APPENDIX IR14-2 SPRINGBANK OFF-STREAM RESERVOIR PROJECT – CONCEPTUAL DESIGN UPDATE

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Appendix IR14-2 Springbank Off-Stream Reservoir Project – Conceptual Design Update
May 2019

Stantec

Memo

To:	Syed Abbas Alberta Transportation	From:	John Montgomery John Menninger Stantec
File:	110773396	Date:	April 3, 2015

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

1.0 PURPOSE

The purpose of this memorandum is to provide a summary of design considerations and recommend updates to the Initial Design Concept (IDC) presented in the *Southern Alberta Flood Recovery Task Force, Flood Mitigation Measures for the Bow, Elbow and Oldman River Basins, Volume 4 – Flood Mitigation Measures - Final: Appendix G – Conceptual Design of the Springbank Off-stream Flood Storage Site* as prepared by AMEC, dated June 2014[1]. Elements of the proposed IDC system were:

- Diversion Structures on the Elbow River (Gated Concrete Fishway/Sluiceway; Concrete Overflow Weir; Flood Plain Berm; Gated Diversion Outlet Structure)
- Diversion Channel leading from the Elbow River to the Off-stream Reservoir
- Off-stream Storage Dam

The IDC, as originally postulated, was to mitigate flooding downstream of Glenmore Reservoir for flood events up to the 1:100 year with limited consideration given to the 2013 flood event. In addition, the plan assumed that up to 15,400 dam^3 of flood storage would be available at Glenmore Reservoir to supplement SR1. The IDC also included a permanent pool within the Off-stream reservoir for water supply augmentation.

Following completion of the AMEC Study, the Government revised the design flood event from the 1:100 year to the June 19 – June 21, 2013, flood and adjusted additional design criteria as detailed in Section 2.0. This memorandum completes the Concept Validation and Update stage of the project. Preliminary Design will commence after acceptance of these findings.

2.0 DESIGN CRITERIA AND CONSTRAINTS

Design criteria for this project were initially defined in the Terms of Reference for Flood Mitigation Works (TOR0015997)[2]. Following notice-to-proceed, elements of criteria and constraints were modified by Alberta Transportation (AT). Current design criteria are:

- Design Event: 2013 Flood or Equivalent Magnitude
- Permanent Pool: None (Dry Reservoir)

- Acceptable Flood Flow at Glenmore Reservoir Outlet: 170cms (was 350cms in the TOR)
- Available Flood Storage at Glenmore Reservoir: 10,000 dam^3

3.0 HYDROTECHNICAL METHODS

3.1 HYDROLOGY

Hydrologic data used in the Conceptual Design is based on previous work by others, as outlined below. Detailed hydrologic analyses are currently underway and will be completed in Preliminary Design. Those analyses will include the development of a calibrated rainfall-runoff and snowmelt flood routing model, construction of synthetic design and operations flood hydrographs and performance of a site-specific Probable Maximum Precipitation (PMP) study.

The Conceptual Design of the Diversion Structure, Diversion Channel and Off-stream Storage Dam is based on the June 19 to June 21, 2013 flood hydrograph provided by the City of Calgary[3], as recorded at Glenmore Reservoir, and presented as Exhibit A.1. Based on time-series rainfall data for the June, 2013 event, approximately 90% of rainfall for the storm fell in watersheds upstream of the SR1 diversion site. The impact of inflows downstream of the SR1 site to the peak flow and total volume of the observed hydrograph were assumed negligible for Conceptual Design purposes. Exhibit A.2 shows 10km gridded rainfall values for the June, 2013 storm. Calibration of the hydrologic model for the 2013 flood event will provide additional information on attenuation and inflows between SR1 and the Glenmore Reservoir and will be incorporated in final design of system elements. For Conceptual Design, however, the hydrograph at Glenmore Reservoir was directly applied at the SR1 diversion site.

Additional flood peak flow rates for the Elbow River at the diversion site were used to assess the performance of the structure for flood events less than and greater than the 2013 design event. These flows were estimated using the regression equations for Elbow River Peak Flows published in the *Bow River and Elbow River Basin-Wide Hydrology Assessment and 2013 Flood Documentation* as prepared by Golder Associates, 2014[4]. The peak flow rates for the Elbow River drainage area at the diversion site (870 km^2) are presented in Table 1. Calculations are provided as Exhibit A.3.

Table 1. Summary of Flood Frequency Estimates

Flood Event	Estimated Peak Discharge (CMS)
1:2 year	60
1:5 year	150
1:10 year	220
1:100 year	720
1:1000 year	1,800

The Probable Maximum Flood (PMF) was estimated by use of the Creager diagram[5]. From that diagram at a drainage area of 870 km^2, the PMF peak discharge ranges from 1,300 cms to 6,400 cms. The diagram indicates that flood data for Canada and other regional PMF studies in Alberta have PMF peak discharges in the lower half of that range. Based on this data, the PMF at the diversion site is estimated to have a peak discharge of approximately 2,200 cms assuming a C value of 33, which bounds the majority of recorded Alberta data points on Exhibit A.4.

Model calibration and hydrology verification will be performed during Preliminary Design. Results presented will change based on final hydrologic analysis.

3.2 HYDRAULICS

Hydraulic performance of the diversion structures was assessed using steady flow, 1-dimensional (1D) computer models developed in HEC-RAS v4.1.0[6] and 2-dimensional (2D) models developed with Hydronia's Riverflow 2D Plus[7] software package.

A 1D model was developed for the Elbow River beginning upstream of the Highway 22 Bridge and extending 3 km further upstream. This model was used to assess impacts of the diversion on water surface elevations. Channel roughness values were based on observations of aerial imagery and field reconnaissance, and from the existing regulatory HEC-2 computer model. The 1D model was also developed for the Diversion Channel to calculate flow depths and velocities, and to estimate shear stresses for channel armoring assessments.

Two dimensional models were developed to confirm stage/discharge relationships developed in HEC-RAS for the various structures and to evaluate flow velocities through the structures. Channel roughness values were similar to those used in the 1D model.

4.0 SYSTEM OPERATING REGIMES

For the purpose of this review, Stantec identified three system operating regimes as defined by the flow rate in the Elbow River. They are:

No Diversion (0-160cms). Diversion of flow from the Elbow River is not anticipated for flows less than the 160cms capacity of the low level outlet at Glenmore Reservoir. Performance of the river structure for this flow condition is based on criteria for fish passage, sediment and debris transport, river morphology and recreational navigation.

Design Flood Operation (161-1240cms). At river flows greater than 160cms, storage capacity reserved within Glenmore Reservoir for flood mitigation will begin to fill and diversion to SR1 may be necessary depending on the flood event. A flow rate of 1240cms represents the estimated peak flow for the 2013 event and the design limit for flood mitigation operations. Under this flow regime, Stantec developed two bounding operation strategies:

- Constant Diversion Flow. This strategy diverts the minimum constant flow rate necessary to achieve the required storage volume to the Off-stream Storage Reservoir for the 2013 flood hydrograph. Once flow in the river exceeds 160cms, gates operate allowing diversion to occur. Hydraulics are assumed to be controlled such that the diverted flow rate from the river and through the diversion channel is capped at this constant rate. This constant

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

diversion flow rate required to limit the 2013 flood event peak flow to less than 170cms downstream of Glenmore Reservoir was estimated to be 480cms. All flows exceeding 480 cms are assumed to pass downstream of SR1 to Glenmore Reservoir.

- Constant River Flow. This strategy would divert all flows in excess of 160cms to the Off-stream Storage Reservoir until the flood mitigation storage is exhausted or the Province determines the risk of flood damage has subsided. The Glenmore Reservoir capacity would be used to off-set the remaining flood volumes. Considering this strategy, the peak diversion flow rate to limit the 2013 flood event peak flow to 170cms downstream of Glenmore Reservoir was estimated to be 1,080cms.

Hydrographs illustrating the impact of each strategy on river flows and Glenmore Reservoir storage are provided in Exhibit B.1. The Constant Diversion Flow shows Glenmore Reservoir storage being used early during the 2013 flood hydrograph, while the Constant River Flow strategy allows for delayed use of this storage.

Structural Resilience and Dam Safety (1241 - 2200cms). Facilities will be designed to pass flow rates in the Elbow River greater than the design flood flows up to and including the 1:1000 year flood event (~1800cms) without significant damage to critical infrastructure. A flow of 2200cms represents the estimated PMF peak flow rate in the Elbow River at the diversion site for the purpose of this Conceptual Design. System elements will be designed to prevent a catastrophic failure of the Off-stream Storage Dam, Diversion Channel and Diversion Structures on the Elbow River during the PMF event.

5.0 DESIGN ALTERNATIVE CONSIDERATIONS

5.1 Diversion Capacity

Stantec evaluated conceptual designs with diversion capacities from the minimum (480cms) to maximum (1080cms) identified in the bounding operation strategies described above. The Constant Diversion Flow strategy establishes the minimum hydraulic capacity required for the Diversion Structure and Channel to achieve the design criteria. This provides the minimum project requirements, and thus lowest construction cost. Some key considerations of this strategy are:

- Successful operation of the system during larger flood events requires timely adjustments to gate positions during the flood and accurate flood forecasting. As an example, during the 2013 flood event, the time-to-peak of the hydrograph occurred within approximately 15 hours of normal base flow conditions and within 6 hours of exceeding the diversion operation threshold (160cms). This illustrates that response time is critical.

- Inadequate hydraulic capacity of the diversion may prevent conveying additional excess flow to SR1 in the event storage in Glenmore Reservoir is not available or there is mis-operation of the gates during a flood event requiring “catch-up”.

- The diversion structure and channel do not have additional capacity to account for blockages from debris, sediment or malfunctioning gates (partially closed or open).

The Constant River Flow strategy establishes the upper bound on hydraulic capacity of the diversion system and addresses the issues above, but results in a significant construction cost increase due to the use of larger diversion structures and channel to accommodate the increased diversion discharge.

Considering the factors above, Stantec recommends proceeding to Preliminary Design with a design diversion capacity of 600cms. The 600cms diversion capacity will meet the minimum project goal of 480cms while providing additional capacity (25%) to address debris or sediment blockage concerns and allow for “catch-up” operations. Performance of the diversion structure at 600cms maximum capacity is shown in Exhibit B.2.

Stantec developed scenarios based on a 1080cms diversion capacity. However, considering this capacity magnitude is not necessary to achieve the design criteria and considering the resulting diversion structure and channel increased costs $25 to $30 million, Stantec does not recommend further consideration of the 1080cms diversion scenario.

During Preliminary Design, the system elements will be refined to further address cost and operational concerns. Optimization is not part of this conceptual design level review.

5.2 Diversion Location

Stantec reviewed potential adjustments to the Diversion Structure location relative to the proposed IDC. Downstream locations were considered, but quickly dismissed due to the required Full Supply Level (FSL) elevation in the reservoir for the 2013 design event relative to river elevations. An alternate upstream location, approximately 400m upstream of the IDC site, was identified with potential design, operations and construction cost impacts assessed relative to the IDC location.

The comparison between the upstream and IDC locations revolved around the benefits of increased channel elevations (at the upstream location) versus the shorter diversion channel (at the downstream location).

Results of the review indicated that the upstream location is approximately $5-15 Million more expensive than the IDC location and provides limited advantages to diversion structure operations. Based on this assessment, Stantec recommends the IDC location with a diversion capacity of 600cms.

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

6.0 CONCEPTUAL DESIGN UPDATE

6.1 DIVERSION STRUCTURE

The diversion structures on the Elbow River include three primary elements:

- Diversion Inlet
- Sluiceway and Service Spillway
- Floodplain Berm and Diversion Emergency Spillway

Each will be discussed in detail below.

6.1.1 Diversion Inlet

The Diversion Inlet is located at the upstream entrance to the Diversion Channel on the north west bank of the Elbow River. The Diversion Inlet is a gated concrete structure that will control diversion of river flows into the Diversion Channel during flood events.

The concrete structure, presented on Sheet 4, includes four 10m wide by 6m high radial gates with a concrete sill at El. 1211.5m, approximately 1.5m above the river bed of the Elbow River. The structure consists of an approach channel, ogee crest surmounted by gates, a stilling basin and a concrete lined transition tapering to the diversion channel. Maintenance slots will be provided for stop logs so that an individual gate bay can be removed from service for maintenance or operation checks.

For this conceptual design, the maximum gate opening was set to achieve the desired design capacity during the 2013 flood hydrograph (600 cms) while also limiting diversion flows during higher river flow events. Note that vertical lift gates of the same size opening as the radial gates in combination with a breast wall could also be used. Final gate selection and configuration for the Diversion Inlet will be determined during Preliminary Design.

The conceptual operation of the gates is as follows:

- No Diversion (< 160cms): Gates closed.
- Design Flood Operation (161cms – 1240cms): Gates open full at 160cms to allow up to 600 cms in the Diversion Channel; gates close when Off-stream Storage Reservoir reaches design flood storage capacity.
- Structure Resilience and Dam Safety (1241cms – 2200cms): Gates will be operated to limit flow to less than or equal to 600 cms; gates close when Off-stream Storage Reservoir reaches design flood storage capacity.

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

6.1.2 Sluiceway and Service Spillway

The Sluiceway and Service Spillway, shown on Sheet 4 are one integrated concrete structure located within the Elbow River channel immediately downstream of the Diversion Inlet. Each gate passage consists of a concrete apron and entrance, a concrete structure to support the particular type of gate, a concrete stilling basin and an outlet channel to the Elbow River.

The Sluiceway and Service Spillway form a gated structure designed to control Elbow River water surface elevations upstream of the Diversion Inlet during a flood event. This serves to regulate the required hydraulic head (water depth) over the Diversion Inlet weir to control the flood diversion flow.

The Sluiceway is located on the north end of the structure adjacent to the left descending bank and nearest to the Diversion Inlet. The Sluiceway is a 10m wide gate bay housing a 7.5m high radial gate with a sill at El. 1210.0m, approximately equal to the river bed elevation. The Sluiceway will allow conveyance of river bed-load sediment through the Diversion Structure during flood operation. Normal position for the gate is open. Maintenance slots will be provided for stop logs so that the radial gate bay can be removed from service for maintenance or to perform operation checks. During flood events, the gate will partially close in combination with the Service Spillway crest gates rising to regulate upstream water levels. Flow under the gate will be maintained to provide a pathway for a portion of bed load sediment to continue downstream.

The Service Spillway is located adjacent to and south of the Sluiceway and is comprised of two 15m wide gate bays separated by an intermediate pier and housing two 4m tall crest gates with a sill elevation of 1210.0m. Normal position for the crest gates is open, flush with the gate sill. For maintenance of the service spillway, an access road on the floodplain berm was provided on the upstream side so that a temporary cofferdam could be installed across the Service Spillway entrance. During flood events, the crest gates are raised or lowered to regulate upstream water levels. The Service Spillway is designed to allow passage of river flows and debris over the crest gates during normal and flood operations. Debris passage is the primary advantage of crest gates over undershot gates as they reduce the required vertical supports and eliminate the need for an overhead superstructure.

The total combined gate width (40m) of the Sluiceway and Service Spillway was sized to replicate the hydraulic geometry of the Elbow River bankfull channel. The bankfull, or dominant, discharge is the flow that is responsible for the channel's dimension. It is also the flow at which sediment is transported downriver most efficiently over time. Impacts of erosion, scour, sediment and debris flow, and sediment and debris accumulation that the river has on the diversion and the diversion has on the Elbow River can be best managed using this approach. Stantec used the 1:2 year event as a surrogate for the bankfull discharge during conceptual design. Velocity figures included as Exhibit C.1 show the diversion structures performance during the 1:2 year event as compared to existing conditions. A detailed geomorphic assessment, including updated bankfull flow calculations, will be included in Preliminary Design.

