Phased Environmental Impact Assessment (EIA) Submission for Development of the Pangburn Hydrocarbon Well: Well Pad Construction and Vertical Stratigraphic Drilling

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Project No. 121810275
April 11, 2014

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EXECUTIVE SUMMARY

SWN Resources Canada, Inc. ("SWN RC") proposes to further explore for hydrocarbon resources based on potential for such resources inferred from information gathered from exploration activities and available information.

SWN RC has retained Stantec Consulting Ltd. (Stantec), to prepare this submission for New Brunswick's Phased Environmental Impact Assessment (EIA) Process.

The exploration activity proposed herein is the drilling of a vertical stratigraphic well to further assess the potential for hydrocarbon-bearing formations underground and will include the construction of an access road and well pad on Crown Land near Pangburn, New Brunswick (the "Project"). This document contains information solely pertaining to the Project. The completion of any future work at this location will be dependent on the results obtained from the Project findings and subject to additional review by the New Brunswick Department of Environment and Local Government (NBDELG). The scope of future work will be defined as a new project description and submitted as a sequel to this Phased EIA Submission.

A description of the existing environment is presented in Section 3.0 of this Phased EIA Submission and is based on available information, public, stakeholder and First Nations communications and field surveys conducted by Stantec during 2013. The valued environmental components (VECs) that may interact with the Project include:

- Atmospheric Environment;
- Aquatic Environment;
- Water Resources;
- Terrestrial Environment;
- Historical and Current Use by First Nations;
- Socio-economic Environment;
- Land Use;
- Visual Environment;
- Heritage Resources; and
- Transportation Network.

This Phased EIA Submission considers the potential interactions of the Project, as presented in Section 3.0, with the surrounding environment. There were no species at risk, or ecologically sensitive or protected areas that would provide critical or limiting habitat within the Project Development Area (PDA) that were identified during the desktop review or site visits conducted for the Project.

In consideration of operational siting and environmental planning considerations (Section 3.2); the implementation of planned, proven and effective mitigation (Section 3.4) as part of the Project to reduce potential environmental interactions; and the inclusive continued First Nation, public and stakeholder engagement opportunities (Sections 4.0 and 5.0, respectively), there are no substantive environmental interactions anticipated as a result of the Project.

SOMMAIRE

SWN Resources Canada, Inc. (« SWN RC ») propose d'explorer davantage les ressources en hydrocarbures en fonction des ressources potentielles déterminées à l'aide de l'information recueillie à partir des activités d'exploration et des renseignements disponibles.

SWN RC a retenu les services de Stantec Consulting Ltd. (Stantec) afin de préparer cette soumission pour le processus d'étude d'impact sur l'environnement (EIE) par étapes du Nouveau-Brunswick.

Les travaux d'exploration proposés dans le présent sommaire visent le forage d'un puits vertical stratigraphique afin de poursuivre l'examen du potentiel de formations souterraines pétrolifères et inclura la construction d'une voie d'accès et d'une plateforme sur les terres de la Couronne près de Pangburn au Nouveau-Brunswick (le projet). Ce document contient uniquement de l'information concernant ce projet. La réalisation de travaux futurs à cet endroit dépendra des résultats obtenus à partir des conclusions du projet, sous réserve d'un examen additionnel effectué par le ministère de l'Environnement et des Gouvernements locaux du Nouveau-Brunswick. L'étendue de travaux futurs sera définie dans une nouvelle description de projet et sera présentée en tant que suite à la soumission de l'EIE par étapes.

Une description de l'environnement existant est fournie dans la section 3.0 de la soumission de l'EIE par étapes et a été préparée à partir des renseignements disponibles, des communications publiques, avec les intervenants et les Premières Nations, et des études sur le terrain réalisées en 2013 par Stantec Les composantes valorisées de l'écosystème pouvant avoir une interaction avec le projet comprennent :

- le milieu atmosphérique;
- le milieu aquatique;
- les ressources hydriques;
- le milieu terrestre;
- l'utilisation courante et historique par les Premières Nations;
- l'environnement socioéconomique;
- l'utilisation du territoire;
- l'environnement visuel;
- les ressources patrimoniales; et,
- le réseau de transport.

Cette soumission de l'EIE par étapes tient compte des interactions possibles du projet, telles qu'elles sont présentées dans la section 3.0, avec le milieu environnant. L'examen documentaire ou les visites du site effectués dans le cadre du projet n'ont pas révélé la présence d'espèces en péril ou d'aires protégées ou écosensibles qui fourniraient un habitat limitant ou essentiel au sein de la zone d'aménagement du projet.

Compte tenu des considérations relatives au choix du site et à la planification environnementale (section 3.2); de la mise en œuvre de mesures d'atténuation planifiées, éprouvées et efficaces (section 3.4) dans le cadre du projet afin de réduire les interactions possibles avec l'environnement; et des possibilités de participation inclusive et continue des Premières Nations, du public et des intervenants (sections 4.0 et 5.0, respectivement), on ne prévoit pas d'interaction importante avec l'environnement découlant du projet.

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LIST OF INITIALISMS AND UNITS

Initialisms/Unit	Definition
AANDC	Aboriginal Affairs and Northern Development Canada
AAS	(New Brunswick) Aboriginal Affairs Secretariat
AC CDC	Atlantic Canada Conservation Data Centre
AER	Alberta Energy Regulator (previously the Energy Resources Conservation Board of Alberta (ERCB)
API	American Petroleum Institute
asl	above sea level
BOP	blow-out preventer
CAODC	Canadian Association of Oilwell Drilling Contractors
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
dB_A	decibels on the A-weighted scale (measure of noise)
DFO	Department of Fisheries and Oceans
DWA	deer wintering area
EIA	environmental impact assessment
ERCB	Energy Resources Conservation Board (Alberta)
FIT	formation integrity test
GHG	greenhouse gas
GWP	global warming potential
ha	hectare
IADC	International Association of Drilling Contractors
IK	indigenous knowledge
IPCC	Intergovernmental Panel on Climate Change
km	Kilometre
kPa	KiloPascal
L_{dn}	equivalent sound pressure level averaged over a day and night period
L_{eq}	equivalent sound pressure level
LiDAR	light detection and ranging (for the purpose of digital elevation modeling)
LOS	level of service
m	metre
m^3	cubic metre
MSDS	Material Safety Data Sheets
N_2O	nitrous oxide

Initialisms/Unit	Definition
NAAQO	National Ambient Air Quality Objectives
NBDELG	New Brunswick Department of Environment and Local Government
NBDEM	New Brunswick Department of Energy and Mines
NBDNR	New Brunswick Department of Natural Resources
NBDNRE	New Brunswick Department of Natural Resources and Energy
NBDTI	New Brunswick Department of Transportation and Infrastructure
NBENV	New Brunswick Department of Environment
NORM	Naturally-occurring radioactive materials
NO_x	nitrogen oxides
NTNB	Nature Trust of New Brunswick Inc./La Fondation pour la protection des sites naturels du Nouveau-Brunswick Inc.
PDA	Project Development Area
PID	parcel identifier
PNA	Protected Natural Area
PM	particulate matter
POL	Petroleum, oils and lubricants
SAR	species at risk
SNB	Service New Brunswick
SO_2	sulphur dioxide
SOCC	species of conservation concern – Those listed under provincial or federal Species at Risk Acts, or ranked S3 "Sensitive" or rarer by the ACCDC
SWN RC	SWN Resources Canada, Inc.
Tcf	trillion cubic feet
THC	total hydrocarbon
tonne	metric tonne
TRC	Technical Review Committee
VEC	valued environmental component
WHO	World Health Organization

1.0 INTRODUCTION

New Brunswick legislation and regulation require that certain projects or work must be evaluated through an environmental impact assessment (EIA) process (see Schedule A to the New Brunswick *Environmental Impact Assessment Regulation—Clean Environment Act*, Regulation 87-83). In addition, the Province of New Brunswick has created a Phased EIA process and though the process is not yet governed by specific legislation or regulation, certain projects such as oil and gas exploration drilling work are evaluated through a Phased EIA Submission to the New Brunswick Department of Environment and Local Government (NBDELG). The Phased EIA process is characterized as an opportunity for greater environmental stewardship by allowing regulators and the public to conduct early stage evaluation of various project developments.

This document is being submitted to NBDELG as part of the Phased EIA Process for the construction of an access road and well pad, and the drilling of a single vertical stratigraphic well (the "Project") on Crown Land on PID No. 45093291 near Pangburn, New Brunswick (the "Project Site" or the "Site") by SWN Resources Canada, Inc. ("SWN RC", or the "Proponent"). The Phased EIA process closely mirrors the EIA registration process and this submission reflects that. For greater certainty, this Project does not trigger an EIA registration but rather this document is a submission pursuant to the Phased EIA process.

This document contains information solely pertaining to the Project. . The completion of any future work at the Site is dependent on the results obtained from the Project findings. If a decision to carry out further work is made, the scope of that work will be defined as a new project description and submitted in addition to this Phased EIA Submission. An EIA registration requires governmental approval before the work that is described therein may be carried out.

1.1 OVERVIEW OF THE PROJECT

The Project Site is located in Queens County, New Brunswick approximately 4.5 km southeast of the rural area of Pangburn, 6.7 km northwest of the rural residential area of Forks Stream, and approximately 20 km east of the Village of Chipman (Figure 1.1).

The Project will consist of the construction of a 2 hectare (ha) well pad to house the well and one 430 m long access road connecting the well pad to existing road infrastructure, the drilling of a single vertical stratigraphic well to an approximate depth of 1,000–4,000 m and drainage infrastructure. This construction and drilling will allow for an examination of the stratigraphy that will aid in assessing the potential for hydrocarbon resources.

The specific activities that will be conducted as part of the Project are described in Section 2 of this Phased EIA Submission document and include the following:

- access road and well pad construction, including surveying, clearing, grubbing, and leveling of one access road and well pad;

- preparation and construction of the sub-base and base for the one access road and well pad using local aggregates and fill materials, compaction, and ditching (as applicable);
- stratigraphic drilling (with no hydraulic fracturing or other hydrocarbon producing activities), and casing installation;
- examination of stratigraphy and well logs;
- decommissioning of the well and restoration of the Site (if the well is determined to be unsuitable for future development), or the preparation of the well to allow for further testing exploration in subsequent projects, as the case may be;
- Project-related transportation;
- road repair and maintenance;
- water and material sourcing; and
- management of emissions and wastes associated with the above-noted activities.

As discussed in Section 2.2.3.1, if the well is determined to have insufficient potential for hydrocarbon development and a decision is made not to proceed with additional testing or drilling at this Site, the well will be permanently plugged and decommissioned, and restoration of the Site will occur. Conversely, if SWN RC identifies the potential for hydrocarbon resources as a result of the Project and seeks to explore this further, then the well will be temporarily rendered inactive and secured pending procedures for such subsequent Phased EIA Submissions or EIA registrations for such further work.

1.2 PURPOSE/RATIONALE/NEED FOR THE PROJECT

SWN RC proposes to further explore for hydrocarbon resources at this location based on potential for such resources inferred from information gathered from exploration activities and available information. The exploration activity proposed herein is the drilling of a vertical stratigraphic well to further assess the potential for hydrocarbon-bearing formations underground.

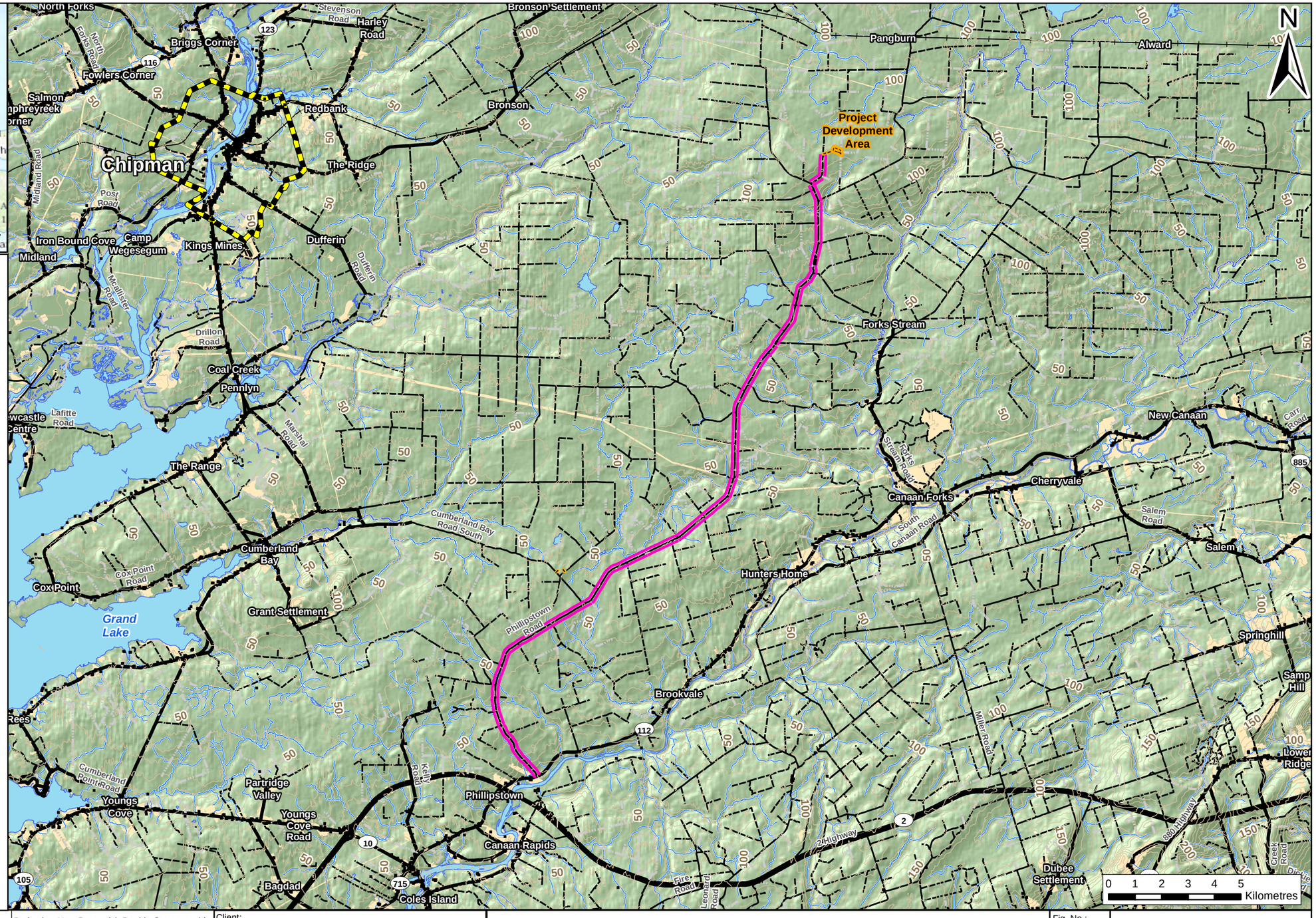
The history of oil and gas development and potential in New Brunswick and background information on geological formations and exploration activities undertaken to date by SWN RC are provided for context below in Section 1.2.1.

1.2.1 History and Background

There is a long history of oil and gas development in New Brunswick, dating back to 1859 when exploration first began within Mississippian-aged sediments of the Moncton Sub-basin. In 1909 commercial production of oil and natural gas began at the Stoney Creek oil field located near Hillsborough, and such production continues today (St. Peter 2000). Other hydrocarbon resources in the form of natural gas were later discovered and developed in 2000 near Penobsquis, in an area now known as the McCully gas field (NBDELG 2012a). An overview of the geological setting, including the location of existing oil and gas operations and infrastructure is presented in Figure 1.2.

Legend

- Building
- Preferred Access Route
- Project Development Area (PDA)
- Municipal Area
- Contour (10m)
- Major Road
- Secondary Road
- Resource Road
- Trail/Abandonned Road
- Railway
- Waterbody (NBDNR)
- Watercourse (NBDNR)
- Non-forest
- Forest



NBDNR: Forest Inventory Database Layers (2009)
SNB: Provincial Layers (2005), Municipalities Layer (Oct 2011),
NBDELG: Regulated Wetland Layer (March 2011)

Projection:	New Brunswick Double Stereographic
Scale:	1:150,000
Date:	08 Apr 2014
Fig. By:	JAB
Appd. By:	MM

Client: SWN Resources Canada

Project: 121810275

Site Location - Pangburn

Fig. No.: 1.1

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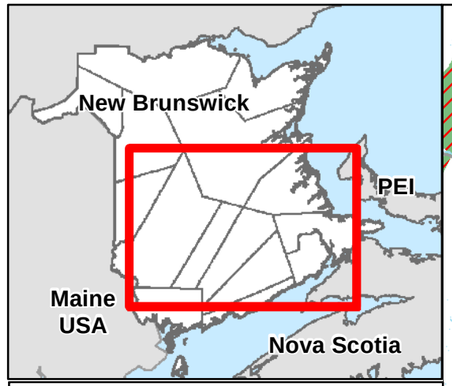

Legend

- NB Provincial Boundary
- Major Road
- Oil and Gas Lease Onshore
- Oil and Gas Licence to Search Onshore
- SWN RC Licence Block Boundary
- Maritimes and Northeast Pipeline
- Carboniferous Age
- Horton Group
- Mabou Group
- Pictou Group
- Waterbody (NBDNR)

SWN RC LICENCE BLOCK
CONTACT EXPLORATION INC.
PETROWORTH RESOURCES INC.
STONEY CREEK GAS FIELD
CONTACT EXPLORATION INC.
CORRIDOR RESOURCES INC.
MCCULLY GAS FIELD
WINDSOR ENERGY INC.
BENEFICIAL ENERGY GROUP, LLC
BENEFICIAL ENERGY GROUP, LLC
PETROWORTH RESOURCES INC.

Big Cove
Bouctouche
Saint-Antoine
Shediac
Hildegarde
Moncton
Dieppe
Riverview
Salisbury
Sackville
Amherst
Sussex
Hampton
Gondola Point
Fairvale
Rothesay
Wells
Forest Hills
Grand Bay
Lakewood Heights
Nashwaaksis
Fredericton
Marysville
New Maryland
Oromocto
Oromocto West

0 10 20 30 40 50 Kilometres

N

Recommended Citation: Rampton, V.N. 1984. Generalized surficial geology map of New Brunswick Department of Natural Resources and Energy, Minerals, Policy and Planning Division, NR-8 (scale 1:500,00).

Projection:	New Brunswick Double Stereographic
Scale:	1:800,000
Date:	06 Apr 2014
Fig. By:	JAB
Appd. By:	MM

Client: swn Resources Canada

Project: 121810275

Southeastern New Brunswick Geology and Oil and Gas Lease / Licence Blocks

Fig. No.: 1.2

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New Brunswick lies along the western portion of the Maritimes Basin, that was formed approximately 340–360 million years ago during the late Devonian and Mississippian periods. The Maritimes Basin is considered to have potential for hydrocarbon resources (Dietrich *et al.* 2009) and it extends from south-central New Brunswick to Prince Edward Island and the northern portion of Nova Scotia. Within the Maritimes Basin, the Lower (deeper) Carboniferous sub-basins extend along a northeast axis between an area south of Fredericton towards Moncton and have a high potential to contain petroleum resources. In these sub-basins, sandstone and shale rock formations within the deeper Horton Group and confined by the shallower Mabou and Pictou Groups have been found to provide a geological setting that is prospective for hydrocarbons. A number of areas within this formation have been explored and have been proven to contain hydrocarbons.

With the emergence of new technologies (*e.g.,* high precision multi-directional drilling techniques, multi-well pads; and hydraulic fracturing), there has been renewed interest in determining whether there are additional economically-viable hydrocarbon reserves in deep sedimentary layers within the Maritimes Basin of New Brunswick. The drilling of a single stratigraphic well (as is described herein) does not require the use of these new technologies. The use of stratigraphic drilling to assess resource potential is a common practice in New Brunswick and, indeed, worldwide and has been conducted many times in this region to assess the potential for hydrocarbons and other commercial resource minerals.

Undeveloped natural gas reserves in New Brunswick have been estimated at 1.9 trillion cubic meters (67.3 trillion cubic feet) (Tcf) (Eaton 2010), equivalent to approximately nineteen times the size of the Sable Island conventional gas field that has been developed since 2000. Though these potential New Brunswick reserves (or their commercial development) are not yet proven, current indicators suggest that these reserves could represent a substantive contribution to energy demand. The commercial development of such resources, should it be determined to be viable, could provide employment opportunities for residents of the province, leasing opportunities for landowners, supply chain business opportunities, royalties and taxes for government, and it has the potential to positively affect the New Brunswick economy for present and future generations. Oil and gas exploration is the process for determining whether these potential reserves exist. Information gained through exploration will further the understanding of New Brunswick's geological history and its potential hydrocarbon resources.

1.2.2 Exploration to Date in New Brunswick by SWN Resources Canada

In 2010, the Province of New Brunswick, pursuant to the New Brunswick *Licence to Search and Lease Regulation—Oil and Natural Gas Act*, Regulation 2001-66) issued Licences to Search to SWN RC for the exploration of hydrocarbon resources over an area of approximately 1.1 million ha of New Brunswick, as shown in Figure 1.2. The purpose of the Licence to Search is to characterize potential hydrocarbon resources within the area so that SWN RC can assess the feasibility of extracting such resources for commercial purposes and to determine if they will seek to convert selected areas to a lease by application under the Licence to Search and Lease Regulation.

Throughout 2010 and 2011, and also in 2013, SWN RC conducted geophysical (seismic, gravity and magnetic) surveys, surface geochemical surveys and aerial photography, and they prepared digital elevation maps. Through these processes, the area near the Project Site was identified as potentially prospective for hydrocarbons, thus requiring further evaluation by drilling a stratigraphic well.

The specific purpose of the Project, (*i.e.,* drilling a stratigraphic well), is to assess the potential for subsurface formations at the Project Site to hold recoverable hydrocarbon resources. Stratigraphic drilling will also be used to calibrate the interpretation of non-intrusive geophysical survey data collected to date to more accurately estimate areas with higher potential for hydrocarbon presence within SWN RC's Licence to Search area.

As part of its Licences to Search, SWN RC has committed to investing $47 million in New Brunswick towards geophysical, geochemical, and drilling exploration of its Licence to Search area. The Project described herein represents an investment of $4–6 million. A portion of this investment will flow into local economies through wages, services, equipment rentals, and purchases. Distribution to local economies will also occur via the workers employed while undertaking the activities for access road and well pad construction and drilling, as well as the purchase of equipment and consumables. This distribution of money will contribute to economic development in the local area and the province.

1.3 PROPONENT INFORMATION

The Proponent contact information is as follows:

Name of Proponent:	SWN Resources Canada, Inc.
Mailing Address of Proponent:	P.O. Box 35 Moncton, NB E1C 8R9
Contact Person for this EIA Submission:	Chad Peters, Manager, New Brunswick, Exploration
Telephone Number:	Toll Free 1-877-SWN-NB23 (1-877-796-6223)
Fax Number:	(506) 382-9497
Electronic Mail Address:	swnnb@swn.com
Website:	www.swnnb.ca

1.4 PROPERTY OWNERSHIP

The Project Site is situated entirely on Crown land on PID No. 45093291, in Queens County, New Brunswick.

1.5 FUNDING

The Project will be financed entirely by SWN RC.

1.6 PROJECT-RELATED DOCUMENTS

Other Project-related documents developed in support of this document, including an Environmental Protection Plan and an Emergency Response Plan, will be submitted to NBDELG under separate cover.

1.7 ORGANIZATION OF THIS DOCUMENT

This Phased EIA Submission contains the following eight sections.

- Background information and an overview of the Project are provided in Section 1.
- A detailed description of the Project and construction and drilling activities associated with the Project are provided in Section 2.
- A discussion of environmental setting and potential Project-environment interactions, along with key mitigation to reduce environmental effects, is provided in Section 3.
- Information on First Nations engagement activities that have been conducted or are planned as part of the Project is provided in Section 4.
- Information on public engagement activities that have been conducted or are planned as part of the Project is provided in Section 5.
- Conclusion and summary of assessment are provided in Section 6.
- Closing remarks and a statement of limitations in respect of this document are provided in Section 7.
- The references consulted in the preparation of this document are provided in Section 8.

2.0 PROJECT DESCRIPTION

This Section provides a general overview of the Project, its location, related elements, and activities to be undertaken. It also provides a description of the mitigation measures that will be put in place to reduce potential environmental effects during the Project.

2.1 PROJECT DEFINITION AND LOCATION

The Project consists of the construction of a 2 ha well pad to allow for the drilling of a stratigraphic well, to an approximate depth of 1,000–4,000 m, to assess the potential for hydrocarbon resources through an examination of the subsurface stratigraphy at the well location. An access road of approximately 430 m length will be constructed within a 20 m wide right-of-way to provide access for equipment and personnel from the existing secondary road adjacent to the west of the well pad.

The Project Development Area (PDA) is defined as the maximum extent of the physical area of disturbance of the Project and is shown on Figure 2.1. The PDA will include a 2 ha well pad, a well pad access road, drainage infrastructure, and all related areas where ground-breaking, clearing, or other construction activities will occur. Of the total area of the well pad portion of the PDA (3 ha), the well pad will be situated on approximately 2 ha, and the remainder may be undeveloped or used for other purposes such as drainage infrastructure, borrow material, and bullpens.

The PDA is situated on Crown land, approximately 4.5 km southwest of the rural area of Pangburn and 6.7 km northwest of the rural residential area of Forks Stream in Queens County, New Brunswick. The parcel identifier of the Project Site as referred to by Service New Brunswick is PID No. 45093291, and the approximate centre of the PDA is at coordinates 46°10'17.567"N and 65°35'7.267"W.

