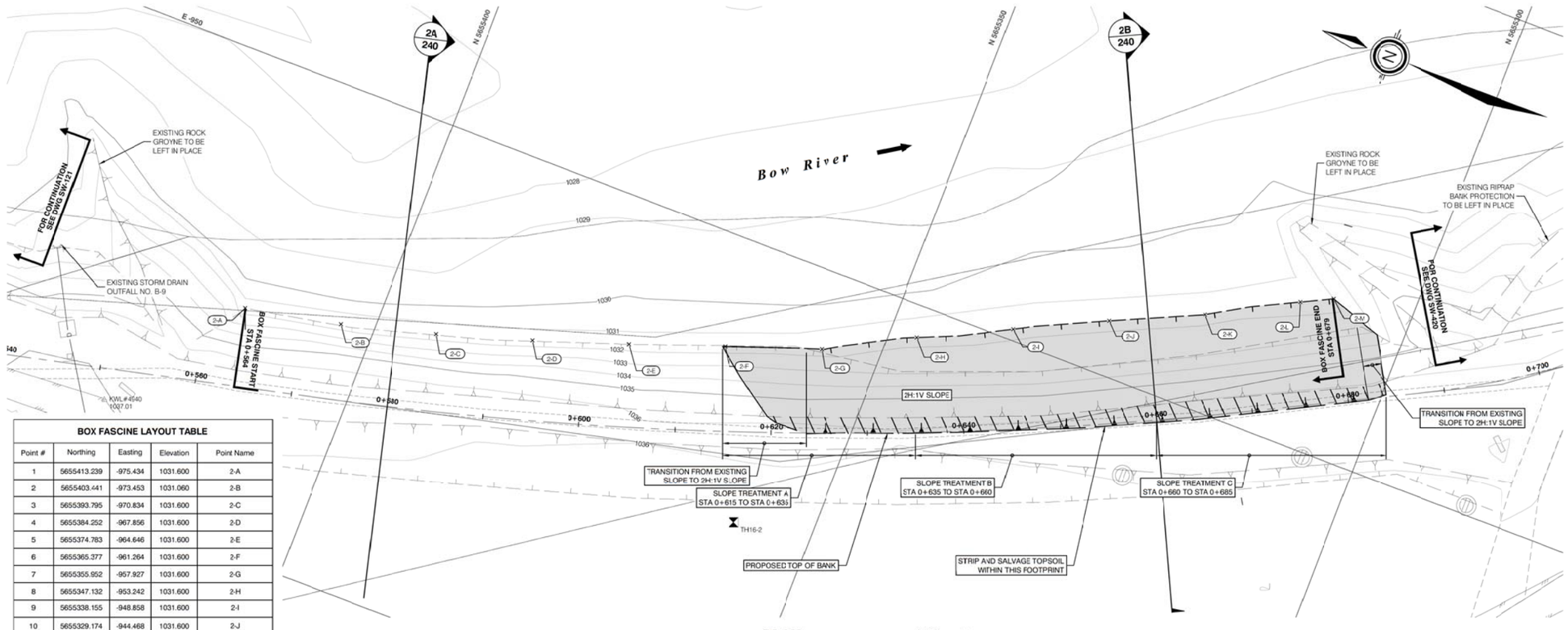
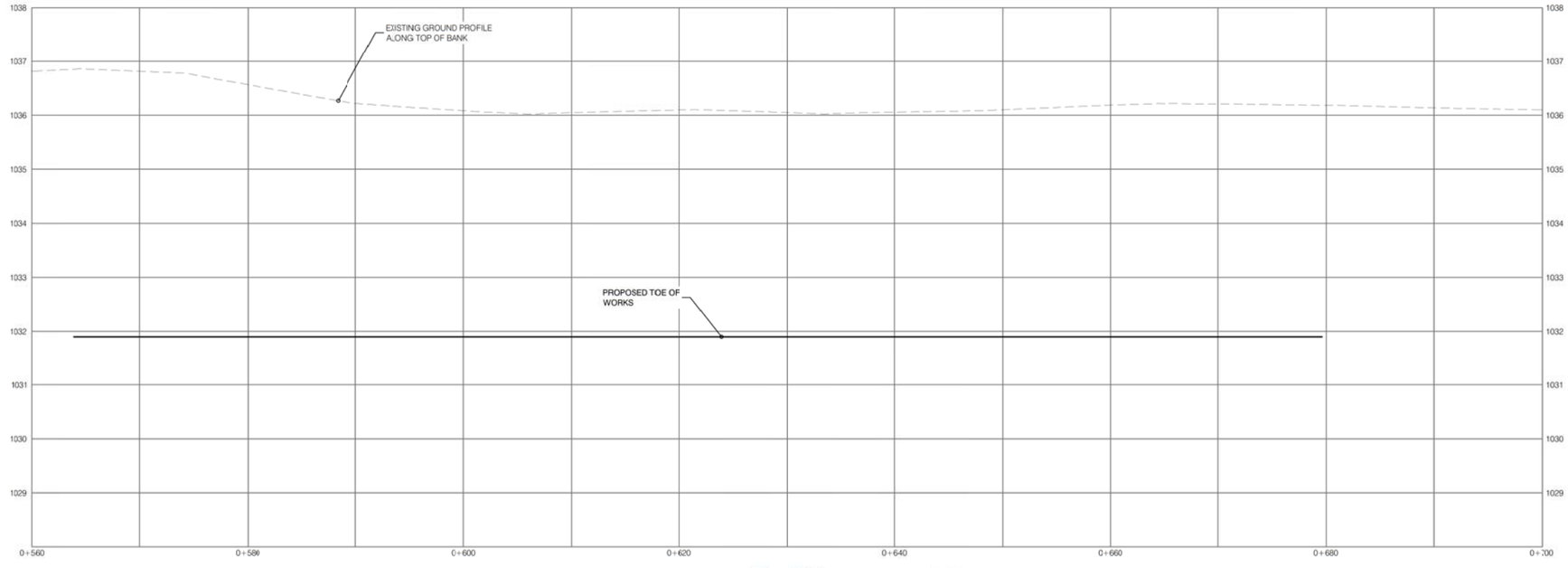


PLAN
Scale: 1:250

0 2 (1:250) 10m

BOX FASCINE LAYOUT TABLE

Point #	Northing	Easting	Elevation	Point Name
1	5655413.239	-975.434	1031.600	2-A
2	5655403.441	-973.453	1031.060	2-B
3	5655393.795	-970.834	1031.600	2-C
4	5655384.252	-967.856	1031.600	2-D
5	5655374.783	-964.646	1031.600	2-E
6	5655365.377	-961.264	1031.600	2-F
7	5655355.952	-957.927	1031.600	2-G
8	5655347.132	-953.242	1031.600	2-H
9	5655338.155	-948.858	1031.600	2-I
10	5655329.174	-944.468	1031.600	2-J
11	5655320.109	-940.287	1031.600	2-K
12	5655311.318	-935.500	1031.600	2-L
13	5655308.214	-933.949	1031.600	2-M



PROFILE
Scale: H 1:250 V 1:50

0 2 (H 1:250) 10m
0 0.5 (V 1:50) 2m

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APRIL,19/2017

Seal:
19 April 2017

APEGA PERMIT TO PRACTICE NO. P07929

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.15/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.16/2016	TWC	TWC	AKS	UPDATED CONTOURS & LINEWORK PER SEP. 2016 SURVEY
C	JAN.05/2017	TWC	ROK	AKS	PROPOSED WORKS SHOWN
D	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 2
PLAN AND PROFILE

Project No.	Drawing No.	Rev.
3552-004	SW-220	D
Group: CIVIL		

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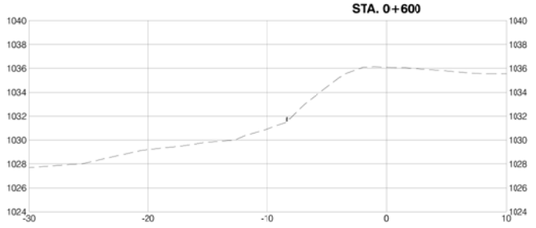

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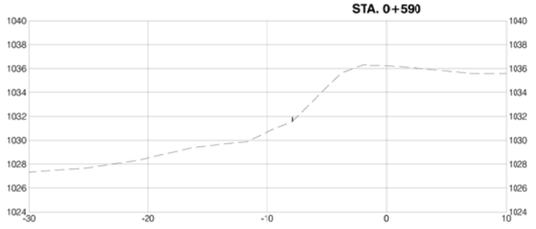

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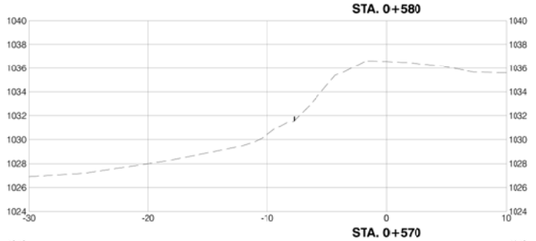

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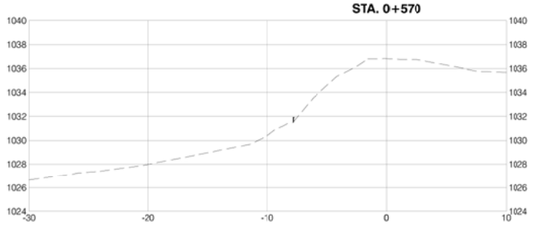

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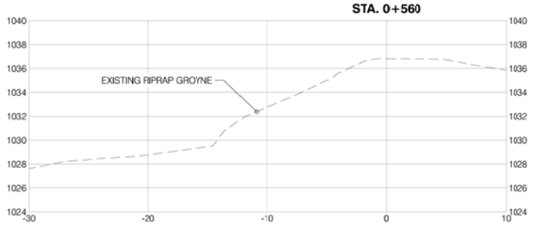

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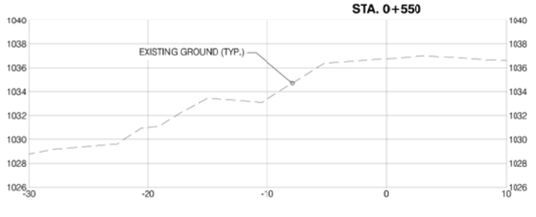
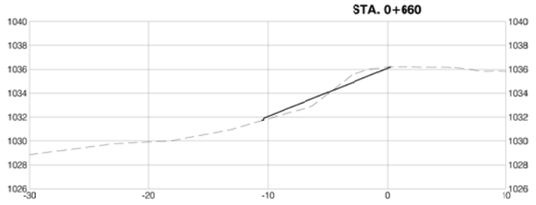
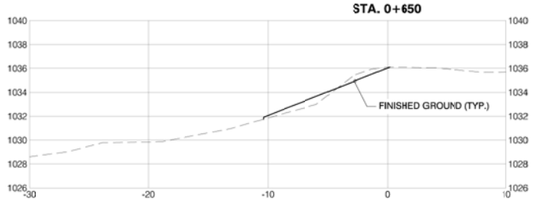


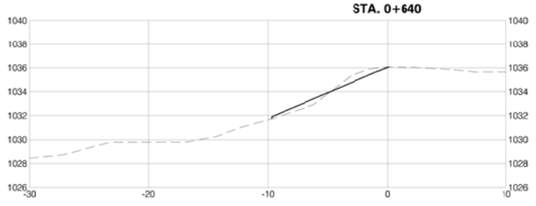
STA. 0+660



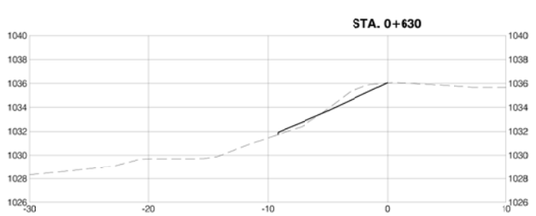
STA. 0+650



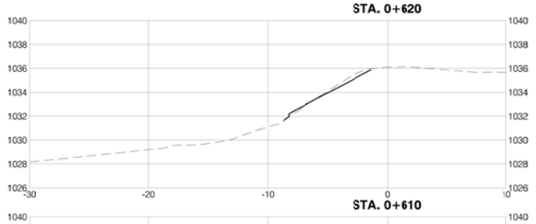
STA. 0+640



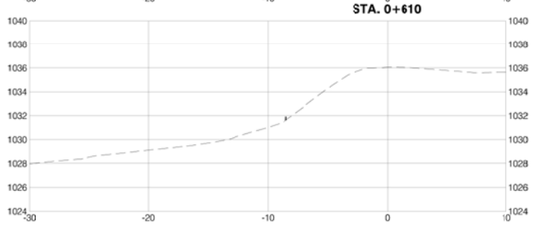
STA. 0+630



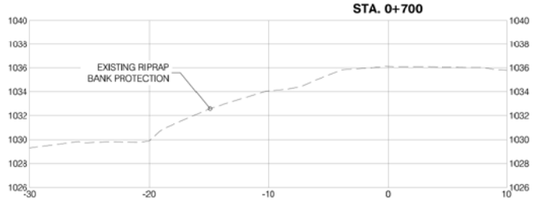
STA. 0+620



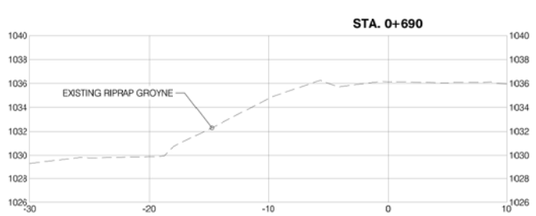
STA. 0+610



STA. 0+700



STA. 0+690



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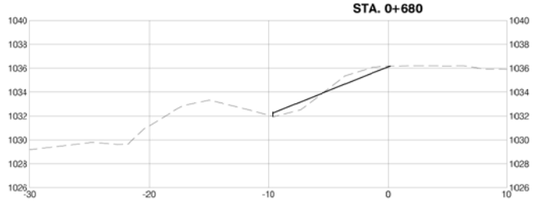
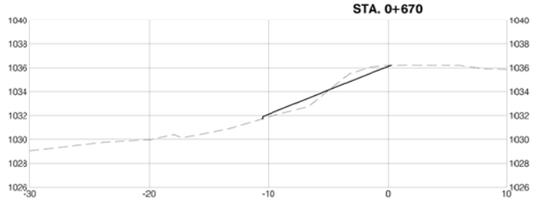


STA. 0+670



SECTIONS
Scale: 1:250

0 2 (1:250) 10m

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES
2. BANK SWALLOW COLONY FROM STATION 0+560 TO STATION 0+610. NO SLOPE TREATMENT

Issued for Approval
Not for Construction
APRIL,19/2017

APEGA PERMIT TO PRACTICE NO. P07929

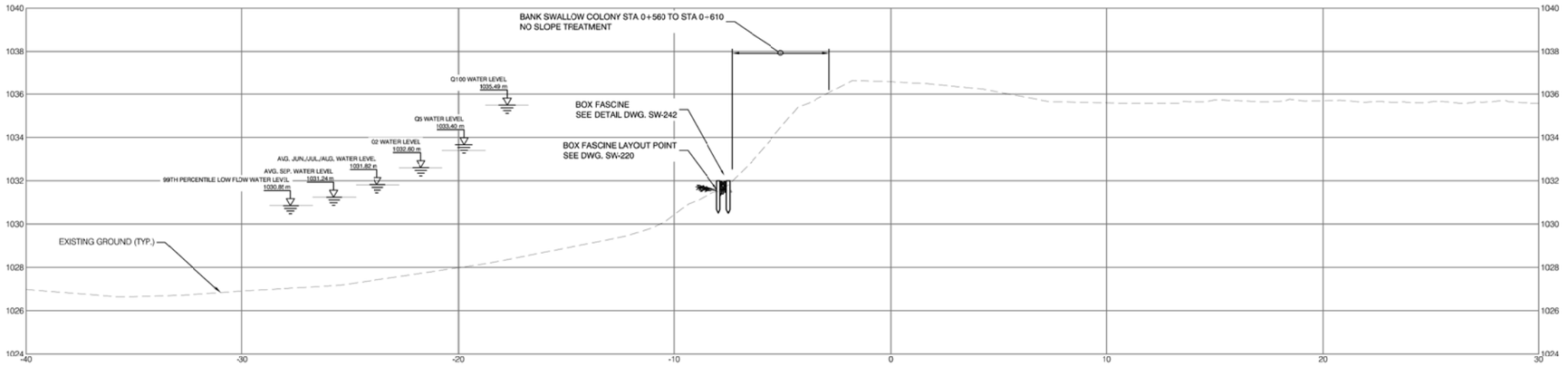
Seal:
19 April 2017

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.14/2016	TWC	ROK	AKS	ORIGINAL PLAN PREPARED
B	NOV.16/2016	TWC	TWC	AKS	SECTIONS UPDATED PER SEP. 2016 SURVEY
C	JAN.05/2017	TWC	ROK	AKS	PROPOSED WORKS SHOWN
D	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 2
SECTIONS
STATION 0+550 TO 0+700

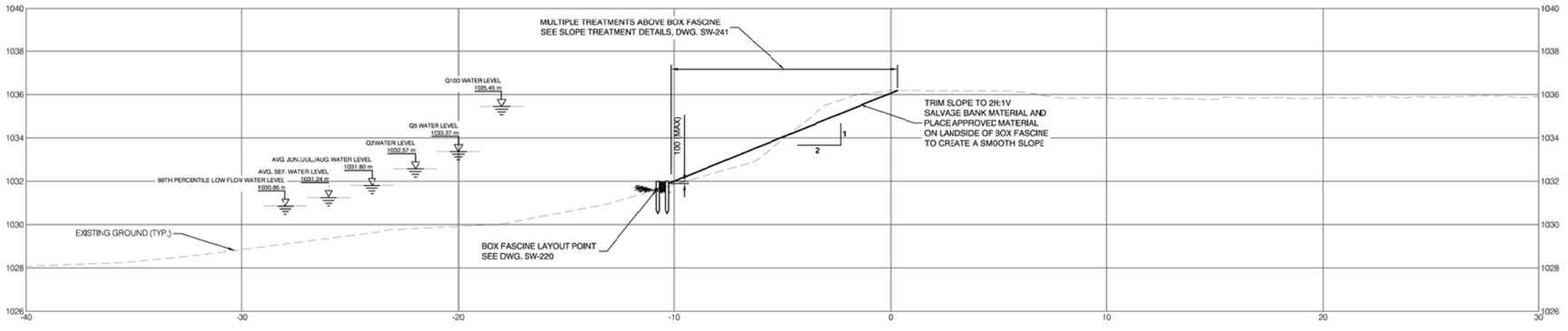
Project No.	Drawing No.	Rev.
3552-004	SW-230	D
Group: CIVIL		



TYPICAL SECTION - STA 0+560 TO STA 0+620 (2A / 220)

Scale: 1:125

0 (1:125) 6m



TYPICAL SECTION - STA 0+620 TO STA 0+685 (2B / 220)

Scale: 1:125

0 1 (1:125) 6m

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NOTES:

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APRIL,19/2017

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19 April 2017

APEGA PERMIT TO PRACTICE NO. P07929

Rev	Date	Des	Dwn	Chk	Description of Revision
A	SEP.15/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.16/2016	TWC	TWC	AKS	EG UPDATED PER SEP. 2016 SURVEY, WATER LEVELS SHOWN
C	DEC.13/2016	MG	ROK	AKS	UPDATED SECTIONS
D	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 2
TYPICAL SECTIONS

Project No.	Drawing No.	Rev.
3552-004	SW-240	D
Group: CIVIL		

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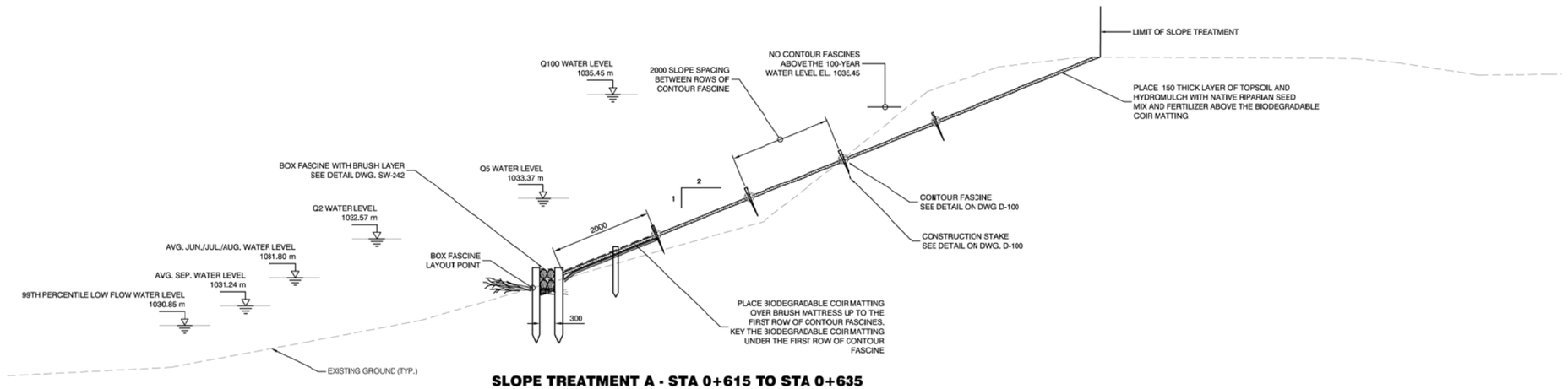

SLOPE TREATMENT A - STA 0+615 TO STA 0+635
BRUSH MATTRESS WITH CONTOUR FASCINE TYPICAL SECTION
Scale: 1:50

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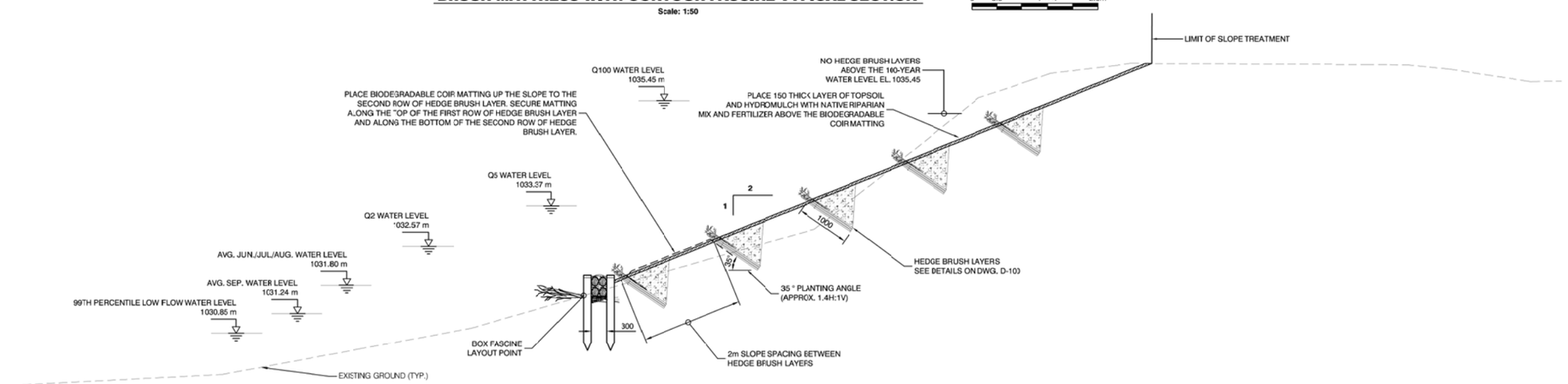

