

# Memorandum Report

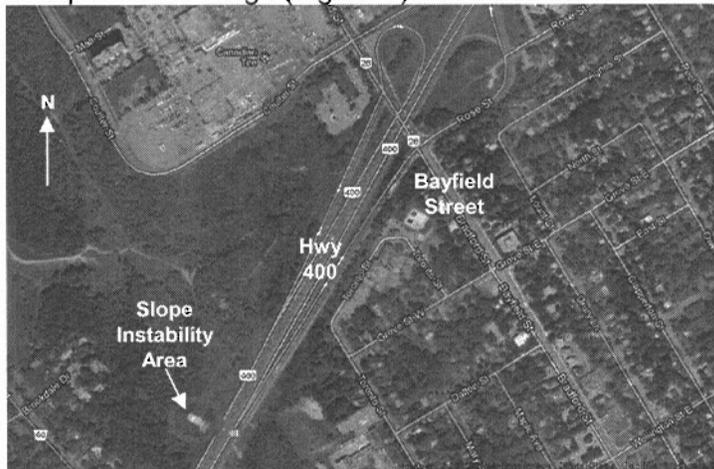
**Date:** April 5, 2012

**Subject:** Assessment and Recommendations for Planning Further Design for Remedial Measures for Embankment Instabilities  
At Culvert just south of W-S Ramp from Bayfield Street to Hwy 400 SB, Barrie  
W.O. 2012-11008  
GEOCREs No. 31D-539

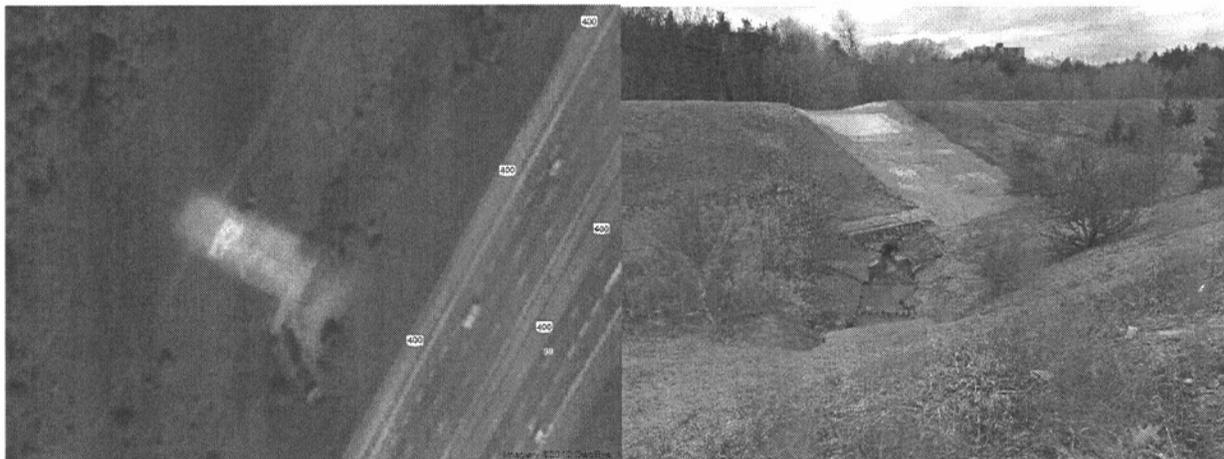
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MERO Pavements and Foundations Section was requested by Central Region (CR) Geotechnical Section and Maintenance to assess the above-noted site and to provide recommendations for the embankment instabilities.

