APPLICATION FOR A

PROJECT APPROVAL CERTIFICATE

Taylor Straddle plant

Prepared for:

NOVAGAS CLEARINGHOUSE LTD.

By:

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Human Dimensions

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April 1997

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Executive Summary

Novagas Clearinghouse Ltd. (NCL) and its potential partner, Canadian Natural Resources Limited (CNRL), are applying to the British Columbia Environmental Assessment Office for a Project Approval Certificate to construct, own, and operate a deepcut straddle plant at Taylor, British Columbia for the purpose of extracting ethane plus (C2+) natural gas liquids (NGLs) from portions of gas streams on the Westcoast Energy Inc. (WEI) natural gas transmission system. The plant will be located about 18 km southeast of Fort St. John, British Columbia, in the Industrial area of the District of Taylor. This project will provide natural gas shippers in northeastern British Columbia with natural gas liquids processing services. The residue gas will be recompressed and returned to the WEI system, and the produced liquids will be shipped by pipeline to fractionators in the Fort Saskatchewan, Alberta area.

The proposal includes the following facilities:

· a natural gas extraction plant (the Taylor Straddle Plant) located in the north half of Section 36, Township 82, Range 18, W6M, capable of processing 9 911 103m3/d of supply gas per day; it will produce approximately 3 180 m3/d of natural gas liquids (NGLs), and 9 061 103m3/d of residue gas;

· two 1.4 km pipelines constructed and installed in a common ditch and elevated pipe racks to transport supply and residue gas in NPS 20 (508 mm OD) pipelines between WEI's Meter Station #43 and the Taylor Straddle Plant; and

· associated equipment including tie-ins and valving on the WEI transmission system.

Project Rationale

Gas volumes from northeastern British Columbia, including the WEI McMahon Plant, have risen steadily over the past 10 years. WEI has predicted additional growth in gas volumes in its deliverability studies. In addition, NCL has conducted a regional natural gas and by-product supply analysis which supports earlier studies.

The Taylor Straddle Plant will process 9 911 103m3/d of the McMahon Plant gas stream. The Taylor Straddle Plant will extract ethane in addition to the heavier C3+ liquids. The result is the removal of a higher value product.

The Taylor Straddle Plant will connect to the WEI transportation system in parallel to the existing Solex Energy Ltd. (Solex) Younger Plant. This provides the most economical development of the straddle plant system in BC and allows the opportunity for the gas shipper (the owner of the NGLs in the gas stream) to contract with whichever straddle plant provides them with the greatest value for their NGLs.

NCL believes that the Taylor Straddle Plant will fill a competitive processing need in northeast British Columbia. More processing options will encourage further development, which will provide increased royalty revenues to the Crown, and enhanced employment and economic opportunities in the region, as well as a need to increase exploration and development in the oil and gas sector.

Project Description

The Taylor Straddle Plant will extract ethane plus (C2+) liquids from the existing Westcoast Energy Inc. (WEI) natural gas transmission system in northeast British Columbia. The residue gas from the straddle plant will be recompressed and returned to the WEI transmission system without any effect on WEI system operating pressures. The NGLs will be transported to fractionators in the Fort Saskatchewan area through product pipelines. These pipelines are the subjects of separate regulatory applications. (The application to the Alberta Energy and Utilities Board (EUB) has been approved; the application to the National Energy Board for the BC segment and the interprovincial pipeline is under consideration. NCL's natural gas pipeline proposal in Alberta has obtained EUB approval. The application for the Redwater Fractionator has received Alberta Environmental Protection approval, and the EUB application is under consideration.)

The plant will be located in the Industrial area of the District of Taylor, on a site in the north half of Section 36, Township 82, Range 18, W6M. This property, east of the Alaska Highway, is currently owned by Numac Energy Inc. and Petro-Canada. NCL has 'Options to Purchase' with Numac Energy Inc. and Petro-Canada to obtain these parcels of land.

The proposed Taylor Straddle Plant will be designed to process approximately 9 911 103m3/d of supply gas; it will produce approximately 3 180 m3/d of natural gas liquids, and

9 061 103m3/d of residue gas. The sweet gas (supply and residue) will be transported at an anticipated pressure of 5 520 kPa (abs) (800 psi).

Two 1.4 km sweet gas pipelines will be constructed to transport supply gas and return gas in NPS 20 (508 mm OD) pipelines between WEI's Meter Station #43 and the Taylor Straddle Plant. The lines will be installed in a common ditch and on elevated pipe racks within the WEI McMahon Plant site. Produced water from the facility will be transported in trucks equipped with tank scrubbers to an approved disposal facility

Issues Scoping and Consultation

NCL's issues scoping program included consultation with personnel from the Environmental Assessment Office, the Treaty 8 Tribal Association, provincial Ministries, the Mayors and other local leaders of Taylor and Fort St. John, other producers in the area, and key consultants with previous experience in northeast British Columbia. These were followed with telephone calls, personal contacts, and meetings with key persons and groups in the area. NCL personally met with members of the First Nations groups whose traditional use areas fall within the proposed project area, as well as local and area residents, resource users, business owners, members of special interest groups, and representatives of local, provincial, federal, and regional governments.

Issues identified from the consultation process included concerns about local noise, air quality, and opportunities for local economic development over the life of the project. These issues were documented and subsequently incorporated into project design and planning activities.

Environmental Assessment

An environmental assessment was conducted for potential biophysical effects associated with the proposed project. Identified issues were used to focus the environmental assessment on topics that are relevant to the Taylor Straddle Plant as proposed, or that are of concern to affected stakeholders and residents. These issues are summarized in Table 4-1. This assessment was conducted by independent technical specialists using established methods reviewed with government representatives. Information obtained from modelling, recent studies and environmental assessments, published literature, and specialist knowledge was used to identify the potential effects associated with all facilities.

Mitigative measures to prevent or reduce potential adverse effects, and any remaining effects were also identified.

With the exception of air emissions, the geographic scope of environmental issues is confined to the proposed plant site, pipeline right-of-way, and adjacent areas within the Taylor 'Heavy Industrial' zone. Because multiple emission sources are present in the Taylor airshed, potential project and cumulative effects are evaluated for the entire airshed.

To reduce overall NOx emissions, NCL will invest in the upgrading of existing WEI equipment. Although NOx emissions from the Taylor Straddle Plant are expected to be approximately 120 tonnes per year, the reduction of 220 tonnes per year from the equipment upgrade will culminate in a net *reduction* of 100 tonnes per year in NOx emissions in the Taylor community.

As a result of the net reduction in NOX emissions, the cumulative effect of the Taylor Straddle Plant NOX emissions on the Taylor airshed is concluded to be positive in direction, sub-regional in scope, long-term in duration, and low in magnitude.

No significant odours are expected from the Taylor Straddle Plant due to the minimal amount of unburned hydrocarbon releases and the low sulphur compound content in the supply gas.

Since the plant will be built on a site previously disturbed by industrial and agricultural activities, and since the zoning of the site as 'Heavy Industrial' will restrict future use, potential effects on wildlife, forest, tourism, or recreational resources or resource use are concluded to be nil.

Numerous design features have been incorporated to prevent and isolate leaks of potential contaminants. In combination, these preventative and containment measures will ensure that effects of site contamination and runoff are local in scope, neutral to negative, long-term, and nil to low in magnitude.

Socio-economic Evaluation

The socio-economic conditions in the project area are discussed at two levels: direct and regional impact areas. The Direct Impact Area (DIA) is the area directly affected (or altered) by the proposed development, i.e., the District of Taylor. The regional impact area includes the near-by community of Fort St. John and surrounding rural areas with services and physical and social infrastructure potentially impacted by the project but located outside the DIA. These include availability of qualified local construction workers, accommodation facilities, and use of medical facilities in Fort St. John.

Discussions with local stakeholders and provincial regulators identified socio-economic project-related concerns that were taken into consideration by NCL in the design and planning of the project.

The local hiring will be positive for the Fort St. John Area's oil and gas service suppliers and contractors. The creation of seven permanent full-time positions to operate the plant, and the tendering of maintenance contracts to local contractors also will create long-term benefits.

The demand for out-patient service and emergency care is not expected to increase in any significant manner because of the project.

No significant impacts or excessive demands on existing fire fighting services are anticipated from this project. To ensure the safety of the public and plant personnel, NCL will be developing an emergency response plan in consultation with local industry operators, and regional fire and emergency response services.

Since the Taylor Straddle Plant does not propose to establish a work camp, no significant impacts are expected from the project except for a moderate and short-term increase in local traffic to and from the plant site.

Under Taylor's Municipal Plan, residential areas that are adjacent to industrial zones are protected by a 'transition zone' intended to act as buffer between the two uses. In the case of the NCL plant, treed buffers or other proven noise barriers will be used to minimize visual and noise impacts.

To meet local community expectations (i.e., maintenance of a high level of public health and safety, need for diverse recreational amenities, and municipal orderly development) NCL is committed to maintaining on-going communication with the District of Taylor and its local residents to ensure the maintenance and improvement in the quality of life of local residents.

A summary of the potential socio-economic effects of the project and proposed mitigation measures is provided in Table 7-2.

Archaeological and Heritage Impact Assessment

An Archaeological Impact Assessment was conducted for the proposed plant location in April 1997. The assessment was conducted by an archaeologist, assisted by a representative from the Kelly Lake First Nation. Chief Buddy Napoleon of the Saulteau First Nation met with the field archaeologists before field work began to review the scope of work.

One previously recorded archaeological site (HaRe 13) occurred in potential conflict with the proposed plant. This site was the most intensively investigated area of the study. However, no cultural material was observed during any of the investigative field work; in addition, no intact post-glacial deposits were observed on the former tank farm¾the site of the proposed plant, and the location of Site HaRe 13. It was reasserted that Site HaRe 13 had been destroyed by past industrial activity. The level of inspection and testing conducted in association with this project is deemed sufficient to suggest that no further assessment in relation to the current development plans is necessary.

Five First Nations were consulted to determine potential conflicts with traditional land use within the proposed project area: the Saulteau, West Moberly, Doig River, Blueberry River, and Kelly Lake First Nations. No specific traditional land use concerns were raised by any of these five First Nations communities.

Potential effects on heritage and archaeological resources resulting from the Taylor Straddle Plant are, therefore, nil in magnitude; confidence in this assessment is good.

Conclusions

This application identifies potential environmental, social, cultural, heritage, and health effects associated with the proposed Novagas Clearinghouse Ltd. Taylor Straddle Plant. The application also identifies the measures to be adopted by NCL and its consultants and contractors, to prevent or mitigate adverse effects, and to maximize local and regional benefits.

NCL has completed the necessary activities required under the Environmental Assessment Act. This application concludes that no significant adverse environmental, social, economic, health, cultural, or heritage effects are likely to result from the Taylor Straddle Plant.

NCL believes that approval of the application will provide the following benefits:

NCL will invest $48.9 million in British Columbia and provide future employment in the northeast region;

Producers that ship natural gas on the Westcoast Energy Inc. transmission system will have an opportunity to choose between NGL extraction facilities in a competitive environment;

The Taylor Straddle Plant will effectively compete with existing infrastructure to encourage further exploration and development in the gas supply area;

Current NOX emission levels in the Taylor airshed will be reduced by approximately 100 tonnes per year; and

The Taylor Straddle Plant will create socio-economic benefits as well as increased revenue to the producers and the province.

NCL requests the approval of the Taylor Straddle Plant Approval Certificate Application in a timely fashion to allow construction to begin July 1997.

LIST OF ABBREVIATIONS AND TERMS

µg	Microgram (10-6 grams).
C	Degree(s) Celsius.
1 ppm CO2	1 860 µg/m3.
1 ppm H2S	1 438 µg/m3.
1 ppm NO2	1 945 µg/m3.
1 ppm SO2	2 706 µg/m3.
103m3/d	Thousand cubic metres per day.
a	Annum (year).
abs	Absolute.
AES	Atmospheric Environment Service.
agl	Above ground level.
AIA	Archaeological Impact Assessment.
Airshed	The volume of air that will be affected by pollutants from a particular source or group of sources.
asl	Above (mean) sea level.
bbl(s)	Barrel(s).
BC	British Columbia.
C2+	Ethane plus.
C3+	Propane plus.
CAPP	Canadian Association of Petroleum Producers.
CNRL	Canadian Natural Resources Limited.
CPA	Canadian Petroleum Association.
CRI	Canadian Regional Airlines.
CSA	Canadian Standards Association.
d	Day.
DCS	Distributed control system.
DFO	Fisheries and Oceans Canada.
DIA	Direct Impact Area.
EAO	BC Environmental Assessment Office.
ERP	Emergency Response Plan.
ESD	Emergency Shutdown.
EUB	Alberta Energy and Utilities Board.
FPAC	Federal-Provincial Advisory Committee.
g	Gram.
GHG	Greenhouse gas(es).
GJ	Gigajoule (109 joules).

ha	Hectare.
hr	Hour.
ISC	Industrial Source Complex (dispersion model).
kg	Kilogram.
km	Kilometres.
kPa	Kilopascal.
kW	Kilowatt.
LPG	Liquified petroleum gas.
m	Metre.
m3	Cubic metre.
MEI	BC Ministry of Employment and Investment.
MELP	BC Ministry of Environment, Lands and Parks.
mm	Millimetres.
mmcf/d	Millions of cubic feet per day.
mol%	Molecular percent.
mole	Molecular.
NAS	National Academy of Sciences.
NCL	Novagas Clearinghouse Ltd.
NCPL	Novagas Clearinghouse Pipelines Ltd.
NEB	National Energy Board.
NGL	Natural gas liquids.
NMHC	Non-methane hydrocarbons.
NOx	Oxides of nitrogen.
NPS	Nominal Pipe Size.
NRCC	National Research Council of Canada.
O3	Ozone.
OD	Outside diameter (of pipe).
pers. comm.	Personal Communication.
PG	Pasquill-Gifford (atmospheric stability scheme).
P/L	Pipeline.
PM	Particulate matter.
ppm	Parts per million.
psi	Pounds per square inch.
PST	Provincial sales tax.
R/W	Right-of-way.
RTDM	Rough Terrain Diffusion Model (dispersion model).
s	Second(s).
Solex	Solex Developments Company Inc.
t	Tonne (1 000 kg).
T8TA	Treaty 8 Tribal Association.
TOC	Total organic compounds.
TSA	Timber supply area.
TSP	Total suspended particulates.
turbulence	One of two mechanisms of atmospheric circulation; the result of atmospheric heating, which causes natural convection currents, and mechanical turbulence resulting from wind shear.
USEPA	United States Environmental Protection Agency.
WEI	Westcoast Energy Inc.
VOC	Volatile organic compounds.

yr Year.

1. INTRODUCTION

Novagas Clearinghouse Ltd. (NCL) has completed commercial arrangements to provide natural gas shippers in northeastern British Columbia with natural gas liquids processing services. NCL and its potential partner, Canadian Natural Resources Limited (CNRL), propose to construct, own, and operate a deepcut straddle plant at Taylor, British Columbia for the purpose of extracting ethane plus (C2+) natural gas liquids (NGL) from portions of gas streams on the Westcoast Energy Inc. (WEI) natural gas transmission system. The straddle plant will dehydrate and cool the gas, thereby condensing the C2+ liquids out of the gas stream. A turboexpander and demethanizer type process will be used. The residue gas will be recompressed and returned to the WEI system without any effect on the WEI system pressures. The produced liquids will be shipped by pipeline to the Fort Saskatchewan, Alberta area for fractionation.

The facilities will fill a competitive processing need in northeast BC. Increased processing capability and options in Taylor will benefit gas producers that ship through the WEI transmission system and WEI, as well as the community, region, province, and Crown.

This application is submitted to the British Columbia Environmental Assessment Office (EAO), and will be made available to relevant federal, provincial, and local agencies; and interested stakeholders and other members of the public information as directed by the EAO. The information contained herein will provide these stakeholders with a detailed description of the proposed project; an assessment of the potential environmental, socio-economic, and cultural/heritage effects; and mitigation measures to ensure the potential impacts are either insignificant or reduced to acceptable levels.

This application to the British Columbia Environmental Assessment Office requests a Project Approval Certificate which will allow NCL to proceed with the Taylor Straddle Plant Project as proposed below.

1.1 project overview

The Taylor Project will consist of a deepcut plant straddling the WEI natural gas transmission system, tie-ins and valving on WEI's transmission system, two sweet gas pipelines for transporting residue gas between WEI's Meter Station #43 and NCL's straddle plant, and a connection, at the straddle plant, to the proposed Novagas Clearinghouse Pipelines Ltd. (NCPL) product pipeline. The NCPL product pipeline is the subject of a separate regulatory application to the National Energy Board.

The straddle plant will be located in the District of Taylor, in the Taylor industrial area, east of the Alaska Highway. Gas will be supplied to the Taylor Straddle Plant from the WEI transmission system. All potential gas sources are from Westcoast Energy Inc., including the residue gas leaving WEI's Meter Station #43, gas from the Boundary Lake pipeline, and gas from the Gordondale mainline which are located adjacent to WEI's meter station. The Taylor Straddle Plant will produce sales gas and ethane plus (C2+) liquids.

Total capital cost of the Taylor Straddle Plant is estimated to be approximately $50 million.

To meet contract commitments, NCL and its potential partner, CNRL, wish to begin production by April 1, 1998. In order to meet this commitment, NCL has made equipment commitments, and proposes to start construction of the plant in July

1997 upon receipt of all necessary regulatory approvals. Construction is scheduled to be complete by mid-March 1998. The peak construction period will be from January to mid-March, 1998. Construction personnel who are not local will be housed in Fort St. John, British Columbia.

1.1.1 Applicant Name and Contact

Novagas Clearinghouse Ltd. (NCL) provides a full range of energy services from well head to burner tip. These services include ownership and operation of natural gas and NGL gathering and processing facilities as well as commercial activities, including risk management services and marketing of natural gas throughout Canada.

NCL's shareholders are NOVA Gas International Ltd. and NGC Canada Inc. NOVA Gas International Ltd. (NGI) is controlled by NOVA Corporation. NGC Canada Inc. is controlled by NGC Corporation. The limited partners of Novagas Clearinghouse Limited Partnership are NGI and NGC Canada Inc.

NCL has approximately 150 employees. Its headquarters are located at 800, 707 - 8th Avenue S.W., Calgary, Alberta, and it has business offices located in Oakville, Ontario.

Communication regarding the Taylor Straddle Plant Project should be sent to:

Novagas Clearinghouse Ltd.

Suite 800, 707 - 8 Avenue S.W.

Calgary, Alberta T2P 3V3

Attention: Mr. Bernie Patterson

Telephone (collect): 403 781 3324

Facsimile: 403 781 3188

1.2 application overview

The Application for a Project Approval Certificate has been prepared pursuant to requirements of the British Columbia Environmental Assessment Process (EAO 1995). This application describes the proposed Taylor Straddle Plant Project. It also discusses issues which were identified during discussions with the BC Environmental Assessment Office, local residents, provincial and federal government agencies, local and regional governments, First Nations, and interested groups and individuals. The application also identifies the potential biophysical and socio-economic effects and describes the proposed mitigation measures.

The document is divided into the following main sections:

1. Project Description — Description of the proposed Taylor Straddle Plant and facilities, including the project rationale and schedule;

2. Issues Scoping and Consultation — Summary of information provided to the public and government contacts, and the proposed program for further information distribution and public consultation;

3. Environmental Assessment — Description of the existing environmental setting, potential effects of construction and operation, and the mitigation and monitoring measures to prevent or reduce potential effects;

4. Socio-Economic Evaluation — Description of the existing social, economic, cultural, and health setting; potential effects of construction and operation; and mitigation and monitoring measures to prevent or reduce potential effects;

5. Archaeological and Heritage Impact Assessment —Summary of the Archaeological Impact Assessment describing the historical and existing heritage and archaeological conditions in the study area, and the potential impact of the Taylor Straddle Plant; and

6. Conclusions — Summary of issues identified during consultation and project assessment, the mitigative measures to be employed, anticipated positive and negative residual effects, monitoring programs, and the proposed program for further information distribution and public consultation.

7. References

To facilitate review by technical specialists, project information pertinent to the environmental assessment (Section 4) and socio-economic evaluation (Section 5) are included in the relevant sections.

A list of abbreviations and terms is provided with the Table of Contents.

1.2.1 Project Team and Responsibilities

NCL retained a multi-disciplinary team to prepare the Taylor Straddle Plant application. The team consisted of NCL staff and independent technical specialists. Team responsibilities were as follows:

Project Approval Certificate Application

Salmo Consulting Inc., Calgary (prime consultant)

REB Environmental Services Inc.

Plant and Pipeline Design Engineering

DPH Engineering Inc.

Novagas Clearinghouse Ltd.

Air Quality

Levelton Engineering Ltd., Richmond

Archaeology and Heritage Resources

Fedirchuk McCullough & Associates Ltd., Calgary

Socio-Economic Evaluation

Human Dimensions, Calgary

Public Consultation

Novagas Clearinghouse Ltd.

2. Project Description

This section describes the proposed Taylor Straddle Plant, including a discussion of associated facilities, the project rationale, construction schedule, and estimated capital and operating costs. Existing gas supply and availability in the project area and activities associated with the Taylor Straddle Plant Project are also described.

A description of the liquids processing facility, and associated pipelines are provided in Sections 2.2, and 2.3 respectively. Overviews of proposed waste management, emergency response, and abandonment and reclamation procedures are presented in Section 2.4 through 2.6. Section 2.7 summarizes the permits, licences and approvals required for this facility.

2.1 Project Location and Scope

NCL and its potential partner, Canadian Natural Resources Limited (CNRL), propose to construct the Taylor Straddle Plant to extract ethane plus (C2+) liquids, pursuant to extraction rights agreements with the gas stream owners, from the existing Westcoast Energy Inc. (WEI) natural gas transmission system in northeast British Columbia. NCL has signed agreements with natural gas shippers on the WEI system to provide NGL processing at the Taylor Straddle Plant. The Taylor Straddle Plant is part of NCL's integrated liquids strategy, which includes a gathering system in British Columbia and Alberta, as well as a liquids fractionator at the existing NCL Redwater Fort Saskatchewan storage facility (Figure 2-1).

The residue gas from the Taylor Straddle Plant will be recompressed and returned to the WEI transmission system without affecting WEI system operating pressures. The natural gas liquids will be transported to NCL's Redwater Fort Saskatchewan facility and other fractionation facilities in the Fort Saskatchewan area by product pipelines that are the subjects of separate regulatory applications. (The application to the Alberta Energy and Utilities Board (EUB) has been approved; the application to the National Energy Board (NEB) for the BC segment and the interprovincial pipeline is under consideration. NCL's natural gas pipeline proposal in Alberta has obtained EUB approval. The application for the Redwater Fractionator has received Alberta Environmental Protection approval, and the EUB application is under consideration.)

The project will consist of a natural gas liquids extraction plant, with tie-ins and valving to the WEI transmission system, gas supply and residue gas return pipelines between WEI's Meter Station #43 and the Taylor Straddle Plant; and a connection to the proposed NCPL product pipeline. NCL originally considered including a truck off-loading terminal with the straddle plant. However, since there are currently two such facilities in Taylor, NCL has determined that it may not be necessary to build one at the plant at this time. In the event an additional truck off-loading terminal in Taylor is deemed advantageous, NCL will submit a separate application for this facility.

The plant will be located about 18 km southeast of Fort St. John, British Columbia, in the Industrial area of the District of Taylor (Figure 2-2). The site is in the north half of Section 36, Township 82, Range 18, W6M, east of the Alaska Highway. The land is already zoned as 'Heavy Industrial' (District of Taylor 1995b). NCL has 'Options to Purchase' with Numac Energy Inc. and Petro-Canada to obtain these parcels of land.

The proposed Taylor Straddle Plant will be designed to process approximately 9 911 103m3/d (350 mmcf/d) of supply gas; it will produce approximately 3 180 m3/d (20,000 barrels/day (bbls/d)) of natural gas liquids, consisting mainly of ethane plus (C2+) liquids, and

9 061 103m3/d (320 mmcf/d) of residue gas. The sweet gas (supply and product) will be transported at an anticipated pressure of 5 520 kPa (abs) (800 psi).

Two short pipelines will be constructed to transport supply and residue gas in NPS 20

(508 mm OD) pipelines between WEI's Meter Station #43 and the Taylor Straddle Plant. These 1.4-km long (0.9-mile) lines will be installed in a common ditch and above ground pipe racks within the WEI McMahon Plant site.

Produced water from the facility will be transported in trucks equipped with tank scrubbers to an approved disposal facility.

2.1.1 Project Rationale

Gas volumes from northeastern British Columbia, including the WEI McMahon Plant, have risen steadily over the past 10 years. WEI has predicted additional growth in gas volumes in its deliverability studies. In addition, NCL has conducted a regional natural gas and by-product supply analysis which supports earlier studies (Sproule Associates Limited 1997).

Currently, Taylor Gas Liquids Limited Partnership owns, and Solex Gas Liquids Ltd. operates the only straddle plant (Younger Plant) downstream of the WEI McMahon Plant at Taylor, BC. This plant has the capacity to process approximately 11 300 103m3/d (400 mmcf/d) of feed gas, and removes propane plus (C3+) liquids from the gas stream. The Younger Plant does not extract ethane. However, an estimated 9 000 103m3/d (320 mmcf/d) of the McMahon Plant residue gas is bypassed by the existing straddle plant.

Approximately another 1 800 103m3/d (65 mmcf/d) of gas from the WEI Boundary Lake lateral bypasses the existing straddle plant. In addition, the Gordondale lateral, depending on the direction of the flow, brings gas to join with the WEI McMahon Plant residue gas, which is also bypassed around the Younger Plant. The McMahon Plant outlet gas, the Boundary Lake gas, and the Gordondale gas all collect at WEI Compressor Station 1 for transportation down WEI-T-North to Compressor Station 2.

The Taylor Straddle Plant will process an additional 9 911 103m3/d (350 mmcf/d) of the McMahon Plant gas stream, the Boundary Lake gas, and the Gordondale gas. The Taylor Straddle Plant also will extract ethane in addition to the heavier C3+ liquids. The result is the removal of a higher value product.

Figure 2-1. Natural gas liquids project: Liquids gathering system route map. (11 x 17 fold-out)

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Figure 2-2. Sketch plan showing proposed pipeline and straddle plant, Taylor, British Columbia.

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The Taylor Straddle Plant will connect to the WEI transportation system in parallel to the existing Younger Plant. This provides the most economical development of the straddle plant system in BC and allows the opportunity for the gas shipper (the owner of the NGLs in the gas stream) to contract with whichever straddle plant provides the shipper with the greatest value for their NGLs.

NCL believes that the Taylor Plant will fill a competitive processing need in northeast British Columbia. More processing options will encourage further development, which will provide increased royalty revenues to the Crown, and enhanced employment and economic opportunities in the region, as well as a need to increase exploration and development in the oil and gas sector.

Some estimated regional revenues due to increased processing by the Taylor Straddle Plant are as follows:

Area	Service	Est. Value
British Columbia	Construction-based services and equipment	$44,600,000
	Construction-based PST income	$3,300,000
	Operation-based wages and burdens	$500,000/yr
	Operation-based utilities, less fuel	$700,000/yr
Taylor/Fort St. John	Operation-based contract services (e.g., maintenance, electrical, instrumentation, labour)	$550,000/yr
	Property tax	$2,000,000/yr

2.1.2 Gas Supply and Availability

NCL has signed firm long-term commitments with the T-North gas shippers for the extraction rights to process their gas to remove NGLs in the Taylor Straddle Plant. These signed agreements represent a sufficient volume to justify proceeding with the construction and operation of the Taylor Straddle Plant.

2.1.3 Associated Facilities and Activities

Other activities associated with the proposed Taylor Straddle Plant Project include gas supply and return tie-ins and valving on the WEI transmission system, and a connection on the new NCPL product pipeline. Since fuel gas will be drawn from the Taylor Straddle Plant residue gas, no additional pipelines will be required.

NCL and its potential partner, CNRL, will construct, own, and operate the Taylor Straddle Plant and its associated facilities. NCL also will own the associated gathering system, and fractionation plant—subjects of other applications and parts of NCL's overall liquids strategy for northeastern British Columbia and northwestern Alberta. NCPL will own the gathering system from Taylor to Boundary Lake.

No road construction is anticipated for the site, except for an entry way to the site from existing roads, and roads within the facility area. Approximately one (1) truck per month will be required to haul produced water from the plant to an approved disposal facility. Other traffic to and from the site will be limited to operations and maintenance personnel and delivery of operational supplies.

To reduce overall NOx emissions, NCL will invest in the upgrading of existing WEI equipment. Although NOx emissions from the Taylor Straddle Plant are expected to be approximately 120 tonnes per year, the reduction of 220 tonnes per year from the equipment upgrade will culminate in a net *reduction* of approximately 100 tonnes per year in NOx emissions in the Taylor community.

2.1.4 Construction and Operations

NCL and its potential partner, CNRL, will construct and own the Taylor Straddle Plant. The plant will be of modular construction where practical, with major equipment packages pre-fabricated and skid mounted. This design will minimize field construction complexity.

Additional construction requirements include installing appropriate valving and controls on the WEI transmission system at or near WEI's Meter Station #43 to divert a portion of the flow from the transmission lines to the Taylor Straddle Plant. The 1.4 km-long supply and return sweet gas pipelines will be installed in a common ditch and on above ground pipe racks to allow gas to be transported between WEI's Meter Station #43 and the Taylor Straddle Plant. A connection to the proposed NCPL product pipeline will also be constructed at the Taylor Straddle Plant, with appropriate valving and controls as safety measures to protect the pipeline and straddle plant.

Major equipment and long delivery material will be purchased by NCL or on behalf of NCL by the engineering design consultants. Shorter delivery materials will be purchased by the contractors engaged to perform the construction.

As non-local construction personnel can be housed in Taylor and Fort St. John, no permanent or temporary camp will be required.

2.1.4.1 Construction Schedule

NCL wishes to meet contractual commitments to place the proposed facilities in service no later than April 1, 1998. In order to meet this commitment, NCL proposes to start construction in July 1997 upon receipt of all necessary regulatory approvals. Plant field construction is expected to take about nine months, from July 1997 to mid-March 1998. A procurement and construction schedule for this project is given in Figure 2-3.

Detailed engineering has commenced. Major equipment for the project, including process modules and compressors that have long lead times, has been ordered. Plant construction should be complete by mid-March 1998, allowing a commissioning and start-up period.

Figure 2-3. Procurement and construction schedule. (B&W)

Construction contractors will be selected to perform the various phases of the work following a competitive bid process. The work may be divided into a number of packages which will be tendered and awarded individually. Local area contractors with suitable expertise and experience will be included on the tender lists. The overall construction efforts will be managed by NCL or its selected representative.

The average work force for facility construction is expected to be approximately 70 people and the peak work force is estimated at 120 people. The peak construction period will be from January through March 1998. Estimated total construction labour for the facilities is estimated to be 100,000 person-days.

2.1.4.2 Capital and Operating Costs

The total capital cost of the Taylor Straddle Plant Project is estimated to be $48.9 million for the plant, tie-ins, and supply and return pipelines combined. The installed capital cost of the proposed plant is $44.5 million. A breakdown of capital costs for the plant and associated facilities is provided in Table 2-1. This cost estimate includes the following:

applications, approvals, permits, and environmental studies;

purchase of prefabricated gas processing modules for liquids recovery;

purchase of pipe for supply and return pipelines;

site utilities including power generation, control system, process heating system, fire protection, and service building;

chemical storage facilities for methanol, glycol, and amines;

residue gas compression to residue pipeline pressure;

site preparation;

on-site electrical, piping and mechanical work, labour, and services;

work crew lodging; and

startup and commissioning.

Seven full-time staff will be required for continuous operation of the plant; these persons will probably live in the Taylor or Fort St. John area. The facility is expected to be manned 24 hours per day, 7 days per week; it will operate an average of 360 days per year.