SLOPE TREATMENT B - STA 0+635 TO STA 0+660
HEDGE BRUSH LAYERS TYPICAL SECTION
Scale: 1:50

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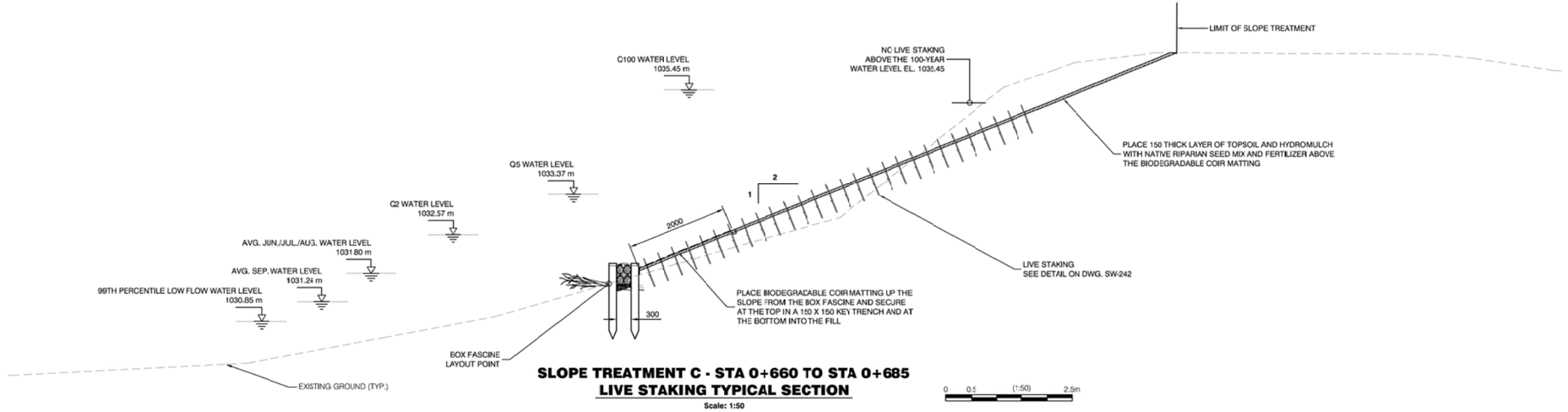

SLOPE TREATMENT C - STA 0+660 TO STA 0+685
LIVE STAKING TYPICAL SECTION
Scale: 1:50

0 0.5 (1:50) 2.5m

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NOTES:

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B	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 2
SLOPE TREATMENT DETAILS

Project No. 3552-004
Group CIVIL
Drawing No. SW-241
Rev. B

SAVED 2017-04-01, 5:26 PM
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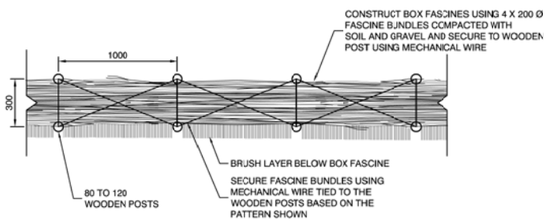
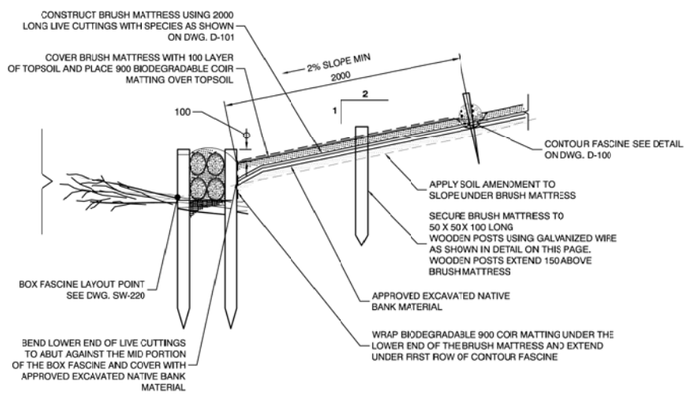


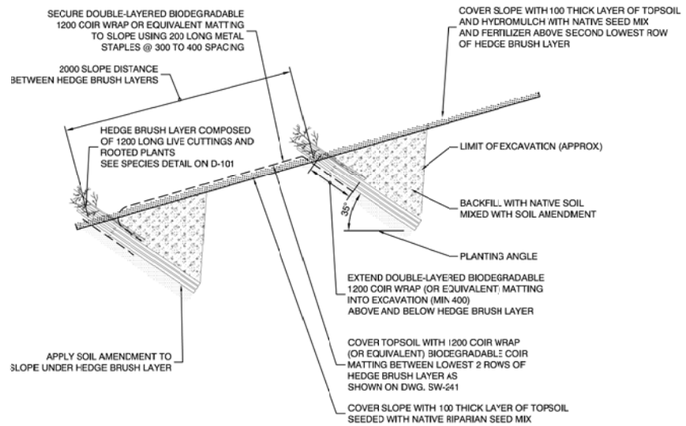
BOX FASCINE DETAIL - PLAN

Scale: NTS



BRUSH MATTRESS WITH BOX FASCINE TOE DETAIL - SECTION

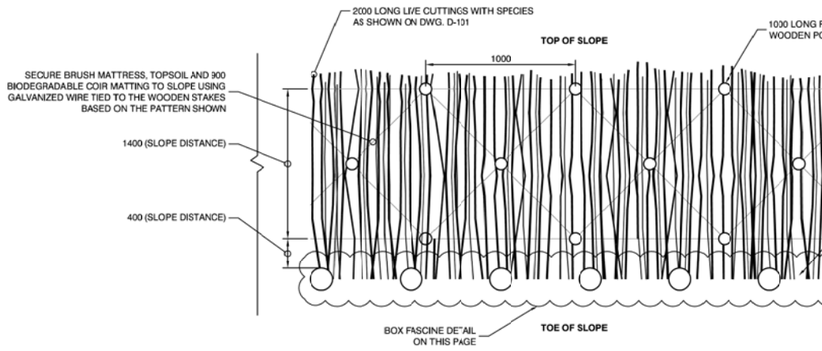
Scale: 1:25



HEDGE BRUSH LAYER DETAIL

Scale: 1:25

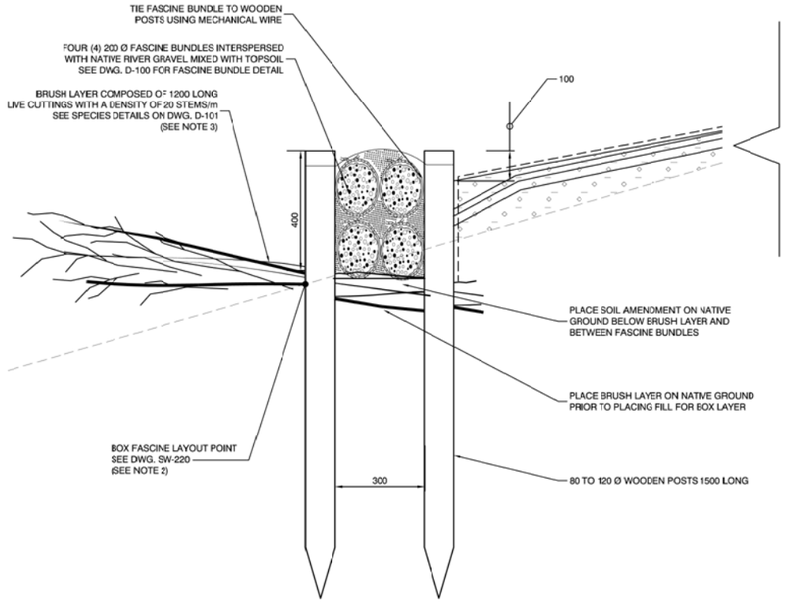
0 0.2 (1:25) 1m



BRUSH MATTRESS DETAIL - PLAN

Scale: 1:20

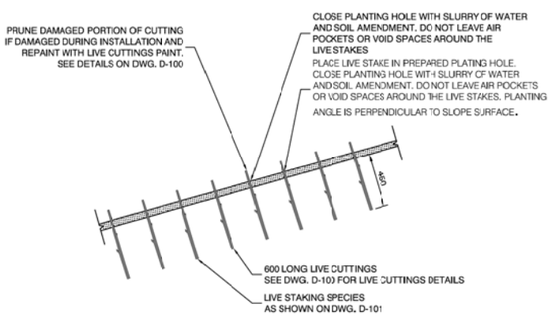
0 0.2 (1:20) 1m



BOX FASCINE / BRUSH MATTRESS/ CONTOUR FASCNE DETAIL - SECTION

Scale: 1:10

0 0.1 (1:10) 0.5m



LIVE STAKING DETAIL - SECTION

Scale: 1:25

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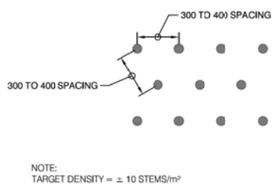

NOTE:
TARGET DENSITY = ± 10 STEMS/m²

LIVE STAKING SPACING - PLAN

Scale: 1:25

0 0.2 (1:25) 1m

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES
2. BOX FASCINE TO BE BUILT USING 4 FASCINE BUNDLES 200 Ø COMPACTED WITH SOIL AND GRAVEL.
3. BRUSH LAYERS UNDER FASCINES TO EXTEND 100 BEHIND ROW OF WOODEN POSTS INSTALLED UP SLOPE.

LEGEND

- PROPOSED TOPSOIL
- PROPOSED BACKFILL WITH NATIVE SOIL
- PROPOSED NATIVE RIVER GRAVEL

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19 April 2017

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Rev	Date	Des	Dwn	Chk	Description of Revision
A	DEC.13/2016	TWC	ROK	AKS	ORIGINAL PLAN PREPARED
B	JAN.25/2017	MG	ROK	AKS	UPDATED LINE WORK AND NOTES
C	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 2
TYPICAL DETAILS

Project No. 3552-004
Group CIVIL
Drawing No. SW-242
Rev. C

PLAN
Scale: 1:500

0 5 (1:500) 25m

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES

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19 April 2017

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B	DEC.15/2016	TWC	ROK	AKS	UPDATED CONTOURS & LINEWORK PER SEP 2016 SURVEY
C	JAN.23/2017	MG	PAC	AKS	ADDED NOTES
D	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 4
EXISTING CONDITIONS PLAN

Project No.	Drawing No.	Rev.
3552-004	SW-400	D
Group: CIVIL		

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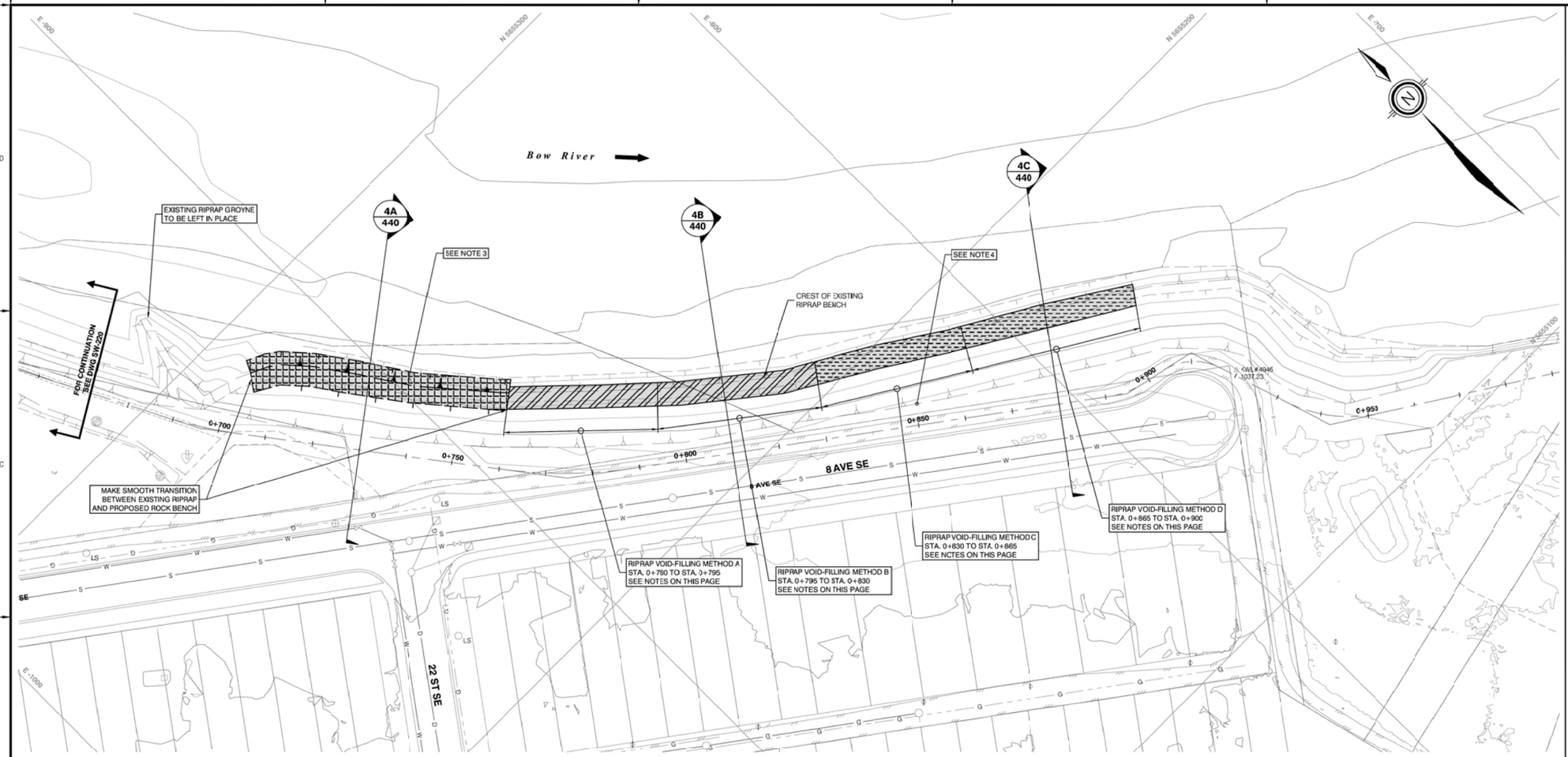

PLAN
Scale: 1:500

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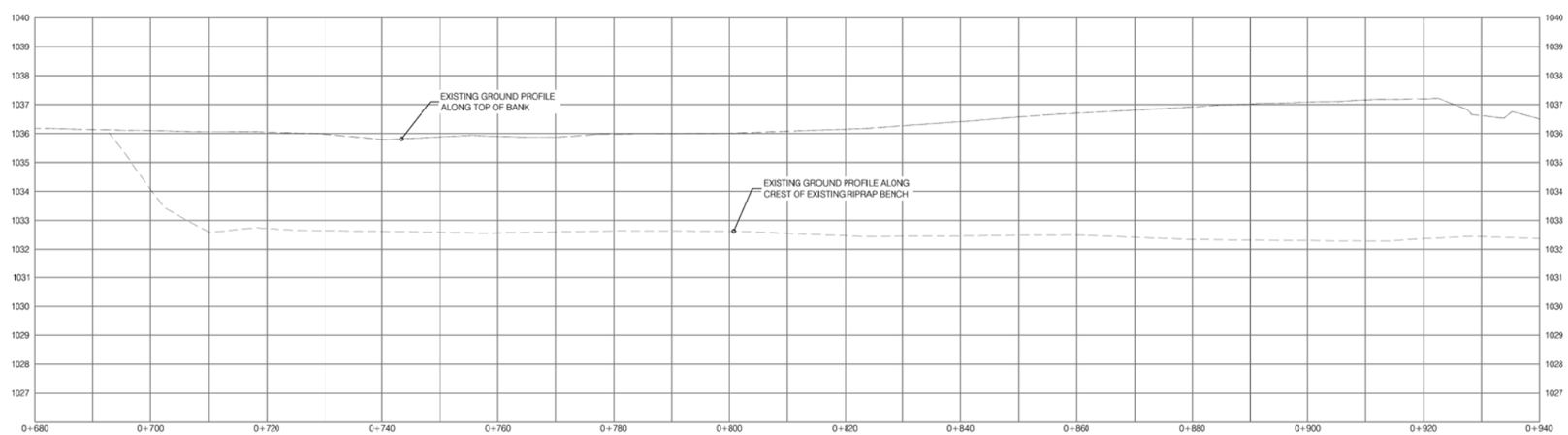

PROFILE
Scale: H 1:500 V 1:100

0 5 (H 1:500) 25m
0 1 (V 1:100) 5m

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES
2. CONSTRUCT THE RIPRAP VOID-FILL PER THE METHODS OUTLINED IN THE TABLE BELOW.
3. EXISTING RIPRAP BANK TO BE LEFT IN PLACE FOR ALL OF SITE 4
4. PROTECT EXISTING BANK RECLAMATION

RIPRAP VOID-FILLING METHOD	DESCRIPTION
A	PLANTING MEDIUM MECHANICALLY VIBRATED INTO EXISTING RIPRAP VOID SPACE
B	PLANTING MEDIUM SLURRY HYDRAULICALLY PLACED INTO EXISTING RIPRAP VOID SPACE
C	MIXED PITRUN AND TOPSOIL MECHANICALLY VIBRATED INTO EXISTING RIPRAP VOID SPACE
D	MIXED PITRUN AND TOPSOIL HYDRAULICALLY PLACED INTO EXISTING RIPRAP VOID SPACE

LEGEND

SOIL COVERED RIPRAP
STA. 0+705 TO STA. 0+790

VOID-FILLED RIPRAP AND CONTAINER SHRUBS
STA. 0+760 TO STA. 8+030

VOID-FILLED RIPRAP AND JOINT PLANTING
STA. 0+830 TO STA. 0+900

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19 April 2017

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C	JAN. 23/2017	MG	PAC	AKS	UPDATED NOTES AND PROPOSED LINEWORK
D	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 4
PLAN AND PROFILE

Project No.	Drawing No.	Rev.
3552-004	SW-420	D
Group: CIVIL		

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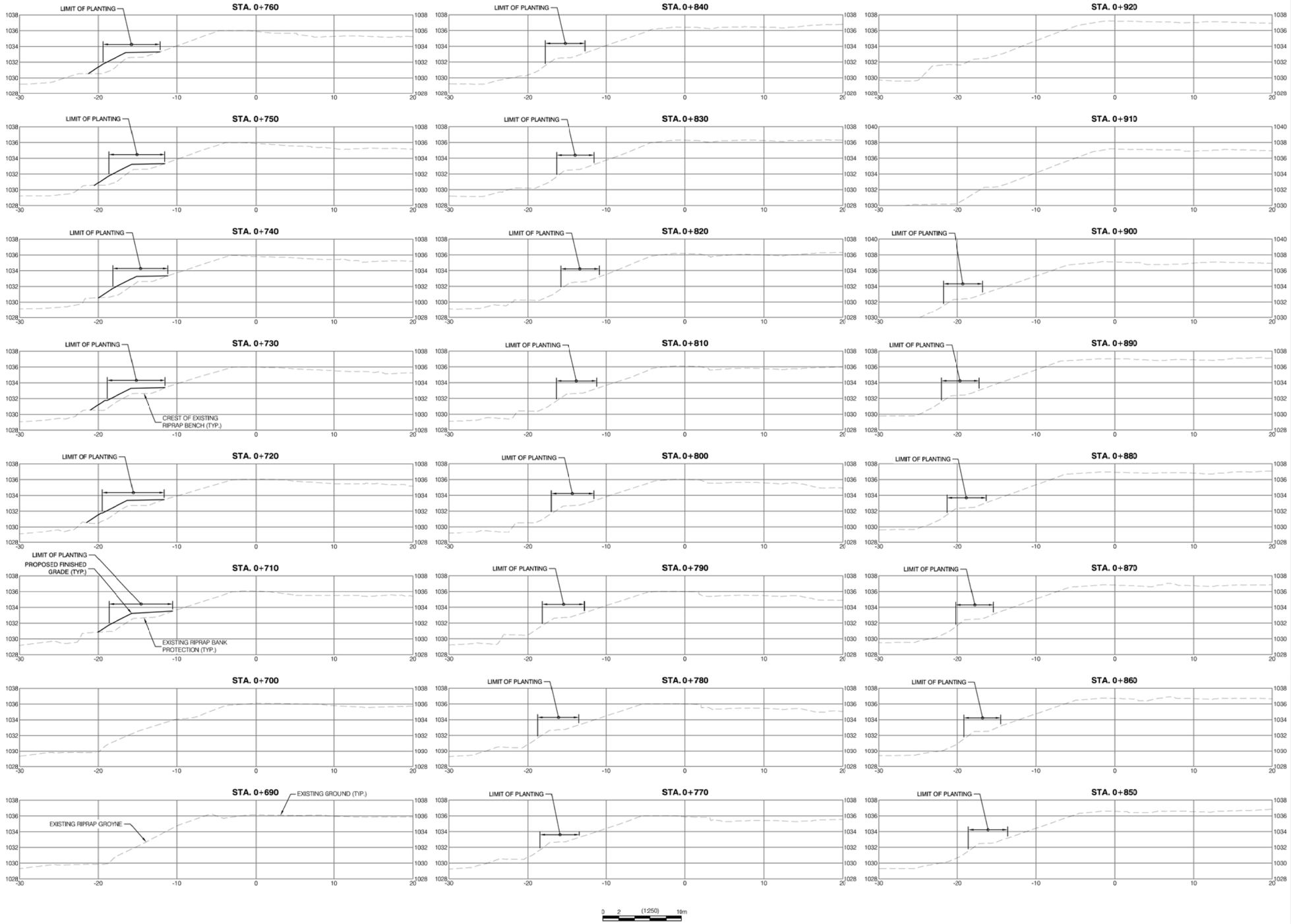

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES

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B	DEC.16/2016	TWC	FOK	AKS	UPDATED SECTIONS PER SEP 2016 SURVEY
C	JAN.18/2017	TWC	PAC	AKS	ADDED NOTES & AREA OF WORK
D	APR.19/2017	MG	FOK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 4
SECTIONS
STATION 0+690 TO 0+920

Project No. 3552-004
Group CIVIL
Drawing No. SW-430
Rev. D

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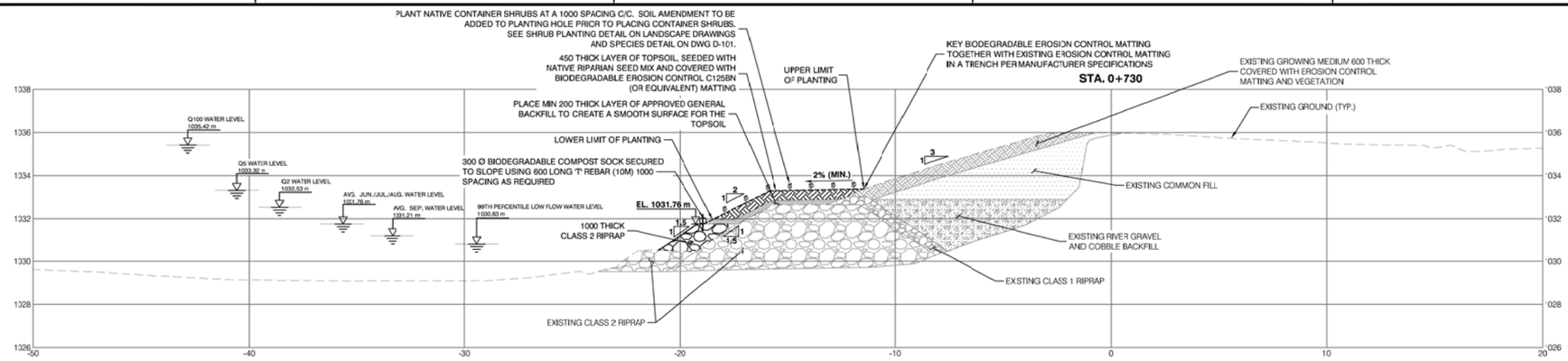
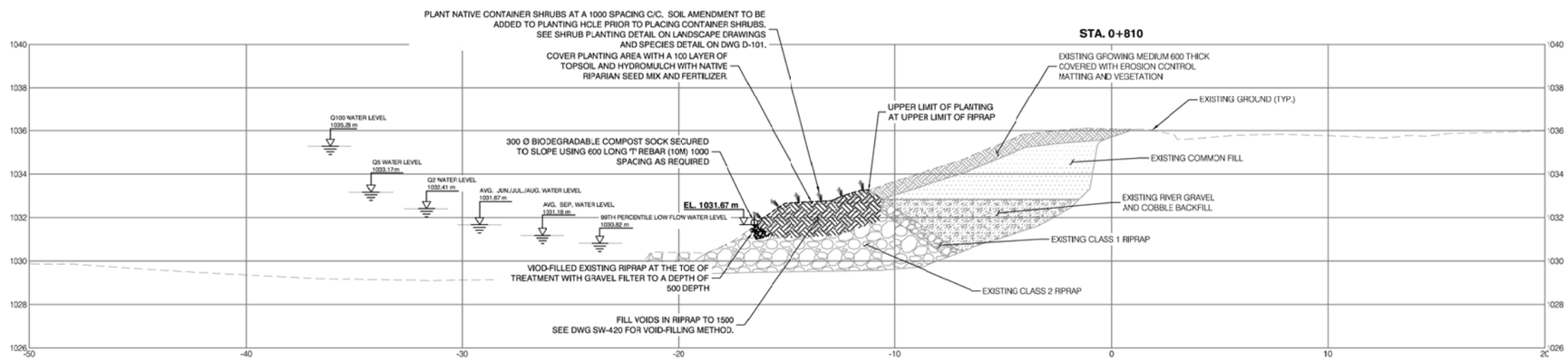


