

**PRELIMINARY
FEASIBILITY FOUNDATION INVESTIGATION
AND DESIGN REPORT FOR ROUTE
ALTERNATIVE STUDY
HIGHWAY 129 FROM 30.2 KM NORTH OF
HIGHWAY 554 NORTHERLY 20.8 KM AND
HIGHWAY 556 FROM HIGHWAY 129
WESTERLY 5.3 KM
DISTRICT OF ALGOMA, ONTARIO
G.W.P. 5670-04-00
GEOCRES 41J-75**

McCormick Rankin Corporation
Mississauga, ON

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Coffey Geotechnics Inc.
(Formerly Shaheen & Peaker Limited)

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1. INTRODUCTION

Coffey Geotechnics Inc. (formerly Shaheen and Peaker Limited (S&P)) has been retained by McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation Ontario (MTO) to carry out a preliminary foundation assessment for the route planning studies for two study areas. The first study area is Highway 129 from 30.2 km north of Highway 554 northerly 20.8 km section and the second study area is Highway 556 from Highway 129 westerly 5.3 km section (See location map, Drawing -1).

This report summarizes the information used to carry out the evaluation of different route alternatives for the two study areas (Highways 129 and 556).

The Terms of Reference for the scope of work are outlined in the MTO request for proposal (Agreement No. 5004-E-0065) and in our proposal PO 7494 dated February, 2006.

The work carried out for this study should be considered preliminary in nature and is intended to highlight general foundation concerns for use in comparing the various route alternatives. A preferred route alternative for each site (highway 129 and 556) was selected from a foundation technical and cost effectiveness perspective. Throughout the assessment, areas of preliminary foundation investigation (i.e. water crossing structures) on the preferred route were identified. No borehole drilling and laboratory testing to establish existing soil conditions was carried out as part of this study. Preliminary and/or detailed foundation investigations will be required in the selected areas such as swamp, soft ground, creek, high fill embankment and bridge foundation in order to obtain information to assess the detail subsurface conditions and to provide recommendations on the foundation and pavement aspects of the design.

It should be noted that the preferred corridors referenced in this report for Highway 129 are those which were presented at the Public Information Center (PIC) in June, 2007 and November, 2007. Relevant and valuable comments were received through the discussions at the PIC and those are considered in this study.

2. SITE DESCRIPTION AND PHYSIOGRAPHY

The project areas for the route alignment selection process generally encompass the lands surrounding Highway 129 from 30.2 km north of Highway 554 northerly for 20.8 km area and Highway 556 from Highway 129 westerly for 5.3 km area as shown in Drawing 1.

The existing Highways 129 and 556 are both essential parts of the provincial highway network in the District of Algoma. The study section of Highway 129 runs typically in north-south direction and is located within the geographic Townships of Daigle and Sturgeon. The study section of Highway 556 runs generally in east-west direction and is located within the geographic Townships of Timbrell and Villeneuve. Both Highway 129 and 556 are typically two-lane undivided roadways and have single lane bridge structures at the Rapid River (Hwy 129) and the Mississagi River (Hwy 556).

The existing Highways 129 and 556 are located mostly in the physiographic landform of glaciofluvial deposit along the Mississagi River Valley and are surrounded by a rock knob dominated area as shown in Drawing 2.

Glacial ice advanced toward the south-southwest and deposited a discontinuous veneer of ground moraine over the bedrock. The drift is often less than 1 m thick, but can increase to more than 5 m in the flank of some of the bedrock hills. During the deglaciation, extensive deposits of outwash sand and gravel were laid down along the narrow valleys. Later, a major spillway developed along the Wenebagon and Mississagi Rivers. The meltwaters flowed southward into a post-Algonquin glacial lake which occupied the basin of present-day Lake Huron and eroded the older valley terrain deposits in the Mississagi River valley.

Glaciofluvial deposit is underlain by extremely rugged Precambrian rock of which there is abundant exposure. Dissection of the bedrock along northwest and northeast trending faults and joints has developed strong relief, with local elevation differences of 100 m and steep, complex slopes. The drainage pattern is largely controlled by these lineaments. Early Precambrian felsic igneous and metamorphic rocks such as granite and granodiorite underlie most of the area (Giblin and Leachy 1967).

3. ROUTE ASSESSMENT PROCEDURES

3.1 GENERAL OVERVIEW

Route assessment procedures for several different route alternatives were carried out for two separate study areas (Highway 129 and Highway 556).

Generally, each of the route alternatives was reviewed and compared based on the available information in the following geological studies and maps:

- *Giblin, P.E. and Leachy, E.J., 1967: Sault Ste. Marie – Elliot Lake Sheet, Algoma, Manitoulin, and Sudbury Districts; Ontario Department of Mines, Map 2108, Geological Compilation Series, Scale 1:253440 or 1 inch to 4 miles, Geological Compilations 1964, 1965.*
- *D.F. VanDINE, 1980: WAKOMATA LAKE AREA (NTS 41J/NW), District of Algoma, Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 92.*
- *Ontario Geological Survey Map 5005: Northern Ontario Engineering Geology Terrain Study Data Base Map, WAKOMATA LAKE.*

MRC provided us previous preliminary design report prepared by Tulloch in 2003 (G.W.P. 14-74-02 & 14-74-15, Highway 129 from 30.3 km north of secondary Highway 554 Northerly 20.8 km) and shallow pavement boreholes were previously drilled along the route by TBT Engineering in 2001. Findings of the TBT investigation were included in the Tulloch report as presented in Appendix D.

In addition to the above mentioned geological information and preliminary design report, some geotechnical investigations were carried out at the main water crossing locations (Mississagi River, Rapid River, Sharpsand River and Lafoe Creek) previously and subsurface information is available in the MTO Geocres information system as follows;

- *GEOCREs 41J-11, 1965, William Trow Associates Limited, Foundation Investigation - Proposed Rapid River Crossing, Highway 639*
- *GEOCREs 41J-31, 1975, Dominion Soil, Foundation Investigation - Proposed La Foe Creek Crossing, Highway 129*
- *GEOCREs 41J-58, 1977, Dominion Soil, Foundation Investigation - Proposed Crossing Rapid River, King's Highway 129*
- *GEOCREs 41J-60, 1977, The Trow Group Limited, Foundation Investigation for Proposed Structure at the Crossing of Gravel River No.2*
- *GEOCREs 41J-59, 1977, Morton, Dodds & Partners Limited, Soil Investigation New Structure over Gravel River No 1.*
- *GEOCREs 41J-37, 1978, Dominion Soil, Foundation Investigation - Proposed Structure Gravel River, King's Highway 129*
- *GEOCREs 41J-54, 1993, Engineering Material Office, Foundation Design Section, Mississagi River Bridge*

The highway route planning study was carried out in two phases. The first phase involved the selection and then evaluation of various corridor alternatives within the project limit by MRC. The second phase involved the selection and evaluation of a number of route alternatives within the preferred corridor.

