ALBERTA INFRASTRUCTURE
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

PEACE REGION
(SWAN HILLS)

SITE SH4: LITTLE SMOKY RIVER SOUTH OF BRIDGE

LEGAL LOCATION:	**34-74-21-W5M**
NEAREST LANDMARK:	**0.5 km south of Little Smoky River Bridge**
Highway Control Section:	**HWY 49:10 (previously Hwy 43:06)**
Date of Initial Observation:	**1982**
Date of Last Inspection:	**1999**
Last Inspected By:	**GAEA Engineering Ltd.**
Instruments Installed:	**2 Slope Inclinometers (1982),** **8 Slope Inclinometers (1989),** **5 replacement Slope inclinometers (1994)**
Instruments Operational:	**5 Slope Inclinometers (2000)**. Only one provides readings below the slide rupture surface
Risk Assessment:	PF(9) * CF(5) = **45**

1. LOCATION

The section of road that is currently being affected by slide activity is located on Hwy 49:10 about 0.5 km south of the bridge crossing over the Little Smoky River as shown on the Site Location Map, Figure SH3-1, Section F.

2. GENERAL DESCRIPTION OF SLOPE INSTABILITY

The section of affected roadway is about 135 m long and located about one third of the way down the west slope of the Little Smoky River valley at a point where the steeper upper portion of the valley slope meets the lower flatter portion of the valley slope. A contour plan of the west valley slope, which was developed by UMA Engineering Ltd. as part of their 1998 functional planning study (Ref. 3) (Figure SH4-2, Section F) indicates that the valley is about 100 m deep. The upper portion of the valley slope is inclined at about 14 $^{\circ}$, the lower portion is inclined at about 7° and the overall slope inclination is about 9.5 $^{\circ}$.

An air photo interpretation by J.D. Mollard and Associates Limited, as reported in the UMA report (attached as Figure SH4-3 in Section F) indicates that the west and east valley slopes along the highway alignment are located in landslide terrain.

Slope indicators (SI's) have been installed at 10 locations through the slide area as shown on Figure SH4-4, Section F. The site plan was developed from previous plans and air photos available in the files. The most recent slope indicator readings are included in Section D. Plots for previous slope indicators which are no longer functional, but showed signs of past deep seated movement and test hole logs for the SI installations, are included in Section G. The depths of the lowest shear zone movements measured in the SI's are noted in brackets on the site plan (Figure SH4-4).

A slope cross-section drawing (Figure SH4-5) was taken from one of the AI files and the soil stratigraphy from the test hole logs and shear zone depths from the SI's have been added to the drawing to provide a summary of available stratigraphic and movement information.

Diagonal cracks across the roadway and pavement subsidence have resulted in the need for ongoing asphalt patching maintenance as shown on selected photographs in Section G which were taken by others during past site inspections. Selected photos of the SI installation work carried out in 1994 which are also provided in Section G show a general view of the slide area.

The site contour plan (Figure SH4-2) suggests that the highway crosses a major slide block located along the outside of a river meander bend. The valley slope instability is likely due to removal of toe support by ongoing outward river erosion. Figure SH4-5 suggests that the head of landslide crosses the highway at the location where road cracking and subsidence has been noted. The steep valley section above this location represents the exposed main scarp of the slide while the gentle sloping ground between the highway and the river represents the main body of the sliding soil mass. The slope indicators indicate that the surface of rupture is located within the upper part of the shale bedrock just below the contact with the overlying clay till deposit.

It is possible that there are several smaller slide blocks moving translationally along a common lower shear zone within the bedrock toward the river in the manner described by Thomson and Hayley, 1975 (Ref. 1). A simplified conceptual stratigraphic section from the Thomson paper which demonstrates the above mechanism is included as Figure SH4-6, Section F.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: Peace River Lowland

Geology: The Little Smoky River occupies a broad pre-glacial valley eroded into the bedrock which belongs to the Smoky River Group and consists of interbedded marine shales and sandstones of Upper Cretaceous age. During glaciation the pre-glacial valley was infilled with till produced by up to three separate glacier advances. Inter-till sand layers were left between the till units in some places. Many areas at the uplands level were later mantled by lacustrine deposits. The present river has rapidly eroded down through the lacustrine and till deposits resulting in large scale landsliding along many miles of the area river valleys.

Hydrogeology: Groundwater flow directions are toward the Little Smoky River which is a discharge area. Discharge may also manifest itself as springs from the bedrock contact higher up on the valley walls however the discharge from the springs would be small in the order of 0.075 to 0.4 L/s.

The above noted geologic descriptions are based on published information.

Stratigraphy: Based on test holes drilled at the SI locations (available logs are provided in Section G), the slide area is underlain by clay till containing sand and clay layers overlying clay shale bedrock. The depth to the upper contact of the bedrock varies from 11.5 m at SI#5 to 41 m at SI#8.

The results of laboratory testing reported by Thompson and Hayley (1975) indicate that the clay till material is typically medium plastic with an effective residual friction angle of 18°. The clay shale is high plastic with effective peak and residual friction angles of 32° and 14°, respectively.

4. CHRONOLOGY

1956 The road link from Valleyview to Peace River was upgraded and paved

1957 Bridge over Little Smoky River completed

1964 A large slide occurred through the affected area. Park Brothers Construction moved earth and benched the area to the approximate current configuration.

1982 SI 1 and SI 2 were installed by Alberta Infrastructure (AI).

1987 First photos available in file of slide area pavement cracking (refer to Section G). A subdrain was installed along the backslope ditch of the highway in sandy stratum.

1989 Eight SI's, SI 3 through SI 10, installed by AI through slide area.

1994 Note to file by Mr. Karl Li, P. Eng. following site visit on July 28, 1994 concluded that due to the deep seated nature of the slide movements it would be more practical to continue monitoring the SI's and carry out highway maintenance work as required to maintain a smooth and safe road surface.

Shelby Engineering Ltd. were retained to install 5 additional slope indicators to replace previous SI's which were no longer functioning (SI 3A, SI 4A, SI 5A, SI 7A and SI 9A).

1998 Kiewit Construction placed an asphalt overlay through the slide area. As part of this work the downslope shoulder was built up with asphalt to correct for past road subsidence, the guard rail was raised and gravel fill was placed to buttress the built up shoulder of the highway.

REFERENCES USED FOR FILE REVIEW

1. Thomson and Hayley, 1975. "The Little Smoky Landslide", Canadian Geotechnical Journal, 12, 379, (1975).

2. Shelby Engineering Ltd., December 1994. "Geotechnical Investigation Hwy 43:06 - Little Smoky River Slides N & S of Little Smoky River Bridge S of Jct Hwy 2A:54".

3. UMA Engineering Ltd., January 1998. "Functional Planning Study For Highway 43:06 - Little Smoky River Crossing North of Valleyview".

4. Alberta Infrastructure Instrumentation Binder, up to 1996. "Little Smoky River (S. of Bridge)".

5. Alberta Infrastructure Slope Indicator Plots, 1998.

6. GAEA Engineering Ltd., July 1999. "Annual Geotechnical Review 1999 - Various Slide Areas - Peace River/ High Level Group and Swan Hills Group".