Local contract maintenance companies will be used on an 'as needed' basis. About 5,000 person-hours per year of contract maintenance services is expected to be required. Annual operating costs are estimated to be $4.8 million (see Table 2-2).

2.2 Liquids Processing Facility

2.2.1 Site Selection

NCL and the project team evaluated several sites for the proposed Taylor Straddle Plant. The principal criteria used for this assessment were that the site should be located within

Table 2-1. Capital cost estimate for the proposed Taylor Straddle Plant.

Item	Estimated Capital Cost (excl. GST)
STRADDLE PLANT COSTS	
Major Equipment	$ 16,000,000
Materials	9,000,000
Construction Labour	10,000,000
Engineering, Management, Land & Fees	2,500,000
Contingency (10%)	4,000,000
PST	3,000,000
TOTAL STRADDLE PLANT	$ 44,500,000
GAS SUPPLY & RETURN PIPELINE, AND TIE-IN COSTS	
Materials	$ 1,300,000
Construction	1,800,000
Engineering, Management, right-of-way, and Fees	600,000
Contingency (10%)	400,000
PST	300,000
TOTAL PIPELINE, ETC.	$ 4,400,000

Table 2-2. Annual operating cost estimate for the proposed Taylor Straddle Plant.

Item	Estimated Operating Cost (excl. GST and PST)

Full-time wages and burdens	$ 500,000
Parts and materials	600,000
Utilities, less fuel	700,000
Taxes, Insurance	2,200,000
Overhead and management costs	250,000
Contract services (maintenance, electrical, instrumentation, labour)	550,000
ESTIMATED TOTAL	$ 4,800,000

reasonable proximity to the WEI transmission system, the area should already be zoned as 'Heavy Industrial', and that there should be adequate existing road access to the site.

The proposed gas plant will be located on the adjoining Numac and Petro-Canada land parcels south of Cherry Avenue, east of the Alaska Highway, and immediately west of the railway right-of-way (Figure 2-4; Appendix D). This site was chosen because of the following:

presence of existing infrastructure, e.g., roads, power and water access;

previously zoned as 'Heavy Industrial';

previously disturbed by agricultural and industrial use;

close to the WEI plant and tie-in points; and

routing of the right-of-way and associated pipelines can lie along existing pipeline corridors.

Aerial photographs from 1961 to 1995 (Appendix C, Plates 8-14; Appendix D) provide an historical indication of land use on the Petro-Canada and Numac properties. The southern portion of the Petro-Canada property (adjacent to Pine Avenue) shows surface disturbance and spoil piles in the 1961 through 1970 photos. By 1975 two petroleum storage tanks had been placed in the southeast corner of this disturbed area. The 1986 photo shows the presence of two additional tanks on this site plus a gravelled area. By 1995 all the tanks had been removed but the gravel pads are still evident. The rest of the Petro-Canada property appears to be cultivated in all photos; however a 100 x 100 m area in the north east area had been used for excavation of clay. It is currently in brome grass and is used for hay production (P. Reid pers. comm.; Appendix C, pp 9, 34).

The Numac property was cultivated historically, as was the Taylor Flats area in general. By 1961, however, the Taylor gravel road grid had expanded into this area. The property has since been allowed to revegetate. In the 1986 photo, the grid is less visible with crop lines confusing the image. (P. Reid pers. comm.; Appendix C, pp 9, 34-41).

A plot plan of the proposed plant is shown in Figure 2-5, illustrating the location of the building, NGL storage, and pipeline tie-ins. A treed buffer zone will be installed on the west and north sides of the site to attenuate noise and reduce the visual impact of the site. Should local residents indicate a similar concern regarding noise and adverse visual impact of the south side and southwest corner of the site, NCL will erect a wall similar to that constructed along major highways.

2.2.2 Process Description

The Taylor Straddle Plant will be designed to extract C2+ liquids, and sales gas from the feed gas stream in accordance with all appropriate regulatory requirements and codes. The residue sales gas will be returned to the WEI transmission system, and the NGLs will be shipped by pipeline to fractionators in the Fort Saskatchewan area. A process schematic diagram is included as Figure 2-6. More detailed information on gas dehydration, liquids removal,

Figure 2-4. Sketch plan showing proposed pipeline and straddle plant, Taylor, British Columbia. (11x17 fold-out)

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Figure 2-5. Conceptual plot plan.

11x17 pull out

Figure 2-6. Process flow schematic.

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product and by-product handling, utilities, and control and monitoring is provided below. The estimated rates of recovery for components in the supply gas stream will be as follows:

	mol %
Ethane (C2)	80.0
Propane (C3)	98.0
Butanes (C4)	99.5
Pentanes Plus (C5+)	99.9

Process conditions and recoveries are based on an average annual ambient temperature of 2·C for Taylor Straddle Plant operation. Operating conditions and recoveries will vary at lower or higher ambient temperatures.

The supply gas stream is metered and then dehydrated in a molecular sieve unit. The mole sieve towers are regenerated in sequence using a hot, dry gas stream which is subsequently cooled to recover liquid water. The regeneration gas stream is heated in a fuel gas-fired process heater.

The dehydrated gas is cooled in heat exchangers and is routed through a turboexpander where pressure reduction and additional cooling occur. During the cooling processes, natural gas liquids are condensed.

The resulting liquid and vapour streams are introduced to the demethanizer tower which provides the optimum split between the products. Residue gas (primarily methane) flows from the top of the tower, and the ethane plus liquid product is drawn from the bottom of the tower. Reboilers are provided for heat input to the tower at appropriate locations.

The residue gas product from the top of the tower is warmed in heat exchangers, and then compressed in the booster compressor, which is driven by the turboexpander. Further compression occurs in the recompressors, which are driven by gas turbine engines. Aerial coolers are provided for cooling after each compression operation. The compressed residue gas stream is then returned via pipeline to the WEI transmission pipeline system.

The liquid product from the bottom of the demethanizer will be pumped into the proposed NCPL liquids pipeline for delivery to fractionators in the Fort Saskatchewan area.

Major equipment in the Taylor Straddle Plant is listed in Table 2-3.

2.2.3 Atmospheric Emission Sources

The operation of the proposed Taylor Straddle Plant will result in the emission of various compounds into the atmosphere and in the generation of noise. Table 2-4 presents a matrix of the emission sources and associated gaseous emissions which may be classified as continuous, intermittent, or fugitive. Potential emissions from the Taylor facility include the following:

Table 2-3. Major equipment for the proposed Taylor Straddle Plant

Type	Equipment(a)	Comment
Rotating Equipment	• Turboexpander/Booster Compressor • Recompressors (3) • Ethane Plus Booster Pumps (2)	• 5 220 kW each; centrifugal type, gas turbine drive • Pumps NGLs to pipeline shipping pumps
Towers	• Molecular Sieve Towers (4) • Demethanizer Tower	
Fired Heaters	• Regeneration Gas Heater • Utility Heater	· Provides heat medium for building heat, tracing, and incidental process heat
Pressure Vessels	• Inlet Separator • Mole Sieve After-filters (2) • Regeneration Gas Separator • Cold Separator • Liquid Product Surge Drum	

Aerial Coolers	• Inlet Cooler • Regeneration Gas Cooler • Booster Compressor After-cooler • Recompressor After-coolers (2)
Heat Exchangers	• Regeneration Gas/Gas Exchanger • Demethanizer Side Reboiler • Demethanizer Bottom Reboiler • Low Temperature Gas/Gas Exchanger
Miscellaneous	• Underground Produced Water Storage Tank • Flare Stack • Expander Building • Recompressor Building • Service Building

(a) Values in brackets indicate number of units, if more than one, of each type.

Table 2-4. Emission source matrix(a) for the proposed Taylor Straddle Plant.

Source(b)	Type(c)	NOx	SO2	CO	GHG(d)	NMHC(e)	PM(f)
Recompressor turbines (3)	C	·	·	·	·	·	n/a
Regeneration gas heater (1)	C	·	·	·	·	û	·
Utility heater (1)	C	·	·	·	·	û	·
Emergency flare pilot and purges (1)	C	·	·	·	·	û	n/a
Emergency flare (1)	I	·	·	·	·	û	n/a
Fugitive Emissions (g)	I	û	û	û	·	·	û

(a) · = present; û = not present.

(b)Values in brackets are number of units of each type.

(c)Type of Source: Continuous (C); Intermittent (I).

(d)Greenhouse gases: CO2, CH4, and N2O.

(e)Non-Methane Hydrocarbons.

(f)Particulate Matter.

(g) Includes water storage tank vent, plant equipment, pipe and fittings.

oxides of nitrogen (NOx);

sulphur dioxide (SO_2);

carbon monoxide (CO);

greenhouse gases: carbon dioxide (CO_2), methane (CH_4 or C1), and nitrous oxide (N_2O);

Non-Methane Hydrocarbons (NMHC); and

Particulate Matter (PM).

To reduce overall NOx emissions, NCL will invest in the upgrading of existing WEI equipment. Although NOx emissions from the Taylor Straddle Plant are expected to be approximately 120 tonnes per year, the reduction of 220 tonnes per year from the equipment upgrade will culminate in a net *reduction* of approximately 100 tonnes per year in NOx emissions in the Taylor community.

Continuous emission sources at the proposed Taylor Plant, expected to operate about 360 days of the year on average, include the following:

recompressors (3 units), each rated at 5 220 kW;

regeneration gas heater (1 unit), rated at 2 kW;

utility heater (1 unit), rated at 10 kW; and

emergency flare pilot and purges.

The plant is serviced by one flare stack with continuous emissions associated with the small volumes of fuel gas purge to keep air out of the flare system for safety reasons.

Intermittent sources of emissions are confined to the operation of the emergency flare stack during plant start-up, shutdown, maintenance, or upset conditions. Intermittent flaring can vary from a few minutes to 2 hours.

Fugitive sources, generally attributed to the process may be continuous or intermittent. Typical fugitive sources include leaks from piping, valves, flanges, and rotating seals. Since the gas stream supply is sales gas, it is not expected to contain reduced or odourous sulphur species.

Additional information on potential emissions from the Taylor Straddle Plant is presented in Section 4.2. Dispersion modeling to predict ambient air quality is also presented.

Any odours which may originate from the plant will be associated with an infrequent release of process hydrocarbons which may contain traces of odour-causing sulphur compounds. No significant odours are expected from the Taylor Straddle Plant due to the minimal amount of unburned hydrocarbon releases and the low sulphur compound content in the supply gas.

Noise will be produced primarily by rotating equipment on the site, such as turbines, compressors, turboexpander, pumps, and aerial coolers. To a lesser degree, fired heaters and gas flow through piping and equipment also create noise. In addition, the vent or flare will create short-term noise during emergency venting or flaring. All major rotating equipment, with the exception of aerial coolers, will be located inside insulated buildings to reduce the noise emissions. Where possible, other equipment will be designed in a manner to reduce noise.

2.2.4 Utility and Support Systems

A summary of systems and facilities to support the main process equipment is provided in Table 2-5. Additional information is provided below.

Fuel gas drawn from the Taylor Straddle Plant residue gas stream will be used in fired heaters, gas turbines, the flare pilot, and miscellaneous purges. Fuel gas use is predicted at 140 103m3/d (5 mmcf/d), which represents energy consumption of 4 800 GJ/d.

Purchased electric line-power will be used for powering electric motors, lighting, and control purposes. Power consumption is projected at 5.3 GJ/yr.

The Taylor Plant flare stack will have one continuously-lit pilot. The flare header will be purged with a small flow of fuel gas to prevent air from entering the system when flaring is not occurring. The height of the flare stack will be determined during detailed design, and will be based on ground-level radiation levels during flaring and on dispersion calculations.

In the event of an upset or emergency condition in the plant, it will be necessary to route combustible hydrocarbon vapours to the flare stack for disposal. Upset or emergency conditions may be caused by equipment malfunction, interruption of supply or sales product stream flows, power failure, or during start-up and shut-down. These conditions may necessitate flaring for a short time, until the situation can be rectified or the plant is shut down. Upset or emergency conditions in this type of plant are estimated to occur four times per year, with an average duration of one hour each. Flaring rates during such an upset could vary from nominal to 450 103m3/hr (16 mmcf/hr).

The Taylor Plant will be equipped with a distributed control system (DCS) to control and monitor the plant process. The control systems will recognize upset conditions, and will automatically shut down equipment and block in the gas supply to the plant when conditions so warrant.

Fire detection and gas detection equipment will be provided in the plant, and will be capable of shutting the plant down under emergency conditions. The facility operator also will be able to shut in the facility from the control room or from various emergency shut-down stations located throughout the facility.

Table 2-5. Support systems and facilities for the proposed Taylor Straddle Plant.

System/Facility	Purpose
Fuel gas system	Measures, controls, and distributes fuel gas to all users fired heaters, gas turbines, the flare pilot, and purges.

Heat medium system	The utility heater, pumps, surge drum, filters, and distribution system to provide heat for buildings, tracing, and process trim heating. A glycol-water mixture will be used as heat medium.
Instrument air system	An electric motor-driven compressor, air dryers, filters, surge drum, and distribution system to provide instrument and utility air to various users.
Cryogenic drain system	A collection system, cold temperature knock-out drum, and a gathering system; for occasional handling and disposal of cold liquids during depressuring and maintenance operations.
Flare system	A gathering system and flare stack for emergency relief and disposal of vapour products.
Methanol injection system	A small methanol storage tank and pump for methanol injection to combat occasional freezing problems which can occur during plant upsets.
Service building	Provides space for electrical switchgear, motor control centres, control systems, office space, shop space, and washrooms.

2.2.5 Water Handling and Discharge

2.2.5.1 Water Requirements

Domestic water for the service building will be purchased from the local municipal water system. There is no requirement for process make-up water at this facility.

2.2.5.2 Produced Water and Wastewater

Water vapour is removed from the supply gas stream in the molecular sieve unit, then condensed into a liquid stream for disposal. The amount of water to be disposed of is about 0.64 m3/d (4 bbls/d). Above ground tanks, located inside a diked area with an impermeable liner, will be used for produced water storage. Produced water will be trucked to an appropriate disposal facility. There are no other liquid waste streams from the process.

2.2.5.3 Domestic Sewage

Sewage from the service building washrooms will connect to a septic tank which will drain to an underground drainage tile system, or to the municipal sewage collection and treatment system. The type of installation will be determined after further site investigations and will be in full compliance with the requirements of the *Health Act* and regulations.

2.2.5.4 Site Runoff

Plant design features will ensure any accidental spills are contained, preventing contamination of surface runoff. Process, power generation, compression, and utility equipment will be housed within buildings where drip trays or metal floors with floor drains will prevent small spills or leaks from contaminating the environment.

The plant site will be graded to direct natural drainage toward shallow ditches or channels. Surface waters collected in the plant process area will be contained within ditch areas and tested prior to release from the plant.

2.3 PIPELINE FACILITIES

The Taylor Straddle Plant Project includes the following pipelines:

Sweet gas supply pipeline to bring natural gas and associated liquids to the plant; and

Sweet residue gas return pipeline to transport lean gas back to the WEI transmission system.

A map of the development area showing these pipelines was provided previously as

Figure 2-4; see also Appendix D.

2.3.1 Route Selection

NCL staff and senior project team members evaluated several minor routing alternatives for the proposed pipelines. The principal criteria used for this assessment was that the route(s) should be the shortest possible, while following existing linear corridors or disturbances. Other routing factors considered included the location of existing industrial developments and above ground pipe racks.

A common pipeline corridor for the sweet gas supply and return pipelines was identified between the Taylor Straddle Plant site and the northernmost point along the Westcoast Energy Inc. (WEI) above ground pipe rack. Sweet gas supply and return pipelines will be placed on above ground pipe racks within the WEI McMahon Gas Plant.

The entire length of the sweet gas supply and return pipelines is on previously disturbed industrial sites, all of which are zoned 'Heavy Industrial' by the District of Taylor.

2.3.2 Size and Design Specifications

Both pipelines will be owned and operated by NCL and its potential partner, CNRL, and will be designed, constructed and operated in accordance with the appropriate standards established by the Canadian Standards Association (CSA) as well as applicable provincial requirements.

The proposed pipelines will be designed and constructed in accordance with the latest edition of the following Codes and Legislation:

CSA Z662¾"Oil and Gas Pipeline Systems"

Government of British Columbia¾"The Rules and Regulations Governing Oil and Gas Pipelines"

ASME B31.3¾"Code for Pressure Piping;

CAN/CSA Z245.1¾"Steel Line Pipe"

CAN/CSA Z245.15¾"Steel Valves for Oil and Gas Pipeline Systems"

CAN/CSA Z245.11¾"Steel Fittings"

CAN/CSA Z245.12¾"Steel Flanges"

CAN/CSA-Z731¾"Emergency Response Planning"

Design details for the proposed pipeline facilities are presented in Table 2-6.

Above ground facilities for the proposed pipelines include Emergency Shutdown (ESD) valves at both the inlet and outlet of the sweet gas supply and return pipelines. The ESD valves will be located within existing industrial sites.

2.3.3 Pipeline Construction and Commissioning

Pipeline installation is scheduled to commence September 1997, subject to receipt of all necessary permits and licenses. A 25 m-wide right-of-way will be applied for to provide sufficient space to install the two NPS 20 pipelines in a common ditch.

Additional working space over and above the 25 m-wide right-of-way will be needed for excess spoil storage at road, railroad, and pipeline crossings. The locations and dimensions of extra working space requirements will be determined during the detailed engineering phase of the project.

Pipeline construction will involve standard procedures, including surveying, hauling stringing, welding, trenching, lowering-in, backfilling, pressure testing, clean-up, and restoration. No clearing is required, and minimal grading is expected to be required due to the level terrain (i.e., industrially developed).

In addition to these pipeline construction procedures, above ground pipeline installation on pipe racks will be required for the southernmost approximately 600 m of the sweet gas supply and return pipelines.

Pipeline construction work will be conducted by a crew of approximately 30 persons. These workers will be based in local accommodation in the Taylor and Fort St. John areas.

Construction truck traffic will occur primarily in daylight hours. Pipeline-related traffic will be relatively constant during the one month construction period, and is estimated to range from 10 to 30 return trips per day.

Table 2-6. Technical specifications for proposed Taylor Straddle Plant pipelines.

	Sweet Gas Supply Line	**Sweet Residue Gas Return Line**
Size (NPS)	20	20

Start Point	WEI's Meter Station #43 15-25-82-18 W6M	Taylor Straddle Plant 10-36-82-18 W6M
End Point	Taylor Straddle Plant 10-36-82-18 W6M	WEI's Meter Station #43 15-25-82-18 W6M
Diameter (mm)	508	508
Wall Thickness (mm)	7.1 7.0 (Z662¾below ground) 20.6 (B31.3¾above ground)	7.2 7.0 (Z662¾below ground) 20.6 (B31.3¾above ground)
Service	Natural gas	Natural gas
MOP (kPa)	7000	7000
Material	Steel	Steel
Pipe Specification	CSA Z245.1 (below ground) A333 Grade 6 (above ground)	CSA Z245.1 (below ground) A333 Grade 6 (above ground)
Depth of Cover	1000 mm	1000 mm
Corrosion Protection	Yes	Yes
• External Coating • Impressed Current • Smart Pig Capable • CP Surveys • Corrosion Inhibition • Corrosion Monitoring	Yes (below ground) No Yes No No	Yes (below ground) No Yes No No
Over Pressure Protection	HPSD	HPSD
• Upstream • Downstream	HPSD	HPSD

Leak Detection	LPSD	LPSD
• Upstream • Downstream	LPSD	LPSD
Right-of-Way Width	25 m	25 m

2.4 Waste Management

The construction, operation, and eventual reclamation and site restoration of the proposed Taylor Straddle Plant will generate a variety of wastes. These will be managed according to a waste management program stressing waste minimization, reuse, recycling, recovery, and, when required, treatment and disposal. The waste management program will use strategies and principles consistent with prudent oil and gas practices and which meet or exceed evolving regulatory requirements including the BC Industrial Pollution Prevention Program, *Waste Management Act, Oil and Gas Production Waste Control Regulation,* Oil and Gas Handbook, and Environmental Operating Guidelines for the British Columbia Upstream Petroleum Industry (CAPP 1993). Specific waste streams anticipated from construction and operation of the Taylor Straddle Plant are described in this section. Since the proposed Taylor Plant is similar to existing NCL facilities, the development and description of its waste streams are based on NCL's previous experience.

2.4.1 Construction Wastes

Construction wastes will consist primarily of used wood materials from forming, scaffolding, shipping containers, fiberglass insulation materials, scrap metals (steel, copper, tin, etc.), refractory materials, and cardboard and paper associated with shipping materials. Other construction wastes anticipated include small volumes of used motor oils, empty paint cans, solvent and adhesive containers, batteries, and household garbage.

Where feasible, NCL's construction contractor will segregate wastes to ensure that materials can be reused, recycled, or disposed of. Disposal of materials will be consistent with regional landfill and provincial regulatory requirements.

No hazardous waste materials are anticipated to be generated during the plant construction phase.

2.4.2 Operational Wastes

During the projected operational life of the proposed Taylor Straddle Plant, various solid and liquid industrial and oil field wastes will be generated. These wastes will be transported to appropriate treatment facilities or temporarily stored on-site (prior to shipping off-site for treatment) according to provincial transportation and storage requirements. Table 2-7 summarizes the anticipated operational wastes and their respective treatments.

An engineered on-site temporary chemical and waste storage facility will be part of the plant's infrastructure. The design of the temporary chemical and waste storage facility will be reviewed and approved by BC Ministry of Environment, Lands and Parks through permit application.

2.4.2.1 Liquid Wastes

Above ground tanks, located inside a diked area with an impermeable liner, will be used for methanol storage. Underground tanks will be used for collecting liquids from building floor drains, for lube oil drains, and for heat medium drain. All underground tanks will be a dual-containment type, with provision for leak detection between the shells.

Used lubricating oil from rotating equipment will be recycled to a used oil reprocessing facility. Other liquids used on site, including methanol and the glycol-water heat medium, will not normally produce any waste stream. In the event that any of these fluids should become contaminated or must be discarded for other reasons, the fluid will be shipped to an appropriate industrial waste disposal facility.

2.4.2.2 Solid Wastes

Used filter elements from process and utility equipment will be collected and shipped to an appropriate waste disposal facility. Domestic garbage and non-hazardous industrial waste will be collected and disposed of at an approved local landfill site in accordance with municipal regulations.

Table 2-7. Summary of anticipated operational waste streams and current treatment options.

Waste Type	Anticipated Volumes	Current Treatment Options
45 Gallon Drums	5/year	Returned to supplier for re-use.
Mole Sieve Desiccant	45.5 tonne once every 3 years	Characterized to determine Special Waste classification; re-use when possible.
Lubrication Oil	4 000 litres/year	Recycle.
Methanol	3.3 litres/year	Disposal with produced water.
Coalescing Filters	10 elements/year	Characterized to determine Special Waste classification*

* Wastes will be characterized to determine if Special Waste classifications apply and handled/disposed of accordingly. Current potential disposal for Special Wastes include Alberta's Swan Hills hazardous treatment facility and the Riley Class I Landfill.

2.5 EMERGENCY RESPONSE PLAN AND PREPAREDNESS

In order to minimize risk to NCL employees, adjacent residents, and the environment, the proposed Taylor Straddle Plant will be designed to prevent potential emergency situations from occurring. The design will meet or exceed all applicable Canadian Standards Association (CSA) standards, prudent oil and gas industry design guidelines and practices, and federal and provincial regulatory requirements.

NCL will prepare an emergency response and implementation plan to ensure that Taylor Straddle Plant employees and contractors respond effectively to emergency situations in the unlikely event that they occur. This will ensure protection of the health and safety of the public, NCL employees, and contractors.

Specific project features to be addressed by the emergency response plan include:

potential for uncontrolled gas release from plant site, or supply and return pipelines; and

potential for produced water spills during trucking operations.

Emergency response plans will be developed in consultation with area residents, industrial facility owners in the area, local and regional government agencies with emergency response responsibilities, and provincial regulatory agencies, according to requirements outlined in the *CAN/CSA-Z731-95 Emergency Planning for Industry*. The elements of the proposed Taylor Straddle Plant are outlined in Table 2-8. In order to ensure an effective response in the event of an emergency at the Taylor Straddle Plant, NCL will develop and maintain an effective training program with project operations personnel and contractors, which will include conducting regular mock emergency training exercises.

2.6 Abandonment and Reclamation

At the end of the useful life of the proposed Taylor Straddle Plant (currently estimated in excess of 20 years), facilities will be dismantled, and the site will be remediated and reclaimed according to prudent oil and gas operations practices, guidelines, or standards. While recognizing that best practices or regulatory requirements applicable at the time of project abandonment cannot be determined now, NCL would currently expect to restore the proposed facility site and pipeline right-of-way to a condition appropriate to the subsequent anticipated land use.

2.6.1 Objectives, Plans, and Procedures

The reclamation objective is to return the plant site and pipeline right-of-way to a condition suitable for future land use consistent with the long-range plans of the District of Taylor, British Columbia. NCL will consider modifications requested by government agencies to address specific land use goals.

Table 2-8. Elements of Taylor Straddle Plant Emergency Response Plan (ERP).

Elements of ERP	Description
Emergency Situations	Inventory of potential situations which could occur, i.e., unplanned gas release, pipeline liquid/gas release, etc.
Definitions of Level of Emergency	Categorization of level of emergency situation.
Personnel accountabilities and responsibilities	Definition of decision making authorities and responsibilities.

Action Plans	Specific actions to be taken based on definition of level of emergency. Specific duties and responsibilities assigned to field or plant staff defined by level of emergency situation.
Notification/Contact List	Names and telephone numbers of NCL personnel, local, provincial, or federal government agencies and area residents to be contacted in the event of an emergency (depending on categorization and level of emergency).
Emergency Response Resources (equipment, personnel)	Inventory of on-site and off-site emergency equipment and/or personnel potentially required, and the location and notification information (phone numbers, contact person, etc.).
Area Maps	Maps of area outlining the location of pipelines, roads, public facilities and residences, significant environmental features, etc. for use in emergency response.
Training	Strategy for ongoing training and plan updates.

2.7 Permits, Licences, and Approvals

Permits Potentially Required	Issuing Agency
Facilities	Ministry of Employment and Investment
Section 116 approval to construct and	Minister of Environment, Lands of Parks
operate a gas processing facility	Regional/Municipal Governments
(Petroleum and Natural Gas Act)	Office of the Fire Commissioner (Regional)
Project Approval Certificate	
(Environmental Assessment Act)	
Permits for Construction (Municipal	
Act; Regional and Municipal By-	
laws)	
Approval to store and dispense fuel	

(Fire Services Act)	
Pipelines Approval to construct a pipeline (Pipeline Act)	Ministry of Employment and Investment
Surface Rights Approval for zoning or rezoning, set backs, land use (Municipal Act; Regional and Municipal By-laws)	Regional/Municipal Governments
Waste Management Air Emission Permit for processing facility and compressors above a specified size (Waste Management Act)	Ministry of Environment, Lands and Parks
Heritage Resources Section 5 permit to alter or destroy archaeological, historic, or heritage sites (Heritage Conservation Act)	Ministry of Small Business, Tourism and Culture, Archaeology Branch
Foreign Crossing Agreements	Various (Municipal Districts; British Columbia Rail; Ministry of Transportation and Highways)

3. ISSUES SCOPING AND CONSULTATION

A vital part of the planning process for the Taylor Straddle Plant was inviting participation from various stakeholders impacted by the project. The underlying goal was to promote understanding and problem-solving through two-way communication. This involved identifying the relevant stakeholders, providing them with notification of and information about the project, seeking their input into identifying and mitigating concerns and issues concerning the proposed project and its potential impacts, and seeking local knowledge, information, and concerns for project design. This communication process will continue through the life of the project via ongoing consultation and follow-up of issues.

The purposes for inviting public participation are many. The process assisted NCL in identifying concerns of its stakeholders before the concerns become significant issues. The company was able to use local knowledge and information, and community priorities and values to complete the impact assessment studies. Public participation helped in identifying ways to avoid or mitigate adverse impacts. The communications alerted local communities and residents of potential economic advantages through employment and business opportunities. In addition, the process provided, and will continue to provide, an opportunity for the local communities and residents to better understand the project.

This section describes the communication activities undertaken by NCL and the Project Team, and summarizes the environmental and socio-economic issues identified during consultations. Section 3.1 describes the process through which key issues were identified, and the action taken or proposed by NCL to address these issues. The section includes a table which summarizes the issues identified, who identified the issue, the action taken, and the current status. Section 3.2 describes the consultation process undertaken for each of the four stakeholder groups: the regional, provincial, and federal governments; interested local groups and individuals; First Nations groups; and the general public. In Section 3.3 NCL's future consultation and corporate communications plans is set forth, including notification of opportunities for local business and employment.

3.1 issues Scoping

NCL used various sources to first identify key stakeholders in the Taylor Straddle Plant Project. These sources included the Environmental Assessment Office, the Treaty 8 Tribal Association, provincial Ministries, the Mayors and other local leaders of Taylor and Fort St. John, other producers in the area, and key consultants with previous experience in northeast BC. Pre-Open House consultations were held with local, regional, and provincial government representatives, resource users, and members of special interest groups including First Nations.

NCL held meetings with provincial, regional, and local government representatives to inform them of the project. Follow-up phone calls updated these persons on the status of the project. A direct mailout, with a project overview, to residents preceded the Open House in Taylor. NCL personally met with members of five First Nations groups, and representatives of local, provincial, federal, and regional governments. Other key stakeholders, such as a local citizens' group and a local environmental association, preferred to attend the Open House rather than hold a separate meeting with NCL.

NCL's goal was to gather pertinent information so that adverse impacts of the proposed project could be avoided or mitigated, and that public concerns could be identified and resolved before they became major issues. The public's input also provided NCL with information and knowledge that would otherwise be unavailable, and this information assisted in designing the project such that it could maximize beneficial impacts and minimize adverse impacts to the environment, local communities, businesses, and residents.

Issues identified during the consultations were noted, and are addressed in the application or were directly addressed with the person who raised the concern. Some actions which relate to later stages of the project still may be pending and will be addressed as outlined in the issues summary in Table 3-1. In this table, persons or groups voicing a concern are identified by general category, and suggested actions by NCL and the status of those actions are specifically identified.

3.2 consultation program

NCL endeavoured to contact all key stakeholders in order to establish two-way communications and promote understanding of the project by providing these stakeholders with easily-understandable information on the proposed project, and by giving them an opportunity to voice concerns and issues, and to share their local knowledge and information with the NCL Project Team. Consultations began in September 1996 and have been ongoing since. At each meeting, attendees were given the name and phone number of an NCL representative whom they could call collect if they had further questions or comments.

The following sections provide more details of NCL's consultation program for each of four groups: governments, local individuals and community groups, First Nations, and the general public. A complete mailing list of persons contacted—with phone numbers—will be provided to the BC Environment Assessment Office with, but separate from, this application to maintain confidentiality. General categories associated with persons contacted are also listed for each issue identified in Table 3-1. A list of communications, a copy of the direct mailout, a copy of the advertisement, and a copy of the emissions information presented at the Open House are provided in Appendix A.

3.2.1 Regional, Provincial, and Federal Governments

NCL representatives and Project Team members (NCL) began consultations with representatives of regional, provincial, and federal governments in September 1996. Input has been sought through correspondence, telephone calls, personal contacts, and formal and informal meetings.

Table 3-1. Summary of issues and concerns identified through consultations.

(Insert table from database here...)

The general purpose of communications with government representatives was first to present and describe the proposed Taylor Project, and then to seek input on any regulatory concerns or issues. Their feedback assisted NCL in addressing these issues in planning the design, construction, and operation of the proposed project.

