BRITISH COLUMBIA

Ministry of Transportation

Horne Lake Connector Study

Conceptual Design and Construction Cost Estimate

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NDLEA™

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EXECUTIVE SUMMARY

The Horne Lake Connector Study project was undertaken to develop a high level cost estimate for a several routes linking Port Alberni to Highway 19 (Island Highway) via Horne Lake. The Horne Lake Connector has been designed to grades and elevations comparable to Highway 4 in order to provide a reasonable alternate route between Port Alberni and the Island Highway.

ND LEA Consultants Ltd. developed two alignment options, as well as the associated typical sections and corresponding construction cost estimates. Total costs for the connector are estimated to range from $38.4M to $45.5M and are based on a rural 2-lane highway standard. These costs reflect new road construction and are similar to the Wolski construction cost estimate of $37.3M prepared by E. Wolski Consulting in March 2004. The presence of the existing Horne Lake Road is estimated to reduce total cost estimates for the Option 2 connector by 5% to 10%.

Estimates of the existing Horne Lake Road average annual daily traffic (AADT) volumes and future traffic volumes of the Horne Lake Connector have been developed assuming two Highway 4 traffic diversion scenarios. These scenarios reflect a diversion of a) 50% of the traffic from Highway 4 travelling to/from points north of the Horne Lake Road / Highway 19 intersection; and b) 75% of the traffic from Highway 4 travelling to/from points north of the Horne Lake Road / Highway 19 intersection. This traffic diversion is primarily attributable to a travel time savings of approximately 13 minutes. It is estimated that 2010 AADT base volumes (no connector) for the Horne Lake Road will be approximately 1200 vpd while summer average daily traffic SADT volumes will reach 2400 vpd. The Horne Lake Connector is expected to attract between 675 vpd and 1000 vpd from Highway 4. This would increase traffic volumes between Horne Lake Provincial Park and Highway 19 up to 2200 vpd.

Preliminary benefit-cost analyses indicate a net benefit-cost ratio of 0.63 to 0.86, and are based on a diversion rate of 50% to 75%, respectively. This economic simulation is limited to the travel time savings for the traffic volumes diverted from Highway 4 only and does not consider safety or mobility benefits to existing traffic along Horne Lake Road.

1.0 BACKGROUND

The Alberni-Clayoquot Regional District (ACRD) has formed a Connector Road Committee to promote construction of a new highway linking Port Alberni to Highway 19. The formation of the Committee was primarily in response to two issues: (i) concerns about the condition of the existing highway between Port Alberni and Highway 19; and (ii) the increase in truck traffic due to the end of rail service to the city.

Previous studies have concluded that there is a greater economic benefit by improving the existing highway than constructing a new route. The Committee is aware that the Ministry of Transportation (MoT) may not be in a financial position to consider the immediate construction of a new highway, but would like the MoT to pursue further studies regarding a new link that could confirm a need to reserve an alignment corridor for future development. The *Vancouver Island Valley Link Study* prepared by E. Wolski Consulting in March, 2004 summarized the costs associated with alignment upgrades and new road construction. This study looked at a number of links including a connector between Port Alberni and Highway 19 via Horne Lake.

The MoT has decided to further investigate the link between Port Alberni and Highway 19 via Horne Lake and refine construction cost estimates based on improved base mapping. The link would likely involve a combination of new road construction between Port Alberni and Horne Lake Caves (HLC) Provincial Park and upgrades to the existing Horne Lake Road between the Provincial Park and Highway 19.

The main objective of the ND LEA conceptual design and construction cost estimate for the Horne Lake Connector Study was to:

(a) obtain digital terrain resource information management (TRIM) mapping and generate a digital terrain;
(b) establish a clear set of design objectives and consistent design criteria to define and evaluate various road alignments;
(c) develop conceptual horizontal alignments, profiles and typical cross sections;
(d) generate cut, fill and template earthwork volumes for alignment options;
(e) produce construction cost estimates based on generated earthwork volumes; and
(f) perform a comparative analysis between the Wolski and ND LEA generated options.

This report also provides an estimate on the existing Horne Lake Road average annual daily traffic (AADT) volumes and future traffic volumes of the Horne Lake Connector assuming various Highway 4 traffic diversion scenarios. ND LEA has also performed preliminary benefit-cost analyses relating to travel time savings and total construction costs. No attempts to quantify benefits related to improved safety along the existing Horne Lake Road have been made.

The cost estimates for the routes identified have been based on consistent design parameters, unit costs and rationale for lump sums as presented in the Wolski method.

2.0 BASE MAPPING

A combination of 1:20,000 TRIM base mapping and aerial photographs were used to assist in route selection. This base mapping shows 25 m major and 5 m minor elevation contours, existing roads, highways, railways, transmission lines, streams and lakes. A digital terrain model (DTM) of the Horne Lake area was then built using point and breakline files within Autodesk Land Desktop software. This model was then used as the base mapping for all elements of the conceptual design.

3.0 DESIGN OBJECTIVES

The object of the Horne Lake Connector Phase 1 Conceptual Design project was to prepare a high level cost estimate for a select number of routes connecting Port Alberni to Highway 19 via Horne Lake. An essential element of the route was that it provides a reasonable alternative to Highway 4. To achieve this, a number of design criteria for both the horizontal alignment and vertical profile were generated. More specifically, the project aimed to minimize the route length, achieve acceptable design speeds, vertical grades and pass elevation over the Beaufort Range Mountains. Other factors, such as provincial park boundaries, natural constraints and development potential for both recreational and residential properties were also considered.

Highway 4 is a rural, two-lane highway with numerous sub-standard reduced speed sections and shoulder widths. The pass elevation between Port Alberni and the Island Highway (Highway 19) is 414 m. Grades leading up to this summit exceed 9%.

The Horne Lake Connector has been designed to comparable maximum grade and pass elevations in order to attract truck traffic from Highway 4. At this conceptual design stage, three-lane sections (climbing or passing lanes) have not been considered. As the pass elevations of the proposed connector and Highway 4 are comparable, it is anticipated that weather related maintenance costs and potential for closures due to inclement weather will be similar. Based on the alignment length and related grades and elevations, it is believed that the Horne Lake Connector will be able to attract between 50% and 75% of the traffic volumes that travel to and from points north of Horne Lake Road from Highway 4. This traffic diversion is primarily attributable to savings in travel times. These travel time savings are presented in Section 6.3 of this report.

The use of existing roads, particularly the Horne Lake Road from Highway 19 to Horne Lake Caves Provincial Park was considered in alignment selection. Wherever possible, existing road footprints were used to minimize construction costs and the environmental impact of new road construction.

4.0 DESIGN CRITERIA

In order to evaluate several alignment options, a set of design criteria was established for the conceptual design of the Horne Lake Connector. These parameters relate to the horizontal alignment, vertical profile and typical cross sections used in the road design and are based on the *Transportation of Canada (TAC) Geometric Design Guide for Canadian Roads (September 1999).*

It should be mentioned that a minimum design speed of 60 km/hr, several reduced speed sections and a maximum grade of 10% were chosen to provide a design that would establish a lower limit construction cost estimate while maintaining an acceptable design standard. For comparison, Highway 4 between Highway 19 to Highway 4A (Redford Road) has a posted speed of 80 km/hr, numerous reduced speed sections (nine 60 km/hr curves, five 50 km/hr curves and one 40 km/hr curve), and existing maximum grades in excess of 9%.

4.1 Horizontal Alignment

- Alignment Length – design to minimize road length where possible;
- Design Speed – design to achieve a minimum 60 km/hr with minimal reduced speed sections;
- Crossings – design to minimize the number of river/stream crossings;
- Existing Roads – identify and utilize existing roads where possible;
- Park Boundaries – identify and avoid provincial park boundaries; and
- Natural Constraints – identify and avoid natural constraints where possible.

4.2 Vertical Alignment

- Maximum Elevation – identify maximum elevation associated with alignment options (422 m). Route selection was performed to minimize this design parameter.
- Maximum Grade – establish maximum grade of 10%. This is consistent with the TAC guidelines for rural mountainous terrain with a 60 km/hr design speed.
- Rate of Vertical Curvature – crest vertical curve K=10; sag vertical curve K=15. By minimizing the rate of vertical curvature the volume of cut and fill material can also be minimized while maintaining acceptable sight stopping distances.

4.3 Typical Cross Sections

- Pavement Structure – a pavement structure of 100 mm asphalt, 300 mm crushed base coarse and 300 mm select granular base coarse was used.
- Lane and Shoulder Widths – lane widths of 3.5 m and shoulder widths of 2.0 m (1.5 m paved and 0.5 m gravel) were used.
- Cut and Fill Slopes – two typical cross-sections were developed using various cut slopes, fill slopes and ditch widths.
- Ditches – ditch widths varied from 0.6 m to 1.0 m, depending on the typical section.

4.4 Alignment Options

A number of alignment options were identified and evaluated based on the preliminary design criteria described above. Of the approximately ten alignments or variations on alignments initially identified by ND LEA, all but two were eliminated due to a combination of unfavourable topography, considerably higher pass elevations and/or longer route lengths. Potential routes starting from Highway 4 at the top of the Alberni hump were found to add considerable elevation gain and/or length to the Horne Lake Connector. It was also found that a route from the east side of the Alberni hump to the east side of Horne Lake (between Mount Horne and Mount Wesley) would require road construction through very steep and difficult terrain. This would result in much higher construction and maintenance costs, and would present a significant visual impact from the Cameron Lake area (MacMillan Provincial Park, Little Qualicum Falls Provincial Park) relative to the alignment options identified further to the west.

This preliminary screening process resulted in the selection of two alignment options for further refinement and review. These alignments, Option 1 and Option 2, follow the south and north shore of Horne Lake, respectively. Apart from deviating from each other around Horne Lake, the alignments are common, constrained by a combination of various design criteria. Figure 80011-SK-01 shows the Horne Lake Alignment Options in plan. Station labels for Option 1 are shown from Port Alberni to Dunsmuir, while stationing for Option 2 is shown only around Horne Lake. A station equation of Option 1 Sta 21+919 = Option 2 Sta 23+272 indicates that Option 2 around the north shore of Horne Lake is approximately 1.35 km longer. Total road lengths of 25.4 km and 26.7 km were determined for Options 1 and 2, respectively. With both options there is the opportunity to utilize existing roads.

Figure 80011-SK-02 shows the profiles associated with alignment Options 1 and 2. As noted, the horizontal alignments and corresponding profiles are common in the gray shaded areas. Additionally, a maximum elevation of 422 m is common for both options and is reached at approximate Sta 6+350.

Figure 80011-SK-03 shows all slopes and dimensions for both Typical Section A and Typical Section B. These sections were applied to both alignment Option 1 and Option 2 in order to determine the effect of ditch width and cut and fill slope ratios on overall construction costs.

5.0 HORNE LAKE CONNECTOR COST ESTIMATES

5.1 Wolski Cost Estimate

In March of 2004, the *Vancouver Island Valley Link Study* was completed by Focus with E. Wolski responsible for the cost estimating. A number of routes were identified as part of this study. Included in this link study was a 29 km route between Port Alberni and Dunsmuir which closely follows the option identified as Option 2 by ND LEA, i.e. around the north shore of Horne Lake. As part of the Wolski report, a detailed construction cost estimate was prepared quantifying all management, engineering, construction and land acquisition costs, along with additional project contingencies.

Engineering and construction costs were further itemized, quantified and associated with a unit cost to determine the overall project cost. The Wolski report also categorized the proposed alignment into different sections based on the condition of existing roads. The condition of these existing roads was based on 1:50,000 topographic maps and were categorized into the following class types:

Class 1—all weather 2-lane gravel requires minor upgrade to road structure, paving but no widening

Class 2—less than 2-lane gravel requires widening, minor upgrade to road structure and paving

Class 3—dry weather gravel road requires widening, extensive upgrade to road structure and paving

Class 4—unclassified road requires extensive widening, extensive upgrade and paving

The Wolski cost estimate is essentially based on 10 km of new road construction, 4.5 km of class 1 upgrades, 7.5 km of class 2 upgrades, 1 km of class 3 upgrades and 6 km along Highway 4 where no significant upgrades are required.

