SURFACE WATER QUALITY
AND FISHERIES RESOURCES

Fort McKay
Specific Assessment

Fort McKay
Industry Relations Corporation

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5.0 Water Quality and Fisheries Resources

"Hunting and fishing is addictive, you crave it. We are hunter-gatherers. It is inside of us." (Fort McKay Cultural Heritage Assessment 2009)

5.1 Fort McKay Key Concerns – Water Quality and Fisheries Resources

Fort McKay is concerned about impacts to local and regional water quality in rivers, streams and lakes. Community members are concerned about project-specific and cumulative impacts to their drinking water sources, the fish and plants that live in local waters, and to aquatic ecosystems in the region. The water quality and fisheries issues related to the Shell projects that are of specific concern for Fort McKay are:

- loss of aquatic habitat and diversion or other physical changes of significant watercourses and waterbodies,
- degraded water quality in local and regional lakes, ponds and wetlands will be harmful to aquatic ecosystems and contaminate fish and traditionally used aquatic plants,
- seepage from tailings ponds may contaminate the Athabasca River, Muskeg River, and their tributaries; muskeg and overburden dewatering and other runoff may contaminate receiving waters,
- catastrophic failure of any of the tailings impoundment dykes or end pit lakes that would cause unprecedented harm to the Athabasca River and its tributaries, as well as to Lake Athabasca, the delta and waters downstream, and
- End Pit Lakes will not function as designed to reduce toxic substances.

The following is a brief outline of each of these key concerns related to water quality and fish.

5.1.1 Lost, Diverted and Contaminated Aquatic Systems

Fort McKay is very concerned for the well-being of the Athabasca River and its many tributaries, the Muskeg River, Kearl (Muskeg) Lake, the Pierre River and other waterbodies. They are concerned that if wetlands or muskeg are replaced with diversion ditches or pipes, the water will no longer be naturally decontaminated. This concern is supported through the well known ability of wetland plants to sequester heavy metals and other contaminants (Scholz and Lee 2005). If natural

water levels are raised in Kearl Lake, Fort McKay is concerned about the loss of traditional plants like rat root.

Increases in water pollutants introduced from the air and through project processes have the potential to be accumulated by aquatic biota including plants, invertebrates and fish. If ecosystems are removed or become contaminated, a source of traditional food and medicine will be unavailable to the Community.

5.1.2 Contamination from Seepage and Runoff

Seepage of process waters from tailings ponds and other holding areas may cause a decline in downstream water and sediment quality. Runoff from mine sites, cleared areas and dykes, and flows from muskeg dewatering may introduce contaminants downstream more rapidly than ever occurs naturally in the area.

When flows are diverted elsewhere or are naturally low dilution is reduced, causing the increased concentration of incoming pollutants. Some of the contaminants of concern are slow or incompletely degraded. Many of these substances lack guidelines because little or nothing is known about their toxicity, especially when they occur as mixtures with other chemicals.

5.1.3 Catastrophic Failure of Tailings Impoundments

Fort McKay is worried about the environmental consequences should any natural or unnatural event cause the failure of a large tailings reservoir.

5.1.4 End Pit Lakes

Fort McKay is concerned about the planned function of end pit lakes to reduce polycyclic aromatic hydrocarbons (PAHs), naphthenic acids (NAs) and metals to levels that make water suitable for discharge downstream. They believe that some of the contaminants will remain in the water, in biota, and especially in sediments for a very long time. The pit lakes will be massive reservoirs on a landscape that naturally was very different. The artificial ecosystem may support biota, but these biota will be contaminated.

5.2 Fort McKay Specific Assessment Approach

5.2.1 Introduction

Fort McKay's approach to assessing water-related issues focuses on aspects of Shell's Jackpine Mine Expansion Project and Pierre River Mine Project that are of specific interest to the community. In addition to the general oil sands concerns described in Section 5.1, Fort McKay is very concerned about the loss or disturbance

of watercourses (e.g., Muskeg River) and waterbodies (e.g., Kearl Lake) that have been used by them for generations.

These waters are connected with the Athabasca River and are within Fort McKay's Traditional Lands. They are culturally important to Fort McKay, and any change caused by water diversion, habitat destruction or introduction of deleterious substances damages a part of their home.

Fort McKay wishes to understand how water quality and fisheries resources will change in the region, and whether these changes will impact their health or the health of plants and animals that live in the water. They have a good understanding of the way things "used to be", and realistically know that changes have and will continue to occur. They are concerned about the degree of change that might be caused by these and other oil sands projects, and about changes to landscapes and waterscapes that are traditionally important to them.

We address pre-development and predicted water quality variables compared with federal or provincial guidelines, as well as the criteria developed for the Fort McKay's Healing the Earth Strategy (HTES; Aquatic Change Index). Our HTES criteria and recommendations to maintain good water quality are conservatively based on the caveat that the long-term impacts of mixtures of contaminants is unknowable regardless of single contaminant concentrations.

Note that a catastrophic failure of tailings reservoirs or other incompletely treated process water reservoirs (including pit lakes) might occur for any of the development case scenarios, and would cause unprecedented damage. This is among the greatest fears of the people of Fort McKay.

5.2.2 Water and Fish Data Sources and Limitations

Fort McKay relied on Shell and its researched sources for water quality variable concentrations, loading rates and model predictions. Our assessment assumes that quality control and reliable methodology were used in the collection, processing and analyses of samples.

The principle sources of data that Fort McKay used in this assessment are:

- Shell's Jackpine Mine Expansion (Jackpine Mine Expansion Project) and Pierre River Mine (Pierre River Mine Project) EIA and Application (Shell 2007);
- Fort McKay assessment-specific information requested from Shell and provided by Shell and Golder Associates Ltd. (Golder 2009) for the Jackpine Mine Expansion Project;
- EIA and Project approval applications for other recent oil sands development projects;

- Pierre River Mine Project – Supplemental Information, Volume 1: Project Update and ERCB SIRs, Volume 2: AENV SIRs and Supplements (Shell 2009); and
- Reports, studies, summaries, or databases from Regional Aquatics Monitoring Program (RAMP), Alberta Environment or other sources.

The Pre-Development data are described as "up to 1996" and Current Scenario data are described as "up to 2006" (Golder 2009). The Current Scenario is described throughout this document as representing conditions as at 2006.

Sample methodology and analysis has improved over the decades, making results of some variables from early years potentially unreliable. This is possible for such variables as metals, including mercury collection and analyses (McEachern and Noton 2002).

5.2.3 Water Quality and Fisheries Resources Study Areas

Fort McKay applies the same aquatic study areas that Shell delineated for the Jackpine Mine Expansion Project and Pierre River Mine Project. The study areas are shown in ***Figure 4-1*** and ***Figure 4-2*** in ***Section 4 – Surface Water Resources*** of this assessment. These are the same as Figures 6.2-3 and 6.2-4 of the EIA (Volume 4A, Shell 2007).

For the Jackpine Mine Expansion Project, the main watercourses and waterbodies considered are:

- Muskeg River, and its tributaries (including Stanley Creek and Jackpine Creek)
- Athabasca River
- Kearl Lake

For the impact analysis of this report, we focus on the mouth of the Muskeg River (Node M3), and predicted concentrations early in development (2012) and in the far future (2065). Flows at the mouth were selected because they might also potentially impact the Athabasca River.

