



BRIEF SITE SUMMARY  
AND  
RISK ASSESSMENT

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| 1. Site (GP# 16)                           | Hwy 666:02 Wapiti River   |
| 2. Reference Location along Highway        | Hwy 666:02<br>West of Junction Hwy 40 at Wapiti River<br>Bridge |
| 3. Legal Description                       | Section 15, Twp 70 Rge 6, W6M                                   |
| 4. UTM Coordinate                          | N 6,102,564 E 383,227   |
| 5. AT File                                 | Hwy 666:02  |
| 6. Alberta Transportation Plan and Profile | Highway mosaics   |
| 7. General Description of Instability      |   |

Hwy 666:02 is a sidehill alignment going up the Wapiti River valley. Sliding movement of the river valley slope occurred to destabilize the highway sidehill alignment.

This is a historic slide site which includes two portions:

- I) Old Major Slide which dated back 20-30 years to late 1970's when the highway was upgraded from a local road. The distress of this slide was well recorded in AIT files.
- II) Recent Adjacent Slide which dated back 5-10 years (1996-2001) when pavement cracking and settlement deteriorated to indicate slope movements. This adjacent site deteriorated within the recent 3-5 years (2002/2006).

It is very likely that the two portions of the slide will coalesce and nest to form one slide system with time. This slide site is vast in area (Major Slide and Recent Adjacent Slide) and deep seated and under influence of adverse groundwater regime. Remediation will be very difficult and costly. The proposal of an alternate alignment has encountered local resistance to require continual maintenance of this roadway for use.

I) Old Major Slide

The slide activates entailed the movements of both sideslope and backslope.

- Along the sideslope (below highway elevation)
  - The highway traverses the centre of slide of this Wapiti River valley slope. It can probable that this slide was a previous historical geological sliding of the whole valley slope which run-out to block the Wapiti River channel. The

- river subsequently re-excavated its present channel with the slide tongue debris forming the depositional island at centre of the present channel.
- Slide movement was monitored (with instrumentation) at 20-25m depths along the sideslope R/W area and the landslide slippage was monitored to occur along a gentle inclination slip plane along weak sandstone/clayshale strata with frequent coal seams.
  - Previous investigation of this slide concentrated along the highway R/W and investigation was not undertaken at the bottom toe (river bank) area. Thus the toe area and the daylighting of the slide remains to be investigated.
- Along the backslope
    - Slumping movement of overburden soil can be assessed as semi-circular slide movements. A portion of the backslope along the top upland fringe was excavated (around 1998) to offload a portion slide mass to lessen its driving force to enhance stability of backslope so that safety of the highway below can be improved.
    - At the top of backslope. Along fringe perimeter of upland and at top area adjacent to the backslope portion of this slide, the subdivision of Landry Height was located. The instrumentation monitoring of any transgression of the slide movement was undertaken. No obvious movement were monitored along 3 slope indicators (SI 1-3) along the west portion of the upland perimeter along edge of this Subdivision. Despite the blockage of 1 slope indicator (SI-4) (blocked at 25.9m depth), site observation along the setback areas of subdivision did not shown obvious signs of land deformation from slide retrogression.

## II. Recent Adjacent Slide (Minor Slide)

The slide entailed movements of the Wapiti River valley slope which featured intermediate benches of past slippage movements.

- From investigation with slope indicators, this Recent Adjacent Slide daylights at the elevations of the intermediate benches of the valley slope below the highway elevation. Movement is likely along gentle inclination slip planes, either at interface with bedrock OR along weak zones (coal and/or bentonite) within the bedrock strata of sandstone/clayshale.

### 7.1 Site Maintenance and Future Realignment Strategy

A realignment route via Grovedale was previously studied and presented to bypass this distressed valley slope site. However, public desire to retain existing alignment was very strong and, thus, public acceptance of the realignment remains to be resolved. It appears that this unstable alignment needs to be maintained for a longer duration until further future slide movement episodes render the roadway unsafe for further use OR until the new alignment has been accepted by the community and constructed.

In the interim and for continual operation of this roadway, it will be appropriate

- to strategize and advertise the realignment option to render it receptive to the traffic public as an inevitable “eventuality and reality” OR,
- to strategize to accept a lowering of level of roadway serviceability when the traffic public insist on the continual use of the existing alignment. It should be well understood

that, in the event of future deterioration of slide movements, the remediation of this large slide system will be very difficult and very costly to be successful.

Future visual and instrumentation monitoring of this site should be continued.

