**GROUNDWATER**

# Fort McKay
# Specific Assessment

**Fort McKay**
**Industry Relations Corporation**

**March 2010**

# Contents

# Figures



# Tables

# 3.0 GROUNDWATER

## 3.1 Fort McKay's Key Concerns Related to Groundwater

Fort McKay residents have made direct and indirect use of the groundwater resources during traditional pursuits on Traditional Lands for many years. Oil sands mining and other industrial activities have the potential to negatively impact the groundwater resources in the area, and as a result can impact the ability of Fort McKay community members to utilize their Traditional Lands as they have in the past.

Direct use of groundwater occurs at places where community members spend time, including on traplines, at cabins or simply spending time on the land. The main source of direct groundwater use is from fens, which are groundwater-dependant. Groundwater might also be obtained from springs as well as from small streams dependent on groundwater baseflow, especially during dry periods and winter months.

Indirect use of groundwater occurs where traditional activities such as gatherings take place and the vegetation communities at the gathering sites are dependent on groundwater for survival. An example would be a wetland area where traditionally used plants are harvested.

Fort McKay is concerned about affects on groundwater resources located within the proposed mining disturbance area itself as well as areas adjacent to the proposed mine developments that might be affected by changes in groundwater levels or quality. Fort McKay's expectation is that the groundwater resources on their traditionally used lands will be maintained as close to natural conditions as possible.

## 3.2 Fort McKay Specific Assessment Approach – Groundwater

### 3.2.1 Introduction

The focus of this groundwater resource assessment is on the quantity and quality of the groundwater on Fort McKay's Traditional Lands and the potential impacts on opportunities for traditional use related to direct or indirect use of groundwater.

### 3.2.2 Potential Impacts on Groundwater

Several of the activities associated with oil sands mines development have the potential to impact the groundwater resources on Fort McKay's Traditional Lands. These activities may result in changes to groundwater levels, groundwater flows and flow directions and groundwater quantity. These changes can impact aquatic resources including surface water flows, surface water quality and wetlands. Activities that can result in changes to the groundwater flow and groundwater quality include:

- Overburden dewatering and removal
- Basal Aquifer depressurization
- External tailings disposal
- Plant-site material handling
- Mine pit backfill
- Mine closure and Reclamation

Potential linkages are as follows:

- Basal Aquifer depressurization effects on groundwater flows, levels and flow patterns,
- Overburden and Pleistocene Channel Aquifer dewatering and mine pit seepage effects on groundwater flows, levels and flow patterns,
- External Tailings Deposit Area (ETDA) seepage effects on groundwater flows, levels and flow patterns and quality,
- Pit backfill and reclamation effects on groundwater flows, levels and flow patterns and quality, and
- Construction and operation of plant facilities effects on groundwater quality.

The physical removal of an aquifer will prevent any future groundwater use from the aquifer. Aquifer dewatering and depressurization can also prevent Community use of this resource during pumping, and possibly for some time after the pumping ceases while the water levels in aquifers recover. Removal of aquifers and pumping groundwater from aquifers can also impact surface waterbodies by reducing groundwater base flow to lakes and streams.

Potential effects on wetlands can occur when active and/or passive dewatering activities associated with mining cause shallow groundwater level declines. Effects on fens are a major concern of Fort McKay residents, as groundwater from fens is commonly used on Traditional Lands. CEMA (2007) indicates that, based on current reclamation knowledge and experience in the region, organic bogs and fens cannot be reclaimed.

Figure 3-1 (ARC 2007 in CCA 2009) depicts the subsurface groundwater flow in the vicinity of both an in-situ and a surface mining oil sands project such as the proposed Jackpine Mine Expansion and the Pierre River Mine. It shows some of the linkages noted above.

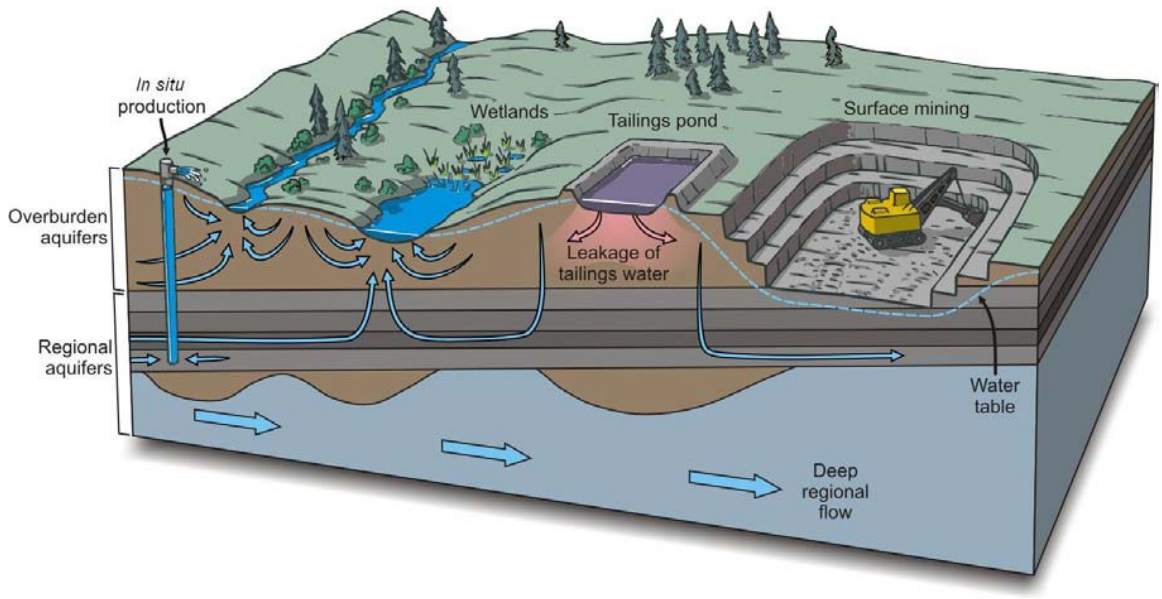



**Figure 3-1: Typical Groundwater Flow Patterns in the Vicinity of Oil Sands In-situ and Surface Mining Projects (ARC in CCA 2009)**

Groundwater quantity is affected as the water table declines, as shown in Figure 3-1, in response to the removal of the overburden to access the oil sands. The water table level decline extending into the area surrounding the mining pit could impact the ability of a wetland to be productive, or at least to be as productive as it was prior to the mining activity. The declining water table levels can contribute to lower surface waterbody levels or flows as the amount of groundwater discharging as baseflow to the surface waterbody decreases. Pumping groundwater to facilitate mining or for use in processing will also result in declining water levels in the aquifers surrounding the pumping well centres. Dewatering aquifers, aquifer depressurization and groundwater use from aquifers is allowed under authorization from Alberta Environment (License or Approval), but the pumping must not have an unreasonable impact on existing groundwater users.

Groundwater quality is affected when process-affected seepage from a tailings pond enters the groundwater flow system as shown in the external or out-of-pit tailings pond in Figure 3-1. In-pit tailings ponds, which are used when there is sufficient storage space in the mined out area, can also contribute process-affected seepage to the groundwater flow system. However, seepage from in-pit tailings ponds might be less than seepage from external tailings ponds, since it is possible to have better containment from tailings placement within areas surrounded by lower hydraulic conductive materials. In either case the process-affected seepage can travel along subsurface groundwater flow paths and enter freshwater aquifers, surface waterbodies and wetland areas.