Representatives in the regional office in Prince George, the local office in Fort St. John, and head offices in Victoria of several provincial Ministries were also involved in identifying and resolving issues and concerns. These included the following:

Environmental Assessment Office

Ministry of Employment and Investment

Ministry of Environment, Lands and Parks

Ministry of Transportation and Highways

Meetings with these stakeholders began in September 1996; meetings and other communications have continued since. Contact persons have been able to provide meaningful information, such as the pertinent First Nations communities to contact, and key concerns to address, such as questions regarding air quality from the Ministry of Environment, Lands and Parks.

On the local and regional levels, NCL has met and/or spoken with the Mayors and other community leaders of Taylor and Fort St. John. These communications occurred in December 1996 and January 1997. Attendees were provided with pertinent information on the project. For example, the Mayors were provided with an overview of the project and a map showing the proposed plant site and pipelines route. The attendees provided meaningful feedback to NCL, such as safety concerns regarding children crossing the Alaska Highway-Cherry Avenue intersection.

Topics of mutual interest to NCL and various government representatives included air quality, and noise. A complete list of topics and issues is found in Table 3-1.

3.2.2 Interested Local Community Groups and Individuals

Local and community groups were also contacted by NCL, including residents living near the proposed Taylor Straddle Plant. Some of these residents attended a Open House in Taylor on January 30, 1997. Other interested parties contacted personally, and by correspondence or telephone were the following:

representatives from other resource users such as petroleum companies, and

special interest groups including the Taylor Environmental Concerned Citizens and Peace Valley Environmental Association.

NCL provided a map of the proposed project area, and other general information concerning the project. Issues and concerns were solicited from and offered by those contacted. Individuals sought opportunities for contracting services, employment, and other economic benefits from the project. Local residents were concerned with potential effects of the project on air quality, and potential impacts on their lifestyle. Specific concerns raised are grouped by topic in Table 3-1 which includes NCL's proposed action for each issue.

3.2.3 First Nations

NCL first invited the involvement of First Nations groups in January 1997. The proposed Taylor Straddle Plant is located within the traditional use area of five First Nations: the Blueberry, Doig River, Kelly Lake, Saulteau, and West Moberly. NCL has met or spoken with representatives from all five bands and the Treaty 8 Tribal Association to discuss the project. Each was presented with a topographical map of the proposed project area and information concerning the proposal. The First Nations were invited to have a representative present during the field work for the Archaeological Impact Assessment, and were asked for approval of the archaeological consultant. In response to a request from the Doig River First Nations, NCL invited Heritage North Consulting Limited to assist with the Archaeological Impact Statement. Communications have continued, mainly through phone calls. Representatives from the Blueberry and Saulteau First Nations are particularly interested in NCL's scholarship program at Northern Lights College. The Saulteau and Kelly Lake First Nations are interested in learning more of other aspects of NCL's overall plans for northeastern BC. Issues and concerns of interest to particular First Nations groups are identified in the issues list in Table 3-1.

3.2.4 Open House

An Open House was held in Taylor on January 30, 1997, at the Lone Wolf Golf Course Club House. This location and the specific facility used for the Open House was chosen for its central location and its ability to facilitate interaction with the general public. The event was advertised in the local newspaper, *Alaska Highway News*, on January 27, 28, and 29, 1997. About 40 people attended the Open House. A copy of the advertisement is included in Appendix A. An information package mailed to all residents in Taylor on January 24, 1997, is also included in Appendix A.

NCL set up three stations at the event that showed a 3-D artistic drawing of the plant and plant plot plan, and a map of the area. A copy of the text regarding NOx emissions is included in Appendix A. Five Project Team members, representing socio-economic concerns, pipelines, processing, business concerns, safety, health, environment, and community relations, were present to answer questions and address concerns.

Some attendees had been personally contacted by NCL and already were apprised of project details, and many had received the direct mailout. However, several people took this opportunity to learn more about the proposed Taylor Straddle Plant, and to ask questions and voice concerns.

Issues and concerns raised at these events have been recorded in the issues list in Table 3-1. This table also includes concerns raised in conversations with persons in the area met other than at an Open House. A list of members of the general public contacted are included in Appendix A.

3.3 ongoing CONSULTATION activities

NCL has made a commitment to First Nations, and other groups and individuals to continue to provide ongoing communications regarding the Taylor Straddle Plant. A database has been established to help NCL track these contacts. Consultation will continue to be maintained through correspondence, a newsletter, telephone calls, personal contacts, and formal and informal meetings.

Residents of Taylor and other key contacts already have the name and phone number of an NCL representative, and this information will be updated when necessary. Persons may call the number collect to share information or voice concerns.

A newsletter will provide regular updates on the progress of the project and inform recipients of upcoming events of interest in connection with the proposal. This newsletter will be sent to all residents in the area using direct mail contracted through Canada Post.

NCL will prepare advertisements for the notification that the application has been submitted to the Environment Assessment Office (EAO) for review, and that copies are made available, in Taylor, Fort St. John, and other places as requested by the EAO, for viewing by the general public. NCL will solicit feedback on the application from the general public as well as the other key stakeholders identified above.

4. ENVIRONMENTAL ASSESSMENT

This section provides information on the potential physical and biological effects of the proposed Taylor Straddle Plant. It begins with a discussion of the assessment scope and methods and environmental issues identified during the consultation process (Section 4.1). Sections 4.2 through 4.4 describe the existing setting and potential biophysical effects of plant construction and operation and the mitigative measures to be employed to prevent or reduce these effects.

4.1 assessment scope and methods

The environmental assessment of the proposed Taylor Straddle Plant was undertaken by the Project Team identified in Section 1.2.1. Consultation with government, First Nations, and public representatives was initiated in September 1996 to identify biophysical issues and confirm proposed study methods.

4.1.1 Environmental Issues

Potential biophysical issues associated with Taylor Straddle Plant construction and operation were identified by the study team from a number of sources. These included:

consultation with public, First Nations, and government representatives in Taylor, Fort St. John, Prince George, and Victoria;

recent environmental assessments from the region (Morrison Petroleums Limited 1995; Solex Development Company Inc.1996; Salmo Consulting Inc. 1996; WGSI 1996b);

review of environmental assessment guidelines prepared by the British Columbia Environmental Assessment Office (EAO 1995);

published literature on impact sources and effects; and

Project Team knowledge of existing resources and likely effects.

Identified issues were used to focus the environmental assessment on topics that are relevant to the Taylor Straddle Plant as proposed, or that are of concern to affected stakeholders and residents. These issues are summarized in Table 4-1.

With the exception of air emissions, the geographic scope of environmental issues is confined to the proposed plant site, pipeline right-of-way, and adjacent areas within the Taylor 'Heavy Industrial' zone. Because multiple emission sources are present in the Taylor airshed, potential project and cumulative effects are evaluated for the entire airshed.

4.1.2 Assessment Methodology

Potential environmental effects associated with the Taylor Straddle Plant and associated pipelines were identified and assessed by Project Team members using a consistent process.

Table 4-1. Environmental issues identified for the Taylor Straddle Plant. (omitted; available from registry)

Specific definitions were adopted to explain the predicted direction, duration, scope, magnitude, duration, and confidence of potential environmental effects for the environmental indicators.

Direction

Positive: net benefit to the resource.

Neutral: no net benefit or gain to the resource.

Negative: net loss to the resource.

Spatial Scope

Local: within the plant site, pipeline right-of-way, or access roads.

Sub-regional: extends beyond the plant site or pipeline right-of-way but within the Taylor airshed (air quality) or Industrial Complex (all other issues).

Regional: beyond the sub-regional boundary.

Duration

Very short-term: less than 1 day.

Short-term: greater than 1 day but less than 1 year.

Medium-term: greater than 1 year but less than 10 years.

Long-term: greater than 10 years.

Magnitude

Nil: no change anticipated.

Low: disturbance expected to be somewhat above typical background conditions and concentrations, but within established or accepted protective standards (e.g., provincial Level A or federal Desirable air quality objectives), or to cause no detectable change in or to cause no detectable change in biological, social, or economic parameters.

Medium: disturbance expected to be considerably above background conditions or concentrations but within established criteria or scientific effects thresholds (e.g., provincial Level B or federal Acceptable air quality objectives), or to cause a detectable change in biological, social, or economic parameters within range of natural variability.

High: disturbance expected to exceed established criteria or scientific effects thresholds associated with potential adverse effects (e.g., provincial Level C or federal Tolerable air quality objectives), or to cause a detectable change in biological, social, or economic parameters beyond range of natural variability.

Confidence

Poor: subjective ranking.

Fair: subjective ranking.

Good: assessment based on reliable sub-regional or regional data and well documented cause-effect relationships.

Significance

Significant Adverse Effect: High probability of permanent or long-term negative effect on biological, social, or economic sustainability that cannot be technically or economically mitigated or compensated.

Significant Positive Effect: High probability of permanent or long-term positive effect on biological, social, or economic parameter.

Unknown: Potential significance cannot be defined with existing information or knowledge.

Insignificant: All other effects.

These definitions are referenced in the assessments provided below for each biophysical component.

Each section begins with a description of existing biophysical conditions and potential effects of the proposed Taylor Straddle Plant based on the project information provided in Section 2. The mitigative measures to be used to prevent or reduce these effects are then described, along with a summary of the predicted residual project-related effects.

4.2 airshed

The town of Taylor lies near the base of the Peace River valley at an elevation of 478 metres above mean sea level (asl) (see Figure 4-1). The southern side of the valley rises approximately 225 m up to the plains, while the northern side rises approximately 150 m above the valley floor. Terrain at the top of the Peace River valley is undulating to rolling.

The proposed plant site is located on a flood plain in the centre of the valley. The Peace River is oriented in an east-west direction and is located approximately 1 km south of the plant. Consequently, the topography of the area has an effect on the local meteorology and plume dispersion. Topographic forcing in the Peace River valley will affect wind speed, wind direction, and temperature. Other meteorological parameters may also be affected to a lesser extent.

Spatial boundaries must be established when defining the airshed of Taylor. An airshed can be defined as the region that will be affected by pollutants from a particular source, or group of sources. This will depend on the nature of the source or sources, the local meteorology, and the local topography.

For the Taylor Straddle Plant, NOX is the main continuous source pollutant, and the site is located in a valley where there are numerous other industrial point sources of NOX. The topography of the Peace River Valley around Taylor defines the boundaries of much of the local airshed. Thus, the airshed boundaries can be defined by the valley walls to the north and south, and approximately 10 km to the east and west of Taylor. Since there is potential for

Figure 4-1. Location of NOX sources in the Taylor airshed.

COLOUR

pollutants to extend beyond the valley at times, a few more kilometres of the surrounding plains above the valley would encompass all of the 'Taylor Airshed'. The airshed defined by these boundaries includes all of the industrial NOX sources near Taylor, the highway through Taylor which is also a NOX source, and the volume of air through which all of the pollutants emanating from these sources are immediately dispersed (Figure 2-4).

Therefore, the dispersion models were set to model atmospheric dispersion over a 10 km radius around the plant site to encompass all of the Taylor airshed. Modelling analysis confirmed that the area of potential impact is within 10 km of the emission sources.

4.2.1 Existing Conditions

4.2.1.1 Climate and Meteorology

The climate of the area can be characterized as semiarid continental, with cool short summers and long cold winters. The seasonal variation of temperature gives the area four distinct seasons. Cold Arctic high pressure systems can dominate the synoptic patterns in winter, resulting in extended periods of extremely cold temperatures and stable atmospheric conditions. The cold weather during the winter can abruptly change when warm, dry Chinook winds flow down the lee side of the Rocky Mountains.

When synoptic patterns change after Arctic high pressure outbreaks, dense, cold and stable air can remain in the valleys of the area (including the Peace River Valley), while warmer air above the valleys creates an inversion and traps the cold air below. This can result in contrasts between meteorological variables measured in the valleys and those measured on the plains. This type of cold air pooling can be detected from an examination of meteorological data measured at Taylor and data measured at Fort St. John on the Great Plains, some 220 m above Taylor.

During the summer, extreme changes in temperature can also occur. Freezing temperatures can be expected eleven months of the year, while temperatures can soar above 30oC from May through September. The majority of the precipitation in the area falls during the summer months when thunderstorms are common. Snowfall, and precipitation in general, is relatively light as the area is in the rain shadow of the Rocky Mountains. The extremes in climate that the area can experience produces a range of intensities of atmospheric dispersion. Stable cold conditions result in very little atmospheric dispersion while unstable, convective conditions can result in strong dispersion and the dilution of airborne pollutants.

It is necessary to analyze climate and meteorological data of the region to evaluate the dispersion of air contaminants associated with the proposed Taylor Straddle Plant. A detailed analysis is provided in Appendix B.

Two types of meteorological data were used in this assessment. First, climate normals from the Environment Canada, Atmospheric Environment Service (AES) Fort St. John station (summarizing the period from 1961 through 1990) were used to estimate the average wind conditions, temperatures, and frequency of precipitation in the vicinity of the proposed site. Secondly, twelve months of hourly meteorological observations from the WEI Taylor meteorological station (Figure 4-1) from 1995 to 1996, were used as input in the dispersion models employed in this analysis.

The Fort St. John airport, the closest principal AES weather station to the proposed site, is located approximately 10 km to the north-north-west, at an elevation of 695 m asl. The Fort St. John weather station is situated on the northern edge of the Great Plains and is much higher in elevation than the proposed site. Therefore, wind speeds and directions at Fort St. John may be quite different from the base of the valley. However, other climate data from the Fort St. John airport would remain comparable. Data sets of temperature, precipitation, wind speed and direction, and the parameters needed to calculate atmospheric stability are all available from the Fort St. John station, and have been recorded for over 40 years.

A comparison of the climate normals of Fort St. John with the data used in the dispersion modelling reveals that the meteorological data used for modelling is a suitable representation of the area. Hence, one can describe the climatology of Taylor in terms of the climatology of Fort St. John. There is, however, a significant wind direction difference between the two sites making the Taylor wind data essential to the dispersion modelling.

4.2.1.2 Regulatory Ambient Air Quality Objectives

In Canada, the federal and provincial governments have promulgated ambient air quality objectives to ensure long-term protection of public health and the environment. Federal and provincial committees have established a series of national ambient air quality objectives for five common pollutants, namely carbon monoxide (CO), nitrogen dioxide (NO2), sulphur dioxide (SO_2), total suspended particulates (TSP), and ozone (O_3). Up to three objective values have been recommended using the categories 'Desirable', 'Acceptable', and 'Tolerable'. The Desirable objective is the most stringent. British Columbia has established similar sets of objective values, designated as levels A, B and C, with Level A being the most stringent.

Level A is typically applied to new and proposed discharges to the environment, and is usually the same as the federal Desirable objective. The general intent of the federal and provincial objectives is described in Table 4-2.

The current provincial and federal air quality objectives for NO_2, SO_2 and H_2S which were chosen with input from the Federal-Provincial Advisory Committee on Air Quality (FPAC), are shown in Table 4-3. NO_2 objectives are relevant to straddle plants because NO_2 is emitted from fuel combustion equipment. The objectives for SO_2 and H_2S are pertinent, as SO_2 and H_2S can be emitted as a result of fugitive leaks and from flares. However, SO_2 and H_2S will not be a major source of emissions from the Taylor Straddle Plant, as the plant is designed to process sweet gas.

Nitrogen Dioxide

The province of British Columbia does not have its own air quality objectives for NO_2. The BC Ministry of Environment, Lands and Parks uses a standard for NO_2 equivalent to the federal air quality objectives. These federal objectives were reviewed in 1987 by FPAC (1987) considering the published literature on the effects of NO_2 on vegetation, human health, and materials. Currently there are no federal objectives for the maximum desirable 1-hour and 24-hour average concentration of NO_2.

NO_2 is a yellowish-brown, photo-chemically active gas which causes a discoloration of the atmosphere and reduced visibility. It has a pungent odour and is considered to be a highly corrosive gas.

Nitric oxide (NO) is the major by-product of the combustion of fossil fuels. NO is fairly reactive, and can be oxidized to NO_2 by various reactions. Hydroxyl radicals, formed by photolysis of aldehydes and nitrous acid in the atmosphere, react with hydrocarbons, carbon monoxide and other compounds in polluted atmospheres to produce hydroxyl-peroxy and alkyl-peroxy radicals. In a polluted or urban atmosphere, these radicals initiate reactions which increase the speed of the oxidation of nitric oxide to NO_2, thus favouring NO_2 formation.

Absorption of light by an NO_2 molecule results in the destruction of one of the nitrogen-oxygen bonds, yielding nitric oxide and a reactive ground state oxygen atom:

The free oxygen atom can combine with an oxygen molecule to produce an ozone molecule:

where M is a third body molecule. Photo-dissociation of NO_2 can, therefore, result in regeneration of nitric oxide and formation of ozone. This is the principal participation of NO_2 in the formation of photo-chemical smog.

In relatively clean rural environments, NO is primarily oxidized by ozone to form NO_2. Hence, in clean environments high levels of NO and ozone cannot coexist. Within an airshed where there are a number of industrial emission sources, as in the Taylor airshed, the chemical processes that govern NO_2 and ozone formation are much more complicated. Numerous VOC species, particulate matter and other pollutants affect both the conversion of NO to NO_2 and the formation of ozone. Thus, the conversion of NO_X to NO_2 can only be estimated by using a range of conversion factors, where the amount of NO_2 is proportional to the amount of NO_X.

Several studies indicate that nitrogen dioxide is efficiently absorbed and retained in the human respiratory tract. Odour perception and dark adaptation have been shown to become

Table 4-2. Description of the federal and BC ambient air quality objectives.

Jurisdiction	Objective	Description
Federal	Maximum Desirable (most stringent)	Long-term goal for air quality. Provides a basis for anti-degradation policy for unpolluted parts of the country and for continuing development of control technology.
	Maximum Acceptable	Provides adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well being.
	Maximum Tolerable (least stringent)	Indicates appropriate abatement strategies required without delay to avoid further deterioration to air quality to protect the health of the general population.
BC	Level A (most stringent)	Provides long-term environmental protection. Required for new and proposed discharges and, within the limits of the best practicable technology, to existing discharges by planned staged improvements for these operations.
	Level B	Provides adequate protection against adverse effects on human health, vegetation and animals. Usually set as an intermediate objective for all existing discharges to reach within a specified time period, and as an immediate objective for existing discharges which may be increased in quantity or altered in quality as a result of process expansion or modification.
	Level C (least stringent)	Appropriate action is necessary to protect the health of the general population.

Table 4-3. Summary of ambient air quality objectives for BC and Canada for SO2, H2S and NO2.

Parameter	British Columbia Objectives		National Ambient Air Quality Objectives	
	Level A New/ Expanded Discharges mg/m3 (ppm)(a)	Level B Interim mg/m3 (ppm)(a)	Maximum Desirable mg/m3 (ppm)(b)	Maximum Acceptable mg/m3 (ppm)(b)

Nitrogen Dioxide	¾	¾	¾	400 (0.21)
1-hour Maximum	¾	¾	¾	200 (0.11)
24-hour Maximum	¾	¾	60 (0.03)	100 (0.05)
Annual Mean				
Sulphur Dioxide	450 (0.17)	900 (0.34)	450 (0.17)	900 (0.34)
1-hour Maximum	160 (0.06)	260 (0.10)	150 (0.06)	300 (0.11)
24-hour Maximum	25 (0.01)	75 (0.03)	30 (0.01)	60 (0.02)
Annual Mean				
Hydrogen Sulphide	7 (0.005)	28 (0.02)	1 (0.0007)	15 (0.0108)
1-hour Maximum	3 (0.002)	6 (0.004)	¾	5 (0.0036)
24-hour Maximum				

(a) Concentrations given in micrograms per cubic metre at 20oC, 760 mm Hg, dry basis, and, in parentheses, ppm by volume.

(b) Concentrations given in micrograms per cubic metre at 25oC, 101 kPa, dry basis, and, in parentheses, ppm by volume.

(Values for air quality objectives supplied by the BC Ministry of the Environment, Lands and Parks)

temporarily impaired by inhalation of NO2 at concentrations of 200 to 400 mg/m3 (0.1 to 0.2 ppm) (Feldman 1974; Henschler et al. 1960; Salamberdze 1967). Irritation and effects on pulmonary functions were found during short-term (1-hour) exposure to NO2 at concentrations as low as 200 mg/m3 (0.11 ppm) (Orehek et al. 1976). In another study with a smaller test group, it was found that the pulmonary effects in healthy and asthmatic subjects are minimal for short-term (less than 1-hour) exposure to NO2 at concentrations of 230 mg/m3 (0.12 ppm) (Koenig et al 1988). In the same study, Koenig et al (1988) found that the total respiratory resistance in both healthy and asthmatic test groups, increased as a result of short term exposure to 340 mg/m3 (0.18 ppm) of ozone. The health effects of ozone are an important result considering the role of NO2 in ozone formation.

Effects on animals due to exposure to NO2 include alterations in pulmonary function, and morphological and biochemical parameters. Reduced host resistance to bacterial and viral respiratory tract infection also has been observed with the lowest levels of exposure, 1 900 or 3 800 mg/m3 (1 or 2 ppm) (Ehrlich and Henry 1968). However, other studies of susceptibility to viral infection after long-term exposure to low levels of NO2 were inconclusive (Kulle and Clements 1988).

The types of materials most commonly affected by NO2 exposure are textile dyes. Nitrogen oxide acts as a fading agent (USEPA 1971) which causes dilution of dyes on cellulose acetate, cotton, viscose rayon, and nylon. It also causes the yellowing of white fabrics and colour destruction or changes in permanent press garments containing polyesters (NAS 1977).

There is some indication that nitrogen dioxide may contribute to vegetative injury, especially through deposition of nitrous acid in the form of acid rain.

Sulphur Dioxide and Hydrogen Sulphide

The provincial levels A and B 1-hour ambient air quality objectives for SO_2 are the same as the current Desirable and Acceptable federal objectives, respectively. The provincial objective for the 24-hour maximum SO_2 concentration is slightly higher, while the annual mean is slightly lower than the respective federal objectives. The federal objectives were reaffirmed in 1987 (FPAC 1987), following a review of the recent literature on the effects of sulphur dioxide on vegetation and human health, with vegetation being recognized as the more sensitive receptor.

British Columbia has Level A and Level B, 1-hour and 24-hour ambient H_2S objectives. There is no federal air quality objective for H_2S for the maximum desirable 24-hour concentration.

4.2.1.3 Background Air Quality

Both spatial and temporal boundaries must be set when defining the background air quality. Background air quality will depend on the time period and area over which pollutant concentrations are averaged. For this study, the previously defined Taylor airshed acts as the study boundary. As the dispersion models used in this analysis cannot predict average ground level concentrations for periods of less than one hour, background pollutant concentrations averaged over at least one hour must be used for comparison to model results. Ambient air quality data from January 1994 to June 1996 in Taylor were available for determination of background pollutant concentrations. The main sources from the Taylor Straddle Plant will be emissions of NO_2. Since SO_2 and H_2S are only expected to occur as fugitive emissions, their effects on the air quality of the region would be insignificant. Therefore, this study will focus on NO_2.

There are two ambient air quality monitoring trailers that are owned and operated by WEI near Taylor, BC (Figure 4-1). They are equipped with standard meteorological instrumentation at a 10-m level, and can measure ambient concentrations of NO_2, SO_2, and H_2S. There are also some limited ozone measurements available from these trailers. Thus, the WEI monitors can provide some insight into the background concentrations of pollutants in the area.

Average ground level concentrations of NO_2 from the monitoring trailers are available from January 1994 to June 1996. Figure 4-2 shows the maximum hourly, and monthly average concentrations of NO_2 measured during this period at Monitoring Trailer #2, which is situated approximately 500 m to the southwest of the proposed plant. The maximum hourly concentrations each month varied from a high of 909 mg/m3 (0.48 ppm) down to 32 mg/m3

(0.017 ppm). In January 1994, the maximum hourly NO_2 concentration for the entire monitoring period was recorded, and the federal Maximum Acceptable air quality objective for hourly concentrations of NO_2 was exceeded 82 times. For the remainder of the monitoring period there was only one other hour when the Maximum Acceptable objective was exceeded, when a concentration of 420 mg/m3 (0.22 ppm) was recorded. For much of the monitoring period, the average ground level 1-hour concentration was well below 100 mg/m3 (0.052 ppm). With the exception of January 1994, the federal 24-hour Desirable objective for NO_2 was not exceeded. For this monitoring period, the monthly averages generally fell below 50 mg/m3 (0.026 ppm).

An analysis of the NO_2 monitoring data reveals that although the Desirable objectives were exceeded 83 times, generally, the 'background' concentrations of NO_2 are well below the government guidelines. These measured concentrations will be lower than what the dispersion models predict, since the models produce a very conservative estimate of ground level concentrations of pollutants.

In addition to the ambient air quality data available from WEI, dispersion models were used to estimate the background concentrations of NO2 in the Taylor airshed. Emission estimates of all the major NO2 sources in the Taylor airshed were obtained from a report prepared for WEI by SEACOR Environmental Engineering Inc. (1996), and used as input in numerical dispersion models. The models produced an estimate of the maximum expected NOX concentration at 2 m above ground level (agl) (see Appendix B for dispersion model methodology). The maximum predicted 1-hour average 2 m level NOX concentrations over the Taylor airshed resulting from existing emission sources are displayed in Figure 4-3. Over the entire area, the maximum predicted 1-hour 2 m level NOX concentration was 5 335.7 mg/m3 (2,700 ppm), and the maximum predicted 24-hour average NOX concentration was 1 815.1 mg/m3 (940 ppm). Estimates of NO2 concentrations must be made from these predictions. The concentration of NO2 expected at a point will be some fraction of the predicted NOX concentration at that point. In Section 4.2.4, predicted NO2 concentrations will be presented assuming 100, 75, 50, and 25% conversion of NOX to NO2.

4.2.1.4 Taylor Straddle Plant Emission Sources

The operation of the proposed Taylor Straddle Plant will result in the emission of various compounds into the atmosphere. Table 4-4 presents a matrix of the emission sources and associated gaseous emissions which may be classified as continuous, intermittent, or fugitive. Potential emissions from the Taylor facility include the following:

Figure 4-2. Ambient NO2 concentrations measured at the Westcoast Energy Inc., Monitoring Trailer #2 in Taylor, BC. (B&W)

Figure 4-3. Maximum 1-hour NOX concentrations predicted from the existing sources in Taylor at the 2 metre level.

COLOUR

Table 4-4. Emission source matrix(a) for the proposed Taylor Straddle Plant.

Source(b)	Type(c)	NOx	SO2	CO	GHG(d)	NMHC(e)	PM(f)
Recompressor turbines (3)	C	·	·	·	·	·	n/a
Regeneration gas heater (1)	C	·	·	·	·	û	·
Utility heater (1)	C	·	·	·	·	û	·
Emergency flare pilot and purges (1)	C	·	·	·	·	û	n/a
Emergency flare (1)	I	·	·	·	·	û	n/a
Fugitive Emissions (g)	I	û	û	û	·	·	û

(a) · = present; û = not present.

(b)Values in brackets are number of units of each type.

(c)Type of Source: Continuous (C); Intermittent (I).

(d)Greenhouse gases: CO_2, CH_4, and N_2O.

(e)Non-Methane Hydrocarbons.

(f)Particulate Matter.

(g)Includes water storage tank vent, plant equipment, pipe and fittings.

oxides of nitrogen (NO_x);

sulphur dioxide (SO_2);

carbon monoxide (CO);

greenhouse gases (GHG): carbon dioxide (CO_2), methane (CH_4 or C1), and nitrous oxide (N_2O);

Non-Methane Hydrocarbons (NMHC); and

Particulate Matter (PM).

Continuous emission sources at the proposed Taylor Plant, expected to operate about 360 days of the year on average, include the following:

recompressors (3 units), each rated at 5 220 kW;

regeneration gas heater (1 unit), rated at 2 kW;

utility heater (1 unit), rated at 10 kW; and

emergency flare pilot and purges.

The plant is serviced by one flare stack with continuous emissions associated with the small volumes of fuel gas purge to keep air out of the flare system for safety reasons.

Intermittent sources of emissions are confined to the operation of the emergency flare stack during plant start-up, shutdown, maintenance, or upset conditions. Intermittent flaring can vary from a few minutes to 2 hours.

Fugitive sources, generally attributed to the process may be continuous or intermittent. Typical fugitive sources include leaks from piping, valves, flanges, and rotating seals. Since the gas stream supply is sales gas, it is not expected to contain reduced or odourous sulphur species.

4.2.2 NOx Emissions

Oxides of nitrogen (NOx) are produced as a result of the combustion process in fired heaters, gas turbines, and flare pilots. Low NOx burners and combustors will be specified for all such equipment to minimize these emissions. The amount of NOx emitted from the Taylor Straddle Plant is shown in Table 4-5. Other equipment parameters related to NOx dispersion are also shown in this table.

To reduce overall NOx emissions to the Taylor airshed, NCL will invest in the upgrading of existing WEI equipment. Although NOx emissions from the Taylor Straddle Plant are expected to be approximately 120 tonnes per year, the reduction of 220 tonnes per year from the equipment upgrade will culminate in a net *reduction* of 100 tonnes per year in NOx emissions in the Taylor airshed.

4.2.2.1 NOX Ground-Level Concentration Predictions

To evaluate the environmental impact of airborne emissions from the Taylor Straddle Plant project, dispersion modelling was divided into two scenarios. First, modelling of emissions from the proposed Taylor Straddle Plant alone was performed to identify its contribution to the airshed. These results are presented in this section. Secondly, all significant sources of NO2 within the Taylor airshed were modelled along with the emissions from the Taylor Straddle Plant, to determine the cumulative effects of NO2 on the surrounding environment. These results are provided in Section 4.2.4. The general outline of the modelling and analysis methodology is described in Appendix B. Specific modelling inputs and outputs for the assessment of the Taylor Straddle Plant alone are described in the next section.

Model Inputs

Both the ISC/3 and RTDM models were used to assess the ground level concentrations of pollutants emanating from the proposed Taylor Straddle Plant. ISC/3 was used for terrain below the highest stack top and RTDM was used for terrain above the stack top.

The Taylor Straddle Plant is designed to use low NOx burners and combustors to minimize emissions and environmental effects. Other sources of NOx at the plant include gas turbines, a fire heater, a utility heater, and a flare pilot. The modelled NOx source characteristics of the plant are shown in Table 4-6.

To be conservative, emissions from all possible sources of NOx were assumed to be in the form of NO2, that is, 100% of the NOx is converted to NO2. The results of the dispersion analysis are presented below. Tables and contour plots of NO2 concentrations show the combined results from both ISC/3 and RTDM.

Model Results of NOx Emissions Emanating from the Taylor Straddle Plant

The maximum predicted 1-hour ground level NO2 concentrations by stability class are summarized in Table 4-7 assuming 100% of the emitted NOx is converted to NO2. The

Table 4-5. Source parameters for NOx emissions ***(a)*** *at the proposed Taylor Straddle Plant.*

Source	Type(b)	Rating (kW)	Stack Height (m)	Stack Diameter (m)	Stack Flow (kG/s)	Stack Velocity (m/s)	Exit Temperature (·C)	NOx Emissions (t/a)

Recompressor turbine 'A'	C	5 220	10.97	1.17	21.4	46.9	454	36.58
Recompressor turbine 'B'	C	5 220	10.97	1.17	21.4	46.9	454	36.58
Recompressor turbine 'C'	C	5 220	10.97	1.17	21.4	46.9	454	36.58
Regeneration gas heater	C	2.0	6.1	0.305	0.214	4.77	172	0.71
Utility heater	C	10.0	6.1	0.457	1.168	11.06	172	3.546
Emergency flare pilot and purges	C	n/a	85.4	1.067	0.0025	0.005	—	0.152
Emergency flare	I	n/a	85.4	1.067	96.33	149.67	—	—
TOTAL								114.148

(a) Data based on 100% load, 518 m elevation, 60% RH, -12.2·C ambient, and SoLoNOx installed.