The comparison and evaluation of the different corridor alternatives and the subsequent selection of the route alternatives were based on an evaluation of social, economic, natural environmental and technical considerations. The foundation components were included as a part of the technical considerations.

Foundation evaluations for the route alternatives included a quantitative and comparative assessment of geological conditions, topography, overall drainage conditions, extent of swamps, soft ground and foundation concerns. To minimize risk and cost, construction in swamp and soft ground areas needs to be minimized as do the number of water crossing structures. Overall difficulty of construction was also considered for the route evaluation. For the area of the Mississagi River Valley, flood possibilities and erosion by river flow need to be taken into account for route alternative evaluation. In addition, erosion by river flow may cause slope instability (Picture G-3 in Appendix) due to the ground loss at the slope toe area in the Mississagi River valley.

Using the criteria listed below, each factor was assessed for each alternative for both Highway 129 and 556 sites.

Table 3.1.1 Factors of Route Alternative Evaluation.

Factors	Indicator	Measure	Consideration Details	Criteria
Geologic condition	Quaternary geology of site	Quantitative assessment	Essential information for geotechnical /foundation engineering assessment	Proportion (percentage, %) out of total route length
Topography	Topographic / terrain variation	Quantitative assessment	Topography directly relate to vertical alignment of highway as well as amount of earth work.	Proportion (percentage, %) out of total route length
Drainage	Drainage ability, extent of ponded water	Quantitative assessment	Dewatering/unwatering requirement for construction. Use three drainage categories: rapid/fair/poor/ponded	Proportion (percentage, %) out of total route length
Swamps and soft ground	Extent of swamps and soft ground	Quantitative assessment	Anticipated additional loads due to highway construction can cause unacceptable settlement within swamp and soft ground area. Ground improvement such as preloading or surcharge may necessary for soft ground.	Number of swamps/ length of possible soft ground
Foundation	Subsurface conditions for foundation design	Qualitative assessment	Anticipated depth of bedrock Foundation type and depth (depend on subsurface conditions)	General bedrock depth for each landform.
Construction	Construction issues	Qualitative assessment	Balance of earth work and difficulty of construction	Anticipated amount of cut and fill balance Construction difficulties
Additional factors to be considered for the Mississagi River Valley area during future studies				
Factors	Description	Measure	Detail	Criteria
Erosion (by river flow)	Especially for the river valley area Possible slope instability	Qualitative assessment	Soil erodibility, scour and slope geometry need to be take into consideration Detail study is required	-
Flood	Especially for the river valley area Based on historical data	Qualitative assessment	Detail study is required	-

Based on the above evaluation factors, each of the route alternatives were assessed and rated as favorable, less favorable or not recommended for the Highway 129 and Highway 556 sites.

3.2 ROUTE ASSESSMENT

The evaluation process for the route alternatives involves the compilation, review and office analysis (i.e. desk top study) of existing available information to create an overall picture of the proposed alignment areas, considering potential foundation concerns.

This step should be followed by a site reconnaissance (i.e. field work) of the preferred route alternative in the detail design phase to verify the existing information, as required.

The available existing information reviewed included subsurface, geologic and geographic information in the form of air photo, topographic maps (i.e. contour maps and profile drawings in Appendices), Northern Ontario Engineering Geology Terrain Study 92 (District of Algoma, Ministry of Natural Resources, 1980), Ontario Geologic Survey Map 5005 (See Drawing-2) and relevant information provided by MRC and internal Coffey (formerly S&P) files.

These resources were used to identify regional trends with respect to terrain/topographic variation, drainage patterns, extent of rock knobs and out croppings, extent of swamps, and to identify the locations of water crossing structures. The existing Highway 129 and Highway 556 alignments were superimposed on the Ontario Geologic Survey Map 5005 which is shown in Drawing 2 to identify the geologic conditions at the sites.

3.2.1 ROUTE ASSESSMENT FOR HIGHWAY 129

The route alternative evaluation for Highway 129 starts from the south limit of the project at 30.2 km north of Highway 554 in the Township of Daigle and extends about 20.8 km northerly to the Township of Sturgeon.

The various corridors for Highway 129 were positioned by MRC so as to minimize impact on the environment: avoid major lakes, swamps and/or low lying wetland areas and to cross rivers, streams or other water courses at the narrowest point with a smooth approach alignment, where possible. The preferred Highway 129 corridor was presented at a Public Information Centre (PIC) in June, 2007. The corridor study results are shown in Drawing A-1. The various route alternatives shown in Drawing A-3 were proposed by MRC within the above mentioned 5 corridors for Highway 129.

As indicated in Drawing A-3, the study area is divided into north and south sections.

The geographic features of the Mississagi River Valley characterize the existing highway area (See Photographs in Appendix C). The highway is generally oriented in a north-south direction with the Mississagi River on the west and steep rock outcrops (See Photographs C-1, C-5, C-7 and C-8 in Appendix C) or gravel embankments to the east. In several areas,

the road embankment forms the east bank of the river. The existing highway crosses over several creeks and rivers, which are tributaries to the Mississagi River. Glaciofluvial outwash terrain lies along the Mississagi River valley and some of its tributaries are shown in Drawing A-2. Outside of the Mississagi River Valley, rock knob terrain dominates the study area (See Drawing 2).

Based on the aforementioned evaluation factors in Section 3.1, each route alternative is assessed and rated as 'favorable', 'less favorable' or 'not recommended'. Because of the long stretch of the alignment (about 20.8 km), route alternatives were subdivided into 3 groups which are north section route alternatives (Route Alternatives N3, N4, N5, N6, N7, and N8), south section route alternative (Route Alternative S3) and south to north section route alternatives (Route Alternatives N1/S2 and N2/S1). A detail evaluation of each route alternative is shown in Appendix B (See Table B-1 to B-9). A summary and evaluation of route alternatives are shown below:

North Section Route Alternatives: Route Alternatives N3, N4, N5, N6, N7, and N8 are for the north section of the project. More than 65% of the total length of Route Alternatives N3, N4, N5, N6, N7, and N8 (north section) are located in a very rugged or flat top rock knob area. Massive rock cut is required for Route Alternatives N5, N6, N7 and N8 and relatively less rock cut is required for Route Alternative N3 and N4. Profiles of the preferred route alternative are shown in Appendix A.

The southerly portion of Route Alternatives N3, N4, N5, N6, N7, and N8 lie in a glaciofluvial open plain.

Based on the MTO Geocres information, glaciofluvial and current river deposits typically consisting of cobbles and boulders, sand and sandy silt with zones of coarser materials were encountered at main water crossing locations (Lafoe Creek, Rapid River and Sharpsand River). Typical sizes (diameter) of well-rounded boulders at the ground surface were recorded about 0.1 to 0.6 m, however, larger size boulders are always expected at the site.

