ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – GRANDE PRAIRIE DISTRICT
2020 CALL OUT

THURBER ENGINEERING LTD.

Site Number	**Location**	**Name**	**Hwy**	**km**
Call Outs	North of Grande Cache	Rockfall & 2 Debris Flows	40:36	8.5 to 11.2
Legal Description		**UTM Co-ordinates (NAD 83)**		
Km 8.55: SW29-57-8-W6 Km 10.9: SE5-58-8-W6 Km 11.2: SE5-58-8-W6		11U N 5,981,420 11U N 5,983,463 11U N 5,983,698	E 358,460 E 359,373 E 359,415	

	Date	**PF**	**CF**	**Total**
Previous Inspection:	July 12, 2019	10 10	4 5	40 (km 8.55 - rockfall basis) 50 (km 11.2 & 13.75 sites)
Current Inspection:	May 25, 2020	10 10	4 5	40 (km 8.55 - rockfall basis) 50 (km 10.9 & 11.2 sites)
Road AADT:	1,150		**Year:**	2018
Inspected By:	Don Proudfoot, Nicole Wilder (Thurber) Ed Szmata, Rishi Adhikari, Dwayne Lowen (AT)			
Report Attachments:	☑ Photographs	☑ Plans		☑ Maintenance Items

Primary Site Issue:	Three (3) separate debris flows that originated upslope along existing drainage channels, and flowed out into the west highway ditch. The km 8.55 site is considered more of a rockfall than a debris flow site.	
Dimensions:	Debris/mud/rock/water accumulations in the West Ditch – Vary from 25 m to 100 m long.	
Date of any remediation:		
Maintenance:	The highway at the km 10.9 and 11.2 sites was cleared of the debris that overflowed onto the highway and some debris was pushed into the east side of the highway.	
Observations:	**Description**	**Worse?**
☐ Pavement Distress		☐
☑ Slope Movement	The debris flows are retrogressing upslope at km 10.9 and 11.2 that have slabs of soil still with tree's growing on them.	☑
☑ Erosion	Backslope erosion and/or slumping existed at all 3 sites. Erosion gullies exist in the west ditch debris buildup at the km 10.9 and 11.2 sites.	☐
☑ Seepage	On June 14, 2020 the MCI provided a photo of the rockfall site at km 8.55 and the area at the base had pooling water which was flooding and flowing over the highway. Water was also observed trickling down the backslope at the rockfall site.	☑
☐ Bridge/Culvert Distress		☐
☑ Other	Sediment build-up of varying extents and sediment sizes were observed in the west ditch at all 3 sites. A windrow of debris existed on the east side of the highway at the km 10.9 and 11.2 sites.	☑
Instrumentation: None		

Assessment:
The scenario is similar at the 2 debris flow sites, somewhat different at the rockfall site.

At the rock fall site at km 8.55 (Figure 2 attached), there is a backslope cut with a variable thickness (up to 4 m) of granular overburden overlying what appears to be an exposed ledge of weathered sandstone protruding from the top of the bedrock surface, that overlies a near vertical bedrock face. The overburden and the mantle of weathered sandstone directly underlying the overburden fell down along the bedrock face and became deposited in the ditch. The exposed overburden from this slumped area appears to be wet, with a slight trickle of flow running down from the top of the backslope, and overtop the center of the debris build-up in the ditch. It is possible flow from the slope above may have been diverted to this location. It is surmised that the additional weight of the saturated overburden, along with possible aggravation by flow erosion, broke the protruding mantle of weathered sandstone that was supporting it above, which fell down along the lower bedrock face and became deposited in the west ditch.

At the two debris flow sites, large sudden flow events triggered by heavy rainfall from further up the mountain have travelled along defined channels picking up and depositing debris into the west highway ditch (and across the hwy into the east ditch at both sites). The Alberta Topography Map (Figure 1 attached), the LiDAR drawing (Figure 4 attached), and an excerpt from the Debris Flow Map obtained from AT (Figure 6), documents defined flow channels at or adjacent to these two sites. The debris flow events may possibly have been triggered or complicated by upstream channel blockages that suddenly let loose, unleashing a torrent of water down along the channels. Some portions of the current flow channels above the ditch may have been forced outside of their former channel bed paths at some locations by tree/rock debris barriers created by the sudden flood event, and this re-routing carved out new channel paths. At both debris flow sites the concentrated flows likely saturated the overburden materials and transformed it into more of an earth slide as the flow event progressed.

The debris piles existing in the west ditch of the 10.9 and 11.2 sites were generally conically shaped, with the apex containing coarser material, and progressively finer material being deposited towards the lower end extremities. Directly across from the flow channel outlet point into the west hwy ditch, the apex of buildup has forced runoff at both sites (from either continuing channel flow and/or hwy ditch surface runoff from further upslope in the ditch) around the east edge of the apex and up against the edge of the highway shoulder (gravel embankment at both sites, and also against the ACP at both debris flow sites).