Fort McKay currently accepts Shell's information that no project-related flows will interact with flows to McClelland Lake through surface or near-surface groundwater. With the exception of the lenticular patterned fen on the northern fringe of the Muskeg River watershed, McClelland Lake and most of the associated fen is an area that Shell considered to be a groundwater study area only.

For the Pierre River Mine Project, in addition to the Athabasca River, the main watercourses considered are:

- Pierre River
- Eymundson Creek
- Asphalt Creek
- Big Creek
- First Creek
- Redclay Creek
- Several unnamed creeks

5.2.4 Water Quality and Fisheries Resources Key Indicators/Receptors

The following variables are considered key water or sediment quality indicators that potentially affect aquatic biota related to oil sands projects:

- Naphthenic acids (NAs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Total dissolved solids (TDS) or salinity (i.e., sodium)
- Metals
- Acute and chronic toxicity
- Tainting potential
- Temperature
- Dissolved oxygen

5.2.5 Water Quality Guidelines and Fisheries Resources Assessment Criteria

Water Quality Guidelines

Wherever feasible, Fort McKay applies CCME, AENV or USEPA water quality guidelines for the protection of aquatic life. These criteria are used by Fort McKay in its Healing the Earth Strategy as well as the Aquatic Change Index described below (HTES, Fort McKay IRC 2010). These were applied to water quality modeling from each of the Jackpine Mine Expansion and Pierre River Mine Project projects, at selected temporal snapshots and spatial nodes as provided by Shell. Where guidelines are not available, other criteria or professional judgments might be applied.

The data for the Base Case and Application Case are available for the Jackpine Mine Expansion Project in Tables 4.3-1 through 4.3-5 provided by Shell (Golder 2009). For the Pierre River Mine Project the EIA documentation was referred to without reanalysis of the data.

Fish Health

The fisheries resource assessment examines impacts to fish health, which are assessed by examining:

- Guideline exceedances in specific water quality parameters, and/or
- The magnitude of change of the water quality parameters (see the Aquatic Change Index below)

The fisheries resources (fish health) assessment criteria are based on the potential toxic effect of aquatic guideline exceedances or predicted substantial increase of relevant key indicators that may or may not have current guidelines, as well as habitat disturbance. Guidelines are compared with the median predicted concentrations of water quality variables.

This assessment indirectly considers that exposure of fish to toxic substances occurs not only from water (through their gills), but also from bottom sediments, and especially through food web uptake (diet). Of course, humans are at the top of the food chain. Any contaminants that increase with higher levels in the food chain (e.g. methylmercury and certain organic contaminants) may be elevated in piscivorous fish (like walleye or northern pike), rendering some fish unsuitable for frequent human consumption.

While it might be acceptable that peak (i.e. highest) water concentrations will result in occasional guideline exceedances, any exceedances of the *median* concentration (meaning that half of the measurements exceed guidelines) will be assessed as a significant adverse impact related to that specific parameter.

Fishing Opportunities

Impacts on fishing opportunities for Fort McKay were assessed by considering:

- Impacts on fish health (as described above);
- Habitat change and potential stress on fish populations as assessed by direct loss of loss of watershed area and changes in flows (see ***Section 4 – Surface Water Hydrology***, which rates the state of surface water as sustainable (green), threatened (yellow) or endangered (red),
- Impacts to fish habitat as described by Shell in the EIA and the preliminary fish habitat compensation plans.

- The potential human health effects related to the consumption of fish harvested from the proposed compensation lake.

With respect to impacts to fish and fish habitat, Fort McKay understands that Shell is in the process of planning compensation for lost fish habitat in consultation with Fisheries and Oceans Canada (DFO), Fort McKay and other stakeholders.

Loss of fishing opportunities is rated, as described above in the Aquatic Change Index, as low, moderate or high.

Aquatic Change Index

Fort McKay assessed the potential change in water quality and fisheries resources for the watersheds using the approach used in the Healing the Earth Strategy (HTES, Fort McKay IRC 2010). An index to highlight the degree of change in water quality variables and loss of fishing opportunities was developed to assess the significance of the impact. The HTES approach to water quality change is an abbreviated version of the Canadian Council of Ministers of the Environment (CCME) Water Quality Index (CCME 2001) in terms of data reconnaissance, in that pre-development median values are compared against future time snapshots. For example, if the pre-development concentration of substance *X* is 0.01 mg/L, and the post-development concentration of substance *X* is 0.20 mg/L, the resultant multiple change is 20X (0.20/0.01).

The low-moderate-high index ("Aquatic Change Index") provides a quick guide as to the magnitude of predicted change in a given water quality variable, change in fish health and habitat or loss of fishing opportunities. From a regulatory perspective, it helps to identify the need for a shift from case-by-case approvals to a comprehensive plan for a watershed. The following are the categories in the Aquatic Change Index utilized in this assessment:

- **Low** – a **green** situation - less than 10 times change in predicted median water quality concentrations compared to pre-development to the given time snapshot in any given season and/or few guideline exceedances expected. If all variables are assessed as low (<10X multiple), no water quality or fishing opportunities management plan is needed at this time and is assessed by Fort McKay as no adverse impact.
- **Moderate** – a **yellow** situation - Between 10 and 25 times change in predicted median mean water quality concentrations expected and/or aquatic life guideline exceedances at certain times of the year. Where aquatic life may be at risk, a watershed management and fishing opportunities management plan should be developed to establish impact limits and provide direction to development. Professional judgment is required to assess whether the impact is significant.

- **High** – a **red** situation - more than 25 times change in predicted median water quality concentrations and/or with guideline exceedances expected frequently; potential toxic effects related to mixtures of chemicals. Fishing opportunities are lost. A watershed management and fishing opportunities management plan is needed to establish impact limits, and provide direction to development. A significant adverse impact is likely to be the result.

The index criteria allows for the acceptance of substantial natural variability in water quality. However, mean or median water quality concentrations are not likely to vary naturally to the degree indicated for the moderate and high change categories without some degree of anthropogenic disturbance.

The overall qualitative **low**-**moderate**-**high** Aquatic Change Index that is used for the Projects indicates the potential need for watershed management planning. It is important to include related indicators, such as water quantity (hydrology) and the state of local wetlands and terrestrial areas, to add further detail to the state of a watershed.

5.2.6 Fort McKay's Healing the Earth Strategy

Fort McKay's Healing the Earth Strategy (HTES; Fort McKay IRC 2010a) has four strategies (*retain*, *reclaim*, *improve* and *offset*) that the Community supports with regard to addressing environmental issues. With respect to water quality, aquatic resources and fish the HTES focuses on retaining and improving water quality and aquatic habitats and fishing opportunities. However, reclamation and offset strategies are also required.

5.3 Jackpine Mine Expansion Impact Assessment

5.3.1 Stressors on Water Quality and Fisheries Resources

A number of stressors on water quality and fisheries resources in local and regional rivers, streams and lakes might occur related to the Jackpine Mine Expansion Project. Degraded water quality and lost aquatic habitat might be related to:

- Release of muskeg drainage and overburden dewatering flows into Muskeg River and Muskeg Creek;
- Diversion of the Muskeg River and some of its tributaries;
- Creation of closed-circuit areas that withhold water from local rivers;
- Escape via seepage or runoff of process-affected waters from tailings ponds or pit lakes; and

- Loss of the natural outflow from Kearl Lake and replacement with two constructed outlets.