In addition, at plant-sites the storing and handling of materials and chemicals can result in underlying groundwater contamination if spills or leakage occurs.

### 3.2.3 Data Sources and Limitations

Details of the groundwater resources of the Province began to be recorded in the late 1960's when concern over the use of this resource by the oil industry was being expressed. Most of the groundwater information from this time on is in the form of Water Well Driller Reports, which were filed with the Provincial Government. Since few water wells were being drilled in the oil sands area in northeastern Alberta, there is little historical data on which to base a pre-development scenario.

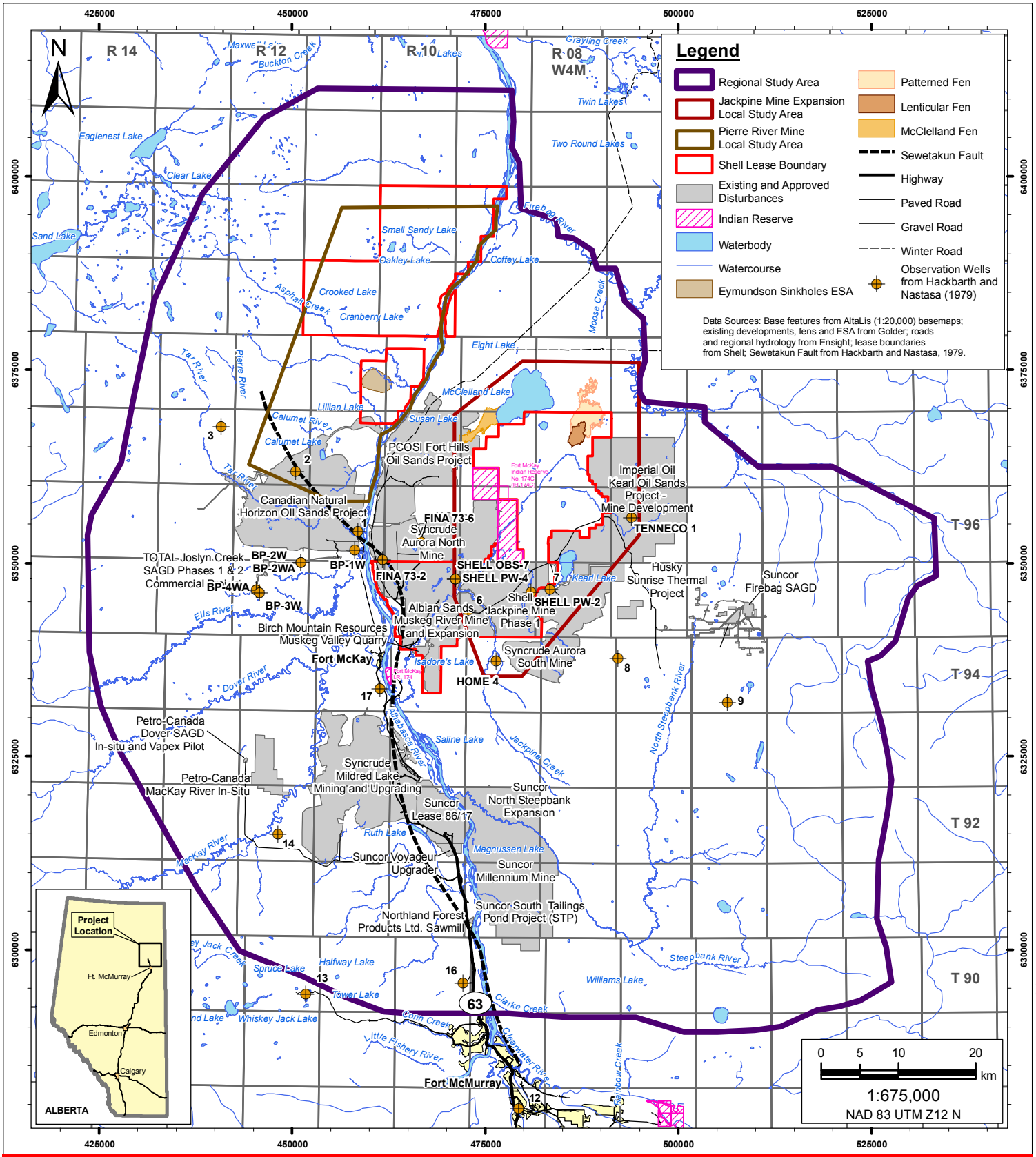
The primary data source for the Fort McKay Specific Assessment is the data gathered by Shell and its consultants and presented in the EIA (Shell 2007) and some additional information specific to this assessment that was requested from Shell and provided by Shell and Golder Associates (Golder 2009). The majority of the data used was collected by Shell in the past few years. As is often the case with groundwater studies, little historical data are available.

Due to data availability limitations, computer model simulations and professional judgments are used to predict changes and impacts that a proposed oil sands mining development will have on the groundwater resources of the area. "Worst case conditions" are often modeled to provide conservative predictions. Computer modeling predictions are always subject to possible errors as a result of the hydrogeological uncertainties in a complex environment, and hence the potential impacts could be under- or over-estimated. Ongoing groundwater level and groundwater chemistry monitoring are necessary to ensure that computer-predicted results are valid.

### 3.2.4 Groundwater Study Areas

Both the Pierre River Mine Project and the Jackpine Mine Expansion are within Fort McKay's Traditional Lands. The Fort McKay Specific Assessment focuses on potential impacts on Fort McKay's Traditional Lands occurring within the proposed project local study areas (LSAs) where groundwater quantity or quality impacts are predicted to occur (Figure 3-2).

This Fort McKay Specific Assessment assesses changes in groundwater quantity and quality that could affect the quality and availability of groundwater resources used for traditional activities. This assessment considers potential impacts on human consumption of groundwater as well as on groundwater-dependent plant-gathering areas.




Infrastructure & Environment

# SHELL CANADA LIMITED
# JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

## REGIONAL AND LOCAL HYDROGEOLOGY STUDY AREAS AND SURROUNDING DEVELOPMENTS AND LOCATIONS OF OBSERVATION WELLS FROM HACKBARTH AND NASTASA (1979)

| 12-FEB-09 | date | J.L. | edited by | S.L. | drawn by | | app by |
|---|---|---|---|---|---|---|---|

PROJECT NUMBER: F35772860

FIGURE: 3-2



FILE: Q:\F3577_Shell\F35772860\ArcGIS\MXDs\RSA_location.mxd Issued By: Edmonton GIS

### 3.2.5 Groundwater Key Indicators

The key groundwater impact indicators are:

- groundwater levels, representing groundwater quantity changes, and
- groundwater chemistry, representing groundwater quality changes.

Groundwater level changes can be identified by monitoring the water levels in water wells or piezometers completed in various aquifers. Groundwater quality changes can be identified by obtaining groundwater samples from the water wells or piezometers completed in the various aquifers and submitting them to a laboratory for chemical analyses. Regular ongoing groundwater level and chemistry monitoring is required to detect any changes.

### 3.2.6 Fort McKay's Groundwater Assessment Criteria

#### *3.1.1.1* Healing the Earth Groundwater Management Strategies

Fort McKay's Healing the Earth Strategy (HTES; Fort McKay IRC 2010) has four strategies (***retain***, ***reclaim***, ***improve*** and ***offset***) that the Community supports with regard to addressing environmental issues. This assessment uses groundwater quantity and quality management and mitigation strategies and impact analysis criteria described in the HTES that reflect Fort McKay's values and perspectives. Healing the Earth strategies for groundwater management include:

- ***retaining*** its quantity and quality,
- protecting the aquatic ecosystem from process-affected discharge and changes in quantity that would affect flows/water levels,
- providing ***offsets***, acceptable to Fort McKay, where reasonable mitigation cannot protect the groundwater component of the ecosystem, and
- expanding groundwater monitoring within Fort McKay's Traditional Lands.

