



**ALTERNATE ROUTE FOUNDATION ASSESSMENT REPORT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64
TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY**

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C O N S U L T I N G E N G I N E E R S

ALTERNATE ROUTE FOUNDATION ASSESSMENT REPORT

for

Highway 69 Four-Laning
From 4.5 km North of Highway 64
to 8.7 km North Of Highway 637
GWP 5379-02-00
District 54, Sudbury

1. INTRODUCTION

This report provides the foundation assessment of four alternative routes for a four-lane Highway 69 that extends from 4.5 km north of Highway 64 to 8.7 km north of Highway 637, District 54, Sudbury. The study was carried out for the Ministry of Transportation of Ontario (MTO) on behalf of Stantec Consulting Ltd. (Stantec).

The Preferred Corridor is 300 m wide and extends from Sta. 10+000 to Sta. 31+499 (Preferred Corridor Chainage). The proposed construction will involve the four-laning of Highway 69, construction of embankments, interchanges, grade separation structures and bridges. Four alternative routes were selected within the Preferred Corridor by Stantec for consideration:

- (NORTH A) Twinning on the east of existing Highway 69
- (NORTH B) Twinning on the west of existing Highway 69
- (NORTH C) New northbound and southbound lanes to the east of existing Highway 69
- (NORTH D) New northbound and southbound lanes to the west of existing Highway 69

Stantec provided drawings of the Preferred Corridor and the alternative routes.

The purpose of this preliminary foundation assessment was to determine the geologic features and hydrogeology along the Preferred Corridor and assess the potential effect of these features on the four alternative routes selected for the new four-lane highway.



2. SITE DESCRIPTION

The study area is about 35 km south of Sudbury and includes parts of the Townships of Cox, Servos and Burwash. The study alignment does not contact significant population centres. A Key Plan is attached as Drawing A.

The southern 15.5 km of the Preferred Corridor extends along terrain characterized by relatively hilly and sloping topography, while the northern 6.0 km cross a uniformly flat ground. Exposed rock knobs and ridges are noted along the existing Highway 69 alignment, where numerous rock cuts up to 9 m high were blasted to construct the existing road platform.

The existing highway corridor crosses major water bodies and swamps, such as Ink Lake, Murdock River and the relatively wide swamp west of Sheppard Lake. The water bodies and swamp sections were traversed by means of embankments and culverts therefore bridges were not constructed along this alignment.

The corridor contains forested areas with evergreen and deciduous trees comprising red oak, jack pine, hemlock and other hardwoods and the low lands are covered with grasses and alders. The area has mixed drainage characteristics with local areas of good drainage and also extensive poorly drained swampy sections.

Land use is mostly limited farming at the north end of the project. There are some cottaging areas near the Rock Bay and Lovering Lake areas and also near Crooked and Ink Lakes. To the west of the alignment at the north end of the corridor, the Department of National Defence has facilities that include a rifle firing range.



A Hydroelectric power line corridor crosses the existing alignment near Sta. 14+400. Highway 69 at grade road intersections along the study corridor are:

ROAD DESIGNATION	APPROXIMATE STATION
Crooked Lake Road	13+100
Murdock River Road	20+550
Lovering Lake Road	20+600
Highway 637	22+450
Burwash Industrial Farm Road	27+600

3. INVESTIGATION PROCEDURES

The geotechnical evaluation involved a review of the available geological, topographical and hydrogeological mapping, existing geotechnical reports, studies, aerial photographs and construction drawings for the existing highway. Field visual observations were carried out to verify the inferred data. Field drilling, in situ testing and sampling were not carried out.

3.1 Reference Documents and Literature Review

The general physiographic conditions along the corridor and the four alternative route alignments were obtained primarily from The Physiography of Southern Ontario (Chapman and Putnam, 1984), the Northern Ontario Engineering Geology Terrain Study Data Base Map, Sudbury (Ontario Geological Survey, J.F. Gartner, 1978) and reports from MTO Geocres for the French River and Highway 607. Well records obtained from the Ministry of Environment (MOE) and the Aggregate Resources Inventory Update (Jagger Hims Limited, 1998) supplemented the data.

The documents and literature reviewed in whole or in part for this study are listed in Appendix A. The list reflects the selected data that contains geotechnical content relevant to the assessment. The list of the wells considered for the project is included in Appendix B.



The location of swamps and water courses/bodies along the alternative routes were interpreted from the Ministry of Natural Resources Ontario Base Maps in conjunction with the photomosaic (Northway-Photomap Inc., 2003) and hard copy aerial photographs (Northway-Photomap Inc., May 2003).

3.2 Site Reconnaissance

Reconnaissance visits of the existing alignment and the adjacent lands within the 300 m wide Preferred Corridor were carried out on November 6, 7 and 20, 2003. The site reconnaissance visits consisted of a drive-by and walk-through of selected sections of Highway 69 and adjacent lands. The ground truth checks verified the surficial geology and drainage conditions inferred from the literature and map reviews. A comprehensive commentary and notes from the site reconnaissance visits including inferred swamp depths, rock knob/outcrop occurrences, geology at river crossings and topography is presented in Appendix C.

Relevant natural features in selected areas of the corridor were photographed. Thirty-Two representative site photographs are included in Appendix C.

4. INFERRED SUBSURFACE CONDITIONS

The anticipated extent of the major physiographic/geological units along the Preferred Corridor is summarized on Table 1 and shown on the enclosed Inferred Geological Conditions, Drawings 1 to 13. The legends and symbols used are shown on the Legend Drawing B.

The Preferred Corridor and alternative routes are located in the physiographic region known as the Georgian Bay Fringe, which include:

- A bedrock plain and soil complex comprising exposed bedrock knobs, subordinate glacial till moraine and a peat/muck organic terrain over bedrock.
- Peat/muck organic terrain.



- A glaciofluvial sandy outwash plain with subordinate peat/muck organic terrain.
- Wetland areas containing peat, alluvial deposits of silt, sand and clay.

The bedrock plain consists of a bedrock and soil complex and is inferred along most of the corridor.

North of Sta. 25+300 and extending to the termination of the project at Sta. 31+499 the terrain is relatively flat and comprises inferred glaciofluvial deposits of silts and sands and local areas with organic and clayey deposits. A major feature is the swamp located west of Sheppard Lake near the northern end from Sta. 25+300 to Sta. 25+900.

The mineral soil cover in the bedrock plain is typically less than 1 m and may vary greatly over short distances. Locally, in swampy lands the soil cover may extend to depths exceeding 30 m. The soils were deposited by river action associated with glacial Lake Algonquin and later partly by Lake Nipissing. Beach and near shore deposits, deltas, subaquatic fans, quiet water deposits of silt and clay were formed by sedimentation in and adjacent to Lake Algonquin and its successors. Outwash deposits of sand or silts of lacustrine or glaciofluvial origins occur in low-lying depressions in the bedrock surface along the Highway 69 corridor within the study area.

Most of the original gravel deposits along the corridor have been depleted as a result of intensive past gravel pit extraction operations. One such depleted gravel pit exists to the west of the northern section of the Highway 69 alignment, south of Trout Lake Road. Organic deposits and floodplain alluvium have been deposited and/or accumulated in poorly drained depressions in bedrock.

The study area is within a structural subdivision of the Canadian Precambrian Shield identified as the Grenville Province. In particular, the study area traverses the western portion of the Central Gneiss Belt within the Grenville Province wherein pink and grey gneisses are predominant. The section near the Ink Lake and Highway 637 areas winds through the large dome-like Cox and Servos Plutons, respectively. These formations comprise mainly pink and grey gneiss and gneiss tonalite and gabbro.



The extent of these physiographic/geological formations is summarized below:

GEOLOGICAL UNIT	APPROXIMATE CHAINAGE	LENGTH (m)	TOTAL LENGTH (m)	PERCENTAGE OF ALIGNMENT (%)
Bedrock Plain and Bedrock/ Soil Complex	Sta. 10+000 to 25+300	15,300	16,299	76
	Sta. 25+900 to 26+500	600		
	Sta. 31+100 to 31+499	399		
Glaciofluvial Deposit and Swamp/Bedrock	Sta. 25+300 to 25+900	600	5,200	24
	Sta. 26+500 to 31+100	4,600		
Total Length			21,499	100

Generally, surface water run off along the Preferred Corridor drains into streams, swamps and scattered ponds. Groundwater is inferred typically near ground surface (less than 1 m deep) in particular in the low-lying areas. Major swampy locations and low-lying areas that required high embankments occurred at the start of the study section, Sta. 10+000 (4 m high fills), Ink Lake crossing (9 m high fill), Murdock River crossing (about 7 m high fills) and at Rock Bay (up to 12 m high fill). Major water bodies and streams along the alignment are Ink Lake and Murdock River.

The existing rivers and water bodies are typically cut into bedrock or follow inferred bedrock fault lines. The terrain and glacial origin of the typically shallow soil cover suggest that the area of the alignment is not prone to landslides.



5. ALTERNATE ROUTE FOUNDATION ASSESSMENT AND RANKING

Four route alternatives for a four-lane highway were developed by Stantec within the Preferred Corridor.

The corridor was subdivided into three subsections to evaluate the alternative routes and to identify a Preferred Route from a foundation perspective. The subsections are 3.25, 7.75 and 10.5 km long; the boundary between each section was selected where the locations of the four alternative routes converge. The subsection boundaries are listed below:

- South Project Limits - Sta. 10+000
- Crooked Lake Road - Sta. 13+250
- Lovering Lake/Rock Bay - Sta. 21+000
- North Project Limits - Sta. 31+499

The limits of each subsection for the four alternative routes are listed on the following table:

ALTERNATIVE ROUTE	ROUTE SUBSECTION	SUBSECTION LIMITS
ROUTE NORTH A: Twinning on the east of existing Highway 69	North A-1	Sta. 10+000 to Sta. 13+250
	North A-2	Sta. 13+250 to Sta. 21+000
	North A-3	Sta. 21+000 to Sta. 31+499
ROUTE NORTH B: Twinning on the west of existing Highway 69	North B-1	Sta. 10+000 to Sta. 13+250
	North B-2	Sta. 13+250 to Sta. 21+000
	North B-3	Sta. 21+000 to Sta. 31+499
ROUTE NORTH C: New northbound and southbound lanes to the east of existing Highway 69	North C-1	Sta. 10+000 to Sta. 13+250
	North C-2	Sta. 13+250 to Sta. 21+000
	North C-3	Sta. 21+000 to Sta. 31+499
ROUTE NORTH D: New northbound and southbound lanes to the west of existing Highway 69	North D-1	Sta. 10+000 to Sta. 13+250
	North D-2	Sta. 13+250 to Sta. 21+000
	North D-3	Sta. 21+000 to Sta. 31+499



5.1 Criteria Used In Assessing Alternatives

The terms of reference for this project identified six criteria to be considered from a foundation perspective, as follows:

- Extent of Soft Ground
- Groundwater Conditions
- Structure Foundations
- Embankment Settlement
- Embankment Stability
- Construction Considerations

A rationale for what each criterion represents and a method for measuring and evaluating each criterion was developed. The results of the evaluation are provided in Tables F-1 to F-6. A discussion of the assessment criteria follows.

5.1.1 Extent of Soft Ground/Swamps (Table F-1)

The potential impact of soft ground and/or swamps along each alternative route was evaluated on the basis of the total length of the route with inferred soft ground/swamps between 0 and 3 m deep; 3 and 10 m deep; and over 10 m deep.

Soft ground/swamps less than 3 m deep that may be excavated with conventional backhoe equipment were considered the most favourable. Soft ground/swamp ground that is between 3 and 10 m deep typically requires a long-stick excavator and are of intermediate favourability. The treatment of areas with soft ground/swamps over 10 m deep need special equipment such as drag lines or require non-conventional treatment (wick drains, preloading) and are the least favourable.



5.1.2 Groundwater Conditions (Table F-2)

The extent of each route alternative with inferred groundwater at depths greater than 5 m (most favourable condition); between 1 and 5 m deep; and between 0 and 1 m deep (least favourable condition) were employed to assess the potential impact of this criterion.

The greater the groundwater depth the easier structures and embankments are to construct and the better the performance of embankments.

5.1.3 Structure Foundations (Table F-3)

The type of foundation required to support bridges, interchange structures and major culverts was employed to assess the potential impact of this criterion. Shallow foundations were considered to be the most favourable and deep foundations the least favourable. The potential foundation type was estimated based on the inferred type and quality of founding subgrade materials along each route alternative.

5.1.4 Embankment Settlement (Table F-4)

Evaluation of embankment settlement was based on the total length of route alternatives over compressible materials. For evaluation purposes, the compressible soils were grouped into less than 3 m deep areas; 3 to 10 m deep zones; and more than 10 m deep zones. Each of these groups was further divided into potentially sandy or clayey deposits.

The most favourable condition was defined as the swamp areas containing less than 3 m of compressible deposits of a sandy nature (for example, loose sand), and the least favourable conditions are in areas with compressible deposits of soft clayey soils deeper than 10 m.



5.1.5 Embankment Stability (Table F-5)

The potential impact of embankment stability was evaluated on the basis of the total length of embankment and composition of the founding material. Conventional embankments that require little or no excavation and use conventional slope configurations were considered the most favourable, followed in decreasing favourability by embankments that require significant subexcavation, embankments that may require toe-stabilizing berms and (the least favourable) sections that may contain deeper than 10 m soft clays requiring pre-loading and wick drains.

5.1.6 Construction Feasibility (Table F-6)

The impact of construction feasibility was assessed on the basis of the number of structures and length of swamp sections, in conjunction with the inferred composition of the founding material and groundwater. In addition, embankment in swamps up to 10 m deep were considered to be conventional construction (most favourable) and those in swamps more than 10 m deep were special construction (least favourable). The formulae used are indicated on Table F-6.

The issue of constructing twin options versus two new embankments through swamps was considered. However, this factor will not influence the overall score because the difficulties associated with constructing a twin embankment was offset by the additional embankment length required in the New to East or New to West routes.

5.2 Weighting of Evaluation Criteria (Tables F-1 to F-7)

A weighting system was developed to enable selection of the preferred subsections along each alternative route. The weighting system involved two factors:

- A favourability factor F to score the assessment for each of the evaluation criteria based on the foregoing discussion. The F values ranged from 5 for the most favourable to 1 for the least favourable.



- An impact weight B_i to reflect the significance of each of the six criteria on the design and construction of the highway. The impact weight varies from 0 to 1. The six evaluation criteria were compared in terms of relative importance and impact and assigned an individual impact weight as presented below:

EVALUATION CRITERION	IMPACT WEIGHT, B_i
Soft Ground Swamp	0.25
Embankment Settlement	0.25
Structure Foundations	0.15
Construction Feasibility	0.15
Embankment Stability	0.10
Groundwater Conditions	0.10
TOTAL	1.00

The more important the individual evaluation criterion was considered for the design and/or construction of the highway, the higher the impact weight assigned. A value of 0 would be assigned if the criteria were deemed to have no impact on alternative route selection.



The favourability factors, F, used in Tables F-1 to F-6 and the impact weights, B_i, used in the summary Table F-7 are summarized in the following table.