Further, cumulative stressors must be considered in light of the many other projects that will operate in the area including Albian Sands Muskeg River Mine and Expansion, Shell Jackpine Mine – Phase 1, Syncrude Aurora North and South mines and Imperial Oil's Kearl Project.

5.3.2 Pre-Development Scenario (up to 1996)

The water quality Pre-Development Scenario is represented by data that were collected from 1972 to December 31, 1996, a period that pre-dates oil sands development in the Muskeg River watershed. Pre-Development (1972 to 1996) water quality is described in a column within Tables 4.3-1 to 4.3-5 in Golder (2009)[1] as a range of natural variation from low to high, and a median of concentrations for each variable. No historical data were provided in these tables for TDS/salinity, dissolved oxygen or temperature, although salinity might be assessed through the sodium and chloride concentrations that are provided. Some additional information from an Alberta Environment (AENV) review paper was also used (McEachern and Noton 2002).

The fish and fish habitat pre-development scenario is represented as a summary of historical data organized by decade from 1960 onwards (based on year of publication) in Tables 4.4-3 to 4.4-4 (Golder 2009). The column representing the decade 1990-1999 has a mix of publication dates for the pre-development and later years.

The above data tables are not reproduced in this assessment; instead relevant Pre-Development data for specific parameters are shown in assessment tables for the development scenarios/cases (Current Scenario, Base Case, Application Case and Planned Development Case). (To view full data tables see Golder 2009; which is an electronic appendix that accompanies this report.)

5.3.3 Current Scenario (2006)

The Current Scenario for the Muskeg River is the known water quality in the watershed from 1997 to 2006. The relevant column in the water quality Tables 4.3-1 to 4.3-5 provided by Golder (2009) is labeled "Observed natural variation up to 2006"[2]. Additional and more recent water quality data for the Muskeg River may be found in RAMP (2009) and previous RAMP technical reports, but only the data provided by Shell were utilized for our analyses.

[1] From the Fort McKay Community Assessment – Water (Golder 2009).
[2] The inclusion of data prior to 1997 is implied.

Fish species presence or absence is organized by decade with publications dated up to 2007 as the relevant data for the Current Scenario (Tables 4.4-3 and 4.4-3; Golder 2009), with recent survey data presented in Section 5 of the Aquatics Environmental Setting Report (Shell 2007). The Aurora North Mine and the Muskeg River Mine and Expansion account for developments that may have influenced changes in water quality and fish habitat since the Pre-Development Scenario. Fish species data will mainly be used for planning the fish compensation lake.

Aquatic Change Index

Application of the Aquatic Change Index indicates that none of the water quality parameters changed substantially (all medians were less than 10X changed) from Pre-Development to the Current Scenario, and as such all are rated as low impact (a **green** situation (Table 5-1).

Fish

Since the Surface Water Hydrology assessed change in flow is less than 5% with relatively small changes in watershed size (***Section 4 – Surface Water Hydrology***, ***Table 4-4*** and ***Table 4-5*** of this Specific Assessment), and the Aquatic Change Index are all assessed as low impact, the impact on fish habitat and fishing opportunities for the Current Scenario is also rated as low and is considered sustainable (a **green** situation). The primary tenet of the HTES (*retain*) is satisfied under the Current Scenario.

5.3.4 Base Case Assessment

In addition to the Aurora North and Muskeg River Mine and Expansion, the Base Case includes the Aurora South Mine, Jackpine Mine – Phase 1, and the Kearl Oil Sands Project. Impacts to surface waters from the Base Case may occur due to:

- Muskeg and overburden dewatering flows, and associated contaminants;
- Escape of contaminated water from closed-circuited development areas;
- Seepage of toxic process-affected waters from tailings ponds; and
- Discharge of pit lake flows of unknown quality directly or indirectly to the Muskeg River.

Shell described their Base Case assessment in Section 6.5.5.1 (p. 6-375) of the EIA. They identified that during mine development muskeg and overburden dewatering flows would be released directly into the Muskeg River from the projects listed above. Later in the projects, pit lake water from each of the projects will be released to the Muskeg River, and seepage of process-affected water from the projects will discharge to local watercourses and to Kearl Lake.

Table 5-1: Current Scenario (1997-2006) Selected Water Quality Concentrations at Mouth of the Muskeg River (M3) Compared to Pre-Development Scenario

Parameter	Guidelines	Median Concentration		Multiple Change*
		Pre-Dev (PD) (1972 – 1996)	Current Case (1997 – 2006)	
aluminum	0.1	0.036	0.05	1.4
arsenic	0.005	0.00022	0.00021	1.0
cadmium - µg/L	0.017	0.087	<0.0002	-
chloride	230	2.7	3.8	1.4
chromium	0.001	0.00084	0.00036	0.4
copper	0.003	0.00057	0.00039	0.7
iron	0.3	**1.2**	**0.93**	0.8
mercury - µg/L	0.026	0.005	<0.0001	-
molybdenum	0.073	0.0001	0.00008	0.8
NAs -labile	0.0011[3]	0.000001	-	-
NAs-refractory	-	0.7	-	-
NAs -total	-	0.7	-	-
nickel	0.065	0.00067	-	0.3
PAH group 1	0.015	0.000001	-	-
selenium	0.001	0.00023	<0.0004	-
silver	0.0001	0.000002	<0.000022	-
sodium	-	7.3	12	1.6
sulphate	-	4	5	1.3
sulphide	0.002	0.0033	<0.01	-
tainting potential	1	0.000001	-	-
TDS	-	200	227	1.1
total phenolics	0.005	0.0026	0.002	0.8
total P	0.05	0.033	0.029	0.9
toxicity -chronic	-	0.000001	-	-
vanadium	-	0.00033	<0.001	-
zinc	0.03	0.0057	0.005	0.9

*Increases over Pre-Development (PD): <10X PD=**low**, 10-25X PD=**moderate**, >25X PD=**high**

All concentrations are mg/L unless noted otherwise. Values below detection limits (<x) cannot be used for calculations.

Guideline exceedances are in bold.

Aquatic Change Index

Predicted water quality results at the mouth of the Muskeg River indicate that at one or more future time periods, these developments will substantially increase water concentrations of a number of variables. Using the colour-coded Aquatic Change

[3] NAs = naphthenic acids; Guideline is for naphthalene (PAH – trace organic).

Index that highlights the magnitude of change, PAHs are predicted to increase by more than 25 times and silver by 13.5 times by 2012 (Table 5-2). Guideline exceedances of the median concentrations are expected for chromium, iron and TP. No category increase was assigned to iron because median levels exceeded the guideline in pre-development records. Note that median chromium concentrations are predicted to exceed guidelines in every future time snapshot provided in the EIA (2012, 2033, 2052 and 2065).

Looking forward to the 2065 snapshot, the median concentrations of five of the 26 selected variables are predicted to increase by more than 25 times, and all of them will increase substantially more than 25 times (from 550 – 170,000 times; Table 5-2). Naphthenic acids (NAs), PAHs, tainting potential, chronic toxicity and molybdenum are all categorized with high increases in the 2065 time snapshot.