In addition to MTO Geocres information, a review of a previous site investigation of 43 boreholes (See Borehole logs in Appendix D) carried out by TBT engineering (G.W.P. 14-74-02 & 14-74-15, 2001) along the Mississagi River Valley, indicates that the native materials were found to be extremely coarse, well rounded granular soils with a high percentage of cobbles and boulders. Granular materials consisting of gravel, cobbles and boulders which are well rounded results in the roadside cut face being prone to sloughing.

Route Alternatives N3, N4, N5, N6, N7, and N8 at north section of the project need a new bridge structure over the Rapid River. This new bridge will need to be constructed in a deeper and wider valley of Rapid River than at the existing bridge location. The existing

Rapid River Bridge (See Photograph C-9) is a 27 m single lane bailey bridge (prefabricated truss bridge) installed in 1988.

In addition, major swamps (See Photographs C-4), lakes (See Photograph C-6) and possibly soft grounds exist along the Route Alternatives N3, N4, N5, N6, N7 and N8, especially in the low lying area as shown in Drawings A-3 to A-4.

Route Alternatives N3, N4, N5, N6, N7 and N8 are rated as 'less favorable' to 'not recommended' due to new bridge construction in a wider and deeper valley, to its potential to encroach the swamp and lake areas and the requirement of major rock cuts.

South Section Route Alternative: Route Alternative S3, shown in Drawing A-3 is the only alternative that covers only the south section of study site. This route is similar to the existing Highway 129 route, except that it is located some distance away from the Mississagi River, but within the River Valley. About 70% of the total length is located in a glaciofluvial plain area within the Mississagi River Valley and the rest of the route (i.e. towards north) is located in rock knob area, immediately adjacent to the River (towards the north end of the south section as shown in Drawing A-3). Route Alternative S3 includes a crossing of Lafoe Creek. The existing creek crossing structure at Lafoe Creek is a 42S SuperCor culvert which replaced a deteriorated bailey bridge. Route alternative S3 is rated as 'less favorable' because of rock cut requirements.

South to North Section Route Alternatives: Route Alternatives N1/S2 and N2/S1 follow the existing Highway 129 from south section to north section with revisions to the existing highway alignment (horizontal and vertical). The existing single lane bridge over the Rapid River is also proposed to be upgraded to two lanes. Route Alternatives N1/S2 and N2/S1 stay within the Mississagi River Valley which is a typically glaciofluvial open plain area with some local relief of rock knob mostly at the bends of the Mississagi River, such as Devil's Gap. Bedrock outcroppings are found at numerous locations, especially in the middle of the study area where the river valley is restricted by the encroachment of a high rock bluff. Route Alternatives N1/S2 and N2/S1 are in agreement with the PIC comments and MTO response where Highway 129 is recommended to stay within the Mississagi River Valley. Preferred route alternative profiles are presented in Drawings A5 to A-34.

Table 3.2.1.1 Summary of Route Alternatives Evaluation for Highway 129

Alternative Number	Pros	Cons	Remark
N3	-Less rock cut than other alternatives (N4, N5, N6, N7 and N8) for north section of Highway 129	-About 70% of the total length is located in rugged rock knob area -New bridge over wider and deeper Rapid River Valley -Swamps and Lakes	Less favorable

Alternative Number	Pros	Cons	Remark
		-Creek crossings	
N4	-Relatively less rock cut than other alternatives (N5, N6, N7 and N8) for north section of Highway 129	-About 75% of the total length is located in rugged rock knob area -New bridge over wider and deeper Rapid River Valley -Swamps and Lakes -Creek crossings	Less favorable
N5	-Less rock knob area than other alternative for north section	-About 80% of the total length is located in rugged rock knob area -New bridge over wider and deeper Rapid River Valley -Massive rock cuts -Swamps and Lakes -Creek crossings	Not recommended
N6	-Relatively straight alignment along its north section	-About 75% of the total length is located in rugged rock knob area -New bridge over wider and deeper Rapid River Valley -Massive rock cuts -Swamps and Lakes -Creek crossings -Longer alignment than other alternatives	Not recommended
N7	-Shorter distance	-About 70% of the total length is located in rugged rock knob area -New bridge over wider and deeper Rapid River Valley -Massive rock cuts -Swamps and Lakes -Creek crossings	Not recommended
N8	-Shorter distance -Avoids main lakes	-About 65% of the total length is located in rugged rock knob area -New bridge over wider and deeper Rapid River Valley -Massive rock cuts -Creek crossings	Not recommended
N1/S2	-About 95% of the total length is located in glaciofluvial open plain area -Revision of existing Highway 129 -Route alignment stays in the Mississagi River Valley (agree with PIC comment and MTO response)	-Local wet silt zones (high frost susceptibility) -Creek crossings (less in S2) -Erosion by river flow	<u>Favorable</u>

Alternative Number	Pros	Cons	Remark
	-Less swamps	-Flood possibility	
N2/S1	-About 95% of the total length is located in glaciofluvial open plain area -Revision of existing Highway 129 -Route alignment stays in the Mississagi River Valley (agree with PIC comment and MTO response) -Less swamps	-Local wet silt zones (high frost susceptibility) -Creek crossings (less in S1) -Erosion by river flow -Flood possibility	Favorable (preferred option) because this route alternative is the closest one to the existing Highway 129)
S3	-More than 70% of total length are located in glaciofluvial open plain area -only one route alternative for south section of study area	-Rock cut -Creek crossings	Less favorable

As a result of above mentioned assessment and comparison, Route Alternative N2/S1 is found to be the most favorable alternative for the Highway 129.

3.2.2 ROUTE ASSESSMENT FOR HIGHWAY 556

For Highway 556 the five route alternatives shown in Drawing E-2 were considered by MRC for route evaluation.

The route alternative evaluation for Highway 556 starts at the east limit of the study at its junction with Highway 129 in the Township of Timbrell and extends about 5.3 km westerly to the Township of Villeneuve

A total of five route alternatives were proposed for this area including "Do Nothing" (Route Alternative 1).

The geographic features of the Mississagi River Valley characterize the existing Highway 556 area (See Photographs in Appendix G). Highway 556 is generally oriented in east-west direction along the Mississagi River which runs south of the existing Highway. To the north of the existing Highway, a steep rock knob with shallow veneer of drift prevails. The existing highway crosses over several watercourses and the Mississagi River. A glaciofluvial outwash open plain lies along the Mississagi River valley in this area. Outside the Mississagi River Valley, rock knob terrain dominates the study area as shown in Drawing 2.