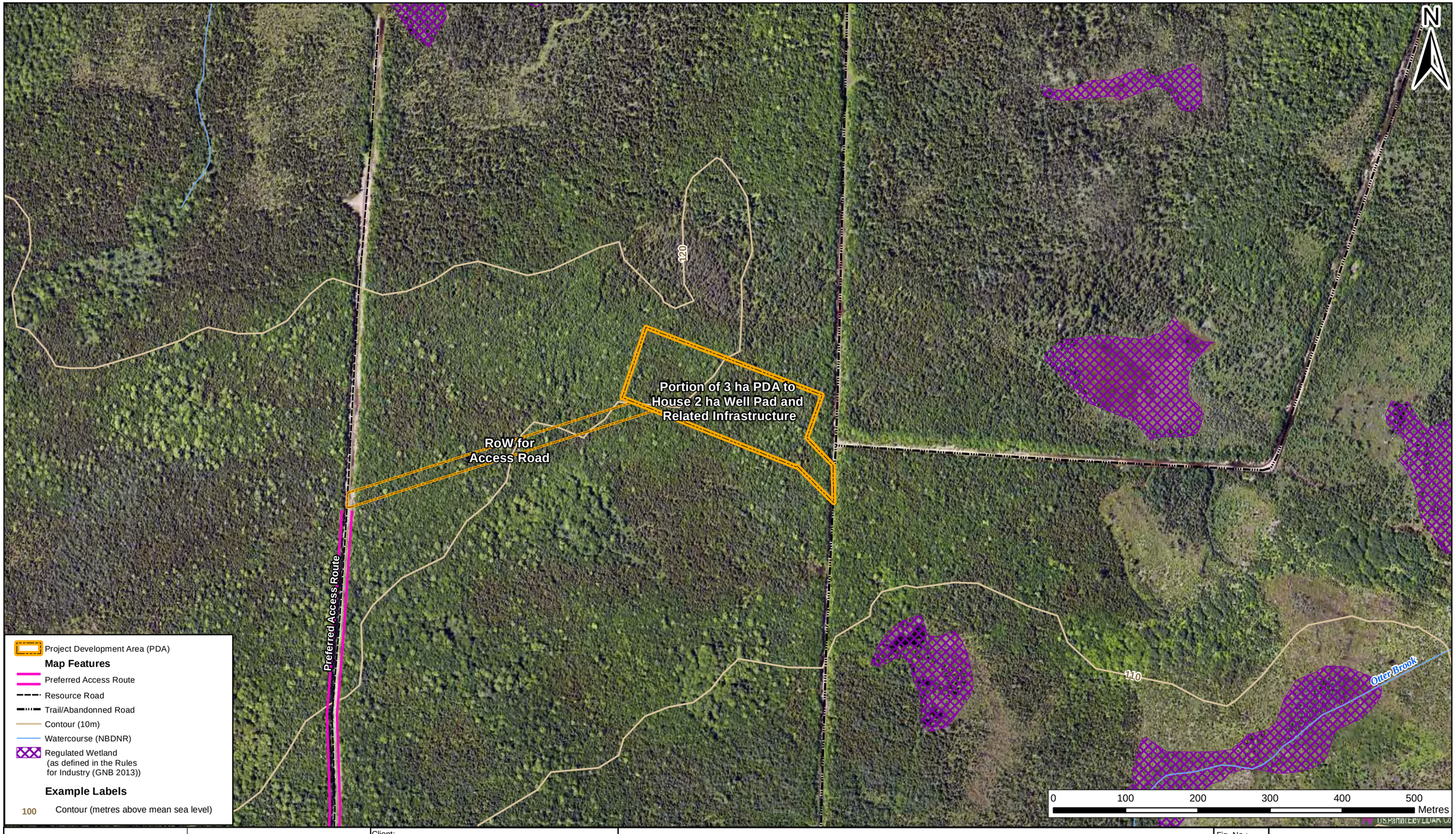
Since the PDA is located outside of an incorporated municipality; local governance is by the Regional Service Commission – District 8. The Crown Lease for the Site is currently held under the Fundy Crown Timber Licence, which is being managed by J.D. Irving, Limited. Access to the PDA will be via existing forest resource roads that eventually join with Phillipstown Road and then to Route 112 to the south (Figure 1.1).

2.1.1 Site Selection Process

SWN RC uses a systematic site selection process to identify sites to drill a stratigraphic well to assess the geology for potential hydrocarbon resources. The process begins with a thorough review of existing geological and environmental information over the Licence to Search area. The PDA was selected considering the following, among other factors:

- geology and geophysical survey results (existing information and information gathered by SWN RC surveys conducted in 2010, 2011, and 2013);
- environmental constraints; and
- operational constraints and feasibility.

The process by which the Project Site and the PDA were selected is discussed further in Section 3.2.



Sources: Base Data: NBDNR, SNB, NBENV;
ESA, Species Observations, Managed Areas: ACCDC
Aerial Imagery: Spatial Energy 2011
Regulated Wetland layer provided by NBDELG, obtained from GeoNB in March 2012.

Projection:	New Brunswick Double Stereographic
Scale:	1:5,000
Date:	29 Mar 2014
Fig. By:	JAB
Appd. By:	MM

Client: SWN Resources Canada

Project: 121810275

Project Development Area (PDA) - Pangburn, Queens County, New Brunswick (Crown Land PID No. 45093291)

Fig. No.: 2.1

Stantec

2.2 PROJECT COMPONENTS AND ACTIVITIES

This Section describes the components and activities required for, and associated with, the Project.

Project components include:

- well pad;
- well pad access road;
- associated infrastructure (*e.g.,* storm water collection ponds, fluid storage tanks, fuel tanks, bull pens, borrow pits, fencing, access route roadway maintenance and repairs, as necessary);
- stratigraphic well drilling and associated equipment; and
- once drilled, the stratigraphic well itself and its associated components (*e.g.*, casing, grouting).

The construction of these and other Project components will be carried out during the Project as follows:

- construction (for the access road and well pad, including surveying, clearing, grubbing, levelling, site preparation, sub-base and base construction, ditching and drainage management, and related activities) (collectively referred to as a phase known as "Construction"); and
- drilling (including all activities associated with the drilling of the stratigraphic well and associated mitigation measures, casing, cementing, drilling fluid management, and waste management) (collectively referred to as a phase known as "Drilling");
    - stratigraphic examination (including review of well logs, and testing and monitoring of the well to examine the stratigraphy of the well); and
    - preparation for subsequent exploration or testing (if the well stratigraphy is determined to be viable and worthy of pursuing ongoing development), or decommissioning and site restoration (if the well is determined to be non-viable for hydrocarbon resources and not worthy of further development).

The Environmental Protection Plan (provided under separate cover) provides additional details on how the above activities will be completed in terms of environmental protection measures and procedures that must be implemented for the Project as planned by SWN RC. Drilling of the stratigraphic well and associated activities will be conducted in accordance with "Responsible Environmental Management of Oil and Natural Gas Activities in New Brunswick; Rules for Industry, February 15, 2013" (hereinafter referred to as the "Rules for Industry"; GNB 2013).

Further details on these Project components and the activities that will be conducted to complete well pad development and Drilling are provided below.

2.2.1 Construction : Access Road and Well Pad

The Project Site was chosen, in part, because of its proximity to an existing road network that is suitable for transportation of construction and drilling Equipment and related activities; therefore no new roads will be required other than one short access road to the well pad. The 430 m long access road will be constructed within the 20 m wide right-of-way, as shown in Figure 2.1, to link the existing adjacent secondary road to the well pad location.

The activities associated with the construction of the access road and the well pad are consistent with the following work progression and activities:

- site preparation;
- sub-base and base construction;
- run-off management;
- well pad layout;
- construction of ancillary facilities; and
- installation of fluid storage tanks and construction of secondary containment.

2.2.1.1 Site Preparation

Site preparation includes:

- surveying;
- clearing;
- grubbing; and
- bull pen construction and use for disposal and/or temporary storage of natural materials (*e.g.*, top soil, overburden, removed vegetation) cleared from within the PDA.

2.2.1.1.1 Surveying

Surveying occurs prior to clearing and includes the cutting and marking of a centerline and cross-section offsets wide enough to provide unobstructed sight lines. The well pad and access road will be located more than 150 m away from Otter Brook and Perry Brook. The location of the well pad and well head will be in accordance with existing legislation and Section 9.8 of the Rules for Industry (GNB 2013).

At the time of surveying, a pre-construction site assessment will be conducted to document existing (pre-development) soil type(s) and distribution, vegetation type(s) and distribution, drainage and topography at the PDA to guide future restoration activities in accordance with Section 9.12 and Appendix 17 of the Rules for Industry (GNB 2013). Section 2.2.4 provides additional information on the

decommissioning and restoration of the PDA. Ditches may be established at this time to drain water away from the well pad area.

2.2.1.1.2 Clearing and Grubbing

Clearing and grubbing will be limited to within the PDA. Clearing and grubbing boundaries will be delineated by visual flagging of the limits of the PDA during surveying. The width of the access road will be based on the requirements for the anticipated equipment to be used for the drilling of the well and associated traffic. The clearing and subsequent handling of merchantable timber will be managed in consultation with NBDNR and the Crown Timber Licensee for the area.

Grubbing for construction of the access road and the well pad involves the removal of surficial organic material and unsuitable materials, debris, and soil above the sub-soil layer. Bulldozers will remove the organic material from the underlying sub-soil and stockpile it for future restoration of the PDA; this will include topsoil that will be managed in accordance with the *Topsoil Preservation Act*. Other grubbed material will be stockpiled and or disposed of in the bull pen within the PDA.

Clearing and grubbing activities will be avoided to the extent necessary during the peak bird breeding period of May 1 to August 31 to avoid direct harm to protected bird species known to nest and breed in New Brunswick. Protected bird species include those protected under the federal *Migratory Birds Convention Act* and/or *Species at Risk Act* (*SARA*), and under the New Brunswick *Species at Risk Act* (NB *SARA*). Other mitigation steps may be taken as needed during clearing and grubbing to reduce the risk of nest destruction or disturbance to breeding birds. A bird biologist will be engaged prior to the start of clearing and grubbing activities to verify conditions and to identify additional mitigation if needed. The potential presence of protected bird species is discussed further in Section 3.4.4.

2.2.1.1.3 Bull Pen Construction and Use

Bull pens will be used within the PDA for the disposal and/or temporary storage of natural materials cleared from the PDA (*e.g.*, non-merchantable trees, stumps, and grubbing debris). Bull pens will be located at least 30 m from watercourses and regulated wetlands as defined in the Rules for Industry (GNB 2013) unless under the authority of a Watercourse and Wetland Alteration (WAWA) permit issued under the New Brunswick *Watercourse and Wetland Alteration Regulation—Clean Water Act*, Regulation 90-80 (the *Watercourse and Wetland Alteration Regulation* (WAWA Regulation)).

2.2.1.1.4 Sub-base and Base Preparation and Construction

Following grubbing, the sub-base for the well pad and new access road will be prepared by leveling the terrain through excavation or placement of soil materials. The sub-base is the stable material upon which the access road and well pad will be built to provide the required strength and stability to support Site activities and equipment. If the exposed natural soils are of a suitable material to be used as the sub-base, these soils will be compacted until firm and stable. Soils that cannot withstand heavy loads will be excavated and replaced with a material that can withstand heavy loads. Compaction will be accomplished using rollers, soil compactors, or both.

Once the sub-base has been prepared, a granular base will be applied in selected areas and graded to provide structural integrity, supply drainage, and improve weather resistance. Materials used to construct the sub-base and base will consist of suitable materials from within the well pad location (if available), or otherwise obtained from already developed local quarry areas or gravel pits.

2.2.1.1.5 Run-Off Management

SWN RC will develop a site-specific run-off management plan to manage run-off generated by rainfall and snow melt at the Site in a manner that aims to prevent soil erosion and the transport of contaminants off the well pad. This plan will be developed prior to ground disturbance. This plan will consider well pad design, as well as standard mitigation tools that may be used including but not limited to the following:

- erosion-control fencing;
- check dams;
- surface water catchment ponds;
- diversion ditches;
- mulching;
- impermeable liners; and
- containment berms.

Surface water will be managed throughout the PDA to reduce erosion and the potential release of petroleum, oils and lubricants (POL) or other contaminants to the surrounding environment. Areas that will be used for storage and handling of drilling fluids or wastes will be equipped with an impermeable synthetic liner and contained on the perimeter by berms. Storm water or other fluid that accumulates within the containment berms will be collected and trucked to a disposal facility, tested and treated as necessary on-site prior to release to the environment. The remainder of the well pad area will have perimeter ditching to avoid off-site surface run-off from draining onto the well pad as well as to direct run-off from un-lined areas of the well pad away from equipment work areas and towards storm water collection ponds. Storm water collection ponds will be designed to allow suspended sediments to settle out of the water column prior to release from the Site.

Ditches, containment berms and storm water collection ponds will be sized to accommodate anticipated heavy precipitation events.

The well pad and access road locations will be more than 150 m from the nearest watercourse, Otter Brook; therefore no watercourse-crossing structures will be required as part of the Project.

2.2.1.2 Well Pad Layout and Ancillary Facilities

The purpose of the well pad is to provide a level and stable area that drilling activities can take place upon, isolated from the surrounding environment. The central component of the well pad is the drilling rig, which is supported by various types of equipment and ancillary facilities. A typical well pad layout is shown in Figure 2.2. A site-specific and detailed plan of the well pad, including access road location, will be developed and submitted prior to commencement of the Project.

Equipment required to support Drilling can be generally categorized and described as follows.

- General Operational Resources (Auxiliary Equipment): Key components that are required to support Drilling include power generators (power package), fuel storage tanks, power source for blow-out preventer (BOP) equipment, hydraulic equipment, and water storage tanks.

- Drill Fluid System Components: Throughout Drilling, drilling fluid is circulated and monitored to facilitate drilling in consideration of any changes in sub-soil and rocks types that may be encountered below surface. A number of mixing/processing units, storage tanks, and pumps are used to manage this process.

- Drilling Fluid Cleaning and Waste Management Components: Various pieces of equipment are used to separate drill cuttings from drilling fluid, as well as to store or treat waste by products that are generated. Generally, a series of shakers and centrifuges are used to separate drilling fluid from cuttings, as well as storage tanks and dehydrators, to further manage the drilling fluid and drill cuttings.

- Staff Facilities: Facilities to accommodate the staff working at the Site include buildings/mobile trailers brought on-site to be used as offices, living quarters, washrooms, lunchrooms, and changing areas. Potable water storage tanks will be used to supply freshwater to these buildings. Wastewater from staff facilities will be managed using storage tanks and disposal at septage handling facilities.

- Equipment and Material Storage: The well pad is also used for storage of casing, pipe, cement and other drilling equipment that is not in current use.

2.2.1.3 Fluid Storage Tanks and Secondary Containment

The main fluids that will be used as part of the Project and stored on-site are water, diesel fuel and water-based drilling mud. Although not considered a fluid, drill cuttings will be produced and will have varying moisture content; therefore, they will be treated as a fluid until they are sufficiently dried. Fluid storage tanks (other than water) on the well pad will be equipped with secondary containment with sufficient capacity to contain 110% of the largest single tank or of all the connected tanks (whichever is greater). Containment will be constructed in accordance with specifications outlined in Appendix 8, of the Rules for Industry (GNB 2013). In addition to Appendix 8, diesel fuel or other petroleum storage tanks will also comply with the *Petroleum ProductStorage Handling Regulation—Clean Environment Act*, Regulation 87-97.

A description and approximate volume of fluids to be stored in tanks on the well pad are provided below:

- freshwater: approximately 100 m^3;
- potable water: approximately 20 m^3;
- diesel fuel: approximately 38,000 L;
- drilling fluid: 80–160 m^3;
- displaced drilling fluid during cementing: 200 m^3;
- mix fluids for cementing: 50-100 m^3; and
- drill cuttings: approximately 100 m^3 .

The configuration of the tanks will be determined in discussion with the drilling contractor, once the contractor has been selected. The freshwater tank will be made of steel or plastic, and all other tanks will be made of steel. All tankage will be above-ground and inspected by a Professional Engineer prior to use and a signed and stamped copy of the inspection report will be kept at the Site. To avoid a release, plugs or valves located on fluid storage tanks will be locked when not in use to avoid accidental or intentional releases as a result of vandalism or other causes.

2.2.2 Drilling

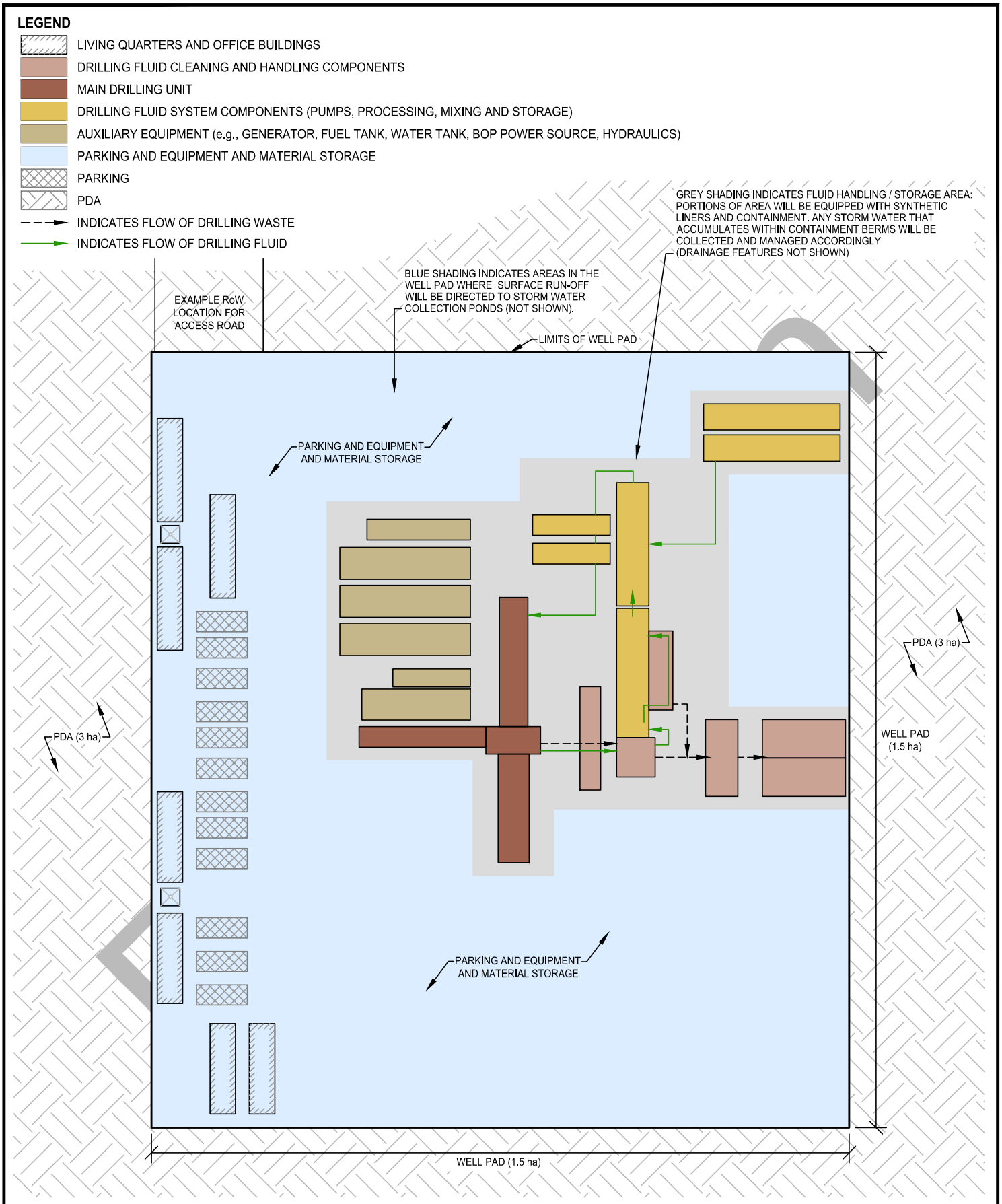
A single stratigraphic well will be drilled to an approximate depth of 1,000–4,000 m. The following Sections describe the drilling process and the various components required to support it.

2.2.2.1 Drilling Rig and Drill String Components

A drilling unit and its ancillary equipment, collectively referred to as a "drilling rig" or simply "rig", will be used to bore a well into the ground to the desired final depth. The drilling rig will be selected in consideration of the capacity of the rig to achieve the maximum desired target depth of the well, and the availability of rigs within the planned drilling timeline. The specific drilling rig or drilling contractor have not yet been selected for the Project; therefore the equipment and processes described below are to be considered typical for Drilling to be completed. The conductor hole, or uppermost section of a drilled well (anticipated to be approximately 20 m deep), will likely be drilled by a smaller drilling rig, prior to moving in the rig that will be used to drill the wellbore.

The drilling of the wellbore into the ground is accomplished by rotating a weighted metal drill string with a drill bit attached to its end into the ground (Figure 2.3). The wellbore is completed as a result of the weight of the lower components of the drill string providing downward pressure on the drill bit. Taken together, these various components are called the "drill string" and consist, from the bottom up, of:

- the drill bit: made with very hard metal or diamond surfaces, capable of breaking apart the rock formation into which it is being drilled;



THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

TYPICAL WELL PAD LAYOUT WITHIN THE PDA

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Date:	10-APR-2014
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Fig. No.: 2.2

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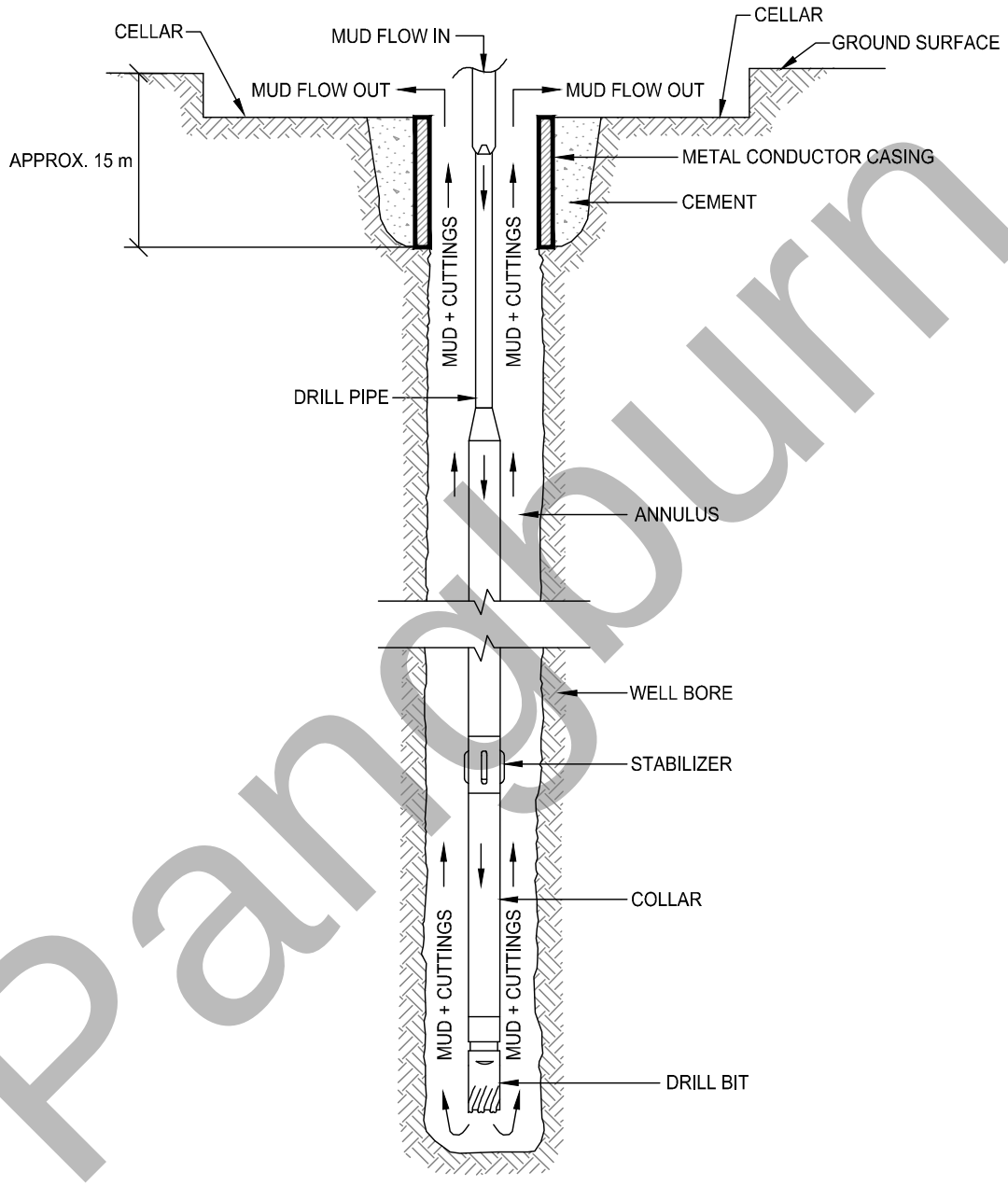
LEGEND

METAL CASING

EXISTING GROUND

CEMENT



TYPICAL DRILL DETAIL

Job No.:	121810275
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Dwn. By:	JL
App'd By:	MK

Fig. No.: 2.3

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- drill collars (usually with stabilizers: Thick walled tubes of metal positioned near the bottom of the drill string to provide weight for the drilling. Drill stabilizers are generally installed near the bottom of the drill string to provide stability and maintain a straight, vertical hole; and

- drill pipe: lightest and smallest diameter metal tubing used to connect the lower components of the drill string to the surface equipment.

The nature of the anticipated rock formations to be drilled and purpose of the wellbore are used to determine which combination of drill bit, collars, and stabilizers will provide the optimum combination of penetration rate and operating duration. All components of the drill string are hollow to facilitate the circulation of drilling fluid though the drill string to the drill bit.

2.2.2.2 Drilling Fluid and Drilling Fluid Management

Drilling fluid, also referred to as "drilling mud" or simply "mud", serves a wide variety of functions and is a fundamental component of the drilling process. Drilling fluid is used to:

- lubricate, clean, and cool the drill bit;

- carry the drilled rock cuttings to the surface;

- provide a jetting action at the drill bit to enhance rock breakage;

- act as a sealant on the wellbore formation walls;

- provide hydrostatic pressure to control influx of formation fluids; and

- maintain the integrity of the wellbore.

In its simplest form, drilling fluid consists of freshwater and bentonite (clay). Other materials are added to enhance specific properties or characteristics as described in more detail in Section 2.2.2.1. The drilling fluid is fed into a large pump from storage tanks and pumped through a flexible high-pressure hose into the top of the hollow drill string. The drilling fluid pumps provide the pressure to force the drilling fluid through the inside of the drill string and down the wellbore, emerging into the wellbore through ports or "jets" in the drill bit. Pumping the drilling fluid through the drill bit creates a jetting action, which assists in breaking the formation rock. The remaining pressure is adequate to overcome the small amount of friction and circulate the fluid and drill cuttings back up the wellbore to the surface in the space between the drill string and wellbore formation wall, known as the "annulus", as shown in Figure 2.3.

As the drilling fluid returns to the surface, the fluid and bedrock cuttings mixture is captured and carried to the drilling fluid cleaning equipment and drilling fluid storage tanks. Following the cleaning, the drilling fluid is then recirculated into the drilling process.

There are two types of drilling fluid (mud) commonly used in exploration drilling:

- water-based mud (WBM); and

- oil-based mud (OBM).

Hole tortuosity (*i.e.*, the aggregated effect of multiple curves throughout the wellbore, which can result in increased friction during Drilling) and the nature of formation rock are conditions that are considered in determining the type of drilling fluid to be used. Oil-based mud generally reduces friction between the drill string and the wellbore. Also, naturally-occurring chemical elements or materials in the formations encountered may react with water-based mud, whereas oil-based mud is generally non-reactive.

Water-based mud is planned to be used for this well; however, contingency plans are in place to convert to an oil- or synthetic-based mud system should such a conversion be deemed necessary based on the above described considerations. No system other than a water-based mud system will be used when drilling through freshwater zones near the surface, until such time that these freshwater zones are properly cased and cemented.

Drilling fluid and rock cuttings will be managed on the well pad using a closed-loop system, in that the drilling mud will be stored, mixed, contained, and cleaned using tanks rather than in-ground pits.

2.2.2.2.1 Drilling Fluid Components

Conditions within the wellbore will change as the drill bit is driven deeper below the ground surface and encounters older and more varied rock formations. These changes will affect the integrity of the wellbore, and may compromise the ability of the drilling fluid to perform its various functions properly. As such, drilling fluids consist of several components that are generally used in the drilling fluid mixture to achieve the correct balance of weight, viscosity, lubrication and ability to withstand pressure and heat. Information on the drill fluid component materials and their Material Safety Data Sheets (MSDS) will be readily available at the Site.