Km 8.55 Site:
At this rockfall site, the debris consists of unsorted overburden with some bedrock boulders that ended up as a deposit over a length of about 25 m in the west ditch in a conical shape (estimated at about 130 m^3 of material).

The crest of the backslope is about 15 m above the road at this location. The exposed slope face consisting of up to 4 m of overburden material overlying bedrock extends a significant distance in both directions from the rock fall area, and AT is concerned that adjoining areas could similarly fall. It appears that two older gullies with scarring on the backslope face below exist (one a short distance north, and the other a greater distance south, of this existing rock fall location), that may have carried flow in the past.

Km 10.9 Site:
At the time of the call out, debris build-up of fine sediments was deposited in the west ditch in a general conical or deltaic fan shape (see Figure 3 attached). The channel flow had appeared to incise an outlet point through the overburden backslope at this location (the top of the backslope of this earth flow scarp was now estimated at about 18 m above the highway and about 50 m from the highway).

One stream of water having low to moderate flow volumes was observed running down the backscarp from further upslope, over the slumped material and debris deposit, and outletting into the west ditch. Predominant fine sediments/debris infilled the west ditch and extended over a length of about 100 m. Some additional sloughing of material should be expected as the stream likely saturated much of the debris and overburden.

Debris had also flowed across the hwy at this location, as evidenced of material that had been graded along the hwy shoulder.

Km 11.2 Site:
At the time of the call out, debris build-up of fine sediments was deposited in the west ditch in a general conical or deltaic fan shape (see Figure 5 attached). The channel flow had appeared to incise an outlet point through the overburden backslope at this location (the top of the backslope of this earth flow scarp was now estimated at about 25 m above the highway and about 50 m from the highway).

Two streams of water having low to moderate flow volumes were observed running down the backscarp from further upslope, over the slumped material and debris deposit, and outletting into the west ditch. The streams ran in opposite directions and were pooling along the west ditch, indicating the ditch at this site was at a relative elevation high. Predominant fine sediments/debris infilled the west ditch and extended over a length of about 50 m (equidistant from the apex center), with an estimated removal volume of about 250 m^3. Some additional material could be expected however, as the two streams likely saturated much of the debris, and the existing excavation could mobilize more debris material from the backslope channels above.

Debris had also flowed across the hwy at this location, as evidenced by a windrow of material that had been graded against the east hwy shoulder (an additional ~100 m^3).

The backslope of thew highway is relatively steep and eroded with shallow ongoing sloughing of soil.

Discussion:

The debris accumulations at all 3 sites are the result of high precipitation events, that may have blocked or circumvented previous channel locations, and became re-routed at other locations. At the km 8.55 site, the extra runoff water likely broke/dislodged the underlying weathered bedrock ledge that was previously supporting it. In the case of the km 10.9 and 11.2 site, the flow event flushed out loose rocky debris from previous existing gullies in the mountainside down to the road level which also caused earth flows to occur. The immediate risk to road users of such occurrences is the possibility of a rapid debris flow running out onto the road and hitting a vehicle. This could be followed by the risk that traffic could run into debris that is piled on the highway before the maintenance contractor has a chance to close the road and clear off the material.

The first line of defence against a debris flow running onto the highway is to have a storage area to collect potential debris. In the case of these sites visited the main storage area available is the highway ditch. It is therefore important that the existing debris be cleared from the ditch as soon as possible and removed to a disposal site on stable ground that is located away from the highway ditches and any gullies. The existing debris piles have taken up any available storage capacity and hence if they are not removed before another event occurs there is a higher likelihood that debris could flow straight out onto the highway. The debris also needs to be removed to avoid blockage and diversion of ditch water that could lead to erosion of the highway shoulder and sideslope and buildup of silt in the ditch.

Secondary remedial considerations could include:

- Overburden removal/rock scaling (at the km 8.55 site). Access for any equipment or human traffic appears to be difficult, and this would be expensive.
- Catch Fence or Mesh Draping (at the km 8.55 site). A catch fence could possibly be installed along the ditch, while a mesh draping would need to be anchored behind the potential overburden slide scarp to reduce the risk of rocks tumbling onto the highway. Again, access is difficult, but this could be less costly than the excavation/scaling.
- Ditch deepening and/or barrier installation (at all sites). Deepening the ditches to provide more storage space would alter existing flow regimes, and would require assessment. Jersey barriers or lock blocks installed in a row along the toe of the highway embankment (due to restricted ditch widths) could help contain small debris volumes, but would present a safety hazard to traffic.
- The backslope could be cut back further to a flatter angle at the km 11.2 site to improve slope stability and create more storage room in the highway ditch.