Based on evaluation factors mentioned in Section 3.1, each of route alternatives is assessed and rated as 'favorable', 'less favorable' or 'not recommended'. A detailed evaluation of each route alternative is shown in Appendix F (See Table F-1 to F-5). A summary and evaluation of route alternative is shown below.

Existing Highway 556 follows the north side of the Mississagi River Valley, turns easterly immediately before Mississagi River crossing and has very sharp turn on the west approach to the existing bridge (See Photograph G-6) which is single lane bailey bridge (See Photograph G-7) over the Mississagi River. Highway 556 merges with Highway 129, westerly, about 0.7 km after the river crossing. Most of the existing Highway 556 alignment is located in glaciofluvial open plain area.

Both Route Alternatives 2 and 3 closely follow the existing alignment of Highway 556 except for the portion just before and after the Mississagi River crossing.

Route Alternative 3 needs a new bridge for a less sharp west turn on the approach to the bridge than the existing alignment and then follows Mississagi River again and merges with Highway 129, westerly. At the west approach of the bridge, more than 200 m long major rock cut is required. For this reason, this route alternative is rated as 'less favorable'.

For Route Alternative 2, existing bridge needs to be improved to two lanes (i.e. a new bridge will be required to replace the existing one). More than 200 m long rock cut is required for less sharp west turn on the approach to the bridge than existing condition. Similar to Route Alternative 3, this route alternative merges with Highway 129 westerly after the river crossing. This route alternative is also rated as 'less favorable' due to this difficult rock cut section, as well as an even shaper approach to the bridge, but less sharp than existing alignment.

Route Alternatives 4 and 5 follow the same alignment on the existing Highway 556 easterly before Mississagi River crossing (See Drawing E-2). However, these alternatives cross the river some 1.5 km east of the existing bridge. A new bridge is required for the Mississagi River crossing. Beyond the new crossing these route alternatives proceed some considerable distance to the south of Mississagi River Valley (especially Route Alternative 5). Major rock cuts are required for western part of the Route Alternatives 4 and 5. Route alternative 5 has continuous uphill section (with slope ranging +2% to +7%) which may cause some difficulties for the future truck traffic. Alternative 5 is evaluated as 'not recommended' because of uphill length and slope. Route Alternative 4 (See Profile In Drawing E-3 and E-4) is rated as 'less favorable' because of relatively shorter uphill length than alternative 5 and relatively more favorable slope around +2% to +5%, in comparison with route Alternative 5.

Route Alternative 1, "Do Nothing", stays within the Mississagi River Valley which is typically glaciofluvial open plain area with local relief of rock knob. An Improvement of signage and guide rail is included in Route Alternative 1.

It should be noted that swamps and soft ground may locally existed in this study area.

Table 3.2.2.1 Summary of Route Alternatives Evaluation for Highway 556

Alternative Number	Pros	Cons	Remark
1	-Do nothing with existing Highway 556 alignment -Improvement of signage and guide rail -Route alignment stays in the Mississagi River Valley (agree with PIC comment and MTO response)	-Sharp turn on the west approach to the bridge	<u>Favorable</u>
2	-Less sharp turn on the west approach to the bridge with mostly same alignment of existing Highway 556	-Rock cut section	Less favorable
3	-Less sharp turn on the west approach to the bridge with mostly same alignment of existing Highway 556	-Rock cut section	Less favorable
4	-Less sharp turn is required at the new bridge location	-Rock cuts -Relatively short uphill section with lower slope angle -Creek crossings	Less favorable but can be a possible long term solution
5	-Shorter distance than Route Alternative 4	-Rock cuts -Uphill all the way with maximum 7% angle which can cause some difficulties to the future truck traffic -Creek crossings	Not recommended

The preferred route alternative based on the above criteria for Highway 556 is Route Alternative 1 ("Do Nothing"), which follows the Mississagi River with improvements to signage and guide rail.

Outside of the existing corridor of Highway 556, Route Alternative 4 can be the best route alternative in the long term for Highway 556, as it avoids massive rock cut and future traffic hazard (i.e. less sharp turn to the future bridge).

3.2.3 CONSTRUCTION COMMENTS FOR THE STUDY AREA ON HIGHWAYS 129 AND 556

For the rock knob area, major constraints in term of construction are the presence of massive, irregular and complex bedrock outcrops and the occurrence of large boulders on the ground surface. This means that ground excavations will require blasting. Site grading will be expensive and rock fills will be necessary in grading works for a balanced profile. Foundation conditions should be excellent on the bedrock, but route alignments will require

major cut and fill. Because of shallow drift cover and complex bedrock slope, development activities would be more difficult, and hence more expensive, than in areas of thicker overburden. Construction will be extremely difficult in these areas of high sheer rock cliffs and steep bedrock hills. The shallow soils that cover the steep and variable rock slopes are susceptible to surface erosion, especially when cleared of vegetation.

According to the northern Ontario engineering geology terrain study 92 Wakomata Lake Area (NTS 41J/NW), district of Algoma, Ontario (D.F. VanDINE, 1980), excavation at the site will encounter few problems (i.e. large size boulders, construction dewatering), except in areas with high water tables (e.g. along the Mississagi River and where bedrock lies near the surface) in the glaciofluvial plain area. Handling and compaction of the wet granular materials (especially dilatant silt) with large volumes of cobble and boulders should present few problems as well. Bearing capacity for normal structures should be adequate, but specific site (such as local wet silt zone) should be investigated in more detail. General earth grading conditions should be good in this area. Because of the vicinity of the river, flood possibility and erosion by river flow need to be considered for glaciofluvial plain area. Erosion by river flow can cause slope instability due to ground loss at the slope toe. Erosion potential needs to be checked for the route sections adjacent to river, especially at river bends.

Extremely coarse, well rounded granulars with high percentage of cobbles and boulders and sand in the glaciofluvial open plain areas are non frost susceptible to low frost susceptible soils. Silty sand and sand with clay encountered in glaciofluvial plain area would present moderate to high frost susceptibility. Wet silt zones observed along existing Highway 129 (glaciofluvial plain area) can be classified as high frost susceptible soil. A high ground water table is expected in glaciofluvial plain area due to vicinity of Mississagi River.

Organic soils in low lying areas and swamp areas have to be removed and replaced with acceptable earth materials or rock fill. Rock fill will likely be available from the rock cuts.

4. RECOMMENDED ADDITIONAL INVESTIGATION FOR PREFERRED ROUTE

Following completion of the route evaluation process, a preliminary foundation investigation is required.

Foundation investigation related to alignment revisions/refinements and preliminary design should be carried out as soon as possible.

Detail investigations are also required especially for major swamps/soft ground areas due to a high compressible ground condition which can cause significant stability and settlement concerns.

For the selected bridge structure locations, sufficient information is required for the preliminary design to confirm span configuration of bridge and to minimize potential for having to change the configuration or bridge type at detail design stage.