NAs appear likely to become a particular concern with the greatest increases of all variables compared with both pre-development and 2012 concentrations. Furthermore, the more toxic labile NA concentrations show a pattern of steady increase at the Base Case time snapshots for Muskeg River at the mouth modeled by Shell with median levels of <0.001 µg/L in 2012, to 28 µg/L by 2033, 93 µg/L by 2052, and finally, 170 µg/L by 2065 (Table 4.3-4a; Golder 2009).

For Kearl Lake, Table 6.5-9 of the EIA indicates that water column median aluminum and cadmium concentrations will exceed guidelines, and labile naphthenic acids will increase significantly between 2012 and 2065 (Shell 2007).

Fish

While the current guidelines do not indicate that fish health will be affected by single-substance water quality under future projections, the surface water hydrology assessment indicates that flows will be altered and that watershed size will be severely reduced for the Base Case by the 2049 snapshot (***Section 4 – Surface Water Hydrology***, ***Table 4-5***). The state of surface water is assessed overall as endangered (36% of the watershed disturbed, ***Table 4-6***; and mean open water flows reduced by 19% by 2049, ***Table 4-5***). As such, fish stocks will also be stressed, and fishing opportunities for Fort McKay in the Muskeg River watershed will be reduced. It is also possible that the combined increases in several contaminants, while individually at or below guidelines, will stress aquatic biota.

Despite survival, resident fish are likely to accumulate a variety of contaminants that are concentrated when dilution rates (flows) decline, or when diverted water does not flow naturally through wetlands. Any food web contamination will result in lost fishing opportunities because of contaminated fish tissue. The impact assessment for fishing opportunities for Fort McKay is therefore ranked as high and adverse, a **red** situation.

Table 5-2: Base Case Selected Water Quality Median Concentrations at Mouth of Muskeg River (M3) from Pre-Development, and Predicted for 2012 and 2065, Using Aquatic Change Index

Parameter	Guidelines	Median Concentration			Multiple Change*	
		Pre-dev	2012	2065	2012	2065
aluminum	0.1	0.036	0.059	**0.17**	1.6	4.7
arsenic	0.005	0.00022	0.00049	0.00061	2.2	2.8
cadmium - µg/L	0.017	0.087	0.0001	0.00036	1.1	4.1
chloride	230	2.7	4.4	25	1.6	9.3
chromium	0.001	0.00084	**0.0023**	**0.002**	2.7	2.4
copper	0.003	0.00057	0.0017	0.0015	3.0	2.6
Iron	0.3	**1.2**	**1**	**0.77**	0.8	0.6
mercury - µg/L	0.026	0.005	0.0007	0.0036	1.4	7.2
molybdenum	0.073	0.0001	0.0005	0.055	5.0	550.0
NAs -labile	0.0011[4]	0.000001	0.000001	0.17	1.0	170000.0
NAs-refractory	-	0.7	1	3.3	1.4	4.7
NAs -total	-	0.7	1	3.5	1.4	5.0
nickel	0.065	0.00067	0.0048	0.0065	7.2	9.7
PAH group 1	0.015	0.000001	0.0059	0.0013	5900.0	1300.0
selenium	0.001	0.00023	0.00018	0.00042	0.8	1.8
silver	0.0001	0.000002	0.000027	0.000025	13.5	12.5
sodium	-	7.3	13	39	1.8	5.3
sulphate	-	4	19	87	4.8	21.8
sulphide	0.002	0.0033	0.0045	0.0007	1.4	0.2
tainting potential	1	0.000001	0.000001	0.04	1.0	40000.0
TDS	-	200	306	428	1.5	2.1
total phenolics	0.005	0.0026	0.004	0.0004	1.5	0.2
total P	0.05	0.033	**0.1**	**0.054**	3.0	1.6
toxicity -chronic	-	0.000001	0.000001	0.06	1.0	60000.0
vanadium	-	0.00033	0.00064	0.0026	1.9	7.9
zinc	0.03	0.0057	0.014	0.011	2.5	1.9

* Increases over Pre-Development (PD): <10X PD=**low**, 10-25X PD=**moderate**, >25X PD=**high**

All concentrations are mg/L unless noted otherwise. Guideline exceedances (**bold**) that are predicted to occur in future time snapshots, but did not occur during pre-development, resulted in one index category increase.

The primary tenet of the HTES (retain) is not satisfied for water quality or fish health under the Base Case scenario. Opportunities to retain or improve water quality and fish health are required.

[4] NAs = naphthenic acids; Guideline is for naphthalene (PAH – trace organic).

5.3.5 Application Case Assessment

The Jackpine Mine Expansion Project adds 9,700 hectares (ha) to the total disturbed area in the Muskeg River watershed, making the area of watershed disturbance for the Application Case 66,533 ha, or 44.6% (see *Table 4-4* in Section 4 – Surface Water Resources). Development activities resulting from the Application Case will remove 223 km^2 of the Muskeg River watershed and divert a 21 km stretch of the Muskeg River during the operations phase (Shell 2007).

Changes in water quality variable concentrations or in fish habitat that differ from the Base Case are considered to be caused by the Jackpine Mine Expansion Project. Changes caused by this project are listed in Section 6.5.5.3 of the EIA (Volume 4A, Shell 2007), and include:

- Flow diversions from the upper Muskeg River, Muskeg Creek and Kearl Lake;
- Creation of dykes to contain increased water levels in Kearl Lake;
- Dewatering of muskeg and overburden flows with releases to the Muskeg River;
- Closed-circuiting of parts of the Muskeg River;
- Surface runoff, seepage and other water fluxes from tailings areas, overburden dumps and reclaimed pit surfaces; and
- Updating and further creation of pit lakes that will discharge to surface watercourses.

Aquatic Change Index

In spite of the large area developed and the scale of the project, the Jackpine Mine Expansion Project model predicts only a few additional water quality changes in the Muskeg River comparing the Application to the Base Case. However, the trend is negative.

In 2012, PAHs (Group 1) are predicted to increase in the Muskeg River (M3) by more than 5000 times and guideline exceedances will be frequently expected for chromium, sulphide and total phosphorus (TP; Table 5-3). A similar substantial increase occurred for the Base Case for PAHs in 2012 (Table 5-2).

By 2065, five additional variables are predicted to increase to a high degree (range of 940 – 110,000 times) compared to pre-development, including NAs, sulphate, tainting potential, chronic toxicity and molybdenum. Guideline exceedances for half of all measurements (i.e., median) in the Muskeg River at the mouth are expected for aluminum, chromium, iron, and molybdenum. Sulphide and TP will decrease to acceptable levels compared to 2012. Depending on the frequency and length of

exposure of elevated concentrations of contaminants, a significant adverse impact may occur for some biota.

NAs may be a concern as the more toxic labile NAs are predicted to increase substantially (110,000X) by the 2065 snapshot. The labile NA forms' median concentrations are expected to be from <0.001 µg/L to above 100 µg/L in the far future time snapshot (Table 5-3).

With an increased number of guideline exceedances as time goes on together with high increases of several substances, biota are likely to become stressed at certain times of the year or during sensitive life cycle stages. The long-term impact on organisms, communities and populations is unknowable at this time, but there is likely to be an overall significant adverse impact in the coming decades.

Fish

The Application Case impact assessments for fish and for fishing opportunities for Fort McKay are the same as described for the Base Case in Section 5.3.4 above, including a further decline of mean open water flows to -26% by 2049 (Section 4, ***Table 4-5***).

