



**FOUNDATION 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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**FOUNDATION DESIGN REPORT  
OJIBWAY CANYON – SWAMP CROSSING**

for

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**

Realignment and four-laning of an approximately 8.1 km long 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).

The study corridor for the Ojibway Canyon crossing extends for an approximate length of 62.5 m from Sta. 20+775 to 20+837.5 (Mowat Township), new Highway 69 centreline. This crossing was assigned for foundation investigation within the Phase 3 limits.

Two alternatives were tentatively planned for the SBL and NBL of the new Highway 69 across the Ojibway Canyon. These alternatives are NBL and SBL bridge construction or rockfill embankment. Due to the good condition of the site revealed during the recent field work, the rockfill embankment alternative was adopted.

The report provides recommendations for construction of embankment at the swamp crossing for the project, where special construction procedures are required to minimise post-construction settlement of and differential settlement at the roadway surface due to consolidation of the rockfill embankment, as well as comments on stability of the embankment and construction method. Recommendations for construction of embankments along the sections of the alignment identified in the Term of Reference for geotechnical investigation are provided in the Pavement Design Report under separate cover (PML Ref.: 06TF034C).

The subject for the 300 series swamp and high fill crossings from approximate Station 13+400 to 20+300 (Mowat Township), new Highway 69 chainage was carried out by PML and submitted under report 06TF033C. The subject included a total of 14 swamp and high fill crossings





identified in the Request for Proposal (RFP) for foundation investigation within the Phase 3 limits. For ease of reference, PML identified the crossings by sequential numbers in the 300 series from 301 to 314. The identification number and location of each crossing are shown on the Key Plan (Drawing 1).

In this report, the single swamp crossing located at the Ojibway Canyon was designated swamp 315 and listed in table below as well as in Table 1:

PML SWAMP NO.	STATION LIMITS (TOWNSHIP OF MOWAT)	LENGTH (m)
Highway 69 Mainline		
315	Sta. 20+775 to 20+837.5	62.5

All elevations in this report are expressed in metres. A list of standard specifications referenced in this report is provided in the attached Table 2.

## **2. SWAMP AND HIGH FILL CROSSINGS**

### **2.1 Proposed Works and Red Flag Issues**

A summary of the subsurface conditions (depth to competent soil, type of soil below the base of excavation and depth to probable bedrock) for the swamp crossing is compiled in the attached Table 1.

In this study a new NBL and SBL embankment construction at new alignment through swamp 315 is required.

The embankment height within the project limits ranges from 17.5 to 19.5 m and decreases to about 1.5 and 6.5 m at the south and north top edges of the canyon.

It is envisaged that the section of the proposed Highway 69 through swamp 315 will be constructed with removal of existing peat/topsoil and localized organic clayey materials. The





swamp area may require special treatment to mitigate settlement and differential settlement concerns due to a variable rockfill thickness and the presence of a multi-use structure at the south rim of the canyon and near vertical rock face at the north and south limits of the canyon, as further discussed in this report.

If construction of the wildlife culvert C8 (located at the bottom of the canyon) commences prior to placement of the rockfill embankment, precaution measures should be taken when considering the placement, type and compaction methods of the rockfill. This attention is required to avoid any damage that may occur to the culvert structure.

The "red flag" issues outlined in the preceding paragraphs and the recommended methods of overcoming these issues noted in the following sections of the report are intended to alert and aid the designer and the contractor. These comments and recommendations are based on the conditions revealed during the investigation and no responsibility is assumed by the consultants or the MTO for alerting the contractor to all critical issues for each foundation alternative. The requirements to deliver acceptable construction quality remain the responsibility of the contractor.

The selection of the construction method for the embankment at the swamp crossing will depend on stability and post-construction total and differential settlements as well as other factors such as environmental considerations and relative costs. Discussions of the stability and settlement of the proposed embankment and of other considerations are provided in the following sections of this report.

## **2.2 Embankment Stability**

It is proposed that the Ojibway Canyon be backfilled with rockfill to raise the existing grade at the canyon to the proposed road centerline grade of the southbound and northbound lanes.

The subsurface stratigraphy revealed in the boreholes drilled in the swamp generally comprised a surficial peat/topsoil unit, or snow/ice layer overlying a peat unit. The peat/topsoil units were underlain by cohesionless soils containing cobbles and boulders which in turn mantled probable bedrock or bedrock. Locally, the peat unit mantled bedrock. Bedrock was contacted at shallow





depths. Talus bedrock boulders and outcrops spread over the site. Groundwater was observed at shallow depths as well as open water was visible across the floor of the canyon.

Upon removal of the peat/topsoil from the site and since no soft clayey soils exist, the embankment fill will be placed on native compact to dense cohesionless soils. Accordingly, there are no concerns regarding the stability of the embankment fill placed on native cohesionless soils.

If required, rockfill should be employed to construct the portion of the embankment below existing grade and/or below the water level to satisfy constructability constraints (soft soils, stable base, working below the water table) as well as to minimise post-construction settlements since it would be difficult to compact earth and/or pit-run granular materials below the water table. In addition, the magnitude of construction dewatering required to enable such work to be performed in the dry may not be feasible due to environmental impacts and economic constraints. Earth and/or granular material could be employed above existing grade and/or 1 m above the water level, whichever is higher.

The rockfill above grade should be placed to a 1.25H:1V slope or flatter (as required by the designer) while the earth fill should be placed to a 2H:1V slope. Embankments constructed with rockfill overlain by earth fill should be sloped at 2H:1V.

The slope stability is expected to be as listed below:

PML SWAMP NO.	APPROXIMATE MAXIMUM EMBANKMENT HEIGHT	MINIMUM FACTOR OF SAFETY	FIGURE NO.
315	17.5 to 19.5 m thick rockfill placed on compact to dense cohesionless soils (containing cobbles and boulders) overlying bedrock	> 1.3	N/A

It is considered that new embankments constructed using rockfill placed on competent soils will be stable. These embankments should be constructed as prescribed by MTO and indicated previously in this section to replace the excavated soils.





## **2.3 Embankment Settlement**

### **2.3.1 Settlement of Cohesive Soils**

A localized thin layer of organic cohesive soil contacted in a single test hole should be fully subexcavated. No cohesive soils were encountered in the remaining test holes drilled across the site, hence there is no further detail required in regard of settlement of cohesive soils.