The followings table lists the anticipated major water crossing structures based on available information.

Table 4.1 Recommended Preliminary Foundation Investigation

Location (Name of Water Course)	Highway	Type of Structure	Preliminary Foundation Investigation Requirements
Lafoe Creek	129	Culvert	Existing structure will be retained
Grindstone Creek	129	Culvert	Total 1 Borehole
Rapid River	129	Bridge	About 40 m long bridge depends on location Total 2 Boreholes
Sharpsand River No.1	129	Culvert	Total 1 Borehole
Sharpsand River No.1	129	Culvert	Total 1 Borehole
Mississagi River	556	Bridge	About 50 m long bridge depends on location Total 2 Boreholes

5. CLOSURE

The Limitations of Report, as quoted in Appendix H are an integral part of this report.

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ZO:tr/ldrive

Drawings

Appendix A

Highway 129 Route Alternative Drawings

Appendix B

Highway 129 Route Alternative Evaluation

Table B-1 Evaluation of Route Alternative N3 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N3	Southern part and very northern part of the route (30%)- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open at the start and end of the route (about 10+000-11+700 and about 20+100-21+000)	Surficial condition -Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 9 creek crossings on this alternative	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity	Less cut and fill than any other alternatives among alternatives 1 to 7	Less Favorable
	Middle part of the route (70%)- Rock knob: - Precambrian igneous and metamorphic rock.	Open (relatively flat top area) to very rugged (some location has about 5-10 m relief) Difficult near the river section(about 18+000)	Surficial condition -Dry (sandy till veneer, rapid)	More than 4 lakes besides this route More than 2 swamps beside this route	Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	

Table B-2 Evaluation of Route Alternative N4 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N4	Southern part and very northern part of the route (25%)- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open at the start and end of the route (about 10+000-11+000 and about 19+300-20+200)	Surficial condition -Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 12 creek crossings on this route	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity	More rock cut and fill is required than alternative 1.	Less favorable
	Middle part of the route (75%)- Rock knob: - Precambrian igneous and metamorphic rock.	Open (relatively flat top area) to difficult (some location-about 10-15m relief)	Surficial condition -Dry (sandy till veneer, rapid)	More than 6 lakes besides this route More than 3 swamps beside this route	Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	

Table B-3 Evaluation of Route Alternative N5 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N5	Southern part and very northern part of the route (20%)- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open at the start and end of the route (about 10+000-11+500 and about 17+800-19+300)	Surficial condition -Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 4 creek crossings on the route	Glaciofluvial: -Thickness of glaciofluvial deposit > 5 m, -Medium bearing capacity	Massive rock cut and fill is required. Glaciofluvial: Good source of aggregate	Not recommended
	Middle part of the route (80%)- Rock knob: - Precambrian igneous and metamorphic rock.	Open (relatively flat top area) to difficult (some location-about 20m high relief)	Surficial condition -Dry (sandy till veneer, rapid)	More than 3 lakes besides the route More than 3 swamps beside the route (1 swamp is very close)	Rock knob: -Shallow drift over the bedrock < 1 m, -Sandy till drift near flank of hills > 5 m	Rock knob: Difficult to cut, can be used as crushed stone	

Table B-4 Evaluation of Route Alternative N6 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/pounded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N6	Southern part and very northern part of the route (25%)- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open at the start of the route (about 10+000-11+100)	Surficial condition -Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 12 creek crossings on this route More than 4 lakes besides this route (2 lakes are very close) More than 4 swamps beside this route (2 swamps are very close)	Glaciofluvial: -Thickness of glaciofluvial deposit > 5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock < 1 m, -Sandy till drift near flank of hills > 5 m	Massive rock cut and fill is required. Lakes and swamps are very close to the route. Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	Not recommended
	Middle part of the route (75%)- Rock knob: - Precambrian igneous and metamorphic rock.	Open (relatively flat top area) to difficult (some location- about 20 m high relief)	Surficial condition -Dry (sandy till veneer, rapid)				

Table B-5 Evaluation of Route Alternative N7 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/pounded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N7	Southern part and very northern part of the route (30%)- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open at the start and end of the route (about 10+000-11+400 and about 19+500-20+200)	Surficial condition -Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 6 creek crossings on this route More than 4 lakes besides this route More than 2 swamps beside this route	Glaciofluvial: -Thickness of glaciofluvial deposit > 5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock < 1 m, -Sandy till drift near flank of hills > 5 m	Massive rock cut and fill is required. Deep river crossing (more than 30 m deep) Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	Not recommended
	Middle part of the route (70%)- Rock knob: - Precambrian igneous and metamorphic rock.	Open (relatively flat top area) to difficult (some location- about 25m high relief)	Surficial condition -Dry (sandy till veneer, rapid)				

Table B-6 Evaluation of Route Alternative N8 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N8	Southern part and very northern part of the route (35%)- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open at the start and end of the route (about 10+000-11+600 and about 20+100-20+900)	Surficial condition – Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 6 creek crossings on the route	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Massive rock cut and fill is required. Deep river crossing (more than 20 m deep) Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	Not recommended
	Middle part of the route(65%)- Rock knob: - Precambrian igneous and metamorphic rock.	Very rugged to difficult (some location- about 20 m high relief)	Surficial condition – Dry (sandy till veneer, rapid)	More than 4 lakes besides this route More than 2 swamps beside this route			

Table B-7 Evaluation of Route Alternative N1/S2 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N1/S2	Glaciofluvial outwash (95%): (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open	Surficial condition – Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 4 creek crossings On this route	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Improvement of the existing Hwy 129 with vertical and horizontal revision. Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	Favorable
	Rock knob (5%): Precambrian igneous and metamorphic rock	Open to very rugged (some location- about 6 m relief)	Surficial condition – Dry (sandy till veneer, rapid)				
	Local wet silt zone	Local wet silt zone with clay can be found-detail investigation is required.	Suspected high water table (vicinity of river and creek)	More than 1 swamp beside the route			

Table B-8 Evaluation of Route Alternative N2/S1 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
N2/S1	Glaciofluvial outwash (95%): (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open	Surficial condition – Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 4 creek crossings on this route	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Improvement of the existing Hwy 129 with vertical and horizontal revision. More revision than route Alternative 8.	Favorable (Preferred)
	Rock knob (5%): Precambrian igneous and metamorphic rock	Open to very rugged (some location- more than 6 m relief)	Surficial condition – Dry (sandy till veneer, rapid)	More than 2 swamps beside the route		Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	
	Local wet silt zone	Local wet silt zone with clay can be found-detail investigation is required.	Suspected high water table (vicinity of river and creek)				