The typical components of the drilling fluid, their relative approximate percentage weight (assuming a 1,100 kg/m^3 freshwater system) and their key functions are listed below:

- freshwater (85–92%): main component of the drilling fluid;
- bentonite (2–8%): added to the drilling fluid to provide viscosity to carry drilled cuttings and carry weightings;
- polymers (0–0.7%): added to increase the viscosity and ability of the drilling fluid to carry drilled cuttings to the surface from the deeper depths;
- caustic soda and lime (0.5–2%): used to raise the pH and maintain the efficiency of the drill fluid; low pH (acid) is corrosive on the metal components of the drilling rig; pH is usually kept in the 9–10 range because of the danger of the drilling fluid becoming acidic and can be varied, depending on other additives;
- lignite and calcium carbonate (0–7%): used to control fluid loss into porous rock formations within the wellbore;

- lignosulfonate (and sometimes lignite) (0–0.5%): used to deflocculate the drilling fluid by breaking down the large particles of amalgamated drilled solids so the fluid viscosity is decreased;
- gilsonite (0–0.5 %): used to help stabilize shale rock formations encountered in the wellbore; and
- weighting agents such as barite or calcium carbonate (0–8%): used to increase the hydrostatic pressure of the drill fluid column.

The drilled rock fragments that break away from the formations being drilled are referred to as "cuttings". As the drill progresses into the ground, the cuttings are brought to the surface in the returning drilling fluid. At the surface, the cuttings are removed from the drilling fluid in a cleaning process. The cleaning equipment typically includes:

- a shale shaker, which is a set of vibrating screens to remove larger cuttings;
- a degasser, which removes any gases that enter the drilling fluid from drilled formations; and
- desanders, desilters or a centrifuge, all of which remove finer cuttings and other solids by centrifugal force.

Once cleaned, the drilling fluid is stored in a tank or multiple tanks on the surface until reused in the drilling fluid pumping system and again circulated through the well. Discarded drilling fluid will be diverted to a storage tank and gradually returned to the drill fluid system, or designated for off-site disposal at a waste management facility legally able to accept the discarded drilling fluid.

Cuttings and discarded drilling fluid will be analyzed on a routine basis for the presence of naturally-occurring radioactive materials (NORMs) and other contaminants. Based on the results of this analysis, a decision will be made as to where the cuttings can be sent for disposal. Prior to disposal, the cuttings and discarded drilling fluid will be dried by mixing them with sawdust, wood chips, or some other absorbent material; placed in storage tanks; and managed as outlined in Section 2.2.5.

2.2.2.3 Drilling Plan and Casing Design

It is predicted that the target depth of the well (1,000-4,000 m) will be reached in three drilling stages, with the section of the wellbore for each drilling stage cased with steel pipe cemented in place. Casing is threaded metal tubing installed within the wellbore. The purpose of casing and the surrounding cement is to:

- isolate and protect shallow ground water zones;
- protect the more fragile shallow bedrock formations from the higher hydrostatic pressures required for the deeper drilling sections; and
- effectively control the well and avoid upward migration of fluids or gases.

The staged process for drilling the stratigraphic well, along with supporting steps within the drilling process, is described below.

Figure 2.4 depicts a typical cross section view of a well, including a typical casing and cement design. In accordance with Section 2.20 of the Rules for Industry (GNB 2013), a casing and cementing plan will be submitted to the government department having jurisdiction (the "Regulator") in advance of Drilling.

2.2.2.3.1 Conductor Hole

The "conductor hole" is the uppermost section of a drilled well. It will be a minimum of 20 m deep and may be drilled by a smaller rig in advance of the rig that will be used to drill the main well. The conductor hole will be located within a larger excavated hole that will be dug during the construction of the well pad. This excavated hole is called the "cellar", and its functions are to provide access to the lower casing head and BOP valves and to be a sump hole used to capture spilled drilling fluid during Drilling. The cellar is excavated and lined with either cement or corrugated culvert pipe with a cement floor. Any drilling fluid that is captured in the cellar is pumped to the drilling fluid cleaning units and is re-circulated into the drilling fluid system.

After drilling the conductor hole, steel casing (known as conductor casing) will be installed. The purpose of conductor casing is to keep the top of the wellbore (where there are much looser soils) from caving in and to provide a conduit to control and direct the flow of the drilling fluid returns to the drilling fluid cleaning equipment. The casing is inserted into the conductor hole, with the joints being threaded together at the surface. Construction grade cement will then be circulated into the annular space between the casing and walls of the wellbore and allowed to harden before further drilling takes place.

To provide an additional safety measure, the conductor casing will be equipped with a diverter system that can be used to facilitate well control in the event that high-pressure formations are encountered while drilling the surface hole. This will allow any gases or liquids flowing out of the well to be directed away from the working area. The diverter is removed after running and cementing the surface casing and is replaced by the BOPs. Additional details are provided in Section 2.2.2.4.

After the completion of the conductor hole, the drilling rig to be used for the remainder of the drilling will be moved onto the well pad and set up.

2.2.2.3.2 Surface Hole

The next section of the well is referred to as the "surface hole" and is projected to be 300−400 m deep, although it may be deeper. The actual depth of this drilled section will depend on the nature of the formation being drilled in order to verify the bottom of the casing (the casing shoe) is in non-porous, competent rock, and is at least 25 m below formations that contain non-saline groundwater. The casing for this section is called "surface casing". When the proper depth is reached, electric logs (electric resistivity, porosity, and gamma ray detection tools) will be run down the length of the well to provide a continuous record of the rock formations penetrated and also to verify water salinity throughout. This information aids drillers to identify the depth of freshwater zones relative to the depth of surface casing. It should be noted that 300 m is expected to be well below the anticipated depth of non-saline groundwater in this area. A more complete description of the logging program is discussed further in Section 2.2.3.

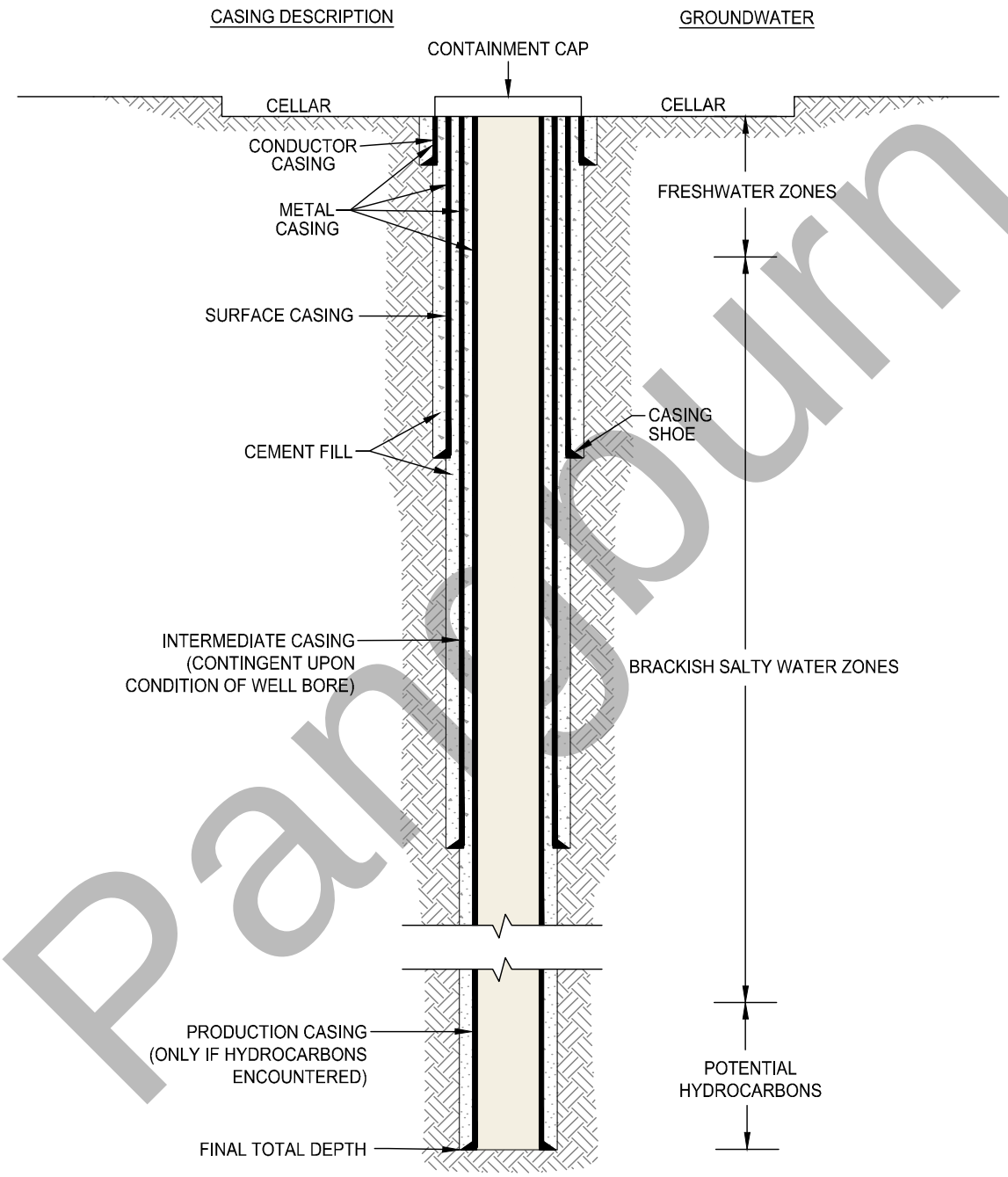
LEGEND

METAL CASING

CEMENT FILL

DRILLING FLUID

EXISTING GROUND



TYPICAL WELL CROSS SECTION AND CASING DESIGN

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Date:	2013 11 18
Dwn. By:	JL
App'd By:	MK

Fig. No.: 2.4

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After it is confirmed that the surface hole extends to an appropriate depth pursuant to the criteria described above, the surface casing will be installed and cemented in place. The surface casing will be made of steel or alloy and will be designed to withstand the pressures, forces, and environmental conditions it will be subjected to. Just prior to setting the casing, drilling fluid will be circulated through the surface hole to condition the wellbore, removing any remnant cuttings and hole cavings so that the hole is stabilized to avoid the casing from getting caught due to blockages or friction before it reaches the bottom of the hole.

Bow type centralizers will be installed at appropriate intervals along the surface casing to confirm that the casing sits properly within the annulus. Appropriate intervals are defined by American Petroleum Institute (API) Recommended Practice 10D2, "Recommended Practice for Centralizer Placement and Stop Collar Testing" (API 2013). Class A Portland cement, which will develop a minimum compressive strength of 3,500 kPa, will then be circulated down inside the casing and up the annular space between the surface casing and walls of the wellbore using the circulation method.

During the cementing operation, the casing will be moved up and down continuously to improve the likelihood that cement fully displaces all drilling fluid between the casing and wellbore wall and does not leave voids. Cement will be pumped down the inside of the casing until it is circulated back to surface on the outside of the casing. The pumping or "displacement" rate of the cement will be as high as practical so that cement in the annulus achieves turbulent flow to greatly reduce the potential of leaving voids in the cement in the annulus.

The amount of cement to be pumped will be adequate to fill the annular volume with a safety factor in accordance with requirements listed in Section 2.13 of the Rules for Industry (GNB 2013). This volume will be mixed and pumped into the wellbore. In the event cement does not reach surface, a small pipe will be run down the outside of the casing from surface to the top of the cement. When the top of the cement column is encountered, the well will be circulated with drilling mud to confirm that there are no cuttings or cavings restricting full annular flow. Once clean, additional cement will then be mixed and pumped down the pipe until clean cement is recovered from the annulus at surface

If there is doubt as to the effectiveness of the surface casing cement, or if shallow gas zones are encountered during the drilling of the surface hole, a cement evaluation technique approved by NBDEM will be used to determine the quality of the cement in accordance with Rule 2.18, of the Rules for Industry (GNB 2013). If problems are detected, a remedial cementing plan will be developed and submitted to the Regulator for approval prior to being implemented, in accordance with Section 2.16 of the Rules for Industry (GNB 2013).

Cement will be left to cure for 8 hours to allow it to achieve the target compressive strength of at least 3,500 kPa. The curing time could potentially be shorter than 8 hours if pursuant to the results of a bench test and consultation with NBDEM. Bench tests will be conducted in accordance with API RP 10 B-2 "Recommended Practice for Testing Well Cements" (API 2013) prior to cementing being performed.

2.2.2.3.3 Function and Pressure Testing

Following installation and cementing of the surface casing, the BOP stack (see Section 2.2.2.4 for description and discussion of the BOP System) will be installed directly on top of the casing head by

bolting the bottom flange of the stack to a casing bowl that will be threaded or welded to the top of the casing. The BOP stack will consist of several specialized valves used to seal, control, and monitor any significant increases in pressure encountered within the wellbore during Drilling.

Once installation of the BOP stack is complete, two tests will be performed on the components in accordance with ERCB Directive 036 (2006): a Function Test and a Pressure Test. The Function Test will be conducted to confirm that all components are functioning properly. The Pressure Test will be conducted to confirm that all of the drilling components and the surface casing are properly sealed and can withstand the pressures that might be encountered once Drilling resumes. Pressure tests will be completed at both a high pressure and a low pressure, where the specific test pressure applied depends on the component, stage of drilling, and other drilling criteria (see ERCB Directive 036 for additional detail). Pressure tests will be conducted so that all components of the system are tested in the critical direction.

Each pressure test will be accomplished by pumping drill fluid into a space confined by the components to be tested, bringing that volume up to the desired pressure, and holding it for a set period of time. If the pressure drops, the leak is located and repaired, and the test is re-run. When all the tests have passed and it is determined that it is safe to proceed, the drilling will resume and proceed into the next bedrock formation.

Function tests will be performed daily and/or each time the drill string is pulled to surface, depending on the component.

2.2.2.3.4 Final Hole Section

After drilling the cement shoe and 2–3 m of new rock formation, drilling will be halted and a formation integrity test (FIT) will be performed. A FIT is completed by slowly applying pressure to the wellbore using drilling fluid to confirm that the strength of the cement at the casing shoe and the rock directly beneath the bottom of the casing is adequate to withstand the maximum anticipated hydrostatic pressure of the drilling fluid column. A FIT is necessary to determine the safe value, so that the pressure applied to the uncased formation does not exceed the known formation strength.

Upon completion of the FIT, drilling will continue. Throughout the drilling of the final hole section, particular attention will be paid to the cuttings and drilling fluid circulated from the well, in order to detect any abnormal pressures, escaping fluids, and other information important to drilling safety. Samples of the cuttings will be collected and examined, then bagged and dried, and they will form part of the permanent well record. Drilling will continue until final total depth is reached and electric logging is completed (see Section 2.2.3 – Well Logging).

If any issues are identified during drilling (*e.g.*, the wellbore formation walls becoming unstable, lost circulation of drilling fluids, or indicated unsafe formation pressures), a contingency casing (also referred to as intermediate casing) may be installed within and below the surface casing to isolate the wellbore. As with the surface casing, this casing will be made of steel or alloy and will be designed to withstand the pressures, forces and environmental conditions to which it could potentially be subjected. Bow type centralizers will be installed to maintain the casing string in the center of the wellbore.

Once the contingency casing is in place, the hole will be conditioned. Then cement will be pumped into the annulus using the circulation method (as described for the surface casing). Depending on the geologic conditions and temperatures encountered in the hole section being cased, either Class A or Class G Portland cement with a minimum cured compressive strength of 3,500 kPa will be used. The amount of cement to be pumped will be adequate to fill the annular volume with a safety factor in accordance with requirements in the Rules for Industry (GNB 2013). A cement evaluation log will also be conducted from the top of the shallowest porous zone to the top of cement to verify that hydraulic isolation has been achieved.

Once the cement has cured, a pressure test will be completed to confirm wellbore integrity. If any issues are encountered, pursuant to Section 2.16 of the Rules for Industry (GNB 2013), a remedial cementing plan will be developed and submitted to NBDEM for approval prior to being implemented. After drilling the cement shoe and 2–3 m of new formation, a FIT will be performed and, upon its completion, drilling will continue.

In any drilling operation, the potential exists for some part of the bottom hole drilling assembly to become stuck and not retrievable. If that adverse occurrence should happen on this well it is expected the pipe will be cut or unscrewed a short distance above the stuck point and the free portion of the assembly recovered. The well may then be sidetracked around the stuck section using directional drilling technologies. Once the sidetrack has been successfully accomplished, the well will be finished as normal.

When the well has reached its final total depth, a complete set of logs will be run. The logging program is discussed further in Section 2.2.3.

Upon completion of drilling and logging the final well section, a decision will be made as to whether any of the formations encountered are suitable for further evaluation. Well logging is further described in Section 2.2.3. If logging identifies hydrocarbon potential and additional testing or exploration is desired, the decision will be made to install additional casing over this final section of the wellbore and operations will be suspended pending additional Phased EIA Submissions or EIA registrations for further work. Additional casing will be installed and cemented using the same procedures as used on the contingency casing. The well will be secured for the protection of safety and the environment.

Alternatively, if the formation is determined to be non-viable, no casing will be run, cement isolation plugs will be set in the hole, the well will be permanently decommissioned, and the PDA will be restored. Additional well decommissioning and site restoration details are provided in Section 2.2.4.

2.2.2.4 Formation Pressure Management and Blow-Out Preventers

During activities, formation fluids, salt water, oil, and gas may be encountered within the rock formation being drilled. The pressure of these fluids is controlled by varying the density of the drilling fluid so that the pressure does not exceed the hydrostatic head (*i.e.*, the weight) of the drilling fluid in the wellbore above it. If the *in situ* pressure of these fluids exceeds the hydrostatic pressure of the drilling fluid column and they are in a permeable formation, they may enter the wellbore and travel up the annulus with the circulating drilling fluid. As this gas rises up the annulus, hydrostatic pressure decreases. This allows the gas to expand, taking up an increasing percentage of the overall mud column. Since gas is much

lighter than drilling fluid, this phenomenon decreases overall hydrostatic pressure at the formation, allowing more formation fluids to enter the wellbore. If left uncontrolled, the process would repeat itself and become dangerous.

Identification and safe management of these sub-surface pressures is essential to maintaining overall safety of the drilling process, through the following measures.

- Pre-planning: Prior to the start of Drilling, information on the sub-surface rock formations is gathered from available sources such as NBDEM, other operators, and the results of the geophysical (seismic) survey. Based on this background research (continually upgraded by on-site observation), the drillers develop an understanding of whether or not there is a potential to encounter abnormally-pressured formation fluids.

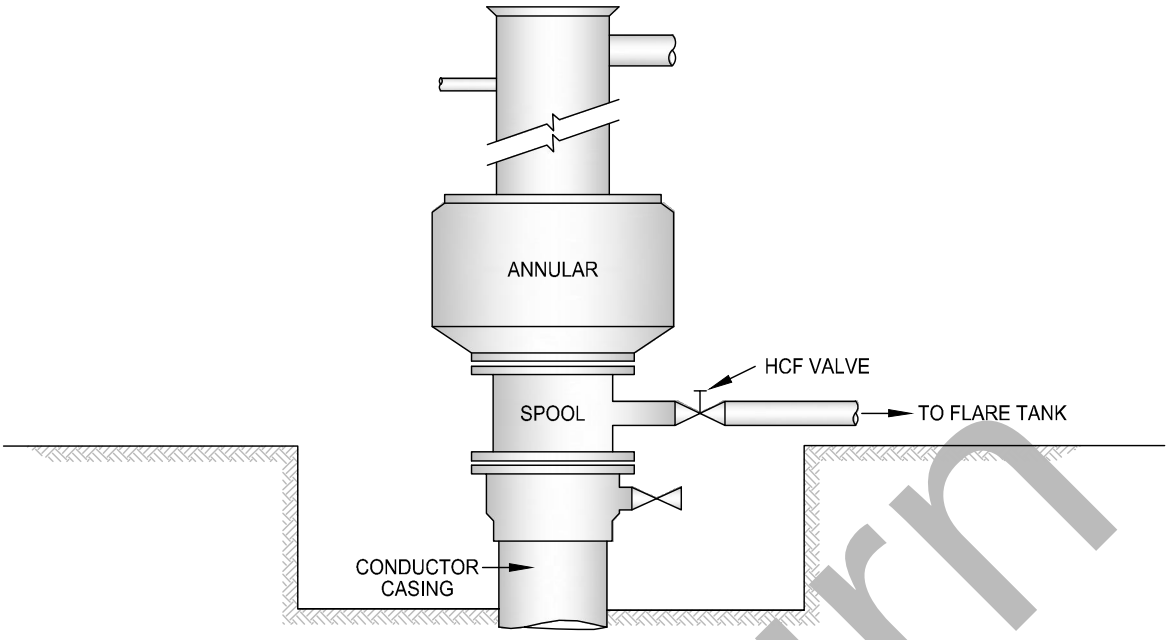
- Monitoring: Small amounts of natural gas are released from the rock as it is drilled (see Section 3.4.1.2.2 for further information). The level of natural gas circulated to surface in the drilling fluid ("background gas") is continuously monitored. An increase in this reading usually indicates that the density of the drilling fluid must be increased. This is achieved by adding weighting materials, such as barite or calcium carbonate, to the drilling fluid.

- Secondary Monitoring: If a porous formation is encountered while drilling, as indicated by an increase in drilling rate, drill string rotation and pumping are immediately stopped for a pre-determined amount of time. The well is monitored for flow during this time to confirm that fluids in this section are not at a higher pressure than the hydrostatic head of the drilling fluid column.

- Detection: The presence of a gas pocket moving up the annulus is detected by an increased volume of drilling fluid in the mud pits or by an increase in the flow rate of the drilling fluid returns from the wellbore. Both of these phenomena are detected by mechanical means attached to alarms.

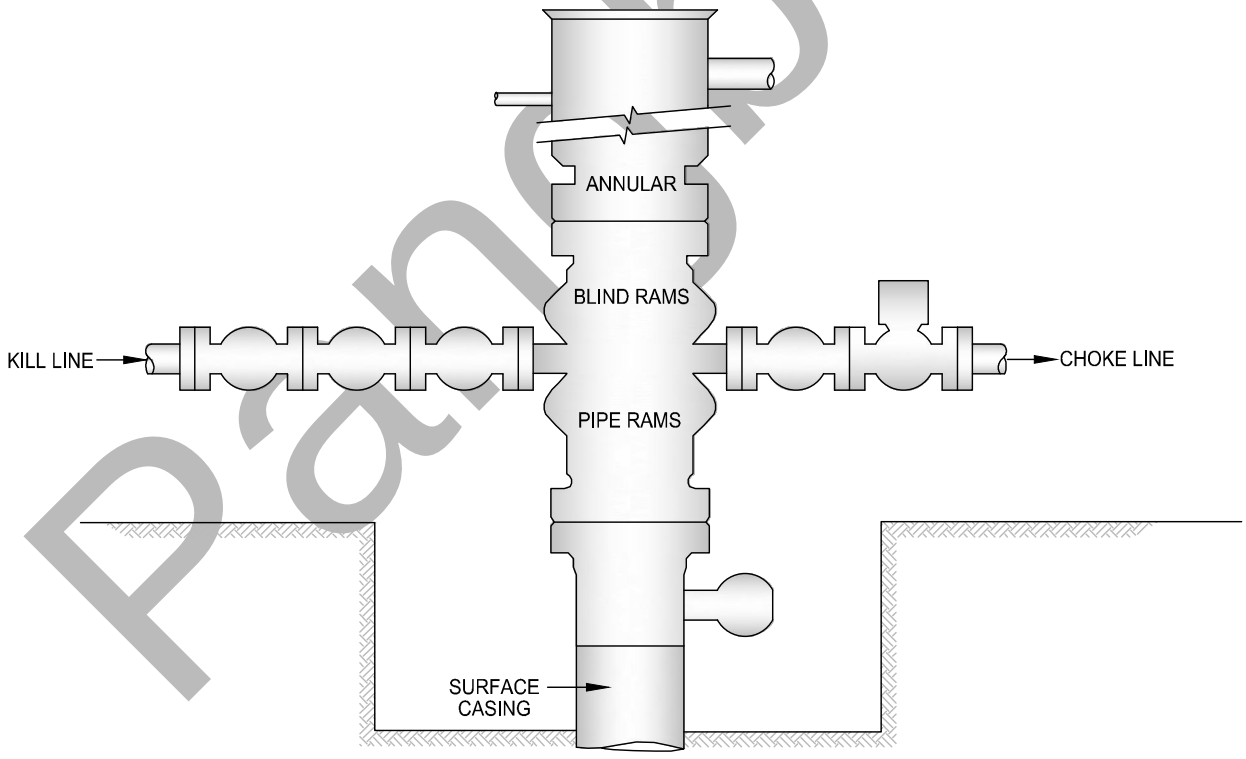
In most cases, these high-pressure formations are encountered at greater depths after the surface hole is drilled. However, it is also possible for high-pressure formations to exist near to the surface. Because no previous oil and gas drilling has taken place in the general area of the Project, well control equipment must to be installed on the conductor casing during shallow drilling, as well as during drilling on deeper formations.

As introduced in Section 2.2.1.5, the equipment for managing any significant increase in pressure within the wellbore is called the blow-out preventer (BOP). The BOP is used to safeguard against blow-out incidents and work to mitigate pressure increases by engaging equipment to block the annular portion of the wellbore, redirect well flow, or block off the well completely. The anticipated configuration of the BOP will differ between shallow and deeper drilling. Both BOP configurations are shown in Figure 2.5, although the exact configuration of the equipment may vary based on the type of drilling rig being used and equipment available.



ARRANGEMENT OF BOP COMPONENTS TO BE USED WHEN DRILLING SURFACE HOLE
1 ANNULAR PREVENTER AND DIVERTER LINE

N.T.S.



ARRANGEMENT OF BOP COMPONENTS TO BE USED WHEN DRILLING DEEPER FORMATIONS
1 ANNULAR PREVENTER, 2 RAM PREVENTERS

N.T.S.

BLOW-OUT PREVENTER EQUIPMENT

Job No.:	121810275
Scale:	NOT TO SCALE
Date:	2013 11 18
Dwn. By:	JL
App'd By:	MK

Fig. No.: 2.5

Client: SWN RESOURCES CANADA, INC.

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In the event of high pressures being encountered in shallow formations, the conductor casing shoe may not be strong enough to withstand high pressure, and therefore the BOP will consist of a single annular preventer. If this BOP is engaged, well flow will be directed through a remotely actuated diverter valve (HCF valve) to a flare tank that is situated away from the well head. This redirection of well flow is intended to allow fluids or gases encountered to flow away from working areas, hereby protecting personnel, equipment and the environment. It is common that shallow pockets of pressure are of limited extent and therefore easily depleted by controlled flow.