(b) C = Continuous; I = Intermittent

Table 4-6. Modelled NOx source characteristics for the Taylor Straddle Plant.

Source	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (oC)	NOx Emissions (t/a)	NOx Emissions (g/s)
Recompressor A	10.97	1.17	45.32	454	36.58	1.160
Recompressor B	10.97	1.17	45.32	454	36.58	1.160
Recompressor C	10.97	1.17	45.32	454	36.58	1.160

Regeneration Gas Heater	6.1	0.305	4.77	172	0.71	0.023
Utility Heater	6.1	0.457	11.06	172	3.546	0.112
Emergency Flare Pilot	85.4	1.067	0.005	873	0.152	0.005
Emergency Flare	85.4	1.067	149.67	¾	¾	¾

Table 4-7. Maximum predicted one-hour average NO2 concentrations by stability class resulting from Taylor Straddle Plant emissions.

Pasquill-Gifford Stability Class	Frequency of Stability Class (%)	NO2 Concentration Ground Level (mg/m3)	NO2 Concentration Flagpole (mg/m3)
A - Extremely Unstable	0.00	21.8*	23.6*
B - Moderately Unstable	10.31	13.9	16.8
C - Slightly Unstable	17.77	31.4	36.3
D - Neutral	33.43	47.7	54.9
E - Slightly Stable	6.07	39.6	52.1
F - Moderately Stable	32.42	66.2	67.0

Note: The 1-hour federal Maximum Acceptable objective for NO2 is 400 mg/m3.

* Since there was no 'A' Stability Class at Taylor, this result is based on Screening Meteorology

maximum predicted 1-hour average ground level concentration of NO2 was 66.2 mg/m3 or 16.5% of the federal Maximum Acceptable objective of 400 mg/m3. The maximum 1-hour average concentration at a height of 2 m above the ground was 67.0 mg/m3. Figure 4-4 is a presentation of the spatial distribution of the maximum predicted, 1-hour, flagpole level NO2 concentrations resulting from emissions from the proposed Taylor Straddle Plant. The contours represent maximum 1-hour concentrations of NO2.

The maximum predicted 24-hour average NO_2 ground level concentration was 18.11 mg/m3, or 9.1% of the federal Maximum Acceptable objective of 200 mg/m3, and the 2-m flagpole predicted concentration was 18.10 mg/m3. Figure 4-5 is a presentation of the spatial distribution of the maximum predicted, 24-hour, flagpole level NO_2 concentrations resulting from emissions from the proposed Taylor Straddle Plant.

The maximum annual average NO_2 concentration predicted at ground level and flagpole level 1.38 mg/m3, which is 1.4% of the federal Maximum Acceptable objective of 100 mg/m3, and 2.1% of the federal Desirable objective of 60 mg/m3. Figure 4-6 is a presentation of the spatial distribution of the maximum predicted, annual, flagpole level NO_2 concentrations resulting from emissions from the proposed Taylor Straddle Plant. As the flagpole and ground level model results are nearly equivalent, only the more conservative flagpole results will be presented in the following sections regarding the assessment of the Taylor airshed air quality.

The NO_x emissions from the proposed Taylor Straddle Plant alone are predicted to be well within the federal Maximum Acceptable objective for 1 hour, 24 hour, or annual averages of NO_2. Thus the environmental impact of NO_x emissions from the proposed Taylor Straddle Plant alone is expected to be negative in direction, sub-regional in scope, long-term in duration, and low in magnitude.

4.2.3 Other Emissions

4.2.3.1 Sulphur Dioxide (SO_2)

The NO_x emissions from plant equipment, described in the previous section, are of the most environmental concern with regard to the proposed plant. There will, however, be a limited amount of sulphur dioxide (SO_2) released to the atmosphere from an emergency flare. The emergency flare will be used intermittently to flare large volumes of sales or supply gas during plant start-up, shutdown, maintenance, or upset conditions. Intermittent flaring can vary from a few minutes to two hours. NCL has estimated that upset or emergency conditions would occur four times per year, with an average duration of one hour each. The total SO_2 release rate of 0.471 tonnes per year shown in Table 4-8 was generated for a more conservative emergency flaring scenario of two hours per month.

Combined SO_2 emissions from continuous and intermittent sources at the Taylor Straddle Plant are not significant.

4.2.3.2 Carbon Monoxide (CO), Non-Methane Hydrocarbons (NMHC), and Particulate Matter (PM)

Table 4-8 lists the emissions of SO_2, NMHC, CO, and PM associated with the operation of the proposed Taylor Plant. All of these values were determined from emission factors for the various pieces of equipment (USEPA 1995a). CO is also a product of incomplete combustion, and is produced in small quantities. NMHC emissions include all hydrocarbons heavier than methane. These exist in the process gas, and will be vented to the atmosphere during an emergency venting and as a result of fugitive emissions. PM may result from certain combustion processes where incomplete combustion leads to carbon particles in the flue gas.

Windborne dust also can be present on an industrial site such as the Taylor Straddle Plant.

4.2.3.3 Greenhouse Gases (GHGs)

Greenhouse Gases associated with the operation of the proposed Taylor plant are methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2). Methane is the major constituent of any process gas that is vented directly to the atmosphere, due to an emergency or due to fugitive emissions. Fugitive emissions are small leaks that may occur from piping and equipment systems, despite good design, construction, and maintenance practices. Small amounts of CH_4 also may be present in the flue gas of combustion-type equipment.

Carbon dioxide is a product of all combustion processes in the fired heaters, gas turbines, and flare pilots. Small quantities also may be present in any process gas that is directly vented to the atmosphere. Greenhouse gases are converted to equivalent amounts of CO_2.

GHG emissions are shown in Table 4-9. The values for methane and nitrous oxide are based on emission factors (USEPA 1995a) while the values for CO_2 are determined from the fuel gas consumption derived from mass and energy balance calculations.

The total emission of methane from fugitive sources is roughly equal to those from combustion sources. The approximate total emission of methane is 72 tonnes per year (t/a); for nitrous oxide, 3 t/a; and for carbon dioxide, 91 800 t/a. Methane has been determined to have a global-warming potential of 24.5 times that of CO_2, while the value for nitrous oxide is 320 (CAPP 1996). Using these factors, the total CO_2-equivalent emission is about 95 000 t/a.

4.2.3.4 Odour

Any odours which may originate from the plant will be associated with an infrequent release of process hydrocarbons which may contain traces of odour-causing sulphur compounds. No significant odours are expected from the Taylor Straddle Plant due to the minimal amount of unburned hydrocarbon releases and the low sulphur compound content in the supply gas.

Figure 4-4. Maximum 1-hour NO_2 concentrations predicted from the proposed NCL Straddle Plant at the 2 metre level.

COLOUR

Figure 4-5. Maximum 24-hour NO_2 concentrations predicted from the proposed NCL Straddle Plant at the 2 metre level.

COLOUR

Figure 4-6. Maximum annual NO_2 concentrations predicted from the proposed NCL Straddle Plant at the 2 metre level.

COLOUR

Table 4-8. Estimated annual emission of SO_2, CO, NMHC, and PM from the proposed Taylor Straddle Plant.

Source	SO_2 (t/a)	CO (t/a)	NMHC (t/a)	PM (t/a)
Recompressor turbines	0.647 ea	33.047 ea	21.770 ea	n/a
Regeneration gas heater	0.024	0.452	0.0124	0.027

Utility heater	0.118	2.255	0.006	0.136
Emergency flare pilot & purges	0.005	0.097	0.002	n/a
Emergency flare(a)	0.471	n/a	0	n/a
Fugitive emissions	0	0	22.89	0
TOTAL	**2.088**	**101.945**	**88.220**	**0.163**

Emergency flare values not included in Total of Continuous Emissions; SO_2 value based on conservative emergency flaring scenario of two hours per month.

Table 4-9. Estimated annual emission of greenhouse gases from the proposed Taylor Straddle Plant.

Source	CH4 (t/a)	CH4 as CO2 (t/a)	N2O (t/a)	N2O as CO2 (t/a)	CO2 (t/a)	Total CO2 Equivalent (t/a)
Recompressor turbines	9.464 ea	231.87 ea	1.109 ea	354.736 ea	28 559 ea	87 436.8
Regenerator gas heater	0.026	0.645	0.013	4.211	990.63	995.49
Utility heater	0.132	3.225	0.066	21.059	4 953.78	4 978.06
Emergency flare pilot & purges	0.229	5.616	0	0	211.42	217.04
Emergency flare	n/a	¾	0	0	n/a	¾
Fugitive emissions(a)	43.767	1 072.290	0	0	0	1 072.290
TOTAL	72.546	1 777.386	3.406	1 089.478	91 832.83	94 699.68

(a) Assumed continuous for all sources.

4.2.4 Cumulative Effects

To evaluate the cumulative air quality impact of NO_2 emanating from the proposed Taylor Straddle Plant and existing

NOx sources within the Taylor airshed, all of the major NOx sources in the Taylor airshed were analyzed together in one dispersion modelling scenario. Table 4-10 summarizes the stack characteristics for all the existing, major NOx sources in the airshed. These sources were modelled along with the proposed sources from the Taylor Straddle Plant listed in Table 4-6. The source characteristics in Table 4-10 represent the emission characteristics of the existing sources after an NOx emission reduction has been applied to the WEI Compressor Station CS-1. The details of this emission reduction are described in Section 4.2.5.1.

The emissions from all possible sources were assumed to be in the form of NOX, and the conversion to NO2 was assumed to be some fraction of the total emitted NOx. Since the elevations and locations of the sources in the area are different, model runs were separated into separate groups. In RTDM, sources must be co-located. Therefore, individual RTDM runs were made for each plant. The results from each run were then combined using the RTDM post processing program SEQADD, and analyzed for cumulative impacts. The results of the dispersion analysis are stated below.

4.2.4.1 Cumulative NOx Emissions, Modelling Results

The maximum predicted 1-hour average, 2-m flagpole height, NO2 concentrations are summarized by stability class in Table 4-11. The predicted concentrations are presented assuming a 100, 75, 50, and 25% conversion of NOx to NO2. Figure 4-7 is a presentation of the spatial distribution of the maximum predicted, 1-hour average, flagpole NO2 concentrations across the Taylor airshed, resulting from all major NOx sources. The contours represent the maximum predicted 1-hour concentrations of NO2 assuming 100% of the emitted NOx is converted to NO2.

The maximum predicted 24-hour and annual average, 2-m flagpole height NO2, concentrations are summarized in Table 4-12. The maximum predicted 24-hour average, flagpole NO2 concentrations across the Taylor airshed, resulting from all major NOx sources are presented in Figure 4-8. Figure 4-9 is a presentation of the spatial distribution of the maximum predicted, annual average, flagpole NO2 concentrations across the Taylor airshed, resulting from all major NOx sources. The contours in Figures 4-8 and 4-9 represent the maximum predicted concentrations of NO2 assuming 100% of the emitted NOx is converted to NO2.

Model predictions show that federal air quality objectives are exceeded when it is assumed that 100% of the emitted NOX is converted to NO2. However, the predicted maximum concentrations of NO2 at the 2-m flagpole height for all averaging periods, are all less than for the existing case (see Section 4.2.5 for details). From a comparison of model results to

Table 4-10. Modelled NOx source characteristics for the Taylor airshed existing sources after emission reduction of WEI's Compressor Station # 1.

Source	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (o K)	NOx Emission (t/a)	NOx Emission (g/s)
McMahon Gas Plant						
MGP1-sulphur recovery waste stack	91.0	1.660	22.6	798.2	94.6	3.000

MGP2-new sulphur recovery waste stack	91.0	1.660	22.6	798.2	94.6	3.000
Westcoast Energy Compressor Station CS-1						
CS1-KVS (with lean burn) #1	13.7	0.495	20.8	763.5	52.7	1.670
CS2-KVS #2	13.7	0.495	20.8	763.5	76.9	2.440
CS3-KVS (without lean burn) #3	13.7	0.495	20.8	763.5	297.7	9.440
CS4-KVS (without lean burn) #4	13.7	0.495	20.8	763.5	297.7	9.440
CS5-KVS (without lean burn) #5	13.7	0.495	20.8	763.5	297.7	9.440
CS6-KVS (without lean burn) #6	13.7	0.495	20.8	763.5	297.7	9.440
CS7-KVS (without lean burn) #7	13.7	0.495	20.8	763.5	297.7	9.440
CS8-Taurus Turbine	17.1	1.175	44.8	661.0	33.7	1.070
CS9-Allison Turbine	13.7	1.175	14.0	837.6	129.3	4.100
CS10-KVR (without lean burn) #1	10.4	0.700	8.0	699.0	574.3	18.210
CS11-KVR (without lean burn) #2	10.4	0.700	8.0	699.0	574.3	18.210

WEI & CU Power Co-Generation Plant						
CO1- unit #1 (North) emission stack	30.5	3.350	13.9	407.7	154.5	4.900
CO2- unit #2 (North) emission stack	30.5	3.350	12.9	415.2	141.9	4.500
Fibreco Joint Venture						
FIB1-package boiler #1 & #2	33.3	1.220	12.6	533.2	109.7	3.480
FIB2-first stage cyclone #14	39.6	2.450	8.8	345.2	28.7	0.910
FIB3-first stage cyclone #17	39.6	2.450	8.8	345.2	28.7	0.910
FIB4-proposed furnace #31	50.0	1.800	17.3	505.2	121.7	3.860
Canfor Taylor Sawmill						
CF1-bee-hive burner #1	21.3	5.000	10.0	755.4	28.7	0.910
CF4-gas fired lumber dry kiln	7.5	Modelled as a Volume Source- 6.98m Dimensions				1.880

Table 4-11. Maximum predicted one-hour average, flagpole NO2 concentrations by stability class, using the ISC/3 and

RTDM models.

Pasquill-Gifford Stability Class	Frequency of Stability Class (%)	NO2 Concentration 100% Conversion (mg/m3)	NO2 Concentration 75% Conversion (mg/m3)	NO2 Concentration 50% Conversion (mg/m3)	NO2 Concentration 25% Conversion (mg/m3)
A - Extremely Unstable	0.00	422*	317*	211*	106*
B - Moderately Unstable	10.31	2043	1532	1022	511
C - Slightly Unstable	17.77	2535	1901	1268	634
D - Neutral	33.43	3235	2426	1618	809
E - Slightly Stable	6.07	2598	1949	1299	650
F - Moderately Stable	32.42	5102	3827	2551	1276

Note: The 1-hour average federal Maximum Acceptable objective for NO2 is 400 mg/m3.

* Since there was no 'A' Stability Class at Taylor, this result was based on Screening Meteorology.

Table 4-12. Maximum predicted 24-hour and annual average, flagpole NO2 concentrations using the ISC/3 and RTDM models.

Averaging Period	NO2 Concentration 100% Conversion (mg/m3)	75% Conversion (mg/m3)	50% Conversion (mg/m3)	25% Conversion (mg/m3)
24 Hour	1696	1272	848	424
Annual	175	131	88	44

Note: The 24-hour average federal Maximum Acceptable objective for NO2 is 200 mg/m3.

Note: The annual average federal Maximum Acceptable objective for NO2 is 100 mg/m3.

ambient monitoring of NO2, it was concluded that approximately 32% of the emitted NOX in the Taylor airshed is converted to NO2. Using this conversion factor the maximum annual average concentration in the Taylor airshed is expected to be 56 mg/m3, which is 93% of the most stringent federal air quality objective for annual averages of NO_2. Therefore, it is concluded that the environmental impact of airborne NO_2 emanating from the proposed Taylor Straddle Plant and all other major NO_2 sources in the Taylor airshed will be positive in direction when compared to the existing conditions, due to the net reduction in NO_X emissions in the Taylor airshed.

Figure 4-7. Maximum 1-hour NO_2 concentrations predicted from the cumulative sources in Taylor at the 2 metre level. *(omitted due to size constraints)*

Figure 4-8. Maximum 24-hour NO_2 concentrations predicted from the cumulative sources in Taylor at the 2 metre level. *(omitted due to size constraints)*

Figure 4-9. Maximum annual NO_2 concentrations predicted from the cumulative sources in Taylor at the 2 metre level. *(omitted due to size constraints)*

4.2.5 Mitigation and Residual Effects

4.2.5.1 Mitigation

The Taylor airshed is considered to be sensitive because of the local topography and because it contains several sources of NO_x emissions. The major existing NO_x sources are as follows:

McMahon Gas Plant¾thermal oxidizers, flare stacks, flare pits

Compressor Station CS1 and Booster Station BS1¾compressor engines

Westcoast Power co-generation Facility

Canfor Sawmill¾beehive burner, dry lumber kiln

Fiberco Pulp Mill¾expected future emissions

Alaska Highway¾motor vehicle traffic

As noted in Section 4.2.1.3, model predictions of 1-hour, 24-hour, and annual concentrations of NO_2 resulting from combined Taylor airshed emissions are all above federal ambient air quality objectives. Although observed ambient 1-hour and 24-hour concentrations were generally below air quality objectives, there are times when air quality objectives are exceeded. Consequently, the addition of a new source of NO_x emissions should include methods to mitigate its impact on the local airshed. NCL has adopted two mitigation strategies to reduce the impact of the proposed Taylor Straddle Plant on the airshed.

In the first strategy, low NO_x burners and combustors will be specified for all fired heaters, gas turbines, and the flare pilot to minimize NO_x emissions. With this equipment, the total amount of NO_x emitted from the Taylor Straddle Plant will be 114 tonnes per year.

In the second strategy, NCL will invest in the upgrading of existing WEI equipment to reduce NO_x emissions at Compressor Station No. 1 by approximately 220 tonnes per year. The net impact of this emissions trading on the Taylor airshed will be a reduction in NO_x emissions of about 106 tonnes per year. For the purpose of modelling, it has been assumed that the emission reductions apply to the source CS2-KVS #2 at the Westcoast Energy Compressor Station CS-1 (see Table 4-10).

4.2.5.2 Residual Effects

Section 4.2.4 shows the net impact on the Taylor airshed of the combined NOx emissions from the Taylor Straddle Plant plus the existing sources with emissions trading included. The maximum 1-hour, 24-hour, and annual flag pole concentrations of NO2 for the combined emissions are all less than the maximum values for the existing sources before emissions trading.

Figures 4-10, 4-11, and 4-12 show the difference in NO2 concentrations between the cumulative sources (the Taylor Straddle Plant plus existing sources with emissions trading) and the existing sources before emissions trading. Figures 4-10 and 4-11 show that the 1-hour and 24-hour concentrations of NO2 are significantly reduced over the Taylor airshed after the addition of the Taylor Straddle Plant and emissions trading.

Figure 4-12 shows that there is a slight reduction or no change for the annual concentrations of NO2 over most of the airshed. On the high terrain northeast and southwest of the Taylor Straddle Plant the annual concentrations are increased slightly. The increases occur over areas where the annual air quality objective is not exceeded, while the decreases occur over areas where the annual air quality objective was exceeded. Hence the net result is an overall improvement in the air quality of the airshed.

Modelling of the existing sources was done specifically for a 2-m flagpole receptor at the location of Monitoring Trailer #2 (Figure 4-1). A comparison of the model predictions and the observations of NO2 at the trailer reveals that the model consistently over-predicts concentrations of NO2 assuming 100% conversion of NOx to NO2. The average annual concentration of NO2 observed at the trailer for the period March 1995 to January 1996 was 21.49 mg/m3. The model prediction over the same period was 67.09 mg/m3 which is a Factor Three higher than the observation. Figure 4-13 shows the maximum hourly model predicted and observed concentration of NO2 for each month. The trends of both sets of data are similar with the model being about three times greater than the observations. One can conclude from this analysis that on average about 32% of the emitted NOx is converted to NO2 within the Taylor airshed.

As a result of the net reduction in NOx emissions, the cumulative effect of the Taylor Straddle Plant NOx emissions on the Taylor airshed is concluded to be positive in direction, sub-regional in scope, long-term in duration, and low in magnitude. Confidence in this assessment is good. NCL will participate in the Taylor Airshed Management Planning Committee which funds meteorology and air quality monitoring in the Taylor airshed.

4.3 Terrestrial resources

The proposed Taylor Straddle Plant site is situated on two land parcels that are zoned as 'Heavy Industrial' (District of Taylor 1995b). The southern portion of the Petro-Canada parcel was previously used as a petroleum storage tank farm. The remainder of the site was cultivated and vacant; it is currently in brome grass and used for hay production. The Numac property was previously disturbed by agricultural use and an extension of the Taylor road grid; it has since been allowed to revegetate (see Section 2.2.1 and Appendix D). Access to the site is limited to existing roads, and the entire length of the proposed pipeline right-of-way is on previously disturbed industrial sites, all of which are also zoned 'Heavy Industrial'.

Since the facilities will be built on previously disturbed sites, potential effects on wildlife, forest, tourism, or recreational resources or resource use are concluded to be nil. Similarly, site zoning restricts the nature of any future development and the associated impact on terrestrial resources.

4.4 Aquatic resources

Natural drainage on the site is toward the south and east, but the site is surrounded by residential and industrial development. No permanent or ephemeral surface drainage courses exist between the site and the Peace River or its tributaries, and fish or fish habitat will not be affected.

The Taylor Straddle Plant site will be designed and contoured to segregate surface runoff from areas with potential contamination. Potential sources of contamination include produced water, liquid and solid wastes, chemicals, sanitary wastes, and site runoff.

Numerous design features have been incorporated to prevent and isolate leaks of potential contaminants. Minor spills or leaks will be contained within the buildings or designated chemical storage areas. The above ground produced water storage tanks will be located inside a diked area with an impermeable liner. All tanks will be diked as a contingency against spills. All plant effluents will be contained on site and none will be discharged into surface waters. Site runoff will be directed to shallow ditches or channels. Surface waters collected in the plant process area will be contained within ditch areas and tested prior to release. In combination, these preventative and containment measures will ensure that effects of site contamination and runoff are local in scope, neutral to negative, long-term and nil to low in magnitude. Confidence in this assessment is fair.

Figure 4-10. Difference of 1-hour NO2 concentrations predicted from the cumulative - the existing sources at the 2 metre level. *(omitted due to size constraints)*

Figure 4-11. Difference of 24-hour NO2 concentrations predicted from the cumulative - the existing sources at the 2 metre level. *(omitted due to size constraints)*

Figure 4-12. Difference of annual NO2 concentrations predicted from the cumulative - the existing sources at the 2 metre level. *(omitted due to size constraints)*

Figure 4-13. Comparison of predicted model NO2 concentrations and measured NO2 concentrations at Monitoring Trailer #2. (B&W) *(omitted due to size constraints)*

5. SOCIO-ECONOMIC IMPACT ASSESSMENT

5.1 METHODOLOGY

The socio-economic assessment is based on traditional socio-economic assessment methodology. Section 5.2 discusses the baseline scenariothe socio-economic conditions prevailing in the project area without the proposed project. Section 5.3 discusses the socio-economic conditions in the study area with the Taylor Straddle Plant. In other words, the baseline information generated in Section 5.2 is overlaid with the Taylor Straddle Plant's characteristics to determine and assess the scope, magnitude, duration and direction of impacts and identify mitigation measures to enhance benefits and reduce the economic and social costs of the project on affected communities.

5.1.1 Definition of Impact Areas

The socio-economic conditions in the project area are discussed at two levels: direct and regional impact areas. The Direct Impact Area (DIA) is the area directly affected (or altered) by the proposed development, i.e., the District of Taylor. The regional impact area includes the near-by community of Fort St. John and surrounding rural areas with services, and physical and social infrastructure potentially impacted by the Taylor Straddle Plant but located outside the DIA. These include the availability of qualified local construction workers, accommodation facilities, and use of medical facilities in Fort St. John.

To avoid lengthy analysis, the assessment uses an issue-focused approach that concentrates on concerns and issues raised during the consultation process by stakeholder groups including provincial regulators.

As a result of discussions with local stakeholders and provincial regulators, six socio-economic project-related concerns have been identified:

- air emissions
- noise
- community stability
- orderly municipal development
- maximization of purchase of local goods and services including full-time and contract employment opportunities
- on-going consultation and information sharing between local stakeholders and NCL

Two of these concerns (air and noise) were discussed more fully in Sections 2 and 4 of this Application. These two issues are discussed in the socio-economic section from a Quality of Life perspective.

5.2 SOCIO-ECONOMIC DESCRIPTION OF THE STUDY AREA WITHOUT THE PROJECT

The project area includes the City of Fort St. John, the District of Taylor, and the rural areas surrounding these two municipalities, i.e., Area 'C' of the Peace River Regional District (see Figure 2-2).

5.2.1 Socio-Economic Conditions of the Project Area

The project area is situated in the District of Taylor, which is within the Peace River Regional District of northeastern British Columbia. Taylor is 18 km south of Fort St. John, the largest urban settlement and regional service centre for the region. The regional economy is predominantly based on agriculture, forestry, and the oil and gas sectors.

5.2.1.1 Population

The project area comprises Subdivision B of the Peace River Census division and local municipalities with a total land area of approximately 7 895 000 ha. It includes the City of Fort St. John (Pop: 14,818); the Districts of Hudson's Hope (Pop: 985) and Taylor (Pop: 950); and the communities of Baldonnel (Pop: 86), Wonowon (Pop: 84), Altona (Pop: 154), and Prespatou (Pop: 421) (Statistics Canada 1991 Census Data; Ministry of Government Services 1995:346).

The cyclical nature of the resource-based sectors has greatly influenced the settlement and population growth in the region. In 1991 the population of the Fort St. John area was 24,437, a decrease of 1.1% from 1986. This followed a 7.9% decline from 1981 to 1986. The decline between 1981 and 1991 is attributable primarily to a sharp drop in oil and gas activities in the region. An increase in oil and gas activities has been recorded since 1993 and the population has begun to grow again. Further hydro-electric developments on the Peace River near Fort St. John (Bennett Dam), expansion of the forest industry into higher value-added products, and the development of the petrochemical industry are contributing to a general upswing in economic activities in the region.

5.2.1.2 Oil and Gas

Northeastern British Columbia is the main source of natural gas in the Province of British Columbia and, until recently, the only source of oil. The petroleum sector has played a vital role in the region's economy since the early 1950's. In 1957, an oil refinery, the McMahon Oil and Gas Plant, was constructed in Taylor. The City of Fort St. John has been nicknamed the 'Energy Capital of British Columbia'. The area holds significant gas reserves and is increasingly the focus of intensive exploration efforts and secondary gas processing.

Taylor has become the industrial centre for the area with facilities to clean natural gas before being transported by pipeline south to markets. One plant extracts sulphur, and a $65 million plant designed to extract propane, butane, and condensate was completed in late November 1985.

A small oil refinery operated at Taylor by Petro-Canada closed in mid-1991, resulting in the loss of 118 jobs. This was offset to some extent by a $108 million expansion of the WEI McMahon Gas Plant in 1991 to handle increased gas production, and a $115 million natural gas-fired co-generation facility, completed in late 1993. In 1996 Westcoast Energy Inc. began to expand facilities in the Fort St. John supply area. This expansion includes the Westcoast Gas Services Inc. (WGSI) Jedney Projecta $48 million gas processing facility and sales gas transmission pipeline located 145 km northwest of Fort St. John, a proposed $53 million expansion of the Jedney Project, and the WGSI Highway Projecta $63 million gas and liquids plant and sweet gas pipeline located 120 km northwest of Fort St. John (Ministry of Government Services 1995:347; WGSI 1995; WGSI 1996a; WGSI 1996b).

5.2.1.3 Forestry

Crown-regulated forest resources are contained within the Fort St. John Timber Supply Area (TSA), the bulk of the MacKenzie TSA, and the southwest corner of the Fort Nelson TSA.

Small portable sawmills operate on an intermittent basis, often in conjunction with land clearing for agriculture. In 1993, there were only two large permanent lumber operations: Canadian Forest Products Ltd at Fort St. John and Taylor. Production capacity at the Taylor Mill was virtually halved in 1992 due to saw log shortages. In late 1988, Fibreco Pulp Inc. completed a $170 million pulp mill at Taylor. Cogenix Development Corporation has proposed construction of a 125 MW co-generation plant adjacent to the pulp mill. If approved, the plant will supply electricity and steam to the mill, and will favourably impact pulp production costs (Ministry of Government Services 1995:346).

5.2.1.4 Agriculture

Agriculture is a major economic factor in the area's economy and continues to expand. Grain growing is concentrated near Fort St. John with cattle ranches spreading over a large area to the north and west. Pigs, sheep, and beef cattle are raised in conjunction with grain operations, and a number of large community pastures have been established to provide summer grazing for livestock.

The Ministry of Government Services (1995:347) reports that of the 342,169 acres of crops, 38% was in hay; 33% in wheat, barley and oats; and 16% in canola. Cattle numbered 55, 511 head. Farm capital was estimated at $307.7 million and sales receipts at $36.7 million.

5.2.1.5 Manufacturing

Heavy manufacturing related to the resource sectors is concentrated in Taylor where Peace Woods Products Division of Balfour Forest Products has a large sawmill. Westcoast Energy Inc. produces natural gas liquids while Slocan Forest Products Ltd. operates the Fibreco Pulpmill. Other manufacturing reported in the area includes a large lumber mill, printing and publishing, machine shops, cement products, metal fabricating, and dairy and honey processing (Ministry of Government Services 1995:346).

5.2.1.6 Tourism

Large numbers of visitors travel through the area on the Alaska Highway, but with relatively few overnight stays. The northeast tourist region (which includes the project area) has the lowest number of visitor/days and the least amount of dollars spent in all regions of British Columbia. Big game hunting (caribou, moose, bear, mountain goat, elk) is one of the primary attractions for visitors.

5.2.1.7 Labour Profile

Most of the employment opportunities generated in the project area are linked to the natural resource-based sector of the economy. Recent figures on employment by industry indicate a large proportion of the labour force (20.4%) is directly involved in primary industries. This proportion is even higher if we take into account the large number of manufacturing and service companies operating in northeastern BC that supply or use products from the agricultural, mining, and forestry sectors (Ministry of Skills, Training, and Labour 1995). In 1991, the region's labour force numbered 31,290 persons, or 1.8% of the provincial total. The region ranked first in British Columbia in the proportion of the labour force participating in mining activities (which includes the oil and gas sector) at 10.8%, followed by agriculture (7.5%), and transportation and storage (7.6%).

Unemployment in the area tends to be lower than the provincial average and labour force participation rates tends to be higher than the rest of the province, particularly for males (Ministry of Skills, Training, and Labour 1995).

5.2.2 Regional Infrastructure and Services

5.2.2.1 Transportation Services

The main highway in the project area is the Alaska Highway which runs north-south. It begins in Dawson Creek and provides a route through Taylor, Fort St. John, Fort Nelson, the Yukon, and Alaska. The highway acts as the main commercial and personal road transportation axis for the region.

Fort St. John boasts the third largest mainland runway in British Columbia. The airport is served by Canadian Regional Airlines (CRI) and Central Mountain Air. CRI offers services to Vancouver, Victoria, Grande Prairie, Edmonton, Calgary, Fort Nelson, and Prince George via Fort Nelson. Central Mountain Air has scheduled flights to Prince George with connections to the Interior of British Columbia and Vancouver (Alaska Highway News 1995:41).

Buses depart twice daily for Edmonton and Vancouver, and daily to Fort Nelson and Hudson's Hope. Fort St. John also operates a daily public transportation system (bus) except on Sunday.

BC Rail has a major service centre in Fort St. John, providing regular transportation service to the agriculture, lumber, and petroleum industries.

5.2.2.2 Health Services

Aside from an elementary school, post office, and volunteer fire department located in Taylor, the nearest location for most essential services (medical, emergency, educational) is the City of Fort St. John (District of Taylor 1995a).