#### 3.2.6.1 Assessment Criteria

Fort McKay's assessment of impacts emphasizes how significant the predicted changes are from the Community's perspective and to the ability of community members to continue groundwater-dependent traditional practices on their Traditional Lands. The following criteria guide is used to determine the significance of groundwater quantity and quality effects and whether the predicted effects should be considered for more detailed assessment and/or ongoing monitoring:

1. Any groundwater quantity or quality changes that *will affect* a community member's direct or indirect use of groundwater on Traditional Lands is

considered a significant adverse effect that would require further mitigation or analysis. Such impacts are considered as being a "red situation", requiring additional mitigation or suitable offsets.

2. Any groundwater quantity or quality impacts that *might affect* a community member's direct or indirect use of groundwater on Traditional Lands was considered as an adverse effect that require further analysis and/or discussion. Such impacts are considered as being a "yellow situation", possibly requiring ongoing monitoring (the greater the uncertainty, the more extensive the monitoring will be) and potentially additional mitigation or suitable offset.

3. Any groundwater quantity or quality changes that *will not or are unlikely to have a negative effect* on a community member's direct or indirect use of groundwater on Traditional Lands would require further discussion. Such impacts are considered as being a "green situation", but might require some ongoing monitoring to validate the predictions of little or no impact.

The following matrices, Table 3-1 and Table 3-2 detail Fort McKay's assessment criteria for groundwater quality and quantity. The assessment criteria are based on professional judgement and Fort McKay's perspective that measurable changes in groundwater quantity and quality are of concern. In addition, Shell's own hydrogeological assessment for the Jackpine Mine Expansion and Pierre River Mine projects considered a drawdown greater than 1 metre (m) to have the potential to negatively affect fen structure and function by reducing flood attenuation capacity. (References provided included Szumigalski and Bailey 1997, and Thormann et al 1988). Fort McKay acknowledges that any loss of fen productivity due to groundwater level decline may recover once the cause of the groundwater level decline is removed and groundwater levels return to pre-mining elevations.

An assessment will be provided for each issue and assessment case (Pre-Development, Current, Base, Application and Planned Development) and colour coded as:

- **Green** (no or very minor adverse effect),
- **Yellow** (possible adverse effect), and
- **Red** (significant adverse effect, requiring action).

It should be noted that the assessment criteria described in Table 3-1 and Table 3-2 apply to the groundwater resources outside the active mining area, as it is assumed that any direct or indirect use of groundwater on Traditional Lands located within the disturbance footprint, where active mining will take place, will be unavailable for the duration of mining and possibly for an extended time period after closure and reclamation. Such direct loss of groundwater resources is considered by Fort McKay to be a significant adverse impact that requires additional mitigation (e.g., off-sets).

**Table 3-1: Fort McKay's Groundwater Quantity Assessment Criteria**

| Issue | Assessment – Predicted Impact | | |
|---|---|---|---|
| | less than 0.1 metre groundwater level decline | 0.1 up to 1.0 metre groundwater level decline | Impact predicted to be greater than 1.0 metre groundwater level decline. |
| Groundwater Quantity | Effects not significant. Impact Verification monitoring likely not needed. | Effects might be adverse and significant. Some impact verification monitoring required. Additional mitigation might be required. | Effects considered adverse and significant. Severity of impact monitoring required. Additional mitigation required. |

**Table 3-2: Fort McKay's Groundwater Quality Assessment Criteria**

| Issue | Assessment – Predicted Impact | | |
|---|---|---|---|
| | No impact predicted | Might be an impact on groundwater quality | Will be an impact on groundwater quality |
| Groundwater Quality | Effects not significant. Verification monitoring might be needed. | Effects might be significant. Verification monitoring required. Additional mitigation might be required. | Effects are significant. Severity of impact monitoring required. Additional mitigation required. |

## 3.3 Jackpine Mine Expansion Impact Assessment

### 3.3.1 Stressors on Groundwater

Several of the activities associated with the development of the proposed Jackpine Mine Expansion project have the potential to impact the groundwater resources on the Traditional Lands of Fort McKay First Nations. The stressors on the groundwater resource include:

- The physical removal of aquifers with the overburden to facilitate mining. This will include the removal of a portion of the Pleistocene Channel Aquifer – a potentially important aquifer in the area,
- The use of water wells to dewater surficial aquifers, including the Pleistocene Channel Aquifer which are located in the overburden, to facilitate mining,
- The use of water wells to depressurize the Basal Aquifer to facilitate mining, and
- The seepage of process-affected seepage from external and in-pit tailings ponds,

### 3.3.2 Pre-Development Scenario

The oldest groundwater data available for the Pleistocene (surficial) deposits included in the proponent's summary of groundwater data points is from one location installed in 1972 and from five locations installed in 1985. Groundwater data are available from nine locations for the Basal Aquifer, two installed in 1975, one in 1981 and six installed in 1985. Some of the these locations are outside the area where groundwater resources are predicted to be impacted by activities associated with the Jackpine Mine Expansion project. As a result, there is very little pre-development data available.

### 3.3.3 Current Scenario

There are several oil sands mines (existing and operating) that are at development stages, which could impact the groundwater resources at the proposed Jackpine Mine Expansion project location. These include:

- Shell's Muskeg River and Muskeg River Expansion mines,
- Syncrude's Aurora North and Aurora South mines,
- Shell's Jackpine Mine – Phase 1 mine,
- Suncor's Fort Hills Oil Sands Project, and
- Imperial Oil's Kearl Oil Sands Project and Husky's Sunrise wells on the Kearl Lease.

Existing mining activity is having an impact on the surficial deposits groundwater resources and on the groundwater resources in the deeper Basal Aquifer in the Jackpine Mine Expansion project LSA. These impacts will be reflected in the current groundwater levels and flow directions.

The current Basal Aquifer groundwater levels and flow directions are presented in Figure 6.3-3 of the EIA (Volume 4, Shell 2007). The groundwater flow is primarily towards the Athabasca River, which is the major regional groundwater discharge feature in the area.

The current surficial deposits groundwater levels and flow directions are presented in Figure 6.3-12 of the EIA (Volume 4, Shell 2007). Groundwater flow in the surficial deposits is typically dependent on the topography. Groundwater flow is from higher areas such as the Muskeg Mountain Plateau to the southeast and from the Fort Hills upland to the northwest, towards lower areas such as the Muskeg River valley, a local groundwater discharge feature.

Fort McKay does not consider the changes from the pre-development groundwater levels and flow directions to be significant effects, but uses this example to emphasize the need for coordination monitoring of groundwater resources by the

various project operators as their individual project impacts might overlap and be cumulative. The Current Scenario is classified as a **yellow** situation, with monitoring needed to confirm predictions.

### 3.3.4 Base Case

There are several operating and approved oil sands mines near the proposed Jackpine Mine Expansion that are close enough to the LSA for some impacts to occur. These include:

- Shell's Muskeg River and Muskeg River Expansion mines,
- Syncrude's Aurora North and Aurora South mines,
- Shell's Jackpine Mine – Phase 1 mine,
- Fort Hills Corporation's Fort Hills Oil Sands Project, and
- Imperial Oil's Kearl Oil Sands Project including Husky's Sunrise wells on the Kearl Lease.