The upgrades required are essentially based on the presence and condition of existing roads. The Wolski Horne Lake Connector, also described as Link C in the *Vancouver Island Valley Link Study*, partitioned the connector into four sub-sections: C–1 through C–4.

- C–1: an existing 2-lane 6 km paved road section from Port Alberni along Highway 4 to the start of the connector. No major work is required for this section.
- C–2: an 11 km section that involves the construction of a new 2-lane paved road. Wolski assumes 1 bridge crossing, 4 major culverts, 1 railway crossing and 400 m^2 of retaining walls.

- C–3: an existing 7.5 km gravel road section (Horne Lake Road) that requires widening, grade rehabilitation and paving. Wolski assumes 1 bridge, no major culverts, 200 m^2 of retaining walls and roadside barriers. Provision for a 10.2 m-wide road (two 3.6 m lanes with two 1.5 m shoulders) was made in the road widening cost estimates. It was assumed that existing roads in the C–3 section are generally 7.2 m wide.
- C–4: an existing 4.5 km road section (Horne Lake Road). It was assumed that the width for this section is correct for the new profile and that no major bridges, culverts or retaining walls are required. Main costs for C–4 are associated with the pavement structure.

A breakdown of the major cost items and relative percent of total project cost of the Wolski cost estimate is provided in the following table.

Table 1. Wolski Major Cost Items

Item	Activity	Cost	Percent of Total Cost
1.0	Project Management	$ 1,331,937.60	4%
2.0	Engineering	$ 2,492,447.23	7%
3.0	Construction	$ 24,681,754.48	66%
4.0	Contingency	$ 5,914,977.86	16%
5.0	Management Reserve	$ 1,774,493.36	5%
6.0	Land Acquisition	$ 1,068,750.00	3%
	TOTAL COST	**$ 37,264,360.53**	**100%**

A further breakdown of the project items and associated costs along the Wolski sections is provided in Table 2: Wolski Cost Estimate.

Table 2. Wolski Cost Estimate

Item	Activity	Section C-1	Section C-2	Section C-3	Section C-4	TOTAL
1.0	**PROJECT MANAGEMENT**	$ 2,067	$ 808,162	$ 382,540	$ 139,168	$ 1,331,937
2.0	**ENGINEERING**					
2.1	*Preliminary Design*	$ *20,000*	$ *388,283*	$ *265,351*	$ *157,500*	$ *831,135*
2.2	*Detailed Design*	$ *1,507*	$ *1,020,989*	$ *472,784*	$ *166,029*	$ *1,661,311*
	Total Engineering	$ 21,507	$ 1,409,273	$ 738,135	$ 323,529	$ 2,492,447
3.0	**CONSTRUCTION**					
3.1	*Grade Construction*	$ *20,600*	$ *11,021,897*	$ *4,450,743*	$ *1,033,156*	$ *16,526,397*
3.2	*Other Construction*	$ -	$ *324,449*	$ *133,899*	$ *401,699*	$ *860,049*
3.3	*Structural Construction*	$ -	$ *547,321*	$ *475,221*	$ -	$ *1,022,542*
3.4	*Paving Construction*	$ -	$ *2,014,315*	$ *1,373,396*	$ *824,038*	$ *4,211,750*
3.5	*Operational Construction*	$ -	$ *39,964*	$ *25,544*	$ *9,270*	$ *74,778*
3.6	*Utility Construction*	$ -	$ -	$ *100,000*	$ -	$ *100,000*
3.7	*Resident Engineering*	$ *1,730*	$ *1,160,630*	$ *533,361*	$ *190,513*	$ *1,886,235*
	Total Construction	$ 22,330	$ 15,108,578	$ 7,092,167	$ 2,458,678	$ 24,681,754
4.0	**CONTINGENCY**	$ 9,181	$ 3,588,952	$ 1,698,818	$ 618,025	$ 5,914,977
5.0	**MANAGEMENT RESERVE**	$ 2,754	$ 1,076,685	$ 509,645	$ 185,407	$ 1,774,493
6.0	**LAND ACQUISITION**	$ -	$ 618,750	$ 281,250	$ 168,750	$ 1,068,750
	TOTAL	***$ 57,841***	***$ 22,610,403***	***$ 10,702,558***	***$ 3,893,557***	***$ 37,264,360***

5.2 ND LEA Cost Estimate

The ND LEA construction cost estimates for the Horne Lake Connector Option 1 and Option 2 alignments are based on the Wolski cost estimate model, with revised quantities generated using the LDD terrain models. Unit costs associated with grade and paving construction were typically taken from the Wolski report, with the unit cost of excavation and fill placement set at $\$10/m^3$. Lump sum costs relating to project management, contingency, management reserve and land acquisition were also taken from the Wolski estimate. Engineering costs account for approximately 10% of the total construction costs.

Apart from deviating from each other around Horne Lake, the Option 1 and Option 2 alignments are common, constrained by a combination of various design criteria. Option 1A relates to alignment Option 1, Typical Section A whereas Option 1B relates to alignment Option 1, Typical Section B. Similar terminology is used for alignment Option 2.

Structural costs associated with bridge construction are based on the assumed unit cost of $\$2000/m^2$ plus associated engineering and management costs. From reviewing the 1:20,000 TRIM base mapping it has been estimated that the Option 1 alignment will contain 3 major crossings and 2 minor crossings, while the Option 2 alignment will contain 5 major and 5 minor crossings. A major crossing has been defined as having a 16 m span, while the minor crossing has been defined as having a 10 m span. For cost estimating purposes, a drainage area of 200 ha or more requires a major crossing. Both major and minor crossings have a width of 11.4 m. This is comprised of two 3.5 m lanes, 1.8 m shoulders and an allowance of 0.4 m for barriers. An allowance for minor culverts has been made based on an assumed spacing of 60 m.

These assumptions are conceptual in nature and are intended for 'order of magnitude' cost estimation only. Verification of all structural requirements associated with the Horne Lake Connector will be performed at a later design stage.

Table 3 summarizes the ND LEA construction cost estimates for the various Horne Lake Connector Options.

Table 3. Summary of ND LEA Horne Lake Connector Cost Estimates

Item	Activity	Option 1A	Option 1B	Option 2A	Option 2B
1.0	**PROJECT MANAGEMENT**	$ 1,331,938	$ 1,331,938	$ 1,331,938	$ 1,331,938
2.0	**ENGINEERING**				
2.1	*Preliminary Design*	$ 1,429,281	$ 1,234,088	$ 1,628,075	$ 1,489,573
2.2	*Detailed Design*	$ 1,429,281	$ 1,234,088	$ 1,609,582	$ 1,471,081
	Total Engineering	$ 2,858,562	$ 2,468,175	$ 3,237,657	$ 2,960,654
3.0	**CONSTRUCTION**				
3.1	*Grade Construction*	$ 19,440,154	$ 16,709,984	$ 21,346,525	$ 18,576,494
3.2	*Other Construction*	$ 860,050	$ 860,050	$ 860,050	$ 860,050
3.3	*Structural Construction*	$ 1,813,212	$ 1,813,212	$ 3,269,220	$ 3,269,220
3.4	*Paving Construction*	$ 4,411,189	$ 4,411,189	$ 4,647,012	$ 4,647,012
3.5	*Operational Construction*	$ 74,778	$ 74,778	$ 74,778	$ 74,778
3.6	*Utility Construction*	$ 100,000	$ 100,000	$ 100,000	$ 100,000
3.7	*Resident Engineering*	$ 1,886,236	$ 1,886,236	$ 1,886,236	$ 1,886,236
	Total Construction	$ 28,585,619	$ 24,681,754	$ 32,183,821	$ 29,413,790
4.0	**CONTINGENCY**	$ 5,914,978	$ 5,914,978	$ 5,914,978	$ 5,914,978
5.0	**MANAGEMENT RESERVE**	$ 1,774,493	$ 1,774,493	$ 1,774,493	$ 1,774,493
6.0	**LAND ACQUISITION**	$ 1,068,750	$ 1,068,750	$ 1,068,750	$ 1,068,750
	TOTAL	**$ *41,534,340***	**$ *38,413,784***	**$ *45,511,637***	**$ *42,464,603***

Similar to the Wolski cost estimate, the ND LEA cost estimate recognizes that a significant amount of existing road can be used to reduce construction costs. The alignment Option 2 was divided into sections C-1 through C-4 preserving the section lengths for C-3 and C-4, as these two sections generally fall on the existing Horne Lake Road alignment. Deviations between the Wolski alignment and Option 2 generally occur in section C-2, and result primarily from restricting the maximum road grade to 10%. Apart from this C-2 section, the ND LEA Option 2 alignment is generally common to the Wolski alignment, following the Horne Lake Road to Horne Lake Cave Provincial Park before heading south to intersect with Highway 4 immediately east of the Highway 4 / 4A junction. Figure 80011-SK-04 shows the approximate location of the C-1 through C-4 sub-sections along the ND LEA Option 2 alignment.

Options 1 and 2 both assume an engineering cost at 10% of the total construction cost. For Option 1, the ratio of the ND LEA section C-2 length over the Wolski section C-2 length was applied to the site preparation, grubbing, drainage structures and hydroseeding quantities in the cost calculations. Option 1 was not broken in sections as the condition of existing roads along this alignment is unknown at the time of writing. If Option 1 is to be pursued in a later stage of this study, it is recommended that a field reconnaissance be performed to evaluate the condition of existing road and to what extent it may reduce construction costs.

The following tables summarize the ND LEA construction cost estimates for sections C-1 through C-4 along the Option 2 Horne Lake Connector alignment. Table 4 relates to Typical Section A while Table 5 relates to Typical Section B. These construction costs are generated using a reduction factor of 1.0, meaning that no cost savings due to the existing roads were factored into the construction cost estimate.

The intention of showing these base costs is to quantify the cost implication of Typical Section A verses Typical Section B, and to also provide a reference point for the following discussion on cost reduction factors attributable to the presence of existing roads along the proposed Horne Lake Connector Option 2 alignment.

Table 4. Option 2A Cost Estimate by Section

Item	Activity	Section C-1	Section C-2	Section C-3	Section C-4	TOTAL
1.0	**PROJECT MANAGEMENT**	$ 2,067	$ 808,162	$ 382,541	$ 139,167	$ 1,331,938
2.0	**ENGINEERING**					
2.1	Preliminary Design	$ 20,000	$ 958,093	$ 491,242	$ 158,739	$ 1,628,075
2.2	Detailed Design	$ 1,508	$ 958,093	$ 491,242	$ 158,739	$ 1,609,582
	Total Engineering	$ 21,508	$ 1,916,187	$ 982,483	$ 317,479	$ 3,237,657
3.0	**CONSTRUCTION**					
3.1	Grade Construction	$ 20,600	$ 3,197,625	$ 6,340,823	$ 1,787,477	$ 21,346,525
3.2	Other Construction	$ -	$ 324,450	$ 133,900	$ 401,700	$ 860,050
3.3	Structural Construction	$ -	$ 1,882,016	$ 1,387,204	$ -	$ 3,269,220
3.4	Paving Construction	$ -	$ 2,557,183	$ 1,304,000	$ 785,829	$ 4,647,012
3.5	Operational Construction	$ -	$ 39,964	$ 25,544	$ 9,270	$ 74,778
3.6	Utility Construction	$ -	$ -	$ 100,000	$ -	$ 100,000
3.7	Resident Engineering	$ 1,730	$ 1,160,631	$ 533,361	$ 190,513	$ 1,886,236
	Total Construction	$ 2,330	$ 19,161,868	$ 9,824,833	$ 3,174,789	$ 32,183,821
4.0	**CONTINGENCY**	$ 9,181	$ 3,588,953	$ 1,698,819	$ 618,025	$ 5,914,978
5.0	**MANAGEMENT RESERVE**	$ 2,754	$ 1,076,686	$ 509,646	$ 185,408	$ 1,774,493
6.0	**LAND ACQUISITION**	$ -	$ 618,750	$ 281,250	$ 168,750	$ 1,068,750
	TOTAL	**$ 57,841**	**$ 27,170,606**	**$ 13,679,572**	**$ 4,603,618**	**$ 45,511,637**

From Table 5 it can be shown that the total cost of paving the Horne Lake Connector along the Option 2 alignment is approximately $4,650,000. This applies to both Options 2A and 2B as the width of paved surface does not vary from Typical Section A to Typical Section B.