### **2.3.2 Settlement of Cohesionless Soils**

The anticipated subgrade for the embankment comprises native cohesionless soils with cobbles and boulders over bedrock. The native soils are considered to be compact to dense and no long-term settlement is expected due to placement of the embankment fill provided that the peat/topsoil and other excessively loose, soft, organic or otherwise deleterious materials within the limits of the embankment fill are subexcavated prior to fill placement. Settlements of cohesionless soils will occur rapidly during and within 3 months after fill placement.

### **2.3.3 Settlement of Rockfill**

Settlement of the rockfill is calculated based on the following criteria established from review of research documents prepared by MTO (RR229 dated March 1983) and discussions with the Pavements and Foundations Section of MTO:

- **Rockfill Above Grade**

Total settlement is about 0.5% of the rockfill height provided the fill is placed in accordance with SP 206S03.

- **Rockfill Below Grade**

Total settlement is up to 2% of the rockfill thickness since the rockfill is end dumped and placed in relatively large lift thicknesses with minimal or no compaction effort.





- Rate of Rockfill Settlement

About 50% of the total settlement occurs during the first year following placement of the rockfill and the remaining 50% at a progressively decreasing rate during the following 5 to 10 year period.

The required embankment fill throughout the Ojibway Canyon is about 17.5 to 19.5 m and decreases to about 1.5 and 6.5 m at the south and north top edges of the canyon.

Where the Ojibway Canyon is constructed with rockfill, total settlement of the rockfill surface, both during and following completion of construction, due to “consolidation” of the rockfill is likely to occur. The magnitude of total settlement is estimated to be about 0.5% of the rockfill height placed by end dumping provided that the rockfill is placed in accordance with SP 206S03 above the water table.

The magnitude of long-term total and differential settlements of the rockfill is anticipated to be reduced very little by way of surcharging as the thick rockfill (about 17.5 to 19.5 m) is not expected to be influenced by a 2 m high surcharge. Consequently, the effect of surcharging on rockfill settlements is considered negligible. The estimated rockfill settlements are given in Table 3, attached.

A multi-use structure is proposed to be constructed at the top of the canyon at the south edge. At this location the rockfill thickness will be about 2.0 m and its estimated settlement will be small (about 10 mm).

There are concerns about the performance of the roadway due to the differential settlement that will be experienced over the very short transition zone between the bedrock outcrop at the edge of the canyon and the near vertical up to 15 m high rock face. Effective compaction of the rockfill will be very difficult in this location.

The estimated settlements of the 17.5 to 19.5 m thick of rockfill placed above the water table will be in the order of 90 to 100 mm, half of which would occur within the initial six months to one year





after construction and the remaining within the following 5 to 10 years (Case 'A'). In Case 'A', a multi-use culvert was proposed to be placed on the bedrock (see Drawing 2).

The differential settlements at the location of the north edge of multi-use structure with top south edge of the canyon are expected to be in order of 45 and 90 mm after 1 year and 5 to 10 years, respectively. These differential settlements will be reduced to half if 10m subexcavation of bedrock beneath the multi-use structure is carried out (Case 'B'). In Case 'B', a multi-use culvert is proposed to be founded on rockfill after subexcavating the bedrock beneath the culvert (see Drawing 3).

The subexcavation of the bedrock outcrop beneath the invert of the multi-use structure (case 'B') was rejected due to the high cost and longer construction period requirements. Instead, the multi-use structure was proposed to be shifted 3 m to the south away from the top edge of the rock face.

The estimated total and differential settlements for Cases A and B are provided in Table 7, attached.

Due to difficulties of compaction of the rockfill at the nearly vertical rock face location, it was proposed to place Granular B Type II along rock face to facilitate the compaction efforts and to decrease the differential settlement at this location. A geosynthetic filter fabric was also proposed to be provided between Granular B material and rockfill to avoid migration of finer materials into voids of the rockfill. This would provide lesser differential settlement at the transition zone with anticipated differential settlements in the order of 20 and 40 mm after 1 year and 5 to 10 years, respectively. After discussions with MTO the use of granular materials and a geosynthetic filter fabric was considered unnecessary and the 3 m shift of the multi-use structure to the south proposed instead.





### **3. SWAMP AND HIGH FILL CROSSING TREATMENT**

#### **3.1 General**

The swamp crossing treatment at this section was reviewed and recommended primarily using the following criteria:

- i) Post-construction settlement of the embankment surface due to settlement of the rockfill and consolidation of subgrade to be minimal.
- ii) Stability of the embankment fill.

Generally, the stable inclination of the embankment fill slope as well as the magnitude of post-construction settlement of the embankment surface and time required for essential completion of primary consolidation for treatment option are dependent on the embankment height, the composition and thickness of the subgrade soil. For this site, the stability and settlements of cohesionless soils under the proposed embankment were discussed in the previous sections of the report. The following section provides a review of the swamp crossing and recommended treatment.

For the purposes of this report, competent soil was generally defined as loose to dense cohesionless soils (standard penetration test N-values in excess of 7) cognisant of the embankment height and expected settlements. A summary of depth to competent soil at the programmed location of test holes at crossing 315 is provided in the attached Table 4.

The depths to competent soil at the programmed locations of test holes ranged from 0.0 to 1.1 m (elevation 182.2 to 191.6).

The existing topsoil/peat and localized organic cohesive soils are highly compressible and generally not capable of supporting the weight of embankment fill to be placed. The cohesionless soils containing cobbles and boulders underlying the peat/topsoil, organic soils talus bedrock boulders and bedrock outcrop are deemed to be competent and capable of supporting the proposed rockfill embankments. The loose sandy soils may be left in place since settlement of this material occurs rapidly during construction.





### 3.2 Construction Methods

Two applicable methods of crossing construction at crossing 315 were considered. A summary of the methods, their general advantages and disadvantages is provided in the following table:

	<b>ALTERNATIVE EMBANKMENT CONSTRUCTION METHOD</b>	<b>ADVANTAGES</b>	<b>DISADVANTAGES</b>
1	Construction of NBL and SBL bridges across the Ojibway Canyon	<ul style="list-style-type: none"> <li>• No post-construction settlements</li> </ul>	<ul style="list-style-type: none"> <li>• Typically too costly</li> <li>• Requires construction of piers at the floor of the canyon</li> <li>• Requires dewatering control</li> <li>• Difficult construction at the floor of the canyon due to access issues</li> <li>• Difficult pile driving due to cobbles and boulders</li> </ul>
2	Rockfill embankment (lengthening the construction schedule and/or advance contracts to increase the time period between construction of the embankment and construction of the roadway)	<ul style="list-style-type: none"> <li>• Reduced post-construction differential settlements</li> <li>• Work is not as weather sensitive as bridge alternative</li> <li>• Less costly compared to bridge construction</li> </ul>	<ul style="list-style-type: none"> <li>• Requires a long construction period</li> </ul>

The preferred construction method will be influenced by the soil profile at the crossing, environmental considerations, the accepted post-construction performance (settlement), design requirements, the construction schedule, construction constraints and economic considerations.

