

GEOCRES No:
31D-400

FINAL
PRELIMINARY
PAVEMENT DESIGN
AND ROAD INFRASTRUCTURE MANAGEMENT REPORT

G.W.P. 314-00-00

Highway 11
and Muskoka Road 169 Interchange
at Gravenhurst
MTO District 52, Huntsville

Merlex Reference No. 02/02/02013m-1

October 7, 2002



MERLEX ENGINEERING LTD.

CONSULTING GEOTECHNICAL ENGINEERS

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1.0 INTRODUCTION

Group Work Project (GWP) 314-00-00 is located at Highway 11 and Muskoka Road 169 Interchange at Gravenhurst. The project is located within the District of Muskoka.

Merlex Engineering Ltd. (MEL) was retained as sub-consultants to Stantec Consulting Ltd. to complete a preliminary geotechnical assessment and a ranking of alternative highway alignments and interchange configurations, and to provide preliminary design comments on pavement structures and road embankments.

The assessment includes a review of existing source documents and field reconnaissance. No new boreholes were advanced for this study.

2.0 SITE DESCRIPTION, PHYSIOGRAPHY AND TOPOLOGY

The site for the alignments and interchange configurations under review is, in general, located within an envelope extending east of the existing Highway 11, easterly to include a 1000 m median centre line horizontal radius for a realigned Highway 11. This easterly limit for the study begins approximately 1 km south of the MTO Patrol Yard, passes through the MTO Patrol Yard, skirts the West end of Jevins Lake, and terminates at Pinedale Road/Hewitt Street intersection with existing Highway 11. The work includes realignment of Highway 11; realignment, with possible extension, of Muskoka Road 169; and interchange configuration options.

Throughout the report, reference is made to a 650 m radius previously proposed by the Municipality and a 575 m radius developed and studied by the Ministry in 1979. These realignments of Highway 11 fall within the study envelope described above.

The project area is located in the Precambrian Shield. The bedrock is middle to late Precambrian and is composed of clastic metasediments. Numerous bedrock outcrops are located in the project area. Deeper, well drained sands are found in the area of the MTO Patrol Yard.

The topography of this site consists of an extensive, flat muskeg area to the north and bedrock knobs, sand flats, and small areas of muskeg/wetlands to the south. These two areas are divided by steeply sloping bedrock. A poorly defined drainage stream follows the base of the bedrock outcrop from west to east. The new alignment will skirt the west side of Jevins Lake in the northern part of the site.

Two previously closed garbage dumps are located within the project limits. The approximate locations of these dumps is provided on the Site Plan in Appendix II.

Photographs providing a visual description of the site conditions are contained in Appendix I.

3.0 SCOPE OF GEOTECHNICAL ASSESSMENT

The assessment and ranking of alternative configurations is based on a review of existing documents and field reconnaissance of the site. The document review consists of available well records; pavement design/soils design reports; foundation investigation and design reports; soils profiles; topographic mapping; Ontario Base Mapping; and contract documents.

Non-intrusive field reviews were conducted to correlate the findings of the literature review with actual, visible field conditions. No intrusive fieldwork was completed.

The assessment of the alternative alignments consists of a discussion of several criteria that impact the design of pavement structure and ramps, approaches and embankments and a weighting of their impact. The alternatives will be ranked based on these criteria and their relative impact on the alternative/configuration.

4.0 REVIEW OF LITERATURE/SOURCE DOCUMENTS

4.1 WP 341-87-00 Preliminary Design Study for the Ultimate Freeway Design

This study will provide a full-move interchange including realignment of Highway 11, elimination of the Pinedale Rd./Hewitt St. at-grade intersection access (with provision of a flyover), and provision of a service road on the west side of Highway 11 utilizing a portion of the existing Highway 11 southbound lanes.

The study addresses two issues that have potential relevance to the pavement design and road infrastructure management for this site. Jervins Lake is a candidate heritage site due to the existence of a geological feature (potholes) and due to the existence of plant life (tuckahoe).

4.2 Soils Design Reports

Soils Design / Pavement Design Reports were requested for the immediate site and sites to the immediate north and south of this WP. Northern Region Geotechnical Section indicated that proposed rehabilitation of Highway 11 to the north and south would involve milling and paving with no change in the existing profile.