Table 5. Option 2B Cost Estimate by Section

Item	Activity	Section C-1	Section C-2	Section C-3	Section C-4	TOTAL
1.0	**PROJECT MANAGEMENT**	$ 2,067	$ 808,162	$ 382,541	$ 139,167	$ 1,331,938
2.0	**ENGINEERING**					
2.1	Preliminary Design	$ 20,000	$ 877,234	$ 436,793	$ 155,546	$ 1,489,573
2.2	Detailed Design	$ 1,508	$ 877,234	$ 436,793	$ 155,546	$ 1,471,081
	Total Engineering	$ 21,508	$ 1,754,467	$ 873,586	$ 311,092	$ 2,960,654
3.0	**CONSTRUCTION**					
3.1	Grade Construction	$ 20,600	$ 11,580,428	$ 5,251,854	$ 1,723,612	$ 18,576,494
3.2	Other Construction	$ -	$ 324,450	$ 133,900	$ 401,700	$ 860,050
3.3	Structural Construction	$ -	$ 1,882,016	$ 1,387,204	$ -	$ 3,269,220
3.4	Paving Construction	$ -	$ 2,557,183	$ 1,304,000	$ 785,829	$ 4,647,012
3.5	Operational Construction	$ -	$ 39,964	$ 25,544	$ 9,270	$ 74,778
3.6	Utility Construction	$ -	$ -	$ 100,000	$ -	$ 100,000
3.7	Resident Engineering	$ 1,730	$ 1,160,631	$ 533,361	$ 190,513	$ 1,886,236
	Total Construction	$ 22,330	$ 17,544,672	$ 8,735,864	$ 3,110,924	$ 29,413,790
4.0	**CONTINGENCY**	$ 9,181	$ 3,588,953	$ 1,698,819	$ 618,025	$ 5,914,978
5.0	**MANAGEMENT RESERVE**	$ 2,754	$ 1,076,686	$ 509,646	$ 185,408	$ 1,774,493
6.0	**LAND ACQUISITION**	$ -	$ 618,750	$ 281,250	$ 168,750	$ 1,068,750
	TOTAL	**$ 57,841**	**$ 25,391,690**	**$ 12,481,706**	**$ 4,533,366**	**$ 42,464,603**

Existing roads were considered for both the Wolski and ND LEA construction cost estimate. The Horne Lake Road, extending 12 km from Highway 19 to the Horne Lake Caves Provincial Park, is generally well used and may have a significant impact on the overall construction costs. The Wolski and ND LEA cost estimates categorize this road into sections C-3 and C-4: both are gravel road sections that require grade rehabilitation and widening. Section C-3 is 7.5 km while section C-4 is 4.5 km.

Due to the nature of the base information (1:20,000 TRIM), it is difficult to accurately quantify the impact of these existing road sections on the overall construction cost of the Horne Lake Connector. The cost estimates that follow are intended to provide 'order of magnitude' construction cost savings due to the existing 12 km Horne Lake Road. It is assumed for simplicity that the C-1 and C-2 construction costs are unaffected by existing roads in the Horne Lake area. In addition, no attempt has been made to quantify the impact of existing roads along the Option 1 alignment as these conditions are currently unknown.

The following table summarizes the effect of this reduction factor on the overall construction costs for alignment Option 2, Typical Section A. The reduction factor is only applied to costs associated with road grade excavation and placement of fill along the 12 km of sections C-3 and C-4. It is assumed that, for simplicity, engineering costs remain at 10% of the total construction cost and that pavement structure material quantities such as the crushed base course, select granular sub-base and asphalt remain unchanged.

Table 6. Reduced Costs for Option 2 Typical Section A

		Reduction Factor, f			
Item	**Activity**	***f =1.0***	***f =0.75***	***f =0.50***	***f =0.25***
1.0	Project Management	$ 1,331,938	$ 1,331,938	$ 1,331,938	$ 1,331,938
2.0	Total Engineering	$ 3,237,657	$ 3,105,561	$ 2,973,465	$ 2,841,368
3.0	Land Acquisition	$ 1,068,750	$ 1,068,750	$ 1,068,750	$ 1,068,750
4.0	Total Construction	$ 32,183,821	$ 30,862,859	$ 29,541,898	$ 28,220,936
5.0	Contingency	$ 5,914,978	$ 5,914,978	$ 5,914,978	$ 5,914,978
6.0	Management Reserve	$ 1,774,493	$ 1,774,493	$ 1,774,493	$ 1,774,493
	TOTAL COST	**$ 45,511,637**	**$ 44,058,579**	**$ 42,605,521**	**$ 41,152,463**

Similarly, reduced costs have been developed for Option 2, Typical Section B. Again, the reduction factor is only applied to costs associated with road grade excavation and placement of fill along the 12 km of sections C-3 and C-4. Table 7 summarizes the effect of this reduction factor on the overall construction costs for alignment Option 2, Typical Section B.

Table 7. Reduced Costs for Option 2 Typical Section B

		Reduction Factor, f			
Item	**Activity**	***f =1.0***	***f =0.75***	***f =0.50***	***f =0.25***
1.0	Project Management	$ 1,331,938	$ 1,331,938	$ 1,331,938	$ 1,331,938
2.0	Total Engineering	$ 2,960,654	$ 2,857,379	$ 2,754,103	$ 2,650,828
3.0	Land Acquisition	$ 1,068,750	$ 1,068,750	$ 1,068,750	$ 1,068,750
4.0	Total Construction	$ 29,413,790	$ 28,381,037	$ 27,348,284	$ 26,315,531
5.0	Contingency	$ 5,914,978	$ 5,914,978	$ 5,914,978	$ 5,914,978
6.0	Management Reserve	$ 1,774,493	$ 1,774,493	$ 1,774,493	$ 1,774,493
	TOTAL COST	**$ 42,464,603**	**$ 41,328,574**	**$ 40,192,546**	**$ 39,056,518**

The effect of applying the reduction factors along the C-3 and C-4 sections of alignment Option 2 for the excavation and fill volumes is summarized in Table 8. It can be seen, for example, that if we assume the existing Horne Lake Road results in a reduction of 75% of the cut and fill volumes (f=0.25) for the 12 km along sections C-3 and C-4, the total cost of the Horne Lake Connector (Typical Section A) will be 90% of the total cost associated with no reduction in quantities.

Table 8. Effect of Reduction Factors on Option 2 Total Cost

Design Scenario	**Percent of Unadjusted Total Project Cost**			
	f =1.0	***f =0.75***	***f =0.50***	***f =0.25***
Option 2 Typical Section A	100%	97%	94%	90%
Option 2 Typical Section B	100%	97%	95%	92%

Table 8 also shows that if the existing 12 km Horne Lake Road accounts for a 50% reduction in the excavation and fill quantities along sections C-3 and C-4, the total cost of the 26.7 km Horne Lake Connector Option 2 is reduced by approximately 5% to 6%, depending on which typical section is used.

6.0 TRAFFIC OPERATIONS

6.1 Reduced Design Speed Sections

Several reduced speed sections were introduced in order to satisfy the maximum grade design criteria of 10%. Reduced speed sections were also necessary to minimize the construction costs associated with excessive earth cut and fill volumes. For the mobility modeling, it was also assumed that vehicles will travel at 10 km/hr above the posted speed within reduced speed sections.

Design speeds relating to the horizontal curve radii assume 0.06 m/m maximum superelevation, and were taken from Table 2.1.2.3 of the TAC design guidelines. Table 9 summarizes the reduced speed sections along the Horne Lake Connector for both Options 1 and 2.

Table 9. Horne Lake Connector Reduced Speed Sections

Alignment	Approximate Start Station	Approximate End Station	Curve Radii (m)	Design Speed (km/hr)	Travel Speed (km/hr)
Option 1	7+200	7+300	125	50	60
	10+950	11+250	120	50	60
Option 2	11+200	11+300	125	50	60
	11+500	11+600	125	50	60

6.2 Traffic Volumes

Summer volumes were found to be roughly four times the volumes experienced in January. This trend in seasonal traffic volume fluctuations is consistent with similar recreational areas found throughout British Columbia. It is estimated that over 50,000 people visited Horne Lake Provincial Park in 2004, and that an additional 30% to 40% visited the surrounding regional parks. These attendance volumes generate approximately 18,500 to 20,000 annual vehicle trips based on an average vehicle occupancy rate of 3.5. These volumes are in addition to traffic generated by active logging and over 350-privately owned cabins along Horne Lake.

Traffic volumes at the Horne Lake Road/Highway 19 intersection and the Highway 4/ Highway 19 interchange (Qualicum Interchange) were provided by the Ministry of Transportation. Average annual daily traffic (AADT) projections for Horne Lake Road assumed that the January average daily traffic is approximately 50% of the AADT, while the August average daily traffic was assumed to be approximately 200% of the AADT.

Annual traffic growth was found to be quite variable from year to year, and between various turning movements. An approximate average of 3% annual growth was selected for the purpose of traffic volume projection, and was applied to the 2001 AADT traffic count data to determine volumes for the 2005 and 2010 horizon years. Furthermore, it was estimated that the Horne Lake Connector will attract between 50% and 75% of the southbound right and eastbound left turning movements at the Highway 4 / Highway 19 interchange. The rationale behind this diversion in traffic volumes is that the majority of the users performing these turning movements will have origins / destinations north of the Horne Lake Road / Highway 19 intersection. It is expected that these users will therefore experience considerable travel time savings by using the connector route over the existing Highway 4 / Highway 19 route.

Traffic volume projections for the 2005 AADT, 2010 AADT Base (no connector) and the 2010 AADT Connector (Horne Lake Connector) are shown in Figures 80011-SK-05 through 80011-SK-07. Diversion volumes ranged from 325 vpd to 485 vpd for the eastbound left movement (50% and 75% respectively) and 350 vpd to 520 vpd for the southbound left movement (similarly, 50% and 75% respectively).

6.3 Travel Time

For purposes of comparison, travel times were estimated between two points: the Highway 4 / Highway 4A intersection, and the Horne Lake Road / Highway 19 intersection. Travel times were estimated for three routes: existing route, Horne Lake Connector Option 1 and the Horne Lake Connector Option 2.

The approximate travel time along Highway 4 from the junction of Highway 4 and Highway 4A to the junction of Highway 4 and Highway 19 is 27 minutes and 35 seconds. This corresponds to an average travel speed of 73.4 km/hr over 33.7 km of road. To then travel from the Highway 19 / Highway 4 junction to the intersection of Horne Lake Road and Highway 19 is 7 minutes and 53 seconds. This corresponds to an average travel speed of 109.9 km/hr over 14.4 km of road and results in a total travel time of 35 minutes and 28 seconds from the Highway 4 / 4A intersection to the Highway 19 / Horne Lake Road intersection using the existing route.

It is estimated that the travel time along the Horne Lake Connector to Highway 19 will be approximately 21 minutes and 50 seconds for the Option 1 alignment, while the Option 2 alignment will result in a travel time of approximately 22 minutes and 55 seconds. These travel times take into consideration the reduced speed sections and assume an average travel speed of 10 km/h plus the posted speed limit. Table 10 summarizes the travel times currently experienced by drivers between Port Alberni and Highway 19 along Highway 4, and estimates associated with the two Horne Lake Connector options.