The primary tenet of the HTES (retain) is not satisfied under the Application Case scenario. Changes to project design would be required to improve these aspects, fish habitat compensation lakes are the primary mode to reclaim losses, and further efforts are required to provide offsets by protecting water quality and enhancing fish habitat in currently undisturbed areas.

Table 5-3: Application Case Selected Water Quality Median Concentrations at Mouth of Muskeg River (M3) from Pre-Development, and Predicted for 2012 and 2065, Using Aquatic Change Index

Parameter	Guidelines	Median Concentration			Multiple*	
		Pre-dev	2012	2065	2012	2065
aluminum	0.1	0.036	0.057	**0.21**	1.6	5.8
arsenic	0.005	0.00022	0.00039	0.00055	1.8	2.5
cadmium µg/L	0.017	0.087	0.088	0.370	1.0	4.3
chloride	230	2.7	4.4	49	1.6	18.1
chromium	0.001	0.00084	**0.0021**	**0.0021**	2.5	2.5
copper	0.003	0.00057	0.0015	0.0015	2.6	2.6
iron	0.3	**1.2**	**1**	**0.69**	0.8	0.6
mercury - µg/L	0.026	0.005	0.0006	0.0036	1.2	7.2
molybdenum	0.073	0.0001	0.0005	**0.094**	5.0	940.0
NAs -labile	0.0011[5]	0.000001	0.000001	0.11	1.0	110000.0
NAs-refractory	-	0.7	1	4.6	1.4	6.6
NAs -total	-	0.7	1	4.7	1.4	6.7
nickel	0.065	0.00067	0.0046	0.081	6.9	12.1
PAH group 1	0.015	0.000001	0.0052	0.0014	5200.0	1400.0
selenium	0.001	0.00023	0.00018	0.00054	0.8	2.3
silver	0.0001	0.000002	0.000017	0.000018	8.5	9.0
sodium	-	7.3	11	54	1.5	7.4
sulphate	-	4	19	117	4.8	29.3
sulphide	0.002	0.0033	**0.0045**	0.0005	1.4	0.2
tainting potential	1	0.000001	0.000001	0.06	1.0	60000.0
TDS	-	200	306	553	1.5	0.1
total phenolics	0.005	0.0026	0.004	0.0003	3.0	1.5
total P	0.05	0.033	**0.1**	0.05	1.0	56000.0
toxicity -chronic	1	0.000001	0.000001	0.056	1.9	11.8
vanadium	-	0.00033	0.00064	0.0039	2.5	1.8
zinc	0.03	0.0057	0.014	0.01	1.6	5.8

* Increases over Pre-Development (PD): <10X PD=**low**, 10-25X PD=**moderate**, >25X PD=**high**

All concentrations are mg/L unless noted otherwise. Guideline exceedances (**bold**) that are predicted to occur in future time snapshots, but did not occur during pre-development, resulted in one index category increase.

[5] NAs = naphthenic acids; Guideline is for naphthalene (PAH – trace organic).

5.3.6 Planned Development Case

The Planned Development Case (PDC) was considered by Shell to be the same as the Application Case for the Muskeg River watershed[6]. Operational and reclamation water releases will ultimately be discharged into the Athabasca River from planned developments in the region. As for the Application Case, the operational water releases include muskeg drainage and overburden dewatering flows through polishing ponds, and reclamation waters (process-affected water seepages and fluxes and runoff from reclaimed surfaces that will receive treatment in wetlands and pit lakes; Shell 2007).

The assessment for water quality and fisheries resources for the PDC is currently the same as for the Application Case, including addressing the four tenets of the HTES.

5.3.7 Shell's Proposed Mitigation and Monitoring

5.3.7.1 Mitigation

Shell proposes the following mitigation measures to reduce impacts to water quality (EIA Section 6.1.4.3 Volume 4A, Shell, 2007):

- Use of sedimentation ponds equipped with oil removal capabilities, for muskeg drainage and overburden dewatering;
- Closed-circuit water recycling of process-affected, runoff or seepage waters during operations;
- Perimeter ditches and wells to capture tailings pond water seepage;
- At closure, use of wetlands, pit lakes and treatment lakes to attempt the decontamination of reclamation waters prior to release;
- A self-sustaining closure drainage system that directs water after decommissioning to wetlands, pit lakes and a treatment lake; and
- Best management practices to manage accidental spills and prevent failure of retention structures.

Shell proposes the following mitigation measures to reduce impacts to fisheries resources for the Jackpine Mine Expansion Project (Section 6.1.6.2):

[6] There are currently no additional developments planned for the Muskeg River; therefore, no planned development case was assessed. There are however, additional oil sands leases within the Muskeg River watershed that could potentially be developed in the future.

- Designing operational diversions and closure channels to provide for fish passage;
- Using best practices including sediment and erosion control during construction;
- Screening the water intake to meet federal and provincial requirements;
- Use of a fish salvage program for watercourse segments and lakes permanently lost; and
- Developing a fish compensation plan.

With regard to fisheries resources, Fisheries and Oceans Canada (DFO) have already assessed that a Harmful Alteration, Disruption or Destruction (HADD) to fish habitat will occur as a result of the Jackpine Mine Expansion Project. Plans for compensation are in progress, and it appears that fish compensation habitat will be located at the north end of the Pierre River Mine Project, distant from the Muskeg River watershed.

5.3.7.2 Monitoring

Shell describes a water and sediment monitoring plan in the Aquatics Monitoring Program (2007) Appendix 4-9 of the EIA (Shell 2007).

5.3.8 Significance Assessment and Conclusions

Removal of 21 km of the mainstem Muskeg River is contrary to one of the early recommendations in the draft Muskeg River Watershed Framework[7] as well as the expressed position of many stakeholders. This river is relatively near Fort McKay. It is one of the most important watercourses to the Community, having been used by them for generations.

Reflecting on the Base Case and Application Case in relation to the Pre-Development scenario, many water quality variables are expected to show substantial increases in concentration with increasing development in the Muskeg River. The high numbers of variables that are expected to increase moderately or highly suggest that further mitigation and/or revised management and possibly development plans are necessary. Overall, water quality impacts are rated as moderate (a **yellow** situation).

It is important that guideline exceedances not be the sole focus of an assessment because there is still a poor understanding of the impact of mixtures of chemicals on aquatic ecosystems. In other words, even if there are few or no guideline

[7] Referring to Shell's Jackpine Expansion application, Alberta Environment later re-worded this recommendation to be guided by the "public interest" (AENV 2008).

exceedances, negative impacts to biota may occur under conditions of the combined incremental increases of mixed metals and organic contaminants.

Furthermore, fish that are able to survive in pit lakes or that inhabit the compensation lake may be contaminated with methylmercury and other contaminants. Some of the fish high in the food chain would not be suitable for frequent human consumption. Therefore, Fort McKay community members who formerly enjoyed fishing in the Muskeg River watershed will lose this traditional use unless other safe opportunities are available. The loss of fishing opportunities to Fort McKay is assessed as a significant adverse impact, a **red** situation (Table 5-4).

The approach used in this assessment demonstrates the magnitude of change of individual water quality variables that may occur with the simultaneous development of many oil sands projects in the Muskeg River watershed. The red (high) level of change in the Aquatic Change Index highlights where greater than 25 times increase in the median concentration may occur. While an increase by 25 times or more of any one variable may not stress the ecosystem unduly, the combined high increase of several variables concurrently has the potential to stress biota, resulting in a significant adverse impact.

