Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION AND DESIGN REPORT

for

OJIBWAY CANYON – SWAMP CROSSING
HIGHWAY 69 FOUR-LANING
FROM 3.8 KM NORTH OF HWY 522
TO 11.9 KM NORTH OF HWY 522
G.W.P. 5203-06-00
DISTRICT 54, SUDBURY, ONTARIO

PHASE 3: STA. 13+400 TO 21+500 (TOWNSHIP OF MOWAT)

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PML Ref.: 06TF033C-1
Index No.: 1861FIR and 1862FDR
Geocres No.: 41H-243
November 19, 2009

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION REPORT
for
Ojibway Canyon – Swamp Crossing
Highway 69 Four-Laning
From 3.8 km North of Hwy 522
To 11.9 km North of Hwy 522
G.W.P. 5203-06-00
District 54, Sudbury, Ontario

PHASE 3: Sta. 13+400 to 21+500 (Township of Mowat)

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1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the swamp crossing located at the Ojibway Canyon which is within the phase 3 limits of the realignment and four-laning of the section of Highway 69 that extends from 3.8 km north of Highway 522 to 11.9 km north of Highway 522, District 54, Sudbury. Peto MacCallum Ltd. (PML) conducted the foundation investigation for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation of Ontario (MTO).

PML previously conducted foundation investigations for swamp and high fill crossings (PML Ref: 06TF033C) for the realignment and four-laning of the approximately 6.9 km long section of Highway 69 that extends from approximate Sta. 13+400 to 20+300 (Mowat Township), new Highway 69. A total of 14 swamp crossings were previously assigned for foundation investigation within the Phase 3 limits. For ease of reference, PML identified the swamp crossings by sequential numbers in the 300 series from 301 to 314. In this report, the single swamp crossing located at Ojibway Canyon at between approximate Sta. 20+775 and 20+837.5, for an approximate total length of 62.5 m was designated swamp 315.

All elevations in this report are expressed in metres.

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2. SITE DESCRIPTION AND GEOLOGY

Realignment and four-laning of Highway 69 is planned about 50 km south of Sudbury.

The Ojibway canyon is running along west/east direction and its north and south edges are nearly vertical rock faces. The ground cover at the bottom of the canyon comprises grasses and typical swamp vegetation, bushes, stands of trees, exposed bedrock, and visible stream. Talus bedrock boulders exist at the toe of each of the nearly vertical rock face at the limits of the Ojibway Canyon. Boulders are also strewn across the floor of the canyon.

The bedrock outcrops at many locations throughout the site. The slopes of the bedrock at the north and the south edges of the 10 to 14 m high canyon vary from west to east and range between 50 to 80° with the horizontal.

Boulders exposed at the surface and spread throughout the site An open water is visible across floor of the canyon.

The study area is located in the Precambrian Laurentian peneplane. The topography of study area is irregular with shallow bedrock sections and deep swamp deposits. Pleistocene lacustrine/fluvial deposits and recent swamp sediments have been laid down in depressions and are probably associated with the Nipissing post-glacial stage of the Great Lakes.

Metasedimentary rocks of the Huronian Supergroup and gneisses of the Grenville Province underlie the alignment. The area has undergone considerable folding, intrusive activity, regional metamorphism and faulting.

3. INVESTIGATION PROCEDURES

The field subsurface investigation for the Ojibway Canyon crossing was carried out during the period from February 17 to May 11, 2009 and comprised a total of 15 test holes (9 boreholes, 4 dynamic cone tests and 2 manual probes) were advanced. The data from subsurface

investigation for culvert C8 and two bridge piers comprised 5 and 2 boreholes, respectively is also considered relevant to the current swamp investigation since these boreholes were drilled within the foundation swamp limits. Three test holes, designated D7-2, D7-3 and D7-3A, drilled on March 2004 within swamp limits are also considered relevant to this swamp investigation.

The test hole numbers for the swamp, culvert and piers were identified by 315-1 through 315-15, C8-1 through C8-5, and P1-SBL and P2-NBL, respectively. Test holes for swamp crossing were numbered sequentially from left to right in the direction of increasing chainage. The test hole locations at the crossing are shown on Drawing 315-1. The records of the test holes are appended.