SOIL COVERED RIPRAP TYPICAL SECTION - STA. 0+705 TO STA. 0+760

0 1 (1:125) 6m

Scale: 1:125

4A / 420

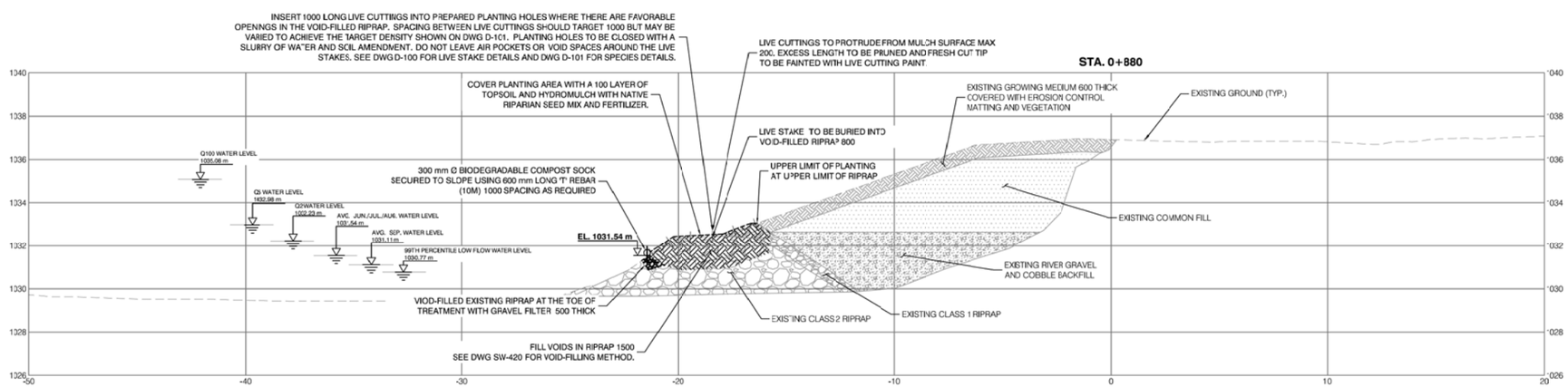


VOID-FILLED RIPRAP AND CONTAINER SHRUB PLANTING TYPICAL SECTION - STA. 0+760 TO STA. 0+830

0 1 (1:125) 6m

Scale: 1:125

4B / 420



VOID-FILLED RIPRAP AND JOINT PLANTING TYPICAL SECTION - STA. 0+830 TO STA. 0+900

0 1 (1:125) 6m

Scale: 1:125

4C / 420

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NOTES:

1. REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES
2. SECTION DETAILS TAKEN FROM PHASE 2 - BANK RESTCRATION OF BOW RIVER AT INGLEWOOD TYPICAL SECTIONS ISSUED FOR CONSTRUCTION DRAWINGS BY GOLDER ASSOCIATES LTD. DATED NOV 2014. MATERIAL HATCHING FROM GOLDER SECTIONS NOT PROVIDED IN LEGEND, BUT LABELED AS SHOWN
3. RIPRAP VOID FILLING METHODS ARE DESCRIBED ON DWG. SW-420

LEGEND

- PROPOSED RIPRAP
- PROPOSED GENERAL FILL
- PROPOSED TOPSOIL

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APEGA PERMIT TO PRACTICE NO. P07929

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A	SEP.16/2016	TWC	TWC	AKS	ORIGINAL PLAN PREPARED
B	NOV.15/2016	TWC	ROK	AKS	UPDATED SECTIONS PER SEP 2016 SURVEY
C	JAN.05/2017	TWC	ROK	AKS	PROPOSED WORKS SHOWN
D	JAN.23/2017	MG	PAC	AKS	UPDATED NOTES AND PROPOSED LINEWORK
E	APR.19/2017	MG	ROK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

SITE 4 TYPICAL SECTIONS

Project No. 3552-004
Group CIVIL
Drawing No. SW-440
Rev. E

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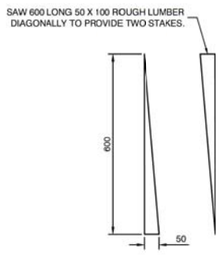
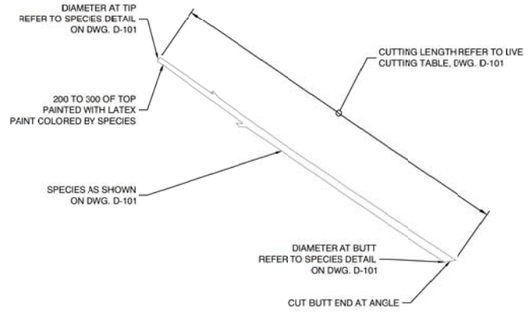
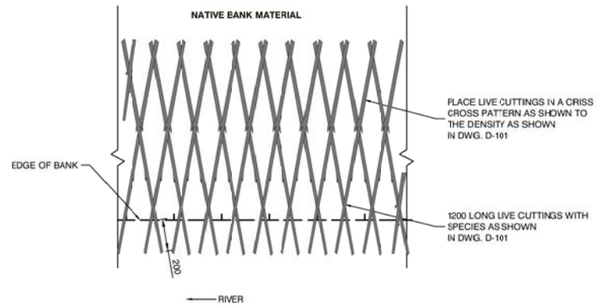


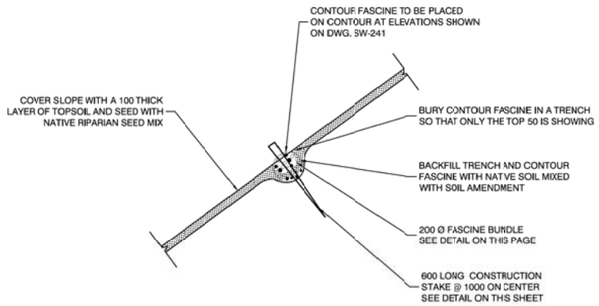
CONSTRUCTION STAKE DETAIL
Scale: 1:10



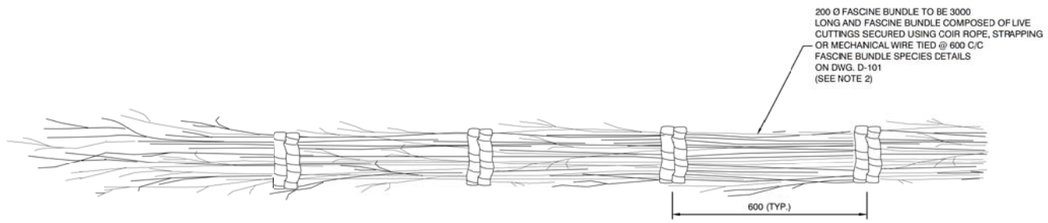
LIVE CUTTING DETAIL
Scale: 1:10



BRUSH LAYER DETAIL - PLAN
Scale: 1:20



CONTOUR FASCINE DETAIL - SECTION
Scale: 1:25



FASCINE BUNDLE DETAIL - PLAN
Scale: 1:10

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NOTES:

1. REFER TO DWG. D-020 FOR LEGEND AND GENERAL NOTES
2. CONTOUR FASCINE BUNDLES TO OVERLAP 300 WHEN INSTALLED

LEGEND

PROPOSED TOPSOIL AND NATIVE RIPARIAN SEED MIX

Issued for Approval
Not for Construction
APRIL,19/2017

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19 April 2017

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BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

STANDARD DETAILS

Project No.	Drawing No.	Rev.
3552-004	D-100	B
Group: CIVIL		

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SITE 1-1 AND SITE 1-2 - VEGETATED RIPRAP APRON (STA 10+000 TO STA 10+140)

PLANT LIST - LIVE STAKING — PLANTING DENSITY - 4,444 stems/ha (SPACING OF 1.5m x 1.5m)

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/ha)	STOCK TYPE	LENGTH (m)
SALIX EXIGUA	SANDBAR WILLOW	50	2,222	LIVE CUTTINGS	1.2
CORNUS STOLONIFERA	RED OSIER DOGWOOD	30	1,333	LIVE CUTTINGS	1.2
POPULUS BALSAMIFERA	BALSAM POPLAR	20	889	LIVE CUTTINGS	1.2

WET MEADOW SEED MIX — APPLICATION RATE - 30 to 40 kg/ha

SITE 1-3 AND SITE 1-4 - TIMBER CRIB WALL (STA 10+146 TO STA 10+286)

PLANT LIST - BRUSH LAYER — PLANTING DENSITY - 20 stems/lm

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	40	8	LIVE CUTTINGS	1.75 - 2.0
SALIX EXIGUA	SANDBAR WILLOW	40	8	LIVE CUTTINGS	1.5 - 2.0
CORNUS STOLONIFERA	RED OSIER DOGWOOD	20	4	LIVE CUTTINGS	1.5 - 2.0

SITE 1-3 AND SITE 1-4 - SOIL WRAP (STA 10+146 TO STA 10+286)

PLANT LIST - BRUSH LAYER — PLANTING DENSITY - 10 stems/lm

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	40	5	LIVE CUTTINGS	1.75 - 2.0
SALIX EXIGUA	SANDBAR WILLOW	40	4	LIVE CUTTINGS	1.5 - 2.0
POPULUS BALSAMIFERA	BALSAM POPLAR	20	1	LIVE CUTTINGS	1.75 - 2.0

SITE 1-4 - BRUSH MATTRESS (STA 10+286 TO STA 10+351)

PLANT LIST - BRUSH MATTRESS — PLANTING DENSITY - 40 stems/lm

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	50	20	LIVE CUTTINGS	2
SALIX BEBBIANA	BEAKED WILLOW	20	8	LIVE CUTTINGS	2
SALIX EXIGUA	SANDBAR WILLOW	20	8	LIVE CUTTINGS	1.5 - 2.0
CORNUS STOLONIFERA	RED OSIER DOGWOOD	10	4	LIVE CUTTINGS	1.5 - 2.0

PLANT LIST - CONTOUR FASCINE (>= 200mm DIAMETER)

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	BUNDLE LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	35	N/A	LIVE CUTTINGS	
SALIX EXIGUA	SANDBAR WILLOW	30	N/A	LIVE CUTTINGS	
POPULUS BALSAMIFERA	BALSAM POPLAR	20	N/A	LIVE CUTTINGS	
FILLER*					3.3
*ALNUS TENUIFOLIA**	RIVER ALDER	15	N/A	CUTTINGS	
*POPULUS TREMULOIDES**	TREMBLING ASPEN				
*BETULA OCCIDENTALIS**	WATER BRCH				

*NOTE: EACH CONTOUR FASCINE TO HAVE UP TO A MAXIMUM OF 15% FLLER MATERIAL OF THE SPECIES LISTED OR AS APPROVED BY SOIL BIOENGINEERING SPECIALIST

PLANT LIST - BRUSH LAYER — PLANTING DENSITY - 10 stems/lm

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	40	4	LIVE CUTTINGS	1.2
SALIX EXIGUA	SANDBAR WILLOW	40	4	LIVE CUTTINGS	1.2

SITE 2-1 AND SITE 2-2 - BOX FASCINE (STA 0+560 TO STA 0+685)

PLANT LIST - BRUSH LAYER — PLANTING DENSITY - 20 stems/lm

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	LENGTH (m)
SALIX EXIGUA	SANDBAR WILLOW	50	10	LIVE CUTTINGS	0.7
CORNUS STOLONIFERA	RED OSIER DOGWOOD	50	10	LIVE CUTTINGS	0.7

PLANT LIST - BOX FASCINE — PLANTING DENSITY - 4 FASCINE BUNDLES (>= 200mm DIAMETER) PER CROSS-SECTION

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	BUNDLE LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	35	20	LIVE CUTTINGS	
SALIX EXIGUA	SANDBAR WILLOW	30	12	LIVE CUTTINGS	
SALIX BEBBIANA	BEAKED WILLOW	20	8	LIVE CUTTINGS	
FILLER*					3.3
*ALNUS TENUIFOLIA**	RIVER ALDER	15	N/A	CUTTINGS	
*POPULUS TREMULOIDES**	TREMBLING ASPEN				
*BETULA OCCIDENTALIS**	WATER BIRCH				

*NOTE: EACH FASCINE FOR THE BOX FASCINE TO HAVE UP TO A MAXIMUM OF 15% FILLER MATERIAL OF THE SPECIES LISTED OR AS APPROVED BY SOIL BIOENGINEERING SPECIALIST

SITE 2-2 - SLOPE TREATMENT A (STA 0+615 TO STA 0+635)

PLANT LIST - BRUSH MATTRESS — PLANTING DENSITY - 40 stems/lm

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	40	16	LIVE CUTTINGS	2.0
SALIX BEBBIANA	BEAKED WILLOW	20	8	LIVE CUTTINGS	2.0
SALIX EXIGUA	SANDBAR WILLOW	20	8	LIVE CUTTINGS	1.5 - 2.0
CORNUS STOLONIFERA	RED OSIER DOGWOOD	20	8	LIVE CUTTINGS	1.5 - 2.0

PLANT LIST - CONTOUR FASCINE (>= 200mm DIAMETER)

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	BUNDLE LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	35	N/A	LIVE CUTTINGS	
SALIX EXIGUA	SANDBAR WILLOW	30	N/A	LIVE CUTTINGS	
POPULUS BALSAMIFERA	BALSAM POPLAR	20	N/A	LIVE CUTTINGS	
FILLER*					3.3
*ALNUS TENUIFOLIA**	RIVER ALDER	15	N/A	CUTTINGS	
*POPULUS TREMULOIDES**	TREMBLING ASPEN				
*BETULA OCCIDENTALIS**	WATER BIRCH				

*NOTE: EACH CONTOUR FASCINE TO HAVE UP TO A MAXIMUM OF 15% FILLER MATERIAL OF THE SPECIES LISTED OR AS APPROVED BY SOIL BIOENGINEERING SPECIALIST

SITE 2-2 - SLOPE TREATMENT B (STA 0+635 TO STA 0+660)

PLANT LIST - HEDGE BRUSH LAYER — PLANTING DENSITY - 10 stems/lm + 1 rooted stock alternating between the species noted below

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/lm)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	40	4	LIVE CUTTINGS	1.2
SALIX EXIGUA	SANDBAR WILLOW	40	4	LIVE CUTTINGS	1.2
POPULUS BALSAMIFERA	BALSAM POPLAR	20	2	LIVE CUTTINGS	1.2
*ALNUS TENUIFOLIA**	RIVER ALDER			#5 CONTAINER	0.8 - 1.0
*CORNUS STOLONIFERA**	RED OSIER DOGWOOD			#5 CONTAINER	0.8 - 1.0

*NOTE: ALTERNATE ROOTED STOCK SPECIES EACH METER

SITE 2-2 - SLOPE TREATMENT C (STA 0+660 TO STA 0+685)

PLANT LIST - LIVE STAKING — PLANTING DENSITY - 100,000 stems/ha (SPACING OF 0.3m x 0.3m)

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/ha)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	50	50,000	LIVE CUTTINGS	0.6
SALIX EXIGUA	SANDBAR WILLOW	20	20,000	LIVE CUTTINGS	0.6

SITE 4-1 - SOIL COVERED RIPRAP (STA 0+705 TO STA 0+760)

PLANT LIST - CONTAINER SHRUB PLANTINGS — PLANTING DENSITY - 10,000 stems/ha (SPACING OF 1m X 1m)

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/ha)	STOCK TYPE	STEM HEIGHT
SALIX EXIGUA	SANDBAR WILLOW	30	3,000	#1 CONTAINER	
CORNUS STOLONIFERA	RED OSIER DOGWOOD	30	3,000	#1 CONTAINER	
ALNUS TENUIFOLIA	RIVER ALDER	10	1,000	#1 CONTAINER	SEE SPECIFICATIONS
BETULA OCCIDENTALIS	WATER BIRCH	10	1,000	#1 CONTAINER	
*POPULUS BALSAMIFERA**	BALSAM POPLAR	20	2,000	#1 CONTAINER	

*NOTE: PLANT BALSAM POPLAR ON BENCH ONLY

SITE 4-2 - VOID-FILLED RIPRAP AND CONTAINER SHRUB PLANTING (STA 0+760 TO STA 0+830)

PLANT LIST - CONTAINER SHRUB PLANTINGS — PLANTING DENSITY - 10,000 stems/ha (SPACING OF 1m X 1m)

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/ha)	STOCK TYPE	STEM HEIGHT
SALIX EXIGUA	SANDBAR WILLOW	30	3,000	415D (PLUG)	
CORNUS STOLONIFERA	RED OSIER DOGWOOD	30	3,000	415D (PLUG)	
ALNUS TENUIFOLIA	RIVER ALDER	10	1,000	415D (PLUG)	SEE SPECIFICATIONS
BETULA OCCIDENTALIS	WATER BIRCH	10	1,000	415D (PLUG)	
POPULUS BALSAMIFERA	BALSAM POPLAR	20	2,000	415D (PLUG)	

SITE 4-3 - VOID-FILLED RIPRAP AND LIVE STAKING (STA 0+830 TO STA 0+865)

PLANT LIST - LIVE STAKING — PLANTING DENSITY - 10,000 stems/ha (SPACING OF 1m x 1m)

BOTANICAL NAME	COMMON NAME	% MIX	DENSITY (stems/ha)	STOCK TYPE	LENGTH (m)
SALIX LUTEA	YELLOW WILLOW	40	4,000	LIVE CUTTINGS	1.0
SALIX EXIGUA	SANDBAR WILLOW	30	3,000	LIVE CUTTINGS	1.0
CORNUS STOLONIFERA	RED OSIER DOGWOOD	10	1,000	LIVE CUTTINGS	1.0
POPULUS BALSAMIFERA	BALSAM POPLAR	20	2000	LIVE CUTTINGS	1.0

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308 Hart St. Nelson, B.C. V1L 5N5
Tel: 250 352 2757
www.terraerosion.com

NOTES

1. **REFER TO DWG. G-020 FOR LEGEND AND GENERAL NOTES**

Issued for Approval
Not for Construction
APRIL,19/2017

Seal: PROFESSIONAL ENGINEER ALBERTA — 19 April 2017

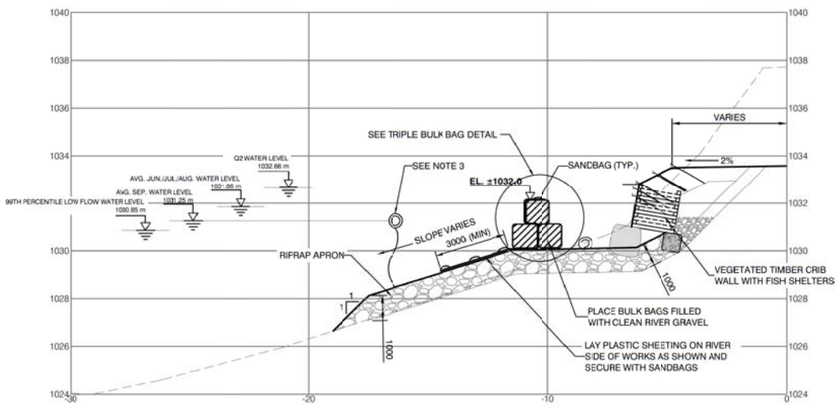
APEGA PERMIT TO PRACTICE NO. P07929

Rev	Date	Des	Dwn	Chk	Description of Revision
A	JAN.19/2017	MG	PAC	MG	ORIGINAL PLAN PREPARED
B	JAN.31/2017	MG	TWC	AKS	UPDATED SPECIES TABLES
C	APR.19/2017	MG	RCK	AKS	UPDATED PER COMMENTS FROM AEP / CITY OF CALGARY

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT

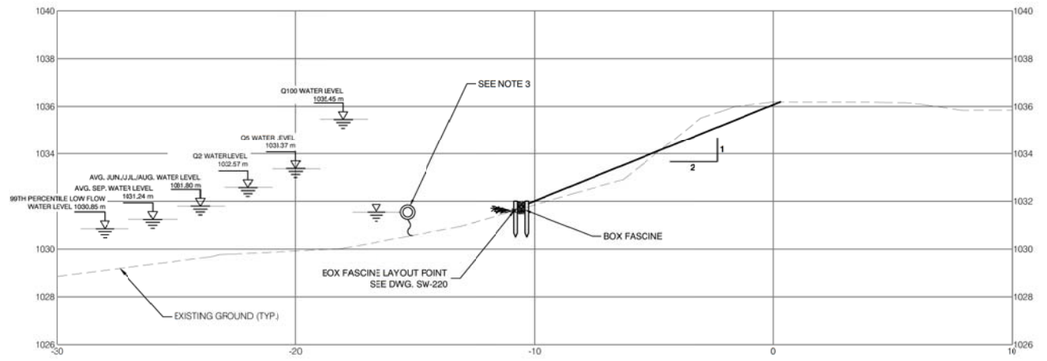
PLANTING SPECIES LISTS

Project No.	Drawing No.	Rev.
3552-004	D-101	C
Group: CIVIL		



ISOLATION DETAIL - SITE 1
VEGETATED TIMBER CRIB WALL WITH FISH SHELTERS
Scale: 1:125

0 1 (1:125) 6m

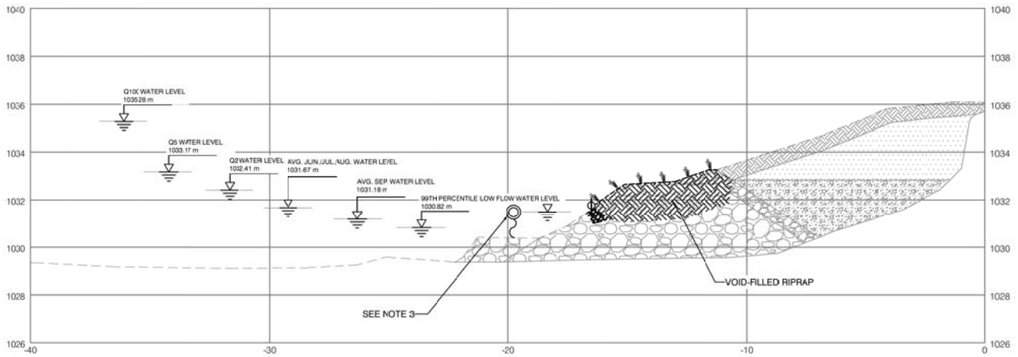


SITE 2 - TYPICAL TURBIDITY CURTAIN DETAIL
Scale: 1:125

0 1 (1:125) 6m

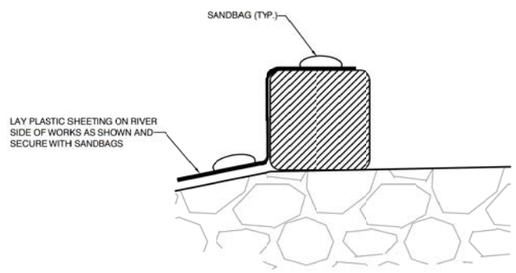
ISOLATION DETAIL - SITE 1
VEGETATED TIMBER CRIB WALL
Scale: 1:125

0 1 (1:125) 6m

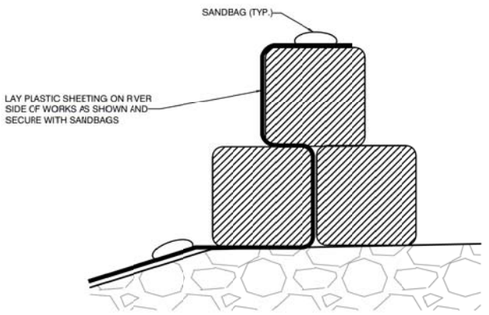


SITE 4 - TYPICAL TURBIDITY CURTAIN DETAIL
Scale: 1:125

0 1 (1:125) 6m



SINGLE BULK BAG DETAIL
Scale: 1:30



TRIPLE BULK BAG DETAIL
Scale: 1:30

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NOTES
1. REFER TO DWG. D-020 FOR LEGEND AND GENERAL NOTES
2. TURBIDITY CURTAIN TO BE WEIGHTED TO THE RIVER BED
3. INSTALL TEMPORARY TURBIDITY CURTAIN PRIOR TO START OF CONSTRUCTION AND REMOVE AT THE END OF CONSTRUCTION

LEGEND
- PROPOSED RIPRAP
- PROPOSED GENERAL FILL
- PROPOSED TOPSOIL
- PROPOSED CLEAN RIVER GRAVEL

Issued for Approval
Not for Construction
APRIL,19/2017

Seal: ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS & GEOPHYSICISTS OF ALBERTA
19 April 2017

APEGA PERMIT TO PRACTICE NO. P07929

Rev	Date	Des	Dwn	Chk	Description of Revision
A	APR.19/2017	MG	MAR	AKS	ORIGINAL PLAN PREPARED

BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT
ISOLATION DETAILS

Project No.	Drawing No.	Rev.
3552-004	D-102	A
Group: CIVIL		

SAVED 2017-04-18 6:24 PM
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millimeters
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Appendix C

Cushing Bridge Wildlife Corridor Design Guidelines Report by O2

UNDERPASS WILDLIFE CORRIDOR

design guidelines

O2 PLANNING + DESIGN

CONTENTS

LITERATURE REVIEW

Government of Alberta - Best Practice Guidelines: Planning and Considerations for Wildlife Passsage in Urban Environments

These guidelines provide project specific guidance to assist in determining which Best Practices Guidelines (BPGs) to consider for incorporation into environmental assessments.