Recommendations:

Short Term:
The short-term recommendation is to remove the built-up debris at all 3 sites as noted above (in the order of 1,000 m^3), and dispose of it in stable areas outside the valley. Also repair any damaged road sideslopes or ditch erosion that may have occurred (using gravel and soil coverings).

Ball Park Cost $50,000.

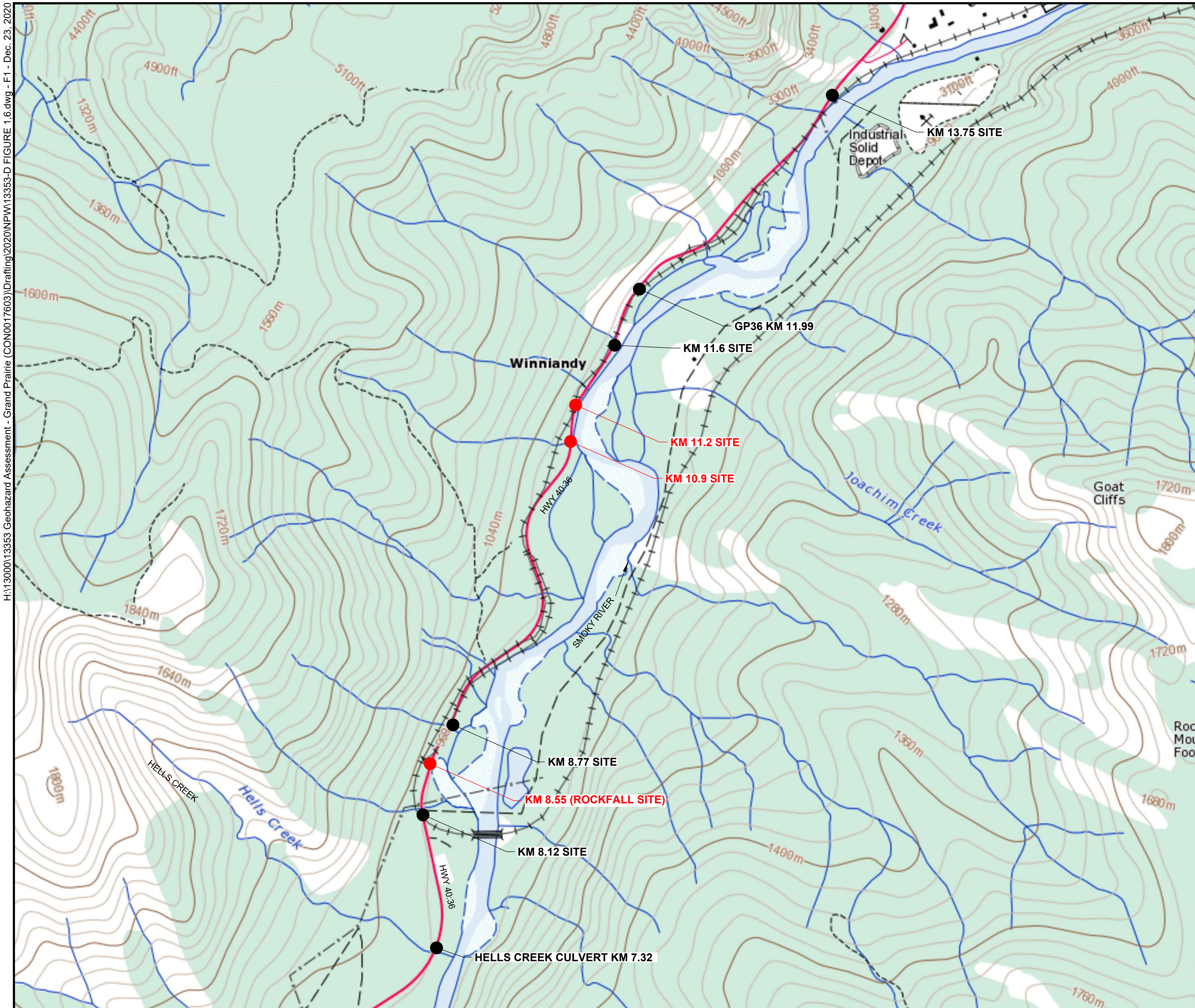
Maintenance:
Once the previous debris has been cleared and the ditch re-established it will be important to routinely inspect the ditch areas following any major rainfall event and promptly clear any ensuing debris as described above.

Investigation:
The risks of future debris flows affecting this stretch of roadway could be further assessed by reviewing LiDAR and available geology maps to identify similar gullies through similar steeply sloping slopes abutting the highway and then carrying out a site reconnaissance of each gully to assess the amount of source material that is present within the gullies upslope of the highway. In addition, hydrology assessments to determine flow volumes and channel path traits could be performed to design the required size and extent of erosion resistant surfacing to control outflow from these gullies.

