THURBER ENGINEERING LTD.

July 18, 2023 File No.: 32121

Alberta Transportation and Economic Corridors
Provincial Building
9621 – 96 Avenue
Peace River, Alberta
T8S 1T4

Attention: Mr. Max Shannon

**GEOHAZARD RISK MANAGEMENT PROGRAM (CON0022164)**
**PEACE REGION (PEACE RIVER DISTRICT**
**SECTION D CALL-OUT REPORT**
**THE BIG EDDIE, BRICK'S HILL: HWY 684:02 km 8.86 to 8.98**

Dear Mr. Shannon:

This report presents the results of a call-out for the above-noted site located on Hwy 684:02 between km 8.86 and 8.98, which is about 20 km southwest of the Town of Peace River on the north valley slope of the Peace River in an area known as "Brick's Hill." The legal description of this site is NW24/SW25-91-23-W5M. The AADT (average annual daily traffic) on the two-lane paved highway is 370 vehicles per day as of September 2021.

Mr. Ken Froese, P.Eng., of Thurber Engineering Ltd. (Thurber) undertook a call-out inspection on June 9, 2023, in the presence of Messrs. Max Shannon and Erwin Kurz (Maintenance Contractor Inspector, MCI) and Ms. Mae Stewart (Operations Engineer) from Peace Region Operations office of Alberta Transportation and Economic Corridors (TEC).

It is a condition of this letter that the performance of Thurber's professional services is subject to the attached Statement of Limitations and Conditions.

## 1. BACKGROUND

This site was brought to the attention of TEC by the MD of Peace No. 136 who noticed the slide starting to develop. As of June 6, 2023, the slide was about 15 m from the south fence line or about 47 m from the southbound shoulder. Rapid movement shortly thereafter led TEC to submit a request to Thurber on June 8, 2023, for a call-out inspection which was completed the following day.

Although there had not been distress noted at this location since the 1980s, Google Earth imagery from May 10, 2023, shows cracks starting to form in the lower half of the fill slope. These cracks, shown in Figure 1.1, have been approximately transferred on to the Drawings.


***Figure 1.1 – Google Earth image dated May 10, 2023***

Subsequent reviews of historical information in Thurber's files from the Geohazard Site Binders for adjacent locations and additional information provided by TEC determined that there had been previous instability at this location. The Section A report written by AMEC (1999) identified that a slide occurred on the Shaftesbury Trail near the top of the valley where the road crossed a gully. Cracking was observed in 1985 and the initial slide occurred on April 25, 1986. An inspection of the site by Alberta Transportation and Utilities (ATU, now TEC) personnel in May 1986 noted that the slide was about 50m in width, the cracks in the pavement had a vertical differential between 0.6 m and 1.0 m, and the rupture surface appeared to be 2 m to 3 m deep. Clay till was exposed to at least 6 m in depth and underlain by fine sand which had seepage. EBA Engineering Consultants Ltd. (EBA) (1986) completed a drilling investigation for ATU in May 1986 encountered clay till fill overlying clay over sand.

Conversations with local residents, Hubert Wald and Peter Van De Ligt, provided some additional history regarding this area. The highway was paved in about 1972 primarily to improve access to the prison on Shaftesbury Trail closer to Peace River and, as an experiment, was done without using granular base course to determine if that would be a cost-effective method to consider for future projects. They recalled that during the slide repair, there was no material removed off-site so anything excavated was used as fill for the berms and embankment below the highway. Although the highway was under the Rural Municipality's control at the time, Alberta

Transportation provided the assessment, design, and construction as the RM was unable to afford the work.

EBA (1986) interpreted the lower two units (clay and sand) as highly weathered clay shale bedrock of the Shaftsbury Formation (due to high SPT blow counts) and noted a high groundwater table in the area particularly at the toe of the slide. Slope inclinometer results had shear movement at 3 m depth (located 10 m to the upslope side of the original highway centerline) and 13.7 m depth (located 11 m on the downslope side of centerline). There was a culvert on the east side of the slide which may have become obstructed potentially leading to ponding and infiltration of water into the slide mass. EBA considered the rupture surface to be a translational slide assumed to be in the clay shale with a steep headscarp and gently dipping basal surface inclined at about seven. EBA hypothesized that high horizontal stresses developing from glacial rebound led to the formation of pre-sheared planes on which the slide was triggered that year due to high groundwater conditions.

EBA's stability analysis determined that the internal angle of friction of the clay shale was near nine (no cohesion used in the analysis) which was considered reasonable for the overconsolidated clay shale. At the time, EBA recommended that the slide mass be stabilized by a toe berm 3 m high and 10 m wide constructed at the narrowest part of the gully with a subexcavation of 1 m to develop passive resistance on the downslope side. They also recommended a 5 m deep subdrain below the north ditch which could daylight further to the east and removal of the existing culvert so that surface flow would be kept in the north ditch away from the slide. In addition to those measures, they recommended that the road be realigned at least 75 m upslope or keep the same alignment but replace the upper portion of the slide mass with geogrid-reinforced gravel. An intermediate berm was also recommended for the latter option as well as trench drains upslope of the highway and upslope of the intermediate berm. EBA noted that realigning just to the north of the existing alignment had a factor of safety less than 1.0.

A review of publicly-available mapping indicates that the bedrock at this site could be in the order of 10 m deep (Alberta Geological Survey DIG 2020 0023); however, drilling at the adjacent PH040 to the east did not encountered bedrock within the 20 m depth of investigation. The large-scale mapping is unreliable in valleys. The uppermost bedrock unit is anticipated to be marine clay shale, with some siltstone and sandstone, of the Shaftesbury Formation (Alberta Geological Survey Map 236). The bedrock surface slopes southwest toward the pre-glacial valley thalweg that approximately underlies the present-day Peace River valley (Alberta Geological Survey Digital Map DIG_2020_0022, 2020). The surficial geology map indicates that the uplands in this area consist of an extensive glaciolacustrine plain (clay, silt, and sand) with an eolian deposit (fine sand and silt) at the crest of the uplands above this site. The terraces down at river valley level consist of fluvial deposits (stratified gavel, sand, and silt) with bedrock outcrops near the toe of the valley north and south of the site where not covered by colluvium. The site itself is situated on the extensive colluvium which mantles all the valley slopes between the uplands and terraces for much of the Peace River valley (Alberta Geological Survey Digital Map DIG_2004_0044, 2004). The Peace River is only slightly meandering and the bottom of the valley does not extend much beyond the width of the river. From crest to crest, the overall valley width in the area is about 5 km and the valley depth is about 240 m.

## 2. OBSERVATIONS

Observations made during the site visit are illustrated in Drawings 32121-PH093-1 and 32121-PH093-2A, attached. Selected photographs of the site visit are also included at the end of this letter (Appendix B). Measurements were made on site using a tape measure, hand-held GPS, and drone photogrammetry.

The highway road surface measures about 10 m in width. The north sideslope is inclined at approximately 8H:1V and the highway is about 0.8 m above the north ditch bottom. The south (downslope) side shoulder of the highway is about 2 m above the plateau beyond and the south sideslope is inclined at about 3.8H:1V. Prior to failure, the plateau to the south of the highway extended about 75 m from the edge of the highway and sloped downward at 4H:1V for an additional 100 m where the apparent fill ended at the bottom of a gully. There was a drainage swale at the crest of the plateau which sloped toward the west. A centerline culvert was present at the west edge of the slide which discharged north ditch flow on to a gabion mattress channel which ran down the west flank of the fill.

According to legal boundaries provided by McIntosh Perry (shown on Drawing 32121-PH093-2 as taken from their emergency detour design submission), it appears that the highway was previously shifted upslope up to 27 m at the east edge of the current slide and 15 m at the west edge. Thus, the slope below the highway appears to have been constructed in partial accordance with both of the recommendations made by EBA in 1986: a toe berm was constructed and the highway was shifted upslope (although not the full 75 m recommended).

The main headscarp was located 42 m from the roadway centreline at the east side and 106 m at the west side. The widest distance, from flank to flank, was about 132 m. The toe was approximately 350 m from the headscarp and the disturbed material had appeared to have been funnelled down an existing gully.

