Appendix E. Fisheries Reports

PRELIMINARY FISHERIES RESOURCES IMPACT ASSESSMENT FOR THE PROPOSED CLOVERDALE LIGHT RAIL TRANSIT BRIDGE OVER THE NORTH SASKATCHEWAN RIVER

Prepared for: Spencer Environmental Management Services Ltd.
Edmonton, Alberta
April, 2013

PISCES ENVIRONMENTAL CONSULTING SERVICES LTD.

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PRELIMINARY FISHERIES RESOURCES IMPACT ASSESSMENT FOR THE PROPOSED CLOVERDALE LIGHT RAIL TRANSIT BRIDGE OVER THE NORTH SASKATCHEWAN RIVER

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

Prepared by:
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Red Deer, Alberta

April 2013

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1.0 INTRODUCTION

1.1 BACKGROUND

The City of Edmonton is planning to expand Light Rail Transit (LRT) service with the City. The southeast extension will extend service from downtown Edmonton to the community of Millwoods. The proposed alignment for this extension would commence near 97th Street and 102nd Avenue, travel across the North Saskatchewan River, continue along the north side of Connors Road to 75th Street, proceed south to Mill Creek crossing the ravine near 83rd Street before crossing Whitemud Drive and terminating at approximately 28th Avenue. The project would require that the existing Cloverdale pedestrian bridge across the North Saskatchewan River (NSR) be demolished and a new LRT/pedestrian bridge be constructed at the same location (Appendix A: Figure 2.1).

In 2010, Pisces Environmental Consulting Services Ltd. (Pisces) conducted an assessment of the existing fisheries and habitat resources in the vicinity of the proposed project. Results from the assessment were described in the document entitled *Assessment of the Fisheries Resources and Habitat of the North Saskatchewan River for the Proposed Cloverdale LRT Bridge Crossing* (Pisces 2010). The project has progressed and preliminary design has been completed (the reference design). The preferred design for the new bridge consists of an extradosed structure with an underslung pedestrian bridge with two instream piers. This document presents a preliminary analysis of the potential impacts to fisheries resources as a result of the proposed project and includes a discussion of recommended mitigation measures to minimize adverse effects.

1.2 PROJECT DESCRIPTION

The existing pedestrian bridge over the North Saskatchewan River has a total of four spans and three instream piers. The preliminary designs for the new LRT/Pedestrian bridge indicates that there will be two instream piers. An abutment will support the north end of the new bridge while the south end of the bridge will be supported by a series of land-based piers (Appendix B). The extent of riprap armouring that will be required has not been determined but it is expected that both the north and south banks will require some armouring.

The reference design indicates that the new bridge will follow the alignment of the existing bridge, which will necessitate the demolition of the existing bridge prior to construction of the new bridge. Construction plans and schedules have not been determined at this time.

2.0 SUMMARY OF EXISTING CONDITIONS

The following is a brief summary of assessment results presented in the *Assessment of the Fisheries Resources and Habitat of the North Saskatchewan River for the Proposed Cloverdale LRT Bridge Crossing* (Pisces 2010). A copy of this report is provided in Appendix A.

The 2010 study area encompassed approximately 2.5 kilometres of the North Saskatchewan River in the vicinity of the proposed bridge crossing extending from 0.5 kilometres upstream to 2.0 kilometres downstream of the existing Cloverdale pedestrian bridge (Appendix A: Figure 2.1). The *Code of Practice for Watercourse Crossings* St. Paul Management Area Map indicates that the portion of the NSR with the study area is designated as Class C habitat, which is considered moderately sensitive and broadly distributed within the province (Alberta Environment 2006). A section of Class A habitat, which is defined as highly sensitive habitat that is critical for Lake Sturgeon (*Acipenser fulvenscens*), is located approximately 2.5 km downstream of the existing bridge (Alberta Environment 2006).

The habitat within the study section consisted primarily of moderate depth, slow, run habitat, interspersed with discrete areas of deep-water habitat and shallow shoals. In general the substrate was a mixture of fine materials and cobble, with increasing percentages of fines in areas where water velocities were lower and increasing percentages of course substrate (gravel, cobble, and boulder) in higher velocity areas. Cover was relatively scarce within the study section; boulders (from the rip-rap) and water depth were the primary refuge. The streambank assessment indicated that the river banks were steep, relatively well vegetated with grass, shrubs and trees, and were composed of fine materials. Streambank armouring with rip-rap was quite common within the study section, particularly along the north river bank.

The average wetted width of the channel was approximately 160 metres. Water depths were generally less than two metres with the exception of the area immediately upstream of the existing bridge where depths exceeded four metres.

The NSR supports a wide array of sport and non-sport fish species (Appendix A: Table 4.2). Of particular importance is the Lake Sturgeon, which is designated as “Threatened” provincially and has been assessed as “Endangered “by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2006). As of April 2013, the federal government has not made a decision on whether or not the NSR Lake Sturgeon population should be listed under the *Species At Risk Act*.

3.0 POTENTIAL IMPACTS AND MITIGATION

3.1 PROJECT IMPACTS

Bridge construction and/or demolition can impact fish and fish habitat through direct and indirect sources that are typically dependent on the design of the structure, timing of construction and construction and demolition techniques. Principal potential impacts to fisheries resources associated with the proposed project are related to:

- interruption of critical fish movements;
- sediment introduction;
- pollutant loading;
- fish mortality during the construction phase; and
- the loss or alteration of fish habitat.

The presence of critical Lake Sturgeon habitat in the general vicinity of the proposed project crossing magnifies these potential issues.

Fish Distribution

Fish move between habitats for a variety of reasons. Individuals migrate for spawning, to search for food, to escape predators, or to leave undesirable habitat. Interference with fish passage becomes most critical when instream construction activities are scheduled to coincide with spawning times. According to the Code of Practice for Watercourse Crossings St. Paul Management Area Map (Alberta Environment 2006), the North Saskatchewan River is a mapped Class C waterbody and is subject to a restricted activity period (RAP) from September 16th to July 31st which is in place to protect both spring and fall spawning species.

Instream work associated with the proposed project will need be isolated from flowing water in order to facilitate both the demolition and construction phases of the project. Isolation works typically result in channel constriction and increased water velocities. Depending on the extent of the channel constriction and the subsequent impact on water velocities, it is possible that upstream fish movements can be impeded.

Once constructed the bridge is not expected to affect fish movements since it will not pose a physical barrier to fish and it is not expected to have an impact on water velocities.

Sediment

Sediment is generated at stream crossing sites during instream construction and from surface runoff over disturbed ground around the site during, and after, construction.

Sedimentation can have adverse effects on fish health and fish behavior. During construction there is potential for particulate sediment to become suspended in the water column. Increased levels of TSS (total suspended solids) in the water column may lead fish to exhibit an avoidance response (Waters 1995), however Gregory *et al.* (1993) note that fish may use elevated TSS for cover. Further increases in TSS can cause physiological stress that can result in respiratory difficulty and, in extreme cases, mortality. While individual species sensitivity to suspended sediment is variable, the effects are dependent on two variables: the concentration of TSS to which fish are exposed and the time of exposure (Newcombe and Jenson 1996). Sediment deposition during egg incubation periods for fish can also smother eggs that can result in increased mortality.

Increased sediment loads can impact habitat quantity and quality. Sediment loads that exceed the transport capacity of the receiving stream may result in deposition, which may reduce pool depth and fill in the interstitial spaces in coarse substrates (gravels and cobbles) that serve as spawning habitat and produce invertebrates used as food by fish (Waters 1995).

The potential for sediment to affect fish populations and habitat of the North Saskatchewan River is moderate. The transport capacity of the river is substantial and the stream bank assessment for this portion of the subject watercourse indicates that the banks are potentially unstable as they are composed primarily of fines that can be readily mobilized during construction by rain or high water.

Pollutant Loading

Deleterious substances, such as hydrocarbons, can be introduced into fish habitat during construction activities as well as when the bridge is in service. Debris from the bridge demolition could also contain delirious substances. Deleterious substances can potentially cause adverse effects to fish health, degradation of fish habitat, or fish mortality.

Fish Mortality

Instream work that requires isolation of a portion of a waterbody has the potential to result in entrapment of fish that can result in mortality once the isolated area is dewatered.

Direct Loss or Alteration of Fish Habitat

The direct alteration or loss of fish habitat i.e. Harmful Alteration, Disruption or Destruction (HADD) can occur during instream construction associated with the construction and/or demolition of watercourse crossing structures. The magnitude of permanent HADD depends upon the type and size of the crossing structure and is typically directly related to the instream footprint (i.e. instream piers and streambank armouring) of the crossing structure. In addition, the use of isolation works to facilitate instream works can temporarily impact fish habitat and its accessibility. The extent that habitat alteration is considered harmful depends on the quality and sensitivity of fish habitat that is impacted.

Reference design plans indicate that the new bridge will have two instream piers compared to the three instream piers that currently exist. The north abutment and the land-based piers on the south side of the river will not be located within the active channel and are not expected to affect fish habitat. It is assumed that some riprap armouring will be necessary to protect the streambanks and bridge structure. Armouring placed on the north bank is not expected to impact fish habitat since that bank already has extensive rip-rap; impacts resulting from the placement of armour on the south bank will depend on the extent of proposed bank protection works, which are still to be determined.

Impacts to fish habitat as a result of isolation works to facilitate bridge demolition and/or construction will depend on the isolation method as well as the size of the isolation areas.

3.2 MITIGATION

The following mitigation measures have been developed after review of the reference design plans that have been provided. Additional mitigation measures may be required depending on final design and construction plans.

Construction Timing

The development of the construction schedule should take into account the restricted activity period (September 16^{th} to July 31^{st}) and should be devised so that the phases of construction with the most potential to impact critical life cycle phases for fish (i.e. the installation and removal of isolation works) are not completed during sensitive periods. In particular construction and removal of isolation works should be scheduled to avoid April 1^{st} to July 31^{st} – the spring portion of the restricted activity period – to mitigate potential effects on important spring spawning species including Lake Sturgeon. Given habitat attributes found within the study section, Mountain Whitefish (*Prosopium williamsoni*) is likely the only fall spawning species that would use the habitat in the immediate vicinity of the project for spawning. They are quite adaptable and will utilize a wide range of habitat conditions for spawning (Thompson and Davies 1976). However, the habitat in the vicinity of the project is neither unique nor in short supply in the NSR and is therefore not considered critical to Mountain Whitefish. As such, while it would be optimal to avoid completing the installation and/or removal of berms during the fall, it may be possible if deemed integral to the overall construction schedule. Additional field investigations (i.e. kick net surveys for Whitefish eggs) and/or mitigation strategies (i.e. restricted compliance limits during sediment monitoring) may be required if instream work within the restricted activity period is required.

Scheduling the demolition work for the winter period so that work could be completed from the ice surface may minimize potential impacts to fisheries resources associated with the removal of the existing bridge.

Isolation of Instream Works

Instream work associated with the bridge construction and demolition should be isolated from flowing water so that construction of piers, abutments, and any other bridge components within the active channel are completed in the dry. While regulators often prefer that non-earthen cofferdams be installed, the installation of armoured berms constructed of high plastic clay is the most commonly used isolation method when the isolation works will be in place for long periods and need to withstand winter conditions and large fluctuations in flow.

Fish Movements

The potential impacts relating to fish passage can be mitigated through implementation of a number of strategies including:

- Minimize the size of isolation works so that constriction of North Saskatchewan River is minimized.
- Implement construction schedule so that constriction of the North Saskatchewan River is minimized (i.e. sequential process whereby only one side of the river is isolated at a time);
- Develop a hydraulic model to assess the effect of potential river constriction on water velocities and to provide level of confidence that there will be zones where velocities are low enough to allow for upstream fish movements.
- Monitoring to assess fish movements through the construction area during the project.

Erosion and Sediment Control

Implementation of surface runoff controls during the construction phase and maintaining those controls during the early operation phase are imperative to mitigate the potential effects of sediment introduction. Sediment in surface runoff water from disturbed ground at and adjacent to crossing sites can be controlled in the short term by utilizing surface controls as described by Alberta Infrastructure’s Fish Habitat Manual (2009). Post construction stabilization, principally by revegetation of exposed cuts, fills and ditches will mitigate the longer-term potential effects of sediment generation. A list of best management practices (BMP’s) for controlling erosion and sediment at construction sites has been compiled in Alberta Transportation’s Design Guidelines for Erosion and Sediment Control for Highways (2011). These BMP’s should be reviewed and appropriate BMP’s selected based on local site conditions.

Sediment Monitoring

A sediment-monitoring program should be implemented during instream construction. The extent of such a program will depend on site logistics and construction scheduling. The monitoring program should identify specific monitoring procedures, compliance criteria, and reporting protocols to ensure minimum introduction of sediments during instream construction.

Deleterious Substances

During construction and demolition, heavy equipment entering the active channel of the NSR should be thoroughly cleaned and inspected prior to commencement of work. In addition, refueling of heavy machinery should be done in an area away from the river, in an area where potential spills will not potentially enter the aquatic environment.

During demolition, debris should be trapped and contained to insure potential contaminants will not enter the river.

Interception of the bridge deck runoff before it enters the river and direction of runoff to settling ponds and/or other treatment facilities will mitigate the longer-term potential effects of deleterious substance loading during the operation of the bridge.

Fish Mortality

Fish salvage operations should be conducted in all isolated work areas with the intent of removing fish that are trapped in the isolated areas and transferring them to a suitable release location in the NSR.

If a pump is used to de-water fish-bearing waters the pump intake should be screened in accordance with Fisheries and Oceans Freshwater End-of-Pipe Fish Screen Guideline (DFO 1995).

Direct Loss or Alteration of Fish Habitat

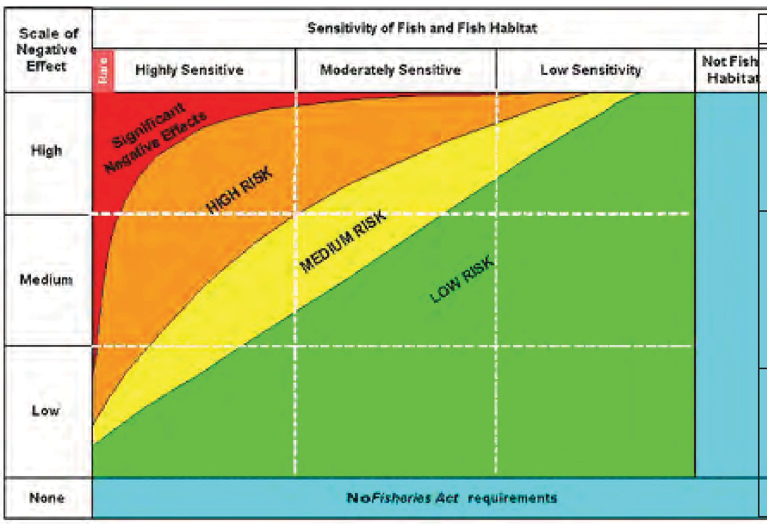
Potential loss or alteration of fish habitat can be mitigated through implementation of a number of strategies including:

- Disturbances to fish habitat should be minimized during the construction period and any impacted channel or bank should be rebuilt to replicate natural conditions
- The size of the isolation area(s) should be minimized.
- Isolation works must be completely removed from the river.
- Use of bioengineering techniques to stabilize streambanks.

3.3 Residual Impacts

Residual impacts (ie. Harmful Alteration, Disruption, or Destruction of fish habitat (HADD)) can occur during watercourse crossing construction if potential impacts of the project cannot be fully mitigated (DFO 2007).

Fisheries and Oceans Canada (DFO) provides a risk management based framework for determining whether a proposed project has the potential to result in HADD of fish habitat (Figure 1). HADD can occur depending on the potential magnitude of effect of a proposed project on fish and fish habitat (ie. the Scale of Negative Effect) and the sensitivity of the habitat potentially affected (ie. the Sensitivity of Fish and Fish Habitat).



Risk Rating	Description
Low Risk	• effects are well understood and readily mitigable using standard measures • not likely to result in HADD provided appropriate mitigation measures are applied • management option typically 'No HADD Likely as Proposed' letter
Medium Risk	• effects are routine in nature and resulting HADD is small-scale and/or temporary in duration, and have predictable outcomes with a low level of uncertainty surrounding potential negative effects • streamlined authorization process often suitable
High Risk	• effects are variable and involve sensitive fish and fish habitat resulting in potential HADD that is large-scale and may occur of a long period of time • require site-specific review and *Fisheries Act* Authorization

Figure 1. Risk assessment matrix for the assessment of HADD (from DFO 2007).

Scale of Negative Effect

The Scale of Negative Effect depends on the extent of the project, the duration of the effect, and the intensity of the change. The proposed bridge will be a permanent structure (potential for long term impact) but is not expected to have a major footprint since there will be fewer piers and impacts to riparian areas will be limited since bank armouring is already prevalent in the area. Isolation works will be temporary and as such the footprint is expected to be short-lived. Given these factors and based on current project information the Scale of Negative Effect for the project is rated low.

Sensitivity of Fish and Fish Habitat

The sensitivity of the habitat depends on what species may utilize the habitat, the potential of the habitat to provide for critical life cycle phases, the rarity of the habitat, as well as the resiliency of the habitat. The habitat potentially impacted by the proposed project is utilized by a wide variety of fish species for a number of life cycle phases. The habitat within the study section was not rare within the NSR, however, there is critical Lake Sturgeon habitat located some distance downstream of the project. Overall, the habitat is considered to be moderately resilient. Given these factors, the sensitivity of the habitat potentially affected by the project is judged moderate/high.

Risk Analysis

Considering available project information and assuming that recommended mitigation measures will be properly implemented the potential for HADD of fish habitat, based on application of the DFO Risk Assessment Matrix (Figure 1), is expected to be low. However, final determination of HADD will depend on final design and construction plans and review of the project by Fisheries and Oceans Canada.

4.0 CLOSURE

We believe the project information presented in this report is accurate but cannot guarantee its accuracy or completeness. Any use that a third party makes of this report is the responsibility of such third party. Should any portion of the report require clarification, please contact the undersigned.

Pisces Environmental Consulting Services Ltd.

Qualified Aquatic Environment Specialists and Field Staff:

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APPENDIX A:
Fisheries Resources Assessment for Cloverdale LRT Bridge (Pisces 2010)

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PISCES ENVIRONMENTAL

ASSESSMENT OF THE FISHERIES RESOURCES AND HABITAT OF THE NORTH SASKATCHEWAN RIVER FOR THE PROPOSED CLOVERDALE LRT BRIDGE CROSSING

PISCES ENVIRONMENTAL CONSULTING SERVICES LTD.

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ASSESSMENT OF THE FISHERIES RESOURCES AND HABITAT OF THE NORTH SASKATCHEWAN RIVER FOR THE PROPOSED CLOVERDALE LRT BRIDGE CROSSING

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Edmonton, Alberta

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1.0 INTRODUCTION

The City of Edmonton is planning to expand LRT service within the City and conceptual designs are underway for two LRT extensions. One of these extensions, referred to as the southeast extension, will extend service from downtown Edmonton to the community of Millwoods. The proposed alignment for this extension would commence near 97th Street and 102nd Avenue, travel across the North Saskatchewan River, continue along the north side of Connors Road to 75th Street, proceed south to Mill Creek crossing the ravine near 83rd Street before crossing Whitemud Drive and terminating at approximately 28th Avenue. The project would require that the existing Cloverdale pedestrian bridge be demolished and an new LRT/pedestrian bridge be constructed at the same location (Figure 2.1).