In summary, Option 2 with shifting the multi-use structure 3 m to the south is considered to be the preferred method of construction of the embankment for the new Highway 69 SBL and NBL.

#### 3.2.1 Discussion of Construction Methods

The alternatives such as full excavation, preloading/surcharging without removal of compressible soils, lightweight fill and wick drains options are not applicable since there are no cohesive deposits at the swamp 315 crossing.





Treatment option such as construction of a bridge is considered to be too costly at this crossing.

The advantages, disadvantages, relative costs and risks/consequences of the feasible swamp treatment options are presented for the swamp 315 crossing in the attached Table 5. The recommended treatment is incorporated in Table 1.

### 3.2.2 Comparison of Preliminary Cost Estimates

No comparison of preliminary cost estimates is required at this swamp crossing since methods of full excavation of compressible soils and using wick drains to mitigate post-construction settlements are not required or applicable.

### 3.2.3 Recommended Treatments

The results of the geotechnical investigation at the Ojibway Canyon reveal that the site is well suited for the rockfill embankment construction. A minimal peat/topsoil veneer was contacted surficially over shallow compact to dense cohesionless soils containing cobbles and boulders which in turn were extended down and mantled the bedrock. Talus bedrock boulders and bedrock outcrop were strewn throughout the site. No clayey materials were encountered. Due to very favourable subsurface conditions, only minor swamp treatment is required. The treatment is that the peat/topsoil and localized organic clayey soils should be removed from the site prior to rockfill placement.

In summary, lengthening the construction schedule (option 2) is considered to be the preferred method of construction of the embankment fill for the Highway 69.

For reference, the recommended temporary backslope inclination for swamp excavation is given in the attached Table 6.





### **3.3 Construction Method for Embankment Widenings**

A partial-lane platform and the full-lane embankment widening are not required at this swamp crossing.

Refer to Section 5.3 for further construction recommendations.

## **4. TYPE OF EXCAVATION**

A summary of subsoil conditions and recommended treatment for the swamp 315 crossing is provided in Table 1.

Excavation of the surficial peat/topsoil, cohesive soils and localized organic deposits is required throughout the swamp area. Swamp excavation is recommended where open water covers the floor of the canyon.

Swamp excavation materials are expected to be stable at 10H:1V. The height of stockpiles will be controlled by the available width of the disposal area. These stockpiles should be placed on competent ground away from streams.

The excavation activities for the swamp should be carried out in conjunction with the construction of the wildlife culvert (C8) located at the middle portion of and across the swamp. The recommendations for excavation below the invert of culvert C8 alignment provided in the culvert report prepared by PML under separate cover (06TF035C) should be followed.

## **5. ADDITIONAL CONSTRUCTION CONSIDERATIONS**

### **5.1 General**

Embankments on competent material for this crossing should be constructed in accordance with OPSD-201.020, OPSD-202.010, OPSD-203.010 and SP 206S03. The side slopes of the embankments should be inclined no steeper than 2H:1V for earth fill and 1.25H:1V for rockfill. A





minimum of 2 m wide mid-height berm for erosion control and slope maintenance purposes should be provided, since the anticipated slope height is in excess of 8 m for earth fill embankments and 10 m for rockfill embankments.

Excavated inorganic soils can be placed at the toe of rockfill embankment provided that the inclination of the slope flattening is not steeper than 3.5H:1V.

## **5.2 Twinning Sections**

Not applicable for the swamp 315 crossing.

## **5.3 Embankment Widening Sections**

Not applicable for the swamp 315 crossing.

# **6. ADDITIONAL SETTLEMENT CONSIDERATIONS**

## **6.1 General**

Some settlement of the embankment fill surface, both during and following completion of construction, due to settlement of the rockfill and consolidation of the subgrade soils should be expected. The magnitude of settlement for the recommended treatment option is summarised in Table 3. For embankments constructed on bedrock – practically incompressible material, settlement of the subgrade will be negligible. The settlement of embankments due to compression of cohesionless subgrade soils remaining in place is provided in Section 2.3.2 of this report.

Some loss of rockfill is likely to occur as a result of the rockfill "punching" into the very loose to loose cohesionless soils below the recommended excavation depths. For volume calculation purposes, the loss of rockfill should be accounted for assuming a 100 to 300 mm penetration below the base of excavation depending on the relative density of underlying soils. The maximum





value of 300 mm should be applied in case of loose cohesionless soils and minimum value of 100 mm for compact / dense soils.

The width of the embankment platform should be widened a minimum of 2 m on each side if constructed on native inorganic soil according to Northern Region Engineering Directive NRE 98-200 dated October 28, 1998 (1 m if founded on bedrock). The anticipated post-construction settlement of the embankment due to settlement of the rockfill and consolidation of subgrade material, the slope flattening specified by MTO and the minimum requirements called for in NRE 98-200 that include accommodation of a 200 mm thick pavement overlay in future should be considered. Refer to the Pavement Design Report for additional comments in this regard.

## **6.2 Settlements in Widening Sections**

Not applicable for the swamp 315 crossing.





## **7. CLOSURE**

This report was prepared by Mr. Idib (Adeeb) Sadoun, MSc, P.Eng., and by Mr. C.M.P. Nascimento, P.Eng., Senior Project Engineer. Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

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and stamped**

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TABLE 1

SUMMARY OF SUBSOIL CONDITIONS AND RECOMMENDED TREATMENT

PML SWAMP No.	LOCATION	ADDITIONAL FILL HEIGHT, m	DEPTH TO COMPETENT SOIL, m	SOIL BELOW EXCAVATION BASE	DEPTH TO PROBABLE BEDROCK, m	EXCAVATION PROCEDURE	RECOMMENDED TREATMENT
<b>HIGHWAY 69 MAINLINE</b>							
315	Sta. 20+775 to 20+837.5	17.5 – 19.5	0.4 – 1.1	Loose to dense cohesionless soils (containing cobbles and boulders) extending to bedrock	0.0 – 5.2 (El. 183.1 – 188.7)	Earth excavation	Removal of peat/topsoil and organic soils

- NOTES: 1. Depths to competent soil and probable bedrock are based on both borehole and dynamic cone penetration test data.  
 2. All peat and organic soils are to be removed.