Long Term:
Depending on the results of the investigation, designs could be prepared to look at the potential for flattening the backslopes to gentler angles (where possible), or developing larger storage areas near the bases of the more critical gullies with the highest risk of future debris flows. This might include the channels at the km 10.9 and 11.2 sites where debris flows have run out over the highway.

For the km 8.55 site, overburden removal/scaling or catch fence/mesh draping could be considered (as mentioned in the **Discussion** section of this report).

H:\13000\13353 Geohazard Assessment - Grand Prairie (CON0017603)\Drafting\2020\NPW\13353-D FIGURE 1.6.dwg - F1 - Dec. 23, 2020



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NOTE:
1. 40m CONTOUR INTERVALS
2. 2017 & 2019 DEBRIS FLOW SITES SHOWN IN BLACK
3. 2020 DEBRIS FLOW SITES SHOWN IN RED.

0 250 500 750 1000 1250 1500m
SCALE 1:25000

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PEACE REGION (GRANDE PRAIRIE)
CALLOUT: HWY 40:36, 8 TO 14 km NORTH OF GRANDE CACHE - 3 DEBRIS FLOWS

TOPO MAP
2020 INSPECTION PLAN

FIGURE 1

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:25 000
DATE	DECEMBER 2020
FILE No.	13353D

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LEGEND

① ↗ PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTES:

1. SITE FEATURES ARE APPROXIMATE.

0 2 4 6 8 10 15 20m

SCALE 1:300

SATELLITE IMAGE DOWNLOADED FROM ESRI IMAGERY ON AUGUST 12, 2019 (YEAR OF IMAGE UNKNOWN)

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PEACE REGION (GRANDE PRAIRIE)
CALLOUT: HWY 40:36 - DEBRIS FLOWS
8 TO 14 KM NORTH OF GRANDE CACHE

KM 8.55 SITE
MAY 25, 2020

FIGURE 2

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:300
DATE	DECEMBER 2020
FILE No.	13353D

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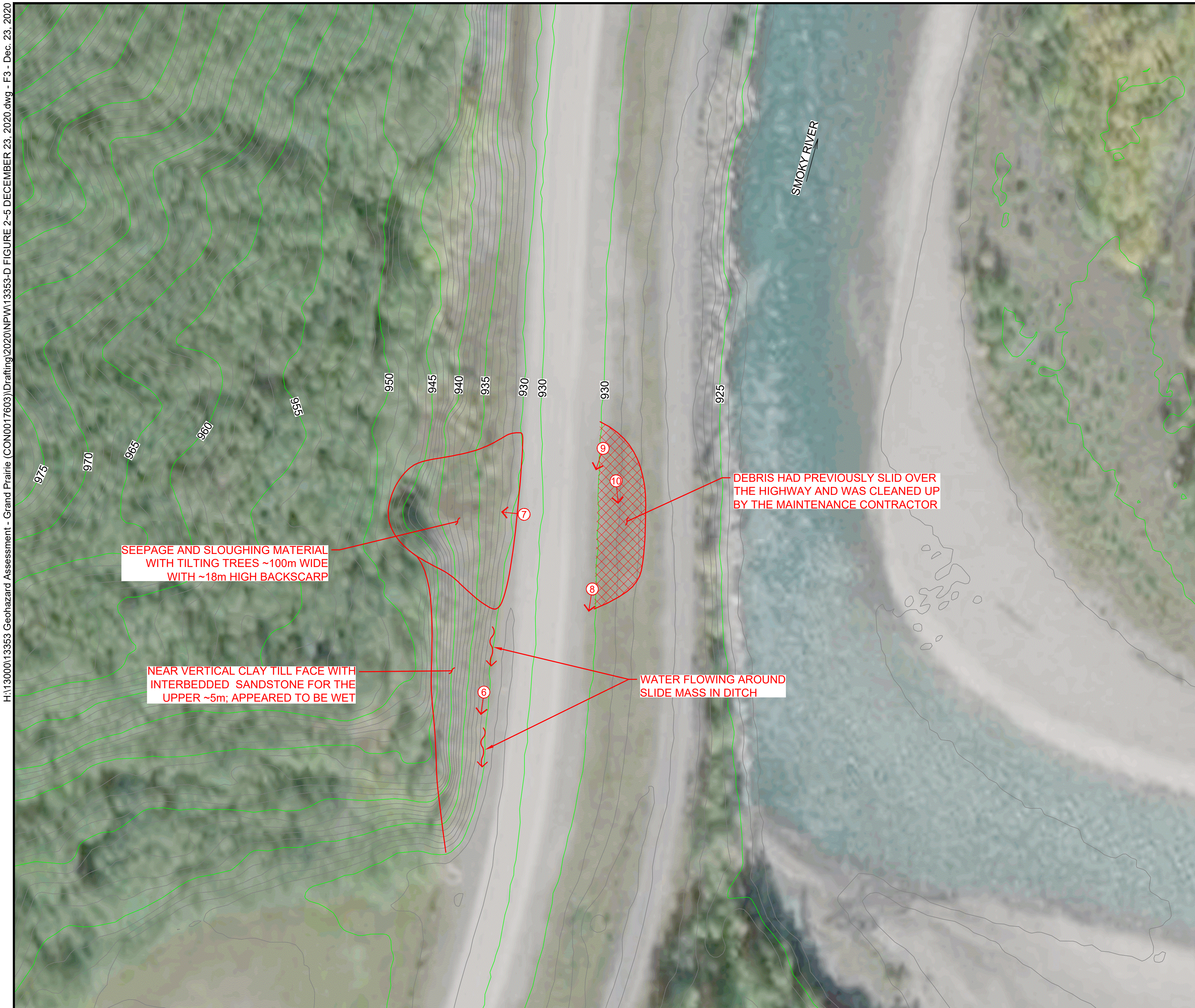
H:\13000\13353 Geohazard Assessment - Grand Prairie (CON0017603)\Drafting\2020\NPW\13353-D FIGURE 2~5 DECEMBER 23, 2020.dwg - F2 - Dec. 23, 2020