EVALUATION CRITERION	IMPACT WEIGHT, B _i	FAVOURABILITY FACTOR, F				TABLE		
		MOST		AVERAGE			LEAST	
Soft Ground Swamps	0.25	Based on relative length and depth of soft ground (SG) and/or swamps (SWP):				F-1		
		SG or SWP 0 to 3 m Deep		SG or SWP 3 to 10 m Deep			SG or SWP Over 10 m Deep	
		F=5		F=3			F=1	
Groundwater Conditions	0.10	Based on inferred groundwater (GW) depth:				F-2		
		GW Deeper than 5 m		GW 1 to 5 m			GW 0 to 1 m	
		F=5		F=3			F=1	
Structure Foundations	0.15	Based on estimated type of foundation requirements:				F-3		
		Shallow Foundation		Deep Foundation				
		F=5		F=3				
Embankment Settlement	0.25	Based on length of sections with compressible soil with three depth ranges:				F-4		
		Less than 3 m deep		3 to 5 m deep			Deeper than 5 m	
		Sandy	Clayey	Sandy	Clayey		Sandy	Clayey
		F=5	F=4	F=4	F=3		F=2	F=1
Embankment Stability	0.10	Based on estimated type of construction required to establish embankment on competent ground:				F-5		
		Conventional Construction		Significant Subexcavation			Toe-Stabilizing Berms Required	
		F=5		F=3			F=2	
Construction Feasibility	0.15	Based on combined assessment of structure foundations, and embankment construction over deep swamps				F-6		
		Conventional Structure Foundation		Special Structure Foundation			Conventional Embankment Construction	
		F=5		F=1			F=5	



With reference to Table F-1, Soft Ground/Swamp Evaluation Criterion, the weighted favourability value A_1 for the North A-1 subsection was obtained by multiplying the Favourability factor F by the length of alignment for which the condition is applicable and dividing by the total length of the soft ground or swamp in the subsection, as presented below:

DEPTH RANGE (m)	LENGTH (m)	FAVOURABILITY FACTOR, F
0 - 3	0	5
3 - 10	1430	3
>10	0	1

$$A_1 = \text{Weighted Favourability Value} = \frac{(0 \times 5) + (1430 \times 3) + (0 \times 1)}{0 + 1430 + 0} = 3.00$$

The weighted favourability value, A_i , computed for each subsection is provided on Tables F-1 to F-6.

5.3 Scoring of Foundation Criteria (Table F-7)

The alternative route subsections were scored by adding the weighted favourability value A_i for each evaluation criteria multiplied by the impact weight B_i for the criteria. For example, the 3.29 score for the subsection North A-1 was obtained as follows (Refer to Table F-7):

EVALUATION CRITERIA	SOFT GROUND/ SWAMPS	GROUNDWATER CONDITIONS	STRUCTURE FOUNDATIONS	EMBANKMENT SETTLEMENT	EMBANKMENT STABILITY	CONSTRUCTION FEASIBILITY	
TABLE NO.	F-1	F-2	F-3	F-4	F-5	F-6	
IMPACT WEIGHT, B_i	$B_1 = 0.25$	$B_2 = 0.10$	$B_3 = 0.15$	$B_4 = 0.25$	$B_5 = 0.10$	$B_6 = 0.15$	
North A-1	A_1	3.00	1.82	5.00	3.00	4.10	3.00

$$\text{Score} = (3.00 \times 0.25) + (1.82 \times 0.10) + (5.00 \times 0.15) + (3.00 \times 0.25) + (4.10 \times 0.10) + (3.00 \times 0.15)$$

$$\text{Score} = 3.29$$



The scores and rankings of the foundation evaluation criterion for the twelve alternative route subsections are provided on Table F-7 and the results are summarized below:

SUB-SECTION	SCORE	RANKING	SUB-SECTION	SCORE	RANKING	SUB-SECTION	SCORE	RANKING
North A-1	3.29	4	North A-2	3.08	3	North A-3	3.42	4
North B-1	3.56	2	North B-2	2.93	4	North B-3	3.43	2
North C-1	3.32	3	North C-2	3.44	1	North C-3	3.43	3
North D-1	3.79	1	North D-2	3.31	2	North D-3	3.48	1

The results indicate that the alternative route subsections North B-1 (twinning to west) and North D-1 (new alignment to west) have the higher scores of 3.56 and 3.79, respectively with North D-1 being higher. The western routes North B-1 and North D-1 are preferred over the two easterly route subsections, North A-1 and North C-1, which have scores of 3.29 and 3.32, respectively.

Subsections North C-2 (new alignment to east) and North D-2 (new alignment to west) have close scores of 3.44 and 3.31, respectively. These subsections are preferred over the two twinning options North A-2 and North B-2 which have lower scores of 3.08 and 2.93.

The scorings for the third subsection (North A-3, North B-3, North C-3 and North D-3) have similar scores between 3.42 and 3.48, with North D-3 (new alignment to west) being slightly higher than the other three subsections. Therefore these subsections are practically equivalent in terms of foundation favourability.

The relatively small differences between scores obtained for some of the subsections are generally consistent with the minor variation of the geology within the Preferred Corridor (east to west).



6. ROUTE REVIEW AND RECOMMENDATIONS

From an embankment and structures design perspective, the route that incorporates the highest scoring subsections will be the preferred alignment.

Since the alternative routes cross the same swamps in relatively close proximity, the swamp crossings (east-west) do not influence the scores and selection of each route subsection as much as the swamps that are located adjacent to the routes (north-south). Hence, the preferred route will avoid the swamps to achieve bedrock foundations, since embankment foundations over bedrock will be more stable and will be subjected to minimal postconstruction settlements.

In particular, the swamps located to the west of the existing highway north of Ink Lake (Sta. 16+000 to 16+500), north of Murdock River (Sta. 17+950 to 18+400) and the east of Burwash Industrial Farm Road intersection (Sta. 27+300 to 27+800) will affect some of the alternative routes and should be avoided. To this end, the subsection North B-2 (twinning to west) through the swamp north of Ink Lake; subsections North B-2 and North D-2 (new to west) through the swamp north of Murdock River; and subsection North C-3 (new to east) at the Burwash Industrial Farm Road should be avoided.

The crossing of the swamp west of Sheppard Lake (Sta. 25+300 to 25+900) is expected to require special embankment construction because the soft compressible materials are expected to be too deep (up to 25 m) to be completely excavated. The selection of the final alignment should follow an investigation of the quality and condition of the existing local deposits. This crossing will require special design and construction methods/procedures such as wick drains and preloading carried out ahead of the road construction or the construction of a structure to span the deeper portion of the swamp.



6.1 Embankment Design

The embankments will likely comprise rockfill since the aggregate deposits in the area have been depleted. Conventional embankment design and construction procedures for rockfill embankment should be suitable. MTO Northeastern Region guidelines for mid height berms at every 6 m interval of height for embankments should be followed. The geometry of the embankments should also include 2 m widenings on each side of the platform through swamps as per Northeastern Region Directive 98-200.

The available information suggests that swamp depths through most the study corridor do not exceed 10 m. The possibility of encountering deeper deposits of peat and soft clay should not be overlooked, such as at the swamp west of Sheppard Lake, Sta. 25+750.

The implications of constructing road embankments in swamps with soft soils over 10 m deep are highlighted in the following subsections.

6.2 Embankment Stability

All alternative routes cross swamps that may contain very soft to firm clayey soils of varying depths, typically in the 5 to 10 m range. Typically, these weak soils will not provide adequately stable foundations for embankment construction. It is anticipated that subexcavation of soft soils will be required for construction of the road embankments.

The use of non-standard slope configurations such as toe-stabilizing berms or wick drains and preloading may be required through swamps that are deeper than 12 to 15 m, such as the swamp located west of Sheppard Lake.

The alternative route comprising embankment twinning options through deep swamps, such as the various swamps located between Sta. 10+000 and 13+500, the swamps north of Ink Lake and Murdock River and at Burwash Industrial Farm Road, may require wider than standard median widths to permit subexcavation of soft soils without affecting the stability of the existing



embankment. Preloading or toe-stabilizing berms may also be considered to limit the excavation depths adjacent to the existing highway embankments.

6.3 Embankment Settlements

It is anticipated that settlement of embankments founded on bedrock or competent non-swamp glaciolacustrine soil deposits will be minimal.

The swamp soils are typically not considered suitable for supporting the highway embankments due to their high compressibility and low strength. The magnitude and rate of the settlements will depend on the thickness and nature of the soils in each of the swamps and may exceed MTO criteria if placed on very soft to firm clayey soils to depths exceeding 15 m and/or may affect existing embankments/structures which are in close proximity.

Non-conventional construction procedures may be required to reduce postconstruction settlements to tolerable levels such as the use of lightweight fill, wick drains and/or preloading.

6.4 Structure Foundations

The existing corridor does not contain bridge structures. We understand however that the existing culverts at Ink Lake and Murdock River crossings may need to be replaced or extended. Alternatively, bridges may be required at one or both of these locations. Bedrock outcrops were encountered on both sides of the Ink Lake and Murdock River crossings. Long span bridges over the water will be founded on shallow foundations in/on bedrock. For alternative route North B (twinning to the west) rock may be deeper on the relatively longer (skewed) southbound lanes and require deep foundations in water.

The location of the interchange structures along all four alternative routes, are likely to be over typically shallow rock. The type of foundation (shallow or deep) will depend ultimately on the road grades at the structures and structural design concepts. However, foundation material for both spread footings or pile foundations is expected to comprise bedrock.



The possible interchange location north of Crooked Lake Road is expected to be in a bedrock area, therefore foundations are expected to be on shallow bedrock. The foundations at the interchange structure(s) will depend on the final location of the interchange.

The foundations for the Highway 637 interchange structure are expected to be of similar types (shallow) for all alternative routes and therefore have no significant influence on the alternative route selection.

Culverts at the Lovering Lake/Rock Bay site, Sheppard Lake swamp and water crossing at Sta. 26+500 are expected to be founded on similar founding conditions for each of the alternative routes and should not influence the route selection.

6.5 Construction Considerations

It is anticipated that the typical embankment construction will be accomplished with conventional methods since the alignment is on rock plains and across relatively shallow swamps less than 10 m deep. Although deeper organic/soft clay deposits are anticipated in the swamp located west of Sheppard Lake (Sta. 25+300 to 25+900), all alternative routes cross this area at approximately the same angle and it is expected that the degree of difficulty will be similar for embankment construction.

Several swamp crossings also involve open water bodies, such as at Sta. 10+500 (new to west), Sta. 12+600 across from Crooked Lake Road (east side of Highway 69), Ink Lake, Murdock River, Lovering Lake/Rock Bay channel, swamp north of Sheppard Lake (Sta. 26+500) and swamp across from Burwash Industrial Farm Road. Excavation under water or non-conventional construction requiring long preloading periods (one to two years) may need to be considered. Without subexcavation of soft materials, construction of these embankments ahead of the remainder of other highway embankments will be required.



6.6 Additional Studies

The preliminary assessments in this report are based on literature reviews and site reconnaissance only. Additional data should be obtained by conducting preliminary investigation(s) to confirm the data inferred during these studies. In particular, the depth and extent of glaciofluvial deposits and organic/soft/wet soils in swamps and low-lying areas should be investigated.

A Preferred Route was received from Stantec in February 2004. Within the first route subsection limits from Sta. 10+000 to 13+250, the Preferred Route follows alternative North B-1 Twinning to the West (score 3.56). Along the second subsection, the Preferred Route follows the Twinning to the East alternative North A-2 (score 3.08) to Sta. 17+000 and changes from this chainage to the New to the East subsection North C-2 (score 3.44) to Sta. 21+000. The Preferred Route follows an alignment located between alternative subsections North A-3 (score 3.42) and New to the West North D-3 (score 3.48) to Sta. 24+000; and from this chainage to the end of the project the route follows primarily the North C-3 alternative (score 3.43).

It is also recommended that the potential bridge locations over the Ink Lake and Murdock River interchanges, overpass/underpass structures and major culvert locations be investigated. A preliminary list of structures from the Preferred Route plan is compiled in Table 2. The bedrock at each location should be proven with cores to confirm that the preferred sites are adequate.



7. CLOSURE

This report was prepared by Mr. C.M.P. Nascimento, P. Eng., Senior Project Engineer and reviewed by Mr. B. R. Gray, MEng, P. Eng., MTO Designated Contact. Mr. D.W. Kerr, MEng, P. Eng., Chief Foundation Engineer, conducted an independent review.

Yours very truly,

Peto MacCallum Ltd.

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



Brian R. Gray, MEng, P. Eng.
MTO Designated Contact



Dennis W. Kerr, MEng, P.Eng.
Chief Foundation Engineer



CN-cn-mi



TABLE 1
MAIN GEOLOGICAL FEATURES WITHIN PREFERRED CORRIDOR
ALTERNATIVE ROUTE ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00, DISTRICT 54, SUDBURY

APPROXIMATE CHAINAGE	GEOLOGICAL UNIT	UNIT DESCRIPTION
10+000 to 25+300	Bedrock Plain	Bedrock knobs with subordinate till ground moraine and peat/muck organic terrain drift veneer over bedrock. Mainly low undulating to rolling local relief. Mixed wet and dry. <u>Note:</u> East half of right of way from Sta. 24+600 to 24+850 : Peat muck organic terrain. Mainly low plain local relief. Wet.
25+300 to 25+900	Glaciofluvial Deposits and swamp	Sandy outwash plain with subordinate peat/muck organic terrain. Mainly low plain local relief. Mixed wet and dry with high suspected water table (Sheppard Lake in fill).
25+900 to 26+500	Bedrock/soil complex	Bedrock knobs with subordinate till ground moraine and peat/muck organic terrain drift veneer over bedrock. Mainly low undulating to rolling local relief. Mixed wet and dry.
26+500 to 31+100	Glaciofluvial Deposits and Bedrock	Sandy outwash plain with subordinate peat/muck organic terrain. Mainly low plain local relief. Mixed wet and dry with high suspected water table. <u>Note:</u> East half of right of way from Sta. 27+100 to 28+000: Bedrock and soil complex. Mainly low undulating to rolling local relief. Mixed wet and dry.
31+100 to 31+499.242	Organic Deposits and Glaciofluvial Deposits	Peat/muck organic terrain. Mainly low plain local relief. Wet. <u>Note:</u> East half of right of way from Sta. 30+800 to 31+413.203: Glaciofluvial Deposits. Mainly low plain local relief. Mixed wet and dry with high suspected water table.

NOTES:

1. Primary Data Sources:
 - Northern Ontario Engineering Geology Terrain Study, Data Base Map, Sudbury. Ontario Geological Survey, Map 5003, Scale 1:100 000. Published 1978.
 - Southern Ontario Engineering Geology Terrain Study, Data Base Map, Byng Inlet. Ontario Geological Survey, Map 5500, Scale 1:100 000. Published 1981.
2. Stations refer to centerline of 300 m wide reference corridor.



TABLE 2
RECOMMENDED LOCATIONS FOR FOUNDATION MAINLINE INVESTIGATIONS
PREFERRED ROUTE
ALTERNATIVE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00, DISTRICT 54, SUDBURY

STATIONS	PROPOSED WORKS
<u>Fill Area/Swamp Crossing Highway 69</u>	
10+130 to 10+400	Embankment fill up to 3 m high, swamp area
10+600 to 10+880	Embankment fill up to 5 m high, swamp area
11+110 to 11+520	Embankment fill up to 5 m high, swamp area
12+250 to 13+370	Embankment fill up to 10 m high, swamp area
15+350 to 15+430 (Ink Lake)	Embankment fill up to 6 m high, swamp area
15+950 to 16+400	Embankment fill up to 3 m high, swamp area
16+870 to 17+060	Embankment fill up to 7 m high, swamp area
17+370 to 17+570 (Murdock River)	Embankment fill up to 12 m high
19+150 to 19+560	Embankment fill up to 7 m high
19+660 to 19+830	Embankment fill up to 15 m high
20+580 to 20+800	Embankment fill up to 9 m high, swamp area
20+850 to 20+910 (Lovering Lake)	Embankment fill up to 15 m high
21+470 to 21+660	Embankment fill up to 14 m high, swamp area
23+220 to 23+600	Embankment fill up to 12 m high, swamp area
23+770 to 24+160	Embankment fill up to 11 m high, swamp area
24+200 to 24+450	Embankment fill up to 5 m high
24+480 to 24+670	Embankment fill up to 8 m high
24+750 to 25+000	Embankment fill up to 9 m high, swamp area
25+200 to 25+440	Embankment fill up to 4 m high, swamp area
25+540 to 25+900 (Sheppard Lake)	Embankment fill up to 3 m high, swamp area
26+210 to 26+600	Embankment fill up to 6 m high, swamp area
26+600 to 27+160	Embankment fill up to 10 m high
27+270 to 27+800	Embankment fill up to 7 m high, swamp area
29+000 to 29+090	Embankment fill up to 3 m high, swamp area

- NOTES: 1. Chainages are approximate and may vary for northbound and southbound mainlines to be confirmed/refined during preliminary and detailed design.
2. The swamp crossing between Sta. 30+710 and 31+090 was investigated previously (GWP 312-99-00).