A tension crack was present behind the headscarp which cut into the highway sideslope and had east-west extents of similar width. This crack appears to be the next retrogression of the failure. The MCI established three transects across the crack on which to track the movement rates as the block below continued to move downslope. These lines are shown on the Drawing as A (west side), B (near the highway), and C (east side) and results of the ongoing measurements are provided in Section 4.

There is an approach on the north side of the highway which acts as a ditch check directing east-ward flow into a 900 mm-diameter CSP culvert on the west side of the site. The outlet, which was mostly obstructed, discharges onto a grass-lined swale which went down the west flank of the embankment fill plateau which is likely the edge of the fill placed in 1986. Below the crest of the fill, the 2 m-wide channel was lined with a gabion mattress and intermittent check dams. There was disturbance along the edge of the gabion mattress near the crest of the slope where tension on the lower portion of the mattress was pulling it away from the surrounding ground surface. This was located about 14 m upslope of the main headscarp. Also observed on this side of the plateau was a 900 mm deep crack about 4 m behind the main scarp. The main headscarp cut through the drainage channel into the adjacent ground which appears to have been previously undisturbed. Upslope of this west end of the scarp and before the main crack at the highway sideslope, there were other smaller tension cracks starting to open with depths up to 500 mm.

To the east of the channel, the soil profile exposed in the 3.5 m vertical face of the headscarp consisted of 330 mm of topsoil and clay till fill containing a 100 mm thick piece of asphalt pavement, 250 mm of high plastic clay, over clay till (also potentially fill) with sandy and silty zones (Sample 1).

In the central portion of the slide, the headscarp exposed what appeared to be predominantly sandy clay till fill. There were pieces of asphalt, zones of rootlets (that look like original ground surface), pieces of birch branches at depths of 2 m to 3.3 m below ground surface. This could indicate poor fill quality or remnants from the 1986 slide debris that had not been removed. On the eastern flank, there were numerous pockets and zones of fine sand exposed in face of the scarp. Some of the exposed soils had a regular, layered pattern which was inclined at 10° to 15° downslope.

There is a hill on the east side into which the flank of the slide has started to cut. The hill slope was inclined at 35° toward the slide. This hill may represent wasted material as the headscarp below contained variable zones of material including large fine sand deposits and chunks of clay shale. Alternatively, it may have been over-steepened by erosion from the gully that existing on the east side of the site prior to the 1986 failure, as the only other locations observed on the LiDAR with slopes this steep are on the sides of the gully below the fill.

At about the elevation of the bottom of the original fill, there is a transition point between depletion and accumulation and below this point, the tongue of the slide had deposited material in ridges on each side. The area between the ridges was relatively lower giving a concave transverse section. The soil deposited was in loose blocks with numerous closely spaced cracks and scarps.

Pieces of asphalt were exposed at many locations near the toe. Trees along the margins had been pushed over or buried by the debris. At many locations along the flanks of the slide, the slip surface was exposed and consisted of smeared, high plastic clay. The spacing and width of the desiccation cracks indicates that there may have been significant moisture when the sliding happened. Below the desiccated crust, the slickensides and joints below had films of water. Some of the samples collected during the reconnaissance were an attempt to quantify this moisture content.

The toe of the slide debris was relatively steep: 30° near the crest becoming about 43° at the bottom. There were some small zones of seepage and wet soil noted near the bottom (Sample 4) but, interestingly, the gully floor beyond the toe appeared to be undisturbed.

Several soil samples were collected during the site reconnaissance to understand the potential range of moisture contents present in the landslide debris. The locations of the samples are shown on Drawing 32121-PH093-2A and summarized below in Table 2.1.

***Table 2.1 – Soil Samples Analysed***

| SAMPLE NUMBER | SOIL TYPE | WATER CONTENT (%) | DESCRIPTION / DISCUSSION |
|---|---|---|---|
| 1 | CL-ML | 22.5 | Clay and silt, some sand, silty, trace rootlets and gravel Probable clay fill; taken from the exposed face of the headscarp |
| 2 | CH | 10.6 | Weathered clay, silty, trace siltstone inclusions: taken from chunk exposed in face of headscarp |
| 3 | CH | 30.1 | Clay, silty, trace silt and sand lenses and gravel: taken from below desiccated crust of exposed slip surface |
| 4 | CH | 40.6 | Clay, silty: taken from wet zone in toe of debris |
| 5 | CH | 33.9 | Clay, silty: taken from below desiccated crust of exposed slip surface |
| 6 | CH | 31.7 | Clay, silty: taken from below desiccated crust of exposed slip surface |
| 7 | CH | 30.3 | Clay, silty: taken from below desiccated crust of exposed slip surface |
| 8 | CH | 26.3 | Weathered clay shale, silty, trace siltstone inclusions: taken from below desiccated crust of exposed slip surface |
| 9 | CL-ML | 24.8 | Clay and silt, some sand, trace rootlets: taken from vicinity of seeps near drainage channel location |
| 10 | CH | 28.2 | Varved clay and siltstone: taken from outcropping in headscarp |

## 3. INSTRUMENTATION

There is no instrumentation at this site.

## 4. ASSESSMENT

Based on comparison between the pre-disturbance LiDAR ground surface captured in 2007 and the post-disturbance UAV photogrammetry-derived elevation model, the transition between depletion and accumulation occurs coincident with the downslope end of the toe berm constructed following the 1986 slide (see Drawing 32121-PH093-3). That would suggest that the failure occurred within the fill or native, possibly disturbed, material beneath the fill. Since the failure took 37 years to occur, it is likely due to gradually straining of the relatively weak native clay soils under the load of the fill that was replaced for the repair, combined with a gradual loss of cohesion which resulted in a progressive failure. It is possible that there was also some oversteepening by erosion at the toe of the embankment. The likely source of erosion would be from the gabion mattress channel on the west side. Above-average rainfall may also have been a contributing factor in triggering erosion or raising the local groundwater table. Environment Canada's 1981 to 2010 Climate Normals for Peace River are 18 mm of rainfall for month of April and 40 mm for May. In 2023, April had only 5 mm of rainfall. But there was 72 mm in May 2023 with 50 mm of that, greater than the long-term average for the whole month, fell between May 22 and 24. However, the Google Earth imagery indicates that failure had already initiated earlier in May (assuming their dates are correct) so the heavy rainfall later in the month was not the cause although it most likely contributed to the rate and size of movement.

Given the long run out of the slide and the appearance of flow slide-type behaviour, an advancing zone of water and mud could have been anticipated but the dried leaves on the gully floor did not show evidence of such. It is possible that there was some wetter material in the initial phase of movement which was subsequently buried by drier material.

The elevation model derived from the UAV imagery does not exclude vegetation and was not corrected with ground control points so comparison with the 2007 LiDAR is subject to errors. Within those limitations, there appears to have been about 45,000 $m^3$ of depletion from the fill slope and a corresponding amount of accumulation below in the gully. As discussed above, the slide appeared like a flow slide wherein a sensitive clay fails suddenly resulting in a wet mass of material flowing out and then spreading. In this case, there does not appear to have been a large amount of water involved in the slide and the appearance may simply result from the existing gully funneling the debris. There appears to be about 6 m thickness of material deposited in the gully.

Due to the presence of the large tension crack in the sideslope of the highway (3.96 m from the fog line at the closest point), on site discussions included consideration of closing the road immediately. However, as the nearest county road was not suitable for a detour, it was agreed to keep the road open but reduce the speed limit to 30 kph, place jersey barriers along the downslope side of the highway and increase the frequency of inspection. The MCI has been measuring the separation between the stakes at Lines A, B, and C routinely. As of July 17, 2023, the slide had not retrogressed into the highway but there has been 97 mm of horizontal displacement at A, 95 mm at B, and 31 mm at C. After an initial high rate of movement in early June right after the slide occurred, the rate has slowed to an average of 1 mm per day at Lines A and B. The average rate of movement at Line C over the previous two weeks has been less than 0.2 mm per day. The displacements measured at all three lines are plotted in Figure 4.1. The displacement was measured between the reference survey lathe rather than on the crack itself for ease of repeatability. Photographs provided by the MCI have shown the increasing displacement and graben formation along this main crack but relatively little loss of material at and below the headscarp.