City of Edmonton- Wildlife Passage Design Guidelines

These guidelines were designed to provide transportation designers and decision makers with recommendations that will incorporate the needs of wildlife into transportation projects.

GENERAL DESIGN GUIDELINES

Retrofitting Existing Structures (Underpass/Tunnel)

- The amount of human use, vegetative cover, substrate, and infrastructure-opening dimensions are important factors affecting wildlife movement at retrofitted passages.
- Installing wing fencing, planting vegetation and providing an appropriate walking surface may be required to make the passage structures suitable for wildlife movement.
- In ravines and along creeks attempt to mirror habitat conditions found on both sides of the passage.
- Provide shrubs adjacent to the passage structure to allow cover for animals approaching the structure. No large vegetation (i.e., trees) should be planted directly under or adjacent to the structure. Passages should be designed so that wildlife can see through the structure to suitable habitat on the other side.
- Where practical, maximize microhabitat complexity and vegetative cover within the passage using salvage materials (i.e., logs, root wads, rocks, etc.) to encourage use by wildlife.
- If recreational pathways are also located in the passage, use vegetation, logs, stumps, rocks or elevation change as a shield to separate human-use from wildlife where practical. If the passage is wide enough, recreational pathways should be confined to one side, leaving a dedicated corridor for wildlife use on the other side.

- Wing fencing is the most effective and preferred method to guide animals to a passage in order to prevent intrusions onto the highway. Wing fencing for most large mammals should be 2.4 m high.

- Large rip rap, rocks or boulders that typically exists under bridges do not provide an adequate walking surface for wildlife.

- Structures surfaced with natural substrates are preferred over manufactured surfaces like concrete, metal, asphalt or gravel.

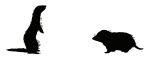
SPECIES GROUP DESIGN GUIDELINES

- The most effective crossing structures are designed with several species in mind and are linked to larger landscape features.

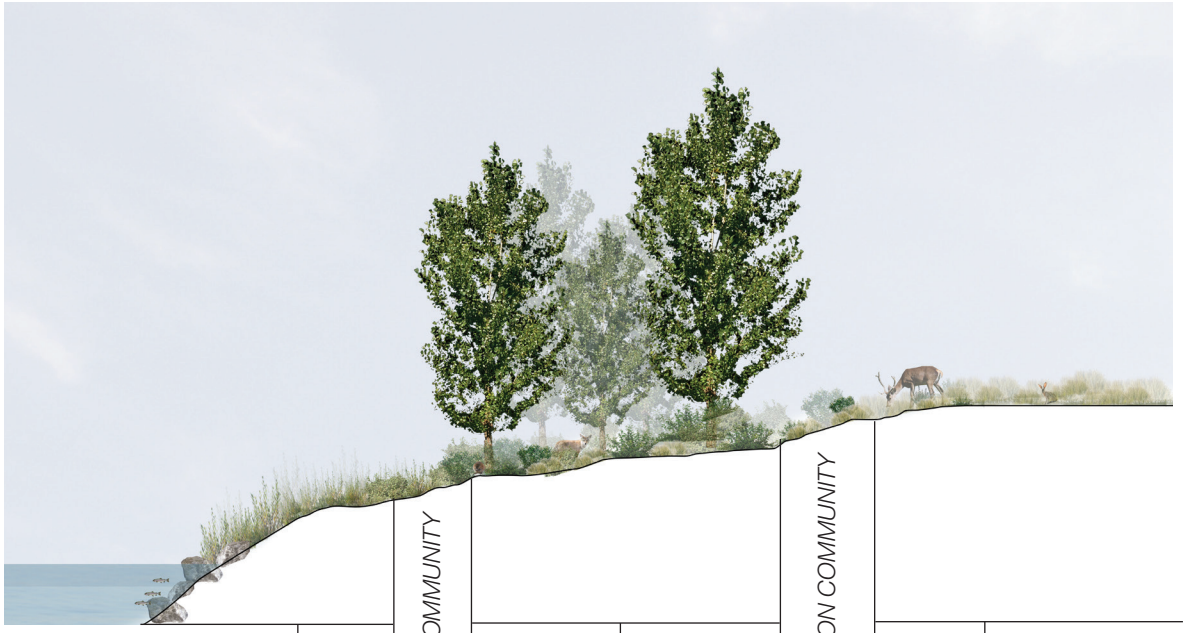
- Physical size of the species dictates how large a crossing must be. However, factors other than size may also dictate crossing structural preferences. For example, some larger terrestrial species, like deer, prefer large open crossing structure with good visibility on either side. While smaller species like mice prefer smaller crossing structures with ample overhead cover.

- All species identified as utilizing the area should be considered. The design should be based on the largest species group expected to use the corridor. Design elements for smaller species can then be incorporated into the larger corridor (see Table at right).

- Wildlife and humans can use the same greenspace for movement especially considering that human and wildlife peak. activity often occurs at different times of the day.

Species to Consider		Corridor Recommendations
Large Ungulates		• 2.5 m high x 6 m wide; ideally with ~2 m dry walkway • clear line of sight through crossing • rip rap should be buried and vegetated • lighting is recommended to increase visibility through the corridor • native vegetation at entrance with high forage value
Medium Terrestrial		• 1.5 m high x 1.5 m wide with 0.5 m dry walkway • low cover such as shrubs, logs or stumps for smaller prey • rip rap should be buried and vegetated • native vegetation at entrance with high forage value
Small Terrestrial		• 0.3 m high x 0.3 m wide • low cover such as shrubs, logs or stumps • small, rasied berm of natural substrate or “vole tube” used to funnel small wildlife across a larger corridor • native vegetation, rocks and stumps at entrance • limited mowing in habitat on either side of corridor
Amphibians and Reptiles		• 0.2-0.6 m in diameter • alinged with migration routes, not drainage patterns • typically not affiliated with streams
Aerial Mammals		• 1.3-3 m tall • provide day and night roosts • vegetation to direct towards crossing (i.e., hedgerow) • only minimal spill lighting should be used
Birds		• no specific requirements for underpass design as birds are highly mobile and can easily fly large distances between habitat patches

LOCAL VEGETATION COMMUNITY GRADIENT



RIPARIAN
SHRUB COMMUNITY

Typical Site:
Alluival deposits
subject to annual flooding

Ideal Community Type for Site:
Salix exigua

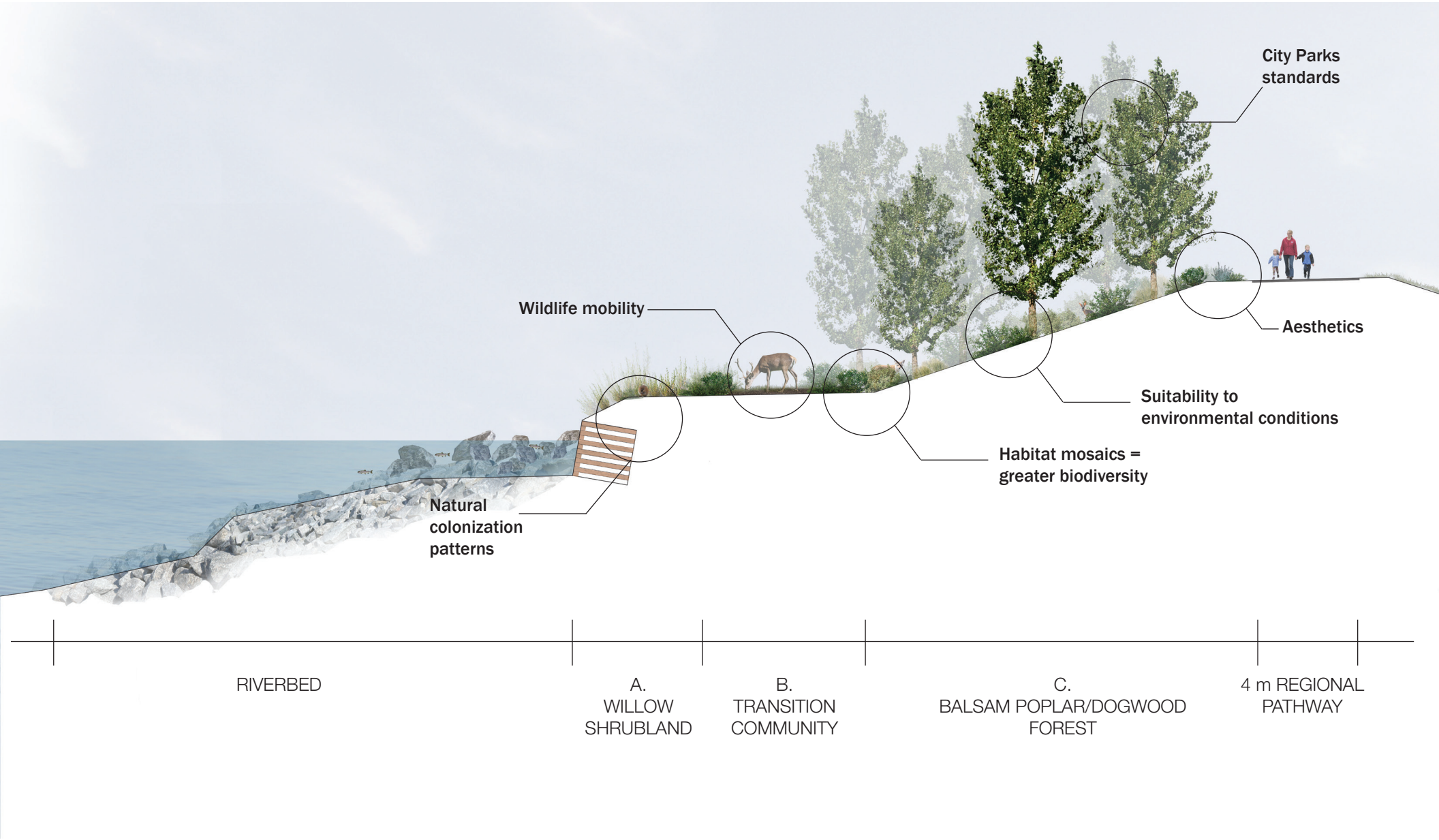
RIPARIAN
FOREST

Typical Site:
Alluival terraces
of major streams and rivers

Ideal Community Type for Site:
Balsam poplar/red-osier dogwood

UPLAND
GRASSLAND COMMUNITY

PLANTING APPROACH



VEGETATION SPECIES BY COMMUNITY

A. WILLOW SHRUBLAND

Salix exigua
(sandbar willow)

Cornus stolonifera
(red-osier dogwood)

Salix lutea
(yellow willow)

native seed mix -
1:5 year flood level and
below

B. TRANSITION COMMUNITY

Cornus stolonifera
(red-osier dogwood)

Ribes oxycanthoides
(northern gooseberry)

Potentilla fruticosa
(shrubby cinquefoil)

Viburnum edule
(low bush cranberry)

native seed mix -
above 1:5 year flood level

C. BALSAM POPLAR/DOGWOOD FOREST

Populus balsamifera
(balsam poplar)

Cornus stolonifera
(red-osier dogwood)

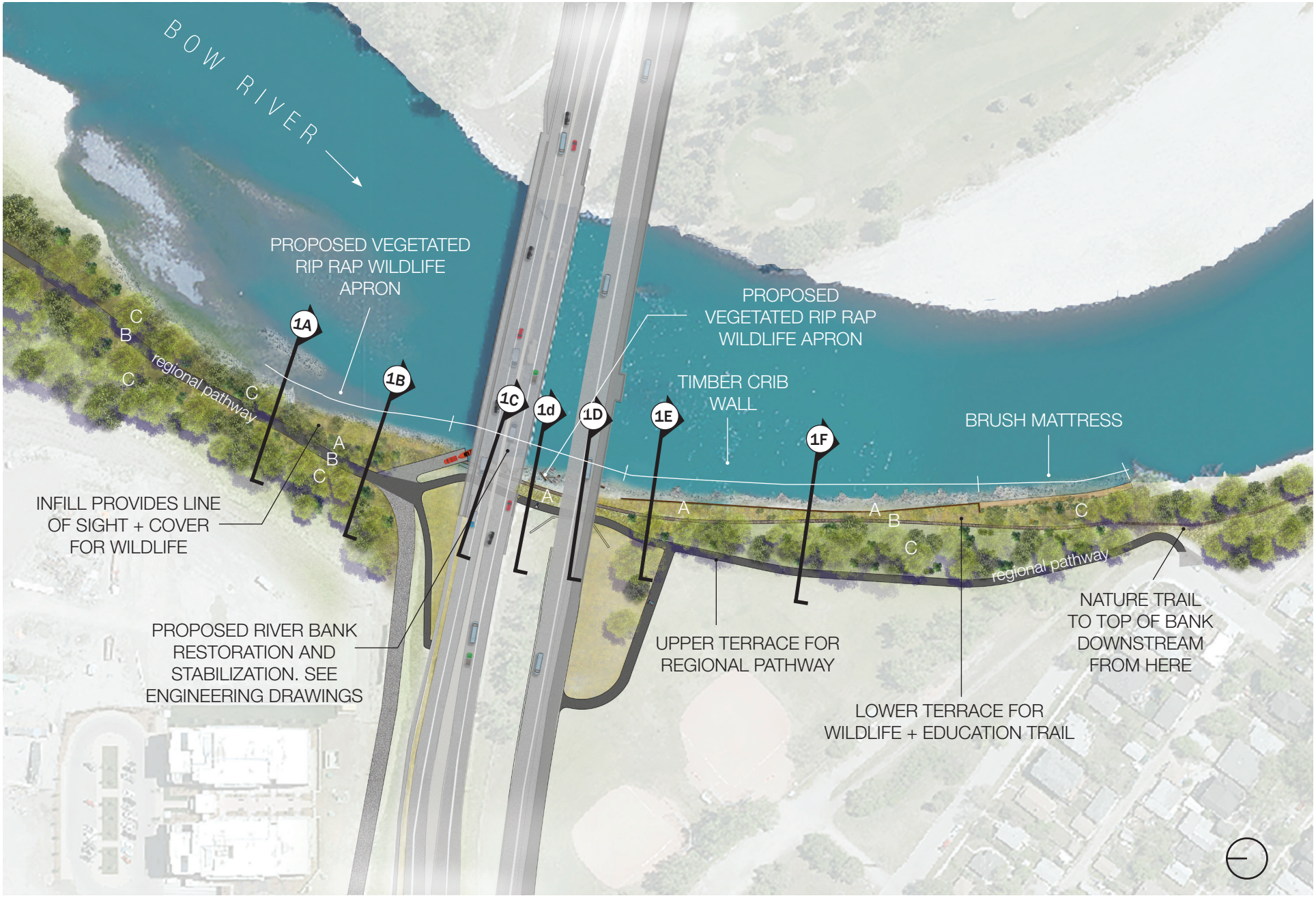
Eleagnus
commutata
(silverberry)

Ameliancher
alnifolia
(Sasktaoon)

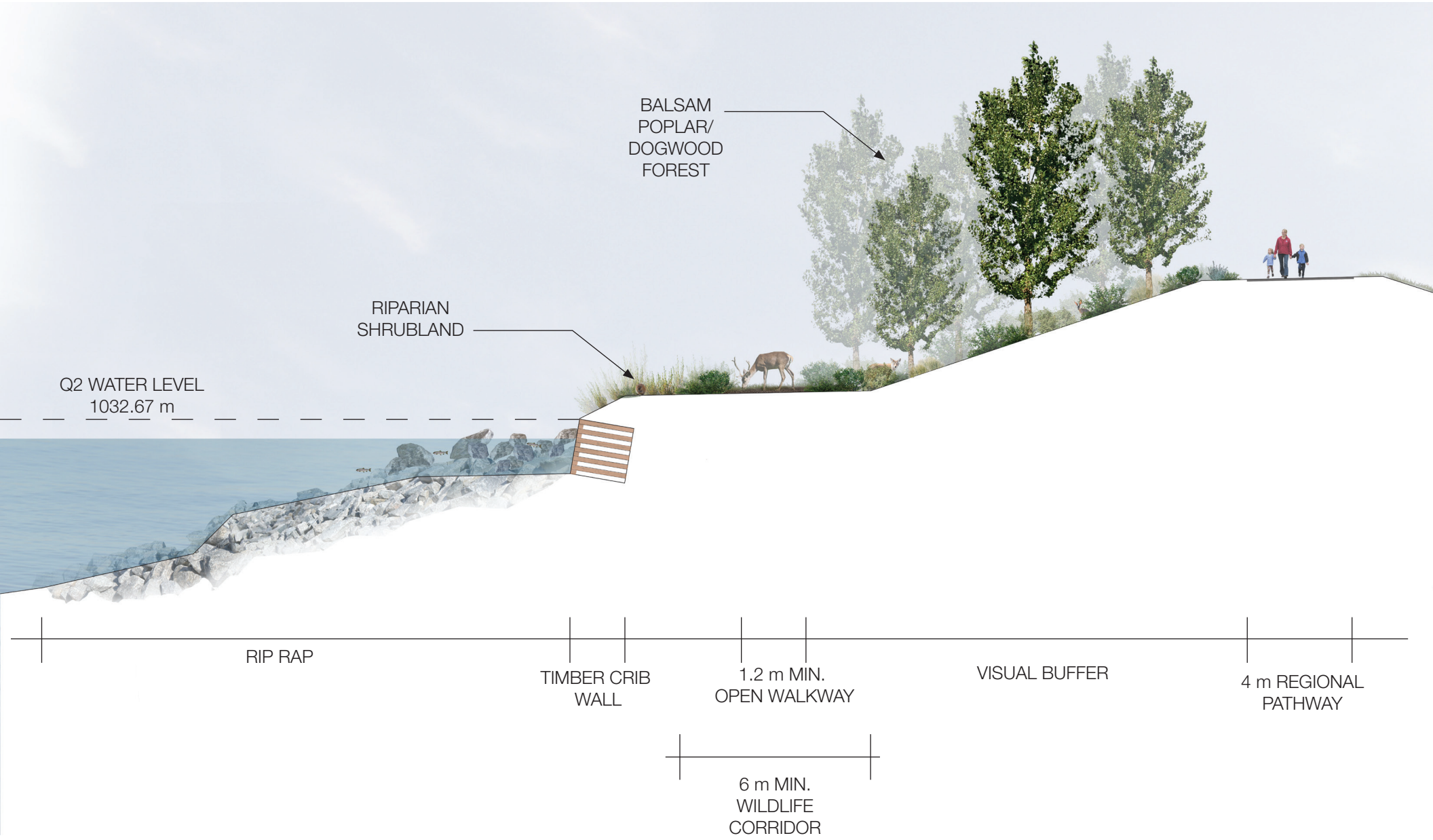
Rosa woodsi
(common wild rose)