Table B-9 Evaluation of Route Alternative S3 for Highway 129

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
S3 (south section of the project site)	Glaciofluvial outwash (70%): (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open	Surficial condition – Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas More than 1 creek crossing on this route	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Massive rock cut and fill is required. Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	Less favorable
	Rock knob (30%): Precambrian igneous and metamorphic rock	Open to difficult (some location- about 10m relief) 45m high relief at about 16+300	Surficial condition – Dry (sandy till veneer, rapid)	More than 1 lake besides this route			

Appendix C

Highway 129 Photographs



Photograph C-1 North bluff along Hwy 129



Photograph C-2 Shallow veneer of drift on the hill, Hwy 129



Photograph C-3 Possible swamp area (low lying area)



Photograph C-4 Wetland area at alternative 1 and 2, Hwy 129



Photograph C-5 Surrounding area of Hwy 129



Photograph C-6 Lake in surrounding area of Hwy 129



Photograph C-7 Surrounding area of Hwy 129



Photograph C-8 Hwy 129 adjacent to steep rock face



Photograph C-9 Single lane bailey bridge over Rapid River, Hwy 129



Photograph C-10 Drainage concerns, Hwy 129

Appendix D

Highway 129 Borehole Logs (TBT Engineering, Pavement Boreholes)



TBT ENGINEERING

GEOTECHNICAL ENGINEERING DIVISION

**GEOTECHNICAL DESIGN
REPORT**

for

Preliminary Design

W.P. No. 14-74-15 & 14-74-02
(TBTE Ref. # 01-047)

MTO DISTRICT: 62 –Sault Ste Marie

HIGHWAY 129

Highway 129 – Lafoe Creek northerly

December, 2001

HIGHWAY 129 – TWP. DAGLE

Station references are to Line 'A' (unless otherwise noted) and were scaled off plans and are therefore approximate

TH #3A (Sta 10+975) C/L (Alt Line)
(314940 E, 5167893 N)

0 - 50 Tps
50 - 300 Br F Sa(y) Gr Tr Si Occ Bld (Moist)
300 - 1.7 Br F-Co Cob(ly) Gr with Sa & Blds Tr Si (Moist & Comp) (Cementated from 300-500)
1.7 NFP Blds

TH #3A (Sta 10+975) C/L (Alt Line)
Sample No.01-PO-597 (600 – 1.0)

% Passing 4.75 mm	17.8%
% Passing 75 um	1.6%
FMC @ 1.7	5.5%
Group Symbol	GP

TH #4A (Sta 11+190) C/L (Alt Line)
(315042 E, 5168094 N)

0 - 500 Ob (Stripping)
500 - 1.0 Br F-Co Cob(ly) Gr with Sa & Blds Tr Si (Moist) (Cementated from 900)
1.0 NFP Blds

TH #5 (Sta 11+640) 3.6 Rt Existing C/L
(315294 E, 5168592 N)

0 - 80 ST
80 - 300 Cr Gr
300 - 800 Br F Sa Tr Si Occ Gr (Moist)
800 - 2.2 Br F-Co Cob(ly) Gr with Sa & Blds (Moist)
2.2 NFP Cont Slough & Blds

TH #5 (Sta 11+640) 3.6 Rt Existing C/L
Sample No.01-PO-590 (1.8 – 2.2)

% Passing 4.75 mm	37.7%
% Passing 75 um	4.7%
FMC @ 2.2	4.3%
Group Symbol	GW

TH #6 (Sta 11+720) 3.5 Rt Existing C/L
(315308 E, 5168679 N)

0 - 130 ST
130 - 250 Cr Gr
250 - 600 Br F Sa Tr Si Occ Gr (Moist)
600 - 2.1 Br F-Co Cob(ly) Gr with Sa & Blds (Moist)
2.1 NFP Cont Slough & Blds

TH #7 (Sta 12+960) 3.6 Rt Existing C/L
(316100 E, 5169424 N) (2 Attempts)

0 - 50 ST
50 - 270 Cr Gr (Tr Tps @ 270)
270 - 1.8 Br F-Co Cob(ly) Gr with Sa & Blds (Moist-Wet & Comp)
1.8 NFP Cont Slough & Blds

TH #7 (Sta 12+960) 3.6 Rt Existing C/L
Sample No.01-PO-591 (1.4 – 1.8)

% Passing 4.75 mm	47.6%
% Passing 75 um	10.4%
FMC @ 1.8	9.3%
Group Symbol	GW-GM

TH #8 (Sta 13+920) 4.0 Rt Existing C/L
(316872 E, 5170185 N)

0 - 40 CM
40 - 800 Br F-Co Sa with Gr & Cobs Tr Si Occ Bld (Moist) (Wet from 700)
800 NFP BR

TH #9 (Sta 13+960) 3.4 Rt Existing C/L
(316904 E, 5170210 N)

0 - 50 ST
50 - 150 Cr Gr (Sa(y))
150 - 800 Sh Rk & Sa Mixed (Moist) (Wet from 700)
800 NFP Frag BR

TH #10 (Sta 14+000) 3.5 Rt Existing C/L
(316945 E, 5170235 N)

0 - 40 ST
 40 - 220 Cr Gr
 220 - 800 Br F-Co Sa Tr Si Occ Gr & Cobs
 (Moist)
 800 - 1.7 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist)
 1.7 NFP Blds & Cont Slough

TH #10 (Sta 14+000) 3.5 Rt Existing C/L
Sample No.01-PO-592 (1.4 - 1.7)

% Passing 4.75 mm 41.3%
 % Passing 75 um 5.7%
 FMC @ 1.7 5.4%
 Group Symbol GP-GM

TH #11 (Sta 14+690) 3.5 Rt Existing C/L
(317396 E, 5170631 N)

0 - 50 ST
 50 - 330 Cr Gr
 330 - 2.0 Br M-Co Sa Occ Gr (Moist)

TH #12 (Sta 14+970) 3.4 Rt Existing C/L
(317664 E, 5170771 N)

0 - 40 ST
 40 - 200 Cr Gr
 200 - 750 Br M-Co Sa Tr Gr Occ Cobs
 (Moist)
 750 - 1.2 Sh Rk & Sa Mixed (Moist) (Wet
 from 1.0)
 1.2 NFP BR

TH #12A (Sta 14+970) 8.0 Rt Existing C/L
(D+1.5) (317664 E, 5170771 N)

0 - 100 Ob to Frag BR

TH #13 (Sta 15+165) C/L
(317854 E, 5170768 N)

0 - 500 Ob to Frag BR (Moist)

TH #14 (Sta 15+310) C/L
(318004 E, 5170774 N)

0 - 100 Ob to BR

TH #15 (Sta 15+460) 3.1 Rt Existing C/L
(318161 E, 5170807 N)

0 - 40 ST
 40 - 260 Cr Gr
 260 - 600 Br F-Co Sa Tr Gr Occ Cobs
 (Moist)
 600 - 1.4 Sh Rk & Sa Mixed (Moist) (Wet
 from 1.0)
 1.4 NFP BR