Table 10. Comparison of Travel Times

Route	Route Distance (km)	Average Speed (km/hr)	Travel Time (hr:min:sec)
Hwy 4 / Hwy 4A to Hwy 4 / Hwy 19	33.7	73.4	00:27:35
Hwy 19 / Hwy 4 to Hwy 19 / Horne Lake Road	14.4	109.9	00:07:53
Existing Route Total	48.1	80.4	00:35:28
Horne Lake Connector Option 1	25.4	69.8	00:21:50
Horne Lake Connector Option 2	26.7	69.9	00:22:55

Travel time estimates based on the proposed Horne Lake Connector Option 1 show a travel time savings over the existing Highway 4 – Highway 19 route of approximately 13 minutes and 38 seconds. Travel time savings corresponding to Option 2 are estimated at 12 minutes and 33 seconds. It is anticipated that these travel time savings, for both Option 1 and 2 are applicable to trips to and from Port Alberni with destinations / origins north of the Horne Lake Road / Highway 19 intersection.

The majority of vehicles travelling to and from points south of the Highway 4 / Highway 19 interchange are expected to use the existing Highway 4 route. This is primarily a result of travel time savings for vehicles travelling to/from the south using Highway 4 compared to vehicles travelling to/from the south using the Horne Lake Connector. Figure 8 illustrates the estimated travel times along both the existing and proposed route options.

6.4 Trucks

The ability of the Horne Lake Connector to attract heavy vehicles from Highway 4 was considered in the selection of the design criteria. In providing a design standard similar to the Highway 4 route, it is anticipated that the connector will attract truck volumes proportionate to the total volume diverted from Highway 4. Assuming that heavy vehicles account for 5% of the total Highway 4 volume, truck volumes on the connector are expected to range from 35 to 50 vpd.

There is the potential that the absence of climbing/passing lanes from the connector will offset the expected travel time savings related to alignment length to some degree. This increase in travel times resulting from the absence of climbing/passing lanes would likely reduced the ability of the Horne Lake Connector to attract both heavy vehicles and passenger cars from Highway 4.

7.0 BENEFIT-COST ANALYSIS

An economic analysis was performed to provide an indication of the user benefits relative to the total cost of project construction. The benefits modelled are limited to the travel time savings for the traffic volumes diverted from Highway 4 only. The simulation does not consider benefits realized from improved safety or mobility to vehicles currently using the Horne Lake Road. Reviewing historical accident data and quantifying accident reduction factors attributable an improved alignment is beyond the scope of this study.

MicroBENCOST, a benefit-cost simulation model was used to determine discounted user benefits, discounted construction costs, discounted salvage value, benefit-cost ratios and internal rates of return for the Option 2A scenario. This scenario was selected to provide an indication of the economic measures related to the Horne Lake Connector.

For the MicroBENCOST analysis, it was necessary to make a number of assumptions, including:

- Discount Rate: 6%
- Analysis Period: 25 yrs
- Year Improvements Completed: 2010
- Heavy Vehicles: 5%
- 2010 AADT: 675 vpd (50% diversion); 1005 vpd (75% diversion)
- Saturation Flow Rate (capacity): 1100 vehicles/lane/hr
- Annual Traffic Growth: 3%
- Automobile Costs: default values
- Vehicle Type Parameters: default values
- Traffic Distribution: default values
- Pavement Condition and Maintenance Costs: default values

The following table summarizes the results of the MicroBENCOST economic simulation.

Table 11. Summary of MicroBENCOST Analysis Results

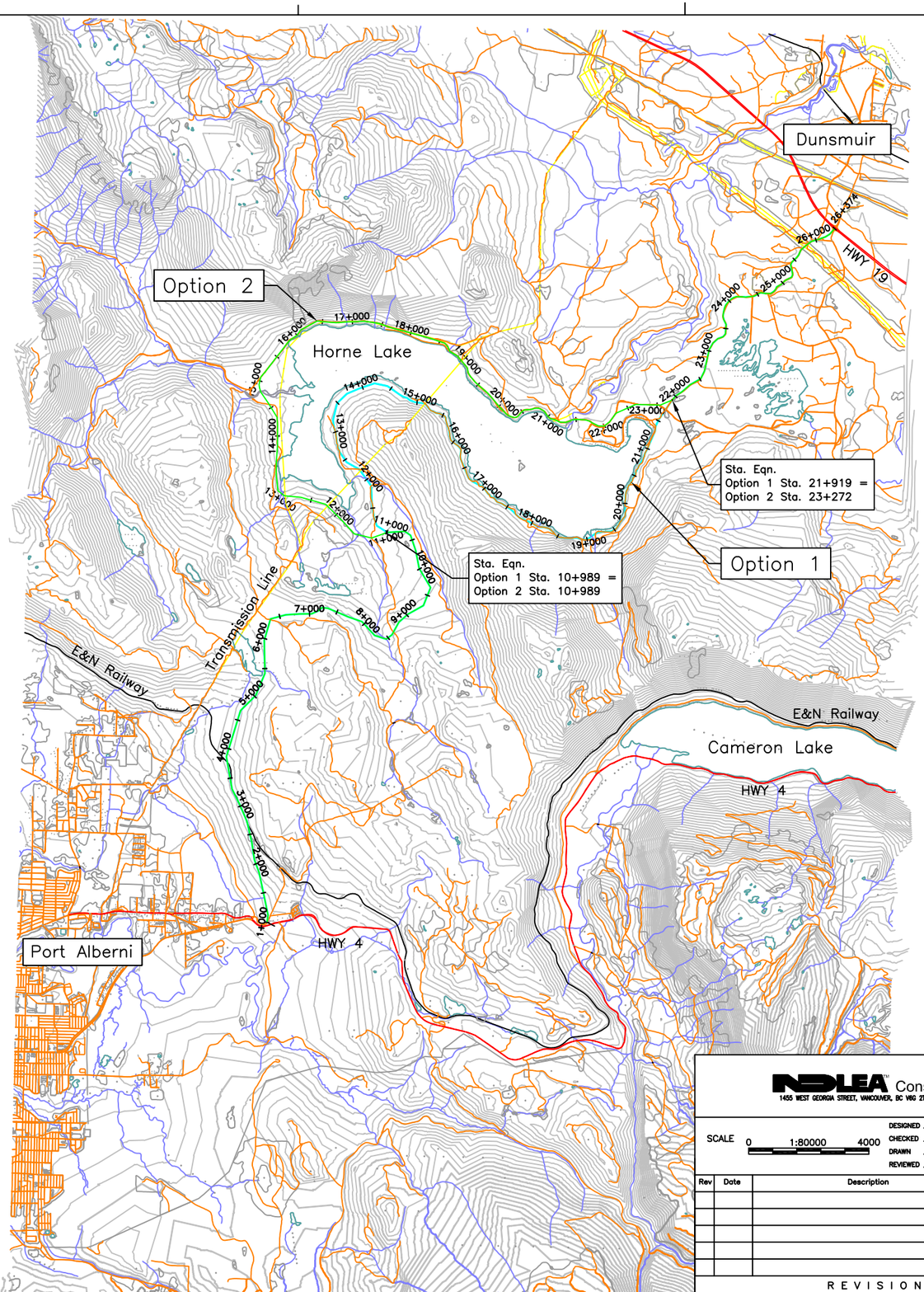
Economic Measure	Scenario 1 50% Diversion	Scenario 2 75% Diversion
Total Discounted User Benefits (million $)	20.169	30.435
Discounted Construction Cost (million $)	42.936	42.936
Discounted Salvage Value (million $)	6.655	6.655
Fuel Consumption Savings (million gal.)	6.664	10.005
Carbon Monoxide Emission Reduction (million kg.)	6.705	0.140
Net Present Value (million $)	-16.111	-5.846
Gross Benefit-Cost Ratio	0.556	0.839
Net Benefit-Cost Ratio	0.625	0.864
Internal Rate of Return (%)	3.375	5.104

8.0 CONCLUSIONS

Construction cost estimates for the Horne Lake Connector assuming new road construction were found to range from $38.4M to $45.5M, depending on the alignment option and typical cross-section. If the existing 12 km Horne Lake Road alignment is used, it will reduce construction costs for the connector by up to 10%. ND LEA construction cost estimates are based on a rural 2-lane undivided highway standard and are similar to the Wolski construction cost estimate of $37.3M.

ND LEA has performed preliminary benefit-cost analyses relating to travel time savings and total construction costs. The benefits modeled are limited to the travel time savings for the traffic volumes diverted from Highway 4 only and do not consider benefits due to improved safety or mobility along existing sections of Horne Lake Road. It was found that the economic benefits from the expected travel time savings yield a benefit-cost ratio of less than one. Unless it can be demonstrated that the connector will attract a significantly greater volume of traffic from the existing highway infrastructure, it is recommended that the Ministry of Transportation does not pursue this project.

It is recommended that the general public be involved in the selection of the preferred Horne Lake Connector route from the options identified in this report. Public consultation should also be performed to identify other social, economic or environmental concerns not recognized in this study. Regional districts affected by the connector may also consider the routes identified in this report during a future official community plan review to evaluate public support.



LEGEND

- HIGHWAY 4
- HIGHWAY 19
- EXISTING ROADS
- OPTION 1 (14+000)
- OPTION 2 (14+000)
- E&N RAILWAY
- TRANSMISSION LINE
- 25 M CONTOUR
- STREAM
- LAKESHORE

NDLEA Consultants Ltd.
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MINISTRY OF TRANSPORTATION
HIGHWAY DESIGN AND SURVEY ENGINEERING
SOUTH COAST REGION

SCALE 0 1:80000 4000

DESIGNED	SJC	DATE MAR/05
CHECKED	DS	DATE
DRAWN	DH	DATE MAR/05
REVIEWED	SW	DATE

Rev	Date	Description	Signature

REVISIONS

ALIGNMENT OPTIONS

HORNE LAKE CONNECTOR STUDY
CONCEPTUAL DESIGN

SENIOR DESIGNER

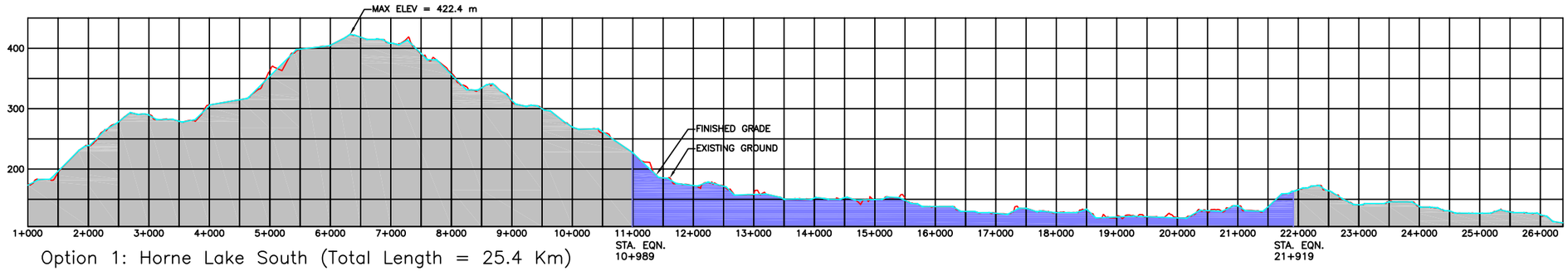
DATE

FILE No.	PROJECT No.	REG.	DRAWING No.
–	–	–	80011–SK–01

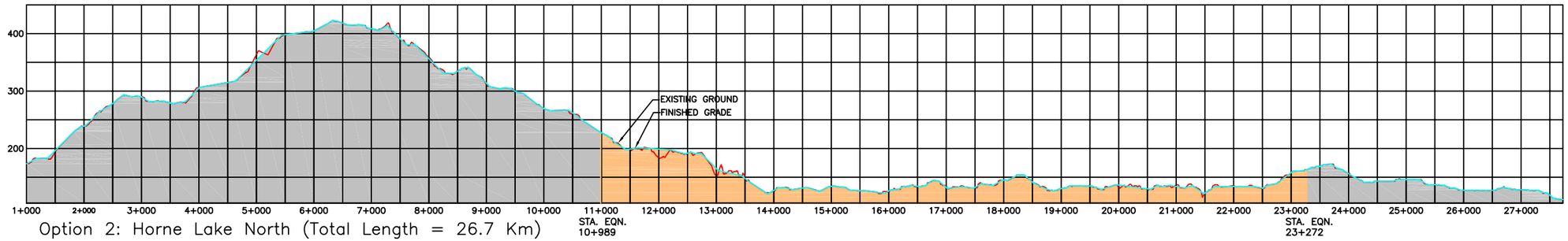
CANCEL PRINTS BEARING PREVIOUS LETTER

FILE: 80011-SK-01

UPDATE : JUNE 20, 2005



Option 1: Horne Lake South (Total Length = 25.4 Km)



Option 2: Horne Lake North (Total Length = 26.7 Km)

LEGEND

EXISTING GROUND

PROPOSED GRADE

NOTE

1. ALIGNMENTS AND CORRESPONDING PROFILES ARE COMMON FOR BOTH OPTION 1 AND OPTION 2 IN GRAY SHADED AREAS.
2. MAXIMUM GRADE 10%
3. RATE OF VERTICAL CURVATURE (K) 10 FOR CREST VERTICAL CURVES, 15 FOR SAG VERTICAL CURVES.