**TABLE 2**  
**LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT**

<b>DOCUMENT</b>	<b>TITLE</b>
SP 206S03	Construction Specification for Grading
OPSD-201.020	Rock Grading-Divided Rural
OPSD-202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment
OPSD-203.010	Embankments Over Swamp - New Construction
NRE 98-200	Northeastern Region Directive - Platform Widening





**TABLE 3**  
**COMPUTED SETTLEMENT OF EMBANKMENT SURFACE**  
**DUE TO SETTLEMENT OF ROCKFILL**

<b>SWAMP No.</b>	<b>RECOMMENDED TREATMENT OPTION</b>	<b>FILL HEIGHT (m)</b>	<b>TOTAL ROCKFILL SETTLEMENT (mm)</b>	<b>RECOMMENDED SURCHARGE PERIOD (months)</b>	<b>SETTLEMENT DUE TO SURCHARGE (mm)</b>	<b>SETTLEMENT REMAINING AFTER 12 MONTHS FOLLOWING FILL PLACEMENT (mm)</b>
315 Sta. 20+775 to 20+837.5 Township of Mowat	Removal of peat/topsoil and organic soils	17.5 – 19.5	90 – 100	N/A	N/A	45-50

- Notes: 1. Includes rockfill settlement above and below grade / water table.  
 2. Refer to Section 2.3.3 of the report for estimated rate of settlement.





**TABLE 4**  
**SUMMARY OF DEPTH TO COMPETENT SOIL**

SWAMP No.	TEST HOLE No.	LOCATION OF EXCAVATION TO COMPETENT SOIL	COMPETENT SOIL AT	
			DEPTH (m)	ELEVATION
315	315-1	Sta. 20+780, o/s 18.8m Rt. CL Med.	1.1	187.0
	315-2	Sta. 20+787, o/s 19.0m Lt. CL Med.	0.0	189.3
	315-3	Sta. 20+787.5, CL Med.	1.3	186.6
	315-4	Sta. 20+787.5, o/s 58.0m Rt. CL Med.	0.8	186.8
	315-5	Sta. 20+795, o/s 55.0m Lt. CL Med.	0.8	188.3
	315-6	Sta. 20+800, o/s 18.8 m Rt. CL Med.	0.9	186.8
	315-7	Sta. 20+812.5, o/s 58.0 m Lt. CL Med.	1.0	187.6
	315-8	Sta. 20+812.5, o/s 58.0m Rt. CL Med.	0.9	187.0
	315-9	Sta. 20+814, CL Med.	0.8	186.8
	315-10	Sta. 20+820, CL Med.	0.3	187.3
	315-11	Sta. 20+820, o/s 12.8m Rt. CL Med.	0.6	188.7
	315-12	Sta. 20+821, o/s 18.8m Lt. CL Med.	0.2	188.1
	315-14	Sta. 20+833, o/s 60.0m Lt. CL Med.	0.8	189.5





**TABLE 4**  
**SUMMARY OF DEPTH TO COMPETENT SOIL**

SWAMP No.	TEST HOLE No.	LOCATION OF EXCAVATION TO COMPETENT SOIL	COMPETENT SOIL AT	
			DEPTH (m)	ELEVATION
	315-15	Sta. 20+837.5, CL Med.	0.0	191.6
	C8-1	Sta. 20+807.3, o/s 58.0 m Lt. CL Med.	0.4	187.6
	C8-2	Sta. 20+805.7 o/s 38.3m Lt. CL Med.	1.2	187.3
	C8-3	Sta. 20+803, CL Med.	0.8	186.9
	C8-4	Sta. 20+799.5, o/s 38.4m Rt. CL Med.	1.1	186.6
	C8-5	Sta. 20+798, o/s 58.0 m Rt. CL Med.	0.6	186.9
	P1-SBL	Sta. 20+803, o/s 18.8 m Lt. CL Med.	0.3	187.4
	P2-NBL	Sta. 20+809, o/s 18.8m Rt. CL Med.	0.8	186.6
	D7-2	Sta. 20+800, o/s 0.4m Lt.	0.6	187.0
	D7-3	Sta. 20+808, o/s 50.8m Lt.	0.6	187.8
	D7-3A	Sta. 20+809, o/s 49.7m Lt.	0.6	187.8

- NOTES: 1. Competent soil is either bedrock or probable bedrock for all other test hole locations.  
 2. Swamp excavation is to primarily remove peat/topsoil and organic cohesive soils.  
 3. Allowance for additional 100 to 300 mm penetration of rockfill below the levels indicated should be made depending on the relative density of underlying soils.





**TABLE 5**  
**ADVANTAGES, DISADVANTAGES AND RELATIVE COSTS OF SWAMP TREATMENT ALTERNATIVES**

<b>PML SWAMP No.</b>	<b>TREATMENT TYPE</b>	<b>ADVANTAGES</b>	<b>DISADVANTAGES</b>	<b>RELATIVE COSTS</b>	<b>RISKS/ CONSEQUENCES</b>	<b>RANK</b>
315	Construction of a bridge to span the swamp / compressible soil	<ul style="list-style-type: none"> <li>• No issues of stability and long-term</li> <li>• Eliminate future highway maintenance</li> <li>• No excavation or disposal soil is required</li> <li>• No rockfill required</li> </ul>	<ul style="list-style-type: none"> <li>• Longer time required for construction</li> <li>• Too costly</li> </ul>	<ul style="list-style-type: none"> <li>• Increased cost for abutment locations investigation</li> <li>• Increased costs for bridge construction</li> </ul>	<ul style="list-style-type: none"> <li>• Lesser risk than other options due to no stability concerns</li> <li>• Controlled long-term settlements</li> </ul>	2
	Lengthening the construction schedule and/or advance contracts to increase the time period between construction of the embankment and construction of the roadway	<ul style="list-style-type: none"> <li>• Reduced disposal of excavated soil</li> <li>• Reduced post-construction settlements</li> </ul>	<ul style="list-style-type: none"> <li>• Requires a long construction period</li> <li>• Post-construction settlement possible</li> <li>• Increased rockfill quantities</li> <li>• Potentially requires more frequent highway maintenance to correct settlements</li> </ul>	<ul style="list-style-type: none"> <li>• Increased rockfill costs</li> <li>• Increased costs for soil disposal</li> <li>• Increased costs for minor swamp excavation</li> <li>• Increased costs for pavement maintenance</li> <li>• Increased costs for Wildlife culvert construction</li> </ul>	<ul style="list-style-type: none"> <li>• Settlements of embankment rockfill</li> <li>• Differential settlement could occur at the edge zones</li> </ul>	1