As part of the environmental overview process undertaken by the City, Pisces Environmental Consulting Services Ltd. (Pisces) completed an assessment of the fisheries resources and habitat of the North Saskatchewan River in the vicinity of the proposed crossing site in November 2010. The primary objectives of the assessment were to:

- review existing information and consult with regional fisheries managers regarding the fish community of the North Saskatchewan River;
- conduct fall season electrofishing surveys in the vicinity of the project;
- complete a fisheries habitat inventory at and adjacent to the proposed bridge crossing;
- identify potential Lake Sturgeon (*Acipenser fulvescens*) habitat in the vicinity of the project;
- assess the stream bank conditions at, and adjacent to, the proposed disturbance area;
- develop a technical document to support information requirements under the Federal *Fisheries Act*, Alberta Environment's *Code of Practice for Watercourse Crossings*.

2.0 STUDY AREA

The study area encompassed approximately 2.5 kilometres of the North Saskatchewan River in the vicinity of the proposed bridge crossing extending from 0.5 kilometres upstream to 2.0 kilometres downstream of the existing Cloverdale pedestrian bridge (Figure 2.1).

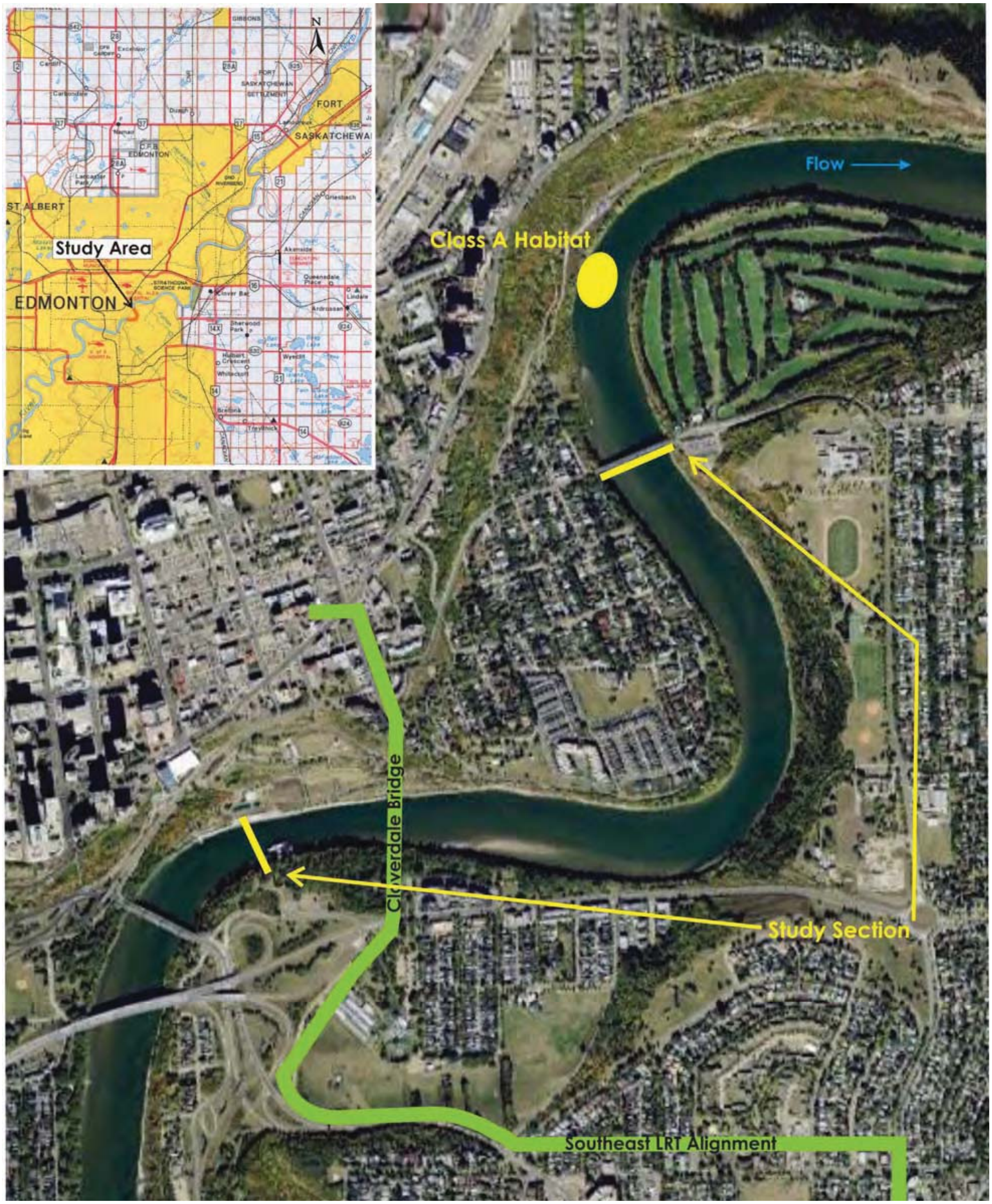


Figure 2.1. Study area location for Cloverdale LRT bridge crossing	N W E S	**Project:** City of Edmonton Cloverdale Bridge Replacement **Prepared For:** Spencer Environmental Management Services Ltd. **Pisces Environmental Consulting Services Ltd.**

According to the *Code of Practice for Watercourse Crossings* Edmonton Management Area Map, the majority of the river in the vicinity of the proposed project is classified as Class C habitat which is considered moderately sensitive and broadly distributed within the province (Alberta Environment 2006). In addition, there are several sections of the North Saskatchewan River in the vicinity of Edmonton that are designated as Class A habitat, which is defined as highly sensitive habitat that is critical to the continued viability of a population of fish in the area (Figure 2.1., Alberta Environment 2006).

3.0 METHODS

Pisces conducted the assessment following the standard procedures described in Appendix A. These standard procedures meet the criteria outlined by the Water Act – *Code of Practice for Watercourse Crossing* and Fisheries and Oceans Canada information requirements.

Field investigations were conducted from November 1st to 3rd, 2010.

3.1 Habitat Inventory

The habitat of the North Saskatchewan River was inventoried using the Large River Classification System developed by R.L. & L. Environmental Services Ltd. (O'Neil and Hildebrand 1986). This system is based on gross morphology and habitat types along riverbanks and is, therefore, suited to assessment of large mainstream rivers that do not show defined instream channel units such as pools, riffles, or runs. The procedure defines the type of channel present as Unobstructed (Type U), Singular Island (Type S), and Multiple Island (Type M) and maps available habitat based on bank habitat types and special habitat features (such as tributary confluences). Inventory data was detailed on air photos (approximately 1:8000) in the field. Detailed descriptions of the assessment parameters of the large River Habitat Classification System are provided in Appendix A.

A Lowrance X-16 depth sounder was used to determine water depth throughout the study section and to identify deep water that would be suitable Sturgeon holding habitat. Two transects, established parallel with the stream flow were situated at approximately one-third and two-thirds of channel width. Substrate composition at the existing bridge crossing site was assessed using an Aquaview underwater camera at transect locations.

3.2 Fish Presence

Electrofishing surveys were completed on November 1st, 2010 utilizing a jet boat and Smith-Root GPP Electro-fisher. Fish sampling was conducted while drifting downstream along transects with sampling concentrated along shorelines where cover (primarily rip-rap) was present.

In addition, the Fisheries Management Information System (FWMIS) maintained by Alberta Sustainable Resource Development, as well as other available literature with record of historical sampling of the river were reviewed.

3.3 Stream bank and Channel Assessment

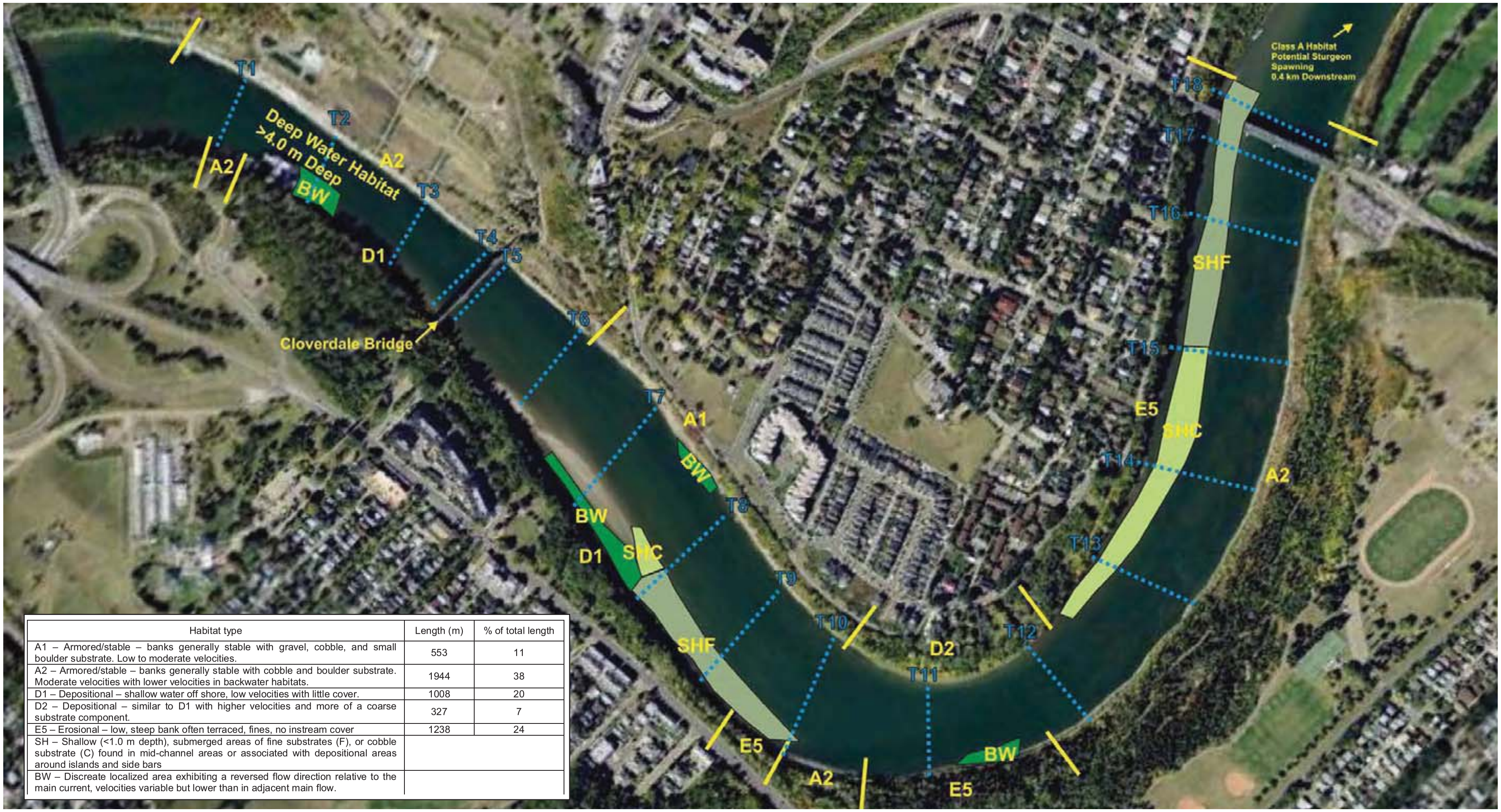
Eighteen transects, generally at intervals of approximately 150 metres, were established across the channel throughout the study section. Transect 1 was established furthest upstream of the proposed crossing site with transect numbers increasing with downstream direction (Figure 5.1). At each transect a Lowrance X-16 depth sounder was used to establish a cross section of the channel. A detailed description of the physical measurements taken at each transect is provided in Appendix A.

4.0 RESULTS

4.1 Habitat Inventory

The North Saskatchewan River consists of one main channel within the study section. As such, the channel was classified as "U" (unobstructed channel).

Approximately 38% of the study section was classified as armored habitat (A2) (Figure 4.1). Erosional habitat (E5) accounted for approximately 35% of the study section while depositional habitat (D1 and D2) comprised approximately 27% of the study section (Figure 4.1). Water depths offshore were generally less than 2 metres deep, however the area immediately upstream of the crossing site was almost 5 metres deep. The shoals located in the study area were generally very shallow (<0.5 m deep) with fine and coarse substrate components both present. Backwater



Habitat type	Length (m)	% of total length
A1 – Armored/stable – banks generally stable with gravel, cobble, and small boulder substrate. Low to moderate velocities.	553	11
A2 – Armored/stable – banks generally stable with cobble and boulder substrate. Moderate velocities with lower velocities in backwater habitats.	1944	38
D1 – Depositional – shallow water off shore, low velocities with little cover.	1008	20
D2 – Depositional – similar to D1 with higher velocities and more of a coarse substrate component.	327	7
E5 – Erosional – low, steep bank often terraced, fines, no instream cover	1238	24
SH – Shallow (<1.0 m depth), submerged areas of fine substrates (F), or cobble substrate (C) found in mid-channel areas or associated with depositional areas around islands and side bars		
BW – Discreate localized area exhibiting a reversed flow direction relative to the main current, velocities variable but lower than in adjacent main flow.		

FIGURE 4.1.

Habitat mapping and transect locations for the North Saskatchewan River adjacent to the proposed Cloverdale LRT bridge crossing.

N W E S

Scale: 1:5400

100 0 100 200 m

Project: City of Edmonton Cloverdale Bridge Replacement

Prepared For: Spencer Environmental Management Services Ltd.

Created: December 2010

Pisces Environmental Consulting Services Ltd.

areas, generally the result of streambank irregularities, were also found within the study section but did not account for a large segment of the total habitat area.

Object cover was generally scarce within the study section with the exception of boulders (provided by rip-rap) that were common in A2 habitat areas. Depth and turbidity also provided cover for fish. The streambed was primarily composed of a mixture of coarse substrates and fine material with cobbles and fines the most common. Coarse substrates (cobble, boulder, gravel) were more common in areas of higher velocities while low velocity areas generally had a greater proportion of fine materials.

Photos depicting habitat conditions at the time of assessment are provided in Appendix B.

4.2 Fish Capture

A 1400 metre long electrofishing survey completed adjacent to the existing Cloverdale bridge resulted in the capture of Mooneye, Mountain Whitefish, Northern Pike, Walleye, Emerald Shiner, Longnose Sucker, Spottail Shiner, Trout-perch, and White Sucker during 2308 seconds of electro-fisher on time (Table 4.1). The majority of fish were captured along rip-rap shoreline or at the edge of deep water habitat. A detailed record of fish captured and sampling effort expended in November, 2010 is provided in Appendix C. Additional 2010 sampling completed approximately 1.2 kilometres upstream of the Cloverdale bridge found the same species as well as Burbot (Pisces *in prep* 2010.).

Table 4.1 Summary of fish captured near Cloverdale Bridge in November, 2010

Species	Number	Length (mm) (range)	Weight (g) (range)
Emerald Shiner	4	72 (57-85)	3 (1-5)
Longnose Sucker	1	146	43
Mountain Whitefish	5	292 (179-324)	339 (68-475)
Mooneye	3	253(243-266)	236(198-301)
Northern Pike	1	232	83
Spottail Shiner	1	62	1
Trout-Perch	1	58	2
Walleye	2	193 (174-212)	82 (68-95)
White Sucker	1	405	1078

Historical fish presence data for the North Saskatchewan River in the vicinity of the City of Edmonton indicates that there is a diverse community in this section of the river including 11 sport and 19 non-sport fish species (Table 4.2). At present, none of the species historically reported from this section of the river are listed on Schedule 1 under the *Federal Species at Risk Act* (SARA). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has assessed lake sturgeon as endangered (COSEWIC 2006). As of December, 2010, the ministerial response to the COSEWIC status assessment for Lake Sturgeon indicates that the Minister of Fisheries and Oceans will undertake consultations on whether or not the Lake Sturgeon Saskatchewan River populations should be listed under the Species at Risk Act (SARA 2010).

Table 4.2 Historical record of fish species captured from the North Saskatchewan River in the vicinity of Edmonton, Alberta.

Common Name	**Scientific Name**	**Provincial Status** (ASRD 2005)	**Federal Status** (SARA 2010)	**Historical Inventories**
Brook Stickleback	*Culaea inconstans*	Secure	Not Listed	b
Brook Trout	*Salvelinus fontinalis*	Exotic/Alien	Not Listed	b
Brown Trout	*Salmo trutta*	Exotic/Alien	Not Listed	a,b
Bull Trout	*Salvelinus confluentus*	Sensitive	Not Listed	a
Burbot	*Lota lota*	Secure	Not Listed	a,b
Emerald Shiner	*Notropis atherinoides*	Secure	Not Listed	b,c
Fathead Minnow	*Pimephales promelas*	Secure	Not Listed	b
Finescale Dace	*Phoxinus neogaeus*	Undetermined	Not Listed	b
Flathead Chub	*Platygobio gracilis*	Secure	Not Listed	b
Goldeye	*Hiodon alosoides*	Secure	Not Listed	a,b
Lake Chub	*Couesius plumbeus*	Secure	Not Listed	b
Lake Sturgeon	*Acipenser fulvescens*	At Risk	Under Consideration	a,b
Longnose Dace	*Rhinichthys cataractae*	Secure	Not Listed	b
Longnose Sucker	*Catostomus catostomus*	Secure	Not Listed	b.c
Mooneye	*Hiodon tergisus*	Secure	Not Listed	b,c
Mountain Sucker	*Catostomus platyrhnchus*	Secure	Not Listed	b
Mountain Whitefish	*Prosopium williamsoni*	Secure	Not Listed	a,b,c
Northern Pike	*Esox lucius*	Secure	Not Listed	a,b,c
Northern Redbelly Dace	*Phoxinus eos*	Sensitive	Not Listed	b
Pearl Dace	*Margariscus margarita*	Undetermined	Not Listed	b
Quillback	*Carpoides cyprinus*	Undetermined	Not Listed	b
River Shiner	*Notropis blennius*	Undetermined	Not Listed	b
Sauger	*Stizostedion canadense*	Sensitive	Not Listed	a,b
Shorthead Redhorse	*Moxostoma macrolepidotum*	Secure	Not Listed	b
Silver Redhorse	*Moxostoma anisurum*	Undetermined	Not Listed	b
Spoonhead Sculpin	*Cottus ricei*	May be at Risk	Not Listed	b
Spottail Shiner	*Notropis hudsonius*	Secure	Not Listed	b,c
Trout-perch	*Percopsis omiscomaycus*	Secure	Not Listed	b,c
Walleye	*Sander vitreus*	Secure	Not Listed	a,b,c
White Sucker	*Catostomus commersoni*	Secure	Not Listed	b,c

* a Allan (1984)
b FMIS (2010)
c this study

4.3 Stream bank and Channel Assessment

The North Saskatchewan River, near Edmonton, meanders through an entrenched stream cut valley. Valley walls range in height but are generally steep and composed of fine material. The banks within the study section were primarily stable and relatively well vegetated with grass, shrubs, and trees. Streambank armoring with rip-rap was common within the study section along stretches that would likely have been naturally unstable.