After the cementing of the surface casing, the shallow BOP equipment will be replaced with a more robust configuration better suited to manage the potential high pressures that could be encountered in deeper formations. When activated this BOP and associated control valves effectively close in the well. The surface pressure is allowed to build and stabilize. The required mud weight to overcome the fluid influx can be calculated by using this stabilized pressure and by knowing the depth of the well and the weight of the drilling fluid column. Most of this weight is then mixed and circulated into the well while controlling the back pressure at surface by means of an adjustable choke. In only the most extreme and rare situations, the system allows controlled venting of gas or flow of fluids (similar to what was described for shallow pressure formations) to avoid compromising the weaker formations near the casing shoe.

This BOP stack will consist of many more components than the previous diverter system. Arrangement of the stack will include:

- an annular preventer;
- at least two Ram-type preventers;
- flow lines with hydraulic and manual valves to restrict or permit well flow in a well control situation;
- pump-in lines to add weighted fluid to the annulus side of the well system;
- pressure gauges; and
- a remote choke manifold equipped with hydraulic and manual chokes and numerous control valves.

The main components and function of each component to be used as part of the primary BOP at the PDA are described in Table 2.1.

Table 2.1 Blow-Out Preventer Components

Name	Description
Annular Preventer	Acts like a balloon to physically block the annulus.
Pipe Ram	Closes like a door over the casing and annulus, with a space for the drill string and tubing.
Blind Ram	Closes like a door over the casing and annulus, with no space for the drill string and tubing; would be used if well flow is detected when there is no pipe in the hole.
Choke Line	Used to circulate fluid or gas out of the wellbore during instances when a ram or annular preventer is engaged.

Table 2.1 Blow-Out Preventer Components

Name	Description
Kill Line	Used to circulate drilling fluid into the annular side of the wellbore during instances when a ram or preventer is engaged and normal circulation is not possible.
Choke Manifold	A series of valves and chokes used to control the well in the event of significant well flow.

The BOP components will be equipped with remote actuators that are capable of operating independently of the rig power source and located at least 25 m away from the well head. The BOP actuator will also be equipped with a back-up power source. All lines, valves and fittings connecting the BOP and the remote actuator will be flame resistant and have a working pressure rating higher than the maximum anticipated wellhead surface pressure.

Each drill crew will be trained in the operation of the BOP and specifically on proper procedures to follow in any abnormal pressure situation. The driller provided by the drilling contractor will have a "First Line Supervisor" certificate in blow-out prevention and kick control procedures, issued within the last three years. The drilling contractor will also provide at least one person on-site who has a "Second Line Supervisor" certificate in well control procedures issued within the last two years, both by ENFORM (ENFORM.ca) or an equivalent agency. A SWN RC well site representative will also have a Second Line Supervisor certificate in well control procedures issued within the last two years. Blow-out drills will be performed before drilling out any casing shoe and once a week by each crew thereafter, and these drills will be recorded in the daily drilling log book. Also, the procedures, calculations, formulas and current data needed to control a kick at the well will be posted at the rig at all times.

2.2.3 Stratigraphic Examination (Well Logging)

Before drilling begins, all available information will be reviewed to provide an indication of the likely characteristics of the stratigraphy at the Site, such as local hydrology, topography, depth-to-water-table data, seismic results). Available well logs from other drillers will also be examined in addition to information from NBDEM for exploratory wells it has drilled in the province.

As drilling proceeds, information about this particular well will be recorded. Two different well logging techniques will be used to examine and record the stratigraphy. The first, Geological Logging, consists of a visual examination of cutting samples collected at surface and continuous recording of data such as gas in the drilling fluid and bit penetration rate. The samples are visually inspected and described in terms of various material characteristics such as mineral type, density, porosity, hydrocarbon concentration, and the depth from which information was collected.

The second technique, Electric Logging, includes the use of electronic measurement devices that are connected to a multi-wire cable and lowered into the wellbore through a depth measurement tool. Signals from these devices travel up one or more wires within the cable and are collected at surface, translated into data and presented together as a value-versus-depth trace on paper or computer. Some of the more common electric logging tools are described below.

- Resistivity Log: Resistivity logs measure the conductivity of adjacent formations at various distances from the wellbore. This information may be used in identifying the type of fluid in porous formations

and changes in formation rock and provides an estimate of formation permeability. This log can also yield the conductivity of water, providing a measure of salinity. This information is also used to aid in identifying the depth of freshwater zones.

- Gamma Ray Log: This tool measures naturally-occurring gamma ray emissions from the formation and can be used as an indicator to differentiate between shale and non-shale formations and systems.

- Sonic Log: This tool provides an estimate of formation porosity by measuring the speed of sound in adjacent formations.

- Neutron log: This tool provides a second and complementary estimate of porosity by bombarding the adjacent formation with neutrons and identifying and measuring the resulting emitted radiation.

Taken together, the above data collection will be used to determine and record the nature of the sub-surface rock, in terms of materials (rock types and entrapped fluids) and structure (layering). Although the technology is sophisticated and the interpretation of the data is done by experienced scientists using highly complex computer programs, the information is not exact and must be considered in the context of all other known information about the Site. No single method accurately describes the structure and characteristics of the formations below the surface. Professional experience and technology are used in combination to infer the nature of sub-surface rock.

2.2.3.1 Decision to Restore the Site or Proceed with Further Evaluation

Based on the data collected during all previous exploration activities as well as from stratigraphy examination (in particular well logging), SWN RC will decide whether to proceed with further evaluation of this well, or to decommission the well and restore the PDA if no further testing of the well is warranted (as described in Section 2.2.4). Should it be decided to proceed with further evaluation, SWN RC would gather all available information and prepare a Phased EIA Submission or EIA registration as described in Section 2.2.4.

2.2.4 Decommissioning and Restoration

If SWN RC decides not to proceed with further evaluation, the well will be permanently plugged, and decommissioned, and the PDA will be restored. The details of the decommissioning and restoration of the PDA will be developed in consultation and agreement with the Regulator. The well will be plugged using cement to continue to protect subsurface resources, groundwater, surface water, air and soil. As shown in Figure 2.6, cement plugs will be placed within uncased portions of the well as needed to verify that the hydrocarbon-bearing zone and the freshwater-bearing zone are properly isolated from one another.

These cement plugs will extend for at least 15 m above and below hydrocarbon or freshwater zones, and plug at least 15 m above and below the lowermost casing shoe. If competent rock is not encountered at the base of the well, a 15 m cement plug will also be placed at the bottom of the well. Additionally, a cement plug of at least 45 m in length will be set in the casing no more than 45 m below ground-level. Depending on circumstances and availability, a permanent bridge plug and

cement may be set in lieu of the one or more of the cement plugs described above. Depths and lengths of these plugs will be based on information obtained from drilling and wireline logs, and will be agreed to in consultation with the Regulator.

Once the well is plugged, conductor and surface casings (and intermediate casing, if present) will be cut off and capped at 1.5–2.0 m below ground-level. The cellar will be filled in, and a steel pipe permanently marked with the well location information will be welded to the casing cap and extended at least 1 m above ground.

The remainder of the PDA will then be decommissioned and restored as follows. All surface equipment and buildings will be removed from the well pad, disturbed areas will be returned to pre-construction grades, and stockpiled organic material/topsoil will be distributed across the disturbed areas. Re-vegetation of the PDA will be considered to avoid soil erosion or siltation of watercourses. Site-specific details guiding restoration will be determined during a pre-construction site assessment of soil, vegetation, drainage and topography, which will be conducted prior to land clearing (see Section 2.2.1.1).

An environmental site assessment will be conducted following decommissioning and prior to restoration, to confirm that no contamination of soil or groundwater has occurred at or near the Site as a result of Project-related activities.

2.2.5 Materials and Waste Management

The materials used for the Project, and the associated emissions, wastes, and waste management practices are discussed in this Section.

2.2.5.1 Water Sourcing

Water will be required during Drilling in order to mix drilling fluid and cement, to clean equipment; for use in the living quarters, and for other general purposes. Specific consideration has been given to both the quantity and quality of water required to complete planned activities. In order to drill the well and carry out the associated activities, approximately 1,200–1,600 m^3 of water are expected to be required at the Project Site. The following options will be considered for the supply of water:

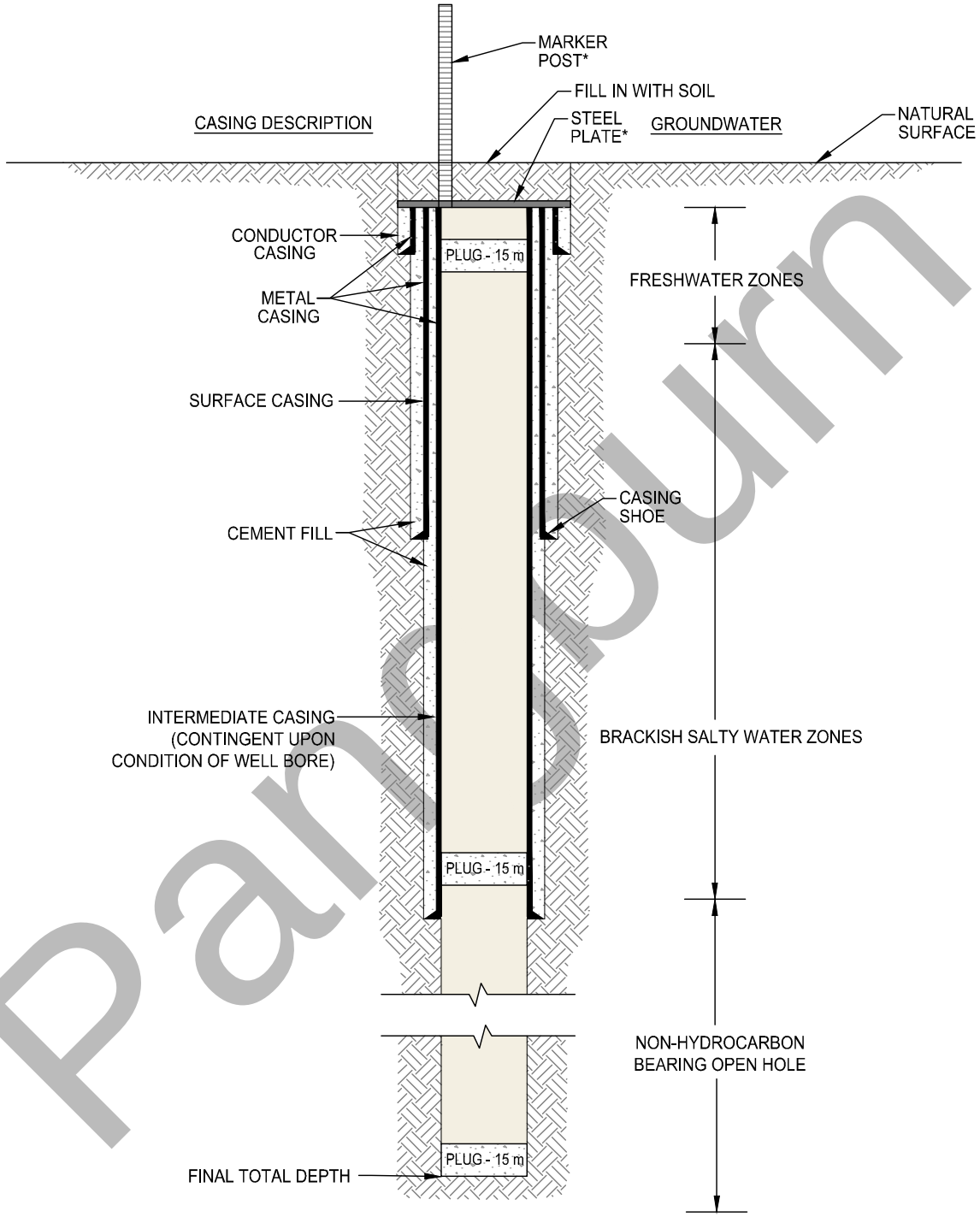
- an existing industrial water supply;
- untreated water from a nearby municipal water supply; or
- surface water withdrawn at a rate of less than 50 m^3/day.

Small quantities of potable freshwater from a nearby municipal water supply will also be used at the Site for domestic purposes. Drinking water stored at the Site will be tested and stored in accordance with Section 4 of the New Brunswick *General Regulations—Occupational Health and Safety Act*, Regulation 91-191.

LEGEND

- METAL CASING
- CEMENT FILL
- DRILLING FLUID
- EXISTING GROUND

* NOTE: STEEL PLATE WILL BE PLACED OVER THE WELL. THIS WILL BE BURIED 1.5 m (AT MINIMUM) BELOW GROUND. A MARKER POST (1 m TALL) WILL INDICATE THE WELL LOCATION.



THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

TYPICAL CASING DETAIL: NON-VIABLE WELL: PLUG AND DECOMMISSIONING

Job No.:	121810275
Scale:	NOT TO SCALE
Date:	2013 11 18
Dwn. By:	JL
App'd By:	MK

Fig. No.: 2.6

Client: SWN RESOURCES CANADA, INC.

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2.2.5.2 Transportation

Transportation for the Project will occur in four distinct stages: well pad and access road construction, drill equipment mobilization, drilling support, and drill equipment demobilization. A summary of the transportation needs for the Project is provided in Table 2.2.

Table 2.2 Estimated Total Number of Truck Loads

Stage of the Project	Description	Estimated Total # of Truck Loads (round-trip)
Construction (well pad and access road)	Construction equipment and materials (*e.g.*, excavators, gravel).	• Equipment Mobilization: 5–7. • De-mobilization: 5–7. • Gravel, water: < 350, depending on-site conditions and if imported fill material required.
Drill Equipment Mobilization	Drilling equipment and ancillary elements (*e.g.*, drilling rig components, logging and cementing equipment and Site buildings).	• 40–50.
Drilling	Drilling materials, equipment, and waste (*e.g.*, casing, cement, cuttings, supplies, water).	• 100–150.
Drill Equipment De-mobilization	Drilling equipment and ancillary elements are removed from the well pad (*e.g.*, drilling rig components, logging and cementing equipment and Site buildings).	• 40–50.

Vehicles and equipment used for construction of the well pad and access road will include (and will not be limited to) excavators, bulldozers, rollers, dump trucks, and graders. Most of these vehicles operate on diesel fuel and require some form of daily maintenance. Truck traffic generated by the Project during well pad and access road construction is largely dependent upon the amount of imported material required. If *in situ* soil conditions are not suitable for construction of the sub-base and base, aggregate will be obtained from off-site local borrow pits or quarries, and the amount of truck traffic on the access road will increase accordingly. *In situ* material, from within the boundary of the PDA, will be used wherever possible. Construction equipment will also need to be transported to and from the Project Site, however this is not expected to result in a substantial amount of traffic.

Truck traffic generated by the Project leading up to and during Drilling will consist mainly of the mobilization and demobilization of drilling-related equipment and associated supplies to the Project Site. Transport trucks, which operate using diesel fuel, will be the main vehicle used for transporting equipment and supplies. A combined 80-100 loads of equipment and supplies are expected to be transported to and from the Site as part of the mobilization (40–50 loads) and demobilization (40–50 loads) of Drilling supplies and equipment.

Truck traffic will also be required during Drilling to transport freshwater, drill cuttings and various materials for drilling (*e.g.*, casing, cement, drilling fluid materials). If not sourced from local surface water, it is anticipated that approximately 70–80 tankers of water will be required for drilling. Approximately 40–60 truckloads of cuttings will be generated and potentially shipped to a waste management facility legally

able to accept the cuttings. In total, it is estimated that approximately 150 loads of water, cuttings and materials will be transported during Drilling.

Transport traffic will be limited to the preferred access route shown in Figure 1.1, unless this route becomes unavailable. The preferred access route is selected to avoid increased truck traffic through collector roads in rural residential areas. Trucks using local and collector highways for access to the Project will be subject to applicable speed limits, designated postings, provincial gross vehicle weight maximums and spring weight restrictions. Where practical, transport traffic will be avoided in populated areas during school transportation hours (*i.e.,* peak morning and afternoon traffic periods for buses), and oversize loads will be transported in good visibility.

Some road maintenance and repair may be required to support Project-related truck traffic on forest resource roads along the preferred access route, and athough the specific details of any road maintenance and repair activities have not yet been defined, this activity is included as part of the Project. A review of the preferred access route to the PDA will be conducted prior to and during Construction and Drilling to identify roadway areas that may require maintenance or repair. Road maintenance and repair, where determined to be required, will be carefully planned and designed, and conducted in accordance with applicable legislation and in consultation with the responsible authorities (*e.g.*, NBDNR, Crown timber licence holder). If required, permits pursuant to the New Brunswick WAWA Regulation will be obtained, and any required specific mitigation measures included therein, will be implemented.

2.2.5.3 Emissions and Waste Management

The following different types of emissions and waste will be produced during the Project:

- drill cuttings;
- drilling fluid;
- cement;
- solid waste;
- wastewater;
- air contaminant emissions; and
- petroleum, oil, and lubricants (POLs).

All waste materials produced as part of the Project will be managed to avoid contamination of soil, surface water, and groundwater. Waste management procedures will comply with Sections 4.4 to 4.7 and Section 4.9 of the Rules for Industry (GNB 2013) as well as any disposal/treatment facility requirements. Waste will be characterized as required prior to being transported to verify that chemical parameters are within the acceptance criteria of the facility intended to receive the waste. Waste types and disposal options are described below.

2.2.5.3.1 Drill Cuttgs

Approximately 200–400 m^3 of drill cuttings will be generated during the Project. These cuttings will be separated from the drilling fluid using shakers and centrifuges and then directed to an on-site storage tank. Generally these drill cuttings are expected to be inert, however there is a small possibility they may contain trace concentrations of heavy metals, sulphides, chlorides, NORM, or hydrocarbons, depending on the type of rock formations being drilled. Such elements would be identified by the on-site geologist examining the cuttings or as part of subsequent laboratory analysis.

The nature of the cuttings will also depend on composition of the drilling fluid being used. If drilling uses water-based mud (as planned), it is unlikely that petroleum-based additives will be required. If the contingent oil-based mud is used, cuttings from that section of the well will contain hydrocarbons. Once the material is characterized, drill cuttings will be transported to a waste management facility legally able to accept the waste with the concentrations of chemical parameters identified. On-site disposal of drill cuttings may be considered if this is determined to be acceptable in consultation with the Regulator and pursuant to the process outlined in Section 4.7 of the Rules for Industry (GNB 2013).

2.2.5.3.2 Drilling Fluid (Mud)

Upon the completion of drilling activities, any drilling fluid remaining will either be recovered and reused during subsequent drilling operations, or transported to a waste management facility legally able to accept such waste.

If NORM is detected in the cuttings, spent drilling mud will also be analyzed for NORM and if present, will be disposed of at a facility legally able to accept such waste.

2.2.5.3.3 Cement

During the installation of the casing, cement will be used to seal the casing in place and this will likely result in small amounts of waste cement being generated at the surface. This waste cement will be collected and disposed of at a construction and demolition debris disposal site or other facility legally able to accept the material.

2.2.5.3.4 Solid Waste

Solid waste will be generated at the Site in small quantities. This includes mostly domestic waste (*i.e.*, general refuse) from staff working at the Site, as well as minor amounts of construction waste that may include spent containers, grease tubes, engine oil containers, cans and sacking from drilling fluid additives, welding rods, slag, and worn or broken mechanical components. These materials will be stored in a dumpster marked for general refuse only and shipped periodically to the regional sanitary landfill.

2.2.5.3.5 Wastewater

Septage generated at the Site from washroom facilities in the Site buildings will be collected within storage tanks. Vacuum trucks will periodically empty these tanks and dispose of the septage at

municipal sewage treatment facilities. Consideration will also be given to separating gray and black domestic waste water and recycling or disposing of the gray water on-site.

Surface run-off on the PDA will be managed as per Section 2.2.1.3. Excess surface water collected at the PDA, from within bermed and lined areas, will be temporarily stored in on-site containers until it is collected and trucked to a wastewater treatment facility that is legally able to accept such waste.

2.2.5.3.6 Air Contaminant Emissions

All equipment on-site will be motorized or run from on-site diesel engines or generators. All such equipment will be fitted with proper mufflers to reduce noise.

Dust that may be generated as a result of having a large surface area of exposed soils will be managed through the application of water or water containing lignin-based dust suppressants.

2.2.5.3.7 Petroleum, Oil and Lubricants

Waste POLs, used containers, rags, contaminated soil or water, will be disposed of at a legally able to accept these wastes. There are several used oil collectors that are legally able to receive many of these materials.

Strict management practices and environmental protection measures that will be followed when managing POL are discussed in detail in the Environmental Protection Plan (EPP) for the Project (provided under separate cover). Some of the general measures to be implemented at the Site include:

- fueling and lubrication of equipment will be carried out in a manner the limits the possibility of spills;
- fuel storage will be equipped with secondary containment with sufficient capacity to contain 110% of the largest single tank or of all the connected tanks (whichever is greater);
- waste containers for temporary on-site storage of spill clean-up materials will be located in a secure, covered area, where rain water cannot come into contact with these containers;
- spill kits will be readily available on-site; and
- all workers on-site will receive training in the prevention, control, and clean-up of spills.

2.3 PROJECT SCHEDULE

Well pad and access road construction (three to four week duration) is planned for late 2014. Drilling (four to eight week duration) is planned to follow Construction.

Construction will be conducted daily between the hours of 7:00 and 19:00, whereas Drilling operations will run continuously, 24 hours per day.

2.4 ENVIRONMENTAL MANAGEMENT SYSTEM

SWN RC has developed an Environmental Management System (EMS) to reduce potential adverse environmental interactions that could arise from Project implementation through careful planning and engineering. The EMS will be comprised of the following components:

- Environmental Protection Plan (EPP); and
- Emergency Response Plan (ERP).

The EPP (provided under separate cover) sets out the environmental protection measures and procedures that will implemented for the Project by SWN RC. The EPP is the primary document to lay out the plans for implementing mitigation measures to avoid and reduce potential adverse environmental interactions that might otherwise occur from routine Project activities.

The ERP (provided under separate cover) is intended to advise Project personnel on how to implement specific actions to respond to accidents, malfunctions or unplanned events, as defined therein. The ERP outlines specific responses, actions, duties, responsibilities, and notification requirements for key personnel for unplanned events that could conceivably occur in the course of carrying out activities associated with the Project (Rules for Industry, Section 8.1 and Appendix 12; GNB 2013).

3.0 ENVIRONMENTAL SETTING AND POTENTIAL INTERACTIONS BETWEEN THE PROJECT AND THE ENVIRONMENT

This Section provides background on the physical setting for the Project, followed by operational siting and environmental planning considerations, and a listing of known environmental approvals, permits and authorizations required for the Project to proceed as planned. Following this, potential interactions between the Project and environmental components are identified, including a description of the existing environment and mitigation that is planned so as to avoid or reduce interactions between the Project and the environment.

3.1 PHYSICAL SETTING

The PDA is located in Queens County in eastern New Brunswick (Figure 1.1). The PDA is 4.5 km northeast of the rural area of Pangburn, 6.7 km northwest of the rural residential area of Forks Stream, and 20 km east of the Village of Chipman's municipal boundary. The PDA is located on Crown land and is approximately 1,400 m to the northwest of the nearest potentially human-occupied property along the Rerry Brook Road.

The Canaan River Wildlife Management Area is approximately 15 km east of the PDA. The PDA is located at the crest of land between Perry Brook and Otter Brook to the northeast of Grand Lake, and approximately 2.5 km to the west of Spring Brook. The PDA is located in a forested area, and contains no surface water features. Biological features near the PDA are:

- an NBDNR-identified watercourse, Otter Brook, approximately 595 m south of the PDA that flows to the south into Forks Stream, and Perry Brook, approximately 645 m north from the PDA, that also flows into Forks Stream (Figure 3.1);
- a large forested wetland complex surrounding the PDA that contains numerous regulated wetlands, as defined in the Rules for Industry (GNB 2013); the nearest wetland is a field-identified wetland associated with Otter Brook, located approximately 35 m to the north of the PDA; the next nearest wetland is a field-identified wetland associated with Perry Brook, located approximately 300 m northwest of the PDA; and
- the presence of a species of conservation concern (SOCC) vascular plant species to the east and north of the PDA along a resource road (field milkwort *(Polygala sanguinea)* ranked as S2 "*Sensitive*" by AC CDC).

Included in the PDA is *a* 430 m access road that connects the well pad to an existing forestry resource road to the west that eventually joins with the Phillipstown Road and then Route 112 (Figure 1.1).

Photos depicting habitat at the PDA are provided in Photos 1 and 2.

Photos 1 and 2: Habitat at the Pangburn PDA (September 2013).

3.1.1 Surficial Geology

Based on a digital elevation model obtained from Spatial Energy, the existing elevation ranges between approximately 70 m and 125 m above sea level (asl) within a 1 km radius of the centre point of the PDA. The PDA is located within the Grand Lake Basin, a subdivision of the New Brunswick Lowlands, which is in turn a division of the Maritime Plain of the larger Appalachian Region. The Grand Lake Basin is characterized by broad, flat areas separated by poorly-defined valleys. Surface relief may be as much as 75 m in local areas adjacent to the Southwest Miramichi and Bouctouche Rivers, but overall is much less (Rampton 1984).

Quaternary geology maps indicate that the surficial geology at the PDA consists of a blanket of morainal sediments (*i.e.*, till). Sediments are expected to be less than 0.5 m, depending on bedrock relief at that particular location. Till consists of a heterogeneous mixture of silt, sand, and gravel (NBDNRE 2002).

3.1.2 Bedrock Geology

The bedrock within the PDA is part of the Pictou Group of the Late Carboniferous Age and consists of primarily sedimentary rocks: red to grey arkosic sandstone, conglomerate and shale. These types of rock are formed in a terrestrial setting and, like all sedimentary rocks, may contain fossils.

Arkosic sandstone is composed of sedimentary rocks with particles derived from weathered silicate particles originating from older rocks or pyroclastic volcanism. Arkosic sandstones are those containing >25% feldspar. Particle size typically ranges between silt-sized particles (75 µm) and coarse particles (2 mm). Primary mineral types include quartz, feldspar and clay minerals/fine mica.

Conglomerate is composed of sedimentary rocks with particles derived from weathered silicate particles originating from older rocks or pyroclastic volcanism. Conglomerates contain >30% gravel-sized particles (>2 mm). Particles can be igneous, metamorphic or sedimentary of origin and the rock can be described as either clast supported or matrix supported. Clast-supported conglomerates occur when gravel-sized particles are dense enough to form the supporting framework. Matrix-supported conglomerates occur when a fine-grained matrix of silt, clay, and sand bind less frequent gravel-sized particles together.

Shale is composed of siliciclastic sedimentary rocks containing >50% particles with grain sizes <0.062 mm. Silt- and clay-size particles (0.004 mm to 0.062 mm) are the dominant particle size in these rocks. Primary minerals include clay minerals, and fine quartz and feldspar. Shale is easily identified by its lamination or fissility, meaning it can be readily split into very fine layers.

3.2 OPERATIONAL SITING AND ENVIRONMENTAL PLANNING CONSIDERATIONS

SWN RC employs a systematic process for selecting potential locations that might be used to develop a hydrocarbon well or well system. This process considers the following, among other factors:

- geology and geophysical survey results;
- environmental constraints; and
- operational feasibility.

