REPORT

August 23, 2013

23466 - HIGHWAY 97A HUMMINGBIRD CREEK CHANNEL REPAIRS

Design and Completion Report

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Golder Associates Ltd. (Golder) is pleased to provide the following detailed design and completion report that summarizes the hydrotechnical engineering design for the Hummingbird Creek Channel Repairs that were required after the June 23, 2012 runoff event. This report should be read in conjunction with the *Important Information and Limitations of this Report* (see Section 9).

1.0 BACKGROUND

On June 23, 2012, a significant runoff event (the "event") caused local flooding and damage to Highway 97A infrastructure and private property in the community of Swansea Point (Six-Mile) approximately 8 kilometres south of Sicamous, BC. Hummingbird Creek and Mara Creek (a tributary to Hummingbird Creek) drain approximately 38 square kilometres of the Monashee Mountains east of Mara Lake in an area called Hunters Range. Highway 97A and Swansea Point are located on the alluvial fan of the watershed, which has a history of large hydrogeomorphic activity.

2.0 SCOPE OF WORK

At the request of the Ministry of Transportation and Infrastructure (MoTI) and the Ministry of Forests, Lands and Natural Resources Operations (MFLNRO), hereafter referred to as the (Province), Golder Associates Ltd. (Golder) was asked to provide a hydraulic analysis and engineering design recommendations for restoration works in Hummingbird Creek. A Terms of Reference was provided to Golder and this is included in Appendix A. Specifically, Golder's Scope of Work was to:

- Prepare base plans of Hummingbird Creek using survey information provided by others;
- Review available background hydrologic reports and information and estimate the 1:200 year return period maximum instantaneous "clear flow" discharge;
- Develop a hydraulic model and estimate channel capacity of Hummingbird Creek prior to the event based on the 1:200-year return period maximum instantaneous discharge plus 600 mm freeboard;
- Develop a hydraulic model and estimate channel capacity of Hummingbird Creek after the event based on the 1:200-year return period maximum instantaneous discharge plus 600 mm freeboard;
- Provide an assessment of the existing culvert at Highway 97A;
- Provide engineering recommendations on channel improvements and restoration;
- Prepare detailed design drawings (issued for construction) for channel improvements and restoration;
- Assist with Temporary Licence to Construct drawings for MoTI;
- Provide construction monitoring / field reviews of construction activity; and
- Prepare record drawings and reporting on all of the above tasks.

Golder's Scope of Work did not include environmental or biological services for in-stream work, or engineering services for reinstatement of highway and local road infrastructure. These services were provided by others. Golder also did not provide geotechnical engineering services for the classification or stability of soils, or for engineering services related to the potential presence or contamination of groundwater resources.

Design criterion for this work is discussed in Section 2.3, but Golder was asked to design restoration works for the estimated 200-year return period "clear" hydrologic flow. Sediment transport and deposition and changes to the design from erosion and scour have not been considered. Hydrogeomorphic events, such as debris flows or debris floods, can cause flows to be significantly higher than basic hydrologic flow estimates, but designing restoration works for these events was beyond the Scope of Work provided to Golder. Golder has not assessed the watershed for the possible future hydrogeomorphic events or provided recommendations on mitigation measures for such events.

3.0 HUMMINGBIRD CREEK CHANNEL REPAIRS

The following Sections describe the analysis and design work performed by Golder for channel improvements and restoration in Hummingbird Creek.

3.1 Site Visit

Golder performed a site visit on November 11, 2012 with the following people:

- Mike Sullivan, P.Eng. – Golder Associates Ltd.
- Jeptha Ball, P.Eng. – Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO).
- Steve Sirett – Ministry of Transportation and Infrastructure (MoTI).
- Paul Hague, B.Sc., RPF – Summit Environmental Consultants Inc.
- Dean Handley, R.F. – Binnie & Associates Ltd.
- Brent Persello, R.P.Bio. – MoTI.
- Craig Beeson, P.Ag. – MFLNRO.

Representative photographs are included in Appendix D from this site visit, which show the condition of the channel following the event and identifies bank areas affected by scour. The purpose of this site visit was to identify and assess scour locations of the channel and any potential unstable banks that may require repair.

3.2 Site Surveys

Topographic surveys of Hummingbird Creek have been performed by others and provided to Golder for use in preparing hydraulic models, preparing detailed channel restoration designs and preparing Record Drawings after construction. The various surveys include the following:

- A Light Detection and Ranging (LiDAR) survey performed for MoTI in 2011, identified as the Pre-Event or (LiDAR Survey).
- A Post Event survey that was performed by R.F Binnie & Associates Ltd. (Binnie) on September 30, 2012 identified as the (Binnie Survey).
- A Post Construction survey that was performed by Setch Surveys between March 1 and March 30, 2013, identified as the (Setch Survey).

The LiDAR survey was representative of the pre-event channel conditions and extended approximately 50 m on either side of the Hummingbird Creek channel centerline. The Binnie survey did not extend as far on either side of the creek centerline and was representative of the post event channel conditions. Golder combined or merged the LiDAR and the Binnie surveys to provide a survey that was representative of the post event channel conditions and extended 50 m on either side of the creek centerline. The combined survey was used by Golder for assessing the post-event channel capacity and for preparing the detailed channel restoration designs.

3.3 Hydrologic Design Criterion

As provided by the Province, the hydrologic design criterion Golder has used for this work is the estimated 200-year return period maximum instantaneous flow of clear water. For design work in British Columbia, the standard engineering practice is to use the estimated 200-year return period flow or the flood of record. For the design of the Hummingbird Creek channel restoration works, the 200-year clear flow plus 600 mm freeboard is the design criterion that has been specified by the Province with the policy being to return the stream to the conditions immediately prior to the event and not to improve conditions.

3.4 Hydrologic Review

As part of the hydrological review, Golder reviewed the following previous reports by others:

1) "Hummingbird Creek Debris Event", Inter-Agency Report by the Ministry of Environment, Lands, and Parks; the Ministry of Forests; the Ministry of Transportation and Highways; and the Ministry of Attorney General, October 1997. (MELP et al., 1997).

2) "Stream Restoration and Restoration Alternatives at Hummingbird Creek – Mara Lake, BC", EBA Engineering Consultants Ltd. And Kerr Wood Leidal Consultants Ltd., 1998. (EBA and KWL, 1998).

3) "An Unusually Large Debris Flow at Hummingbird Creek, Mara Lake, British Columbia", Canadian Geotechnical Journal. 37(5): 1109-1125, Jakob, M., D. Anderson, T. Fuller, O. Hungr, and D. Ayotte, 2000. (Jakob et. al., 2000).

4) "Flood Hazard Assessment: Hummingbird Creek Adjacent to Hummingbird Creek Estates", (Summit No. 800-359.3) Reference: 100801, Polar Geoscience Ltd, October 4, 2007. (Polar Geoscience, 2007).

The (EBA and KWL, 1998) report included a regional hydrologic analysis based on the index flood method and an estimation of design flow rates for Hummingbird Creek. The Hummingbird Creek drainage area was estimated to be approximately 39 km^2 including Mara Creek. Table 1 is an extract from the EBA/KWL report and provides a summary of the design flow rates for Hummingbird Creek for various return period events.

Table 1: EBA/KWL Hummingbird Creek Return Period Flow Rates.

Return Period (Y)	Peak Instantaneous Flow (m^3/s)
Mean Annual	9,6
10	14.5
50	17.8
100	19.0
200	20.1

Golder has accepted the previous hydrologic analysis and design flow rates prepared by EBA & KWL, 1998 with the 1:200-year return period maximum instantaneous flow rate of 20.1 m^3/s.

3.5 Hydraulic Analysis

The hydraulic analysis for Hummingbird Creek included the preparations of hydraulic flow models using the U.S. Army Corps of Engineers, Hydrologic Engineering Centre - River Analysis System (HEC-RAS) model, which is a one-dimensional flow model and is a standard tool for this type of work. Channel capacity and water velocity estimations have been performed using the steady flow analysis, with both the sub-critical and mixed flow regimes in Hec-Ras using the normal depth as the boundary conditions.

For steeper mountain streams, the flows would tend to cascade over the rocks and into downstream pools. Critical flow would likely occur as the flows cascade over the rocks and subcritical flow would likely occur in the downstream pools. Therefore both flow regimes have been considered. Using the subcritical flow regime in Hec-Ras limits the flows to critical, with Froude numbers being limited to less than or equal to 1.0. This results in subcritical to critical flow depths. The mixed flow regime allows supercritical flows to occur with Froude numbers exceeding 1.0. This results in shallower flow depths with higher associated velocities than the sub-critical flow regime. Thus, the sub-critical flow regime would tend to provide conservative (higher) water levels, while the mixed flow regime would tend to provide conservative (higher) velocities.

The sub-critical flow regime was used for the assessment of water levels and freeboard requirements while the mixed flow regime was used for the assessment of channel velocities and riprap sizing.

The hydraulic analysis included:

- Development of a Hec-Ras Model based on the 2011 Pre-Event LiDAR survey to assess the pre-event channel capacity; and an assessment of the capacity of the existing Structural Plate Corrugated Steel Pipe (SPCSP) Pipe Arch culvert under Highway 97A.

- The development of a Hec-Ras Model based on the Post-Event combined LiDAR and Binnie surveys to assess the post-event channel capacity; the channel bedload removal that would be required to meet the 1:200-year water level, plus 600 mm freeboard; and the riprap bank protection works that were necessary to reinstate the existing channel banks to pre-event conditions.

3.5.1 Hec-Ras Model development based on the 2011 LiDAR Survey

A Hec-Ras model was developed based on the 2011 LiDAR survey. The survey extended from the confluence of Mara Creek and Hummingbird Creek located upstream of Highway 97A, downstream to Mara Lake. Cross sections were created from the LiDAR survey for input into the Hec-Ras model along with the topographic information for the existing Structural Plate Corrugated Steel Pipe (SPCSP) Pipe Arch culvert under Highway 97A. Refer to Figure 1, Appendix B.

Upstream of Highway 97A, the channel is quite steep with a slope of approximately 7.5%. The channel bed material consists of a mixture of large and small cobbles and boulders which have been deposited from previous events and have been naturally formed into a series of step pool like systems. Downstream of Highway 97A, the channel slope reduces towards Mara Lake from 7.1% at the Hwy 97A crossing to approximately 1.6% near Mara Lake.

Manning's "n" coefficients were estimated for the Hummingbird Creek channel to be approximately 0.05 for the main channel and 0.1 for the overbank areas upstream of Highway 97A and approximately 0.035 for the main channel and 0.05 for the overbank areas downstream of Highway 97A.

A total of 32 cross-sections were extracted from the LiDAR survey for input into the Hec-Ras model. Sub-critical and mixed flow regimes were used in the model along with normal depths as boundary conditions with slopes of 0.075 m/m upstream and 0.026 m/m downstream.

The design flow rates from the EBA & KWL, 1998 report were used in the model, see Section 2.4.

The existing Structural Plate Corrugated Steel Pipe (SPCSP) Pipe Arch culvert under Highway 97A was measured to be approximately 3.8 m wide x 2.3 m high with a mitered inlet. Referring to the standard sizes for pipe arches (Atlantic Industries Ltd), there are several pipe arches that are quite similar in size, (3730 mm x 2290 mm, 3759 mm x 2362 mm, and 3810 mm x 2413 mm). A 3.75 m x 2.36 m corrugated metal Pipe Arch with a mitered inlet was used in Hec-Ras to model the Highway 97A culvert, with an upstream invert elevation of 369.62 m and a downstream invert elevation of 367.76 m. The culvert length was estimated to be approximately 33.2 m.

The channel capacity was assessed based on the 1:200-year water level and the available freeboard to the top of the bank. The lowest top of bank elevation was used from selecting either the right or left bank to estimate the available freeboard. Table 2 and Table 3 in Appendix B provide a summary of the Hec-Ras output for the 1:200 and 1:100-year return period flow rates, respectively.

The existing culvert under Highway 97A was previously documented (EBA & KWL, 1998) as being a 3.8 m x 2.3 m corrugated metal pipe (CMP) elliptical culvert with a capacity of 13.5 m^3/s (based on inlet control) and is undersized to pass the peak instantaneous 1:200-year discharge of 20.1 m^3/s (EBA & KWL, 1998).

The capacity of the existing 3.8 m x 2.3 m Structural Plate Corrugated Steel Plate (SPCSP) Pipe Arch culvert under Highway 97A was assessment using various methods including: (1) the standard culvert nomographs; and (2) the Hec-Ras Model. As neither the standard culvert nomograph method nor the Hec-Ras model could match the exact existing culvert dimensions (3.8 m span x 2.5 m rise), a different close approximation of the existing culvert dimensions and configuration was used in each. A 3.73 m span x 2.29 m rise pipe arch was used for the standard nomograph method and a 3.75 m span x 2.36 m rise pipe arch was used for the Hec-Ras modelling.

A standard culvert nomograph for a corrugated steel pipe arch is provided in the Handbook of Steel Drainage and Highway Construction Products, 2nd Edition, November 2009, Figure 4.12. For a 3.73 m x 2.29 m Pipe Arch culvert with a HW/R ratio of 1.0 and a mitered inlet, the capacity was estimated to be approximately 14.0 m^3/s.

A headwater versus discharge curve for the selected culvert in Hec-Ras (3.75 m x 2.36 m) Pipe Arch culvert with a mitered inlet was created based on the results of the Hec-Ras model culvert output table. (Refer to Table 4 in Appendix B).

The Hec-Ras model results in Table 4, show that the capacity of the selected pipe arch culvert having the dimensions of 3.75 m x 2.36 m is approximately 16 m^3/s before overtopping the concrete headwall and spilling into the highway ditch along the east side of the Highway 97A. Once water levels reached 372.13 m, flows would start flowing across Highway 97A to the downstream side.

The existing culvert was found to be undersized for the 1:200-year return period flow rate of 20.1 m^3/s. The capacity of the 3.75 m x 2.36 m pipe arch culvert was estimated to be approximately 16 m^3/s which is slightly under the 1:50-year flow return period rate of 17.8 m^3/s.

3.5.2 Hec-Ras Model Development based on the combined Lidar and Binnie Surveys

A Hec-Ras model was developed based on the pre-event LiDAR survey (2011) and the post event Binnie Survey (September 30, 2012). Both surveys extended from the confluence of Mara Creek and Hummingbird Creek located upstream of Highway 97A, downstream to Mara Lake. Cross sections were created from the combined survey for input into the Hec-Ras model along with the topographic information for the existing Structural Plate Corrugated Steel Pipe (SPCSP) Pipe Arch culvert under Highway 97A.

The HEC-RAS model based on the combined surveys was used to:

- Assess the capacity of the existing Hummingbird Creek channel to convey the 1:200-year flow, plus the 600 mm freeboard requirement; and
- Assess bedload removal requirements.

The results of the Hec-Ras model indicated that the following channel locations did not have sufficient capacity to meet the 200-year water level plus the 600 mm freeboard requirement:

- Sta 0+260 – Upstream of the Hwy 97A crossing on the right bank.
- Sta 0+428 – Located just downstream of the Hwy 97A crossing.
- Sta 0+740 to Sta 1+080 (inclusive).

The right bank at Sta 0+428, which is located just downstream of the Hwy 97A culvert crossing, had been previously disturbed by emergency works equipment immediately after the June 23, 2012 event. It is likely that due to the disturbance, that the available freeboard on the right bank may have been compromised. Additional riprap was proposed in this area to increase the height of the right bank to provide the required freeboard.

Bed load removal was required in the channel starting at Sta 0+740 down to Sta 1+080 near the outlet to Mara Lake.

Refer to Appendix B, Table 5 and Table 6 for the Sub-Critical and Mixed Flow Regime Hec-Ras Model Output respectively, Hec-Ras Model - Cross-Sections, and Hec-Ras Model - Profile.

3.5.3 Riprap Bank Erosion Protection and Bar Scalping

Bank protection or stabilization works were required in approximately six locations upstream of Highway 97A and one location downstream of Highway 97A. The locations of the required bank protection works were identified during a site visit on November 5, 2012 with MFLNRO, MoTI, Summit, Binnie and Golder staff.

During the spring freshet and debris flow event of June 23, 2012, the flows had scoured out the channel banks at various locations and deposited bed-load throughout the creek.

All bank protection works that have been proposed have been designed simply to reinstate the Hummingbird Creek banks back to the same or similar state as that occurring prior to the June 23, 2012 debris flow event.

The following locations were identified as requiring riprap bank protection works:

- Sta 0+100, Sta 0+120, Sta 0+160, Sta 0+200, Sta 0+260 Sta 0+340 and Sta 0+428.

Based on the Hec-Ras Model results, the 1:200-year mean channel velocity was estimated to be approximately 3.8 m/s using the mixed flow regime. A design velocity of 4.0 m/s was used for riprap sizing. From the Supplement to TAC riprap design chart, for a bank slope = 1.5H:1V, the design riprap = Class 250 Kg. Table 7 provides the riprap gradation for Class 250 kg riprap.

Table 7: Riprap Gradation.

Percent Lighter (Finer) Than	Class 250-kg	
	Mass (kg)	Equivalent Size* (mm)
15	25	262
30	95	409
50	250	565
85	750	816
100	1250	967
Layer Thickness	1130 mm (min.)	

*Equivalent size is an approximate dimension for a spherical stone for each given mass. Stone mass governs each class and its gradations. Above gradation table is based on an assumed specific gravity of 2.64 for riprap (S=2.64).

Note: Riprap shall be hard, durable, angular, and generally good quality quarry rock that does not generate acids. Riprap shall be free of structural defects, clean, and generally well-graded according to the above gradation table.

Bar scalping was also recommended in various sections throughout the upstream reach of Hummingbird Creek to increase the flow capacity within the channel and to avoid the potential for further debris accumulations within the near future.

3.6 Temporary Diversion Channel

A temporary diversion channel was considered the best option for dewatering the main channel of Hummingbird Creek to allow the bed-load removal between Sta 0+820 to Sta 1+000 near Mara Lake.

The design of the temporary diversion channel was based on the 1:10-year maximum daily discharge for the month of November, which was the time when the design was being done. The actual construction would likely occur after January 2013 due to the permitting and approval process. The 1:10-year maximum daily flow rate for the month of November was considered to be a conservative estimate since the flows tend to reduce over the winter months. Based on regional hydrologic analysis the 1:10-year maximum daily flow rate for the month of November was estimated to be approximately 0.5 m^3/s.

The inlet to the diversion channel was selected based on the most practical location from a conveyance perspective as well as to minimizing the impact to the riparian vegetation and trees. Other factors that were considered in selecting the inlet location included the bed-load removal requirements of the main channel to meet the 1:200-year water level plus 0.6 m freeboard requirement. The diversion channel inlet was located near Sta 0+820. The temporary diversion channel was designed with a base width of 1.5 m, side slopes 1:1, a depth of 1.0 m and a channel slope of 0.018 m/m. With the design flow rate of 0.5 m^3/s, the mean channel velocity was approximately 2.7 m/s. The diversion channel was designed to be lined with either poly or non-woven geotextile. Sand bag weirs were required every 30 m with a height of 0.5 m to reduce the supercritical flow velocities within the diversion channel. The upstream diversion channel invert elevation was 352.34 m at approximately Sta 0+820 and the downstream outlet elevation was 349.5 m at approximately Sta 1+000. Temporary License to

Construct (TLC) drawings were created based on the potential area of impact during the construction of the diversion channel. The TLC drawings have not been included in this report.

An alternate Temporary Diversion Channel Design was prepared that included a shorter length of channel. The alternate diversion channel would be considered depending on the amount of flow in the channel occurring at the time of construction.

3.7 Design Drawings

Golder prepared "Issued for Construction" design drawings and these are included in Appendix C. The design drawings include the following eight (8) sheets:

Figure 1 – Overall Site Plan

Figure 2 – Bedload Removal Works (Sta. 0+740 to 1+050)

Figure 3 – Bedload Removal Profile and Typical Cross Section

Figure 4 – Bedload Removal Cross-Sections

Figure 5 – Temporary Creek Diversion Works

Figure 6 – Temporary Creek Diversion Works Alternate Design

Figure 7 – Riprap Bank Rehabilitation Works

Figure 8 – Bank Rehabilitation Works Cross-Sections

4.0 CONSTRUCTION MONITORING

Construction commenced on February 18, 2013 and was managed by R.F. Binnie & Associates Ltd. The downstream bedload removal and channel shaping were completed first, prior to mobilizing the equipment upstream to complete the riprap bank erosion protection and bar scalping. Construction was substantially complete by March 23, 2013. Golder provided construction monitoring / field reviews from February 23, 2013 to March 21, 2013. Copies of the construction monitoring field reviews are included in Appendix G and post construction photographs are included in Appendix D. The following Sections describe the works constructed.

4.1 Bedload Removal (0+740 to 1+050)

Bedload removal construction began on February 18, 2013 when equipment was mobilized to Swanshore Road in preparation for the works. The streamflow was very low at this time and it was decided that construction could commence without the need for the temporary channel diversion. Environmental works were monitored on-site by Summit Environmental Consultants Inc. Bedload removal was conducted generally as designed and the channel invert elevations were checked in the field by the surveyor. The constructed channel geometry was also shaped generally as designed with a 5 metre bottom channel width and 2(H):1(V) side slopes. These works were substantially complete on February 28, 2013.

It should be noted that the terms of reference that were specified (Appendix A) for the bedload removal process was to minimize the disturbance to the existing banks and that no disturbance of the pre-event bank protection was to occur.

The bedload removal volume upstream of Highway 97A was estimated to be approximately 1150 m^3 (refer to Drawing 5) and the bedload removal volume downstream of Highway 97A between Sta 0+740 and Sta 1+080 was estimated to be approximately 2200 m^3 (refer to Drawing 2). The total bedload removal volume was estimated to be approximately 3350 m^3.

4.2 Riprap Bank Erosion Protection and Bar Scalping

The design drawings indicate seven locations for riprap bank erosion protection and an additional four areas were identified for bedload removal/bar scalping (Refer to Drawing 5). Riprap was supplied by the Baird Brothers, with their pit located near Enderby, BC. Golder visited their quarry to observe the riprap prior to hauling activities. The riprap appeared to meet the 250-kg class gradation requirements in the design drawings and was approved for use. The riprap had previously been tested and approved for use in-stream by others, and the acid rock drainage and metal leachate testing results are included in Appendix E for reference.

There was a field change made when construction commenced on all of these locations, which was to delete the 200 mm thickness of 75 mm (3") minus well-graded granular filter layer. Based on field observations, the native bank soils were identified to be adequate to allow this change to the design. As an added item, a field decision was made to add a single layer of 75 mm-150 mm (3"-6") crushed rock where necessary prior to placing riprap. This crushed rock was the same type of rock as the riprap. The total estimated placed riprap volume was estimated to be approximately 4115 m^3 (Refer to Drawing 5).

Construction activities of the seven locations are described in the Sections below. The station chainage refers to the approximate midpoint of each location and this was used in the design drawings for reference. RB and LB are used to denote the right bank and left bank when facing in a downstream direction towards Mara Lake.

4.2.1 Station 0+100 (RB)

Construction at this location partially changed from the design drawings. An access ramp was constructed into the channel bank for the exactor to work from, but the streamflow was not diverted and the riprap toe key could not be constructed due to environmental constraints. As an alternative, a self-launching toe was placed along the bottom of the channel bank. Riprap was placed up to the top of bank and the thickness was observed to be at least 1.13 m as designed. At the downstream end of this location the riprap was secured against very large existing boulders approximately 3 m in diameter (though not fully visible). The length of riprap bank erosion protection was approximately 16 m.

4.2.2 Station 0+120 (LB)

Similar to Sta 0+100, this location partially changed from the design drawings. An access ramp was also constructed into the channel bank for the exactor to work from and the riprap toe key could not be constructed

due to environmental constraints. As an alternative, a self-launching toe was placed along the bottom of the channel bank. Riprap was placed up to the top of bank and the thickness was observed to be at least 1.13 m as designed. The length of riprap bank erosion protection was approximately 11 m.

Bar scalping was completed at this location by selectively picking out large boulders in the channel that were loose and unsupported. These boulders reduced channel capacity and could mobilize when freshet flows come.

4.2.3 Station 0+160 (RB)

The stream was diverted at the upstream end of this location and once the stream was diverted, excavation of the toe key was completed generally as designed. Riprap was placed up to the top of bank and the thickness was observed to be at least 1.13 m as designed. At the upstream end of this location there was an existing water well and riprap was carefully placed around the HDPE manhole. At the downstream end of this location the riprap was secured against very large existing boulders approximately 3 m in diameter (though not fully visible). The length of riprap bank erosion protection was approximately 37 m.

Bar scalping was completed at this location by selectively picking out large boulders in the channel that were loose and unsupported. These boulders reduced channel capacity and could mobilize when freshet flows come.

4.2.4 Station 0+200 (LB)

The stream was diverted at the upstream end of this location and once the stream was diverted, excavation of the toe key was completed generally as designed. There was an existing water well at this location and some mature trees and remnant stumps in front of the concrete manhole. The trees and stumps were removed by an arborist. A field decision was made to reduce the length of riprap bank protection required on the downstream end at this location by approximately 25 m. The excavation material from the toe key and right bank works was spoiled at this location to re-contour the banks slope and fill against the concrete manhole. Riprap was placed up to an equivalent elevation of the right bank top of bank and the thickness was observed to be at least 1.13 m as designed.

Bar scalping was completed at this location by selectively picking out large boulders in the channel that were loose and unsupported. These boulders reduced channel capacity and could mobilize when freshet flows come. They were placed at the downstream end at approximately 0+260 to fill a low spot and build up the bank. Some riprap pieces were also placed at this location on top of the boulders. The length of riprap bank erosion protection was approximately 55 m.

4.2.5 Station 0+260 (RB)

The stream thalweg was primarily flowing in the centre and left bank at this location and the toe key was excavated without diverting the stream. This location also had an existing depression in the land surface behind the right bank that was identified as a fill area. Excavation material from around the project site was used to fill this area. Riprap was placed up to the top of bank and the thickness was observed to be at least 1.13 m as designed. The length of riprap bank erosion protection was approximately 55 m.

4.2.6 Station 0+340 (LB)

The left bank upstream of the highway culvert at this location was nearly vertical and an access road was excavated for a working platform. The toe key was completed at this location and the riprap was blended into the existing riprap near the highway culvert. Riprap was placed up to an equivalent elevation of the right bank top of bank and the thickness was observed to be at least 1.13 m as designed. The length of riprap bank erosion protection was approximately 55 m.

A bench was left on the left bank adjacent the culvert inlet at this location. The purpose of this was for easy equipment access for maintenance work during freshet flows.

4.2.7 Station 0+428 (RB)

This was the only location identified for improvements downstream of Highway 97A. Sample test pits were excavated along this bank and some existing riprap was present, but the rock quality was marginal and there was not a solid blanket with appropriate thickness. Some of this riprap was re-incorporated into the new construction. The stream was not diverted and a field decision was made to construct a self-launching toe rather than the toe key. Another change from the design was the riprap bank slope, which was constructed much flatter at approximately 3-4(H):1(V). Excavation material from construction of the upstream locations was spoiled on top of the existing bank to raise the elevation of this location. Riprap was placed up to the top of bank and the thickness was observed to be at least 1.13 m as designed. The length of riprap bank erosion protection was approximately 85 m.

4.3 Record Drawings

Golder has prepared record drawings of the construction works and these are included in Appendix F, Figures 1 to 6. The record drawings show the areas of bedload removal near the mouth of Hummingbird Creek as well as the riprap bank erosion protection and bar scalping areas further upstream. These drawings are based on the survey provided to Golder (performed by Setch Surveys) and the site observations made by Golder.

5.0 EXPECTED PERFORMANCE, INSPECTION AND MAINTENANCE

The mitigation measures that have been constructed within the channel and the riprap bank protection works that have been installed should be inspected periodically and periodic maintenance may also be required.

6.0 CONCLUSIONS AND RECOMMENDATIONS

A detailed design has been prepared with the intent of reinstating the Hummingbird Creek channel to the Pre-Event (June 23, 2012) conditions and to have a channel capacity to pass the 1:200-year return period maximum instantaneous “Clear Flow” flow rate plus 600 mm freeboard.

The detailed design included:

- Channel Bedload Removal in the downstream reach below the Highway 97A culvert crossing between Sta 0+740 and Sta 1+080. The design cross-section included a 5.0 m wide base width with 2H:1V side slopes.
- Riprap bank protection works primarily upstream of Highway 97A with one location just downstream from Highway 97A on the right bank. The locations for riprap bank protection works included: Sta 0+100, Sta 0+120, Sta 0+160, Sta 0+200, Sta 0+260, Sta 0+340 and Sta 0+428. Class 250 kg riprap was specified with some oversized rock, as was available, being placed in the toe key trenches.
- Channel Bedload Removal/Bar Scalping upstream of Highway 97A. This included removing some gravel and bedload material within the channel as necessary to provide better conveyance capacity and to remove material that could potentially block or cause further debris to become clogged within the channel.

Golder has the following recommendations:

- The existing SPCSP Pipe Arch culvert under Highway 97A is undersized to convey the 1:200-year return period "Clear Flow" flow rate of 20.1 m^3/s and based on the hydraulic assessment would only have the capacity to convey between 14.0 m^3/s to 16.0 m^3/s. Golder recommends that the existing culvert be replaced with either a larger culvert or if possible a clear span bridge.
- Throughout the Spring 2013 freshet, Golder recommends that an excavator be stationed in close proximity to the upstream end of the existing culvert as a precautionary measure to be available to clean out any debris that may tend to clog the culvert inlet during the freshet. After the spring 2013 freshet, Golder recommends returning to MoTI's normal seasonal freshet monitoring practices.

7.0 CLOSURE

Golder has prepared the Hummingbird Creek channel repair designs based on the Terms of Reference that were provided by the Province. It was beyond the scope of work for Golder to assess debris flow potential or to assess debris flow mitigation plans. As there has been a history of debris flow events on Hummingbird Creek, this is something that should be considered.

We trust this meets your current requirements. Please contact the undersigned if you require any further information regarding this Completion Report.

GOLDER ASSOCIATES LTD.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
AUG 23, 2013

Mike Sullivan, P.Eng.
Senior Water Resources Engineer

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Geoff Cahill, P.Eng.
Water Resources Engineer

MS/GC/RM/tc

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8.0 THIRD PARTY DISCLAIMER

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Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

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Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction

activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

10.0 REFERENCES

EBA and KWL (EBA Engineering Consultants Ltd. and Kerr Wood Leidal Consultants Ltd.). 1998. *Stream Restoration and Restoration Alternatives at Hummingbird Creek – Mara Lake, BC*. Submitted to Ministry of Environment, Lands, and Parks. 0806-97-87663. April 1998.