The Fort St. John General Hospital is a 64-bed facility including three intensive care beds. The hospital offers a full range of medical, diagnostic, and X-ray services. To date there are 19 resident physicians. A well-equipped emergency room handles routine as well as oil field-related emergencies. A landing pad for helicopters is also available. The hospital offers a mobile nuclear medicine service to city residents and the surrounding areas (Alaska Highway News 1995:28).

The other medical service of relevance to the proposed Taylor Straddle Plant is the Peace River Health Unit. It offers a wide range of services to local area residents including information on pregnancy and child care, newborn visits, consultation on private water systems, immunization clinics, counselling and treatment for communicable diseases, dental services for elementary school children and seniors, and environmental health inspections (Alaska Highway News 1995:28).

5.2.2.3 Educational Services

The Fort St. John Area is within School District #60, one of the three largest in British Columbia. It takes in Fort St. John, Taylor, Hudson's Hope, Wonowon, Prespatou, several rural communities and schools, and a large area bordered to the west by Williston Lake. The District operates 14 elementary schools, two junior high schools, and one senior high school (Alaska Highway News 1995:16).

Adult education is primarily offered by the Northern Lights College, a major vocational institution that operates eight campuses throughout the northeast region. The Dawson Creek and Fort St. John campuses, through their respective vocational programs, offer a variety of courses relevant to the oil and gas industry, including carpentry, professional driver education, welding, commercial transport mechanics, automotive mechanics, a one-year power engineering and gas processing program, and numerous trades upgrading courses. The number of full-time students enrolled at the college in 1994 was approximately 1,300 (Alaska Highway News 1995:17). With the chronic shortage of skilled tradespersons in the area, the vocational institutions are becoming increasingly popular with individuals seeking to upgrade their professional skills.

5.2.2.4 Commercial Services

Fort St. John has a well-developed retail sector offering the range of products expected in a community of its size. Accommodation facilities in Fort St. John and the immediate surrounding area include 10 hotels with a total of 617 rooms, and 2 campground/RV parks providing 56 sites (Ministry of Small Business, Tourism, and Culture 1995:92).

5.2.3 The District of Taylor

5.2.3.1 Community Characteristics

The project is located within the boundaries of the District of Taylor. Taylor is a small industrial and residential community located in the Peace River Regional District on the north bank of the Peace River. Taylor's land base is relatively small, only 11.5 km2. Its current population is approximately 950, an increase of 16% since the 1991 census (L&M Engineering Limited 1995:8).

Population growth of the community has closely followed the pattern found in the northeast region of British Columbia, with significant increases between 1978 and 1981, a sharp decrease between 1981 and 1986, and a gradual increase since the late 1980's (L&M Engineering Limited 1995:89).

Taylor is somewhat unique insofar as having a relatively large industrial base but a small residential population. As a result, the municipality has the lowest residential tax rates in the Peace River Regional District, an increasingly attractive draw for families seeking cheaper housing alternatives in the region (L&M Engineering Limited 1995:19; T. Johnson, pers. comm.).

The industrial sector is dominated by the WEI facility and its co-generation plant, Fibreco Pulp Inc., Canadian Forest Products' stud mill, Cargill Grains' grain handling facility, and Peace River Greenhouses which grow seedlings for northeastern BC's reforestation programs. More recently Solex Development Company Inc. received regulatory approval to expand and operate the Younger Natural Gas Liquids Extraction Plant in Taylor. The proposed NCL plant would add to the continuing growth of Taylor's industrial base.

5.2.3.2 Land Uses in the Vicinity of the Proposed Plant Site

Industrial facilities including the proposed Taylor Straddle Plant, are located mainly in the eastern quadrant of the town site, down-wind of the residential and recreational land uses. This area is designated as 'Heavy Industrial' in the current District of Taylor Official Community Plan No. 509 (L & M Engineering Limited 1995). The proposed plant site is bordered on the north by Cherry Avenue, on the east by the railroad right-of-way, and to the south by Pine Avenue. The western boundary is adjacent to a transition zone meant to act as a buffer between areas designated as 'Heavy Industrial' and 'Residential'. The nearest residences are located less than 200 m (640 ft) to the west of the proposed site (L&M Engineering Limited 1995:Schedule B), while the plant facilities are located 400 m from the nearest residence.

The residential area located west of the proposed site is characterized by single detached dwellings housing approximately 80 residents, mostly families with children (M. Miller pers. comm.).

5.2.3.3 Municipal Infrastructure and Services

The District of Taylor is a well serviced municipality. Some of its services include a community water supply system, a community sanitary sewer system, a comprehensive open ditch drainage system, paved roads, gravel roads, and a partially completed sidewalk network. The water supply system has been designed to accommodate up to 1,500 residents, while the sewage lagoons can accommodate approximately 2,000 people (L&M Engineering Limited 1995:5556).

According to the District's Official Community Plan, no proposed changes to municipal services and infrastructure will have an effect on current and proposed industrial facilities in Taylor. The only exception is the proposed extension of Pine Avenue East to connect with an existing Solex access road which would provide a second access to primary industrial areas (L&M Engineering Limited 1995:4851).

5.2.3.4 Housing and Recreation

It is estimated that approximately 2025% of the District's residents are employed in Taylor. The remainder of the population is comprised of individuals attracted to the relatively inexpensive housing costs in Taylor compared with Fort St. John (T. Johnson pers. comm.).

The District's Council has endorsed a number of measures to attract permanent residents to the community. A recent subdivision development (Fairway Estates) has increased the housing stock and is attracting a greater number of families to the community. A large portion of Taylor's residents still live in mobile homes (M. Miller pers. comm.).

Another sign of the community's new-found stability and maturity is the establishment of the District Ice Centre, a facility featuring 500 seats, a regulation-size ice surface, and an additional leisure ice skating pad (District of Taylor 1995a).

5.3 SOCIO-ECONOMIC DESCRIPTION OF THE STUDY AREA WITH THE PROJECT

5.3.1 Project Characteristics

5.3.1.1 Construction Costs

NCL expects to spend $48.9 million dollars (excluding the 10% contingency fund) to build the proposed Taylor Straddle Plant, including the auxiliary components such as the gas supply and return pipeline and tie-ins. Table 5-1 indicates the breakdown of the total capital cost into its main components. Construction-related labour and, to a lesser degree, purchase of material are the main items where local contractors and suppliers have an opportunity to become involved in the project. Various construction components will be tendered on a competitive basis allowing these local contractors to compete for the work.

Table 5-1. Capital cost estimate for the proposed NCL Taylor Straddle Plant.

Item	Estimated Capital Cost **(excl. GST)**
STRADDLE PLANT COSTS	
Major Equipment	$ 16,000,000
Materials	9,000,000
Construction Labour	10,000,000
Engineering, Management, Land & Fees	2,500,000
Contingency (10%)	4,000,000
PST	3,000,000
TOTAL STRADDLE PLANT	$ 44,500,000
GAS SUPPLY & RETURN PIPELINE, AND TIE-IN COSTS	
Materials	$ 1,300,000
Construction	1,800,000
Engineering, Management, right-of-way, and Fees	600,000
Contingency (10%)	400,000
PST	300,000

TOTAL PIPELINE, ETC. $ 4,400,000

5.3.1.2 Operating Costs

The annual operating cost for the Straddle Plant is estimated at $4.8 million dollars. Table 5-2 shows the breakdowns of the annual operating costs into the main service areas: wage, purchase of materials, taxes, and maintenance.

The majority of the operating costs will benefit local area residents and municipalities and the Province of British Columbia in the form of wages, maintenance contracts, and local and provincial taxes. Local contract maintenance companies will be used on 'as needed' basis. Approximately 5,000 person hours per year of contract maintenance services are expected to be required.

5.3.1.3 Construction Schedule and Workforce

NCL proposes to start construction in July 1997 and commence operation in mid-March 1998. Including all disciplines, an average of 70 people are expected to work on the project during the nine-month construction period with a labour force peaking to 120 during the first quarter of 1998. The estimated total construction labour for the facilities is 100,000 person days.

5.3.1.4 Operation Workforce

Seven full-time staff will be required to operate the plant. These persons will be living in the Taylor/Fort St. John area. The facility is expected to be manned 24 hrs per day, 7 days per week, and will run an average of 360 days per year.

5.3.2 Impact Areas And Proposed Mitigation Measures

5.3.2.1 Economic Impacts

Short-Term Benefits

NCL is committed to maximize the purchase of local goods and services whenever possible. If local area contractors are competitive and available during the proposed construction schedule, local contractors will be used to complete different segments of the construction phase. The local hiring will be positive for the Fort St. John Area's oil and gas service suppliers and contractors. Short-term economic impacts are therefore anticipated to be local to regional in scope, and positive.

Long-Term Benefits

Long-term economic benefits will come in the form of increased revenues for the Province of British Columbia (crown royalties) and the District of Taylor (property tax). The creation of seven permanent full-time positions to operate the plant, and the tendering of maintenance contracts to local contractors will also create long-term benefits. Long-term economic impacts, therefore, are anticipated to be local to regional in scope, and positive.

Table 5-2. Estimated annual operation costs.

Item	Estimated Operating Cost (excl. GST and PST)
Full-time wages and burdens	$ 500,000
Parts and materials	600,000
Utilities (less fuel)	700,000
Taxes, Insurance	2,200,000
Overhead and management costs	250,000
Contract services (maintenance, electrical, instrumentation, labour)	550,000
ESTIMATED TOTAL	$ 4,800,000

5.3.2.2 Labour

Manpower requirements for this project are relatively modest but the current high level of economic activities in the Fort St. John Area may restrict the availability of qualified local tradespersons at the time of construction. The timing of the construction phase of this project and others in the region will play a determining role in the ability of NCL to hire local contractors.

It is recommended that NCL use a variety of resources to identify qualified personnel, including a widely-advertised bidding process, the use of Canada Employment's computer job network, and the Industrial Adjustment Service Branch (IAS). It was suggested that NCL organize a pre-tendering meeting for potential local contractors and suppliers *(particularly in the area of plant safety) to define and discuss the project needs. This would allow local firms to harness the necessary resources and skill set to be competitive during the bidding process.*

5.3.2.3 Medical Services

The demand for out-patient service and emergency care is not expected to increase in any significant manner because of the Taylor Straddle Plant. The effects on health and safety are determined to be local in scope, low in magnitude, short-term to long-term in duration, and negative; the potential of significant adverse impact is unlikely.

5.3.2.4 Fire Protection

The District of Taylor and NCL have the appropriate resources (personnel and equipment) to deal with most fire-related incidents. Depending on the magnitude of the hazard, the fire department in Fort St. John and Dawson Creek could be called in for back-up. To ensure the safety of the public and plant personnel, NCL will develop an emergency response plan in consultation with local stakeholders (Section 2.5). The effects of the Taylor Straddle Plant on fire protection are expected to be local in scope, nil to low in magnitude, and short-term in duration.

5.3.2.5 Police Protection

The Fort St. John RCMP Detachment has 15 uniformed police officers covering the rural area surrounding the City of Fort St. John, including the District of Taylor. Since the Taylor Straddle Plant does not propose to establish a work camp, no significant impacts are expected from the project except for a moderate and short-term increase in local traffic to and from the plant site. The effects of the Taylor Straddle Plant on police protection therefore are expected to be local in scope, nil to low in magnitude, and short-term in duration.

It is recommended that NCL provide a project schedule to the RCMP to allow the RCMP to anticipate any potential changes to traffic patterns in the project area.

5.3.2.6 Land, Noise, and Visual Impacts

The Taylor Straddle Plant is to be constructed on land zoned as 'Heavy Industrial' designed to accommodate the type of facility NCL and its potential partner, CNRL, are proposing to build. Except for the residential area bordering the west side of the proposed site, adjacent land uses are not incompatible with the proposed development. Under Taylor's Municipal Plan, residential areas that are adjacent to industrial zones are protected by a 'transition zone' intended to act as buffer between the two uses. In the case of the NCL plant, treed buffers will be used to minimize visual and noise impacts.

NCL also will conduct noise surveys prior to construction and during operation to document noise levels. If required, NCL will work with Taylor authorities and local residents to develop a mitigation plan that will reduce the visual and noise impacts of the plant on the residents living along 98th, 99th, and 100th streets.

The potential impact of the Taylor Straddle Plant on land, noise and visual aesthetics is determined to be local in scope, nil to low in magnitude, negative to positive, and long-term in duration.

5.3.2.7 Community Issues

The District of Taylor, like other communities in northeastern British Columbia, have been affected by the 'boom and bust' nature of the natural resource sector. Municipal governments and local citizens are wary of any reoccurrence of such trend. Consequently, development that strengthens the industrial base of the community by providing long-term employment opportunities, if only for a small number of individuals, is seen as a positive step towards achieving long-term community stability. This stability translates into 'quality of life'-related expectations on the part of residents typically associated with more established communities. To meet these community expectations (i.e., maintenance of high level of public health and safety, need for diverse recreational amenities, and municipal orderly development) will require NCL and other industrial users in Taylor to maintain on-going communication with the District of Taylor and its local residents to ensure the maintenance and improvement in the quality of life of local residents.

Based on these factors, the potential impact of the Taylor Straddle Plant on quality of life and community stability are expected to be local in scope, nil to low in magnitude, negative to positive, and short-term to long-term in duration.

A summary of the potential socio-economic effects of the Taylor Straddle Plant and proposed mitigation measures is provided in Table 7-2.

6. ARCHAEOLOGICAL AND HERITAGE IMPACT ASSESSMENT

This section summarizes archaeological and heritage overview and impact assessments conducted for the proposed Taylor Straddle Plant and associated supply and return pipelines. The complete Archaeological Impact Assessment as required by the BC Archaeology Branch is included in Appendix C.

6.1 HERITAGE ASSESSMENT SUMMARY

6.1.1 Ethnohistoric Overview

In the mid 1700s, the Beaver Indians' traditional territory included the entire basin of the Peace River below its junction with the Smoky, the district around Lake Claire, the valley of the Athabaska River as far south as the Clearwater and Methye Portage, and extended west to Portage la Loche and Lesser Slave Lake (Jenness 1977). With the advent of the fur trade the eastern Beaver were slowly pushed west by the Cree. As a result, the eastern Beaver pushed the western Beaver even further west up the Peace River and they, in turn, displaced the Sekani into the mountains (Ives 1990). By the turn of the century three geographical groups of Beaver Indians were identified as occupying the region of the Peace River to the falls about forty miles below Vermilion (Goddard 1916). One group traded at Fort St. John, the second group lived near Dunvegan, and the third group lived near Fort Vermilion on a reserve along Paddle River. In addition to the Beaver, the fur trade resulted in the eastern migration of Cree, Iroquois, and Saulteau people employed by the Northwest Company and the Hudson's Bay Company. Many of these people intermarried with local native groups and settled in the Peace River country. The Saulteau eventually settled on the east shore of Moberly Lake.

The project area falls within the lands covered under Treaty 8. The terms of Treaty 8 were concluded at Lesser Slave Lake in 1899 in consultation with the Cree. Following the negotiations, the Commissioners had also intended to make treaty with the Beaver of Fort St. John in June 1899. There was some confusion, however, and no Beaver Indians signed until the following year. In subsequent years, many of those individuals that had not signed adhesions in 1900, took treaty (Madill 1986).

As part of the treaty settlement, a number of reserves were allocated. In British Columbia, reserves were established at Halfway River, Crawford River, Doig River, and Blueberry River. The Doig and Blueberry bands once occupied a common reserve. In 1916, a parcel of land in the Peace River Block, known as the St. John Indian Reserve No. 172, was set aside for the St. John Band (Ridington 1988). In 1945, the reserve was sold to the director, Veterans Land Act, and the proceeds from the sale were credited to the Fort St. John Band. This reserve was replaced by Beaton River I.R. No. 204, Blueberry I.R. No. 205, and Doig River I.R. No. 206 (Madill 1986). In 1914, the Saulteau signed treaty and East Moberly Lake Reserve No. 169 was established.

6.1.2 Traditional Use Overview

In order to determine potential conflicts with traditional land use within the proposed project area, the Saulteau, West Moberly, Doig River, Blueberry River, and Kelly Lake First Nations were provided with a proposed development map for their internal review. In addition, all five First Nations were offered the opportunity to participate in the field program. A representative of the Kelly Lake First Nation, Francis Gladue, assisted during the monitoring for the length of the auger testing program. Chief Buddy Napoleon of the Saulteau First Nation met with the field archaeologists prior to initiation of the project to review the scope of work. Arrangements for a representative from the Blueberry River First Nation were made but the representative was not present during the field reconnaissance. No specific traditional land use concerns were raised by the any of the five First Nations communities contacted in relation to this development project.

6.2 ARCHAEOLOGICAL IMPACT ASSESSMENT SUMMARY

Archaeological Impact Assessment studies are initiated in response to development proposals which will potentially disturb or alter the landscape, thereby endangering archaeological sites (Archaeology Branch 1995). The following sections provide a brief summary of an Archaeological Impact Assessment undertaken in April 1997 for the proposed Taylor Straddle Plant. The Final Report for the Archaeology Impact Assessment is contained in Appendix C.

The work was conducted under Heritage Inspection Permit No. 1997-043, which was issued by the Archaeology Branch, Ministry of Small Business, Tourism and Culture, to Barbara Kulle of Fedirchuk McCullough & Associates Ltd. A review of archaeological literature and Archaeological Site Inventory for the area was completed prior to initiation of field work.

Included in this section is summary information on archaeological resources in the project area and a discussion of the anticipated effect of project activities on archaeological resources.

6.2.1 Regional Setting

The study area is situated on the edge of the "ice free corridor" between the Cordilleran and Laurentide ice sheets. This corridor is postulated to be one of the earliest ice-free regions available for occupation by humans, and may have served as a migration route for the peopling of the New World from northeast Asia. These early residents are believed to have occupied the fringes of proglacial lakes which formed along the edge of the retreating ice sheets. The study area was free of ice and available for human occupation possibly in the Early Clayhurst Stage, but certainly in the Late Clayhurst Stage of Glacial Lake Peace (Mathews 1980). Clovis Paleo-Indian cultural materials recovered from the Charlie Lake Site, British Columbia, were radiocarbon-dated to approximately 10,400 years ago (Fladmark et al. 1988). Approximately 150 km northwest of Fort St. John, other Clovis cultural material, as well as Scottsbluff, Plainview, Lerma, and later possible Salmon River material, were recovered at the Pink Mountain Site (Wilson 1989). Clovis represents the earliest recognized archaeological complex in the New World. The archaeological record indicates that the region was occupied continuously from this early period to historic times. The Charlie Lake Cave site has yielded a continuous record over approximately 11,000 years.

A substantial number of archaeological investigations have been conducted within and adjacent to the current study area as a result of interest in early Holocene sites in the region (Fladmark et al. 1988) and industrial development. Most of the sites identified in association with these industrial projects are small artifact scatters of limited extent and potential to yield substantive data, although several sites have been extensive enough to warrant mitigative programs in association with project development (Walde 1990a, 1990b). In addition to precontact sites, post-contact sites associated with fur trade activities along the Peace River have also been investigated (Hamilton 1987; Hamilton et al. 1988; Burley et al. 1996).

A search was conducted of the site inventory files maintained by the Archaeology Branch, Ministry of Small Business, Tourism and Culture. The site file search consisted of Borden Blocks HaRd, HaRe, HbRd and HbRe (Figure 6-1). The search indicated that at least 15 previously recorded archaeological sites occur within 1.5 km of the proposed development zone. These sites consist of two isolated finds, 11 surface scatters of lithic artifacts, one buried deposit of lithic artifacts, and one site identified as a grave house. Only one, HaRe 13, occurs in conflict with the proposed plant site. The site identified as the grave house (HaRe 1) was recorded in excess of one kilometre southwest of the proposed development zone and, as a result, will not be subject to direct or indirect impact in relation to the proposed construction and operation of the Taylor Straddle Plant. Site HaRe 13 was recorded in 1975 by Fladmark, at which time two flakes were recovered from the ground surface. Re-inspection of the site in 1984 led to the interpretation that the site had been destroyed by industrial activity.

6.2.2 Archaeological Impact Assessment Summary

Aerial photograph coverage of the project area was reviewed to evaluate past land use (see Appendix C, Plates 814). This record indicates modest agricultural utilization of the north and western portions of the property but intensive industrial use of the southern portion within the previous petroleum storage tank farm. Based on past agricultural use, the intensive industrial development in the project area, the general nature of the known heritage resource sites, and the contexts in which the sites have been found, it was anticipated that any surface or shallowly buried sites would be found mainly in dispersed or disturbed contexts, and would be of limited archaeological potential. Deeply buried sites, located within the circumscribed Peace River floodplain, would have greater potential for being identified in undisturbed contexts. As a result, the focus of the field portion of the Archaeological Impact Assessment was the testing of these deeper deposits, through monitoring of auger testing program and controlled backhoe testing.

Due to scheduling conflicts between the time needed for review of the Application for a Project Approval Certificate and anticipated construction, the Archaeological Impact Assessment was initiated under winter conditions. Auger testing conducted for soil sampling was scheduled for late spring 1997 and was utilized as an opportunity for subsurface testing across the proposed plant site property. Prior to the auger testing program, a surface inspection of the plant site, buffer zone, and other exposures within the plant property was made. Natural melting of snow provided very good visibility with approximately 80 percent surface exposure. No surface cultural materials were observed.

Monitoring of 49 auger tests was completed and 19 soil samples were thawed and screened through 6 mm mesh. In addition, two backhoe tests were excavated along the north margin of the proposed buffer zone to verify the interpretation of auger profiles. No cultural material was observed during any of these investigation procedures.

The area which correlates to Site HaRe 13 was the area most intensively investigated during the auger testing program with 12 boreholes drilled in the vicinity. Neither intact post-glacial deposits nor any cultural material were observed in this area. It is, therefore, reasserted that Site HaRe 13 has been destroyed by past industrial activity.

Two proposed developments in association with the proposed plant site were to be included in the assessment. A flare stack with its supply pipeline originating within the plant site and extending north approximately 180 m will be constructed within the previously disturbed right-of-way of an existing gas pipeline traversing the site property. Owing to the previous disturbance and the presence of an active gas pipeline in the right-of-way, no testing was undertaken in relation to the alignment. No intact sediments will be affected by construction of the flare stack and supply line.

The second development is the supply and return pipeline from the proposed plant site to the existing Westcoast Energy Inc. meter station on the lower Peace River terrace. The route consists of two segments, approximately 800 m of below ground pipeline and about 600 m of above ground pipeline. In both cases, the route traverses intensively utilized industrial terrain which was considered unsafe for subsurface testing. The potential for intact deposits within the proposed development route is remote. No further study is recommended in relation to the supply and return pipelines, or the flare stack and its supply pipeline.

6.2.3 Conclusions and Recommendations

No cultural material was observed during the field work of the Archaeological Impact Assessment for the proposed Taylor Straddle Plant; in addition, no intact post-glacial deposits were observed on the former tank farmthe site of the proposed plant. The level of inspection and testing conducted in association with this project is deemed sufficient to suggest that no further assessment in relation to the current development plans is necessary.

Potential effects on heritage and archaeological resources resulting from the Taylor Straddle Plant are, therefore, nil in magnitude; confidence in this assessment is good.

Figure 6-1. Proposed Taylor Staddle Plant. (FMA) *(omitted due to size constraints)*

7. CONCLUSIONS

7.1 SUMMARY OF ISSUES

Summaries of the biophysical and socio-economic issues and potential effects resulting from the proposed Taylor Straddle Plant are provided in Tables 7-1 and 7-2 respectively. These issues were identified during consultation with local residents, representatives from all levels of government, First Nations, and the general public in the Taylor area. More detailed information on the issues scoping and consultation process is provided in Section 3 and Appendix A.

7.2 POTENTIAL EFFECTS AND MITIGATION

Tables 7-1 and 7-2 also identify the mitigation and monitoring programs to be employed by NCL, consultants, and contractors to address each issue or concern. Conclusions on the spatial scope, direction, magnitude, and duration of residual effects are provided based on the assessment methodology and definitions provided in Section 4.1.2. Finally, the tables show conclusions on the likelihood of significant adverse impacts.

As shown in these tables, numerous environmental and socio-economic concerns and issues were identified during consultation. NCL had already incorporated a number of design features and operating strategies to prevent or reduce negative effects. Additional preventative and mitigative measures were identified during project planning, siting, and pipeline routing to prevent or reduce potential negative effects and enhance anticipated positive effects.

7.2.1 Environmental Effects

Specific environmental protection measures to be employed for the Taylor Straddle Plant are described by topic in Section 4.

Environmental effects were evaluated using specific definitions provided in Section 4.1.2. These definitions describe the spatial scope (local, sub-regional, regional), duration (very short-term, short-term, medium-term, long-term), direction (positive, neutral, negative), and magnitude (nil, low, medium, high) of potential environmental effects. Table 7-1 summarizes all potential biophysical effects.

Potential effects on air quality depended on the type and frequency of the emission being considered. Because total emissions in the Taylor airshed will be reduced as a mitigative measure, cumulative effects of the proposed Taylor Straddle Plant were concluded to be positive, sub-regional in scope, long-term in duration, and of low magnitude.

Potential effects on wildlife, forest, agricultural, tourism and recreational resources or resource use were concluded to be nil.

Potential effects on hydrology and hydrogeology were concluded to be neutral to negative, local in scope, long-term in duration, and of nil to low magnitude. Potential effects on fisheries were concluded to be nil.

No significant adverse residual environmental effects resulting from the Taylor Straddle Plant were considered to be likely.

7.2.2 Socio-Economic Effects

From a socio-economic perspective, the proposed project will consist of a short period of relatively intense activity during construction of the plant, and pipelines. This will be followed by ongoing, but low intensity, activities.

Socio-economic effects were evaluated using the same definitions as the environmental assessment (Section 4.1.2). Table 7-2 summarizes all potential socio-economic effects.

Potential construction-related effects on population, income, employment, services, transportation, health and safety, quality of life, and infrastructure were concluded to be positive (e.g., employment opportunities) to negative (e.g., increased road traffic during construction), local to regional in scope, short-term (less than 1 year) in duration, and nil to low in magnitude.

Potential effects during operations varied with the effect being considered. They ranged from positive (e.g., employment opportunities) to negative (e.g., community stability based on petroleum industry), local in scope, long-term in duration, and nil to low in magnitude.

Overall, no significant adverse residual socio-economic effects were considered to be likely.

7.2.3 Cultural and Heritage Effects

Overview and impact assessments to assess potential effects on heritage and archaeological resources have been completed. The completed Archaeological Impact Assessment is in Appendix C. Five First Nations communities were asked to review the project and to submit issues or concerns regarding conflicts between the proposed development and traditional use sites; they were also invited to send representatives to assist with the archaeological field work. No specific traditional land use concerns were raised by any of these First Nations communities.

A previously-identified grave house is located outside the project location and will remain undisturbed by construction and operation of the Taylor Straddle Plant and associated facilities. One previously-identified archaeological site (HaRe

13) initially appeared to be in potential conflict with the project development, but intensive investigations reasserted that the site had been destroyed by past industrial activity. No cultural material was observed during any of the field investigations; in addition, no intact post-glacial deposits were observed.

Potential effects on archaeological and heritage resources are expected to be nil. The level of inspection and testing conducted in association with this project is deemed sufficient to suggest that no further assessment relative to the current development plans is necessary.

7.2.4 Health Effects

Local residents expressed concern about the potential effects of the project on their health. NOx emissions in the Taylor airshed will be reduced due to mitigative measures initiated by NCL as a result of the Taylor Straddle Plant project; this is projected to improve air quality.

7.2.5 Consultation and Issues Resolution

NCL has made a commitment to local residents, First Nations, and interested employees, businesses, groups, and individuals to continue to provide ongoing communications on the status and plans of the Taylor Straddle Plant. A variety of communication methods will be used to encourage participation.

7.3 APPLICATION CONCLUSIONS

NCL has completed the necessary activities required under the Environmental Assessment Act. This application concludes that no significant adverse environmental, social, economic, health, cultural, or heritage effects are likely to result from the Taylor Straddle Plant.

NCL believes that approval of the application will provide the following benefits:

1. NCL will invest $48.9 million in British Columbia and provide future employment in the northeast region;
2. Producers that ship natural gas on the Westcoast Energy Inc. transmission system will have an opportunity to choose between NGL extraction facilities in a competitive environment;
3. The Taylor Straddle Plant will effectively compete with existing infrastructure to encourage further exploration and development in the gas supply area;
4. Current NOx emission levels in the Taylor airshed will be reduced by approximately 100 tonnes per year; and
5. The Taylor Straddle Plant will create socio-economic benefits as well as increased revenue to the producers and the province.

NCL and its potential partner, CNRL, request the approval of the Taylor Straddle Plant Approval Certificate Application in a timely fashion to allow construction to begin July 1997.

8. REFERENCES

AES. (Atmospheric Environment Service). 1993. Canadian Climate Normals, 19611990. Volume 1: British Columbia.

Alarie et al. 1972. Long-term Continuous Exposure to Sulfur Dioxide in Cynomolgus Monkeys. Archives of Environmental Health. Vol. 24. February.

Alaska Highway News. 1995. The 1995 North Peace and Area Fact Book. Alaska Highway News.

Archaeology Branch. 1995. British Columbia Archaeological Impact Assessment Guidelines. Archaeology Branch, Ministry of Small Business, Tourism and Culture, Province of British Columbia.

Burley, D. V., J. S. Hamilton and K. R. Fladmark. 1996. Prophecy of the Swan: The upper Peace River fur trade of 1794-1823. UBC Press, Vancouver.

CAPP. (Canadian Association of Petroleum Producers). 1993. Environmental Operating Guidelines for the British Columbia Upstream Petroleum Industry. Prepared for CAPP by Bromley Engineering Ltd. Calgary, Alberta.

CAPP. (Canadian Association of Petroleum Producers). 1996. Guide: Global Climate Change Voluntary Challenge; CAPP Guide and Calculating Greenhouse Gas Emissions (7). May 2.

Cole, H.S. and Summerhays, J.E. 1979. A review of techniques available for estimating short-term NO2 Concentration. JAPCA 29:812 (1979).

District of Taylor. 1995a. Welcome To Taylor: "The Place To Live".

District of Taylor. 1995b. Zoning bylaw no. 510. L&M Engineering Limited, Prince George, BC. 1:10,000 mapsheet.

Dreisinger, B.R. and McGovern, P.C. 1970. *In* Proceedings: Impact of Air Pollution on Vegetation. Specialty Conference, Toronto, Ontario, APCA. pp. 1128.

EAO. (Environmental Assessment Office). 1995. Guide to the British Columbia Environmental Assessment Process. Environmental Assessment Office, Victoria.

Ehrlich, R. and M.C. Henry. 1968. Chronic Toxicity of Nitrogen Dioxide I Effect on Resistance to Bacterial Pneumonia. Arch. Environ. Hlth., 17: 860 (1968).

Environment Canada. 1984. Enviro Technical Information for Problem SpillsHydrogen Sulphide. TIPS manual.

Environment Canada. 1985. Enviro Technical Information for Problem SpillsSulphur Dioxide. TIPS manual.

Feldman. Y.G. 1974. The Combined Action on a Human Body of a Mixture of the Main Components of Motor Traffic Exhaust Gases. Giq.i.Sanit, 10:7 (1994). (Russian)

Fladmark, K. R., J. C. Driver, and D. Alexander. 1988. The Paleoindian component at Charlie Lake Cave (HbRf 39), British Columbia. American Antiquity, Vol. 53, no. 2. Salt Lake City.

FPAC. (Federal-Provincial Advisory Committee). 1987. Review of National Ambient Air Quality Objectives for Sulphur Dioxide (Desirable and Acceptable Levels). Federal-Provincial Advisory Committee (FPAC) on Air Quality. April.