The PDA was selected following the collection and analysis of various geological, geochemical, and geophysical data (see Section 2.1.1) as well as an extensive review of available geographic information and databases, and environmental and operational constraints. By reviewing a large area for hydrocarbon potential and constraints prior to this submission, SWN RC was able to select a site for the Project that it is considered to have elevated potential for hydrocarbons, while limiting the potential for environmental interactions with the Project and avoiding operationally difficult areas. Section 3.2.1 discusses this site-selection process in more detail.

3.2.1 Identification of Areas with Potential for Hydrocarbons

Because little exploration for hydrocarbons had previously taken place outside of the Moncton Sub-basin, SWN RC completed geophysical surveys over the Licence to Search area in 2010 and 2011, and again in 2013, to help identify areas that have higher potential for containing hydrocarbons. A description of the methods used by SWN RC to date to collect the geophysical and geochemical data is provided in this Section.

- Gravity and Magnetic Surveys: Gravity and magnetic surveys involve measuring the gravitational and magnetic fields of the Earth's subsurface. Both these surveys are carried out non-invasively by using specialized remote-sensing equipment on board an airplane or helicopter. Using the results of these surveys, anomalies in the regional geology can be identified and help define the spatial extent of sedimentary basins where hydrocarbons may reside. Gravity and magnetic surveys were completed over the Licence to Search area in 2010.

- Two-dimensional (2D) Seismic Testing: Seismic testing is used to map subsurface rock formations and help identify sedimentary basins where hydrocarbons may reside. This testing is accomplished by emitting controlled sources of energy and recording the rebounding seismic waves using geophone seismometers. Seismic energy is typically emitted using vibroseis trucks along the surface of existing roads, or in some cases using small explosive charges as seismic sources activated in a controlled manner at a depth of 15 m below the surface. This information is subsequently processed and interpreted to present a two-dimensional image of the geology below ground and can be used to locate sedimentary basins potentially containing hydrocarbons. Seismic surveys were completed throughout much of the Licences to Search area in 2010, 2011, and 2013.

Project Data

- Project Development Area (PDA)
- SWN Seismic Line

Base Data

- Resource Road
- Trail/Abandonned Road
- Contour (10m)
- 100 Contour (metres above mean sea level)
- Property Boundary
- 45093291 Property Identifier (PID) from SNB

Environmental Data

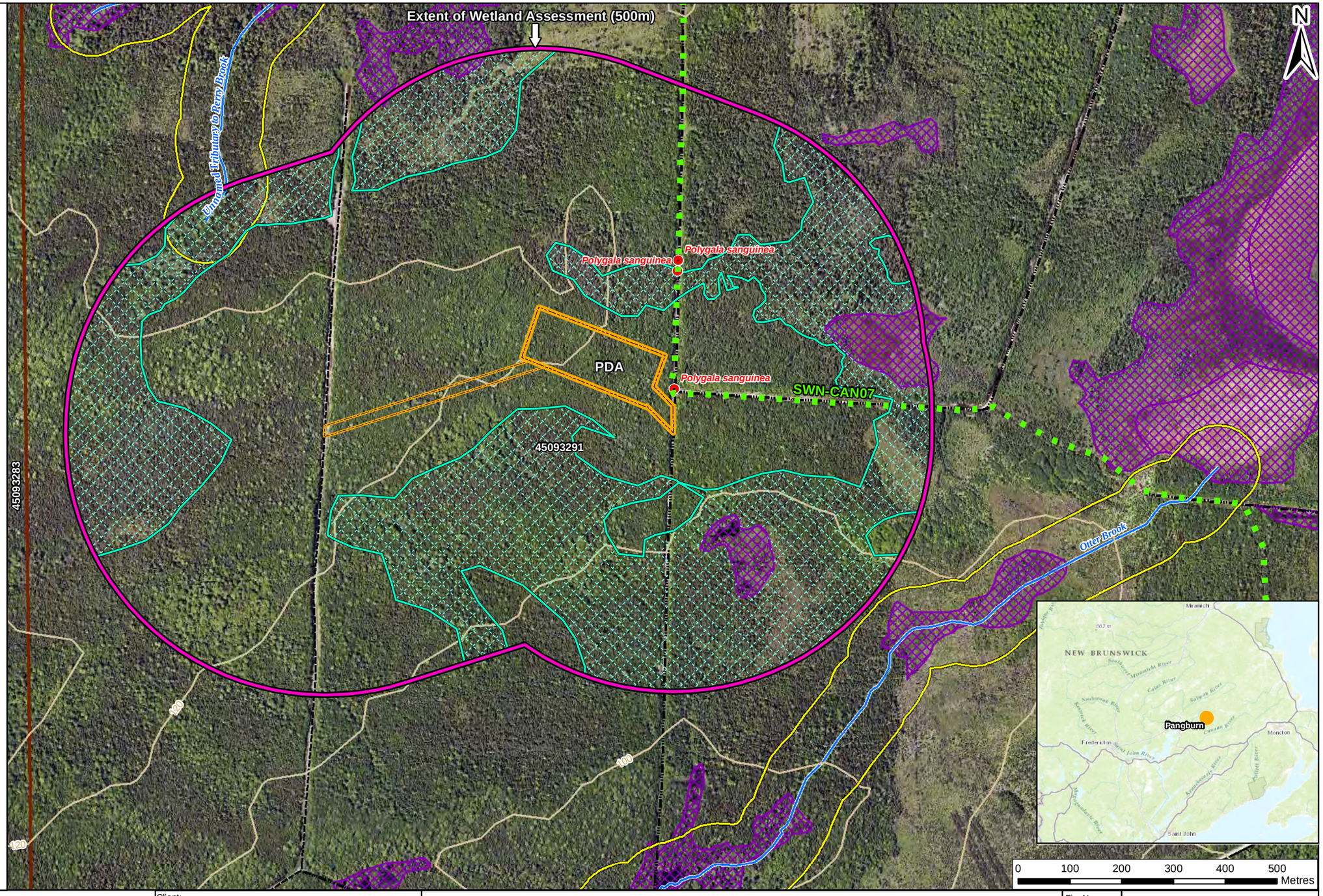
- Field Observed Rare Plant
- Regulated Wetland (as defined in the Rules for Industry (GNB 2013))
- Field-Delineated / Interpreted Wetland Boundary
- Extent of Wetland Assessment (500 m)
- Watercourse (NBDNR)
- Medium/High Potential Archaeological Site

Environmental Data Not Present on Map

- Waterbody (NBDNR)
- Deer Wintering Area
- Municipal Area
- Protected Watershed
- First Nations Land
- Protected Wellfield
- Parks and Protected Areas
- Cemetery
- Historic Period Archaeological Site
- Pre-contact Period Archaeological Site
- Plane Crash
- New Brunswick Portage Route
- *Potential Paleo-Indian (11,500 to 9,000 years ago) Archaeological Area*
- Archaeological Site / Portage Route 200m Buffer
- Ecologically Significant Areas
- Managed Area

AC CDC Species Observation

- Bird Observation
- Fish Observation
- Mammal Observation
- Reptile Observation
- Invertebrate Observation
- Nonvascular Plant Observation
- Vascular Plant Observation



ACCDC Species Observations: Locations are within 100m unless otherwise noted: *Location is within 500m-1km **Location is within 5-10km

Sources: Base Data: NBDNR, SNB, NBENV; ESA, Species Observations, Managed Areas: ACCDC
Aerial Imagery: Spatial Energy 2011
Regulated Wetland layer provided by NBENV, obtained from GeoNB in March 2012.
Potential Archaeological Sites near mapped NBDNR/SNB streams subject to field verification.

Projection:	New Brunswick Double Stereographic
Scale:	1:7,500
Date:	10 Apr 2014
Fig. By:	JAB
Appd. By:	MM

Client: SWN Resources Canada

Project: 121810275

Environmental Constraints Analysis for Well Pad Placement - Pangburn

Fig. No.: 3.1

Stantec

- Surface Geochemical Testing: Surface geochemical testing is used to record trace (measured in parts per billion) amounts of hydrocarbons that naturally diffuse from depth to the Earth's surface over time. This testing helps to indicate if hydrocarbons have formed in rock formations below the surface. Sampling involves making a small (1-cm diameter), shallow (30-cm deep) hole in the ground and inserting a flexible Gore-tex® tube that adsorbs hydrocarbon vapour. The tube is subsequently removed after a few weeks in the ground and analyzed at a laboratory to determine the presence of a wide variety of volatile organic compounds. Confirmation of the presence of hydrocarbons using this method indicates possible areas of hydrocarbon accumulation in the sub-surface of the Earth. Geochemical testing was completed within the Licence to Search area in 2010 and 2011.

- High-Resolution Aerial Photography and LiDAR: High resolution aerial photography and LiDAR (Light Detection and Ranging) are used to generate a digital elevation model to better understand current land conditions, especially in terms of updated information on ground cover, geology, topography, access and accessibility. High-resolution aerial photography provides more current and higher-quality photographs than would otherwise be available, which is particularly helpful in determining current vegetation on the landscape. LiDAR is an optical remote-sensing technology that can measure the distance to, speed of, rotation of, and even chemical composition and concentration of a target. LiDAR technology is used an exploration tool to better understand geology, and as an elevation model to facilitate a better understand of topography. The Licence to Search areas well was flown-over for updated aerial photography and LiDAR in 2011.

- Other Methods: SWN RC also reviewed available geophysical and geological data (*e.g.*, rock cores, well logs, and seismic, and geochemical data) historically acquired by government or other resource companies for the purpose of hydrocarbon or other resource exploration throughout the Carboniferous Maritimes Basin. By analyzing these data, SWN RC was able to better interpret the results of their geophysical surveys and calibrate their analysis.

Following a review of all the geological, geophysical, and geochemical data, several potential drilling locations were selected for additional consideration. These potential locations were evaluated based on the following criteria:

- the potential for hydrocarbon-rich formations to be located at a suitable depth (based on seismic and geochemical tests);

- the potential extent or size of the sedimentary basin (based on gravity and magnetic surveys as well as other geological data); and

- operational logistics (*e.g.*, land ownership, access).

The areas having the highest evaluations for hydrocarbon resource potential were identified as potential drilling areas.

3.2.2 Environmental and Operational Planning

After the potential drilling area was identified by SWN RC, based on a review of the resource data, an environmental/operational planning process was implemented to determine the well pad location that would reduce the potential for environmental and operational constraints.

SWN RC set out the following objectives to help guide the process to determine the potential locations for a well.

- Operational Objectives:
    - the PDA should be approximately 3 ha in area to accommodate the construction of a 2ha well pad, one access road (Figure 2.1) and drainage features;
    - the well pad should be within 300 m of a seismic line for reliance on the seismic data collected that infers the potential for a hydrocarbon resource underground;
    - the well pad should be located 250 m away from residences, 500 m from other sensitive receptors such as schools, nursing homes and hospitals, and 100 m from other permanent buildings; and
    - the well pad should be accessible to an existing roadway and be located on relatively flat terrain.
- Environmental Objectives:
    - to the extent practical, the well pad should be located so to avoid and minimize potential environmental constraints and to reduce potential adverse environmental interactions, in accordance with the Rules for Industry (GNB 2013).

A constraint base map was prepared to show important operational features and where sensitive or protected environmental features may lie in proximity to the PDA. Environmental constraints include features that are protected under federal and provincial legislation and can extend to also include features that have special status conferred by published guidelines or policies (*e.g.,* Ecologically Significant Areas). This constraint map also incorporated mapped information from mapping of known archaeological sites and known First Nation portage routes, and from predictive mapping of potential Paleo-Indian (9,000–11,500 years ago) shoreline areas.

Table 3.1 lists the information that was considered in preparing the base map. Information was obtained by the sources listed, geo-referenced and then placed on a map in 1:7,500 scale by a Geographic Information System (GIS) specialist. The base map includes symbols used to denote each feature and the latest date of the data/information source.

Table 3.1 Summary of Information Used for Environmental and Operational Constraint Analysis

Environmental and Operational Data/Information	Data/Information Source
Seismic Line Location	SWN RC
Roads (major, secondary, resource roads)	New Brunswick Department of Natural Resources (NBDNR)
Railway	NBDNR Data Set
Underground Pipeline	NBDNR Data Set
NB Power Transmission Line	NBDNR Data Set
Mining Area	Natural Resources Canada
Topographic Contours	NBDNR (10 m contours)+ LiDAR (light detection and ranging) data (15 cm resolution)
Aerial photo imagery	NBDNR Data Set or SWN RC (whichever was most current)
Property Boundaries and Parcel Identifiers (PIDs)	Service New Brunswick (SNB)
Location of rare species (species at risk, species of conservation concern)	Atlantic Canada Conservation Data Centre (AC CDC)
Breeding Birds	Maritimes Breeding Bird Atlas (MBBA)
Ecologically Significant Areas (ESAs)	AC CDC/Nature Trust of New Brunswick/La Fondation pour la protection des sites naturels de Nouveau-Brunswick Inc. (NTNB)
Watercourses (mapped)	NBDNR; SNB
Water Body (mapped)	NBDNR
Watershed boundaries (mapped)	National Hydrographic Network
Regulated Wetlands (as defined in the Rules for Industry (GNB 2013)	Service New Brunswick (GeoNB Wetland Map Layer)
Wellfield Protected Areas	NBDELG
Watershed Protected Areas	NBDELG
Field-identified Wetlands (field identified , plus air photo interpretation)	NBDNR aerial photos (interpreted by a wetland specialist)
Depth to Water Table (<25 cm)	NBDNR
30-m Buffer Around Watercourses and Wetlands	Applied by a GIS Specialist
Recreational Areas	Field Observation
Parks and Protected Areas	SNB
Municipal Boundaries	SNB
Underground Pipelines	NBDEM
First Nation Communities and Reserve Land	Aboriginal Affairs and Northern Development Canada
Land Ownership and Land Use (zoning)	SNB
Access	SNB; NBDNR
Proximity to Existing Infrastructure and buildings	SNB; NBDNR; Owner
Transmission line	NBDEM
Registered Archaeological Sites	Archaeological Services, New Brunswick Department of Tourism, Heritage and Culture
Potential Paleo-indian (9,000–11,500 years ago) Shoreline Areas	Archaeological Services, New Brunswick Department of Tourism, Heritage and Culture
First Nation and Historic Period Portage Route	Archaeological Services, New Brunswick Department of Tourism, Heritage and Culture
High/Medium Potential Archaeological Areas	Archaeological Services, New Brunswick Department of Tourism, Heritage and Culture

Using this base map and aerial photography, a wetland and plant biologist reviewed the information to interpret habitat characteristics of the Site in terms of tree cover, cut stage, potential wetland habitat, and potential un-mapped watercourses. These interpreted boundaries were added to the base map. Using the mapped information, areas for potential PDA was identified that appeared to meet the operational objectives listed above and avoid environmental constraints shown on the map.

A site visit was conducted in September 2013 to review the potential areas, verify what was shown on the map, confirm the locations or boundaries of sensitive and protected environmental features, and to identify additional features or expanded boundaries that should be avoided. The field team consisted of a driller to review operational objectives, a biologist with wetland/botany/aquatic/forestry expertise, and a wildlife/avian biologist. The site visit included the PDA and approximately 100 m around the outside of the PDA. A hand-held GPS (Global Positioning System) unit was used to record the location of protected features, and these data were subsequently uploaded to the base map.

The result of the planning process to date to identify a suitable location for the PDA is shown in Figure 3.1 within which the well pad and access road will be sited and developed, along with drainage features as required. The PDA encompasses approximately twice the area required for development to allow for flexibility to adjust the location of the PDA features once the survey has been conducted to meet operational and environmental objectives.

As explained in Section 3.4, the PDA lies in relatively flat terrain, and lies more than 150 m away from the nearest watercourse (Otter Brook) and is more than 30 away from any regulated wetlands as defined in the Rules for Industry (GNB 2013) and field-identified wetlands. The PDA lies in an area deemed by Archaeological Services, New Brunswick Department of Tourism, Heritage and Culture (herein referred to as Archaeological Services) to have low archaeological potential, having no known archaeological sites or known First Nation portage routes, and is not situated in areas predicted to be potential locations of Paleo-Indian shorelines. The PDA does not include any known SOCC. The PDA is distant from any protected wellfield area, protected watershed area, First Nations reserve lands, established parks, Ecologically Significant Areas, noise-sensitive receptors, or residences.

3.3 KNOWN APPROVALS, PERMITS OR AUTHORIZATIONS REQUIRED FOR THE PROJECT

The Project as defined is not a Designated Project under the *Regulations Designating Physical Activities,* SOR 2012-147 under the *Canadian Environmental Assessment Act, 2012*. As such, a federal environmental assessment is not required. Because key environmental features (*e.g.,* watercourses, and critical habitat under the *Species at Risk Act*) are also avoided through site selection, there are no federal permits or approvals or other forms of federal authorizations that are believed to be required to enable the Project to be carried out.

Similarly, because the Project is located outside of municipal boundaries, no municipal authorizations are needed.

Those permits, approvals, and authorizations that have been identified as being required in advance of the Project being implemented are listed in Table 3.2.

Table 3.2 Regulatory Permits, Approvals, and Authorizations

Permit Name	Regulatory Recipient	Nature of the Permit
Well Licence	NBDEM	Required under the *Oil and Natural Gas Act* prior to the drilling of any oil and gas wells.
Crown Licence of Occupation	NBDNR (Crown Lands Branch)	Required as part of Section 26 of the *Crown Lands and Forest Act* for any work conducted on Crown Land.
Letter of Permission	NBDELG	Required from the Environmental Assessment Section of NBDELG as part of the Phased EIA Process.
Approval to Construct or Operate	NBDELG (Impact Management Branch)	Required under the New Brunswick *Water Quality Regulation—Clean Environment Act*. Regulation 82-126. Required under New Brunswick *Air Quality Regulation—Clean Air Act*, Regulation 97-133.
Petroleum Storage Site Approval	NBDELG	Required for petroleum storage facilities 2,000 L or greater.
Petroleum Storage Environmental Approval	NBDELG	Required for petroleum storage facilities 2,000 L or greater.
Special Permit for Truck Traffic on NB Highways	NBDTI	Section 261 (1) of the *Motor Vehicle Act* requires that any vehicle, with or without load, or any combination of vehicles with or without load, not conforming to the weights and dimensions set out in the New Brunswick *Vehicle Dimensions and Mass Regulation—Motor Vehicle Act*, Regulation 2001-67 must make application for, and obtain, a special permit in order to be authorized to operate such vehicles on New Brunswick highways.
Land Use Proposal	NAV CANADA	The Land Use Program's assessment process applies to NAV CANADA's interests only, and assesses the effect of a proposed physical structure as it may relate to the Air Navigation Services.
Topsoil Preservation	NBDELG	Required under the New Brunswick *General Regulation—Topsoil Preservation Act*, Regulation 95-66 for the removal of topsoil if the layer to be removed is greater than 4cm and the quantity is greater than 5 m^3 (Section 9).

3.4 POTENTIAL INTERACTIONS BETWEEN THE PROJECT AND THE ENVIRONMENT, AND PLANNED MITIGATION

According to the professional judgment of the Study Team, the valued environmental components (VECs) that may interact with the Project include:

- Atmospheric Environment;
- Aquatic Environment;
- Water Resources;
- Terrestrial Environment;

- Historical and Current Use by First Nations;
- Socio-economic Environment;
- Land Use;
- Visual Environment;
- Heritage Resources; and
- Transportation Network.

The following Sections describe each of these environmental components, the existing (baseline) conditions for each environmental component, as well as the potential interactions with the Project and planned mitigation as part of the Project to reduce environmental interactions.

3.4.1 Atmospheric Environment

The Atmospheric Environment is the component of the environment that comprises the layer of air near the earth's surface to a height of approximately 10 km. The Atmospheric Environment is typically characterized by:

- air quality, which is characterized by the chemical and physical properties of the air in the lower atmosphere, including gaseous and particulate air contaminant concentrations in the ambient air;
- greenhouse gas (GHG) releases; and
- sound quality, which is characterized by the type, character, frequency, intensity, and duration of noise (unwanted sound) in the outdoor environment.

3.4.1.1 Existing Conditions

3.4.1.1.1 Air Quality

An extensive air-quality monitoring network for various air contaminants has been operated by the government and industry in New Brunswick for a number of years. The monitoring network was designed by NBDELG primarily to monitor compliance with ambient air-quality standards.

In the establishment of ambient air quality, each air contaminant has been given an Air Quality Index (AQI) level by NBDELG, based on measured concentration and environmental and health effects. The highest index level determined the overall AQI for the area. The levels were defined as good, fair, poor, and very poor. In this system, "good" is defined as concentrations that are below the maximum desirable National Ambient Air Quality Objectives (NAAQO) and "fair" is defined as concentrations that are above the maximum desirable NAAQO but are below the maximum acceptable NAAQO (NBDELG 2012b).

According to the NBDELG report entitled "New Brunswick Air Quality Monitoring Results: 2010" (NBDELG 2012b) and previous annual reports, the existing and historical ambient air quality at Fredericton, the closest air quality monitoring location to the PDA, is generally considered good (NBDELG 2012b). In 2009, Fredericton had "good" air quality for 99.5% of the year, and "fair" air quality 0.5% of the year (NBDELG 2012b). There were no exceedances of the maximum acceptable NAAQO in Fredericton in 2010 for the monitored compounds which included nitrogen oxides, carbon monoxide, ozone, and $PM_{2.5}$ (NBDELG 2012b).

The next closest air quality monitoring location to the PDA is at Moncton. In 2009, Moncton had "good" air quality for 99.3% of the year and "fair" air quality for 0.7% of the year (NBDELG 2012b). There were no exceedances of the maximum acceptable NAAQO in Moncton in 2010 for the monitored compounds which included nitrogen dioxides, carbon monoxide, ozone, and particulates (measured as $PM_{2.5}$)(NBDELG 2012b).

Given the rural nature of the Project area, it is expected that the ambient air quality in the vicinity of the PDA would be similar, or better than, that reported above for Fredericton or Moncton. This is inferred as much of the air contaminant emissions in the Fredericton and Moncton area are related to on-road and off-road vehicle use and lower traffic volumes exist in rural areas of the province. In addition to vehicle emissions, longer range transport from industrial sources in other parts of Atlantic Canada and the United States likely contributes somewhat to ambient air contaminant concentrations near the Project.

3.4.1.1.2 Greenhouse Gas Emissions

Greenhouse gases (GHG) of concern generally include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), among others. Provincial GHG emissions in 2010 were 8,227,975 tonnes of carbon dioxide equivalent (CO_2e) (Environment Canada 2010). Fifteen facilities reported GHG emissions to Environment Canada for 2010. Major GHG emitters in New Brunswick include the Irving Oil Refinery in Saint John (35% of the 2010 provincial emissions), the Belledune Generating Station in Belledune (32%), the Dalhousie Generating Station in Dalhousie (11%), and Bayside Power in Saint John (9.4%).

National GHG emissions in 2010 were 261,868,761 tonnes CO_2e (Environment Canada 2010). New Brunswick's contribution to national GHG emissions is 3.1%.

Greenhouse gas emissions globally are estimated to be 33 Gt per year (Climate Analysis Indicator Tool (CAIT) 2012). Canada's contribution to global GHG emissions is 0.79%.

3.4.1.2 Sound Quality

Existing sound levels at the PDA have not been documented. Based on observations made during field surveys, it is a rural forested area dominated by natural sounds (*e.g.*, wind and bird calls). There would be occasional noise associated with nearby harvesting of forest resources (*e.g.*, wood cutting and maple sap harvesting) and recreational activity (*e.g.*, all-terrain vehicle and snowmobile use, and hunting).

The PDA is located in a rural area with low population density (Figure 1.1). The nearest potentially human-occupied property is a recreational camp on Rerry Brook road, approximately 1,400 m southwest of the PDA boundary. The rural area of Fork Stream, approximately 6.7 km southeast of the PDA, is located on rural roads that would be subject to rural vehicle traffic noise, but is generally rural in character due to the low population density (Figure 1.1). From the rural nature of the area and the relatively low level of human activity, it can be implied that sound quality in the area is generally good (*i.e.*, low presence of noise), signified by a relatively low noise level.

Information on sound quality is available from the Alberta Energy Regulator (AER), which has collected information at locations in Alberta that are considered similar to the Project. The AER found that background natural sounds in a rural environment were on average 35 decibels (dB_A as rated on an "A" rated scale) during the night (23:00–07:00) and approximately 10 dB_A higher during the day (up to 45 dB_A) due to increased human and wind activity and animal sounds during the day (ERCB 2007). Professional experience confirms this range, although rare, extremely quiet, still nights may result in minimum levels under 30 dB_A, while natural animal sounds such as from spring peepers can cause local sound levels of over 60 dB_A at night.

In general, potential noise-sensitive receptors include residences, daycares, schools, hospitals, places of worship, nursing homes, and First Nations and Inuit Communities (Health Canada 2010). There is one noise-sensitive receptor within 5 km of the Project that meets the Health Canada definition: a recreational camp site located on Rerry Brook Road 1,400 m southwest of the PDA.

3.4.1.3 Project Interactions with the Atmospheric Environment

3.4.1.3.1 Air Quality

Project activities may release air contaminants such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), total hydrocarbons (THC), and particulate matter (PM) to the atmospheric environment. Project-related emissions were estimated based on assumed equipment parameters (*e.g.*, engine horsepower), transportation parameters (*e.g.*, round-trip distances, number of round-trips), soil properties (*e.g.*, moisture), and land area cleared for the PDA. Emission factors from Transport Canada (2012) and US EPA (1995, 1996, 2005, 2006, 2010) were used.

Emissions of air contaminants to the environment generated during Construction will occur primarily from construction equipment associated with the Project (*e.g.,* emissions from combustion of fuel and dust). Earth moving activities associated with Site preparation during Construction may result in particulate emissions during dry periods (dust). Emissions from the transportation of construction equipment and materials (*i.e.*, mobile fuel consumption) to the Site are anticipated to be a minor contributor to construction emissions. Table 3.3 provides an estimate of emissions from construction activities over the entire Construction period.

Table 3.3 Air Contaminant Emissions from Construction Activities

Activity	Estimated Emissions (tonnes)				
	CO	NO_x	SO_2	PM	THC
Site preparation equipment	0.2	0.5	0.1	0.03	0.03
Transportation of equipment	0.07	0.06	0.0002	0.001	0.005
Fugitive dust (ground clearing)	--	--	--	11	--
Total From Project	**0.2**	**0.5**	**0.1**	**11**	**0.03**

Notes:
* Volatile organic compounds are reported.

Legend:
CO = carbon monoxide. NO_x = nitrogen oxides as nitrogen dioxide. SO_2 = sulphur dioxide.
PM = particulate matter. THC = total hydrocarbons.

Emissions related to the combustion of fossil fuel from operation of construction equipment associated with the Project are anticipated to be very low (relative to other larger construction sites), intermittent, and of short duration. Particulate matter emissions from Construction activities represent approximately 0.05% of the reported particulate matter emissions (22,130 tonnes) for New Brunswick from the 2010 National Pollutant Release Inventory (NPR) (Environment Canada 2012). Due to the relatively small magnitude of equipment required, emissions are not expected to exceed ambient air-quality standards for New Brunswick. Equipment will be maintained in good working order and within manufacturer's specifications.

Emissions generated during Drilling will be from combustion of fossil fuels as well as dust, related to drilling activity, transportation of equipment to the Site, equipment moving the waste drill cuttings within the PDA, and the trucking of waste to the waste processing facility which is assumed for modeling purposes to be to 200 km away. Total estimated emissions from drilling activities are provided in Table 3.4.