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

The conceptual flood operation of the gates is as follows:

- No Diversion (< 160cms): Sluiceway radial gate open in raised position and Service Spillway crest gates open in lowered position; river flows freely.
- Design Flood Operation (161cms – 1240cms): Sluiceway gate partially closes and Service Spillway gates rise/lower to regulate flow into diversion.
- Structure Resilience and Dam Safety (1241cms – 2200cms): River flows freely as Off-stream Storage Reservoir is full.

6.1.3 Floodplain Berm and Diversion Emergency Spillway

The Floodplain Berm and the Diversion Emergency Spillway are located on the South floodplain of the Elbow River. The Floodplain Berm constrains flow within the Elbow River active channel and floodplain, and directs flow through the Diversion Structure. It ties into natural ground on the right descending bank of the river at an elevation that prevents circumvention of the diversion system.

The Floodplain Berm, presented on Sheet 3, is an earthen embankment approximately 1200m long with a maximum height of approximately 7.5m. The berm crest elevation is fixed at 1220.6m. The crest was set at 1m above the calculated 1:1000 year flood elevation and checked to confirm that the PMF can be passed without overtopping.

The Diversion Emergency Spillway is a lowered section of the Floodplain Berm adjacent to the Service Spillway. The 235m long Emergency Spillway has a fixed crest at El. 1215.6m. The crest and downstream slope are armored with articulated concrete block (ACB) mats. The upstream face is protected with riprap (shown) or concrete revetments. As proposed, the ACB crest and slope will be designed to withstand overtopping for events greater than the 2013 flood event up the PMF with an overtopping depth of 1.5m.

6.2 DIVERSION CHANNEL

The Diversion Channel conveys flows from the Diversion Inlet to the Off-stream Storage Reservoir. The channel alignment and grading is presented on Sheets 5 and 6. The channel alignment balanced excavation considerations with impacts to utilities, private property and transportation infrastructure.

The channel dimensions were determined based on an iterative design with the Diversion Structure using the 1D hydraulic model. A 24m wide bottom width channel with 3H:1V side slopes was selected for the Conceptual Design. At 600cms and a channel slope of 0.1%, the required channel depth is 6.9m including 0.5m of freeboard.

At the design flow rate, the velocity (2.2 m/s) and shear stress (62.3 N/m^2) within the channel are greater than recommended values for unlined or vegetated channels[8]. For Conceptual Design and construction cost planning, Stantec assumed that rock channel lining would be required along the full reach. The size of the channel lining was determined using AT approved methods[9]. These calculations resulted in an AT Class 1M riprap 350mm thick. Horizontal limits were determined based on hydraulic modeling. Potential for reduction or elimination of channel lining will be evaluated further in Preliminary Design.

6.3 OFF-STREAM STORAGE DAM

The proposed Off-stream Storage Dam is a zoned earthen embankment approximately 4000m long with a maximum embankment height of 27 m. The proposed alignment and grading is presented on Sheet 8.

6.3.1 Location

Stantec reviewed two potential locations for the dam alignment. The IDC dam location was compared against an alternative location approximately 300m down valley. The down valley location allows for a reduction in the dam crest elevation for the same flood storage volume. The lower dam crest allows for reduced property and roadway impacts; while, the upstream location requires less embankment volume. The down valley option would also allow for the flexibility to raise the dam crest should preliminary design analyses result in an increase in storage volume or an increased level of protection is desired in the future. For these reasons, Stantec recommends the down valley location be brought forward to Preliminary Design.

6.3.2 Crest Elevation

Required storage capacity to meet the 2013 flood event criteria is 70,200 dam^3. Considering 10% storage loss due to sediment and debris accumulation, PMF routings and freeboard results in a dam crest elevation of 1213.5m. An area/capacity curve for the Off-stream Storage Reservoir is provided as Exhibit C.2.

6.3.3 Outlet Works

The presented design concept maintains the IDC outlet works. Calculations indicate it would require 40 days to draw down the pool from the design flood storage volume. Criteria to draw down the pool has not been identified. If the Province wishes to draw down the pool in a shorter time the outlet conduit will need to be enlarged. This option has not been included in the presented design concept. Outlet capacity and configuration will be considered during Preliminary Design.

6.3.4 Dam Spillway

The Dam Spillway is located at the dam's right abutment near the Diversion Channel Outlet. The 62 m wide concrete unregulated overflow spillway is presented on Sheet 11. The spillway discharges into an adjacent tributary to the Elbow River and flows over natural ground to its discharge point at the Elbow River. It consists of an approach channel, a concrete lined entrance channel, a 6 cycle 62m wide concrete labyrinth weir with access road above, a concrete chute and stilling basin, and an outlet channel to the tributary. The labyrinth spillway, which has a crest at El. 1210.5m, has a discharge capacity of 700 cms at 1.5m of head.

The Spillway is designed to pass a portion of the Elbow River PMF assuming the flood storage capacity of the reservoir is exhausted. This is consistent with practices for water supply canals when the water surface exceeds a set elevation and for power canals which must pass the entire flow upon load rejection[10]. The PMF design flow was calculated using the 1D hydraulic model assuming the Diversion Inlet gates failed open and the Sluiceway and Service Spillway on the Diversion Structure were open. This condition resulted in approximately 700cms entering the Diversion Channel.

6.3.5 Additional Considerations

Limited grading and drainage modifications are anticipated within the impoundment footprint of the Off-stream Storage Dam to facilitate drawdown and limit fish stranding. The presented design concept includes approximately 5 km of stream channel construction to establish secondary drainage to depressions within the reservoir and connect the diversion channel to the Outlet Works. Approximately, 1.4 Million cubic metres of borrow excavation will be required in the vicinity of the dam and reservoir. The location of this borrow will be identified further in Preliminary Design.

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

7.0 SUMMARY AND COST OPINION

The SR1 Conceptual Design Phase included an evaluation of the Initial Design Concept for the updated Design Criteria, comparison of alternative Diversion Structure and Off-stream Storage Dam sites and selection of the preferred alternative arrangement.

Based on the analyses to date, the selected alternative:

- provides sufficient capacity to meet project goals for the 2013 Flood Event;
- will accommodate the Probable Maximum Flood without catastrophic failure;
- has a maximum diversion capacity of 600cms;
- maintains the Diversion Structure at the same location as the IDC; and
- moves the Off-stream Storage Dam to a down valley location.

7.1 RECOMMENDED DESIGN

The recommended design concept to move forward to Preliminary Engineering is presented in the attached Drawing Set. Primary project components are summarized in the table below.

Table 2. Recommended Design Summary

Diversion Structure	
Diversion Inlet: Gated concrete weir	
Inlet: Four Radial Gates	10.0m x 6.0m
Structure Height	14.6m
Crest Elevation	1211.5m
Total Crest Length	40m
Discharge Capacity at WSE 1215.6m	600cms
Sluiceway / Service Spillway: Gated concrete weir	
Sluiceway: Radial Gate	10.0m x 7.5m
Service Spillway: Crest Gates (2)	15.0m x 4.0m
Structure Height	14.6m
Crest Elevation	1210.0m
Total Crest Length	40m

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

Table 2. Recommended Design Summary (cont.)

Floodplain Berm: Zoned earthfill	
Crest Elevation	1220.6m
Crest Length	940m
Emergency Spillway: Uncontrolled ACB-armored crest and downstream slope	
Crest Elevation	1215.6m
Crest Length	235m
Discharge Capacity at WSE 1217.1m	835cms
Diversion Channel	
Length	4,700m
Design Carrying Capacity	600 cms
Bottom Width	24m
Side Slopes	3:1
Water Depth at 600cms	6.4m
Lining Thickness, Class 1M	350mm
Off-stream Storage Dam	
Dam Embankment: Zoned earthfill	
Structure Height	27m
Crest Elevation	1213.5m
Crest Length	3959m
Top Width	6m
Maximum Base Width	205m
Storage Capacity at El. 1213.5m (Top of Dam)	104,600dam^3
Storage Capacity at El. 1209.3m (2013 Event)	70,200dam^3
Spillway: Uncontrolled concrete labyrinth	
Crest Elevation	1210.5m
Crest Length	260.4m
Discharge Capacity at WSE 1212.0m	700cms
Outlet Works: 1.8mx1.5m concrete conduit, gate controlled	
Discharge Capacity at WSE 1210.5m	25cms

7.2 COST OPINION

Stantec has prepared a cost opinion for the presented concept included as Exhibit D.

7.3 LIMITATIONS

The work performed to date is based on available published information and Stantec's experience with similar projects. Access to the properties affected by this project is currently not available. As a result, site specific explorations and reconnaissance have not been performed. Results from these explorations could materially affect the project as presented.

Required explorations include, but are not limited to geotechnical explorations, field reconnaissance of the affected areas, geomorphic surveys, river flow monitoring, and topographic surveys. Stantec is prepared to perform these explorations once site access is available. Following these explorations, the design concepts will be updated as appropriate.

Additionally, hydrology and hydraulic analyses are preliminary and require further calibration and verification. Concepts will be updated during preliminary design based on final hydrology and hydraulic analysis results.

Reference: Springbank Off –Stream Reservoir (SR1) – Conceptual Design Update

8.0 REFERENCES

1. AMEC Environment and Infrastructure (2014). *Flood Mitigation Measures for the Bow River, Elbow River and Oldman River Basins: Appendix G – Conceptual Design of the Springbank Off-stream Flood Storage Site*. Southern Alberta Flood Recovery Task Force.
2. Alberta Transportation (2014). *Terms of Reference (TOR 0015997) for Flood Mitigation Works Springbank Off-stream Storage Project (SR1) (WAC0078983).*
3. City of Calgary. *June 19, 2013 Hydrograph Estimate at Glenmore Reservoir*.
4. Golder Associates (2014). *Bow River and Elbow River – Basin-Wide Hydrology Assessment and 2013 Flood Documentation*. Alberta Environment and Sustainable Resource Development.
5. Alberta Environment (2002). *Paddle River Dam Probable Maximum Flood*.
6. US Army Corps of Engineers (2010). *HEC-RAS River Analysis System, Version 4.1.0*. Hydrologic Engineering Center.
7. Hydronia, LLC (2014). *RiverFLow2D Plus Model, Version 4.0*.
8. Alberta Transportation (2003). *Design Guidelines for Erosion and Sediment Control for Highways Appendix F – Guidelines for Design of Open Channels*.
9. US Army Corps of Engineers (1994). *Engineer Manual 1110-2-1601 – Hydraulic Design of Flood Control Channels*.
10. US Bureau of Reclamation (1967). *Design Standards No. 3 – Canals and Related Structures*.

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EXHIBIT A.1 – June 19-26, 2013 Flood Hydrograph at Glenmore Reservoir

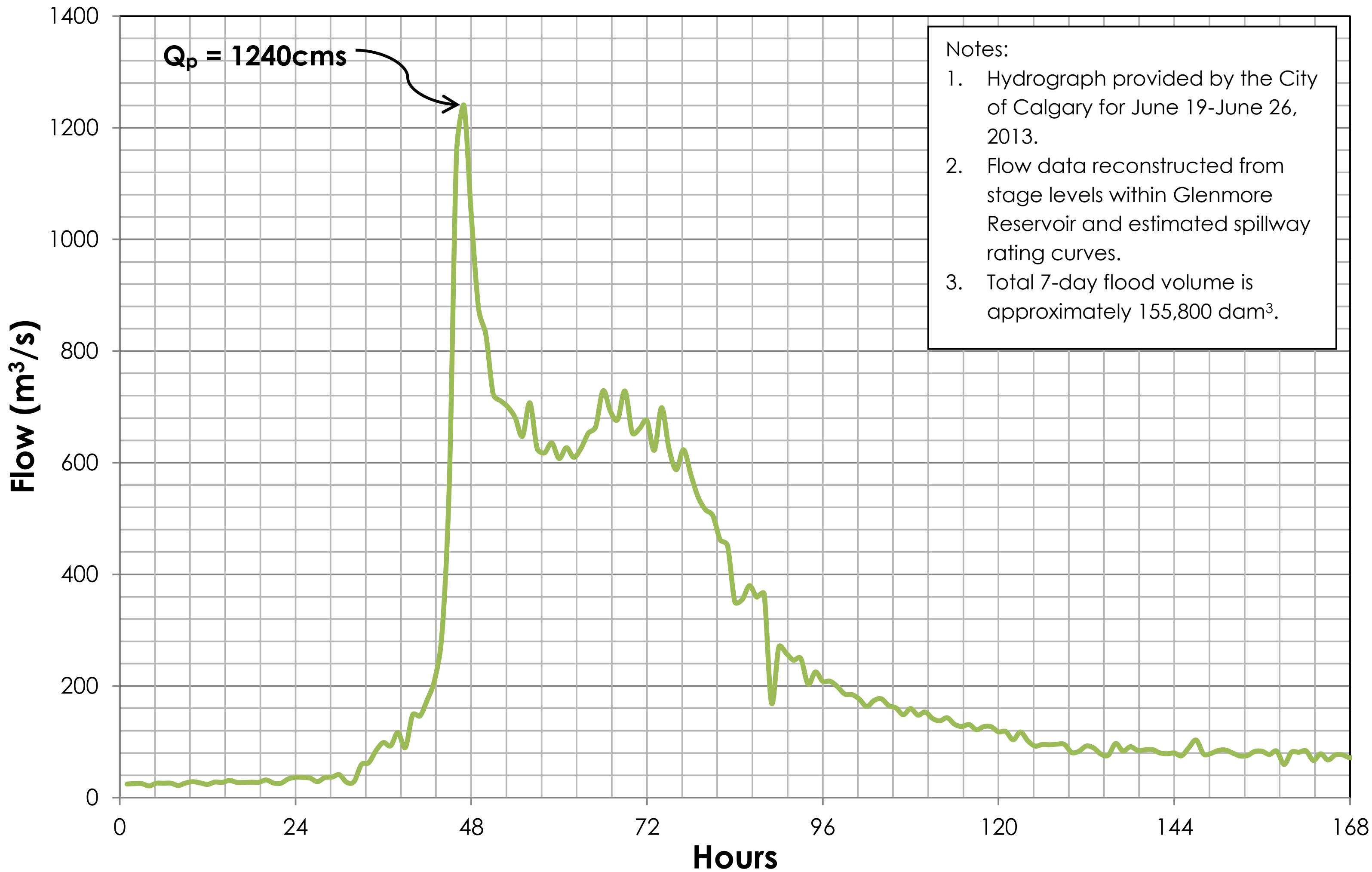


EXHIBIT A.2 – June 19-22, 2013 Event Cumulative Rainfall Totals

Notes:
1. Rainfall data provided by Advanced Weather Associates.
2. Total rainfall depths were displayed on 10 kilometer square grid.