Northern Region Geotechnical Section provided the following report:

4.2.1 Interchange, Gravenhurst South WP 30-79-01

This report was prepared for the Gravenhurst South Interchange, recommended in the Preliminary Design Study for the Ultimate Freeway Design (WP 341-87-00). The design investigated included a new interchange, located at a distance of 350 m northeast of the existing interchange and a horizontal realignment with a 575 m radius.

Findings in this report include descriptions of the following:

Swamp: up to 5.2 m depth underlain by silty sand and sand with silt. The sand is described as being very loose to loose. The underlying sand will have a "quick sand effect" if the organic is not removed with caution. Silty clay layers were found in the sand.

Garbage Dumps: Two garbage dumps are located within the project limits. Neither dump is presently in use. An older dump is encircled by ramp 'E' ("E-NS") and a newer dump is located at Station $\pm 11+250$ for Highway 11. Borehole data indicated garbage depth to 1.2m in the areas investigated.

Bedrock: majority of bedrock to be removed is on the escarpment south of the bridge location and towards Bethune Drive at the north end of the proposed realignment of Highway 169.

The report provides recommendations including the following that have been summarized:

Pavement Design: full depth reclamation of asphalt over all existing, affected roads. The pavement structure to be comprised of HL4 Surface Course and Recycled Hot Mix Binder Courses (70/30 mix).

Swamp Excavation: all organics to be subexcavated for their full depth. Subexcavated materials to be replaced with select subgrade material to a level one metre above the existing swamp surface.

Garbage Dumps: Material to be excavated and all garbage and garbage contaminated material disposed of at an approved site.

Mid-height Berms: are recommended where the maximum height of fill above swamp level exceeds a "safe fill height" of 5 m.

Soil Erodibility: is estimated to be slight to moderate. Slopes are to be trimmed on completion of construction and topsoil/seeding operations completed as soon as possible.

Frost Penetration: can be assumed to be 1.4 m for this project.

4.2.2 (Soils Profile) Interchange, Gravenhurst South WP 30-79-01

An extensive Soils Profile (11N11-14), complete with pedological sketches was completed as part of WP 30-79-01.

4.3 Geocres Reports

Geocres was searched for existing reports. The following were made available for review.

31D-120	WP: (Nil) (WJ 63-F-119)	Gravenhurst Patrol Yard
31D-123	WP 247-60-1 (WJ 67-F-30)	South Interchange of Gravenhurst By-Pass
31D-272	WP 30-79-02	Gravenhurst South Interchange

Relevant geotechnical information included the following:

4.3.1 Gravenhurst Patrol Yard WP: Nil (WJ 63-F-119)

This site is located south of the existing interchange and the area of the existing patrol yard will be incorporated in the alternative alignments being reviewed.

Three boreholes were extended to a depth of ± 5 m. The stratigraphy of the soil was found to be uniform throughout the site. Below a thin layer of topsoil, a layer of silty sand with occasional gravel was encountered for the full depth of the boreholes. The relative density of this layer is dense to very dense. The water level was approximately 4.2 m below existing ground level at the time of the investigation (October 1963). Water levels will fluctuate seasonally.

4.3.2 South Interchange of Gravenhurst By-Pass WP 247-60-1 (WJ 67-F-30)

This investigation was conducted for Bridge Site No. 42-139 and the location is described as the proposed crossing of the proposed Highway 11 Southbound Lane and Toronto-Gravenhurst Ramp.

The initial investigation (April 1967) included 6 sampled boreholes and 7 dynamic cone penetration tests. This investigation indicated that the main deposit was bedrock. Outside the area where the rock surface is visible, a deposit of "industrial waste material consisting of cinders, sand, and organics" was encountered. Borehole logs indicate that where this material was encountered, it extends to depths up to 8.8 m (29.1 feet). The density of this material is described as being very loose to very dense. The elevation of the rock surface varies "somewhat erratically".

The recommendations included use of spread footings placed directly on the bedrock.

A subsequent investigation (October 1967) included 8 sampled boreholes. This investigation revealed bedrock at the south abutment location at a depth of ± 10.6 m and the upper portion of the subsoil; which was considered unsuitable for spread footings.

Recommendations included use of H piles with Oslo-Points driven ± 5 cm to 7.5 cm into the bedrock.

4.3.3 Gravenhurst South Interchange WP 30-79-02

This site is located some 350 m east of the existing Highway 11 and Muskoka Road 169 interchange.