TABLE 2
RECOMMENDED LOCATIONS FOR FOUNDATION MAINLINE INVESTIGATIONS
PREFERRED ROUTE
ALTERNATIVE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00, DISTRICT 54, SUDBURY

STATIONS	PROPOSED WORKS
<u>Structures (Bridges and Culverts)</u>	
14+920	Crooked Lake Road Interchange structure
15+400	Culvert at Ink Lake
17+500	Murdock River Bridge
18+560	Forest Access Road Overpass
20+700	Lovering Lake Road Overpass
20+890	Lovering Lake Bridge
22+430	Highway 637 Interchange structure
25+700	Culvert at Sheppard Lake swamp
26+500	Culvert at unnamed swamp
29+050	Culvert at abandoned old gravel pit road



TABLE F-1 – SOFT GROUND/SWAMPS
ALTERNATE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY

ALTERNATE ROUTE	ALTERNATE ROUTE SUBSECTION	TOTAL LENGTH (L,m) OF SECTIONS WITH INFERRED RANGE OF SOFT GROUND/SWAMP DEPTHS AND FAVOURABILITY (F)						WEIGHTED FAVOURABILITY VALUE (A _i)	
		L ₁ (m)	F ₁	L ₂ (m)	F ₂	L ₃ (m)	F ₃	$\frac{\sum L_i \times F_i}{\sum L_i}$	
		Depth Range 0 - 3 m		Depth Range 3 - 10 m		Depth Range > 10 m			
North A Twinning to East	North A-1	-	5	1430	3	-	1	3.00	A ₁
	North A-2	145	5	1025	3	1060	1	2.18	A ₂
	North A-3	320	5	2465	3	370	1	2.97	A ₃
North B Twinning to West	North B-1	-	5	1680	3	-	1	3.00	A ₄
	North B-2	365	5	1255	3	1095	1	2.46	A ₅
	North B-3	445	5	2435	3	375	1	3.04	A ₆
North C New to East	North C-1	70	5	1675	3	-	1	3.08	A ₇
	North C-2	375	5	295	3	455	1	2.86	A ₈
	North C-3	195	5	2610	3	310	1	2.93	A ₉
North D New to West	North D-1	85	5	665	3	-	1	3.23	A ₁₀
	North D-2	-	5	1870	3	575	1	2.53	A ₁₁
	North D-3	585	5	2530	3	310	1	3.16	A ₁₂

NOTE: Enter weighted favourability value A_i in Table F-7.



TABLE F-2 – GROUNDWATER CONDITIONS
ALTERNATE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY

ALTERNATE ROUTE	ALTERNATE ROUTE SUBSECTION	TOTAL LENGTH (L,m) OF SECTIONS WITH INFERRED RANGE OF GROUNDWATER DEPTHS AND FAVOURABILITY (F)						WEIGHTED FAVOURABILITY VALUE (A _i)	
		L ₁ (m) Depth Range >5 m	F ₁	L ₂ (m) Depth Range 1 - 5 m	F ₂	L ₃ (m) Depth Range 0 - 1 m	F ₃	$\frac{\sum L_i \times F_i}{\sum L_i}$	A _i
North A Twinning to East	North A-1	0	5	1320	3	1910	1	1.82	A ₁
	North A-2	3840	5	2395	3	925	1	3.81	A ₂
	North A-3	4660	5	2182	3	3860	1	3.15	A ₃
North B Twinning to West	North B-1	0	5	1055	3	2175	1	1.65	A ₄
	North B-2	3225	5	1505	3	2370	1	3.24	A ₅
	North B-3	4535	5	2064	3	4025	1	3.10	A ₆
North C New to East	North C-1	0	5	1805	3	1475	1	2.10	A ₇
	North C-2	3125	5	3040	3	1085	1	3.56	A ₈
	North C-3	5065	5	2648	3	3015	1	3.38	A ₉
North D New to West	North D-1	0	5	2420	3	830	1	2.49	A ₁₀
	North D-2	4005	5	2625	3	810	1	3.86	A ₁₁
	North D-3	4450	5	1938	3	4220	1	3.04	A ₁₂

NOTE: Enter weighted favourability value A_i in Table F-7.



TABLE F-3 – STRUCTURE FOUNDATIONS
ALTERNATE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY

ALTERNATE ROUTE	ALTERNATE ROUTE SUBSECTION	CONTEMPLATED STRUCTURE/INTERCHANGE SITE, TYPE OF FOUNDATION AND FAVOURABILITY (F)														WEIGHTED FAVOURABILITY VALUE (A _i) Σ F _i (No. Structures)	
		Crooked Lake Road I/C		Ink Lake Bridges or Culvert		Murdock River Bridges or Culvert		Rock Bay/Lovering Lake Culvert		Hwy 637 I/C		Sheppard Lake Swamp Culvert		Water Body Sta. 26+500 Culvert			
		Type	F ₁	Type	F ₂	Type	F ₃	Type	F ₄	Type	F ₅	Type	F ₆	Type	F ₇		
North A Twinning to East	North A-1	A	5	-	-	-	-	-	-	-	-	-	-	-	-	5.00	A ₁
	North A-2	-	-	A	5	A	5	A	5	-	-	-	-	-	-	5.00	A ₂
	North A-3	-	-	-	-	-	-	-	-	A	5	B	3	A	5	4.35	A ₃
North B Twinning to West	North B-1	A	5	-	-	-	-	-	-	-	-	-	-	-	-	5.00	A ₄
	North B-2	-	-	B	3	A	5	A	5	-	-	-	-	-	-	4.35	A ₅
	North B-3	-	-	-	-	-	-	-	-	A	5	B	3	A	5	4.35	A ₆
North C New to East	North C-1	A	5	-	-	-	-	-	-	-	-	-	-	-	-	5.00	A ₇
	North C-2	-	-	A	5	A	5	A	5	-	-	-	-	-	-	5.00	A ₈
	North C-3	-	-	-	-	-	-	-	-	A	5	B	3	A	5	4.35	A ₉
North D New to West	North D-1	A	5	-	-	-	-	-	-	-	-	-	-	-	-	5.00	A ₁₀
	North D-2	-	-	A	5	A	5	A	5	-	-	-	-	-	-	5.00	A ₁₁
	North D-3	-	-	-	-	-	-	-	-	A	5	B	3	A	5	4.35	A ₁₂

NOTES: A: Shallow Foundation, F = 5
 B: Deep Foundation, F = 3
 I/C: Denotes Interchange Location
 Enter weighted favourability value A_i in Table F-7.



TABLE F-4 – EMBANKMENT SETTLEMENT
ALTERNATE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY

ALTERNATE ROUTE	ALTERNATE ROUTE SUBSECTION	LENGTH (L _i , m) OF COMPRESSIBLE SUBSOIL WITHIN DEPTH RANGE, SUBSOIL TYPE AND FAVOURABILITY FACTOR (F _i)						WEIGHTED FAVOURABILITY VALUE (A _i)	
		Less than 3 m Deep		3 m to 10 m Deep		Deeper than 10 m			
		L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	$\frac{\sum L_i \times F_i}{\sum L_i}$	A _i
		Sandy (F ₁ =5)	Clayey (F ₂ =4)	Sandy (F ₃ =4)	Clayey (F ₄ =3)	Sandy (F ₅ =2)	Clayey (F ₆ =1)		
North A Twinning to East	North A-1	-	-	-	1430	-	-	3.00	A ₁
	North A-2	-	145	-	1025	470	590	2.33	A ₂
	North A-3	-	320	-	2465	-	370	2.87	A ₃
North B Twinning to West	North B-1	-	-	-	1680	-	-	3.00	A ₄
	North B-2	-	365	-	1255	460	635	2.50	A ₅
	North B-3	-	445	-	2435	-	375	2.91	A ₆
North C New to East	North C-1	-	70	-	1675	-	-	3.04	A ₇
	North C-2	-	375	-	295	350	105	2.84	A ₈
	North C-3	-	195	-	2610	-	310	2.86	A ₉
North D New to West	North D-1	-	85	-	665	-	-	3.11	A ₁₀
	North D-2	-	-	-	1870	425	150	2.70	A ₁₁
	North D-3	-	585	-	2530	-	310	2.99	A ₁₂

NOTE: Enter weighted favourability value A_i in Table F-7.



TABLE F-5 – EMBANKMENT STABILITY
ALTERNATE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY

ALTERNATE ROUTE	ALTERNATE ROUTE SUBSECTION	LENGTH (L _i ,m) OF SECTION REQUIRING CONVENTIONAL OR SPECIAL DESIGN REQUIREMENTS AND FAVOURABILITY (F _i)				WEIGHTED FAVOURABILITY VALUE (A _i) $\frac{\sum L_i \times F_i}{\sum L_i}$	
		L ₁	L ₂	L ₃	L ₄		
		Conventional Embankment Slopes (F ₁ = 5)	Embankment Requiring Subexcavation (F ₂ = 3)	Embankment Requiring Toe-Stabilizing Berms (F ₃ = 2)	Embankment Requiring Pre-Loading/Wick Drains (F ₄ = 1)		
North A Twinning to East	North A-1	1750	1430	-	-	4.10	A ₁
	North A-2	1500	1170	825	235	3.46	A ₂
	North A-3	4797	2785	150	220	4.13	A ₃
North B Twinning to West	North B-1	1600	1680	-	-	3.98	A ₄
	North B-2	660	1620	850	245	2.99	A ₅
	North B-3	4619	2880	150	225	4.10	A ₆
North C New to East	North C-1	1185	1745	-	-	3.81	A ₇
	North C-2	2465	670	215	240	4.18	A ₈
	North C-3	4863	2805	270	180	4.12	A ₉
North D New to West	North D-1	2835	750	-	-	4.58	A ₁₀
	North D-2	1375	1870	280	295	3.49	A ₁₁
	North D-3	4333	3115	200	150	4.05	A ₁₂

NOTE: Enter weighted favourability value A_i in Table F-7.



TABLE F-6 – CONSTRUCTION FEASIBILITY
ALTERNATE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY

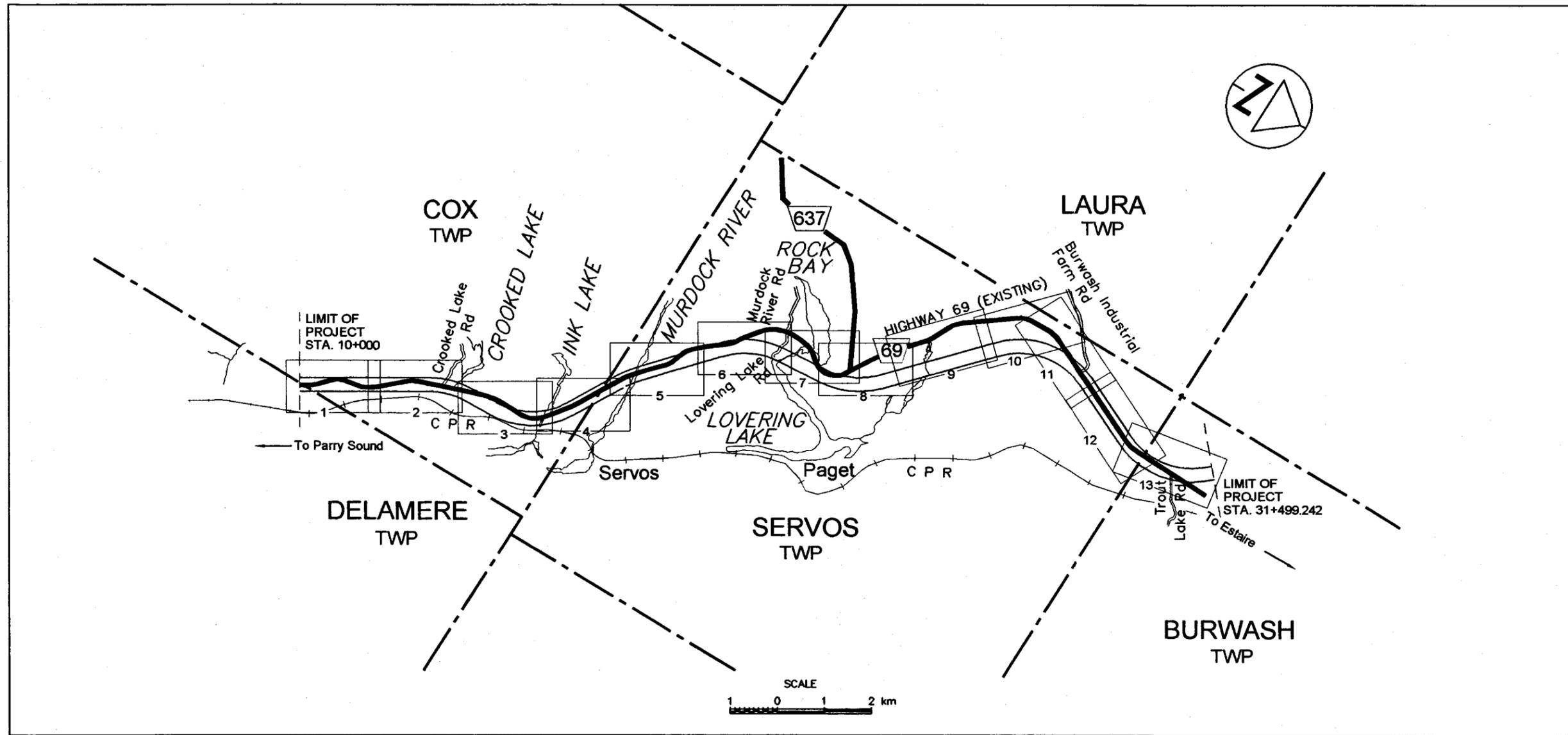
ALTERNATE ROUTE	ALTERNATE ROUTE SUBSECTION	STRUCTURE/SECTION OF EMBANKMENT REQUIRING SPECIAL CONSTRUCTION AND FAVOURABILITY FACTOR (F)						WEIGHTED FAVOURABILITY VALUE (A _i)	
		No. of Structures Foundation		No. of Major Culverts Foundation		Deep Swamps L(m)			
		S ₁	S ₂	C ₁	C ₂	L ₁	L ₂	$\frac{\sum S_i F_i + \sum C_i}{\sum L_i}$	A _i
Convnt. (F ₁ = 5)	Special (F ₂ = 1)	Convnt. (F ₁ = 5)	Special (F ₂ = 1)	Convnt. (F ₁ = 5)	Special (F ₂ = 1)				
North A Twinning to East	North A-1	-	1	-	-	1430	-	3.00	A ₁
	North A-2	2	-	1	-	1170	1060	3.16	A ₂
	North A-3	1	-	1	1	2465	370	3.84	A ₃
North B Twinning to West	North B-1	1	-	-	-	1680	-	5.00	A ₄
	North B-2	1	1	1	-	1620	1095	2.75	A ₅
	North B-3	1	-	1	1	2435	375	3.83	A ₆
North C New to East	North C-1	-	1	-	-	1745	-	3.00	A ₇
	North C-2	2	-	1	-	670	455	3.24	A ₈
	North C-3	1	-	1	1	2610	300	3.87	A ₉
North D New to West	North D-1	1	-	-	-	750	-	5.00	A ₁₀
	North D-2	2	-	1	-	1870	575	3.46	A ₁₁
	North D-3	1	-	1	1	2530	310	3.86	A ₁₂

NOTES: Special Designation Applied to Following Conditions
 A - Foundations with piers in water or deep foundations
 B - Culverts in Lakes
 C - Embankments through deep (> 10 m) swamps
 (Only the ratio of conventional length to the length considered for ranking).
 Enter weighted favourability value A_i in Table F-7.