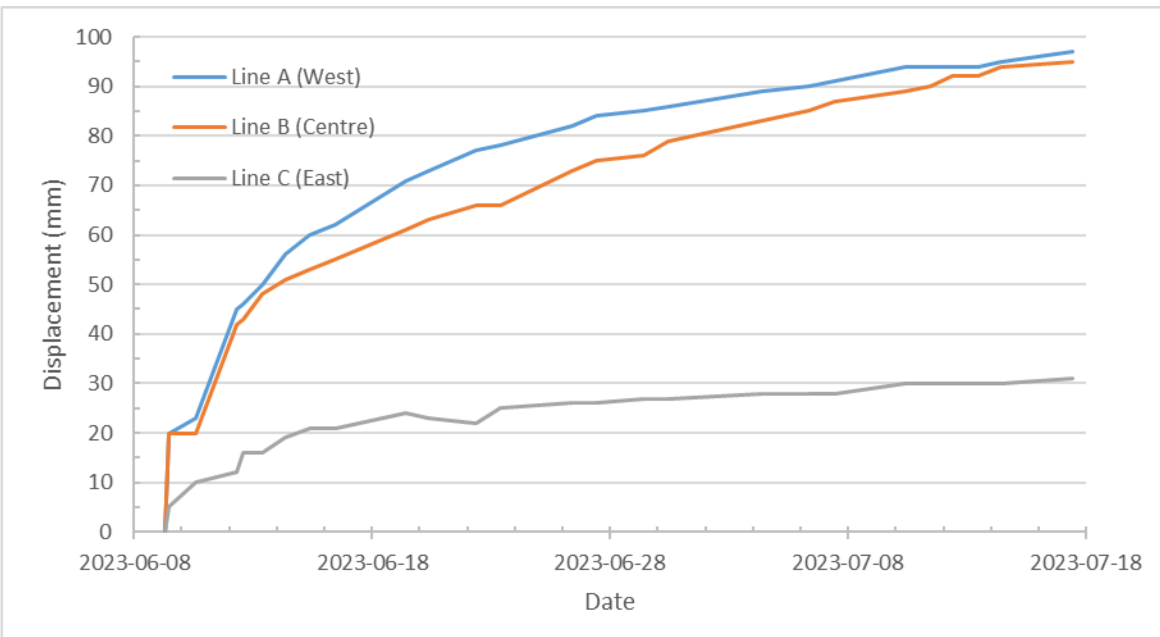



***Figure 4.1: Displacement Between Survey Lathe On The Transects Established At The Main Crack Near The Highway***

It is expected that the slow movements will continue until there is a sudden, brittle failure and this next block slides out. This may be triggered by high rainfall raising the groundwater table and lubricating the slip surfaces or by steady erosion of the slide material below the headscarp leading to further stabilization of the overall slope. As such, McIntosh Perry (MP) was retained to develop a low-speed temporary detour that could be constructed upslope of the existing highway with minimal cut and fill so that material would not be imported. This has been provided to TEC for implementation by the Maintenance Contractor.

## 5. RISK LEVEL

Based on the AT's Risk level rating system, the risk level for this site has been assessed as follows:

Risk (112) = PF (14) x CF (8)

This risk level was based on a Probability Factor (PF) of 14 ("active with high rate of movement") and a Consequence Factor (CF) of eight (between "closure of the road would be a direct and unavoidable result" and "rapid mobilization of large-scale slide possible"). There is an immediate risk to the public if the failure occurs suddenly and happens overnight or in poor visibility conditions as most, or all, of the roadway surface could be lost. The consequence factor can be reduced through construction of the temporary detour which would reduce the likelihood of the slide completely closing the road. Loss of the road before the detour is in place would necessitate the use of the sub-standard country road (winding, poor site lines, soft surface) or detouring via Highway 2 between Grimshaw and Peace River.

## 6. RECOMMENDATIONS

As discussed above, the short-term recommendation is to construct a low-speed detour as far upslope of the existing highway as can be done without cutting into the hill above the highway. This has already been designed by MP and can be constructed by the Maintenance Contractor as soon as funding is available. The proposed alignment is attached in Appendix C.

On a preliminary basis, realignment of the highway would appear to be the most economical solution for long-term remediation of this slide. The realignment would start on the east side where the highway is still protected by the PH040 pile wall, cut into the hill, and return to the original alignment well on the west side of the slide. The backslope cut will be extensive as the cut will be on the order of 20 m deep and will need to be analyzed to confirm that destabilization of the valley slope above will not result. The slope on the south/downslope side should also be offloaded and flattened. Realignment will generate significant quantities of material that will have to be hauled out of the valley for disposal. If the design speed of the highway could be lowered, that would allow for tighter curves and a reduced amount of excavation and associated lower cost.

A pile wall could also be considered to maintain the existing alignment, but this option is expected to be considerably more expensive than the re-alignment option. Drilled cast-in-place concrete piles on the order of 25 m deep, with two or more rows of ground anchors/tiebacks would likely be required.

Even with highway re-alignment it might be advisable to install a smaller cantilever pile wall along the downslope side of the re-aligned highway to further increase the factor of safety.

On a preliminary basis, the recommendations for the emergency realignment are:

- The topsoil from the footprint of the new embankment and ditch bottom should be stripped and stockpiled for reuse
- All soft or organic material should be removed from below the embankment footprint
- On-site material should be used as fill and moisture-conditioned as required to achieve compaction
- The new upslope ditch should be graded to ensure flow to the east away from this slide

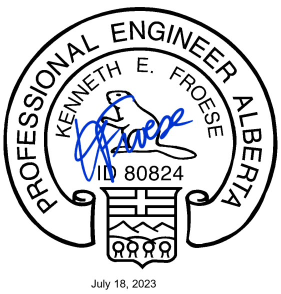
The C Estimate for the temporary gravel-surface detour prepared by MP was $146,300 (including contingency) and is attached in Appendix C.

A geotechnical investigation is required to confirm soil properties and groundwater levels particularly prior to undertaking stability analyses to determine the feasibility of realignment or structural reinforcement. A proposal for this work has been submitted to TEC and included the estimated cost of about $30,000 for MP to provide layout and construction supervision for the temporary detour construction.

## 7. CLOSURE

We trust that this information is sufficient for your present requirements. We would be pleased to answer any questions that you may have regarding this letter report.

Yours truly,
Thurber Engineering Ltd.
Don Proudfoot, M.Eng., P.Eng.
Review Principal




**PERMIT TO PRACTICE**
**THURBER ENGINEERING LTD.**
RM SIGNATURE: [signature]
RM APEGA ID #: 51674
DATE: July 18, 2023
**PERMIT NUMBER: P005186**
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Ken Froese, M.Eng., P.Eng.
Geotechnical Engineer
/nf

Attachment
- Statement of Limitations and Conditions
- Appendix A: Drawings
- Appendix B: Selected Photographs
- Appendix C: McIntosh Perry Temporary Detour Design and C Estimate