**TABLE 6**

**TEMPORARY BACKSLOPE INCLINATION FOR SWAMP EXCAVATION**

<b>SWAMP NO.</b>	<b>TEMPORARY BACKSLOPE FOR SWAMP EXCAVATION (H:V)</b>
315	N/A

**NOTE:**

1. Recommended sideslopes for new embankment construction are 1.25H:1V for rockfill and 2H:1V for earth fill.

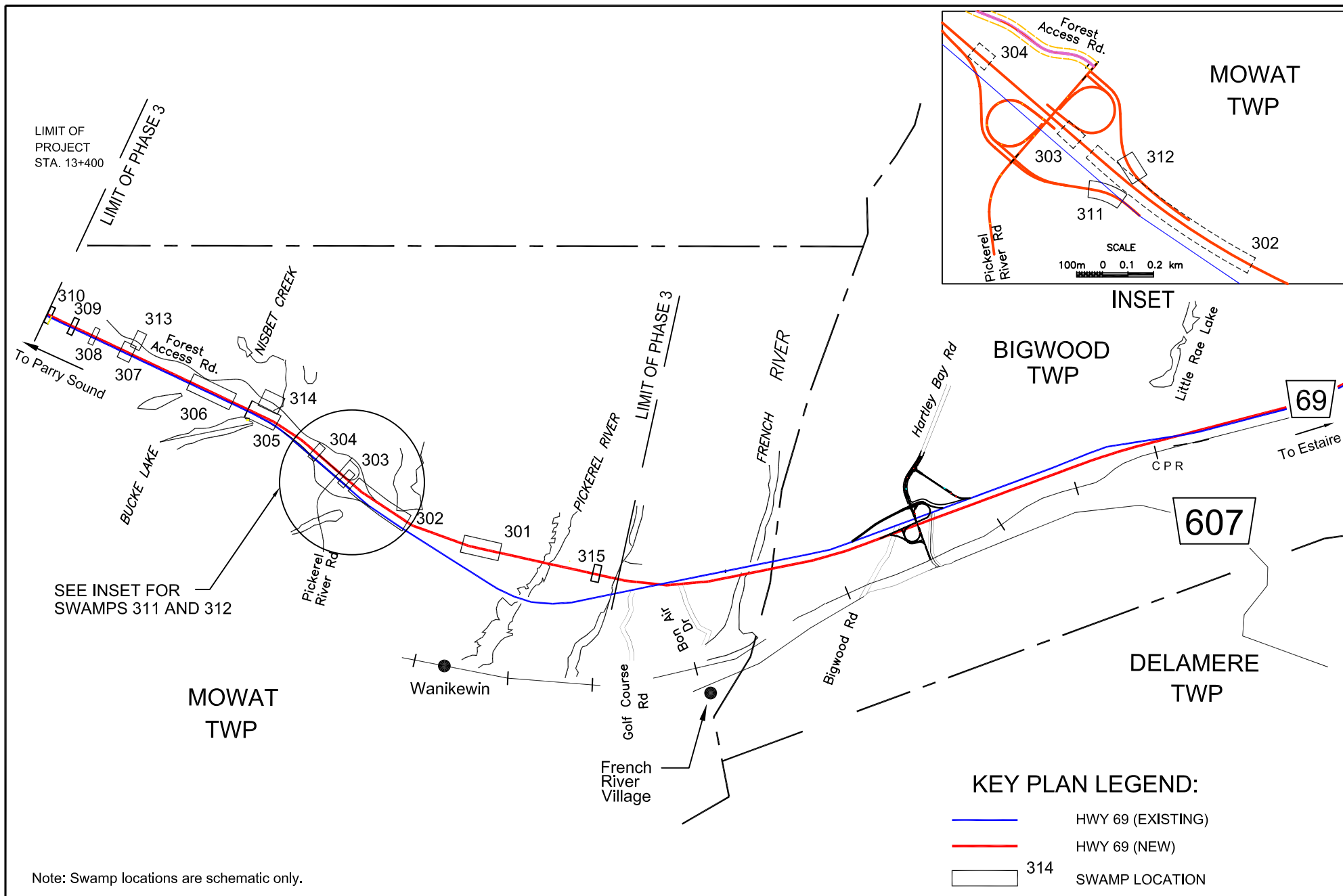




**TABLE 7**  
**COMPUTED SETTLEMENT AND**  
**DIFFERENTIAL SETTLEMENT OF EMBANKMENT ROCKFILL**

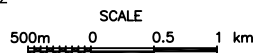
<b>Case 'A' – Multi-Use Culvert Founded on Bedrock (Sta. 20+767)</b>					
Zone No.	Rockfill Height (m)	Total Settlement (mm)	Differential Settlement (mm) between	Settlement Remaining after 12 months following fill placement (mm)	Differential Settlement (mm) after 12 months between
1	4	20	Zones 1 & 2 10 mm	10	Zones 1 & 2 5 mm
2	2	10	Zones 2 & 3 90 mm	5	Zones 2 & 3 45 mm
3	20	100	Zones 3 & 4 0 mm	50	Zones 3 & 4 0 mm
4	20	100	Zones 4 & 5 20 mm	50	Zones 4 & 5 10 mm
5	16	80	Zones 5 & 6 55 mm	40	Zones 5 & 6 25 mm
6	5	25		15	
<b>Case 'B' – Multi-Use Culvert Founded on Rockfill after Bedrock Subexcavation (Sta. 20+767)</b>					
1	15	35	Zones 1 & 2 10 mm	75	Zones 1 & 2 25 mm
2	10	25	Zones 2 & 3 25 mm	50	Zones 2 & 3 50 mm
3	20	50	Zones 3 & 4 0 mm	100	Zones 3 & 4 0 mm
4	20	50	Zones 4 & 5 10 mm	100	Zones 4 & 5 20 mm
5	16	40	Zones 5 & 6 10 mm	80	Zones 5 & 6 15 mm
6	13	30		65	