native seed mix -
balsam poplar forest mix

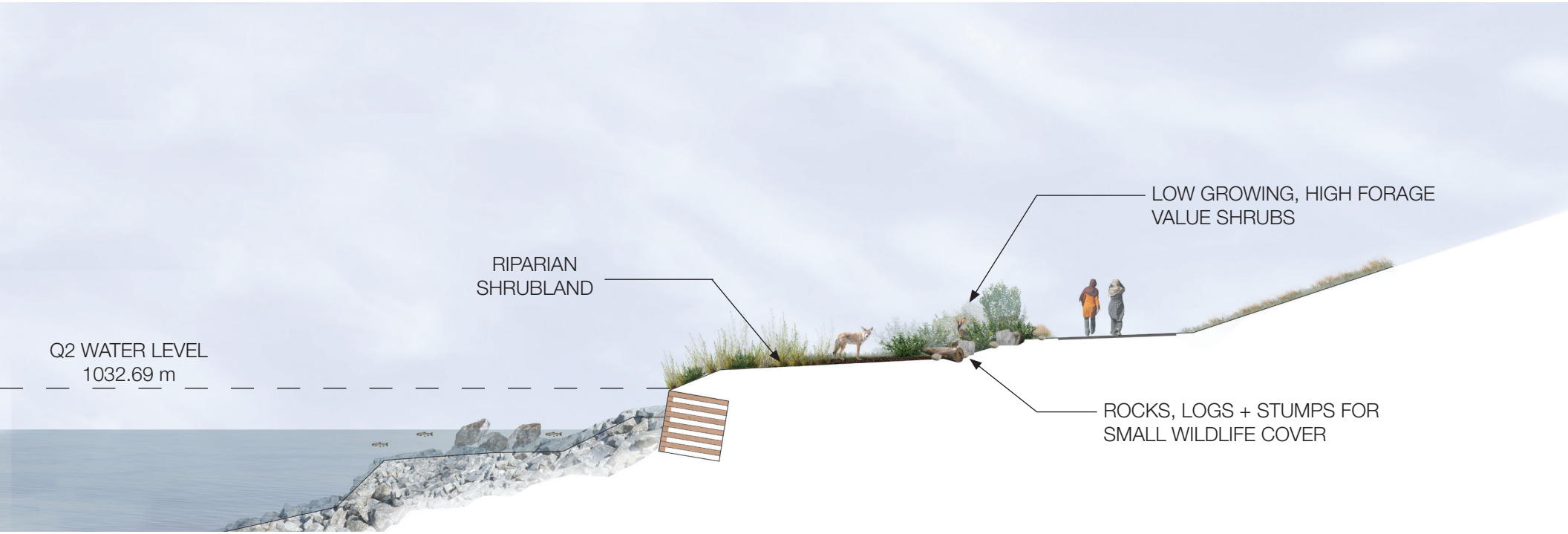
CONCEPTUAL SITE PLAN

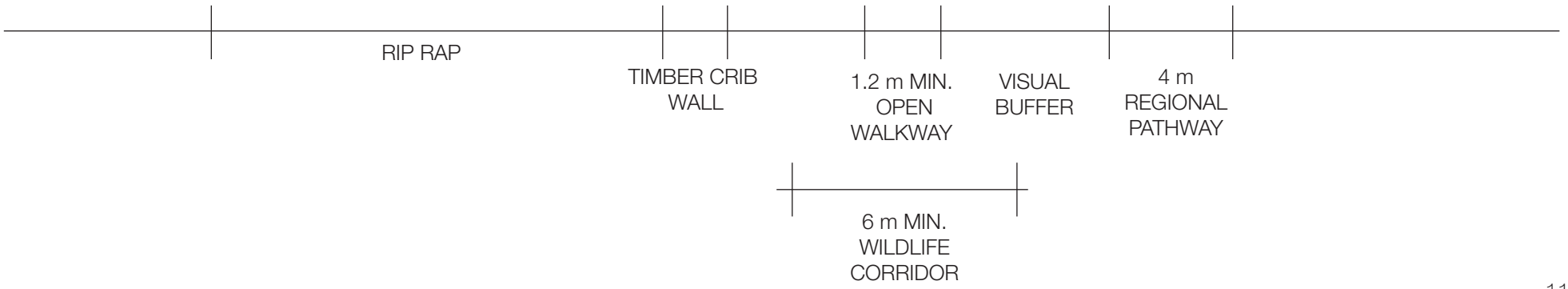


SECTION 1F - FOREST

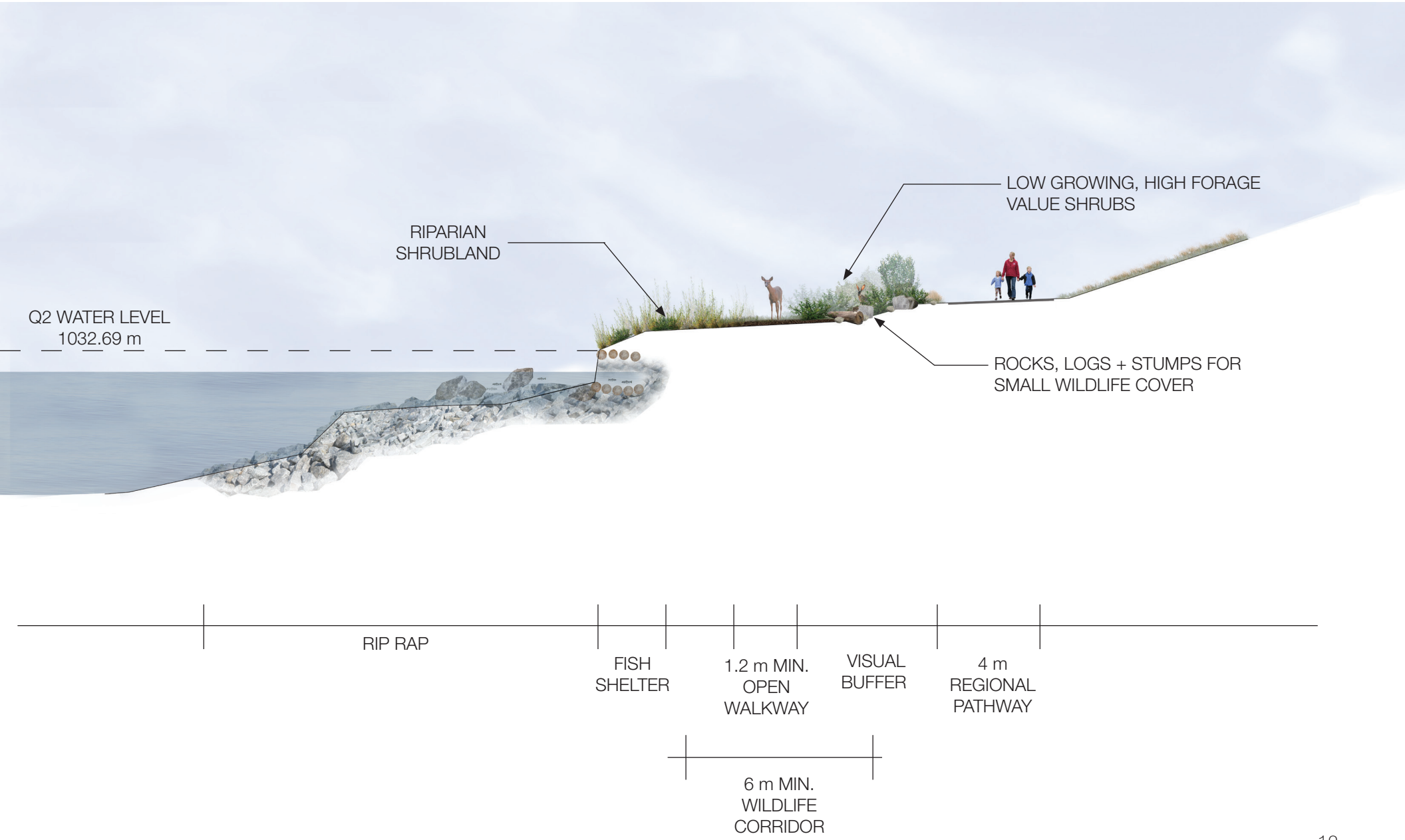


SECTION 1E - NEARING UNDERPASS

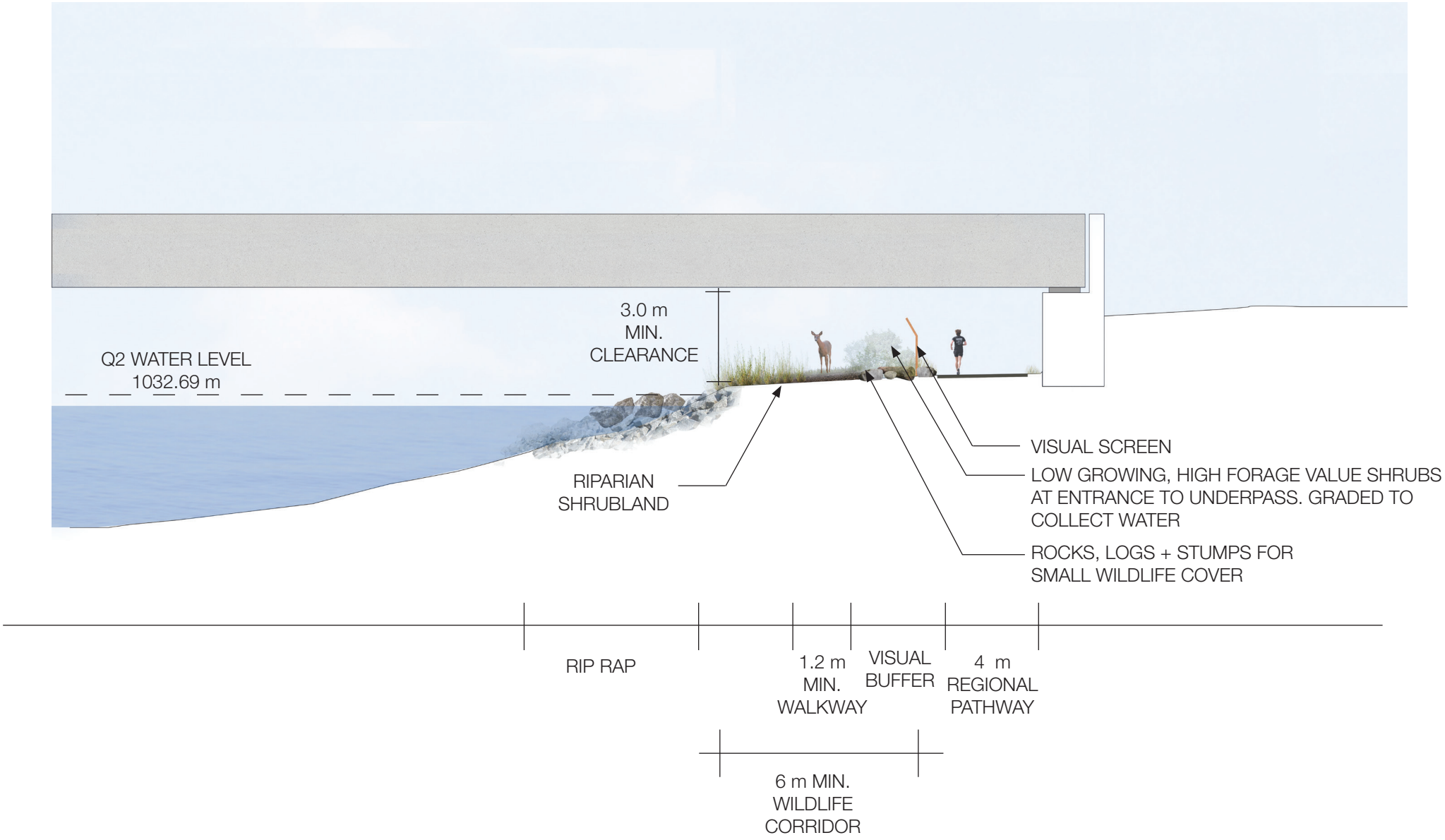




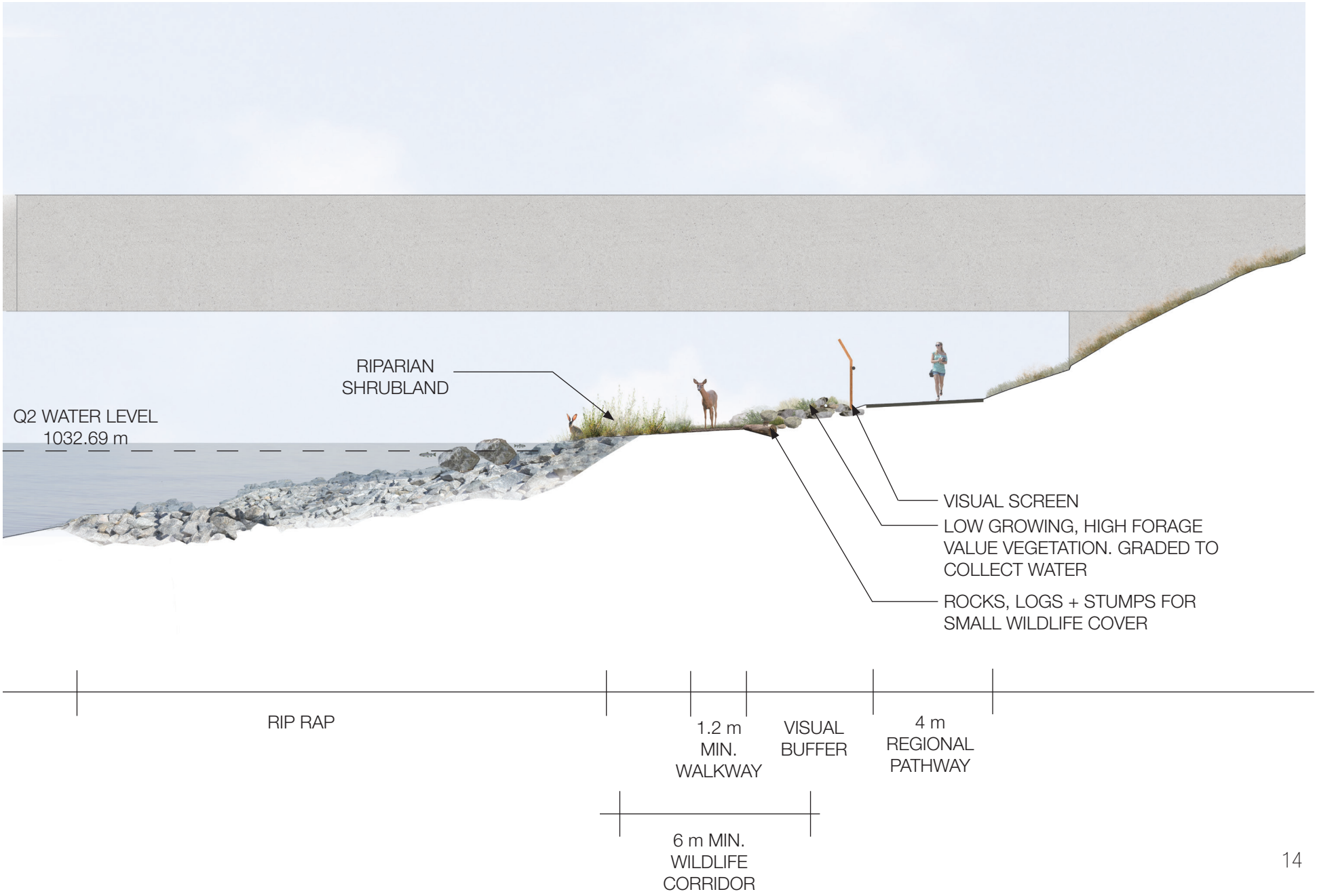
SECTION 1E - NEARING UNDERPASS (with fish shelter)



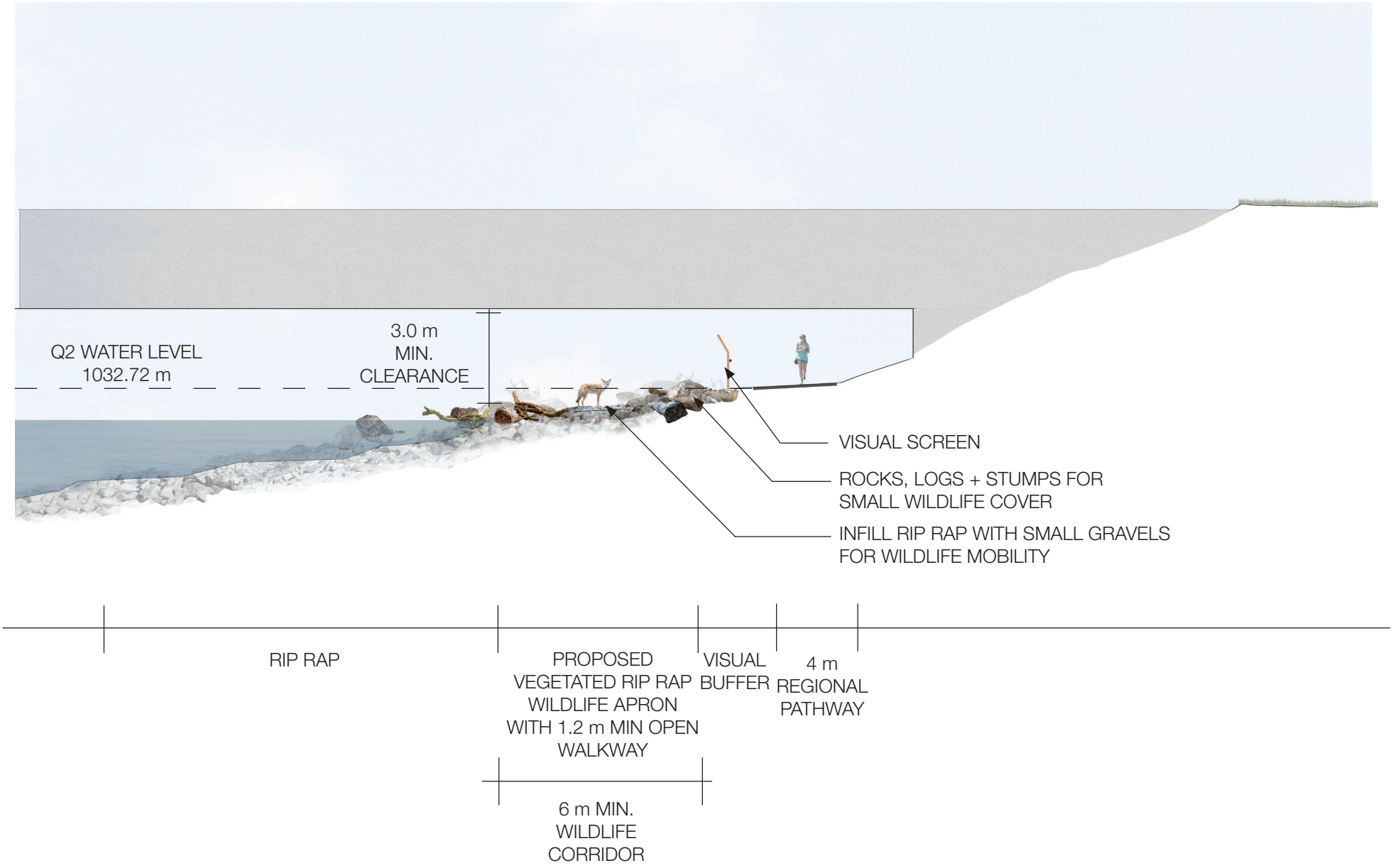
SECTION 1D - AT UNDERPASS ENTRANCE/EXIT



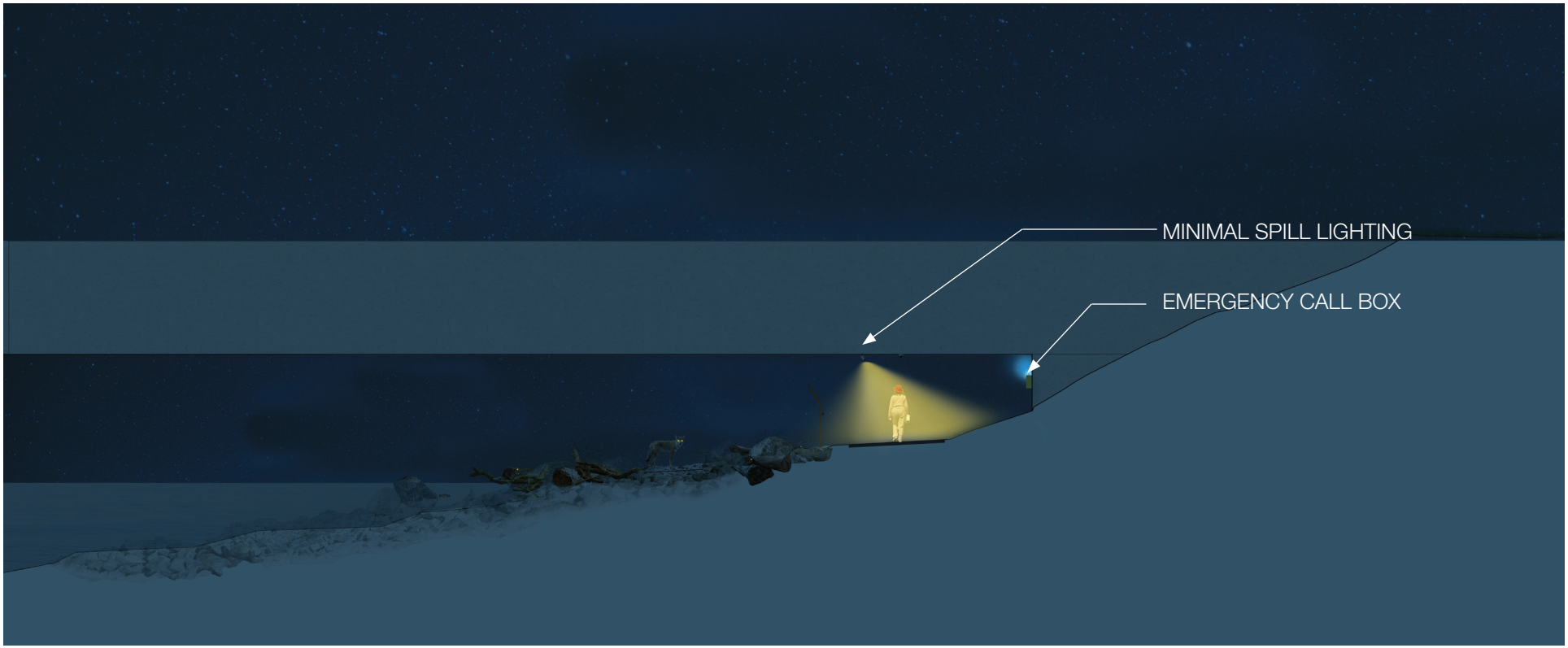
SECTION 1d - BETWEEN BRIDGE DECKS



SECTION 1C - UNDER BRIDGE DECK



SECTION 1C - UNDER BRIDGE DECK AT NIGHT



RIP RAP

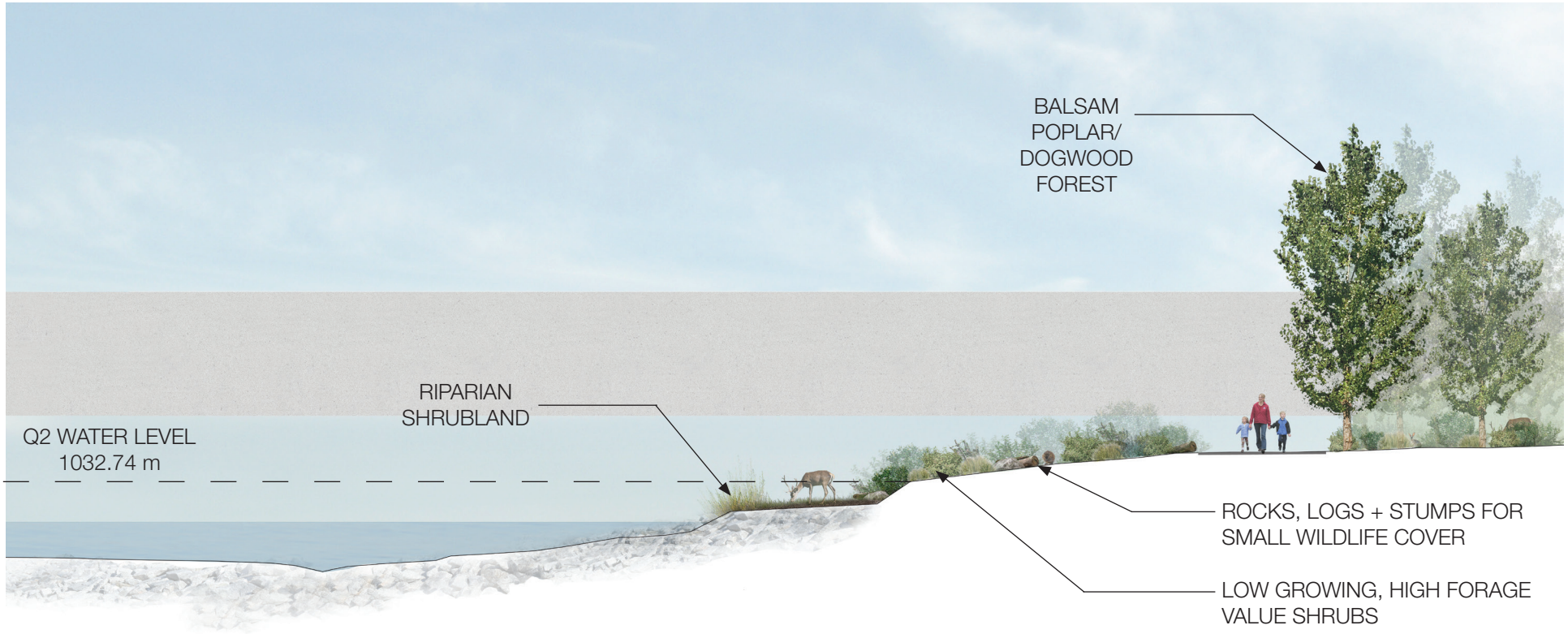
PROPOSED VEGETATED RIP RAP WILDLIFE APRON WITH 1.2 m MIN OPEN WALKWAY