The approach used to assess impacts to fish health considered both water quality impacts as well as loss of fish habitat through hydrologic changes. Some species may not thrive in the compensation lake, and regardless of the optimistic outlook of industry and regulators, the degree of success of the compensation lake is unknowable at this time.

If one group of organisms is adversely affected by water quality, for example, invertebrates, another group (like fish) is likely to be indirectly affected. The impact on fish health for the Base Case and Application Case is, therefore, assessed as adverse and of moderate significance, a **yellow** situation (Table 5-4).

While not addressed directly in the Water Quality Index assessment, Fort McKay remains concerned about the viability of end pit lakes as a method of treatment for mature fine tailings and process-affected water. In a recent peer review of the CEMA End Pit Lake Technical Guidance Document, all 12 external experts concluded that the knowledge presented in the document was unacceptable based on the unsupported assumption of the uniqueness of oil sands end pit lakes, lack of references, errors in fact, lack of expertise of the authors, and complete lack of peer review up to the present (CH2M Hill 2009).

End pit lakes are not currently demonstrated to be a viable option of treatment that will result in future sustainable and healthy ecosystems. The outcome of the external review of the CEMA document means that there is currently no acceptable technical guidance documentation for end pit lakes in northern Alberta. Despite this, projects applications that include end pit lakes are routinely approved by regulators.

Table 5-4: Summary of Fort McKay's Assessment of Water Quality and Fisheries Resources for each Development Scenario for the Jackpine Mine Expansion

	Pre-Dev Scenario	Current Scenario	Base Case	Application Case	Planned Dev Case
Water Quality	No adverse effect	Low adverse effect	9 of 26 selected variables adversely affected	11 of 26 selected variables adversely affected	11 of 26 selected variables adversely affected
Fish Health*	No adverse effect	Low adverse effect	Moderate adverse effect	Moderate adverse effect	Moderate adverse effect
Fishing Opportunities	No adverse effect	Low adverse effect	Significant adverse effect	Significant adverse effect	Significant adverse effect

* Assumes fish will have sustainable populations in the planned compensation lake.

5.3.9 Fort McKay's Recommendations

Based on Fort McKay's assessment of significant adverse effects in the Muskeg River watershed under the Base Case and Application Case, Fort McKay recommends to the regulators the following:

Project-Specific Recommendations

- A mandatory minimum set back of 100 metres (m) for all fish-bearing watercourses, including the main stem of the Muskeg River, Jackpine Creek, Muskeg Creek and other fish-bearing tributaries of the Muskeg River.
- Prohibition of increases in water level of Kearl Lake and the development of methods to prevent such increases. This includes retaining as much of the natural shoreline and riparian area as is required to maintain natural processes and vegetation.
- Mitigation and accommodation measures to be developed and consultation with Fort McKay with respect to the lost fishing opportunities caused by the Jackpine Mine, including but not limited to, the development of a fishing opportunities management plan. DFO-authorized habitat compensation is not compensation or mitigation from the perspective of Fort McKay's lost fishing and other traditional use opportunities due to unknowns about contamination of fish remaining in the system, concerns regarding potential mercury levels in fish in the compensation habitat, the loss of culturally-significant areas and the conversion of river habitat to artificial lakes.

Cumulative Effects Recommendations

- Prior to any final decisions affecting the mainstem of the River, finalization of the Watershed Management Plan for the Muskeg River Watershed and Fort McKay to be intricately involved in the development and finalization of the Muskeg River Watershed Plan.
- That the acceptance and reliance on end pit lakes for treatment of MFT and process waters be curtailed until such time as this method of treatment is proven to be viable in a scientifically-defensible (peer-reviewed) manner.

5.4 Pierre River Mine Impact Assessment

5.4.1 Stressors on Water Quality and Fisheries Resources

Some of the stressors caused by the Pierre River Mine Project on water quality and fisheries resources in local and regional rivers, streams and lakes are similar to those caused by the Jackpine Mine Expansion Project. Degraded water quality and lost aquatic habitat might occur related to:

- Release of muskeg drainage and overburden dewatering flows into Eymundson Creek and Athabasca River within the Pierre River Mine Project;
- Diversion of the Pierre River, Asphalt, Eymundson, Big and Redclay Creeks; loss of Eymundson Sinkhole (karst) lakes;
- Creation of closed-circuit areas that withhold water from the Athabasca River and local smaller rivers, as well as diversion of flows for the creation of pit lakes, raw water storage facilities and Redclay Compensation lake;
- Escape via seepage, runoff of process-affected waters from tailings ponds or pit lakes (may include runoff or seepage); and
- Rupture or leakage of bitumen and solvent from the pipeline crossing at the Athabasca River Bridge.

5.4.2 Pre-Development Scenario (1965)

As there has been no industrial development in the local Pierre River Mine Project area, the current data available represent the Pre-Development Scenario. Also, because so few variables were predicted to change significantly for the Pierre River Mine Project, the Aquatic Change Index calculations are not shown here for that project. Information from Shell's EIA and updates were used for assessing the Pierre River Mine Project.

5.4.3 Current Scenario (2006) and Base Case

The Current Scenario for the Pierre River Mine Project study area is the same as pre-development because no industrial activity (other than some clearing) has yet occurred in the study area. Any change in water quality and fisheries that has occurred is considered natural, or at least, uninfluenced by oil sands development. The nearest active project is CNRL Horizon to the south, with no current connection to watersheds of the Pierre River Mine Project area.

The only change considered part of the Base Case is a 3-km-long segment of a diversion channel for the approved CNRL Horizon Project (that will be merged in future with the proposed Pierre River diversion channel for the Pierre River Mine Project). Of four water quality variables modeled (NAs, tainting potential, TDS and toxicity) none were predicted by Shell to increase for the Base Case compared to background levels (Shell 2007).

In order to assess potential future changes to the Pierre River area due to the Horizon and Pierre River Mine Project projects, data from the EIA (Shell 2007) and new information collected in 2007 (Shell 2009) were used. The collection of data in the Pierre River project area was discussed by the RAMP technical committee (spring 2009). As of then, there were plans to include only the Pierre River in RAMP monitoring by 2011 (M. Davies, Hatfield Consultants, pers. comm.) This would be in addition to any monitoring proposed in Appendix 4-9 of the EIA (Shell 2007).

Based on the current information available and the application of the Aquatic Change Index (where selected water quality variables will show less than 10X increase), the Current Scenario/Base Case for the Pierre River watershed is assessed as no adverse effect (a **green** situation).

5.4.4 Application Case Assessment

The stressors on water quality and fisheries resources for the Application Case are those listed in Section 5.4.1 above. Muskeg and overburden dewatering, diversions, closed circuiting, seepage, contaminated runoff and potential accidents may all impact the aquatic environment. Previously undeveloped watersheds will be re-routed or lost to mining, tailings disposal areas and other project activities.

Water quality predictions for Athabasca River, Pierre River (Node PR1), Eymundson Creek (Node AE1) and Big Creek (Node BC3, BC1) were provided in the Shell EIA, with additional data in the Update indicating no change to the median concentrations or modeling results provided in the original EIA (Shell 2009). According to the tables in Appendix 4-7 of the EIA that show modeled future water quality, only small changes are expected by Shell to be caused by the project (Shell 2007).