The wetted width averaged 159 metres within the study section (across the 18 transects). Water depths were generally less than two metres with the exception of the area immediately upstream of the Cloverdale Bridge where depths exceeded four metres. Cross sections of the channel were measured from the right-upstream-bank (RUB) to the left-upstream-bank (LUB) producing a cross section image of the channel as it would appear looking in the downstream direction. Cross sections of the channel at each transect are presented in Figures 4.2 to 4.6.

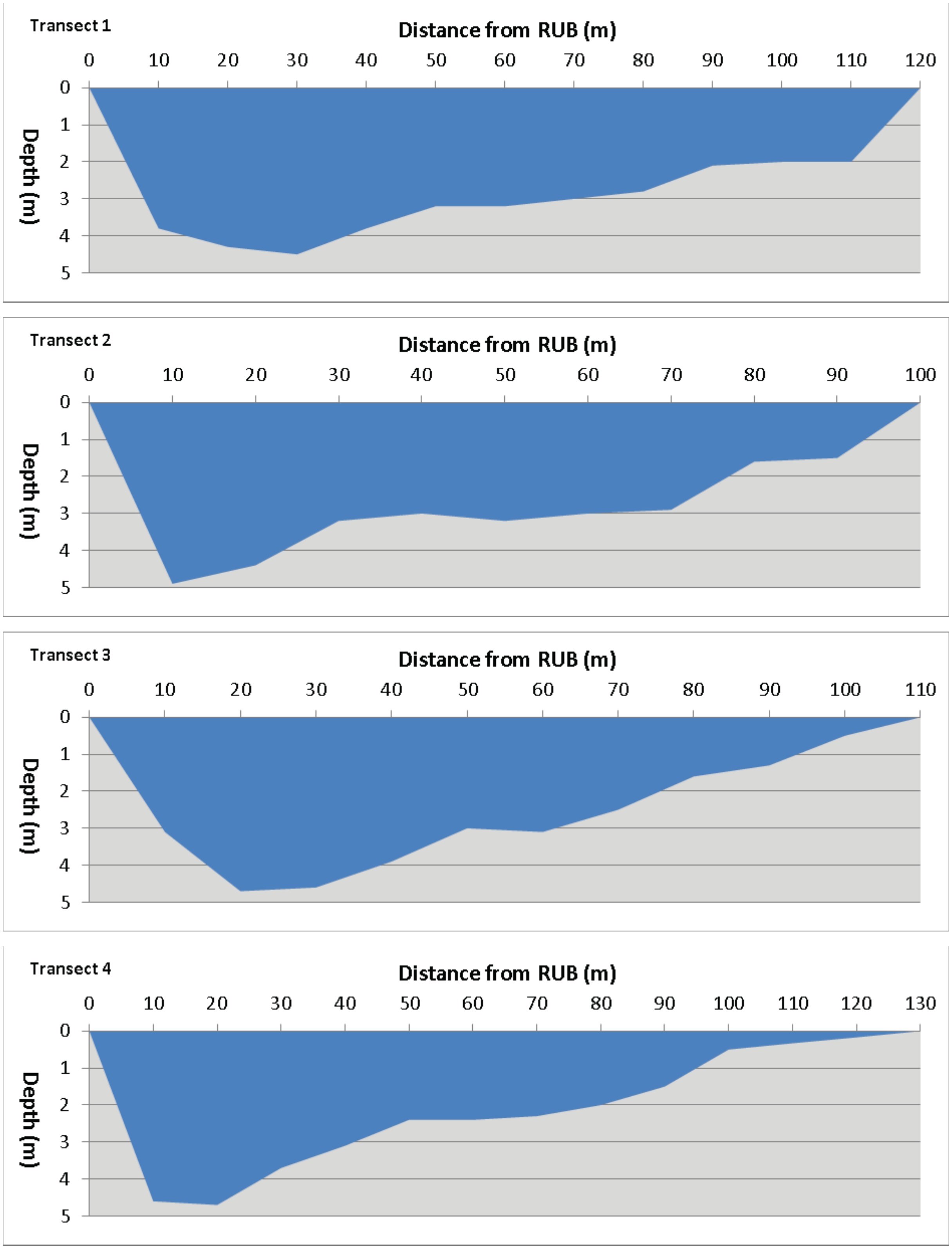


Figure 4.2. Channel cross section at Transects 1-4.

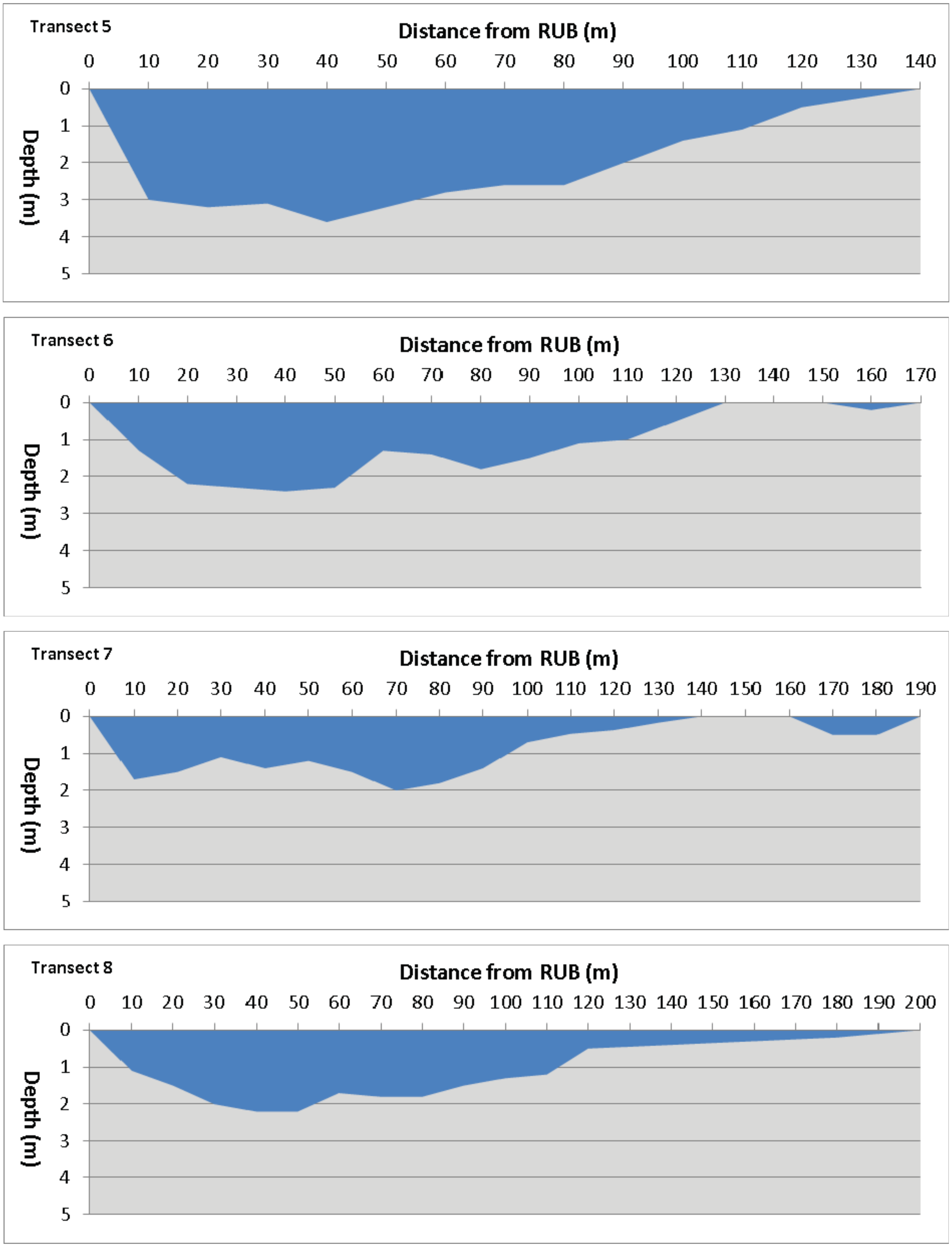


Figure 4.3. Channel cross section at Transects 5-8.

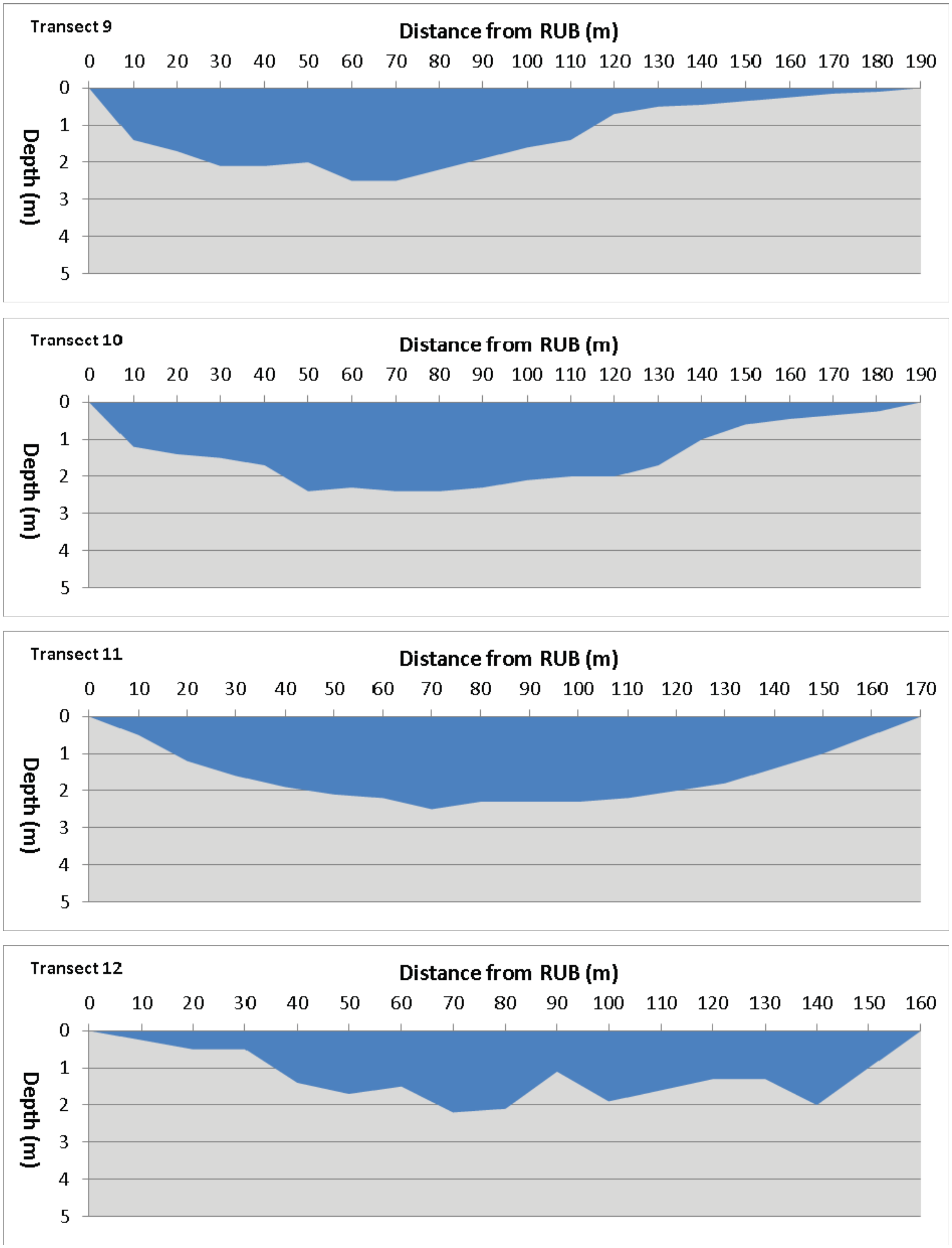


Figure .4.4 Channel cross section at Transects 9-12.

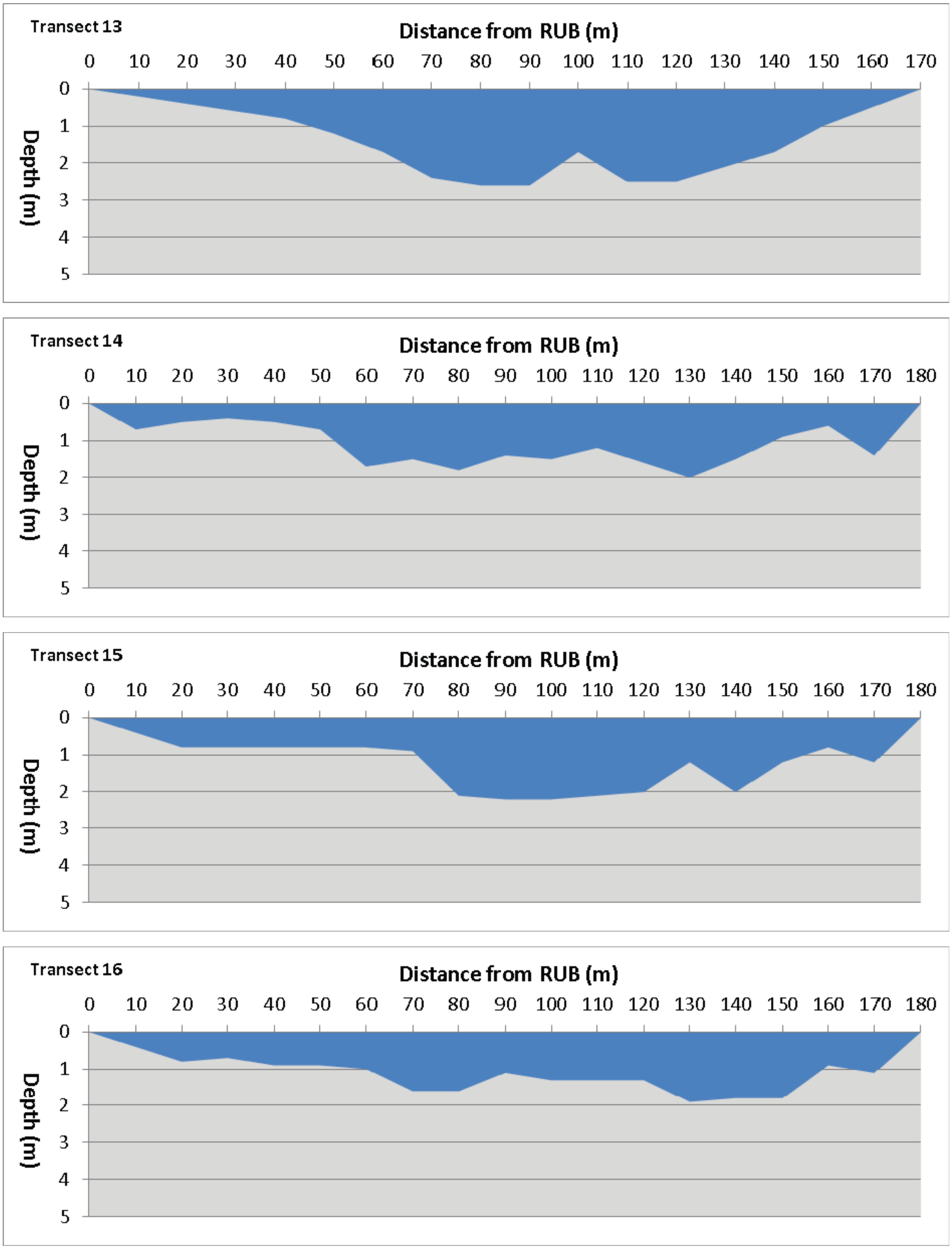
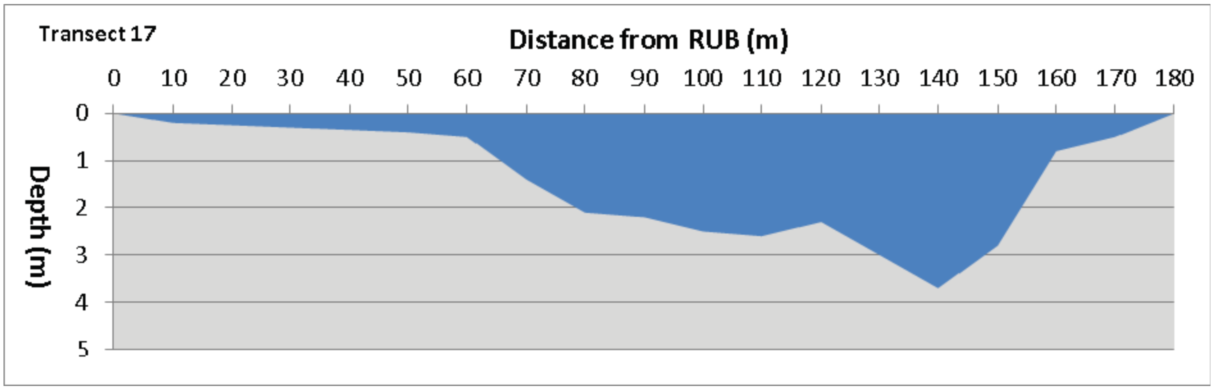


Figure 4.5. Channel cross section at Transects 13-16.



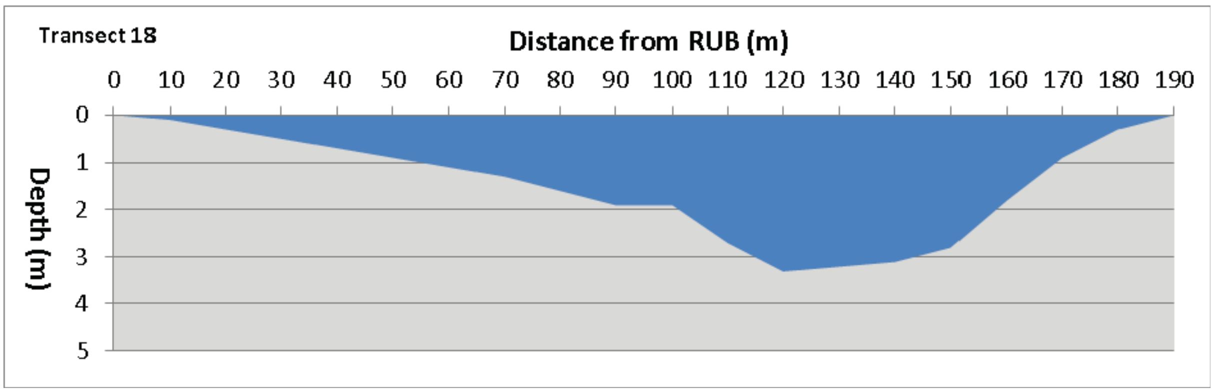


Figure 4.6. Channel cross section at Transects 17-18.