Base Case depressurizing of the Basal Aquifer will result in the decline of groundwater levels associated with the Basal Aquifer by as much as 50 to 80 m (2033) along the Jackpine Expansion Mine boundary, and will extend into the proposed mining area. The decline will be reduced to about 10 m during later stages of development (2052), except along the boundary with the Kearl Project where the drawdown in the Basal Aquifer will be about 50 m due to ongoing oil sands mine development. Fort McKay does not consider the effects to be significant from their perspective.

Base Case dewatering of the Pleistocene Channel Aquifer for the Shell Jackpine Phase 1 and the Imperial Oil Kearl project will cause drawdown predicted to be less than 20 m up to 2 km from the southern boundary of the Jackpine Mine Expansion project LSA. The Pleistocene Channel Aquifer occurs at a depth ranging from 10 to 25 m below the ground surface. The groundwater level drawdown up to 20 m refers to the water level associated with the aquifer, as could be measured in a water well completed in the aquifer, and does not refer to a water level decline in any nearby surface waterbody. The amount of groundwater level decline in the portion of the aquifer, which extends into the Jackpine Mine Expansion project local study area decreases with increasing distance from the dewatering wells completed in the Pleistocene Channel Aquifer to lower the groundwater levels at existing projects. Since Fort McKay is not currently making direct or indirect use of the groundwater from this aquifer, the groundwater decline is not considered significant from their perspective.

Base Case dewatering of the Quaternary deposits will result in a maximum drawdown in the Quaternary in the Jackpine Mine Expansion project LSA predicted to be about 20 m within 1 to 3 km from the Jackpine Mine Expansion pit boundaries.

Fort McKay considers the groundwater level decline to be significant (a **red** situation) since it is likely to have an effect on wetland plant productivity.

Overburden and Pleistocene Channel Aquifer dewatering and Basal Aquifer depressurization at existing and approved facilities is predicted to cause a decrease in groundwater discharge to the Muskeg River of up to 160 L/s (by 2033) and to Jackpine Creek of up to 50 L/s (by 2012 and in 2033). Groundwater seepages from McClelland and Kearl Lakes are not predicted to be affected by Base Case activities. Fort McKay agrees that Base Case impact is unlikely to have a significant effect on the lakes.

### 3.3.5 Application Case

The Application Case includes the Base Case plus the groundwater resource impacts predicted to result from the proposed Jackpine Mine Expansion project. The data, on which the impact assessment was made, is therefore a combination of actual measurements, professional judgment and modeling results.

#### 3.3.5.1 Direct Loss of Groundwater Resources

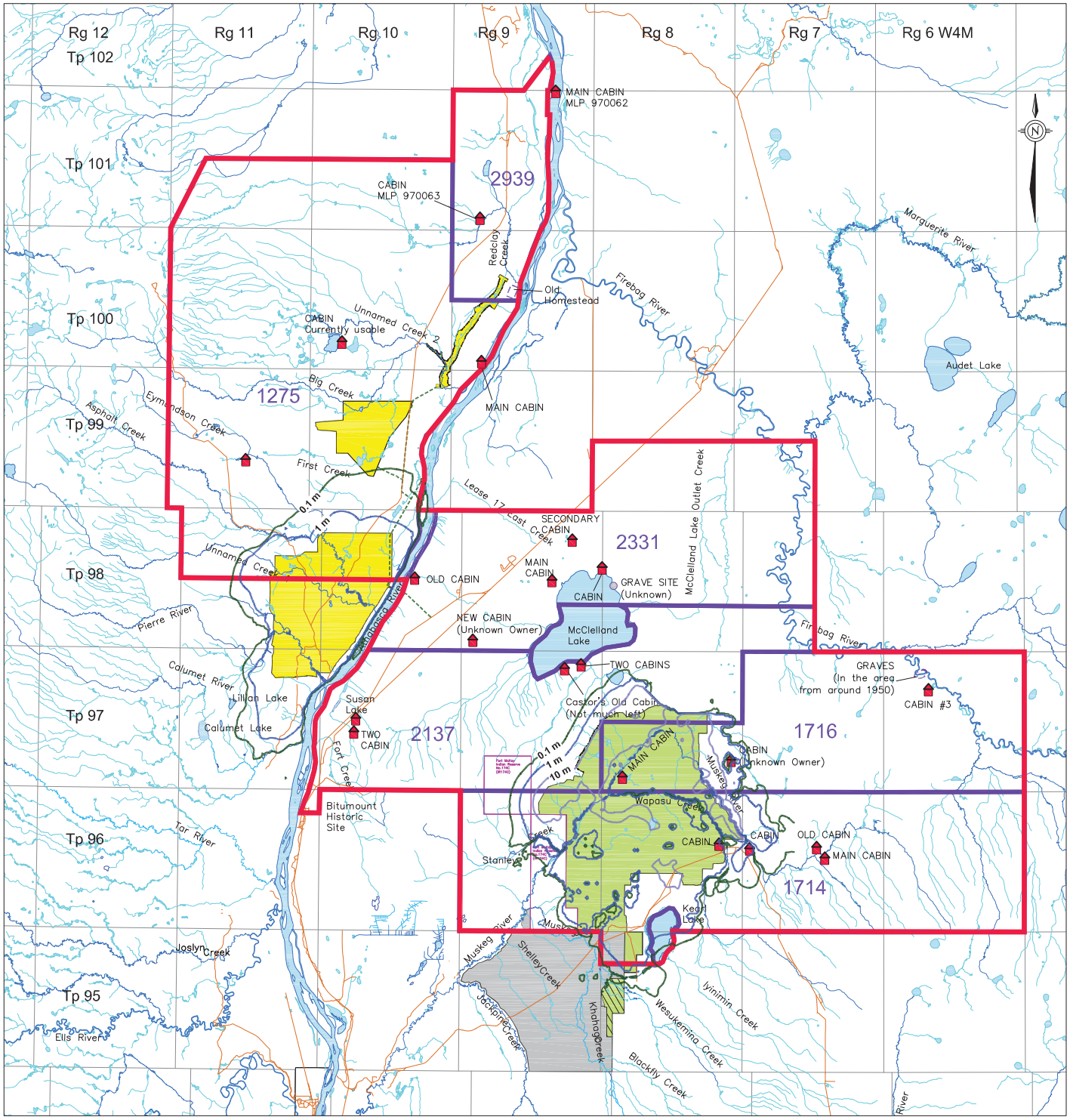
For the Jackpine Expansion Project the maximum disturbance footprint is 10,936 hectares (ha) plus the previously approved disturbance for Jackpine Mine Phase 1, which is 11,156 ha (Shell 2007, Volume 3, Section 2.6). The Community will lose access to any groundwater-dependent activities on traditionally used lands that occur in the proposed active mining area. The lands might be accessible after mine closure and reclamation, but will likely not be desirable for Fort McKay's usage due to ongoing groundwater quantity or quality issues. Due to the complete loss of the potential for groundwater–dependant activities, Fort McKay assesses this as a "significant" effect and that some form of "offset" might be the only possible mitigation to address this loss of access to groundwater resources.