# KEY PLAN

HIGHWAY 69 FOUR-LANING (Phase 3)  
From 3.1 km North of Highway 522 to 10.7 km North of Highway 522  
District 54, Sudbury



METRIC



Ministry of  
Transportation  
Ontario



Peto MacCallum Ltd.  
CONSULTING ENGINEERS

PRIME CONSULTANT

MRC

MCCORMICK RANKIN CORPORATION

GWP 5203-06-00



DRAWING  
1



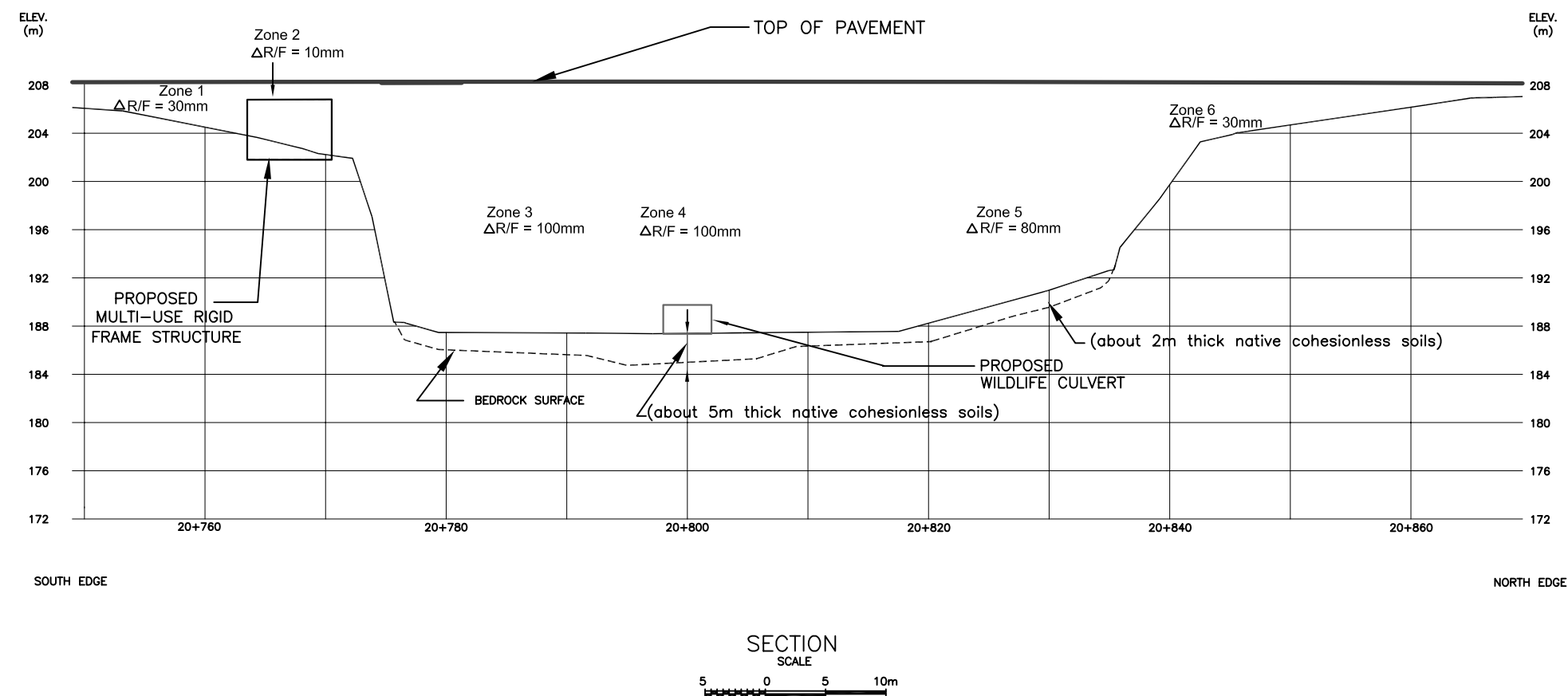
CONT No  
GWP No 5205-06-00

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OJIBWAY CANYON  
HIGHWAY 69 FOUR-LANING  
SWAMP 315, STA. 20+750 TO 20+870 MOWAT TWP



ESTIMATED SETTLEMENT AND DIFFERENTIAL SETTLEMENT  
OF EMBANKMENT FILL ACROSS OJIBWAY CANYON  
CASE 'A' - MULTI-USE CULVERT FOUNDED ON BEDROCK  
(STATION 20+767)



- NOTE -

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

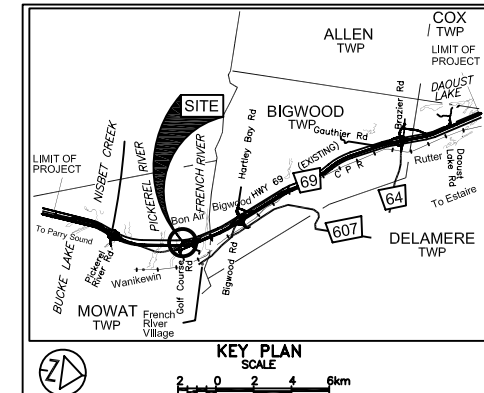
REVISIONS						
DATE		BY		DESCRIPTION		
Geocres No. 41H-243						
HWY No 69						DIST 54
SUBM'D AS	CHECKED AS	DATE NOV. 18, 2009			SITE --	
DRAWN NA	CHECKED CN	APPROVED BRG			DWG 2	