Jakob, M., D. Anderson, T. Fuller, O. Hungr, and D. Ayotte. 2000. "An unusually large debris flow at Hummingbird Creek, Mara Lake, British Columbia." *Canadian Geotechnical Journal*. 37(5): 1109-1125.

Polar (Polar Geoscience Ltd.). 2007. *Flood Hazard Assessment: Humming Creek adjacent to Hummingbird Creek Estates (Summit No. 800-359.3)*. Reference: 100801. October 4, 2007.

Province of BC. 1997. *Hummingbird Creek Debris Event – July 11, 1997*. Inter-Agency Report. Ministry of Environment, Lands, and Parks; Ministry of Forests; Ministry of Transportation and Highways; and Ministry of Attorney General. October 1997.

APPENDIX A

MoTI/MFLNRO Terms of Reference

Terms of Reference
For
Hummingbird Creek – Hydraulic Analysis

Background

On June 23, 2012, the Hummingbird and Mara Creek Watersheds experienced a significant runoff event resulting in flooding and damage to roads and infrastructure within the community of Swansea Point. During the period between the event and the end of September, there has been some effort put into re-establishing the Hummingbird Creek channel and related bank protection at two locations within the reach between Mara Lake and a point approximately 100m upstream of Highway 97A. Near the location where Hummingbird Creek enters Mara Lake, it is assumed that the adjacent landowner of Hummingbird Creek Estates has partially excavated bedload material from the creek channel. From a point approximately 100metres downstream of Highway 97A to 100 metres upstream of the highway, MOTI has partially reinstated flood and erosion protection works damaged during the flood event. Within the remainder of the creek reach within the Hummingbird Creek alluvial fan (Figure 1) the ability of the current channel to convey flood flows and provide protection to the adjacent landowners is unknown.

MOTI, on behalf of EMBC is now commencing an investigation of the extend of works that would need to be completed to ensure that the creek channel within the Hummingbird Creek alluvial fan has the ability to safely convey future flood flows. Using the existing site conditions as observed in 2011 as a baseline, and updating that information with field survey completed in late September 2012, the following work plan was developed with the aim of determining the existing site hydraulic conditions and providing recommendations on improvements to the conveyance capacity through the study reaches and channel stability

Task 1- 2011 Site Conditions

1-A: Base Plan

- Using the topographic information derived from the LIDAR survey completed by MOTI in 2011, develop base plans and profiles of Hummingbird Creek that extend from Mara Lake to a point approximately 50 metres upstream of the confluence of Mara and Hummingbird Creek;
- The base plan should combine the LIDAR image, ground contours and any relevant notes related to structures, topographic features etc.;
- The base should extend laterally at least 30 metres from the left and right top of bank;
- The plan(s) should be of suitable scale , (example: 11x17" sheet = 2 to 4 pages @ scale of 1:2000, A1 sheet = 1 -2 pages @ scale of 1:2000)

1-B: Hydraulic Capacity

- Review any available hydrologic background material to determine the1:200 year maximum instantaneous design discharge that could be expected downstream of the confluence of Mara and Hummingbird Creeks. Make an assessment of its validity and, if deemed necessary, re-establish the 1:200 year design flow.
- Using the base plan developed for Task 1A, develop a hydraulic model (HEC-RAS) that extends throughout the entire reach included in the base plan. The hydraulic model should incorporate the existing culvert under highway 97A. The geometry and upstream and downstream inverts of

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the culvert are to be obtained as part of an ongoing existing conditions topographic survey of the watercourse.

- Using the hydraulic model, determine the channel capacity for the site conditions as observed in the 2011 LIDAR survey;
    - Provide information on water levels and flow velocities that would have resulted from the 1:200 year design flow.
    - Provide an assessment of the maximum flow conditions that will provide a minimum freeboard of 0.6m (standard floodplain mapping freeboard allowance) at all locations within the creek channel both upstream and downstream of Hwy 97A.
    - Provide a headwater vs. discharge curve and/or table for the highway 97A culvert based on an unobstructed inlet. The curve/table should provide information on pipe full capacity, capacity at the stage when flow overtops the road profile and the amount of flow that would be diverted away from the downstream channel if water leaves the main stem and runs southward along the east side of Hwy 97A.
    - Based on culvert capacity determined in previous task, provide an assessment of the ability of the Hwy 97A culvert to convey the design flow and the affect of that capacity on streamflow conditions in the downstream reach.

Task 2- Existing Conditions as of September 2012

2-A: Base Plan

- Produce a separate set of base plans that use field survey of the channel area collected for MOTI in September 2012 to update base plans from Task 1A to reflect existing conditions topography. Existing topographic conditions within the channel limits (top of bank to top of bank) will be provided in digital format (GPS data, ASCII format, X,Y, Z data in a CSV file), based on site information collected by MOTI by October 3rd, 2012.
- Develop existing conditions base plans and profiles of Hummingbird Creek that extend from Mara Lake to a point approximately 50 metres upstream of the confluence of Mara and Hummingbird Creek.
- The base plan should combine the LIDAR image, ground contours and any relevant notes related to structures, bank protection, topographic features etc. and where possible indicate areas where remedial channel protection measures may be required;
- The base should extend laterally at least 30 metres from the left and right top of bank;
- The plan(s) should be of suitable scale , (example: 11x17" sheet = 2 to 4 pages @ scale of 1:2000, A1 sheet = 1 -2 pages @ scale of 1:2000)

2-B: Hydraulic Capacity

- Using the base plan developed for Task 2A, develop a hydraulic model (HEC-RAS) that extends throughout the entire reach included in the base plan. The model cross sections should be situated at the same position as in the 2011 condition scenario.
- Using the hydraulic model, determine the channel capacity for the site conditions as presented in the updated base plans;
    - Provide information on water levels and flow velocities that would result from the 1:200 year design flow.
    - Provide an assessment of the maximum flow conditions that will provide a minimum freeboard of 0.6m (standard floodplain mapping freeboard allowance) at all locations within the creek channel both upstream and downstream of Hwy 97A.

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- Identify locations in both the upstream and downstream reaches where the channel capacity does not meet the criteria of 0.6m freeboard under the 1:200 year flood event scenario.
- Provide a headwater vs. discharge curve and/or table for the highway 97A culvert based on an unobstructed inlet. The curve/table should provide information on pipe full capacity, capacity at the stage when flow overtops the road profile and the amount of flow that would be diverted away from the downstream channel if water leaves the main stem and runs southward along the east side of Hwy 97A.
- Provide an assessment of the streamflow capacity of the existing channel upstream and downstream of Hwy 97A and the ability of the culvert to convey that flow.

Task 3: Hydraulic Capacity, Existing Conditions as of September 2012 with bedload Removal

- Using the base plan developed for Task 2A, and the hydraulic model (HEC-RAS) developed for Task 2B, investigate the impact of bedload removal from the reach from Mara Lake to the downstream side of the Hwy 97A culvert. Assumed geometry of the bedload removal is as follows:
    - At locations identified in Task 2B to have insufficient channel capacity to convey the 1:200 year discharge (with 0.6m freeboard), remove sufficient material below current average top of bedload in the cross-section to obtain the required capacity.
    - Ensure a constant longitudinal channel bed profile between adjacent cross sections. (I.E. Maintain a constant downstream slope toward Mara Lake)
    - Minimum bottom width of 5 metres
    - Side slopes of 2:1 (H:V) from bed elevation to daylight
    - Excavation is to remain within the current channel and adjustments can be made to the bed width and side slopes to prevent disruption to the existing creek banks and bank protection.
    - Provide an estimate of the quantity of bedload material that would have to be excavated (Total and by reach).
    - Provide information on water levels and flow velocities that would result from the 1:200 year design flow following bedload removal.
    - Provide a headwater vs. discharge curve and/or table for the highway 97A culvert based on an unobstructed inlet. The curve/table should provide information on pipe full capacity, capacity at the stage when flow overtops the road profile and the amount of flow that would be diverted away from the downstream channel if water leaves the main stem and runs southward along the east side of Hwy 97A.
    - Provide an assessment of the streamflow capacity of the existing channel upstream and downstream of Hwy 97A and the ability of the culvert to convey that flow.

Task 4: Documentation and Recommendations

- Provide MOTI with a detailed report of the procedures and results of the analysis completed.
- Provide recommendations on locations and type of remedial works necessary to repair existing and any new channel and bank protection works required to provide flood and erosion protection for the 1:200 year event design event;
- Provide an assessment of the hydraulic conditions at the Hwy 97A stream crossing and provide recommendations for any remedial works that would be required to upgrade the structure to accommodate the 1:200 year design discharge.

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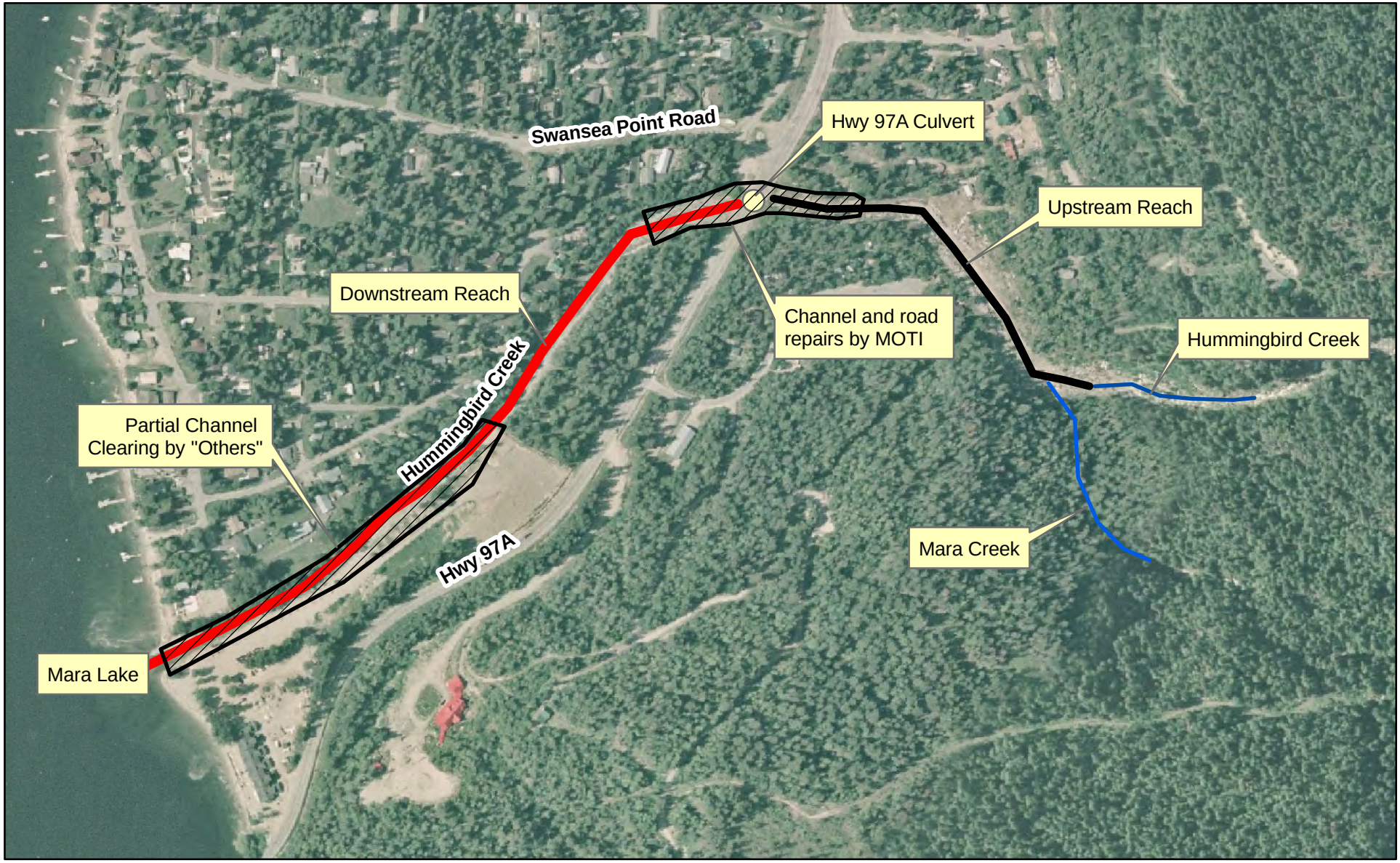

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0 30 60 120 180 240 Meters

Swansea Point - Hummingbird Creek Location Plan

Figure 1

APPENDIX B

Hec-Ras Model Results – Tables 2 to 6

LEGEND

—·—·—·— AS-CONSTRUCTED TOP OF BANK

– – – – – AS-CONSTRUCTED BOTTOM OF BANK

NOTES

1. CONTOURS CREATED FROM LiDAR SURVEY DATA (PROVIDED BY MoT) DATED SEPTEMBER 2011 AND ARE SHOWN IN 0.5m INTERVALS.
2. ALL PROPERTY LINES ARE TO BE CONSIDERED APPROXIMATE AND ARE TO BE CONFIRMED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.
3. POST CONSTRUCTION SURVEY COMPLETED MARCH 2013 BY SETCH SURVEYS.

REFERENCES

BASE IMAGERY PROVIDED BY THE CLIENT (MOTI).

NORTH-WEST IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE.
IMAGERY DATE: APRIL 10, 2004. GOOGLE EARTH IMAGE IS NOT TO SCALE.

50 0 50
SCALE METRES

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
△	-	-	-	-	-	-

PROJECT
B.C. MINISTRY OF TRANSPORTATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
OVERALL SITE PLAN & HEC-RAS CROSS-SECTION LOCATIONS

Golder Associates

PROJECT No. 12-1494-0066-4001-003B			FILE No.	12-1494-0066
DESIGN	RP	10-10-12	SCALE	1:2,500
CADD	RP	10-10-12	FIGURE	1
CHECK	MS	10-10-12		
REVIEW	RM	10-10-12		

N:\Active\2012\1494\12-1494-0066 MoTI As And When\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modelling\09 CAD\Asbuilts May 29\12-1494-0066 Base.dwg | Layout: Figure 1 | Modified: rpurdy 08/14/2013 2:45 PM | Plotted: rpurdy 08/14/2013

Table 2 - Hec-Ras Model Output - LiDAR Survey - 200-Year Flow rate

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Top of Bank (m)	Freeboard (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
1	32	200 Yr	20.1	395.17	396.21	405.9	9.69	396.21	396.45	0.031651	2.19	9.18	18.53	0.99
1	31	200 Yr	20.1	394.58	395.68	399.39	3.71	395.68	395.95	0.030957	2.29	8.79	16.41	1
1	30	200 Yr	20.1	393.74	394.82	398.3	3.48	394.82	395.21	0.028647	2.76	7.27	9.34	1
1	29	200 Yr	20.1	391.7	392.88	397.16	4.28	392.88	393.26	0.028349	2.74	7.34	9.6	1
1	28	200 Yr	20.1	388.14	389.25	391.6	2.35	389.25	389.61	0.02866	2.67	7.54	10.25	0.99
1	27	200 Yr	20.1	386.6	387.68	389.21	1.53	387.68	388.06	0.028533	2.72	7.39	9.79	1
1	26	200 Yr	20.1	383.58	384.51	386.33	1.82	384.51	384.85	0.0289	2.61	7.71	11.15	1
1	25	200 Yr	20.1	382.22	383.2	384.7	1.5	383.2	383.56	0.028921	2.63	7.63	10.86	1
1	24	200 Yr	20.1	380.04	381.1	382.89	1.79	381.1	381.48	0.028569	2.73	7.37	9.72	1
1	23	200 Yr	20.1	378.28	379.56	381.23	1.67	379.56	379.95	0.028105	2.76	7.28	9.29	1
1	22	200 Yr	20.1	377.86	378.95	381.46	2.51	378.93	379.26	0.027748	2.48	8.1	12.32	0.98
1	21	200 Yr	20.1	377.43	378.57	380.18	1.61	378.57	378.97	0.028637	2.8	7.19	9.05	1
1	20	200 Yr	20.1	376.27	377.34	378.79	1.45	377.34	377.72	0.028075	2.74	7.34	9.52	1
1	19	200 Yr	20.1	372.01	373.26	376.34	3.08	373.26	373.7	0.028883	2.95	6.82	7.84	1.01
1	18	200 Yr	20.1	370.45	372.45	374	1.55	371.57	372.53	0.002828	1.22	16.49	12.52	0.34
1	17	200 Yr	20.1	369.75	372.17	372.64	0.47	371.31	372.47	0.004629	2.4	8.36	10.8	0.5
1	16.5		Culvert											
1	16	200 Yr	20.1	367.56	368.86	370.78	1.92	368.86	369.45	0.023378	3.4	5.91	7.44	1
1	15	200 Yr	20.1	367.6	368.53	369.86	1.33	368.53	368.85	0.014729	2.52	7.97	12.49	1.01
1	14	200 Yr	20.1	363.82	364.93	367.69	2.76	364.93	365.31	0.014217	2.76	7.28	9.54	1.01
1	13	200 Yr	20.1	362.97	363.73	366.77	3.04	363.73	364.01	0.015434	2.36	8.53	15.36	1.01
1	12	200 Yr	20.1	361.43	362.3	365.27	2.97	362.3	362.55	0.015424	2.22	9.06	18.08	1
1	11	200 Yr	20.1	360.51	361.54	364.17	2.63	361.54	361.83	0.015003	2.36	8.53	15.13	1
1	10	200 Yr	20.1	358.59	359.55	361.67	2.12	359.55	359.89	0.014187	2.58	7.79	11.5	1
1	9	200 Yr	20.1	356.43	357.73	360.42	2.69	357.73	358.16	0.013906	2.91	6.91	8.01	1
1	8	200 Yr	20.1	354.64	355.7	357.37	1.67	355.7	356.08	0.013957	2.75	7.31	9.51	1
1	7	200 Yr	20.1	352.84	354	356.05	2.05	354	354.44	0.014149	2.94	6.83	7.85	1.01
1	6	200 Yr	20.1	351.9	352.77	353.27	0.5	352.77	353.12	0.014454	2.62	7.66	11.07	1.01
1	5	200 Yr	20.1	350.94	351.81	352.45	0.64	351.81	352.15	0.013997	2.58	7.79	11.34	0.99
1	4	200 Yr	20.1	349.79	350.82	351.32	0.5	350.82	351.18	0.013794	2.67	7.54	10.26	0.99
1	3	200 Yr	20.1	348.59	349.62	350.11	0.49	349.62	349.99	0.013847	2.72	7.4	9.71	0.99
1	2	200 Yr	20.1	347.38	348.32	350.1	1.78	348.32	348.69	0.014263	2.67	7.52	10.46	1.01
1	1	200 Yr	20.1	346.49	347.16	347.28	0.12	347.16	347.4	0.015423	2.16	9.32	19.54	1

Table 3 - Hec-Ras Model Output - LiDAR Survey - 100-Year Flow rate

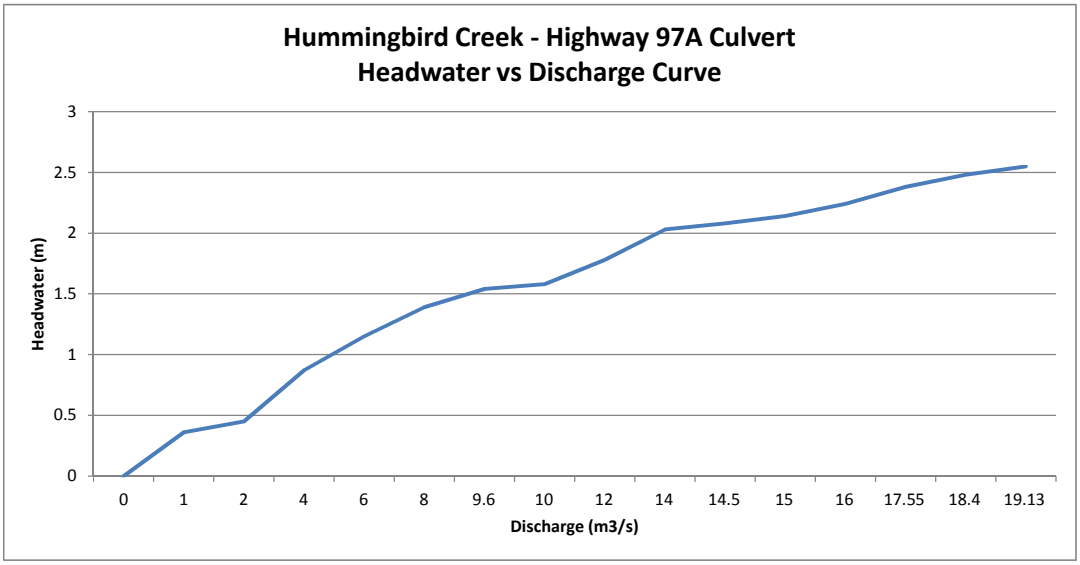
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Top of Bank (m)	Freeboard (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
1	32	100 Yr	19	395.17	396.18	405.9	9.72	396.18	396.42	0.033063	2.17	8.74	18.45	1.01
1	31	100 Yr	19	394.58	395.66	399.39	3.73	395.66	395.92	0.031259	2.25	8.46	16.35	1
1	30	100 Yr	19	393.74	394.79	398.3	3.51	394.79	395.17	0.029329	2.74	6.92	9.16	1.01
1	29	100 Yr	19	391.7	392.84	397.16	4.32	392.84	393.22	0.028576	2.7	7.03	9.46	1
1	28	100 Yr	19	388.14	389.22	391.6	2.38	389.22	389.57	0.02925	2.63	7.21	10.17	1
1	27	100 Yr	19	386.6	387.65	389.21	1.56	387.65	388.02	0.028528	2.67	7.1	9.66	1
1	26	100 Yr	19	383.58	384.48	386.33	1.85	384.48	384.82	0.02923	2.57	7.39	11.02	1
1	25	100 Yr	19	382.22	383.18	384.7	1.52	383.18	383.52	0.02856	2.58	7.37	10.72	0.99
1	24	100 Yr	19	380.04	381.07	382.89	1.82	381.07	381.44	0.028785	2.69	7.07	9.6	1
1	23	100 Yr	19	378.28	379.52	381.23	1.71	379.52	379.9	0.028997	2.75	6.91	9.09	1.01
1	22	100 Yr	19	377.86	378.91	381.46	2.55	378.91	379.22	0.029274	2.48	7.65	12.11	1
1	21	100 Yr	19	377.43	378.54	380.18	1.64	378.54	378.92	0.028876	2.75	6.9	8.95	1
1	20	100 Yr	19	376.27	377.31	378.79	1.48	377.31	377.68	0.028335	2.7	7.03	9.39	1
1	19	100 Yr	19	372.01	373.22	376.34	3.12	373.22	373.65	0.029071	2.9	6.54	7.74	1.01
1	18	100 Yr	19	370.45	372.36	374	1.64	371.54	372.44	0.003073	1.24	15.35	12.12	0.35
1	17	100 Yr	19	369.75	372.1	372.64	0.54	371.25	372.38	0.004624	2.35	8.09	10.53	0.5
1	16.5		Culvert											
1	16	100 Yr	19	367.56	368.82	370.78	1.96	368.82	369.38	0.023549	3.33	5.71	7.34	1
1	15	100 Yr	19	367.6	368.5	369.86	1.36	368.5	368.82	0.014846	2.49	7.62	12.23	1.01
1	14	100 Yr	19	363.82	364.89	367.69	2.8	364.89	365.27	0.014339	2.72	6.99	9.43	1.01
1	13	100 Yr	19	362.97	363.7	366.77	3.07	363.7	363.98	0.015635	2.32	8.19	15.28	1.01
1	12	100 Yr	19	361.43	362.28	365.27	2.99	362.28	362.53	0.015604	2.18	8.71	18	1
1	11	100 Yr	19	360.51	361.52	364.17	2.65	361.52	361.79	0.015211	2.32	8.18	15	1
1	10	100 Yr	19	358.59	359.53	361.67	2.14	359.53	359.85	0.014324	2.54	7.48	11.38	1
1	9	100 Yr	19	356.43	357.69	360.42	2.73	357.69	358.11	0.014006	2.87	6.61	7.85	1
1	8	100 Yr	19	354.64	355.66	357.37	1.71	355.66	356.04	0.014275	2.72	6.98	9.38	1.01
1	7	100 Yr	19	352.84	353.97	356.05	2.08	353.97	354.39	0.014253	2.9	6.55	7.74	1.01
1	6	100 Yr	19	351.9	352.75	353.27	0.52	352.75	353.09	0.014352	2.57	7.4	10.98	1
1	5	100 Yr	19	350.94	351.78	352.45	0.67	351.78	352.11	0.014163	2.55	7.46	11.2	1
1	4	100 Yr	19	349.79	350.78	351.32	0.54	350.78	351.14	0.014293	2.65	7.17	10.11	1
1	3	100 Yr	19	348.59	349.58	350.11	0.53	349.58	349.95	0.014067	2.69	7.07	9.56	1
1	2	100 Yr	19	347.38	348.3	350.1	1.8	348.3	348.65	0.014343	2.63	7.22	10.35	1.01
1	1	100 Yr	19	346.49	347.14	347.28	0.14	347.14	347.37	0.015496	2.13	8.94	19.25	1

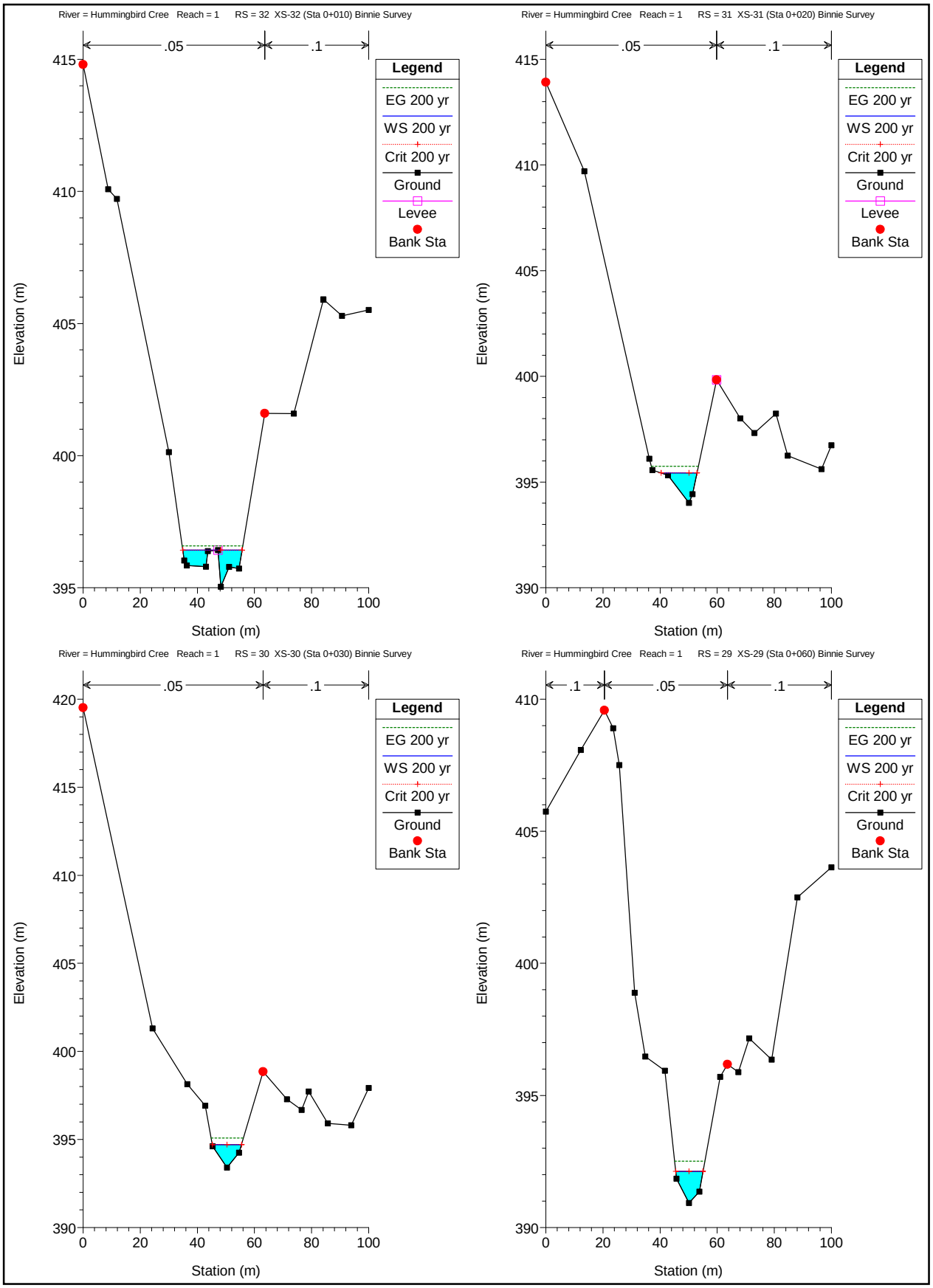
Table 4 - Hummingbird Creek - Highway 97A Culvert Assessment