5.0 DISCUSSION

Fish Presence

While 2010 sampling totals were relatively low, the results were consistent with previous sampling of the North Saskatchewan River in the City of Edmonton in terms of species presence. In 1984, Allan reported nine sport fish species in the main-stem of the North Saskatchewan River near Edmonton. According to Allan (1984), Northern Pike, Walleye, and Goldeye were common or seasonally abundant; Sauger, Mooneye, and Yellow Perch occurred occasionally; and Lake Sturgeon, Mountain Whitefish, and Bull Trout were rare. Seasonal sampling completed within the City limits in the early nineties found 17 different species occupying the study section but discovered that the fish population was mainly comprised of nine sport and non-sport species (Table 4.2, Kippen Gibbs 1993). Mountain Whitefish and Goldeye were the most common sport fish species captured while non-sport species were dominated by Longnose Sucker, White Sucker, Shorthead Redhorse, and Longnose Dace (Kippen Gibbs 1993). Seasonal abundance (between spring, summer and fall) was relatively constant for most species however, Mountain Whitefish, Goldeye, and Shorthead Redhorse all exhibited some variation (Kippen Gibbs 1993). Mountain Whitefish were present in moderate numbers in the spring; were almost absent in the summer; and dominated the sport-fish catch in the fall (Kippen Gibbs 1993). Goldeye were the most common sport fish in the spring and summer but were virtually absent in the fall and Shorthead Redhorse also decreased in relative abundance in the fall compared to other seasons (Kippen Gibbs 1993).

Habitat Utilization

Much of the habitat in the Edmonton area consists of moderate depth placid run habitat that is neither unique nor in short supply within the North Saskatchewan River (Kippen Gibbs 1993, Stemo 2006). As such, habitat utilization of the area is varied as some species may frequent the area on a seasonal basis while others may occupy this section of the river during all life cycle phases on a year-round basis. The Alberta Government has classified most of the North Saskatchewan River as Class C habitat which by definition is considered widely distributed and moderately sensitive (Alberta Environment 2006). However, some portions of the North

Saskatchewan, including areas downstream of the study area have been designated as Class A Lake Sturgeon habitat (Alberta Environment 2006).

Lake Sturgeon have a limited presence in Alberta and the North Saskatchewan River population is one of only two sub-populations in Alberta. According to Alberta Sustainable Resource Development (2005), the Lake Sturgeon is considered ‘threatened’ and the Federal Government is considering listing the North Saskatchewan River population based on the ‘endangered’ recommendation of COSEWIC (2006). An assessment of Lake Sturgeon populations in the North Saskatchewan River conducted in 1992 focussed on a 240 kilometre section of the river extending from approximately 110 kilometres upstream of Edmonton to approximately 130 kilometres downstream of the city (Watters 1993). Abundance was low and individuals appeared to have a grouped distribution with fish concentrated in a few specific locations (Watters 1993). Several habitat characteristics that were common between these sites were identified as preferential for Sturgeon including a back eddy below a gravel bar or island, with deep water (>3.8 m) adjacent to the river bank (Watters 1993). Investigations in 2010 found one site that met this criteria located immediately upstream of the existing Cloverdale Bridge. However, there is no historical record of Lake Sturgeon occupying this habitat (FWMIS 2010, Watters *Pers. Comm* 2010).

Mountain Whitefish utilize a range of habitat for spawning including riffle, run or deep pool habitat (Thompson and Davies 1976, McAfee 1966) and have demonstrated an adaptability in utilizing varying substrates and water depths. Mountain Whitefish eggs have been found in water ranging from 0.1 to 1.0 metres (IEC Beak Consultants 1984, Ford *et. al* 1995) and have been reported to use coarse substrates ranging from 50 to 500 millimetres in diameter (Northecote and Ennis 1994, Thompson 1974). Considering these wide-ranging characteristics it appears that habitat that may be suitable for spawning is relatively common within the study section and likely the entire reach of the North Saskatchewan River near the City of Edmonton. In addition, suitable rearing, feeding, and overwintering habitat did not appear to be limited within the study section.

The Goldeye that occupy the river in the vicinity of the project are part of a large migratory population that are very abundant in the Edmonton area during the early summer and migrate downstream to the lower reaches of the North Saskatchewan River to overwinter (Allan 1984). Munson (1978) postulated that Goldeye spawn in Alberta during the spring and eggs and/or fry drift downstream to Saskatchewan until they reach maturity at age 3 or 4 at which time the adults return to Alberta. Spawning is believed to occur in lower velocity areas (backwaters or pools) with some turbidity and it seems possible that spawning may occur in the Edmonton area.

The margins of the river likely provide rearing habitat for Walleye and the capture of juvenile Walleye in fall 2010 suggests that the study section is utilized for this life cycle phase. Walleye typically spawn on clean gravel or rubble substrate 2.5-15 centimetres in diameter (McMahon et al 1984) in areas with slow to moderate velocities. While this type of habitat is relatively common with the study section, the relatively low densities of Walleye captures historically suggests that spawning activity may be limited in this part of the North Saskatchewan River.

The role of aquatic vegetation in the life cycle of northern pike is of considerable importance, specifically in reproduction and rearing (Craig 1996). It is widely agreed that meeting spawning habitat requirements (including the presence of adequate vegetation) is the most critical conditions for establishing a durable pike population (Inskip 1982, Raat 1988). Suitable vegetation for Northern Pike reproduction was not present within the study section and it seems more likely that Pike spawn in tributary streams such as Whitemud Creek. River margins and backwater areas within the study section are probably used by Northern Pike for rearing and the deeper runs may provide overwintering habitat.

Burbot are generally widespread in the North Saskatchewan River (Mayhood 1995) and it seems likely that they occupy the river in the vicinity of Edmonton (including the study section) throughout the year for all life cycle phases.

Larger bodied coarse fish species and forage fish species are relatively abundant in the North Saskatchewan River near Edmonton (Kippen Gibbs 1993) and likely occupy the study section on a year-round basis. Habitat attributes within the river appear to be suitable for spawning, rearing, feeding and overwintering. Ripe fish have been captured in Edmonton in the past (Kippen Gibbs 1993) which suggests that some spawning has been attempted and the it seems likely that deeper habitat could be used during the winter. These habitats were not rare within the study section and are considered to be quite common in the North Saskatchewan River in general.

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7.0 PERSONAL COMMUNICATIONS

Watters, D. December, 2010. Senior Fisheries Technician Alberta Sustainable Resource Development, Edmonton, Alberta.

APPENDIX A:

Assessment Methods

STANDARD PROCEDURES FOR WATERCOURSE CROSSING ASSESSMENTS TO MEET WATER ACT CODE OF PRACTICE AND DEPARTMENT OF FISHERIES AND OCEANS INFORMATION REQUIREMENTS

Existing Information

An information search and review will be conducted to determine the necessity for field investigation as per Schedule 4, Section 1, Subsection (1)(b)(i) and Subsection 2(a) of the Code of Practice.

Preliminary Assessment

Determine if the watercourse meets the definition of a 'water body' under the meaning of Section 1 (2)(bb) of the Code of Practice. If the watercourse does not have defined bed and banks, whether water is present or not, then proceed with those physical assessment components, particularly photographs, to demonstrate that the watercourse does not have defined bed and banks and is not therefore a 'water body' and does not have any fish habitat attributes. If the watercourse is a water body, proceed with a full assessment.

Physical Assessment

Study Sections:

Determine the legal land location and UTM coordinates of the crossing site and if possible, a bridge file number.

Establish three study sections, one upstream of the crossing site beyond any influence of the crossing, one encompassing the crossing site disturbance zone, and one downstream of the crossing site. The upstream section should not be less than 50 to 100 m in length. The downstream section should not be less than 300 m in length, allowing for instream obstructions and other local conditions, and should include the entire expected zone of sediment influence. The zone of influence can be estimated using Table 1 or can be calculated using the formula in Table 2. The study sections can be contiguous if the boundaries of the disturbance zone and the upstream boundary of the zone of sediment influence are clearly identified.

Habitat:

For small to medium sized rivers, habitat and cover types, as described in Table 3, within the study section(s) will be measured (m^2) and mapped (where appropriate). The percent composition of each substrate type present (Table 4) and bank vegetation type (Table 5) will be recorded for each habitat type unit. Record all data on a standard Pisces Habitat Inventory form (HI/95-1).

For large rivers, bank habitat types, as described in Table 6, within the study section(s) will be mapped.

Establish 5 equidistantly spaced transects with the middle transect (number 3) centered on the approximate center line of the crossing structure. Transects should be spaced such that they encompass the disturbance zone. At each transect measure bank full and wetted width (m), water depth at 0.25, 0.5 and 0.75 of the wetted width, substrate types across the transect and bank height (m), slope (degrees), composition (Table 7) and stability (stable or eroding). Table 6 describes the parameters in more detail. At the middle transect measure water velocity at 0.25, 0.5 and 0.75 of wetted width. If a structure is present at the middle transect, take measurements at the next transect upstream.

Determine dissolved oxygen concentration, pH, turbidity, conductivity and temperature at one location on transect #3 (Table 8). Obtain photographs showing both banks at the crossing site and the stream channel immediately upstream and downstream of the crossing site, including if possible the transect locations. Record all data on a standard Pisces Stream Bank Assessment form (BA/98-2).

Classify the water body according to the Rosgen channel type classification system described in Table 9.

Other Features:

Note presence of any major groundwater sources.
Note presence of any barriers to fish movement.
Describe any adjacent land use activities that are affecting the water body.
If an existing crossing structure is to be replaced, describe and photograph the existing structure.

Biological Assessment

Determine, by appropriate means (electrofishing, seining, trapping, observation), fish species composition in the study section. An electrofishing sample section need not be the same length as the habitat inventory section, but should not be less than 300 m where conditions allow. Record number of each species captured or observed, effort and area sampled. Weigh (g) and measure fork length (mm) of all sport fish species captured. Where possible record the life stage, gender and maturity of sport fish captured. Record sample section length and width and duration of capture effort. Record all data on a fish capture record form (ECR/95-1).

Where fish passage is an issue, identify the species and size of fish appropriate for passage design purposes.

Effects Assessment

Assess potential adverse and positive effects of the works and their construction. Potential adverse effects may include, but are not necessarily limited to, sediment, fish passage, habitat loss and/or changes in flow regime. Designs, plans and construction procedures are required to quantify changes in habitat type and availability.

Where residual effects are identified, the cumulative effect of the residual effect of the watercourse crossing structure relative to the cumulative effects of other watercourse crossings in a cumulative effects study area will be assessed. The CEA study area for small streams normally encompasses the entire watershed of that stream. For rivers, a portion of the watershed will be used.

Specifications and Recommendations

Under most circumstances, the Code of Practice requires that a Qualified Aquatic Environment Specialist (QAES) certify that if the specifications and recommendations of the QAES and the plans prepared under Section 6 of the Code of Practice are adhered to, the works will be in compliance with the requirements of Part 1 (a) of Schedule 2 of the Code of Practice. A QAES cannot and should not provide specifications and recommendations or issue a certification unless the QAES has reviewed any plans (design drawings, location plans, construction procedures) prepared under Section 6 and Schedule 2 and determined that the plans are adequate to address potential effects and identify mitigation and/or compensation strategies.

Specifications and recommendations of a QAES may include but may not be restricted to the following:

1) timing of construction
2) construction procedures
3) structure design
4) mitigation and/or compensation measures

pertinent to the protection of habitat or mitigation of potential adverse effects on fish or fish habitat.

Mitigation and/or compensation measures should be described in sufficient detail in text and on drawings or plans to meet the information requirements of the Department of Fisheries and Oceans. Determine areas (m^2) of habitat by type that will be altered, disrupted or destroyed and the area of habitat by type that will be created as compensation or mitigation.

Documentation

Documentation may take the form of a formal report or a 'letter of advice'. In either case the following subjects should be addressed:

description and location of the study site(s)
methods used for the fisheries resource assessment
results of the assessment, including habitat maps and photographs
assessment of potential adverse and positive effects
description of mitigation and/or compensation measures, given as Code of Practice specifications and recommendations
copies of the appropriate plans, drawings and descriptions of construction procedures and mitigation/compensation measures supplied by the client/owner
references
appendices containing detailed information on fish captures

Table 1. Criteria for estimating the length of the zone of influence downstream of a crossing site.

Stream Type	Stream characteristics						Length of zone
	Width	Slope	Energy	Dominant substrate	Velocity	Habitat	
L1	< 10 m	low	low	fines	low	runs and flats	300 m
L2	> 10 m	low	low	fines	low	runs and flats	500 m
M1	< 10 m	moderate	moderate	fines and coarses	moderate	long runs separated by short riffles	300 m
M2	> 10 m	moderate	moderate	fines and coarses	moderate	long runs separated by short riffles	500 m
H1	< 10 m	moderate to high	high	coarses	moderate to high	frequent riffles and cascades	300 m
H2	> 10 < 20 m	moderate to high	high	coarses	moderate to high	frequent riffles, cascades and high velocity runs	1000 m
H3	> 20 m	moderate to high	high	coarses	moderate to high	frequent riffles and high velocity runs	> 1000 m

Table 2. Procedure for calculating the length of the zone of sediment influence and particle fall velocity (m/s).

Determine specific critical settling velocity (W_c) for the stream using $W_c = (V*S)/1.65$, where V is average water velocity (m/s) and S is stream gradient (m/m). If W_c is > fall velocity for the selected particle size given in the table below, then use Table 1 for length of zone of sediment influence. If W_c is < fall velocity for the selected particle size given below, then calculate the length of the zone of influence (L_{dz} in m) using $L_{dz} = (d*V)/w$, where d is the average water depth (m), V is the average water velocity (m/s) and w is the fall velocity (m/s) for the selected particle size as given below.			
Water Temperature (C)	Type L Stream Fine sand 0.1 mm	Type M Stream Sand 0.4 mm	Type H Stream Coarse sand 1.0 mm
0	0.0002	0.0036	0.0119
5	0.0002	0.0038	0.0121
10	0.0003	0.0039	0.0123
15	0.0003	0.0041	0.0124
20	0.0003	0.0042	0.0125
25	0.0004	0.0043	0.0126

Table 3: Parameters used for habitat mapping and inventories, small to medium size rivers.

DESCRIPTION					
habitat type	water depth	Surface	flow	substrate	velocity
Riffle (RF)	<0.5 m	irregular broken	turbulent	coarse	high
Class 1 Run (R1) R1o	>1.0 m >2.0 m	irregular rarely broken	moderate turbulence	coarse	moderate to high
Class 2 Run (R2)	0.5 to 1.0 m	irregular rarely broken	moderate turbulence	coarse	moderate to high
Class 3 Run (R3)	<0.5 m	irregular rarely broken	moderate turbulence	coarse	moderate
Class 1 Pool (P1) P1o	>1.0 m >2.0 m	smooth	low turbulence	variable	low, variable
Class 2 Pool (P2)	0.5 to 1.0 m	smooth	low turbulence	variable	low, variable
Class 3 Pool (P3)	<0.5 m	smooth	low turbulence	variable	low, variable
Class 1 Flat (F1) F1o	>1.0 m >2.0 m	smooth	laminar	fines	low
Class 2 Flat (F2)	0.5 to 1.0 m	smooth	laminar	fines	low
Class 3 Flat (F3)	<0.5 m	smooth	laminar	fines	low
Cascade (CA)	<0.5 m	irregular, broken	very turbulent	very coarse	highly variable
Rapids (RA)	>0.5 m	irregular, broken	very turbulent	very coarse	highly variable
Chutes (CH)	<0.5 m	irregular	shooting	bedrock	high

COVER COMPONENTS	
Woody Debris (WD)	large, in stream woody debris
Overhanging Bank (OB)	undercut, overhanging bank
Overhanging Vegetation (OV)	overhanging terrestrial vegetation
Aquatic Vegetation (AV)	dense, well distributed aquatic vegetation providing cover
Boulder Garden (BG)	dense, well distributed boulders providing cover

OTHER FEATURES	
Ledges (LG)	bedrock outcrops forming hydraulic controls
Log Ledge (LL)	large woody debris forming a hydraulic jump, typically with a scour pool beneath
Beaver Dams (BD)	beaver dams
Log Jam (LJ)	accumulation of woody debris across channel with water flowing through

Table 4. Substrate types and description (from American Geophysical Union, Subcommittee on Sediment Terminology).

Type	bedrock	boulder	cobble	gravel	fines
abbreviation	BR	BL	CB	GR	FN
size (mm)	N/a	>250	64-250	2-64	<2

Table 5. Bank vegetation types.

Type	Trees	Shrubs	Grass	Exposed
Abbreviation	Tr	Sh	Gr	Exp

Table 6. Parameters used for habitat mapping and inventories, large rivers

BANK HABITAT TYPE		
Category	Code	Description
Armoured/ Stable	A1	Banks generally stable and at repose with cobble/small boulder/gravel substrates predominating; uniform shoreline configuration with few/minor bank irregularities; velocities adjacent to bank generally low/moderate, instream cover limited to substrate roughness; overheadcover provided by turbidity or occasional large woody debris.
	A2	Banks generally stable and at repose with cobble/small boulder and large boulder substrates predominating; irregular shoreline configuration generally consisting of a series armored cobble/boulder outcrops that produce backwater habitats; velocities adjacent to bank generally moderate with low velocities provide in BW habitats; instream cover provided by substrate roughness; overhead cover from depth, turbidity and LWD; occasionally associated with C1, E4 and E5 banks.
	A3	Similar to A2 in terms of bank configuration and composition although generally with higher composition of large boulders/bedrock fractures; very irregular shoreline produced by large boulders and bedrock outcrops; velocities adjacent to bank generally moderate to high; instream cover provided by roughness; overhead cover from depth and turbidity; exhibits greater depth offshore than A1 or A2; often associated with C1 banks.
Canyon	C1 n	k substrate consists primarily of large cobble/boulder/bedrock; generally stable at bank/water interface although on upper bank slumps/rock falls common; typically deep with high velocities offshore; abundant velocity cover provided by substrate roughness and bank irregularities.
	C2	ock banks associated with canyon cliffs or bedrock outcrops; deep to moderate depths offshore with generally moderate to fast velocities; regular bank form; velocity cover occasionally provided by bedrock fractures.
	C2B	Similar to C2 but bank is regular with no instream cover.
	C3	k substrate consists primarily of fines with some gravel/cobble at base; moderately eroding at bank/water interface; slumping on upper bank common. Moderate to high velocities, no instream cover.
Depositional	D1	with shallow water depths offshore; substrate consists predominantly of fines; low velocities; instream cover generally absent, or if present consisting of shallow depressions between dunes, embedded coarse substrate particles or woody debris; generally associated with bar formations.
	D2	Low relief, gently sloping bank with shallow water depths offshore; substrate consists of coarse particles (gravel/cobble); low to moderate velocities offshore; areas with higher velocities usually producing riffles; overhead cover from turbidity, or turbulence; instream cover from substrate; often associated with bars and shoals.
	D3 o	D2 but with coarser substrates more dominant; boulders often embedded in cobble/gravel matrix; higher average velocities than D1 or D2; abundant instream cover from coarse substrate; overhead cover from turbulence; often associated with riffles or rapids; a transitional type between armoured and depositional.
Erosional	E1	High, eroding, steep banks; often terraced; unstable, frequently slumping and eroding; fine substrates; moderate to high offshore velocities; steep bank profile extends under water surface resulting in deep water immediately offshore; abundant instream cover from woody debris; overhead cover from partially submerged vegetation, depth and turbidity.
	E2	Similar to E1 but without woody debris or submerged vegetation; depth offshore less than E1.
	E3	High, steep eroding banks, substrates consist of loose till deposits; moderate to high velocities offshore; moderate depths offshore; instream cover limited to substrate roughness, overhead cover to turbidity.
	E4	Steep, eroding or slumping highwall bank; substrates variable but consisting primarily of fines; moderate to high velocities offshore; offshore depth moderate to deep; limited instream cover; overhead cover from depth and turbidity
	E4B	Same as E4, but with log jam and/or large woody debris cover.