TABLE F-7 – SCORING OF FOUNDATION CRITERIA
ALTERNATE ROUTE FOUNDATION ASSESSMENT
HIGHWAY 69 FOUR-LANING
FROM 4.5 KM NORTH OF HIGHWAY 64 TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00
DISTRICT 54, SUDBURY

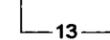
	SUBSECTION LIMITS	EVALUATION CRITERIA		SOFT GROUND/ SWAMPS	GROUNDWATER CONDITIONS	STRUCTURE FOUNDATIONS	EMBANKMENT SETTLEMENT	EMBANKMENT STABILITY	CONSTRUCTION FEASIBILITY	SCORE FOR SUBSECTION $\sum A_i B_i$	RANKING
		TABLE NO.		F-1	F-2	F-3	F-4	F-5	F-6		
		IMPACT WEIGHT, B_i		$B_1 = 0.25$	$B_2 = 0.10$	$B_3 = 0.15$	$B_4 = 0.25$	$B_5 = 0.10$	$B_6 = 0.15$		
WEIGHTED FAVOURABILITY VALUE, A_i FROM TABLES F-1 TO F-6	STA. 10+000 TO STA. 13+250	North A-1	A_1	3.00	1.82	5.00	3.00	4.10	3.00	3.29	4
		North B-1	A_4	3.00	1.65	5.00	3.00	3.98	5.00	3.56	2
		North C-1	A_7	3.08	2.10	5.00	3.04	3.81	3.00	3.32	3
		North D-1	A_{10}	3.23	2.49	5.00	3.11	4.58	5.00	3.79	1
	STA. 13+250 TO STA. 21+000	North A-2	A_2	2.18	3.81	5.00	2.33	3.46	3.16	3.08	3
		North B-2	A_5	2.46	3.24	4.35	2.50	2.99	2.75	2.93	4
		North C-2	A_8	2.86	3.56	5.00	2.84	4.18	3.24	3.44	1
		North D-2	A_{11}	2.53	3.86	5.00	2.70	3.49	3.46	3.31	2
	STA. 21+000 TO STA. 31+499	North A-3	A_3	2.97	3.15	4.35	2.87	4.13	3.84	3.42	4
		North B-3	A_6	3.04	3.10	4.35	2.91	4.10	3.83	3.43	2
		North C-3	A_9	2.93	3.38	4.35	2.86	4.12	3.87	3.43	2
		North D-3	A_{12}	3.16	3.04	4.35	2.99	4.05	3.86	3.48	1



KEY PLAN

ALTERNATE ROUTE ASSESSMENT
 HIGHWAY 69 FOUR-LANING FOR 21.5 km
 From 4.5 km North of Highway 64 to 8.7 km North of
 Highway 637, District 54, Sudbury
 GWP 5379-02-00

KEY PLAN LEGEND:

-  HWY 69 (EXISTING)
-  HWY 69 (NEW) CORRIDOR
-  SHEET NUMBER

METRIC

 Ministry of
 Transportation
 Ontario

 **Peto MacCallum Ltd.**
 CONSULTING ENGINEERS

CONT No
 GWP No 5379-02-00

HIGHWAY 69
 HIGHWAY 69 FOUR LANING FOR 21.5 km From 4.5 km
 North of Hwy 64 to 8.7 km North of Hwy 637
 KEY PLAN



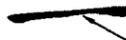
SHEET
 A

NOTES:

- BEDROCK CUTS AND OUTCROPS SHOWN ON PLANS ARE BASED ON EXISTING CONSTRUCTION DATA, SITE RECONNAISSANCE AND AERIAL PHOTOGRAPHS. THE SYMBOLS ON THE PLANS INDICATE THE LOCAL PRESENCE OF THE BEDROCK UNIT AND DO NOT REPRESENT THE FULL EXTENT OF EACH ROCK OUTCROP.
- THE EXTENT OF SWAMPS, WATER BODIES AND FILL AREAS IS AS INTERPRETED FROM SITE RECONNAISSANCE AND AERIAL PHOTOGRAPHS. THE AREAL EXTENTS SHOWN ON THE PLANS REPRESENT ESTIMATES ONLY AND ACTUAL AREAS MAY VARY FROM THOSE SHOWN.
- ESTIMATED DEPTH TO COMPETENT GROUND AND OR BEDROCK IN SWAMPS IS BASED ON GEOLOGICAL EVIDENCE, DESKTOP LITERATURE SEARCH DATA AND LIMITED SITE RECONNAISSANCE INFORMATION.
- THE GEOLOGIC UNIT SYMBOLS SHOWN ON THE PLANS REPRODUCE THOSE SHOWN ON GEOLOGIC MAPPING OF THE AREA AND ARE ONLY A GENERAL REPRESENTATION OF BEDROCK AND SOIL UNITS.
- WATER WELL LOCATIONS PLOTTED ON THE PLANS ARE BASED ON EXISTING MINISTRY OF THE ENVIRONMENT RECORDS AND MAY NOT REFLECT ALL WELLS PRESENT ON SITE. THE LOCATIONS PLOTTED ARE APPROXIMATE.
- THE PLANS ARE AN ECLOSURE TO THE ROUTE SELECTION STUDY PREPARED BY PETO MACCALLUM LTD. THE DATA ON THESE PLANS MUST BE READ IN CONJUNCTION WITH THE REPORT.
- THE DETAIL SHOWN ON THE PLAN IS CONSIDERED APPROPRIATE FOR ROUTE SELECTION PURPOSES. WHEN THE PREFERRED ROUTE HAS BEEN SELECTED, A SUBSURFACE INVESTIGATION SHOULD BE UNDERTAKEN TO DELINEATE THE STRATIGRAPHIC CONDITIONS ON A SITE SPECIFIC BASIS FOR PRELIMINARY AND DETAILED DESIGN PURPOSES.

LEGEND:

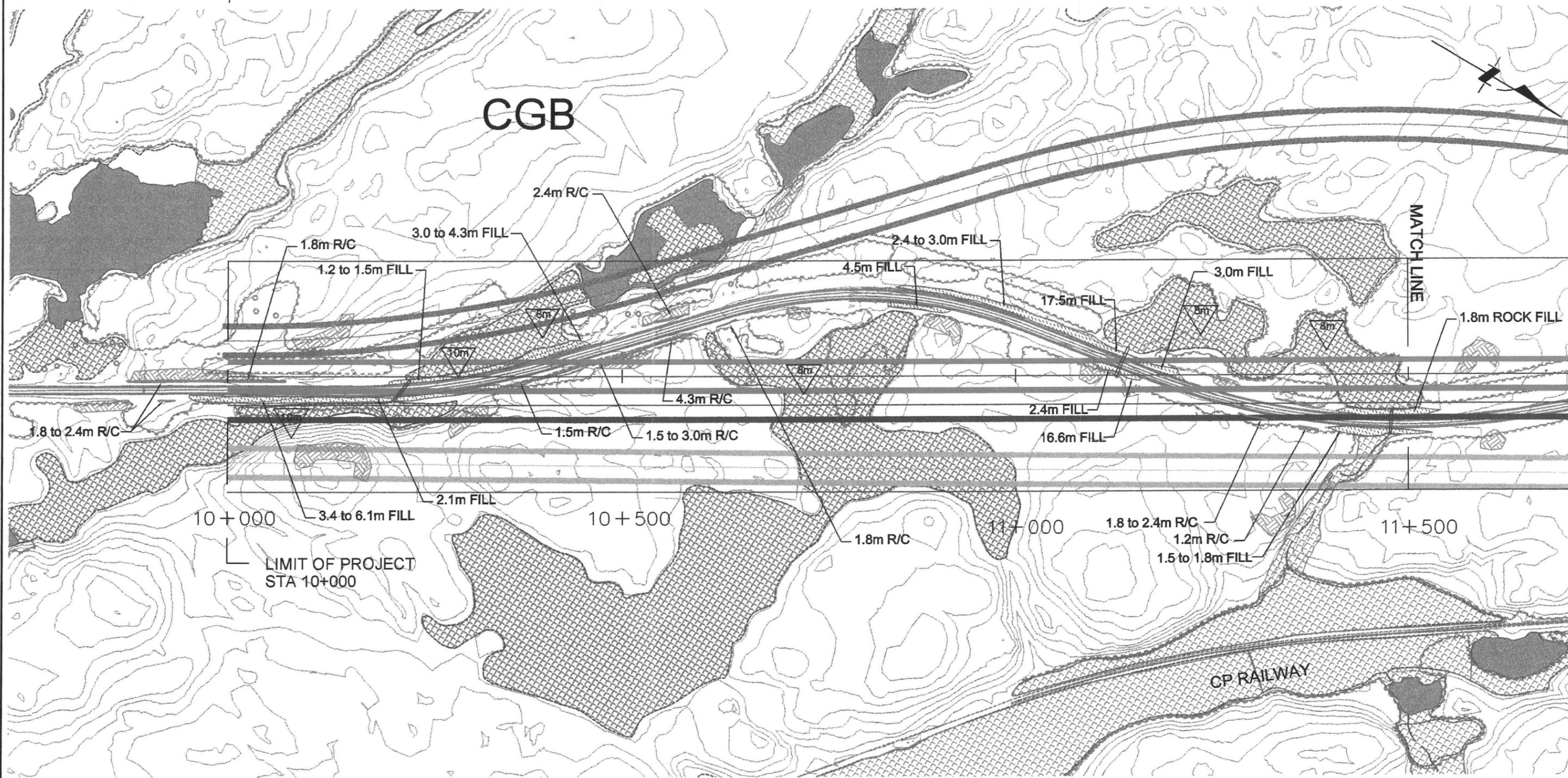
- ALTERNATE ROUTES
-  LIMITS OF PREFERRED CORRIDOR
 -  NORTH A (TWINNING TO THE EAST)
 -  NORTH B (TWINNING TO THE WEST)
 -  NORTH C (NEW TO THE EAST)
 -  NORTH D (NEW TO THE WEST)

-  ROCK CUT (R/C)
4.5m R/C - ROCK HEIGHT FROM RECORDS
-  BEDROCK OUTCROP (R O/C)
-  SWAMP AREA
-  ANTICIPATED DEPTH TO COMPETENT MATERIAL/BEDROCK
-  WATER BODY
-  FILL AREA
- CGB - CENTRAL GNEISS BELT**
-  COX PLUTON
-  SERVOS PLUTON
-  GFD
GLACIOFLUVIAL DEPOSITS
-  PML REFERENCE NO.
DEPTH TO BEDROCK (m)
5 (1.5)
WATER WELL (MOE RECORD)

BEDROCK PLAIN
STA 10+000 TO 25+500

CGB

MATCH LINE



STA. 10+000 TO 11+500 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



Ministry of
Transportation
Ontario

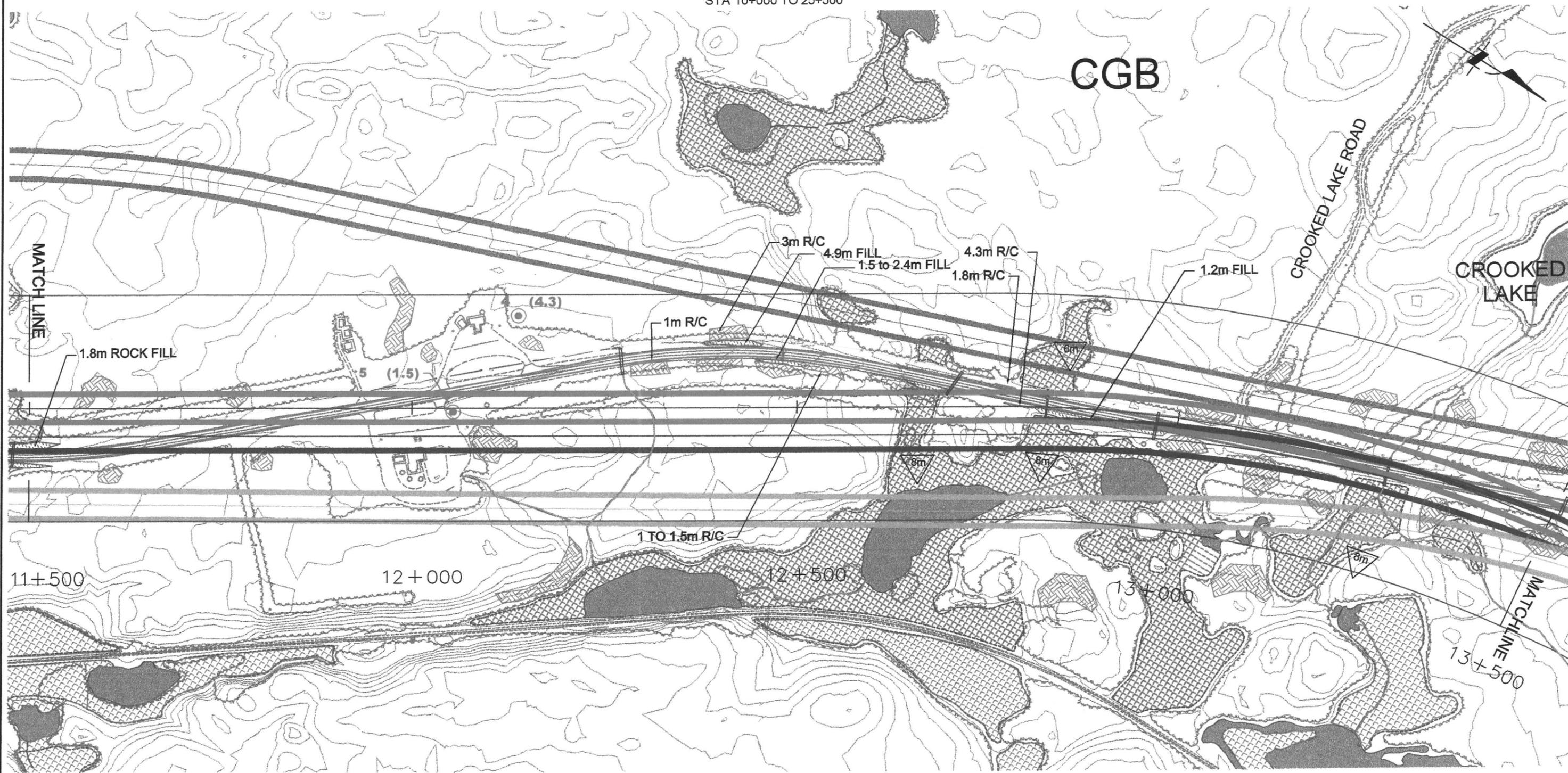
PML **Peto MacCallum Ltd.**
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00
HIGHWAY 69
HIGHWAY 69 FOUR LANING FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS

SHEET
1

BEDROCK PLAIN
STA 10+000 TO 25+500

CGB



STA. 11+500 TO 13+500 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



Ministry of
Transportation
Ontario

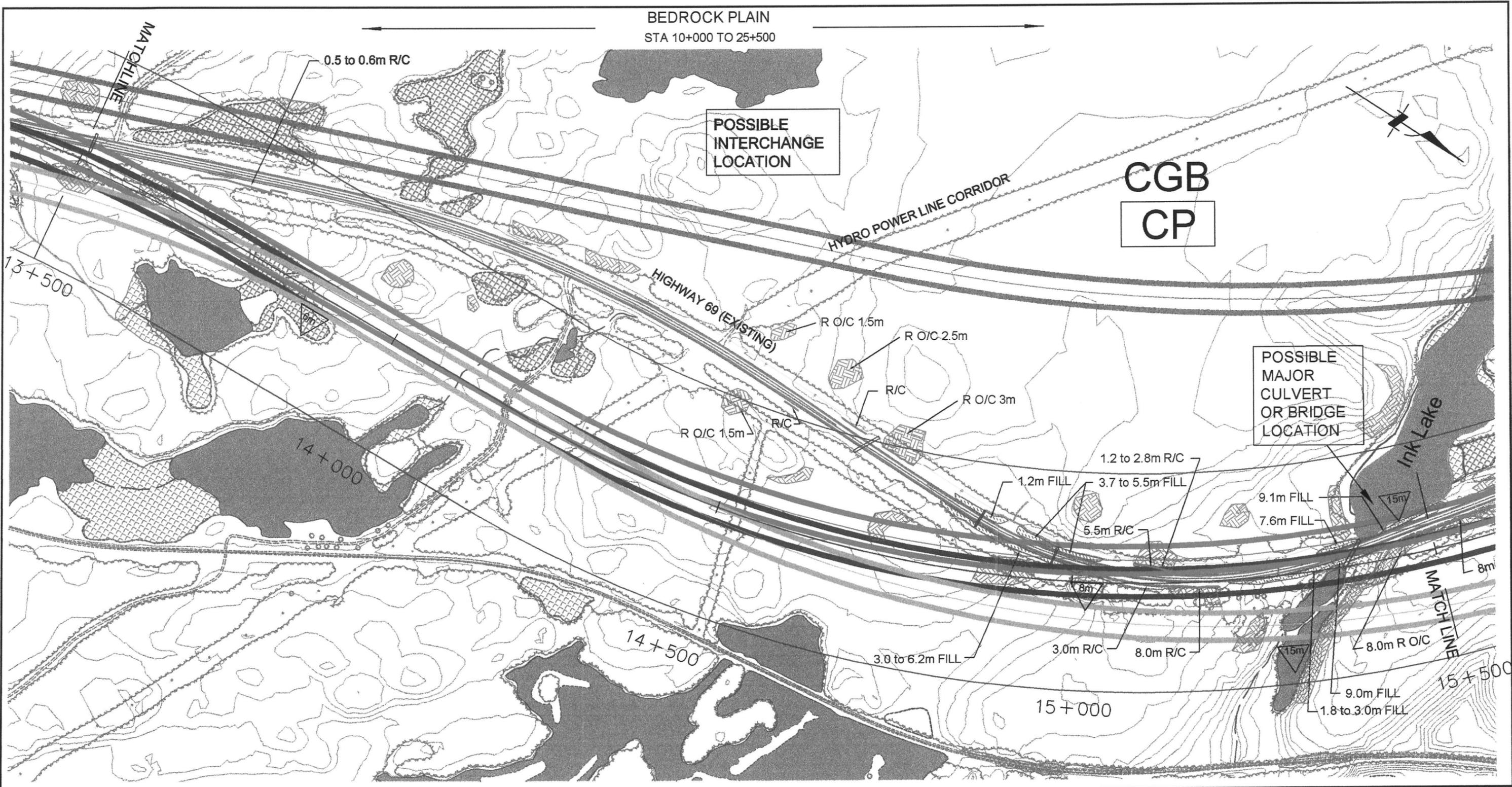
Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANING FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS



SHEET
2



STA. 13+500 TO 15+500 (HIGHWAY 69 STUDY CORRIDOR)

METRIC




 Ministry of
 Transportation
 Ontario


Peto MacCallum Ltd.
 CONSULTING ENGINEERS

CONT No
 GWP No 5379-02-00

HIGHWAY 69
 HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km
 North of Hwy 64 to 8.7 km North of Hwy 637
 INFERRED GEOLOGICAL CONDITIONS

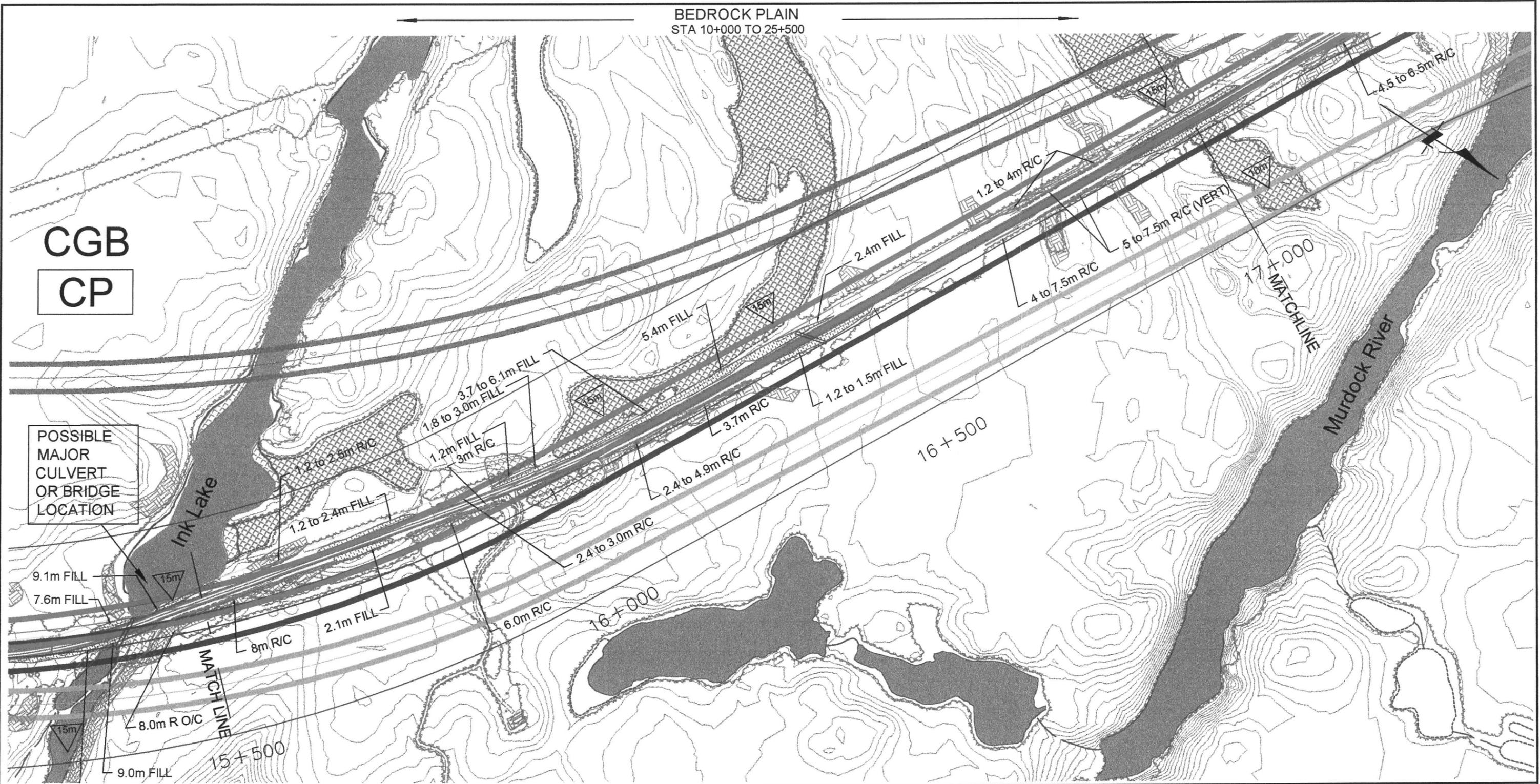


SHEET
 3

BEDROCK PLAIN
STA 10+000 TO 25+500

CGB
CP

POSSIBLE MAJOR
CULVERT
OR BRIDGE
LOCATION



STA. 15+500 TO 17+000 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



Ministry of
Transportation
Ontario

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS



SHEET
4

BEDROCK PLAIN
STA 10+000 TO 25+500

CGB

HYDRO POWER LINE CORRIDOR

Murdock River

POSSIBLE MAJOR CULVERT OR BRIDGE LOCATION

2.7m RIC (VERT)

1.5 to 1.8m FILL

1.8 to 2.1m FILL

5 to 8m R O/C

HIGHWAY 69 EXISTING

19+000
MATCHLINE

17+500
4.6m FILL

6.7m FILL

5.5 to 6.1m RIC

18+500

3.65 to 9.0m RIC

3.65 to 5.2m RIC (VERT)

18+000

5 to 7m RIC

SIDE ROAD

4.5 to 6.5m RIC

17+000

STA. 17+000 TO 19+000 (HIGHWAY 69 STUDY CORRIDOR)

METRIC

PLAN SCALE



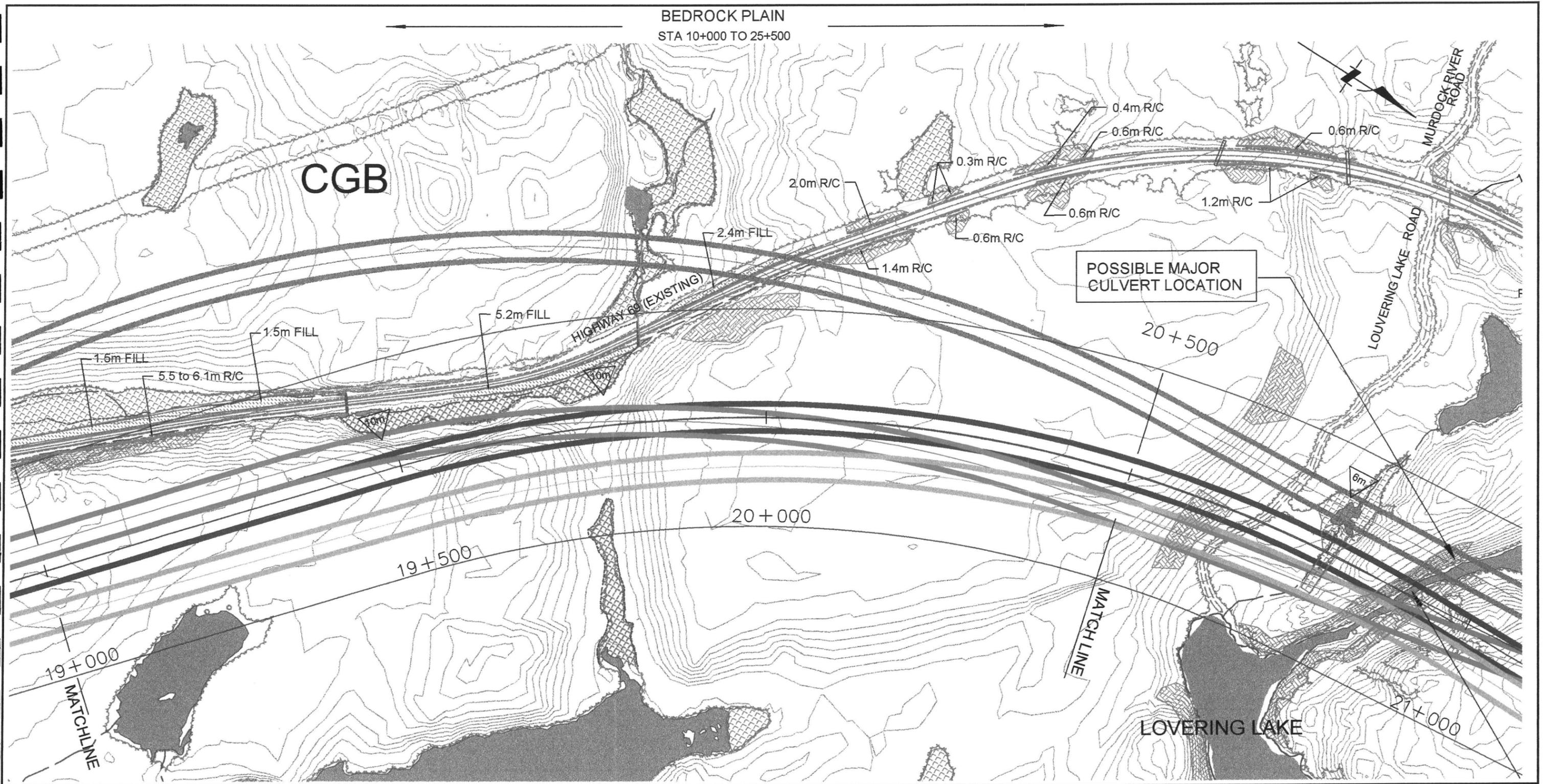
PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS



SHEET
5



STA. 19+000 TO 20+500 (HIGHWAY 69 STUDY CORRIDOR)

METRIC

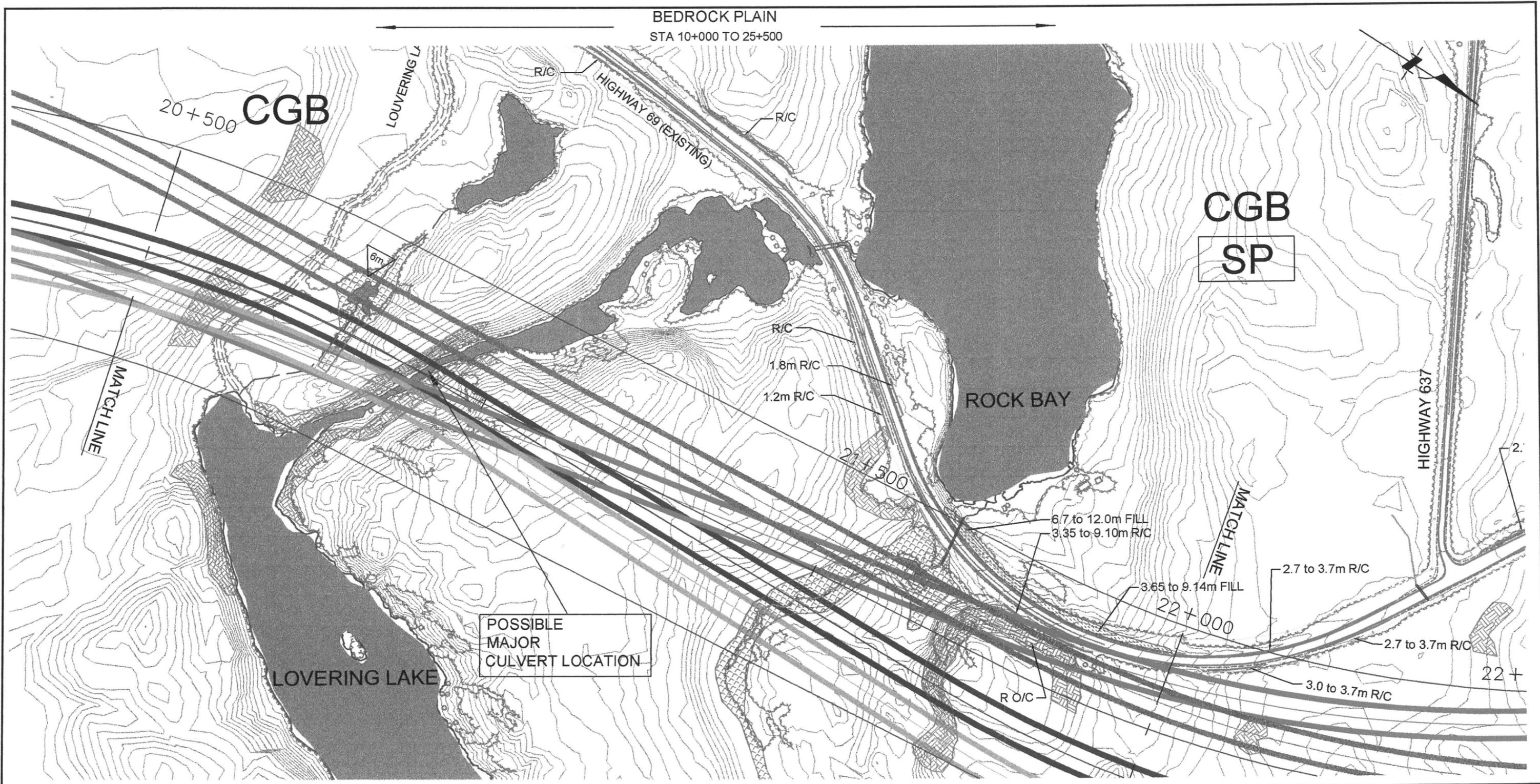


CONT No
GWP No 5379-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANING FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS



SHEET
6



STA. 20+500 TO 22+000 (HIGHWAY 69 STUDY CORRIDOR)

METRIC




 Ministry of Transportation
 Ontario


Peto MacCallum Ltd.
 CONSULTING ENGINEERS

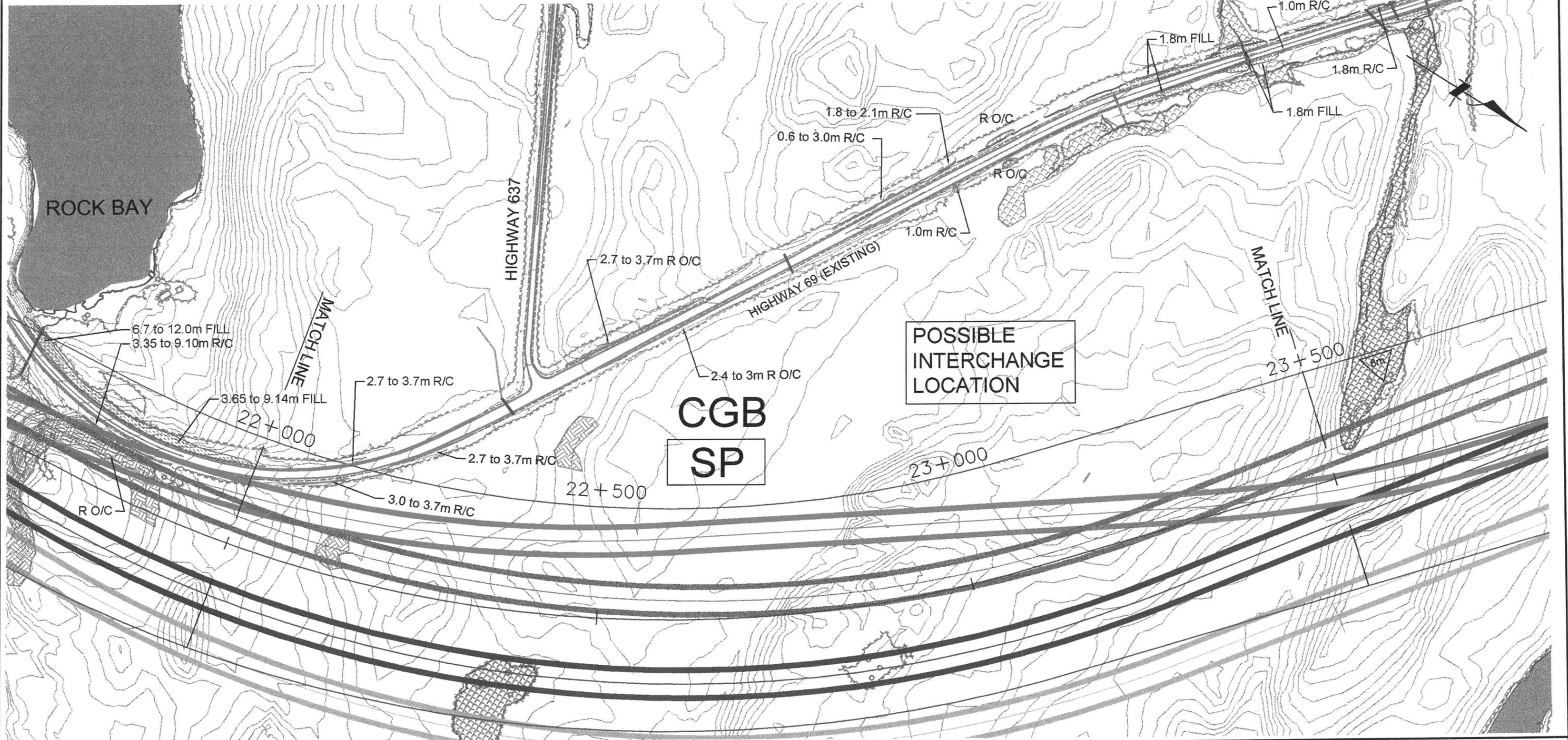
CONT No
 GWP No 5379-02-00

HIGHWAY 69
 HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km
 North of Hwy 64 to 8.7 km North of Hwy 637
 INFERRED GEOLOGICAL CONDITIONS



SHEET
 7

BEDROCK PLAIN
STA 10+000 TO 25+500



STA. 22+000 TO 23+500 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



Ministry of
Transportation
Ontario

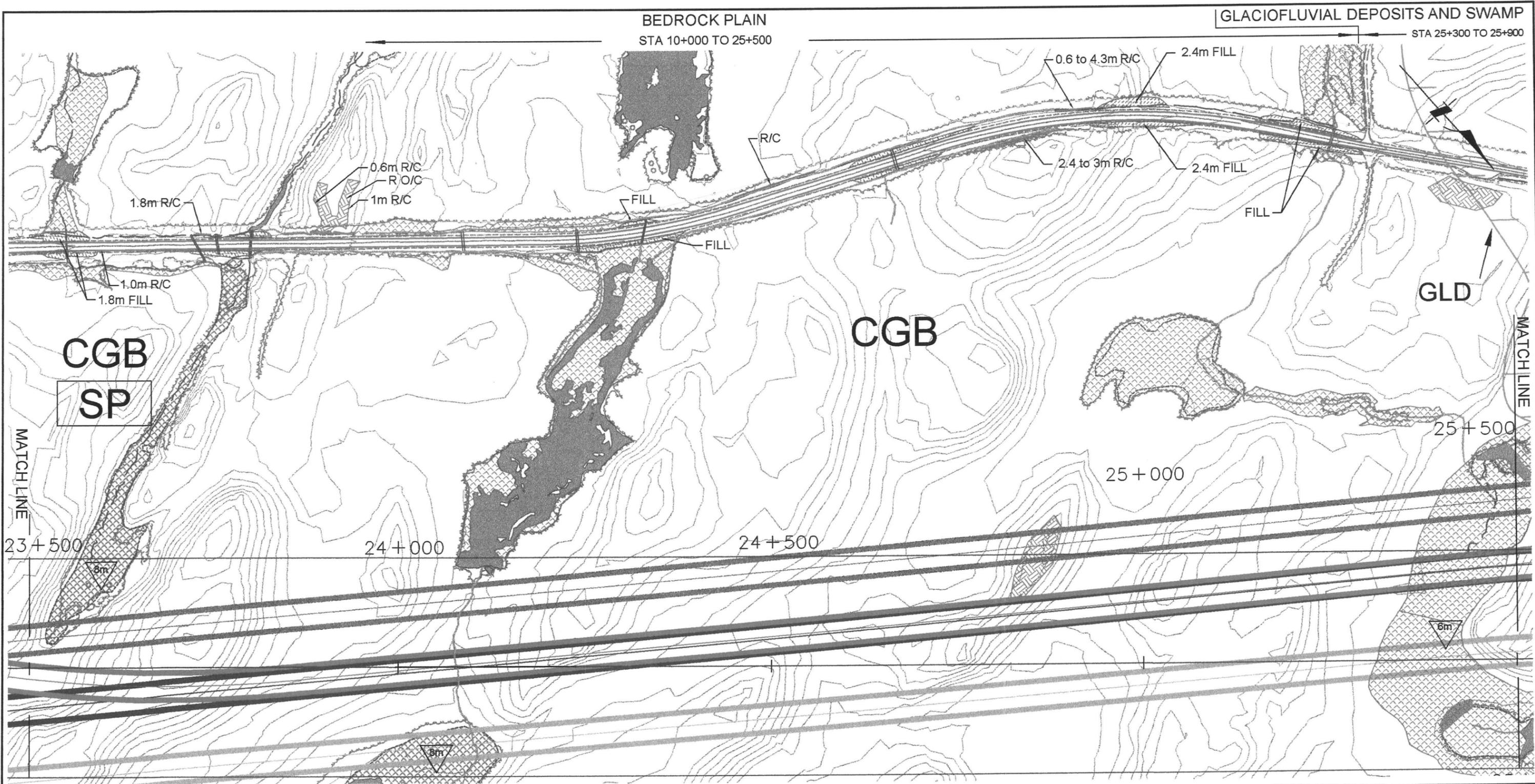
PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS



SHEET
8



STA. 23+500 TO 25+500 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



Ministry of
Transportation
Ontario

PML **Peto MacCallum Ltd.**
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00
HIGHWAY 69
HIGHWAY 69 FOUR LAMING FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS

SHEET
9

GLACIOFLUVIAL DEPOSITS AND SWAMP

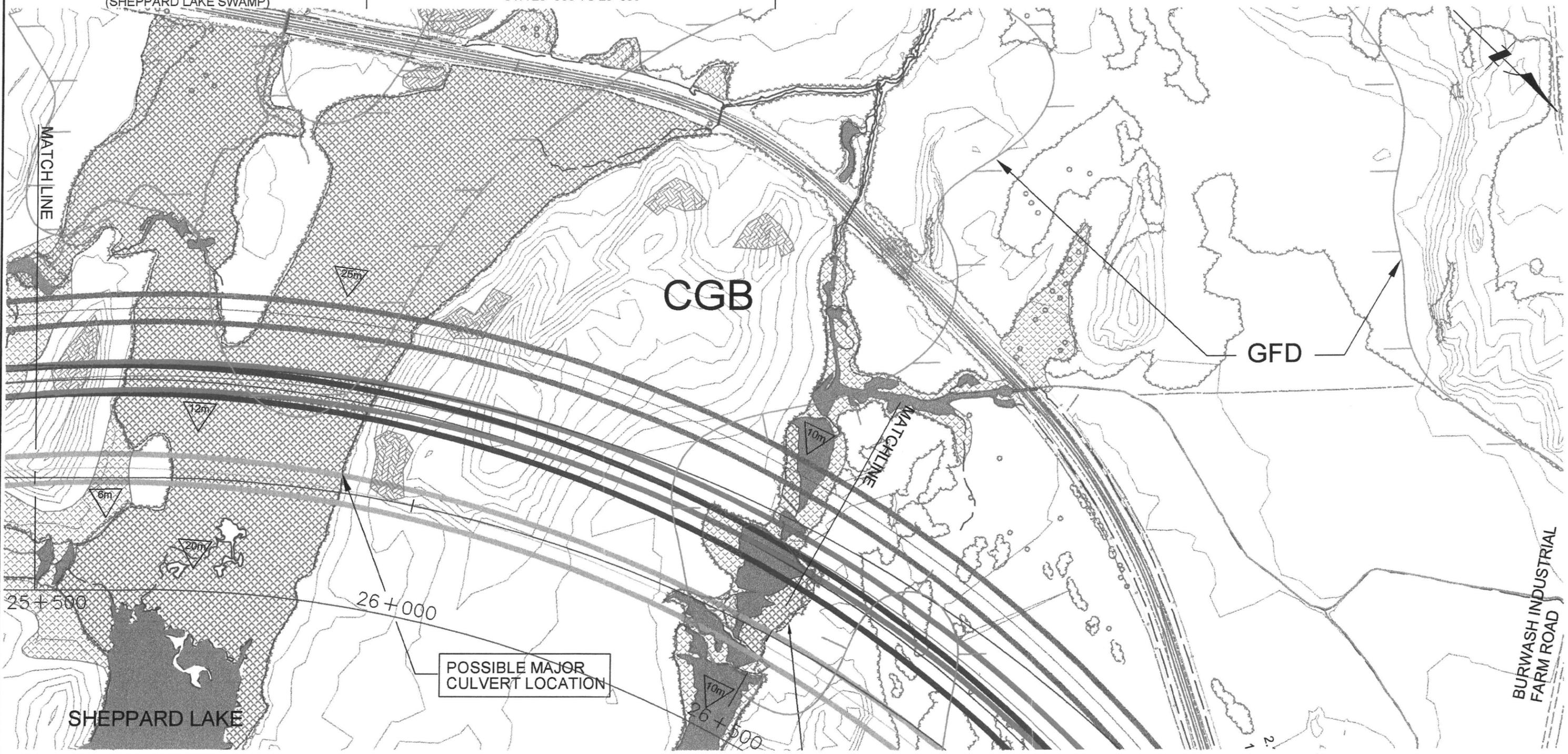
STA 25+300 TO 25+900
(SHEPPARD LAKE SWAMP)