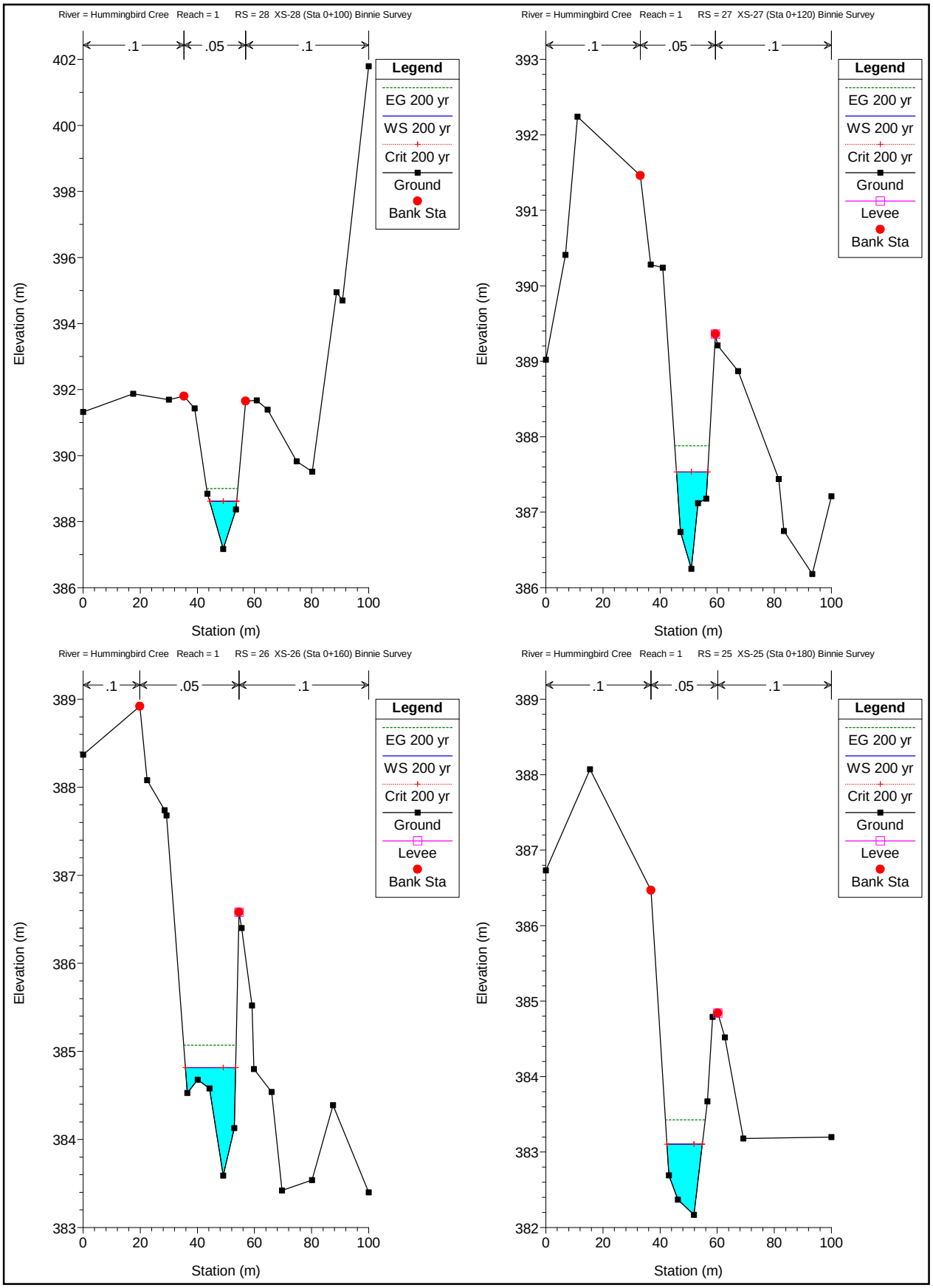
Return Period (m3/s)	E.G. US. (m)	W.S. US. (m)	E.G. IC (m)	E.G. OC (m)	Min El Weir Flow (m)	Q Culv Group (m3/s)	Q Weir (m3/s)	Delta WS (m)	Culv Vel US (m/s)	Culv Vel DS (m/s)	H/W (m)
0						0					0
1	370.11	370.02	370.11	370.08	372.12	1		2.08	1.42	2.32	0.36
2	370.3	370.17	370.3	370.3	372.12	2		2.14	1.79	3.03	0.45
4	370.63	370.49	370.61	370.63	372.12	4		2.36	2.19	3.9	0.87
6	370.93	370.77	370.86	370.93	372.12	6		2.56	2.58	4.53	1.15
8	371.2	371.01	371.1	371.2	372.12	8		2.7	2.84	4.88	1.39
MAF	371.37	371.16	371.27	371.37	372.12	9.6		2.76	2.93	5.15	1.54
10	371.41	371.2	371.32	371.41	372.12	10		2.79	2.97	5.22	1.58
12	371.63	371.4	371.51	371.63	372.12	12		2.88	3.16	5.51	1.78
14	371.89	371.65	371.71	371.89	372.12	14		3.05	3.52	5.75	2.03
10 Yr	371.94	371.7	371.76	371.94	372.12	14.5		3.07	3.56	5.81	2.08
15	372	371.76	371.81	372	372.12	15		3.11	3.6	5.86	2.14
16	372.11	371.86	371.91	372.11	372.12	16		3.16	3.68	5.97	2.24
50 Yr	372.27	372	372.06	372.27	372.12	17.55	0.25	3.23	3.79	6.12	2.38
100 Yr (19)	372.38	372.1	372.15	372.38	372.12	18.4	0.6	3.28	3.93	6.19	2.48
200 Yr (20.1)	372.47	372.17	372.22	372.47	372.12	19.13	0.97	3.32	4.03	6.25	2.55

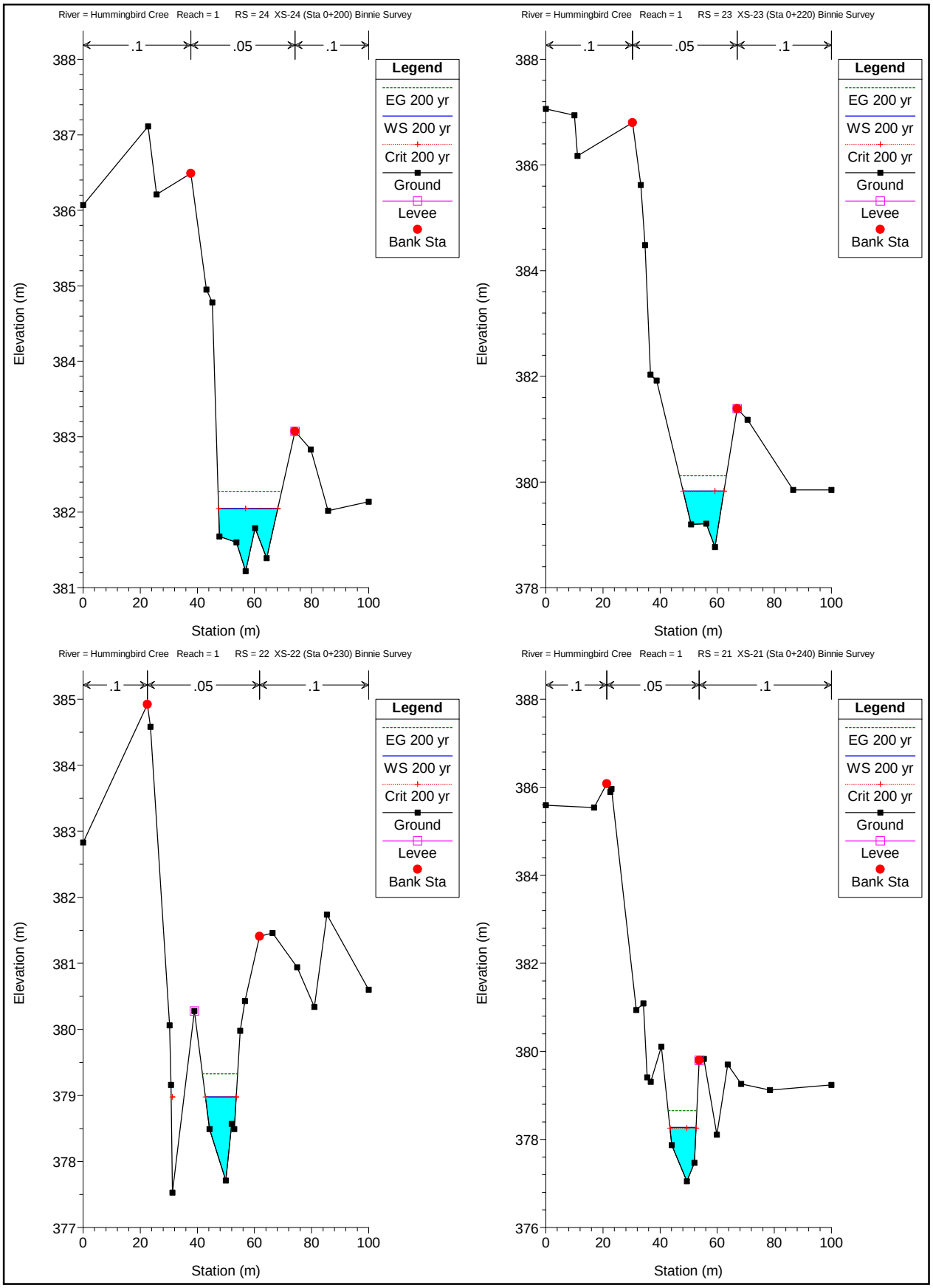
Existing culvert assumed to be 3.75 m span x 2.36 m rise SPCSP Pipe Arch

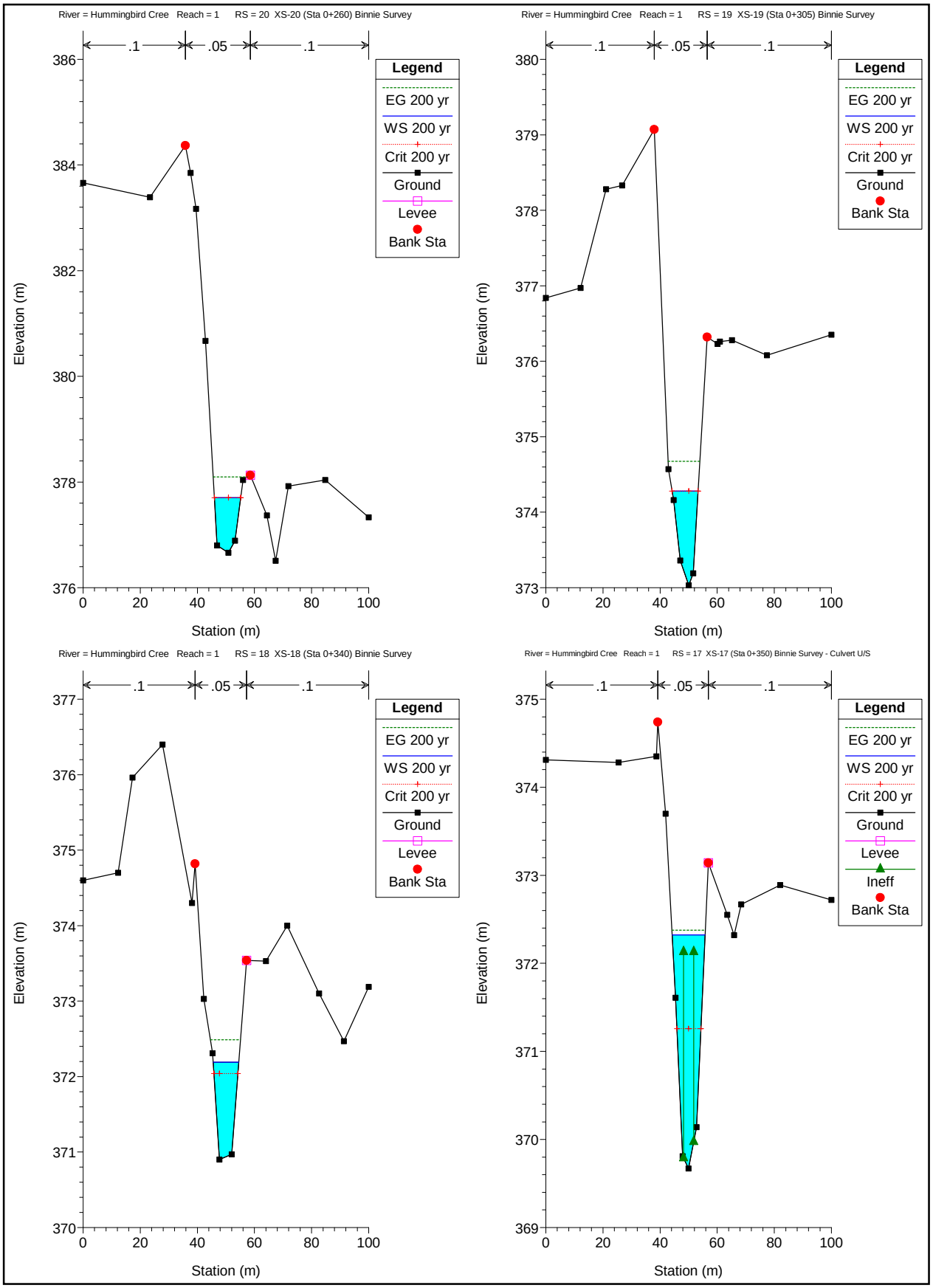
Upstream invert Elev =	369.62	m
Rise =	2.36	m
Crown of culvert =	371.98	m
Top of Headwall =	372	m
Crown of Road =	372.13	m

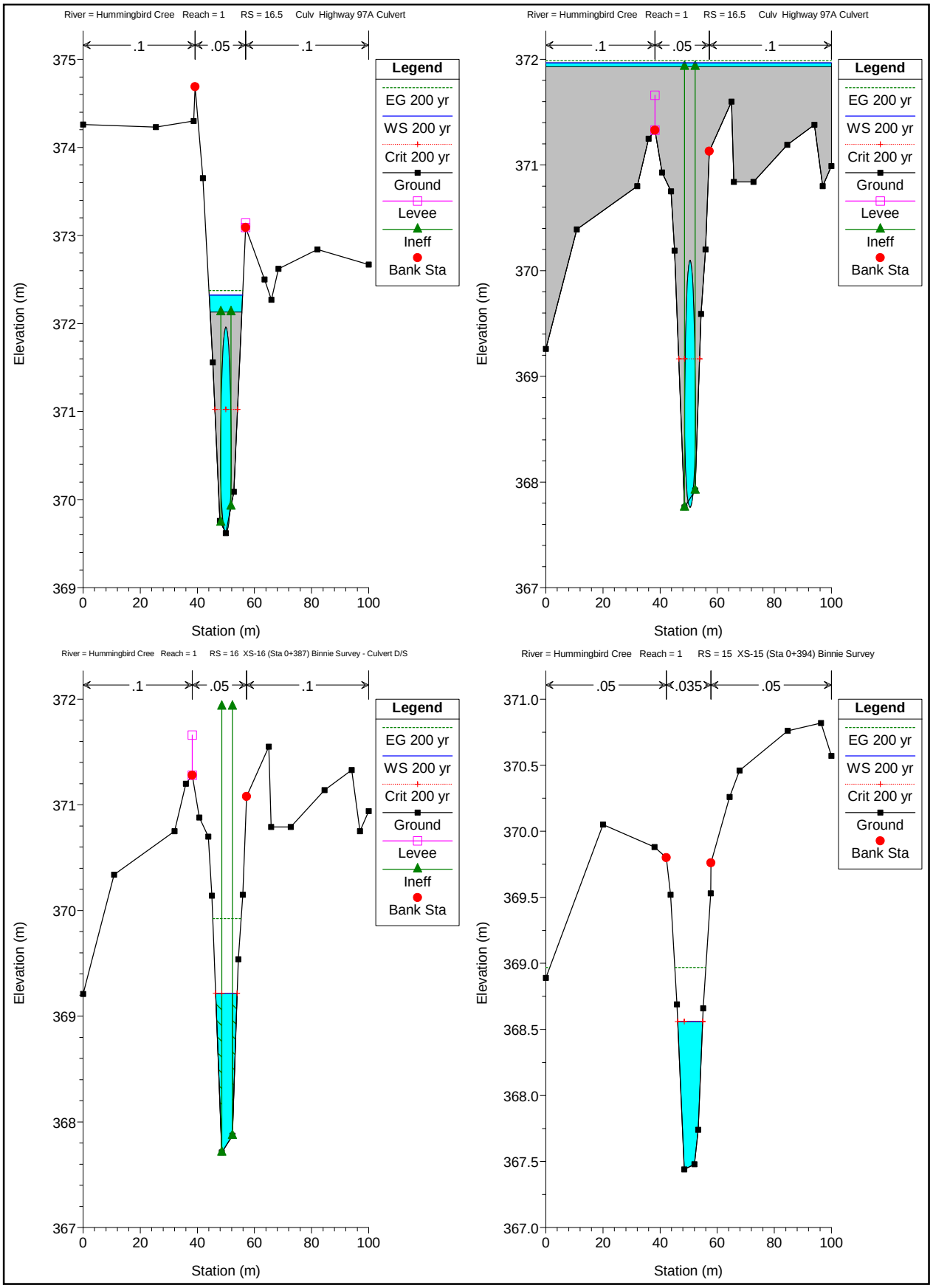


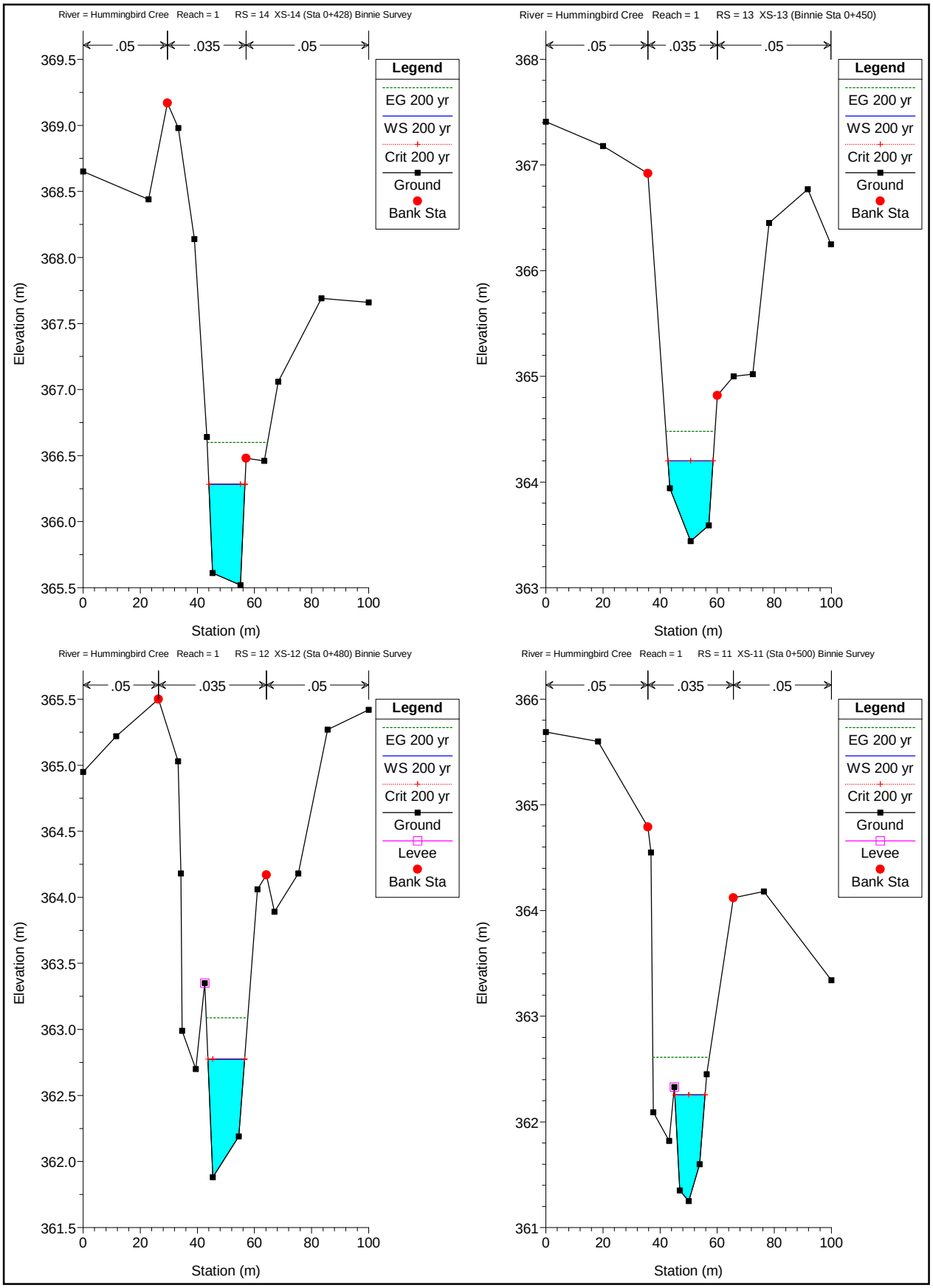

River = Hummingbird Cree Reach = 1 RS = 32 XS-32 (Sta 0+010) Binnie Survey
.05
.1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 31 XS-31 (Sta 0+020) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 30 XS-30 (Sta 0+030) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 29 XS-29 (Sta 0+060) Binnie Survey

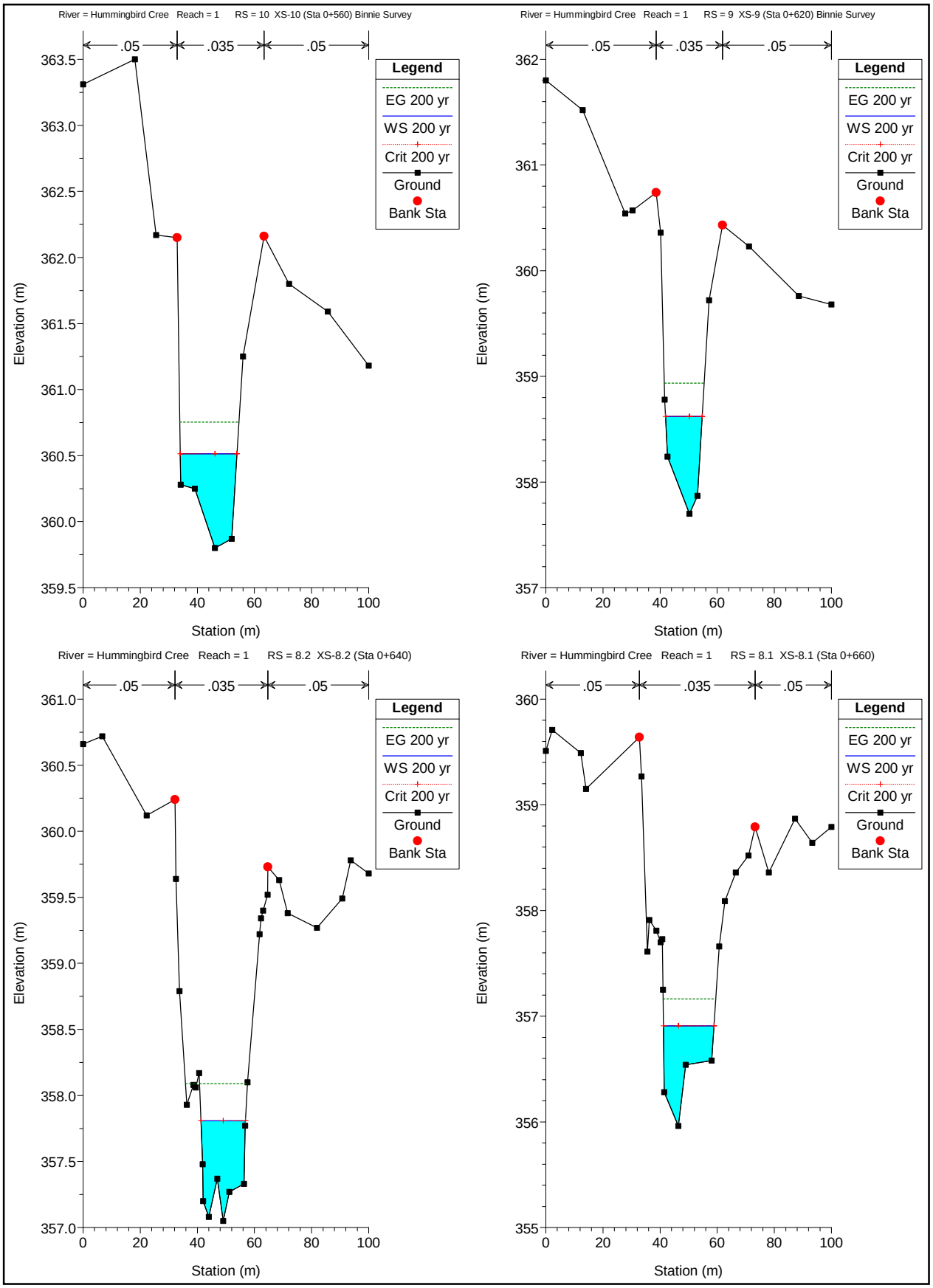

River = Hummingbird Cree Reach = 1 RS = 28 XS-28 (Sta 0+100) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 27 XS-27 (Sta 0+120) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 26 XS-26 (Sta 0+160) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 25 XS-25 (Sta 0+180) Binnie Survey
.1
.05
.1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)

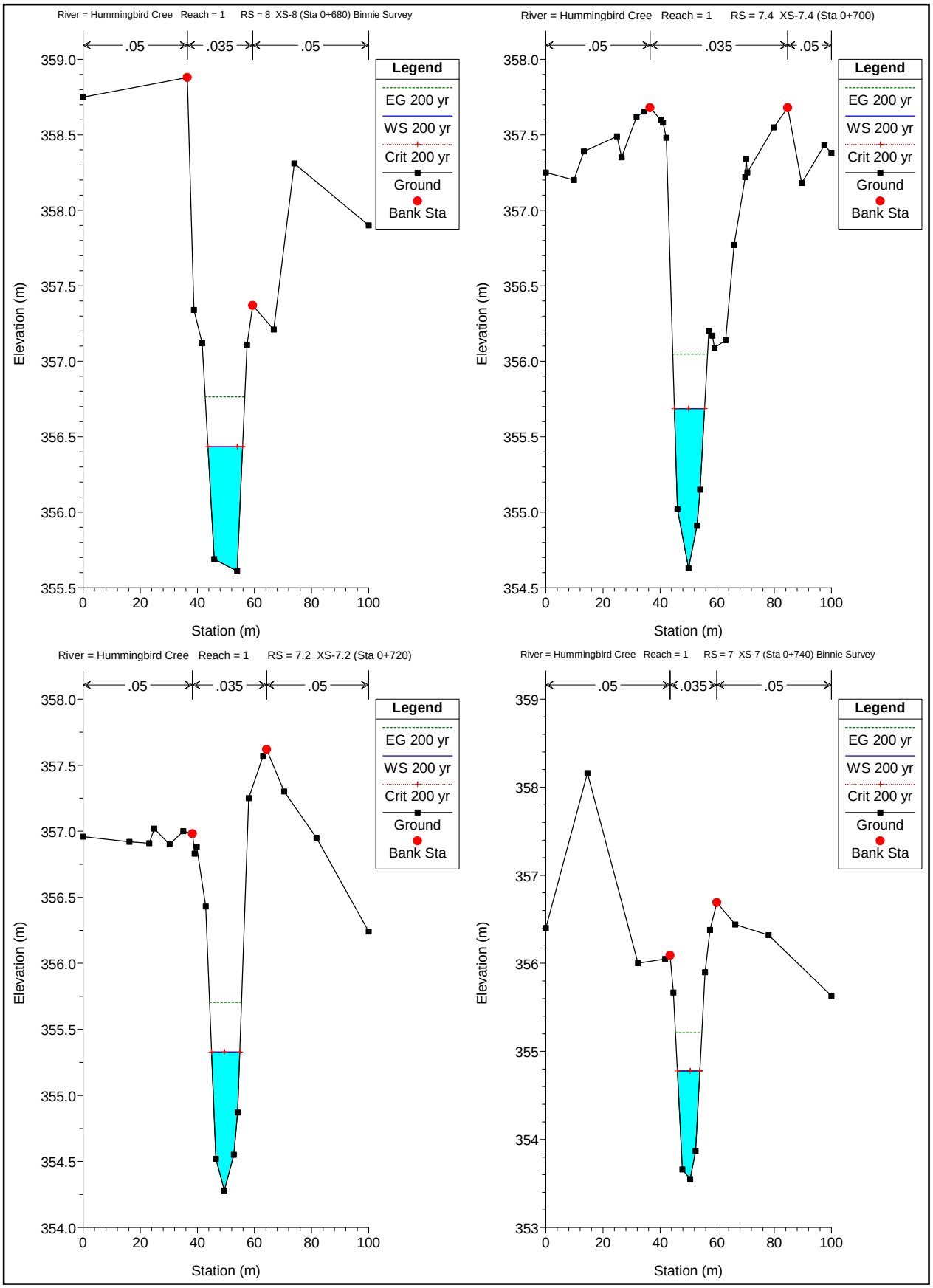

River = Hummingbird Cree Reach = 1 RS = 24 XS-24 (Sta 0+200) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 23 XS-23 (Sta 0+220) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 22 XS-22 (Sta 0+230) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 21 XS-21 (Sta 0+240) Binnie Survey
.1
.05
.1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)

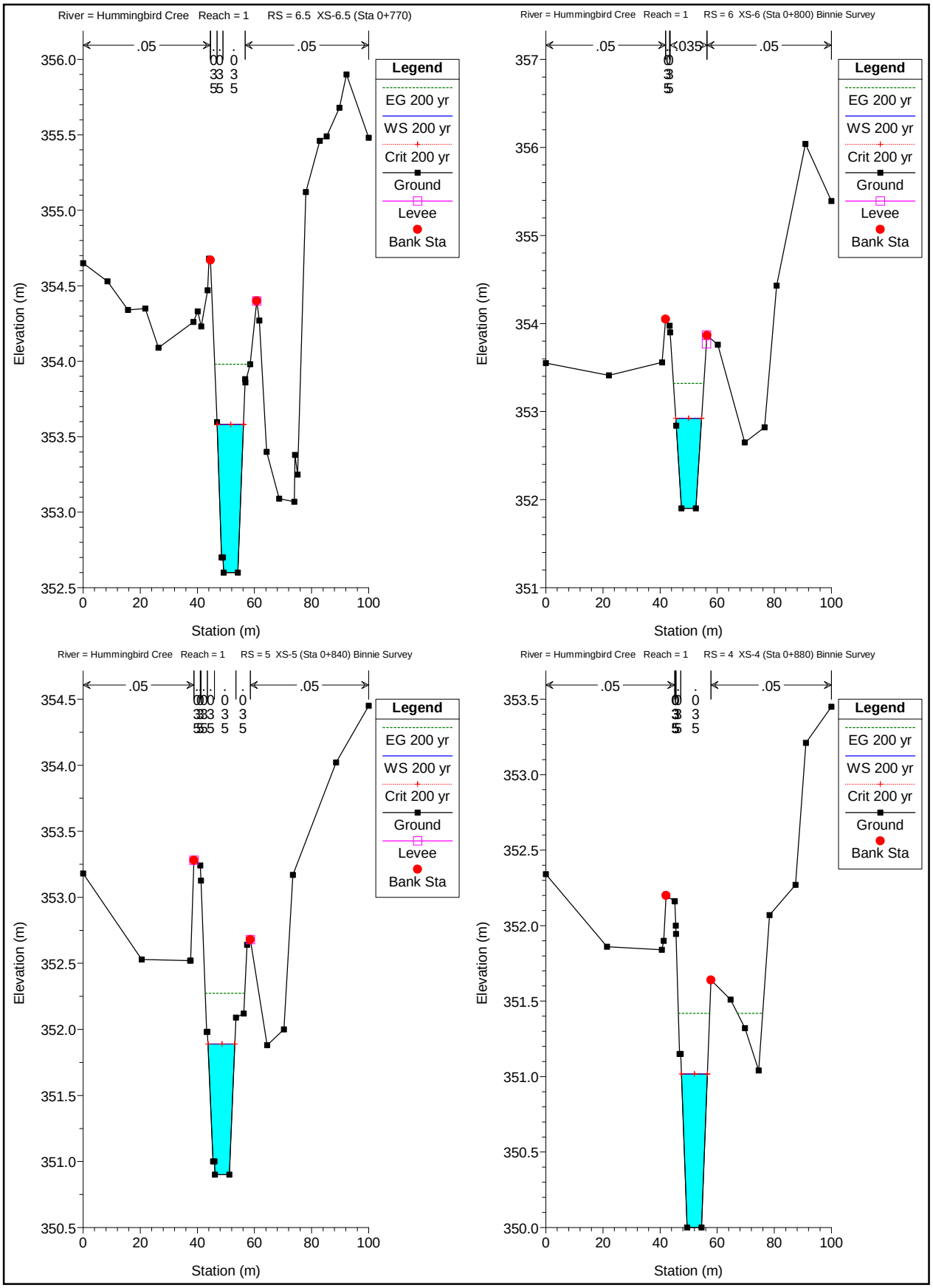

River = Hummingbird Cree Reach = 1 RS = 20 XS-20 (Sta 0+260) Binnie Survey
.1
.05
.1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 19 XS-19 (Sta 0+305) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 18 XS-18 (Sta 0+340) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 17 XS-17 (Sta 0+350) Binnie Survey - Culvert U/S
Ineff