The test borehole locations were established in accordance with the MTO requirements indicated in the RFP and in general accordance with the requirements of the MTO Northeastern Region Pavement Design Practices and Guidelines (May 20, 1997). Callon Dietz Inc., Ontario Land Surveyors laid out the reference lines of the new highway in the field and these lines were used by PML to select the borehole locations. The ground surface elevations at the boreholes were provided by Callon Dietz Inc., Ontario Land Surveyors.

The boreholes were advanced using continuous flight hollow and solid stem augers, manual probe and NW washboring, powered by track-mounted D-50 and CME-55 drill rigs. The equipment was supplied and operated by a specialist drilling contractor working under the full-time supervision of members of PML engineering staff. The test holes were taken into competent native soils, auger refusal or where bedrock was encountered. The boreholes C8-1, C8-3, C8-3, P1-SBL and P2-NBL were taken to the bedrock and extended 3.1 to 4.7 m into bedrock using rotary diamond drilling methods.

Representative soil samples were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.

An approximate 3.1 to 4.7 m length of rock cores were recovered using NQ rock coring equipment. A PML senior geologist examined and classified the recovered rock core samples. Detailed descriptions of the recovered rock core are provided in Table A.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open borehole.

Upon completion of drilling, all the boreholes were backfilled with a bentonite/cement mixture in accordance with the MTO and MOE Reg. 903 guidelines for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. The recovered samples were returned to our laboratory for detailed visual examination and classification. The laboratory testing programme consisted of moisture content determinations and grain size distribution analyses. The soil samples recovered at the site were either very little or none due to the presence of cobbles and boulders; therefore, only a limited number of grain size distribution analyses were conducted. Atterberg plasticity limits was not attempted on any sample since the soils were identified to be cohesionless (non-plastic) by visual and tactile examination. The laboratory testing program comprised the following tests:

- Natural moisture content determinations (14)
- Grain size analyses (8)

The results of the laboratory natural moisture content determinations and grain size distribution analyses are shown on the Record of Borehole Sheets. The grain size distribution charts are presented on Figures 315-1, C8-GS-1 and P1-GS-1.

4. SUMMARIZED SUBSURFACE CONDITIONS

4.1 General

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, soil boundary elevations, standard penetration resistance values, and groundwater observations. The results of laboratory grain size distribution analyses and moisture content determinations are also shown on the Record of Borehole sheets.

The borehole locations and soil strata are shown on Drawing 315-1 and 315-2, respectively. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat/topsoil unit, or snow/ice layer overlying a peat unit. The peat/topsoil units were underlain by cohesionless sand soils which in turn mantled probable bedrock or bedrock. Locally, the peat unit mantled bedrock. Bedrock was contacted at depths of 2.8 to 5.2 m (elevations 182.3 to 185.2). Boulders were at surface of the bottom of the canyon and were contacted at shallow depths. The shallow boulders covered most of the site as inferred by auger refusal at the majority of the test holes. Groundwater was observed at 0.3 to 0.8 m depths (elevations 186.2 and 187.7) and open water was visible across the floor of the canyon.

A description of the subsurface stratigraphy is summarised in the following subsections of the report.

4.2 Snow/Ice

A 300 and 800 mm thick snow/ice layer was surficially contacted in test holes 315-1, 315-4, 315-5, 315-6, 315-7, 315-8, 315-9,315-11,315-14, C8-2 through C8-5, P2-NBL, D7-2, D7-3 and D7-3A.

4.3 Peat/Topsoil

The surficial peat/topsoil units contacted in test holes 305-3, 315-10, 315-12, C8-1 and P1-SBL and beneath the snow/ice layer in boreholes 315-1, 315-4, 315-5, 315-6, 315-9, 315-11, 315-14, C8-2 through C8-5 and P2-NBL were 200 to 500 mm thick and were penetrated at elevations 186.6 to 189.5.

A localized 0.3m thick organic clayey silt was encountered beneath the peat unit at 0.8 m depth (elevation 186.9) in borehole C8-4 and extended to 1.1 m depth (elevation 186.6).