8. Date of Initial Observation

(i) Old Major Slide

- Late 1977's when the highway was upgraded from a local road
- Early 1980's when geotechnical investigation was undertaken to include instrumentation

(ii) Recent Adjacent Slide

- 1996-2001

9. Date of Recent Observation

- July 2008 (2008 Slide Tour – Geohazard – Inspection Assessment)

I. Old Major Slide area,

- Along roadway pavement
  - slide cracking has obviously reflected back (since 2004/2005 overlay) along previous crack patterns the highway and pavement settlement is obviously noticeable.
  - At the west (south) edge of slide located upgrade from the centre area of slide, the accumulated subsidence (slide movement) of the pavement has rendered the west (south) edge of slide definitive and noticeable. The slumping of sideslope has persisted to (2005/2007) transgress onto the shoulder and climbing lane of this roadway
  - The Major Slide area extends about 300m (width) along roadway.
- Along backslope
  - No obvious signs of backslope movement affecting the highway can be observed.

II. Recent Adjacent Slide (Minor Slide),

- the pavement crack has reflected back along previous crack patterns. As noted in recent 3-5 year (2003-2008), contortion and cracking of pavement has accelerated at this area

- Obvious deterioration of pavement cracking, contortion and subsidence has persisted over previous (2006/2007) year.

- Pavement cracking propagates and meanders to criss-cross centerline. More serious pavement cracks can be noted at south edge (upgrade of roadway) of this slide where the pavement crack maybe coalescing with the adjacent Major slide zone. Pavement subsidence (in the range of 100mm) was obvious.
- At the south edge (upgrade of roadway) of this slide, about 30-50mm width of the headscarp crack was evident along the sideslope and pavement shoulder edge.
- This Recent Adjacent Slide extends about 200m in length.

(I) Old Major Slide

Along the backslope top and upland perimeter of the Wapiti River Valley slope, 4 deep (60m depths) slope indicators were installed and monitored since 1997.

- No obvious movement were monitored along 3 slope indicators (SI 1-3) along the west portion of the upland perimeter. However, at the east end of this monitoring perimeter, 1

slope indicator (SI-4) was found blocked at 25.9m depth; the possibility that shearing movement was occurring at 25.9m cannot be ruled out. From site observation of slumping and undulation along fringe of valley slope at this east end, it maybe possible that transgression of slide movement maybe starting to affect this east end area. However, site observation along the setback areas of subdivision did not shown obvious signs of land deformation from slide retrogression.

Along the sideslope and lower valley slope (just beneath roadway elevation) area:

- Previous slope indicator data indicated movements at 20-25m depth along sideslope R/W. High pore pressures and groundwater seepage flows was monitored with an equivalent groundwater level assessed at 6m below ground surface.
- Slippage movement can be likely along gently inclination planes and mostly affected by weak layers (s.a. coal, possible bentonitic deposits) of sandstone/clayshale.

## (II) Recent Adjacent Slide (Minor Slide)

Along the backslope ditch

- Slope indicator (SI-41) did not indicate transgression of the slide to headslope area. It appear that the existing headscarp is stationery along the cracking pavement area along the highway.

Along the sideslope and down the River Valley slope (along the Overhead Powerline Clearing)

- At toe of sideslope at R/W edge at about 15m offset from shoulder, slide movement was monitored (SI-54) at 12m depth (Elevation 552m).
- Along the valley slope down to the river bank, a series of intermediate slope terraces can probably be relics of past slide movements. Slope movements (SI-53) were monitored at 12 to 19m depth along the River Valley slope and the slide slip plane probably daylight along elevations of the slope terraces.

## 10. Instrumentation Installed

### At the Old Major Slide.

Since the 1980's, about 6 to 10 slope indicators and a number of associated piezometers were installed. Most of the SI sheared off and cannot be monitored. Most of the piezometer were not operational and cannot be monitored. Along top of backslope (perimeter of Landry Heights subdivision), 4 deep SI (60m) were installed and 3 SIs are still functional and can be monitored.

### At the Recent Adjacent

Slide (Minor Slide), 4 to 5 SI and associate piezometers were installed. A major portion of instrumentation is still functional and can be monitored.