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LEGEND

① PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

GROUND SURFACE CONTOUR (CONTOUR INTERVAL = 1m)

NOTE:
1. SITE FEATURES ARE APPROXIMATE.

0 10 20 30 40 50 60m
SCALE 1:1000

SATELLITE IMAGE DOWNLOADED FROM ESRI IMAGERY ON DECEMBER 22, 2020 (YEAR OF IMAGE UNKNOWN), YEAR OF LIDAR CONTOUR INFORMATION UNKNOWN

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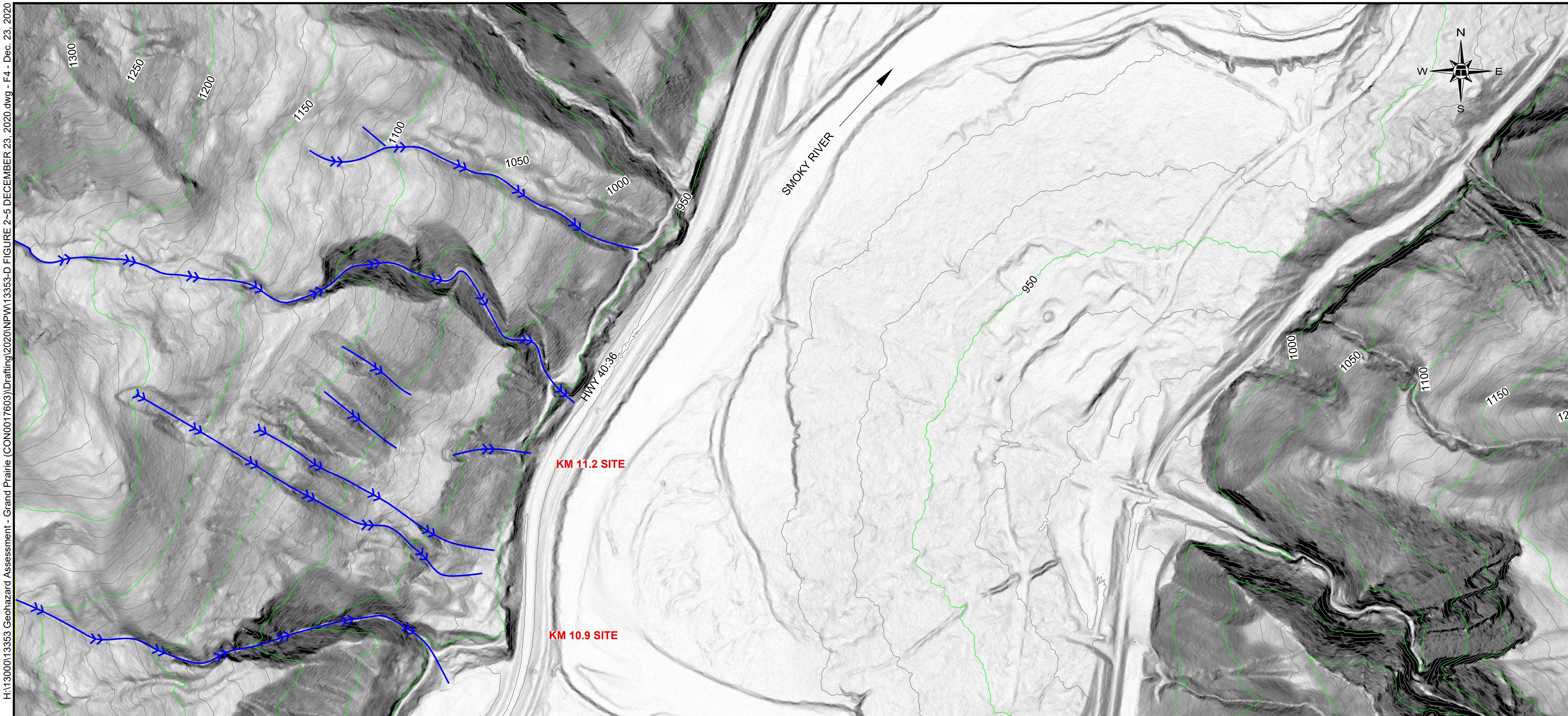
PEACE REGION (GRANDE PRAIRIE)
CALLOUT: HWY 40:36 - DEBRIS FLOWS
8 TO 14 KM NORTH OF GRANDE CACHE