	E5	Low, steep banks often with terraced profile; predominantly fine substrates; low velocities offshore; offshore depths usually shallow to moderate; instream cover absent; often associated with BW habitats in A1 and A2 types; overhead cover limited to turbidity.
	E6	Low slumping/eroding bank, substrates either cobble/gravel or fines with cobble/gravel patches; depths offshore moderate; velocities moderate to high; instream cover from boulders or woody debris; overhead cover from overhanging vegetation, depth and turbidity; may include numerous small BW.

Table 6 cont.

	SPECIAL HABITAT FEATURES
Tributary Confluences (TC)	confluence area of tributary entering mainstem; classified according to flows at time of survey and wetted width at the mouth. TC1-intermittent flow (dry/trickle); ephemeral stream TC2-flowing; width at mouth <5.0 m TC3-flowing; width at mouth 5-15 m TC4-flowing; width at mouth 15-30 m TC5-flowing; width at mouth 30-60 m TC6-flowing: width at mouth >60 m
Shoal (SH)	shallow (<1.0 m depth), submerged areas of coarse (SHC) or fine (SHF) substrates generally found in mid-channel areas or associated with depositional areas around islands and side bars. Shoal boundaries are visually assessed and approximate locations mapped
Backwater (BW)	discrete, localized area of variable size, exhibiting a reversed flow direction relative to the main current; generally produced by bank irregularities; velocities variable but generally lower than in adjacent main flow; substrate similar to that in adjacent channel although usually with higher percentage of fines

Table 7. Stream bank assessment components.

Height (m)	height from the bank base to the top of bank
Angle/slope (^{o})	angle of bank from the base to the top of bank
Water contact (m)	distance from base of bank to water
Cover (m^2) (WD, OB, OV, AV, BL)	material or objects providing cover for fish originating from the bank (woody debris, overhanging bank, overhanging vegetation, aquatic vegetation, boulder cover)
Vegetation Cover (Gr, Sh, Tr, Exp)	cover of live vegetation and exposed ground on the bank (grass, trees, shrubs, exposed)
Stream bank composition (FN, GR, CB, BL, BR)	material that the bank is made of (fines, gravel, cobble, boulder, bedrock)
Streambed composition (FN, GR, CB, BL, BR)	material that the stream bed is made of (fines, gravel, cobble, boulder, bedrock)

Table 8. Other Physical and Chemical parameters measured.

Wetted width (m)	width of channel presently containing water
Bank full width (m)	width of channel at the top of bank
Water temperature (^{o}C)*	measured with a 1 degree Celsius accuracy thermometer
Velocity (m/s)	calculated by measuring the time it takes a float to travel a measured distance
Conductivity (μMHOS)*	measured using a Yellow Springs Instrument Co. model 33 Salinity – Conductivity – Temperature meter
Turbidity (NTU)*	measured using a LaMotte 2020 Turbidimeter
pH*	measured using a Hanna Instruments pHep 3 pH meter
Dissolved O_2 (mg/l)*	measured using a model FF-1A Hach kit

* measured at one transect only

Table 9. Channel types of Rosgen.

Type	Description	Slope	Landform
Aa	Very steep, deeply entrenched with debris transport	>10%	High relief, deeply entrenched and erosional. Vertical steps with deep scour pools and waterfalls
A	Steep, entrenched, step-pool with high energy and debris transport	4-10%	High relief, entrenched and confined. Cascading reaches with frequently spaced deep pools in a step-pool bed morphology
B	Moderately entrenched, moderate gradient, riffle-dominated, infrequently spaced pools with very stable banks and profile	2-3.9%	Moderate relief, colluvial deposition and/or residual soil, moderate entrenchment, and moderate width:depth ration. Predominately rapids with occasional pools in a narrow, gently sloping valley
C	Low gradient, meandering, point bar, riffle, pool, alluvial channels with broad, well-defined floodplain	<2%	Broad valley with terraces associated with the floodplain, alluvial soils, slightly entrenched, and well-defined meandering channel. Riffle-pool streambed morphology
D	Wide channel with longitudinal and traverse bars with eroding banks	<4%	Broad valley with abundant sediment in alluvial and colluvial fans, glacial debris, and other depositional features exhibiting active lateral adjustment
Da	Anastomosing channels that are narrow and deep with stable banks, very gentle relief, highly variable sinuosity, and an expansive well-vegetated floodplain and associated wetlands	<0.5%	Broad, low-gradient valleys with fine alluvium and/or lacustrine soil. Anastomosing geologic control creating fine deposition with well-vegetated bars that are laterally stable and broad wetland floodplain
E	Low gradient, riffle-pool with very efficient and stable meandering rate, low width:depth ratio, and little deposition	<2%	Broad valley-meadow. High sinuosity with stable well-vegetated banks and floodplain of alluvial material. Riffle-pool morphology with very low width:depth ratio
F	Entrenched meandering riffle-pool with a low gradient and high width:depth ratio	<2%	Entrenched in highly weathered material with gentle gradient and high width:depth ratio Riffle-pool morphology with meandering channel that is laterally unstable with high bank erosion
G	Entrenched "gully" step-pool with moderate gradient and low width:depth ratio	2-3.9%	Gully, step-pool morphology with moderate slopes, low width:depth ratio, narrow valleys that are deeply incised alluvial or colluvial material. Unstable with grade control problems and high bank erosion rates

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APPENDIX B:

Colour Plates

Plate 1– Armored (A2) habitat. Photo facing upstream from 0.2 km upstream of Cloverdale footbridge.

Plate 2.- Armored habitat (A2) on RUB immediately adjacent to Cloverdale footbridge (facing downstream).

Plate 3 – Armored habitat (A1) along RUB 0.4 km downstream of Cloverdale Bridge.

Plate 4 – Transition of RUB Bank 0.6 km downstream of Cloverdale Bridge from depositional habitat (D1) to erosional habitat (E5).

Plate 5 – Depositional habitat (D2) along RUB 1 km downstream of Cloverdale bridge.

Plate 6 – Erosional habitat (E5) along RUB 1.4 km downstream of Cloverdale bridge.

	
Plate 7–. Armored habitat (A2) on LUB approximately 1.4 km downstream of Cloverdale Bridge.	Plate 8– Looking upstream from downstream end of study section (approximately 2 km downstream of Cloverdale Bridge).
	
Plate 9 – Looking upstream from downstream end of study section (approximately 2 km downstream of Cloverdale Bridge).	

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APPENDIX C:

Electrofishing Record

Table C-1 Fish Captured immediately downstream of Cloverdale Bridge.

Waterbody	North Saskatchewan River	
Date	01-Nov-10	
Seconds	1149	
Species	**Length (mm)**	**Weight (g)**
EMSH	82	5
NRPK	232	83
SPSH	62	1

Table C-2 Fish Captured along right upstream rip-rap bank immediately upstream of Cloverdale Bridge.

Waterbody	North Saskatchewan River	
Date	01-Nov-10	
Seconds	1159	
Species	**Length (mm)**	**Weight (g)**
EMSH	57	1
EMSH	62	1
EMSH	85	4
LNSC	146	43
MNWH	179	68
MNWH	312	361
MNWH	321	383
MNWH	324	475
MNWH	324	408
MOON	243	198
MOON	250	208
MOON	266	301
TRPR	58	2
WALL	174	68
WALL	212	95
WHSC	405	1078

APPENDIX B:
Reference Design Plans (selected sections)

NORTH SASKATCHEWAN RIVER BRIDGE		
SHEET NO.	DRAWING NO.	TITLE
-	-	NORTH SASKATCHEWAN RIVER BRIDGE COVER SHEET
029	SEW-2400-01-PE-1000	NORTH SASKATCHEWAN RIVER BRIDGE DRAWING INDEX AND GENERAL NOTES
030	SEW-2400-01-PE-1001	NORTH SASKATCHEWAN RIVER BRIDGE SITE PLAN
031	SEW-2400-01-PE-1002	NORTH SASKATCHEWAN RIVER BRIDGE BOREHOLE LOCATION PLAN
032	SEW-2400-01-PE-1003	NORTH SASKATCHEWAN RIVER BRIDGE BOREHOLE STRATIGRAPHY
033	SEW-2400-01-PE-1100	NORTH SASKATCHEWAN RIVER BRIDGE SINGLE TOWER EXTRADOSED OPTION PLAN AND PROFILE
034	SEW-2400-01-PE-1101	NORTH SASKATCHEWAN RIVER BRIDGE SINGLE TOWER EXTRADOSED OPTION NORTH ABUTMENT - PLAN AND PROFILE SHEET 1 OF 3
035	SEW-2400-01-PE-1102	NORTH SASKATCHEWAN RIVER BRIDGE SINGLE TOWER EXTRADOSED OPTION RIVER SPAN - PLAN AND PROFILE SHEET 2 OF 3
036	SEW-2400-01-PE-1103	NORTH SASKATCHEWAN RIVER BRIDGE SINGLE TOWER EXTRADOSED OPTION SOUTH APPROACH - PLAN AND PROFILE SHEET 3 OF 3
037	SEW-2400-01-PE-1104	NORTH SASKATCHEWAN RIVER BRIDGE VARIABLE DEPTH CONCRETE BOX GIRDER OPTION PLAN AND PROFILE
038	SEW-2400-01-PE-1105	NORTH SASKATCHEWAN RIVER BRIDGE VARIABLE DEPTH CONCRETE BOX GIRDER OPTION NORTH ABUTMENT - PLAN AND PROFILE SHEET 1 OF 3
039	SEW-2400-01-PE-1106	NORTH SASKATCHEWAN RIVER BRIDGE VARIABLE DEPTH CONCRETE BOX GIRDER OPTION RIVER SPAN - PLAN AND PROFILE SHEET 2 OF 3
040	SEW-2400-01-PE-1107	NORTH SASKATCHEWAN RIVER BRIDGE VARIABLE DEPTH CONCRETE BOX GIRDER OPTION SOUTH APPROACH - PLAN AND PROFILE SHEET 3 OF 3
041	SEW-2400-01-PE-1130	NORTH SASKATCHEWAN RIVER BRIDGE SINGLE TOWER EXTRADOSED OPTION CROSS SECTIONS SHEET 1 OF 2
042	SEW-2400-01-PE-1131	NORTH SASKATCHEWAN RIVER BRIDGE SINGLE TOWER EXTRADOSED OPTION CROSS SECTIONS SHEET 2 OF 2
043	SEW-2400-01-PE-1132	NORTH SASKATCHEWAN RIVER BRIDGE VARIABLE DEPTH CONCRETE BOX GIRDER OPTION CROSS SECTIONS SHEET 1 OF 2
044	SEW-2400-01-PE-1132	NORTH SASKATCHEWAN RIVER BRIDGE VARIABLE DEPTH CONCRETE BOX GIRDER OPTION CROSS SECTIONS SHEET 2 OF 2
045	SEW-2400-01-PE-1134	NORTH SASKATCHEWAN RIVER BRIDGE SUSPENDED PEDESTRIAN DECK NORTH ABUTMENT AND SOUTH ABUTMENT
046	SEW-2400-01-PE-1135	NORTH SASKATCHEWAN RIVER BRIDGE SUSPENDED PEDESTRIAN DECK PIER LOOKOUT - OPTION 1
047	SEW-2400-01-PE-1136	NORTH SASKATCHEWAN RIVER BRIDGE SUSPENDED PEDESTRIAN DECK PIER LOOKOUT - OPTION 2

GENERAL NOTES:

GENERAL

1. DRAWINGS DESCRIBE PRELIMINARY ENGINEERING DESIGN FOR SINGLE TOWER EXTRADOSED AND VARIABLE DEPTH CONCRETE BOX GIRDER BRIDGE OPTIONS.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE DESIGN DEVELOPMENT REPORT FOR THE NORTH SASKATCHEWAN RIVER BRIDGE,CITY OF EDMONTON LRT DESIGN GUIDELINES AND ALL OTHER SEtoW PROJECT DOCUMENTS.
3. ALL DIMENSIONS SHOWN IN PLAN AND PROFILE DRAWINGS ARE IN METERS AND CROSS SECTION DRAWINGS ARE IN MILLIMETERS.
4. DRAWINGS ARE BASED ON TRACK AND ROADS GEOMETRY AS PER DECEMBER 7, 2012.
5. STATIONS ARE IN METERS MEASURED ALONG THE SOUTHBOUND TRACK.
6. ALL PROFILES ARE DRAWN WITH REFERENCE TO THE SOUTHBOUND TRACK.

DESIGN SPECIFICATIONS AND GUIDELINES

1. CANADIAN HIGHWAY BRIDGE DESIGN CODE CAN/CSA-S6-06.
2. CITY OF EDMONTON LRT DESIGN GUIDELINES, LATEST.
3. CEB-FIP MODEL CODE FOR CONCRETE STRUCTURES,1990.
4. AASHTO LRFD STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 2012.
5. PTI RECOMMENDATIONS FOR STAY CABLE DESIGN, TESTING AND INSTALLATION, 2007.
6. AREMA MANUAL OF RAILWAY ENGINEERING, 2012
7. AASHTO GUIDE SPECIFICATIONS FOR DESIGN AND CONSTRUCTION OF SEGMENTAL BRIDGES, 1999.

SERVICE LIFE

1. THE STRUCTURE SHALL HAVE A DESIGN LIFE OF 100 YEARS WITHOUT REPLACEMENT OF ANY MAJOR COMPONENTS. OTHER COMPONENTS OR ELEMENTS MAY HAVE LESSER SERVICE LIFE AND SHALL BE DESIGNED TO BE REPLACED OR REHABILITATED DURING THE 100 YEARS DESIGN LIFE OF THE BRIDGE.

DESIGN LOADING

1. DEAD LOAD CONSISTS OF THE FOLLOWING:
   - PERMANENT MATERIALS WHICH INCLUDE ALL CONCRETE COMPONENTS, STEEL REINFORCEMENT, POST-TENSIONING COMPONENTS AND ANCHORAGES, STRUCTURAL STEEL.
   - SUPERIMPOSED LOAD COMPONENTS INCLUDING WALKWAY, INVERT CONCRETE AND PLINTHS AND RAILINGS.
   - ALLOWANCE FOR LRT FACILITIES SUCH AS TRACKS, CATENARIES, POLES, SIGNALS, COMMUNICATION, ELECTRICAL, DRAINAGE PIPES AND OTHER UTILITIES ATTACHED TO THE BRIDGE.
2. LRT VEHICLE LOADING AS PER THE LATEST EDITION OF THE CITY OF EDMONTON LRT GUIDELINES.

CONSTRUCTION MATERIALS

1. CONCRETE STRENGTHS ARE ASSUMED AS FOLLOW
   a. GIRDERS 45 MPa
   b. PIERS, ABUTMENTS, PILE CAPS 35 MPa
   c. PILES 30 MPa
2. REINFORCING STEEL TO CSA-G30.18-09 GRADE 400R.
3. PRE-STRESSING STEEL: SEVEN-WIRE, UNCOATED, LOW-RELAXATION, TO ASTM A416-12a, GRADE 1860.
4. ALL STAY CABLES FOR THE EXTRADOSED BRIDGE SHALL BE SEVEN WIRE LOW RELAXATION STRANDS PROTECTED BY A "FLOW-FILLED" EPOXY COATING OR INDIVIDUAL GREASING IN ADDITION TO A HIGH DENSITY POLYETHYLENE SHEATH. STAY CABLE ANCHORAGES SHALL ALLOW FOR CABLE REPLACEMENT.

FOUNDATION AND SOIL INFORMATION

1. SUBSTRUCTURE DESIGN IN ACCORDANCE WITH THE LATEST REVISION OF GEOTECHNICAL REPORTS EDMONTON SOUTHEAST LRT EXTENSION APPRAISAL OF GEOTECHNICAL CONDITIONS, MARCH 14 2012, EDMONTON SOUTHEAST LRT EXTENSION PRELIMINARY SLOPE STABILIZATION ASSESSMENT, MAY 2012, EDMONTON SOUTHEAST LIGHT RAIL TRANSIT EXTENSION DEFORMATION ANALYSIS OF NORTH VALLEY SLOPE WITH STABILIZATION PILES, FEBRUARY 26, 2013 PREPARED BY THURBER.
2. EDMONTON LRT EXPANSION PROJECT DOWNTOWN TO MILLWOODS, SOUTHEAST EDMONTON FUNCTIONAL PLANNING STUDY GEOTECHNICAL ASSESSMENT REPORT TO CH2M HILL BY THURBER
3. REFER TO GEOTECHNICAL REPORT FOR BOREHOLE STRATIGRAPHY.