#### 3.3.5.2 Groundwater Quality and Quantity at Cabin Sites

There are four cabin sites within the Jackpine Mine Expansion project LSA that are located within the Moderate Use Culturally Significant Ecosystem area for all traditional uses where groundwater levels will be affected by the Jackpine Expansion mining project (Figure 3-3, which is the same as Figure 4.1-8 in Golder 2009). The four cabins are as follows:

#### Main Cabin on Trapline #1716 near the Confluence of Muskeg River and Wapasu Creek

This cabin site will remain available until 2040 at which time it will need to be relocated due to mine operations. Dewatering of overburden deposits and the Pleistocene Channel Aquifer will result in groundwater drawdown between 1 and 10 m at this cabin site and the groundwater levels might be expected to decline




LEGEND

- RIVER OR STREAM
- PUBLIC ROADWAY
- PIERRE RIVER MINE
- JACKPINE MINE EXPANSION
- LEASE SWAPPED TO SYNCRUDE
- JACKPINE MINE – PHASE 1
- TRADITIONAL LAND USE LOCAL STUDY AREA
- 2137 TRAPLINES
- CABIN
- GROUNDWATER DRAWDOWN CONTOUR 0.1 m
- GROUNDWATER DRAWDOWN CONTOUR 1 m
- GROUNDWATER DRAWDOWN CONTOUR 10 m

10 0 10

SCALE KILOMETRES

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.)
USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR
DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

# TRAPLINES WITHIN THE TRADITIONAL LAND USE LOCAL STUDY AREA

| | | | | | |
|---|---|---|---|---|---|
| PROJECT 08.1346.0006.5722 | | | FILE No. | | RFMA–LSA |
| DESIGN | HE | 23/01/09 | SCALE | AS SHOWN | REV. 0 |
| CADD | PSR | 11/02/09 | | | |
| CHECK | MB | 11/02/09 | | | |
| REVIEW | WES | 12/02/09 | | | |

**Figure 3-3**

L:\2008\1346 Oil Sands\08-1346-0006-SHELL\5722-Fort McKay Assess\HYDROGEOLOGY-WORLEYPARSONS\Fig 4.1-8 Traplines within the Traditional Land Use LSA.dwg Feb 12, 2009 - 1:25pm

during the period of about 2035 until the end of mining in about 2049. Due to the declining groundwater level, the use of shallow groundwater might not be possible after 2035. Also, the groundwater quality at the site of the main cabin might change by 2035. Following Closure, an end pit lake will occupy this site.

### Cabin on Trapline #1714 at the Upper Reaches of Wapasu Creek within the Mine Footprint

This cabin site will remain available until 2037 at which time it will need to be relocated due to mine operations. Dewatering of overburden deposits and the Pleistocene Channel Aquifer will result in groundwater drawdown of about 1 m at this cabin site. The use of shallow groundwater might be possible until the cabin is relocated and the groundwater quality at the site of the Cabin is unlikely to change prior to 2037 relocation date. Following Closure, the cabin could be reinstalled at this site; however, the quantity and quality of the groundwater at the cabin site might be undesirable.

### Cabin on Trapline #1714 and Cabin (Unknown Owner) on Trapline #1716

These cabins are located outside of Shell's Lease Boundary. Dewatering of overburden deposits and the Pleistocene Channel Aquifer will result in groundwater drawdown of up to about 1 m at these cabin sites. This drawdown could occur from the early 2040s and last until near the end of mining, about 2049. Shallow groundwater use could be affected at these cabin sites. Once mine dewatering is completed, shallow groundwater levels will re-establish and groundwater use could recommence. The groundwater quality should not change significantly as the result of any impact. However, due to the potential for seepage of process-affected water from the tailings ponds entering the groundwater flow system, no use of groundwater at either cabin should be considered prior to initial, and thereafter regular, chemical analyses of the groundwater.

### Drawdown in Groundwater-Dependant Traditional Use Plant-Gathering Areas

As discussed above, drawdown impacts to fens and other wetlands are of concern to Fort McKay and might affect Fort McKay's opportunities to use groundwater-related resources and plant communities. Figure 3-4, which is the same as Figure 7.5-1 from Shell's EIA (Volume 5, Section 7.5.2.2, Shell 2007), shows groundwater drawdown within fens adjacent to the Jackpine Expansion mining area (Figure 3-4).
Table 7.4-33 (EIA Volume 5, Shell 2007) indicates that Application Case fen alteration will be 425 ha due to the Jackpine Mine Expansion Project. About one-quarter (106 ha) of this drawdown affected fen area has a water-level decline greater than 1.0 m and, therefore, is assessed as a significant adverse effect (a **red** situation) by Fort McKay (based on Fort McKay's assessment criteria). About three-quarters of this (318 ha) is predicted to have a drawdown of greater than 0.1 ha and

less than 1.0 m and is assessed by Fort McKay to potentially be an adverse effect (a **yellow** situation) on groundwater-dependant traditionally used plant-communities.

## Potential Process-Affected Seepage

Process-affected seepage from Jackpine Mine expansion tailings storage ponds can impact groundwater quality in aquifers and make them unusable by the community during mining and potentially for many tens of years after mine closure and reclamation. Process-affected seepage can also impact surface waterbodies if it enters the groundwater flow system and is contributed as baseflow to lakes and streams. Seepages from the external tailings disposal area (ETDA) and from the tailings-backfilled mine pits will be intercepted, and recycled or directed to end pit lakes via wetlands. Fort McKay is not satisfied that the proposed mitigation would result in all the process-affected seepage being intercepted and/or contained. Effects of seepage on Traditional Lands are rated as uncertain (a **yellow** situation).

During operations, seepages from the ETDA and from the tailings-backfilled mine pits will be intercepted, captured and recycled. Local groundwater flow directions in both surficial deposits and the Basal Aquifer for the Jackpine Mine Expansion project will be towards the mining areas that are being dewatered or depressurized, thereby enhancing the capture of process-affected seepage within the mining areas, further preventing seepage from the mining footprints.

In the Closure Case, process-affected seepage from both the ETDA and the tailings-backfilled mine pits will be collected and directed to the end pit lakes or treatment ponds, where they will undergo natural treatment. Tailings will be placed below the top of the McMurray Formation or behind low permeability dykes in mined out pits and non-segregated tailings (NST) pit backfill will be separated from Quaternary sand and gravel deposits through a layer of low permeability material. It is unlikely that all the process-affected seepage will be intercepted and/or contained. Wetland areas in the area surrounding the area that was actively mined are at risk to groundwater quality changes as process-affected seepages moving through the groundwater flow systems may discharge to the wetlands.

Reclamation of the tailings ponds will include the placing of a layer of coarse sand tailings on top of the tailings backfill and contoured such that any seepage from the tailings backfill will be captured in the sand cap and directed to end pit lakes through the sand cap.

Upon closure, groundwater flow in the reclaimed landscape will be directed from topographically high areas towards topographically low areas, where groundwater will discharge to treatment wetlands and end pit lakes for the Jackpine Mine Expansion Project. Process-affected seepage from the ETDA or backfilled mine pits will to be contained within the reclaimed mine areas.