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REVIEWED	SW	DATE

Rev	Date	Description	Signature

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PROFILE OPTIONS
HORNE LAKE CONNECTOR STUDY
CONCEPTUAL DESIGN

SENIOR DESIGNER

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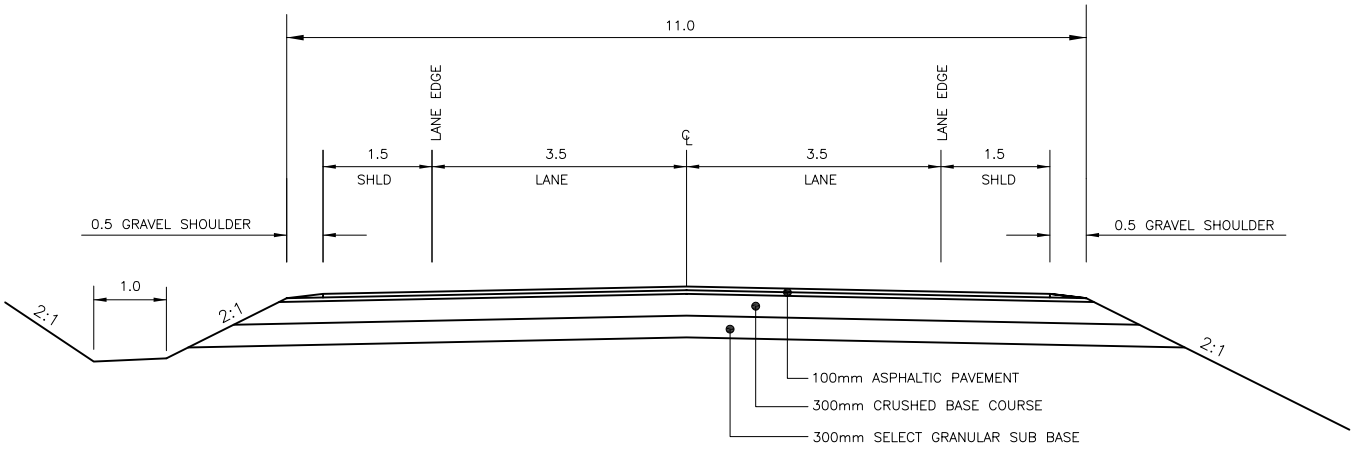
FILE No.	PROJECT No.	REG.	DRAWING No.
–	–	–	80011-SK-02

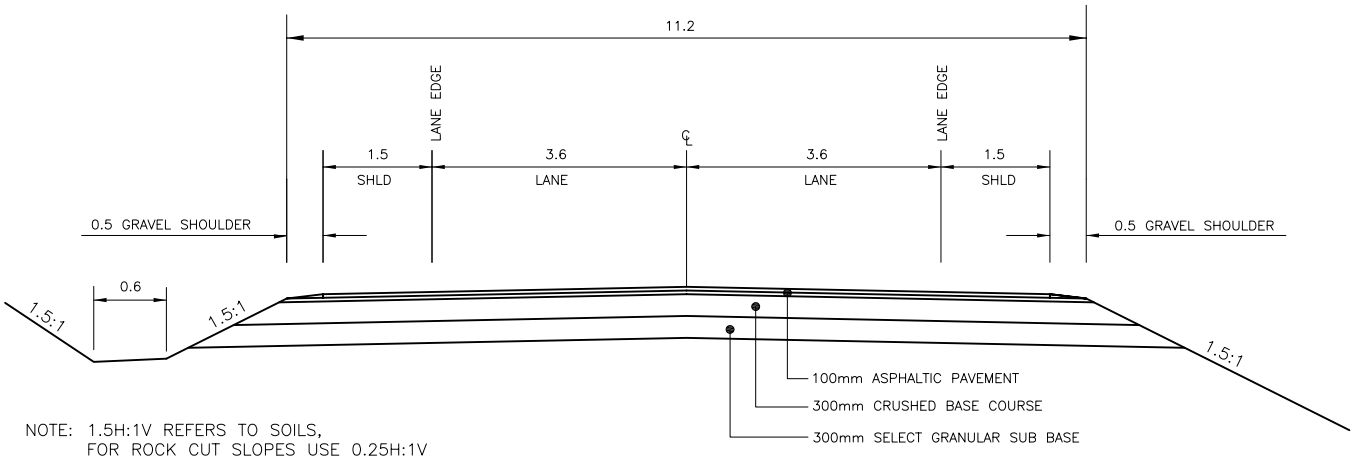
CANCEL PRINTS BEARING PREVIOUS LETTER

FILE: 80011-SK-02

UPDATE : APRIL 1, 2005



TYPICAL SECTION A
NTS



NOTE: 1.5H:1V REFERS TO SOILS,
FOR ROCK CUT SLOPES USE 0.25H:1V
FOR ROCK FILL SLOPES USE 1.5H:1V (PREFERABLE)
OR 1.3H:1V (IF NECESSARY)

TYPICAL SECTION
NTS

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REVIEWED ____ DATE ____

Rev	Date	Description	Signature

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TYPICAL SECTIONS
HORNE LAKE CONNECTOR STUDY
CONCEPTUAL DESIGN

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FILE No.	PROJECT No.	REG.	DRAWING No.
–	–	–	80011-SK-03

CANCEL PRINTS BEARING PREVIOUS LETTER

FILE: 80011-SK-03

UPDATE : JUNE 20, 2005

FILE: 80011-SK04

DUNSMUIR

HWY 19

27+700

MOUNT MARK

OPTION 2

15+700

Horne Lake

Existing Cabins

23+200

SPIDER LAKE

HORNE LAKE CAVES PROVINCIAL PARK

SPIDER LAKE PROVINCIAL PARK

DIFFICULT TERRAIN

Existing Cabins

OPTION 1

Transmission Line

Connector Summit Max. Elev. 422 m

MOUNT WESLEY

MOUNT HORNE

E&N RAILWAY

DIFFICULT TERRAIN

E&N Railway

DIFFICULT TERRAIN

Cameron Lake

HWY 4

LITTLE QUALICUM PROVINCIAL PARK

MACMILLAN PROVINCIAL PARK

HWY 4

1+000

HWY 4A

PORT ALBERNI

Alberni Hump

HWY 4

LEGEND

OPTION 1	23+200
OPTION 2 SECTION C-1	1+000
OPTION 2 SECTION C-2	15+700
OPTION 2 SECTION C-3	23+200
OPTION 2 SECTION C-4	27+700
HIGHWAY 4	
HIGHWAY 19	
EXISTING ROADS	
E&N RAILWAY	
TRANSMISSION LINE	
STREAM	
LAKESHORE	
25 M CONTOUR	

SECTION	LENGTH	COMMENTS
C-1	6 KM	NO MAJOR WORK REQUIRED
C-2	14.7 KM	NEW ROAD CONSTRUCTION REQUIRED
C-3	7.5 KM	WIDENING, GRADE REHABILITATION & PAVING REQUIRED
C-4	4.5 KM	MINOR WIDENING, GRADE REHABILITATION & PAVING REQUIRED