The investigation (March/April 1980) included 5 sampled boreholes accompanied by dynamic cone penetration tests, one sampled borehole, and 6 probe holes augered to refusal. The report identifies the extensive muskeg area ranging in depth from 1.2 m to 5.2 m. The predominant mineral soil deposit underlying the site extending to bedrock is silty sand to sand

ranging from very loose to very dense. A cohesive stratum of silty clay interbedded with alternating layers of silt and sandy silt was encountered, increasing in thickness from south to north. Random inclusions and partings of silt occur throughout. It has a maximum thickness of 6.2 m and "pinches out" where it intersects the steeply sloping bedrock to the south. The consistency of this silty clay stratum is assessed as soft to stiff, but generally firm throughout.

Due to the low lying marshy nature of the area and poor drainage characteristics across the site, groundwater levels can be assumed to be at or immediately below ground surface (elevation ± 247).

Recommendations include full depth removal of the muskeg and replacement with select subgrade material to a level 1 metre above the existing swamp surface.

Safe fill heights of 5.0 m and 9.0 m and construction of the respective mid-height berms are discussed for the embankments. These values reflect the properties of the silty clay. Where the silty clay is described as soft to firm, a safe embankment height of 5.0 m is noted. Where the silty clay is described as firm to stiff, a safe embankment height of 9.0 m is noted.

(Note, these safe fill heights and their relation to the silty clay are discussed further in the comments section of the Foundation Engineering portion of WP 314-00-00).

Recommendations for the Highway 169 structure included use of steel H piles with Oslo tips driven into the rock, reinforced concrete caissons socketed into the sloping bedrock, or footings to be founded on competent bedrock.

4.4 Well Records

Well records were searched and obtained for wells drilled within 2 km of the intersection of Highway 11 and Muskoka Road 169. The records indicated overburden consisting of fine to coarse sands and gravel overlying bedrock (granite). The overburden depths ranged from very shallow depths (0.6 to 1.0 m) to depths exceeding 19 m. Static water levels of 1.5 m to 7.4 m (5 feet to 24 feet) were recorded.

Records for wells advanced immediately south of the existing MTO Patrol Yard were bedrock wells with sands and gravels overlying the granite bedrock with static water levels reported at 3 m to 7 m.

Wells advanced for the MTO Patrol Yard and former Government Services, north of the patrol yard were completed within the sand overburden and had static water levels reported at 3 m to 6 m.

4.5 Contract Documents

Contract drawings were prepared for WP 30-79-01/02.

Plate 37 provides muskeg excavation sections. These sections require full-depth muskeg removal to firm bottom or as directed by the Engineer and backfilling with uncompacted, select subgrade material to elevation 248.0. Sections are given for varying fill heights (<2.2 m, 2.2 m to 3.0 m, 3.0 m to 5.0 m, and > 5.0 m). A table detailing fill heights from 5.0 m to 9.2 m and required mid height berm widths is provided. No mid-height berm was specified for fills to 5.0 m in height. At 13 m fill height, a 9.2 m mid height berm was specified.

Plate 40 provides sections for cuts and fills in the garbage dump area(s). Excavation to bottom of garbage or firm bottom and backfilling with suitable earth fill is specified.

5.0 FIELD RECONNAISSANCE

Several field reviews were completed to correlate the factual data reviewed and the existing current conditions.

Waste materials (household items, appliances, furniture, etc.) were observed in the general areas of the garbage dumps. It was not apparent as to whether these materials were disposed of prior to or subsequent to the closing of the dumps. The lateral extent of the dumps was not obvious during the field reviews of this site. The approximate locations of the dumps are provided on the Site Plan in Appendix II.

Photos documenting these reviews and describing the site conditions are provided in Appendix I.

Two specific areas were reviewed in greater detail due to limited information and their impact on the selection of an alternative/configuration:

5.1 Area Bounded by the Southbound Access to Gravenhurst from Highway 11, Highway 11, and Muskoka Road 169

Very little factual information on the swamp/soft ground area bounded by the southbound access ramp to Gravenhurst from Highway 11, and Muskoka Road 169 is available. The alignment of the southbound access to Gravenhurst appears to have been selected to avoid the centre of this swamp. This area may be part of an alternative to realign Muskoka Road 169. While it is anticipated that embankment heights in this area would be low, an investigation to determine the muskeg depth and underlying soils will have to be undertaken.