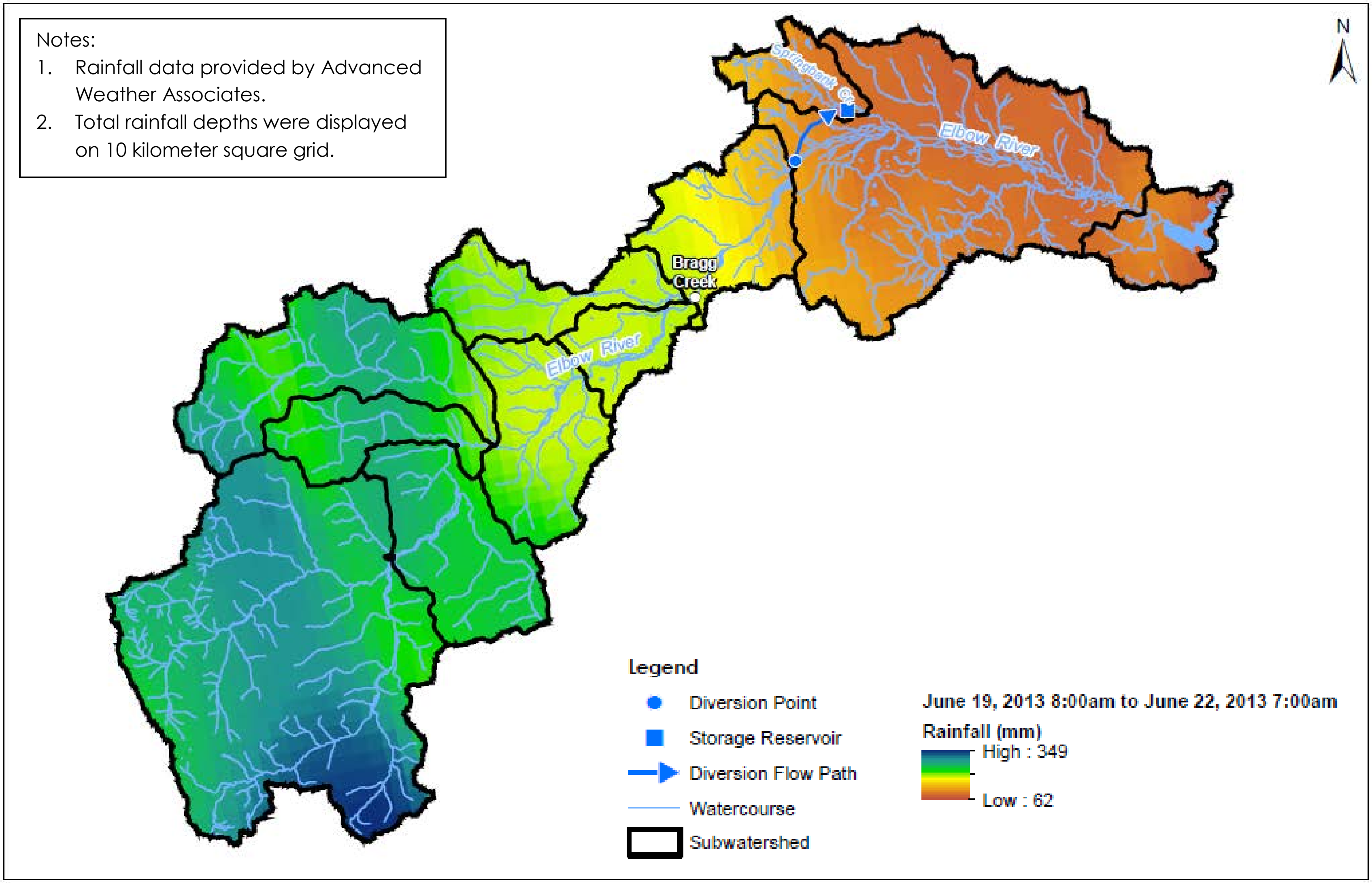


EXHIBIT A.3 – Flood Frequency Estimates at SR1 Diversion Site

EXHIBIT A.4 – Preliminary PMF Estimate – Creager Curve

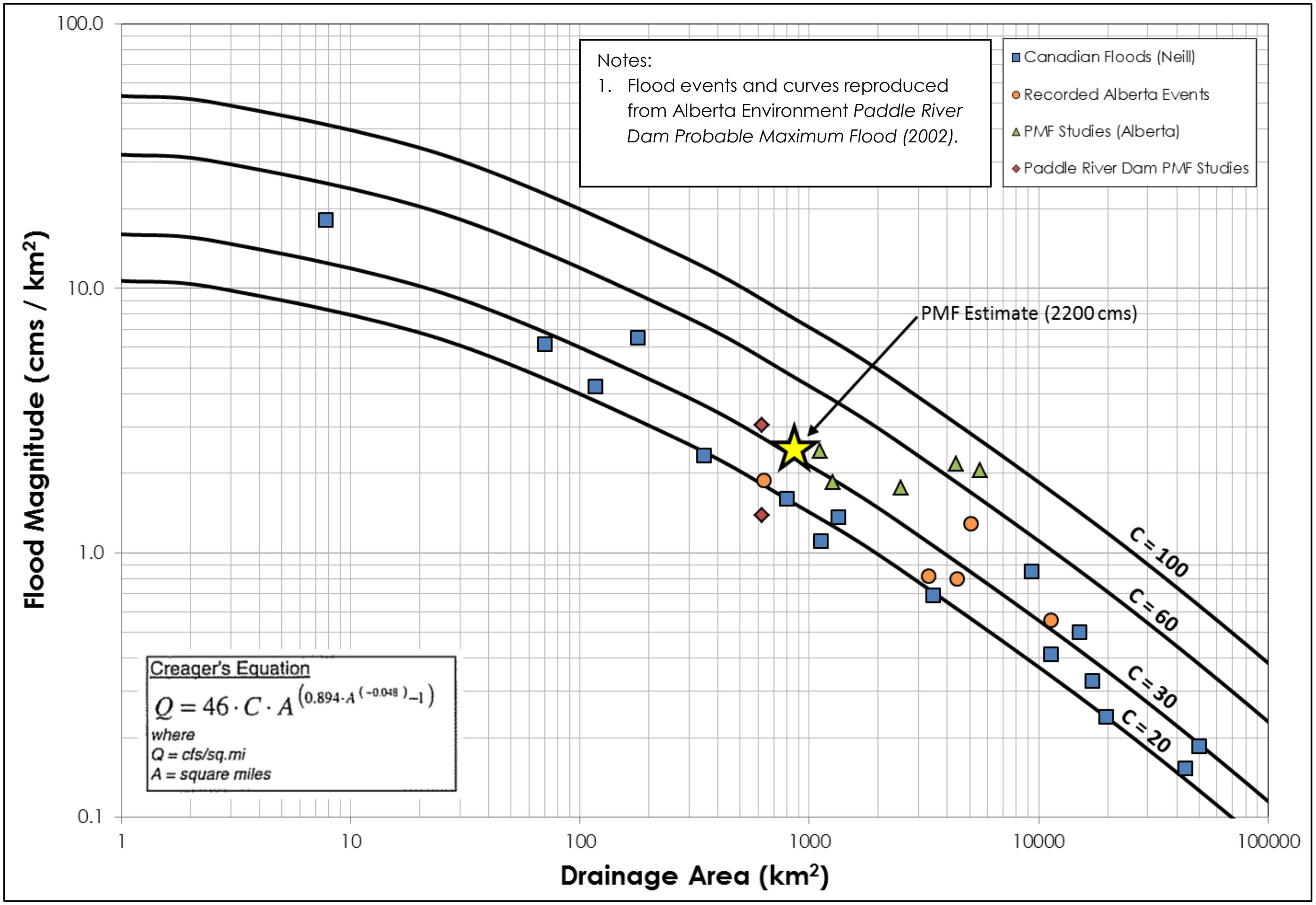
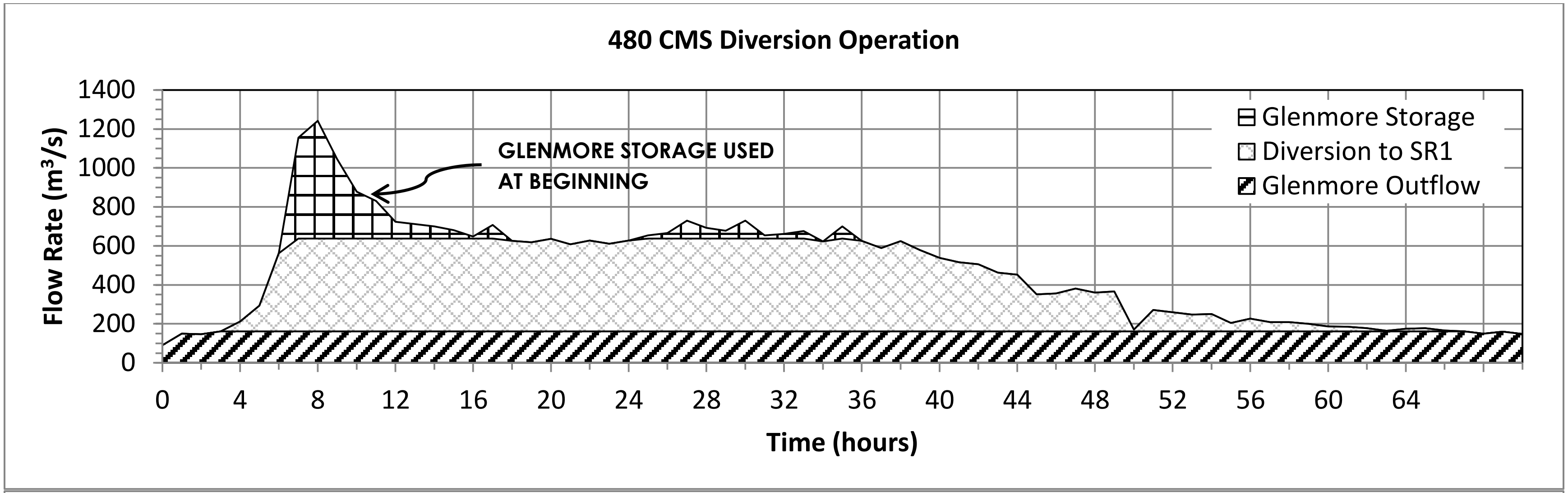


EXHIBIT B.1 – 2013 Design Flood Theoretical Operating Bounds



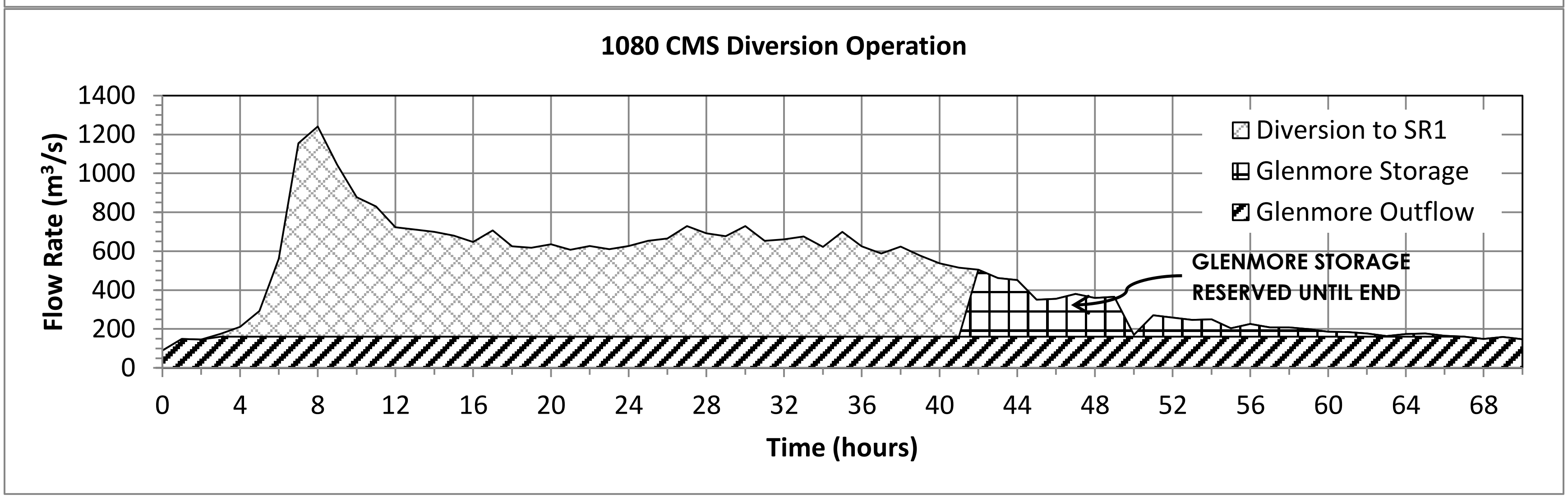


EXHIBIT B.2 – 600 cms Maximum Diversion Operations

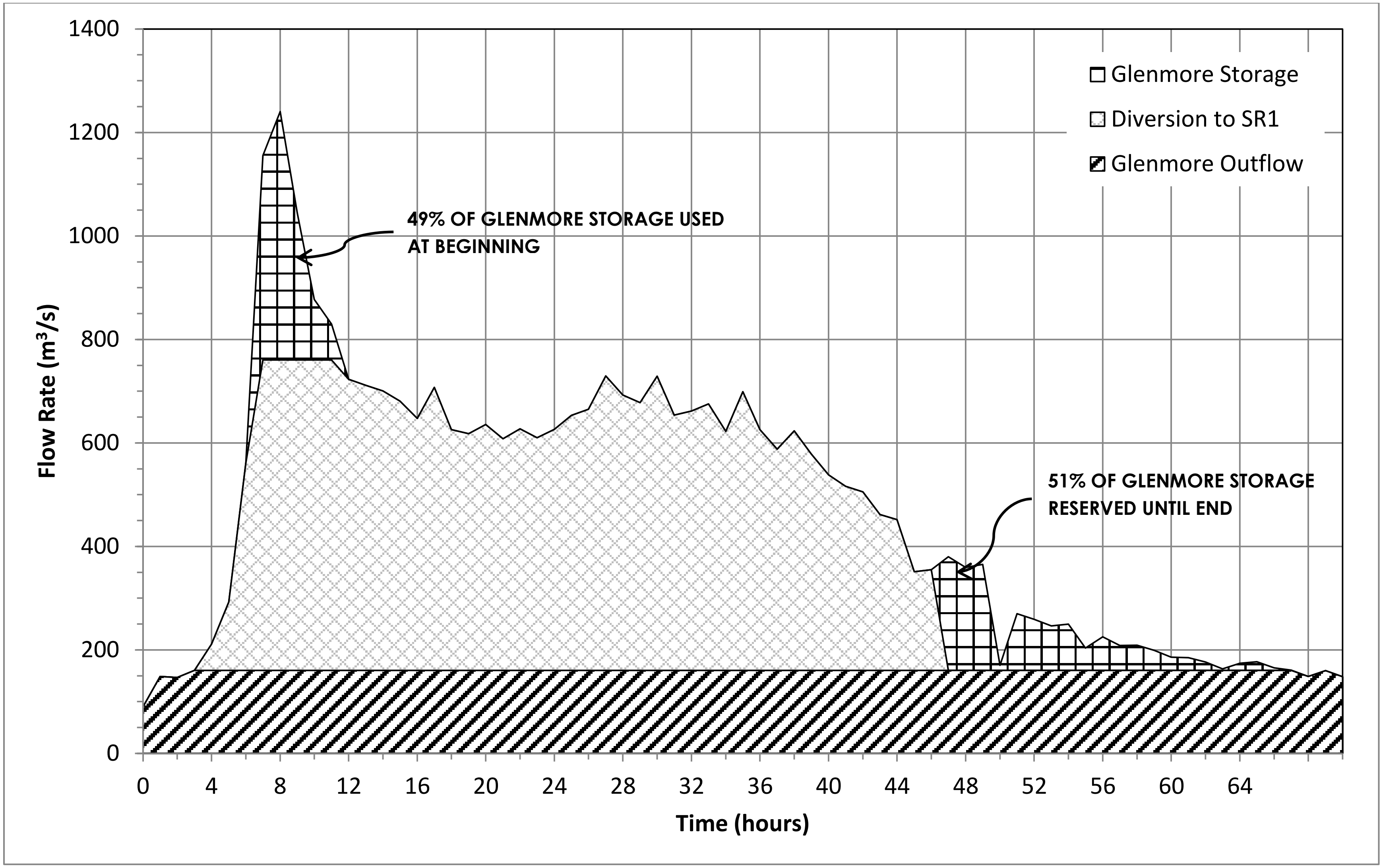


EXHIBIT C.1 – 2D Hydraulic Model Results (1:2 Year Event vs Existing Conditions)