BEDROCK

STA 25+900 TO 26+500

GLACIOFLUVIAL DEPOSITS

STA 26+500 TO 31+100



STA. 25+500 TO 26+500 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



Ministry of
Transportation
Ontario

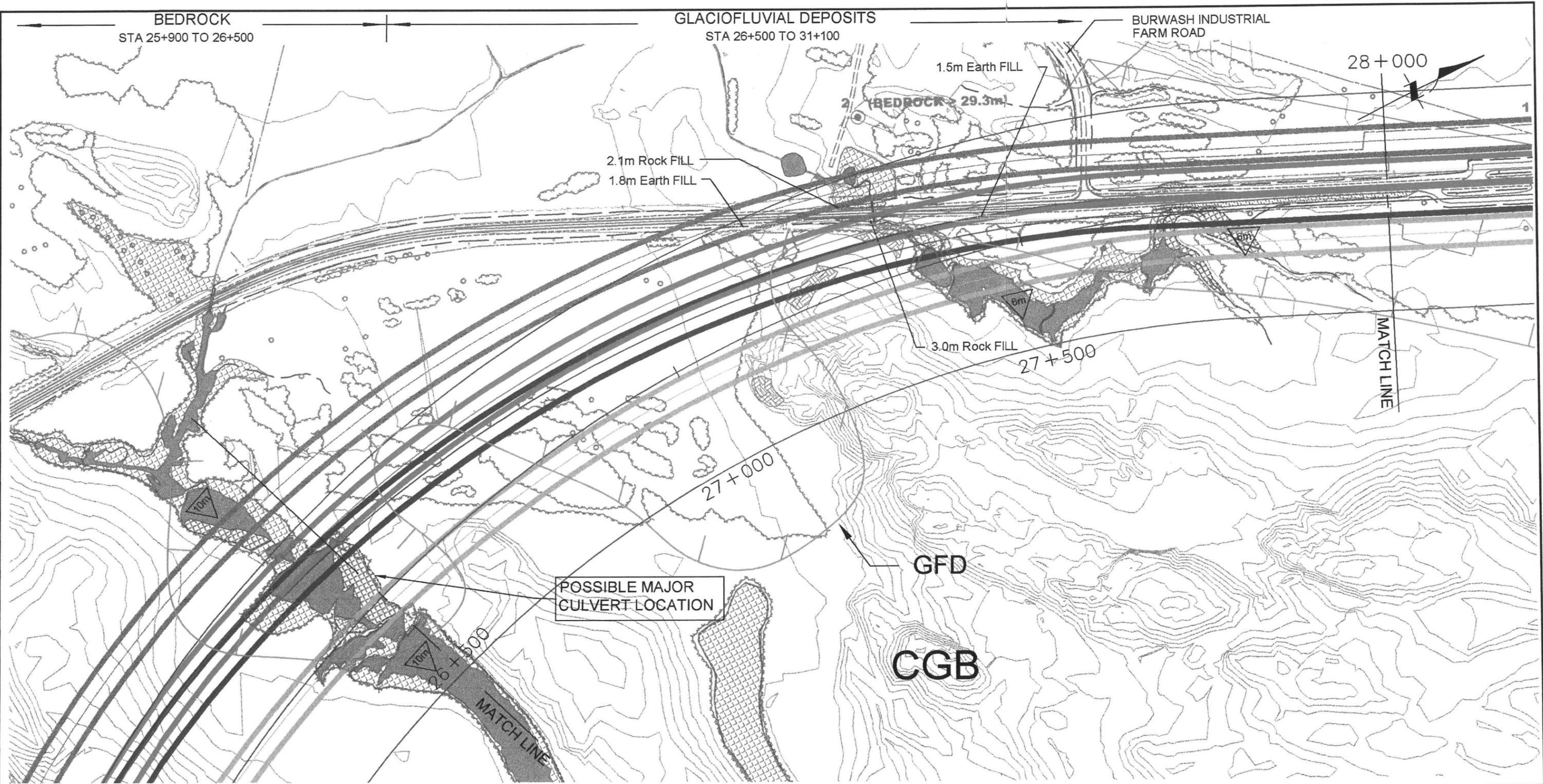
PMI **Peto MacCallum Ltd.**
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS



SHEET
10



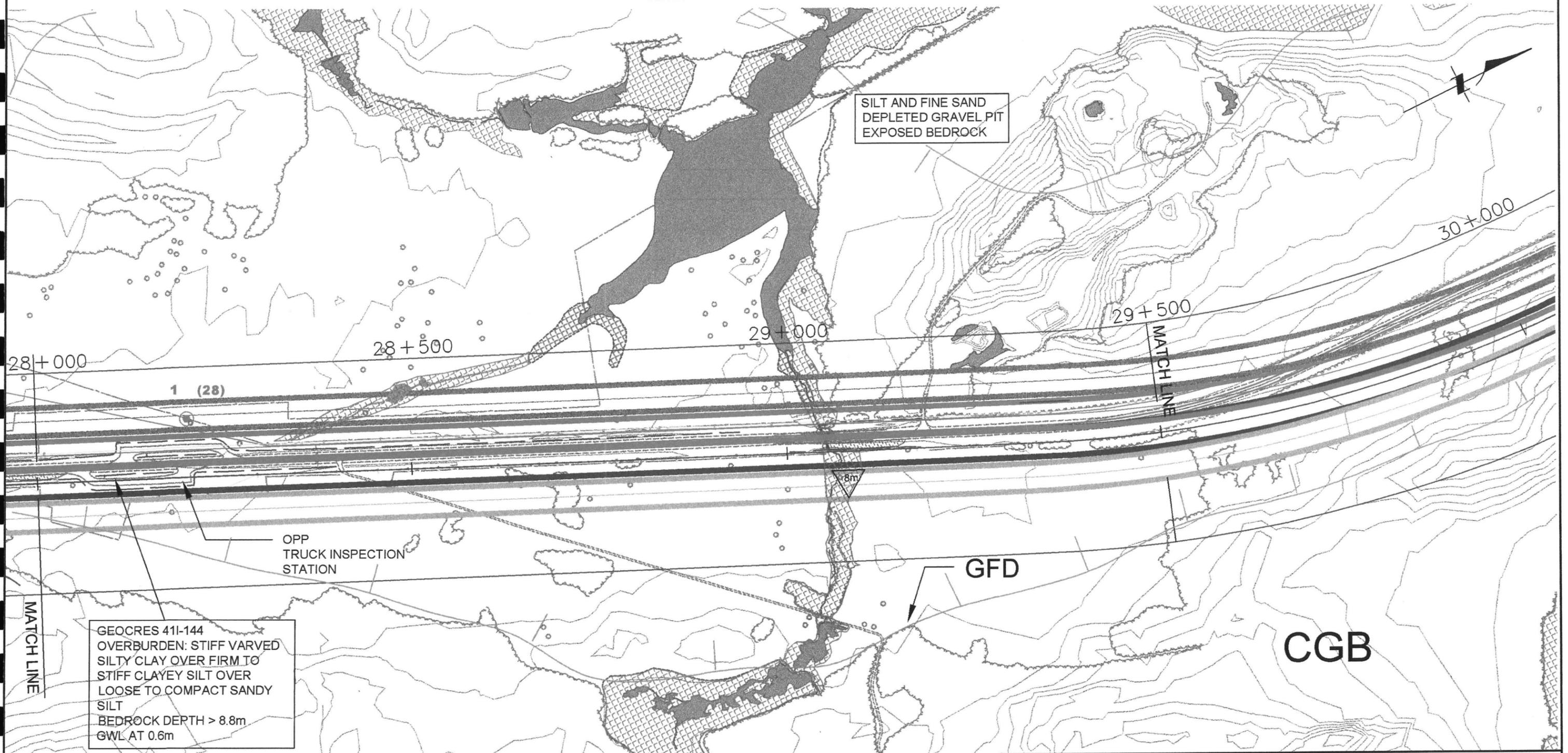
STA. 26+500 TO 28+000 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



<p>Ministry of Transportation Ontario</p>	<p>Peto MacCallum Ltd. CONSULTING ENGINEERS</p>	<p>CONT No GWP No 5379-02-00</p>	<p>SHEET 11</p>
		<p>HIGHWAY 69 HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km North of Hwy 64 to 8.7 km North of Hwy 637 INFERRED GEOLOGICAL CONDITIONS</p>	

GLACIOFLUVIAL DEPOSITS
STA 26+500 TO 31+100



SILT AND FINE SAND
DEPLETED GRAVEL PIT
EXPOSED BEDROCK

GEOCRES 411-144
OVERBURDEN: STIFF VARVED
SILTY CLAY OVER FIRM TO
STIFF CLAYEY SILT OVER
LOOSE TO COMPACT SANDY
SILT
BEDROCK DEPTH > 8.8m
GWL AT 0.6m

STA. 28+000 TO 29+500 (HIGHWAY 69 STUDY CORRIDOR)

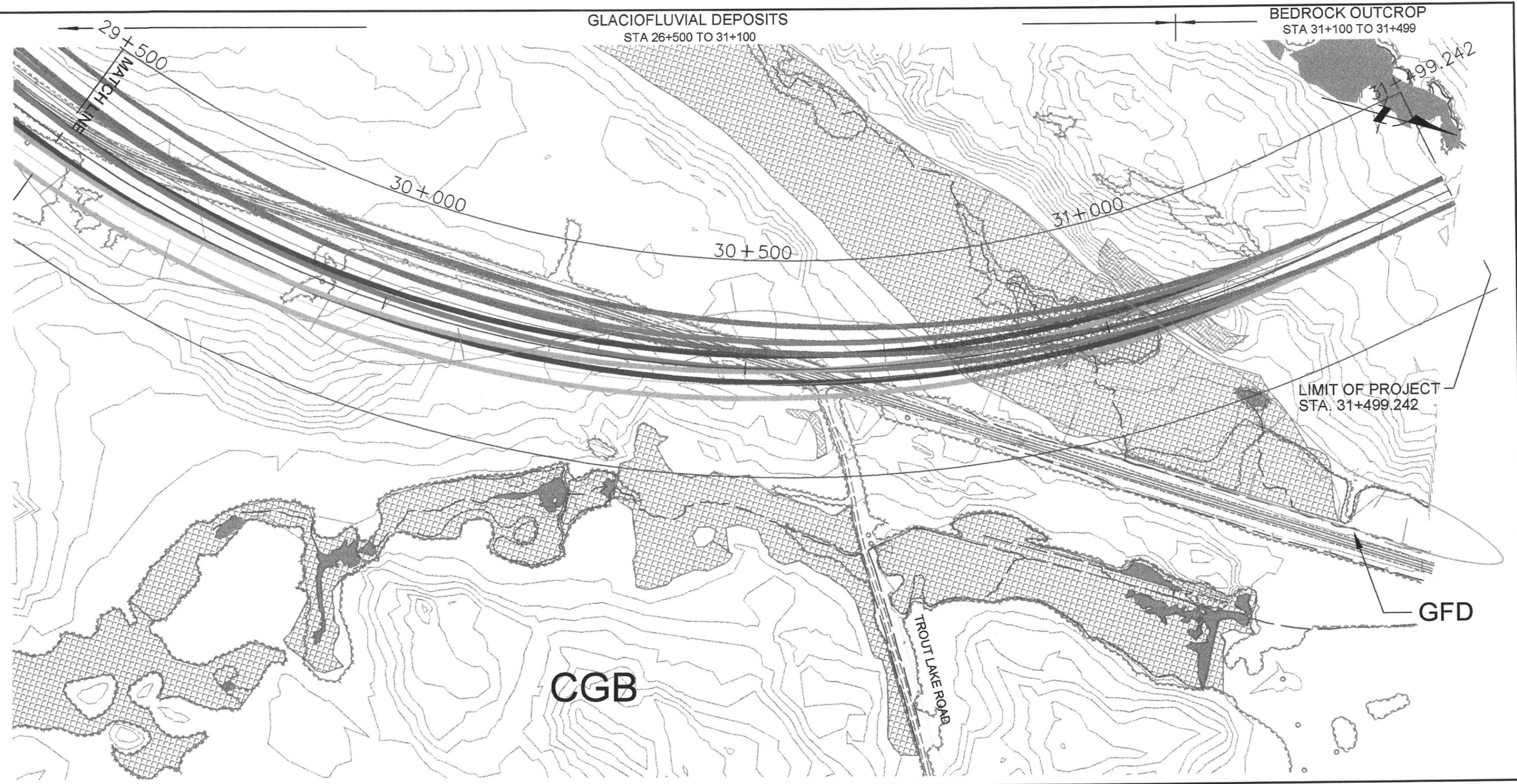
MATCH LINE

MATCH LINE

METRIC



<p>Ministry of Transportation Ontario</p>	CONT No GWP No 5379-02-00	<p>SHEET 12</p>
	<p>Peto MacCallum Ltd. CONSULTING ENGINEERS</p>	



GLACIOFLUVIAL DEPOSITS
STA 26+500 TO 31+100

BEDROCK OUTCROP
STA 31+100 TO 31+499

LIMIT OF PROJECT
STA. 31+499.242

CGB

GFD

TROUT LAKE ROAD

STA. 29+500 TO 31+499 (HIGHWAY 69 STUDY CORRIDOR)

METRIC



Ministry of
Transportation
Ontario

PML **Peto MacCallum Ltd.**
CONSULTING ENGINEERS

CONT No
GWP No 5379-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE FOR 21.5 km From 4.5 km
North of Hwy 64 to 8.7 km North of Hwy 637
INFERRED GEOLOGICAL CONDITIONS



SHEET
13



APPENDIX A

List of Reference Documents



APPENDIX A

LIST OF REFERENCE DOCUMENTS

ALTERNATIVE ROUTE ASSESSMENT
HIGHWAY 69 FOUR-LANING FOR 21.5 KM
FROM 4.5 KM NORTH OF HIGHWAY 64
TO 8.7 KM NORTH OF HIGHWAY 637
GWP 5379-02-00, DISTRICT 54, SUDBURY

A. Geological Maps

- Geology of the Burwash Area, Map 2271, Districts of Nipissing, Parry Sound and Sudbury from Ontario Division of Mines, Published 1974. Scale 1:126,720.
- Geological Map of the Province of Ontario, Map No. 1958B from Ontario Department of Mines, Compiled 1958. Scale 1:1,267,200.
- Quaternary Geology of Ontario, Southern Sheet, Map 2556 from Ontario Ministry of Northern Development and Mines, Compiled 1991. Scale 1:1,000,000.
- Geology of the Burwash Area (West Half), Districts of Sudbury and Parry Sound, from Ontario Department of Mines and Northern Affairs. Scale 1 inch to 1 mile.
- Ontario Geological Survey, Map 5003, Northern Ontario Engineering Geology Terrain Study, Sudbury, from Ontario Ministry of Natural Resources. Scale 1:100,000.

B. Ontario Base Maps

- Ontario Base Maps from Ontario Ministry of Natural Resources, Sheet No. 2017 5200 51000, Published 2002. Scale 1:20,000.
- Ontario Base Maps from Ontario Ministry of Natural Resources, Sheet No. 2017 5200 51100, Published 2002. Scale 1:20,000.
- Ontario Base Maps from Ontario Ministry of Natural Resources, Sheet No. 2017 5100 51100, Published 2002. Scale 1:20,000.
- Ontario Base Maps from Ontario Ministry of Natural Resources, Sheet No. 2017 5100 51200, Published 2002 from 1980 Air Photography. Scale 1: 20,000.

C. Resource Maps

- Ontario Mineral Map, Map 2024 from Ontario Department of Mines, Compiled 1958. Scale 1:1,584,000.



D. Physiographic Maps

- Physiography of Southern Ontario, Map P.2715 Ontario Geological Survey, 1984. Scale 1:600,000.
- Geology Terrain Study of Burwash, Northern Ontario Engineering Map 5003 from Ontario Ministry of Natural Resources, published 1978. Scale 1:100,000.

E. Topographic Maps

- Topographic Base Map of Delamere, Ontario from the Army Survey Establishment, R.C.E., Published 1957. Scale 1:50,000.
- Topographic Base Map of Coniston, Ontario from the Army Survey Establishment, R.C.E., Published 1957. Scale 1:50,000.
- Topographic Map of Coniston, Sheet No. 41-I/7, Edition 6, by Energy, Mines and Resources Canada, Published 1995. Scale 1:50,000.
- Topographic Map of Delamere 41-I/2, Edition 4 from the Energy, Mines and Resources Canada, Published 1995. Scale 1:50,000.
- Topographic Map of Chapleau – Sudbury, Ontario from the Canada Departments of Mines Hydrographic and Map Services, Published 1941. Scale 1: 506,880.

F. MTO Reports

- Foundation Investigation Report for Massey Creek Culvert, W.P. 99-79-01, Site 46-196, Hwy 637, District 17, Sudbury, MTO Geocres 41I-114.
- Report on Soil Conditions, Truck Inspection Station, W.P. 2500-75-01, West Side of Hwy 69 (3.93 Miles North of Hwy 637), Prepared by Site Investigation Services Ltd., MTO Geocres 41I-144.