Garner. 1967. Garner's Veterinary Toxicology. Third Edition revised by E.G.C. Clarke and M.L. Clarke. published by the Williams and Wilkins Company, Baltimore.

Goddard, P. E. 1916. The Beaver Indians. Anthropological Papers of the American Museum of Natural History. Vol. 10, no. 4:201-294.

Greenwald. I. 1954. Effects of inhalation of low concentration of sulfur dioxide on man and other animals. Arch. Ind. Hyg, Occupational Med. 10:455 *in* Wark and Warner 1981.

Hamilton, S. 1987. The end of season report of the 1986 excavations at Rocky Mountain Fort HbRf 31, Permit 1986-16. Report on file, Archaeology Branch, Victoria.

Hamilton, S., D. Burley and H. Moon. 1988. Rocky Mountain Fort and the land based fur trade research project; the 1987 end of season report, permit 1987-13. Report on file, Archaeology Branch, Victoria.

Hengevald. 1995. A State of the Environment Report: Understanding Atmospheric Change. Second Edition. AES, Environment Canada.

Henschler, D., A. Stier, H. Beck and W. Newiman. 1960. Offactory Threshold of Some Important Irritant Gases and Effects in Man at Low Concentrations. Arch. Gewerbepathol. Gowercbehug, 17:547 (1960) (German).

Ives, John W. 1990. The Theory of Northern Athapaskan Prehistory. University of Calgary Press, Calgary.

Jenness, D. 1977. The Indians of Canada. National Museum of Canada, Bulletin 65. Ottawa.

Johnson, T. Personal Communication. Administrator, District of Taylor, BC. Telephone
(250) 789-3392.

Kennedy, K.A., P.A. Addison and D.G. Maynard, 1988. Effect of Elemental Sulphur on the Vegetation of a Lodgepole Pine Stand. Environmental Pollution, Vol. 51, pp121130.

Koenig, J.Q., W.E. Pierson, S.G. Marshall, D.S. Covert, M.S. Morgan and G. van Belle. 1988. The Effects of Ozone and Nitrogen Dioxide on Lung Function in Healthy and Asthmatic Adolescents. Health Effects Institute, Report No. 14.

Kulle, T.J. and M.L. Clements, 1988. Susceptibility to Virus Infection with Exposure to Nitrogen Dioxide. Health Effects Institute, Report No. 15.

L&M Engineering Limited. 1995. District of Taylor Official community Plan Bylaw No. 509, 1995.

Linzon, S.N. 1978. Effects of air-borne sulfur pollutants on plants. *In:* J.O. Nriagu (ed.). Sulfur in the Environment, Part II: Ecological Impacts. J. Wiley & Sons. pp. 109-162.

Madill, Dennis F.K. 1986. Treaty Research Report: Treaty Eight. Treaties and Historical Research Centre, Indian and Northern Affairs Canada, Ottawa.

Mathews, W. H. 1980. Retreat of the last ice sheets in northeastern British Columbia and adjacent Alberta. Geological Survey of Canada, Bulletin 331. Ottawa.

Miller, M. Personal Communication. Municipal Clerk/Collector/ Treasurer, District of Taylor, BC. Telephone (250) 789-3392.

Ministry of Government Services, 1995. British Columbia Regional Index 1995. BC Stats.

Ministry of Skills, Training, and Labour. 1995. Northeastern British Columbia, Labour Force Market Update.

Ministry of Small Business, Tourism, and Culture, 1995. British Columbia Accommodations, 1995. Tourism marketing, A Division of Monday Publications Ltd.

Morrison Petroleums Limited. 1995. Bulrush natural gas production and processing facility: Energy Project Certificate Application.

NAS (National Academy of Sciences). 1977. Medical and Biological Effects & Environmental PollutantsNitrogen Oxides. NAS, Washington, DC.

NRCC. 1977. Sulphur and Its Inorganic Derivatives in the Canadian Environment. Report NRCC No. 15015 by the National Research Council of Canada, Ottawa.

Orehek, J., P. Massari, C. Grimand and J. Charpin. 1976. Effect of Short-term Low-level Nitrogen Dioxide Exposure on Bronchial Sensitivity of Asthmatic Patients. J. Clin. Invest., 57:301.

Paine, R.J and Egan, B.A. 1987. User's Guide to the Rough Terrain Diffusion Model (RTDM) (Rev. 3.20). Environmental Research and Technology, Inc. Report PB88-171467. Prepared for the USEPA.

Patty. 1978. Patty's Industrial Hygiene and Toxicology. 3rd Revised Edition. Volume I.

Reid, P. Personal Communication. 3-D Reclamation Inc., Calgary. Telephone
(403) 237-6700.

Ridington, W. R. Jr. 1988. Trail to Heaven: Knowledge and Narrative in a Northern Native Community. Douglas and McIntyre, Vancouver.

Salamberdze, O.P. 1967. Reflex Effects of Mixtures of Sulfur and Nitrogen Dioxides. Hug. Sanit, 32:710.

Salmo Consulting Inc. 1996. Application for a project approval certificate: Caribou Gas Processing Project. Prepared for Novagas Clearinghouse Ltd, Calgary. 324 pp plus appendices.

Sanderson, K. 1981. Agriculture and the Environment. Published by Environment Council of Alberta. November.

SEACOR Environmental Engineering Inc. 1996. Cumulative NOx dispersion modelling for the Taylor, BC airshed. Prepared for Westcoast Energy Inc., Vancouver. 28 pp plus appendices.

Solex Developments Company Inc. 1996. Project Approval Certificate Application: Younger NGL Extraction Facility Plant Expansion. 59 pp plus appendices.

Sproule Associates Limited. 1997. McMahon Area, British Columbia: Regional natural gas by-product supply analysis. Calgary.

Sunshine, I. (ed.). 1969. Handbook of Analytical Toxicology. Published by the Chemical Rubber Co. of Cleveland, Ohio.

Turner, D.B. 1964. A diffusion model for an urban area. Journal of Applied Meteorology, 3:83-91 (1964).

USEPA. (United States Environmental Protection Agency). 1971 Air Quality Criteria for Nitrogen Oxides. Air Pollution Control Office, Washington, DC. No. AP-84.

USEPA. (United States Environmental Protection Agency). 1986. Guideline on Air Quality Models, Revised. Report EPA-450/2-78-027R.

USEPA. (United States Environmental Protection Agency). 1988. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources. Report EPA-450/4-88-010. August.

USEPA. (United States Environmental Protection Agency). 1993. User's Guide to the Builder Profile Input Program. Office of the Quality Planning and Standards. October.

USEPA. (United States Environmental Protection Agency). 1995a. Compilation of Air Pollutant Emission Factors. Volume I and II. 5th Edition AP-42 January. Office of Air Quality, Planning and Standards.

USEPA. (United States Environmental Protection Agency). 1995b. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models: Volume IUser Instructions, Volume IIDescription of Algorithms. Report No. EPA-454/B-95-003a&b. September.

USEPA. (United States Environmental Protection Agency). 1995c. SCREEN3 Model User's Guide. Office of Air Quality Planning and Standards. EPA-454/B-95-004.

Walde, K. 1990a. Heritage resource inventory and impact assessment Placer Cego Petroleum pipeline (Amerada Hess Canada Ltd.) in Township 84, Range 15, W6M, Peace River District. Permit 1988-93b,c. Consultant's report on file, Archaeology Branch, Victoria.

Walde, K. 1990b. Monitoring and recovery of archaeological data Placer Cego Petroleum pipeline at HbRb 3, in LS 11-1-84-15-W6M, Peace River District. Permit 1989-8. Consultant's report on file, Archaeology Branch, Victoria.

WGSI. (Westcoast Gas Services Inc.). 1995. Application for a project approval certificate: Jedney Project. Calgary. 235 pp plus appendices. December 13, 1995.

WGSI. (Westcoast Gas Services Inc.). 1996a. Application for a project approval certificate: Jedney Project. Calgary. 403 pp plus appendices. October 18, 1996.

WGSI. (Westcoast Gas Services Inc.). 1996b. Application for a project approval certificate: Highway Project. Calgary. 264 pp plus appendices. October 24, 1996.

Wilson, I. R. 1989. The Pink Mountain Site (HhRr-1): an Early Prehistoric campsite in northeastern BC. Canadian Journal of Archaeology, Vol. 13:51-68.

Appendix B

Dispersion Modelling Information

Air Quality Evaluation

Overview

Our current understanding of how pollutants in the air are dispersed can be compiled into mathematical equations and translated into computer programs that calculate the ground level concentration of a pollutant released from a source during various types of weather conditions. These programs are called computer models or numerical dispersion models and attempt to predict how a plume will rise, spread and move, that is how the plume will disperse. Numerical dispersion models are the main tool used for assessing the environmental impact of airborne emissions from ground based sources. There are many factors that can affect the dispersion of a plume and some models are designed to simulate the effect of certain factors over others. Some of the more important variables which the models are most sensitive to are outlined below.

Meteorology

For a given source of pollutant, the weather or meteorology can effect the dispersion characteristics. Meteorological factors such as wind speed and direction, air temperature, stability, turbulence and the height of the mixing layer all have a direct affect on the dispersion and dilution of air pollution.

Wind blowing over the surface of the earth develops a turbulent, well-mixed layer. This layer is referred to as the mixing layer and the top of this layer is the mixing height. This mixed layer is about a kilometre or so in height, although it can vary from several kilometres high to less than 100 metres. Air pollution released from ground based, point sources is emitted into this layer and trapped below the mixing height. Thus, the properties of the mixing layer determine how serious air pollution is in a given region. For example, if the mixed layer is about a kilometre deep and if a pollutant plume released near the ground is spreading upward at the rate of 0.25 m/s then it will reach the top of the mixed layer in about an hour. If the wind speed within the mixing layer is around 15 km/hr then the plume will have travelled 15 km downwind in that time. As a further example consider the same plume from a source that is 100 m high. In the absence of intense vertical mixing and with the plume spreading vertically at a rate of 0.25 m/s, the edge of the plume will reach the ground after approximately 400 seconds or after it has travelled about 1 to 2 km downwind. Therefore, the maximum ground level concentration would be expected at that point. Hence, mixing height, and wind speed and direction will affect the magnitude and location of ground level concentrations of emitted pollutants.

The amount of turbulence, or wind action, in the atmosphere will have a major effect on the rise of a pollutant plume and its subsequent dispersion. Any factor which enhances the vertical motion of the air (rising or sinking) will increase the degree of turbulence. The ease with which a parcel of air will rise in the atmosphere depends on the stability of the air. Very unstable air means that when a parcel of air is "pushed" upward it will continue to rise and disperse quickly whereas in very stable air the parcel of air would stop or sink back to its starting position and remain relatively undiluted. Thus, stability affects turbulence which affects plume dispersion. The most commonly used stability classification scheme is the Pasquill-Gifford Stability classification. The classes are A, B, C, D, E, and F (or 1, 2, 3, 4, 5, and 6). Class A denotes the most unstable and hence most turbulent conditions, and Class F denotes the most stable or least turbulent conditions.

The ambient temperature and stability also affects plume rise and dispersion. If the plume temperature is hotter than the ambient air it will rise and if the air is unstable it will tend to continue rising. If the plume temperature is the same as the ambient air temperature or the air is very stable the plume will tend to stop rising soon after it leaves the source. The vertical speed of the plume at the source will also affect plume rise.

Topography

An important factor affecting the dispersion of a plume is the topography surrounding the emission point. The path followed by the plume and the turbulence levels which result in dilution of the plume are affected by hills, mountains and valleys. The magnitude of these effects depend on the meteorological conditions, terrain elevation, the terrain shape and the height of the plume with respect to the terrain. Some models are designed to handle the airflow around complex terrain such as hills and valleys, where others are more suited to simple terrain.

The importance of terrain effects, and the appropriate choice of regulatory model is partly determined by the height of the plume and stack. The US Environmental Protection Agency (EPA) defines three regimes of terrain relative plume height:

- Simple Terrain is defined as terrain lower than the stack height, and therefore not susceptible to direct plume impingement.

- Intermediate Terrain is defined as terrain lower in height than the final plume height but higher than the stack. Regulatory models developed for intermediate terrain include the Industrial Source Complex Model, Version 3 (ISC/3).

- Complex Terrain is defined as terrain higher than the final plume height. Models developed for complex terrain include the Rough Terrain Diffusion Model, Version 3.2 (RTDM). Complex terrain models can also be applied to simple and intermediate terrain.

Building Downwash

Winds blowing across and around buildings create turbulence which has a significant effect on the dispersion of airborne pollutants. If emissions are released through short stacks, a plume could potentially be trapped in turbulent wakes by an effect referred to as building downwash. Two effects can result from the dispersion of pollutants within a turbulent wake:

1. the increased turbulence disperses the plume more readily than with no building present, and
2. the increased dispersion causes portions of the plume to be brought to the ground resulting in increased ground-level concentrations with the presence of the building.

To ensure that plumes can escape from this downwash effect, the stack should be of a suitable height. Stacks should be equal to or greater than the Good Engineering Practice (GEP) height if building wake effects are not to be modelled (USEPA, 1993). The ISC/3 model incorporates building wake effects into its calculations. However, RTDM does not handle building wake and hence is not suitable for estimating concentrations near a pollutant source.

Stack-Tip Downwash

Wind flowing past a cylinder will cause a region of decreased pressure to form on the downwind side. Stack-tip downwash occurs when plume material is drawn down into the low pressure region of the stack wake. This results in the initial plume height being depressed by an amount that depends on the ratio of the wind speed to exit velocity. Both the ISC/3 and RTDM models have algorithms to account for stack tip downwash.

Dispersion Analysis Methodology

Model Selection

The terrain in the vicinity of the proposed NCL Deepcut Straddle Plant warrants the use of two numerical dispersion models to determine expected ground level concentrations of airborne pollutants emanating from the plant (USEPA, 1986). Some of the terrain in the area is below the stack top and can be categorised as simple terrain. However, much of the terrain within the Taylor airshed exceeds this elevation and is called intermediate to complex terrain. The determination of ground level concentrations of airborne pollutants in the simple terrain, was accomplished using the Industrial Source Complex Model Version 3 (ISC/3), while ground level concentrations in the intermediate and complex terrain were evaluated using the Rough Terrain Diffusion Model, Version 3.20 (RTDM). Both of these models have been approved for use by the BC Ministry of Environment, Lands and Parks.

The ISC/3 model is a straight line, steady state, Gaussian dispersion model used to predict ground level concentrations on terrain at or below plume height, within approximately 20 km of a source (USEPA, 1995b). The model uses hourly meteorological data to calculate average ground level concentrations over various time periods, ranging from one hour to one year.

RTDM, is a sequential Gaussian plume model designed to predict ground level pollutant concentrations in complex (and simple) terrain within approximately 15 km of one or more co-located point sources (Paine and Egan, 1987). As RTDM cannot predict ambient pollutant concentrations from volume or line sources, an average NOX concentration resulting from emissions from the highway through Taylor was determined and added to the RTDM predictions resulting from all other NOX sources in Taylor. The average NOX concentration added to the RTDM results was determined by taking a spatial average of the maximum predicted NOX concentrations from the ISC/3 model, within 4 kilometres of the proposed NCL plant. This is an overly conservative method but will result in predictions of NO2 over the entire airshed, resulting from all major emission sources in and around Taylor. RTDM also uses sequential hourly meteorological data for the calculation of expected ground level concentrations.

The potential environmental effects of NO2 emissions from the project were evaluated using ISC/3 and RTDM. The evaluation focused on the principle emission sources from the proposed plant and the other major sources in the area, namely:

- McMahon Gas Plant- thermal oxidisers, flare stacks, flare pits

- Compressor Station CS1 and Booster Station BS1- compressor engines
- Westcoast Power co-generation Facility
- Canfor Sawmill- beehive burner, dry lumber kiln
- Fiberco Pulp Mill- expected future emissions
- Alaska Highway- motor vehicle traffic

The emission source characteristics for all major NOX sources in the Taylor airshed are displayed in Table B-1. The NOX emissions for WEI's compressor station No. 1 stated in Table B-1 represent the emissions before and after an emission reduction.

Table B-1

Modelled NOX Source Characteristics for the Taylor Airshed Existing Sources

	Stack	Stack	Exit	Exit	NO**X**	NO**X**
Source		Diameter	Velocit	Temperatur	**Emissions**	**Emissions**
	Heigh	(m)	y	e (**o K)**		

(T/Yr.) **(g/s)**

	t (m)		(m/s)			
McMahon Gas Plant						
MGP1-sulphur recovery waste stack	91.0	1.660	22.6	798.2	94.6	3.000
MGP2-new sulphur recovery waste stack	91.0	1.660	22.6	798.2	94.6	3.000
Westcoast Energy Compressor Station CS-1						
CS1-KVS (with lean burn) #1	13.7	0.495	20.8	763.5	52.7	1.670
CS2-KVS#2-current	13.7	0.495	20.8	763.5	297.7	9.440
-after reduction					76.9	2.440
CS3-KVS (without lean burn) #3	13.7	0.495	20.8	763.5	297.7	9.440

CS4-KVS (without lean burn) #4	13.7	0.495	20.8	763.5	297.7	9.440
CS5-KVS (without lean burn) #5	13.7	0.495	20.8	763.5	297.7	9.440
CS6-KVS (without lean burn) #6	13.7	0.495	20.8	763.5	297.7	9.440
CS7-KVS (without lean burn) #7	13.7	0.495	20.8	763.5	297.7	9.440
CS8-Taurus Turbine	17.1	1.175	44.8	661.0	33.7	1.070
CS9-Allison Turbine	13.7	1.175	14.0	837.6	129.3	4.100
CS10-KVR (without lean burn) #1	10.4	0.700	8.0	699.0	574.3	18.210
CS11-KVR (without lean burn) #2	10.4	0.700	8.0	699.0	574.3	18.210

WEI & CU Power Co-Generation Plant

CO1- unit #1 (North) emission stack	30.5	3.350	13.9	407.7	154.5	4.900
CO2- unit #2 (North) emission stack	30.5	3.350	12.9	415.2	141.9	4.500
Fibreco Pulp Joint Venture						
FIB1-package boiler #1 & #2	33.3	1.220	12.6	533.2	109.7	3.480
FIB2-first stage cyclone #14	39.6	2.450	8.8	345.2	28.7	0.910
FIB3-first stage cyclone #17	39.6	2.450	8.8	345.2	28.7	0.910
FIB4-proposed furnace #31	50.0	1.800	17.3	505.2	121.7	3.860
Canfor Taylor Sawmill						
CF1-bee-hive burner #1	21.3	5.000	10.0	755.4	28.7	0.910
CF4-gas fired lumber dry	7.5	Modelled				1.880

kiln	as a Volume Source-6 .98m Dimensions

Terrain/Receptor Data

An electronic format of the terrain in the vicinity of the proposed plant was prepared using NTS 1:50,000 scale topographic maps and digital TRIM data. Within 10 kilometres of the plant site the elevation and spatial co-ordinates of discrete points spaced at 500 metre intervals were determined, and used as input into the dispersion models. These points were used as receptor locations upon which ground level concentrations were calculated. Within 5 kilometres of the plant site, the spacing of these points was reduced to 250 metres for better resolution of near source ground level concentrations. Receptors with elevations below the height of the highest stack were used in ISC/3 while receptors with elevations above this height were used in RTDM. The dividing elevation between RTDM and ISC/3 was the elevation of the top of McMahon Gas Plant sulphur recovery stack, 548 m asl. Additional receptors were added in steep terrain to provide better resolution of the distribution of ground level concentrations on steep slopes. The density of the receptor grids were based on guidance from the BC Ministry of Environment, Land and Parks (MELP).

Meteorology

Data Sources

Meteorological data from two sources was used in this analysis. First, climate and hourly cloud data from a nearby Environment Canada, Atmospheric Environment Service (AES), summarising the period from 1961 through 1990 was used to estimate the average wind conditions, temperatures and frequency of precipitation in the vicinity of the proposed site. Secondly, twelve months of hourly meteorological observations, from Westcoast Energy Inc.'s, (WEI) Taylor meteorological station from 1995 to 1996, was used as input in the dispersion models employed in this analysis. Figure 4.1 and 4.2 show the location of the Fort St. John and Taylor meteorological observation stations.

The closest principal AES weather station to the proposed plant site is located at the Fort St. John airport, approximately 10 km to the north-north-west, at an elevation of 695 m asl. Data sets of temperature, precipitation, wind speed and direction, and the parameters needed to calculate atmospheric stability are all available from the Fort St. John station, and have been recorded for over 40 years.

The AES does not report stability class as part of the climate normals. In this analysis, hourly stability class, and the frequency of occurrence for each class, for Fort St. John, were calculated for a seven year period, 1989 through 1995. This seven year data set of stability class is the best available data for determining a climate normal for stability class.

Because of the unique location of Taylor, only meteorological observations from Taylor and climate data from Fort St. John are suitable for this assessment. The following is an examination of the meteorological data and climate normals employed in this analysis. To illustrate that the data set used for dispersion modelling was appropriate, the hourly meteorological model data was compared to climate normals of the area.

Temperature

A summary of the temperature climate normals for Fort St. John are compared with the twelve months of Taylor data, and presented in Figure B-1. The mean daily temperatures were calculated by averaging the daily mean temperature over the entire monitoring period for each month. The mean daily maximum and minimum temperatures were calculated by averaging daily maximum and minimum temperatures over the monitoring period for each month. The extreme maximum and minimum temperatures are the maximum and minimum temperatures recorded during the monitoring period for each month.

From a review of the temperature normals from Fort St. John and the one year of temperature data measured in Taylor, the temperatures in the vicinity of the proposed straddle plant site can be characterised as follows:

- the observations of temperature made at Taylor are comparable to the Fort St. John normals.
- during winter, temperatures at Taylor were colder than the average Fort St. John temperatures.
- the mean daily temperatures are below freezing from November through March.
- extreme minimum temperatures below freezing are possible eleven months of the year. Only in the month of July are extreme minimum temperatures expected to be above freezing.
- extreme maximum temperatures above freezing are possible throughout the entire year.
- the mean daily temperature difference between the coldest winter month and the warmest summer month is approximately 31oC.

Precipitation

Precipitation normals from the AES station at Fort St. John airport are summarised in Figure B-2. Table B-2 shows the precipitation normals for Fort St. John. The mean rainfall, snowfall and total precipitation data were found by averaging the mean monthly precipitation data over the entire monitoring period. The number of days with measurable precipitation was determined by averaging the total number of days of precipitation per month over the monitoring period. The greatest rainfall, snowfall and precipitation data are the maximums measured during the monitoring period. The tabulated data indicate the following precipitation patterns:

- the majority of the precipitation in the area falls during the months of May through September (60.5%) and is almost entirely in the form of rain.
- most precipitation during the months of October through April is in the form of snow.
- the driest months are in the late winter and early spring

- heavy rainfall, greater than 50 mm per day, can occur at anytime in May through August
    - there are approximately 125 days with measurable precipitation per year.

Table B-2

Precipitation Climate Normals for Fort St. John

Month	Mean Rainfall [mm]	Mean Snowfall [cm]	Total Precipitation [mm]	Number of Days With Measurable Precipitation
January	0.7	35.9	30.8	12
February	0.2	28.4	23.5	9
March	0.8	28.3	24.1	10
April	7.3	14.0	20.8	7
May	34.1	6.6	40.9	9
June	66.5	0.4	67.0	11
July	73.7	0.0	73.7	12
August	56.7	0.8	57.5	10
September	39.7	4.3	43.9	11
October	12.8	15.1	27.1	9
November	2.6	29.6	28.8	11
December	0.7	34.8	29.4	12
Annual	295.9	198.2	467.5	125

Month	Greatest Rainfall in 24 hr [mm]	Greatest Snowfall in 24 hr [cm]	Greatest Precipitation in 24 hr [mm]
January	8.1	21.4	18.5

February	3.0	27.3	17.4
March	6.6	31.5	31.5
April	19.6	20.8	21.6
May	49.8	47.8	49.8
June	80.3	11.7	80.3
July	60.2	0.0	60.2
August	58.4	18.5	58.4
September	37.3	18.5	37.3
October	15.2	34.5	34.5
November	12.7	19.1	24.9
December	5.8	28.7	28.7
Annual	80.3	47.8	80.3

<u>Wind</u>

Wind data is the most crucial data required for any dispersion analysis. Model predictions of ground level concentrations at a receptor, are determined by wind direction and are inversely proportional to wind speed. The mean hourly wind speeds stated below are derived by averaging the hourly winds speeds over the entire monitoring period. Since there is only one year of meteorological data from Taylor, climate normals can not be determined from this site. However, by using the winds at Fort St. John, the wind on the plain above the straddle plant can be characterised as follows:

- calm winds are expected for a small percentage of the time at Fort St. John, 6.5%;
- the prevalent wind directions at Fort St. John are from the south-west (24.2%), north (16.6%), and west (14.3%).
- the mean wind speed at Fort St. John is relatively strong (4.2 m/s) as is the maximum wind speed recorded from 1961 through 1990 (26.9 m/s).

A summary of one years worth of Taylor wind data, (Feb 1995- Feb 1996), which used in the dispersion analysis, is presented graphically as a wind rose in Figure B-3. The mean wind speeds, directions and frequencies for the same monitoring period at Fort St. John, are also shown in the wind rose diagram. This Figure displays the difference in frequencies of wind directions that occur between Fort St. John and Taylor.

The topography of Taylor leads to slightly different localised wind patterns than what is observed at Fort St. John. Frequently, the valley tends to force wind in an east-west direction, and often the valley sides will cause upslope winds due to radiant heating in the day, and downslope winds due to radiant cooling at night. This will cause a difference in wind speed and direction at Taylor as compared to Fort St. John. The local topographic effects on the wind at Taylor makes the use of site specific wind data crucial for an accurate dispersion analysis.

Atmospheric Stability

The lowest level of the atmosphere can be classified into six stability categories, known as the Pasquill-Gifford stability classes. These stability classes range from extremely unstable, to neutral, to stable conditions. Stability classification is a method of categorising the amount of turbulence in the lower atmosphere and the associated vertical temperature gradient. Low levels of turbulence and a stable temperature gradient will restrict the dispersion of airborne pollutants, while a turbulent atmosphere coupled with an unstable temperature gradient will increase dispersion. The amount of turbulence in the atmosphere varies with wind speed, solar insolation and the roughness of the underlying surface. Turbulence levels are generally greatest at mid to late afternoon when solar heating is strong and mean wind speeds are strongest. A rough surface, such as a heavily wooded area, will generate more turbulence than a smoother surface such as a grassy plain. Thus, hourly stability classification is important for dispersion modelling.

A summary of the atmospheric stability over seven years at Fort St. John and one at Taylor are shown in Figure B-4. From Figure B-4 the stability of the lower atmosphere above Taylor can be categorised as:

- similar to Fort St. John;
- neutral for a majority of the time - The Pasquill-Gifford stability class D accounts for approximately 48% of the atmospheric conditions.
- stable for a large portion of the time - The stability class F accounts for approximately 19% of the atmospheric conditions. These conditions coincide with light to calm wind speeds and a stable vertical temperature gradient.
- unstable for less than 8% of the time.

Conclusions from the Comparison of Model Input Data to Climate Normals

A comparison of the climate normals of Fort St. John with the data used in the dispersion modelling reveals that the meteorological data used for modelling is a suitable representation of the area. Hence, one can describe the climatology of Taylor in terms of the climatology of Fort St. John. There is, however, a significant wind direction difference between the two sites making the Taylor wind data essential to the dispersion modelling.

Meteorological Model Input

Both the ISC/3 and RTDM models require hourly meteorological inputs of wind speed, wind direction, dry bulb temperature, Pasquill-Gifford stability class, and mixing height. For the purposes of the dispersion modelling, one year of hourly meteorological data from WEI's Taylor meteorological station were used as input.

The wind speeds and direction observed at the 10 metre level at the Taylor station were measured using a R.M. Young Model 05701 Wind Monitor. This anemometer can measure winds as low as 0.2 m/s. However, the ISC3 and RTDM models treat any wind speed below 1 m/s as a calm wind. As part of the meteorological data pre-processing, any wind speed that was measured below 1m/s and above 0.2 m/s was set to a 1 m/s wind, and the wind direction left untouched. A calm wind, (wind speed equal to 0) was set to 1 m/s and the previous hours wind direction used. Therefore, the calms processing routine in the models did not have to be used, and more valid wind direction measurements were used in the model.

Temperature was also measured at the Taylor station. The average hourly temperature was used as input for the dispersion models.

Hourly values of mixing heights were calculated using the worst-case assumption of a mixing height always capping plume dispersion. Hence, following MELP protocol, mixing heights were set to the height of the tallest plume plus one metre down to a minimum of 50 metres to simulate a capping inversion. The stack that resulted in the highest plume was the McMahon Gas Plant sulphur recovery waste stack. The mixing heights determined by these stack characteristics were used for all modelling scenarios. This allowed for a comparison of model results between each scenario.

Hourly stability classification is important for dispersion modelling. Stability class was calculated using Turner's method (Turner, 1969) which uses cloud cover and cloud ceiling along with sun angle to determine the stability of the lower atmosphere. Table B-3 defines stability class using these parameters. Since cloud cover and cloud ceiling were not available from the Taylor station, cloud data for the same time period for Fort St. John was used to calculate stability. This is a reasonable approximation because Taylor is less than 20 km away from the Fort St. John Airport where the cloud measurements were made.

The wind speed, wind direction, dry bulb temperature, mixing layer heights, and Pasquill-Guifford stability class were formatted and used as input into the dispersion model.

Table B-3

Pasquill-Gifford Stability Classification System

Surface Conditions Wind Speed [km/h]	Daytime Insolation c Strong [Solar Heating]	Moderate [Solar Heating]	Slight [Solar Heating]	Night-time Thin Overcast or > 3/8 Cloudiness b [Weak Radiation Loss]	3/8 Cloudiness [Strong Radiation Loss]
< 7.2	A	A-B	B	-	-
7.2 -	A-B	B	C	E	F

10.8					
10.8 - 18.0	B	B-C	C	D	E
18.0 - 21.6	C	C-D	D	D	D
> 21.6	C	D	D	D	D

A Extremely Unstable Conditions D Neutral Conditions a

B Moderately Unstable Conditions E Slightly Stable Conditions

C Slightly Unstable Conditions F Moderately Stable Conditions

a Applicable to heavy overcast day or night.

b The degree of cloudiness is defined as that fraction of the sky above the local apparent horizon that is covered by clouds.

c Insolation (Incoming solar radiation), will depend on sun angle, cloud cover, and cloud amount.

Model Options

The following modelling options were evoked in the RTDM and ISC/3 dispersion models:

- final plume rise is reached instantaneously

- stack tip downwash
- buoyancy induced dispersion
- no calms processing routine (due to meteorological pre-processing)
- no missing data processing
- default wind speed and temperature profiles

To ensure the correct analysis of plume dispersion at the site, the USEPA, Building Profile Input Program (BPIP) was used to analyse stack and building dimensions for possible building wake effects of the proposed plant (USEPA, 1993).

The results of the BPIP model were then used as input to ISC/3, and turbulent wake effects were simulated. The BPIP model determines the appropriate height and cross wind projection of all buildings that affect plume dispersion from each stack for:

1. buildings within a distance of 5 times the lesser of its width or peak height from each stack; and

1. stacks below the GEP height calculated as:

HGEP = Hb + 1.5 x L

where: Hb = the building height

L = the lesser of the building height or the projected

building width

Ozone Limiting

Although NO2 may be emitted directly to the atmosphere, most is formed through reactions between NO and other gases. The reaction of NO with ozone is an effective means of conversion to NO2. In polluted atmospheres, reactions between NO and organic radicals is the major source of NO2. Another source of NO2 is the thermal conversion process: 2NO + O2 => 2NO2; which is only significant within stacks or immediately downwind where NO concentrations are greater than about 1 ppm.