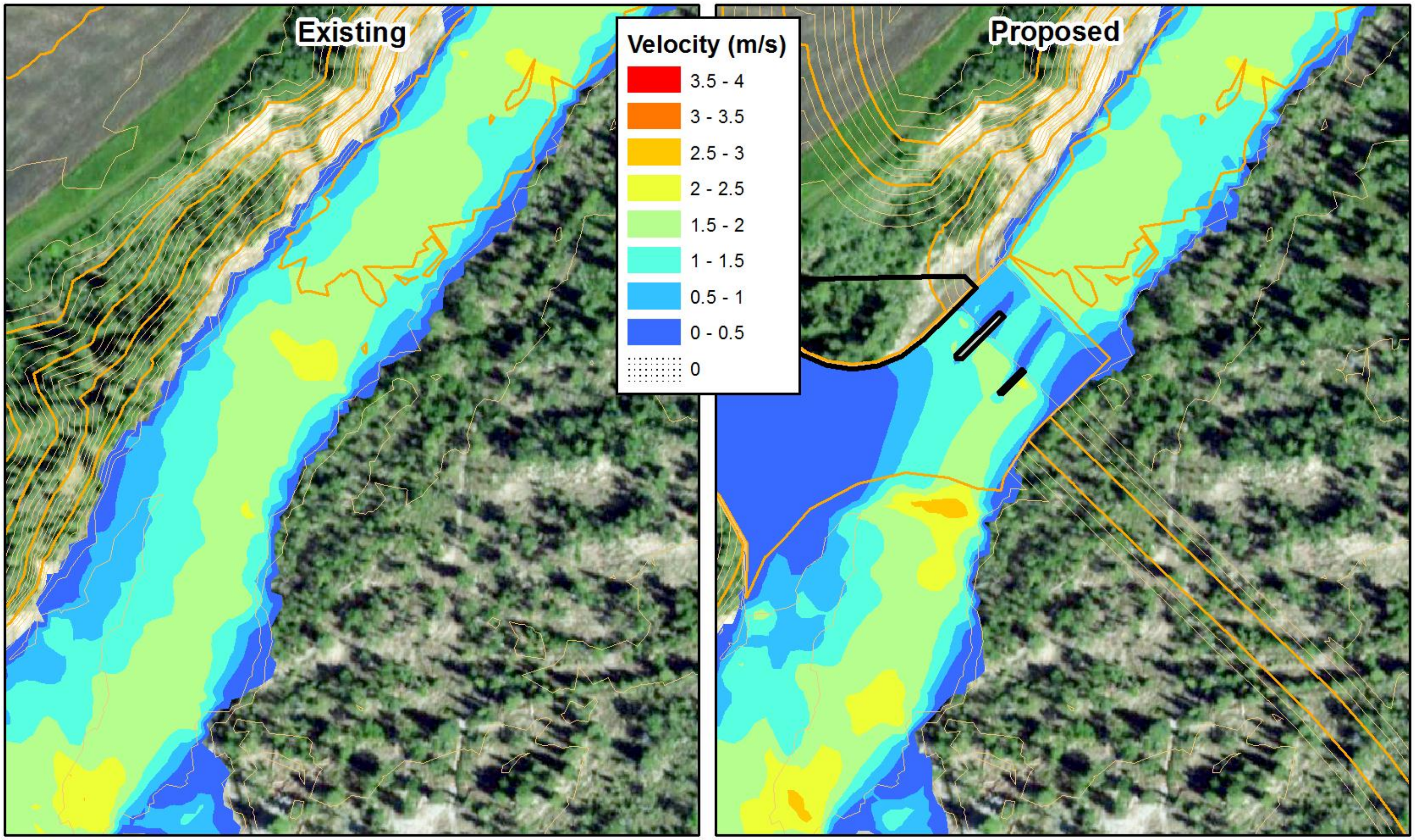


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EXHIBIT C.2 – Dam Stage / Area / Capacity Curve

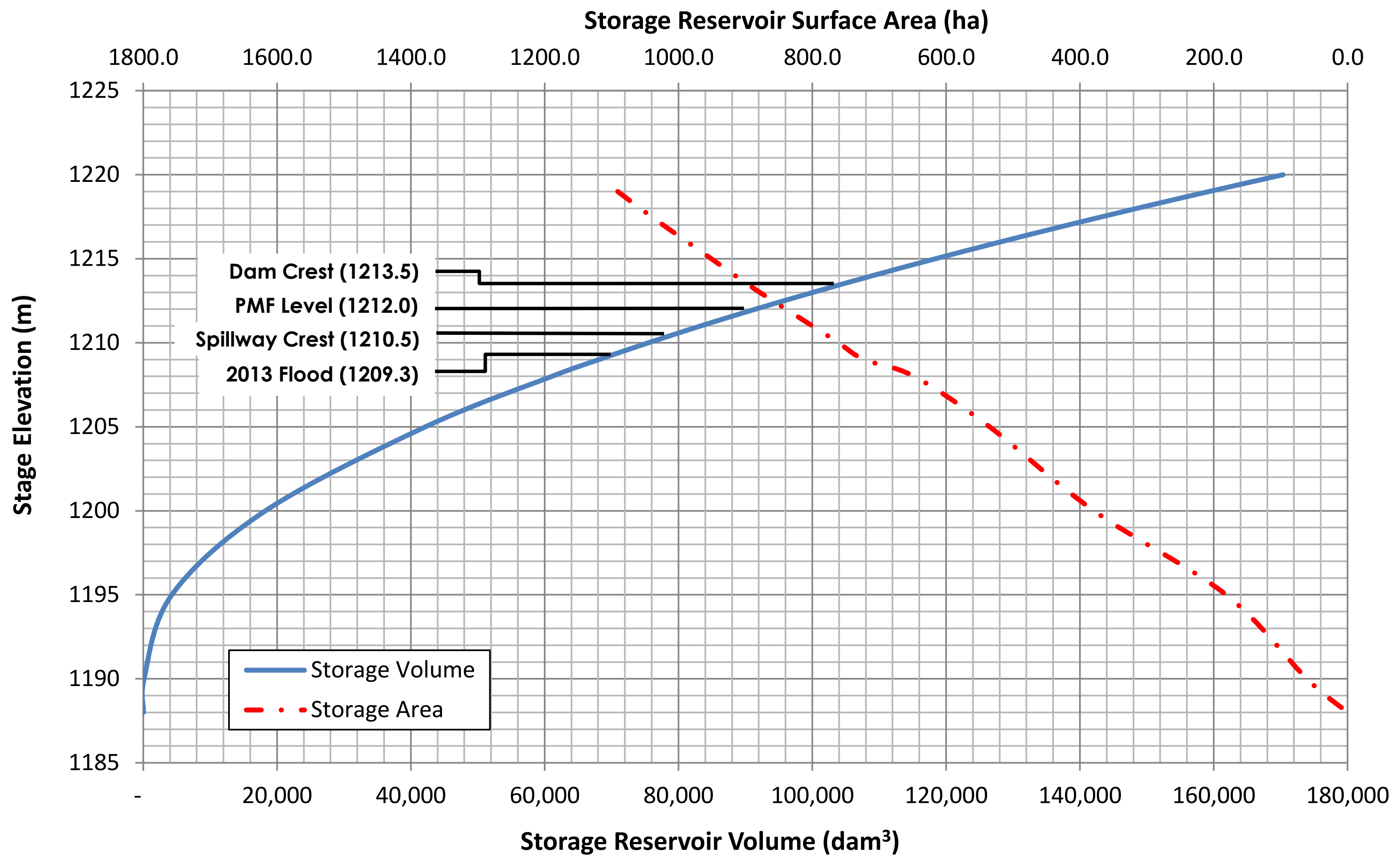

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EXHIBIT D - CONCEPTUAL CONSTRUCTION COST OPINION

	Item	Unit	Unit Costs	Quantities	Total Costs
1	**General**				
2	Mob./Demobilization	lump sum	$12,000,000.00	lump sum	$12,000,000
3	Care of Water	lump sum	$3,000,000.00	lump sum	$3,000,000
4	Clearing & Timber Salvage	hectares	$12,000.00	10	$120,000
5	Raise Highway 22	lump sum	$2,600,000.00	lump sum	$2,600,000
6	Local Road Modifications	km	$500,000.00	15	$7,500,000
7	Topsoil/Seeding, etc…	m^2	$3.20	1,000,000	$3,200,000
8					
9	**General Subtotal**				**$28,420,000**
10	**Diversion Structure**				
11	Stripping	m^3	$5.50	33,000	$181,500
12	Common Excavation	m^3	$5.50	435,000	$2,392,500
13	Structure Fill	m^3	$1.50	72,400	$108,600
14	Service Spillway Concrete	m^3	$1,150.00	3,100	$3,565,000
15	Sluiceway Concrete	m^3	$1,150.00	2,900	$3,335,000
16	Diversion Inlet Concrete	m^3	$1,150.00	9,400	$10,810,000
17	Fine Filter	m^3	$90.00	2200	$198,000
18	Coarse Filter	m^3	$90.00	2200	$198,000
19	Rock Riprap	m^3	$230.00	4500	$1,035,000
20	Gate/Hoist Systems - River Outlet (Crest Gates)	each	$405,000.00	2	$810,000
21	Gate/Hoist Systems - River Outlet (Radial Gates)	each	$615,000.00	1	$615,000
22	Gate/Hoist Systems - Diversion Inlet (Radial gates)	each	$575,000.00	4	$2,300,000
23	Controls/Instrumentation	lump sum	$450,000.00	lump sum	$450,000
24	Electrical/Mechanical	lump sum	$500,000.00	lump sum	$500,000
25	Control Building	lump sum	$500,000.00	lump sum	$500,000
26					
27	**Diversion Structure Subtotal**				**$26,998,600**
28	**Floodplain Berm**				
29	Stripping	m^3	$5.50	17,200	$94,600
30	Impervious Fill	m^3	$1.50	70,000	$105,000
31	Random Fill	m^3	$1.50	24,000	$36,000
32	Fine Filter	m^3	$90.00	7,300	$657,000
33	ACB Amoring (including geogrid and geotextile	m^2	$300.00	6,000	$1,800,000
34	Gravel Road	m^3	$48.00	1,200	$57,600
35	Rock Riprap	m^3	$230.00	4,000	$920,000
36	Bedding Gravel	m^3	$90.00	2,000	$180,000
37					
38	**Floodplain Berm Subtotal**				**$3,850,200**
39	**Diversion Channel**				
40	Stripping	m^3	$5.50	225,800	$1,241,900
41	Common Excavation	m^3	$5.50	3,216,400	$17,690,200
42	Rock Excavation	m^3	$15.50	383,000	$5,936,500
43	Impervious Fill	m^3	$1.50	27,600	$41,400
44	Outlet Chute Concrete	m^3	$1,150.00	2,000	$2,300,000
45	Fine Filter	m^3	$90.00	700	$63,000
46	Coase Filter	m^3	$90.00	1,800	$162,000
47	Bridge Crossings	each	$5,400,000.00	1	$5,400,000
48	Pipeline Crossings	lump sum	$4,000,000.00	lump sum	$4,000,000
49	Power Line Relocation	lump sum	$300,000.00	lump sum	$300,000
50	Rock Channel Lining - Class 1M	m^3	$220.00	64,000	$14,080,000
51	Gravel Road	m^3	$48.00	4,600	$220,800
52					
53	**Diversion Channel Subtotal**				**$51,435,800**
54	**Off-Stream Storage Dam**				
55	Stripping	m^3	$5.50	394,000	$2,167,000
56	Borrow Excavation	m^3	$5.50	1,405,000	$7,727,500
57	Topsoil/Seeding of Borrow Area	m^2	$3.20	500,000	$1,600,000
58	Overhaul	m^3*km	$1.20	7,198,000	$8,637,600
59	Impervious Fill	m^3	$1.50	1,755,000	$2,632,500
60	Random Fill	m^3	$1.50	2,565,000	$3,847,500
61	Fine Filter	m^3	$90.00	215,000	$19,350,000
62	Rock Riprap	m^3	$220.00	500	$110,000
63	Geotechnical Instruments	lump sum	$400,000.00	lump sum	$400,000
64	Reservoir Improvements	m	$600.00	5,000	$3,000,000
65	Spillway	m^3	$1,150.00	6,800	$7,820,000
66					
67	**Off-Stream Storage Dam Subtotal**				**$57,292,100**
68	**Dam Outlet Structure and Downstream Channel Improvements**				
69	Structure Excavation	m^3	$5.50	55,000	$302,500
70	Structure Fill	m^3	$1.50	20,000	$30,000
71	Reinforced Concrete	m^3	$1,400.00	1,600	$2,240,000
72	Rock Riprap	m^3	$220.00	600	$132,000
73	Bedding Gravel	m^3	$90.00	300	$27,000
74	Gate/Hoist Systems	each	$160,000.00	2	$320,000
75	Controls/Instrumentation	lump sum	$100,000.00	lump sum	$100,000
76	Electrical/Mechanical	lump sum	$400,000.00	lump sum	$400,000
77	Superstructure	lump sum	$200,000.00	lump sum	$200,000
78					
79	**Dam Outlet Structure and Downstream Channel Improvements Subtotal**				**$3,751,500**
80	**Springbank Road Relocation**				
81	Grading	km	$550,000.00	5	$2,750,000
82	Base/Pavement	km	$650,000.00	5	$3,250,000
83	Creek Crossings	lump sum	$1,000,000.00	lump sum	$1,000,000
84					
85	**Springbank Road Relocation Subtotal**				**$7,000,000**
86	**Totals**				
87	**Construction Subtotal**				**$178,248,200**
88	Construction Contingencies (25%)				$44,562,050
89	**Construction and Contingency Subtotal**				**$222,810,250**
90	Engineering/Environmental Fees				**$23,000,000**
91					
92	**Total Project Cost Opinion**				**$245,810,250**

Notes:
1. This Construction Cost Opinion is based on the Conceptual Design and therefore following the Estimating and Contingency Determination guidelines as provided by APEGA it is intened to be within +/-50% of final costs.
2. Unit prices are based on Alberta Transportation historic bid data, past project experience, and engineering judgement.