G. Miscellaneous Reports by Others

- Highway 69 Feasibility Study, French River to Estaire, dated October 1973, prepared by Cole, Sherman & Associates Ltd.
- Aggregate Resources Inventory Update, Highway 69 and Vicinity, Consultant Agreement 9750-7411-5208, dated February 1998, prepared by Jagger Hims Limited.
- Airphoto Interpretation Aggregate Search, ±417 Square Miles, West of Lake Nipissing, Vicinity of Hwy 64, Lavigne to Hwy 69, North Bay District, dated October 1972, prepared by Terra Scan Limited, Ref.: 72TS41.
- Report on Hydrographic and Geophysical Survey, French River, Ontario, dated May 17, 1984, prepared by McQuest Marine Sciences Limited, Project Ref. 84-00199.



H. Digital Files

- Photomosaic MrSID format from Stantec Consulting Ltd.
- Highway 69 Four-Laning Base Plans NAD 83 Zone 12 from Stantec Consulting Ltd.
- Highway 69 Topographic Contours from Stantec Consulting Ltd.



APPENDIX B

MOE Well Records



WATER WELL DATA SYSTEM Jun 12 2003													PAGE: 1		COUNTY: SUDBURY		GROUND WATER BULLETIN REPORT									
MUNICIPALITY CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA	KIND OF INS	WATER FOUNDED FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR:MN	WATER USE	SCREEN DEPTH FEET	SCREEN LENGTH FEET	OWNER DEPTHS IN FEET TO WHICH FORMATIONS EXTEND									
SERVOS TOWNSHIP																										
1	CON	06 011	59- 514900 03819 5123900	750	1977/11	2428	06	FR	0294	5	200	5	8 :0	DO			MTC GREY CLAY BLDL 0092 GREY GRNT 0194 BLCK GRNT 0287 RED GRNT 0300 INDUSTRIAL FARM LQAM 0001 FSND 0080 CSND 0087 GRVL 0096									
2	CON	06 012	59- 514450 01730 5123100	740	1960/06	2402	07	FR	0090	16	70	20	3 :0	PS	0088	08										
COX TOWNSHIP																										
3	CON	05 003	59- 521589- 05092 5112715		1985/08	1462	06	FR	0246	20	140	4	1 :0	DO			PALMER, GRANT SAND OBDN 0010 RED GRNT 0120 GREY GRNT 0150 BLCK GRNT 0200 RED GRNT 0225 BLCK GRNT 0250									
4	CON	04 002	59- 522374- 07715 5111108		1999/04	1462	06	FR	0195	10	222	3	1 :	DO			MCKEOWN, ENWIN CLAY 0014 GREY GRNT 0180 RED GRNT 0200 GREY GRNT 0222									
5	CON	04 001	59- 522650 03880 5111050	750	1977/08	2612	06	FR	0076	5	25	10	1 :0	DO			SPUR B GREY CLAY 0005 GREY GRNT 0079									
DELAHÈRE TOWNSHIP																										
6	CON	03 010	59- 526032- 05388 5109544		1987/05	5210	06	FR	0105	5	125	5	1 :0	DO			DUMMONT, YVON SAND GRVL 0027 WHIT QTZ 0125									
7	CON	01 013	59- 523777- 06294 5106316		1990/10	2612	06	UK	0345	20		12	1 :0	PS			SPORTSMANS TENT & T. SAND CLAY STNS 0002 GREY GRNT 0350									
7a	CON	01 013	59- 523777- 07057 5106316		1994/10	2305	06			18		6	72:0	DO			CROULX, ROGER BRWH SAND GRVL BLDL 0016 GREY GRNT 0312									

⊙ Well shown on map



APPENDIX C

Site Reconnaissance Observations and
Site Photographs 1 to 32



APPENDIX C

SITE RECONNAISSANCE OBSERVATIONS AND SITE PHOTOGRAPHS

Site Reconnaissance Survey (SRS) of the existing alignment and adjacent lands approximately within the 300 m wide corridor were conducted during the study. The SRS consisted of a drive-by and walk-through of selected sections of Highway 69 and adjacent lands. The ground truth checks verified the surficial geology and drainage conditions inferred from the literature and map reviews as summarized below.

South Project Limits to Crooked Lake Road

The terrain consists of low-lying rock ridges with numerous swamps and rock knobs on both sides of the existing highway and extends the full width of the corridor (Photographs 1 to 3).

- There is opportunity to improve the highway geometrics with the elimination of a number of curves which will necessitate crossing major swamps at Sta. 10+300, 10+750, 11+200, 11+450, 12+700 and 12+850. The swamp depth is estimated between 5 and 10 m.
- Several rock cuts exist along the Highway 69 with numerous bedrock outcrops as rock knobs evident along the alignment, such as at the Big M truck stop and White Pine gas bar.

Crooked Lake Road to Murdock River

- The low rock ridge and local rock knob terrain continues beyond Crooked Lake Road for about 1 km. Swamps are encountered at Sta. 13+600, 13+850, 13+900, and 14+200. The estimated swamp depth is typically shallow in the 5 to 8 m range.
- North of Sta. 14+200 to Ink Lake (Sta. 15+500), the corridor follows a heavily forested area with numerous bedrock ridges, rock knobs and road cuts. Swamp features are unusually absent except for a shallow 5 m swamp (estimated deep) at Sta. 15+050.
- An existing 10 m high rockfill embankment crosses Ink Lake (Photographs 4 to 7). To the east of the existing embankment, bedrock exposures were evident in the north and south limits of Ink Lake. The width of the lake is about 40 m. At the east end of Ink Lake, at the east side of the corridor, the area is reported as an abandoned gravel pit.
- To the west of the Ink Lake embankment, although bedrock outcrops on both the north and south slopes to the lake, the lake widens substantially to 70 to 110 m. Furthermore, within 50 to 100 m of the existing highway, there exists a 50 to 100 m wide swamp extending northerly from Ink River for 200 m. The swamp depth is estimated to exceed 10 m.
- Extensive rock cuts exist along the highway typically in the 4 to 8 m height range.



- A major swamp exists on the west side of the existing highway between about Sta. 16+000 to 16+600. Swamp depth is estimated at 10 m.
- A second major swamp crossing exists at about Sta. 17+000 (Photographs 8 and 9). The estimated swamp depth is 5 to 10 m.
- A 7 m high rockfill embankment crosses the Murdock River. The river is typically about 60 m in width, bedrock exposures are readily evident on both north and south banks on both sides of the river (Photographs 10 to 14).

North of the Murdock River, the corridor swings to the east of the existing Highway 69. Existing Highway 69 is typically along the western limits of the corridor. Along the western limits of the corridor, major swamps exist between Sta. 18+000 to 18+400 and 18+600 to 19+800 (Photograph 18).

- Along this section of highway, the east side of the road hugs an existing 20 m high slope (Photographs 15 to 17). Rock cuts are typically up to 6 m in height and composite till/bedrock slope are readily visible.
- North of about Sta. 19+800, the corridor swings to the east away from Highway 69.
- From the Murdock River, the eastern half of the corridor follows a rolling bedrock ridge to Sta. 20+500, about 100 m south of Lovering Lake Road.
- North of Sta. 20+500, the ground drops about 25 m with a prominent bedrock exposure readily visible. A shallow swamp exists at about Sta. 20+750. The swamp depth is estimated at 5 m.
- Bedrock is exposed along both north and south banks of the water course connecting Lovering Lake and Rock Bay for the full width of the corridor (Photographs 19 and 20).
- Immediately north of Lovering Lake, the ground surface rises sharply by 40 m with extensive bedrock outcrops readily visible.
- At the east end of Rock Bay at the parking lot on the east side on the highway, an abandoned quarry was observed.
- North of Sta. 21+500, the corridor is within about 50 m of Highway 69. A 35 m high rock slope exists on the east side of the highway which climbs up to Highway 637.



Highway 637 to North Project Limits

- Highway 637 northerly to Sheppard Lake, about 3 km, the corridor is typically 500 m east of existing Highway 69 and is characterized by rolling forested bedrock terrain.
- Minor swamps and water crossings exist at about Sta. 22+400, 23+500, 24+100, 24+400 and 24+850 (Photograph 22). The swamp at Sta. 22+400 is about 80 m in diameter and is expected to be relatively shallow in the 5 to 8 m depth range. Elsewhere at the creek crossings, the width of the water course is typically only 20 to 50 m with anticipated organic accumulation in the 5 to 10 m depth range.
- The corridor crosses a major swamp at the west end of Sheppard Lake (Photographs 23 to 25). The eastern limit of the corridor approximates the westerly extend of the open water of Sheppard Lake which is about 200 m in width. To the west, the limits of the swamp increase to about 300 m extending to about Sta. 25+600 to 25+900. To the north and south of the swamp limits bedrock outcrops dominate and reach heights about 15 m above the swamp level. It is suspected that the depth of peat and organics and soft clay will be quite extensive reaching 15 to 25 m depths. The swamp depth should lessen in a westerly direction, however, the width of the swamp based on topographic features actually increases up to 350 m along the western limits of the corridor.
- North of the rock outcrop at Sta. 26+000, there is a major change in the topography along the corridor. The corridor has moved from the swamp and rolling forested bedrock terrain to the south to a major relatively flat open field terrain extending northerly for about 4.5 km to the northern project limits near Trout Lake Road. The level landscape is broken by bedrock outcrops at Sta. 26+600 and 27+300 (Photographs 26, 27, 30 and 31) and by a swamp crossing at Sta. 26+450 and swamp/water course crossings between Sta. 27+300 to 27+800 and Sta. 29+050 (Photographs 28 and 29). Swamp depths are estimated in the 5 to 10 m range.
- A licensed sand and gravel pit exist on the west side of the corridor at about Sta. 29+200 (Photograph 32), extending to about Sta. 29+800.
- North of Trout Lake Road, the corridor swings to the west away from Highway 69 crossing a 200 m wide swamp reaching the northern project limits in a bedrock outcrop. This swamp has been drilled as part of GWP 312-99-00. Below a surficial 1.5 to 2.7 m thick peat deposit, major clay, silty and sand deposits were contacted and extended to bedrock typically between 6 to 12 m depth but locally as deep as 22 m.



PHOTOGRAPH 1: View looking west Sta. 10+150. Swamp areas on both sides of Highway 69. Rock cut at Sta. 10+090 on the right.



PHOTOGRAPH 2: View looking south at Sta. 12+850. Rolling bedrock ridge/knob topography.



PHOTOGRAPH 3: View looking north Sta. 12+850. Rolling ridge/knob topography.



PHOTOGRAPH 4: View looking east at Sta. 15+350, from east shoulder Highway 69 rockfill embankment at east end Ink Lake. Bedrock exposed south side of lake.



PHOTOGRAPH 5: View looking west Sta. 15+400, from east shoulder rockfill embankment across Highway 69 down Ink Lake. Bedrock outcrop at north and south banks.



PHOTOGRAPH 6: View looking north at Sta. 15+400 from west shoulder Highway 69 rockfill embankment across Ink Lake (approximately 170 metres). Bedrock cut east side Highway 69.



PHOTOGRAPH 7: View looking south Sta. 15+450 from east shoulder Highway 69. Rockfill embankment across east end of Ink Lake. Bedrock exposed, south side of lake and rock cut east side of Highway 69 to south.



PHOTOGRAPH 8: View looking east at Sta. 17+000, from east side Highway 69 rockfill embankment at 60 metres wide swamp.



PHOTOGRAPH 9: View looking west Sta. 17+000, from west side Highway 69 rockfill embankment at 100m wide swamp.



PHOTOGRAPH 10: View looking west Sta. 17+550 up Murdock River, from west side Highway 69 rockfill embankment. Bedrock outcrops on south bank, swamp to north (Right).



PHOTOGRAPH 11: View looking north Sta. 17+550 from west side of Highway 69 rockfill embankment crossing Murdock River. Bedrock outcrops south bank and swamp north side.



PHOTOGRAPH 12: View looking east Sta. 17+550 down Murdock River from east side Highway 69 rockfill embankment. Bedrock outcrops on both north and south banks.



PHOTOGRAPH 13: View looking south Sta. 17+650 along east half of corridor, Highway 69 rockfill embankment across Murdock River. Bedrock outcrops south bank.



PHOTOGRAPH 14: View looking south at Sta. 17+650 along west rockfill embankment across Murdock River with bedrock outcrops of south side river.



PHOTOGRAPH 15: View looking north at Sta. 17+900 from east shoulder of Highway 69. Till cover over bedrock on steep right (east) slope. Bedrock cut right side in distance.



PHOTOGRAPH 16: View looking north at Sta. 18+950 from east shoulder of Highway 69. High (5 – 8 m) rock cut right side with swamp area to tree line left side highway.



PHOTOGRAPH 17: View looking south at Sta. 19+250 from east shoulder of Highway 69 (at west edge of corridor). Bedrock cut left (east) foreground, then till cover over bedrock. Rock cut (5 – 6 m) at Sta. 19+000 in distance.



PHOTOGRAPH 18: View looking north at Sta. 19+400 from east shoulder with swamp along right side and bedrock cut on left side Highway 69.



PHOTOGRAPH 19: View looking west Sta. 20+800 from south side of Lovering Lake. Mouth of river at east side of corridor. Bedrock outcrops north and south slopes.



PHOTOGRAPH 20: View looking west Sta. 20+800 down river from Lovering Lake to Rock Bay 70 metres west of east limit of corridor. Bedrock outcrops north and south banks.



PHOTOGRAPH 21: View looking north Sta. 21+600 from east side of Highway 69 at west limit of corridor. Steep bedrock outcrop dominates landscape. Creek beyond evergreen tree line in foreground.



PHOTOGRAPH 22: View looking west Sta. 24+850 from center of corridor across snow covered pond to south of beaver dam (Left).



PHOTOGRAPH 23: View looking east Sta. 25+600, east shoulder Highway 69 across swamp at west end of Sheppard Lake. Bedrock outcrops at north (Left) of photo. West side of corridor at tree line mid photo.



PHOTOGRAPH 24: View looking west Sta. 26+000 from east of Highway 69 across 300 metres wide swamp, west end of Sheppard Lake. Bedrock outcrops north and south limits.



PHOTOGRAPH 25: Close-up view of PHOTOGRAPH 15.



PHOTOGRAPH 26: View looking south east from Sta. 26+900 from east shoulder of Highway 69 along centreline of corridor which swing to east away from Highway 69. Area mapped as outwash plain (glaciofluvial). Bedrock outcrops at tree-line in background.



PHOTOGRAPH 27: View looking north Sta. 26+900 from east shoulder of Highway 69 corridor, rejoins existing Highway 69 at evergreen tree line. Bedrock ridge is evident in evergreen and deciduous forest.



PHOTOGRAPH 28: View looking north Sta. 27+650 from east shoulder of Highway 69 along east side of corridor (outwash plain-glaciofluvial). Water course on east half of corridor. Signs of embankment movement. Gabion baskets at timber culvert. Beaver dam visible at hydro pole.



PHOTOGRAPH 29: View looking south Sta. 27+750, from east shoulder of Highway 69 along east side of corridor. Water course at toe of fill with beaver dam in foreground. Outwash plain (glaciofluvial) with bedrock knob outcrop at tree-line.



PHOTOGRAPH 30: View looking north Sta. 28+170, from north end of truck inspection station at flat outwash plain (glaciofluvial), along east side of corridor. Geocres 411-144, however revealed varved silty clay and clayey silt, typically 5 to 6m underlain by sandy silt to silty fine sand.



PHOTOGRAPH 31: View looking north west at Sta. 28+170 from north end truck inspection station across Highway 69 and flat outwash plain (glaciofluvial), along west side of corridor.



PHOTOGRAPH 32: View looking north Sta. 29+150 about 50 metres east of Highway 69 at stockpiles in gravel pit. Outwash plain (glaciofluvial).