5.2 Swamp/Soft Ground Area in Northern Part of Study Area

Factual information indicates depths of muskeg in this area to 5.3 m. Foundation investigations indicate a cohesive stratum of silty clay of up to 6.2 m in thickness. The silty clay stratum needs to be delineated and its properties investigated. Embankment design will be dependent on these findings. Field review indicates access may be difficult, possibly requiring the use of winter roads.

6.0 ALTERNATIVE ALIGNMENT/CONFIGURATION ASSESSMENT AND RANKING

6.1 Criteria Used In Assessing Alternatives

To evaluate the alternative alignments being considered, criteria as specified in the RFP will be used. The criteria and a description of the ideal condition that would exist for an alternative follow:

Evaluation Criteria	Conditions Representing Ideal
Drainage	The existing drainage pattern is unaffected by cuts and fills. No culverts are required. Groundwater levels are unaffected by cuts and fills.
Groundwater Conditions	All construction would be completed above existing groundwater levels. No cuts would be required below the existing groundwater level. A minimum 1.5 m clearance between profile grade and existing groundwater level would be maintained.
Potential frost heave problem areas	Soil subgrade indicates a low susceptibility to frost heaving (i.e. absence of silty soils). Soil subgrade is dry.
Soft ground/swamp	Soft ground/swamp does not exist or relatively shallow deposits (< 300 mm) exist in fill areas.
Rock outcrop	Rock cut and fill is balanced. Rock cuts do not affect existing drainage patterns. No existing structures are located within critical blast areas. No vertical rock faces at rock cut/fill interface.
Existing and potential landslides	Area is not prone to landslide based on geologic history using normal construction techniques. No unusual seams/bedding patterns in rock structure.

Evaluation Criteria	Conditions Representing Ideal
Slope stability	Existing soils are cohesionless, compact to dense. No weak zones.
Settlement	Problem of settlement and future grade raises are avoided due to absence of soft ground/swamp
Erosion	Slope geometry and soil cover is not susceptible to erosion (soil has a K factor <0.2). Existing soil types not susceptible to erosion during construction phase. Vegetative cover is unaffected. Soil type in subdrains and culvert outlets is not susceptible to erosion.
Drill rig and construction accessibility	Site is relatively flat and level. Site does not have areas of free water. Soil type is capable of supporting heavy equipment and is not prone to deteriorating due to traffic. Access through private property is avoided.
Construction feasibility	All of above criteria satisfy ideal condition.

6.2 Weighting and Ranking of Criteria Used In Assessing Alternatives

To evaluate the alternative configurations, each criterion was given a numerical indication of the severity of the criteria. A range of values from 0 to 5 was assigned to indicate the severity of the criteria. A value of 0 indicates that the ideal condition (as outlined in the preceding table) exists for the alternative/configuration while a value of 5 indicates that extremely poor or difficult conditions exist.

The criteria used for assessment do not have equal impact on an alternative. For example, bedrock outcropping has a significantly lower impact on an alternative than soft ground/swamp. Based on the expertise of the design team, criteria were established for the assessment of this specific site. The criteria were numerically weighted depending on its relative impact on an alternative. A range of values from 0.1 to 1.0 was used to indicate the relative impact of the criteria on the alternative. A weighting of 0.1 indicates low impact, while a value of 1.0 indicates a very significant impact.

6.3 Ranking of Alternative/Configurations

The following matrix is provided to allow a quantitative assessment of each alternative / configuration.

Alternative:

Criteria	Weight	low	Severity					high	Quantitative Assessment
		0	1	2	3	4	5		
Soft Ground/Swamp	1.0								
Settlement	0.8								
Groundwater	0.7								
Slope Stability	0.6								
Erosion	0.5								
Drill Rig and Construction Access	0.3								
Drainage	0.3								
Frost Heave	0.3								
Existing and Potential Landslide	0.2								
Rock Outcrop	0.1								
Construction Feasibility	0.1								
Total									

7.0 HORIZONTAL AND VERTICAL ALIGNMENT RECOMMENDATIONS

7.1 Horizontal Alignment

From a geotechnical perspective, the preferred horizontal alignment selected will include the following:

- Highway 11 realignment through flat muskeg (soft ground/swamp) area north of the poorly defined drainage ditch/rock face minimized
- Muskoka Road 169 realignment and possible extension located south of the poorly defined drainage ditch/rock face. This would place the alignment on a rock and sand subgrade and avoid potential problems of settlement, groundwater, and drainage in the soft ground/swamp area. The location of the Muskoka Road 169 realignment west of existing Highway 11 avoids the muskeg (soft ground/swamp) located south of the existing southbound access to Gravenhurst.
- Ramps and loops would be located south of the poorly defined drainage ditch/rock face. This would place the alignment on a rock and sand subgrade and avoid potential problems of settlement, groundwater, and drainage in the soft ground/swamp area. Service roads through flat muskeg (soft ground/swamp) areas are minimized.