CONCEPTUAL PLANS

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)

ROCKY VIEW, ALBERTA, CANADA

PREPARED FOR

Government of Alberta ■
Transportation

PREPARED BY

Stantec

VICINITY MAP
NOT TO SCALE

INDEX OF DRAWINGS:

PLAN DESCRIPTION: COVER DRAWING

BAR CODE

PLAN No. | CONTRACT No. - | SITE No. -

PHOTO No. | TITLE SEARCH DATE | GRAPHICS FILE

	BY	DATE
SURVEYED	-	-
DESIGNED	DH	14.12.19
CHECKED	JRM	14.12.19
DRAWN	CW	14.12.19

No.	REVISION	BY	DATE

CONCEPTUAL - NOT FOR CONSTRUCTION

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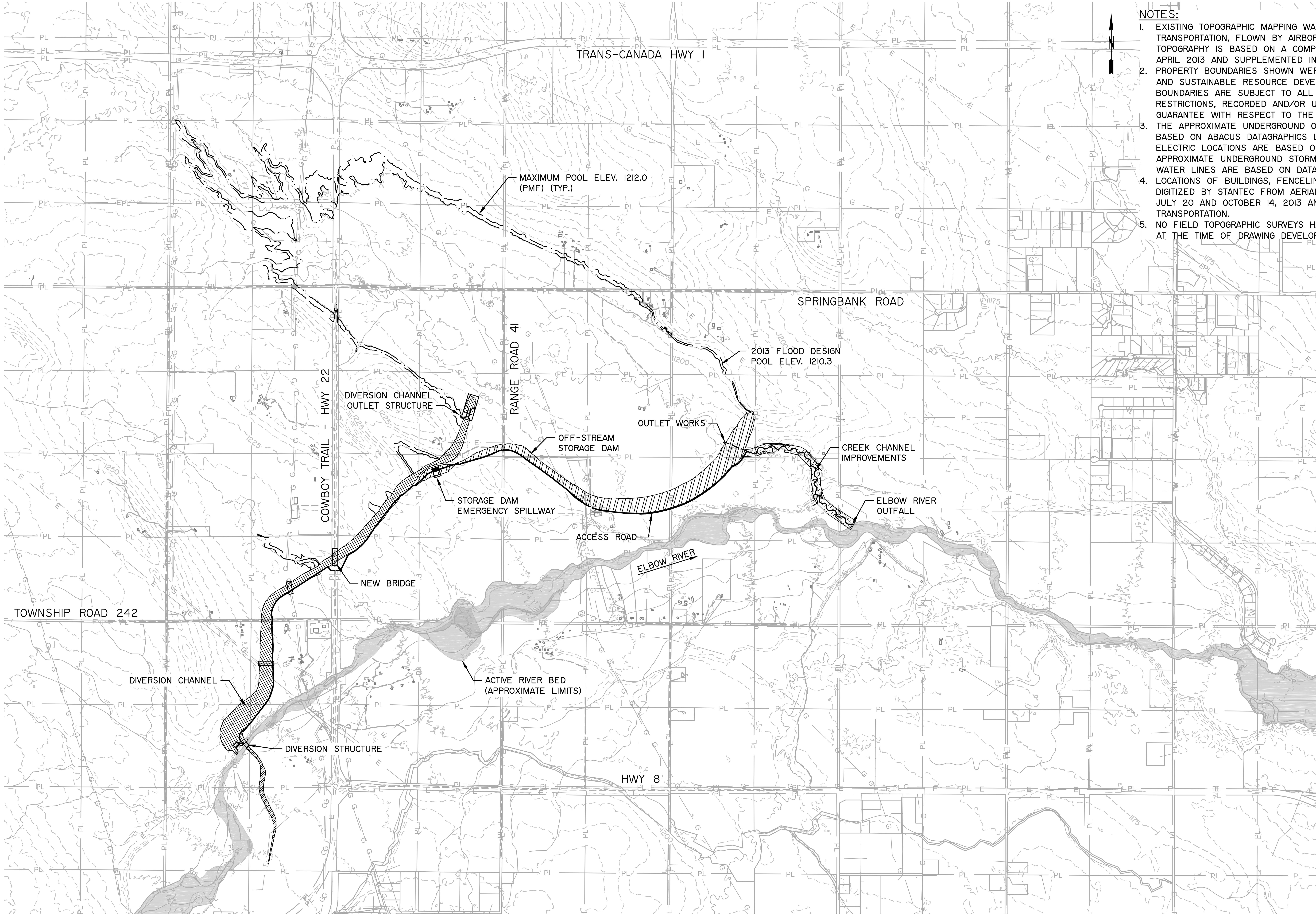

NOTES:

1. EXISTING TOPOGRAPHIC MAPPING WAS PROVIDED BY ALBERTA TRANSPORTATION, FLOWN BY AIRBORNE IMAGING INC. SURFACE TOPOGRAPHY IS BASED ON A COMPOSITE AERIAL SURVEY TAKEN IN APRIL 2013 AND SUPPLEMENTED IN SEPTEMBER 2013.
2. PROPERTY BOUNDARIES SHOWN WERE ACQUIRED FROM ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT (ESRD). THE PROPERTY BOUNDARIES ARE SUBJECT TO ALL EASEMENTS, COVENANTS AND RESTRICTIONS, RECORDED AND/OR UNRECORDED. STANTEC. MAKES NO GUARANTEE WITH RESPECT TO THE EXISTENCE OF SUCH RESTRICTIONS.
3. THE APPROXIMATE UNDERGROUND OIL AND GASLINE LOCATIONS ARE BASED ON ABACUS DATAGRAPHICS LTD. THE APPROXIMATE OVERHEAD ELECTRIC LOCATIONS ARE BASED ON DATA FROM FORTIS. THE APPROXIMATE UNDERGROUND STORM SEWER, SANITARY SEWER AND WATER LINES ARE BASED ON DATA FROM ROCKY VIEW COUNTY.
4. LOCATIONS OF BUILDINGS, FENCELINES, AND EDGE OF PAVEMENT WERE DIGITIZED BY STANTEC FROM AERIAL PHOTOGRAPHY FLOWN BETWEEN JULY 20 AND OCTOBER 14, 2013 AND PROVIDED BY ALBERTA TRANSPORTATION.
5. NO FIELD TOPOGRAPHIC SURVEYS HAVE BEEN PERFORMED BY STANTEC AT THE TIME OF DRAWING DEVELOPMENT.

0 1000 2000 METRES

PROJECT LEGEND:

- PL — PROPERTY LINE
- G — GAS LINE
- E — ELECTRIC LINE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR

CONCEPTUAL - NOT FOR CONSTRUCTION

CONSULTANT	
JOB No. 110773396	PLAN No.
Stantec	

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CHECKER — DATE

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)

PROJECT OVERVIEW

Government of Alberta Transportation

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	2 of 11

PLAN DESCRIPTION: PROJECT OVERVIEW

BAR CODE

PLAN No. -
CONTRACT No. -
SITE No.

		DATE	BY
PHOTO No.		-	-
TITLE SEARCH DATE	SURVEYED	15.03.31	JBW
	DESIGNED	15.03.31	JRM
GRAPHICS FILE	CHECKED / DRAWN	15.03.31	CW

No.	REVISION	BY	DATE

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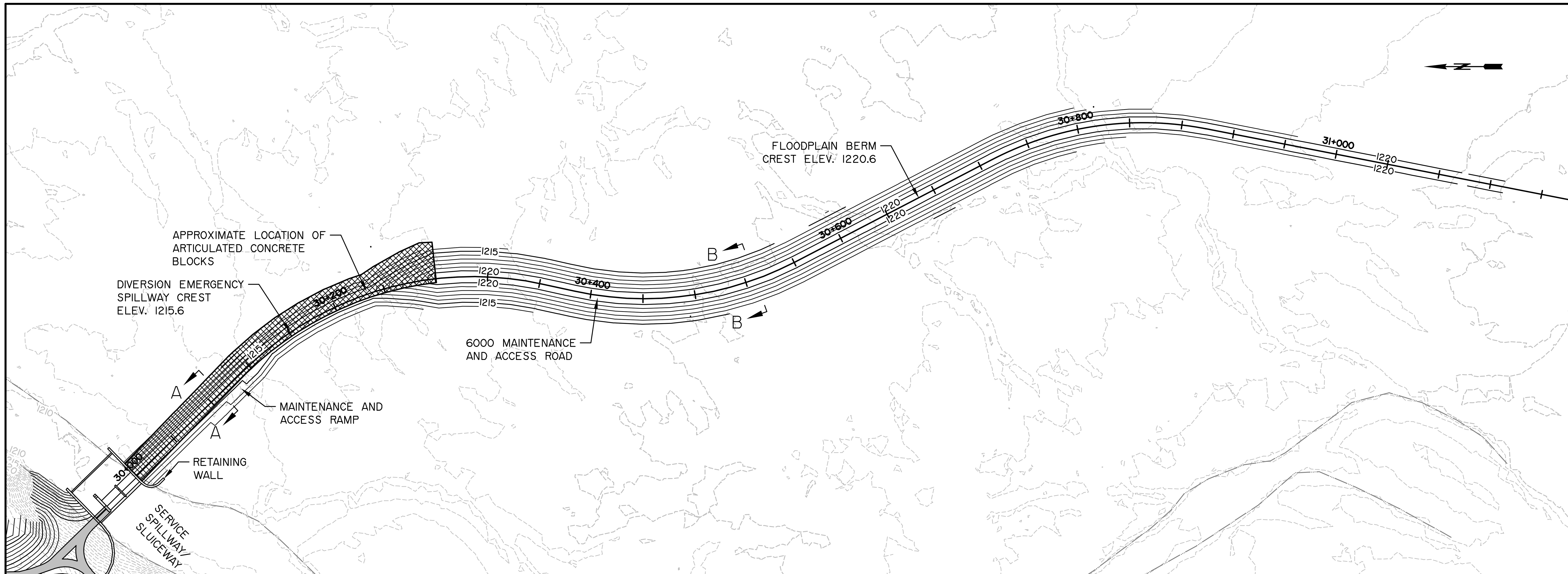
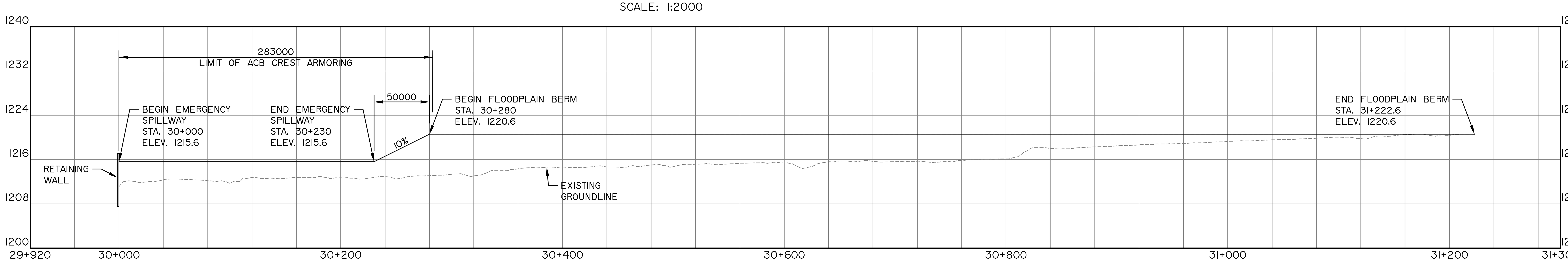
NOTES:

1. SEE DRAWING 1 FOR GENERAL NOTES.
2. ELEVATIONS AND STATIONS ARE IN METRES AND DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.



PLAN

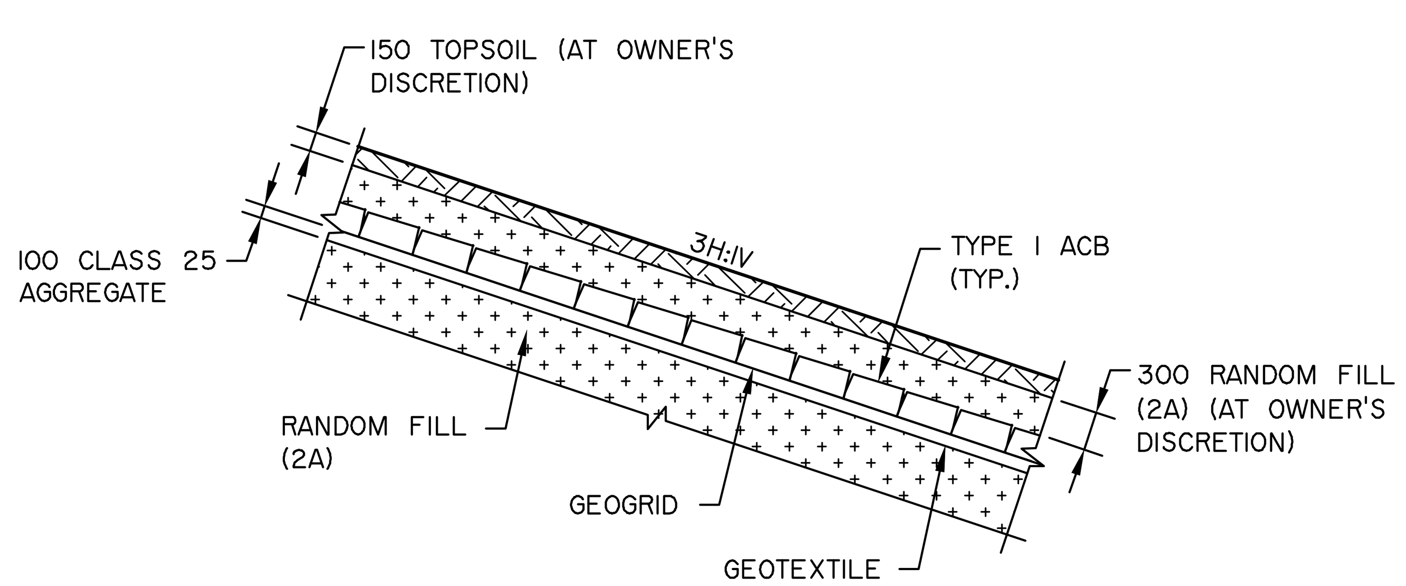
SCALE: 1:2000



PROFILE

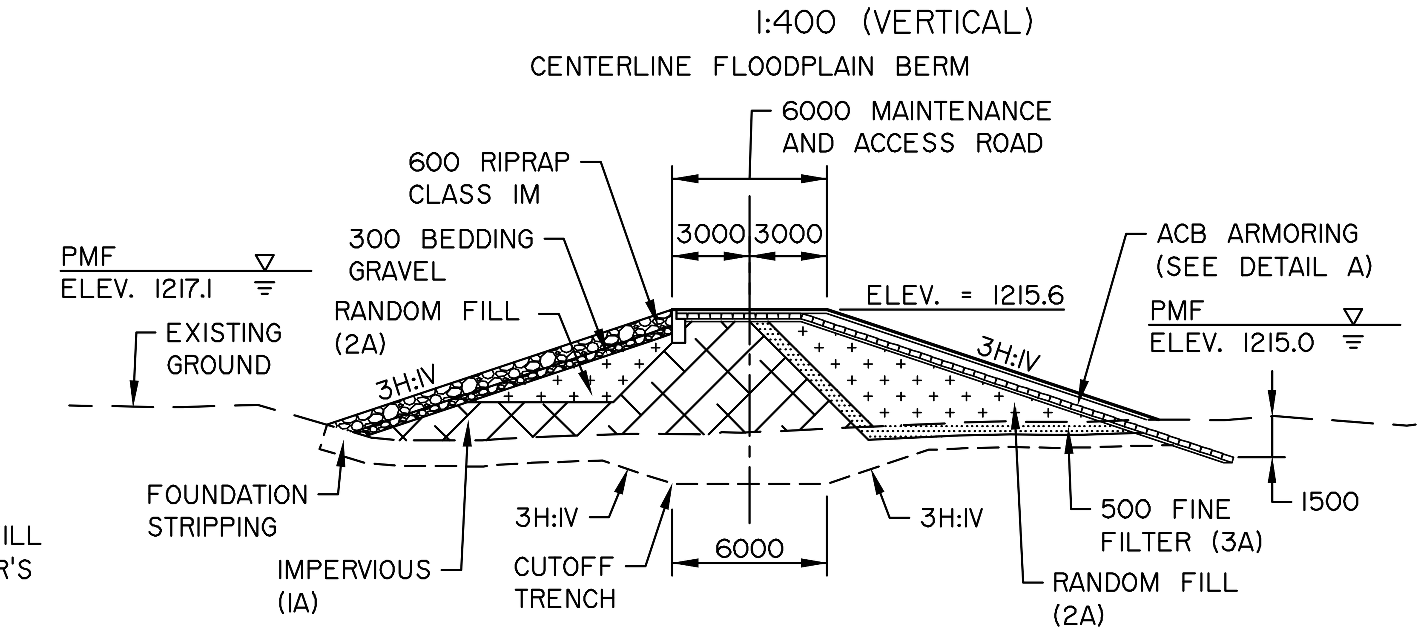
SCALE: 1:2000 (HORIZONTAL)