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# APPENDIX A

Drawings

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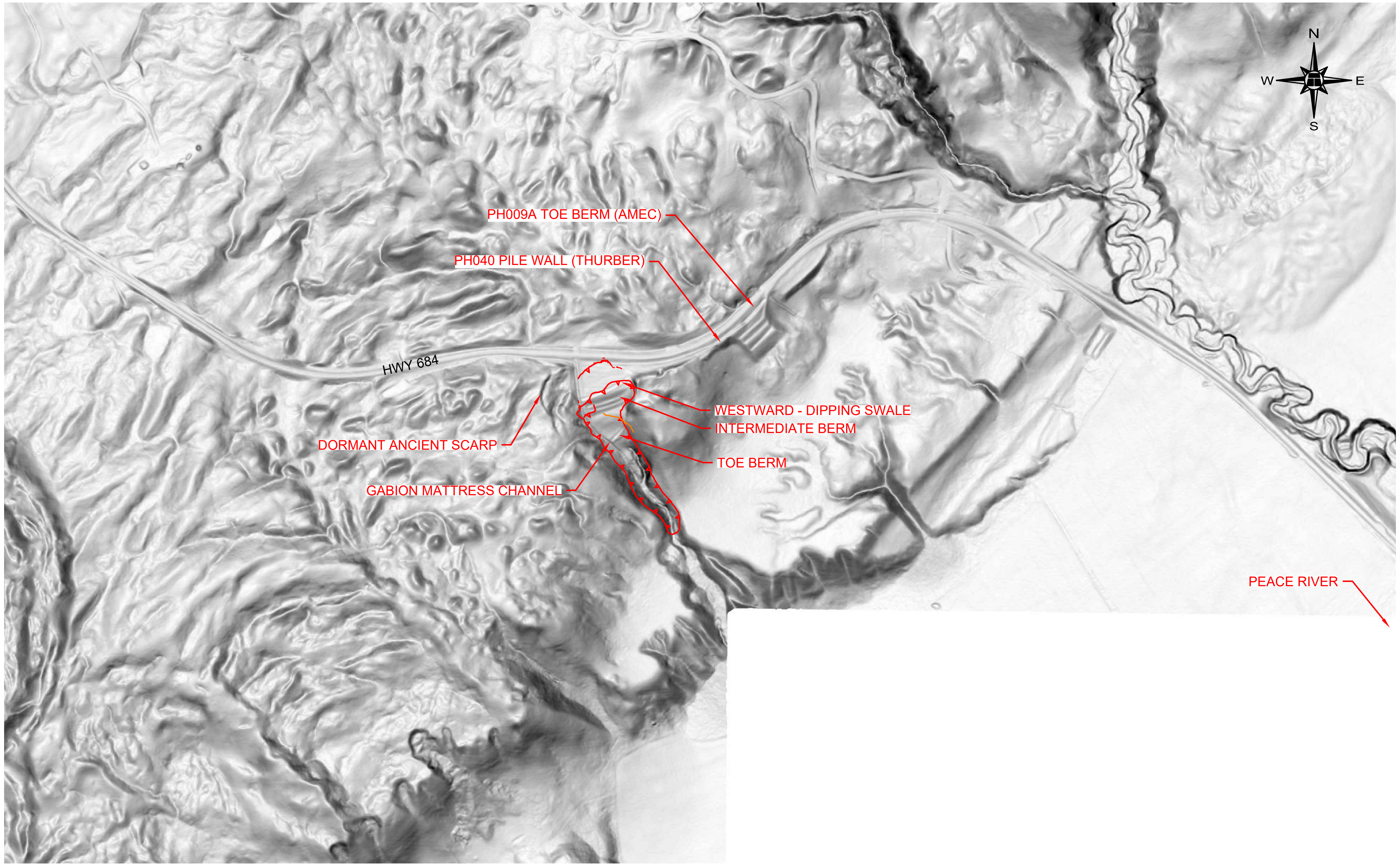


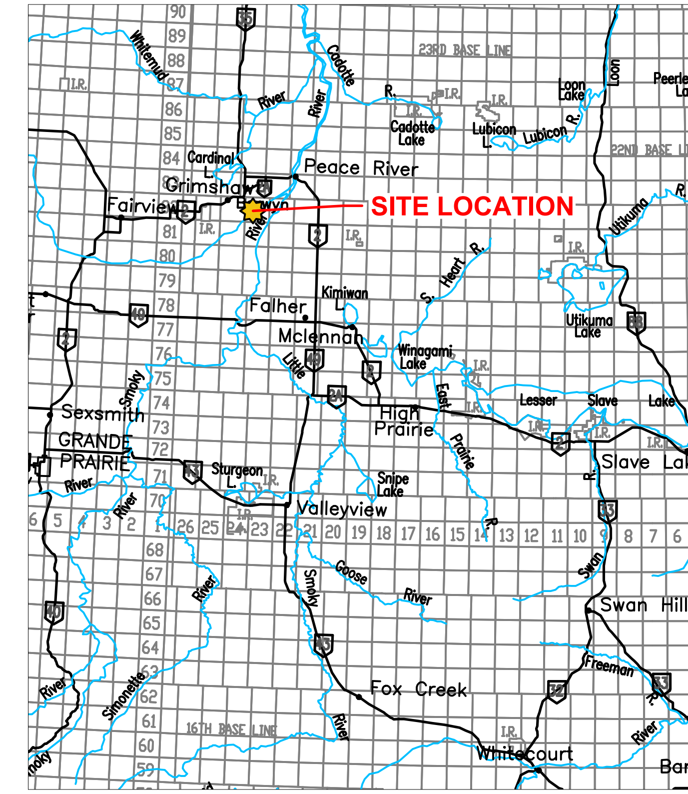


**KEY MAP**

SCALE 1:3 000 000

LIDAR FROM 2007 AND PROVIDED BY ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS

LEGEND

SCARP

NOTES

1. FEATURE LOCATIONS ARE APPROXIMATE.
2. JUNE 9, 2023 OBSERVATIONS SHOWN IN RED.

0 100 200 300 400 500 600m

SCALE 1:10000

Alberta

**PEACE REGION (PEACE RIVER DISTRICT)**
**BIG EDDIE: HWY 684:02 km 8.86 TO KM 8.98**

**CALL-OUT SITE LOCATION PLANS**

**DWG No. 32121-PH093-1**

| | |
|---|---|
| DRAWN BY | KLP |
| DESIGNED BY | KEF |
| APPROVED BY | DWP |
| SCALE | 1:10 000 |
| DATE | JULY 2023 |
| FILE No. | 32121 |