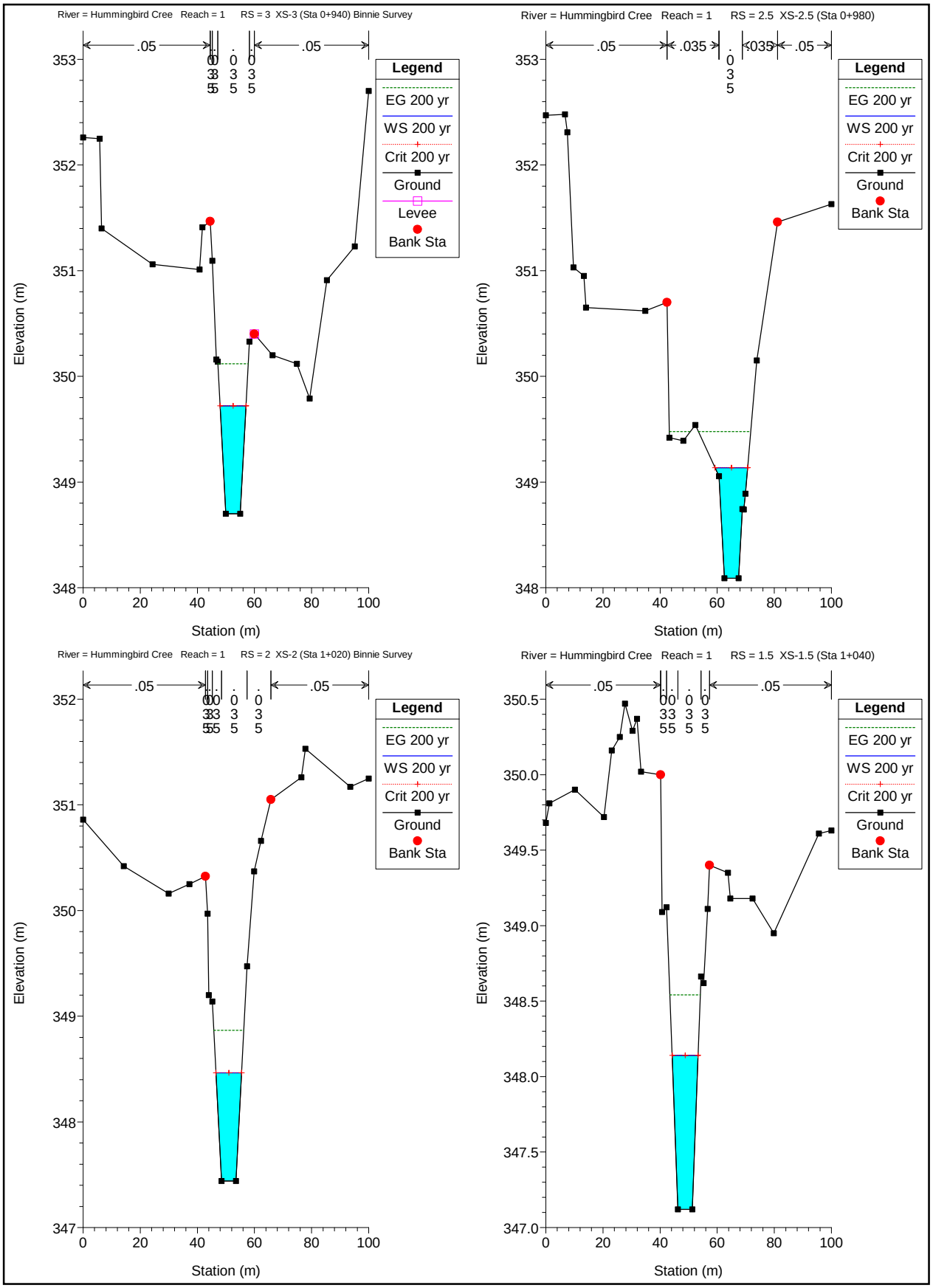

River = Hummingbird Cree Reach = 1 RS = 16.5 Culv Highway 97A Culvert
.1
.05
.1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 16.5 Culv Highway 97A Culvert
.1
.05
.1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 16 XS-16 (Sta 0+387) Binnie Survey - Culvert D/S
.1
.05
.1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 15 XS-15 (Sta 0+394) Binnie Survey
.05
.035
.05
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Bank Sta
Elevation (m)
Station (m)

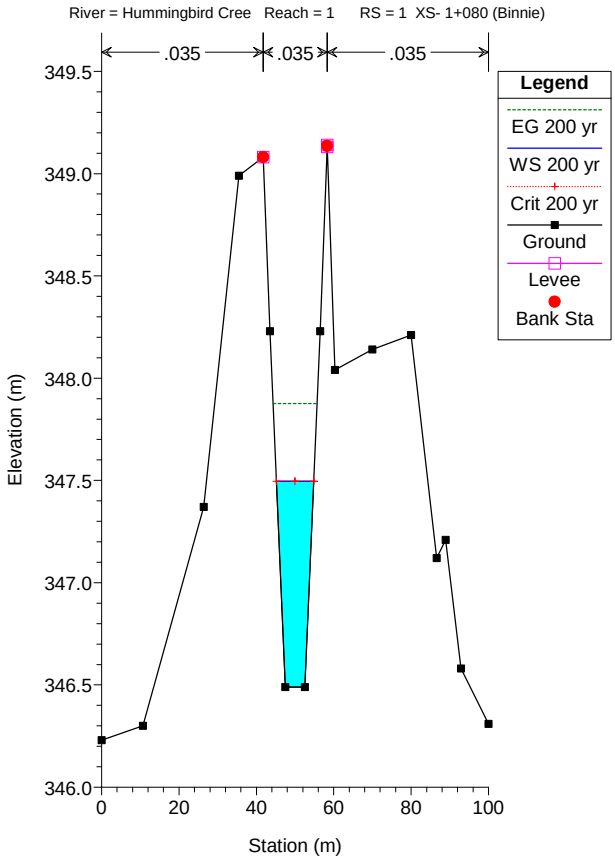

River = Hummingbird Cree Reach = 1 RS = 14 XS-14 (Sta 0+428) Binnie Survey
.05
.035
.05
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 13 XS-13 (Binnie Sta 0+450)
.05
.035
.05
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 12 XS-12 (Sta 0+480) Binnie Survey
.05
.035
.05
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 11 XS-11 (Sta 0+500) Binnie Survey
.05
.035
.05
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)


River = Hummingbird Cree Reach = 1 RS = 10 XS-10 (Sta 0+560) Binnie Survey
.05
.035
.05
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 9 XS-9 (Sta 0+620) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 8.2 XS-8.2 (Sta 0+640)
River = Hummingbird Cree Reach = 1 RS = 8.1 XS-8.1 (Sta 0+660)


River = Hummingbird Cree Reach = 1 RS = 8 XS-8 (Sta 0+680) Binnie Survey
.05
.035
.05
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Bank Sta
Elevation (m)
Station (m)
River = Hummingbird Cree Reach = 1 RS = 7.4 XS-7.4 (Sta 0+700)
River = Hummingbird Cree Reach = 1 RS = 7.2 XS-7.2 (Sta 0+720)
River = Hummingbird Cree Reach = 1 RS = 7 XS-7 (Sta 0+740) Binnie Survey


River = Hummingbird Cree Reach = 1 RS = 6.5 XS-6.5 (Sta 0+770)
River = Hummingbird Cree Reach = 1 RS = 6 XS-6 (Sta 0+800) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 5 XS-5 (Sta 0+840) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 4 XS-4 (Sta 0+880) Binnie Survey
.05
.035
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)


River = Hummingbird Cree Reach = 1 RS = 3 XS-3 (Sta 0+940) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 2.5 XS-2.5 (Sta 0+980)
River = Hummingbird Cree Reach = 1 RS = 2 XS-2 (Sta 1+020) Binnie Survey
River = Hummingbird Cree Reach = 1 RS = 1.5 XS-1.5 (Sta 1+040)
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
.05
.035


River = Hummingbird Cree Reach = 1 RS = 1 XS- 1+080 (Binnie)
.035
.035
.035
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Levee
Bank Sta
Elevation (m)
349.5
349.0
348.5
348.0
347.5
347.0
346.5
346.0
0
20
40
60
80
100
Station (m)

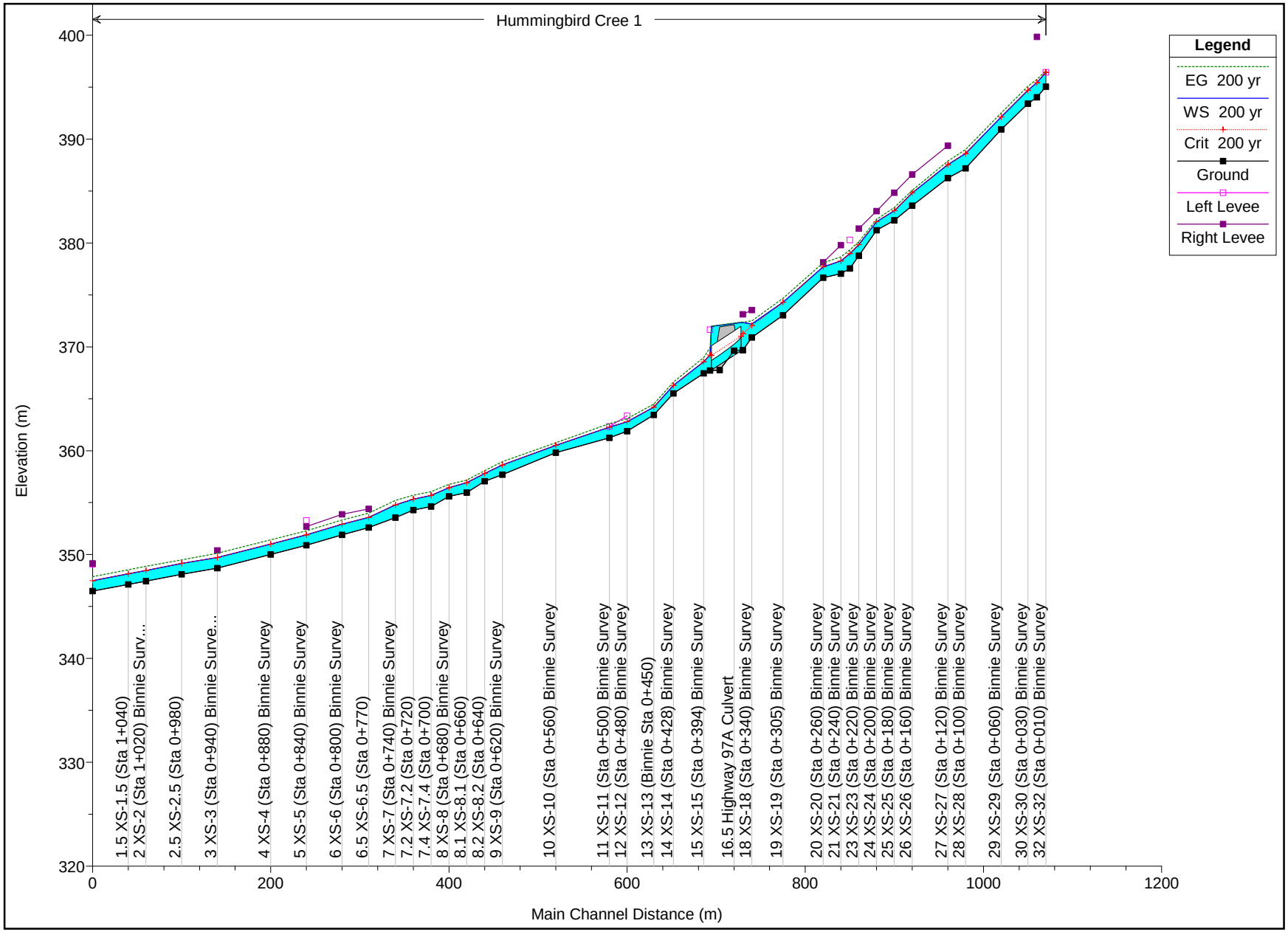

Hummingbird Cree 1
Legend
EG 200 yr
WS 200 yr
Crit 200 yr
Ground
Left Levee
Right Levee
Elevation (m)
Main Channel Distance (m)
400
390
380
370
360
350
340
330
320
0
200
400
600
800
1000
1200
1.5 XS-1.5 (Sta 1+040)
2 XS-2 (Sta 1+020) Binnie Surv...
2.5 XS-2.5 (Sta 0+980)
3 XS-3 (Sta 0+940) Binnie Surve...
4 XS-4 (Sta 0+880) Binnie Survey
5 XS-5 (Sta 0+840) Binnie Survey
6 XS-6 (Sta 0+800) Binnie Survey
6.5 XS-6.5 (Sta 0+770)
7 XS-7 (Sta 0+740) Binnie Survey
7.2 XS-7.2 (Sta 0+720)
7.4 XS-7.4 (Sta 0+700)
8 XS-8 (Sta 0+680) Binnie Survey
8.1 XS-8.1 (Sta 0+660)
8.2 XS-8.2 (Sta 0+640)
9 XS-9 (Sta 0+620) Binnie Survey
10 XS-10 (Sta 0+560) Binnie Survey
11 XS-11 (Sta 0+500) Binnie Survey
12 XS-12 (Sta 0+480) Binnie Survey
13 XS-13 (Binnie Sta 0+450)
14 XS-14 (Sta 0+428) Binnie Survey
15 XS-15 (Sta 0+394) Binnie Survey
16.5 Highway 97A Culvert
18 XS-18 (Sta 0+340) Binnie Survey
19 XS-19 (Sta 0+305) Binnie Survey
20 XS-20 (Sta 0+260) Binnie Survey
21 XS-21 (Sta 0+240) Binnie Survey
23 XS-23 (Sta 0+220) Binnie Survey
24 XS-24 (Sta 0+200) Binnie Survey
25 XS-25 (Sta 0+180) Binnie Survey
26 XS-26 (Sta 0+160) Binnie Survey
27 XS-27 (Sta 0+120) Binnie Survey
28 XS-28 (Sta 0+100) Binnie Survey
29 XS-29 (Sta 0+060) Binnie Survey
30 XS-30 (Sta 0+030) Binnie Survey
32 XS-32 (Sta 0+010) Binnie Survey

Table 5 - Hec-Ras Model Output - Combined Lidar & Binnie Surveys - Design Channel Modification - Steady Flow Analysis - Sub-Critical Flow Regime

River Sta	Hec-Ras Station	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Top of Bank (m)	Freeboard (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
32	0+010	200 yr	20.1	395.04	396.42	401.6	5.18	396.42	396.59	0.020392	1.8	11.15	20.83	0.79
31	0+020	200 yr	20.1	394.01	395.43	399.84	4.41	395.43	395.75	0.029539	2.49	8.06	12.56	0.99
30	0+030	200 yr	20.1	393.41	394.71	398.85	4.14	394.71	395.08	0.029315	2.7	7.43	10.2	1.01
29	0+060	200 yr	20.1	390.93	392.13	397.16	5.03	392.13	392.51	0.028536	2.74	7.33	9.56	1
28	0+100	200 yr	20.1	387.17	388.61	391.67	3.06	388.61	389.01	0.029365	2.77	7.25	9.48	1.01
27	0+120	200 yr	20.1	386.25	387.53	389.36	1.83	387.53	387.88	0.028938	2.61	7.71	10.99	0.99
26	0+160	200 yr	20.1	383.59	384.81	386.58	1.77	384.81	385.07	0.0319	2.24	8.99	17.59	1
25	0+180	200 yr	20.1	382.17	383.11	384.84	1.73	383.11	383.43	0.028992	2.51	8.01	12.4	1
24	0+200	200 yr	20.1	381.22	382.05	383.07	1.02	382.05	382.28	0.03277	2.12	9.46	20.72	1
23	0+220	200 yr	20.1	378.77	379.83	381.39	1.56	379.83	380.12	0.029643	2.39	8.42	14.3	0.99
22	0+230	200 yr	20.1	377.53	378.98	380.28	1.3	378.98	379.33	0.02867	2.62	7.67	10.82	0.99
21	0+240	200 yr	20.1	377.05	378.27	379.83	1.56	378.26	378.65	0.027454	2.74	7.34	9.16	0.98
20	0+260	200 yr	20.1	376.66	377.7	378.13	0.43	377.7	378.09	0.028453	2.77	7.26	9.22	1
19	0+305	200 yr	20.1	373.03	374.28	376.32	2.04	374.28	374.68	0.028517	2.79	7.2	9.1	1
18	0+340	200 yr	20.1	370.9	372.19	373.54	1.35	372.04	372.49	0.017665	2.42	8.31	8.95	0.8
17	0+350	200 yr	20.1	369.67	372.32	373.14	0.82	371.26	372.38	0.001487	1.02	19.78	11.54	0.25
16.5			Culvert											
16	0+387	200 yr	20.1	367.71	369.22	371.28	2.06	369.22	369.92	0.02164	3.73	5.39	7.55	1
15	0+394	200 yr	20.1	367.44	368.56	369.88	1.32	368.56	368.97	0.014057	2.84	7.08	8.74	1.01
14	0+428	200 yr	20.1	365.52	366.28	367.69	1.41	366.28	366.6	0.01442	2.49	8.06	12.68	1
13	0+450	200 yr	20.1	363.44	364.2	366.77	2.57	364.2	364.48	0.015259	2.34	8.6	15.75	1.01
12	0+480	200 yr	20.1	361.88	362.77	364.17	1.4	362.77	363.09	0.014389	2.48	8.1	12.85	1
11	0+500	200 yr	20.1	361.25	362.26	364.12	1.86	362.26	362.61	0.013905	2.64	7.61	10.63	1
10	0+560	200 yr	20.1	359.8	360.51	362.15	1.64	360.51	360.75	0.01612	2.16	9.29	19.91	1.01
9	0+620	200 yr	20.1	357.7	358.62	360.43	1.81	358.62	358.94	0.014447	2.49	8.08	12.8	1
8.2	0+640	200 yr	20.1	357.05	357.81	359.73	1.92	357.81	358.09	0.01557	2.35	8.57	15.56	1.01
8.1	0+660	200 yr	20.1	355.96	356.91	358.79	1.88	356.91	357.16	0.015841	2.24	8.97	17.71	1
8	0+680	200 yr	20.1	355.61	356.43	357.37	0.94	356.43	356.76	0.014508	2.54	7.9	12.13	1.01
7.4	0+700	200 yr	20.1	354.63	355.69	357.68	1.99	355.69	356.05	0.014183	2.66	7.54	10.55	1.01
7.2	0+720	200 yr	20.1	354.28	355.33	356.98	1.65	355.33	355.7	0.013943	2.71	7.4	9.86	1
7	0+740	200 yr	20.1	353.55	354.78	356.09	1.31	354.78	355.21	0.013895	2.93	6.87	7.87	1
6.5	0+770	200 yr	20.1	352.6	353.58	354.4	0.82	353.58	353.98	0.014306	2.8	7.19	9.23	1.01
6	0+800	200 yr	20.1	351.9	352.92	353.86	0.94	352.92	353.32	0.013863	2.79	7.22	9.1	1
5	0+840	200 yr	20.1	350.9	351.89	352.68	0.79	351.89	352.27	0.013809	2.75	7.32	9.42	0.99
4	0+880	200 yr	20.1	350	351.02	351.64	0.62	351.02	351.42	0.014211	2.81	7.15	9.07	1.01
3	0+940	200 yr	20.1	348.7	349.72	350.4	0.68	349.72	350.12	0.014006	2.8	7.19	9.08	1
2.5	0+980	200 yr	20.1	348.09	349.14	350.7	1.56	349.14	349.48	0.014453	2.58	7.78	11.47	1
2	1+020	200 yr	20.1	347.44	348.46	350.32	1.86	348.46	348.87	0.014085	2.81	7.15	8.96	1.01
1.5	1+040	200 yr	20.1	347.12	348.14	349.4	1.26	348.14	348.54	0.014057	2.8	7.18	9.06	1
1	1+080	200 yr	20.1	346.49	347.5	349.08	1.58	347.5	347.88	0.013862	2.73	7.35	9.62	1

Note: In Table 5 above, Sta 0+260 shows that prior to construction the available freeboard above the 1:200-year water level was less than the design criteria of 600 mm. Bar scalping, bed-load removal and riprap bank protection measures were executed and installed upstream of Highway 97A during February and March of 2013 that provided increased channel capacity and freeboard at Sta 0+260. Based on the post construction survey completed by Setch Surveys, the top of bank elevation at Sta 0+260 was increased to approximately 379.3 m resulting in approximately 1.7 m of freeboard above the revised 1:200-year water level of 377.6 m.

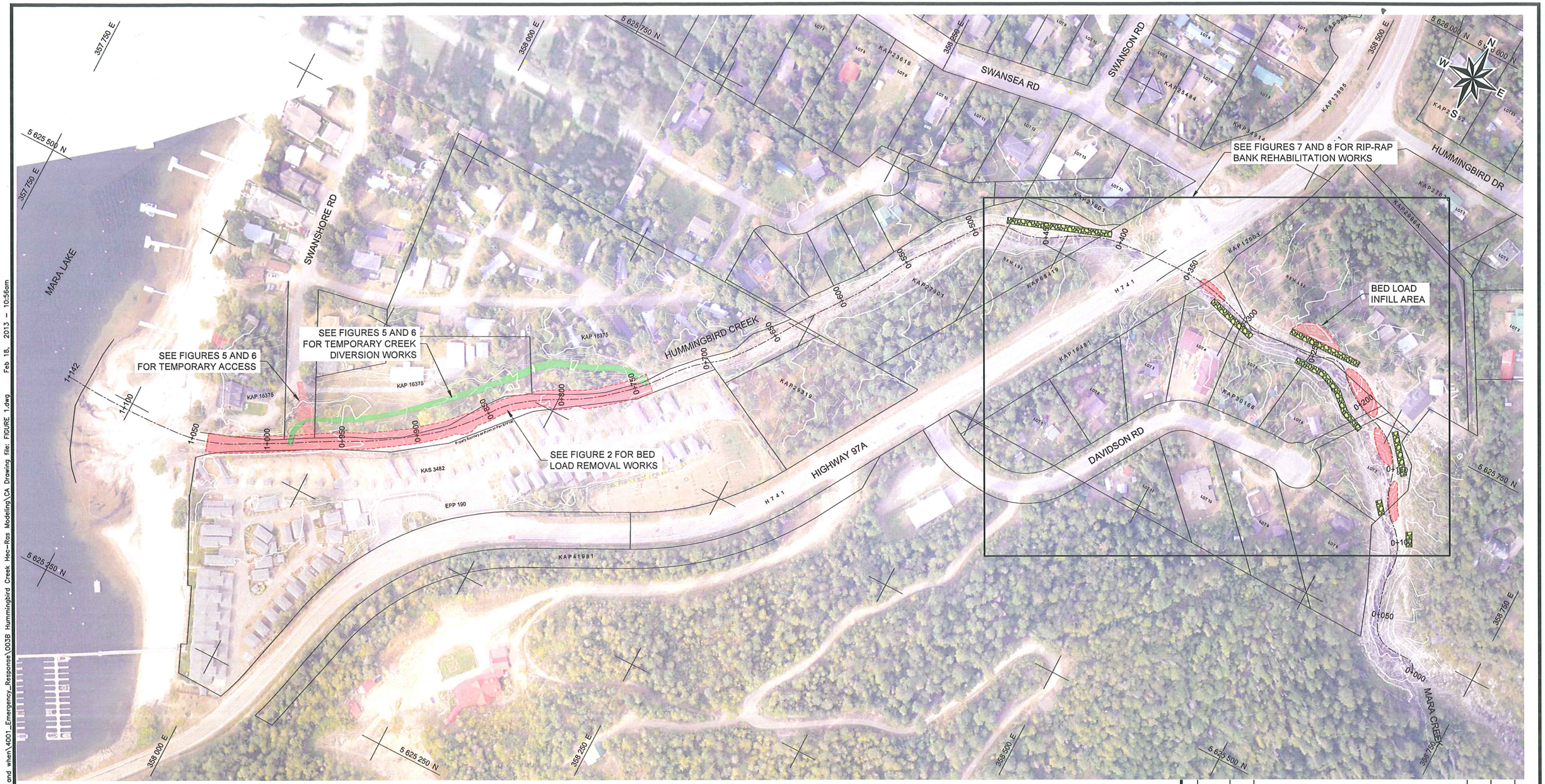
Table 6 - Hec-Ras Model Output - Combined Lidar & Binnie Surveys - Design Channel Modification - Steady Flow Analysis - Mixed Flow Regime

River Sta	Hec-Ras Station	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Top of Bank (m)	Freeboard (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
32	0+010	200 yr	20.1	395.04	396.3	401.6	5.3	396.42	397.04	0.075103	3.81	5.27	8.16	1.51
31	0+020	200 yr	20.1	394.01	395.06	399.84	4.78	395.43	396.08	0.117483	4.48	4.49	8.16	1.93
30	0+030	200 yr	20.1	393.41	394.55	398.85	4.3	394.72	395.15	0.058417	3.43	5.87	9.54	1.39
29	0+060	200 yr	20.1	390.93	391.84	397.16	5.32	392.13	392.78	0.109616	4.28	4.69	8.77	1.87
28	0+100	200 yr	20.1	387.17	388.39	391.67	3.28	388.62	389.14	0.074417	3.84	5.23	8.52	1.56
27	0+120	200 yr	20.1	386.25	387.43	389.36	1.93	387.53	387.9	0.046083	3.04	6.62	10.67	1.23
26	0+160	200 yr	20.1	383.59	384.58	386.58	2	384.81	385.33	0.093834	3.84	5.24	10.19	1.71
25	0+180	200 yr	20.1	382.17	382.91	384.84	1.93	383.11	383.55	0.08162	3.54	5.68	11.46	1.6
24	0+200	200 yr	20.1	381.22	382.01	383.07	1.06	382.05	382.28	0.043004	2.32	8.67	20.47	1.14
23	0+220	200 yr	20.1	378.77	379.52	381.39	1.87	379.83	380.59	0.204566	4.57	4.39	12.04	2.42
22	0+230	200 yr	20.1	377.53	378.8	380.28	1.48	378.98	379.4	0.063334	3.43	5.87	10.07	1.43
21	0+240	200 yr	20.1	377.05	378.07	379.83	1.76	378.26	378.75	0.065913	3.66	5.49	8.67	1.47
20	0+260	200 yr	20.1	376.66	377.7	378.13	0.43	377.7	378.09	0.028453	2.77	7.26	9.22	1
19	0+305	200 yr	20.1	373.03	373.84	376.32	2.48	374.28	375.35	0.182476	5.46	3.68	6.92	2.39
18	0+340	200 yr	20.1	370.9	372.19	373.54	1.35	372.04	372.49	0.017665	2.42	8.31	8.95	0.8
17	0+350	200 yr	20.1	369.67	372.32	373.14	0.82	371.26	372.38	0.001487	1.02	19.78	11.54	0.25
16.5			Culvert											
16	0+387	200 yr	20.1	367.71	369.22	371.28	2.06	369.22	369.92	0.02164	3.73	5.39	7.55	1
15	0+394	200 yr	20.1	367.44	368.14	369.88	1.74	368.56	369.58	0.084572	5.32	3.78	7.09	2.33
14	0+428	200 yr	20.1	365.52	366.02	367.69	1.67	366.28	366.87	0.066068	4.09	4.92	11.64	2.01
13	0+450	200 yr	20.1	363.44	363.93	366.77	2.84	364.2	364.96	0.117299	4.5	4.47	14.23	2.56
12	0+480	200 yr	20.1	361.88	362.62	364.17	1.55	362.77	363.16	0.031896	3.24	6.21	12.03	1.44
11	0+500	200 yr	20.1	361.25	362.16	364.12	1.96	362.26	362.63	0.020592	3.02	6.65	10.18	1.19
10	0+560	200 yr	20.1	359.8	360.38	362.15	1.77	360.52	360.84	0.046776	3.01	6.67	19.44	1.64
9	0+620	200 yr	20.1	357.7	358.53	360.43	1.9	358.62	358.95	0.022355	2.87	7	12.46	1.22
8.2	0+640	200 yr	20.1	357.05	357.62	359.73	2.11	357.81	358.26	0.057639	3.54	5.69	15	1.83
8.1	0+660	200 yr	20.1	355.96	356.78	358.79	2.01	356.9	357.24	0.040764	3.01	6.69	17.33	1.55
8	0+680	200 yr	20.1	355.61	356.42	357.37	0.95	356.43	356.76	0.015713	2.61	7.69	12.04	1.04
7.4	0+700	200 yr	20.1	354.63	355.44	357.68	2.24	355.68	356.23	0.044077	3.92	5.13	9.47	1.7
7.2	0+720	200 yr	20.1	354.28	355.33	356.98	1.65	355.33	355.7	0.014076	2.72	7.38	9.85	1
7	0+740	200 yr	20.1	353.55	354.58	356.09	1.51	354.77	355.29	0.027402	3.72	5.4	7.24	1.38
6.5	0+770	200 yr	20.1	352.6	353.3	354.4	1.1	353.58	354.21	0.047323	4.22	4.77	8.18	1.76
6	0+800	200 yr	20.1	351.9	352.9	353.86	0.96	352.92	353.32	0.015259	2.88	6.98	8.99	1.04
5	0+840	200 yr	20.1	350.9	351.66	352.68	1.02	351.89	352.4	0.035332	3.8	5.29	8.51	1.54
4	0+880	200 yr	20.1	350	351	351.64	0.64	351.02	351.42	0.015146	2.87	7	9	1.04
3	0+940	200 yr	20.1	348.7	349.54	350.4	0.86	349.72	350.19	0.02811	3.57	5.63	8.37	1.39
2.5	0+980	200 yr	20.1	348.09	349.14	350.7	1.56	349.14	349.48	0.014462	2.59	7.77	11.46	1
2	1+020	200 yr	20.1	347.44	348.44	350.32	1.88	348.46	348.87	0.015553	2.91	6.9	8.86	1.05
1.5	1+040	200 yr	20.1	347.12	348.1	349.4	1.3	348.14	348.54	0.016547	2.97	6.78	8.88	1.08
1	1+080	200 yr	20.1	346.49	347.45	349.08	1.63	347.5	347.88	0.016393	2.9	6.93	9.42	1.08

Note: In Table 6 above, Sta 0+260 shows that prior to construction the available freeboard above the 1:200-year water level was less than the design criteria of 600 mm. Bar scalping, bed-load removal and riprap bank protection measures were executed and installed upstream of Highway 97A during February and March of 2013 that provided increased channel capacity and freeboard at Sta 0+260. Based on the post construction survey completed by Setch Surveys, the top of bank elevation at Sta 0+260 was increased to approximately 379.3 m resulting in approximately 1.7 m of freeboard above the revised 1:200-year water level of 377.6 m.