1:400 (VERTICAL)



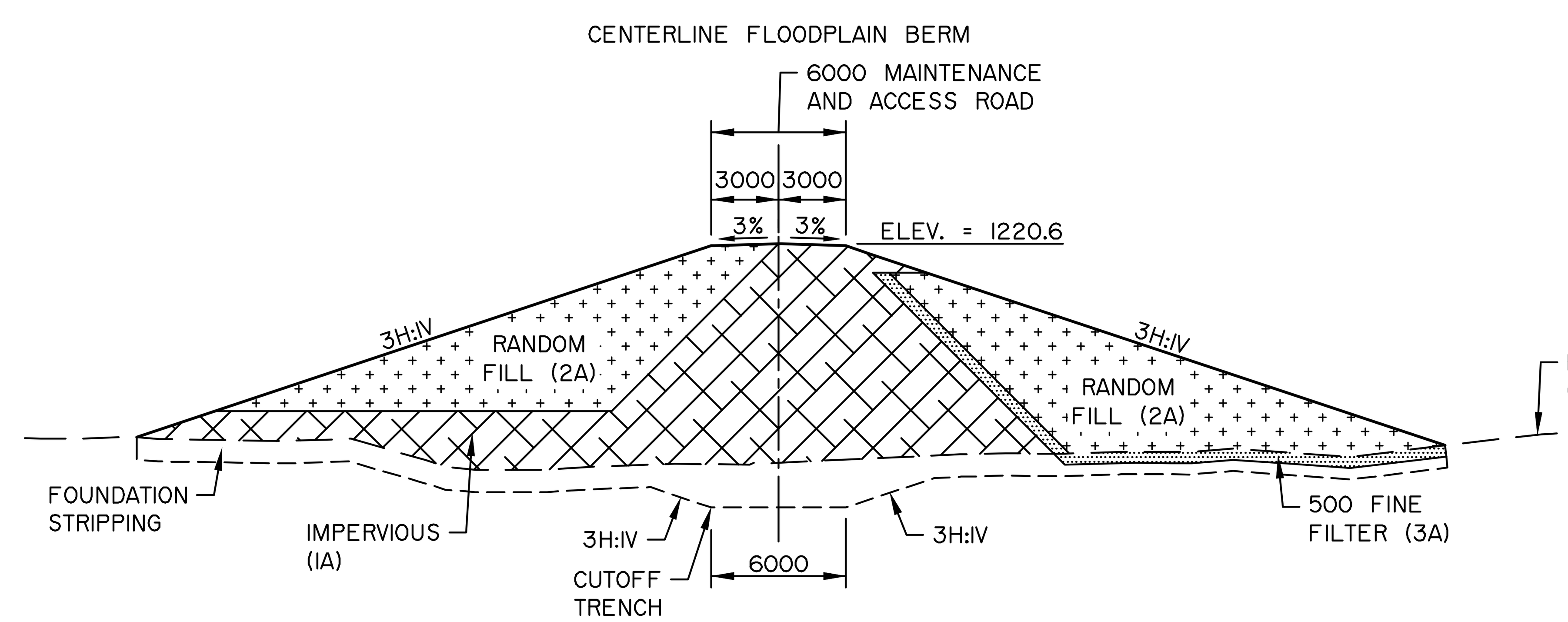
DETAIL A - ACB ARMORING

SCALE: 1:50



TYPICAL SECTION A-A - DIVERSION EMERGENCY SPILLWAY

SCALE: 1:250



TYPICAL SECTION B-B - FLOODPLAIN BERM

SCALE: 1:250

CONCEPTUAL - NOT FOR CONSTRUCTION

CONSULTANT	
JOB No. 110773396	PLAN No.
Stantec	

PERMIT TO PRACTICE

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SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)

DIVERSION STRUCTURE
FLOODPLAIN BERM
PLAN, PROFILE AND SECTIONS

Government of Alberta Transportation

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	3 of 11

PLAN DESCRIPTION: DIVERSION STRUCTURE FLOODPLAIN BERM PLAN, PROFILE AND SECTIONS

BAR CODE

PLAN No.	CONTRACT No.	SITE No.
	-	-

PHOTO No.	TITLE SEARCH DATE	GRAPHICS FILE

	DATE	BY
SURVEYED	-	-
DESIGNED	14.12.19	DH
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No.	REVISION	BY	DATE

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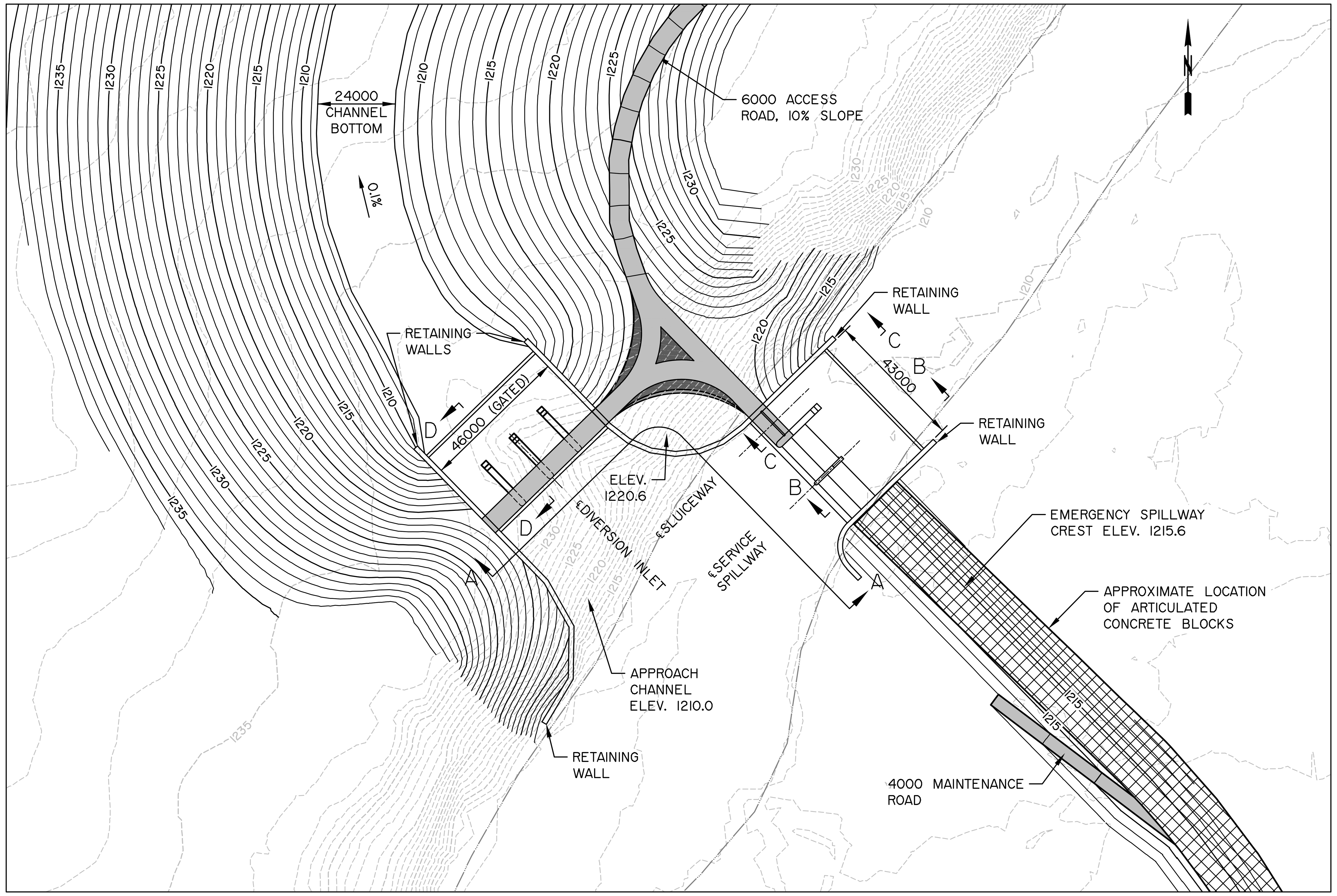
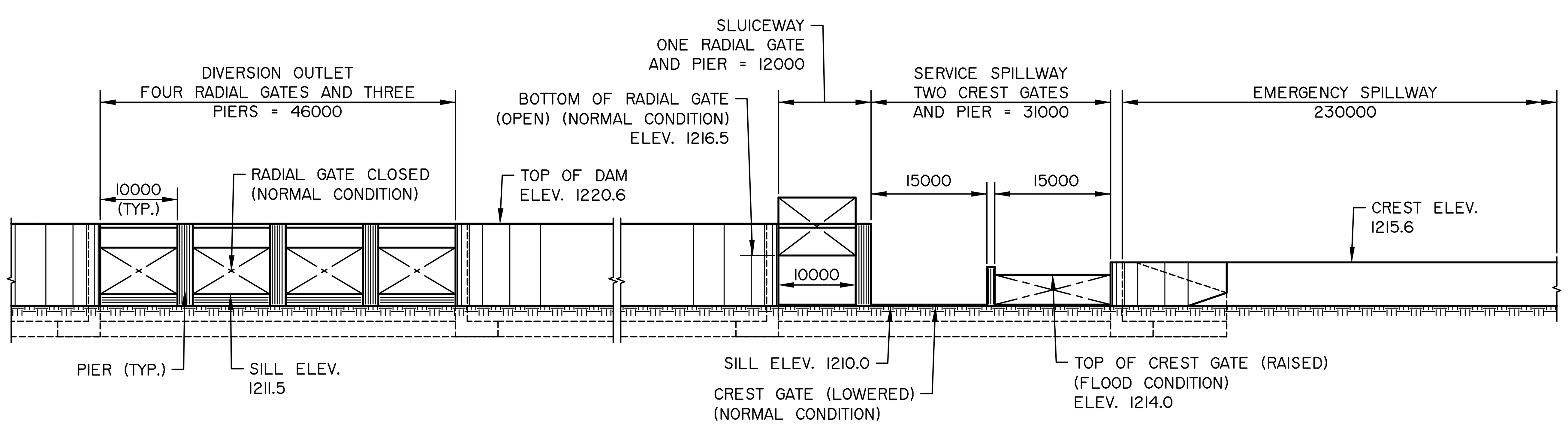