In Big Creek at the upstream node (BC1), median aluminum and chromium concentrations already exceed guideline levels, and these levels will double or triple in the decades ahead (Table 6.5-18 of the EIA). In the Athabasca River downstream of Big Creek (later this may be the outflow of the compensation lake), labile NA concentrations are expected to double or triple in all future time snapshots. Provided the 15 km^2 tailings impoundment (ETDA), the pipeline river crossing, or other major process waters do not accidentally enter surface waters, most operational contamination will be related to seepage and runoff.

From Fort McKay's perspective and based on currently available information, water quality impacts assessed using the Aquatic Change Index for the Pierre River project area's watersheds are assessed to be low to moderate adverse effects and rated as a **yellow** situation.

Fish

Aquatic resources, including fish and fish habitat, will be affected by the loss or diversion of several watercourses linked to the Athabasca River. Shell's joint compensation proposal with the Jackpine Mine Expansion Project will likely result in the construction of a very large compensation lake that runs parallel to the Athabasca River, in the vicinity of Big Creek, Redclay Creek and unnamed watercourses. As the compensation lake is in the planning stages, further assessment is not included in this report.

The Athabasca River mainstem and its tributaries within Fort McKay's Traditional Lands are mapped as "Intense Use" Culturally Significant Ecosystems (McKillop 1992)[8]. The Community has and continues to use the Athabasca River and its tributaries for fishing and other traditional uses.

Similar to the Jackpine Expansion Mine Expansion, the only remaining fishing opportunity off the Athabasca River in the project area is likely to be in the compensation lake. The fish in the compensation lake (reservoir) might be contaminated with methylmercury. While the compensation lake may be suitable from a DFO-regulatory perspective, Fort McKay community members that formerly enjoyed fishing in the area watersheds will lose this traditional use unless replacement opportunities are made available. The loss of fishing opportunities to

[8] The Culturally Significant Ecosystems were developed by McKillop (2002) from spatial data analysis of data from the Fort McKay traditional use and occupancy study "There is Still Survival Out There" (Fort McKay First Nations 1994). Note that this analysis was based on one data set and should not be considered a comprehensive mapping or analysis of Fort McKay's traditional use and occupancy. Substantial, additional traditional use data have been collected since the 1994 study. The Culturally Significant Ecosystems do, however, provide a general spatial picture of Fort McKay's use of the land and are helpful in assessing effects from the perspective of the community. These maps should not be considered as a definition of the Community's value of the land.

Fort McKay, including the loss of traditional river fishing opportunities, is assessed as a significant adverse impact (a **red** situation).

5.4.5 Planned Development Case

The Planned Development Case (PDC) was considered by Shell to be the same as the Application Case for the Pierre River Mine Project. Operational and reclamation water releases will ultimately be discharged into the Athabasca River from planned developments in the region. As for the Application Case, the operational water releases include muskeg drainage and overburden dewatering flows through polishing ponds, and reclamation waters are process-affected water seepages and fluxes and runoff from reclaimed surfaces that will receive treatment in wetlands and pit lakes (Shell 2007).

Provided there are no additional projects approved for the area, the assessment for water quality and fisheries resources for the PDC is likely to be the same as for the Application Case.

5.4.6 Shell's Proposed Mitigation and Monitoring

5.4.6.1 Mitigation

Shell proposes the same mitigation for the Pierre River Mine Project as for Jackpine Mine Expansion Project (Section 5.3.7.1 herein), with the added strategy of using perimeter wells around the external tailings disposal area (ETDA) during operations, decommissioning and closure periods.

5.4.6.2 Monitoring

Shell's proposed project-specific monitoring of the Pierre River Mine Project watercourses and waterbodies includes water quality monitoring prior to construction, during construction, operations and at closure. The monitoring program is described in Section 4 of EIA Appendix 4-9 (Shell 2007). RAMP does not currently monitor within the proposed project area watersheds.

5.4.7 Significance Assessment and Conclusions

The Pierre River Mine Project will disturb or destroy many local tributaries of the Athabasca River that have not previously seen any industrial development. Limited pre-development water quality data are available for many of the tributaries. Fort McKay recommends that further baseline water and sediment quality data be collected for those systems that currently have few or no records, and include the main streams under RAMP.

The Pierre River Mine Project will have residual impacts on water quality and fisheries resources (a **yellow** situation). Mine-related seepage will enter some surface waters, muskeg drainage and overburden dewatering will increase some metals and PAH groups in Eymundson Creek and Big Creek will be diverted to the compensation lake with resulting increases in NAs, toxicity, tainting potential and metals.

Methylmercury is likely to become a fish tissue concern within the compensation lake (reservoir). The overall significance of the impact to fisheries resources (fish health) is assessed as moderate, with lost fishing opportunities assessed as a significant adverse affect, a **red** situation (Table 5-5).

Table 5-5: Summary of Fort McKay's Assessment of Water Quality and Fisheries Resources for each Development Scenario for the Pierre River Mine Project

	Pre-Dev Scenario	Current Scenario	Base Case	Application Case	Planned Dev Case
Water Quality	No adverse effect	No adverse effect	No adverse effect	Potential adverse effect	Potential adverse effect
Fish Health*	No adverse effect	No adverse effect	No adverse effect	Moderate adverse effect	Moderate adverse effect
Fishing Opportunities	Low adverse effect	Low adverse effect	Low adverse effect	Significant adverse effect	Significant adverse effect

*Assumes fish will have sustainable populations in the planned compensation lake.

It is currently unknown whether the end pit lakes will treat water sufficiently for discharge downstream. It is highly likely that the bottom sediments will be contaminated long after the pit lakes are considered sustainable for aquatic life. As was noted in Section 5.4.8, there is a lack of adequate technical guidance that demonstrates the viability of end pit lakes in northern Alberta (CH2M Hill 2009).

The primary tenet of the HTES (*retain*) is not satisfied under the Application and Planned Development Case scenarios. Changes to project design or mitigation would be required to improve these aspects, and efforts beyond providing a fish habitat compensation lake at its currently planned location (distant from Fort McKay) would help to address the *reclaim* tenet in terms of lost fishing opportunities.

5.4.8 Fort McKay's Recommendations

Given that there is a potential for adverse effects caused by the Pierre River Mine project on water quality and significant adverse effects on fish habitat and fishing opportunities, Fort McKay recommends the following:

Project-Specific Recommendations

- A minimum setback of 250 m from the Pierre River Mine project to the Athabasca River to be established.
- A minimum setback of 100 m for all other fish bearing watercourses, including all the diversion channels that drain into fish bearing waters, to be established and mandated.
- Detailed mitigation and compensation plan and accommodation strategy to be developed in consultation with Fort McKay.
- Consultation with Fort McKay regarding the design of the project-specific water quality, sediment quality and fish monitoring program for the Pierre River Mine.

Cumulative Effects Recommendations

In addition to project-specific monitoring by Shell, monitoring of the Pierre River Mine Project watercourses and surface water bodies should be undertaken pursuant to a scientifically defensible and peer-reviewed regional monitoring program. While RAMP is a regional based monitoring program, it samples on an infrequent basis; therefore, it cannot provide the only monitoring for the project or the region.