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SCALE 0 1:50000 2500

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REVIEWED SW DATE

Rev	Date	Description	Signature

REVISIONS

MINISTRY OF TRANSPORTATION
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SOUTH COAST REGION

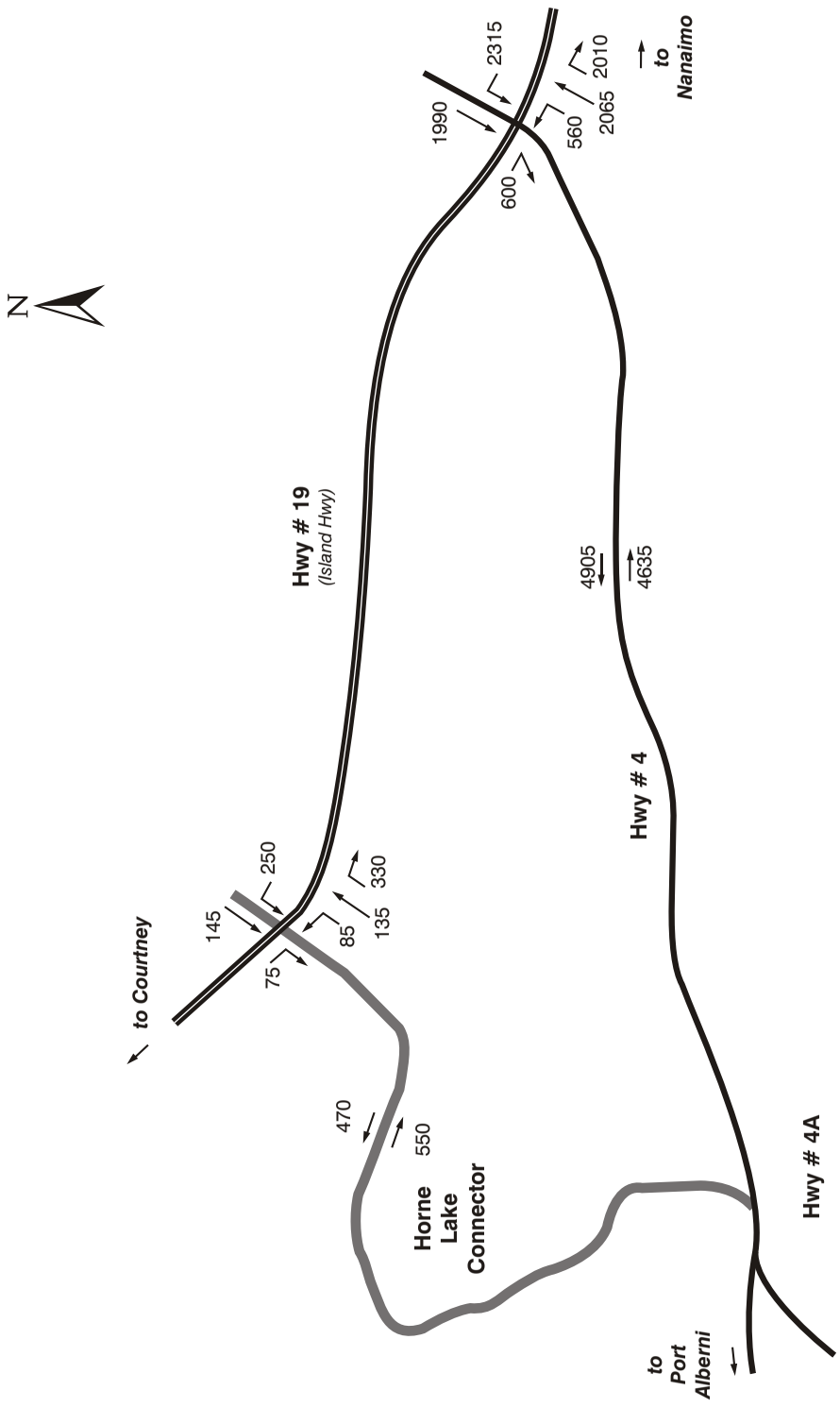
ALIGNMENT SECTIONS
HORNE LAKE CONNECTOR STUDY
CONCEPTUAL DESIGN

SENIOR DESIGNER DATE

FILE No.	PROJECT No.	REG.	DRAWING No.
–	–	–	80011-SK-04

UPDATE : AUGUST 11, 2005

CANCEL PRINTS BEARING PREVIOUS LETTER

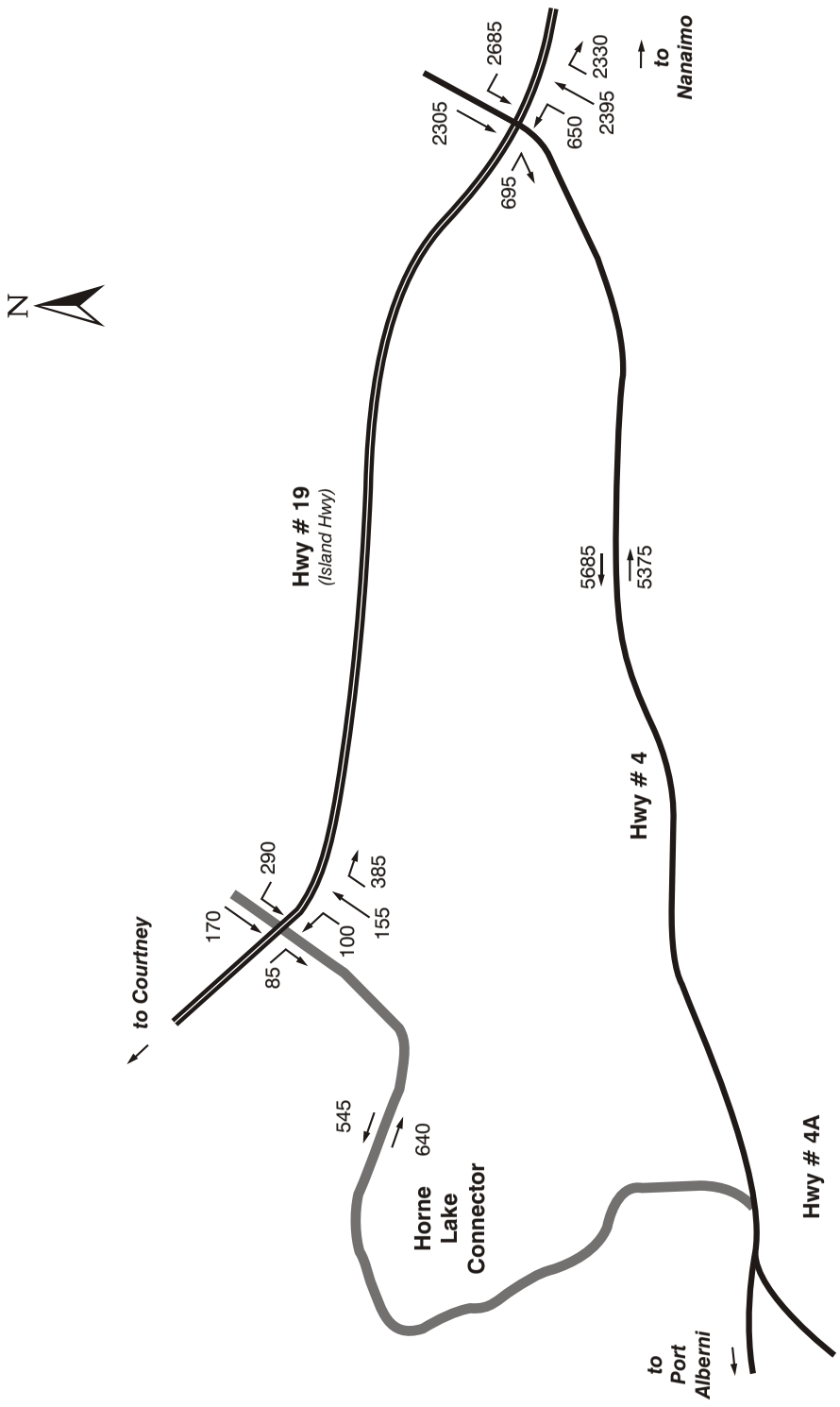


Horne Lake Connector Study
Port Alberni, BC

2005 Average Annual Daily Traffic (AADT) Volumes

80011.301

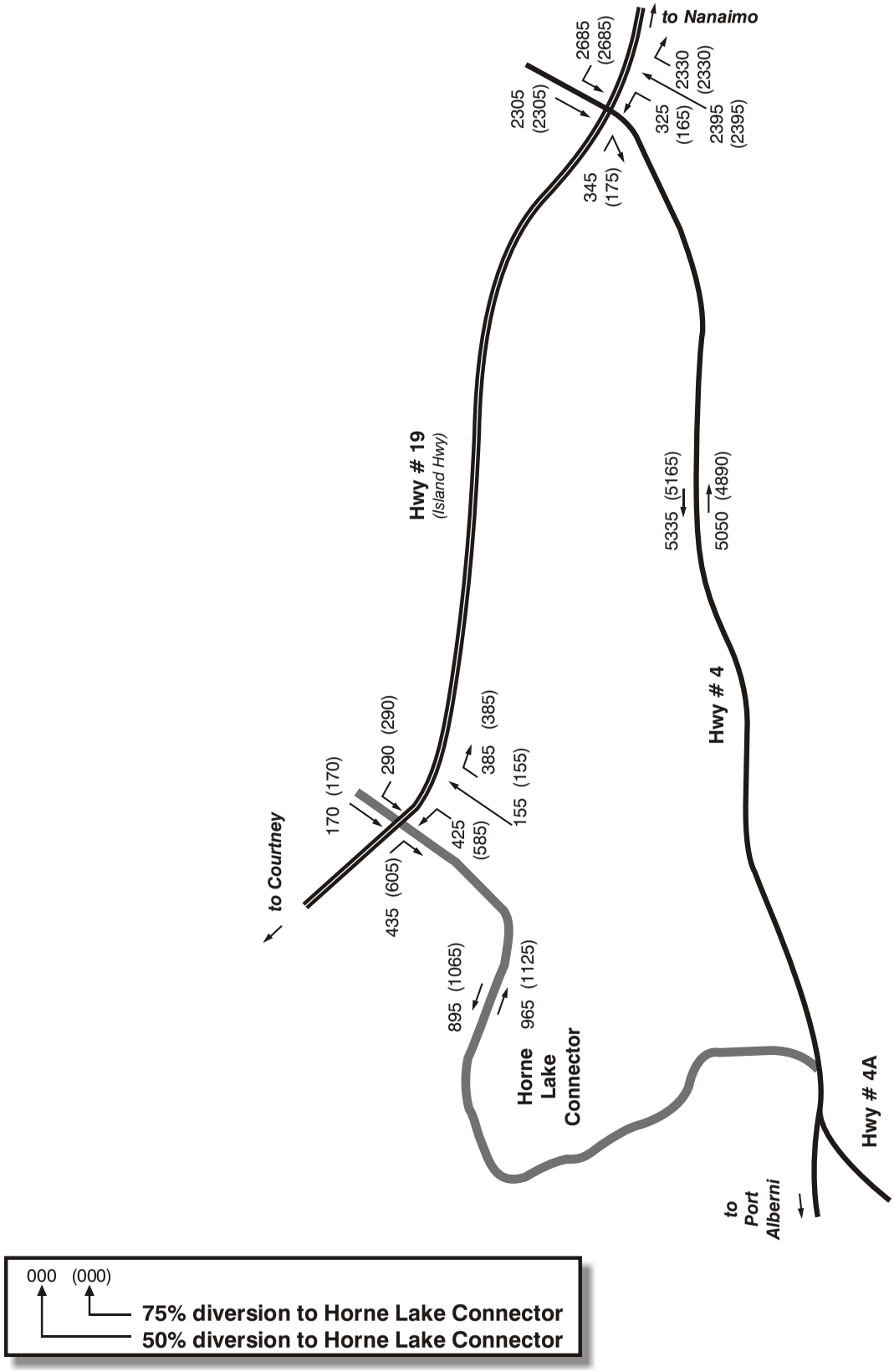
Figure 5



Horne Lake Connector Study
Port Alberni, BC

2010 Average Annual Daily Traffic (AADT) Base Volumes

Figure 6

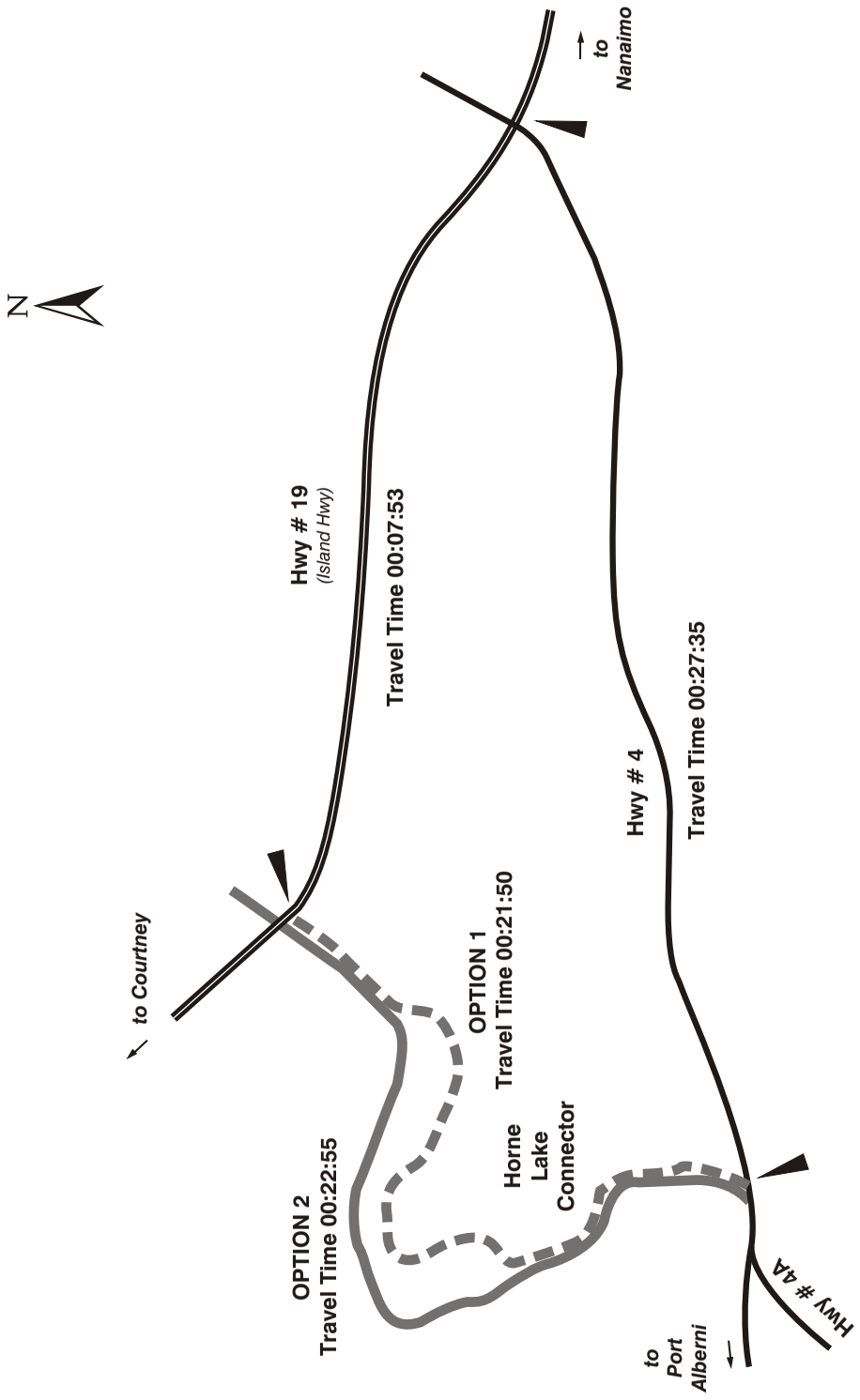


Horne Lake Connector Study
Port Alberni, BC

2010 Average Annual Daily Traffic (AADT) Connector Volumes

80011.301
NDLEA™

Figure 7



Horne Lake Connector Study
Port Alberni, BC

Anticipated Travel Times

Figure 8

APPENDIX A

Photographs

Photo 1: *Horne Lake Rd / Highway 19 Intersection*

Photo 2: *Horne Lake Rd 0.0 km Looking West*

Photo 3: *Horne Lake Rd 6.4 km Looking West*

Photo 4: *Horne Lake Rd 9.2 km Looking East*

Photo 5: *Horne Lake Rd 12.0 km Looking East*

Photo 6: *Horne Lake Rd 13.0 km*

Photo 7: *Horne Lake Rd 13.6 km*

Photo 8: *Horne Lake North FSR 1.0 km (17 km from Highway 19)*

Photo 9: *Horne Lake North FSR 5.0 km (21 km from Hwy 19) Looking east*

Photo 10: *Lacy Lake Road North of Hwy 4 and South of E&N Rail*

APPENDIX B

MicroBENCOST Analysis Output

06/22/05 14:28

***** M i c r o B E N C O S T *****

BENEFIT-COST ANALYSIS OF HIGHWAY IMPROVEMENT PROJECTS
VERSION 1.0 REVISION A

National Cooperative Highway Research Program (NCHRP)

Developed by the Texas Transportation Institute,
Texas A&M University System

Problem 0A Horne Lake Connector

Daily Through Traffic (Thous.)

	WITHOUT Improvement			WITH Improvement		
Year	Existing	Alternate	Proposed	Existing	Alternate	Proposed
2005	0.58	0.00	0.00	0.58	0.00	0.00
2006	0.60	0.00	0.00	0.60	0.00	0.00
2007	0.62	0.00	0.00	0.62	0.00	0.00
2008	0.63	0.00	0.00	0.63	0.00	0.00
2009	0.65	0.00	0.00	0.65	0.00	0.00
2010	0.67	0.00	0.00	0.00	0.00	0.68
2011	0.69	0.00	0.00	0.00	0.00	0.69
2012	0.71	0.00	0.00	0.00	0.00	0.72
2013	0.74	0.00	0.00	0.00	0.00	0.74
2014	0.76	0.00	0.00	0.00	0.00	0.76
2015	0.78	0.00	0.00	0.00	0.00	0.78
2016	0.80	0.00	0.00	0.00	0.00	0.81
2017	0.83	0.00	0.00	0.00	0.00	0.83
2018	0.85	0.00	0.00	0.00	0.00	0.86
2019	0.88	0.00	0.00	0.00	0.00	0.88
2020	0.90	0.00	0.00	0.00	0.00	0.91
2021	0.93	0.00	0.00	0.00	0.00	0.93
2022	0.96	0.00	0.00	0.00	0.00	0.96
2023	0.99	0.00	0.00	0.00	0.00	0.99
2024	1.02	0.00	0.00	0.00	0.00	1.02
2025	1.05	0.00	0.00	0.00	0.00	1.05
2026	1.08	0.00	0.00	0.00	0.00	1.08
2027	1.11	0.00	0.00	0.00	0.00	1.12
2028	1.14	0.00	0.00	0.00	0.00	1.15
2029	1.18	0.00	0.00	0.00	0.00	1.18
2030	1.21	0.00	0.00	0.00	0.00	1.22
2031	1.25	0.00	0.00	0.00	0.00	1.26
2032	1.29	0.00	0.00	0.00	0.00	1.29
2033	1.33	0.00	0.00	0.00	0.00	1.33
2034	1.37	0.00	0.00	0.00	0.00	1.37

EXISTING Route Hwy 4/Hwy 19
Segment 1 Hwy 4/Hwy 19
WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Minor Route Num. Veh. (000)	Fuel Consp. (000) (gal)	Carbon Monox. (000) (kg)	Discounted Motorist Costs (Thous. $) Time Costs	Veh. Oper. Costs	Acc. Costs	Total Costs
2005	48.01	0.58	0.00	332.	24.	1970.	1773.	0.	3743.
2006	48.00	0.60	0.00	342.	23.	1914.	1722.	0.	3635.
2007	47.98	0.61	0.00	352.	22.	1860.	1673.	0.	3534.