APPENDIX C

Design Drawings



LEGEND

- PROPOSED BED LOAD REMOVAL LOCATIONS
- PROPOSED TEMPORARY DIVERSION CREEK LOCATIONS
- PROPOSED RIP-RAP REHABILITATION WORKS

CONSTRUCTION NOTES

1. ADHERE TO ALL ENVIRONMENTAL REQUIREMENTS AS PER SUMMIT ENVIRONMENTAL INCLUDING FISH SALVAGE AND DE-WATERING.
2. SEDIMENT REMOVAL AND CHANNEL EXCAVATIONS ARE REQUIRED BETWEEN STA 0+740 AND 1+040.
3. EXCAVATE EXISTING CHANNEL TO MAINTAIN A CONSISTENT GRADE BETWEEN EACH STATION.
4. MAINTAIN A MINIMUM 5.0m WIDE CHANNEL BASE WIDTH WITH 2H:1V SIDE SLOPES EXTENDING TO DAYLIGHT AT TOP OF EXISTING BANKS.
5. EXCAVATION IS TO REMAIN WITHIN THE CURRENT CHANNEL AND ADJUSTMENTS CAN BE MADE TO BED WIDTH AND SIDE SLOPES TO PREVENT DISRUPTION TO THE EXISTING CREEK BANKS AND BANK PROTECTIONS. AVOID DISTURBANCE TO SOUTH BANK.
6. EXISTING BOULDER CLUSTER WEIRS LOCATED JUST DOWNSTREAM OF THE HIGHWAY 97A CULVERT ARE TO REMAIN INTACT.
7. INSTALL RIP-RAP BANK REHABILITATION WORKS AS SHOWN.

NOTES

1. CONTOURS CREATED FROM LIDAR SURVEY DATA (PROVIDED BY MoT) DATED SEPTEMBER 2011 AND ARE SHOWN IN 0.5m INTERVALS.
2. ALL PROPERTY LINES ARE TO BE CONSIDERED APPROXIMATE AND ARE TO BE CONFIRMED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

50 0 50
SCALE METRES

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
FEB 15, 2013

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	15-02-13	RP/MSH	ISSUED FOR CONSTRUCTION	MSH	MS	RM
1	23-11-12	RP	ISSUED FOR REVIEW	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

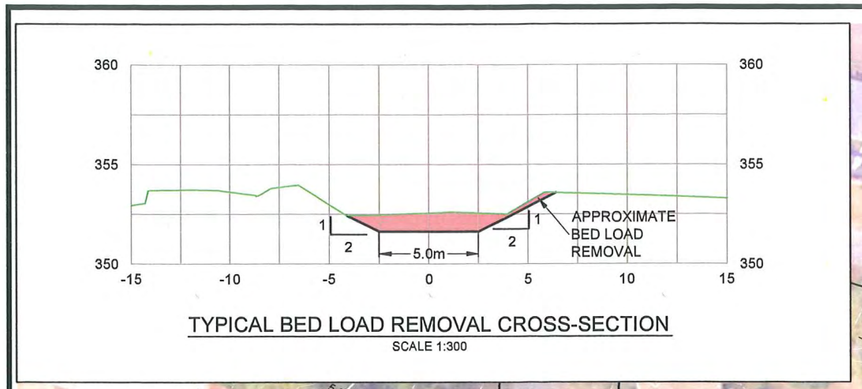
TITLE
OVERALL SITE PLAN

Golder Associates

PROJECT No.	12-1494-0066.4001.0039		FILE No.	FIGURE 1
DESIGN	RP	10-10-12	SCALE AS NOTED	REV. 2
CADD	RP	10-10-12		
CHECK	MS	10-10-12		
REVIEW	RM	10-10-12		

FIGURE 1

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 MoTI as and when\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\CA Drawing file: FIGURE 1.dwg Feb 18, 2013 - 10:56am



TYPICAL BED LOAD REMOVAL CROSS-SECTION

SCALE 1:300

LAYOUT TABLE					
STATION	POINT ID	NORTHING (m)	EASTING (m)	PROPOSED THALWEG INVERT (m)	PROPOSED DEPTH OF EXCAVATION (m)
0+740	RMV-001	5625546.21	358174.02	353.55	0.00m
0+760	RMV-002	5625532.27	358159.70	352.92	0.24m
0+780	RMV-003	5625519.84	358144.04	352.36	0.56m
0+800	RMV-004	5625509.65	358126.86	351.87	0.91m
0+820	RMV-005	5625499.51	358109.63	351.39	0.97m
0+840	RMV-006	5625486.81	358094.26	350.90	0.99m
0+860	RMV-007	5625470.96	358082.08	350.47	0.91m
0+880	RMV-008	5625456.23	358068.57	350.03	1.08m

LAYOUT TABLE					
STATION	POINT ID	NORTHING (m)	EASTING (m)	PROPOSED THALWEG INVERT (m)	PROPOSED DEPTH OF EXCAVATION (m)
0+900	RMV-009	5625443.57	358053.10	349.60	1.17m
0+920	RMV-010	5625432.18	358036.67	349.16	1.25m
0+940	RMV-011	5625421.88	358019.53	348.73	1.29m
0+960	RMV-012	5625412.71	358001.76	348.41	1.37m
0+980	RMV-013	5625402.79	357984.40	348.09	1.37m
1+000	RMV-014	5625392.90	357967.02	347.77	1.47m
1+020	RMV-015	5625383.35	357949.44	347.45	1.60m
1+040	RMV-016	5625375.57	357931.06	347.13	1.80m

LEGEND

- EXISTING TOP OF BANK
- EXISTING BOTTOM OF BANK
- EXISTING LEGAL BOUNDARY
- APPROXIMATE OUTLINE OF BED LOAD REMOVAL
- PROPOSED BED LOAD REMOVAL LOCATION (2900m³)
- RMV-001 LAYOUT POINT

NOTES

1. THE INTENT IS TO CARRY OUT THE BED LOAD REMOVAL WITHOUT IMPACTING THE LEFT BANK OF HUMMINGBIRD CREEK ADJACENT TO THE HUMMINGBIRD CREEK RESORT. A PORTION OF THE LEFT BANK HAS BEEN CONSTRUCTED USING DELTALOK RETAINING WALLS.

20 0 20
SCALE METRES

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN

FEB 15, 2013.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	15-02-13	RP/MSH	ISSUED FOR CONSTRUCTION	MSH	MS	RM
1	23-11-12	RP	ISSUED FOR REVIEW	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

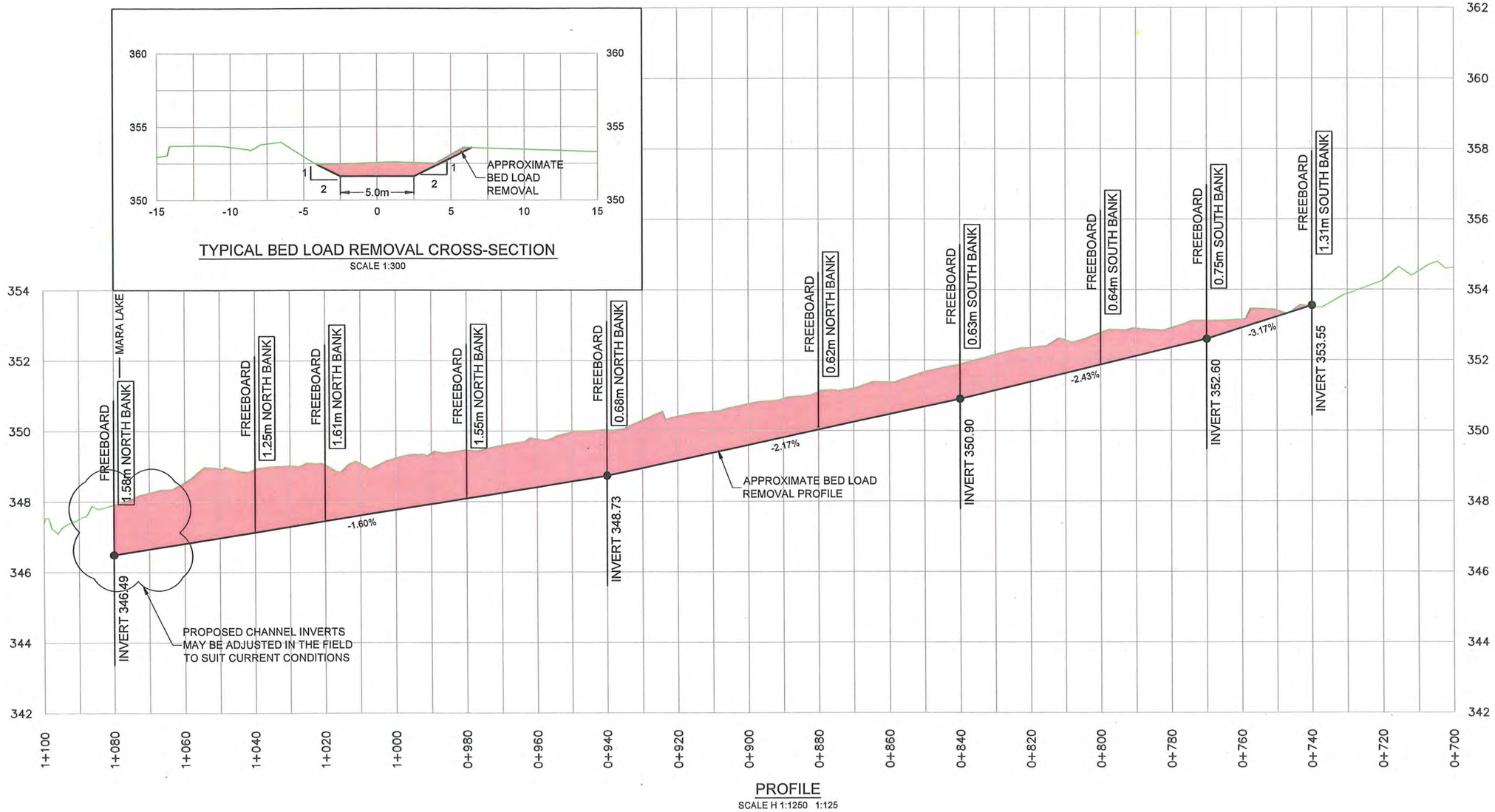
TITLE
BED LOAD REMOVAL WORKS (STA. 0+740 TO 1+050)

Golder Associates

PROJECT No. 12-1494-0066.4001.0039			FILE No. FIGURE 2
DESIGN	RP	10-10-12	SCALE AS NOTED REV. 2
CADD	RP	10-10-12	FIGURE 2
CHECK	MS	10-10-12	
REVIEW	RM	10-10-12	

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 MoTI os and when\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\CA Drawing file: FIGURE 2.dwg Feb 15, 2013 - 5:01pm

TYPICAL BED LOAD REMOVAL CROSS-SECTION
SCALE 1:300



PROFILE
SCALE H 1:1250 1:125

LEGEND

- BINNIE GROUND SURVEY
- PROPOSED BED LOAD REMOVAL

NOTES

1. LiDAR SURVEY THALWEG COMPLETED IN 2011 BY MOTI.
2. BINNIE GROUND SURVEY COMPLETED ON SEPTEMBER 30, 2012.

25 0 25
SCALE METRES

2.5 0 2.5
SCALE METRES

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
FEB 15, 2013

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	15-02-13	RP/MSH	ISSUED FOR CONSTRUCTION	MSH	MS	RM
1	23-11-12	RP	ISSUED FOR REVIEW	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

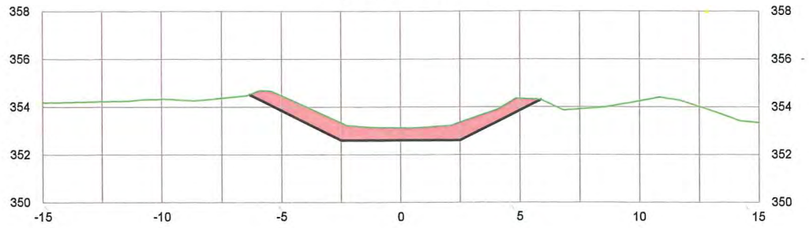
TITLE
BED LOAD REMOVAL PROFILE AND TYPICAL CROSS-SECTION

PROJECT No.	12-1494-0066.4001.003B		FILE No.		FIGURE 3
DESIGN	RP	10-10-12	SCALE	AS NOTED	REV. 2
CADD	RP	10-10-12			
CHECK	MS	10-10-12			
REVIEW	RM	10-10-12			

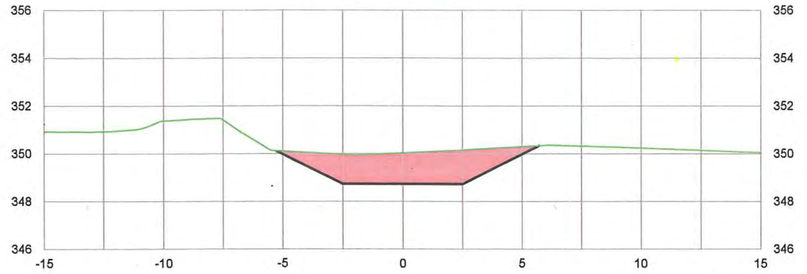
FIGURE 3

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 MoTI os and when\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\CA Drawing file: FIGURE 3.dwg Feb 15, 2013 - 5:01pm

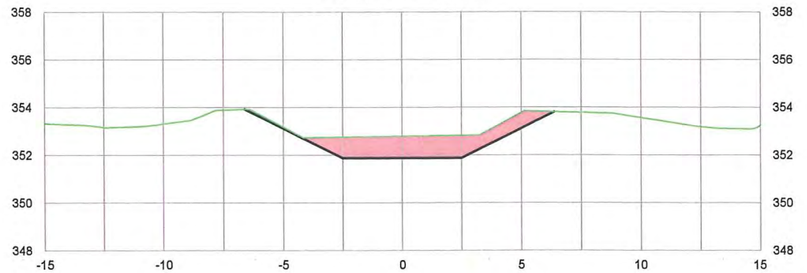
STATION 0+770.0



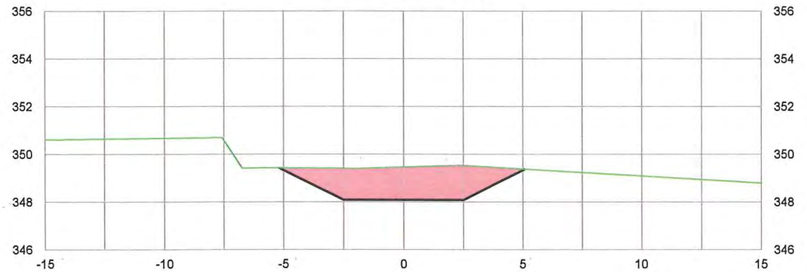
STATION 0+940.0



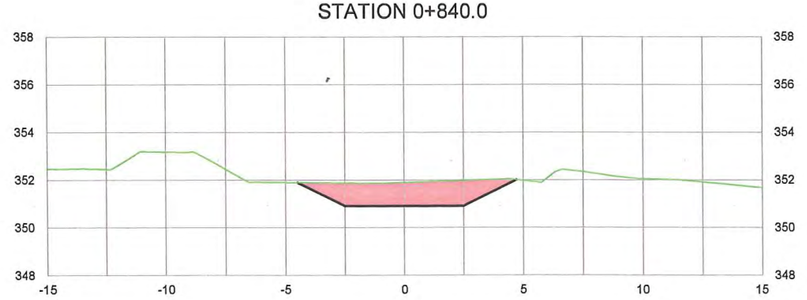
STATION 0+800.0



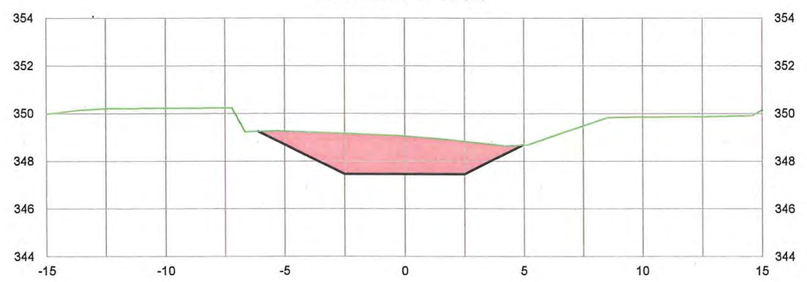
STATION 0+980.0



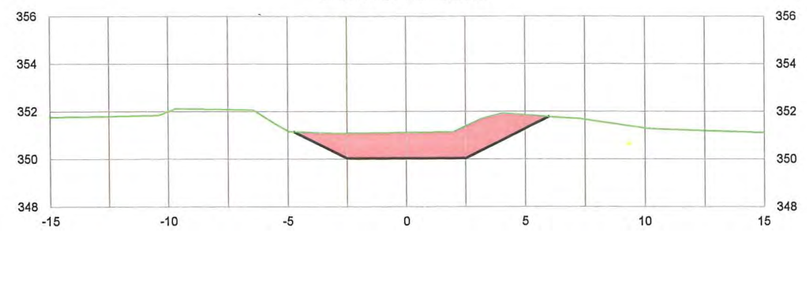
STATION 0+840.0



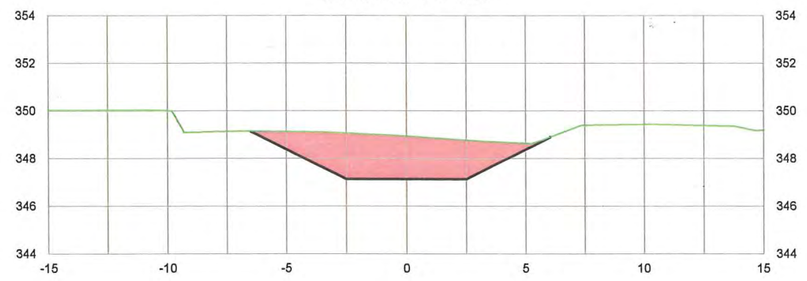
STATION 1+020.0



STATION 0+880.0



STATION 1+040.0



LEGEND

- COMBINED BINNIE & LiDAR GROUND SURFACE
- FINISHED CREEK INVERT
- PROPOSED BED LOAD REMOVAL

5 0 5
SCALE METRES

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
FEB 15, 2013

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	15-02-13	MSH	ISSUED FOR CONSTRUCTION	MSH	MS	RM
0	06-02-13	MSH	ISSUED FOR REVIEW	MSH	–	–

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
BED LOAD REMOVAL CROSS-SECTIONS

Golder Associates

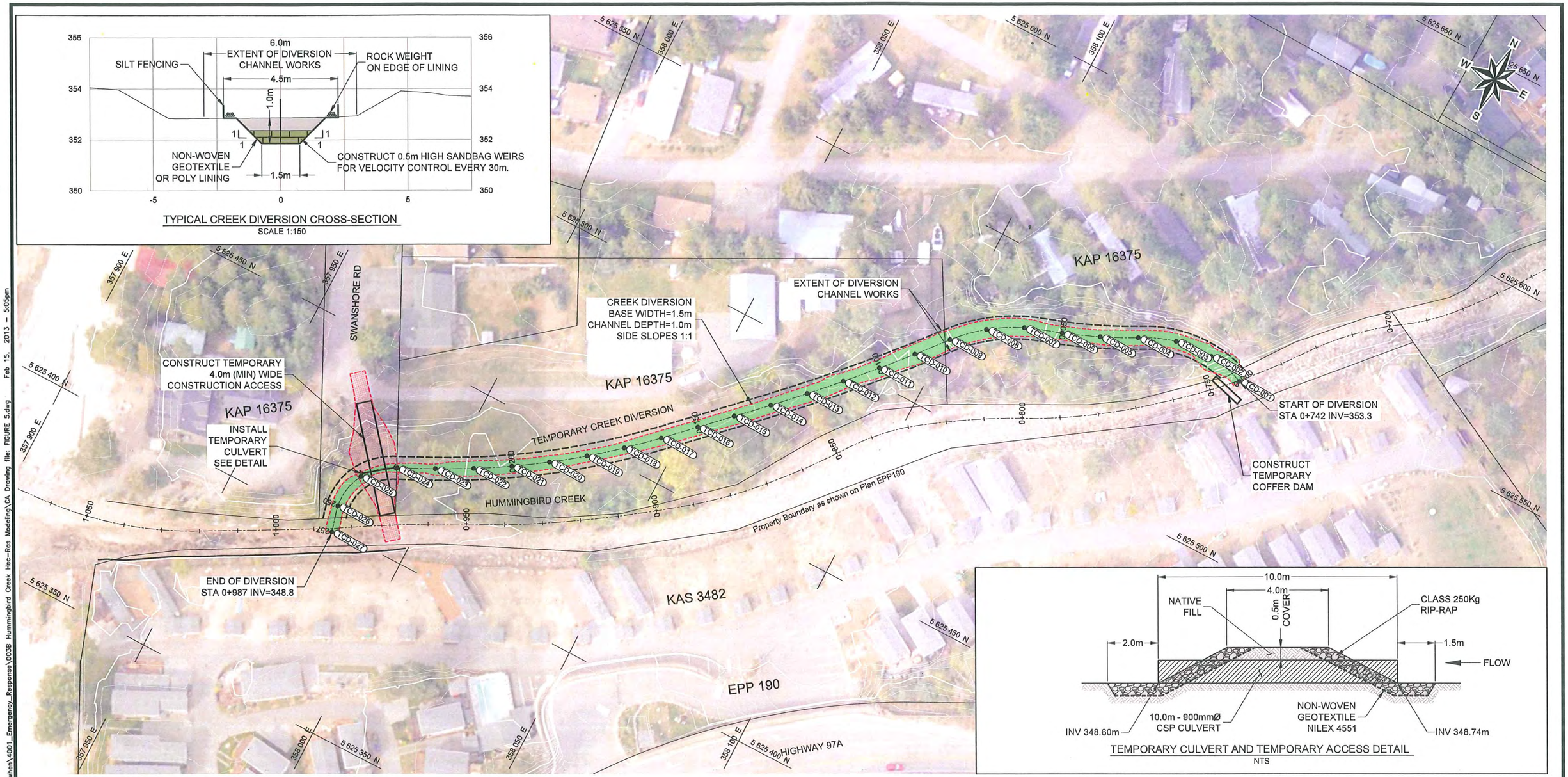
PROJECT No. 12-1494-0066.4001.0039		
DESIGN	RP	10-10-12
CADD	RP	10-10-12
CHECK	MS	10-10-12
REVIEW	RM	10-10-12

FILE No. FIGURE 4
SCALE AS NOTED REV. 0

FIGURE 4

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 MoTI as and when\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\CA Drawing file: FIGURE 4.dwg Feb 15, 2013 - 5:00pm

TYPICAL CREEK DIVERSION CROSS-SECTION
SCALE 1:150



TEMPORARY CULVERT AND TEMPORARY ACCESS DETAIL
NTS

LAYOUT TABLE				
STATION	POINT ID	NORTHING (m)	EASTING (m)	DIVERSION CHANNEL INVERT ELEVATION (m)
0+000	TCD-001	5625544.62	358172.95	352.56
0+010	TCD-002	5625546.98	358163.28	352.34
0+020	TCD-003	5625546.23	358153.35	352.13
0+030	TCD-004	5625542.46	358144.12	351.92
0+040	TCD-005	5625538.05	358135.15	351.71
0+050	TCD-006	5625534.32	358125.88	351.50
0+060	TCD-007	5625530.94	358116.47	351.31
0+070	TCD-008	5625525.90	358107.85	351.15
0+080	TCD-009	5625519.08	358100.57	350.98

LAYOUT TABLE				
STATION	POINT ID	NORTHING (m)	EASTING (m)	DIVERSION CHANNEL INVERT ELEVATION (m)
0+090	TCD-010	5625511.38	358094.19	350.82
0+100	TCD-011	5625503.83	358087.64	350.66
0+110	TCD-012	5625496.43	358080.91	350.49
0+120	TCD-013	5625489.18	358074.02	350.33
0+130	TCD-014	5625482.10	358066.96	350.16
0+140	TCD-015	5625475.12	358059.80	350.00
0+150	TCD-016	5625468.13	358052.65	349.83
0+160	TCD-017	5625461.14	358045.50	349.68
0+170	TCD-018	5625454.37	358038.14	349.54

LAYOUT TABLE				
STATION	POINT ID	NORTHING (m)	EASTING (m)	DIVERSION CHANNEL INVERT ELEVATION (m)
0+180	TCD-019	5625447.98	358030.45	349.41
0+190	TCD-020	5625441.98	358022.45	349.27
0+200	TCD-021	5625436.38	358014.16	349.14
0+210	TCD-022	5625431.21	358005.60	349.01
0+220	TCD-023	5625426.48	357996.80	348.87
0+230	TCD-024	5625422.06	357987.83	348.74
0+240	TCD-025	5625415.62	357980.40	348.60
0+250	TCD-026	5625405.99	357978.51	348.47
0+257.19	TCD-027	5625399.22	357980.26	348.38

LEGEND

- EXTENT OF DIVERSION CHANNEL WORKS
- APPROXIMATE OUTLINE OF TEMPORARY CUT/FILL LOCATIONS
- TCD-005 LAYOUT POINT
- PROPOSED TEMPORARY CREEK DIVERSION
- PROPOSED FILL AREA (950m³)

20 0 20
SCALE METRES

3 0 3
SCALE METRES

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA M.C. SULLIVAN
FEB 15, 2013

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	15-02-13	RP/MSH	ISSUED FOR CONSTRUCTION	MSH	MS	RM
1	23-11-12	RP	ISSUED FOR REVIEW	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

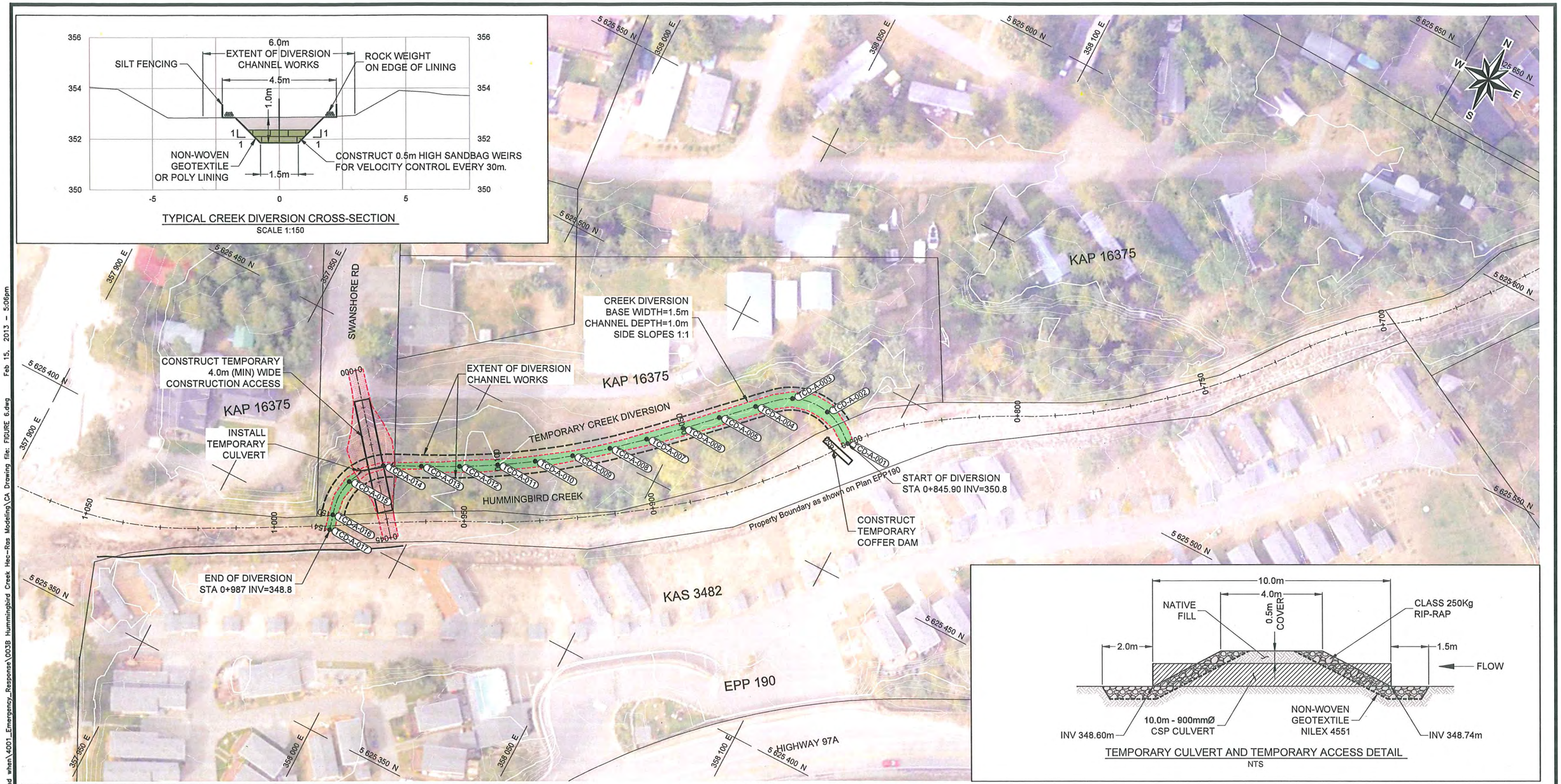
TITLE
TEMPORARY CREEK DIVERSION WORKS

Golder Associates

PROJECT No.	12-1494-0066.4001.0038		FILE No. FIGURE 5
DESIGN	RP	10-10-12	SCALE AS NOTED REV. 2
CADD	RP	10-10-12	
CHECK	MS	10-10-12	FIGURE 5
REVIEW	RM	10-10-12	

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 MoTI as and when\4001_Emergency_Response\0038 Hummingbird Creek Hec-Ras Modeling\CA Drawing file: FIGURE 5.dwg Feb 15, 2013 - 5:05pm

TYPICAL CREEK DIVERSION CROSS-SECTION
SCALE 1:150



TEMPORARY CULVERT AND TEMPORARY ACCESS DETAIL
NTS

LAYOUT TABLE				
STATION	POINT ID	NORTHING (m)	EASTING (m)	DIVERSION CHANNEL INVERT ELEVATION (m)
0+000	TCD-A-001	5625482.48	358090.72	351.00
0+010	TCD-A-002	5625487.39	358082.14	350.70
0+020	TCD-A-003	5625486.30	358072.38	350.40
0+030	TCD-A-004	5625479.95	358064.73	350.17
0+040	TCD-A-005	5625472.95	358057.58	350.07
0+050	TCD-A-006	5625465.96	358050.44	349.96
0+060	TCD-A-007	5625459.00	358043.26	349.86
0+070	TCD-A-008	5625452.35	358035.79	349.75
0+080	TCD-A-009	5625446.08	358028.00	349.65

LAYOUT TABLE				
STATION	POINT ID	NORTHING (m)	EASTING (m)	DIVERSION CHANNEL INVERT ELEVATION (m)
0+090	TCD-A-010	5625440.20	358019.91	349.55
0+100	TCD-A-011	5625434.74	358011.54	349.44
0+110	TCD-A-012	5625429.70	358002.90	349.34
0+120	TCD-A-013	5625425.10	357994.02	349.23
0+130	TCD-A-014	5625420.59	357985.10	349.13
0+140	TCD-A-015	5625412.80	357979.13	349.02
0+150	TCD-A-016	5625402.97	357979.22	348.92
0+154	TCD-A-017	5625399.12	357980.29	348.87

LEGEND

- EXTENT OF DIVERSION CHANNEL WORKS
- APPROXIMATE OUTLINE OF TEMPORARY CUT/FILL LOCATIONS
- TCD-A-004 — LAYOUT POINT
- PROPOSED TEMPORARY CREEK DIVERSION
- PROPOSED FILL AREA (950m³)

20 0 20 SCALE METRES

3 0 3 SCALE METRES

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — M.C. SULLIVAN
FEB 15, 2013

REV	DATE	DES	REVISION DESCRIPTION			
1	15-02-13	MSH	ISSUED FOR CONSTRUCTION	MSH	MS	RM
0	06-02-13	MSH	ISSUED FOR REVIEW	MSH	–	–

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

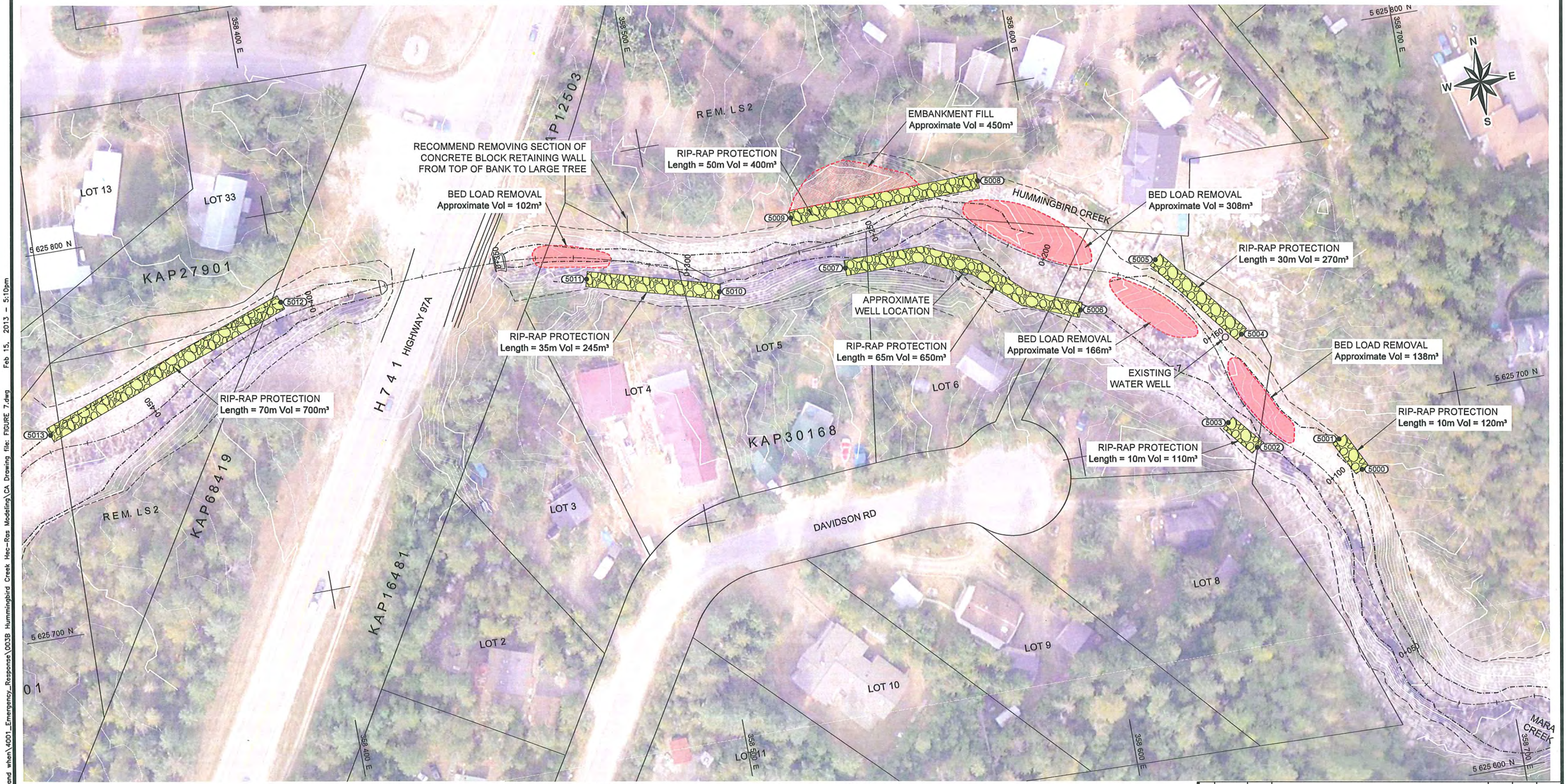
TITLE
TEMPORARY CREEK DIVERSION WORKS ALTERNATE DESIGN

Golder Associates

PROJECT No. 12-1494-0066.4001.003B			FILE No.	FIGURE 6
DESIGN	RP	10-10-12	SCALE AS NOTED	REV. 0
CADD	RP	10-10-12		
CHECK	MS	10-10-12		
REVIEW	RM	10-10-12		

FIGURE 6

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 MoTI as and when\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\CA Drawing files: FIGURE 6.dwg Feb 15, 2013 - 5:06pm



LAYOUT TABLE			
POINT NUMBER	NORTHING (m)	EASTING (m)	ELEVATION (m)
5000	5625684.00	358671.69	391.65
5001	5625692.87	358667.09	391.65
5002	5625694.39	358645.76	389.40
5003	5625702.09	358639.38	389.40
5004	5625724.33	358646.86	386.60
5005	5625747.59	358627.92	386.60
5006	5625737.99	358606.38	383.00
5007	5625759.48	358547.64	383.00

LAYOUT TABLE			
POINT NUMBER	NORTHING (m)	EASTING (m)	ELEVATION (m)
5008	5625776.08	358585.81	378.50
5009	5625774.94	358535.83	378.50
5010	5625759.24	358514.03	373.50
5011	5625768.58	358480.30	373.50
5012	5625776.65	358400.22	366.90
5013	5625752.78	358334.41	366.90

LEGEND

- EXISTING TOP OF BANK
- EXISTING BOTTOM OF BANK
- APPROXIMATE OUTLINE OF CUT / FILL LOCATIONS
- (5012) LAYOUT POINT
- PROPOSED BED LOAD REMOVAL (714m³)
- PROPOSED FILL AREA (450m³)
- PROPOSED RIP-RAP PROTECTION (2495m³)

20 0 20
SCALE METRES

NOTES

1. RIP-RAP WIDTHS SHOWN ARE NOT TO SCALE AND FOR REFERENCE ONLY. SEE FIGURE 8 FOR ALL BANK PROTECTION WORKS CROSS-SECTION DETAILS AND DIMENSIONS. ACTUAL START AND END OF RIP-RAP CAN BE ADJUSTED IN THE FIELD TO SUIT CONDITIONS ON SITE.
2. RIP-RAP SHALL BE KEYED INTO THE EXISTING CHANNEL BANKS AT THE UPSTREAM ENDS OF ALL PROPOSED SECTIONS TO AVOID CHANNEL CONSTRICTIONS AND TO PROVIDE A SMOOTH TRANSITION FROM EXISTING TO PROPOSED WORKS.

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA M.C. SULLIVAN
FEB 15, 2013

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	15-02-13	RP	ISSUED FOR CONSTRUCTION	MSH	MS	RM
1	23-11-12	RP	ISSUED FOR REVIEW	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
RIP-RAP BANK REHABILITATION WORKS

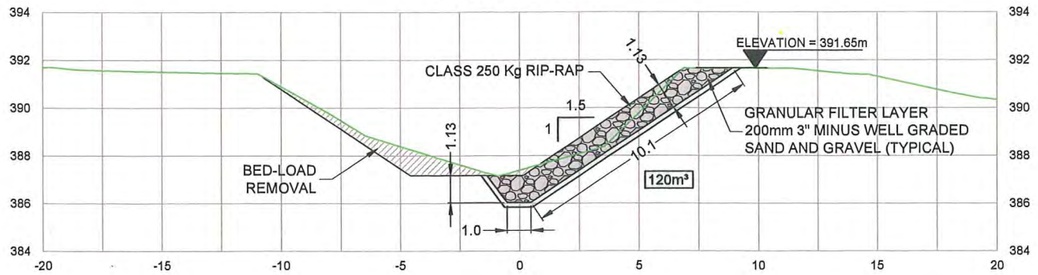
Golder Associates

PROJECT No.	12-1494-0066.4001.0038		FILE No.		FIGURE 7
DESIGN	RP	10-10-12	SCALE	AS NOTED	REV. 2
CADD	RP	10-10-12			
CHECK	MS	10-10-12			
REVIEW	RM	10-10-12			

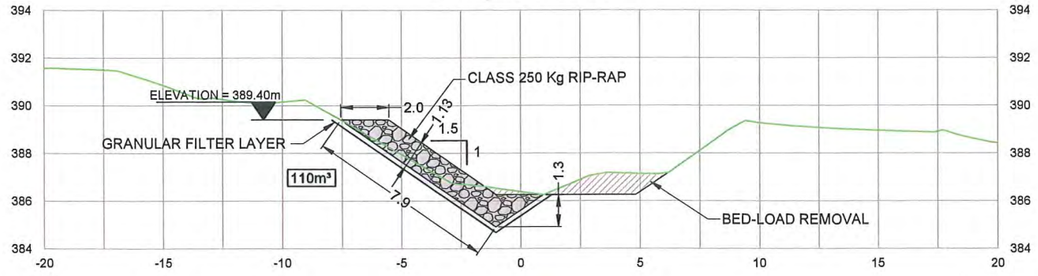
FIGURE 7

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 HoTI as and when\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\CA Drawing file: FIGURE 7.dwg Feb 15, 2013 - 5:10pm

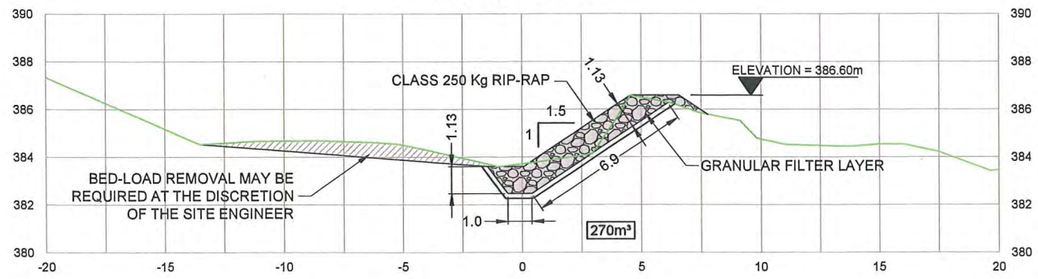
STATION 0+100.0



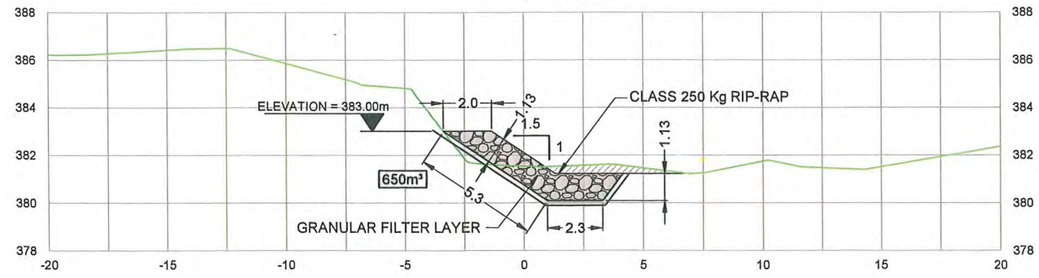
STATION 0+120.0



STATION 0+160.0



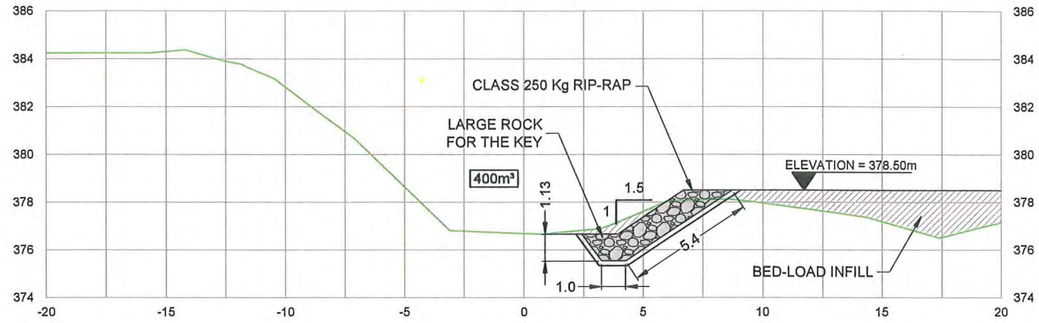
STATION 0+200.0



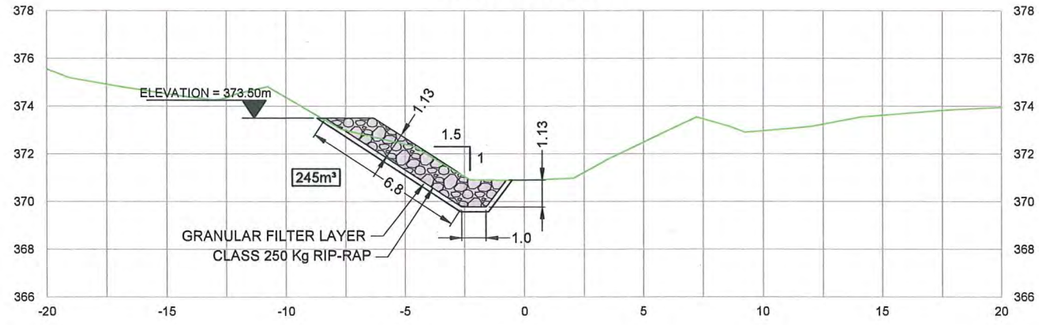
NOTE: RIP-RAP SHALL BE HARD, DURABLE, ANGULAR, AND GENERALLY GOOD QUALITY QUARRY ROCK THAT DOES NOT GENERATE ACIDS. RIP-RAP SHALL BE FREE OF STRUCTURAL DEFECTS, CLEAN, AND GENERALLY WELL-GRADED ACCORDING TO THE ABOVE GRADATION TABLE.

*EQUIVALENT SIZE IS AN APPROXIMATE DIMENSION FOR A SPHERICAL STONE FOR EACH GIVEN MASS. STONE MASS GOVERNS EACH CLASS AND ITS GRADATIONS. ABOVE GRADATION TABLE IS BASED ON AN ASSUMED SPECIFIC GRAVITY OF 2.64 FOR RIPRAP (S=2.64).

STATION 0+260.0



STATION 0+340.0



STATION 0+428.0

LEGEND

- COMBINED BINNIE & LiDAR GROUND SURFACE
- PROPOSED RIP-RAP PROTECTION
- BED LOAD REMOVAL

RIP-RAP GRADATION TABLE		
PERCENT LIGHTER (FINER) THAN	CLASS 250-kg	
	MASS (kg)	EQUIVALENT SIZE* (mm)
15	25	262
30	95	409
50	250	565
85	750	816
100	1250	967
LAYER THICKNESS	1130mm (MIN)	

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
FEB 15, 2013

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
2	15-02-13	RP	ISSUED FOR CONSTRUCTION	MSH	MS	RM
1	23-11-12	RP	ISSUED FOR REVIEW	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
BANK REHABILITATION WORKS CROSS-SECTIONS

Golder Associates

PROJECT No.	12-1494-0066.4001.003B		FILE No.		FIGURE 8
DESIGN	RP	10-10-12	SCALE	AS NOTED	REV. 2
CADD	RP	10-10-12			
CHECK	MS	10-10-12			
REVIEW	RM	10-10-12			

FIGURE 8

N:\Bur-Graphics\Projects\2012\1494\12-1494-0066 Mofi as and when\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\CA Drawing file: FIGURE 8.dwg Feb 15, 2013 - 5:11pm

APPENDIX D

Representative Site Photos

Pre-Construction Photos – November 5, 2012

Figure 1: Facing downstream towards Mara Lake near Station 0+980 after the event and before construction (November. 5, 2012).

Figure 2: Facing upstream near Station 0+960 after the event and before construction (November 5, 2012).

Figure 3: Left bank near Station 0+340, (November 5, 2012).

Figure 4: Left Bank near Station 0+340 (November 5, 2012).

Figure 5: Right bank facing downstream near Station 0+260 after the event and before construction (November 5, 2012).

Figure 6: Right bank facing downstream near Station 0+260 after the event and before construction (November 5, 2012).

Figure 7: Facing upstream near Station 0+260 after the event and before construction (November 5, 2012).

Figure 8: Facing upstream near Station 0+200 after the event and before construction (November 5, 2012).

Figure 9: Left bank facing downstream near Station 0+200 after the event and before construction (November 5, 2012).

Figure 10: Left bank facing upstream near Station 0+200 after the event and before construction (November 5, 2012).

Figure 11: Facing upstream near Station 0+160 after the event and before construction (November 5, 2012).

Figure 12: Right bank facing upstream near Station 0+160 after the event and before construction (November 5, 2012).

Figure 13: Facing downstream near Station 0+120 after the event and before construction (November 5, 2012).

Figure 14: Right bank facing downstream near Station 0+120 after the event and before construction (November 5, 2012).

Figure 15: Facing upstream near Station 0+100 after the event and before construction (November 5, 2012).

Post Construction Photos – February – March 2013.

Figure 16: Facing downstream near Station1+080 Outlet to Mara Lake after construction (March 7, 2013).

Figure 17: Facing downstream near Station1+000 after construction (March 7, 2013).

Figure 18: Facing downstream near Station 0+900 after construction (March 7, 2013)

Figure 19: Facing upstream near Station 0+900 after construction (March 7, 2013).

Figure 20: Facing upstream near Station 0+770 after construction (March 7, 2013).

Figure 21: Facing downstream near Station 0+744 after construction (March 7, 2013).

Figure 22: Facing upstream near Station 0+480 during construction (March 20, 2013).

Figure 23: Right bank facing downstream near Station 0+400 after construction (March 21, 2013).

Figure 24: Right bank facing upstream near Station 0+480 after construction (March 21, 2013).

Figure 25: Left bank facing downstream near Station 0+340 after construction (March 15, 2013).

Figure 26: Left bank facing upstream near Station 0+340 after construction (March 15, 2013).

Figure 27: Right bank facing downstream near Station 0+260 during construction (March 21, 2013).

Figure 28: Right bank facing upstream near Station 0+200 after construction (March 19, 2013).

Figure 29: Left bank facing downstream near Station 0+200 after construction (March 21, 2013).

Figure 30: Left bank facing upstream near Station 0+200 after construction (March 21, 2013).

Figure 31: Right bank facing downstream near Station 0+160 during construction (March 14, 2013).

Figure 32: Right bank facing upstream near Station 0+160 during construction (March 14, 2013).

Figure 33: Right bank facing downstream near Station 0+160 during construction (March 18, 2013).

Figure 34: Left bank facing downstream near Station 0+120 during construction (March 15, 2013).

Figure 35: Left bank facing downstream near Station 0+120 during construction (March 15, 2013).

Figure 36: Right bank facing upstream near Station 0+100 during construction (March 18, 2013).

APPENDIX E

Riprap Testing Certificate

BAIRD BROS LTD.

Ready Mix
Gravel Products
Road Building

Landscape Rock
Excavating
Lowbedding

Box 189 Enderby, BC V0E 1V0 Phone: (250) 838-7265 or (250) 838-6430 Fax: (250) 838-6799

ATTN: Geoff Cahill DATE: April 4 2013

TO: Golder FAX NO: 250-828-1215

COMMENTS:

Hi Geoff,

As per your request I am forwarding onto you the Acid test results for the rip rap that went to Hummingbird

Marie

NUMBER OF PAGES: 2

Box 189
Enderby, BC
V0E 1V0

Phone: (250) 838-7265
or (250) 838-6430
Fax: (250) 838-6799

Ministry Of Transportation
Results Continued

11-Mar-09
E09-0349

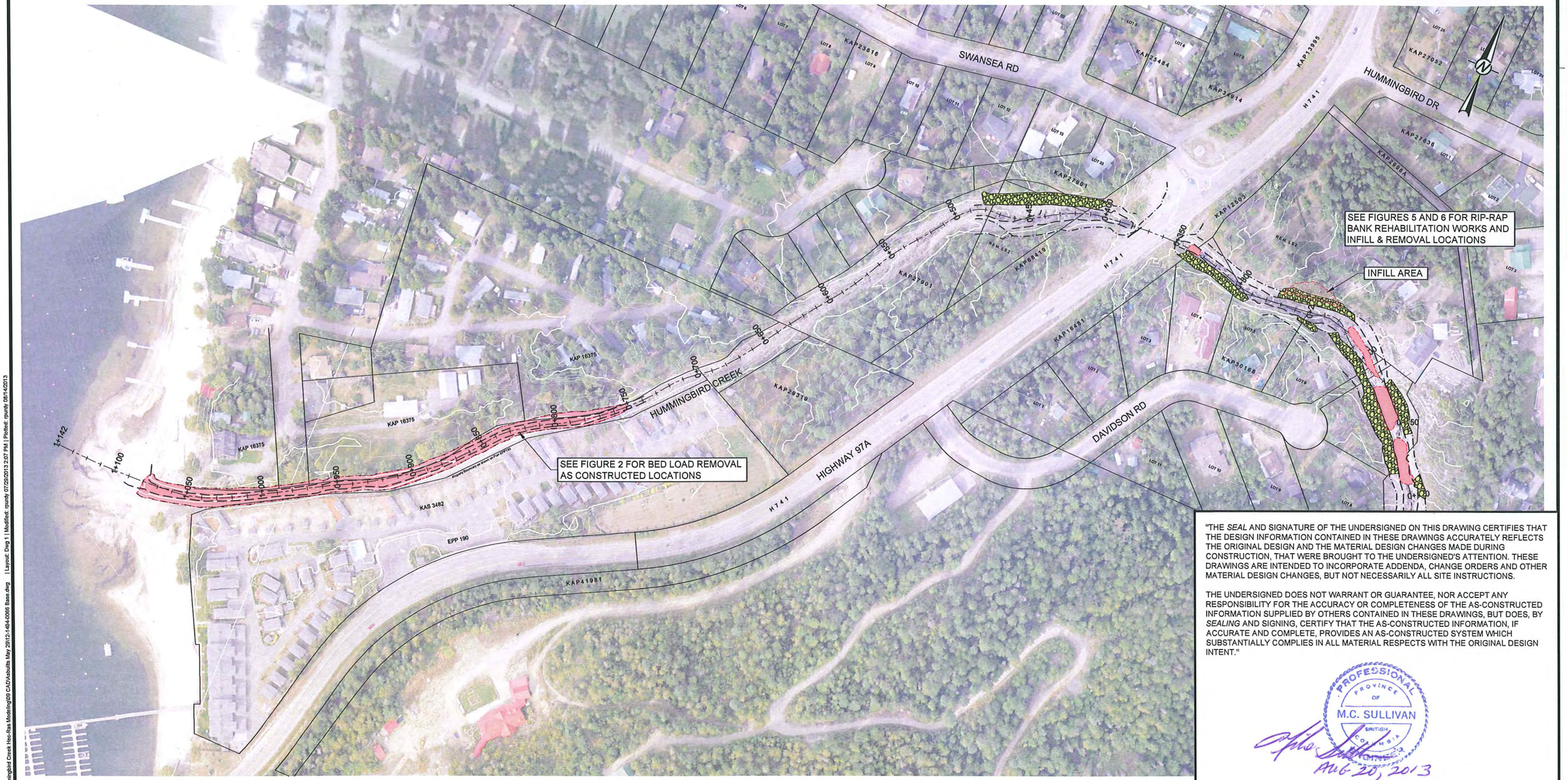
POTENTIAL ACID PRODUCTION / NEUTRALIZATION

Sample #	Paste pH	Total Sulfur (%)	Sulphate (as S) (%)	Tonnes $CaCO_3$ Equivalent per 1000 Tonnes: Acid Production	Neutralization Potential	Net Neutralization Potential	NP/AP
1 3" Crush South Face #1	9.43	0.091	0.003	2.84	12.14	9.3	4.27
2 3" Crush South Face #2	9.58	0.066	0.002	2.06	11.09	5.4	5.38
3 Rip Rap Base	9.49	0.119	0.003	3.72	18.80	15.1	5.05
QC/DATA							
Standard:							
KZK	8.8	0.81	-	25.31	59.5	34	2.35
NBM	8.6	0.291	-	9.09	49.8	41	5.48
Repeat:							
3 Rip Rap Base	9.53	0.119	0.003	3.72	18.6	15	5.00
Resplit:							
1 3" Crush South Face #1	9.39	0.092	0.002	2.88	12.49	9.6	4.34

XLS/09
JA/ap

APPENDIX F

Record Drawings



LEGEND

- AS-CONSTRUCTED BED LOAD REMOVAL LOCATIONS
- AS-CONSTRUCTED RIP-RAP REHABILITATION WORKS
- AS-CONSTRUCTED INFILL AREA

REFERENCES

BASE IMAGERY PROVIDED BY THE CLIENT (MOTI).

NORTH-WEST IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE. IMAGERY DATE: APRIL 10, 2004. GOOGLE EARTH IMAGE IS NOT TO SCALE.

CONSTRUCTION NOTES

1. ADHERE TO ALL ENVIRONMENTAL REQUIREMENTS AS PER SUMMIT ENVIRONMENTAL INCLUDING FISH SALVAGE AND DE-WATERING.
2. SEDIMENT REMOVAL AND CHANNEL EXCAVATIONS ARE REQUIRED BETWEEN STA 0+740 AND 1+040.
3. EXCAVATE EXISTING CHANNEL TO MAINTAIN A CONSISTENT GRADE BETWEEN EACH STATION.
4. MAINTAIN A MINIMUM 5.0m WIDE CHANNEL BASE WIDTH WITH 2H:1V SIDE SLOPES EXTENDING TO DAYLIGHT AT TOP OF EXISTING BANKS.
5. EXCAVATION IS TO REMAIN WITHIN THE CURRENT CHANNEL AND ADJUSTMENTS CAN BE MADE TO BED WIDTH AND SIDE SLOPES TO PREVENT DISRUPTION TO THE EXISTING CREEK BANKS AND BANK PROTECTIONS. AVOID DISTURBANCE TO SOUTH BANK.
6. EXISTING BOULDER CLUSTER WEIRS LOCATED JUST DOWNSTREAM OF THE HIGHWAY 97A CULVERT ARE TO REMAIN INTACT.
7. INSTALL RIP-RAP BANK REHABILITATION WORKS AS SHOWN.

NOTES

1. CONTOURS CREATED FROM LIDAR SURVEY DATA (PROVIDED BY MoT) DATED SEPTEMBER 2011 AND ARE SHOWN IN 0.5m INTERVALS.
2. ALL PROPERTY LINES ARE TO BE CONSIDERED APPROXIMATE AND ARE TO BE CONFIRMED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.
3. POST CONSTRUCTION SURVEY COMPLETED MARCH 2013 BY SETCH SURVEYS.

50 0 50
SCALE METRES

"THE *SEAL* AND SIGNATURE OF THE UNDERSIGNED ON THIS DRAWING CERTIFIES THAT THE DESIGN INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN AND THE MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION, THAT WERE BROUGHT TO THE UNDERSIGNED'S ATTENTION. THESE DRAWINGS ARE INTENDED TO INCORPORATE ADDENDA, CHANGE ORDERS AND OTHER MATERIAL DESIGN CHANGES, BUT NOT NECESSARILY ALL SITE INSTRUCTIONS.

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PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — M.C. SULLIVAN
AUG 20, 2013

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
3	30-05-13	RECORD DRAWING	RP	RP	MS	RM
2	15-02-13	ISSUED FOR CONSTRUCTION	MH	MH	MS	RM
1	23-11-12	ISSUED FOR REVIEW	RP	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORTATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
OVERALL SITE PLAN

Golder Associates

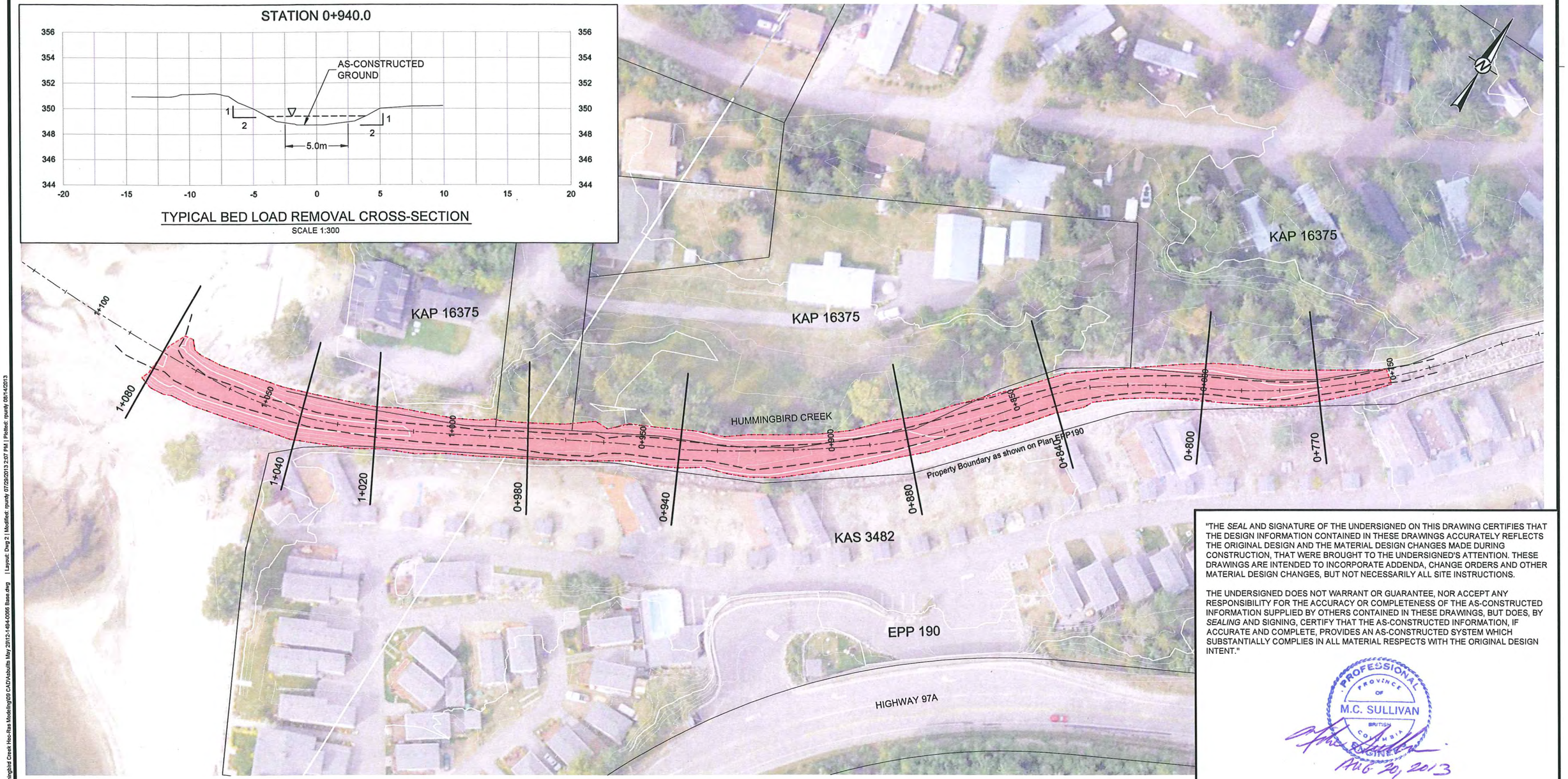
PROJECT No. 12-1494-0066-4001-003B			FILE No.	12-1494-0066
DESIGN	RP	10-10-12	SCALE	1:2,500
CADD	RP	10-10-12	DRAWING	
CHECK	MS	10-10-12		1
REVIEW	RM	10-10-12		

N:\Active\2012\1494\12-1494-0066 MoTI As And When\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modeling\05 CAD\As-builts May 29\12-1494-0066 Base.dwg | Layout: Dwg 1 | Modified: rpurdy 07/29/2013 2:07 PM | Plotted: rpurdy 08/14/2013

STATION 0+940.0

TYPICAL BED LOAD REMOVAL CROSS-SECTION

SCALE 1:300



LEGEND

AS-CONSTRUCTED BED LOAD REMOVAL LOCATIONS

TOTAL ESTIMATED VOLUME OF BED LOAD REMOVAL
STA. 0+740 TO STA. 1+080 = 2200 m³

REFERENCES

BASE IMAGERY PROVIDED BY THE CLIENT (MOTI).

NORTH-WEST IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE.
IMAGERY DATE: APRIL 10, 2004. GOOGLE EARTH IMAGE IS NOT TO SCALE.

NOTES

1. CONTOURS CREATED FROM LIDAR SURVEY DATA (PROVIDED BY MoT) DATED SEPTEMBER 2011 AND ARE SHOWN IN 0.5m INTERVALS.
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3. POST CONSTRUCTION SURVEY COMPLETED MARCH 2013 BY SETCH SURVEYS.

20 0 20
SCALE METRES

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PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
Aug 20, 2013

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
3	30-05-13	RECORD DRAWING	RP	RP	MS	RM
2	15-02-13	ISSUED FOR CONSTRUCTION	MH	MH	MS	RM
1	23-11-12	ISSUED FOR REVIEW	RP	RP	MS	RM

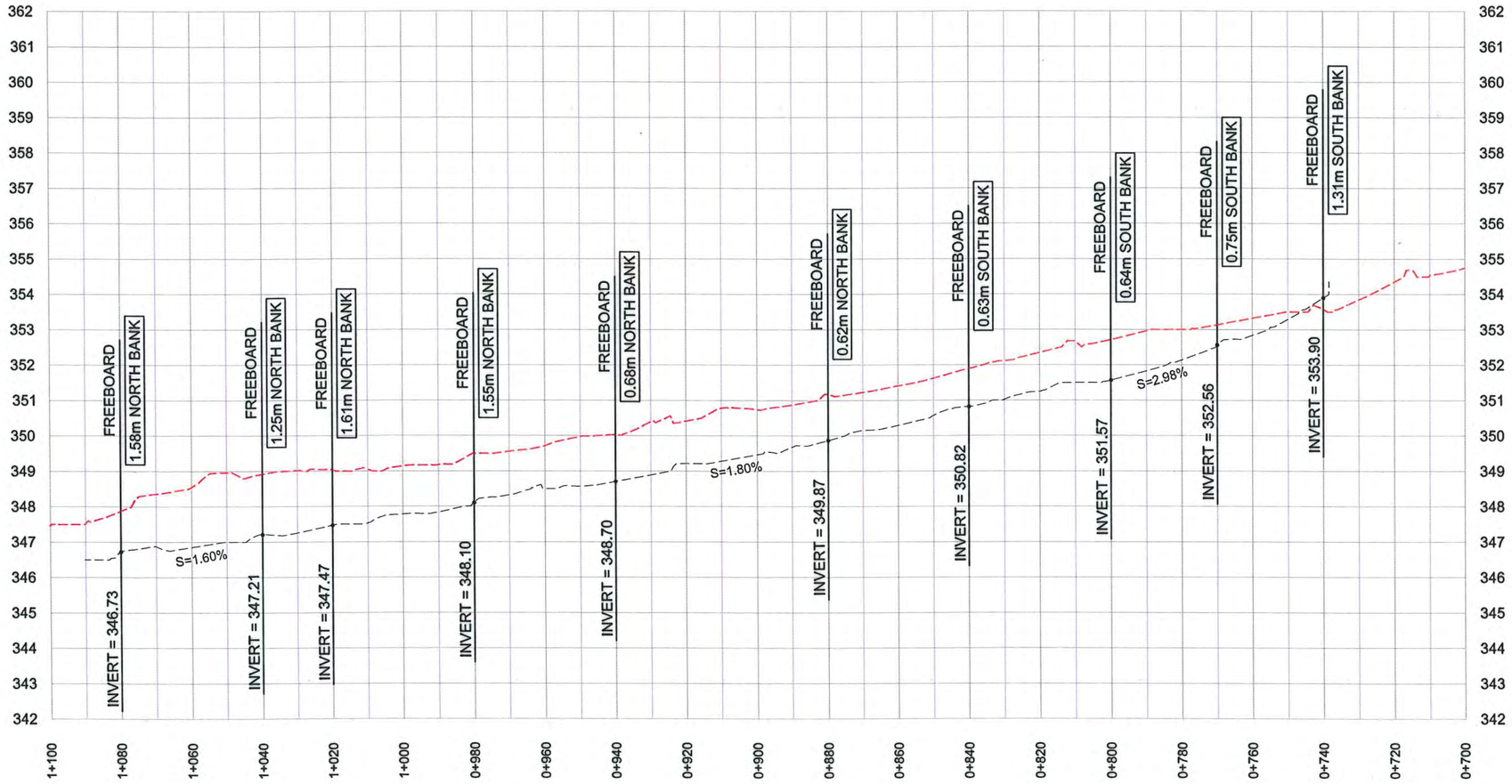
PROJECT
B.C. MINISTRY OF TRANSPORTATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
BED LOAD REMOVAL WORKS (STA. 0+740 TO 1+080)

Golder Associates

PROJECT No. 12-1494-0066-4001-003B			FILE No.	12-1494-0066
DESIGN	RP	10-10-12	SCALE	1:1,000
CADD	RP	10-10-12	DRAWING	
CHECK	MS	10-10-12		2
REVIEW	RM	10-10-12		

N:\Active\2012\1494\12-1494-0066 MoTI As And When\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modelling\09 CAD\Sketch May 29\12-1494-0066 Base.dwg | Layout: Dwg 2 | Modified: rpurdy 07/29/2013 2:07 PM | Plotted: rpurdy 08/14/2013



PROFILE
SCALE H 1:1500 1:150

LEGEND

- AS-CONSTRUCTED BED LOAD REMOVAL PROFILE (MARCH, 2013)
- BINNIE CHANNEL SURVEY (SEPTEMBER 30, 2012)

NOTES

1. PROFILE CREATED FROM POST CONSTRUCTION SURVEY COMPLETED MARCH 2013 BY SETCH SURVEYS.

3 0 3
SCALE VERTICAL METRES

30 0 30
SCALE HORIZONTAL METRES

"THE *SEAL* AND SIGNATURE OF THE UNDERSIGNED ON THIS DRAWING CERTIFIES THAT THE DESIGN INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN AND THE MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION, THAT WERE BROUGHT TO THE UNDERSIGNED'S ATTENTION. THESE DRAWINGS ARE INTENDED TO INCORPORATE ADDENDA, CHANGE ORDERS AND OTHER MATERIAL DESIGN CHANGES, BUT NOT NECESSARILY ALL SITE INSTRUCTIONS.

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PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
AUG 20, 2013

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
3	30-05-13	RECORD DRAWING	RP	RP	MS	RM
2	15-02-13	ISSUED FOR CONSTRUCTION	MH	MH	MS	RM
1	23-11-12	ISSUED FOR REVIEW	RP	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORTATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
BED LOAD REMOVAL PROFILE

Golder Associates

PROJECT No. 12-1494-0066-4001-003B			FILE No.	12-1494-0066
DESIGN	RP	10-10-12	SCALE	H 1:1,500 V 1:150
CADD	RP	10-10-12	DRAWING	3
CHECK	MS	10-10-12		
REVIEW	RM	10-10-12		

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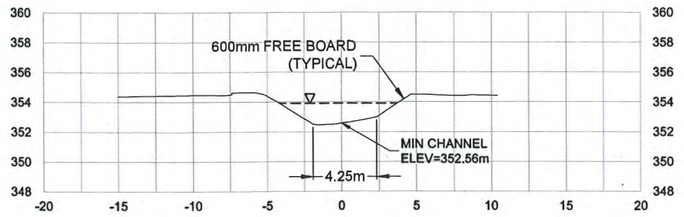
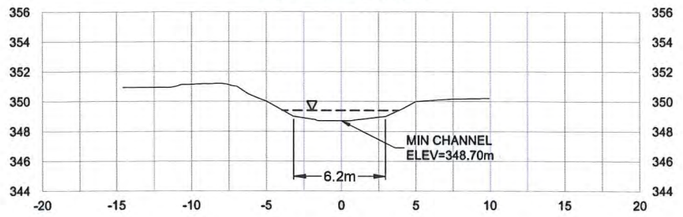


STATION 0+940.0



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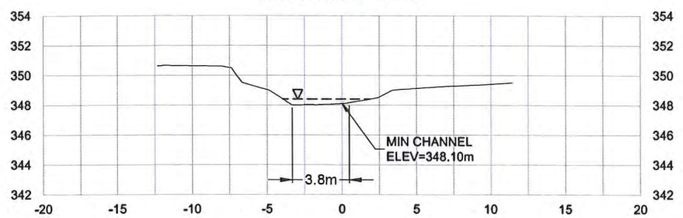
STATION 0+980.0



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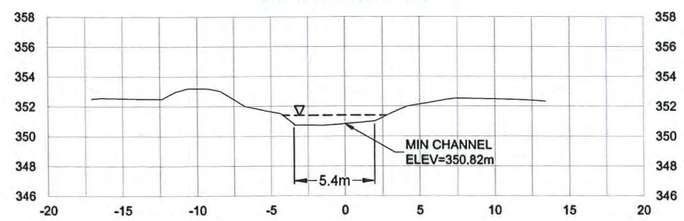

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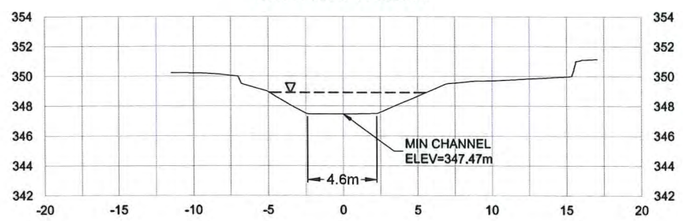

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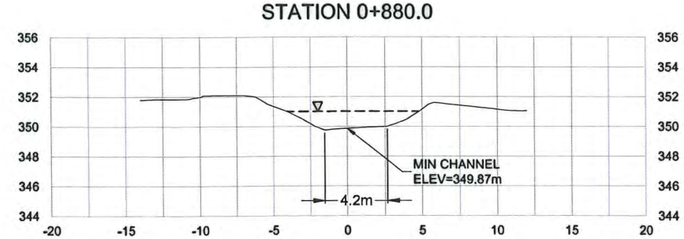

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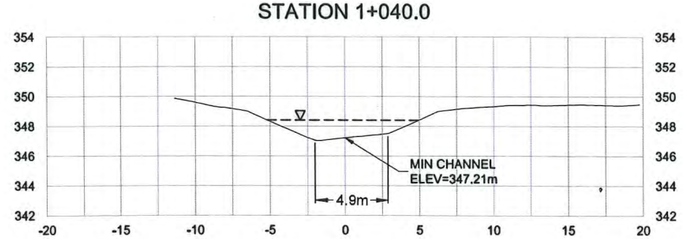

LEGEND

AS-CONSTRUCTED CHANNEL PROFILE

PRE-CONSTRUCTION 200 YEAR WATER LEVEL
(BASED ON HEC-RAS MODEL - BINNIE SURVEY, SEPT 30, 2012)

NOTES

1. PROFILE CREATED FROM POST CONSTRUCTION SURVEY COMPLETED MARCH 2013 BY SETCH SURVEYS.

10 0 10
SCALE METRES

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PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
AUG 20, 2013

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
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2	15-02-13	ISSUED FOR CONSTRUCTION	MH	MH	MS	RM
1	23-11-12	ISSUED FOR REVIEW	RP	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORTATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
BED LOAD REMOVAL CROSS-SECTIONS

Golder Associates

PROJECT No. 12-1494-0066-4001-003B			FILE No.	12-1494-0066
DESIGN	RP	10-10-12	SCALE	1:400
CADD	RP	10-10-12	DRAWING	
CHECK	MS	10-10-12		4
REVIEW	RM	10-10-12		

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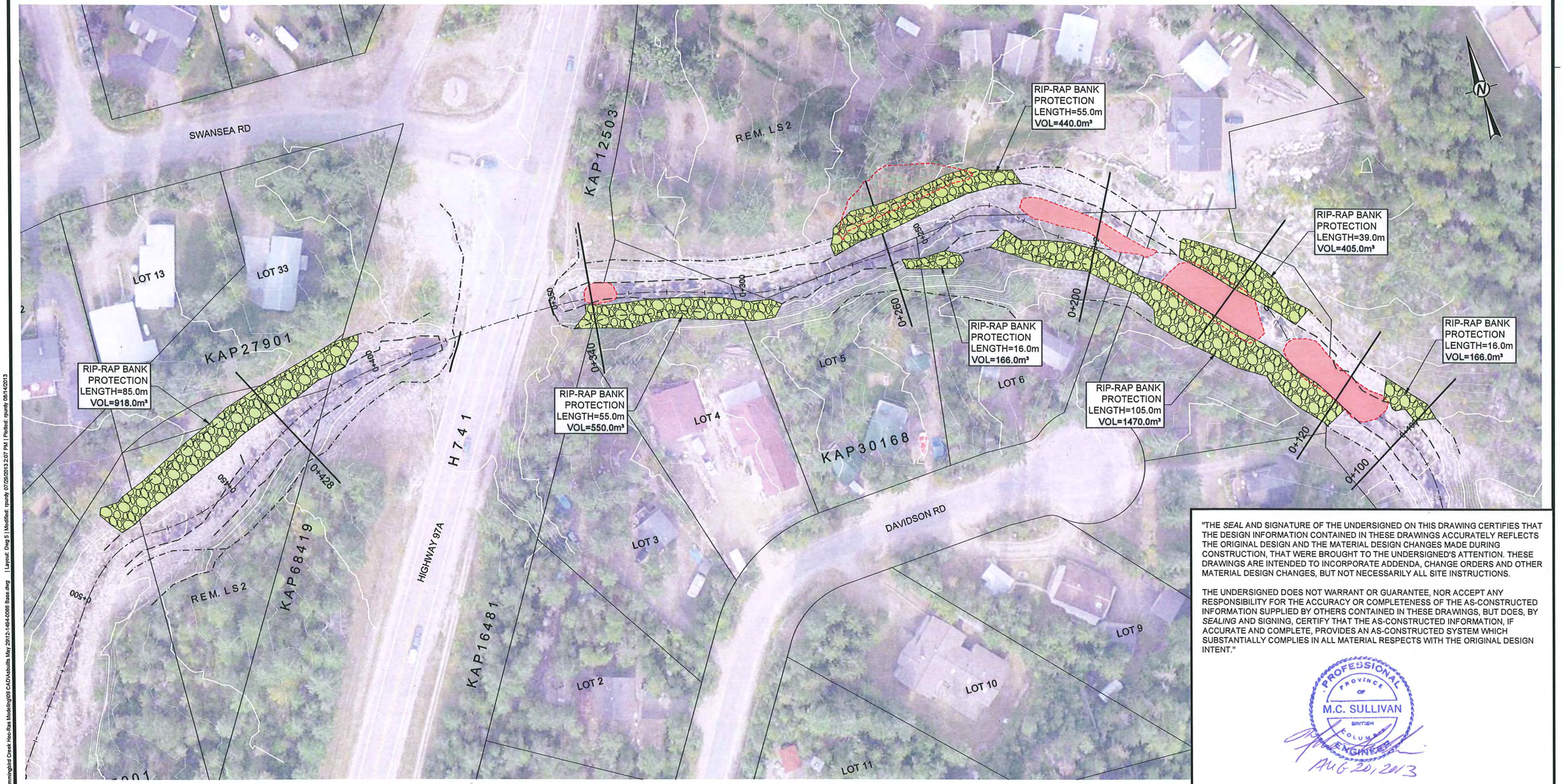

LEGEND

- AS-CONSTRUCTED BED LOAD REMOVAL LOCATIONS
- TOTAL ESTIMATED VOLUME OF BED LOAD REMOVAL **UPSTREAM OF HWY 97A = 1150m³**
- AS-CONSTRUCTED BED LOAD INFILL LOCATION
- AS-CONSTRUCTED RIP-RAP REHABILITATION WORKS

TOTAL ESTIMATED VOLUME OF RIP-RAP PLACED = 4115 m³

NOTES

1. CONTOURS CREATED FROM LIDAR SURVEY DATA (PROVIDED BY MoT) DATED SEPTEMBER 2011 AND ARE SHOWN IN 0.5m INTERVALS.
2. ALL PROPERTY LINES ARE TO BE CONSIDERED APPROXIMATE AND ARE TO BE CONFIRMED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.
3. RIP-RAP WIDTHS SHOWN ARE NOT TO SCALE AND FOR REFERENCE ONLY. SEE FIGURE 8 FOR ALL BANK PROTECTION WORKS CROSS-SECTION DETAILS AND DIMENSIONS. ACTUAL START AND END OF RIP-RAP CAN BE ADJUSTED IN THE FIELD TO SUIT CONDITIONS ON SITE.
4. RIP-RAP SHALL BE KEYED INTO THE EXISTING CHANNEL BANKS AT THE UPSTREAM ENDS OF ALL PROPOSED SECTIONS TO AVOID CHANNEL CONSTRICTIONS AND TO PROVIDE A SMOOTH TRANSITION FROM EXISTING TO PROPOSED WORKS.
5. POST CONSTRUCTION SURVEY COMPLETED MARCH 2013 BY SETCH SURVEYS.

REFERENCES

BASE IMAGERY PROVIDED BY THE CLIENT (MOTI).

NORTH-WEST IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE. IMAGERY DATE: APRIL 10, 2004. GOOGLE EARTH IMAGE IS NOT TO SCALE.

20 0 20
SCALE METRES

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PROVINCE OF BRITISH COLUMBIA
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1	23-11-12	ISSUED FOR REVIEW	RP	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORTATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
RIP-RAP REHABILITATION WORKS

Golder Associates

PROJECT No. 12-1494-0066-4001-003B			FILE No.	12-1494-0066
DESIGN	RP	10-10-12	SCALE	1:1,000
CADD	RP	10-10-12	DRAWING	5
CHECK	MS	10-10-12		
REVIEW	RM	10-10-12		

N:\Active\2012\1494\12-1494-0066 MoTI As And When\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modelling\05 CAD\Arbutis May 29\12-1494-0066 Base.dwg | Layout: Dwg 5 | Modified: rpurdy 07/29/2013 2:07 PM | Plotted: rpurdy 08/14/2013

N:\Active\2012\1494\12-1494-0066 MoTI As And When\4001_Emergency_Response\003B Hummingbird Creek Hec-Ras Modelling\09 CAD\Asbuilts (May 29\12-1494-0066 Base.dwg | Layout: Dwg 6 | Modified: rpurdy 07/29/2013 2:07 PM | Plotted: rpurdy 08/14/2013

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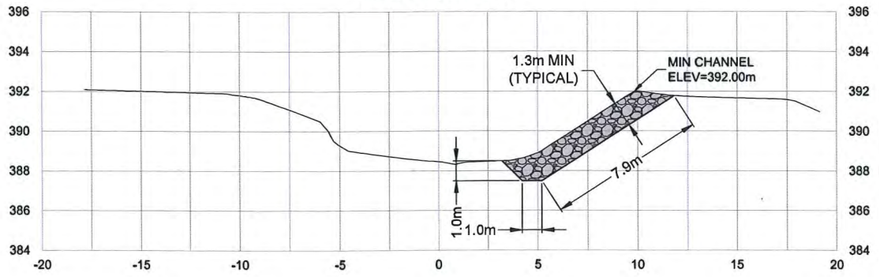

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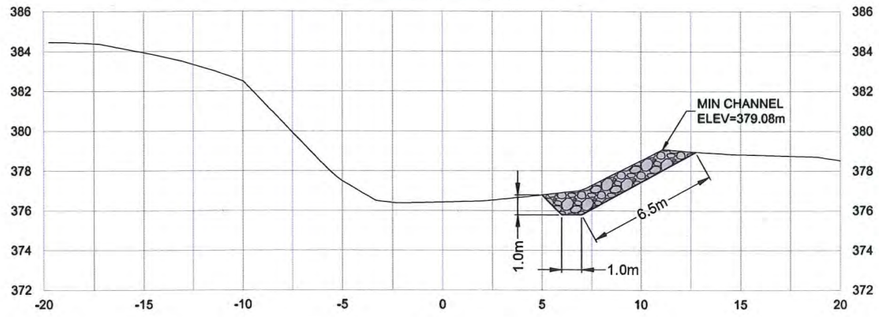

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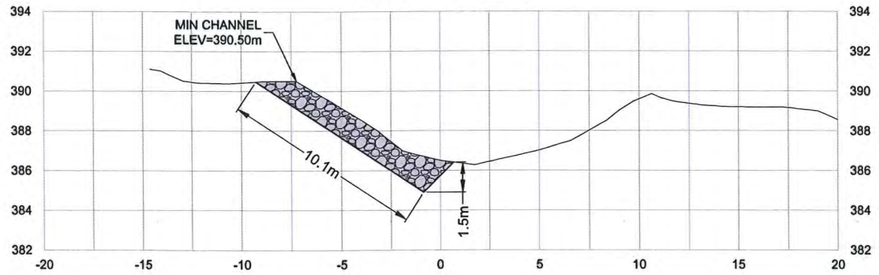

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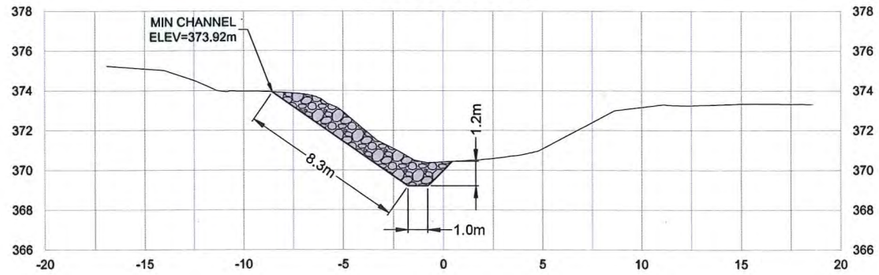

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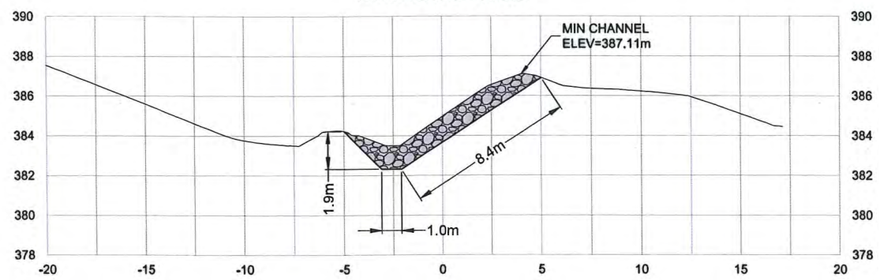

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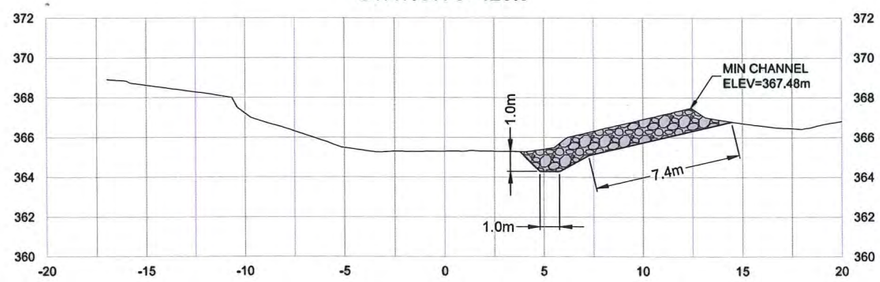

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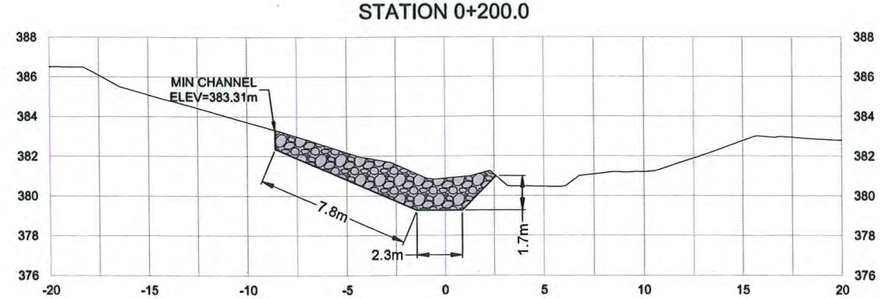

RIP-RAP GRADATION TABLE		
PERCENT LIGHTER (FINER) THAN	CLASS 250-kg	
	MASS (kg)	EQUIVALENT SIZE* (mm)
15	25	262
30	95	409
50	250	565
85	750	816
100	1250	967
LAYER THICKNESS	1130mm (MIN)	

*EQUIVALENT SIZE IS AN APPROXIMATE DIMENSION FOR A SPHERICAL STONE FOR EACH GIVEN MASS. STONE MASS GOVERNS EACH CLASS AND ITS GRADATIONS. ABOVE GRADATION TABLE IS BASED ON AN ASSUMED SPECIFIC GRAVITY OF 2.64 FOR RIPRAP (S=2.64).

NOTE: RIP-RAP SHALL BE HARD, DURABLE, ANGULAR, AND GENERALLY GOOD QUALITY QUARRY ROCK THAT DOES NOT GENERATE ACIDS. RIP-RAP SHALL BE FREE OF STRUCTURAL DEFECTS, CLEAN, AND GENERALLY WELL-GRADED ACCORDING TO THE ABOVE GRADATION TABLE.

LEGEND

AS-CONSTRUCTED CHANNEL PROFILE

AS-CONSTRUCTED RIP-RAP REHABILITATION WORKS

NOTES

1. PROFILE CREATED FROM POST CONSTRUCTION SURVEY COMPLETED MARCH 2013 BY SETCH SURVEYS.
2. GRANULAR FILTER LAYER AS SPECIFIED ON THE IFC. DRAINAGE WAS INSTALLED IN SOME LOCATIONS AS DIRECTED BY THE ON-SITE ENGINEER, HOWEVER IT WAS NOT REQUIRED GENERALLY DUE TO THE NATIVE MATERIAL BEING ACCEPTABLE AS A FILTER MATERIAL.

5 0 5
SCALE METRES

"THE *SEAL* AND SIGNATURE OF THE UNDERSIGNED ON THIS DRAWING CERTIFIES THAT THE DESIGN INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN AND THE MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION, THAT WERE BROUGHT TO THE UNDERSIGNED'S ATTENTION. THESE DRAWINGS ARE INTENDED TO INCORPORATE ADDENDA, CHANGE ORDERS AND OTHER MATERIAL DESIGN CHANGES, BUT NOT NECESSARILY ALL SITE INSTRUCTIONS.

THE UNDERSIGNED DOES NOT WARRANT OR GUARANTEE, NOR ACCEPT ANY RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS, BUT DOES, BY *SEALING* AND SIGNING, CERTIFY THAT THE AS-CONSTRUCTED INFORMATION, IF ACCURATE AND COMPLETE, PROVIDES AN AS-CONSTRUCTED SYSTEM WHICH SUBSTANTIALLY COMPLIES IN ALL MATERIAL RESPECTS WITH THE ORIGINAL DESIGN INTENT."

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
M.C. SULLIVAN
AUG 20, 2013

REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
3	30-05-13	RECORD DRAWING	RP	RP	MS	RM
2	15-02-13	ISSUED FOR CONSTRUCTION	MH	MH	MS	RM
1	23-11-12	ISSUED FOR REVIEW	RP	RP	MS	RM

PROJECT
B.C. MINISTRY OF TRANSPORTATION
23466-H97A HUMMINGBIRD CR CHANNEL REPAIRS
SICAMOUS, B.C.

TITLE
BANK REHABILITATION WORKS CROSS-SECTIONS

Golder Associates

PROJECT No. 12-1494-0066-4001-003B			FILE No.	12-1494-0066
DESIGN	RP	10-10-12	SCALE	1:300
CADD	RP	10-10-12	DRAWING	
CHECK	MS	10-10-12		6
REVIEW	RM	10-10-12		

APPENDIX G

Field Reviews

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 003B
Date SAT FEB 23, 2013
Shift ☑ Day ☐ Night
Time arrived on site 10:00 Am hrs
Time left site 3:30 pm hrs
Time on site 5 hr + 0.5 hr @ PIT
Travel time 1 hr
Total time 8:00 am – 5:30 pm = 9½ hr

Project Name HUMMINGBIRD CK - CHANNEL REPAIRS
Weather OVERCAST / BIT of SNOW / CLEARING / SUN Temperature Range -1 → +5 °C
Contractor's Working Hours 7:00 AM - 5:00 pm.

Work Carried Out

1. VISIT TO BAIRD'S BROS READY MIX - ROCK QUARRY TO LOOK AT RIPRAP. RIPRAP APPEARS TO MEET THE GRADATION SPECIFIED CLASS 250Kg. ROCK APPEARS TO BE A GRANITE SHIST? SEEMS DURABLE, SOUND ANGULAR, CONVERSATION WITH R.J. (QUARRY OPERATOR) MENTIONED ROCK HAS BEEN CHECKED FOR ARD & PASSED, PAPERWORK IS AVAIL.

2. ARRIVED @ HUMMINGBIRD CK ~ 10:30 AM, ACCESS ROAD IS COMPLETE. TRUCKS HAULING BED LOAD FROM LOWER PORTION of CK. I MENTIONED TO DEAN THAT WE SHOULD EXTEND CHANNEL GRADE from STA 1+040 TO DAYLIGHT DOWNSTREAM TOWARDS LAKE AT THE 1.6% GRADE. DEAN TO COORDINATE WITH PAUL from SUMMIT RE: REQUIRE SEDIMENT CONTROL RQMTS. GWEN from SUMMIT WAS ON SITE.

3. WALKED U/S TO CHECK CHANNEL BTWN STA 0+620 & 0+720 CHECKED HEC RAS CROSS-SECTIONS - APPEAR TO HAVE 200yr + 600mm FREEBOARD AT LEAST, PROBABLY MORE AS PER MODEL.

4. CONSTRUCTION: CLEARED DOWN TO STA 1+040 STILL 0.98m of CUT REMAINING. CLEARED U/S TO STA 0+850 APPROX. NO WATER TO DEAL WITH SO FAR

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 003B.
Date MONDAY FEB 25, 2013.
Shift ☑ Day ☐ Night
Time arrived on site 11:00 AM hrs
Time left site 3:30pm hrs
Time on site 4½ hr.
Travel time 4 hrs. + TELECONFCALL.
Total time 8:00AM – 5:30PM = 9½ hr.

Project Name HUMMING-BIRD CK
Weather OVERCAST +3° Temperature Range °C
Contractor's Working Hours 7:00AM – 5:00PM

Work Carried Out

1. BED LOAD REMOVAL – CHANNEL EXCAVATED TO DESIGN GRADE. UP TO STA 0+826, CONFIRMED 5.0m WIDE BASE WIDTH. LOW FLOW TRENCH ≈ 1.0m WIDE x 0.3m DEEP BEING EXCAVATED ALONG SOUTH TOE ADJACENT TO HUMMINGBIRD CK RESORT, DOWN TO ACCESS RAMP.

2. MET PAUL HAGUE (SUMMIT) ON SITE TO REVIEW SEDIMENT CONTROL MEASURES FOR TIE IN TO DAYLIGHT AT DOWNSTREAM CHANNEL SECTION STA 1+080. GOLDER WOULD LIKE TO MAINTAIN 1.6% GRADE FROM STA 1+040 TO DAYLIGHT @ ≈ STA 1+080.
   - SEDIMENT CONTROL (SILT) FENCE BEING INSTALLED DOWNSTREAM of STA 1+080.
   - EXCAVATOR RELOCATING TO DOWNSTREAM END (STA 1+080) TO COMPLETE CHANNEL / BEDLOAD REMOVAL.
   - GOLDER INSTRUCTED TO BINNIE (DEAN HANDLEY) TO ENSURE A SMOOTH CHANNEL TRANSITION ON SOUTH BANK FROM STA 1+040 TO STA 1+080.

3. BED LOAD REMOVAL CONTINUING UPSTREAM FROM STA 0+826.

4. PAUL HAGUE & MIKE SULLIVAN REVIEWED PROPOSED BEDLOAD REMOVAL IMMEDIATELY U/S OF HWY 97A. NO INSTREAM WORKS PROPOSED, JUST PICK OUT LARGER BOULDERS, BAR SCALPING ON NORTH BANK AND INSTALLATION OF RIP RAP. PROPOSED.

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 0038

Date TUES FEB 26, 2013

Shift ☑ Day ☐ Night

Time arrived on site 10.45 am hrs

Time left site 12:30 pm. hrs

Time on site ≈ 2 hr.

Travel time 4 hr.

Total time 6 1/2 hr.

Project Name HUMMINGBIRD CK CHANNEL REPAIRS.

Weather SUN & CLOUDS. Temperature Range +-3 °C

Contractor's Working Hours 7:00 AM – 5:00 pm.

Work Carried Out

ACCESS ROAD - MEASUREMENT 5.0m TOP WIDTH

1. DOWNSTREAM BED LOAD REMOVAL TO GRADE @ 5.0m WIDE BASE WIDTH FROM STA 1+080 TO 1+040.
2. HITACHI EX 200 BROKE A TRACK @ ≈ 8:30 AM, STILL UNDER REPAIR AT 11:00 AM.
3. BED LOAD REMOVAL ON GOING NEAR UPSTREAM STA 0+790. SUMMIT ON SITE (HEATHER) ASSESSING FISH U/S of STA 0+790

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 003B
Date THURS FEB 28, 2013
Shift ☑ Day ☐ Night
Time arrived on site 10:45 hrs
Time left site 3.00pm. hrs
Time on site 4½ hr.
Travel time 4 hr.
Total time 8½ hr.

Project Name HUMMINGBIRD CK.
Weather OVERCAST Temperature Range +3 → +5. °C
Contractor's Working Hours 7.00am – 5:00pm

Work Carried Out CHAD MARSH (MOTI) ON SITE, GEOFF CAHILL (GOLDER)

1. DOWNSTREAM BEDLOAD REMOVAL.
- STILL WORKING ON VERY U/S SECTION STA 0+740 TO 0+770 SEVERAL TREES ALONG RT BANK HAD BEEN REMOVED, RE-SHAPING SOUTH BANK TO PROVIDE BETTER/SMOOTHER TRANSITION
- NEAR STA 1+040 TO STA 1+080 CHANNEL HAS BEEN EXCAVATED TO DESIGN GRADE & WIDTH, EROSION/SEDIMENT BERM IS BEING REMOVED, SILT FENCE ACROSS VERY DOWNSTREAM SECTION STA 1+080 IS FUNCTIONING, WITH VERY LITTLE SEDIMENT IF ANY REACHING THE LAKE
- CHAD, DEAN, MIKE, GEOFF & GWEN WENT U/S TO STA 0+620 TO REVIEW & ASSESS PRIVATE PROPERTY NR PREVIOUS AVULSION LOCATION – CHAD & DEAN TO DISCUSS IF WORK SHOULD BE CONSIDERED – FROM CHANNEL CAPACITY PERSPECTIVE, NO WORK NECESSARY.
- U/S of HWY 97A.

- DOWNSTREAM BEDLOAD REMOVAL COMPLETED ACCESS ROAD BEING REMOVED.

Distribution	Initials

Engineer/Inspector [signature]

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 003B.
Date MONDAY MARCH 4, 2013
Shift ☑ Day ☐ Night
Time arrived on site 12:00 hrs
Time left site 4:30 pm. hrs
Time on site 4½ hr.
Travel time 5 hr. (INCLUDE 1 hr. CONFERENCE CALL)
Total time 9½ hr.

Project Name HUMMINGBIRD CK - CHANNEL REPAIRS.
Weather OVERCAST / SUNNY PERIODS. Temperature Range +3 → +5. °C
Contractor's Working Hours 7:00 AM - 5:00 pm.

Work Carried Out # 1024120 TELECONFERENCE CALL. (10:00 AM - 10:45 AM)
- ASSESS SURVEY RQMTS FOR AS-CONSTRUCTED DRAWINGS AS WELL AS INITIAL LAYOUT IE DEPTH of TOE KEY TRENCH.

UPSTREAM of HWY 97A.

1. STA 0+340 - ACCESS ROAD HAS BEEN CONSTRUCTED from HWY 97A TO UPSTREAM EXTENT of PROPOSED BANK PROTECTION WORKS.
   - SANDBAG COFFERDAM WILL BE INSTALLED AT UPSTREAM END TO DIRECT FLOW TO NORTH BANK. SAND BAGS BEING FILLED NEAR END of DAY. TO BE INSTALLED TUESDAY.

2. STA 0+260 - EXCAVATOR REMOVING BANK MATERIAL + INFILLING AREA BETWEEN CK + EXISTING BANK. APPROXIMATE ALIGNMENT of TOE KEY TRENCH + TOP of BANK IDENTIFIED.

3. RIPRAP BEING HAULED TO SITE.
4. LOOKED AT 3" MINUS FILTER LAYER SAMPLE - SAMPLE DID NOT SEEM APPROPRIATE. DEAN SHOWED ME THE 3"-6" ANGULAR DRAIN ROCK WHICH LOOKED BETTER AS A FILTER LAYER. I RECOMMENDED TO SWITCH THE SPECIFICATION of FILTER LAYER from 3" MINUS TO 3"-6" DRAIN ROCK.

Distribution	Initials

Engineer/Inspector [signature]

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 0038
Date 5-MAR-2013
Shift ☒ Day ☐ Night
Time arrived on site 10:00 hrs
Time left site 16:00 hrs
Time on site 6 hrs
Travel time 4 hrs
Total time 10 hrs

Project Name HUMMINGBIRD CRK REHABILITATION
Weather COOL, CLOUDY W/SUNNY BREAKS Temperature Range 1-5 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW
~~Work Carried Out~~ - ON SITE ~ 10:00 AM
- WEATHER FROM SUMMIT ALSO ON SITE - ISOLATION/SILOCLING NOT COMPLETE
- 3 EXCAVATORS WORKING - HITACHI EX200 (BRUCE) ~ 0+290
- HITACHI EX200 LC (JESSE) ~ 0+270
- HYUNDAI 210LC-7A - STOCKPILING
- LARGE STOCKPILE OF RIPRAP ON-SITE
↳ 250kg GRADATION IS ADEQUATE (APPEARS TO MEET SPEC SO FAR)
- BAIRD BROS HAULING RIPRAP TO SITE
↳ ALSO HAULING 3"-6" ANGULAR ROCK
- TOE KEYS AND BANK WORKS BEING PLACED AT:
- 0+290 LEFT BANK WORKING D/S
- 0+270 RIGHT BANK WORKING U/S
- INSTRUCTED MACHINE OPERATORS & DEAN THAT RIPRAP NEEDS TO BE KEYED/LOCKED TOGETHER AND 1.13m(~4') BLANKET THICKNESS → NOTICED SOME WORK NOT MEETING THIS
- WEATHER OFF SITE ~ 15:00
- TOE KEY TRENCHED STARTING LEAKING WATER ~ 0+250
↳ HAD TO GET TRASH PUMP SETUP TO DEWATER
- PRODUCTION WAS SLOW ~5m ON L.B. @ 0+290
~10m ON R.B. @ 0+270

Distribution	Initials
GEOFF	GC

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 003B
Date 6-MAR-2013
Shift ☒ Day ☐ Night
Time arrived on site 09:30 hrs
Time left site 14:30 hrs
Time on site 5 hrs
Travel time 4 hrs
Total time 9 hrs

Project Name HUMMINGBIRD CRK REHABILITATION
Weather COLD, LIGHT SNOW, OVERCAST Temperature Range 0-3 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW

~~Work Carried Out~~

- 2X HITACHI AND 1X HYUNDAI EXCAVATORS WORKING
- BAIRD BROS STILL HAULING RIPRAP
- STILL PUMPING WATER OUT OF TOE KEY TRENCH (0+250)
- SUMMIT ARRIVED ON SITE ~10:30
  - ↳ TOOK LONG TIME TO SETUP & BEGIN SHOCKING
  - ↳ SETUP ISOLATION NETS AT U/S & D/S ENDS OF SITE
    - 0+090 → 0+350 BLOCKED OFF (U/S END OF CULVERT)
- SUMMIT INSTRUCTED TO KEEP CLEAR WHILE SHOCKING COMPLETED → WILL TAKE MOST OF DAY
- PRODUCTION WAS LIMITED TODAY
- BENCH ROAD CUT IN AT ~0+220 TO ACCESS BAR SCALPING AREA
  - ↳ WILL NEED ROCK TRUCK ON SITE TO HELP MOVE MATERIALS & INCREASE PRODUCTION
- DEAN SHUT DOWN EQUIPMENT AT ~14:00 WHILE SHOCKING COMPLETED

Distribution	Initials
GEOFF	GC

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 003B.
Date THURSDAY MAR 7, 2013
Shift ☑ Day ☐ Night
Time arrived on site 10:30 am. hrs
Time left site 4:00 pm. hrs
Time on site 5½ hr.
Travel time 4hr.
Total time 9½ hr.

Project Name HUMMINGBIRD CK. CHANNEL REPAIRS.
Weather OVERCAST / SUNNY Temperature Range +3° °C
Contractor's Working Hours 7:00 am - 5:00 pm.

Work Carried Out UPSTREAM of HWY 97A.

STA 0+340 RIPRAP BANK PROTECTION BEING INSTALLED ALONG RIGHT BANK STARTING FROM U/S END & WORKING TOWARDS. TIE IN TO EXISTING RIPRAP JUST UPSTREAM of HWY 97A. CULVERT. APPROX 50% COMPLETE, DEALING WITH WATER & SEDIMENT CONTROL WHICH IS IMPACTING & SLOWING PROGRESS.

STA 0+260 PROCEEDING WITH INSTALLING TOE KEY RIPRAP FROM D/S TIE IN WORKING UPSTREAM ≈ 10-15% COMPLETE
- RIPRAP BEING STOCKPILED ON SITE WITH 3"-6" FILTER
- DRAIN ROCK BEING TRUCKED TO SITE AS WELL.

STA 0+120 - EXCAVATOR CLEARING ACCESS TO THIS LOCATION.

MET ED DODDS & CHAD MARSH ON SITE. HEATHER & AL from SUMMIT ENVIRONMENTAL ON SITE ELECTRO SHOCKING CHANNEL. ≈ 5 RAINBOW TROUT COLLECTED.

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 003B.
Date Fri March 8, 2013.
Shift ☑ Day ☐ Night
Time arrived on site 10:30 am hrs
Time left site 4:00 pm hrs
Time on site 5½ hr.
Travel time 4 hr.
Total time 9½ hr.

Project Name HUMMINGBIRD CK.
Weather CLOUDY & SUNNY Temperature Range +5 °C
Contractor's Working Hours 7:00 am – 5:00 pm.

Work Carried Out

1. STA 0+340 LT BANK U/S of CULVERT. ≈ 60% - 70% COMPLETE. CONTINUING TO WORK from U/S TOWARDS CULVERT.
2. HAUL ROAD ESTABLISHED NEAR U/S PORTION of STA 0+260 & NO FURTHER WORK IS BEING DONE AT STA 0+260 FOR NOW.
3. STA 0+100 – EXCAVATION of TOE KEY STARTED. LAUNCHING RIP RAP MAY BE REQUIRED DUE TO WATER/CREEK BEING SO CLOSE TO THE PROPOSED TOE.

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date 9-MAR-2013
Shift [X] Day [ ] Night
Time arrived on site 10:30 hrs
Time left site 15:30 hrs
Time on site 5 hrs
Travel time
Total time

Project Name HUMMINGBIRD CRK REHAB
Weather COOL, SUNNY Temperature Range 3-5 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW

~~Work Carried Out~~
- BANK WORKS AT ~0+100 WERE MOSTLY COMPLETED → I INSPECTED AND INSTRUCTED TO ADD MORE RIPRAP TO STRAIGHTEN ALIGNMENT
- BANK WORKS AT ~0+320 WERE ON GOING
- THREE EXCAVATORS OPERATING
- ONE ROCK TRUCK ON-SITE
- ONE TANDEM TRUCK ON-SITE
- SUMMIT ON-SITE IN MORNING (GWEN)
- BEGAN PREPARING FOR CHANNEL DIVERSION AT ~0+150
  - ↳ ACCESSED OF DAVIDSON RD CUL-DE-SAC
  - ↳ STARTED MOVING LARGE BOULDERS
  - ↳ LAID OUT DIVERSION CHANNEL ALIGNMENT
  - ↳ LAID OUT TOE KEY (APPROX.) FROM ~0+145 → 0+175

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date MAR 11, 2013
Shift ☒ Day ☐ Night
Time arrived on site 11:00 hrs
Time left site 17:00 hrs
Time on site 6 hrs
Travel time 4 hrs
Total time 10 hrs

Project Name HUMMINGBIRD CRK REHAB
Weather SUNNY, COOL Temperature Range 3-5 °C
Contractor's Working Hours 07:00 - 17:00

Work Carried Out

FIELD REVIEW
- TRAVIS FROM SUMMIT ON-SITE & DIRECTING STREAM DIVERSION WORK AT ~0+150
- DIVERSION WORK TOOK ~~[illegible]~~ BETTER PART OF DAY
- WALKED THROUGH WORK AT ~0+320 WITH DEAN AND INSTRUCTED ON ADDITIONAL ROCK PLACEMENT, TRANSITION, AND CLEAN-UP
- THREE EXCAVATORS, TWO ROCK TRUCKS, ONE TANDEM ON-SITE
  ↳ ONE ROCK TRUCK REPORTEDLY HAD OIL LEAK
- DEAN SENT ONE ROCK TRUCK & TANDEM HOME EARLY (~13:00)
- STARTED BANK WORKS AT ~0+120 LEFT
  ↳ ENVIRONMENTAL & SITE CONSTRAINTS LIMIT TOE KEY CONSTRUCTION → MADE DECISION TO CHANGE TO A SELF-LAUNCHING TOE KEY AT THIS LOCATION
- NEAR END OF DAY ONCE DIVERSION COMPLETE AND SUMMIT APPROVED WORKS TO PROCEED, STARTED TO PREP FOR 0+150 BANK WORKS

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 0038
Date TUES MARCH 12, 2013
Shift ☑ Day ☐ Night
Time arrived on site 12:00 NOON hrs
Time left site 3:00 pm. hrs
Time on site 3hr.
Travel time 5hr.
Total time 8hr.

Project Name HUMMINGBIRD CK.
Weather SNOWING. Temperature Range -1 TO +3. °C
Contractor's Working Hours 7:00 am – 5:00 pm.

Work Carried Out

ROCK TRUCKS NOT WORKING DUE TO SNOW COVER.
ONE EXCAVATOR WORKING ON STA 0+160 - EXCAVATING TOE KEY TRENCH FOR RIP RAP PLACEMENT.

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-HPA-0066, 4001, 0038
Date WED MARCH 13, 2012
Shift ☑ Day ☐ Night
Time arrived on site 10.30 hrs
Time left site 4.30 hrs
Time on site 6hr.
Travel time 4hr.
Total time 10hr.

Project Name HUMMING BIRD CK.
Weather LIGHTLY OVERCAST Temperature Range +3 °C
Contractor's Working Hours 7.00 AM - 5 pm.

Work Carried Out

1. STA 0+160 - ≈ 50% COMPLETE - DISCUSS ISSUES WITH WATER WELL WITH LOIS, DAN, CHAD & DEAN. LOIS WANTED FINER GRAVELS REMOVED FROM AROUND WELL SO FINER GRAVELS & COBBLES REMOVED & REPLACED WITH LARGER RIP RAP. TOE KEY TRENCH FROM D/S of WELL BEING TIED INTO NEAR WELL. LOOSE ROUND ROCK REMOVED FROM EMBANKMENT JUST U/S of WELL & REPLACED WITH ANGULAR RIP RAP.

2. STA 0+120 - 75% COMPLETE - CONTINUING TO COMPLETE THIS SECTION - NO ISSUES. TOE KEY NOT!

3. STA 0+100 - NO WORK BEING DONE - 80-90% COMPLETE - NEED TO INSTALL A LITTLE MORE ROCK TO SMOOTH OUT EMBANKMENT

4. STA 0+200 - NO WORK BEING DONE. - 50% COMPLETE.
5. STA 0+260 - " " - 0% " "
6. STA 0+340 - 100% COMPLETE.

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066, 4001, 0038
Date MARCH 14, 2013
Shift ☑ Day ☐ Night
Time arrived on site 10:30 AM. hrs
Time left site 4:30 hrs
Time on site 6 hr.
Travel time 4 hr.
Total time 10 hr.

Project Name HUMMINGBIRD CK.
Weather RAIN Temperature Range +5 °C
Contractor's Working Hours 7:00 AM – 5:00 pm.

Work Carried Out CREEK WATER LEVELS ARE UP DUE TO RAIN
STA 0+100 – NO WORK – ≈ 90% COMPLETE.
STA 0+120 – 100% COMPLETE TO DAY.
– STABILIZED EXISTING BANK PROTECTION JUST UPSTREAM OF NEW RIPRAP & DOWNSTREAM OF NEW RIPRAP WITH NATIVE ROCK.
STA 0+160 – CONTINUING TO PLACE RIPRAP AT TOE KEY, FINISHED TOE KEY & PLACING RIPRAP ON EMBANKMENT SLOPE. 1.5H:1V.
≈ 75–80% COMPLETE.

Distribution	Initials

Engineer/Inspector

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date MAR. 15/2013
Shift ☒ Day ☐ Night
Time arrived on site 10:30 hrs
Time left site 16:00 hrs
Time on site 5.5 hrs
Travel time 4 hrs
Total time 9.5 hrs

Project Name HUMMINGBIRD CRK REHAB
Weather COOL, PARTLY SUNNY Temperature Range 2-6 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW

Work Carried Out
- 3 EXCAVATORS WORKING
- 2 ROCK TRUCKS WORKING, ONE SENT HOME (1/2 DAY)
- SUMMIT (HEATHER) ON SITE
- WALKED THROUGH SITE & WORKS W/ DGAN
- D/S RIGHT BANK (0+475) WORKS STARTED
  - ↳ ACCESS CUT IN AND PREP WORK BEGAN
  - ↳ STARTED PLACING 3"-6" AND RIPRAP
- 3x U/S WORKS SUBSTANTIALLY COMPLETE (0+100 R.B., 0+120 L.B., 0+150 B.B.)
- DIVERSION WORK PLANNED FOR TOMORROW (~0+180)
  - ↳ ONCE STREAM MOVED, L.B. WORK @ ~0+190 CAN BEGIN

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date MAR. 16 / 2013
Shift ☒ Day ☐ Night
Time arrived on site 10:15 hrs
Time left site 17:45 hrs
Time on site 7.5hrs
Travel time 4hrs
Total time 11.5 hrs

Project Name HUMMINGBIRD CRK REHAB
Weather COOL, OVERCAST Temperature Range 4-8 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW

~~Work Carried Out~~
- 3 EXCAVATORS WORKING
- 1 ROCK TRUCK WORKING, 1 PARKED
- D/S WORKS CONTINUING (0+470)
  - ↳ TEST PITS FOUND EXISTING ROCK @ ~0+470
  - ↳ STREAM FLOWING UP TO TOE OF BANK
  - ↳ MADE FIELD DECISION TO NOT EXCAVATE TOE KEY
  - ↳ WILL CONSTRUCT SELF-LAUNCHING TOE
- WORKED ON STREAM DIVERSION @ ~0+180
  - ↳ THIS WORK TOOK ALMOST ALL DAY (VERY SLOW)
  - ↳ COMPLETED DIVERSION BY ~17:30
  - ↳ SHOULD BE READY TO BEGIN LEFT BANK WORK
- SUMMIT ON SITE (GWEN)

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date MAR.18/2013
Shift ☒ Day ☐ Night
Time arrived on site 10:30 hrs
Time left site 15:45 hrs
Time on site 5.25 hrs
Travel time 4 hrs
Total time 9:15 hrs

Project Name HUMMINGBIRD CRK REHAB
Weather COOL, OVERCAST W/ SUN, LIGHT SNOW Temperature Range 5-10 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW

~~Work Carried Out~~

- 3 EXCAVATORS WORKING ON-SITE
- 1 ROCK TRUCK WORKING ON-SITE
- SUMMIT ON-SITE (HEATHER)
- STILL HAVE LARGE STOCKPILE OF RIPRAP
- RIGHT BANK D/S OF HWY RIPRAP PLACEMENT CONTINUED
  - ↳ ONLY APPROX. 10 m COMPLETE
- ACCESS CUT IN TO LEFT BANK WORK @ ~0+190
  - ↳ PICKED OUT SOME NATIVE BOULDERS OF BAR
- RIGHT BANK @ ~0+220 STARTED
  - ↳ WORKING D/S TOWARDS RIPRAP PLACED ALREADY

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date MAR. 19, 2013
Shift ☒ Day ☐ Night
Time arrived on site 09:45 hrs
Time left site 15:15 hrs
Time on site 5.5 HRS
Travel time 4 HRS
Total time 9.5 HRS

Project Name HUMMINGBIRD CRK REHAB
Weather COOL, OVERCAST w/ SUN Temperature Range 5-10 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW

~~Work Carried Out~~

- 3 EXCAVATORS & 1 ROCK TRUCK WORKING
- BAIRD IS HAULING TODAY
- WORKS D/S OF HWY ONGOING
  - ↳ ONLY APPROX. 20m COMPLETE
- TOE KEY TIED INTO STATION ~0+240
  - ↳ RIPRAP SLOPE STILL NEEDS TOP UP & KEYING
  - ↳ THERE ARE STILL SOME GAPS AND LOW SPOTS BETWEEN 0+220 - 0+270
- LEFT BANK 0+190 - 0+260 WORKS STARTED
  - ↳ DECISION MADE TO REDUCE LENGTH OF RIPRAP
  - ↳ D/S EXTENT APPROX. 0+225
  - ↳ PICKED OFF NATIVE BOULDERS AND FILLED LOW SPOT AT 0+250
- ED DODDS & CHAD MARSH ON-SITE IN MORNING FOR INSPECTION
- SUMMIT ON-SITE (HEATHER)

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date MAR. 20, 2013
Shift ☒ Day ☐ Night
Time arrived on site 10:00 hrs
Time left site 14:45 hrs
Time on site 4.75HRS
Travel time 4 HRS
Total time 8.75HRS

Project Name HUMMINGBIRD CRK REHAB
Weather COLD, RAIN, OVERCAST Temperature Range 0-5 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW
Work Carried Out

- 3 EXCAVATORS & 1 ROCK TRUCK ON SITE
- SUMMIT (GEATHER) ON-SITE
- D/S HWY WORKS CONTINUING
  - ↳ APPROX. 40m COMPLETE
- LEFT BANK (~0+220) WORKS CONTINUING
  - ↳ APPROX. 10 m COMPLETE
  - ↳ TOE KEY TRENCH WAS SPILLING SMALL AMOUNT OF SEDIMENT-LADEN WATER INTO STREAM
  - ↳ DEAN & CO. WERE TRYING TO SETUP CONTROL TO PUMP OUT DIRTY WATER
- WORKS REMAINING: R.B. D/S OF HWY APPROX. 20m
  : L.B. 0+190 APPROX. 30m
  : CULVERT INSTALL IN HWY DITCH
  : CLEAN UP L.B. @ HWY FOR MULCHING
  : GENERAL SITE CLEAN UP

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

Golder Associates

ENGINEER'S/INSPECTOR'S REPORT

Project No. 12-1494-0066
Date MAR. 21 / 2013
Shift ☒ Day ☐ Night
Time arrived on site 11:30 hrs
Time left site 17:30 hrs
Time on site 6 HRS
Travel time 4 HRS
Total time 10 HRS

Project Name HUMMINGBIRD CRK REHAB
Weather COOL, SUNNY BREAKS Temperature Range 5-15 °C
Contractor's Working Hours 07:00 - 17:00

FIELD REVIEW

~~Work Carried Out~~

- 3 EXCAVATORS & 1 ROCK TRUCK WORKING
- SUMMIT (TRAVIS) ON SITE
- WORKS ONGOING D/S OF HWY
- WORKS ONGOING @ L.B ~0+190
- HOMEOWNER (LOIS) ASKED FOR A FEW LOADS OF LARGE BOULDERS DROPPED UP BY HOUSE
- BY END OF DAY ALL WORKS SUBSTANTIALLY COMPLETE
  - ↳ ALL RIPRAP PLACED
  - ↳ ONLY SITE CLEANUP REMAINING

Distribution	Initials

Engineer/Inspector GEOFF CAHILL

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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