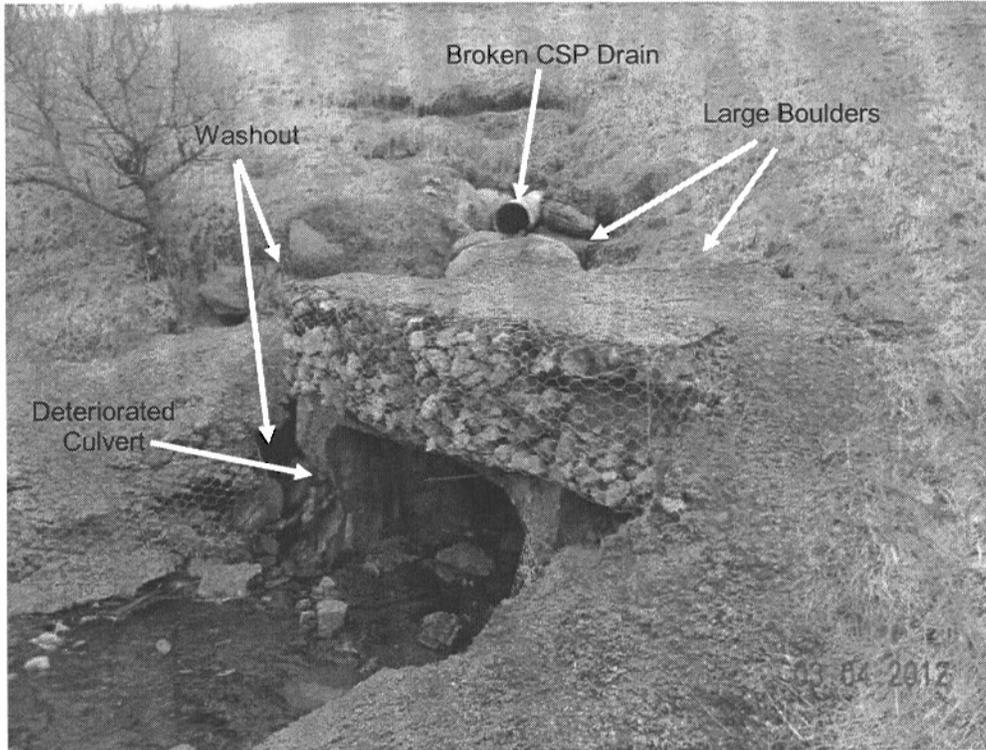
The following Google Map satellite image (Figure 1) illustrates the location of the site.



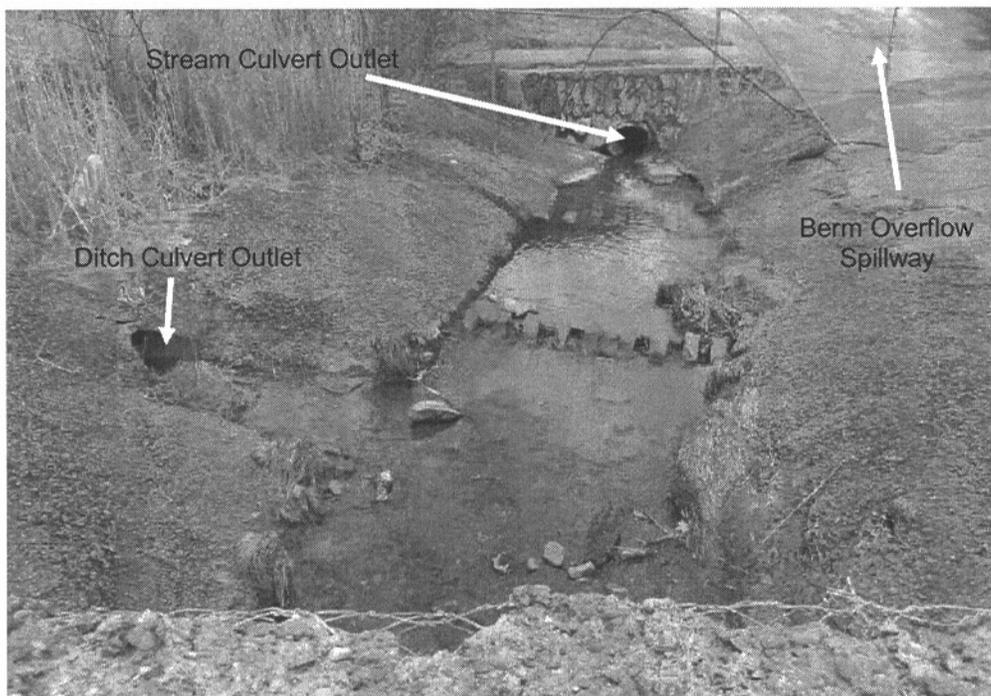
**Figure 1: Location of Slope Instability Area**



**Figure 2a and 2b: Satellite Image and Photo of Slope Instability Area**



**Figure 3: Culvert Inlet under Hwy 400**



**Figure 4: Upstream of Hwy 400 Culvert**

Inspection

Dave Dundas (Senior Foundations Engineer), Danny Tari (Foundations Technician) and Diana Gomez Rodrigues (engineering student) visited the site along with CR Maintenance Co-ordinator Graham Robertson on April 3, 2012.