2008	47.96	0.63	0.00	363.	21.	1810.	1628.	0.	3437.
2009	47.95	0.65	0.00	374.	20.	1759.	1581.	0.	3341.
2010	47.93	0.67	0.00	385.	20.	1708.	1535.	0.	3244.
2011	47.92	0.69	0.00	397.	19.	1663.	1494.	0.	3156.
2012	47.90	0.71	0.00	408.	18.	1614.	1450.	0.	3064.
2013	47.88	0.73	0.00	421.	17.	1571.	1410.	0.	2981.
2014	47.86	0.76	0.00	433.	17.	1527.	1370.	0.	2897.
2015	47.84	0.78	0.00	446.	16.	1483.	1330.	0.	2813.
2016	47.82	0.80	0.00	459.	15.	1442.	1293.	0.	2736.
2017	47.80	0.83	0.00	473.	15.	1402.	1257.	0.	2659.
2018	47.78	0.85	0.00	487.	14.	1363.	1221.	0.	2585.
2019	47.76	0.88	0.00	501.	13.	1324.	1186.	0.	2511.
2020	47.74	0.90	0.00	517.	13.	1289.	1153.	0.	2442.
2021	47.71	0.93	0.00	532.	12.	1253.	1121.	0.	2373.
2022	47.69	0.96	0.00	548.	12.	1218.	1089.	0.	2307.
2023	47.67	0.99	0.00	564.	11.	1183.	1057.	0.	2240.
2024	47.64	1.02	0.00	581.	11.	1151.	1028.	0.	2178.
2025	47.62	1.05	0.00	599.	10.	1119.	999.	0.	2118.
2026	47.59	1.08	0.00	616.	10.	1088.	971.	0.	2058.
2027	47.56	1.11	0.00	635.	10.	1057.	943.	0.	2000.
2028	47.53	1.14	0.00	654.	9.	1028.	917.	0.	1945.
2029	47.50	1.18	0.00	673.	9.	1000.	891.	0.	1890.
2030	47.48	1.21	0.00	693.	9.	972.	865.	0.	1837.
2031	47.44	1.25	0.00	714.	8.	945.	841.	0.	1786.
2032	47.41	1.29	0.00	735.	8.	919.	817.	0.	1736.
2033	47.38	1.33	0.00	757.	8.	894.	794.	0.	1688.
2034	47.35	1.37	0.00	780.	7.	869.	772.	0.	1641.
Total				15770.	422.	40392.	36182.	0.	76575.

EXISTING Route Hwy 4/Hwy 19
Segment 1 Hwy 4/Hwy 19
WITH Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Minor Route Num. Veh. (000)	Fuel Consp. (000) (gal)	Carbon Monox. (000) (kg)	Discounted Motorist Costs (Thous. $) Time Costs	Veh. Oper. Costs	Acc. Costs	Total Costs
2005	48.01	0.58	0.00	332.	24.	1970.	1773.	0.	3743.
2006	48.00	0.60	0.00	342.	23.	1914.	1722.	0.	3635.
2007	47.98	0.61	0.00	352.	22.	1860.	1673.	0.	3534.

2008	47.96	0.63	0.00	363.	21.	1810.	1628.	0.	3437.
2009	47.95	0.65	0.00	374.	20.	1759.	1581.	0.	3341.
Total				1763.	111.	9313.	8378.	0.	17690.

PROPOSED Route Horne Lake Connector
Segment 1 Horne Lake Connector
WITH Improvement

	Major Route		Minor Route			Discounted Motorist Costs (Thous. $)			
Year	Aver. Speed (mph)	Num. Veh. (000)	Num. Veh. (000)	Fuel Consp. (000) (gal)	Carbon Monox. (000) (kg)	Time Costs	Veh. Oper. Costs	Acc. Costs	Total Costs
2010	35.70	0.67	0.00	201.	14.	1279.	863.	0.	2142.
2011	35.69	0.69	0.00	207.	13.	1243.	838.	0.	2081.
2012	35.67	0.72	0.00	213.	13.	1208.	815.	0.	2023.
2013	35.66	0.74	0.00	220.	12.	1176.	792.	0.	1968.
2014	35.64	0.76	0.00	227.	12.	1143.	770.	0.	1913.
2015	35.63	0.78	0.00	233.	11.	1111.	748.	0.	1859.
2016	35.61	0.81	0.00	240.	11.	1080.	727.	0.	1806.
2017	35.59	0.83	0.00	247.	10.	1049.	706.	0.	1755.
2018	35.57	0.85	0.00	255.	10.	1020.	686.	0.	1706.
2019	35.56	0.88	0.00	263.	10.	992.	667.	0.	1659.
2020	35.54	0.91	0.00	271.	9.	964.	648.	0.	1612.
2021	35.52	0.93	0.00	279.	9.	937.	630.	0.	1567.
2022	35.50	0.96	0.00	287.	8.	911.	612.	0.	1523.
2023	35.48	0.99	0.00	296.	8.	886.	595.	0.	1481.
2024	35.46	1.02	0.00	305.	8.	862.	578.	0.	1440.
2025	35.44	1.05	0.00	314.	7.	838.	562.	0.	1400.
2026	35.41	1.08	0.00	323.	7.	814.	546.	0.	1360.
2027	35.39	1.12	0.00	333.	7.	792.	531.	0.	1323.
2028	35.37	1.15	0.00	343.	7.	770.	516.	0.	1286.
2029	35.34	1.18	0.00	354.	6.	749.	501.	0.	1251.
2030	35.32	1.22	0.00	364.	6.	728.	487.	0.	1215.
2031	35.29	1.26	0.00	375.	6.	708.	474.	0.	1182.
2032	35.26	1.29	0.00	386.	6.	688.	460.	0.	1148.
2033	35.24	1.33	0.00	398.	5.	670.	447.	0.	1117.
2034	35.21	1.37	0.00	410.	5.	651.	435.	0.	1086.
Total				7344.	220.	23271.	15634.	0.	38905.