Rg 10
Rg 9
Rg 8
Rg 7 W4M
N
McClelland Lake
Tp 97
Fort McKay Indian Reserve No. 174C (IR 174C)
Stanley Creek
Tp 96
Kearl Lake
Tp 95
Wesukemina Creek
Iyinimin Creek
Jackpine Creek
Black Fly Creek
Green Stockings Creek
Tp 94

**LEGEND**

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- PROJECT FOOTPRINT
- LENTICULAR FEN
- OPEN WATER
- ROAD

**DRAWDOWN ISOBAR**

- 0.1 m - JACKPINE MINE EXPANSION AREA
- 1.0 m - JACKPINE MINE EXPANSION AREA
- 0.1 m - JACKPINE MINE PHASE 1
- 1.0 m - JACKPINE MINE PHASE 1

**DISTURBED**

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

**FEN WETLANDS TYPES**

- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)

**REFERENCE**

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: UTM Zone 12 Datum: NAD 83

5 0 5
SCALE 1:125,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
**FENS POTENTIALLY AFFECTED BY GROUNDWATER DRAWDOWN WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA**

| PROJECT NO. 06-1346-022.7600 | | | SCALE AS SHOWN | REV. 0 |
|---|---|---|---|---|
| DESIGN | AA | 13 Sep. 2007 | | |
| GIS | VR | 05 Dec. 2007 | | |
| CHECK | AA | 06 Dec. 2007 | | |
| REVIEW | TC | 06 Dec. 2007 | | |

**FIGURE 3-4**

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### 3.3.6 Planned Development Case

Activities to be undertaken at two planned oil sands mining projects could affect the groundwater resources at the proposed Jackpine Mine Expansion location and add to the impacts on water levels. The planned projects are the Total E & P Canada Joslyn Mine and the Synenco Energy Inc. Northern Lights Mine. The potential impacts from these two planned developments were assessed, primarily using groundwater modeling. The data are reported by Shell in Volume 4, Appendix 4-1 (Shell 2007).

Activities associated with the proposed projects will change groundwater levels, flows, flow patterns and quality. The changes will primarily take place in the more shallow surficial deposits, including the Pleistocene Channel Aquifer, as well as in the deeper Basal Aquifer. Fort McKay is primarily concerned with the additional impacts on the groundwater levels in the shallow surficial deposits, which will increase the effects on wetland areas, already significantly adversely affected.

### 3.3.7 Conclusions and Significance Assessment Regarding Jackpine Expansion Mine

Fort McKay's conclusions and significance assessment for the various development cases related to the Jackpine mine expansion are shown in Table 3-3.

**Table 3-3: Significance Assessment for Various Jackpine Mine Expansion Project Scenarios and Assessment Cases**

| Issue | Jackpine Expansion Case/Scenario Assessment | | | | |
|---|---|---|---|---|---|
| | Pre-Dev | Current | Base Case | Application Case | Planned Dev Case |
| **Groundwater Quantity** | No effects on Traditional Lands | Significance of effects on Traditional Lands are uncertain | Expected significant adverse effects on Traditional Lands due to drawdown | Expected significant adverse effects on Traditional Lands due to drawdown | Expected significant adverse effects on Traditional Lands due to drawdown |
| **Groundwater Quality** | No effects on Traditional Lands | Significance of effects on Traditional Lands are uncertain | Significance of effects on Traditional Lands are uncertain | Significance of effects on Traditional Lands are uncertain | Significance of effects on Traditional Lands are uncertain |

Direct and/or indirect groundwater use on Fort McKay's Traditional Lands that occurs within the mining disturbance area will be unavailable to the community residents for the duration of active mining, closure and reclamation. In addition, any

aquifers located within the active mining area, which had groundwater of a suitable quantity and quality for human consumption prior to mining might not be available for community use after closure and reclamation, due to removal of aquifers within the overburden to facilitate mining of the bitumen or potential for groundwater contamination in the aquifers by process-affected seepages.

Direct use of groundwater at two cabins located on Traditional Lands outside the active mining area could be impacted as the cabin sites are located at a distance where 1 m of groundwater drawdown is predicted.

Direct use of groundwater at two cabins located on Traditional Lands within the active mining area will be impacted as the cabin sites are located in the mining area and will have to be relocated. If the cabins are reinstalled after mining is finished, the quality of groundwater available is likely to be unsuitable due to process-affected seepage from tailings ponds.

Drawdown of fens will result in adverse effects on 425 ha of fens within Fort McKay's Traditional Lands.

Groundwater discharge to Muskeg River downstream from the Jackpine North Pit Lake and Muskeg Creek will decrease about 100 L/s compared to the current scenario.

The Pleistocene Channel Aquifer is a preferential groundwater flow unit and might result in process-affected seepage from the ETDA moving northeast. Dewatering at Kearl and Aurora South mines might further promote the process-affected groundwater flow in the aquifer.

A plume of process-affected seepage from the in-pit tailings pond will move slowly towards the Athabasca River. Seepage to the Athabasca River will be negligible compared to flow volume.

## 3.4 Pierre River Mine Impact Assessment

### 3.4.1 Stressors on Groundwater

Several of the activities associated with the development of the proposed Pierre River Mine Project have the potential to impact the groundwater resources on Fort McKay's Traditional Lands. The stressors on the groundwater resource include:

- The physical removal of aquifers with the overburden to facilitate mining,
- The use of water wells to dewater surficial aquifers which are located in the overburden, to facilitate mining,
- The use of water wells to depressurize the Basal Aquifer to facilitate mining,

- The seepage of process-affected water from external and in-pit tailings ponds, and
- The contamination of groundwater due to spills associated with plant site activities.

### 3.4.2 Pre-Development Scenario

The proposed Pierre River Mine Project is to be located on the west side of the Athabasca River in an area in which groundwater quantity and quality are considered to be unaffected by any previous oil sands developments, as none are located nearby. The project area will not be affected by any of the current developments operating on the east side of the Athabasca River due to the river being a natural groundwater regional flow system control.

Few groundwater studies have been done over the years in the vicinity of the proposed Pierre River Mine Project. As a result, the hydrogeological characteristics of the area are not as well understood as are those to the east of the Athabasca River, where there have been numerous Environmental Impact Assessment (EIA) investigations. The relative newness of the proposed Pierre River mining area provides an opportunity to obtain a better understanding of the mining impacts, if an approval is given, because, for the time being at least, there should not be any external impacts from other oil sands projects to complicate the impact assessment and the interpretation of ongoing monitoring data.

### 3.4.3 Current Scenario

The Canadian Natural Resources Limited Horizon Oil Sands Project (Horizon Project) is the operating project that is closest to the proposed Pierre River Mine Project and located on the west side of the Athabasca River. Overburden dewatering and Basal Aquifer depressurization at the Horizon Project is predicted to have a minor impact on groundwater outflow to surface waterbodies in the Pierre River LSA, but these will be limited to the Calumet River basin to the south and are beyond the proposed mine development's predicted groundwater impacts on Fort McKay's Traditional Lands. Therefore Fort McKay classifies this as a **green** situation.

### 3.4.4 Base Case

The groundwater resources on the Traditional Lands that will be affected by the proposed Pierre River Mine Project are not affected by any operating oil sands projects and will not to be affected by any of the approved oil sands projects (a **green** situation). As such, the Base Case will also represent the Pre-Development and Current Scenarios. The Base Case data will allow the Community to understand the pre-development and current groundwater resource conditions on its Traditional Lands in the proposed Pierre River mining area. Base Case data, in this situation, are

made up of actual groundwater level measurements and groundwater chemistry analyses.

### 3.4.5 Application Case

The Application Case includes the Base Case (which is also considered to be the Pre-Development Scenario for this particular project) plus the groundwater resource impacts predicted to result from the proposed Pierre River Mine Project. The data, on which the impact assessment was based, is a combination of actual measurements, professional judgment and modeling results.

#### Direct Loss of Groundwater Resources

For the Pierre River Mine Project, the disturbance footprint is 10,403 ha (Shell 2007). The Community will lose access to any groundwater-dependent activities on Traditional Lands that occur in the proposed active mining area, including the ETDA. Some of these lands might be accessible after mine closure and reclamation, but might not be usable by Community members due to ongoing groundwater quantity or quality effects. Due to the complete loss of the potential for groundwater–dependant activities, Fort McKay assesses this as a significant adverse impact (a **red** situation). Fort McKay's assessment is that some form of offset might be the only possible mitigation to address this loss of access to groundwater resources.