SURVEY INFORMATION

1. THE TOPOGRAPHIC SURVEY IS REFERENCED TO GRID. THE COMBINED SCALE FACTOR IS INDICATED BELOW. DIMENSIONS SHOWN ON THESE DRAWINGS ARE TO GROUND.
   a. DATUM CODE NAD 83
   b. MAPPING PLANE 3TM
   c. REFERENCE MERIDIAN 114°
   d. COMBINED SCALE FACTOR 0.99981 APPLIED ABOUT THE ORIGIN (0,0)

ANANDA / March 28, 2013 / Y:\60222337\000-CADD\2400 - STRUCTURES\01 STAGE 1\RIVER BRIDGE\SEW-2400-01-PE-1000.DWG

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A	N/A	-	-

issue data

no.	description	date	checked

revisions

AECOM Consultant

A1 bar scale: NOT TO SCALE

drawn by: A. ANAND

designed by

checked by: N. SAN PEDRO

date: 28-03-2013

permit

seal

consultant job no: 60222337

consultant reviewed by: S. ALEXANDER

AECOM Prime Consultant

THE CITY OF Edmonton TRANSPORTATION SERVICES

prime consultant job no: 60222337

Hatch Mott MacDonald — ISL Engineering and Land Services — DIALOG — gec architecture

PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by: G. MENZIES

drawing title: NORTH SASKATCHEWAN RIVER BRIDGE

DRAWING INDEX AND GENERAL NOTES

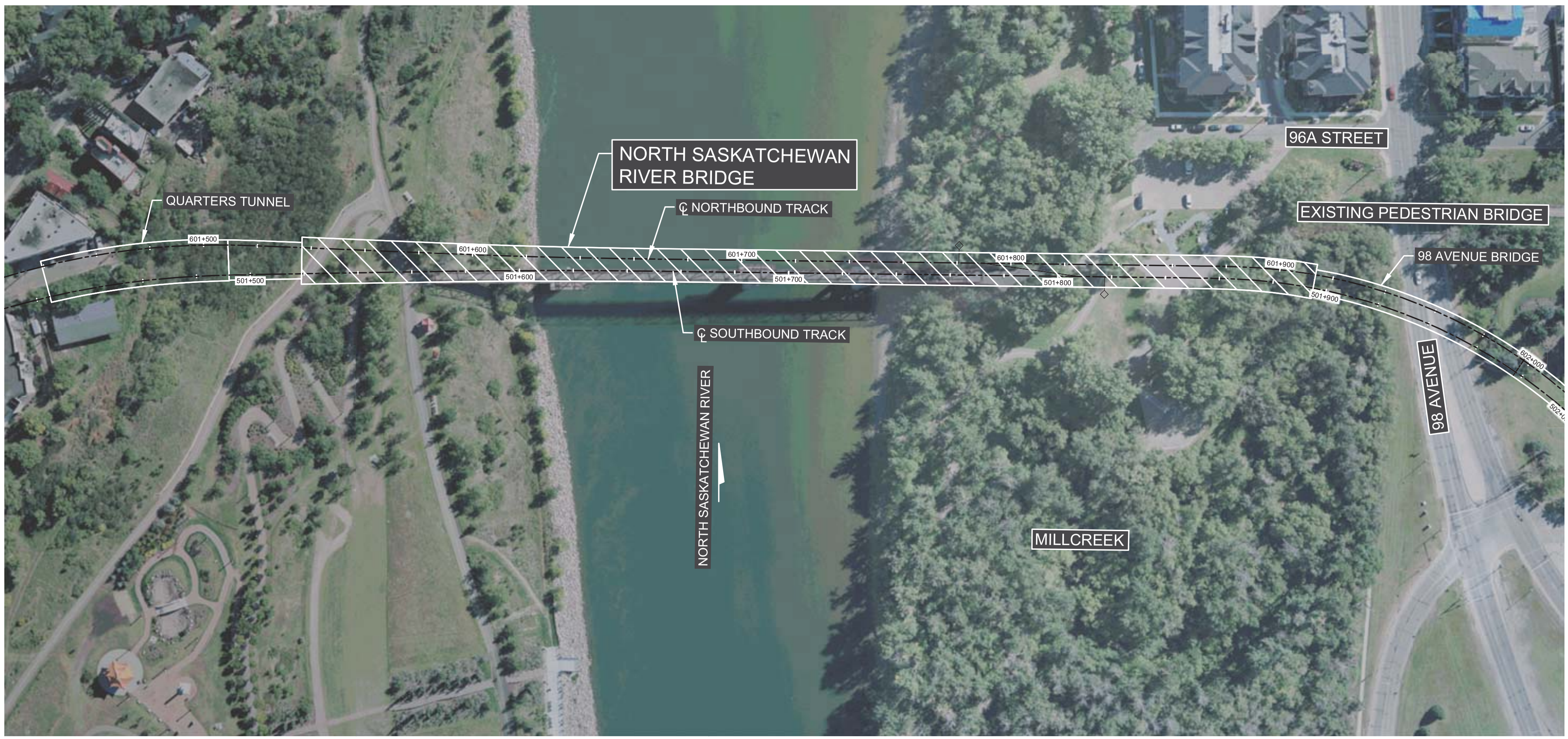
SE to W LRT

MILL WOODS TO LEWIS FARMS

drawing no.: SEW-2400-01-PE-1000

REV

SHT 029



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A	ISSUED FOR 60% REVIEW	22-06-12	R.M.

issue data

no.	description	date	checked

revisions

AECOM Consultant

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drawn by A. ANAND

designed by R. MARZAN

checked by N. SAN PEDRO

date 28-03-2013

permit

consultant job no 60222337

seal

consultant reviewed by S. ALEXANDER

AECOM Prime Consultant

The City of Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald

ISL Engineering and Land Services

DIALOG

gec architecture

PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by G. MENZIES

drawing title
NORTH SASKATCHEWAN RIVER BRIDGE
SITE PLAN

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1001
REV
SHT 030

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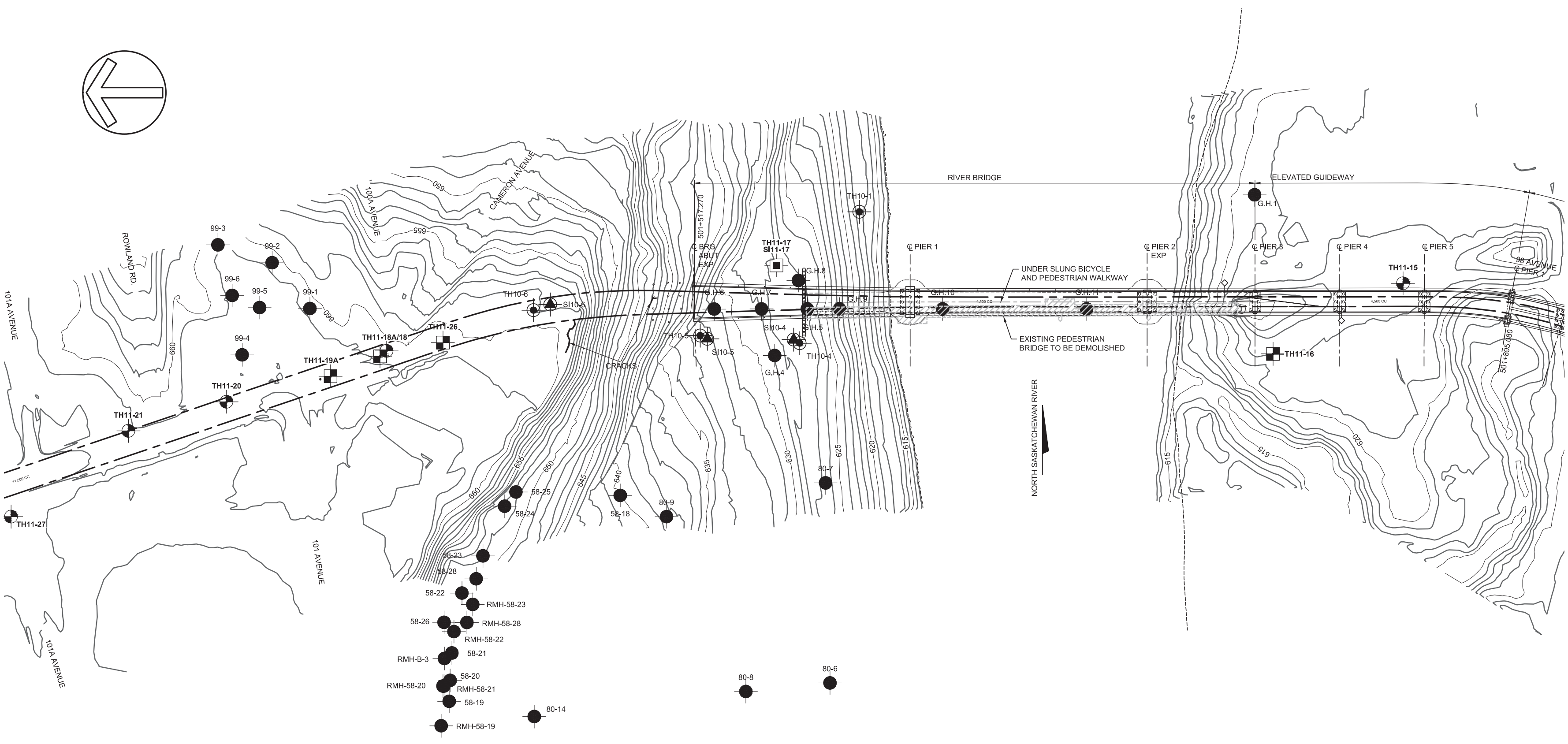

LEGEND

- 2011/2012 TEST HOLE LOCATION (AUGER)
- 2011/2012 TEST HOLE LOCATION (CORING)
- 2011 CORING TEST HOLE LOCATION AND SLOPE INCLINOMETER
- PREVIOUS TEST HOLE (BY THURBER)
- PREVIOUS TEST HOLE (BY OTHERS)
- EXISTING SLOPE INCLINOMETER

NOTES:

FOR GEOTECHNICAL INFORMATION, SEE REPORT "EDMONTON SOUTHEAST LRT EXTENSION APPRAISAL OF GEOTECHNICAL CONDITIONS, MARCH 14 2012"

ANANDA / March 26, 2013 / Y:\60222337\000-CADD\2400 - STRUCTURES\01 STAGE 1\RIVER BRIDGE\SEW-2400-01-PE-1002.DWG

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A	N/A	–	–

issue data

no.	description	date	checked

revisions

THURBER ENGINEERING LTD. Consultant

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drawn by THURBER | designed by THURBER

checked by THURBER | date 10–SEP–12

permit

consultant job no 60222337

seal

consultant reviewed by THURBER

AECOM Prime Consultant

THE CITY OF Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

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PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by THURBER

drawing title

NORTH SASKATCHEWAN RIVER BRIDGE

BOREHOLE LOCATION PLAN

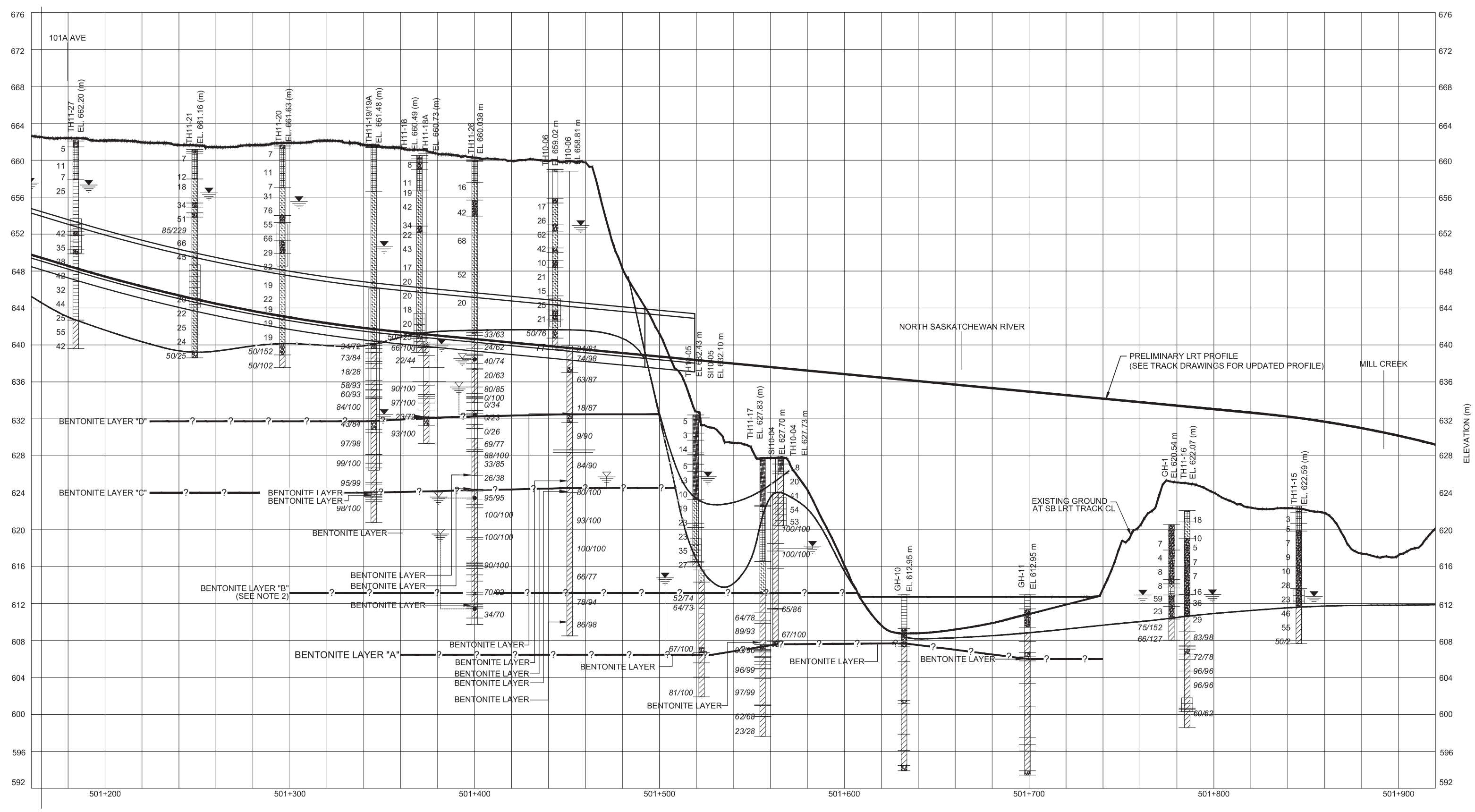
SE to W LRT

MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1002

REV

SHT 031



STATION (SOUTHBOUND LRT TRACK)

LEGEND

- FILL
- CLAY
- CLAY TILL
- SILT
- NO RECOVERY
- SAND, GRAVEL, BOULDERS
- CLAY SHALE, SANDSTONE, SILTSTONE
- COAL
- WATER
- GROUNDWATER LEVEL IN STANDPIPE SEPTEMBER 2012
- PIEZOMETRIC LEVEL IN PNUEMATIC PIEZOMETER SEPTEMBER 2012
- 17 SPT BLOW COUNT
- 67/100 ROCK QUALITY DESIGNATION / PERCENT RECOVERY
- BENTONITE LAYER (OBSERVED)
- —?— BENTONITE LAYER (ESTIMATED)

NOTES

1. REFER TO DRAWING NO. 19-5438-68-1C FOR THE SURVEYED TEST HOLE LOCATIONS.
2. THE SIMPLIFIED STRATIGRAPHIC PROFILE IS PROVIDED FOR ILLUSTRATIVE PURPOSES. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.
3. BENTONITE LAYER "B" WAS REGISTERED IN SEVERAL TEST HOLES NOT SHOWN ON THE CURRENT CROSS-SECTION.
4. FOR GEOTECHNICAL INFORMATION SEE REPORT:- EDMONTON SOUTHEAST LRT EXTENSION APPRAISAL OF GEOTECHNICAL CONDITIONS, MARCH 14 2012.

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	issue data		

no.	description	date	checked
	revisions		

THURBER ENGINEERING LTD. Consultant

A1 bar scale AS SHOWN

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consultant job no 60222337 | consultant reviewed by THURBER

AECOM Prime Consultant

The City of Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald | ISL Engineering and Land Services | DIALOG | gec architecture

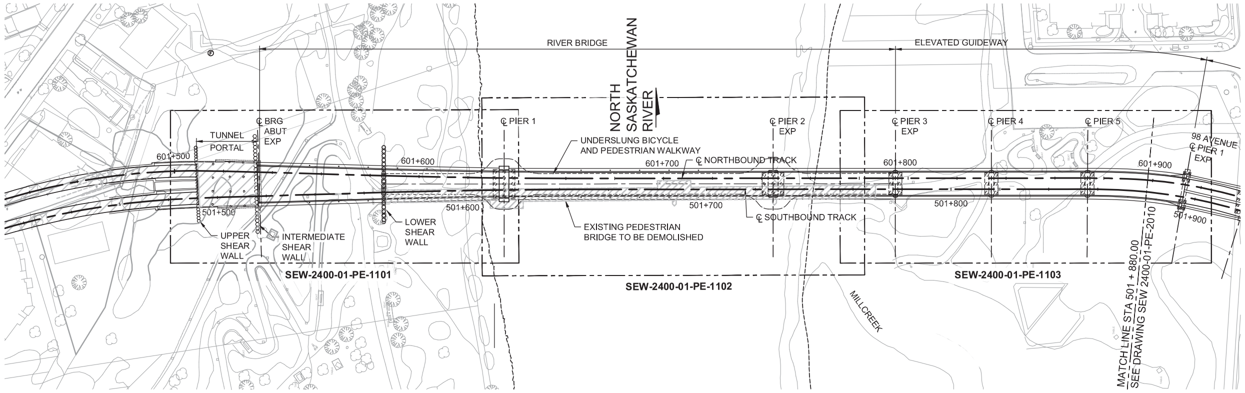
PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by THURBER

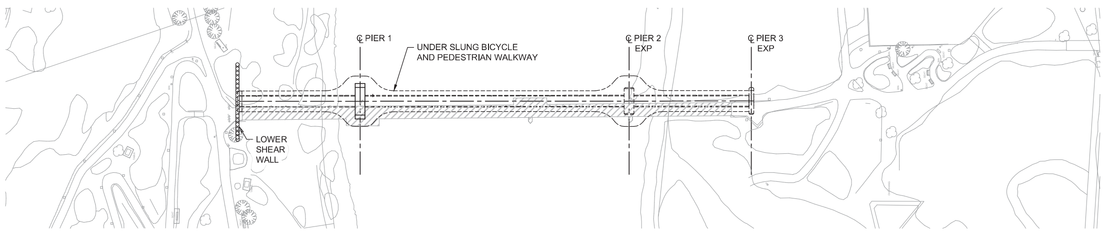
drawing title NORTH SASKATCHEWAN RIVER BRIDGE BOREHOLE STRATIGRAPHY

SE to W LRT
MILL WOODS TO LEWIS FARMS

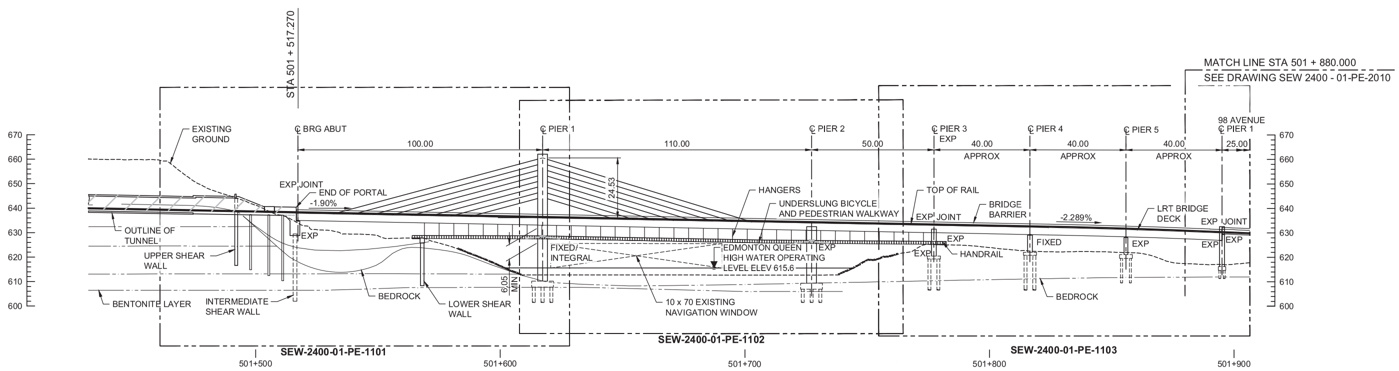
drawing no. SEW-2400-01-PE-1003 | REV | SHT 032