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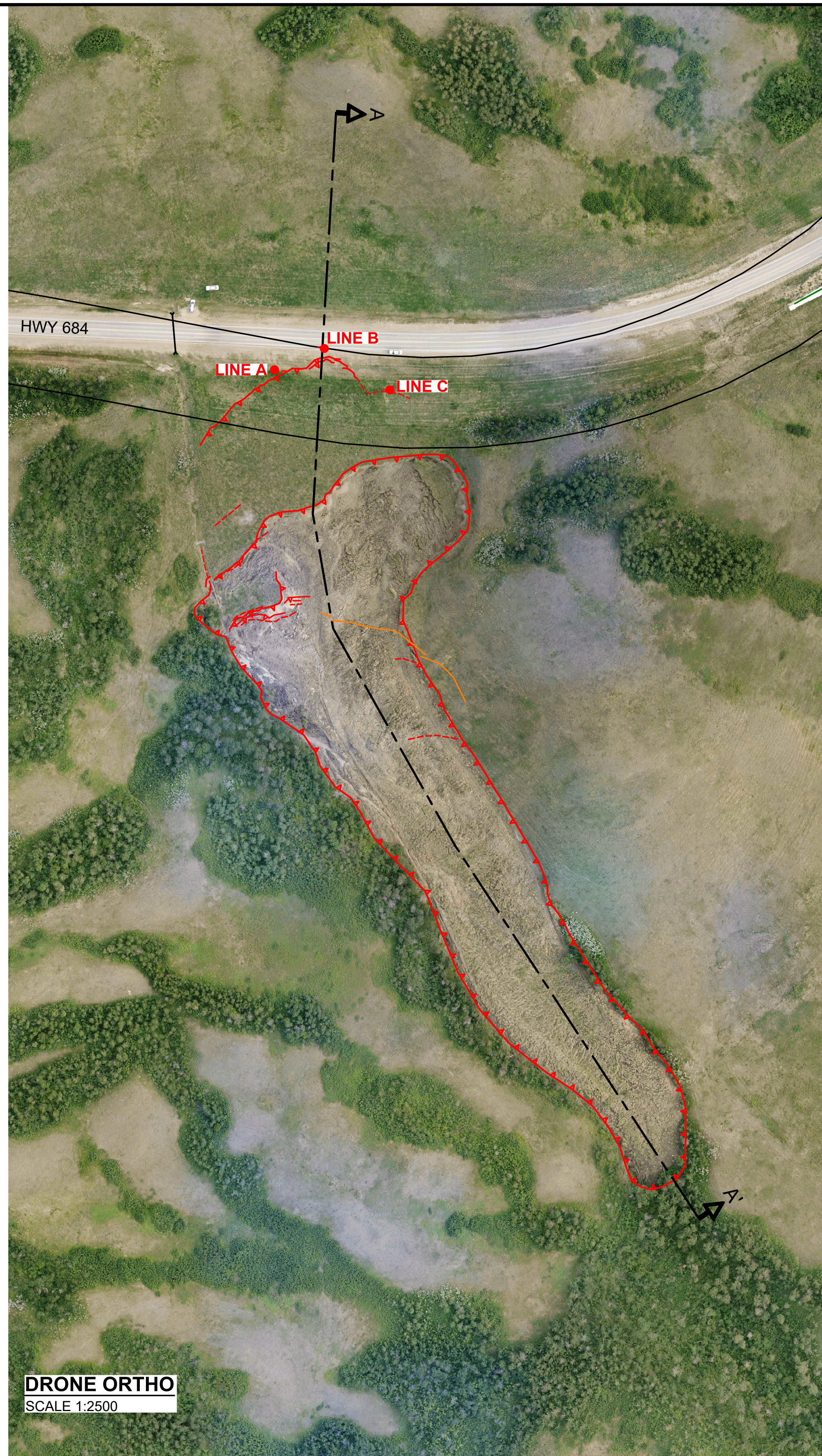
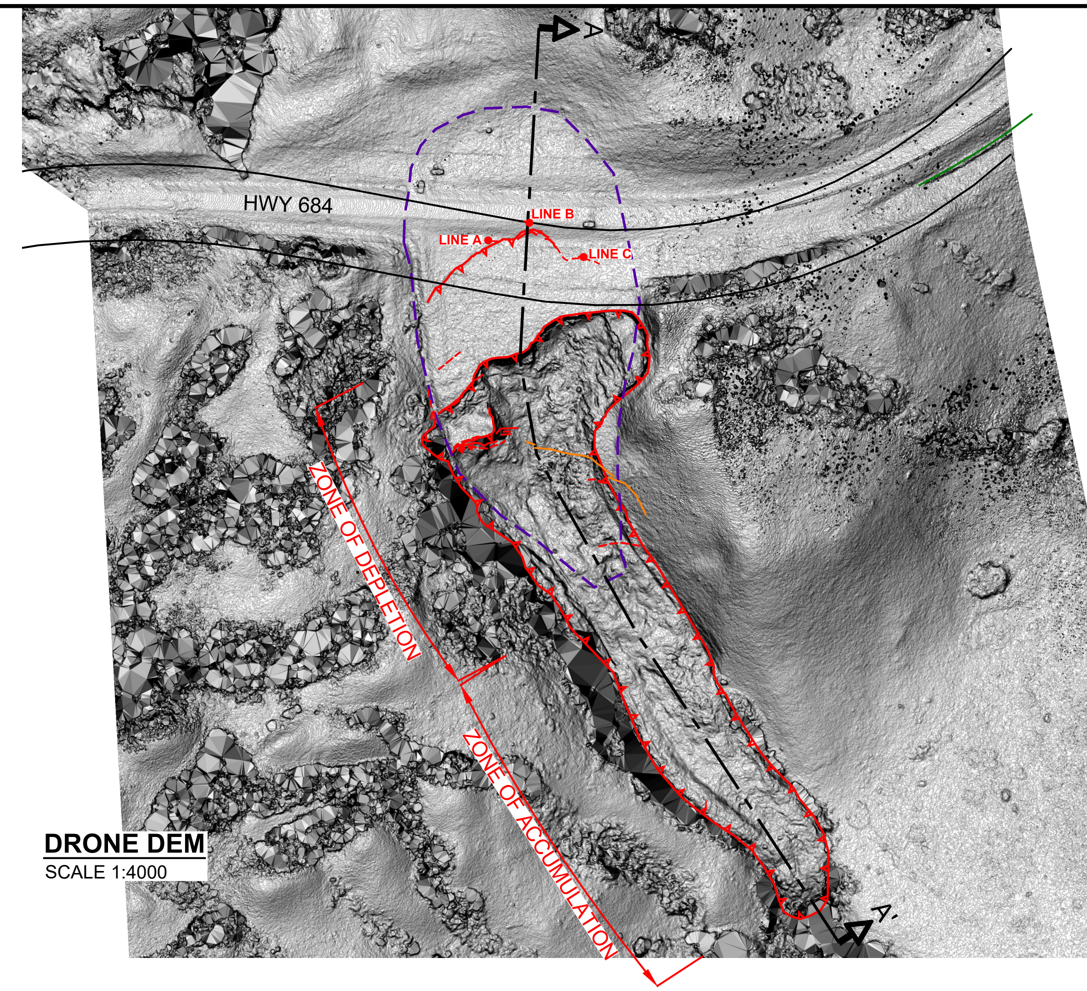
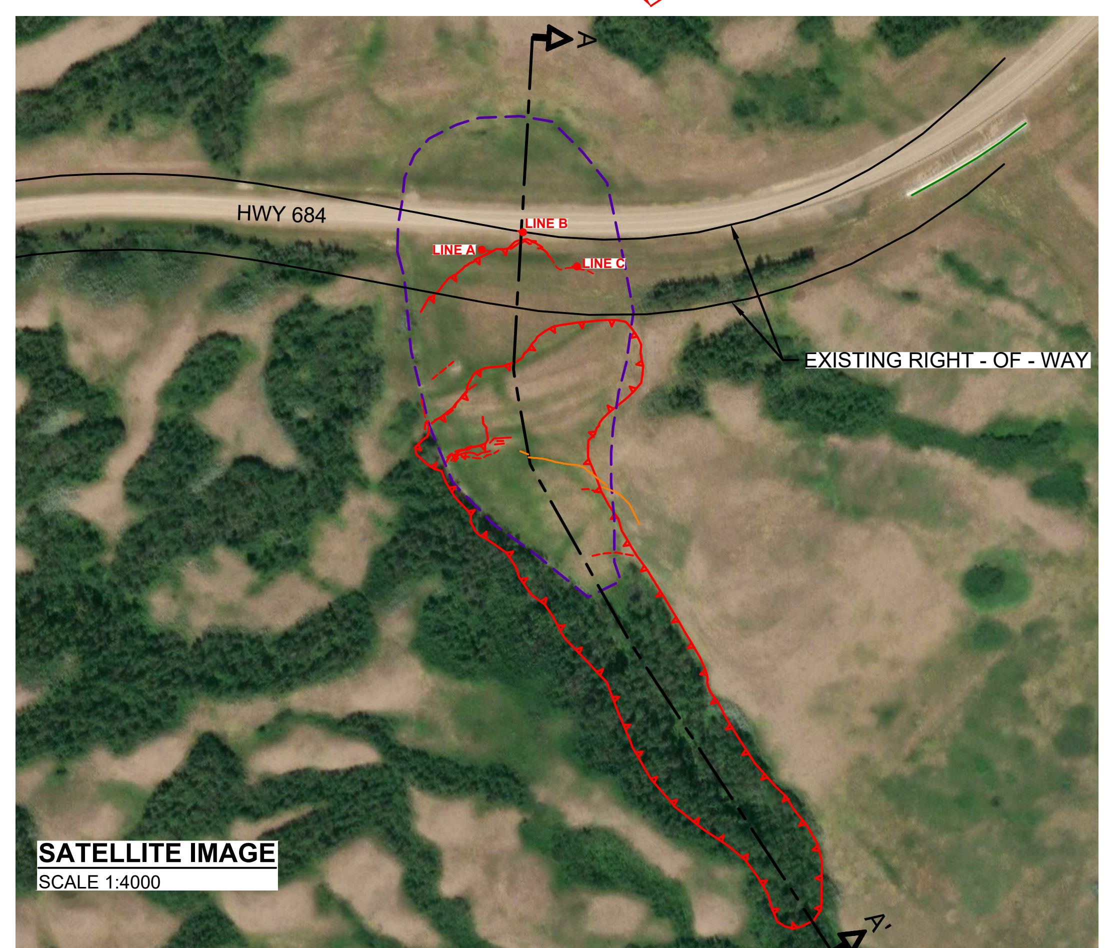



**DRONE ORTHO**
SCALE 1:2500




**DRONE DEM**
SCALE 1:4000




**SATELLITE IMAGE**
SCALE 1:4000

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LEGEND

- SCARP
- CRACK
- CRACK SEEN ON GOOGLE EARTH MAY 10, 2023, SATELLITE IMAGE
- POTENTIAL FILL BOUNDARY
- MOVEMENT MONITORING TRANSECT LOCATION

NOTES
1. FEATURE LOCATIONS ARE APPROXIMATE.
2. JUNE 9, 2023 OBSERVATIONS SHOWN IN RED.