KM 10.9 SITE
MAY 25, 2020

FIGURE 3

DRAWN BY	KLW
DESIGNED BY	NPW
APPROVED BY	DWP
SCALE	1:1000
DATE	DECEMBER 2020
FILE No.	13353D

THURBER ENGINEERING LTD.



YEAR OF LIDAR UNKNOWN

Alberta Transportation

PEACE REGION (GRANDE PRAIRIE)
CALLOUT: HWY 40:36 - DEBRIS FLOWS
8 TO 14 KM NORTH OF GRANDE CACHE

KM 10.9 AND 11.2 SITES
MAY 25, 2020

FIGURE 4

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:6000
DATE	DECEMBER 2020
FILE No.	13353D

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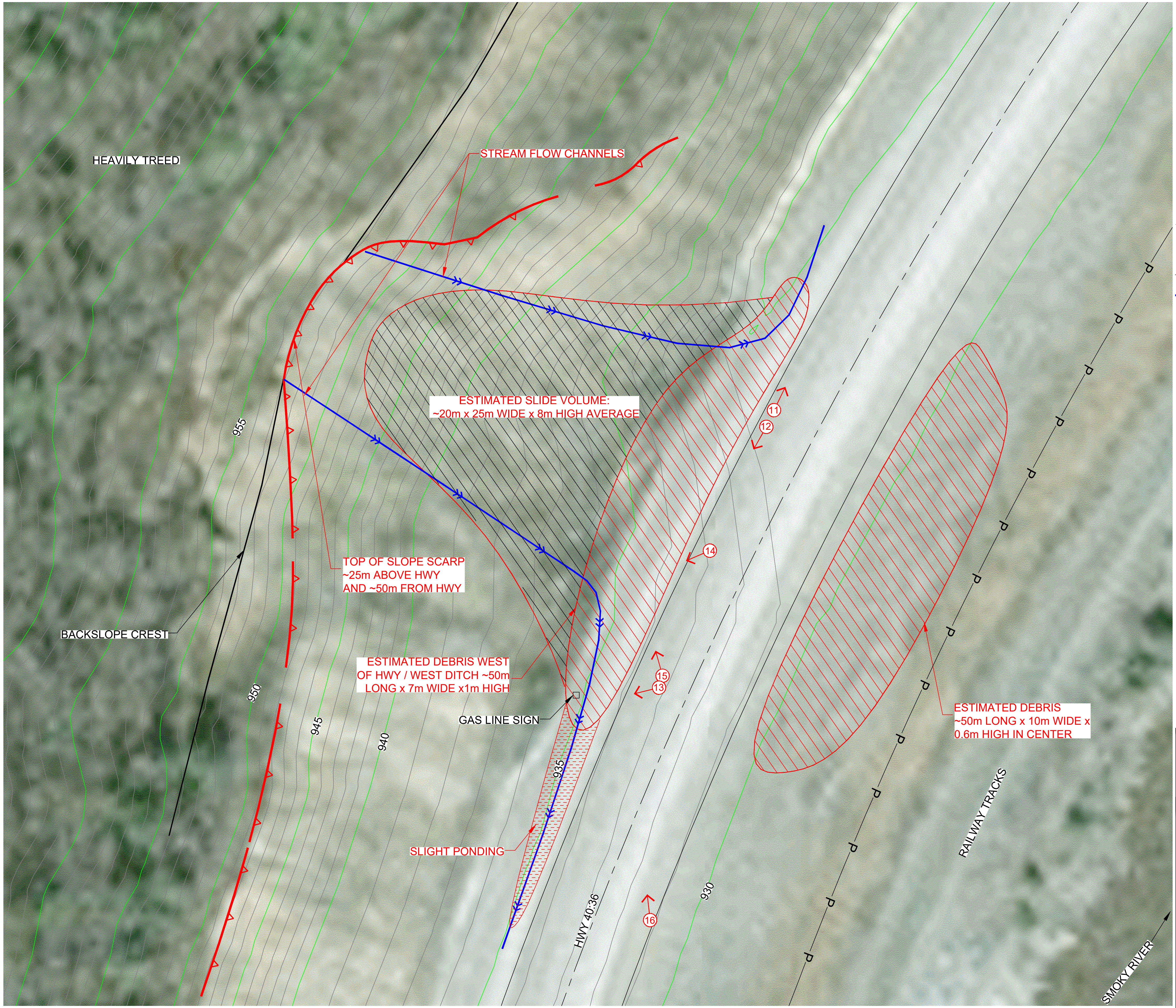
LEGEND