7.2 Vertical Alignment

From a geotechnical perspective, the preferred vertical alignment selected will include the following:

- The profile for Highway 11 through the flat muskeg (soft ground/swamp) area north of the poorly defined drainage ditch/rock face would require fills and construction of embankments allowing a minimum of 1.5 m clearance between profile grade and the

groundwater levels; and a maximum height less than the safe fill height (5 m as specified in WP 30-79-01 Soils Design Report).

- The profiles for the loops and ramps in soft ground/swamp areas would require fills and construction of embankments allowing a minimum of 1.5 m clearance between profile grade and the groundwater levels; and a maximum less than the safe fill height (5 m as specified in WP 30-79-01 Soils Design Report).

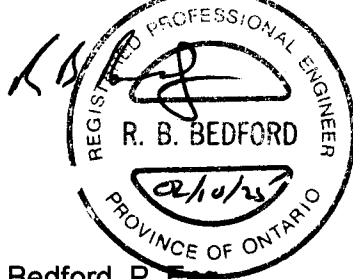
8.0 CLOSURE

The literature review, mapping, borehole and contract data review, review of well records was completed by or under the supervision of Mr. R. Bedford, P. Eng. Mr. R. Bedford and Mr. M. A. Merleau, P. Eng., Principal of the firm completed field reconnaissance trips. The report was written by Mr. R. Bedford, P. Eng. and reviewed by Mr. M. A. Merleau, P. Eng.

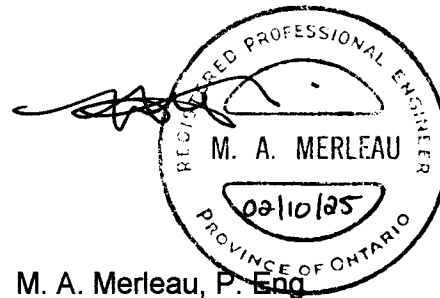
Details of the reviews and recommendations are considered to be complete. However, should any questions arise, please do not hesitate to contact the undersigned.

Yours very truly,

MERLEX ENGINEERING LTD.