0 25 50 75 100 125 150m
SCALE 1:2500

0 50 100 150 200 250m
SCALE 1:4000

SATELLITE IMAGE FROM ESRI WORLD IMAGERY DATED JUNE 21, 2021.
DRONE DEM AND ORTHOMOSIAC DERIVED FROM JUNE 9, 2023, IMAGES OBTAINED BY THURBER.

Alberta

**PEACE REGION (PEACE RIVER DISTRICT)**
**BIG EDDIE: HWY 684:02 km 8.86 TO KM 8.98**

**CALL-OUT SITE PLAN**

**DWG No. 32121-PH093-2**

| | |
|---|---|
| DRAWN BY | KLP |
| DESIGNED BY | KEF |
| APPROVED BY | DWP |
| SCALE | AS SHOWN |
| DATE | JULY 2023 |
| FILE No. | 32121 |

THURBER ENGINEERING LTD.


**DRONE ORTHO**
SCALE 1:2500

N
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LEGEND

- SCARP
- CRACK
- CRACK SEEN ON GOOGLE EARTH MAY 10, 2023, SATELLITE IMAGE
- POTENTIAL FILL BOUNDARY
- DIRECTION AND NUMBER OF PHOTO
- APPROXIMATE SOIL SAMPLE LOCATION
- SAMPLE NUMBER

NOTES
1. FEATURE LOCATIONS ARE APPROXIMATE.
2. JUNE 9, 2023 OBSERVATIONS SHOWN IN RED.

0 25 50 75 100 125 150m
SCALE 1:2500

SATELLITE IMAGE FROM ESRI WORLD IMAGERY DATED JUNE 21, 2021.
DRONE DEM AND ORTHOMOSIAC DERIVED FROM JUNE 9, 2023, IMAGES OBTAINED BY THURBER.

Alberta

**PEACE REGION (PEACE RIVER DISTRICT)**
**BIG EDDIE: HWY 684:02 km 8.86 TO KM 8.98**

**CALL-OUT SITE PLAN**
**(DRONE ORTHO)**

**DWG No. 32121-PH093-2A**

| | |
|---|---|
| DRAWN BY | KLP |
| DESIGNED BY | KEF |
| APPROVED BY | DWP |
| SCALE | 1:2500 |
| DATE | JULY 2023 |
| FILE No. | 32121 |

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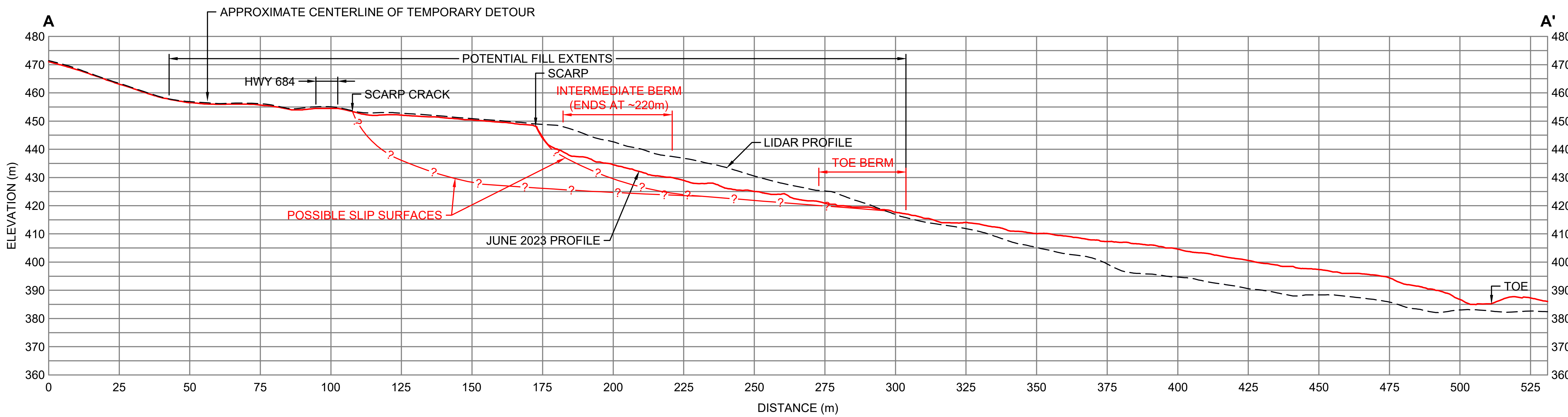


Alberta

**PEACE REGION (PEACE RIVER DISTRICT)**
**BIG EDDIE: HWY 684:02 km 8.86 TO KM 8.98**

**CALL-OUT SECTION A-A'**

**DWG No. 32121-PH093-3**

| | |
|---|---|
| DRAWN BY | KLP |
| DESIGNED BY | KEF |
| APPROVED BY | DWP |
| SCALE | 1:1500 |
| DATE | JULY 2023 |
| FILE No. | 32121 |

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# APPENDIX B

Selected Photographs

**Photo 1: Looking south along grassed drainage channel below centerline culvert.**

**Photo 2: Looking east at main headscarp.**

**Photo 3: Looking south at stretched gabion mattress with west flank visible on the right side going into the trees.**

**Photo 4: Seepage and asphalt exposed below drainage channel.**

**Photo 5: Looking northeast at the west portion of the main headscarp.**

**Photo 6: Looking east at eastern edge of main headscarp.**

**Photo 7: Pockets of fine sand and clay shale in the fill located on the east flank of the main headscarp.**

**Photo 8: Looking north at the east flank of the main headscarp. Note large pocket (circled) of fine sand ravelling out of the face.**

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**Photo 9: Panaroma looking north at the main headscarp.**

**Photo 10: Looking down southwest at the main headscarp.**

**Photo 11: Looking west at the main crack forming in the highway sideslope.**

**Photo 12: Looking southwest along the main crack in the highway sideslope. Line B stakes are in the foreground and Line A in the background. Measurements are made between the stakes.**

**Photo 13: Looking south along east edge of the landslide body. The exposed slip surface on the left-hand side was desiccated.**

**Photo 14: Looking south at eastern ridge of debris where it pushed over onto existing vegetation. The ridge is up to about 2 m high.**

**Photo 15A: Pieces of asphalt exposed in the slide debris.**

**Photo 15B: Asphalt that appears to have been dumped or placed at ground surface and subsequently transported down the gully by the slide.**

**Photo 16: Crest of the toe of the slide.**

**Photo 17: The lower portion of the toe of the slide.**

**Photo 18: Wetter material down at the bottom of the toe.**

**Photo 19: Looking south along undisturbed portion of the gully.**

**Photo 20: Looking north up the tongue of the debris toward the headscarp.**

**Photo 21: Looking north at possible secondary slip surface that cut through debris from an earlier phase of this slide. This groove ran for about 60 m on the west flank of the slide.**

**Photo 22: Distorted gabion mattress in the drainage channel. This suggests both that the drainage channel extended all the way to the bottom of the fill and that the lineal feature in Photo 21 could also have been gabion mattress being dragged.**

**Photo 23: Exposed western flank of the desiccated slip surface.**

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**Photo 24: Looking southwest at a large portion of exposed, desiccated slip surface where drainage channel had been.**