- ASSUMED DRAINAGE RUNS IN PROXIMITY TO SITES
- GROUND SURFACE CONTOUR (CONTOUR INTERVAL = 10m)

0 50 100 150 200 300 m
SCALE 1 : 6 000

H:\13000\13353 Geohazard Assessment - Grand Prairie (CON0017603)\Drafting\2020\NPW\13353-D FIGURE 2~5 DECEMBER 23, 2020.dwg - F5 - Dec. 23, 2020



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LEGEND

- ① PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION
- —P— OVERHEAD POWER LINE
- EXISTING DRAINAGE RUNS
- GROUND SURFACE CONTOUR (CONTOUR INTERVAL = 1m)

NOTE:
1. SITE FEATURES ARE APPROXIMATE.

0 5 10 15 20 25m
SCALE 1:400

SATELLITE IMAGE DOWNLOADED FROM ESRI IMAGERY ON AUGUST 12, 2019 (YEAR OF IMAGE UNKNOWN), YEAR OF LIDAR CONTOUR INFORMATION UNKNOWN

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PEACE REGION (GRANDE PRAIRIE)
CALLOUT: HWY 40:36 - DEBRIS FLOWS
8 TO 14 KM NORTH OF GRANDE CACHE

KM 11.2 SITE
MAY 25, 2020

FIGURE 5

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:400
DATE	DECEMBER 2020
FILE No.	13353D

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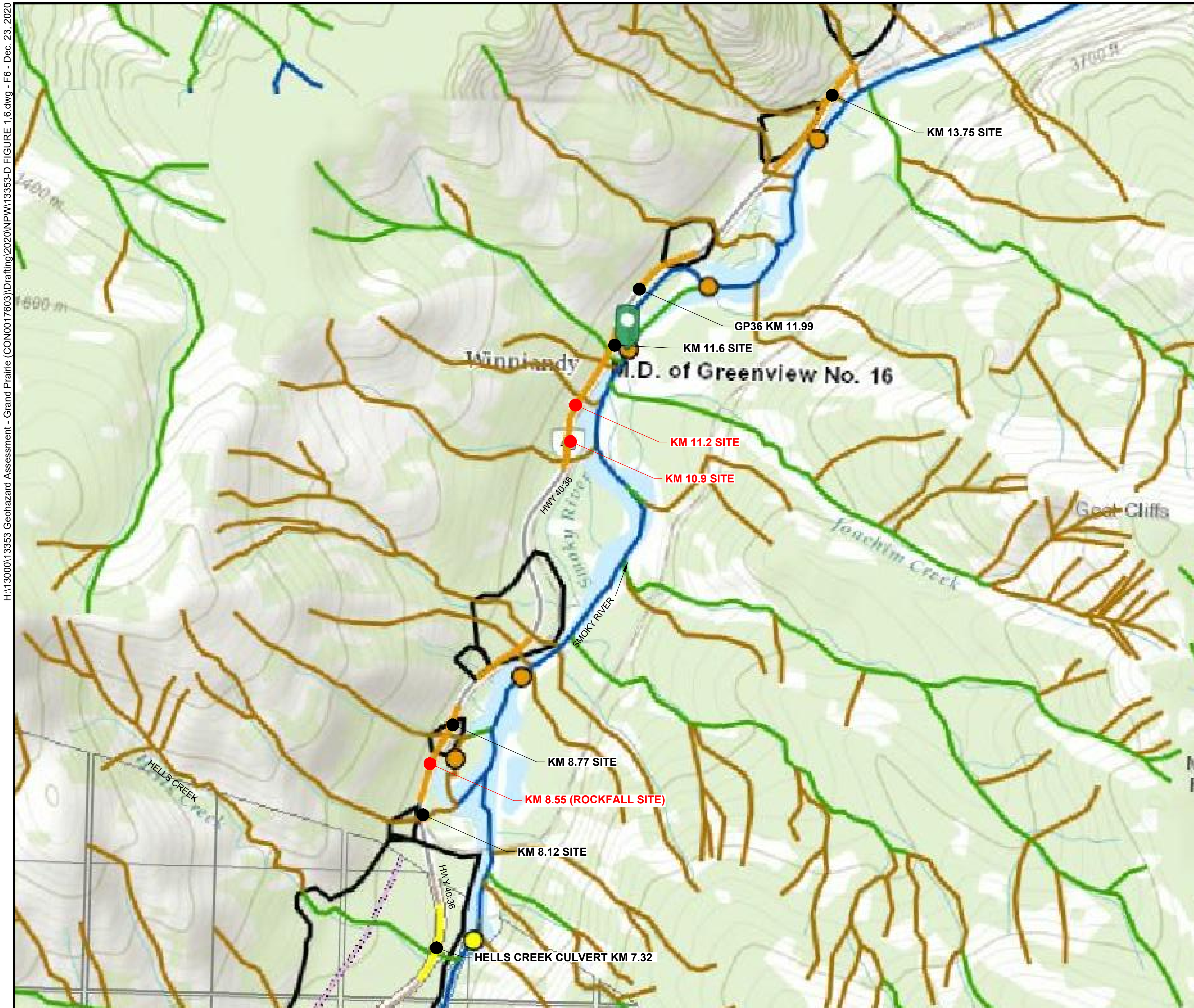
H:\13000\13353 Geohazard Assessment - Grand Prairie (CON0017603)\Drafting\2020\NPW\13353-D FIGURE 1.6.dwg - F6 - Dec. 23, 2020