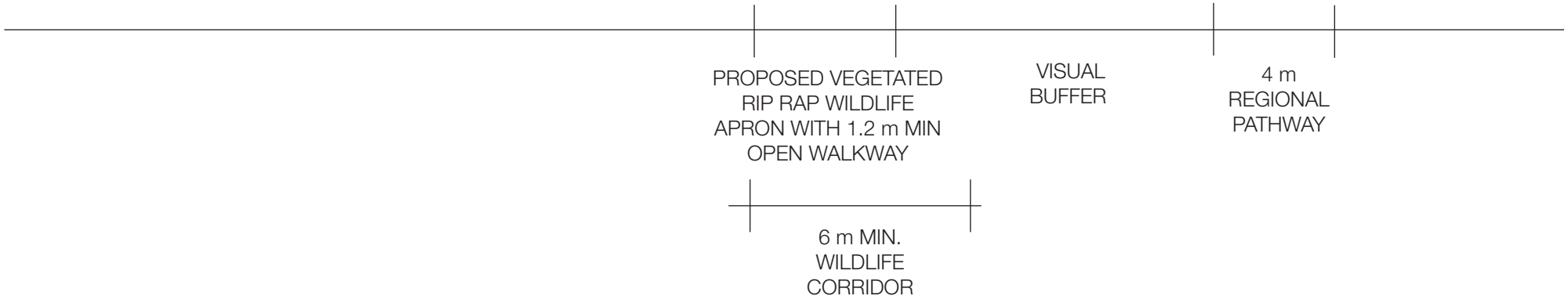
VISUAL BUFFER

4 m REGIONAL PATHWAY

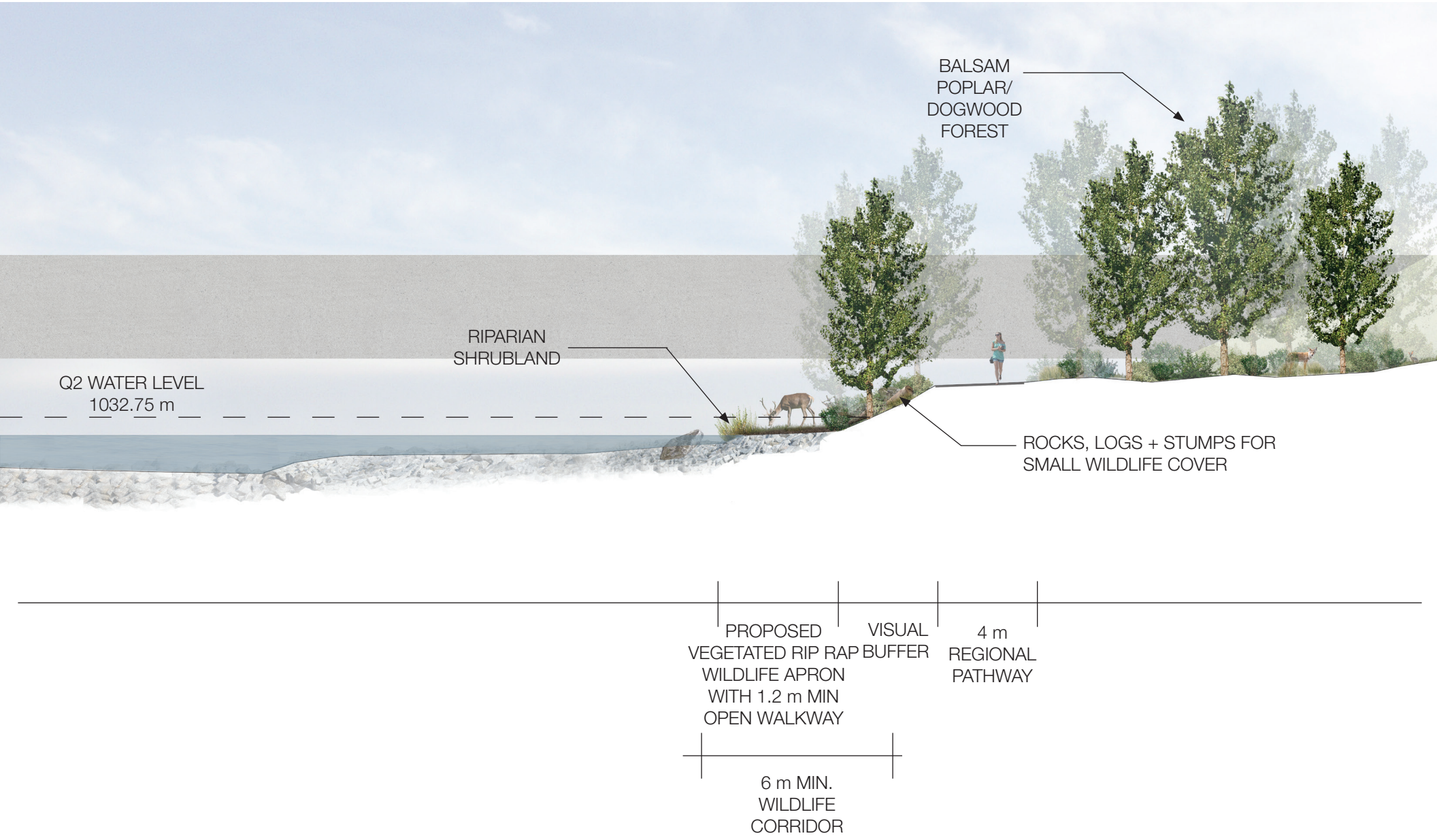
6 m MIN. WILDLIFE CORRIDOR

SECTION 1B - NORTH OF BOAT LAUNCH





SECTION 1A - NORTHERN EXTENT



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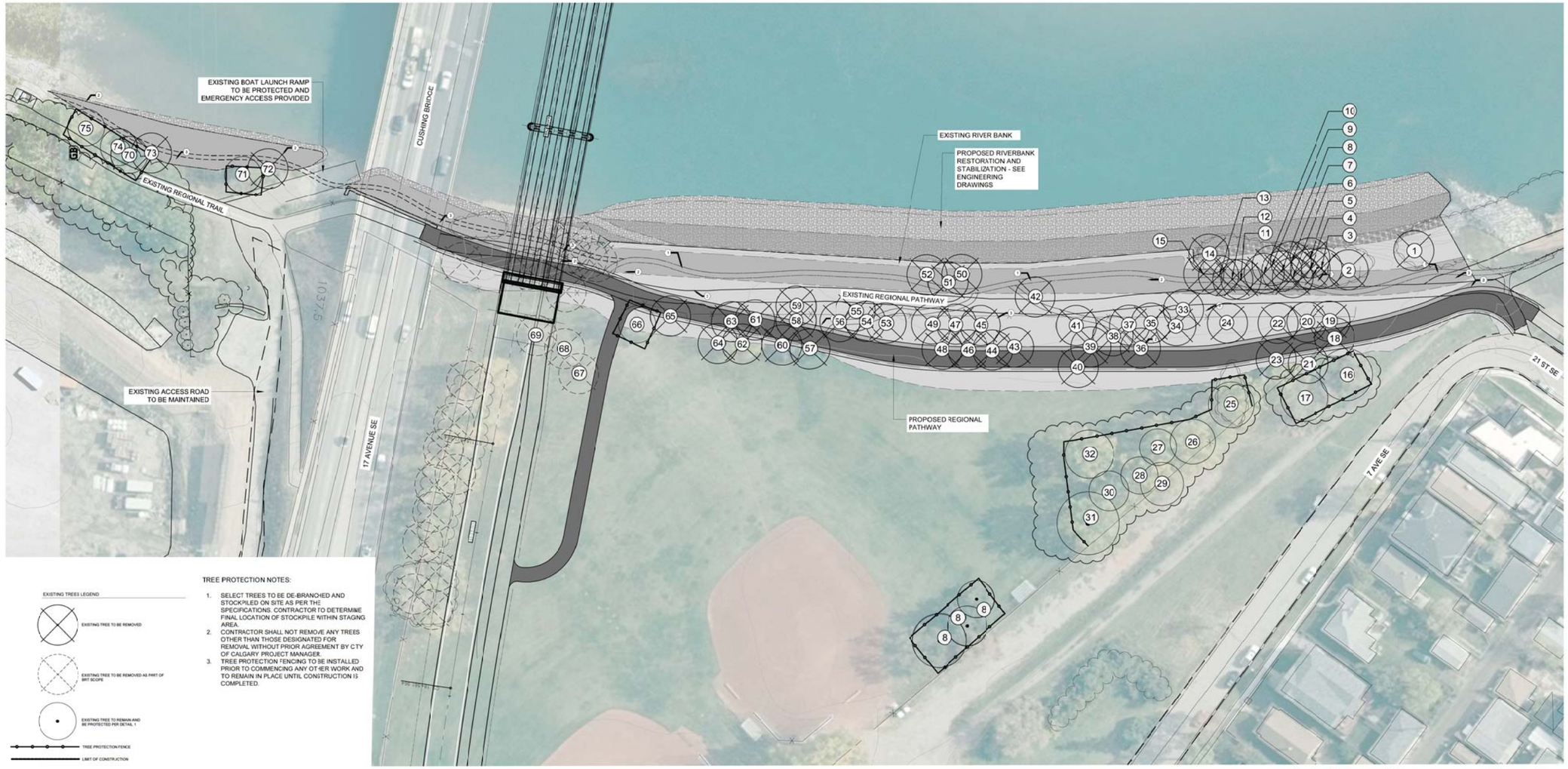
Appendix D

Landscape Design Drawings

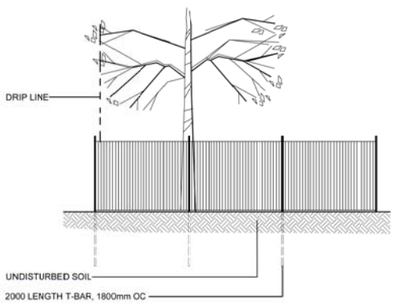


EXISTING TREES LEGEND

- EXISTING TREE TO BE REMOVED
- EXISTING TREE TO BE REMOVED AS PART OF BRT SCOPE
- EXISTING TREE TO REMAIN AND BE PROTECTED PER DETAIL 1
- TREE PROTECTION FENCE
- LIMIT OF CONSTRUCTION

TREE PROTECTION NOTES:

1. SELECT TREES TO EE DE-BRANCHED AND STOCKPILED ON SITE AS PER THE SPECIFICATIONS. CONTRACTOR TO DETERMINE FINAL LOCATION OF STOCKPILE WITHIN STAGING AREA.
2. CONTRACTOR SHALL NOT REMOVE ANY TREES OTHER THAN THOSE DESIGNATED FOR REMOVAL WITHOUT PRIOR AGREEMENT BY CTY OF CALGARY PROJECT MANAGER.
3. TREE PROTECTION FENCING TO BE INSTALLED PRIOR TO COMMENCING ANY OTHER WORK AND TO REMAIN IN PLACE UNTIL CONSTRUCTION IS COMPLETED.



NOTES :

1. 2000mm LENGTH T-BARS SPACED 1800mm OC AND WIRED TO THE INSIDE OF A STANDARD SAFETY FENCE AT THREE LOCATIONS PER STAKE WITH #10 WIRE.
2. ATTACHMENT OF FENCE TO TREES IS NOT PERMITTED
3. ENSURE FENCE IS LOCATED BEYOND THE DRIPLINE OF TREES TO BE PRESERVED
4. FENCING TO BE INSTALLED PRIOR TO START OF CONSTRUCTION AND TO REMAIN IN PLACE UNTIL CONSTRUCTION IS COMPLETED AND/OR LANDSCAPE ARCHITECT APPROVES REMOVAL OF FENCING. CONTRACTOR IS RESPONSIBLE TO MAINTAIN AND REPAIR TREE PROTECTION FENCING FOR DURATION OF CONSTRUCTION.
5. FENCING IS DEFINED AS 1200mm ORANGE PLASTIC SNOW/SAFETY FENCING SUPPORTED BY IRON "T" STAKES.

1 TREE PROTECTION FENCING

1:50 P-O2-FIS-11

EXISTING TREES TO BE REMOVED OR PROTECTED

#	Common Name	Scientific Name	DBH	Protect	Remove
1	Manitoba Maple	Acer negundo	55cm		x
2	Manitoba Maple	Acer negundo	45cm		x
3	Manitoba Maple	Acer negundo	40cm		x
4	Manitoba Maple	Acer negundo	50cm		x
5	Manitoba Maple	Acer negundo	20cm		x
6	Manitoba Maple	Acer negundo	25cm		x
7	Manitoba Maple	Acer negundo	25cm		x
8	Manitoba Maple	Acer negundo	13cm		x
9	Manitoba Maple	Acer negundo	55cm		x
10	Manitoba Maple	Acer negundo	25cm		x
11	Manitoba Maple	Acer negundo	60cm		x
12	Crabapple Species	Malus	23cm		x
13	Manitoba Maple	Acer negundo	20cm		x
14	Balsam Poplar	Populus balsamifera	35cm		x
15	Poplar species	Populus	11cm		x
16	Manitoba Maple	Acer negundo	46cm	x	
17	Manitoba Maple	Acer negundo	52cm	x	
18	Manitoba Maple	Acer negundo	12cm		x
19	Green Ash	Fraxinus pennsylvatica	20cm		x
20	Manitoba Maple	Acer negundo	54cm		x
21	Manitoba Maple	Acer negundo	37cm		x
22	Manitoba Maple	Acer negundo	23cm		x
23	Manitoba Maple	Acer negundo	42cm		x
24	Green Ash	Fraxinus pennsylvatica	20cm		x
25	Northwest Poplar	Populus jackii 'Northwest'	47cm	x	
26	Northwest Poplar	Populus jackii 'Northwest'	48cm	x	
27	Northwest Poplar	Populus jackii 'Northwest'	42cm	x	

#	Common Name	Scientific Name	DBH	Protect	Remove
28	Northwest Poplar	Populus jackii 'Northwest'	46cm	x	
29	Manitoba Maple	Acer negundo	40cm	x	
30	Northwest Poplar	Populus jackii 'Northwest'	31cm	x	
31	Northwest Poplar	Populus jackii 'Northwest'	64cm	x	
32	Northwest Poplar	Populus jackii 'Northwest'	50cm	x	
33	Manitoba Maple	Acer negundo	31cm		x
34	American Elm	Ulmus americana	20cm		x
35	Balsam Poplar	Populus balsamifera	36cm		x
36	Green Ash	Fraxinus pennsylvatica	16cm		x
37	Green Ash	Fraxinus pennsylvatica	14cm		x
38	Manitoba Maple	Acer negundo	30cm		x
39	Green Ash	Fraxinus pennsylvatica	17cm		x
40	Green Ash	Fraxinus pennsylvatica	26cm		x
41	Green Ash	Fraxinus pennsylvatica	18cm		x
42	Northwest Poplar	Populus jackii 'Northwest'	43cm		x
43	Green Ash	Fraxinus pennsylvatica	16cm		x
44	Green Ash	Fraxinus pennsylvatica	20cm		x
45	Green Ash	Fraxinus pennsylvatica	16cm		x
46	Green Ash	Fraxinus pennsylvatica	24cm		x
47	Green Ash	Fraxinus pennsylvatica	18cm		x
48	Green Ash	Fraxinus pennsylvatica	22cm		x
49	Green Ash	Fraxinus pennsylvatica	20cm		x
50	Manitoba Maple	Acer negundo	52cm		x
51	Green Ash	Fraxinus pennsylvatica	22cm		x
52	Green Ash	Fraxinus pennsylvatica	32cm		x
53	Mayday	Prunus padus 'Commutata'	30cm		x
54	Green Ash	Fraxinus pennsylvatica	7cm		x

#	Common Name	Scientific Name	DBH	Protect	Remove
55	Green Ash	Fraxinus pennsylvatica	13cm		x
56	Green Ash	Fraxinus pennsylvatica	20cm		x
57	Green Ash	Fraxinus pennsylvatica	21cm		x
58	Green Ash	Fraxinus pennsylvatica	10cm		x
59	Northwest Poplar	Populus jackii 'Northwest'	55cm		x
60	Green Ash	Fraxinus pennsylvatica	17cm		x
61	Green Ash	Fraxinus pennsylvatica	18cm		x
62	Green Ash	Fraxinus pennsylvatica	19cm		x
63	Green Ash	Fraxinus pennsylvatica	14cm		x
64	Green Ash	Fraxinus pennsylvatica	16cm		x
65	Green Ash	Fraxinus pennsylvatica	9cm		x
66	Balsam Poplar	Populus balsamifera	38cm	x	
67	Green Ash	Fraxinus pennsylvatica	18cm	x	
68	Green Ash	Fraxinus pennsylvatica	18cm	x	
69	Manitoba Maple	Acer negundo	32cm	x	
70	Unknown			x	
71	Unknown			x	
72	Unknown				x
73	Unknown				x
74	Unknown			x	
75	Unknown			x	
			Total:	18	57

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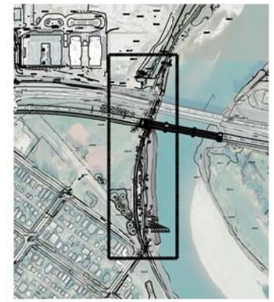
KEYMAP



ISSUED FOR: DESIGN REVIEW
DATE: 2017-04-03

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1	ISSUED FOR REVIEW	2017/03/23	CD
2	ISSUED FOR WATER ACT APPROVAL	2017/04/03	CD

DESIGNED BY: CD/MM
CHECKED BY: MM
PLOT DATE: 2017-04-03
DRAWING FILE NAME: L0.00 TREE PROTECTION PLAN.dwg

DRAWING TITLE :

TREE MANAGEMENT PLAN

L100

2017-04-13 11:34am By: CDyck
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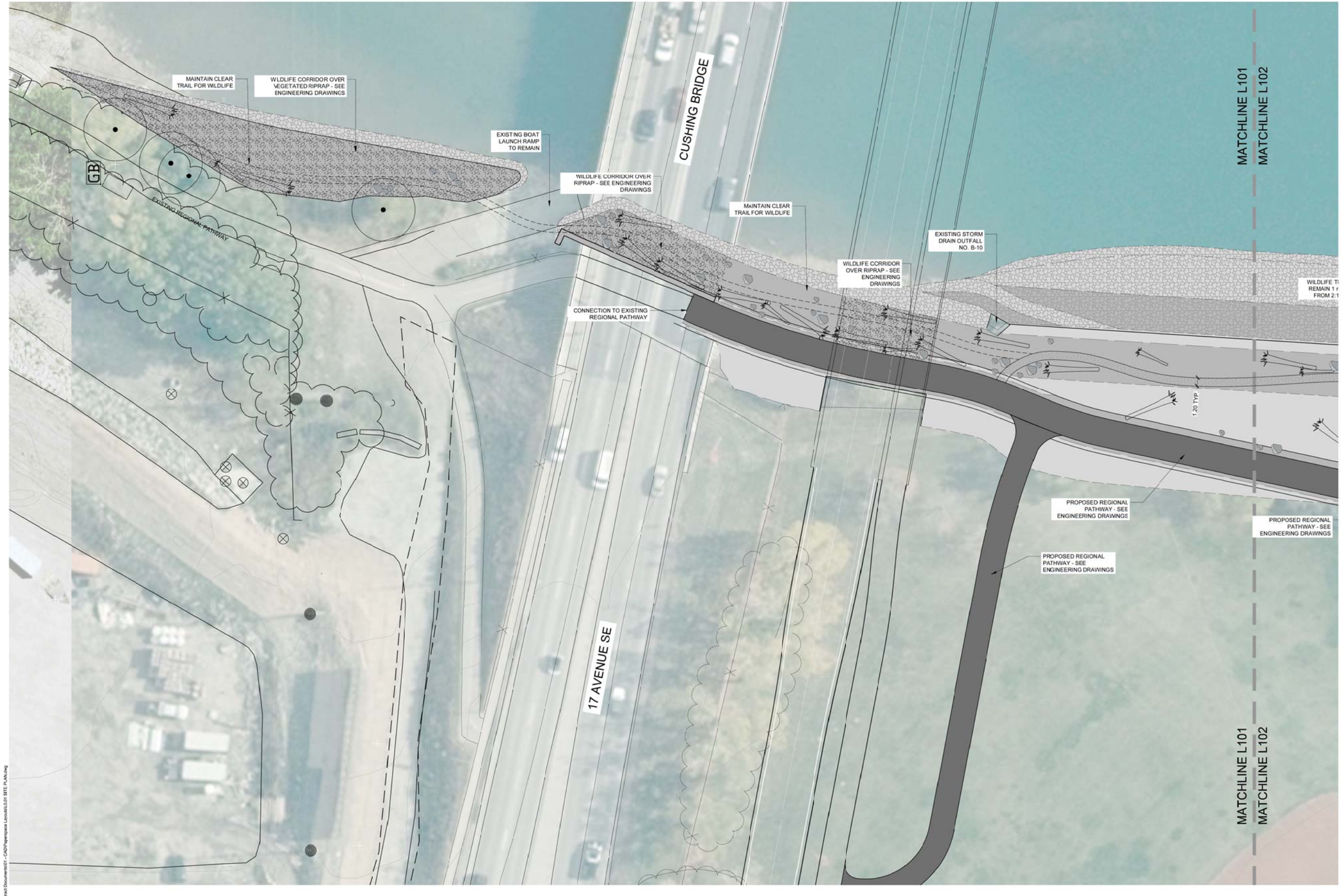

REFERENCE NOTES SCHEDULE SITE

SYMBOL	DESCRIPTION	QTY	DETAIL
	NATURAL SURFACE TRAIL	280m²	5/L8.00
	BOULDER	92	6/L8.00
	HABITAT LOG	35	7/L8.00
	EXISTING TREE TO BE RETAINED		

NORTH

0 2.5 6.25 12.5 25m

SCALE: 1: 250

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DESIGNED BY: SH/MM
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PLOT DATE: 2017-04-13
DRAWING FILE NAME: L0.01 SITE PLAN.dwg

DRAWING TITLE :