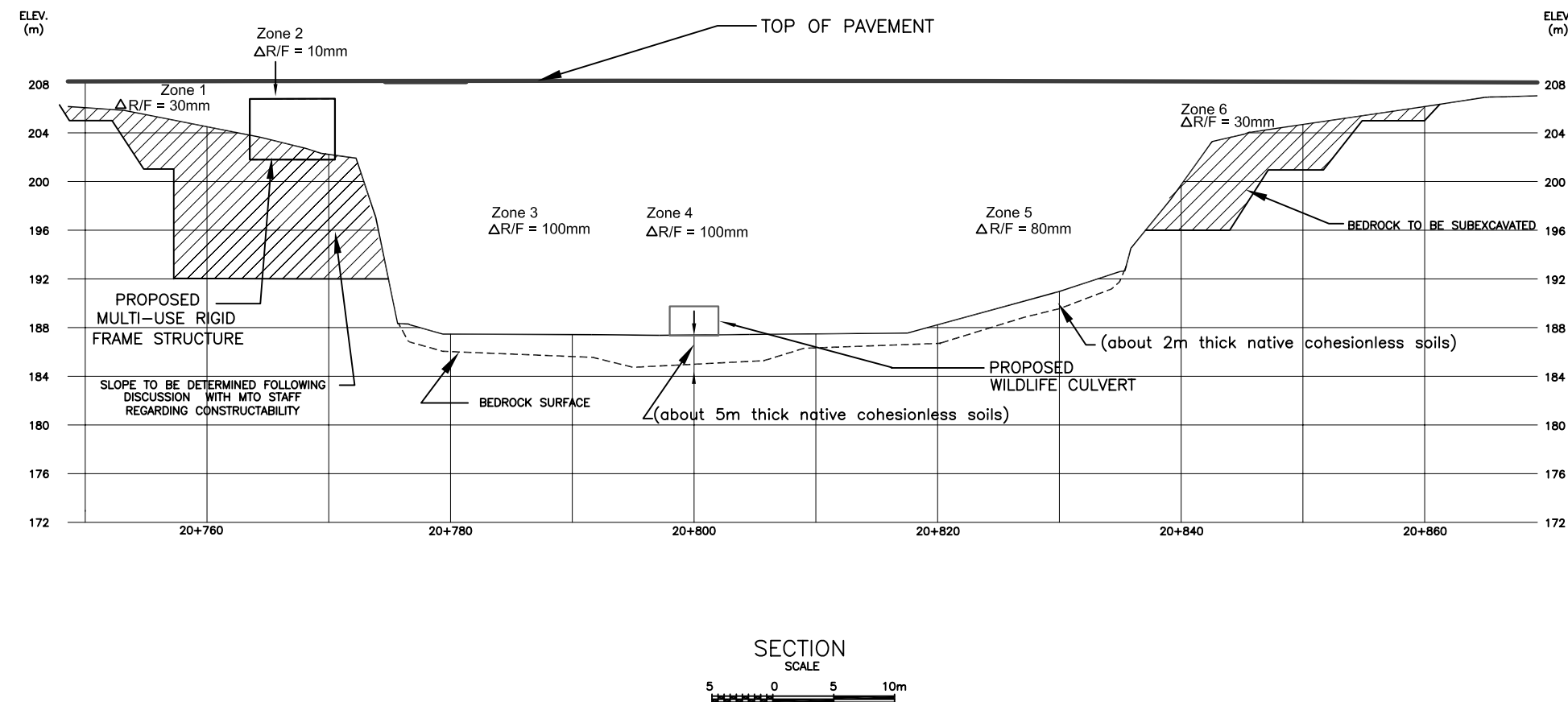
**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES










CONT No  
GWP No 5205-06-00

**OJIBWAY CANYON**  
HIGHWAY 69 FOUR-LANING  
IP 315, STA. 20+750 TO 20+870 MOWAT TWP



ESTIMATED SETTLEMENT AND DIFFERENTIAL SETTLEMENT  
OF EMBANKMENT FILL ACROSS OJIBWAY CANYON  
CASE 'B' - MULTI-USE CULVERT FOUNDED ON ROCKFILL AFTER BEDROCK SUB-EXCAVATION  
(STATION 20+767)



LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
N	Blows/0.3m (Std. Pen Test, 475 J/blow)		
CONE	Blows/0.3m (60° Cone, 475 J/blow)		
	W L at time of investigation Mar 2007		
	D6 Series Mar 2004		
	Head		
	ARTESIAN WATER		
	Encountered		
	PIEZOMETER		
BH No	ELEVATION	STA MOWAT TWP	o/s CL MED