Table 3.4 Air Contaminant Emissions from Drilling Activities

Activity	Estimated Emissions (tonnes)				
	CO	NO_x	SO_2	PM	THC**
Equipment use	2	9	1	0.3	0.3
Transportation	8×10^{-2}	0.1	4×10^{-4}	3×10^{-3}	8×10^{-3}
Dust	--	--	--	2	--
Total From Project	**2**	**9**	**1**	**2**	**0.3**

Notes:
* This only includes THC from fossil fuel combustion. Trace amount of THC from drilling is not included.
** Volatile organic compounds are reported.

Legend:
CO = carbon monoxide. NO_x = nitrogen oxides as nitrogen dioxide. SO_2 = sulphur dioxide.
PM = particulate matter. THC = total hydrocarbons.

Emissions of combustion gases from the Project are very low in comparison to provincial emissions. Nitrogen oxides emissions from drilling activities represent approximately 0.02% of the reported nitrogen oxides emissions (42,374 tonnes) for New Brunswick from the 2010 NPRI (Environment Canada 2012). They are not expected to cause exceedances of ambient air quality objectives because of the low magnitude and short duration of activities and the mobile/transient nature of many of the sources.

Emissions from equipment will be intermittent and transient, thereby reducing environmental interactions at any one location. Dust generated by the movement of vehicles and equipment on the Project access road has been estimated to be 2 tonnes during Drilling. Within the PDA, dust will be managed effectively in dry periods using standard dust-suppression best management practices (*e.g.,* water sprays). With planned mitigation such as the use of dust suppressants (*i.e.,* water), the emission of particulate matter (*i.e.,* dust) during Drilling will be primarily restricted to within 500 m of the PDA.

During dry periods with high winds, dust generated along the preferred access route (Figure 1.1) may be carried distances of up to 1 km. The preferred access route was selected to avoid residential areas so that potential adverse environmental effects are reduced. There are no sensitive receptors within 1,400 m of the Site. At that distance, the generated dust is expected to have been dispersed so air quality will not change substantially as a result of the Project.

Air contaminant emissions from Construction and Drilling are expected to be minor when compared to those from industrial facilities currently operating in the province. The scope and footprint of emission sources required for Project Construction and Drilling is also very small in comparison to many activities routinely conducted in the province without substantive air quality interactions, such as road construction and commercial development. As such, substantive interactions between the Project and air quality are not anticipated.

3.4.1.3.2 Greenhouse Gas Emissions

Emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)—the three main greenhouse gases (GHGs)—may be released to the Atmospheric Environment from Project activities (fuel combustion). A small quantity of methane may also be released from rock formations during Drilling. Total GHG emissions are shown as tonnes of carbon dioxide equivalent (tonnes CO_2e), using 100-year global warming potentials (GWP) defined by the Intergovernmental Panel on Climate Change (IPCC 2007).

Estimated emissions of GHGs from the Construction period are provided in Table 3.5.

Table 3.5 Emissions of Greenhouse Gases from Construction

Activity	Estimated Emissions (tonnes)			
	CO_2	CH_4	N_2O	CO_2e
Site preparation equipment	48.6	NQ	NQ	48.6
Transportation of equipment	11.7	0.001	0.001	12.0
Total from Project	**60.3**	**0.001**	**0.001**	**60.6**

Notes:
NQ = Emission factors are not available.
Legend:
CO_2 = carbon dioxide. CH_4 = methane. N_2O = nitrous oxide. CO_2e = carbon dioxide equivalent.

As shown in Table 3.5, it is anticipated that there will be nominal GHG emissions from the use of heavy construction equipment (*e.g.,* dump trucks, graders) at the Site and from the transportation of equipment and materials. Greenhouse gas emissions from Construction activities represent

approximately 7 x 10^{-4}% of reported GHG emissions (8,227,975 tonnes CO_2e) for New Brunswick from the 2010 GHG Reporting Program (Environment Canada 2010).

Greenhouse gas emissions generated during drilling activities will be related to the combustion of fossil fuel during drilling activity, equipment moving the waste drill cuttings within the PDA, and the trucking of waste to the waste-processing facility. Estimated emissions of GHGs from the Drilling period are provided in Table 3.6.

Table 3.6 Emissions of Greenhouse Gases from Drilling Activities

Activity	Estimated Emissions (tonnes)			
	CO_2	CH_4	N_2O	CO_2e
Equipment use	507	0.02	NQ	507
Transportation	20.0	0.001	0.001	20.3
Gas venting	--	0.16	--	3.26
Total from Project	**527**	**0.18**	**0.001**	**531**

Notes:
NQ = Emission factors are not available.
Legend:
CO_2 = carbon dioxide. CH_4 = methane. N_2O = nitrous oxide. CO_2e = carbon dioxide equivalent.

Overall, GHG emissions from Drilling are expected to be approximately 531 tonnes CO_2e. This represents 0.01% of 2010 provincial GHG emissions (8,227,975 tonnes CO_2e) and <0.001% of 2010 national GHG emissions (261,868,761 tonnes CO_2e) (Environment Canada 2010). Equipment will be maintained in good working order and within manufacturer's specifications to control GHG emissions from the Project to the extent possible.

Fugitive emissions of methane from drilling activities may occur if the well passes through a porous gas deposit. Emissions are not expected to be substantive since the geology of the area is well understood and, based on seismographic surveys, is not known to contain a conventional hydrocarbon reservoir. Gas present is expected to be constrained within the shale being investigated since shale is characterized by a low permeability. It is possible that some natural gas (primarily methane) could be released during Drilling, but if this occurs it would be limited to the release of small pockets within the shale. Section 2.2.2.4 describes the operational procedures that will be followed if gas formation is encountered.

Substantive interactions between the Project and air quality in relation to GHG emissions are not anticipated.

3.4.1.3.3 Sound Quality

The interactions of the Project with sound quality are described in more detail than the other components of the Atmospheric Environment because sound quality has been identified by the Regulator as meriting a more detailed assessment and management (Rules for Industry, Section 9.5; GNB 2013).

Sound emissions will result from construction and drilling activities involving noise-generating equipment including the use of heavy equipment and generators, as well as the drilling of the wellbore.

During Construction, temporary and reversible changes in sound pressure levels will occur over a three to four week period (see Section 2.3) in the vicinity of the Project due to activities such as earth moving and the operation of heavy equipment associated with site preparation, structure construction, access road construction and the development of facilities. Typical sound pressure levels of some commonly used construction equipment are provided in Table 3.7.

Table 3.7 Typical Construction Equipment Sound Pressure Levels

Equipment Powered by Internal Combustion Engines	Sound Pressure Level (dB_A at 15 m)
Roller	85
Front loader	80
Backhoe	80
Excavator	85
Bulldozer	85
Grader	95

Notes:
dB_A = Decibels on an "A" weighted scale.

Source: Federal Highway Administration (FHWA) 2006.

Preliminary information indicates that an excavator, grader, bulldozers, rollers, and various trucks will be required for Construction. However, not all equipment will be in operation at the same time. Stantec estimated sound pressure levels assuming the simultaneous operation of a bulldozer and an excavator as a likely scenario and representative of typical expected sound pressure levels during Construction. The area disturbed during construction is 3 ha. This area is forested and relatively flat. Given the small size of the disturbed area and the straightforward nature of the construction, the simultaneous operation of two pieces of equipment is expected to represent the average number of equipment operating at the Site at any time. The nearest human-occupied receptor is approximately 1,400 m from the PDA. Table 3.8 provides a breakdown of estimated sound pressure levels due to expected construction activities.

Table 3.8 Predicted Daytime Sound Pressure Levels from Construction

Distance from Activity (m)	Daytime Predicted Sound Pressure Level (L_{eq}) (dB_A)[A] (includes background level)
100	72
250	64
500	58
1,000	52
1,400	50
1,500	50

Notes:
[A] Sound pressure level estimates are for outdoor noise level and do not include the 15-25 dB_A decrease in sound pressure levels (depending on insulation and construction quality) that is typically achieved by the walls of a well-built building (windows closed) (Hoover & Keith Inc. 2005). Assume daytime background ambient sound level of 45 dB_A, and nighttime background ambient sound level of 35 dB_A (ERCB 2007). Estimates based on operation of 1 bulldozer and 1 excavator for 12 hours during daytime hours.
dB_A = Decibels on an "A" weighted scale.

For the planned level of Construction, sound pressure levels at 1,400 m and beyond from the PDA will increase beyond background; however, the level of noise should be indistinguishable from other surrounding sounds most of the time and should not be considered intrusive. Based on the typical sound pressure levels provided in Table 3.9 and the heavy machinery assumed to be in use during site preparation, sound levels during the daytime may on occasion reach 50 dB_A during the daytime at 1,400 m which may be just noticeable over expected background levels, but is not expected to cause substantive annoyance. Because construction activities will occur during the daytime only (07:00–22:00 hours), sound levels during the nighttime will be unchanged from the existing nighttime conditions.

During Drilling, temporary (four to eight week period) and reversible changes in sound pressure levels will also occur. The sound pressure levels of equipment anticipated to be used during Drilling are estimated from theoretical predictions and manufacturer's specifications. The sound pressure level at the nearest receptor is estimated based on the expected equipment sound pressure levels, the distance to the receptor, and the assumed sound mitigation measures in place (*e.g.*, engine silencers and equipment enclosures).

This assessment focused on major continuous noise-generating equipment. The estimated sound pressure levels for selected drilling equipment types are summarized in Table 3.9.

Table 3.9 Drilling Continuous Noise Sources

Item	Equipment Description	Sound Pressure Level* at a distance of 20 m (dB_A)	Sound Pressure Level Reference	Assumptions
1	Power Generator Package (two 800 kW generators and two CAT3508 diesel engine units, 60% loaded)	84	theoretical prediction (design and operational data)	Enclosed unit with access doors opened.
2	Rig Drawworks Engine (one GE 752 series motor, 30% loaded)	62	theoretical prediction (design and operational data)	Enclosed unit.
3	Mud Pump Skid (two pumps and two GE 752 Series (1) electric motors, 75% loaded)	73	theoretical prediction (design and operational data)	Enclosed unit with access doors open.
4	House/Trailer Generator (Isuzu 4 cycle generator, 50% loaded)	57	measurements	Enclosed unit.
5	Mixing Skid	56	measurements	NA
6	Shaker Skid	62	measurements	NA
7	Idling Heavy Truck	66	measurements	NA

Notes:
dB_A = decibels (A-weighted scale).
* dB reference pressure is 20 µPa (micro Pascals).
1. Exhaust on all diesel engines are fitted with super-critical grade silencer or higher grade.
2. Equipment enclosure wall and roof assumed to be 3" thick structure with R12 insulation and 20 ga galvanized outside wall cladding.
3. Negligible noise breakout from the equipment enclosure skid.
4. Sound attenuation by ground absorption, barrier effect of terrain and buildings are not included (therefore over-estimated).
5. Equipment in the table above operates continuously at the specified load capacity. If the load capacity is not specified for the equipment, the assessment assumes 100% during Drilling.

The noise from trucking during Construction and Drilling may reduce the sound quality at residences along the transportation route to the processing site; therefore the route was selected to reduce potential interactions with adjacent residents and communities, to the extent feasible (Figure 1.1).

Noise emissions from temporary or intermittent events (*e.g.*, rig tripping operation, cementing operation, air tugger, logging unit, centrifuges, air compressor, vacuum pump, and front end loaders) are not included in the assessment. These activities will be infrequent and will be planned for daytime only wherever possible.

The noise propagation prediction is based on international standard ISO 9613-2:1996 "Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General method of Calculation" (ISO 1996), a commonly accepted calculation method used by acoustic practitioners and recommended by provincial regulations (*i.e.,* Alberta ERCB Directive 038). Predictions were completed assuming the doors are open on equipment with access doors. A breakdown of predicted sound pressure level at various distances from the rig drawworks operation is provided in Table 3.10.

Table 3.10 Sound Pressure Levels from Drilling with Doors Open

Distance from Activity (m)	Predicted Sound Pressure Level without background (dB_A)[a]	Daytime Cumulative Level[b]	Nighttime Cumulative Level[c]
50	77	77	77
100	71	71	71
250	63	63	63
500	56	56	56
1,000	49	51	49
1,400	45	48	46
1,500	45	48	45

Notes:
dB_A = decibels on an "A" weighted scale.
[a] dB reference pressure is 20 µPa (micro Pascals).
[b] Assume daytime ambient sound level of 45 dB_A.
[c] Assume nighttime ambient sound level of 35 dB_A.
* Attenuation from intervening structures, forested areas and topography was from the analysis.

As outlined in the Rules for Industry (GNB 2013), the maximum permissible levels of noise during operation of oil and gas facilities are 50 dB_A L_{eq} for the daytime period (07:00–19:00) and 40 dB_A L_{eq} for the nighttime period (19:00–7:00) at the nearest receptor, or 1,500 m if no receptor is within 1,500 m. This applies to the operation of permanent facilities where the Regulator may allow or require adjustments to the above basic sound levels on the basis of site-specific conditions such as:

a) duration and nature of the noise-generating activity;

b) proximity of the noise receptor to other noise-generating activities (*e.g.*, a highway, airport, etc.);

c) actual ambient noise levels; and

d) presence of noise-sensitive natural features such as wildlife habitat (GNB 2013).

The ERCB Directive 038 is referenced for guidance on when adjustments may be applied. One such condition where adjustments can be applied as per the ERCB directive is in relation to temporary activities, defined as less than 60 days. Where activities are less than 60 days, the ERCB directive indicates that a 5 dB_A adjustment can be applied because there may be some additional tolerance of temporary activities. This would result in maximum permissible levels of 55 dB_A for daytime and 45 dB_A for nighttime.

The predicted sound pressure level at 1,400 m from the drilling rig during continuous drilling operation (based on the equipment in Table 3.10) is expected to be barely distinguishable from background sound levels during the daytime and in compliance with the maximum permissible levels specified in the Rules for Industry (GNB 2013). Assuming a daytime background sound pressure level of 45 dB_A, the predicted daytime cumulative sound pressure level at the nearest receptor at 1,400 m from the drilling rig is 48 dB_A This 3 dB_A increase is expected to be barely perceptible to the human ear. Assuming a nighttime background sound pressure level of 35 dB_A, the predicted nighttime cumulative sound pressure level at a receptor at 1,400 m from the drilling rig is 46 dB_A; which is slightly above the maximum permissible levels specified in the Rules for Industry with an adjustment of 5 dB_A, applied due to the temporary nature of the activity. The human ear is not likely to distinguish a 1 dB_A increase in noise. Furthermore, the noise model applied did not incorporate the reduction in sound pressure level due to forest or ground absorption between the source and the receptor. Therefore, it is likely that the sound pressure level at the receptor location will not reach 46 dB_A.

Impulse noise from the operation of the drilling rig (e.g., metal on metal clanging) may occur during Drilling. Although these sound sources are loud, they are intermittent and occur over a relatively short period of time (four to eight weeks). At the nearest receptor at 1,400 m from the Site, impulse noise will be attenuated such that it will likely not be distinguishable over normal operational noise or other unrelated noise. Noise mitigation will also consider ways to reduce impact or impulse noise from Drilling.

Table 3.11 summarizes the results at the nearest receptor. Although no maximum permissible noise level is specified for Construction in the Rules for Industry, based on the predictions, the noise during Construction is expected to be barely perceptible over background levels at a distance of 1,400 m from the PDA. As construction will be during daytime only, environmental effects due to noise during Construction will not occur during nighttime hours and are not expected to be substantive overall. Communication and complaint management will be employed through the EPP to manage and mitigate noise issues during Construction if they occur.

Table 3.11 Noise Prediction Results Summary for 1,400 m (Nearest Receptor)

Phase	Background Day/Night (dB_A)	Predicted Daytime L_{eq} (dB_A)[1]	Predicted Nighttime L_{eq} (dB_A)[1,2]	Meets Daytime Maximum Permissible Level*	Meets Nighttime Maximum Permissible Level*
Construction	45/35	50	No change (no construction at night)	NA	NA
Drilling (doors open)	45/35	48	46	Yes	No

Notes:
1 dB_A reference pressure is 20 µPa.
2 Construction will not occur at night. Assumed background level presented.
* Permissible level with 5 dB_A adjustment applied for temporary nature of activity.

The sound pressure levels predicted from Drilling when the equipment is operated with the access doors open is over the maximum permissible level for nighttime by 1 dB_A; however, the human ear is not likely to distinguish a 1 dB_A increase in noise.

Sound levels at 1,400 m from the PDA are expected to be reduced from the estimates to within the proposed adjusted maximum permissible levels with noise mitigation being implemented as part of the EPP for the Project, including the following actions:

- use scheduling restrictions where warranted and feasible;
- maintain equipment in good working order in terms of noise;
- place intervening structures or materials such as tanks, trailers, topsoil stockpiles between the noise sources and receptors where warranted and practical;
- where warranted and feasible employ equipment with electric pumps; and
- regularly discuss noise-minimization practices with workers and contractors, and require that site managers periodically check the Site for correct application of noise mitigation as well as check at nearby noise-sensitive receptors for noise issues so that they can be quickly addressed.

Based on the results and the mitigation available, and the human ear unlikely being able to distinguish a 1 dBA increase in noise, substantive interactions between the Project and sound quality are not expected. Periodic noise monitoring will be carried out at the nearest receptor during both Construction and Drilling near the onset of the work to confirm compliance with permissible noise levels. In the event that exceedances of the maximum permissible levels are measured, additional mitigation would be employed in accordance with Section 9.5 of the Rules for Industry (GNB 2013). Based on experience, these levels are achievable for this type of operation.

Overall, while Construction and Drilling may result in emissions of air contaminants, GHG, and sound (noise) to the atmosphere, these emissions are expected to be small in magnitude, of short duration and they are not expected to cause an exceedance of air quality and noise guidelines or result in GHG emissions that are considered important on the provincial, national or global scale. In light of this, substantive interactions between the Project and Atmospheric Environment are not anticipated.

3.4.2 Aquatic Environment

The Aquatic Environment includes consideration of fish and fish habitat, including aquatic species at risk and aquatic species of conservation concern, and water quality and habitat quantity in freshwater bodies.

3.4.2.1 Existing Conditions

Existing conditions in the Aquatic Environment in the area of the Project were determined based on a review of available information (*e.g.,* NBDNR and SNB maps), and site visits. The PDA is located within the Washademoak Creek Watershed and is 1,400 m south of the divide with the Jemseg River

Watershed. The Washademoak Creek Watershed has a total area of approximately 216,660 ha and the Jemseg River Watershed has a total area of approximately 395,140 ha.

Particular attention must be paid to species at risk (SAR) and species of conservation concern (SOCC), which are specifically protected by federal and provincial legislation. Generally, these laws prohibit the destruction, disturbance or other interference with SAR or their residences. The Federal *SARA* is co-administered by Environment Canada, Parks Canada, and DFO; and the NB *SARA* is administered by NBDNR. SOCC are often species on the verge of becoming SAR and are therefore 'listed' in federal and provincial legislation as well as in non-regulatory lists maintained by independent assessment agencies and committees, such as the Atlantic Canada Conservation Data Centre (AC CDC). A search was conducted and the AC CDC has returned no records of aquatic species of conservation concern (SOCC) or species at risk (SAR) within 5 km of the PDA.

There are three watercourses within 1 km of the PDA (Figure 3.1). Otter Brook originates southeast of the Project and flows southwest along the southern side of the PDA where, at its closest point, it is approximately 595 m from the PDA. Perry Brook originates on the northwestern side of the PDA and flows northeastward where, at its closest point, it is approximately 645 m from the PDA. An unnamed tributary to Perry Brook originates 660 m from the PDA and flows northeastward into Perry Brook 830 m from the PDA. The terrain of the PDA, and surroundings, is low and flat with a gentle slope to the southeast toward Otter Brook.

3.4.2.2 Project Interactions with the Aquatic Environment

Pursuant to Section 5.2, Rules for Industry (GNB 2013), surface water quality and fish habitat quality must be determined at upstream and downstream locations in watercourses within 150 m of the PDA, prior to Construction and Drilling. Since the PDA is more than 595 m from the nearest watercourse and involves no watercourse crossings, field characterization of fish and fish habitat (including surface water quality sampling) is not required for the Project. As a result, no direct interaction with the Aquatic Environment is anticipated by the Project as planned.

As described in Section 2.2.1.3, areas of the PDA with potential for spills (*i.e.*, storage tanks) will be situated within a bermed area will be equipped with an impermeable synthetic liner such that potentially spilled fluids are contained for easy and immediate clean-up, thereby avoiding the downward migration of contaminants. Excess wastewater from drilling operations collected at the Site, which cannot be reused, will be trucked to a disposal facility legally able to receive the excess wastewater or tested and treated prior to release to the environment.

Surface water falling on un-lined areas of the well pad will be contained by berms and directed toward perimeter ditching and storm water collection ponds. The storm water ponds will be designed to allow suspended sediments to settle out of the water column prior to release to the environment. Clean surface water run-off originating from off the PDA will be avoided from entering the well pad area by perimeter ditching.

As described in Section 2.2.1.3, a site-specific run-off management plan will be developed for the Project prior to grading with particular focus on areas determined to have high erosion risk. In addition

to careful Project design to avoid direct interaction with watercourses on the PDA, mitigation measures will be used that are protective of the Aquatic Environment, including those listed in Section 2.2.1.3.

Given that the PDA, including drainage features, is located at least 595 m from the nearest watercourse, the Project will not release water into a watercourse or within 30 m of a watercourse. As well, given the run-off management as described in Section 2.2.1.3 and mitigation that will be applied in the site-specific run-off management plan, substantive interactions between the Project and the Aquatic Environment are not anticipated.

3.4.3 Water Resources

Water Resources include surface and groundwater sources that can be used as potable water, or for other residential, agricultural, commercial, or industrial purposes.

3.4.3.1 Existing Conditions

An assessment of the existing conditions for Water Resources was conducted using published data on Wellfield and Watershed Protected Areas, municipal, industrial and other large water supplies, and the occurrence of surface water and groundwater in the vicinity of the Project.

The Project is not located within a NBDELG Wellfield Protected Area, nor is it located within a NBDELG Watershed Protected Area. The nearest municipal water supplies are in the community of Penobsquis, located approximately 48 km southeast of the PDA, and the Town of Sussex, located approximately 50 km to the south of the PDA, both of which derive their water supplies from groundwater. At these distances from the communities the Project will not interact with these municipal water supplies.

The nearest industrial water supplies are at the former NB Coal Mine (closed; groundwater source) located 32 km west of the PDA and at the PCS potash mine (groundwater source) located 47 km to the south of the PDA.

A description of the watercourses in the vicinity of the Project is provided in Section 3.4.2. No existing users of the watercourses have been identified in the vicinity of the PDA.

The PDA lies in a rural area where potable water is likely obtained from residential wells. Information on potable water supplies in the region surrounding the PDA was conducted by query of the NB Online Well Log System (NBDELG 2013) which contains well records for all potable wells drilled in the province beginning in 1994. The query was conducted for wells located within 5 km of the PDA, and it identified no well logs. The search radius was expanded to 10 km, which identified a total of eight well logs, the nearest located at 7.4 km south of the PDA. The well logs reported total well depths ranging between 12.8 m and 27.4 m below ground surface. The mean safe yield (*i.e.*, pumping rate) of the wells is 44 L/min, which is a suitable amount for domestic potable supplies supporting individual residences. The lithology was reported to be red shale and red to grey sandstone, which is consistent with the bedrock geology of the area (see Section 3.1.2).

In accordance with Section 5.1 of the Rules for Industry (GNB 2013), potable water well sampling and analysis is necessary on water wells located within 500 m of the well pad, prior to and after drilling , to

document potable water well quality prior to Construction and Drilling. Since the PDA is more than 5 km from the nearest residential well, there is no potable water well sampling required for the Project.

3.4.3.2 Project Interactions with Water Resources

In total, it is expected that the Project will require approximately 1,200–1,600 m^3 of water, which includes process water and potable water for use by employees at the Site. Process water will be re-used to the extent possible. Process water that cannot be re-used and sanitary waste water will be trucked off-site to a disposal facility.

The water requirements of the Project will be supplied by a municipal source, industrial water supply, or be withdrawn from nearby surface water. If water is withdrawn from nearby surface water, SWN RC will do so at a rate that is less than 50 m^3/day and at a rate and in a manner such that it does not have a substantive effect on the Aquatic Environment (*i.e.*, maintenance flows are observed). A terrestrial and aquatic biologist will survey conditions at the withdrawal point and a WAWA permit will be obtained under the Watercourse and Wetland (WAWA) Regulation. SWN RC will comply with all conditions of the Watercourse and Wetland (WAWA) permit. .

Storm water run-off from the bermed well pad area will also be collected for use by the Project (Section 2.2.1.3). The Project will not release water directly into watercourses or local groundwater.As described in Section 2.2.1.3, areas of the PDA that will be used for storage and handling of drilling fluids or wastes will be equipped with an impermeable synthetic liner and be contained on the perimeter by berms. Storm water or other fluid that accumulates within the containment berms will be collected and trucked to a disposal facility, treated on-site, or be tested prior to being released to the environment. Furthermore, mitigation as listed in Section 2.0 of the Rules for Industry, titled Preventing Potential Contaminants from Escaping the Wellbore (GNB 2013), will be implemented during drilling. Because of the mitigation to be implemented, no release of contaminants from the wellbore or well pad is expected.

As such, substantive interactions between the Project and Water Resources are not anticipated.

3.4.4 Terrestrial Environment

The Terrestrial Environment includes vegetation, wetlands, wildlife, and wildlife habitat, including terrestrial species of conservation concern (SOCC) and species at risk (SAR) (as explained in Section 3.4.2).

3.4.4.1 Existing Conditions

A field site visit of the PDA was conducted in October 2013 to characterize the terrestrial environment. The timing of the field visits was outside the growing season for vegetation and outside the breeding bird season. The composition of the vegetation communities was evident, and the potential for plant and wildlife SOCC and SAR was assessed from visual observation and background information.

3.4.4.1.1 Wetlands

No wetlands (neither regulated wetlands, as defined in the Rules for Industry (GNB 2013), nor field-identified wetlands) were identified within 30 m of the PDA. Wetlands closest to the PDA (approximately 35 m from the perimeter of the PDA) are field-delineated wetlands and were characterized by Stantec biologists in September 2013. Wetland boundaries in the vicinity of the PDA, but beyond the field-delineated boundaries, were interpreted using aerial photography, a digital elevation model (derived bare earth hillshade model), and depth-to-water-table map information available from NBDNR (Figure 3.1).

Forested wetlands are abundant in the region surrounding the PDA. The PDA is surrounded by a large, field-identified wetland complex that is typical to the region, and is approximately 35 m away from the PDA at its closest point. This large wetland complex encompasses all of the nearby regulated wetlands as defined by the Rules for Industry (GNB 2013) and Otter Brook, and is dominated by black spruce forest cover, with expanses of bog to the east and riparian shrub wetland along the nearby watercourses. The black spruce forest cover in the wetland complex is of mixed age, from young to mature, with the most trees in younger age classes as a result of past timber harvesting.