LRT BRIDGE PLAN



UNDERSLUNG BICYCLE AND PEDESTRIAN BRIDGE PLAN



ELEVATION

NOTES:

1. HYDRO-TECHNICAL DATA
   - HIGH WATER LEVEL = EL 622.3
   - ICE WATER LEVEL = EL 621.0
   - HIGH WATER OPERATING LEVEL = EL 615.4
2. NAVIGATION
   - NAVIGATION WINDOW SHOWN CORRESPONDS TO THE EXISTING NAVIGATION WINDOW PROVIDED BY THE EXISTING CLOVERDALE PEDESTRIAN BRIDGE.

no.	description	date	appd
C	FINAL PRELIMINARY ENGINEERING	28-03-13	R.M.
B	ISSUED FOR 90% REVIEW	07-12-12	R.M.
A	ISSUED FOR 60% REVIEW	22-06-12	R.M.

issue data

no.	description	date	checked

revisions

AECOM Consultant

A1 bar scale 1:1000m 0 10 30 50m

drawn by D. KROEKER | designed by B. HU

checked by N. SAN PEDRO | date 28-03-2013

permit

seal

consultant job no 60222337

consultant reviewed by S. ALEXANDER

AECOM Prime Consultant

The City of Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald | ISL Engineering and Land Services | DIALOG | gec architecture

PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

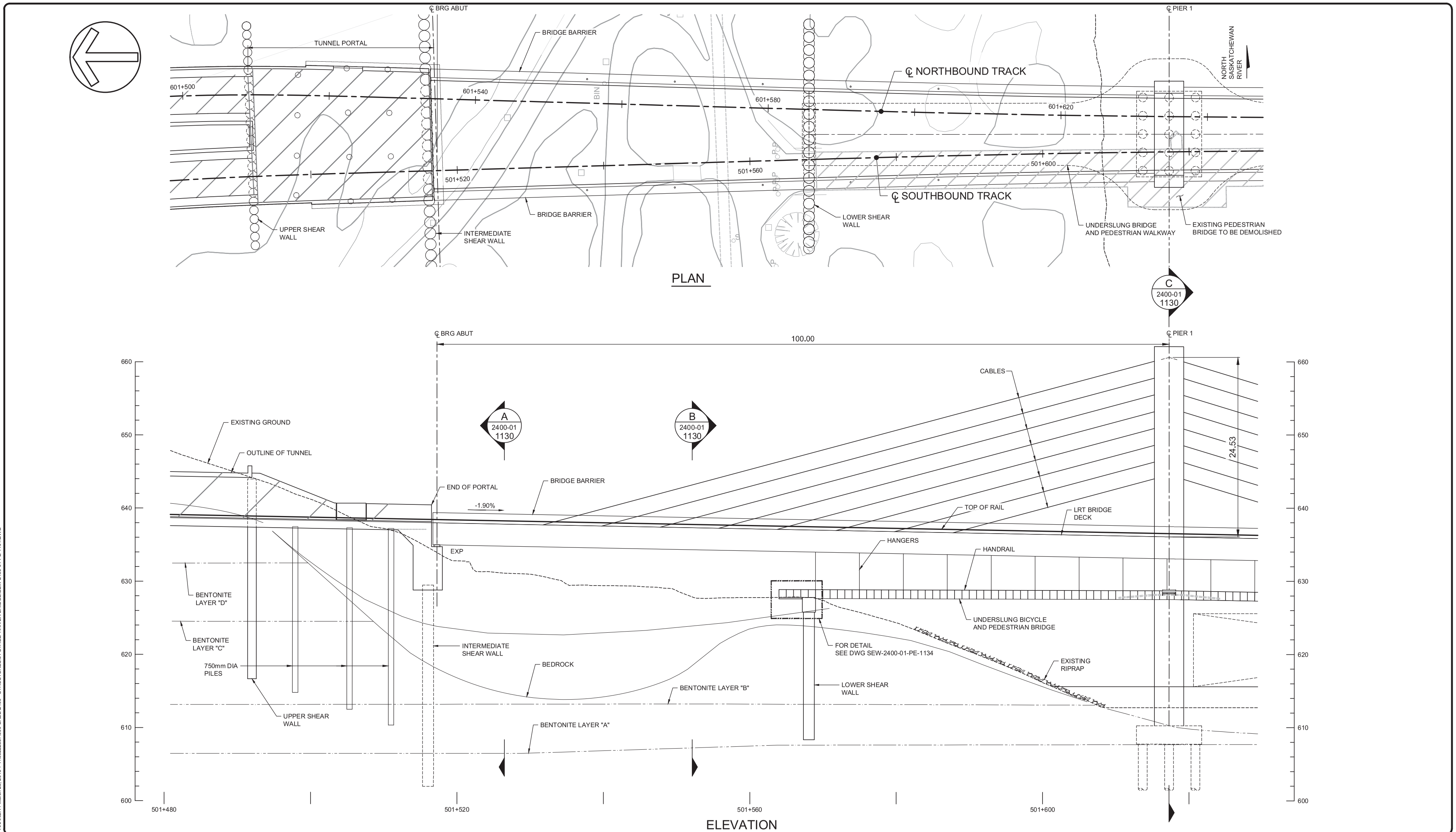
prime consultant reviewed by G. MENZIES

drawing title
NORTH SASKATCHEWAN RIVER BRIDGE
SINGLE TOWER EXTRADOSED OPTION
PLAN AND PROFILE

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1100 | REV | SHT 033

ANANDA / March 28, 2013 / Y:\60222337\000-CADD\2400 - STRUCTURES\01 STAGE 1\RIVER BRIDGE\SEW-2400-01-PE-1100.DWG



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no.	description	date	appd
C	FINAL PRELIMINARY ENGINEERING	28-03-13	R.M.
B	ISSUED FOR 90% REVIEW	07-12-12	R.M.
A	N/A	–	–

issue data

no.	description	date	checked

revisions

AECOM Consultant

A1 bar scale 1:250m 0 2.5 7.5 12.5m

drawn by A. ANAND | designed by B. HU

checked by N. SAN PADRO | date 28-03-2013

permit

consultant job no 60222337

seal

consultant reviewed by S. ALEXANDER

AECOM Prime Consultant

The City of Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald | ISL Engineering and Land Services | DIALOG | gec architecture

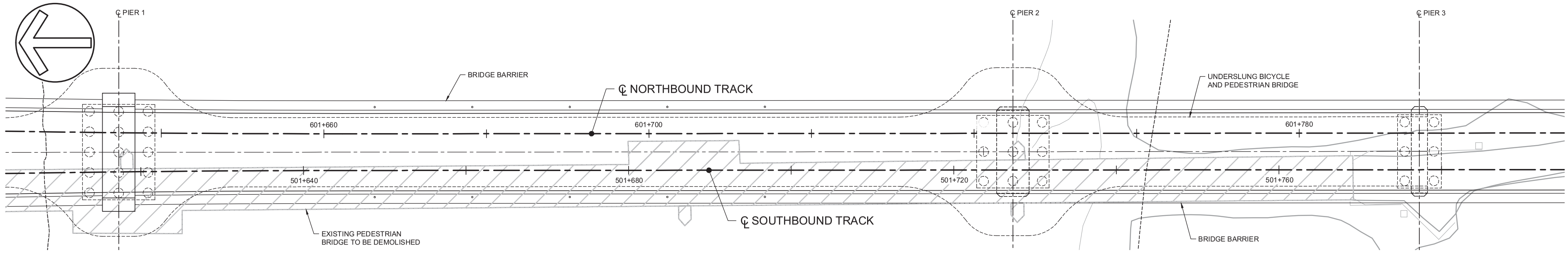
PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

prime consultant reviewed by G. MENZIES

drawing title
NORTH SASKATCHEWAN RIVER BRIDGE
SINGLE TOWER EXTRADOSED OPTION
NORTH ABUTMENT – PLAN AND PROFILE
SHEET 1 OF 3

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1101 | REV | SHT 034



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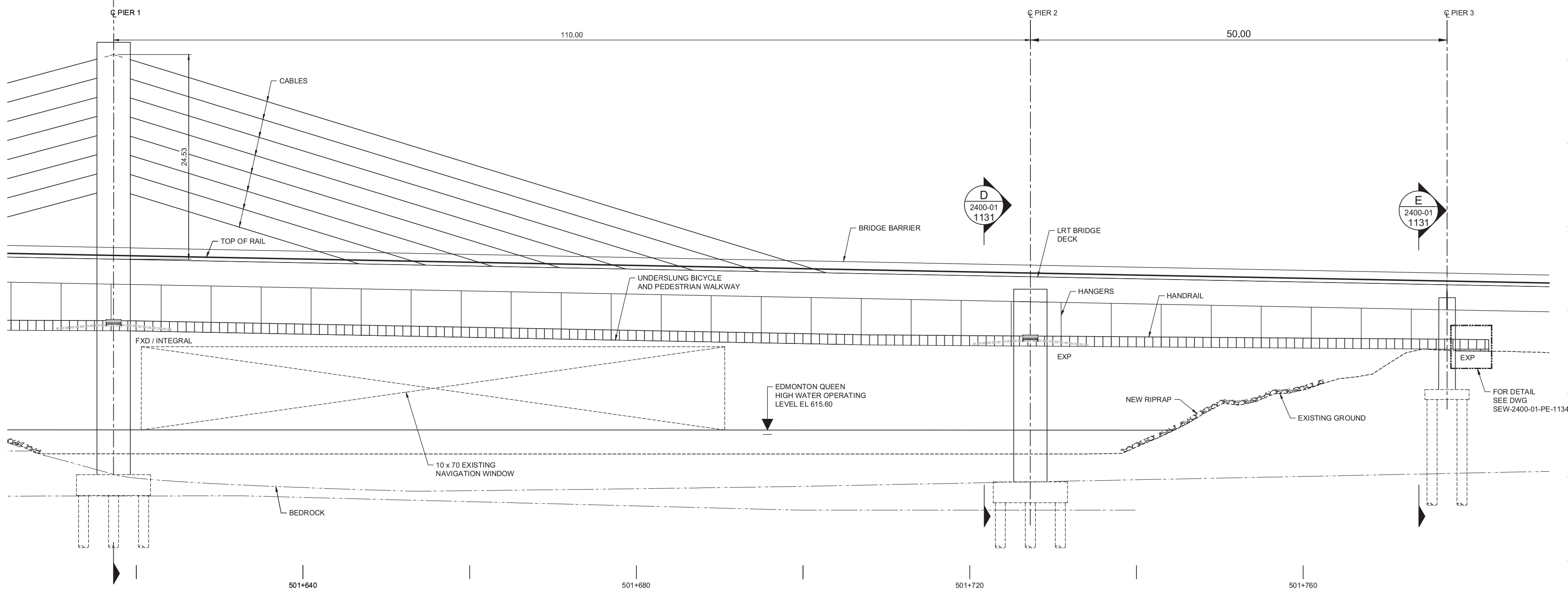

ELEVATION

ANANDA / March 28, 2013 / Y:\60222337\000-CADD\2400 - STRUCTURES\01 STAGE 1\RIVER BRIDGE\SEW-2400-01-PE-1102.DWG

no.	description	date	appd
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B	ISSUED FOR 90% REVIEW	07-12-12	R.M.
A	N/A	–	–

issue data

no.	description	date	checked

revisions

AECOM Consultant

A1 bar scale 1:250m 0 2.5 7.5 12.5m

drawn by A. ANAND

designed by B. HU

checked by N. SAN PADRO

date 28-03-2013

permit

consultant job no 60222337

seal

consultant reviewed by S. ALEXANDER

AECOM Prime Consultant

The City of Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald ISL Engineering and Land Services DIALOG gec architecture

PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by G. MENZIES

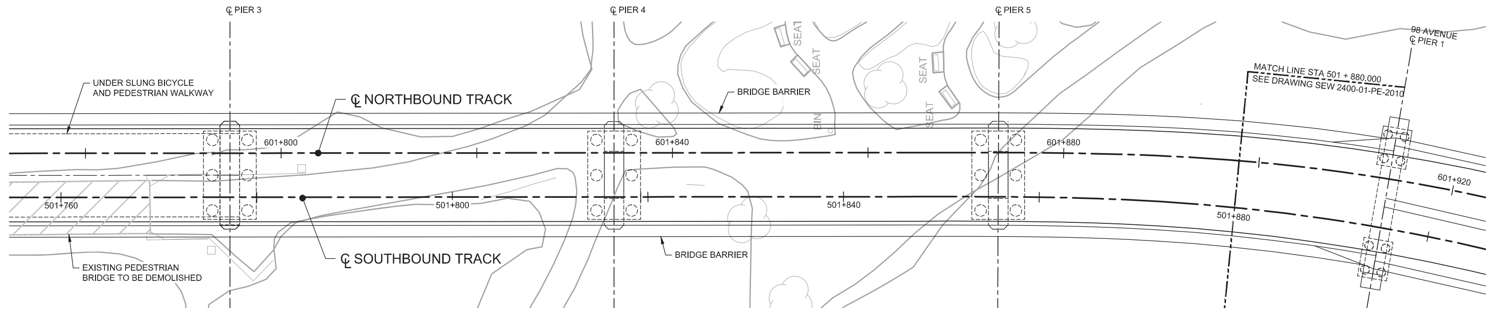
drawing title
NORTH SASKATCHEWAN RIVER BRIDGE
SINGLE TOWER EXTRADOSE OPTION
RIVER SPAN – PLAN AND PROFILE
SHEET 2 OF 3

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1102

REV

SHT 035



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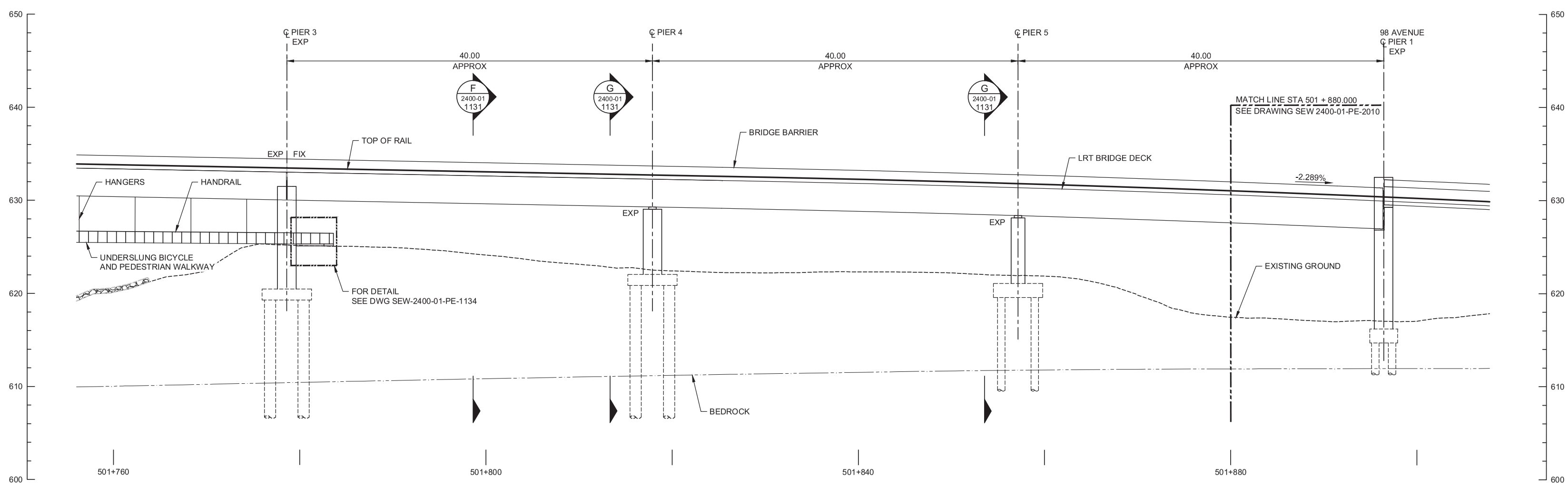


ELEVATION

C	FINAL PRELIMINARY ENGINEERING	28-03-13	R.M.
B	ISSUED FOR 90% REVIEW	07-12-12	R.M.
A	N/A	-	-
no.	description	date	appd
	issue data		

no.	description	date	checked
	revisions		

AECOM
Consultant

A1 bar scale 1:250m 0 2.5 7.5 12.5m

drawn by A. ANAND

designed by R. MARZAN

checked by N. SAN PADRO

date 28-03-2013

permit

consultant job no 60222337

seal

consultant reviewed by S. ALEXANDER

AECOM
Prime Consultant

THE CITY OF Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald

ISL Engineering and Land Services

DIALOG

gec architecture

PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by G. MENZIES

drawing title
NORTH SASKATCHEWAN RIVER BRIDGE
SINGLE TOWER EXTRADOSE OPTION
SOUTH APPROACH – PLAN AND PROFILE
SHEET 3 OF 3

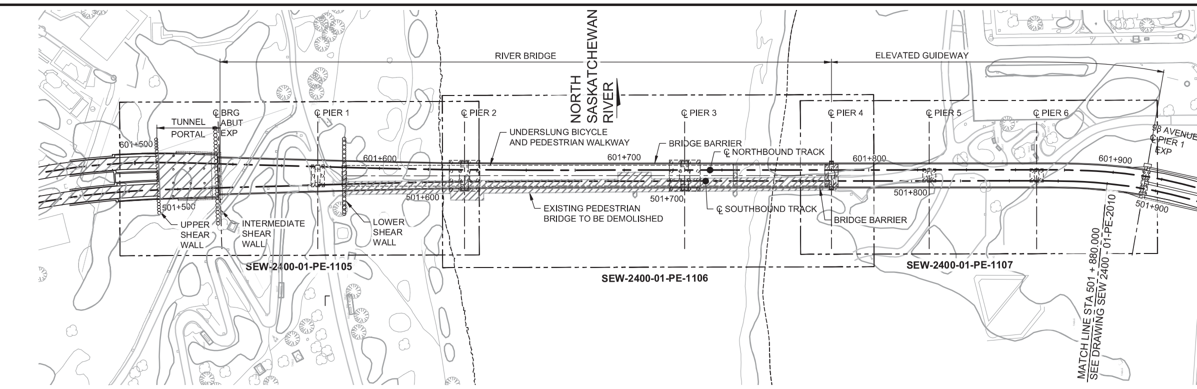
SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1103