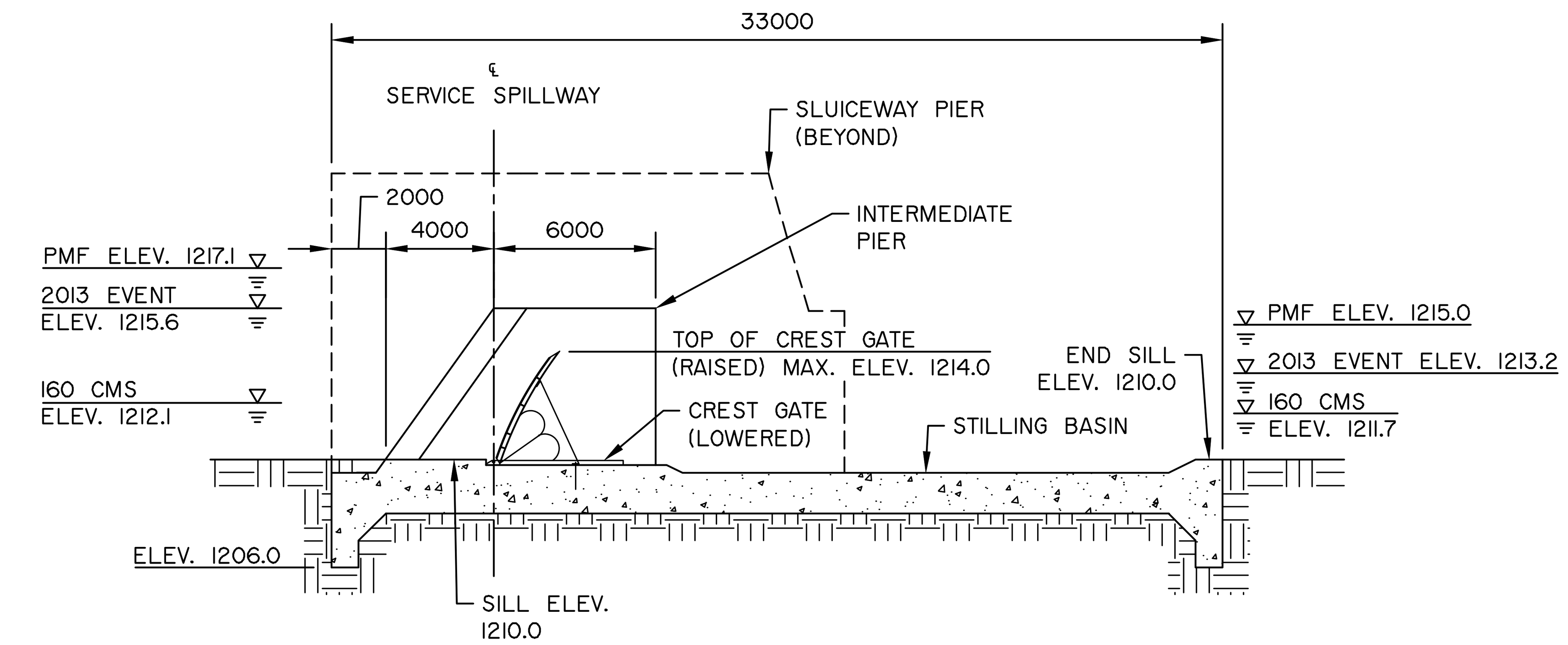
DIVERSION PLAN VIEW

SCALE: 1:1000



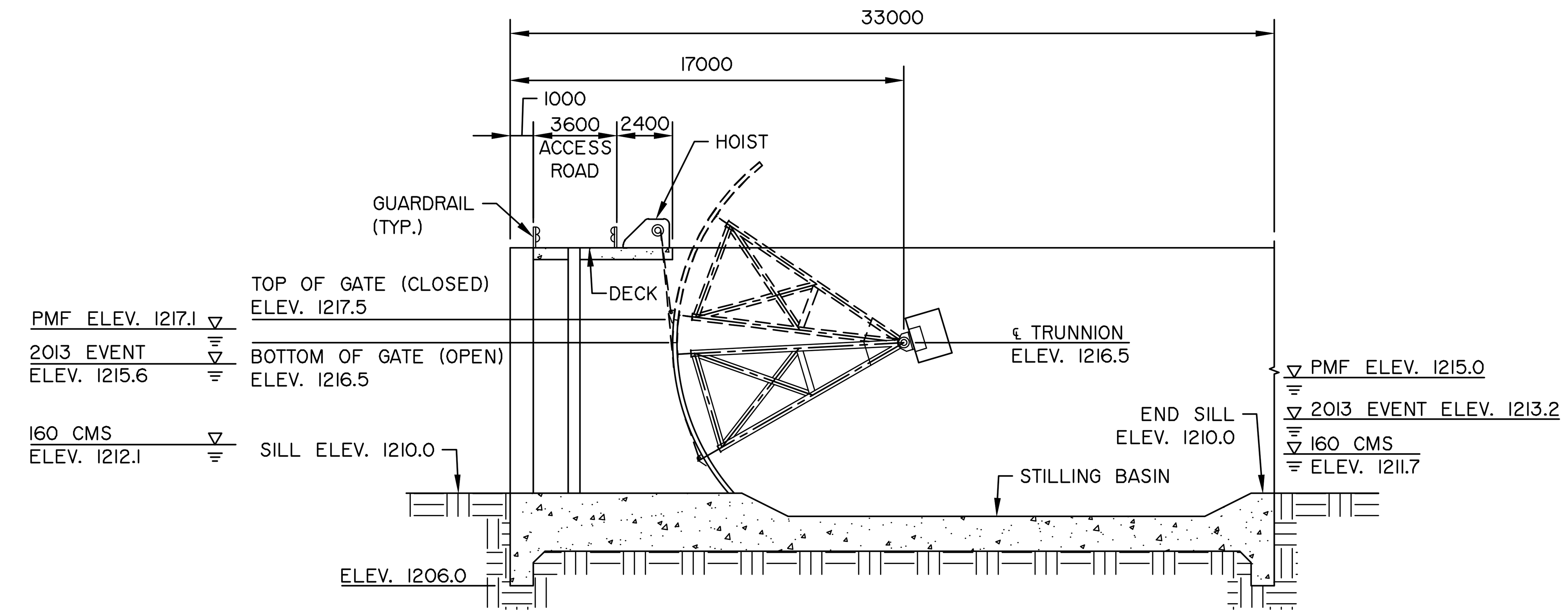
UPSTREAM ELEVATION A-A

SCALE: 1:500



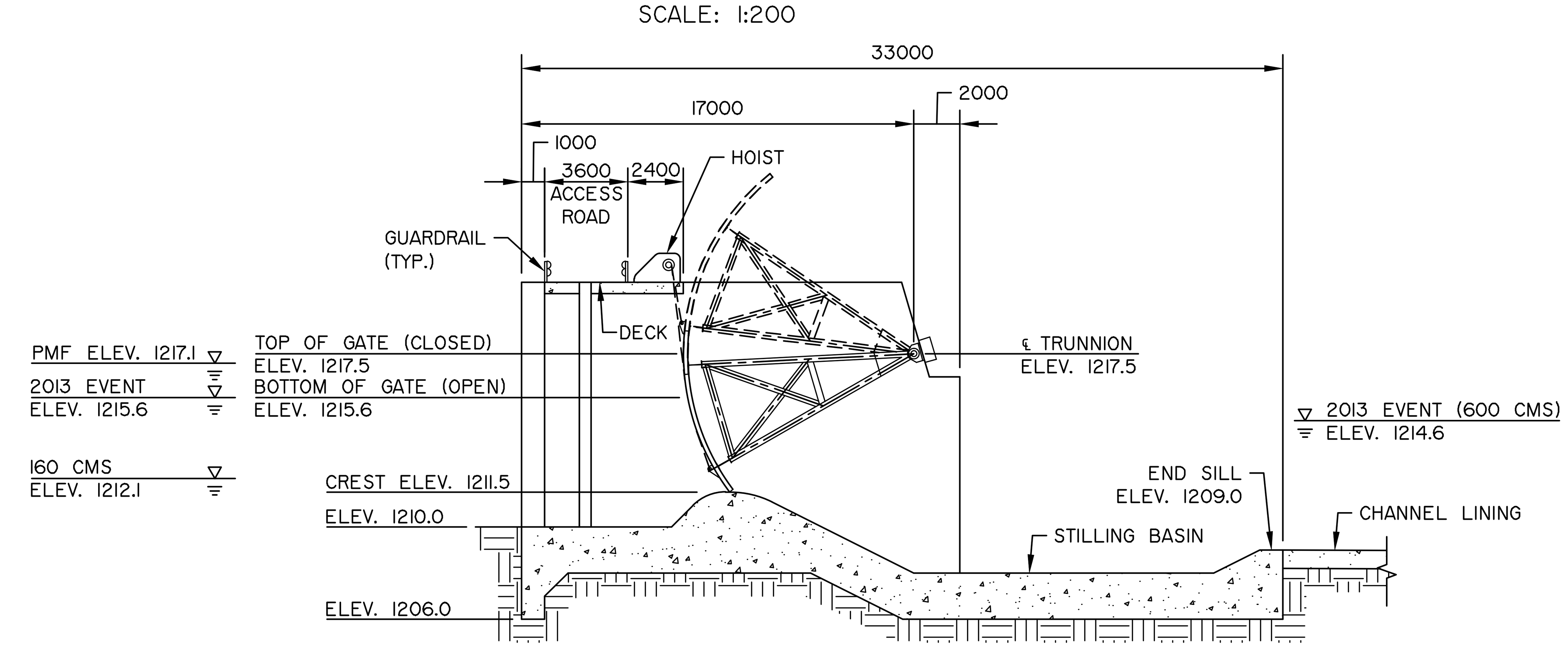
SECTION B-B - SERVICE SPILLWAY

SCALE: 1:200



SECTION C-C - SLUICEWAY

SCALE: 1:200



SECTION D-D - DIVERSION INLET

SCALE: 1:200

NOTES:

1. SEE DRAWING 1 FOR GENERAL NOTES.
2. ELEVATIONS ARE IN METRES AND DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

LEGEND

- SUBGRADE
- EMBANKMENT FILL
- CONCRETE
- STEEL

CONCEPTUAL - NOT FOR CONSTRUCTION

CONSULTANT: Stantec

JOB No. 110773396 | PLAN No.

PERMIT TO PRACTICE | DESIGNER | CHECKER

DATE ______ DATE ______

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)

DIVERSION STRUCTURE
GENERAL ARRANGEMENT
PLAN, ELEVATION AND SECTIONS

Government of Alberta Transportation

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	4 of 11

PLAN DESCRIPTION: DIVERSION STRUCTURE GENERAL ARRANGEMENT PLAN, ELEVATION AND SECTIONS

BAR CODE

	BY	DATE
SURVEYED	-	-
DESIGNED	DH	14.12.19
CHECKED	JRM	14.12.19
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PLAN No. - | CONTRACT No. - | SITE No.

PHOTO No. | TITLE SEARCH DATE | GRAPHICS FILE

No. | REVISION | BY | DATE

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NOTE:
1. SEE SHEET 1 FOR NOTES.

0 250 500 METRES

CONCEPTUAL - NOT FOR CONSTRUCTION

CONSULTANT	
JOB No. 110773396	PLAN No.

Stantec

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DESIGNER — DATE

CHECKER — DATE

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)

DIVERSION CHANNEL

PLAN - (1 OF 2)

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	5 of 11

Government of Alberta Transportation

PLAN DESCRIPTION: DIVERSION CHANNEL PLAN - (1 OF 2)

BAR CODE

PLAN No.	CONTRACT No.	SITE No.
	-	-

PHOTO No. / TITLE SEARCH DATE / GRAPHICS FILE

	BY	DATE
SURVEYED	-	-
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CHECKED	JRM	15.03.31
DRAWN	CW	15.03.31

No.	REVISION	BY	DATE

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PLAN DESCRIPTION
DIVERSION CHANNEL
PLAN - (2 OF 2)

BAR CODE

PLAN No.	
CONTRACT No.	-
SITE No.	-

PHOTO No.	
TITLE SEARCH DATE	
GRAPHICS FILE	

	BY	DATE
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DESIGNED	JBW	15.03.31
CHECKED	JRM	15.03.31
DRAWN	CW	15.03.31

No.	REVISION	BY	DATE

CONCEPTUAL - NOT FOR CONSTRUCTION

CONSULTANT	
JOB No. 110773396	PLAN No.

Stantec

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DESIGNER
DATE

CHECKER
DATE

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)
DIVERSION CHANNEL
PLAN - (2 OF 2)

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	6 of 11

Government of Alberta Transportation

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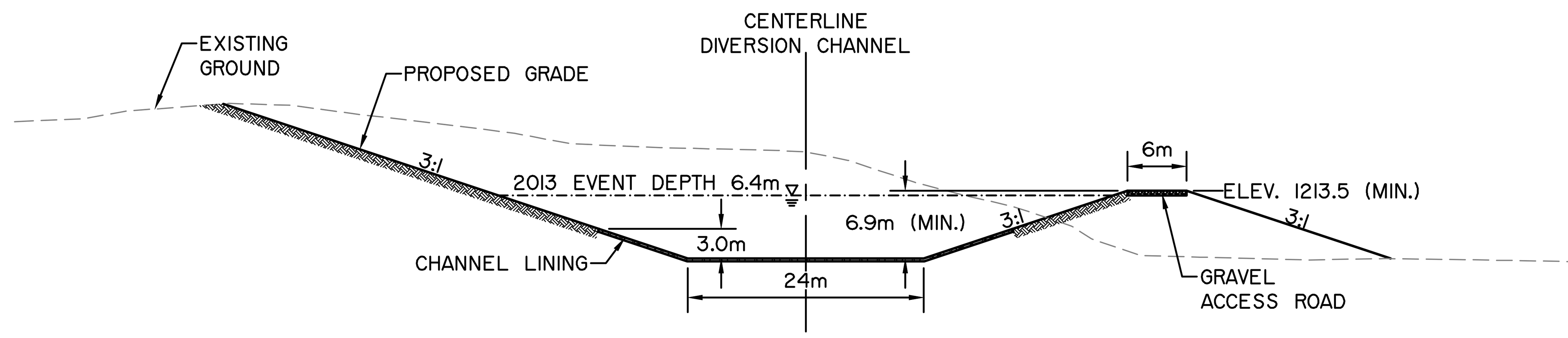
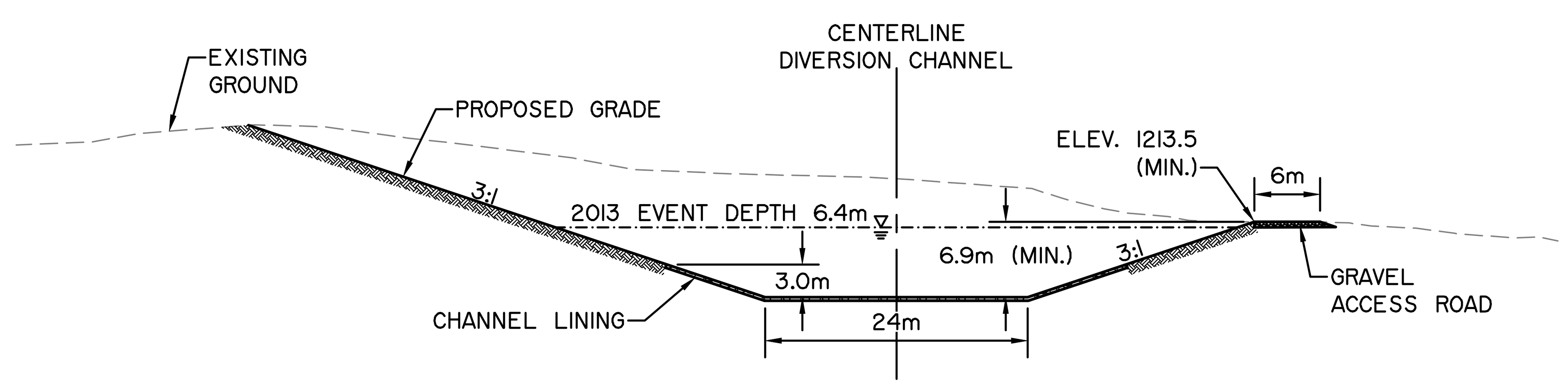


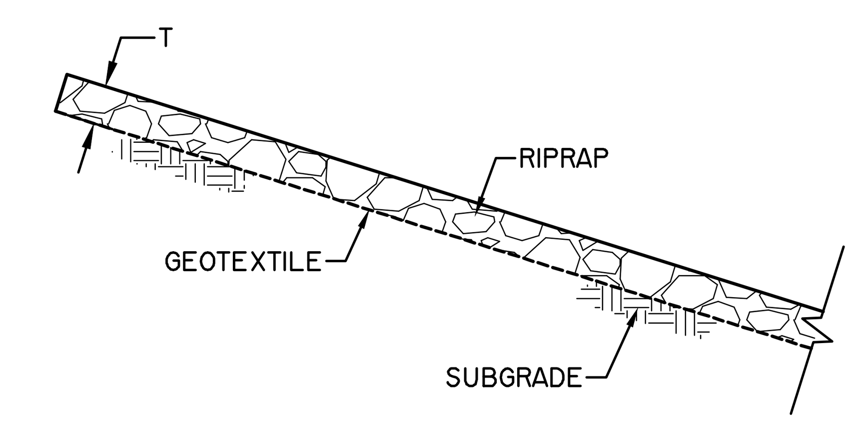
TYPICAL SECTION - DIVERSION CHANNEL - FILL SECTION

SCALE: 1:500



TYPICAL SECTION - DIVERSION CHANNEL - CUT SECTION

SCALE: 1:500



RIPRAP TABLE			
CHANNEL SLOPE	D50 (MM)	CLASS	THICKNESS (T)
0.001	175	CLASS I M	350

TYPICAL SECTION - CHANNEL LINING

SCALE: 1:250

CONCEPTUAL - NOT FOR CONSTRUCTION

CONSULTANT
JOB No. 110773396 | PLAN No.

Stantec

PERMIT TO PRACTICE

DESIGNER
DATE

CHECKER
DATE

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)

DIVERSION CHANNEL

SECTIONS

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	7 of 11

Government of Alberta ■ Transportation

PLAN DESCRIPTION
DIVERSION CHANNEL
SECTIONS

BAR CODE

PLAN No. -
CONTRACT No. -
SITE No.

PHOTO No.
TITLE SEARCH DATE
GRAPHICS FILE

	BY	DATE
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CHECKED	JRM	15.03.31
DRAWN	CW	15.03.31

No. | REVISION | BY | DATE

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NOTE:
1. SEE SHEET 1 FOR NOTES.

0 250 500 METRES

CONCEPTUAL - NOT FOR CONSTRUCTION

PLAN DESCRIPTION	OFF-STREAM STORAGE DAM EMBANKMENT PLAN - (1 OF 2)
BAR CODE	
PLAN No.	-
CONTRACT No.	-
SITE No.	-
PHOTO No.	

	BY	DATE
SURVEYED	-	-
DESIGNED	JBW	15.03.31
CHECKED	JRM	15.03.31
DRAWN	CW	15.03.31
TITLE SEARCH DATE		
GRAPHICS FILE		

No.	REVISION	BY	DATE

CONSULTANT

JOB No. 110773396 | PLAN No.