**Photo 24B: Moisture on slickensides below the desiccated crust.**

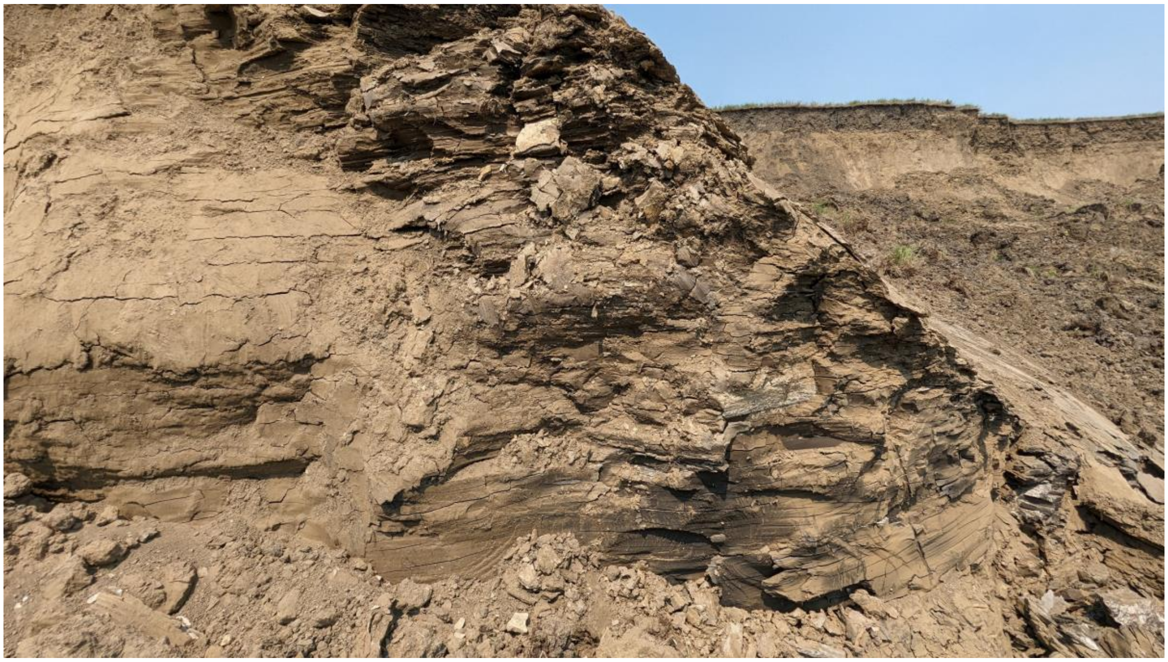
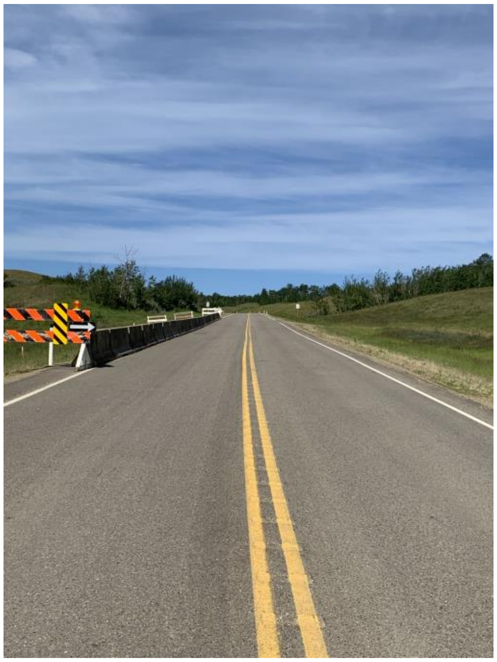


**Photo 25: Intact outcrop of what appears to be varved clay (Sample 10).**

**Photo 26: Looking west along as-yet undisturbed highway surface. The proposed temporary detour will be constructed to the right (north) on the flatter terrain. A probable long-term realignment would cut into the hillside further north.**



**MCI Photo, June 29, 2023: Looking west along still-undisturbed highway with barricades added on the downslope side of the highway.**

**MCI Photo, June 29, 2023: Looking northeast at graben forming below tension crack in the highway sideslope.**

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**MCI Photo, June 29, 2023: Looking west at main headscarp which is mostly unchanged from the condition observed on June 9, 2023 (see Photo 10).**

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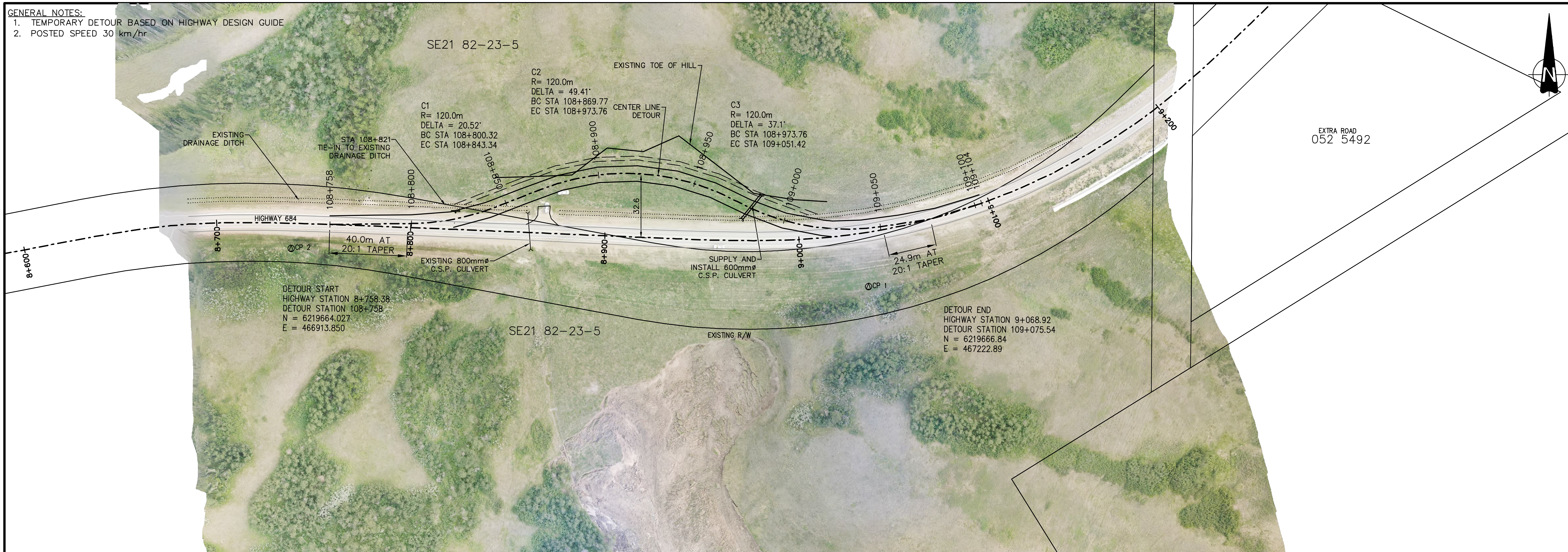
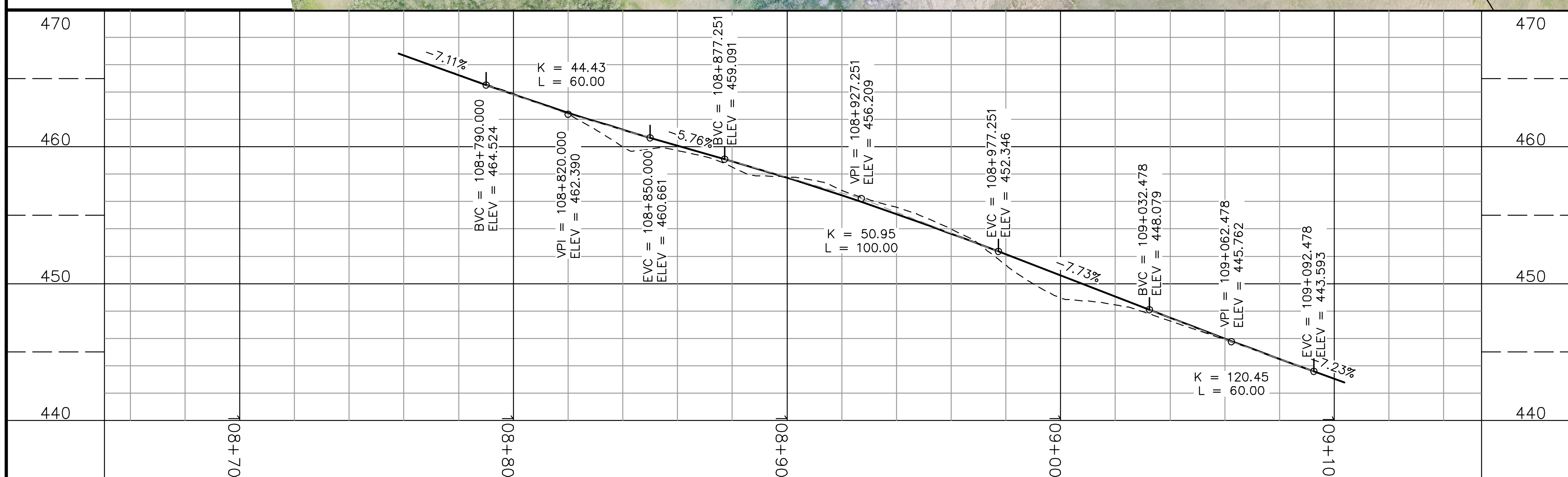
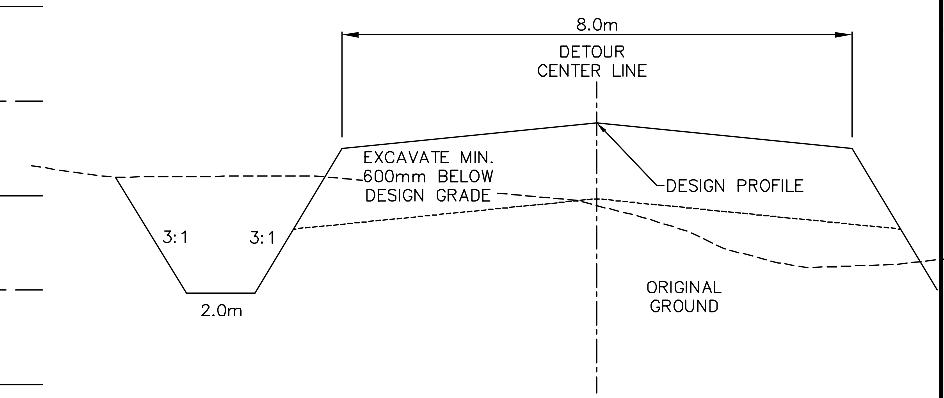
# APPENDIX C