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
2005	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00
2010	435.96	677.78	0.00	1113.74
2011	423.93	658.82	0.00	1082.75
2012	411.81	639.83	0.00	1051.64
2013	400.56	622.14	0.00	1022.70

2014	389.27	604.40	0.00	993.67
2015	378.20	587.04	0.00	965.24
2016	367.65	570.42	0.00	938.07
2017	357.28	554.13	0.00	911.41
2018	347.32	538.48	0.00	885.80
2019	337.53	523.12	0.00	860.64
2020	328.14	508.33	0.00	836.46
2021	318.89	493.80	0.00	812.68
2022	309.97	479.78	0.00	789.74
2023	301.17	465.99	0.00	767.16
2024	292.84	452.89	0.00	745.73
2025	284.77	440.19	0.00	724.96
2026	276.68	427.48	0.00	704.16
2027	268.94	415.35	0.00	684.29
2028	261.46	403.57	0.00	665.04
2029	254.16	392.12	0.00	646.28
2030	246.98	380.83	0.00	627.80
2031	240.18	370.14	0.00	610.32
2032	233.37	359.44	0.00	592.81
2033	226.91	349.28	0.00	576.20
2034	220.60	339.37	0.00	559.98
Total	7914.57	12254.71	0.00	20169.29

Summary Problem Benefits, Costs, and Economic Measures

Total Discounted User Benefits (Mill. $) :	20.169
Discounted Construction Cost (Mill. $) :	42.936
Discounted Salvage Value (Mill. $) :	6.655
Discounted Increase in Maint. and Rehab. (Mill. $) :	0.000
Fuel Consumption Savings (Mill. Gal.) :	6.664
Fuel Savings, Adj. for Induced Traf. (Mill. Gal.) :	6.705
Carbon Monoxide Emission Reduction (Mill. Kg.) :	0.091
Net Present Value (Mill. $) :	-16.111
Gross Benefit-Cost Ratio :	0.556
Netted Benefit-Cost Ratio :	0.625
Internal Rate of Return (Percent) :	3.375

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***** M i c r o B E N C O S T *****

BENEFIT-COST ANALYSIS OF HIGHWAY IMPROVEMENT PROJECTS
VERSION 1.0 REVISION A

National Cooperative Highway Research Program (NCHRP)

Developed by the Texas Transportation Institute,
Texas A&M University System

Problem 0A Horne Lake Connector

Daily Through Traffic (Thous.)

	WITHOUT Improvement			WITH Improvement		
Year	Existing	Alternate	Proposed	Existing	Alternate	Proposed
2005	0.87	0.00	0.00	0.87	0.00	0.00
2006	0.90	0.00	0.00	0.90	0.00	0.00
2007	0.92	0.00	0.00	0.92	0.00	0.00
2008	0.95	0.00	0.00	0.95	0.00	0.00
2009	0.98	0.00	0.00	0.98	0.00	0.00
2010	1.01	0.00	0.00	0.00	0.00	1.00
2011	1.04	0.00	0.00	0.00	0.00	1.03
2012	1.07	0.00	0.00	0.00	0.00	1.07
2013	1.10	0.00	0.00	0.00	0.00	1.10
2014	1.13	0.00	0.00	0.00	0.00	1.13
2015	1.17	0.00	0.00	0.00	0.00	1.16
2016	1.20	0.00	0.00	0.00	0.00	1.20
2017	1.24	0.00	0.00	0.00	0.00	1.24
2018	1.28	0.00	0.00	0.00	0.00	1.27
2019	1.32	0.00	0.00	0.00	0.00	1.31
2020	1.36	0.00	0.00	0.00	0.00	1.35
2021	1.40	0.00	0.00	0.00	0.00	1.39
2022	1.44	0.00	0.00	0.00	0.00	1.43
2023	1.48	0.00	0.00	0.00	0.00	1.48
2024	1.53	0.00	0.00	0.00	0.00	1.52
2025	1.57	0.00	0.00	0.00	0.00	1.57
2026	1.62	0.00	0.00	0.00	0.00	1.61
2027	1.67	0.00	0.00	0.00	0.00	1.66
2028	1.72	0.00	0.00	0.00	0.00	1.71
2029	1.77	0.00	0.00	0.00	0.00	1.76
2030	1.82	0.00	0.00	0.00	0.00	1.82
2031	1.88	0.00	0.00	0.00	0.00	1.87
2032	1.93	0.00	0.00	0.00	0.00	1.93
2033	1.99	0.00	0.00	0.00	0.00	1.98
2034	2.05	0.00	0.00	0.00	0.00	2.04

EXISTING Route Hwy 4/Hwy 19
Segment 1 Hwy 4/Hwy 19
WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Minor Route Num. Veh. (000)	Fuel Consp. (000) (gal)	Carbon Monox. (000) (kg)	Discounted Motorist Costs (Thous. $) Time Costs	Veh. Oper. Costs	Acc. Costs	Total Costs
2005	47.77	0.87	0.00	497.	36.	2970.	2660.	0.	5631.
2006	47.74	0.90	0.00	512.	35.	2887.	2585.	0.	5472.
2007	47.72	0.92	0.00	528.	33.	2807.	2512.	0.	5319.
2008	47.70	0.95	0.00	544.	32.	2730.	2442.	0.	5172.
2009	47.67	0.98	0.00	559.	31.	2653.	2371.	0.	5024.
2010	47.65	1.01	0.00	577.	30.	2580.	2306.	0.	4886.
2011	47.62	1.04	0.00	594.	28.	2508.	2240.	0.	4748.
2012	47.60	1.07	0.00	611.	27.	2438.	2176.	0.	4614.
2013	47.57	1.10	0.00	629.	26.	2370.	2114.	0.	4485.
2014	47.54	1.13	0.00	648.	25.	2304.	2055.	0.	4359.
2015	47.51	1.17	0.00	668.	24.	2240.	1996.	0.	4237.
2016	47.48	1.20	0.00	687.	23.	2178.	1940.	0.	4118.
2017	47.45	1.24	0.00	708.	22.	2118.	1885.	0.	4003.
2018	47.42	1.28	0.00	729.	21.	2061.	1833.	0.	3893.
2019	47.39	1.32	0.00	751.	20.	2003.	1780.	0.	3783.
2020	47.36	1.36	0.00	773.	19.	1947.	1729.	0.	3676.
2021	47.32	1.40	0.00	796.	19.	1894.	1681.	0.	3575.
2022	47.29	1.44	0.00	820.	18.	1842.	1634.	0.	3475.
2023	47.25	1.48	0.00	845.	17.	1791.	1587.	0.	3378.
2024	47.21	1.53	0.00	870.	17.	1742.	1543.	0.	3285.
2025	47.17	1.57	0.00	896.	16.	1693.	1499.	0.	3192.
2026	47.13	1.62	0.00	922.	15.	1647.	1456.	0.	3103.
2027	47.09	1.67	0.00	950.	15.	1602.	1415.	0.	3017.
2028	47.05	1.72	0.00	978.	14.	1558.	1375.	0.	2933.
2029	47.01	1.77	0.00	1008.	13.	1516.	1337.	0.	2853.
2030	46.97	1.82	0.00	1038.	13.	1474.	1299.	0.	2773.
2031	46.92	1.88	0.00	1068.	12.	1433.	1262.	0.	2695.
2032	46.88	1.93	0.00	1100.	12.	1395.	1227.	0.	2621.
2033	46.83	1.99	0.00	1133.	11.	1356.	1191.	0.	2547.
2034	46.78	2.05	0.00	1166.	11.	1319.	1158.	0.	2477.
Total				23606.	636.	61057.	54287.	0.	115344.

EXISTING Route Hwy 4/Hwy 19
Segment 1 Hwy 4/Hwy 19
WITH Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Minor Route Num. Veh. (000)	Fuel Consp. (000) (gal)	Carbon Monox. (000) (kg)	Discounted Motorist Costs (Thous. $) Time Costs	Veh. Oper. Costs	Acc. Costs	Total Costs
2005	47.77	0.87	0.00	497.	36.	2970.	2660.	0.	5631.
2006	47.74	0.90	0.00	512.	35.	2887.	2585.	0.	5472.
2007	47.72	0.92	0.00	528.	33.	2807.	2512.	0.	5319.

2008	47.70	0.95	0.00	544.	32.	2730.	2442.	0.	5172.
2009	47.67	0.98	0.00	559.	31.	2653.	2371.	0.	5024.
Total				2640.	167.	14047.	12570.	0.	26617.

PROPOSED Route Horne Lake Connector
Segment 1 Horne Lake Connector
WITH Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Minor Route Num. Veh. (000)	Fuel Consp. (000) (gal)	Carbon Monox. (000) (kg)	Discounted Motorist Costs (Thous. $) Time Costs	Veh. Oper. Costs	Acc. Costs	Total Costs
2010	35.47	1.01	0.00	300.	21.	1917.	1287.	0.	3204.
2011	35.45	1.04	0.00	309.	20.	1864.	1250.	0.	3114.
2012	35.43	1.07	0.00	318.	19.	1812.	1215.	0.	3027.
2013	35.40	1.10	0.00	328.	18.	1762.	1181.	0.	2943.
2014	35.38	1.13	0.00	338.	18.	1713.	1148.	0.	2861.
2015	35.36	1.16	0.00	348.	17.	1666.	1115.	0.	2781.
2016	35.33	1.20	0.00	358.	16.	1620.	1084.	0.	2704.
2017	35.30	1.24	0.00	369.	15.	1575.	1053.	0.	2629.
2018	35.28	1.27	0.00	380.	15.	1532.	1024.	0.	2555.
2019	35.25	1.31	0.00	392.	14.	1489.	995.	0.	2484.
2020	35.22	1.35	0.00	404.	14.	1449.	967.	0.	2416.
2021	35.19	1.39	0.00	416.	13.	1409.	940.	0.	2348.
2022	35.17	1.43	0.00	428.	13.	1370.	913.	0.	2284.
2023	35.13	1.48	0.00	441.	12.	1333.	888.	0.	2220.
2024	35.10	1.52	0.00	455.	12.	1296.	863.	0.	2159.
2025	35.07	1.57	0.00	468.	11.	1261.	839.	0.	2099.
2026	35.04	1.61	0.00	483.	11.	1226.	815.	0.	2041.
2027	35.00	1.66	0.00	497.	10.	1192.	792.	0.	1984.
2028	34.97	1.71	0.00	512.	10.	1160.	770.	0.	1930.
2029	34.94	1.76	0.00	528.	9.	1128.	748.	0.	1876.
2030	34.90	1.82	0.00	544.	9.	1097.	727.	0.	1824.
2031	34.86	1.87	0.00	560.	9.	1068.	707.	0.	1775.
2032	34.83	1.93	0.00	577.	8.	1039.	687.	0.	1726.
2033	34.79	1.98	0.00	594.	8.	1010.	668.	0.	1677.
2034	34.75	2.04	0.00	613.	8.	983.	649.	0.	1632.
Total				10960.	329.	34969.	23323.	0.	58292.

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
2005	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00
2010	663.47	1019.09	0.00	1682.57
2011	644.53	989.72	0.00	1634.25
2012	626.20	961.30	0.00	1587.50
2013	608.45	933.75	0.00	1542.20

2014	591.23	907.03	0.00	1498.26
2015	574.52	881.08	0.00	1455.60
2016	558.29	855.86	0.00	1414.15
2017	542.50	831.33	0.00	1373.83
2018	528.79	808.89	0.00	1337.67
2019	513.74	785.55	0.00	1299.29
2020	497.98	762.10	0.00	1260.08
2021	485.14	741.19	0.00	1226.33
2022	471.53	720.05	0.00	1191.58
2023	458.23	699.39	0.00	1157.62
2024	446.40	680.21	0.00	1126.61
2025	432.79	659.88	0.00	1092.67
2026	420.62	640.95	0.00	1061.57
2027	409.68	623.27	0.00	1032.95
2028	398.19	605.43	0.00	1003.61
2029	387.80	588.69	0.00	976.49
2030	376.92	571.81	0.00	948.72
2031	365.64	554.86	0.00	920.50
2032	356.11	539.54	0.00	895.65
2033	345.99	523.83	0.00	869.81
2034	336.38	508.90	0.00	845.28
Total	12041.09	18393.70	0.00	30434.79

Summary Problem Benefits, Costs, and Economic Measures

Total Discounted User Benefits (Mill. $) :	30.435
Discounted Construction Cost (Mill. $) :	42.936
Discounted Salvage Value (Mill. $) :	6.655
Discounted Increase in Maint. and Rehab. (Mill. $) :	0.000
Fuel Consumption Savings (Mill. Gal.) :	10.005
Carbon Monoxide Emission Reduction (Mill. Kg.) :	0.140
Net Present Value (Mill. $) :	-5.846
Gross Benefit-Cost Ratio :	0.839
Netted Benefit-Cost Ratio :	0.864
Internal Rate of Return (Percent) :	5.104