11. Instrumentation Operational

Site	Hwy	Site Details	Instrument	Number of		Remarks
				SI	Piezo	
GP-16	666:02	Wapiti River	(I) <u>Old major Slide</u> - Sideslope SI#13 Piezometer #20475, 20492 - Backslope SI#01, 02, 03 (II) <u>Recent Lower Slide</u> SI#41, 51, 52, 53 Piezometer #28901, 28900, 28833, 28441, 28831, 58711, 58713, 55630	8	10	For details: refer 2008 Cycle 2 Report

12. Risk Assessment

$$PF(9) * CF(6) = 54$$

$$PF = 9$$

- Active slide with moderate and steady rate of ongoing movement

**MAJOR SLIDE AREA**

- Medium to deep seated failure, likely along a gently inclination slip plane
- The slippage plane was assessed along weak zones of bedrock strata
- Groundwater pressure active and adverse
- Movement is active and rated as moderate to slow
- It is possible that the area is a historic slide with the existing centre island of Wapiti River being the old slide debris tongue. The river eventually re-excavated its channel and flow through the previous slide debris.
- Crest of slide (at top of highway backslope) was off-loaded around 1997; this alleviates some driving force for the sliding in overburden soils.

**RECENT ADJACENT SLIDE (Minor Slide)**

- Sliding is mostly along base of colluvium and along tops of bentonitic bedrock and/or along weak zones within the bedrock
- Groundwater influence can be more adverse at top portion of slope near highway elevation; moderate groundwater influence can be likely along lower valley slope close to toe area
- Movement rate at top portion appears to be fast than bottom part of slope. This may be due to that the top portion was moving separately along separate slip planes apart from the bottom part of the slope. A gentle inclination slip plane can be likely.

$$CF = 6$$

**BOTH SLIDES**

- Slide occurrence will force closure of road

- Road serves local and industrial traffic of increasing volumes
- A detour or realignment from this slide will incur about 20 km extra travel via Grovedale
- The public is generally aware of this historic slide and its adverse effect on future operation of this highway. However, public resistance to realignment or detour route has been very strong.

*Note:*

*The risk assessment is provided based on a categorization of Hazard Probability Factor (PF) and Consequence Factor (CF) as provided by AIT's RFP 2000.*

*PF 1 to 20 scale*

*CF 1 to 10 scale*

13. Geotechnical Conditions

- The site is a sidehill cut/fill embankment along the midslope portion of the south valley of the Wapiti River Valley.
- Several marshes and swamps are present at the prairie uplands upslope and to the east of the site. They may serve as source of groundwater feed and adverse groundwater regime affecting sliding movements.
- The bedrock stratigraphy comprises the Upper Wapiti Formation: grey, feldspathic, clayey sandstone; grey, bentonitic mudstone and bentonite; scattered coal beds; non-marine (Upper Wapiti Formation is Horseshoe Canyon Formation equivalent).
- From bedrock geology and surficial geology map information, the bedrock elevations in the vicinity of the site vary between 580 and 610 m, and the surficial deposits can be located around elevations range between 530 and 655 m, inferring that that the lower portions of the slide (i.e. the Major Slide) and slippage is likely along the bedrock stratigraphy.
  - From slope indicator monitoring along sideslopes, the slide slippage was monitored along bedrock at Elevation 570m at the Major Slide site where the roadway is located at Elevation about 602m. Movement depth was located at about 25m range below ground surface of sideslope.

14. Chronology

- Prior to 1970's, the existing highway was a gravel local roadway
- In late 1970's, Major Slide become evident at the time when local road was upgraded and constructed to a highway.
  - Seepage exit was noted along slope excavation works. It was reported that a lowering of water level and loss of water was observed along some water wells along the upland Landry Height subdivision.
  - Cracking of roadway pavement was becoming obvious since the construction of pavement.
  - Presence of slide become evident to warrant investigation.
- The Major Slide area maybe pre-existent and a pre-historic slide area prior to highway construction.
- In early 1980's, AT started to investigate this slide and undertake instrumentation monitoring of slide movement.
- In mid 1990's to 2000, jurisdiction of highway (i.e. secondary highway) was transferred to MD authority.

- The slide along the backslope was off-loaded to enhance slope stability of the upper slope which slide movement was of semi-circular movement nature within overburden soils.
- 2000, jurisdiction of this highway transferred back to Alberta Transportation.
- Early 2000's, a study of alternate alignment was completed to relocate the highway from this slide area along the Wapiti River valley slope. The new alignment will route the highway via the town of Glovedale.
- Local resistance to the highway realignment was substantial. Thus, maintenance and repeated patching of this highway was continued. Even one climbing lane was added to accommodate traffic flow.
- 2002-2003, the presence and deterioration of Adjacent Minor Slide became evident and needs investigation.
- 2003, investigation of Adjacent Minor Slide was carried out.

END