R. B. Bedford, P. Eng.
Project Engineer



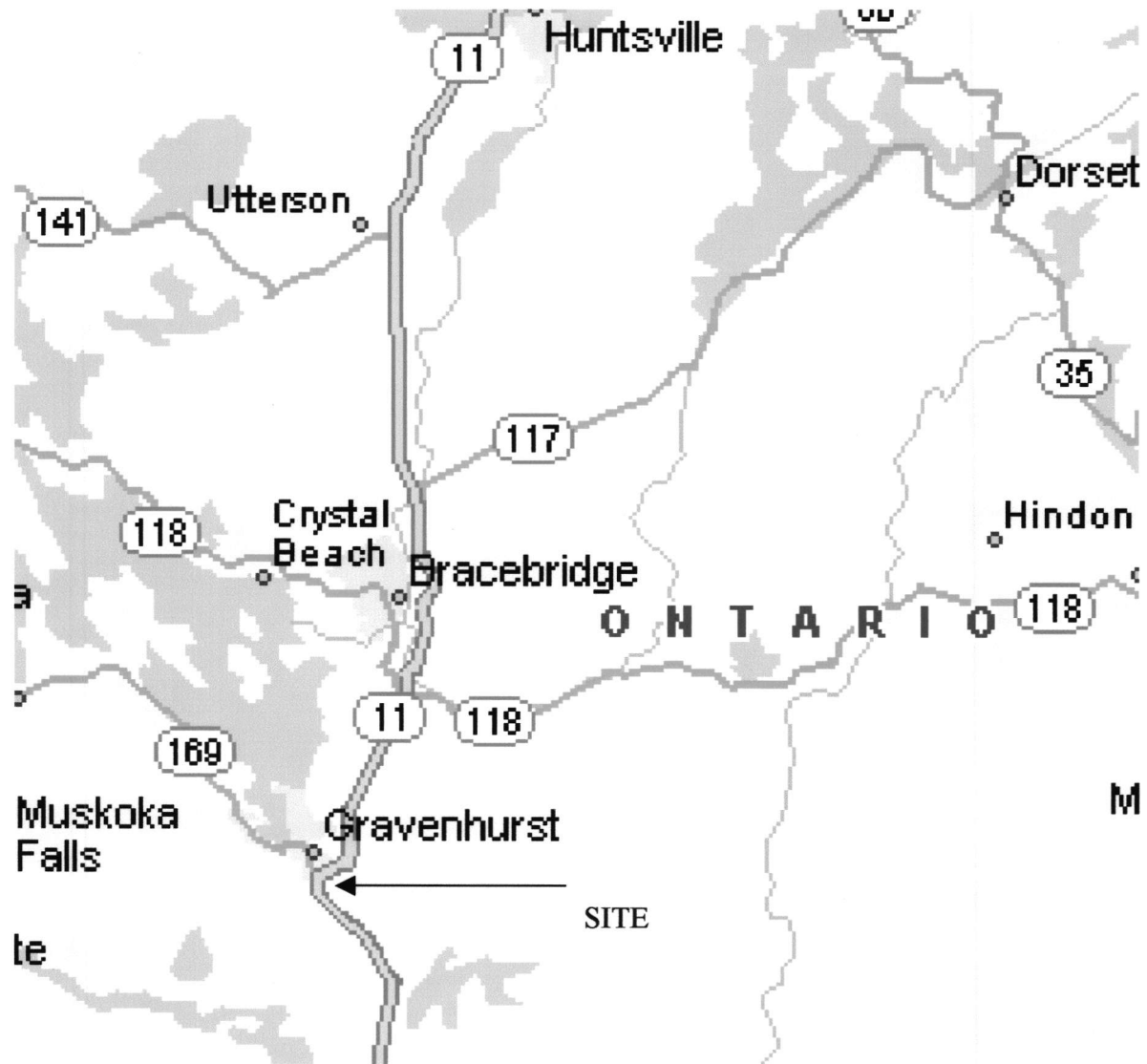
M. A. Merleau, P. Eng.
Principal

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APPENDIX I

Key Plan
Photo Essay

KEY PLAN



Not to Scale

Highway 11 and Muskoka Road 169
Interchange at Gravenhurst MTO District 52, Huntsville
W.P 314-00-00



MERLEX ENGINEERING LTD.
CONSULTING GEOTECHNICAL ENGINEERS



Southern Limit of Project Looking North.

Photo: 1



±600 m North of South Limit of Project East Side of Highway 11.

Photo: 2

Reference No.: 02/02/02013
Project: Hwy 11 & 169

Originated By: MAM / RB
Date: July, 2002



Area South of MTO Patrol Yard. Approximate East Limit of Alternative Alignments.

Photo: 3



Area North of MTO Patrol Yard Approximate East Limit of Alternative Alignments.

Photo: 4

Reference No.: 02/02/02013

Originated By: MAM / RB

Project: Hwy 11 & 169

Date: July, 2002



South End of Municipal (650 m Radius) Alternative.

Photo: 5



On Municipal (650 m Radius) Alternative ± 300 m North of South End Looking North.

Photo: 6

Reference No.: 02/02/02013

Originated By: MAM / RB

Project: Hwy 11 & 169

Date: July, 2002



Swamp/Soft Ground Looking South/East from Highway 11.

Photo: 7



Swamp/Soft Ground Looking North/ East from Highway 11.

Photo: 8

Reference No.: 02/02/02013

Project: Hwy 11 & 169

Originated By: MAM / RB

Date: July, 2002



Swamp/Soft Ground Area West of Highway 11. Looking East
from Muskoka Road 169

Photo: 9



Swamp/Soft Ground West of Highway 11. Looking South from
South Bound Access Ramp.