Stantec

PERMIT TO PRACTICE

DESIGNER — DATE

CHECKER — DATE

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)

OFF-STREAM STORAGE DAM EMBANKMENT PLAN - (1 OF 2)

Government of Alberta Transportation

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	8 of 11

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CONSULTANT	PERMIT TO PRACTICE	DESIGNER	CHECKER	SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)
JOB No. 110773396 / PLAN No.		DATE	DATE	OFF-STREAM STORAGE DAM EMBANKMENT PLAN - (2 OF 2)

Stantec

Government of Alberta Transportation

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	9 of 11

PLAN DESCRIPTION: OFF-STREAM STORAGE DAM EMBANKMENT PLAN - (2 OF 2)

BAR CODE

	DATE	BY
SURVEYED	-	-
DESIGNED	15.03.31	JBW
CHECKED	15.03.31	JRM
DRAWN	15.03.31	CW

PHOTO No. / TITLE SEARCH DATE / GRAPHICS FILE

PLAN No. / CONTRACT No. - / SITE No. -

No.	REVISION	BY	DATE

CONCEPTUAL - NOT FOR CONSTRUCTION

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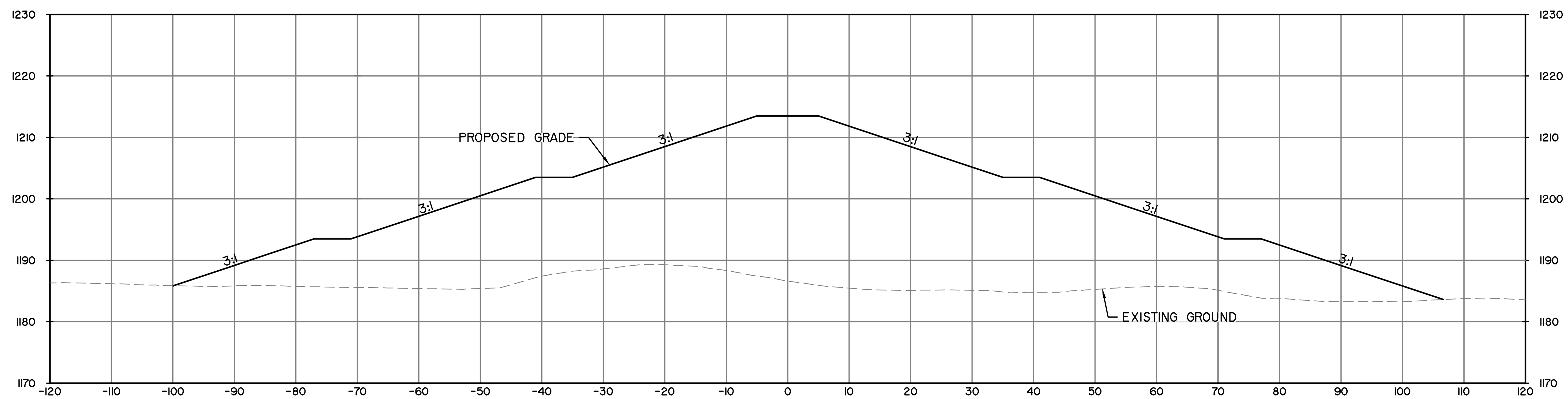

CROSS SECTION 3+580.00
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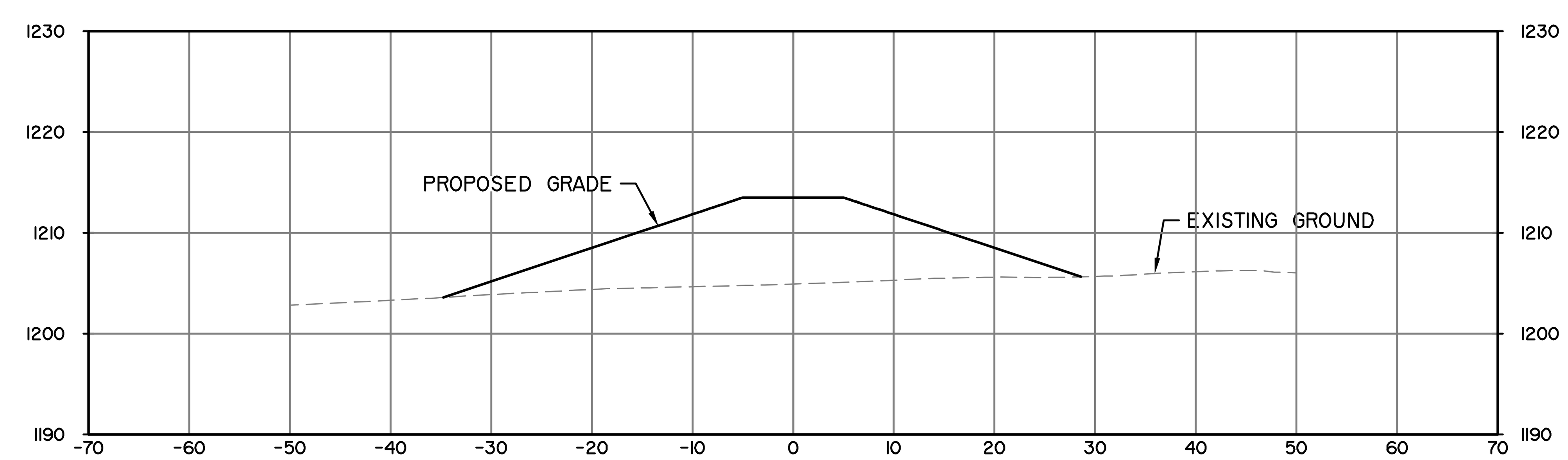

CROSS SECTION 1+260.00
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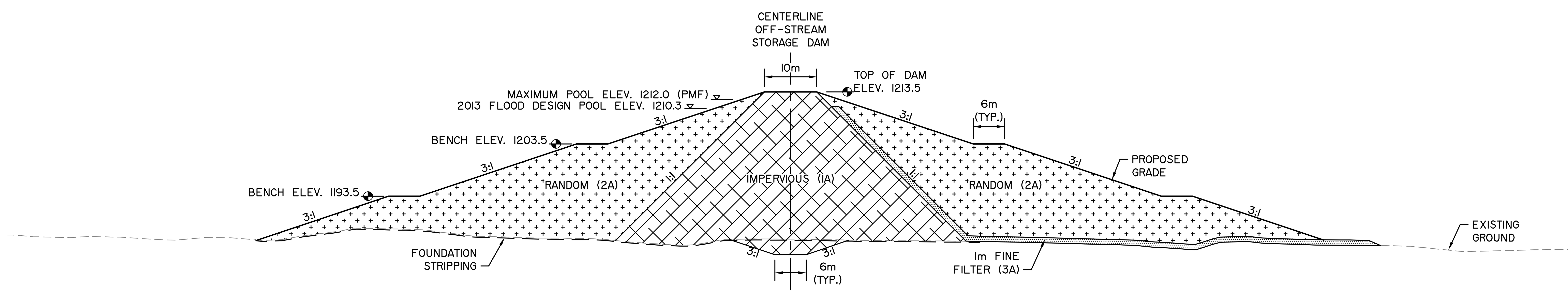

TYPICAL SECTION - OFF-STREAM STORAGE DAM
SCALE: 1:500

CONCEPTUAL - NOT FOR CONSTRUCTION

PLAN DESCRIPTION: OFF-STREAM STORAGE DAM EMBANKMENT SECTIONS

BAR CODE

PLAN No.	CONTRACT No.	SITE No.
	-	-

	PHOTO No.	TITLE SEARCH DATE	GRAPHICS FILE

	BY	DATE
SURVEYED	-	-
DESIGNED	JBW	15.03.31
CHECKED	JRM	15.03.31
DRAWN	CW	15.03.31

No.	REVISION	BY	DATE

CONSULTANT	PERMIT TO PRACTICE	DESIGNER	CHECKER
JOB No. 110773396 / PLAN No.		DATE	DATE
Stantec			

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)
OFF-STREAM STORAGE DAM
EMBANKMENT
SECTIONS

Government of Alberta
Transportation

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	10 of 11

SaveDate: 2015/04/02 11:38 AM Login: Withers, Cheyenne
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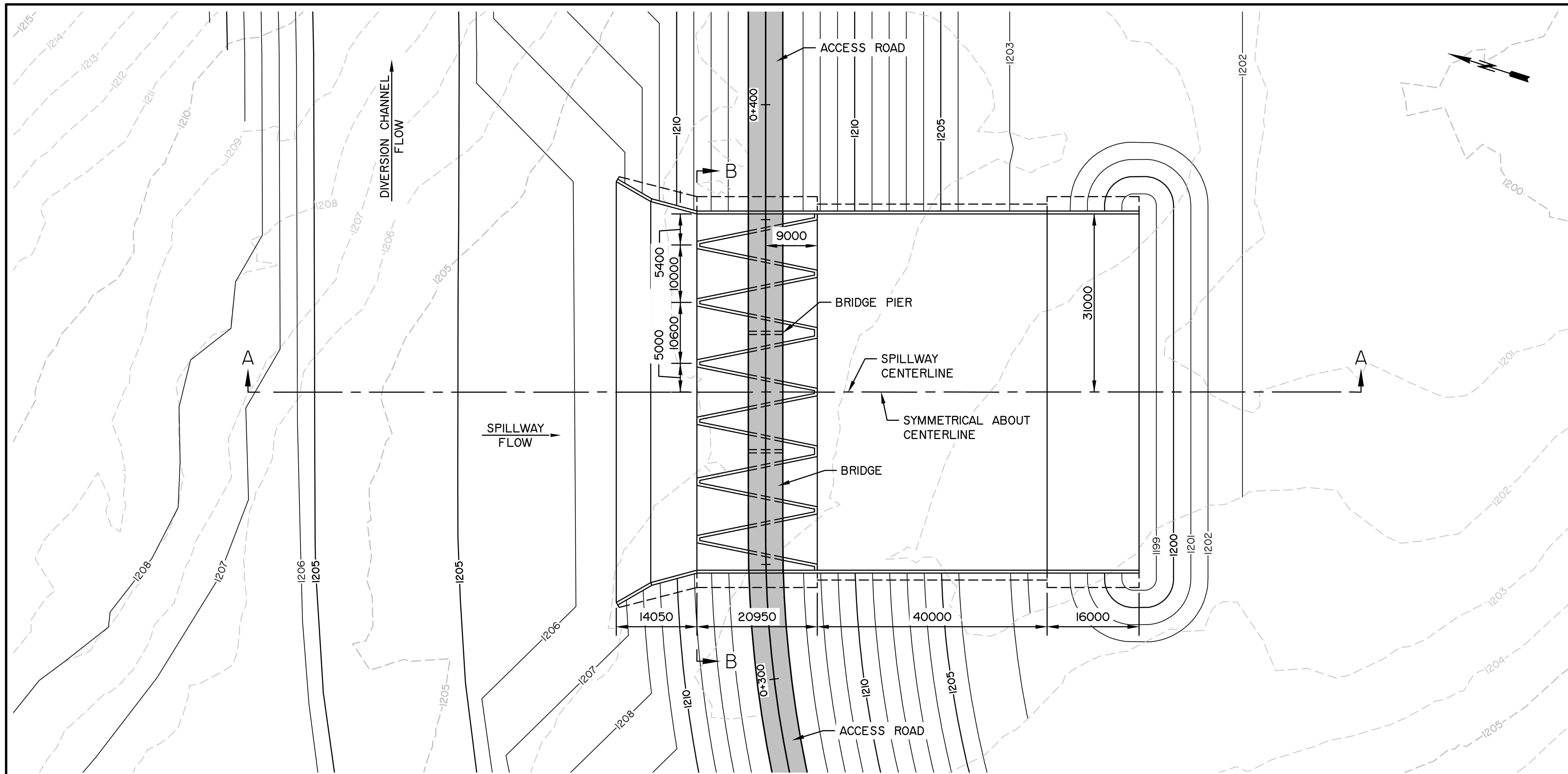
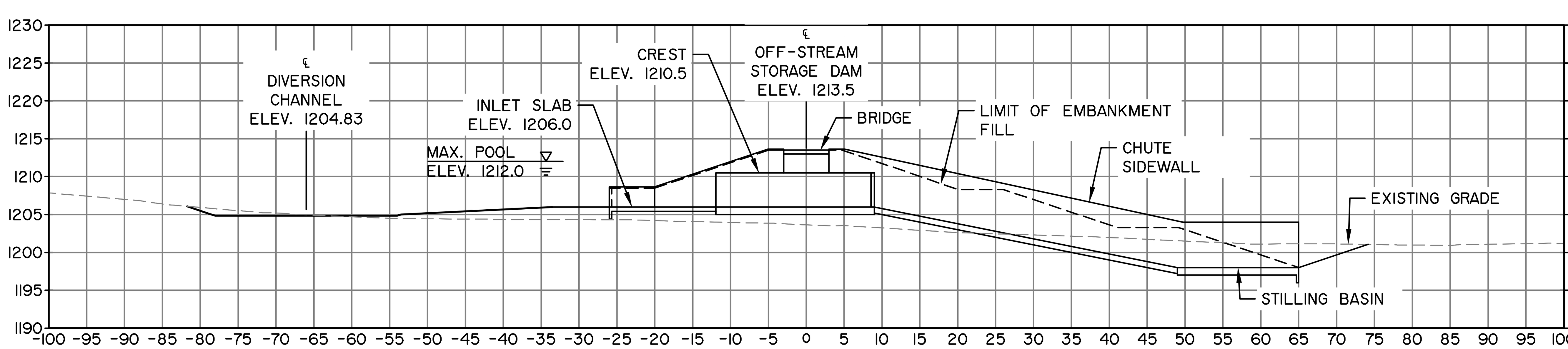
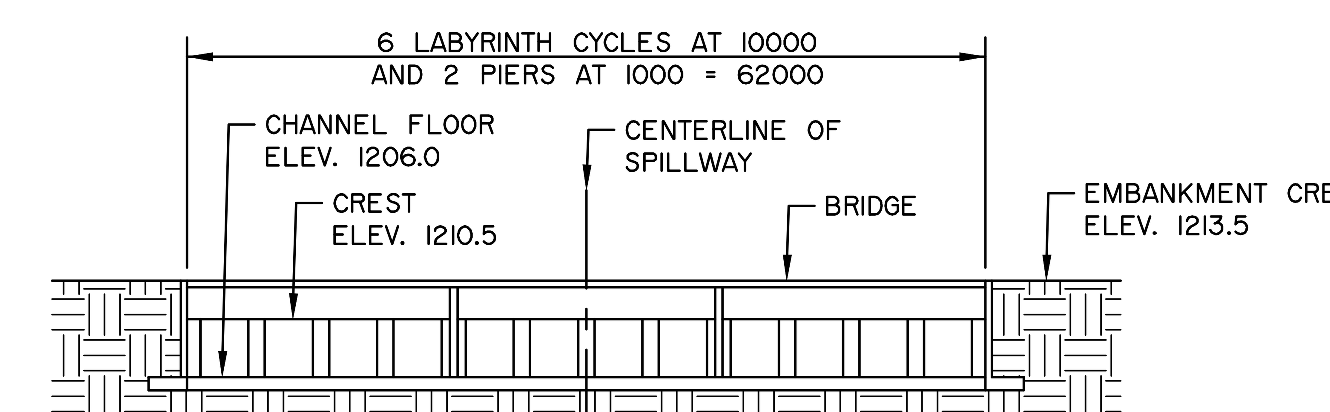
NOTES:
1. SEE DRAWING 1 FOR GENERAL NOTES.
2. ELEVATIONS AND STATIONS ARE IN METRES AND DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.



PLAN - SPILLWAY
SCALE: 1:500



PROFILE A-A - SPILLWAY
SCALE: 1:500



SECTION B-B - LABYRINTH WEIR
SCALE: 1:500

CONCEPTUAL - NOT FOR CONSTRUCTION

CONSULTANT	
JOB No. 110773396	PLAN No.
Stantec	

PERMIT TO PRACTICE

DESIGNER — DATE

CHECKER — DATE

SPRINGBANK OFF-STREAM RESERVOIR PROJECT (SR1)
OFF-STREAM STORAGE DAM
SPILLWAY
GENERAL ARRANGEMENT

REGION	SITE No.	PLAN No.	PROJECT	CONTRACT No.	SHEET
SOUTHERN			SR1	xxxxx	11 of 11

Government of Alberta ■ Transportation

PLAN DESCRIPTION: OFF-STREAM STORAGE DAM SPILLWAY GENERAL ARRANGEMENT

BAR CODE

PLAN No. - CONTRACT No. - SITE No.

	DATE	BY
SURVEYED	-	-
DESIGNED	15.03.09	JBW
CHECKED	15.03.09	JRM
DRAWN	15.03.09	CW

PHOTO No. / TITLE SEARCH DATE / GRAPHICS FILE

No.	REVISION	BY	DATE

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