SITE PLAN NORTH

L101

2017-04-13 11:35am By: CDyck
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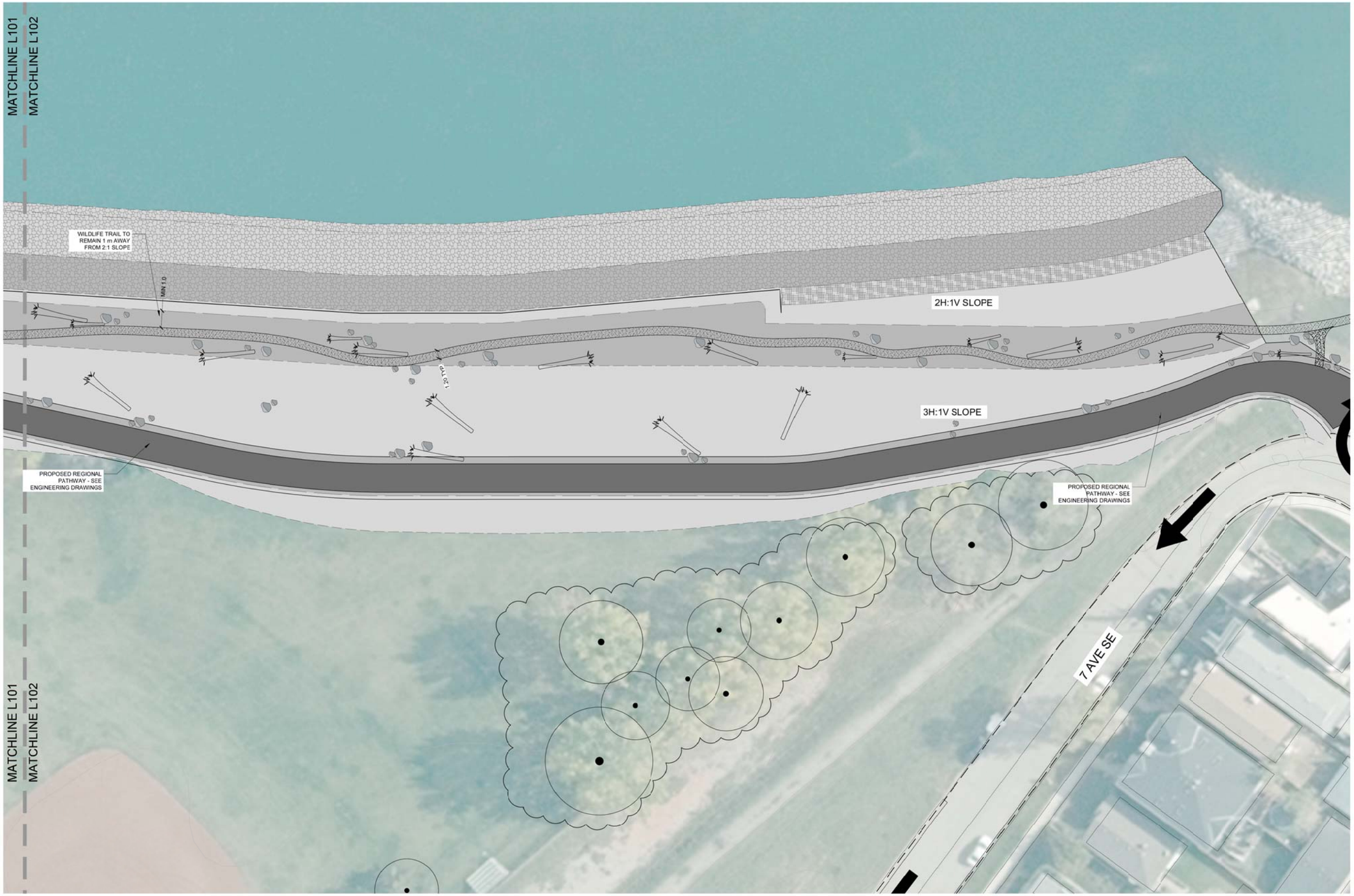

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	NATURAL SURFACE TRAIL	280m²	5/L8.00
	BOULDER	92	6/L8.00
	HABITAT LOG	35	7/L8.00
	EXISTING TREE TO BE RETAINED		

NORTH

0 2.5 6.25 12.5 25m

SCALE: 1:250

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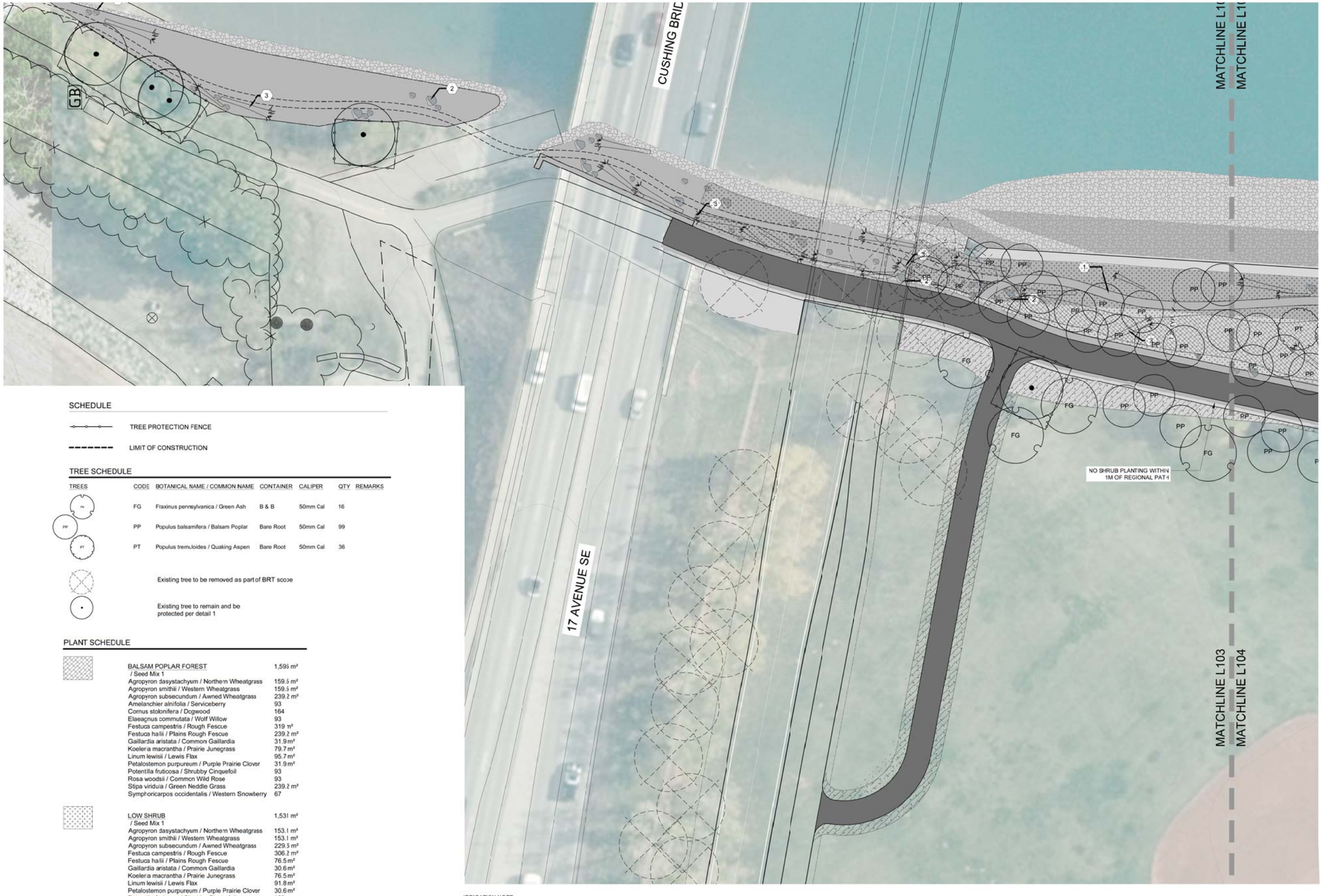
DESIGNED BY: SH/MM
CHECKED BY: MM
PLOT DATE: 2017-04-13
DRAWING FILE NAME:
L0.02 SITE PLAN.dwg

DRAWING TITLE :

SITE PLAN SOUTH

L102

2017-04-13 11:36am By: CDyck
N:\Projects\150705 Alberta Environment FSH\ESDS\ Contract Documents\01 - CAD\Paperspace Layouts\L0.02 SITE PLAN.dwg



SCHEDULE

TREE PROTECTION FENCE

LIMIT OF CONSTRUCTION

TREE SCHEDULE

TREES	CODE	BOTANICAL NAME / COMMON NAME	CONTAINER	CALIPER	QTY	REMARKS
FG	FG	Fraxinus pennsylvanica / Green Ash	B & B	50mm Cal	16	
PP	PP	Populus balsamifera / Balsam Poplar	Bare Root	50mm Cal	99	
PT	PT	Populus tremuloides / Quaking Aspen	Bare Root	50mm Cal	36	

Existing tree to be removed as part of BRT scope

Existing tree to remain and be protected per detail 1

PLANT SCHEDULE

	BALSAM POPLAR FOREST / Seed Mix 1	1,595 m²
	Agropyron dasystachyum / Northern Wheatgrass	159.5 m²
	Agropyron smithii / Western Wheatgrass	159.5 m²
	Agropyron subsecundum / Awned Wheatgrass	239.2 m²
	Amelanchier alnifolia / Serviceberry	93
	Cornus stolonifera / Dogwood	164
	Elaeagnus commutata / Wolf Willow	93
	Festuca campestris / Rough Fescue	319 m²
	Festuca hallii / Plains Rough Fescue	239.2 m²
	Gaillardia aristata / Common Gaillardia	31.9 m²
	Koeleria macrantha / Prairie Junegrass	79.7 m²
	Linum lewisii / Lewis Flax	95.7 m²
	Petalostemon purpureum / Purple Prairie Clover	31.9 m²
	Potentilla fruticosa / Shrubby Cinquefoil	93
	Rosa woodsii / Common Wild Rose	93
	Stipa viridula / Green Neddle Grass	239.2 m²
	Symphoricarpos occidentalis / Western Snowberry	67
	LOW SHRUB / Seed Mix 1	1,531 m²
	Agropyron dasystachyum / Northern Wheatgrass	153.1 m²
	Agropyron smithii / Western Wheatgrass	153.1 m²
	Agropyron subsecundum / Awned Wheatgrass	229.3 m²
	Festuca campestris / Rough Fescue	306.2 m²
	Festuca hallii / Plains Rough Fescue	76.5 m²
	Gaillardia aristata / Common Gaillardia	30.6 m²
	Koeleria macrantha / Prairie Junegrass	76.5 m²
	Linum lewisii / Lewis Flax	91.8 m²
	Petalostemon purpureum / Purple Prairie Clover	30.6 m²
	Potentilla fruticosa / Shrubby Cinquefoil	166
	Ribes oxyacanthoides / Northern Gooseberry	166
	Stipa viridula / Green Neddle Grass	229.3 m²
	Symphoricarpos albus / Snowberry	80
	Viburnum edule / Low Bush Cranberry	487
	GRASS / Standard City of Calgary grass seed mix	697.3 m²

IRRIGATION NOTE:

ALL PLANTING MATERIAL TO BE IRRIGATED UNTIL FAC.

NORTH

0 2.5 6.25 12.5 25m

SCALE: 1: 250

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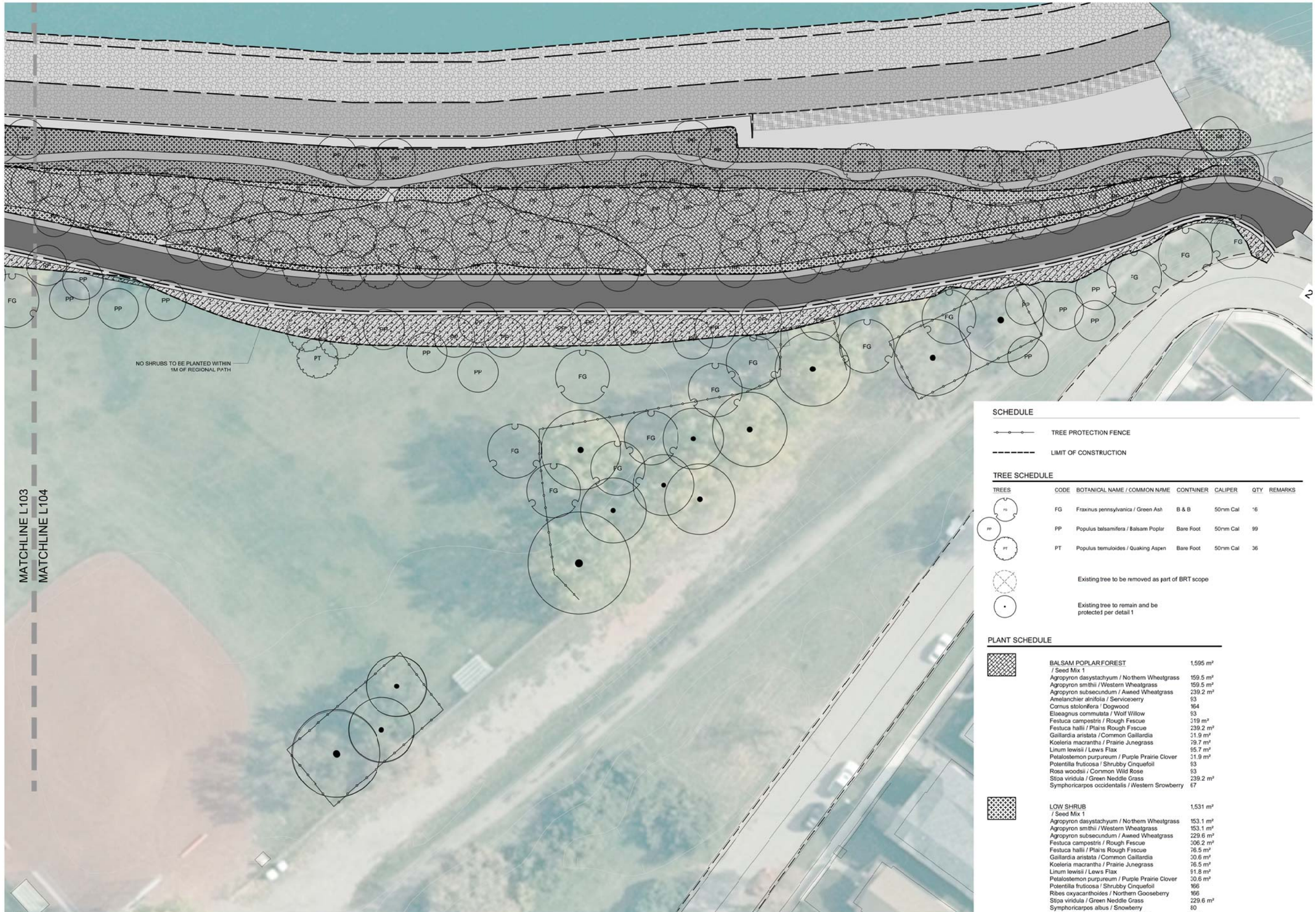
DESIGNED BY: SH/MM
CHECKED BY: MM
PLOT DATE: 2017-04-13
DRAWING FILE NAME: L6.01 PLANTING PLAN.dwg

DRAWING TITLE :

PLANTING PLAN NORTH

L103

2017-04-13 11:37am By: CDyck
N:\Projects\160705 Alberta Environment FBHE\06 Contract Documents\01 - CAD\Paperspace Layouts\L6.01 PLANTING PLAN.dwg



IRRIGATION NOTE:

ALL PLANTING MATERIAL TO BE IRRIGATED UNTIL FAC.

SCHEDULE

TREE PROTECTION FENCE

LIMIT OF CONSTRUCTION

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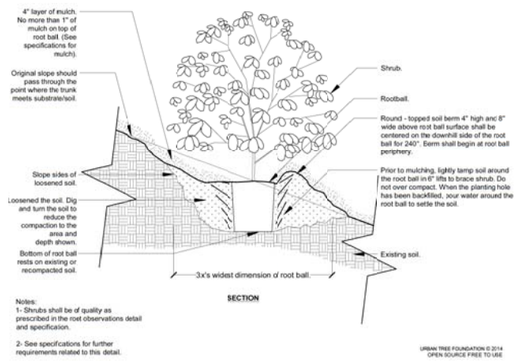
DESIGNED BY: SH/MM
CHECKED BY: MM
PLOT DATE: 2017-04-13
DRAWING FILE NAME:
L6.02 PLANTING PLAN.dwg

DRAWING TITLE :

PLANTING PLAN SOUTH

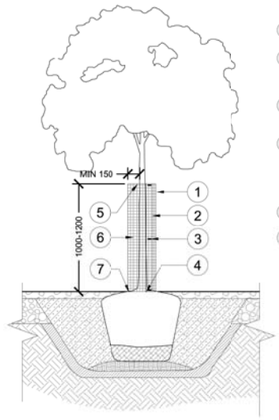
L104

2017-04-13 11:
N:\Projects\160705 Alber



5 SHRUB ON SLOPE 5% (20:1) TO 50% (2:1) - UNMODIFIED

1:20 P-O2-FIS-06



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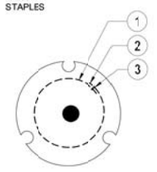
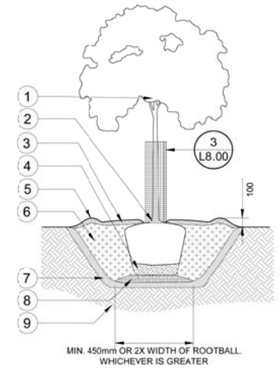


B: PLAN - 1:10

1. 25mm SQUARE MESH STUCCO WIRE FENCH. 14 GUAGE GALVANIZED WIRE
2. WIRE MESH OVERLAPS BY 2 SQUARES OF MESH (50mm)
3. 100mm ALL WEATHER ZIP TIES FASTEN THE WIRE TOGETHER AT TOP, MIDDLE AND BOTTOM
4. WIRE SITS FLAT ON THE GROUND ON ALL SIDES. F TREE IS ON SLOPE, CUT WIRE TO FIT.
5. WIRE SHALL BE 1200mm TALL IN THE CASE OF MOST TREES, 1000mm TALL IN THE CASE OF SMALL TREES THAT WOULD REQUIRE EXCESSIVE PRUNING TO FIT
6. LEAVE 150mm SPACE AROUND ENTIRE TRUNK
7. SECURE WIRE MESH TO GROUND WITH 4x200mm STAPLES

3 INDIVIDUAL TREE BEAVER FENCING

1:30 P-O2-FIS-82



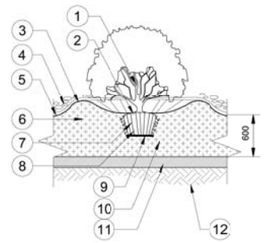
1. TREE TO BE SET PLUMB IN CENTRE OF TREE PIT.
2. TRUNK FLARE TO BE ABOVE FINISHED GRADE OF SOIL.
3. BARK MULCH. REFER TO SPECIFICATIONS. MULCH MUST NOT CONTACT TREE TRUNK.
4. CUT WIRE BASKET, BEND BACK TOP LOOPS AND REMVOE BURLAP FROM TOP 1/3 OF ROOTBALL. REMOVE ALL TWINE AND NON BIODEGRADABLE MATERIAL.
5. BERM OF PLANTING MEDIUM FORMING WATER DISH AROUND OUTSIDE EDGE OF ROOTBALL.
6. TREE PLANTING MEDIUM. REFER TO SPECIFICATIONS.
7. SCARIFY SIDES OF PIT TO 150mm DEPTH IF SURROUNDING SOIL IS NOT NEW PLANTING MEDIUM.
8. MOUND SUBGRADE TO SUPPORT ROOTBALL
9. SUBGRADE.

NOTES:
1. REMOVE ALL DELETERIOUS MATERIALS. INCLUDING GARBAGE, RUBBLE, DEBRIS, GRAVEL, ETC., FROM PLANTING PIT.
2. WATER THOROUGHLY AFTER INSTALLATION.
3. REMOVE TREE RINGS AND STAKES TWO YEARS AFTER INSTALLATION.
4. DO NOT ALLOW AIR POCKETS TO FORM WHEN BACKFILLING.
5. POSITION CROWN OF ROOT BALL 50mm ABOVE FINISHED GRADE TO ALLOW FOR SETTLEMENT.
6. DO NOT DAMAGE OR CUT LEADER.
7. IF STAKING IS DEEMED NECESSARY SEE SPECIFICATIONS.
8. DO NOT WRAP TRUNK.

1 TREE PLANTING

1:40 P-O2-FIS-81

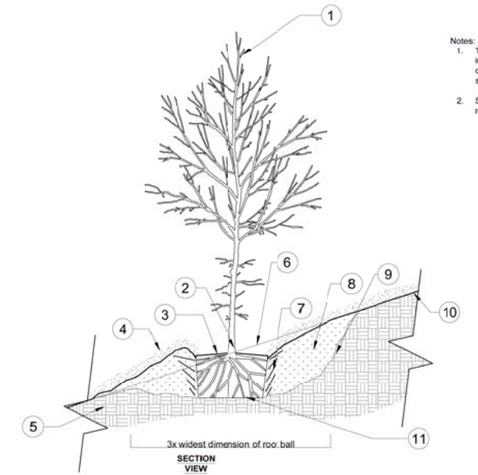
NOTES:
1. ALL PLANT MATERIAL TO BE IRRIGATED FOR 2 YEARS UNTIL FAC.



1. PRUNE ONLY BROKEN, DEAD OR DISEASED BRANCHES
2. PLANT SHRUB SO TOP OF ROOT BALL IS SLIGHTLY ABOVE GRADE.
3. 100mm HIGHER SAUCER AROUND SHRUB
4. MIN. 75mm (3") BARK MULCH. REFER TO SPECIFICATIONS.
5. FINISHED GRADE
6. BACKFILL PLANTING SOIL AROUND SHRUBS IN LIFTS NOT TO EXCEED 150mm IN DEPTH. TAMP DOWN TO REMOVE AIR POCKETS.
7. REMOVE ALL TIES, WIRE AND/OR POTS
8. VERTICAL SCORES 5mm DEEP, EVERY 75mm
9. PLACE 100mm SOIL MIX C UNDER PLANT
10. SOIL MIX VARIES
11. SCARIFY PIT BOTTOM 75mm (3") MIN.
12. SUBGRADE

2 SHRUB PLANTING

1:30 P-O2-FIS-80



Notes:
1. Trees shall be of quality prescribed in crown observations and root observations details and specifications.
2. See specifications for further requirements related to this detail.

1. CENTRAL LEADER. SEE CROWN OBSERVATIONS DETAIL.
2. TRUNK CALIPER SHALL MEET ANSI Z60 CURRENT EDITION FOR ROOT BALL SIZE.
3. ROOT BALL MODIFIED AS REQUIRED.
4. 100mm LAYER OF MULCH. NO MORE THAN 25mm OF MULCH ON TOP OF ROOT BALL. REFER TO SPECIFICATIONS.
5. EXISITING SOIL.
6. ORIGINAL SLOPE SHOULD PASS THROUGH THE POINT WHERE THE TRUNK BASE MEETS THE SUBSTRATE/SOIL.
7. PRIOR TO MULCHING, LIGHTLY TAMP SOIL AROUND THE ROOT BALL IN 150mm LIFTS TO BRACE TREE. DO NOT OVER COMPACT. WHEN THE PLANTING HOLE HAS BEEN BACKFILLED, POUR WATER AROUND THE ROOT BALL TO SETTLE THE SOIL.
8. LOOSENED SOIL. DIG AND TURN THE SOIL TO REDUCE THE COMPACTION TO THE AREA AND DEPTH SHOWN.
9. SLOPE SIDES OF LOOSENED SOIL.
10. ORIGINAL GRADE.
11. BOTTOM OR ROOT BALL RESTS ON EXISTING OR RECOMPACTED SOIL.