5.5 Healing the Earth Strategy

Fort McKay wishes to retain acceptable quality and quantity of surface water. The direction and significance of impacts to water quality from both the proposed Jackpine Mine Expansion and the Pierre River Mine are contrary to the first tenet of the Healing the Earth Strategy, *retain* (acceptable quality and quantity of surface water). It may be possible for Shell to *improve* water quality through redesign or mitigation, but once unacceptably poor water quality enters the natural system, it is unclear whether the tenets of *reclaim* or *offset* could be meaningfully applied.

Fort McKay appreciates that Shell is putting efforts toward reclaiming lost fish habitat by planning for fish habitat compensation lakes. However, until these habitats are built and monitored it is unclear as to whether these would serve as appropriate fishing opportunities and offsets. Fort McKay suggests that room for further improvement may involve locating fish habitat compensation lakes closer to or within the Community in order that community members might benefit from Shell's efforts. The location near the Community of a healthy and uncontaminated aquatic ecosystem including suitable traditionally-used fish species would be viewed as a positive step. As discussed in ***Section 9 - Disturbance and Access***, it is important that at least some *offsets* and protected areas be located close to the Community.

5.6 Fort McKay's Overall Conclusions and Recommendations

The Jackpine Mine Expansion Project and Pierre River Mine Project combined will cause large local-scale destruction of natural ecosystems in parts of northeastern Alberta. The diversion or loss of 21 km of mainstem Muskeg River goes against the recommendations of the Muskeg River Watershed Framework for Water Quantity and Quality (AENV 2007), and against the expressed wishes of many of the people of Fort McKay:

> *"Of all concerns expressed by FMFN participants regarding potential negative environmental effects associated with the proposed Project, those relating to the diversion of the Muskeg River were viewed as being the most serious…" (FMA Heritage Resources Consultants Inc. 2008).*

Water quality predictions indicate that several contaminants will increase substantially in the decades ahead in the Muskeg River at the mouth, resulting in a highly significant adverse-effects ranking using the Aquatic Quality Index. While some of these substances do not currently have guidelines for the protection of aquatic life, such a large-scale chemical change of several substances together is likely to be stressful to biota. This is because the single-substance studies that guidelines are derived from do not take into account the effect of mixtures of contaminants along with variations in temperature, oxygen, organic carbon and other background conditions. Naphthenic acids, PAHs and associated fish tainting and toxicity potential are key concerns from Fort McKay's perspective.

A Watershed Management Plan has been required for the Muskeg River for a number of years as referenced in a number of Energy and Utilities Board (now Energy and Resource Conservation Board) decision reports (Jackpine Mine, EUB decision 2004 – 009; Muskeg River Mine Expansion, EUB decision 2006-128 and Kearl Oil Sands Project, EUB decision 2007-13). To date there is only a Water Management Framework for Water Quantity and Quality (AENV 2008), which was produced by Alberta Environment in June 2008. The water-based framework is not a comprehensive watershed management plan.

As AENV indicated *"This framework will be used by AENV to guide regulatory decisions until it is updated by the Government of Alberta with additional components consistent with cumulative impact management, or until CEMA's Watershed Management Plan is complete and accepted."* Since CEMA stopped working on a Watershed Management Plan in early 2008, there has been no visible progress by AENV or any other party in developing a Watershed Management Plan.

Fort McKay recommends that prior to any decisions affecting the Muskeg River mainstem that a completed Muskeg River Watershed Management Plan be finalized

and that Fort McKay be intricately involved in the development and finalization of the plan. The Muskeg River Water Management Plan should include the criteria and strategies from the Healing the Earth Strategy as presented in this specific assessment.

Existing projects in the Muskeg River watershed have already resulted in impacts to the watershed. Shell's proposed Jackpine Mine Expansion would compound the deterioration of the watershed, Kearl Lake, the Muskeg River and its tributaries (based on the Local Study Area, Shell 2007, 2009). The proposed Pierre River Mine Project would extend the impacts from oil sands mining to other watersheds, that to date, are essentially undisturbed.

These two Shell projects would result in additional impacts to key Fort McKay traditional use areas. Adverse effects on Fort McKay's opportunities for traditional use, including fishing and ultimately on the sustainability of Fort McKay's culture have been demonstrated in this Specific Assessment (***CHA Baseline***, Fort McKay IRC 2010b; ***CHA Project-Specific Assessment***, Fort McKay IRC 2010c).

Fort McKay recommends that mitigation, compensation and accommodation plans to be developed in consultation with Fort McKay with respect to adverse effects and loss of key cultural and traditional use areas of the Muskeg River watershed, including Kearl Lake, and Athabasca River tributaries affected by the Pierre River Mine Project.

In the compensation lake, the fish that lose physical habitat due to both projects may thrive but the fishery created may not be safe for human consumers of fish. Large fish high on the food chain will likely be contaminated with methylmercury for at least a couple of decades.

Fort McKay should be provided with acceptable fishing opportunities that might help offset loss of their traditional fishery. The compensation lake might be a partial option if suitable non-piscivorous species are introduced (e.g., lake whitefish), become sustainable, and are demonstrated to be safe for frequent human consumption[9]. While compensation lakes might partially replace lost fishing opportunities, it is important to note that these lakes will have lower cultural value to Fort McKay than the riverine habitats that are lost.

Fort McKay recommends that mitigation and accommodation measures be developed in consultation with Fort McKay with respect to the lost fishing opportunities caused by the proposed Jackpine Mine Expansion and Pierre River Mine projects, including but not limited to, the development of a Fishing Opportunities Management Plan for the Community. DFO-authorized habitat compensation is not compensation or mitigation from the perspective of Fort

[9] Whitefish and Arctic grayling have been found to have much lower levels of methylmercury than piscivorous species such as northern pike (e.g., Jewett et al. 2003) and walleye (RAMP 2009).

McKay's lost fishing and other traditional-use opportunities due to unknowns about contamination of fish remaining in the system, concerns regarding potential mercury levels in fish in the compensation habitat, the loss of culturally-significant areas and the conversion of river habitat to artificial lakes.

Shell places considerable dependence on the expected treatment capabilities of end pit lakes. The treatment of contaminated process water is expected to occur through dilution, biodegradation and settling after binding to sediment particles. Projected downstream water concentrations of naphthenic acids and other contaminants are reliant on the assumed success of pit lakes as treatment facilities. As the recent external peer review has confirmed, the long-term ability of pit lakes to produce water that is suitable for discharge to the Athabasca River has not yet been demonstrated, and adequate technical guidance within CEMA is lacking (CH2M Hill 2009).

Despite sparse evidence on pit lake treatment abilities and ecosystem functioning, and overreliance on unsubstantiated desktop models, these massive surface waterbodies are routinely approved to dominate the former boreal forest terrestrial landscape.

Fort McKay recommends that the acceptance by government and reliance by industry on end pit lakes for treatment of mature fine tailings (MFT) and process waters be stopped until such time as this method of treatment is proven to be viable in a scientifically defensible manner.

As previously discussed, any artificial lakes, including compensation lakes, have the potential to support fish that might not be suitable for frequent human (or wildlife) consumption. Within end pit lakes, the sediments and resident biota (notably fish, if present) are likely to remain contaminated for a very long time regardless of outflow water quality.

5.7 References

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