Cole and Summerhays (1979) of the US Environmental Protection Agency, reviewed various techniques for estimating short-term NO2 concentrations. They recommended that for relatively unpolluted atmospheres, the Ozone Limiting Method should be used to estimate NO2 concentrations. This method objectively incorporates the oxidising potential of the atmospheric O3. In the absence of hydroxyl radicals found in polluted atmospheres, the conversion of NO to NO2 is primarily a result of the reaction of NO with ozone. The conversion of NO to NO2 in the absence of ozone is very slow and hence ambient ozone concentrations are the limiting factor in this conversion.

The ozone limiting method involves the comparison of the maximum model predicted NOX concentration with the ambient ozone concentration to determine which is the limiting factor to NO2 formation. If the ozone concentration is greater than the maximum predicted NOX concentration, then total conversion is assumed. If the maximum predicted NOX concentration is greater than the ozone concentration, then the formation of NO2 is limited by the ambient ozone concentration.

When the ozone concentration is the limiting factor, then the NO2 concentration is set equal to the ozone concentration plus a correction factor to account for thermal conversion of NOX to NO2 in and near the stack. For combustion sources, it is assumed that 10% of the NOX emissions are thermally converted to NO2.

It can thus be seen that the ozone limiting method of reducing the predicted NO2 concentrations in cases where the oxidising potential of the atmosphere is low, even though NOX (NO plus NO2) concentrations may be significant.

Due to the variety of industries and proximity of various sources in the Taylor airshed the ozone limiting method was deemed not to be a suitable method for NOX to NO2 conversion. Other chemicals, such as hydroxyl radicals or particulate matter may be present in the airshed, making ozone limiting unsuitable. Instead, it was assumed that a certain percentage of the NOX would be converted to NO2. Therefore, in the modelling results, Maximum predicted ground level concentrations are presented in four ways:

- 100% of the NOX was converted to NO2
- 75% of the NOX was converted to NO2
- 50% of the NOX was converted to NO2
- 25% of the NOX was converted to NO2

APPENDIX C

ARCHAEOLOGICAL IMPACT ASSESSMENT

Executive Summary

On behalf of Salmo Consulting Inc. and Novagas Clearinghouse Limited (NCL), Fedirchuk McCullough & Associates Ltd. conducted an Archaeological Impact Assessment of the proposed Taylor Straddle Plant located in the Industrial area of the District of Taylor, on a site in the north half of Section 36, Township 82, Range 18, West of the Sixth Meridian. The plant site area is approximately 40 hectares in size and the development will consist of the structures and facilities of the plant itself, a 60 meter-wide treed buffer zone along the west and north margins of the property, supply and return lines to the Westcoast Energy Inc. meter station, and a flare stack with approximately 180 meters of supply line. The Archaeological Impact Assessment was conducted under Heritage Inspection Permit No. 1997-043.

Due to scheduling conflicts between the time needed for review of the application for project approval and anticipated construction, the Archaeological Impact Assessment was initiated under winter conditions. Auger testing conducted for soil sampling was scheduled for late spring 1997 and was utilized as an opportunity for subsurface testing across the proposed plant site property. Prior to the auger testing program, a surface inspection of the plant site, buffer zone and other exposures within the plant property was made. Natural melting of snow provided very good visibility with approximately 80 percent surface exposure. No surface cultural materials were observed.

A total of 49 tests were excavated by means of an 8 inch auger across the project area. Nineteen tests were excavated within a fenced compound which was formerly a tank farm. This compound corresponds with the plant structures and facilities. An additional 30 tests were excavated outside of the former tank

farm in an area of former cultivation. Of the 30 tests, 18 were placed within the area to be developed into a treed buffer zone. The remaining 12 tests were excavated across the land between the buffer zone and the tank farm. The displaced soil from all auger tests was hand-sorted off the auger blade to facilitate inspection for archaeological materials. In addition to the auger tests, 19 soil samples were taken from the buffer zone, thawed and screened for cultural material with negative results. Two backhoe tests were also excavated within the northern buffer to verify the interpretation of stratigraphy observed in the auger tests. No cultural material was observed at any time during the assessment program.

Subsequent to the field assessment, the southernmost 60 metres of the tank farm compound was eliminated from the proposed development project.

A site file search indicated that at least 15 previously recorded archaeological sites occur within 1.5 kilometers of the proposed development zone but that only one, HaRe 13, occurs in conflict with the proposed plant site. Site HaRe 13 was recorded in 1975 by Fladmark at which time two flakes were recovered from the ground surface. Re-inspection of the site in 1984 led to the interpretation that the site had been destroyed by industrial activity. The site area was revisited in relation to the NCL Taylor Straddle Plant AIA. The area is located within a partially reclaimed tank farm. Twelve auger tests were excavated in the vicinity of the reported site with negative results. No intact post-glacial deposits were observed

within the tank farm area. It is, therefore, reasserted that site HaRe 13 has been destroyed by past industrial activity.

Two proposed developments in association with the proposed plant site were to be included in the assessment. A flare stack with its supply pipeline originating within the plant site and extending north approximately 180 meters will be constructed within the previously disturbed right-of-way of an existing gas pipeline traversing the site property. Owing to the previous disturbance and the presence of an active gas pipeline in the right-of-way, no testing was undertaken in relation to the alignment. No intact sediments will be affected by construction of the flare stack and supply line. The second development is the supply and return pipeline from the proposed plant site to the existing Westcoast Energy Inc. meter station on the lower Peace River terrace. The route consists of two segments, approximately 800 meters of below ground pipeline and about 600 meters of above ground pipeline. In both cases, the route traverses intensively utilized industrial terrain which was considered unsafe for subsurface testing. The potential for intact deposits within the proposed development route is remote. No further study is recommended in relation to the supply and return pipelines and the flare stack and its supply pipeline.

No cultural material was observed during the conduct of the Archaeological Impact Assessment for the proposed NCL Taylor Straddle Plant. No further assessment is recommended in relation to the currently proposed development plans.

Project Personnel

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ARCHAEOLOGICAL IMPACT

ASSESSMENT

NOVAGAS CLEARINGHOUSE LTD.

TAYLOR PLANT SITE

PERMIT 1997-043

INTRODUCTION

On behalf of Salmo Consulting Inc. and Novagas Clearinghouse Limited (NCL), Fedirchuk McCullough & Associates Ltd. conducted an Archaeological Impact Assessment of the proposed Taylor Straddle Plant, scheduled for development in northeastern British Columbia (Figure 1). The plant will be located in the Industrial area of the District of Taylor, on a site in the north half of Section 36, Township 82, Range 18, West of the Sixth Meridian. The plant site area is approximately 40 hectares in size and the development will consist of the structures and facilities of the plant itself, a 60 meter-wide treed buffer zone along the west and north margins of the property, supply and return lines to the Westcoast Energy Inc. meter station, and a flare stack with approximately 180 meters of supply line. The plant site property is east of the Alaska Highway and was formerly owned by Numac Energy and Petro-Canada. The proposed Taylor Straddle Plant will extract ethane-plus liquids from the existing Westcoast Energy Inc. natural gas transmission system in northeast British Columbia. The Archaeological Impact Assessment was conducted under Heritage Inspection Permit No. 1997-043.

OBJECTIVES

The primary objectives of the Archaeological Impact Assessment were to:

1. review literature pertinent to the archaeological, social, and natural history of the study area;

2. conduct a field reconnaissance to determine the potential nature, distribution and density of archaeological sites within the proposed development zone;

Figure 1 Location of study area

3. evaluate the significance of any individual sites identified;

4. forecast the nature and magnitude of site-specific impacts relative to the perceived archaeological potential, and;

5. formulate recommendations concerning the need for further archaeological studies where unavoidable adverse impacts are anticipated.

SCOPE OF WORK

The scope of work for Archaeological Impact Assessments undertaken by Fedirchuk McCullough & Associates Ltd. consists of the following study components:

1. **Record Review** - to identify previously recorded sites which could be affected by the proposed development project and to determine the nature of the data base for the study area.

2. **Ground Reconnaissance** - to relocated, in the field, archaeological sites which may have been previously recorded, as well as to obtain on the ground information regarding archaeological site potential. Site discovery to be based on surficial inspection of exposures and subsurface testing program of potential site areas lacking suitable exposures.

Deep testing using a backhoe or auger may be undertaken in localities of high site potential associated with good depositional characteristics.

3. **Informant Interviews** - to be conducted with individuals who might have personal knowledge of cultural events in the study area. These interviews might be conducted with members of indigenous First Nations, local avocational societies, knowledgeable local residents, or specialists with local or regional expertise, among others.

4. **Site Evaluation** - to determine the nature of the existing resource data base, the quantity and quality of observable remains (e.g. site condition, content, uniqueness, and complexity), and the potential of the site to contribute to public enjoyment and education. Sites are to be evaluated by limited controlled evaluative excavations.

5. **Impact Assessment** - to delineate the magnitude of forecasted impacts to the identified archaeological sites and to recommend site-specific mitigative measures commesurate with the assigned value of each site.

EVALUATING

ARCHAEOLOGICAL POTENTIAL

The distribution of archaeological sites is not random but is patterned based on human activities and environmental conditions. The environment provided both the resources and constraints to which humans adapted and cultural patterns evolved. Economic strategy and many aspects of material culture were intimately related to the opportunities afforded by the regional environment. In addition to environmental factors, cultural constructs and preferences would also dictate site location, directing travel, biasing routes of communication, enhancing or restricting resource procurement, and restricting seasonal occupation to selected localities.

The archaeological record for northern British Columbia indicates a strong association of archaeological sites with distinctive terrain features. Water sources are commonly the focus of precontact sites, as are landforms of pronounced or unique character: for example, isolated knolls or valley edges. The basic landform criteria used in the identification of areas of high archaeological potential may include, but are not limited to, the following characteristics.

- areas surrounding a dramatic break in slope, such as ridges, escarpments, and the upland edges of valleys;
- areas of extreme height within a landscape, including knolls, hills and buttes, especially when they provide a view of the surrounding terrain;
- low, well drained areas within a landscapes such as valley bottoms and protected swales;
- areas adjacent to permanent or seasonal watercourses including creeks, rivers, lakes, or seasonal ponds or marshes; and
- areas characterized by the presence of terraces indicative of ancient river, lake or other glacial landforms that may have existed in times prior to the formation of the modern landscape.

Such characteristics are used as the basis for defining the type of archaeological site potential possessed by the overview area. The evaluated archaeological potential will determine what recommendations may be made regarding the further archaeological assessment of a proposed development area.

ENVIRONMENTAL SETTING

The NCL Taylor Straddle Plant is located within the Peace River region of northeastern British Columbia (Figure 2). Moss (1955, 1952) classified the Peace River Prairie as an extension of the Parkland Prairie phytogeographic zone while Strong (1992) classifies it as part of the Low Boreal Mixedwood Ecoregion. In both cases, the Peace River Prairie is recognized as a transition zone sharing characteristics of forests and grasslands. The Peace River region is known for its prairie isolates, occurring as alternating expanses of prairie and bluffs along the Peace River. The Pouce Coupe prairie, second in size only to Grande Prairie, lies immediately south of Fort St. John. It is bounded by the Pouce Coupe River on the east and is approximately 25 kilometers in east-west extent and about 30 kilometers in north-south extent (Savage 1963). A belt of timber some fifteen kilometers wide lies between its northern edge and the Peace River. Agricultural development is a major land altering factor in the Peace River region, particularly in association with the prairie isolates.

The environmental conditions of the Peace River Prairie are quite complex as the Rocky Mountains to the west contribute to the production of chinook winds in the winter, which can dramatically moderate the climate despite the northern latitude. The area is characterized by parkland-like vegetation dominated by aspen and mixed forests interspersed through grasslands. Poorly drained areas support an overstory of black spruce with an understory of Labrador tea, bog cranberry and mosses. Characteristic fauna of the region are beaver, deer, moose and bear. The region was also part of the historic wood bison range.

Figure 2 Moss's Peace River Prairie (Moss 1952)

The NCL Taylor Plant site is located on the Taylor Flats, a broad mid-level terrace on the north bank of the Peace River. The Taylor Flats are three kilometers wide and six kilometers long, and is bisected by an unnamed side drainage. The proposed plant site is located roughly centrally on this landform, west of the side drainage. The general area has been subject to agricultural activities since the early 1910's, when initial farming settlement of the Peace River region was booming. Early agricultural use resulted in the removal of most native vegetation and tree cover across Taylor Flats.

The northern portion of the development zone is currently unmaintained cultivation, supporting alfalfa and weedy growth (Plates 1, 2, 3). An extension of the Taylor road grid occurs in the western portion of the property but it has been incorporated into the cultivation. A large area at the northeast corner of the plot, approximately 100x100 meters in size, was formerly stripped of topsoil and excavated for clay as lining material for industrial use (E. Scriba, personal communication 1997). The area was reclaimed and also supports alfalfa growth. In addition, two pipeline rights-of-way traverse the eastern portion of the property from north to south.

The southern third of the project area was formerly a "tank farm" or petroleum storage facility. Initial development within this portion of the development zone occurred circa 1975. Each tank sat within an area stripped of its topsoil to expose the glacio-lacustrine clays. Berms approximately 1.5 meters in height were constructed around the tank pad and the surface was stabilized by the application of a layer of ashphalt. At least four discreet tank pads were constructed within the development zone. The tank farm has since been dismantled and levelling activities were undertaken. The area today is characterized by disturbed gravel-laden surface clays with no vegetation development (Plates 4, 5).

Plate 1 Proposed NCL Taylor Plant site property in vicinity of proposed treed buffer zone; note existing Westcoast Energy Inc. plant in background. General view southwest.

Plate 2 Typical alfalfa and weedy growth in northern portion of plant site property; note steep north wall of Peace River valley in background. General view north.

Plate 3 Former Taylor town grid road incorporated into cultivation along west treed buffer zone of NCL Taylor Straddle Plant site. General view southwest.

Plate 4 Former tank farm location in southern portion of development zone to be plant site location. General view southwest.

Plate 5 Former tank farm location; note surface gravel in disturbed clayey matrix. General view northwest.

ARCHAEOLOGICAL RESOURCES

DEFINITION

Within the Province of British Columbia, heritage resources are defined by the *Heritage Conservation Act* (1979, amended 1994), which is designed to *encourage and facilitate the protection and conservation of heritage property in the Province.* Under the definition of the Act, protected heritage property may include an object, site or location of a traditional societal practice that is of historical, cultural or archaeological or palaeontological significance to the Province, community or an aboriginal people. Among the properties, precontact, post-contact, traditional culture resources and palaeontological sites are included.

Precontact heritage sites are those sites and objects which date to the period prior to the arrival of non-aboriginal people in the Province. Post-contact heritage resources encompass objects and sites related to the period after the arrival of non-aboriginal people during the end of the late 18th century. Archaeological site types defined for use by the British Columbia Archaeological Site Inventory Form are presented in Table 1.

Sites pertaining to traditional knowledge may be related to defined archaeological sites, but may also include locations related to family stories, practices or traditions. Such sites may vary from important areas for hunting game, ceremonial sites or sites with spiritual qualities, locations of favoured camping grounds or settlements, cemeteries, cabins, or any other locales deemed by First Nations advisors to be of significance to their cultural heritage.

Palaeontological resources are those containing the fossilized remains of multi-cellular organisms, including vertebrates, invertebrates and plants.

Table 1 British Columbia Archaeological Site Inventory, Defined Site Types

BRITISH COLUMBIA

ARCHAEOLOGICAL SITE INVENTORY - DEFINED PRECONTACT SITE TYPES

Habitation - a physical feature of cultural or natural origin used on a temporary or permanent basis for shelter or other social activities; may consist of subtypes rock shelter, cave, refuge, platform or depression.

Earthwork - a special purpose cultural feature created through earth mounding or other modification of earth surfaces.

Trail - a linear modification of the earth's surface used for human travel between geographic points.

Cultural Material - a surface or subsurface occurrence of cultural or natural materials occurring as the by-product of human activity.

Human Remains - the interment or other disposition of human remains.

Pictograph - a painted design or group of designs found on a rock or rock face.

Petroglyph - a carved design or group of designs found on a rock or rock face.

Petroform - a rock alignment or design of cultural origin.

Subsistence Feature - a cultural feature related to the collection, processing or storage of food; may consist of subtypes land mammal, fowl, fish, depression or other.

BRITISH COLUMBIA

ARCHAEOLOGICAL SITE INVENTORY - DEFINED POST-CONTACT SITE TYPES

Habitation - a structure of cultural origin used on a temporary or permanent basis for shelter.

Cultural Material - a surface or subsurface occurrence of cultural or natural materials occurring as the by-product of human activity.

Human Remains - the interment and/or structure used for the disposition of human remains.

continued

Table 1 Continued

BRITISH COLUMBIA

ARCHAEOLOGICAL SITE INVENTORY - DEFINED POST-CONTACT SITE TYPES

Social - a physical or structural feature of cultural or natural origin used on a temporary or permanent basis for the conduct of social activities.

Educational - a structural feature of cultural origin used on a temporary or permanent basis for educational purposes.

Commercial - a structural feature of cultural origin used on a temporary or permanent basis for commercial purposes.

Farming, Ranching - a physical or structural feature of cultural or natural origin used on a temporary or permanent basis for the purposes of farming and/or ranching.

Subsistence Feature - a cultural feature related to the collection, processing or storage of food.

Industrial - a physical or structural feature of cultural origin used on a temporary or permanent basis for industrial purposes; may consist of subtypes general, food, wood, textile, leather, mining.

Transportation - a physical or structural feature of cultural origin used on a temporary or permanent basis for the purpose of transportation; may consist of subtypes rail, road, trail, marine.

Communications - a structural feature of cultural origin used on a temporary or permanent basis for activities related to communication (for example, post office, radio station, telephone building).

Governmental - a structural feature of cultural origin used on a temporary or permanent basis for the activities of government and law enforcement.

Military - a structural feature of cultural origin used on a temporary or permanent basis for the activities of the military.

Medical - a structural feature of cultural origin used on a temporary or permanent basis for medical purposes.

Religious - a structural feature of cultural origin used on a temporary or permanent basis for religious purposes.

POTENTIAL ADVERSE IMPACTS

Precontact and historic sites occur on the surface and beneath recent sedimentation, and are susceptible to alteration, damage, and destruction by development projects which modify the landscape. The predicted impact on archaeological sites may be primary or secondary. Primary impacts are predictable, planned disturbance factors necessitated by the objectives of the project. Secondary impacts are unplanned disturbance factors.

Planned disturbance factors necessitated by the objectives of the proposed NCL Taylor Straddle Plant which could potentially affect archaeological resources include compaction and displacement of sites occurring on or near the surface by vehicular activity. Archaeological sites may also be impacted during clearing or topsoil removal in agricultural lands by mechanical methods, particularly bulldozing, for construction of facilities and for providing access to the proposed development and associated pipeline rights-of-way. Near surface and buried sites may be impacted during mechanical planting of trees along the treed buffer zone on the west and north margins of the plant site. Landscaping activities may also impact near surface or buried sites. Deeply buried sites may also be impacted during excavations for footings and foundations, and ditching operations for associated pipelines and utilities installation.

Potential unplanned impacts which could adversely affect archaeological sites may include unregulated vehicular activity and the unauthorized collection of specimens.

SIGNIFICANCE CRITERIA

Adverse impacts to archaeological sites can be reduced or eliminated by avoidance or adequate study. The decision whether to avoid a site and the determination of what constitutes an adequate study is based on a set of significance criteria. For the Province of British Columbia, these criteria are outlined in the "Archaeological Impact Assessment Guidelines" (1996:13-14).

The guidelines state that the criteria to be used are site integrity, scientific value, historic significance, public significance, economic value and ethnic significance. Site integrity refers to the degree to which a site has been disturbed as a result of past or current land use, or natural processes. Scientific value is judged on the site's potential for enhancing our understanding of local or regional prehistory. A set of standards are used to evaluate scientific significance, such as whether the site is stratified, the quantity and quality of cultural materials, and so forth.

Historic significance is determined by a sites associations with known historical personages, themes or events. Public significance and economic value may go together. These refer to the potential a site has for enhancing public understanding of the past, and the potential for cost recovery in terms of tourism or site development as a recreational or educational facility. These criteria are usually tied to accessibility and proximity to established recreational areas or population centers.

Ethnic significance applies to sites that have traditional, social or religious importance to a particular ethnic group or community, and is determined based on ethnographic references and local community recognition of and concern for the site. The guidelines state that it is essential that ethnic significance be assessed by someone properly trained in obtaining and evaluating such data (i.e. ethnologists, behavioral scientists, etc.).

OVERVIEW

PRECONTACT RESOURCES

The study area is situated on the edge of the "ice free corridor" between the Cordilleran and Laurentide ice sheets which is postulated to be one of the earliest ice free regions available for occupation by humans. The corridor may have served as a migration route for the peopling of the New World from northeast Asia (Figure 3). These early residents are believed to have occupied the fringes of proglacial lakes which formed along the edge of the retreating ice sheets. Because topography slopes eastward from the Rocky Mountains, the location and morphology of these glacial lakes changed as the ice retreated, exposing ground at increasingly lower levels and forcing the water to migrate downslope to be retained by the ice front which acted as

a barrier to drainage. The stages of the retreating glacial lakes are marked by beach ridges which may have been occupied by early man. The study area was free of ice and available for human occupation possibly in the Early Clayhurst Stage, but certainly in the Late Clayhurst Stage of Glacial Lake Peace (Mathews 1980).

Figure 3 Location of ice free corridor

Evidence for early occupation of this corridor has been recovered from the Charlie Lake Site, British Columbia, in the form of Clovis projectile points, radiocarbon dated to approximately 10,400 years ago (Fladmark, Driver, and Alexander 1988). Approximately 150 kilometers northwest of Fort St. John, two Clovis point bases as well as a Scottsbluff, Plainview, Lerma, and a later possible Salmon River projectile point were also recovered at the Pink Mountain Site. In addition, a microblade core was recovered (Wilson 1989). The Peace River - Grande Prairie region in Alberta is also known for its Palaeo-Indian materials including Clovis, Alberta-Scottsbluff, Browns Valley-Frederick, and Plainview (Wormington and Forbis 1965; Magne 1986). The archaeological record indicates that the region was occupied continuously from this early period to historic times.

The project area occurs southeast of both the Charlie Lake and Pink Mountain sites. The Pink Mountain site is very extensive, being at least one kilometer in length and 150 meters in width, although artifact concentration is not particularly dense (Wilson 1989). The assemblage recovered from this site indicates a stratified site of great antiquity with the earliest materials assigned to the Clovis Complex (11,000 to 11,500 B.P.). Clovis represents the earliest recognized archaeological complex in the New World. Additional early archaeological complexes identified at the site include Scottsbluff (8500 to 9000 B.P.) and Lerma (5000 to 9000 B.P.), as well as possibly Salmon River (4000 to 6000 B.P.). In addition to these identified complexes, microblades and microblade technology were identified at the site, indicating early occupations. Microblade technology in the Northern Cordillera has a terminal date of approximately 4000 to 4500 years before present (Wilson 1989).

The Charlie Lake Cave site has yielded a continuous record over approximately 11,000 years. Four meters of deposition have yielded five stratigraphic zones and 11 sequential cultural components identified through excavations conducted in 1974 and 1983. Two Paleoindian components dating between 9000 and 11,000 years before present have been identified in the lowest levels. At least 14 radiometric dates covering the entire sequence have been recovered from this site. The Clovis fluted projectile point recovered from this site is credited as the first to be excavated in context in British Columbia and the first in Canada to be recovered with a substantial faunal assemblage.

A substantial number of archaeological investigations have been conducted within and adjacent to the current study area. The area has been subject to several academic reconnaissance and excavation programs due to the interest in identifying and defining early Holocene sites in the region (i.e. Fladmark, Driver and Anderson 1988). Industrial development has also been a key factor in the amount and location of archaeological investigations conducted in the past. Inventory and impact assessment studies in the project area have been conducted in association with the former Dam Site C location and reservoir, transmission corridors along and near the Peace River valley, Peace River valley recreational management plans, and oil and gas developments in the Fort St. John, Taylor, Dawson Creek and Pouce Coupe areas. Coal development further to the southwest of the development zone and extensive gas developments in the Chetwynd area have also generated a number of inventory and assessment projects. Most of the sites identified in association with these industrial projects are small artifact scatters of limited extent and potential to yield substantive data, although several sites have been extensive enough to warrant mitigative programs in association with project development (i.e., Walde 1990a, 1990b). In addition to precontact sites, post-contact sites associated with fur trade activities along the Peace River have also been investigated (Hamilton 1987; Hamilton, Burley and Moon 1988; Burley, Hamilton and Fladmark 1996).

ETHNOGRAPHIC BACKGROUND

Introduction

Based on the writings of Alexander Mackenzie, Diamond Jenness (1977:382-383) concluded that in the mid 1700s the Beaver Indians "occupied not only the entire basin of the Peace river below its junction with the Smoky, but the district around lake Claire and the valley of the Athabaska River as far south as the Clearwater and Methye Portage." Their traditional territory also extended west to Portage la Loche and Lesser Slave Lake, which Peter Fidler noted should more properly be called "Beaver Indian Lake" (HBCA, PAM, B.104/a/1, Of,.38d) (Figure 4). With the advent of the fur trade the eastern Beaver were slowly pushed west by the Cree who had obtained guns from European traders during the early part of the seventeenth century. As a result, the eastern Beaver pushed the western Beaver even further west up the Peace River and they, in turn, displaced the Sekani into the mountains (Ives 1990:132).

Figure 4 Approximate distribution of Mackenzie River and Yukon tribes in 1725 A.D. (Jenness 1977: 378)

At the turn of the century Goddard (1916: 208) identified three geographical groups of Beaver Indians occupying "the region of the Peace River to the falls about forty miles below Vermilion". The Beaver trading at Fort St. John consisted of three bands comprised of 102 individuals. They hunted "northward to the headwaters of the Liard River and camp[ed] as far down the Peace as North Pine River where the first trading post for them was established" (Goddard 1916: 208). The second group consisting of 130 individuals lived near Dunvegan under the leadership of a single chief. "They hunted northward to the headwaters of Hay River where they often met Beaver from Vermilion and Fort St. John,...They also occupied considerable territory south of Peace River."

The third group identified by Goddard (1916: 208) lived near Fort Vermilion. At the time there were 148 people "forming one political unit under a Chief recognized by the Canadian government. They live[d] on a reserve along Paddle River, and hunt[ed] and trap[ped] westward toward Hay Lake, and north and eastward toward the Caribou Mountains."

In addition to the Beaver, the fur trade resulted in the eastern migration of Cree, Iroquois and Saulteau people employed by the Northwest Company and the Hudson's Bay Company. Many of these people intermarried with local native groups and settled in the Peace River country. The Saulteau eventually settled on the east shore of Moberly Lake.

Treaty 8

The project area falls within the lands covered under Treaty 8. The Beaver Indians signed Treaty 8. Mineral wealth in the northwest provided the impetus for the signing of treaties with the native groups in this area. With the discovery of oil reserves at Lake Athabasca by Robert Bell, and along the Peace and Mackenzie rivers by Robert McConnell, the Canadian government began to seriously consider negotiating a settlement with the aboriginal occupants. Added incentive to treat with the native inhabitants occupying lands of the north was supplied by the discovery of gold in the Yukon. The sudden influx of miners and prospectors into the northwest beginning in 1897, brought with it an increase in lawlessness, liquor traffic, and native insecurity. In response, the Deputy Minister of Indian Affairs (Canada, Sessional Papers, 1900, No. 14: xviii - xix) stated:

"Although there was no immediate prospect of any such invasion by settlement as threatened the fertile belt in Manitoba and the Northwest Territories and dictated the formation of treaties with the original owners of the soil, none the less occasional squatters had found their way at any rate into the Peace River district.

While under ordinary circumstances the prospect of any considerable influx might have remained indefinitely remote, the discovery of gold in the Klondike region quickly changed the aspect of the situation. Parties of white men in quest of a road to the gold fields began to traverse the country, and there was not only the possibility ahead of such travel being greatly increased, but that the district itself would soon become the field of prospectors who might at any time make some discovery which would be followed by a rush of miners to the spot. In any case the knowledge of the country obtained and diffused...could hardly fail to attract attention to it as a field for settlement-

For the successful pursuance of that humane and generous policy which has always characterized the Dominion in its dealings with the aboriginal inhabitants, it is of vital importance to gain their confidence at the outset, for the Indian character is such that, if suspicion or distrust once be aroused, the task of eradication is extremely difficult.

For these reasons it was considered that the time was ripe for entering into treaty relations with the Indians of the district, and so setting at rest the feeling of uneasiness which was beginning to take hold of them, and laying the foundation for permanent friendly and profitable relations between the races."

Fear of reprisals against immigrant prospectors was voiced by the Order in Council for Setting up Commission for Treaty 8, P.C. No. 2749 (Indian and Northern Development, Pub. no. QS-O576-000-EE-A-16).

"...the desirability...for the making of a treaty with the Indians occupying the proposed line of route from Edmonton to Pelly River;...these Indians, as well as the Beaver Indians of the Peace and Nelson Rivers, and the Sicamas and Nihames Indians, were inclined to be turbulent and were liable to give trouble to isolated parties of miners or traders who might be regarded by the Indians as interfering with what they considered their vested rights..."

The terms of Treaty 8 were concluded at Lesser Slave Lake in 1899 in consultation with the Cree. Present at this meeting was a chief and five headmen as well as band members. Chief Keenooshayoo (The Fish) and his brother, the headman Moostoos (The Bull or Buffalo), were the appointed spokesmen. To them were read prepared statements and conditions of agreement (Mair and Macfarlane 1908: 56-62).

"We understand that stories have been told you, that if you made a treaty with us you would become servants and slaves: but we wish you to understand that such is not the case, but that you will be just as free after signing a treaty as you are now. The treaty is a free offer; take it or not, just as you please...One thing Indians must understand, that if they do not make a treaty they must obey the laws of the land - that will be just the same whether you made a treaty or not, the laws must be obeyed...

Indians have been told that if they make a treaty they will not be allowed to hunt and fish as they do now. This is not true. Indians who take treaty will be just as free to hunt and fish all over as they are now.

We offer you certain terms, but you are not forced to take them...Indians are fond of a free life, and we do not wish to interfere with it. When reserves are offered you there is no intention to make you live on them if you do not want to, but, in years to come, you may change your minds, and want these lands to live on..."

Likewise, the natives expressed their concerns as Keenooshayoo inquired (Mair and Macfarlane 1908: 62I). "Are the terms good forever? As long as the sun shines on us? Because there are orphans we must consider...We want a written treaty, one copy to be given to us, so that we shall know what we sign for..." To which Lieutenant Governor Laird replied: "Treaties last forever, as signed, unless the Indians wish to make a change." And Father Lacombe (Mair and Macfarlane 1908: 63) confirmed "Your forest and river life will not be changed by the Treaty...as long the sun shines and the earth remains..."

These concerns, identified at the meeting at Lesser Slave Lake, were critical as they set the precedence for the acceptance and ultimate signing of Treaty 8 with all the native groups. An affidavit signed by James K. Cornwall (Fumoleau 1973: 74-75) who witnessed the proceedings at Lesser Slave Lake indicates that the negotiations were not without problems. He described the proceedings as follows.

"The treaty, as presented...was apparently prepared elsewhere, as it did not contain many things that they held to be of vital importance to their future existence as hunters and trappers and fishermen, free from the competition of white man. They refused to sign the treaty as read to them by the Chief Commissioner.

Long discussions took place...the Commissioners had unfavourably impressed the Indians, due to lack of knowledge of the bush Indians' mode of life, by quoting Indian conditions on the Prairies.

The Commissioners finally decided, after going into the whole matter, that what the Indians suggested was only fair and right but that they had no authority to write it into the Treaty. They felt sure the Government on behalf of the Crown and the Great White Mother would include their request and they made the following promises to the Indians:

- No thing would be allowed to interfere with their way of making a living, as they were accustomed to and as their forefathers had done. .