#### Groundwater Quality and Quantity at Cabin Sites

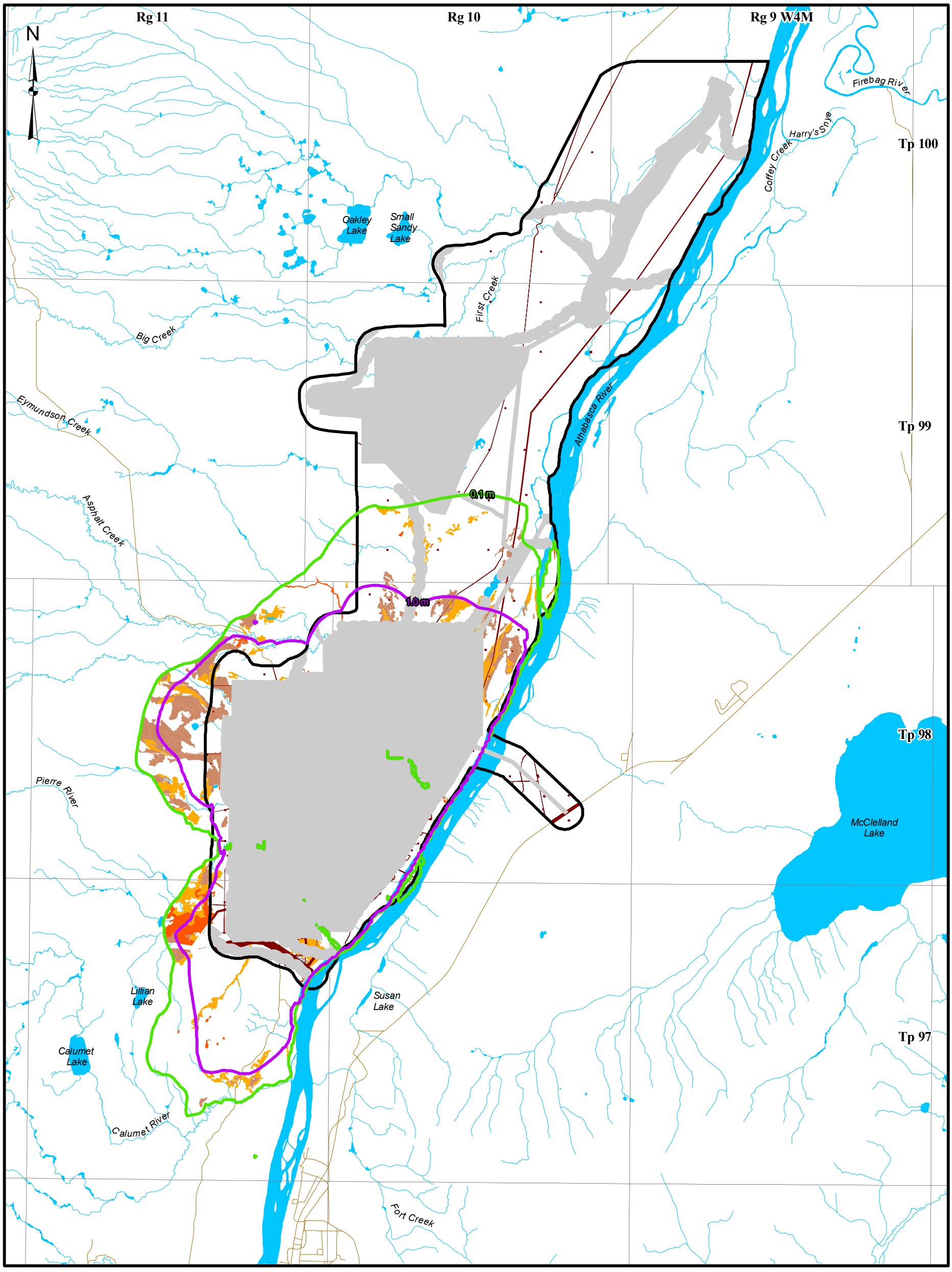
There are two cabin sites within the Pierre River Mine Project hydrogeology LSA as shown on Figure 3-3.

Both cabin sites are located beyond the area where 0.1 m of groundwater drawdown is predicted by modeling; therefore, based on Fort McKay's assessment criteria, these cabins are not expected to be adversely affected by the Pierre River Mine Project operations. Groundwater quality degradation is unlikely at the cabin sites as a result of seepage of process-affected water from the tailings ponds during and following mining and reclamation.

#### Drawdown of Groundwater-Dependant Traditional Use Areas

Mining activities will result in declines of the water table elevation in the surficial deposits as far as 5 km away from the proposed Pierre River mine (see Figure 3-5, which is the same as Figure 7.5-2 from Shell's EIA (Volume 5, Section 7.5.2.2., Shell 2007).

The more extensive groundwater level drawdown will occur northeast and southwest of the mine and will be less extensive to the west. The Athabasca River valley limits drawdown to the east. Drawdown of the shallow groundwater level in the surficial aquifers has the potential to affect wetland areas, particularly fens, as




**LEGEND**

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- PROJECT FOOTPRINT
- OPEN WATER
- ROAD

**DRAWDOWN ISOBAR**

- 0.1 m
- 1.0 m

**DISTURBED**

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

**FEN WETLANDS TYPES**

- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- PATTERNED FEN (FOPN)
- WOODED FEN (FTNN)

**REFERENCE**

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: UTM Zone 12 Datum: NAD 83

5 0 5
SCALE 1:125,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
**FENS POTENTIALLY AFFECTED BY GROUNDWATER DRAWDOWN WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA**

| PROJECT NO. 06-1346-022.7600 | | | SCALE AS SHOWN | REV. 0 |
|---|---|---|---|---|
| DESIGN | AA | 13 Sep. 2007 | | |
| GIS | VR | 26 Nov. 2007 | | |
| CHECK | AA | 06 Dec. 2007 | | |
| REVIEW | TC | 06 Dec. 2007 | | |

**FIGURE 3-5**

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they might be dependent on groundwater flow. Specific groundwater-dependant traditional use sites such as specific groundwater dependant plant-gathering sites, springs and muskeg used for drinking-water have not been identified within the predicted drawdown areas since they were not asked about specifically within either the TLU study or the TEK study (FMA 2009). However, Fort McKay values and uses wetlands within their Traditional Lands and drawdown impacts on fens are considered as being significant adverse effects.

Figure 3-5 shows groundwater drawdown within fens adjacent to the Pierre River Mining area. As indicated in the assessment criteria (Section 3.3.6), up to 0.1 m of groundwater level decline is unlikely to have a significant effect on fens, whereas groundwater level declines that might be greater than 0.1 m might be significant and groundwater level declines greater than 1.0 m are considered to be significant for the health of a fen. Shell indicates (Table 7.5-3, EIA Volume 5, Appendix 5-3, Shell 2007) that fen Application Case alteration of fens due to drawdown will be 1458 ha due to the Pierre River Mine Project. About a third (486 ha) of this drawdown affected fen area is greater than 1.0 m drawdown; therefore, it is assessed as a significant adverse effect by Fort McKay (based on Fort McKay's assessment criteria) (a **red** situation). About two-thirds of this (972 ha) is predicted to have a drawdown of greater than 0.1 ha and less than 1.0 m and is assessed by Fort McKay to potentially be an adverse effect on groundwater-dependant traditionally used plant-communities (a **yellow** situation).