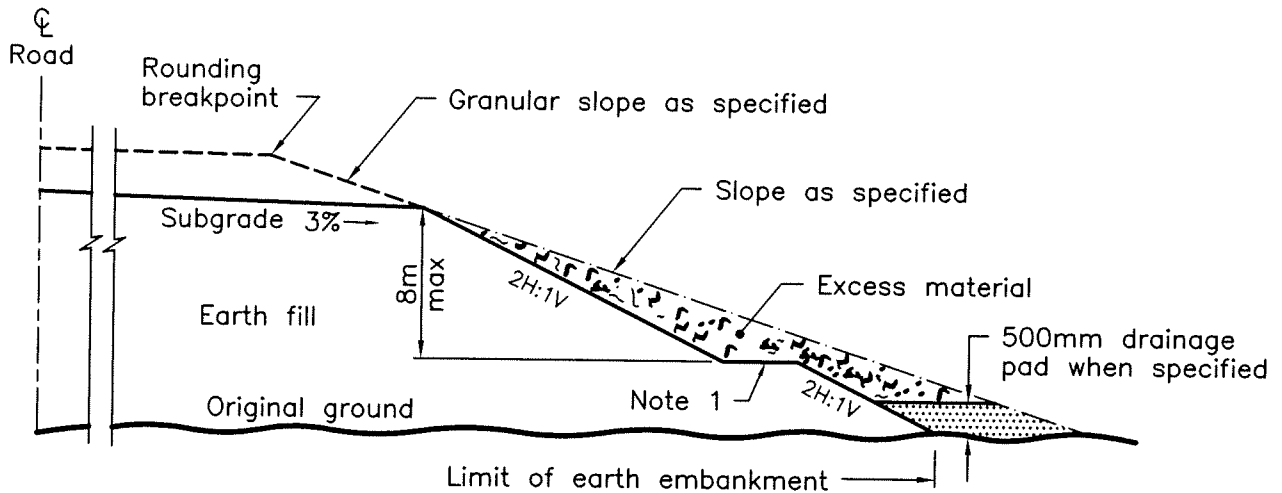
- NOTE -

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

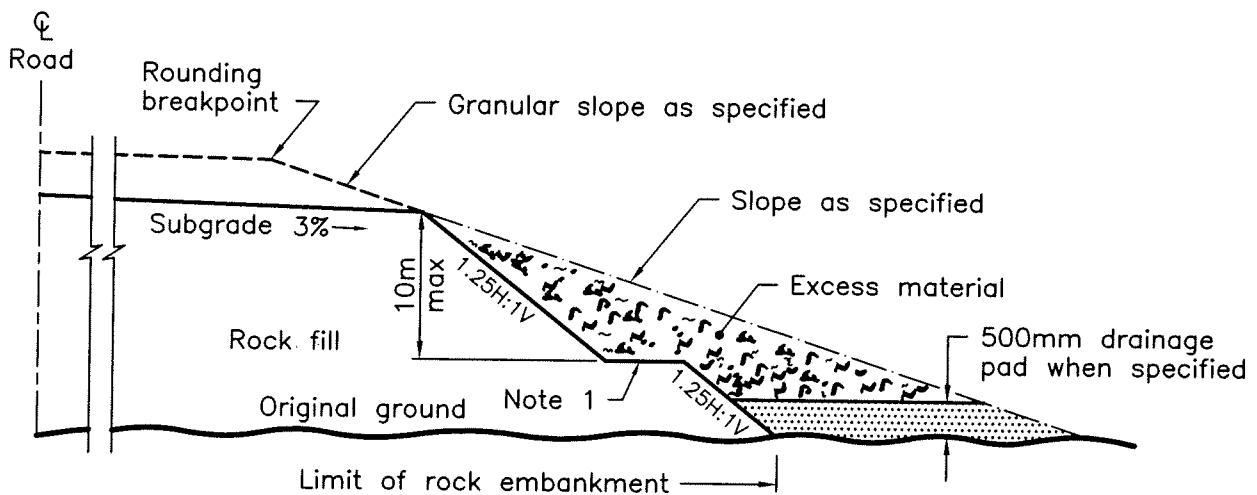
REVISIONS					
DATE		BY	DESCRIPTION		
Geocres No. 41H-243					
HWY No 69					DIST 54
SUBM'D AS	CHECKED AS	DATE NOV. 18, 2009		SITE --	
DRAWN NA	CHECKED CN	APPROVED BRG		DWG 3	








### EARTH EMBANKMENT



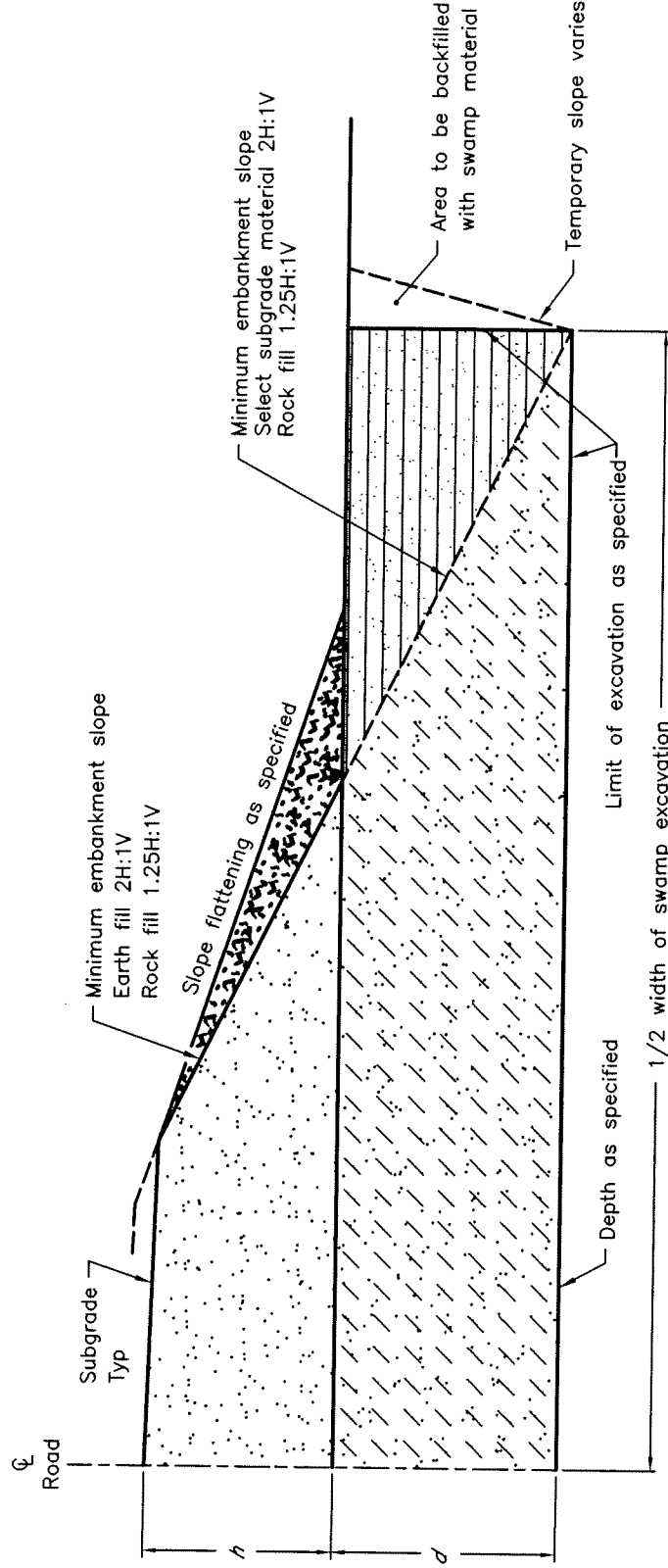
### ROCK EMBANKMENT

#### NOTES:

- 1 Benches 2 metres minimum in width are required along slopes at maximum vertical intervals as shown.
- A Height of fill is the vertical difference between top of subgrade and top of original ground measured at new road centreline.
- B Excess material placed shall not extend beyond the right-of-way.
- C All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING		Nov 2005	Rev	1	
SLOPE FLATTENING USING EXCESS MATERIAL ON EARTH OR ROCK EMBANKMENT		-----			
		-----			
		OPSD - 202.010			

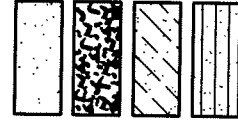




# NOTES:

- A For this OPSD,  $h$  must be  $\leq 4.5\text{m}$  and  $d$  must be  $\leq 6.0\text{m}$ .
- B Height of fill is the vertical difference between top of subgrade and top of swamp elevation measured at new road centreline.
- C For divided roads with median  $< 10\text{m}$ , excavate swamp material full width.
- D For divided roads with median  $\geq 10\text{m}$ , excavate swamp material to limits as specified.
- E All dimensions are in millimetres unless otherwise shown.

## LEGEND:



Embankment materials as specified  
Excavated swamp material  
Excavate and backfill as specified  
Excavate and backfill with swamp material

$h$  - Height of fill  
 $d$  - Depth of sub-excavation

ONTARIO PROVINCIAL STANDARD DRAWING

## EMBANKMENTS OVER SWAMP NEW CONSTRUCTION

Nov 2005 Rev 2



OPSD - 203.010