NOTE:
1. 2017 & 2019 DEBRIS FLOW SITES SHOWN IN BLACK
2. 2020 DEBRIS FLOW SITES SHOWN IN RED.

0 250 500 750 1000 1250 1500m

SCALE 1:25000

MAP EXPORT OBTAINED FROM ALBERTA TRANSPORTATION FILES (YEAR UNKNOWN)

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PEACE REGION (GRANDE PRAIRIE)
CALLOUT: HWY 40:36, 8 TO 14 km NORTH OF GRANDE CACHE - 3 DEBRIS FLOWS

DEBRIS FLOW MAP

FIGURE 6

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:25 000
DATE	DECEMBER 2020
FILE No.	13353D

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 	**Photo 1.** **Hwy 40:36 km 8.5** Looking directly at the face of the west hwy rock backslope and overburden/rock fall deposit in the west ditch.
 	**Photo 2.** **Hwy 40:36 km 8.5** Looking northwest up at the backslope face just to the north of Photo 1. Note that there appear to be a couple of older, smaller debris deposits that have accumulated in the ditch.

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	**Photo 3.** **Hwy 40:36 km 8.5** Looking southwest at the backslope face just to the south of Photo 1. Note that there are a couple of smaller zones of recent rockfalls west of the large one.
	**Photo 4.** **Hwy 40:36 km 8.5** Looking northeast from the shoulder of the EBL of Hwy 40:36 at the fallen rocks on the highway shoulder.

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	**Photo 5.** **Hwy 40:36 km 8.5** Looking southwest from the shoulder of the EBL of Hwy 40:36 taken by AT on June 14, 2020.
	**Photo 6.** **Hwy 40:36 km 10.9** Looking southwest from the shoulder of the SBL of Hwy 40:36.

	**Photo 7.** **Hwy 40:36 km 10.9** Looking west from the middle of Hwy 40:36.
	**Photo 8.** **Hwy 40:36 km 10.9** Looking west from the shoulder of the NBL shoulder of Hwy 40:36 at slide mass now within the SBL ditch.

	**Photo 9.** **Hwy 40:36 km 10.9** Looking southwest from the near the middle of the Hwy at slide mass.
	**Photo 10.** **Hwy 40:36 km 10.9** Looking south from the shoulder of the NBL shoulder of Hwy 40:36 where slide debris previously flowed across the highway.

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	**Photo 11.** **Hwy 40:36 km 11.2** Looking north from the shoulder of the SBL shoulder of Hwy 40:36.
	**Photo 12.** **Hwy 40:36 km 11.2** Looking south from the shoulder of the SBL shoulder of Hwy 40:36 debris in ditch and water flowing around debris along highway shoulder.

	**Photo 13.** **Hwy 40:36 km 11.2** Looking southwest at debris which has slid down into ditch and water is now flowing around it.
	**Photo 14.** **Hwy 40:36 km 11.2** Looking southwest across Hwy 40:36 at debris which has fallen down.

	**Photo 15.** **Hwy 40:36 km 11.2** Looking northwest from SBL shoulder at slide mass.
	**Photo 16.** **Hwy 40:36 km 11.2** Looking northwest from NBL shoulder across Hwy 40:36 towards slide mass.