TH #16 (Sta 16+340) 3.3 Rt Existing C/L
(318872 E, 5171297 N)

0 - 40 ST
 40 - 260 Cr Gr
 260 - 2.6 Br F-Co Sa with Gr Tr Cobs &
 Blds (Moist)
 2.6 NFP Blds & Slough

TH #17 (Sta 16+910) C/L
(318916 E, 5171865 N)

0 - 25 Tps (Wet)
 25 - 1.7 Gry VF-F Si(y) Sa with Cl (Wet
 & Soft) (Wet & Stiff from 1.5)
 (Fr Wat @ 200)
 1.7 NFP Blds

TH #18 (Sta 17+330) 7.0 Lt Existing C/L
(318682 E, 5172147 N)

0 - 100 Tps
 100 - 1.6 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist)
 1.6 NFP Blds

TH #19 (Sta 17+980) C/L
(318916 E, 5171865 N)

0 - 500 Wat
 500 - 700 Br F Sa Occ Bld (Wet)
 700 - 1.0 Br F-Co Cob(ly) Gr with Sa &
 Blds (Wet)
 1.0 NFP Blds

TH #20 (Sta 18+200) C/L
(318286 E, 5172756 N)

0 - 50 Tps
 50 - 400 Ora F-M Sa(y) Gr Tr Si & Cobs
 (Moist)
 400 - 1.0 Br F-Co Cob(ly) Gr with Sa &
 Blds (Moist)
 1.0 NFP Blds

TH #21 (Sta 18+200) 3.2 Rt Existing C/L
(318212 E, 5172881 N)

0 - 40 ST
 40 - 300 Cr Gr
 300 - 2.0 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist)
 2.0 NFP Blds & Cont Slough

TH #21 (Sta 18+200) 3.2 Rt Existing C/L
Sample No.01-PO-593 (1.1 - 1.5)

% Passing 4.75 mm	31.0%
% Passing 75 um	4.1%
FMC @ 1.5	4.4%
Group Symbol	GW

TH #22 (Sta 21+900) 3.4 Rt Existing C/L
(315681 E, 5175551 N)

0 - 60 ST
 60 - 270 Cr Gr
 270 - 1.6 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist)
 1.6 NFP Blds

TH #23 (Sta 22+400) C/L
(315235 E, 5175799 N)

0 - 25 Tps (Wet)
 25 - 1.4 Gry VF-F Si(y) Sa Tr Cl (Wet)
 (Fr Wat @ 500)
 1.4 - 1.5 Br F-Co Sa (Wet)
 1.5 NFP Blds

HIGHWAY 129 – TWP. STURGEON

Station references are to Line 'A' and were scaled off plans and are therefore approximate

TH #24 (Sta 23+200) C/L
(314767 E, 5176405 N)

0 - 300 Ob (Tps, Sa, Blds & Rts)
300 - 500 Br F-Co Bld(y) Gr with Cobs &
Sa Tr Si (Moist & Comp)
500 NFP Blds

TH #25 (Sta 23+500) 3.2 Lt Existing C/L
(314630 E, 5176656 N)

0 - 60 ST
60 - 360 Cr Gr
360 - 1.4 Br F-M Sa with Gr Tr Si Occ
Cobs (Moist) (Rts @ 1.0) (Tr
Tps @ 1.4)
1.4 - 3.0 Br F Sa Tr Si Occ Gr & Cob
(Moist)
3.0 NFP Blds

TH #25 (Sta 23+500) 3.2 Lt Existing C/L
Sample No.01-PO-594 (1.6 – 2.0)

% Passing 4.75 mm 90.0%
% Passing 75 um 32.7%
FMC @ 2.0 17.4%
Group Symbol SM

TH #25A (Sta 23+500) C/L
(314634 E, 5176873 N)

0 - 500 Ob (Tps, Sa, Blds & Rts)
500 - 700 Br F-Co Cob(ly) Gr with Sa &
Blds Tr Si (Moist & Comp)
700 NFP Blds

TH #26 (Sta 23+610) C/L
(314581 E, 5176949 N)

0 - 100 Tps
100 - 500 Br F Sa(y) Gr Tr Si & Cobs Occ
Blds (Moist)
500 - 700 Br F-Co Cob(ly) Gr with Sa &
Blds (Moist)
700 NFP Blds

TH #27 (Sta 24+270) C/L
(314483 E, 5177586 N)

0 - 50 Tps
50 - 600 Ora-Br F Sa with Si Tr Cobs &
Gr Occ Blds (Moist)
600 - 1.1 Lt Br VF Si(y) Sa (Moist-Wet)
1.1 NFP Blds

TH #28 (Sta 24+870) 3.4 Rt Existing C/L
(314691 E, 5177901 N)

0 - 30 ST
30 - 260 Cr Gr
260 - 1.6 Br F-Co Cob(ly) Gr with Sa &
Blds Tr Si (Moist)
1.6 NFP Blds & Cont Slough

TH #28 (Sta 24+870) 3.4 Rt Existing C/L
Sample No.01-PO-595 (1.2 – 1.6)

% Passing 4.75 mm 27.7%
% Passing 75 um 5.4%
FMC @ 1.6 3.8%
Group Symbol GP-GM

TH #29 (Sta 24+970) 4.2 Lt Existing C/L
(314774 E, 5178023 N)

0 - 30 CM
30 - 180 Cr Gr
180 - 800 Br F-M Sa with Gr Tr Si Occ
Cobs (Moist) (Wet from 700)
800 NFP BR

TH #30 (Sta 27+170) C/L
(316648 E, 5179312 N)

0 - 25 Tps (Moist)
25 - 700 Br VF Si(y) Sa Tr Cl Occ Blds
(Moist-Wet) (Wet from 600)
700 NFP Prob Frag BR

TH #31 (Sta 28+300) 3.5 Rt Existing C/L
(317547 E, 5179610 N)

0 - 220 ST
220 - 360 Cr Gr
360 - 2.0 Br F-Co Cob(ly) Gr with Sa &
Blds Tr Si (Moist)
2.0 NFP Blds & Cont Slough

TH #32 (Sta 28+400) 3.6 Rt Existing C/L
(317603 E, 5179697 N)

0 - 30 CM
 30 - 180 Cr Gr
 180 - 1.5 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist)
 1.5 NFP Blds & Cont Slough

TH #32 (Sta 28+400) 3.6 Rt Existing C/L
Sample No.01-PO-596 (1.1 - 1.5)

% Passing 4.75 mm 25.3%
 % Passing 75 um 4.9%
 FMC @ 1.5 3.9%
 Group Symbol GP

TH #33 (Sta 28+500) 3.3 Lt Existing C/L
(317664 E, 5179816 N) (2 Attempts)