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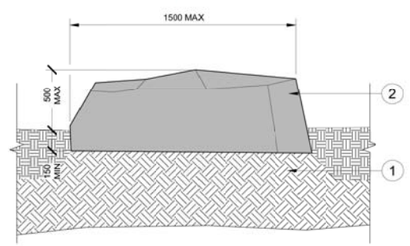
4 TREE ON SLOPE 5% (20:1) TO 50% (2:1) - UNMODIFIED

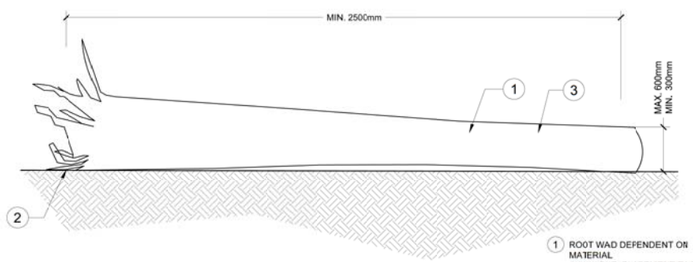
1:25 P-O2-FIS-07



1. COMPACT SUBGRADE TO MIN. 90% SPD BELOW BOULDERS TO MINIMIZE SETTLING
2. RUNDLE STONE BOULDER, TO BE APPROVED BY LANDSCAPE ARCHITECT

6 TYPICAL BOULDER

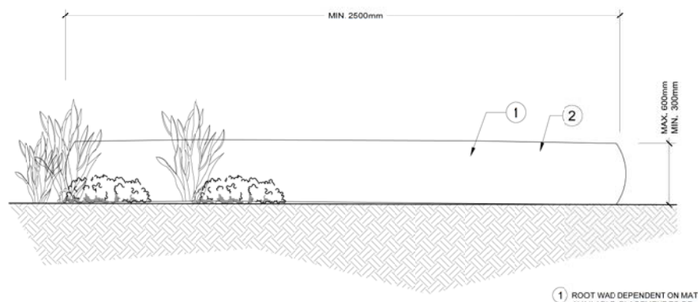
1:20 P-O2-FIS-02



1. ROOT WAD DEPENDENT ON MATERIAL AVAILABLE. PLACEMENT TO BE REVIEWED AND APPROVED BY LANDSCAPE ARCHITECT
2. SAW BOTTOM OF ROOT WAD SO LOG WILL SIT FLUSH WITH GROUND OR DEPRESS BELOW SUBGRADE
3. LOGS TO BE OBTAINED FROM TREES CLEARED ON SITE OR FROM CITY STOCKPILES. MIN DIAMETER 300mm, NO MAX DIAMETER. MAX HEIGHT 600mm.

7 HABITAT LOG WITH ROOT WAD

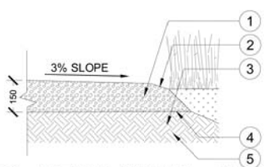
1:20 P-O2-FIS-05



1. ROOT WAD DEPENDENT ON MATERIAL AVAILABLE. PLACEMENT TO BE REVIEWED AND APPROVED BY LANDSCAPE ARCHITECT
2. LOGS TO BE OBTAINED FROM TREES CLEARED ON SITE OR FROM CITY STOCKPILES. MINIMUM DIAMETER 300mm. LOGS SHALL BE TREE OF BRANCHES

8 HABITAT LOG

1:20 P-O2-FIS-04



1. FILL 2A COMPACTED TO 95% SPD
2. PATHWAY TO MOUND UP 25mm FROM SURROUNDING GRADE
3. CLEAR AND GRUB ALL EXISTING PLANT ROOTS. SCARIFY EXISTING SUBGRADE TO 125mm DEPTH AND RECOMPACT TO 98% SPD.
4. ENSURE POSITIVE DRAINAGE OF SUBGRADE
5. EXISTING SUBGRADE OR FILL 2A

9 NATURAL SURFACE TRAIL

1:15

O2 PLANNING + DESIGN
510 255 17th AVE SW CALGARY ALBERTA CANADA
T 403.228.1336 F 403.228.1320 www.o2design.com

PROJECT
BIOENGINEERING DEMONSTRATION AND EDUCATION PROJECT
FOR
ALBERTA ENVIRONMENT
CITY OF CALGARY

MUNICIPAL ADDRESS
MUNICIPAL ADDRESS TBD
LEGAL DESCRIPTION
LEGAL DESCRIPTION TBD

PERMIT

CONSULTANTS
KERR WOOD LEIDAL consulting engineers
Terra Erosion Control Ltd.

SEALS

KEYMAP

ISSUED FOR: DESIGN REVIEW
DATE: 2017-04-03
NOT FOR CONSTRUCTION

REVISIONS:

NO.	DESCRIPTION.	DATE.	BY.
1	ISSUED FOR REVIEW	2017/03/23	CD
2	ISSUED FOR WATER ACT APPROVAL	2017/04/03	CD

DESIGNED BY: SH/MM CHECKED BY: MM
PLOT DATE: 2017-04-13
DRAWING FILE NAME: L8.00 LANDSCAPE DETAILS.dwg

DRAWING TITLE :
LANDSCAPE DETAILS

L200

2017-04-13 11:38am By: CDyck
N:\Projects\150705 Alberta Environment FSH\ESS\6 Contract Documents\01 - CAD\Plan\piece Layouts\L8.00 LANDSCAPE DETAILS.dwg

KERR WOOD LEIDAL
consulting engineers

Appendix E

Detailed Construction Schedule

Bioengineering Demonstration and Education Project

Proposed Construction Schedule

Fisheries Habitat Enhancement and Sustainability (FISHES) Program

April-20-17

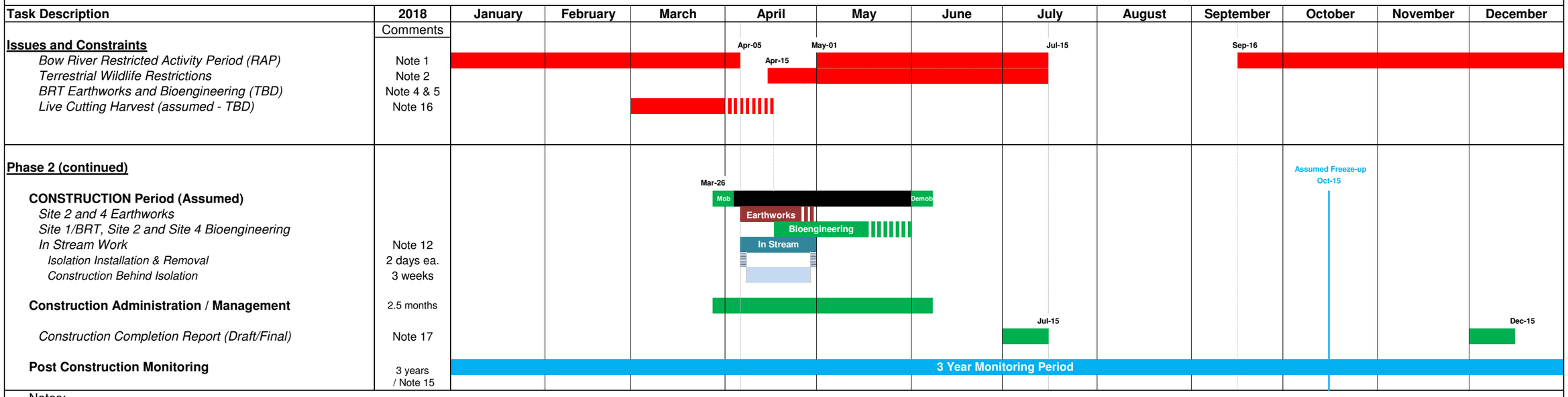
Task Description	2017 Comments	January	February	March	April	May	June	July	August	September	October	November	December
Issues and Constraints					Apr-05	May-01		Jul-15		Sep-16			
Bow River Restricted Activity Period (RAP)	Note 1				Apr-15								
Terrestrial Wildlife Restrictions	Note 2												
BRT Instream Work (Code of Practice No. 00388314)	Note 3				East Berm			West Berm and Pier Construction					
BRT Earthworks and Bioengineering (TBD)	Note 4 & 5												
Tree Clearing	Note 6						Jun-15						
Live Cutting Supply Assessment (by AEP)	Note 7							Jul-15					
Reconnaissance Survey of Live Cutting Source	Note 8											Nov-15	
Live Cutting Harvest (assumed - TBD)	Note 9												
Phase 1				Mar-31									
Amendment Design Completion Date	Plus 1 mo.												
Phase 2													
Regulatory Approvals					Apr-20			Jul-13					
Environmental Coordination and Approvals	Note 10												
WA Approvals	(12 weeks)												
DFO Review	(8 weeks)												
TC NPA Approval	(6 weeks)						Jun-15						
Public Lands Approval	(6 weeks)												
Public Notice Period	Note 11				Apr-15		Jun-30						
First Nations Consultations (assumed duration)	6 weeks						Jun-15						
EcoPlan Development (by contractor)	2 weeks									Aug-25			
										Sep-08			
Contract Documents					Apr-24								
RFP Process Administration	4 wk Posting							Jul-14					
APC Posting - RFP to Construct	Jul-14												
Pre-RFP Site Meeting	Jul-19							Jul-19					
RFP Closing Date	Aug-11								Aug-11				
RFP Submissions Review	1 weeks								Aug-18				
Construction Contract Negotiations & Award	2 weeks									Sep-01			
										Contract			
CONSTRUCTION Period (Assumed)											Assumed Freeze-up Oct-15		
In Stream Work	Note 12									Mob	Construction Period		Demob
Isolation Installation & Removal	1 week ea.										In Stream		
Construction Behind Isolation and instream riprap apron	6 weeks												
Site 1 Earthworks	Note 13										Earthworks		
Bioengineering												Bioengineering	
Construction Administration / Management	3.5 months /Note 14									Aug-15			
Post Construction Monitoring and Maintenance	3 years / Note 15												

Notes:

1. Ref.: Calgary Management Area Map, 2012
2. Bird/raptor/bat migration and nesting restricted period.
3. BRT construction to be carried out under Code of Practice No. 00388314. Isolation to commence Mid-April on river left (east).
4. Earthworks and land based construction schedule not available at the time of schedule preparation.
5. Schedule does not present Site 1 / BRT related bioengineering construction anticipated in 2018.
6. Tree Clearing is delayed to maintain aesthetics for local residents and regional pathway users. Late summer avoids bird nesting period.
7. AEP to identify sources for live cuttings thru desktop and reconnaissance study.
8. Contractor requirement to submit Live Cutting Harvest Plan.
9. Harvesting of live cuttings required to take place while plants are dormant.
10. Regulatory applications submissions. Twelve (12) week turnaround assumed to receive Water Act approval.
11. Public Notice requirement; assumed 7 day duration to take place while awaiting Approvals under the Water Act.
12. Bank excavation material to be utilized in BRT consturction (by others - not part of this application)
13. In stream construction within RAP subject to approval and instituted monitoring plan.
14. Construction completion in 2018 predicated on satisfactory completion of deficiency items identified during construction closeout inspections; RISK: Unconstructable deficiency items carried over from 2017 to 2018 construction period.
15. Assumed City of Calgary Contract.

Bioengineering Demonstration and Education Project
Proposed Construction Schedule

Fisheries Habitat Enhancement and Sustainability (FISHES) Program
April-03-17



Notes:

16. Harvesting of live cuttings required to take place while plants are dormant. Cuttings obtained in winter 2018 to be maintained dormant and must be installed prior to the third (3rd) week in June 2018.
17. Amended AEP FISHES contract term completion assumed July 31, 2018.

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Appendix F

Monitoring and Maintenance Plan

TABLE F-1: MONITORING AND MAINTENANCE PLAN

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Live Cuttings	Contractor must have demonstrated experience in soil bioengineering application + riverbank work.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Once delivered to site, ensure that live cuttings are watered daily to keep cuttings moist, as approved by the Engineer.	All live cuttings to be taken from native stands located in Alberta, within 300 m of elevation and 200 km distance from the site.	Provide a temporary irrigation system to water the live cuttings. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License).	Annual monitoring must occur to evaluate the success of the live cuttings.
	Sources of live cuttings must be provided for review at least 20 days prior to harvest.		Contractor shall discuss live cuttings storage area with Engineer prior to delivery to provide allocation of adequate storage space and location.	Multiple harvest sites must be used to improve genetic diversity.	Temporary rodent fencing to be installed around the perimeter of the installed live cuttings.	
	A plan that details the approach to store, prepare, plant and protect cuttings must be provided for review at least 20 days prior to harvest.		All live cuttings are to be stored placed in cold storage immediately following cutting. They are to remain in cold storage (<0 degrees C) until 1 week prior to planting at which time they will be soaked in water for 1 week and treated with rooting hormone prior to planting and installation.	Live cuttings to be over 2.0 cm in diameter at the tip and be in the required length as specified in applicable sections.	Perform Landscape Maintenance program for three (3) years following the issuance of the Substantial Completion.	
			Schedule and sequence delivery of live cuttings so as to minimize the amount of time between delivery and planting to 1 day, if plantings are being soaked off-site.	Soil around all live stakes and cuttings to be continuously moist for 7 consecutive days (one week) after planting and installation.	Irrigate the sites for a six (6) month period every year (May to October). Watering of planting must occur until the root zone is adequately moist to ensure healthy and vigorous growth. Irrigation must be between the hours of 6am to 9am and/or 7pm to 11pm.	
			Live cuttings must be planted while dormant. Dormant plants cut before the end of March must be kept dormant and must be installed before the 3rd week in June.		All installed fencing will be maintained.	

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Live Cuttings (continued)			Live cuttings must not be exposed to direct sun and heat.		Control weeds to ensure vigorous establishment of the planted vegetation. Control all invasive weeds for the duration of the monitoring and maintenance program (i.e.: three (3) years). Use mechanical, or manual weed control methods to avoid competition stress to planted species.	
					Remove and replant live cuttings that have not survived at the end of the first and second growing season.	
					Submit maintenance log to the responsible project managers and include information such as the condition of irrigation system and fences and the development and condition of live cuttings.	
					If large replacement areas of live cuttings in the bioengineering components will compromise the engineering integrity of the feature complete reconstruction of the structure will be required.	

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Trees, Shrubs + Plugs	The Nursery will be a company specializing in growing and cultivating the trees.		Protect trees from damage and drying out from the time of digging until planting. Trees with broken or abraded trunks or branches will be rejected.	Species and size identifiable in plant schedule, grown in climatic conditions similar to those in locality of the work. Plants must be measured in their normal positions.	Install beaver fence around the base of the tree leaving a no less than 150 mm space between the trunk and the wire mesh. Allow enough space for the tree to mature.	Annual monitoring must occur to evaluate the success of the plantings.
	The Installer will be a company specializing in installing and planting the trees and approved by the nursery.		Deliver plant materials immediately prior to placement.	The plant material will be grown in Zone 2 or 3.	Perform Landscape Maintenance of trees, shrubs, and groundcovers until issuance of the End-of-Warranty Inspection Certificate.	
			All live plant materials will be properly acclimatized prior to planting to ensure that late season planting does not cause an increased risk of mortality. Acclimatization includes the plants being kept at the current climatic conditions for at least two (2) weeks prior to planting.	Plugs shall be grown from seed or cuttings taken from native stands located in Alberta, south of Red Deer. Stock shall be well rooted to fill rooting medium.	Watering and weeding to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License).	
				All tree and shrub plug plants shall be installed between May 1 and June 30.	Prepare monthly reports during the growing season identifying maintenance work carried out, and development and condition of plant materials.	
					Conduct insect and disease control.	
					Replace dead plant material immediately after removal from the Site. Plants that are replaced under warranty are to be maintained and warranted for an additional period of one (1) year. All other maintenance requirements apply during the additional one (1) year.	
					Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities.	

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Trees, Shrubs + Plugs (continued)					All monthly reports must be submitted for review to the responsible project managers.	

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Pathways	Regional and local pathways are hard-surfaced, typically of asphalt pavement, to accommodate multiple users.			Sub-base: 25 mm crushed gravel. Surface: Mix “B-50” asphaltic concrete.	Must be inspected and repaired/renovated on a regular basis, either as required or as scheduled.	
	The Contractor must obtain approval for the pathway alignment and sub-base (i.e. compaction and depth of gravel) prior to surfacing with asphalt.				Clean pathways weekly or when directed by Owner. Provide mechanical power wash equipment to wash paved surfaces around building if directed by Owner to maintain a clean site appearance.	
	All Regional pathways, must be inspected and maintained by Calgary Parks.				Maintain pathways from the time of installation until the FAC is issued by Calgary Parks.	
	Provide 1.0 m clear of all obstacles on both sides and provide 3.0 m clear of all obstacles overhead.					
	Pathway handrails must be installed when a pathway is within 2 m of the top of a 2:1 slope or steeper, and the slope is greater than or equal to 1 m in depth.					
Handrails	Usually made of galvanized steel or wood.				All park features must be fully functional, as designed, at all times and must meet or exceed all legislated requirements.	
Site Furnishing					All park features must be inspected and maintained on a regular basis, either as scheduled or as required. Make weekly inspections for vandalism and damage. Immediately report vandalism and damage to Owner.	
					All park features must be fully functional, as designed, at all times and must be maintained to ensure safe operating conditions.	

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Vegetated Timber Crib Wall	Constructed of rough sawn cedar. Designed to be submerged below the 99th percentile flow line. The Requirements around the vegetated timber crib wall with habitat shelter is identical in principle to the vegetated timber crib wall without habitat shelters. Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Once delivered to site, ensure that live cuttings are watered daily to keep cuttings moist, as approved by the Engineer. Contractor shall discuss live cuttings storage area with Engineer prior to delivery to provide allocation of adequate storage space and location. All live cuttings are to be stored placed in cold storage immediately following cutting. They are to remain in cold storage (<0 degrees C) until 1 week prior to planting at which time they will be soaked in water for 1 week and treated with rooting hormone prior to planting and installation. Schedule and sequence delivery of live cuttings to minimize the amount of time between delivery and planting to 1 day, if plantings are being soaked off-site. Live cuttings must be planted while dormant. Dormant plants cut before the end of March must be kept dormant and must be installed before the 3rd week in June. Live cuttings must not be exposed to direct sun and heat.	150 mm x 150 mm (6 in x 6 in) rough sawn cedar Backfill Soil amendment Coir matting to contain backfill Brush layers (see section on brush layers)	Must be repaired as required based on observations during monitoring activities. Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Submit maintenance log including information such as the condition of the structure, observations as listed in the monitoring section, and any changes since the last inspection. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Cracks and/or ground settlement • Leaning, curving, or uprooting of trees or vegetation • Splitting of wood in the timber crib wall • Bowing or bellying of the wall – horizontally or vertically • Shifting of the wall as a whole • Insect infestations in the timber • Leaning of the wall away from the slope • Cracking or shifting of landscape or paving • Erosion of rock that supports the wall • Added construction to slope at the top of the wall that would contribute additional pressure and weight • Refer to live cuttings section for required observations • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Vegetated Riprap	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Per vegetated timber wall instructions for handling and storage	Rock riprap Live cuttings (see section above)	Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Must be repaired as required based on observations during monitoring activities. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Erosion or scouring of the rock riprap • Refer to live cuttings section for required observations • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Brush Mattress	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Per vegetated timber wall instructions for handling and storage	Live cuttings (see live cuttings section above) Topsoil Soil amendment Mechanical wire Construction posts	Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Must be repaired as required based on observations during monitoring activities. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Erosion that is causing soil or other ground cover to slide or slough away • Cracks and/or ground settlement • Refer to live cuttings section for required observations • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Soil Wraps	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Per vegetated timber wall instructions for handling and storage. Deliver plant materials immediately prior to placement.	Coir matting Erosion control matting Backfill Topsoil Soil amendment Live cuttings	Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Must be repaired as required based on observations during monitoring activities. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Erosion that is causing soil or other ground cover to slide or slough away from behind the soil wraps • Cracks and/or ground settlement • Tears/cuts or sagging coir/erosion control matting • Refer to live cuttings section for required observations • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Box Fascines	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Per vegetated timber wall instructions for handling and storage	Posts Mechanical wire Live cuttings Backfill	Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Must be repaired as required based on observations during monitoring activities. Compensate soil or material loss with compost or soil amendment cover as required. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Erosion that is causing soil or other ground cover to wash away from around the box fascines • Ice damage and displacement. • Note growth and repair as required. • Ensure proper wetting and irrigation during dry periods • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Slope Treatment	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Deliver plant materials immediately prior to placement. Plantings shall be grown from seed or cuttings taken from native stands located in Alberta, south of Red Deer. Stock shall be well rooted to fill rooting medium. All live plant materials will be properly acclimatized prior to planting to ensure that late season planting does not cause an increased risk of mortality. Acclimatization includes the plants being kept at the current climatic conditions for at least two (2) weeks prior to planting.	Live cuttings Contour fascine bundles Soil amendment Topsoil Biodegradable coir matting Hydromulch	Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Must be repaired as required based on observations during monitoring activities. Compensate soil or material loss with compost or soil amendment or mulch cover as required. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Erosion that is causing soil or other ground cover to slide, slough, or wash away • Cracks and/or ground settlement • Displacement and/or ground settlement • Degree of coir matting degradation • Hydromulch distribution and voiding • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Void-filled Riprap	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	n/a	Plugs shall be grown from seed or cuttings taken from native stands located in Alberta, south of Red Deer. Stock shall be well rooted to fill rooting medium. All live plant materials will be properly acclimatized prior to planting to ensure that late season planting does not cause an increased risk of mortality. Acclimatization includes the plants being kept at the current climatic conditions for at least two (2) weeks prior to planting.	Planting medium composed of soil or pitrun Native container plantings Soil amendment Riparian seed mix Topsoil Biodegradable erosion control matting Biodegradable compost sock	Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Must be repaired as required based on observations during monitoring activities. Compensate soil or material loss with compost or soil amendment, riparian seeding, or mulch cover as required. Replace dead or diseased container plantings as required. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Erosion that is causing soil or other ground cover to wash away • Displacement and/or ground settlement • Undermining • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Soil Covered Riprap	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	Harvest live cuttings during the dormant season (typically October to March – refer to supplier's recommendations for each species).	Deliver plant materials immediately prior to placement. Plantings shall be grown from seed or cuttings taken from native stands located in Alberta, south of Red Deer. Stock shall be well rooted to fill rooting medium. All live plant materials will be properly acclimatized prior to planting to ensure that late season planting does not cause an increased risk of mortality. Acclimatization includes the plants being kept at the current climatic conditions for at least two (2) weeks prior to planting.	Planting medium composed of soil or pitrun Native container plantings Soil amendment Riparian seed mix Topsoil Biodegradable erosion control matting Biodegradable compost sock Live cuttings	Watering and weeding for the first 3 years to ensure vigorous plant and seed establishment, including regular monitoring and adjustments to the establishment irrigation system. The contractor is responsible to apply for and adhere to regulatory requirements for temporary irrigation systems (i.e. Temporary Diversion License). Must be repaired as required based on observations during monitoring activities. Compensate soil or material loss with compost or soil amendment, riparian seeding, or mulch cover as required. Replace dead or diseased container plantings as required. Submit monthly maintenance reports identifying maintenance work carried out, development and condition of plant material and preventative or corrective measure which are outside of the Contractor's responsibilities. All monthly reports must be submitted for review to the responsible project managers.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Erosion that is causing soil or other ground cover to wash away • Displacement and/or ground settlement • undermining • General health of vegetation and growth

Element	General	Harvest	Handling + Storage	Materials	Maintenance	Monitoring
Fish Habitat Clusters	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	n/a	n/a	Rock riprap	Maintenance only required in the circumstance of undesirable flow patterns or if foreign and unnatural materials are lodged around the fish habitat clusters.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Undermining or rock displacement. • If displaced, watch for flow patterns around the clusters that concentrate flow toward the bank. • Unnatural debris lodging.
Fish Habitat Micro-Spurs	Must be installed according to drawings and specifications. The contractor is responsible to ensure regulatory approvals are in place and responsible to ensure regulatory requirements are met.	n/a	n/a	Rock riprap	Maintenance only required in the circumstance of undesirable flow patterns or if foreign and unnatural materials are lodged around the fish habitat micro-spurs.	Annual monitoring must occur to assess the condition of the structure to inform maintenance activities. Annual inspections must occur during the low water period in the spring or fall. Additionally, a high water inspection during large flow events and a winter inspection during ice jam events and/or following ice break-up each year to observe any effects due to ice must occur. Monitoring observations must include the following: • Undermining or rock displacement. • If displaced, watch for flow patterns around the clusters that concentrate flow toward the bank. • Unnatural debris lodging.