- The old and destitute would always be taken care of, their future existence would be carefully studied and provided for, and every effort would be made to improve their living conditions.

- They were guaranteed protection in their way of living as hunters and trappers, from white competition; they would not be prevented from hunting and fishing as they had always done, so as to enable them to earn their living and maintain their existence.

Much stress was laid on one point by the Indians, as follows: They would not sign under any circumstances, unless their right to hunt, trap and fish was guaranteed and it must be understood that these rights they would never surrender.

It was only after the Royal Commission had recognized that the demands of the Indians were legitimate, and had solemnly promised that such demands would be granted by the Crown...the Indians accepted and. signed the Treaty, which was to last as long as the grass grew, the river ran, and the sun shone - to an Indian this means FOREVER".

Following the negotiations, the Commissioners had also intended to make treaty with the Beaver of Fort St. John on the 21st of June 1899. There was some confusion, however, and the Beaver Indians were missed.

"Unfortunately the Indians had dispersed and gone to their hunting grounds before the messenger arrived and weeks before the date originally fixed for the meeting, and when the Commissioners got within some miles of St. John the messenger met them with a letter from the Hudson's Bay Company officer there advising them that the Indians after consuming all their provisions, set off on the 1st June in four different bands and in as many different directions for the regular hunt.... It may be stated, however, that what happened was not altogether unforeseen. We had grave doubts of being able to get to St. John in time to meet the Indians, but as they were reported to be rather disturbed and ill-disposed on account of the actions of miners passing through their country, it was thought that it would be well to show them that the Commissioners were prepared to go into their country, and that they had put forth every possible effort to keep the engagement made by the government" (P.A. RG 10, Black Series Vol. 3848).

The following year Muckithay, Aginaa, Dislisici, Tachea, Appan, Attachie, Allalie, and Yatsoose signed on behalf of a total of 46 Beaver who were admitted into Treaty. In subsequent years, many of those individuals that had not signed adhesions in 1900, took treaty (Madill 1986: 49). As part of the treaty settlement, a number of reserves were allocated. In Alberta, reserves were established at Clear Hills, Horse Lake, Child Lake, and Boyer River and in British Columbia at Halfway River, Crawford River, Doig River, and Blueberry River. The Doig and Blueberry bands once occupied a common reserve. In 1916, a parcel of land in the Peace River Block containing 18,168 acres, known as the St. John Indian Reserve No. 172, was set aside for the St. John Band. This was an area where the scattered bands assembled. The place was named after Chief Montagne or Montaney and in Beaver language it was known 'as the place where happiness dwells'. This name denoted an area "where they went to meet their relatives. They thought of this place as an earthly reminder of the land at the end of Yagatunne, the Trail to Heaven" (Ridington 1988: 24). "On 16 October 1945, order-in-council P.C. 6506 authorized the surrender of Indian Reserve No. 172 "to be sold or leased for their benefit"...The reserve was subsequently sold to the director, Veterans Land Act and the proceeds from the sale, totalling $70,000, were credited to the Fort St. John Band. As indicated by Indian Superintendent E. J. Galibois, this reserve was replaced by Beaton River I.R. No. 204, Blueberry I.R. No. 205, and Doig River I.R. No. 206, comprising 6,194 acres" (Madill 1986: 92-93). In 1914, the Saulteau signed treaty and East Moberly Lake Reserve No. 169 was established.

PALAEONTOLOGICAL RESOURCES

The near surface bedrock in the study area consists of a series of formations of the Mesozoic era (ca. 225 to 70 million years). The sediments deposited during the alternate uplifting of the land and inflooding of ocean waters caused by tectonic forces contain a rich dinosaurian fauna, ammonites, fishes, marine reptiles, oysters, clams, and snails, as well as the remains of lush flora which once thrived. Such palaeontological remains are likely found in bedrock exposures or associated talus in deeply incised river valleys.

The bedrock in the study area consists predominantly of Cretaceous sandstones, shales, and conglomerates. Bedrock exposures in the area are limited because of the existing mantle of unconsolidated deposits of Quaternary age. Of particular importance relative to palaeontological remains are Gething, Dunvegan, and Shaftesbury formations and the Minnes Group. The Gething Formation, Lower Cretaceous in age, is associated with abundant plant remains and dinosaur tracks. The Minnes Group (Cretaceous/Jurassic) is also associated with dinosaur tracks. A prominent horizon in the Shaftesbury Formation (Lower Cretaceous) is a fish scale zone. Notable fossils in this formation include Neogastroplites Posidonomya, Nahawisi, and Inoceramus. The Dunvegan Formation of Upper Cretaceous age is important for both non-marine, particularly Unio sp., and marine fossils such as Corbula, Inoceramus, Barbatia, Ostrea, and Dunveganoceras.

The bedrock is overlain by unconsolidated deposits of Quaternary age which may contain large mammalian fauna. During warm interludes of the Pleistocene and early Holocene a rich and varied fauna, including mammoth, mastodon, ground sloth, musk ox, caribou, and bison inhabited the landscape. Bones of these animals are frequently found in old river gravels and sands where eddies have sometimes concentrated them in rich fosilliferous pockets. More often, the bones are found scattered randomly through sands and gravels. Quaternary fossil remains occur in terraces or floodplain deposits left behind as the river became entrenched. Quaternary fossil sites are generally restricted to major river valleys and there is a high probability that such remains will be encountered where major modern rivers cross or reincise buried preglacial river valleys (Churcher and Wilson 1979).

METHODOLOGY

RECORD REVIEW

A search was conducted of the site inventory files maintained by the Archaeology Branch, Ministry of Small Business, Tourism and Culture. The file search consisted of Borden Blocks HaRd, HaRe, HbRd and HbRe, on map sheet 94A/2. The site file search was conducted to determine the nature of the local database and to identify any previously recorded sites which may be in potential conflict with the proposed development route.

DOCUMENTARY REVIEW

Documentary research included a review of current archaeological, anthropological, historical, ethnographic and geological sources, both published and unpublished, through the utilization of libraries, archives, and files maintained by the British Columbia Archaeology Branch. Standard 1:50,000 topographic maps of the National Topographic Series (NTS) and airphotos were reviewed for the study area and adjacent terrain. The documentary review was intended to determine the archaeological potential of the project area and to indicate areas of particular potential such as those with similarities to known resources or through historical information.

FIRST NATIONS CONSULTATION

In order to determine potential conflicts with traditional land use within the proposed project area, the Saulteau, West Moberly, Doig River, Blueberry River and Kelly Lake First Nations were provided with a proposed development map for their internal review. The intent of the First Nations Consultation is to determine if the affected First Nations are interested in meeting to discuss potential traditional use conflicts.

FIELD RECONNAISSANCE

The assessment program for the NCL Taylor Straddle Plant included the area of the plant structures located in the former tank farm, a 60 meter-wide treed buffer zone on the west and north margins of the property, the alignment for a proposed flare stack, and an alignment for a proposed pipeline tie-in to the south (Figure 5). Due to scheduling requirements associated with the application for project approval, it was necessary to initiate the Archaeological Impact Assessment under winter conditions. Auger testing scheduled for early spring 1997 provided an opportunity for subsurface exposures across the proposed development zone and was utilized as an exploratory method for cultural materials.

Snow was initially removed from the length of the buffer zone on the north and west margins of the property using a smooth-edged, front loading bucket on a backhoe. This method removed both snow and loose vegetation, providing very good visibility (Plate 6). By the completion of the drilling program, natural melting eliminated most of the remaining snow within the project area resulting in excellent surface visibility where vegetation was not well developed. Visibility within the tank farm was excellent owing to the heavily disturbed nature of the surface deposits. Approximately 80 percent visibility was achieved by natural melting activities (Plate 7).

Winter condition monitoring consisted of the observation of 8" diameter auger tests to varying depths. Minimum depths were approximately four meters, with several tests to basal sand and till (or auger refusal), generally 10 to 12 meters in depth. Displaced soils were hand-sorted off the auger bit to a depth where definite glacio-lacustrine clays were encountered, normally about 2 to 3 meters below surface. A total of 49 auger tests were excavated; 19 in the tank farm and 30 in the cultivated portion of the plant site. In addition to monitoring the auger tests, a series of 19 soil samples were removed from the length of the proposed buffer zone on the west and north margins of the proposed plant site. These samples were obtained by sinking the auger to a depth of approximately 50 centimeters and bagging the displaced soil. These samples were taken to a heated shed and allowed to thaw prior to screening through a 6mm mesh hand screen.

Figure 5 Aerial view of proposed NCL Taylor Plant Site and associated facilities

Plate 6 Typical surface visibility within cultivated portion of the proposed plant site following snow removal and natural melting. General view east.

Plate 7 Typical visibility within the tank farm. General view northeast.

RESULTS

RECORD AND DOCUMENTARY REVIEW

Previous archaeological research in the area of the proposed NCL Taylor Straddle Plant has indicated the presence of at least 15 known precontact sites within 1.5 kilometers of the development zone (Figure 6). These sites, which were identified during the development of the Alaska Highway and the Taylor industrial area, consist of two isolated finds, 11 surface scatters of lithic artifacts, one buried deposit of lithic artifacts and one site identified as a grave house. Of these sites, only one surface lithic scatter (HaRe 13) has been identified in potential conflict with the proposed development. The site identified as the grave house (HaRe 1) was recorded in excess of one kilometer southwest of the proposed development zone and, as a result, will not be subject to direct or indirect impact in relation to the proposed construction and operation of the NCL Taylor Straddle Plant.

The proposed plant site structures will be situated in an area of highly disturbed terrain which was formerly the site of a tank farm. Based on site file data, this appears to be the location of site HaRe 13, which was identified by Fladmark in 1975, prior to the expansion of the tank farm into the site area. At that time, a collection of two flakes was made from the surface of the site. The general area was re-examined in 1984 by Ian Wilson who concluded "*it is possible that the site is presently buried by sulphur deposits … surficial examination yielded no additional artifacts*" (Wilson 1984:4). Ian Wilson's recommendation regarding the site stated "*It is assumed that site HaRe 13 is either buried by sulphur deposits or lies outside the bounds of the present expansion. The landform on which the site is situated has been severely modified by plant site construction and the likelihood of intact deposits is low. Location information on the site form is too poor to adequately assess the site, however.*" (Wilson 1984:4-5).

Figure 6 Previously recorded sites identified in relation to NCL Taylor Straddle Plant

Airphoto coverage of the project area was reviewed to evaluate past land use. By 1961, the initial petroleum industrial development in Taylor was well underway with a refinery constructed south of the currently proposed plant site (Plate 8). The photo from this time clearly shows the expanded gravel road grid into the western portion of the proposed development zone. Spoil piles are visible in the southern portion of the property in the area which would become the tank farm. Another airphoto from 1962 clearly shows the spoil piles (Plate 9). By 1970, the grid roads are still visible and the spoil piles appear unchanged (Plate 10). By 1975, the first two tanks are established on the property and the pad for a third appears to be in preparation (Plate 11). The grid roads in the western portion of the property are indicated by vegetation differences. Similar conditions are indicated on the airphoto from 1977 (Plate 12). By 1980, the grid roads are less visible with crop lines confusing the image, and there are still only two tanks within the property (Plate 13). By 1986, there are four tank pads within the property and the grid roads are barely visible. Thus the airphoto record indicates modest agricultural utilization of the north and western portions of the property but intensive industrial use of the southern portion within the tank farm.

Given the highly disturbed nature of the deposits at the proposed NCL Taylor Straddle Plant location, the potential for intact surface and near surface cultural remains is remote. Based on past agricultural use, the intensive industrial development in the project area, the general nature of the known heritage resource sites, and the contexts in which the sites have been found, it was anticipated that any surface or shallowly buried sites would be found mainly in dispersed or disturbed contexts, and would be largely of limited archaeological potential. Deeply buried sites, located within the circumscribed Peace River floodplain, would have greater potential for being identified in undisturbed contexts. As a result, the focus of the field portion of the Archaeological Impact Assessment was the testing of these deeper deposits, through monitoring of auger testing program and controlled backhoe testing.

Plate 8 Aerial view of project area, 1961, note visible roads and spoil piles.

Plate 9 Aerial view of project area, 1962, note spoil piles at south end of property.

Plate10 Aerial view of project area, 1970, note spoil piles and faint traces of roads.

Plate 11 Aerial view of project area, 1975, first two tanks installed.

Plate 12 Aerial view of project area, 1977, two tanks, gravel roads becoming faint.

Plate 13 Aerial view of project area, 1980, gravel roads becoming faint.

Plate 14 Aerial view of project area, 1986, final extent of tank farm.

FIRST NATIONS CONSULTATION

All of the five First Nations contacted in relation to this project were offered the opportunity to participate in the field program. No specific traditional land use concerns were raised by the any of the five First Nations communities contacted in relation to this development project. A representative of the Kelly Lake First Nation, Francis Gladue, assisted during the monitoring program for the duration of the auger testing program. Chief Buddy Napoleon of the Saulteau First Nation met with the field archaeologists prior to initiation of the project to review the scope of work. Arrangements for a representative from the Blueberry River First Nation were made but the representative was not present during the field reconnaissance.

FIELD RESULTS

At the time of the field investigations, early spring conditions resulted in the efficient melting of residual snow. Removal of approximately 3 to 5 centimeters of recent snow fall and vegetation along the buffer zone facilitated melting during the initial few days of inspection. Natural snow melting achieved surface visibility of approximately 80 percent or greater by the end of the six-day field program. Surface examinations were made of the tank farm area, the proposed buffer zone, former road locations and other exposures. Monitoring of 49 auger tests was completed and 19 soil samples were thawed and screened through 6mm mesh (Figure 7). In addition, two backhoe tests were excavated along the north margin of the proposed buffer zone to verify the interpretation of auger profiles. No cultural material was observed during any of these investigation procedures.

TANK FARM

Auger testing within the tank farm consisted of 19 tests excavated to a minimum of six meters and a maximum of 12 meters below surface (Plates 15, 16, 17). Testing was focussed on the southwest corner of the tank farm where 12 tests were drilled. All of the tests within the tank farm exhibited similar characteristics; approximately 1 to 2 meters of disturbed gravelly clay overlying relatively Figure 7 Reconnaissance strategy, NCL Taylor Straddle Plant

Plate 15 Auger test DH30 in south-central portion of tank farm. Note nearly snow-free conditions. General view north.

Plate 16 Removal of second auger flight from DH30 (circa 1.5 to 3 meters below surface). Note absence of discernible stratigraphy. General view north.

Plate 17 Auger test DH30 showing sediments between 1.5 and 3 meters in depth. General view north.

homogeneous varved glacio-lacustrine clays associated with Glacial Lake Peace to a depth of approximately 10 meters, at which point well sorted sands were encountered. Auger refusal at approximately 12 meters below surface indicated the depth of till deposits. In no case were intact post-glacial deposits identified within the tank farm.

The proposed plant site structures will occupy the area within the former tank farm. Given the results of the monitoring program during auger testing, it is clear that any cultural sites within the tank farm compound would have been destroyed by past industrial land use activities. The area which correlates to site HaRe 13, based on site file data provided by the Archaeology Branch, was the area most intensively investigated during the auger testing program with 12 boreholes drilled in the vicinity (Figure 7; Plate 18). The area is bounded on the west by an active gas pipeline operated by Westcoast Energy Inc., a buried water line with associated fire hydrants on the east margin, and a well developed access road on the south. Despite the excellent exposures in this area, the surface sediments are secondary deposits associated with berm construction around former tank pads. No cultural material was observed in this area. No further study of the tank farm is recommended due to the absence of non-glacial sediments within the compound.

TREED BUFFER ZONE

Auger testing within the proposed 60 meter-wide buffer zone consisted of 18 boreholes spaced roughly evenly across the area. Twelve of the boreholes were drilled within the western buffer zone and six were drilled along the northern buffer zone. The northern buffer is relatively undisturbed with an informal vehicle track traversing the northern edge of the property. The profiles exposed by the auger testing program (Plates 19, 20, 21, 22) indicated approximately 15 centimeters of dark, organic topsoil over 10 to 15 centimeters of dark brown silty loam. Under the dark Ah and B horizons, there is a dry and friable light brown silty clay which grades into heavy, varved, green-brown glacio-lacustrine clays by 2.5 to 3 meters below surface. The glacio-lacustrine clay continues to approximately 9 to 10 meters below surface where a fine sand grading into gravelly sand is reached. All tests outside of the tank farm were taken to a minimum of four meters below surface, with three taken to the depth of the underlying sand.

Plate 18 Reported location of previously recorded site HaRe 13 in foreground. General view southwest.

Plate 19 Typical soil profile exposed in cultivated portion of property (DH36). General view southeast.

Plate 20 Detail of soil profile from cultivated portion of proposed NCL Taylor Straddle Plant property. Note distinct separation of topsoil and underlying silty clays.

Plate 21 Typical exposure of dry silty clay between 1.5 and 2 meters below surface (DH19).

The western buffer zone coincides with a former low grade gravel road which was an extension of the existing Taylor town road system (see Plate 8). A shallow cut ditch was visible on both sides of the road bed and the borehole samples indicate dense gravel in the upper 10 centimeters of the profile, grading into slightly gravelly topsoil. According to a local resident, the soil cut from the shallow ditches was spread on the road surface and a veneer of gravel was laid down on top (Peter Barrow, personal communication 1997). As the property was never developed for housing, the road would have seen little use and was eventually returned to cultivation or allowed to grow over (see Plates 8 to 14).

In addition to the auger tests excavated along the buffer zone, 19 soil samples were removed at regular intervals along the length of the north and west buffers. The auger was sunk to approximately 50 centimeters below surface and the displaced soil was placed in plastic bags and transported to a heated shed to thaw. Each sample was individually screened through 6mm mesh. No cultural material was observed in any of the 19 samples.

Finally, in order to confirm the profiles identified in the auger testing program and to allow a larger window of exposure, two backhoe tests were excavated within the north buffer zone in undisturbed contexts adjacent to completed auger tests. Each test was approximately 5 meters in length and 50 centimeters wide. The tests were excavated the maximum depth of backhoe reach, approximately 4.5 meters. The backhoe tests provided the same profile as the auger tests (dark organic loam 0-15 cm, dark silty loam 15-25 cm, light brown silty clay 25-200 cm, varved glacio-lacustrine clay 200-450 cm; Plate 22). No cultural material was observed in relation to the backhoe testing.

CULTIVATED PROPERTY

In addition to the auger tests along the buffers, 12 additional boreholes were drilled throughout the cultivated portion of the plant site property. These boreholes presented the same profile as was seen along the northern buffer, with the exception of borehole 25 which was placed at the edge of the area formerly stripped for clay extraction. This borehole indicated about 75 centimeters of disturbed gravelly clay matrix with a veneer of about 10 centimeters of dark

Plate 22 Detail of exposure afforded by backhoe testing along the north buffer zone. Note relatively homogeneous stratigraphy.

brown clayey loam with small inclusions of glacio-lacustrine clay. No cultural material was identified in relation to the boreholes excavated within the cultivated portion of the property.

FLARE STACK AND SUPPLY PIPELINE

A flare stack is planned to extend roughly 300 meters north of the proposed plant site, into the area of cultivation in the eastern half of the property. The supply line to the flare stack and the stack itself will be located within the existing 20 meter-wide Morrison Petroleums Ltd./Northstar Energy Corporation pipeline right-of-way which traverses the property from north to south. Given the existing disturbance zone and the active gas pipeline within the right-of-way, no intact cultural materials are anticipated and no testing was undertaken. No further study is recommended in relation to the proposed flare stack and its associated supply pipeline.

SUPPLY AND RETURN PIPELINES

Another planned development associated with the proposed plant site are the supply and return pipelines from the Westcoast Energy Inc. meter station, located about 1.4 kilometer south of the planned plant site. The proposed route of these supply and return lines traverse heavily utilized industrial terrain. The northern-most 800 meters of these pipelines will be below ground, traversing part of the former tank farm which has not been reclaimed in any way (Plates 23, 24). The remaining 600 meters of the pipelines will be above ground, suspended from metal racks, threaded between existing structures and facilities (Plate 25).

Due to safety regulations, testing of the pipeline area was not permitted as there are numerous buried and surface pipelines, etc. A surface inspection of the below ground pipeline route indicated extensive disturbance related to tank farm development. According to a land representative from Petro-Canada (E. Scriba, personal communication 1997) who escorted field personnel within the tank farm, each tank pad was excavated to the basal glacial clays. The bottom of each tank pad was lined with a layer of river sand obtained directly from the nearby Peace River floodplain. Berms of gravel and displaced soil were

Plate 23 Proposed below ground supply and return pipeline route through abandoned tank farm. Note surface pipelines and WEI McMahon Plant in background. General view south.

Plate 24 Former tank pads, berms and existing pipelines adjacent to proposed supply and return pipeline. General view north.

Plate 25 Proposed above ground alignment of supply and return pipeline through Westcoast Energy Inc. McMahon Plant. Note racks at photographic left to be used to support pipeline. General view south.

constructed around each tank pad to a height of about 1.5 meters. The berms were stabilized by the application of a layer of ashphalt to the surface of the berm. Given the level of disturbance in the tank farm, it is highly unlikely that any cultural materials could be recovered from intact deposits. Similarly, the intensive use of the existing Westcoast Energy Inc. McMahon plant site also suggests that no intact cultural deposits would be encountered in relation to the proposed above ground pipelines. No further study is recommended in association with the development of the currently planned supply and return pipeline route.

CONCLUSIONS

No cultural material was observed during the surface inspection and auger test monitoring program at the proposed NCL Taylor Straddle Plant Site. Although approximately 50 centimeters of frost was encountered, surface exposures were very good owing to late spring conditions. The intensive auger testing program provided excellent subsurface visibility which was maximized by hand-sorting of all displaced non-glacial sediments.

Existing disturbances within the fenced tank farm compound incorporated all of the non-glacial sediments in this area. Site HaRe 13 which was located within this area has apparently been destroyed by past industrial use of the compound. No cultural material was observed on the surface of the tank farm or within the sediments displaced by the auger testing program. The potential for identifying significant archaeological materials in undisturbed context within the compound is remote. No further study is recommended within the former tank farm, including the below ground alignment of the proposed supply and return pipelines.

The entire remaining portion of the property has formerly been cultivated, resulting in the disturbance of the upper 15 to 20 centimeters of topsoil. Additional disturbances within the property include two active 20 meter-wide pipeline rights-of-way, a reclaimed clay borrow pit, and the remains of low grade gravel roads. The homogenous nature of the underlying light brown silty clay in the area provides no indication of buried soils. The area is well removed from the Peace River (ca. 2 kilometers) and side drainages (ca. 500 meters). Extensive auger testing did not yield any evidence of precontact archaeological materials. No further assessment is recommended in relation to the proposed NCL Taylor Straddle Plant Site.

RECOMMENDATIONS

The level of inspection and testing conducted in association with the NCL Taylor Straddle Plant is deemed sufficient to suggest that no further assessment in relation to the current development plans is necessary.

SUMMARY AND

RECOMMENDATIONS

On behalf of Salmo Consulting Inc. and Novagas Clearinghouse Limited (NCL), Fedirchuk McCullough & Associates Ltd. conducted an Archaeological Impact Assessment of the proposed Taylor Straddle Plant located in the Industrial area of the District of Taylor, on a site in the north half of Section 36, Township 82, Range 18, West of the Sixth Meridian. The plant site area is approximately 40 hectares in size and the development will consist of the structures and facilities of the plant itself, a 60 meter-wide treed buffer zone along the west and north margins of the property, supply and return lines to the Westcoast Energy Inc. meter station, and a flare stack with approximately 300 meters of supply line. The Archaeological Impact Assessment was conducted under Heritage Inspection Permit No. 1997-043.

Due to scheduling conflicts between the time needed for review of the application for project approval and anticipated construction, the Archaeological Impact Assessment was initiated under winter conditions. Auger testing conducted for soil sampling was scheduled for late spring 1997 and was utilized as an opportunity for subsurface testing across the proposed plant site property. Prior to the auger testing program, a surface inspection of the plant site, buffer zones and other exposures within the plant property was made. Natural melting of snow provided very good visibility with approximately 80 percent surface exposure. No surface cultural materials were observed.

A total of 49 tests were excavated by means of an 8 inch auger across the project area. Nineteen tests were excavated within a fenced compound which was formerly a tank farm. This compound corresponds with the plant structures and facilities. An additional 30 tests were excavated outside of the former tank

farm in an area of former cultivation. Of the 30 tests, 18 were placed within the area to be developed into a treed buffer zone. The remaining 12 tests were excavated across the land between the buffer zone and the tank farm. The displaced soil from all auger tests was hand-sorted off the auger blade to facilitate inspection for archaeological materials. In addition to the auger tests, 19 soil samples were taken from the buffer zone, thawed and screened for cultural material with negative results. Two backhoe tests were also excavated within the northern buffer zone to verify the interpretation of stratigraphy observed in the auger tests. No cultural material was observed at any time during the assessment program.

Subsequent to the field assessment, the southernmost 60 metres of the tank farm compound was eliminated from the proposed development project.

A site file search indicated that at least 15 previously recorded archaeological sites occur within 1.5 kilometers of the proposed development zone but that only one, HaRe 13, occurs in conflict with the proposed plant site. Site HaRe 13 was recorded in 1975 by Fladmark at which time two flakes were recovered from the ground surface. Re-inspection of the site in 1984 led to the interpretation that the site had been destroyed by industrial activity. The site area was revisited in relation to the NCL Taylor Straddle Plant AIA. The area is located within a partially reclaimed tank farm. Twelve auger tests were excavated in the vicinity of the reported site with negative results. No intact post-glacial deposits were observed within the tank farm area. It is, therefore, reasserted that site HaRe 13 has been destroyed by past industrial activity.

Two proposed developments in association with the proposed plant site were to be included in the assessment. A flare stack with its supply pipeline originating within the plant site and extending north approximately 180 meters will be constructed within the previously disturbed right-of-way of an existing gas pipeline traversing the site property. Owing to the previous disturbance and the presence of an active gas pipeline in the right-of-way, no testing was undertaken in relation to the alignment. No intact sediments will be affected by construction of the flare stack and supply line. The second development is the supply and return pipeline from the proposed plant site to the existing Westcoast Energy Inc. meter station on the lower Peace River terrace. The route consists of two segments, approximately 800 meters of below ground pipeline and about 600 meters of above ground pipeline. In both cases, the route traverses intensively utilized industrial terrain which was considered unsafe for subsurface testing. The potential for intact deposits within the proposed development route is remote. No further study is recommended in relation to the supply and return pipelines and the flare stack and its supply pipeline.

No cultural material was observed during the conduct of the Archaeological Impact Assessment for the proposed NCL Taylor Straddle Plant. No further assessment is recommended in relation to the currently proposed development plans.

REFERENCES CITED

Barrow, Peter

1997 Personal communication. Peace Drilling and Research, Owner and Operator. Taylor, B.C.

Burley, D. V., J. S. Hamilton and K. R. Fladmark

1996 *Prophecy of the Swan, The upper Peace River fur trade of 1794-1823*. UBC Press, Vancouver.

Churcher, C. S. and M. Wilson

1979 Quaternary mammals from the eastern Peace River district, Alberta. *Journal of Palaeontology* 53(1):71-76.

Fladmark, K. R., J. C. Driver, and D. Alexander

1988 The Paleoindian component at Charlie Lake Cave (HbRf 39), British Columbia. *American Antiquity*, Vol. 53, no. 2. Salt Lake City.

Fumoleau, R.

1973 *As long as this land shall last: a history of Treaty 8 and Treaty 11, 1870-1939*. McClelland and Stewart Limited, Toronto.

Goddard, P. E.

1916 The Beaver Indians. *Anthropological Papers of the American Museum of Natural History*. Vol. 10, no. 4: 201-294.

Hamilton, S.

1987 The end of season report of the 1986 excavations at Rocky Mountain Fort HbRf 31, Permit 1986-16. Report on file, Archaeology Branch, Victoria.

Hamilton, S., D. Burley and H. Moon

1988 Rocky Mountain Fort and the land based fur trade research project; the 1987 end of season report, permit 1987-13. Report on file, Archaeology Branch, Victoria.

Ives, John W.

1990 *The Theory of Northern Athapaskan Prehistory*. :University of Calgary Press, Calgary.

Jenness, D.

1977 *The Indians of Canada*. National Museum of Canada, Bulletin 65. Ottawa.

Madill, Dennis F.K.

1986 Treaty Research Report: Treaty Eight. Treaties and Historical Research Centre, Indian and Northern Affairs Canada, Ottawa.

Magne, M.

1986 Archaeological investigations in the Grande Prairie region of northwestern Alberta, 1985. *Archaeological Survey of Alberta, Occasional Paper* no. 29: 185-199. Edmonton.

Mair, C. and R. Macfarlane

1908 *Through the Mackenzie Basin*. Toronto.

Mathews, W. H.

1980 Retreat of the last ice sheets in northeastern British Columbia and adjacent Alberta. *Geological Survey of Canada, Bulletin* 331. Ottawa.

Moss, E. H.

1952 Grasslands of the Peace River region, western Canada. *Canadian Journal of Botany*, vol. 30:93-124.

1955 The vegetation of Alberta. *The Botanical Review*, vol. XXI, no. 9:493-567.

Province of British Columbia

1996 Archaeological Impact Assessment Guidelines. Ministry of Tourism and Ministry Responsible for Culture, Archaeology Branch. Victoria.

Ridington, W. R. Jr.

1988 *Trail to Heaven: Knowledge and Narrative in a Northern Native Community*. Douglas and McIntyre, Vancouver.

Savage, H.

1963 The first journalist. In *Peace River Chronicles*, Prescott Publishing Company, Vancouver, pp. 260-270.

Scriba, E. J.

1997 Personal communication. Coordinator, Operations. Petro-Canada, Fort St. John, B.C.

Strong, W. L

1992 *Ecoregions and ecodistricts of Alberta*. Alberta Forestry, Lands & Wildlife, Edmonton.

Walde, K.

1990a Heritage resource inventory and impact assessment Placer Cego Petroleum pipeline (Amerada Hess Canada Ltd.) in Township 84, Range 15, W6M, Peace River District. Permit 1988-93b,c. Consultant's report on file, Archaeology Branch, Victoria.

1990b Monitoring and recovery of archaeological data Placer Cego Petroleum pipeline at HbRb 3, in LS 11-1-84-15-W6M, Peace River District. Permit 1989-8. Consultant's report on file, Archaeology Branch, Victoria.

Wilson, I. R.

1984 Heritage Resource Assessment of the Proposed Westcoast Transmission Company Ltd. Taylor NGL Plant Site, Permit 1984-25. I. R. Wilson Consultants Ltd.. Consultant's report on file, Archaeology Branch, Victoria.

1989 The Pink Mountain Site (HhRr-1): an Early Prehistoric campsite in northeastern B.C. *Canadian Journal of Archaeology*, Vol. 13: 51-68.

Wormington, H. M. and R. G. Forbis

1965 *An introduction to the archaeology of Alberta, Canada*. Denver Museum of Natural History, Proceedings, 11.

ARCHAEOLOGICAL IMPACT

ASSESSMENT

NOVAGAS CLEARINGHOUSE LTD.

TAYLOR STRADDLE PLANT SITE

PERMIT 1997-043

Prepared For

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April 15, 1997

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T2R 0A5

Attention: Mr. Terry Antoniuk

Dear Mr. Antoniuk:

I am pleased to submit to you this report entitled "Archaeological Impact Assessment Novagas Clearinghouse Ltd. Taylor Straddle Plant, Permit 1997-043".

Should you have any questions regarding this project, please do not hesitate to contact me.

Yours truly,

FEDIRCHUK McCULLOUGH &

ASSOCIATES LTD.

Barbara Kulle, M.A.

/b