0 - 50 ST
 50 - 120 Cr Gr (Dirty)
 120 - 1.5 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist)
 1.5 NFP Blds

TH #34 (Sta 28+600) C/L
(317769 E, 5179953 N)

0 - 50 Tps
 50 - 800 Br F-Co Sa with Gr Tr Si Occ
 Cobs (Moist)
 800 - 1.2 Ora-Br F-Co Sa Tr Cobs & Gr
 Occ Blds (Moist)
 1.2 NFP Blds

TH #35 (Sta 28+800) C/L
(317826 E, 5180114 N)

0 - 50 Tps (Moist)
 50 - 1.0 Br F-Co Cob(ly) Gr with Sa &
 Blds (Moist-Wet) (Wet from
 400) (Fr Wat @ 500)
 1.0 NFP Blds

TH #36 (Sta 28+900) C/L (Stripped Area)
(317836 E, 5180175 N)

0 - 1.2 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist & Comp)
 1.2 NFP Blds

TH #37 (Sta 29+100) C/L (Stripped Area)
(318042 E, 5180371 N)

0 - 1.0 Br M-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist & Comp)
 1.0 NFP Blds

TH #38 (Sta 29+300) C/L
(318322 E, 5180445 N)

0 - 50 Tps
 50 - 1.0 Br F-Co Cob(ly) Gr with Sa &
 Blds Tr Si (Moist & Comp)
 1.0 NFP Blds

TH #39 (Sta 29+670) C/L
(318550 E, 5180546 N)

0 - 500 Wat
 500 - 1.0 Br F-Co Cob(ly) Gr with Sa &
 Blds (Wet)
 1.0 NFP Blds

Appendix E

Highway 556 Route Alternative Drawings

Appendix F

Highway 556 Route Alternative Evaluation

Table F-1 Evaluation of Route Alternative 1 for Highway 556

Alternative Route No	Main geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
1	Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	-	Surficial condition –Dry (rapid) Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity	Improvement of the existing Hwy 556. Glaciofluvial: good source of aggregate	Favorable (Preferred)

Table F-2 Evaluation of route Route Alternative 2 for Highway 556

Alternative Route No	Main geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
2	East part of river crossing- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open	Surficial condition –Dry (rapid) Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity	Massive rock cut Using existing bridge structure	Less favorable
	West part of the river crossing- Glaciofluvial outwash: near the river Rock knob: Precambrian igneous and metamorphic rock.	Glaciofluvial outwash- Plain-open Rock knob- open to difficult (some location- about 20m high relief)	Glaciofluvial outwash- Surficial condition –Dry (rapid) Suspected high water table (vicinity of river and creek) Rock knob- Surficial condition –Dry (sandy till veneer, rapid)		Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	

Table F-3 Evaluation of Route Alternative 3 for Highway 556

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/ponded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
3	East part of river crossing - Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open	Surficial condition -Dry (rapid) Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas	Glaciofluvial: -Thickness of glaciofluvial deposit >5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	Massive rock cut and new bridge construction Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	Less favorable
	West part of the river crossing- Glaciofluvial outwash: near the river Rock knob: Precambrian igneous and metamorphic rock.	Glaciofluvial outwash- Plain-open Rock knob- open to difficult (some location- about 20m high relief)	Glaciofluvial outwash: Surficial condition -Dry (rapid) Suspected high water table (vicinity of river and creek) Rock knob: Surficial condition -Dry (sandy till veneer, rapid)				

Table F-4 Evaluation of Route Alternative 4 for Highway 556

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/pounded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and construction concerns	Recommendation
4	<p>West part of the river crossing</p> <p>Glaciofluvial outwash -(Sand and gravel) deposits are confined laterally but several exposures greater than 5 m thick were observed. Outwash is found in association with alluvial or organic terrain.</p> <p>Rock knob: Precambrian igneous and metamorphic rock.</p>	<p>Glaciofluvial outwash- Plain-open</p> <p>Rock knob-open to difficult (some location- about 20m high relief)</p>	<p>Glaciofluvial outwash: Surficial condition -Dry (rapid)</p> <p>Suspected high water table (vicinity of river and creek)</p> <p>Rock knob: Surficial condition -Dry (sandy till veneer, rapid)</p>	<p>Possible swamps in low lying areas</p> <p>Possible two watercourses (flow from pond to Mississagi River)</p>	<p>Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity</p> <p>Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m</p>	<p>New bridge construction and relatively longer distance than others</p> <p>long uphill section (about 5% uphill section may cause some difficulties to the future truck traffic)</p> <p>Glaciofluvial: Good source of aggregate</p> <p>Rock knob: Difficult to cut, can be used as crushed stone</p>	<p>Less favorable (possible long-term solution)</p>

Table F-5 Evaluation of Route Alternative 5 for Highway 556

Alternative Route No	Geological condition (surficial)	Topography (difficult/very rugged/open)	Drainage ability (rapid/fair/poor/pounded)	Extent of swamps and soft ground areas	Anticipated depth of bedrock	Remark and constructability	Recommendation
5	West part of river crossing- Glaciofluvial outwash: (Sand and gravel) deposits are confined laterally. Outwash is found in association with alluvial or organic terrain.	Plain-open	Surficial condition -Dry Suspected high water table (vicinity of river and creek)	Possible swamps in low lying areas	Glaciofluvial: -Thickness of glaciofluvial deposit>5 m, -Medium bearing capacity Rock knob: -Shallow drift over the bedrock <1 m, -Sandy till drift near flank of hills >5 m	New bridge construction and long uphill section (2-7% uphill section may cause some difficulties to the future truck traffic) Glaciofluvial: Good source of aggregate Rock knob: Difficult to cut, can be used as crushed stone	Not recommended
	East part of the river crossing- Glaciofluvial outwash-near the river Rock knob- Precambrian igneous and metamorphic rock.	Glaciofluvial: Plain-open Rock knob: open to difficult (route is on about 50m high relief)	Glaciofluvial: Surficial condition -Dry Suspected high water table (vicinity of river and creek) Rock knob: Surficial condition -Dry (sandy till veneer, rapid)				

Appendix G

Highway 556 Photographs



Photograph G-1 River bank, Hwy 556



Photograph G-2 Slope, Hwy 556



Photograph G-3 North bluff across the Mississagi River, Hwy 556



Photograph G-4 River bank, Hwy 556



Photograph G-5 River bank, Hwy 556



Photograph G-6 Sharp curve on the west approach to the bridge, Hwy 556



Photograph G-7 Sharp curve on the west approach to the bridge, Hwy 556

Appendix H

Limitations of Report

LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Coffey Geotechnics Inc. (Coffey) at the time of preparation. Unless otherwise agreed in writing by Coffey, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Coffey accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.