Photo: 10

Reference No.: 02/02/02013

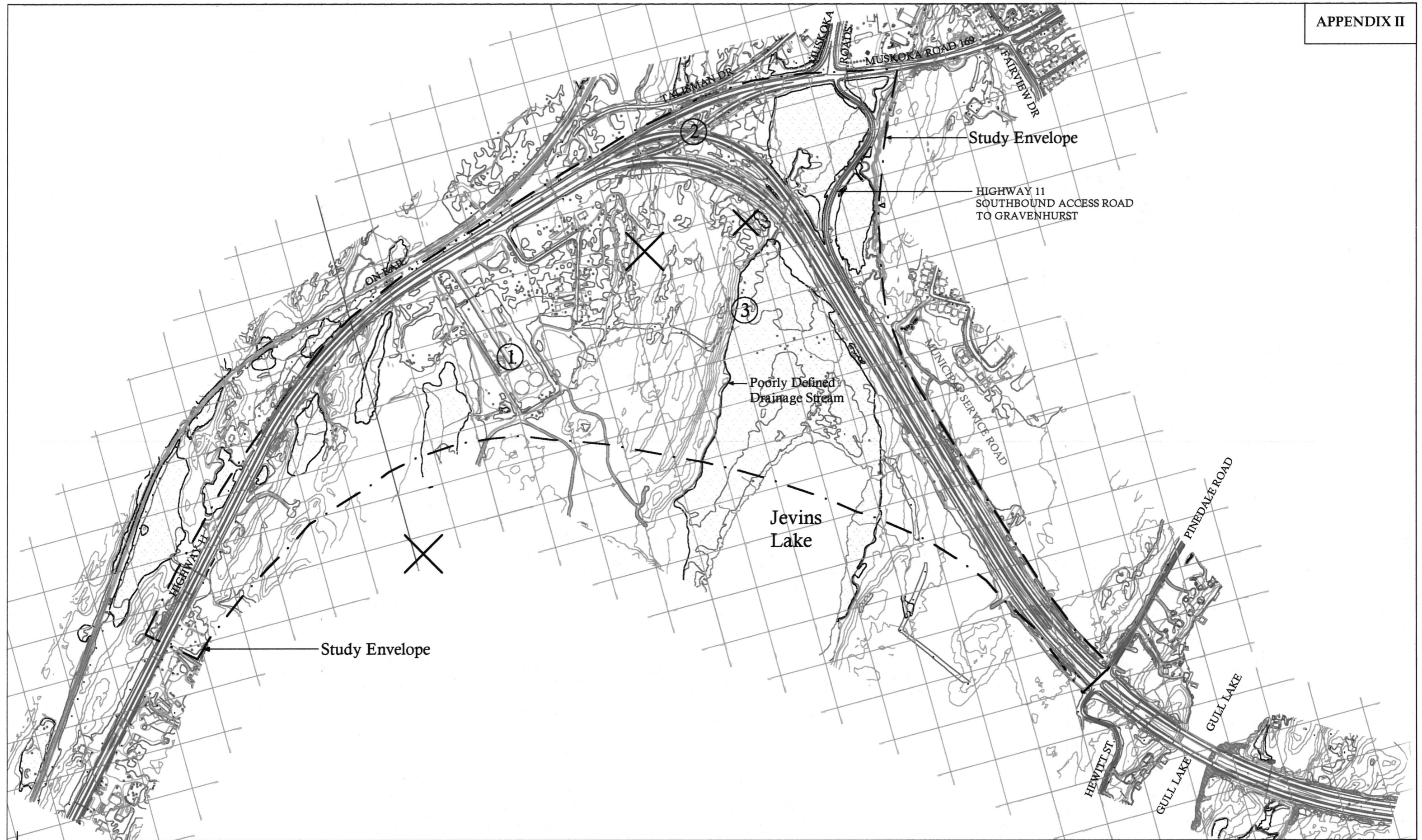
Originated By: MAM / RB

Project: Hwy 11 & 169




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
APPENDIX II

Site Plan



INDEX:

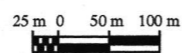
-  Soft Ground / Swamp
-  2.5 m Contours
-  Study Envelope

-  Location of Bedrock Outcropping
-  Approximate Location of Garbage Dump

Foundation Boreholes

- ① : WJ 63-F-119
- ② : WP 247-60-1
- ③ : WP 30-79-02

SCALE



Highway 11 and Muskoka Road 169
Interchange at Gravenhurst MTO District 52, Huntsville
W.P. 314-00-00

Site Plan

 **MERLEX ENGINEERING LTD.**
Consulting Geotechnical Engineers

Project: 02013

Date: 02/07/25