McIntosh Perry Temporary Detour Design and C Estimate

GENERAL NOTES:
1. TEMPORARY DETOUR BASED ON HIGHWAY DESIGN GUIDE
2. POSTED SPEED 30 km/hr




TYPICAL CROSS SECTION DETAIL

LEGEND

| | | | | | |
|---|---|---|---|---|---|
| EXISTING CENTRELINE | — · — · — | PROPOSED R/W | — · · — · · — | SIGNAL LIGHT | |
| PROPOSED CENTRELINE | — · — · — | BROKEN LANE LINE | - - - - - | EXISTING POWER POLE | |
| EXISTING EOP | - - - - - | SOLID LANE LINE | ——— | EXISTING LIGHT STANDARD | |
| PROPOSED EOP | — — — — | WATER VALVE | WV | PROPOSED LIGHT STANDARD | |
| EXISTING R/W | ——— | OBLITERATION | | EXISTING CULVERT | |
| | | EXISTING SIGNAGE | | PROPOSED CULVERT | |
| | | | | TEST HOLE | |

NOTES:
1. ALL DIMENSIONS ARE METERS AND DECIMALS OF A METER.

12m 0 24m — HORIZONTAL 1:1000
2m 0 4m — VERTICAL 1:1000

| CONSULTANT | | DESIGNER | CHECKER |
|---|---|---|---|
| McINTOSH PERRY | | | |
| – | | | |

| REV | DATE | REVISION | BY |
|---|---|---|---|
| 5 | | | |
| 4 | | | |
| 3 | | | |
| 2 | | | |
| 1 | – | – | – |

| DATE | LOCATION | SITE |
|---|---|---|
| – | – | – |

Alberta Transportation

HWY 684:02
PLAN AND PROFILE
PH 40 DETOUR PLAN

| CONTRACT | HIGHWAY | SHEET | DRAWING |
|---|---|---|---|
| – | 684:02 | 1 OF 1 | 212567-12 |

DRAWING 21267-12
HIGHWAY 684:12
CONTRACT
DESCRIPTION –
PHOTO
DATE 2023-06-13
BY MP
SURVEYED
DEPARTMENT BAR CODE

C:\Users\m.wadman\McIntosh Perry\Western Canada Infrastructure - 230817 Thurber Engineering\230817-12 - PH40 Hwy 684 Brick Hill\Detour Design\684_02 Detour Plotting.dwg

McINTOSH PERRY

**File No:** 230817
**Project:** PH 40 Brick Hill Emergency Detour
**Sta:** 8+758 to 9+068

**Emergency Detour Estimate - "C" Estimate**

| BID ITEM NO. | BID ITEM CODE | ITEM DESCRIPTION | UNITS | ESTIMATED QUANTITY | 2023 AVERAGE UNIT PRICE | ESTIMATED UNIT PRICE | 2023 AVERAGE COST | ESTIMATED COST |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 1 | X100 | Mobilization | lump sum | | | 15.00% | $10,800.00 | $17,300.00 |
| 2 | X510 | Cutting of Pavement | m | 160.00 | $10.89 | $13.07 | $1,742.40 | $2,091.20 |
| 3 | G225 | Common Excavation | m3 | 4,430.00 | $8.84 | $16.00 | $39,161.20 | $70,880.00 |
| 4 | G300 | Topsoil Placement | m2 | 950.00 | $1.01 | $2.00 | $959.50 | $1,900.00 |
| 5 | E608 | Broadcast Seeding | ha | 0.10 | $2,014.60 | $2,200.00 | $201.46 | $220.00 |
| 6 | D410 | Culverts - Supply and Install (600 mm dia. C.S.P.) | m | 21.00 | $411.09 | $450.00 | $8,632.89 | $9,450.00 |
| 7 | G220 | Channel Excavation | m3 | 30.00 | $13.99 | $26.00 | $419.70 | $780.00 |
| 8 | E435 | Erosion Control Barrier (Silt Fence) | m | 11.00 | $12.67 | $15.20 | $139.37 | $167.20 |
| 9 | Q186 | Gravel Surfacing - Place and Spread (Des 4-25) | t | 250.00 | $36.06 | $45.00 | $9,015.00 | $11,250.00 |
| 10 | Q187 | Gravel Surfacing - Place and Spread (Des 4-40) | t | 250.00 | $20.83 | $45.00 | $5,207.50 | $11,250.00 |
| 11 | E510 | Erosion Control Soil Covering - Supply and Install (Type C) | m2 | 680.00 | $8.71 | $10.45 | $5,922.80 | $7,106.00 |
| | | | | | | | | |
| | | TOTAL | | | | | $82,201.82 | $132,394.40 |
| | | | | | | | | |
| | | CONTRACT ESTIMATE | | | | | $83,000.00 | $133,000.00 |
| | | 10% CONTINGENCY | | | | | $8,300.00 | $13,300.00 |
| | | TOTAL ESTIMATED COST + 10% CONTINGENCY | | | | | $91,300.00 | $146,300.00 |
| | | ENGINEERING FEE | | | | | | |
| | | **TOTAL "C" ESTIMATE** | | | | | **$91,300.00** | **$146,300.00** |

NOTES:

1.0 NO STOCKPILING OF TOPSOIL OR EXCAVATED MATERIAL WITHIN 20m OF VALLEY CREST ON BOTH SIDES OF SITE

2.0 SURVEY AND TESTING SERVICES TO BE PROVIDED BY McINTOSH PERRY