## Observations

Following is a summary of observations made during the site visit. Refer also to the attached Figures 2, 3 and 4 for illustration.

- The Hwy 400 embankment slope is 2H:1V and the embankment height, from the stream bed, is 15m.
- At the bottom of the Hwy 400 embankment, there is a 2m wide stream that was flowing at about 1m/second at the time of the site visit. The water is clear and the stream bed is visible at a depth of less than 300mm.
- The stream flows from the NE, through a culvert under a berm parallel to and to the west of Hwy 401, then through a culvert under Hwy 400. A small culvert from the west side ditch discharges into the stream between the inlet and outlet culverts. Also, a CSP drain outlets onto the side slope of Hwy 401 above the Hwy 401 culvert inlet.
- The berm is approximately 10m high with a 2H:1V slope on both its east and west sides. It is essentially a truncated triangle placed across a valley.
- There is a concrete spillway on the east side of the berm above the berm culvert outlet – probably part of a storm management system.
- The Hwy 400 culvert is an approximately 1.0m high and 2.0m wide CIP concrete box culvert. The inlet has deteriorated concrete and exposed reinforcing steel. There are 1m x 2m x 1m gabion baskets, covered with asphalt, placed along the sides of the culvert and on the top of the culvert.
- The sediment around the sides and top of culvert has been eroded away; this indicates that water is flowing around the sides of the culvert during flood periods. The immediate backfill to the culvert is composed of boulders. The boulders are round and vary in sizes from 0.50m to 1.0m in diameter.
- There is an embankment slump due to undercutting above the culvert starting a midslope.
- The erosion around the culvert backfill extends about 2m above the culvert obvert and 2m on each side.
- There is a 300mm diameter corrugated steel pipe outletting into the slope above the Hwy 400 culvert inlet. The culvert outlets from the Hwy 400 median sewer. A section of this pipe has been broken by the slope slump leaving the functioning drain outlet buried within the embankment slope.

## Assessment and Recommendations for Planning Further Design for Remedial Measures

Based on the site inspection, instabilities at this site are primarily caused by erosion of the backfill around the inlet of the Hwy 400 culvert. The erosion has led to undermining of the embankment above the culvert and subsequently to shearing of the CSP that drains from the Hwy 400 median sewer onto the slope. Alternatively, the CSP break may have predated and contributed to the slump by outletting into the slope and eroding the backfill.

In our opinion, while the instability does not pose an immediate threat to the performance and safety of Hwy 400, it should be fixed before the winter of 2012 in order to avoid risks associated with future flooding periods. Also, in our opinion, the remedial measures would be beyond the scope of the maintenance contract due to costs likely exceeding \$100K and the need for a coordinated approach for structural repair of the culvert, possible traffic protection and possible environmental issues around the stream.

The fix would probably involve the following, but would have to be confirmed during detail design:

- closing a portion of the SB shoulder lane (note: this is an extremely tight area for traffic)
- excavating the gabions, boulders and whatever backfill remains around the outside say 5m of the culvert and back to stable material
- cutting off the distressed portion of the culvert and replacing that portion with a box culvert addition
- finding and reconstructing the end of the CSP drain that extends from the Hwy median sewer and then outletting it to the base of the embankment ditch instead of onto the slope
- reconstructing the slope and backfill to the culvert per usual MTO standards
- constructing a head wall to the culvert or alternatively an impermeable clay seal around the culvert inlet to channel water through the culvert and prevent erosion of the culvert backfill and the embankment
- armouring the inlet area with rock fill or gabion mat

These recommendations are for planning purposes only. Our office can provide support to scope a Foundations Engineering consultant assignment upon request

Dave Dundas  
Sr. Foundations Engineer