### Potential Process-Affected Seepage

Process-affected seepage from tailings storage ponds can impact groundwater quality in aquifers and make them unusable by the Community during mining and potentially for many tens of years after mine closure and reclamation. Process-affected seepage can also impact surface waterbodies if it enters the groundwater flow system and is contributed as baseflow to lakes and streams. Seepages from the external tailings disposal area (ETDA) and from the tailings-backfilled mine pits will be intercepted, and recycled or directed to end pit lakes via wetlands. Fort McKay is particularly concerned because the Pierre River Mining Project has an ETDA that is outside the active mining area. It is not satisfied that the proposed mitigation will result in all the process-affected seepage being intercepted and/or contained and is concerned that the effects on Traditional Lands will be potentially significant (a **yellow** situation).

## 3.4.6 Planned Development Case

At this time, there are no developments, other than the proposed Pierre River Mine project itself, which could impact the groundwater resources on Traditional Lands in the vicinity of the Pierre River project.

### 3.4.7 Significance Assessment and Conclusions Regarding Pierre River Mine

Table 3-4 summarizes the various aspects of the groundwater impacts.

**Table 3-4: Significance Assessment for Various Pierre River Mine Project Scenarios and Assessment Cases**

| Issue | Pierre River Case/Scenario Assessment | | | | | General Comment –Position |
|---|---|---|---|---|---|---|
| | Pre-Development | Current | Base Case | Application Case | Planned Development Case | |
| **Groundwater Quantity** | No significant effects on Traditional Lands | No significant effects on Traditional Lands | No significant effects on Traditional Lands | Expected significant adverse effects on Traditional Lands due to drawdown | Expected significant adverse effects on Traditional Lands due to drawdown | See Section 3.4.5 to 3.4.7 |
| **Groundwater Quality** | No significant effects on Traditional Lands | No significant effects on Traditional Lands | No significant effects on Traditional Lands | Some uncertainty regarding effects on Traditional Lands due to process-affected seepage. Monitoring required. Additional mitigation might be required. | Some uncertainty regarding effects on Traditional Lands due to process-affected seepage. Monitoring required. Additional mitigation might be required. | See section 3.4.5 to 3.4.7 |

Direct and/or indirect groundwater use on traditionally used lands that occurs within the mining disturbance area will be unavailable to the community residents for the duration of active mining, closure and reclamation. In addition, any aquifers located within the active mining area, which had groundwater of a suitable quantity and quality for human consumption prior to mining, might not be available for community use after closure and reclamation, due to removal of aquifers within the overburden to facilitate mining of the bitumen or potential for contamination of the groundwater in the aquifers by process-affected seepages.

Direct use of groundwater at cabins located on Traditional Lands outside the active mining area will not be affected as the cabin sites are located outside of the area where significant groundwater drawdown is predicted.

The declining water table elevation in the surficial deposits will result in reduced discharge of groundwater to the Pierre River during and after mining.

Process-affected seepages from The ETDA will result in reduced groundwater quality and process-affected seepage to Big Creek and the Athabasca River Valley.

Mine pit backfill will result in reduced groundwater quality and process-affected seepage to the Athabasca River and the north and south pit lakes. Seepage to the Athabasca River will be negligible compared to flow volume.

## 3.5 Overall Conclusions and Recommendations Regarding Groundwater

### 3.5.1 Conclusions

Fort McKay has identified a number of areas where impacts from Shell's proposed activities on the groundwater resources will have, or might have, significant effects on Fort McKay's ability to use Traditional Lands as they have in the past.

The physical removal of an aquifer will prevent any future traditional groundwater use from the aquifer by Fort McKay. Aquifer dewatering and depressurization can also prevent Community use of this resource during pumping, and possibly for some time after the pumping ceases, while the water levels in aquifers recover. Removal of aquifers and pumping groundwater from aquifers can also impact surface waterbodies by reducing groundwater base flow to lakes and streams.

Process-affected seepage from tailings storage ponds can impact groundwater quality in aquifers and make them unusable by the community during mining and potentially for many tens of years after mine closure and reclamation. Process-affected seepage can also impact surface waterbodies if it enters the groundwater flow system and is contributed as baseflow to lakes and streams.

During operations, seepages from the ETDA or from the tailings-backfilled mine pits will be intercepted, captured and recycled. It is unlikely that all the process-affected seepage will be intercepted and/or contained.

At closure, process-affected seepage from both the ETDA and the tailings-backfilled mine pits will be collected and directed to the end pit lakes or treatment ponds, where they will undergo natural treatment. It is unlikely that all the process-affected seepage will be collected; there is some uncertainty with the effectiveness of treatment ponds.

Wetlands in the area surrounding the active mine area are at risk for groundwater quality changes as process-affected seepages moving through the groundwater flow systems discharge to the wetlands.

Reclamation of the tailings ponds will include placing a layer of coarse sand tailings on top of the tailings backfill and contoured such that any seepage from the tailings

backfill will be captured in the sand cap and directed to end pit lakes through the sand cap. It is unlikely that all the process-affected seepage will be captured.

Several computer model simulations have been used to assess and predict changes and impacts of the proposed development on the groundwater resources of the area. Due to the uncertainties in groundwater modeling in general, a community-based groundwater monitoring program is needed to address community-based concerns regarding impacts on the groundwater resources and the ability for Fort McKay residents to carry out their traditional pursuits on the Traditional Lands, during and after mining.

### 3.5.2 Fort McKay's Recommendations

Fort McKay's recommendations related to groundwater are as follows:

#### 3.5.2.1 Project-Specific Recommendations

- Offsets be developed, in consultation with Fort McKay, to mitigate the loss of existing and potential future groundwater sources.
- Shell be required, at its expense, to collect and have potability tests done on groundwater from any source on Traditional Lands at the request of Fort McKay prior to the use of the groundwater from that source.
- Development of a groundwater-monitoring program, in consultation with Fort McKay, designed to detect process-affected seepage that bypasses the interception and/or containment system for external and internal tailings disposal areas.
- The development and implementation of a groundwater monitoring program to detect process-affected seepage that bypasses the collection system, after closure and reclamation.
- Monitoring to confirm that natural treatment systems, through which process-affected groundwater is directed, work effectively and if they do not, implement changes or mitigation measures to address the problems.
- The development of a groundwater monitoring program, in consultation with Fort McKay, to determine the validity of computer and professional-judgment predictions that have the potential to impact groundwater resources and the ability of the Community to utilize their Traditional Lands. Shell should be required to prepare a table summarizing computer-predicted and professional judgment impacts and to outline the groundwater level and quality monitoring to be undertaken to verify that the predictions are accurate. As monitoring data becomes available it should be added to the table and the updated table should be provided to the Fort McKay IRC. Deviations from the predicted impacts, which indicate that impacts have been under-assessed, shall result in a

reassessment of impacts, updating of the table and reassessment of mitigation measures. The reassessment of any impacts should be provided to the Fort McKay IRC, and mitigation measures developed in consultation with Fort McKay.

#### 3.5.2.2 Cumulative-Effects Recommendations

- A regional groundwater management framework should be developed, in consultation with Fort McKay.

## 3.6 References

Alberta Research Council, 2007. Cited in Council of Canadian Academies. Expert Panel on Groundwater. 2009. The Sustainable Management of Groundwater in Canada.

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