4.4 Sand

Underlying the peat/topsoil units at 0.4 to 0.8 m depths (elevations 186.6 and 189.5) in boreholes 315-1, 315-4, 315-5, 315-6, 315-9, 315-11, 315-12 315-14 C8-1, C8-3, C8-5, P1-SBL and P2-NBL and the organic clayey silt at 1.1 m depth (elevation 186.6) in borehole C8-4, a cohesionless sand deposit was contacted. The deposit was 0.4 and 4.7 m thick and extended to the probable bedrock or proved bedrock at 2.8 and 5.2 m depths (elevations 182.3 and 185.2).

The sand deposit contains some to with gravel trace to with silt trace clay, and cobbles and boulders. The relative density of the deposit was compact to dense. The N values ranged from 13 to 35 blows. High N values were recorded but reflect the presence of cobbles and boulders or interface of soil with bedrock. A single low N value of 4 was also recorded and probably due to hydraulic disturbance during sampling. The moisture content of the sand deposit ranged between 10 and 22.

The results of grain size distribution analyses conducted on representative samples of the sand deposit are presented in Figures 315-GS-1, C8-GS-1 and P1-GS-1.

4.5 Boulders

Talus bedrock boulders were at toe of near vertical rock face at the limits of the canyon at elevations 189.3 and 191.6 in boreholes 315-2 and 315-15, respectively. Boulders were below

peat layer at 0.6 and 1.2m depths, elevations 187.0 and 187.3 in test holes C8-2 and D7-2 where test holes terminated. Boulders were also encountered within sand deposit.

4.6 Bedrock

Bedrock was exposed at elevation 188.7 in test hole 315-13. Bedrock was contacted and proved in boreholes C8-1, C8-3, C8-5, P1-SBL and P2-NBL at depths of 2.8 to 5.2 m (elevations 182.3 to 185.2). In test holes 315-3, 315-6, 315-7, 315-10 and C8-4, the bedrock was inferred by refusal at depths ranging from 2.5 to 4.6 m (elevations 183.1 to 185.4).

Generally, the bedrock and probable bedrock surfaces encountered in the drilled boreholes for swamp, culvert and piers slope gently downward at about 3° from west end borehole C8-1 (elevation 185.2) to middle portion of the site borehole C8-3 (elevation 182.8) then become relatively flat between middle portion to east end of the site borehole C8-5 (elevation 182.3).

The retrieved rock cores comprise dark green to black and grey gabbro and exhibited high strength. A detailed description of the rock cores retrieved from boreholes C8-1, C8-3, C8-5, P1-SBL and P2-NBL is given in Table A appended.

The measured core recovery was in a range of 95 to 100%. The RQD determined from the rock cores was in a range of 63 to 100, thus indicating a fair to excellent quality rock. Locally, in borehole C8-3, the RQD determined from rock cores at upper zone, 4.9 to 7.6 m depths (elevations 182.8 to 180.1), was 15 and 29 % indicating a very poor to poor quality rock. This is due to presence of very close to close spaced cross joints in the rock.

4.7 Groundwater

Groundwater was observed in boreholes 315-1, 315-6, 315-9, C8-1 to C8-5, P1-SBL and P2-NBL at depths of 0.3 to 0.8 m (elevations186.2 to 187.7) upon completion of drilling. The groundwater levels at the site are subject to seasonal fluctuations and precipitation patterns.

5. MISCELLANEOUS

The field work was carried out under the supervision of Mr. F. Portela, and the direction of Mr. C.M.P. Nascimento, P.Eng., Senior Project Engineer. Walker Drilling Ltd. supplied the drilling equipment. The laboratory work was carried out in the PML laboratory in Toronto. This report was prepared by Mr. Idib (Adeeb) Sadoun, MSc, P.Eng., and Mr. C.M.P. Nascimento, P.Eng. and was independently reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly

Peto MacCallum Ltd.

NOTE: Hard copies signed and stamped

Carlos M. P. Nascimento, P.Eng.
Senior Project Engineer

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Brian R. Gray, MEng, P.Eng.
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