3.4.4.1.2 Vegetation

The PDA is located in the Castaway Ecodistrict within the Eastern Lowlands Ecoregion. This Ecodistrict is characterized by a low flat area in eastern and central New Brunswick that drains westward to the Saint John River and east to the Northumberland Strait. The intolerant mixedwood and softwood forest cover and abundance of wetlands due to poorly drained soils and low relief are typical to the Ecodistrict and Ecoregion. The soils are typically all nutrient poor in this area and the vegetation community reflects the level of productivity and poor drainage. Watercourses flowing through this Ecodistrict tend to be slow and meandering, and these are characteristic of Otter Brook and Perry Brook near the PDA.

The PDA and vicinity appears to have regenerated following a clearcut that occurred approximately 35 years ago. The forest cover may have been pre-commercially thinned in the past and is now dominated by red spruce (*Picea rubens*) with a minor intolerant hardwood component. No rare plant species were found in the PDA and the likelihood for vascular plant SOCC or SAR is low based on the lack of surface water features or vegetation communities that typically support rare species. Much of the forest cover in the vicinity of the PDA is forested wetland and is dominated by black spruce (*Picea mariana*). As is typical of the Eastern Lowlands Ecoregion, a high proportion of the landscape is forested wetland and peatland. Along watercourse and roadsides, shrub-dominated wetlands are abundant.

Although the likelihood for occurrence of vascular plant SOCC or SAR is considered to be low in and around the PDA, several hundred individual plants of the SOCC field milkwort (*Polygala sanguinea*) were identified on the resource road to the east of the PDA (Figure 3.1). This species is adapted to nutrient poor, disturbed sandy soils and it is often found along resource roadsides in the Eastern Lowlands. The plant is ranked S2 ("Sensitive") by the Atlantic Canada Conservation Data Centre (AC CDC) and Sensitive by NBDNR.

3.4.4.1.3 Wildlife and Wildlife Habitat

According to the AC CDC, there are no records of terrestrial animals of special conservation status within a 5 km radius of the PDA.

Typical assemblages of wildlife are anticipated to be present near the PDA including moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), American black bear (*Ursus americanus*), fox (*Vulpes vulpes*), American mink (*Mustela vison*), beaver (*Castor canadensis*), striped skunk (*Mephitis mephitis*), porcupine (*Erethizon dorsatum*), raccoon (*Procyon lotor*), and varying hare (*Lepus americanus*). Small mammals such as red squirrel (*Tamiasciurus hudsonicus*), and small insectivores and rodentsare anticipated to be widespread on or near the PDA. All these species are common and relatively abundant throughout New Brunswick.

There is one bird, the Olive Sided Flycatcher (*Contopus cooperi*) with a General Status Rank of "At Risk" that is 4.7 km from the PDA based on data provided by the AC CDC. There were no additional rare bird species (S1-S3) observed during the site- visit in September 2013; however, many species have been recorded in the surrounding landscape (within 5 to 20 km). The Atlantic Conservation Data Centre and NatureServe use data and expertise for ranking species rarity or conservation status. Provincial rarity rankings range from S1 (Extremely Rare), to S5 (Abundant). Species occurrences that are individually tracked due to conservation concern in the context of this environmental assessment are those with rankings of S3 ("Uncommon") or rarer (AC CDC 2012).

While common bird species would be expected to nest in the vicinity of the Project, there is also habitat outside the PDA that may be used by avian SAR. The Canada warbler (*Cardellina canadensis*) typically uses swampy habitats with well-developed shrub understories for nesting and foraging and may nest or forage in the riparian areas along the watercourses outside the PDA. There is some potential for common nighthawk (*Chordeiles minor*) to use nearby clearcuts, landings, and peatlands as nesting and foraging habitats. Rusty blackbirds (*Euphagus carolinus*) is often associated with the edges of beaver ponds which are present along the watercourses outside the PDA. The Eastern wood pewee (*Contopus virens*) is also associated with habitat that is common in the region and may be present outside the PDA. These habitat conditions are common on the surrounding landscape, but do not exist within the PDA.

No Ecologically Sensitive Areas (ESAs), as defined by Nature Trust of New Brunswick in partnership with NBENV and NBDNR (Nature Trust of New Brunswick), are located within 5 km of the PDA. There is a Deer Wintering Area (DWA) (174 ha) approximately 3.9 km to the southwest of the PDA. The Canaan Bog Protected Natural Area is approximately 9 km to the northeast of the PDA. The Cranberry Lake ESA and Protected Natural Area (PNA) is approximately 6.5 km to the south of the PDA and is bordered to the north and east by a Candidate PNA #159. No other locations of critical or sensitive habitat for wildlife are known in nearby proximity to the PDA.

3.4.4.2 Project Interactions with the Terrestrial Environment

3.4.4.2.1 Wetlands

There are no wetlands (neither regulated wetlands as defined in the Rules for Industry (GNB 2013) or field-identified wetlands) within the PDA or within 30 m of the PDA, directly as a result of avoidance of wetlands and wetland buffers by SWN RC in selecting this PDA. The closest field-identified wetlands lie approximately 35 m north of the PDA. No Project-related activities will occur within the boundaries of, or within 30 m of, a regulated wetland as defined in the Rules for Industry (GNB 2013) or a field-identified wetland. Furthermore, the Project is not expected to influence hydrology in ways that alter wetland

hydrology in the vicinity of the Project. As such, interactions between the Project and wetlands are not anticipated.

Should there be a requirement for road maintenance and repair along the preferred access route, potential Project interactions with wetlands will be avoided or reduced through careful planning and design, and the use of mitigation measures. All road maintenance and repair work will be conducted in accordance with legislation. Watercourse and Wetland Alteration permits and specific mitigation measures to reduce environmental effects will be implemented. As such, and through the implementation of standard mitigation to reduce environmental effects to the wetland environment (*e.g.*, erosion and sedimentation control measures, avoiding in-wetland work wherever possible), substantive interactions between the Project and wetlands along the preferred access route are not anticipated.

3.4.4.2.2 Vegetation

Only one vascular plant SOCC was been found in the vicinity of the PDA and that is field milkwort (*Polygala sanguinea), ranked as* S2 *Sensitive*. Several hundred individual plants of this species were identified on the resource road to the east of the PDA (Figure 3.1) and no individual plants were found within the PDA during the September 2013 site visit. This species is adapted to nutrient poor, disturbed sandy soils and is often found along resource roadsides in the Eastern Lowlands. The resource road where this species occurs will not be used for the Project and any disturbance that may result from the Project is unlikely to affect this population. The affinity for this species for disturbed roadsides may provide opportunity for this population to spread and/or increase following construction.

The vegetation community in the PDA and its vicinity has been disturbed by past resource extraction activity (*i.e.,* forestry harvesting), and with the exception of field milkwort, is typical of the Ecodistrict. The Project will result in the loss of vegetation in the PDA, however this vegetation is common to the area.

Given the above planning and mitigation, substantive interactions between the Project and vegetation are not anticipated.

3.4.4.2.3 Wildlife and Wildlife Habitat

The potential for wildlife SAR or SOCC to be present within the PDA is generally low. The vicinity of the PDA does not contain important or specialized habitat and is typical of southwestern New Brunswick. No wildlife SOCC or SAR have been observed within or adjacent to the PDA.

Clearing/grubbing activities will be avoided to the extent feasible during the peak bird breeding period (May 1 through August 31) and mitigation will be undertaken during clearing to reduce the risk of nest destruction or disturbance to breeding birds. A bird biologist will complete a walkover at the PDA prior to clearing/grubbing on-site and will consider any additional mitigation if necessary.

Light sources, especially at night and/or during inclement weather have been shown to be an attractant to migrating birds (Avery *et al.* 1976, Evans Ogden 1996, Wiese *et al*. 2001, Rich and Longcore 2006). The attraction of birds to lights on elevated structures and towers and/or flares raises the issue of the increased potential for bird kills due to collisions. With planned mitigation and the short duration of the Project,

negative effects caused by lighting are not anticipated (for additional detail on lighting assessment please see Visual Environment, Section 3.4.8). Furthermore, Construction and Drilling activities are planned to take place outside of peak breeding bird period where feasible, and careful Project planning and siting activities (Section 3.2) have aimed to avoid important bird habitat and areas where rare or protected bird species are known to inhabit, thus further reducing the potential for attracting nocturnal migrating birds.

Since the PDA does not represent specialized or unique wildlife habitat, the habitat within and around the PDA is typical of that area of New Brunswick, and mitigation measures are in place to protect breeding birds, substantive interactions between the Project and wildlife and wildlife habitat are not anticipated.

Should there be a requirement for road maintenance and repair along the preferred access route, potential Project interactions with wildlife and wildlife habitat will be avoided or reduced through careful planning and design, and the use of mitigation measures. All road maintenance and repair work will be conducted in accordance with legislation. Through the implementation of standard mitigation (*e.g.*, avoiding interference with sensitive wildlife species and important wildlife habitat during construction activities), substantive interactions between the Project and wildlife and wildlife habitat along the preferred access route are not anticipated.

Overall, environmental effects to the Terrestrial Environment are not expected to be substantive and can be easily addressed through avoidance, limiting the footprint of disturbance, and mitigation measures as described.

3.4.5 Historical and Current Use by First Nations

SWN RC has been directly engaging First Nations in relation to its exploration activities, which includes exploratory drilling as intended by the Project. The following is a summary of Historical and Current Use by First Nations as communicated to SWN RC by First Nations in such engagement activities as well as from research and literature.

3.4.5.1 Existing Conditions

There are many areas in New Brunswick which have historical and cultural significance to First Nations. These areas include locations where First Nations continue to exercise Aboriginal rights. Aboriginal rights are those rights held by Aboriginal peoples that relate to activities that are an element of a practice, custom, or tradition integral to the distinctive culture of the Aboriginal group claiming such rights and that have not otherwise been extinguished. Aboriginal rights fall along a spectrum with respect to their degree of connection with the land.

First Nations continue to exercise Aboriginal rights in New Brunswick in locations referred to as traditional territories of certain First Nation communities. SWN RC acknowledges that these traditional territories extend beyond the boundaries of the reserve lands that have been surveyed and set apart by the Crown for the use and benefit of a First Nation community.

The PDA may be located in overlapping traditional territories of the Mi'kmaq and Wolastoqiyik First Nations peoples. Pursuant to the environmental and site selection processes as described in Section 3.2.2, our research has not disclosed that there are known archaeological sites or known First Nation portage routes in the PDA or that the PDA is located in an area predicted to be a Paleo-Indian shoreline.

3.4.5.2 Project Interactions with Historical and Current Use by First Nations

As further described in Section 4.0, SWN RC has been directly engaging with First Nations on all exploration activities it has completed since being awarded its Licenses to Search. SWN RC's internal mandate is to continue to communicate Project information to First Nations by various means and facilitate First Nations' comments, questions and participation so that concerns are documented and addressed.

The exact scope and detail of First Nation engagement has yet to be determined and the Province has not yet determined what, if any, consultation obligations may be delegated to SWN RC with respect to the Project. It is anticipated, based on experiences with First Nations and Crown direction relating to previous exploration work completed by SWN RC, that SWN RC's engagement and delegated consultation with First Nations may involve First Nation evaluation and monitoring of the Site to identify historical use and/or current use of the Site by First Nations in exercising Aboriginal rights.

The information gathered from engaging First Nations will be used by SWN RC to prepare protocols for guiding the avoidance, minimization and mitigation of any interaction with features of historical and cultural significance to First Nations and/or current use of the Site by First Nations for exercising Aboriginal rights. If such interactions exist, SWN RC intends to work with First Nations to develop strategies to avoid, reduce or compensate/accommodate possible interactions.

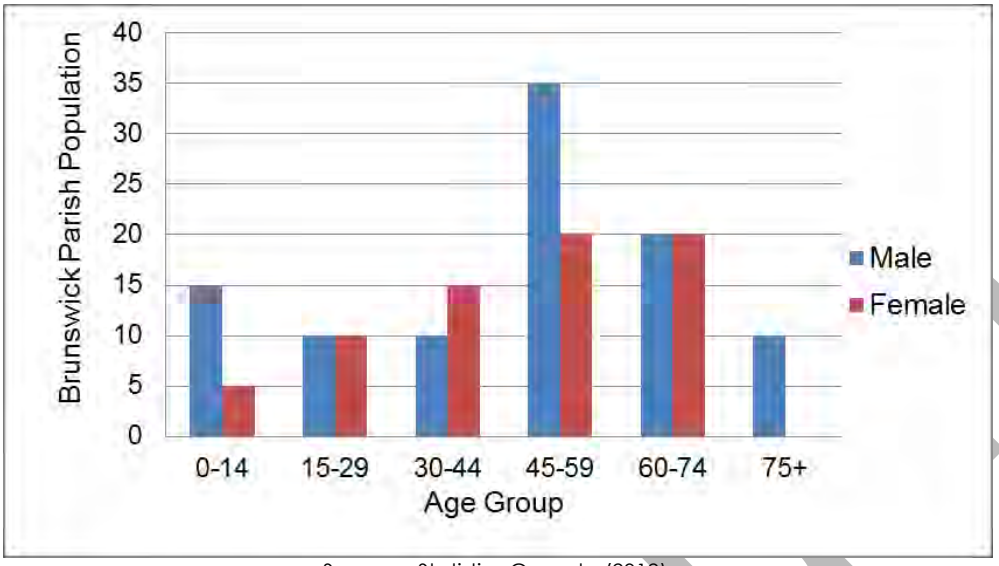
3.4.6 Socio-Economic Environment

The Socio-economic Environment is characterized by a combination of social and economic factors including population demographics and working conditions.

3.4.6.1 Existing Conditions

The Project is located in the Parish of Brunswick, Queens County, approximately 20 km east of the Village of Chipman. The 2011 Census reported a population of Brunswick Parish of 192, with 190 private dwellings (Statistics Canada 2012). Comparatively, the population of New Brunswick as a whole was reported to be 751,171 (Statistics Canada 2012).

The age distribution by sex of the 2011 Brunswick Parish is shown in Figure 3.2.



Source: Statistics Canada (2012).

Figure 3.2 Population by Sex and Age Group, Brunswick Parish, 2011

The New Brunswick economy has traditionally been based on natural resource development, and it centers on its energy, natural resources and manufacturing industries. Tourism and communication technology industries also make substantial contributions to the provincial economy. Although forests occupy 85 percent of the province's land (equivalent to 6.1 million hectares) and have been an economic mainstay throughout its history, the forestry sector has become less of an economic driver within the province due to a decreasing contribution to employment from this sector. This decline has occurred over the past decade with the closure of several lumber and pulp and paper mills throughout the province.

Brunswick Parish is primarily a rural area with some rural residential areas. The main industries that employ the labour force in the Parish of Brunswick are retail trade and agriculture and other resource-based industries (Statistics Canada 2007). Approximately 26.7% of the total labour force within Brunswick Parish was unemployed in 2006, compared to approximately 10% unemployment within the provincial labour force (Statistics Canada 2007).

The Project is not located within an incorporated municipality. A variety of medical, educational, and social services and programs are based in the Village of Chipman, the nearest community to the PDA. Given the Project's close proximity to the Village of Chipman, area residents are generally expected to access community services and infrastructure there.

3.4.6.2 Project Interactions with the Socio-Economic Environment

As described in Section 1, the development of a single well pad costs between $4−6 million, with a portion of this investment flowing into local economies through wages, equipment rentals, and purchases. Distribution to local economies is typically via the workers employed while undertaking the activities associated with well pad development and Drilling, as well as equipment and consumable

purchases. This will contribute to economic development in the local area and the province during the Construction and Drilling of the Project.

The Project will require a variety of specialized and non-specialized workers. It is anticipated that some of the specialized workers (*e.g.,* drillers and mud engineers) will be brought to the Site on contract from elsewhere. These workers will contribute to the local economy while working on the Project by renting temporary accommodations and purchasing meals and other items locally. To further maximize economic benefits to local residents, SWN RC will hire local workers whenever feasible. It is anticipated that approximately half of the on-site workers and all truck drivers and operators will be hired from the local community. As such, it is expected that the Project will result in positive environmental effects on the local and provincial economy.

The number of Project workers will vary as the Project progresses depending on the activity being carried out. It is expected that the Project will result in an approximate average workforce of 8–15 workers. SWN RC will make every effort to employ members of the First Nations for the Project. The development and implementation of the processes discussed in Section 3.4.5 will create several indirect opportunities for First Nations. Since the Project will be carried out over a relatively short period of time (approximately two to three months), and employ a fairly small workforce, most of whom are expected to be hired locally. It is not anticipated that the Project will result in a noticeable change in the demands on community services and infrastructure.

Substantive adverse interactions between the Project and the socio-economic environment are not anticipated.

3.4.7 Land Use

Land Use is considered in the context of the potential Project interactions with current uses of land in the immediate vicinity of the Project. See Section 3.4.5 for discussion of current and historical use of land by First Nations people.

3.4.7.1 Existing Conditions

As described in Section 3.1, the PDA is within 6.7 km of the community of Forks Stream to the southeast, and 20 km from the Village of Chipman municipal boundary to the west. Generally, the nearest private human-occupied property to the PDA is concentrated along Forks Stream Road approximately 6.7 km from the PDA boundary, however, there is a recreational property located approximately 1,400 m from PDA that is believed to be a recreational camp. This property is located southeast of the PDA along the Rerry Brook Road.

Land use planning services for the area are provided by the Regional Service Commission – Region 8. The PDA is within the Brunswick Local Service District. The PDA is currently forested and was subject to harvesting approximately 35 years ago. The PDA contains no surface water features. Access to the PDA will be via the existing forest resource roads that eventually join with Phillipstown Road and Route 112, which is commonly used by industrial truck traffic.

The PDA is located in a mainly forested area on Crown land, with the nearest private land being farther than 4 km from the PDA. NBDNR land use mapping indicates that private land in the area consists mainly of forested land, with some rural residential, industrial, and cultivated land concentrated around roadways. An active CN Rail line runs in a west-east direction, approximately 4.2 km north of the PDA.

The PDA is located within the northwest tip of the Fundy Crown Timber Licence, which is managed by J.D. Irving, Limited.

Due to the large amount of forested land in the surrounding area (mainly Crown), land use activities near to the Project are largely forestry based. Some recreational activity is believed to occur on nearby forested lands and resource roads, including snowmobiling, all-terrain vehicle use, cross country skiing, mountain biking, recreational hunting and fishing, and these are all carried out at the convenience of the Crown. The Canaan River is located approximately 13.5 km south of the PDA and is known to support a variety of commercial and recreational outdoor activities (*e.g.,* power boating, fishing, tubing, canoeing) as well as an assemblage of cottages and seasonal camps.

3.4.7.2 Project Interactions with Land Use

The PDA is located within a forested area of Crown land that is subject to industrial forestry activities and truck traffic. Project activities will be short in duration (approximately two to three months) and will disturb a small area of land (2 ha). No sensitive or unique land uses have been identified within or near to the PDA. Because the PDA is situated in a large area of forested Crown land, forestry and recreational activities will continue in other areas, uninterrupted by the Project. Following eventual completion of the Project, or potential future projects at the Site, the well will be permanently plugged and the PDA will be decommissioned and restored to natural conditions (Section 2.2.4).

Prior to initiating construction and drilling activities, SWN RC will engage neighboring land users during the engagement process to inform them of their plans. The Crown Lands Branch of NBDNR will also be in contact with the Crown Timber Licence holder prior to issuing a Crown Licence of Occupation to SWN RC to explore within the Crown Timber Licence. By issuing a Licence of Occupation, the province of New Brunswick will officially designate the PDA for the proposed activities associated with the Project. The use of the PDA will be determined by NBDNR to be compatible with adjacent land uses.

Project interactions with the Atmospheric Environment are considered in Section 3.4.1, where possible environmental effects to nearby receptors associated with air quality and sound are assessed. Similarly, Project interactions with the transportation network are considered in Section 3.4.9, where possible environmental effects of increased truck traffic to nearby land use is assessed.

Overall, the use of land for the Project is compatible with neighbouring land uses. Therefore, substantive interactions between the Project and Land Use are not anticipated.

3.4.8 Visual Environment

The Visual Environment includes the landscape that surrounds the PDA and the visual aesthetics of the Project within the landscape. The Visual Environment is being considered due to its social and economic importance.

3.4.8.1 Existing Conditions

When assessing the visual environment, the first consideration is how the Project could potentially change, obstruct, or otherwise interfere with the existing view. The most critical natural barrier is the topography of the land, which can provide an initial indication of the Project viewshed. A viewshed determines the potential visibility of a feature through the comparison of altitude angles between any surface location in the surrounding landscape and the maximum height of a feature, considering intervening terrain that may obstruct the view.

The PDA will be located in an area offset from the surrounding rural area of Pangburn, which has no residents or roadways. The PDA is located on an incline to the north of Forks Stream Road and to south of Bronson Settlement Road, approximately 20 km to the east of the Village of Chipman. The PDA is at a higher elevation than the closest rural residential area of Bronson Settlement, approximately 6.7 km to the south of the PDA along Forks Stream Road. There is a recreational camp approximately 1,400 m southwest of the PDA on Rerry Brook Road. The light quality within the surrounding area is typical of a rural environment with dusk-to-dawn lighting at many of the properties on Forks Stream Road and Bronson Settlement Road.

As described in Section 3.1, the PDA is located within a forested parcel of Crown land at a crest of land between Perry Brook and Otter Brook. The topography within 1 km of the centre point of the PDA ranges from between 62 m and 138 m asl based on the digital elevation model, whereas the PDA lies approximate at an elevation of 121 m asl (Figure 3.1).

The closest public highways to the PDA are Route 116, approximately 16 km to the north of the PDA that connects to Route 10, and Route 112, approximately 13 km to the south of the PDA that connects to the Trans-Canada Highway. As discussed in Section 3.4.7 (Land Use), there are no permanent public recreational facilities such as parks, campgrounds, or tourism-related facilities within a 5km radius of the PDA. Recreational activities, such as hunting, fishing, snowmobiling and ATVing are likely to take place within a 5 km radius of the PDA and within the larger Crown land block around the PDA.

3.4.8.2 Project Interactions with the Visual Environment

As described in the Project Description (Section 2.0) the Project as currently conceived includes a number of infrastructure components, each with distinct characteristics for which assumptions have been made based on available information on the PDA (*i.e.*, forest cover, land use and development in the area), typical configuration and layout of the various Project components within the PDA (Figure 2.2).

3.4.8.2.1 Viewshed

Viewsheds are identified to review potential adverse environmental interactions between the Project and the Visual Environment. The primary consideration in identifying viewsheds is the presence of natural barriers to sight, the most important of which is often the physical topography of the land. Topography provides an initial indication of the potential Project viewsheds, leading to the identification of visual viewpoints for the analysis.

A viewshed analysis is conducted to determine if the highest point of the Project will be visible from various vantage points within the general vicinity of the Project, which for lack of defined guidance is taken to be within a 2.5 km radius. Viewshed modelling was conducted based on regional topography and assumed a 9 m high tree cover in the forested areas. Areas from which the highest feature of the Project (the drilling rig) are visible are identified; other features or components of the Project may or may not be visible from these areas, depending on the height of the surrounding forest cover and/or topographical features surrounding the Project location.

The viewshed modelling determined that the Project components are unlikely to be visible at any location within 2.5 km of the PDA, or from the nearest rural residential area of Fork's Stream (Figure 3.3).

Therefore, no part of the Project is anticipated to obstruct key views, nor is the Project located on crestlines or ridgelines where viewsheds could be interrupted or obscured.

3.4.8.2.2 Lighting

Sufficient lighting will be required to support Construction and Drilling and as a security measure for the Project. Lighting requirements for the well pad will be determined following final selection of the drilling rig and during detailed design of the well pad and associated facilities. Selection of lighting solutions for the PDA will consider the surrounding environment, proximity to existing development (*e.g.*, rural, urban, industrial surroundings) and the safety of the employees on the Project Site.

Floodlighting, spot lights and emergency lighting will be installed throughout the well pad to illuminate the PDA and facilitate the safe movement of personnel and vehicles within the well pad. Minimum levels of lighting at task positions will be in accordance with Section 6.11 of the Canada Occupational Health and Safety Regulations. Lighting will be continuously on through periods of active Construction, and will remain on 24 hours a day, 7 days a week during Drilling. Additional lighting will also be placed on the drilling rig derrick in accordance with Standard 621 – Obstruction Marking and Lighting (Transport Canada 2011) and in configurations that provide for the safe air navigation in order to make them conspicuous to pilots during night time.

Mitigation for obtrusive light (ILP 2011) will include the following: selecting the proper lighting solution for the task, directing light downwards to avoid spill lighting, and including proper shades on light solutions which direct the light to the task. The Institute of Lighting Professionals (ILP 2011) defines obtrusive light as being any of the following three forms: 1) sky glow is the brightening of the night sky; 2) glare is the uncomfortable brightness of a light source when viewed against a dark background; and 3) light trespass is the spilling of light beyond the boundary of the property or area being lit.

Light sources that are more than 600 m from a potential receptor (*e.g.*, dwelling, roadway, or public recreation area) are assumed not to create a significant source of obtrusive light or environmental effects, as defined by an internationally-accepted guideline (CIE 2003). Therefore, through careful Project planning (Section 3.2), location of the PDA over 1 km from the nearest potential receptor, the short-term duration of the Project (approximately two to three months) and through the incorporation of efficient lighting design and standard lighting mitigation, adverse environmental interactions due to lighting are predicted to be low and largely limited to areas directly adjacent to or very close to the Project.

Although the necessary obstruction lighting for human safety as required by Transport Canada will be implemented, consideration of less intense light selection and planned mitigation (*e.g.*, downward lighting, shades) that meet Transport Canada's standards (*e.g.*, Standard 621 – Obstruction Marking and Lighting (Transport Canada 2011)) will be considered during final Site design, to potentially reduce bird mortalities as a result of Project lighting.

3.4.9 Heritage Resources

Heritage Resources are defined as any physical remnants found on top of and/or below the surface of the ground, that provide evidence and information about past human use of, and interaction with, the physical environment. These resources may be from the earliest times of human occupation to more recent times. Heritage Resources are relatively permanent features of the environment; however, the integrity of these resources is highly susceptible to construction and ground disturbing activities. Built heritage resources are also considered susceptible to changes, such as the addition of new structures in the immediate vicinity of such resources, or modification to the existing resources. Heritage Resources are an important consideration in recognition of the interest of potentially affected First Nations, the general public as a whole, and provincial and federal regulatory agencies who assure the effective management of these resources.

For clarity, in this Section, Heritage Resources encompasses archaeological, paleontological, and built heritage resources. The New Brunswick *Heritage Conservation Act* defines a "paleontological object" as "*…a work of nature consisting of or containing any remains, trace or imprint of a multicellular plant or animal or a stromatolite preserved in the Earth's crust since some past geologic time, but does not include human remains*…" These resources are contained in bedrock and may be found at or below the surface.