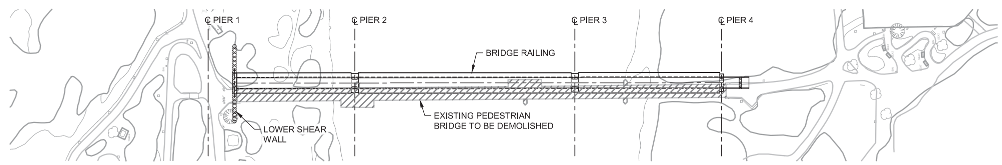
REV

SHT 036

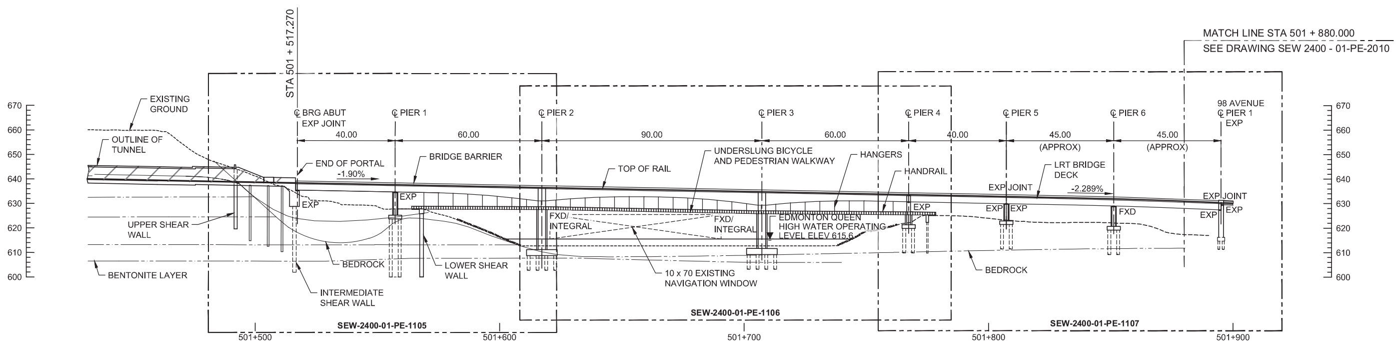
ANANDA / March 28, 2013 / Y:\60222337\000-CADD\2400 - STRUCTURES\01 STAGE 1\RIVER BRIDGE\SEW-2400-01-PE-1103.DWG



LRT BRIDGE PLAN



UNDERSLUNG BICYCLE AND PEDESTRIAN BRIDGE PLAN



ELEVATION

SCALE 1:1000

NOTES:

1. HYDRO-TECHNICAL DATA
   - HIGH WATER LEVEL = EL 622.3
   - ICE WATER LEVEL = EL 621.0
   - HIGH WATER OPERATING LEVEL = EL 615.4
2. NAVIGATION
   - NAVIGATION WINDOW SHOWN CORRESPONDS TO THE EXISTING NAVIGATION WINDOW PROVIDED BY THE EXISTING CLOVERDALE PEDESTRIAN BRIDGE.
3. PIER LOOKOUTS ARE NOT SHOWN ON PIER 2 AND PIER 3.

no.	description	date	appd
C	FINAL PRELIMINARY ENGINEERING	28–03–13	R.M.
B	ISSUED FOR 90% REVIEW	07–12–12	R.M.
A	ISSUED FOR 60% REVIEW	22–06–12	R.M.

issue data

no.	description	date	checked

revisions

AECOM Consultant

A1 bar scale 1:1000m 0 10 30 50m

drawn by A. ANAND | designed by R. MARZAN

checked by N. SAN PEDRO | date 28–03–2013

permit | seal

consultant job no 60222337 | consultant reviewed by S. ALEXANDER

AECOM Prime Consultant

THE CITY OF Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald | ISL Engineering and Land Services | DIALOG | gec architecture

PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by G. MENZIES

drawing title

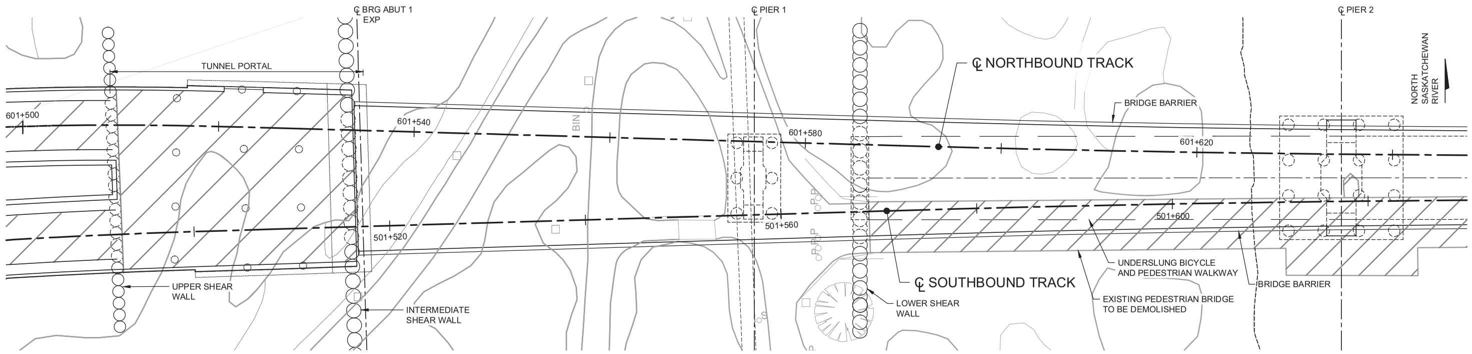
NORTH SASKATCHEWAN RIVER BRIDGE

VARIABLE DEPTH CONCRETE BOX GIRDER OPTION PLAN AND PROFILE

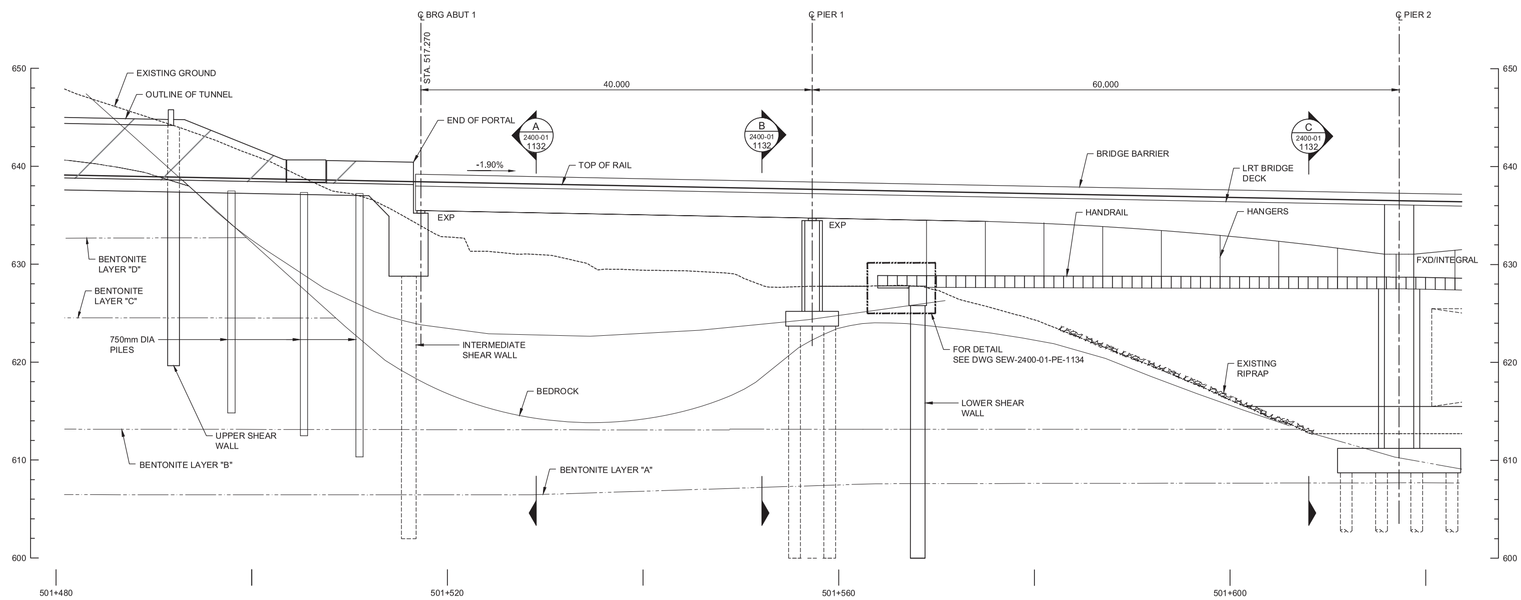
SE to W LRT

MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1104 | REV | SHT 037



PLAN



ELEVATION

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C	FINAL PRELIMINARY ENGINEERING	28-03-13	R.M.
B	ISSUED FOR 90% REVIEW	07-12-12	R.M.
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revisions

AECOM Consultant

A1 bar scale 1:250m 0 2.5 7.5 12.5m

drawn by A. ANAND

designed by R. MARZAN

checked by N. SAN PEDRO

date 28-03-13

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consultant job no 60222337

seal

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PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION

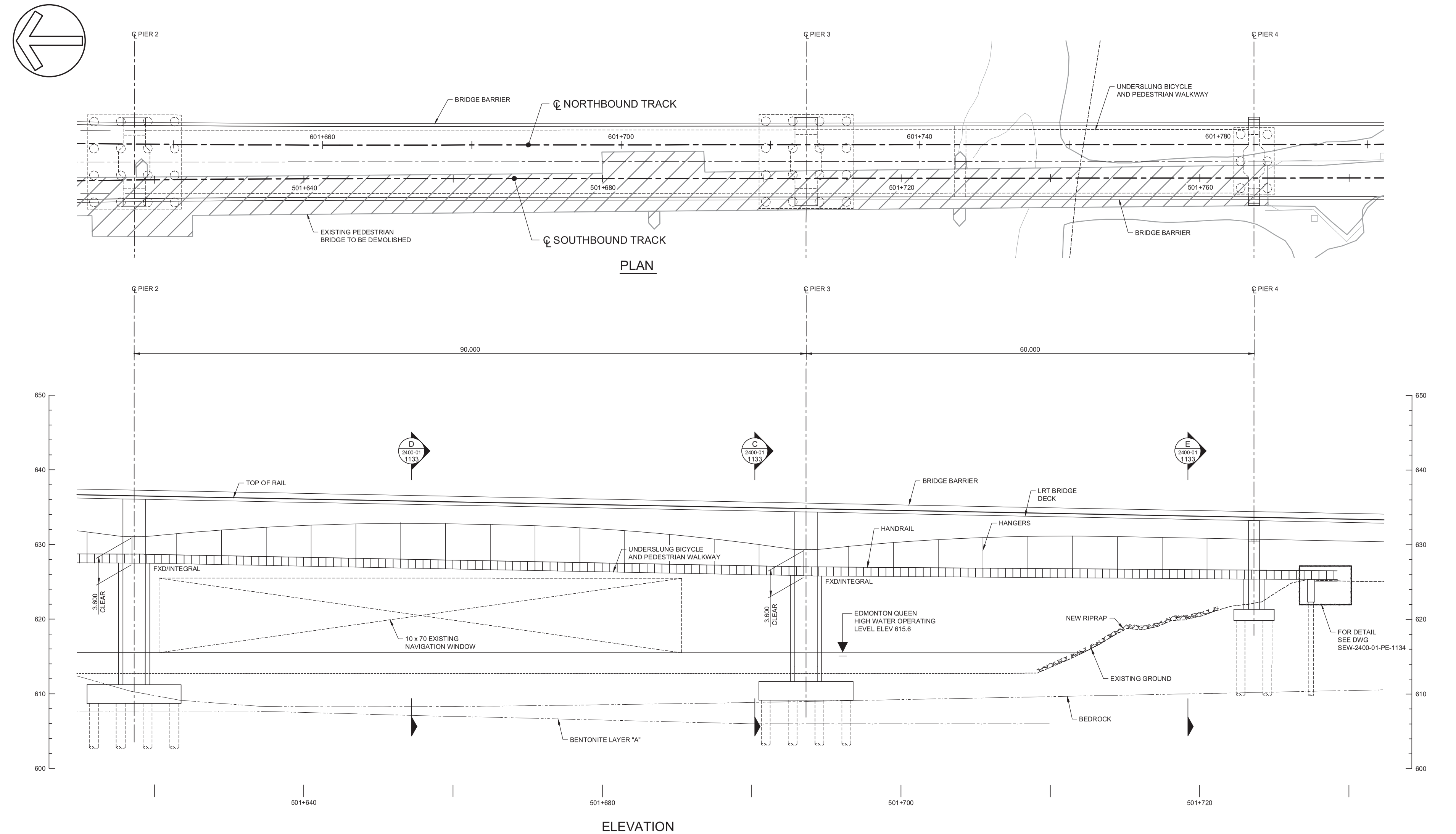
prime consultant reviewed by G. MENZIES

drawing title
NORTH SASKATCHEWAN RIVER BRIDGE
VARIABLE DEPTH CONCRETE BOX GIRDER OPTION
NORTH ABUTMENT – PLAN AND PROFILE
SHEET 1 OF 3

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1105
REV
SHT 038

ANANDA / March 28, 2013 / Y:\60222337\000-CADD\2400 - STRUCTURES\01 STAGE 1\RIVER BRIDGE\SEW-2400-01-PE-1105.DWG



ANANDA / March 28, 2013 / Y:\60222337\000-CADD\2400 - STRUCTURES\01 STAGE 1\RIVER BRIDGE\SEW-2400-01-PE-1106.DWG

no.	description	date	appd
C	FINAL PRELIMINARY ENGINEERING	28-03-13	R.M.
B	ISSUED FOR 90% REVIEW	07-12-12	R.M.
A	N/A	-	-

issue data

no.	description	date	checked

revisions

AECOM Consultant

A1 bar scale 1:250m 0 2.5 7.5 12.5m

drawn by A. ANAND
designed by R. MARZAN
checked by N. SAN PEDRO
date 28-03-2013

permit
consultant job no 60222337

seal
consultant reviewed by S. ALEXANDER

AECOM Prime Consultant
The City of Edmonton Transportation Services
prime consultant job no 60222337

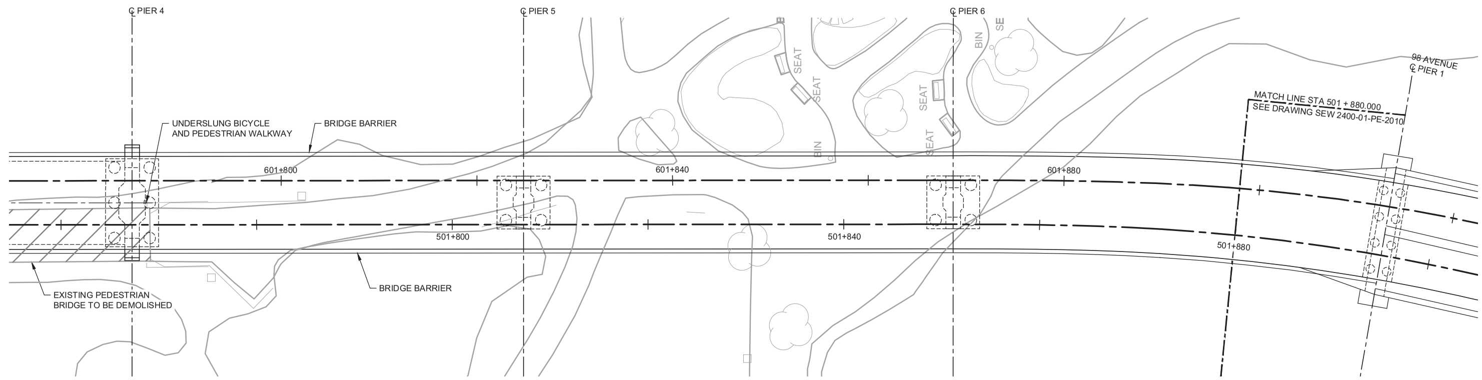
Hatch Mott MacDonald
ISL Engineering and Land Services
DIALOG
gec architecture

PRELIMINARY ENGINEERING DRAWINGS
NOT FOR CONSTRUCTION
prime consultant reviewed by G. MENZIES

drawing title
NORTH SASKATCHEWAN RIVER BRIDGE
VARIABLE DEPTH CONCRETE BOX GIRDER OPTION
PLAN AND PROFILE
SHEET 2 OF 3

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1106
REV
SHT 039



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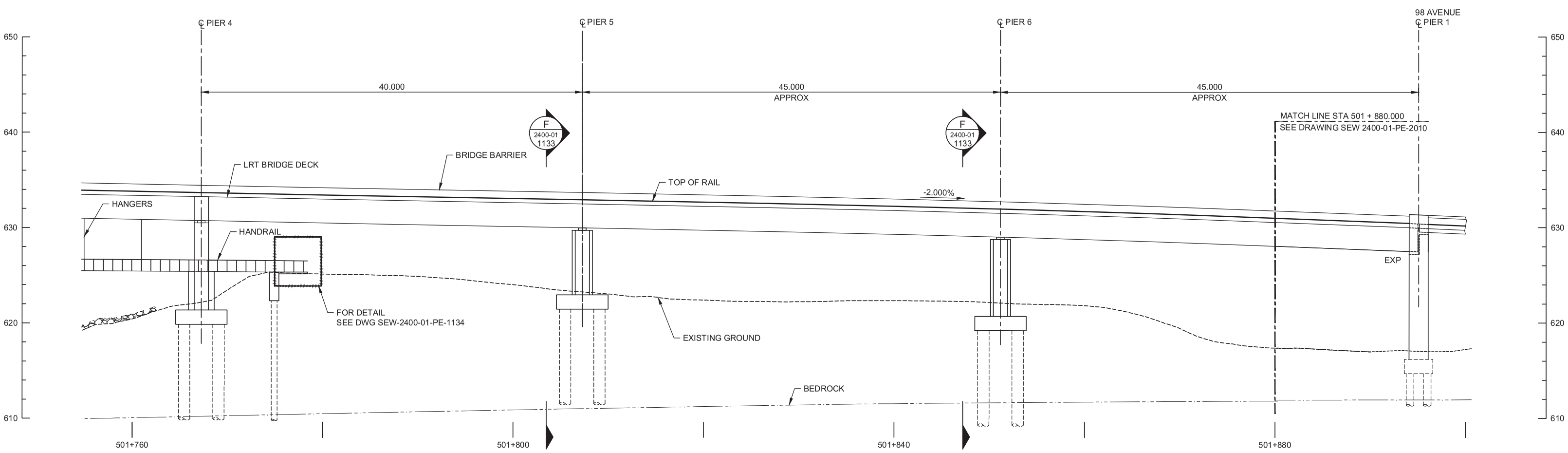

ELEVATION

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C	FINAL PRELIMINARY ENGINEERING	28-03-13	R.M.
B	ISSUED FOR 90% REVIEW	07-12-12	R.M.
A	N/A	-	-

issue data

no.	description	date	checked

revisions

AECOM
Consultant

A1 bar scale 1:250m 0 2.5 7.5 12.5m

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AECOM
Prime Consultant

THE CITY OF Edmonton TRANSPORTATION SERVICES

prime consultant job no 60222337

Hatch Mott MacDonald ISL Engineering and Land Services DIALOG gec architecture

PRELIMINARY ENGINEERING DRAWINGS NOT FOR CONSTRUCTION

prime consultant reviewed by G. MENZIES

drawing title
NORTH SASKATCHWAN RIVER BRIDGE
VARIABLE DEPTH CONCRETE BOX GIRDER OPTION
SOUTH APPROACH – PLAN AND PROFILE
SHEET 3 OF 3

SE to W LRT
MILL WOODS TO LEWIS FARMS

drawing no. SEW-2400-01-PE-1107
REV
SHT 040