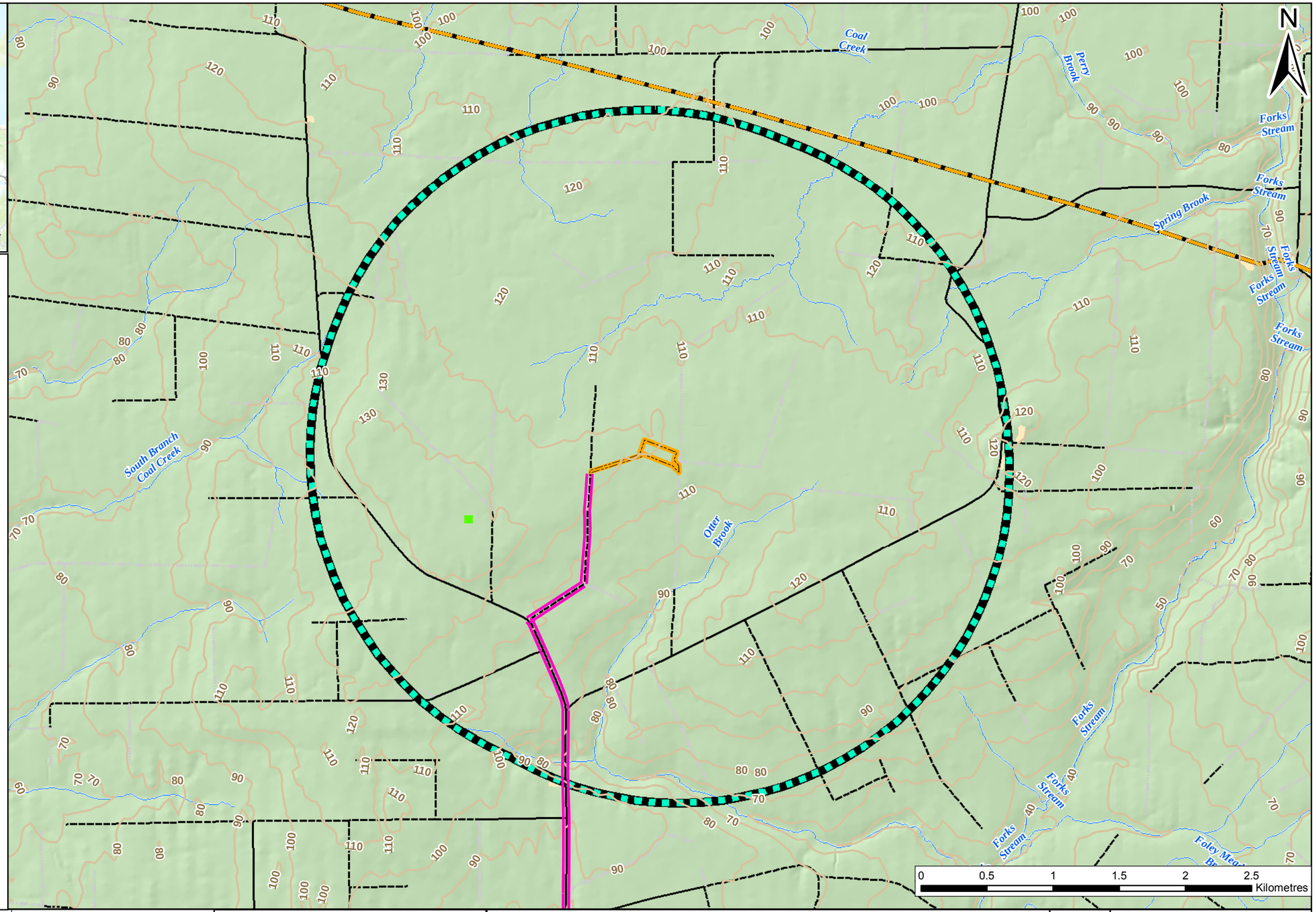
3.4.9.1 Existing Conditions

The existing conditions for Heritage Resources are based on information provided by Archaeological Services. At the time of preparing the present document, a site visit had not yet taken place. However, a site visit will be completed to confirm the findings of this Phased EIA Submission and the results will be provided to the appropriate regulatory agencies before initiating Construction.

Based on Archaeological Predictive Model information received from Archaeological Services, the PDA has low potential for heritage resources. There are no known cemeteries, portage routes, archaeological sites, heritage buildings, or any other documented heritage feature within several kilometres of the PDA. One documented plane crash site is located approximately 9 km to the northwest, while the closest recorded archaeological sites (CbDl-1 and 2) are located 22 km to the west, along the Salmon River. No other heritage related features are documented in the area.

Legend

- Building
- Preferred Access Route
- Contour (10m)
- Project Development Area (PDA)
- Project Potentially Visible*
- Underground Pipeline
- Recreational Property
- 2.5 km Buffer of PDA
- Major Road
- Secondary Road
- Resource Road
- Trail/Abandonned Road
- Railway
- Watercourse (NBDNR)
- Non-forest
- Forest



*Project not visible therefore no yellow shading on the figure.

NBDNR: Forest Inventory Database Layers (2009)
SNB: Provincial Layers (2005), Municipalities Layer (Oct 2011), Properties labelled with PID
NBENV: Regulated Wetland Layer (March 2011)

Projection:	New Brunswick Double Stereographic
Scale:	1:30,000
Date:	01 Apr 2014
Fig. By:	JAB
Appd. By:	MM

Client: SWN Resources Canada

Project: 121810275

Viewshed for Visibilty of Drill Rig When on Site – Pangburn (Assuming 9 m Forest Cover Height)

Fig. No.: 3.3

Stantec

In general, the PDA may be located within overlapping traditional territories of the Mi'kmaq and Wolastoqiyik First Nations peoples. However, both Wolastoqiyik and Mi'kmaq First Nation peoples would have used travel routes in the area (NBDNR 2007). One of the most notable of these, located 34 km northeast of the PDA, was used to travel between the coast and the Saint John River via a portage between the Richibucto and Salmon rivers (Ganong 1899, 1913). Two other important travel routes used to move between the coast and the Saint John River involved a portage between the Southwest Miramichi River and the Nashwaak River (located approximately 30 km west of the PDA) and a portage between the Cains and Gaspereau rivers (located approximately 34 km northwest of the PDA) (Ganong 1899). The general area likely provided several sources of subsistence for First Nations populations through its many marshes, lakes, rivers, and wetlands that provided fish, waterfowl, and other food sources.

Archaeological evidence from the numerous sites identified along the major rivers and lakes outside and to the southwest and north of the PDA indicates continuous use of and habitation by First Nations populations for thousands of years before the present. Along the Salmon River and around Grand Lake, for example, there are many recorded sites dating back at least 3,000 years (some as old as 9,000 years), including one yielding some of the oldest pottery recovered in New Brunswick (NBDNR 2007). These sites are at least 20 km away from the PDA.

The earliest European colonists arrived in this part of New Brunswick in the mid to late 1600s, settling along the coast and shoreline of such rivers as the Miramichi, the Richibucto, and the Kouchibouguacis. Farming, logging, and fishing were the major economic activities, in addition to shipbuilding following European colonization and settlement. The nearest community to the PDA, the Village of Chipman, was settled in the mid-1800s as a farming, forestry and coal mining settlement and, by 1898, was a terminus on the Central Railway (NB Archives 2013).

Based on the requirements of the provincial Guidelines and Procedures for Conducting Professional Archaeological Assessments in New Brunswick (Archaeological Services 2012), there is an 80 m buffer zone along either side of all watercourses with an elevated potential for archaeological resources. The location of the PDA is well outside this 80 m buffer. The PDA therefore has low archaeological potential for archaeological resources. This finding will be evaluated by a permitted archaeologist before any ground-breaking Construction activities are initiated within the PDA.

No built heritage resources are located within the PDA. Since bedrock is not anticipated to be encountered during the development of the well pad, these Construction activities are not anticipated to affect paleontological (fossil) resources.

3.4.9.2 Project Interactions with Heritage Resources

While the PDA has an overall low potential for heritage resources, as described in Section 3.4.8.3, a permitted archaeologist will conduct a site visit of the PDA prior to Construction to confirm the potential presence of heritage resources prior to Construction. Moreover, as discussed in Section 3.4.5.2, it is anticipated that SWN RC's engagement and delegated consultation with First Nations may involve First Nations evaluation and monitoring of the Site. If the site visit confirms the anticipated low archaeological potential and no additional mitigation is warranted, these results and recommendations from the field assessment will be presented to Archaeological Services for confirmation of

recommendations. Any recommendation to conduct additional work (*e.g.*, archaeological shovel testing) will be reviewed by Archaeological Services and completed before Construction. The results of additional mitigation measures will be documented and presented to Archaeological Services for evaluation and approval. Based on the current likelihood that the PDA has low archaeological potential, no shovel testing or other archaeological work is anticipated to be required. At this time, the potential presence of archaeological, paleontological, or built heritage resources in the PDA is considered to be low, given the information available.

In the unlikely event that potential heritage resources are encountered during Construction, work will be suspended, the potential resources will be examined by a permitted archaeologist, and a mitigation strategy will be developed in consultation with Archaeological Services as warranted. This mitigation could include additional shovel testing, excavation, or adjusting the PDA location.

Based on the characteristics of the area, the existing information indicating no known heritage resources in the area, potential engagement of First Nation support, a proposed site visit, and the implementation of any warranted mitigation, it is considered unlikely that there will be any adverse environmental interaction with Heritage Resources as a result of the Project.

3.4.10 Transportation Network

The Transportation Network includes the system of available public routes pertaining to road transportation in a particular area.

3.4.10.1 Existing Conditions

Transportation route options were explored to reduce interactions with adjacent residences and environmental features. The PDA is accessed via existing forest resource roads that eventually join with Forks Stream Road and then Route 112 to the south, as shown in Figure 1.1. The length of forest resource Road between Route 112 and the PDA is approximately 30 km.

Route 112 is a rural, two-lane, paved highway, designated by the New Brunswick Department of Transportation and Infrastructure (NBDTI as a Provincial Collector Highway, which generally allows for posted speed limits up to 80 km/h and is subject to an annual maximum gross vehicle weight restriction of 62,500 kg (NBDTI 2013) as well as seasonal gross vehicle weight restrictions.

Traffic volumes and types along the preferred access route (identified on Figure 1.1.) are generally consistent with other highways in central New Brunswick. Since forests are actively harvested in the vicinity of the preferred access route, logging trucks are at times present. Transport traffic in the area of the preferred access route is generally concentrated along Route 112.

3.4.10.2 Project Interactions with the Transportation Network

Project-related transportation is described in Section 2.2.5.2. All Project-related traffic will abide by applicable weight, size, and speed limits. In the event that an oversized load or vehicle is required, a permit will be obtained from NBDTI, who in issuing such a permit determine under what conditions the oversized load or vehicle will not adversely affect the New Brunswick road transportation network.

Daily truck traffic to the Site will be variable depending on the activities being carried out; however, based on the estimated number of truck loads (Table 2.2) and length of time (approximately two to three months) required for the Project, it is estimated to that the increased truck traffic will range from 9–26 trucks per day (total of 210–614 trucks over a two-month period, see Section 2.2.5.2), depending on the needs of the Project at a particular time(*i.e.*, amount of water and gravel that is required). Most Project employees will travel to the Site in personal vehicles along the preferred access route. As such, it is expected that Project-related traffic will result in a small (but indistinguishable) increase to traffic volumes along the preferred access route. This traffic increase is expected to small (*i.e.*, approximately 9–26 trucks and 8–15 employee vehicles per day), of relatively short duration (approximately two to three months), and is not expected to result in an unacceptable Level of Service.

No features along the preferred access route that create a unique traffic pattern (*e.g.*, an industrial facility with a large volume of truck and employee traffic) that would substantially differentiate it from surrounding roads and highways.

No aspects of the Project would be expected to increase accident rates. As there will be incrementally more traffic along the preferred access route to the Project, there may be incrementally more traffic accidents on an absolute basis; however, accident rates are not expected to change as a result of the Project.

Accordingly, substantive interactions between the Project and Transportation are not anticipated.

4.0 FIRST NATIONS ENGAGEMENT

SWN RC is responsible for its First Nation engagement strategy in partial reliance on direction from and cooperation with the Crown. A summary of SWN RC's First Nation engagement strategy is provided below.

The Constitution of Canada imposes a duty on the Crown to consult with Aboriginal groups when it has knowledge of the potential existence of an Aboriginal right and contemplates conduct that might adversely affect it. Although the Crown is responsible for consultation, Project proponents, like SWN RC, are normally delegated procedural aspects of consultation (*e.g.*, notifying First Nations, seeking input on adverse effects, proposing accommodation measures). With respect to this Project, the Crown's duty to consult arises as a means to reconcile the Crown's objective of responsible resource development with First Nations' exercise of Aboriginal rights.

Since receiving its Licences to Search in March 2010, SWN RC has continuously engaged and consulted with the First Nations in New Brunswick with respect to all its exploration activities. On certain previous exploration work (two-dimensional seismic programs), the Crown formally delegated procedural aspects of consultation to SWN RC via written determinations and these delegations were followed by SWN RC. It is expected that further procedural delegation will occur and SWN RC shall use best efforts to complete the consultation required therein and make any additional efforts as circumstances warrant.

As described in Section 3.4.5, SWN RC will be engaging and/or consulting First Nations on matters concerning historical use and/or current use of the Site by First Nations in exercising Aboriginal rights and intends to implement programs for investigating and mitigating any interactions therewith. SWN RC intends this programming to include in part the leading or support of archaeological visits and programs.

Beyond this focused engagement, SWN RC intends to:

- provide information to the Chiefs and Councils of the First Nation communities identified to have the strongest potential to be affected by the use of the Site. It is intended that this will include information on the Project as well as the programs SWN RC implements with respect to First Nation consultation, request meeting times, solicit any questions or concerns that their community may have;
- provide more general information packages to all other First Nation communities in the Province;
- following submission of this document, the First Nation communities identified to have the strongest potential to be affected by the use of the Site will be sent a copy by mail. SWN RC will work with First Nations to provide support to assist First Nations in fully understanding the information provided regarding the Project;
- offer to host First Nation-specific information sessions;

- share information and collaborate directly with First Nations Chiefs and Councils, any individuals or associations appointed or delegated by Chiefs and Councils to carry out engagement and consultation on the Project; and
- develop and implement additional consultation work as may be mutually agreed to by SWN RC and First Nations or delegated by the Province to SWN RC.

SWN RC intends to also establish communication processes to:

- respond to comments, concerns and questions raised by First Nations in respect of the Project; and
- share with First Nations information and results on the focussed consultation programs implemented with respect to avoiding and mitigating any interaction between the Project and historical use and/or current use of the Site by First Nations in exercising Aboriginal rights.

It is intended that all First Nation individuals who request information will be provided a detailed information package, via Canada Post, containing the following elements:

- a letter from SWN RC;
- a fact sheet providing key information about the Project;
- information on where the Phased EIA Submission document can be viewed;
- a description of the proposed location of the Project including a map;
- a description of the provincial EIA review and approval process;
- a statement indicating citizens are invited to ask questions with regard to the Project, potential environmental effects, and key mitigation;
- SWN RC contact information;
- specific information on the consultation with First Nations being completed with respect to the Project; and
- the deadline date by which all comments should be received.

SWN RC will deliver copies of the information shared with First Nations, including the questions, comments, and concerns it receives from First Nations, to the Province of New Brunswick as required by the Province to satisfy its duty to consult and accommodate First Nations. SWN RC will use reasonable efforts to implement any programming, procedures, or modifications required by the Province of New Brunswick with respect to First Nations and participate in the Province's consultation processes as required.

5.0 PUBLIC ENGAGEMENT

SWN RC has been directly engaging the general public in relation to its exploration activities and the Project. The following is a summary of SWN RC's Public and Stakeholder engagement program in relation to the Project.

The overarching goals of any public engagement program conducted as part of an EIA are to confirm that those potentially affected by a project are aware of the Project and its potential environmental effects, are able to obtain additional information about the Project, and are able to express concerns they may have about a project or its potential environmental effects. A public engagement program is also an important tool for the identification, scoping, and resolution or mitigation of potential issues of concern.

SWN RC has been involved in an extensive public engagement program since being awarded its Licences to Search in March 2010. SWN RC will expand on this program and continue to seek public input throughout the review process for this Phased EIA Submission. SWN RC considers public input and participation to be a key component of ensuring a successful project.

In addition to the broader public and stakeholder engagement program undertaken since 2010, SWN RC will seek to engage the public and stakeholders further with respect to this specific Phased EIA Submission that include written communication to elected officials, written communication to affected landowners, making the Phased EIA Submission document available for public viewing, and preparing and submitting a summary report to NBDELG within 60 days of submitting this document to NBDELG for review. These requirements are specified in NBDELG's *A Guide to Environmental Impact Assessment in New Brunswick*.

5.1 WRITTEN COMMUNICATION TO ELECTED OFFICIALS

SWN RC will send letters and an information package to elected officials within 3 km of the PDA; this will include Keith Ashfield (MP), Dominic LeBlanc (MP), Hon. Rob Moore, Ross Wetmore (MLA), Mayor Edward Farris (Village of Chipman) and Frank Tenhave (Executive Director for Regional Service Commission 11). The purpose of this communication will be to inform officials that a Phased EIA Submission has been submitted to NBDELG and to provide key information about the Project. There are no municipalities within 3 km of the PDA.

5.2 WRITTEN COMMUNICATION TO AFFECTED LANDOWNERS

There are no owner-occupied private residences within 6.7 km of the Project; therefore, an information package will be delivered via Canada Post upon landowner request. The information package will contain the following information:

- letter from SWN RC;
- a fact sheet providing key information about the Project;
- information on where the Phased EIA Submission can be viewed;

- a description of the provincial review and approval process;
- a statement inviting citizens to ask questions with regard to potential environmental effects of the Project and key mitigation;
- SWN RC contact information; and
- the deadline date by which all comments should be received.

5.3 INFORMATION PACKAGES TO GROUPS AND ORGANIZATIONS

SWN RC will provide written communication to local community, environment, and business groups upon request. Based on existing information, there are no known organizations or groups within 1.8 km of the Project. If this should change during the public engagement period for the Project, information packages will be sent to interested organizations or groups. The following organizations will be contacted for their input since members may live within a few kilometres of the PDA: Chipman-Minto Lions Club, the Chipman Fish and Game Club, Grand Lake Sno Crusiders, and the Royal Canadian Legion, Branch #74.

5.4 PHASED EIA SUBMISSION DOCUMENT AVAILABLE FOR PUBLIC VIEWING

As part of the engagement process, SWN RC will make the Phased EIA Submission document available for public viewing at the Chipman Public Library and a second location local to the Project area (to be determined), NBDELG Regional Office in Fredericton and on the SWN RC website, www.swnnb.ca. Public Notices will also appear in local daily and community papers such as Fredericton Daily Gleaner and the Oromocto Post Gazette to inform the public that a Phased EIA Submission document has been submitted. The ads will follow the following format:

Phased EIA Submission
Environmental Impact Assessment Regulation
Clean Environment Act
Opportunity for Public Comment

- date of submission;
- purpose of the Project;
- Project location;
- address for NBDELG Regional Office;
- SWN RC contact information where comments may be submitted (mail and email addresses);
- date by which comments must be received
- visit www.swnnb.ca for additional information; and
- notice placed by SWN RC.

5.5 ADDITIONAL ENGAGEMENT

SWN RC will develop a website module for the Phased EIA Submission document and will send information packages to interested parties as appropriate.

5.5.1 Bilingual Website Module

A bilingual module for the Phased EIA Submission document will be posted on SWN RC's website (www.swnnb.ca) (Photo 3). The web page will allow for ease of access to an electronic copy of the Phased EIA Submission document in a dedicated location that will be visible from the homepage of the website. The module will also provide information about SWN RC and the Project, frequently asked questions (FAQs), and a form to submit questions or comments.

Photo 3: Homepage of website identifying placement of EIA Submission.

5.6 PHASED EIA SUBMISSION INQUIRIES

During the public engagement period, SWN RC will document and track all comments and inquiries received on the Project and the Phased EIA Submission. Within 60 days of submitting this document, SWN RC will produce a report that will summarize the public engagement activities conducted and comments received as part of the public engagement process. The summary report will be provided to NBDELG to document the engagement process and will also be made available for public review on the SWN RC website. The report will include:

- a description of all public engagement activities conducted specifically with respect to the Project, with associated dates and times;
- a copy of the landowner information package;
- copies of correspondence SWN RC receives as a result of engagement activities (with names and addresses of individuals withheld, for privacy reasons);
- key issues or concerns that were raised during the engagement process, and how SWN RC proposes to address the relevant concerns and technical issues as part of the Project; and
- any additional engagement activities that SWN RC has planned.

6.0 CONCLUSION

This Phased EIA Submission document is being submitted to NBDELG as part of the Phased EIA Process for the construction of an access road, and well pad, and the drilling of a single stratigraphic well near Pangburn, New Brunswick (the Project). This assessment considers the potential interactions of the Project, as described in Section 2.0, with the surrounding environment. The VECs that may interact with the Project are identified as Atmospheric Environment; Aquatic Environment; Water Resources; Terrestrial Environment; Historical and Current Use by First Nations; Socio-economic Environment; Land Use; Visual Environment; Heritage Resources; and Transportation Network.

In consideration of operational siting and environmental planning considerations (Section 3.2); the implementation of planned, proven and effective mitigation (Section 3.4) as part of the Project to reduce potential environmental interactions; and the continued First Nation, public and stakeholder engagement opportunities (Sections 4.0 and 5.0, respectively), substantive adverse interactions with the environment are not anticipated as a result of the Project.

7.0 CLOSURE

Except where noted, this report has been *prepared* by Stantec Consulting Ltd. (Stantec) for the sole benefit of SWN Resources Canada, Inc. (SWN RC). The report may not be relied upon by any other person or entity, other than for its intended purposes, without the express written consent of Stantec and SWN RC.

This report was undertaken exclusively for the purpose outlined herein and was limited to the scope and purpose specifically expressed in this report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations. Any use of this report by a third party, or any reliance on decisions made based upon it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

Stantec makes no representation or warranty with respect to this report, other than the work was undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Any information or facts provided by others and referred to or used in the preparation of this report were assumed by Stantec to be accurate. Conclusions presented in this report should not be construed as legal advice.

The information provided in this report was compiled from existing documents and data provided by SWN RC and by applying currently accepted industry standard mitigation and prevention principles. This report represents the best professional judgment of Stantec personnel available at the time of its preparation. Stantec reserves the right to modify the contents of this report, in whole or in part, to reflect the any new information that becomes available. If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

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Appendix A

Additional Information Requirements

General Information Requirements

The following is intended to fulfill the additional information required for the Phased EIA Submission, as outlined in the New Brunswick EIA Guide, entitled *A Guide to Environmental Impact Assessment in New Brunswick, November 2012* (NBDELG 2012) and in the *Responsible Environmental Management of Oil and Natural Gas Activities in New Brunswick: Rules for Industry* (GNB 2013).

1.0 THE PROPONENT

i)	Name of Proponent	SWN Resources Canada, Inc.
ii)	Address of Proponent	P.O. Box 35 Moncton, NB E1C 8R9
iii)	Chief Executive Officer (or designate)	Chad Peters, Manager, New Brunswick Exploration
iv)	Principal Contact Person for the purposes of Environmental Impact Assessment	Chad Peters, Manager, New Brunswick Exploration P.O. Box 35 Moncton, NB E1C 8R9 Toll Free 1-877-SWN-NB23 (1-877-796-6223) (506) 382-9497 Email: Chad_Peters@SWN.COM
v)	Property Ownership	The Project Site is situated on Crown land, in Queens County, New Brunswick, identified by Service New Brunswick as Parcel Identifier (PID) 45093291. The Crown Lease for the Site is currently held under the Fundy Crown Timber Licence by J.D. Irving, Limited.

2.0 THE PROJECT

i)	Name of the Undertaking	Development of the Pangburn Hydrocarbon Well: Well Pad and access road Construction and Vertical Stratigraphic Drilling
ii)	Project Overview	The Project will consist of the construction of a 2 hectare (ha) well pad to house the well, one 430 m long access road connecting the well pad to existing road infrastructure, and the drilling of a single vertical stratigraphic well to an approximate depth of 1,000–4,000 m for stratigraphic examination. This construction and drilling will allow for an examination of the stratigraphy that will aid in assessing the potential for hydrocarbon resources. The specific activities that will be conducted as part of the Project are described in Section 2 of the Phased EIA Submission document.

		As discussed in detail in Section 2.2.3.1 of the Phased EIA Submission document, activities beyond construction of the well pad, drilling of the vertical stratigraphic well and examination of the stratigraphy (*e.g.*, decommissioning or production) will be assessed separately as necessary following the Phased EIA Process and the Rules for Industry (GNB 2013).
iii)	Purpose / Rationale / Need for Undertaking	See Section 1.2 of the Phased EIA Submission document.
iv)	Project Location	The PDA is situated on Crown land, approximately 4.5 km northeast of the rural area of Pangburn and 6.7 km northwest of the rural residential area of Forks Stream in Queens County, New Brunswick. The approximate centre of the Project Development Area (PDA) is at coordinates 46°10'17.567"N and 65°35'7.267"W. For more information, see Section 2.1 of the Phased EIA Submission document.
v)	Siting Considerations	A description of the considerations that were taken into account in choosing the Project location is provided in Section 2.1.1 and operational siting and environmental planning considerations are provided in Section 3.2 of the Phased EIA Submission document.
vi)	Physical Components and Dimensions of the Project	A description of Project components is provided in Section 2.2 of the Phased EIA Submission document.
vii)	Construction Details	An overview of Project construction activities is provided in Section 2.2.1 of the Phased EIA Submission document.
viii)	Operation and Maintenance Details	An overview of Project operation activities is provided in Sections 2.2.2 and 2.2.3 of the Phased EIA Submission document.
ix)	Future Modifications, Extensions, or Abandonment	An overview of decommissioning activities is provided in Section 2.2.4 of the Phased EIA Submission document.
x)	Project-Related Documents	An Environmental Protection Plan and an Emergency Response Plan, will be submitted to NBDELG under separate cover.

3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

The descriptions of all relevant features that are found within the Project location and surrounding areas that could be potentially affected by the Project are provided in Chapter 3 of the Phased EIA Submission document.

4.0 SUMMARY OF ENVIRONMENTAL IMPACTS

Potential environmental effects, or "impacts", of the various Project phases are provided in Section 3.4 of the Phased EIA Submission document.

5.0 SUMMARY OF PROPOSED MITIGATION

Mitigation which will be implemented during Construction and Drilling is presented in Section 2.2 Project Components and Activities and discussed in relation to potential Project-related environmental interactions in Section 3.4 of the Phased EIA Submission document.

A detailed presentation of mitigation measures to be implemented as part of the Project is provided in the Environmental Protection Plan, submitted under separate cover.

6.0 PUBLIC INVOLVEMENT

A brief summary of the planned public involvement activities planned as part of the Project is provided in Chapters 4 and 5 of the Phased EIA Submission document.

7.0 APPROVAL OF THE UNDERTAKING

Permits, licences, approvals, or other authorizations that may be required for the Project are discussed in Section 3.3 of the Phased EIA Submission document.

A federal environmental assessment under the *Canadian Environmental Assessment Act* is not required as it is not a designated project.

8.0 FUNDING

Funding for the Project is being provided entirely by the Proponent, and no provincial or federal funding is anticipated.

9.0 SIGNATURE

April 11, 2014

Chad Peters, Manager, New Brunswick Exploration

Date: