



**RECLAMATION**

**Fort McKay  
Specific Assessment**

**Fort McKay  
Industry Relations Corporation**

**March 2010**



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## 10.0 Reclamation

### 10.1 Introduction

The land is very important to the Community of Fort McKay (Fort McKay IRC 2010a). (Fort McKay often refers to the environment as “land” but this term reflects both land and water and also includes all of the biological components of the environment.) “For many holders of traditional knowledge, land is inseparable from culture” (Garibaldi 2006). Reclamation is a primary method of mitigation of mining impacts on the environment. Guidance from the Elders of the Fort McKay Community to the oil sands industry’s questions about reclamation of the land has been: – *to put it back the way it was* (Healing the Earth Strategy (HTES), Fort McKay IRC 2010b). Fort McKay believes that when the land is mined it should be reclaimed quickly and people be allowed to return to their former uses of the land. Another comment directed to the oil sands industry is: *reclamation is too slow* (HTES, Fort McKay IRC 2010b). People from Fort McKay want to use the land and need to teach their children about the land. If the land is unavailable for traditional uses for a generation or more, much of the traditional knowledge may be lost.

Many people in the Community of Fort McKay also have spiritual beliefs about the land including the plants and animals that occur on the land. They are concerned that when the landscape is reclaimed the land will lose “spirit” and medicines and other plants grown on the reclaimed sites will not be as effective. They do not believe a landscape can be recreated that meets their requirements and believe: *you can’t put the spirit back into the land* (HTES, Fort McKay IRC 2010b). This concern is loosely linked to another of the Community’s fears: *reclaimed land will not be safe for animals or people* (HTES, Fort McKay IRC 2010b). Decades of living with oil sands mining on their Traditional Lands has provided the Community with examples of air, land and water impacts and this experience, in part, may have led to their deep concern regarding the health and safety of animals and people who use the reclaimed land.

The Community recognizes the importance of entire ecosystems, the land, the water and the muskeg (Fitzpatrick 2003). The Community has expressed concerns about water, both on and off the reclaimed mine sites, and has told industry: *muskeg is important, water is important*. Lastly, the Community knows that when the mining is completed industry will leave but Fort McKay will remain, and they have concerns regarding: *who will be responsible for the land when mining is finished?*

The concerns identified by Fort McKay relating to reclamation are discussed in Sections 10.3.1 to 10.3.5.

## 10.2 Data Sources and Limitations

Data on the timing of disturbance and reclamation for the Shell mines were provided by Shell for this assessment (Golder 2009). We requested that this type of information be prepared for all oil sands developments in area but regional-level reclamation data was determined to be outside the scope due to the time constraints of this pilot project. This limited our assessment of the timing of reclamation to only Shell's project areas.

Fort McKay's concerns about oil sands mining and reclamation were derived from discussions conducted with the Community over the past 10 years during environmental assessment reviews of proposed projects, reviews of proposed reclamation plans, participation by community members in CEMA workshops, the development of the Healing the Earth Strategy and through comments from the Community while at reclamation meetings and tours conducted at each of the operating mine sites.

Other sources for understanding of Community concerns regarding reclamation were obtained from the TEK project conducted by Fort McKay and Albion Sands Energy Inc. on how to integrate traditional environmental knowledge in land reclamation (Garibaldi 2006, and Garibaldi 2009, *In press*).

Our understanding of regional reclamation issues and best management strategies has been informed by participation in CEMA's Reclamation Working Group and the following subgroups:

- Soil and Vegetation Subgroup
- Wetlands and Aquatic Subgroup
- End Pit Lakes Subgroup Group
- Reclamation Certification Subgroup
- Biodiversity and Wildlife Subgroup

## 10.3 Fort McKay's Concerns Regarding Reclamation

### 10.3.1 Concern – Put the Land Back the Way It Was

Oil sands mining operations remove land and water to expose and extract bitumen, and then at closure substitute a very different landscape. Both the shape of the land and the proportions of the uplands and wetlands are changed significantly, water flows in different types and sizes of watercourses, and the wetland areas are both reduced and changed in type. Current technology does not allow for the reestablishment of the muskeg (organic wetlands), a difficulty compounded by the salinity of the water on the reclaimed landscape (Harris 2007). At mine closure, lakes will comprise a much larger footprint on the landscape than existed prior to

mining, reducing the areal extent of other vegetation types (*Section 7 - Vegetation*). These lakes will be larger and deeper than the lakes that typically occur in Fort McKay's Traditional Lands (Shell 2007).

Changes to the landscape will result in larger expanses of upland forest, areas with reduced plant species diversity (*Section 8 - Biodiversity*), which may remain depauperate for an undetermined duration of time. Important forage species used by wildlife, and important food and medicine plants used by Fort McKay may be missing from the reclaimed sites for many years, and in some cases indefinitely, if the specific site conditions required for those plants are not reestablished. Additionally, most of the rare plants in the mine areas occur on organic wetlands (*Section 7 - Vegetation*), which cannot presently be reestablished in the reclaimed landscape. It is unknown if many rare plants will become reestablished on reclaimed upland sites.

The hydrology of the landscape is significantly modified by the increase in upland ecosystems and losses of organic wetlands. The wetlands have an important role in the attenuation of water flow, reducing the potential for erosion during high rainfall or snow-melt conditions. These wetlands also have an important function in water storage during dry seasons and years. In reclaimed landscapes, water is stored primarily in large lakes that form in mined out pits. Open water in pit lakes is exposed to evaporative conditions much greater than those that occur in vegetated organic wetlands, resulting in increased water loss from the landscape. An edge effect, where water in organic wetlands is believed to supply upland forest plants with water during periods of drought, is much reduced by the large size and simple shapes of the pit lakes (Harris 2007 and Fitzpatrick 2003). The evapotranspiration that occurs in upland forests is greater than many of the organic wetlands and will further reduce the water in the landscape. Due to stability and erosion concerns, most drainage developed in the reclaimed landscape is designed to move water quickly off of the forested uplands into the pit lakes.

Wildlife species use and diversity is also expected to be modified by the changes to the landscape components. Some species that favor an upland forest condition may prosper while others populations that require riparian or organic wetland habitats will be reduced or lost. Water quality may be restrictive to wildlife consumption for decades after reclamation, when salts and other contaminants are expected to be released from the soils into the drainage water.

### 10.3.2 Concern – Reclamation is Too Slow

The existing approved Shell mines (Muskeg River and Jackpine) and the proposed large-scale mine developments will ultimately occupy a total of 44,000 hectares (ha) of land (Shell 2007, Volume 5). The proposed Jackpine Mine Expansion will cover more than 20,000 hectares and the proposed Pierre River Mine, a further 10,000 hectares. The Jackpine Mine (Figure 10-1; same as Figure 5.5-1 in Golder 2009) will not be fully reclaimed until 2060, with the likelihood that a further 15 to 20 years

will be needed before the land can be certified as reclaimed, which means that the land covered by this mine expansion will be alienated from two to three generations<sup>1</sup> of Fort McKay people. The proposed Pierre River Mine will not be fully reclaimed until 2050. A further 15 to 20 years of vegetation establishment will likely be required before this land will be certified by government as reclaimed, again alienating Fort McKay people for many generations.

The proposed pace of reclamation is different between the Jackpine Expansion and Pierre River mines. At Pierre River Mine, land is disturbed during the first 30 years of mining (approximately one half of the area is disturbed within the first 10 years) but very little reclamation (less than 10%) is completed during mining (Figure 10-2; same as Figure 5.5-2 in Golder 2009). Reclamation activity is primarily planned to occur during the 10-year period after mining is completed in 2040.

In contrast, at the proposed Jackpine Mine Expansion, the disturbance occurs over a longer time frame, approximately 40 years, and during that time period approximately 25% of the area is under reclamation. The remaining 75% of the area is then reclaimed over the next 20-year period after new mine disturbance has ceased (Figure 10-1). While this later scenario reclaims a higher percentage of land earlier in the mining process than the Pierre River scenario, reclamation at both of these projects occurs at a much slower pace than at the Muskeg River Mine where, after 2017, land reclaimed in each year keeps pace with new land disturbance (Figure 10-3, same as Figure 5.5-3 in Golder 2009).

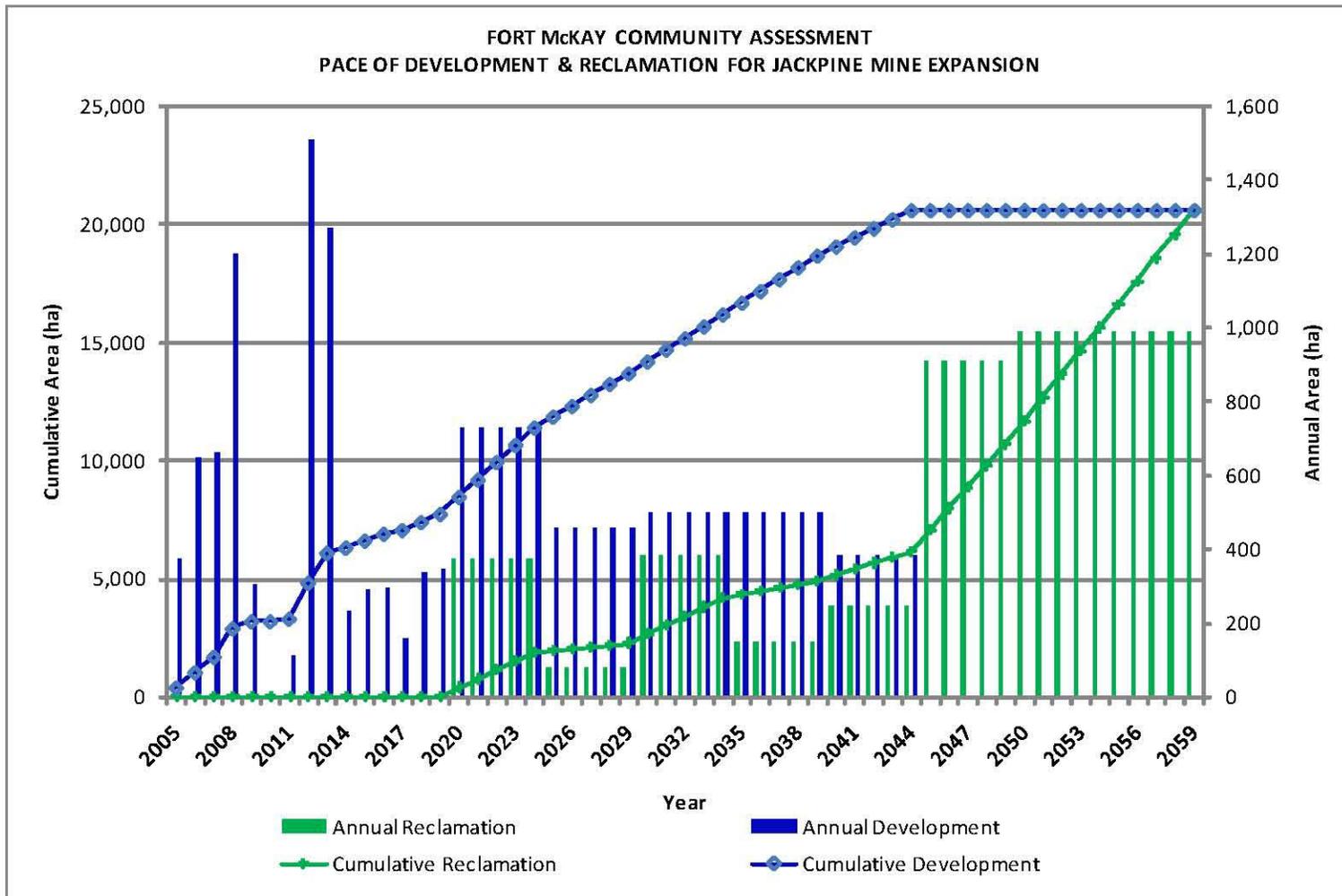
When the disturbance and reclamation from all three mines are considered together, it will take 45 years of mine operation before 50% of the disturbed land will be under reclamation, and the final 50% will be reclaimed during the last 15 years (Figure 10-4, same as Figure 5.5-4 in Golder 2009).

This concern reflects both the loss of the use of the land during the time of the disturbance and during revegetation. The duration of time that the land is unavailable for use is generally a result of the mine plan or design. If mine areas remain active for extended periods of time during the operating life of the mine, reclamation cannot proceed. The tailings management plan is a primary controlling factor in the timing of when land becomes available for reclamation activities in the oil sands.

Mine plans can be developed that allow reclamation to occur earlier in the mine's life, as demonstrated by the Muskeg River Mine example, and such plans would reduce the time that Fort McKay is unable to access and use its traditional lands. If oil sands mines are allowed to be developed on Fort McKay's Traditional Lands, the length of time that the land is unavailable for use by Fort McKay should be an important factor in the selection of mining plans. One major factor that will likely improve the pace of reclamation has been Tailings Directive 074, which was issued

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<sup>1</sup> A generation is defined as 20 years (Ohno 1996).



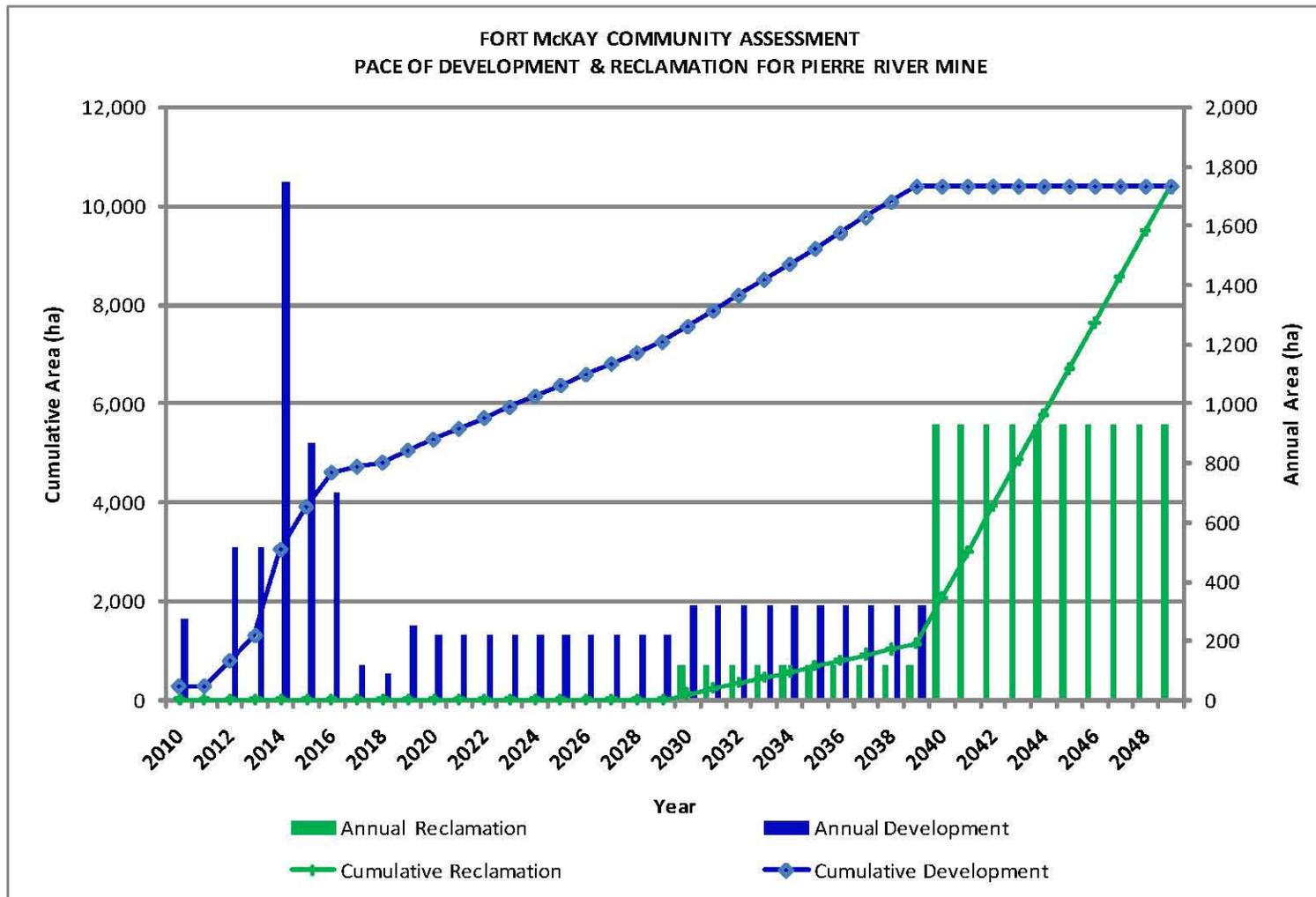
**Sources:**

Shell Canada Limited. 2008. Application for the approval of the Jackpine Mine Expansion and Pierre River Mine Project. Environmental Assessment Update. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Appendix II. Section 3.2. Annual Mining and Reclamation Progressions.

Shell Canada Limited. 2002. Application for Approval of the Jackpine Mine-Phase 1. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 1. Annual Mining and Reclamation Progressions.

<b>PROJECT</b>				
<b>JACKPINE MINE EXPANSION &amp; PIERRE RIVER MINE PROJECT</b>				
<b>TITLE</b>				
<b>FORT McKAY COMMUNITY ASSESSMENT PACE OF DEVELOPMENT &amp; RECLAMATION FOR JACKPINE MINE EXPANSION</b>				
PROJECT No. 08-1346-0006(5722)			FILE No 0813460006_5722_20_1-4.dwg	
DESIGN	JB	19/FEB/09	SCALE	AS SHOWN
CADD	JG	19/FEB/09	REV.	0
CHECK	JB	20/FEB/09	<b>Figure 10-1</b>	
REVIEW	WES	20/FEB/09		

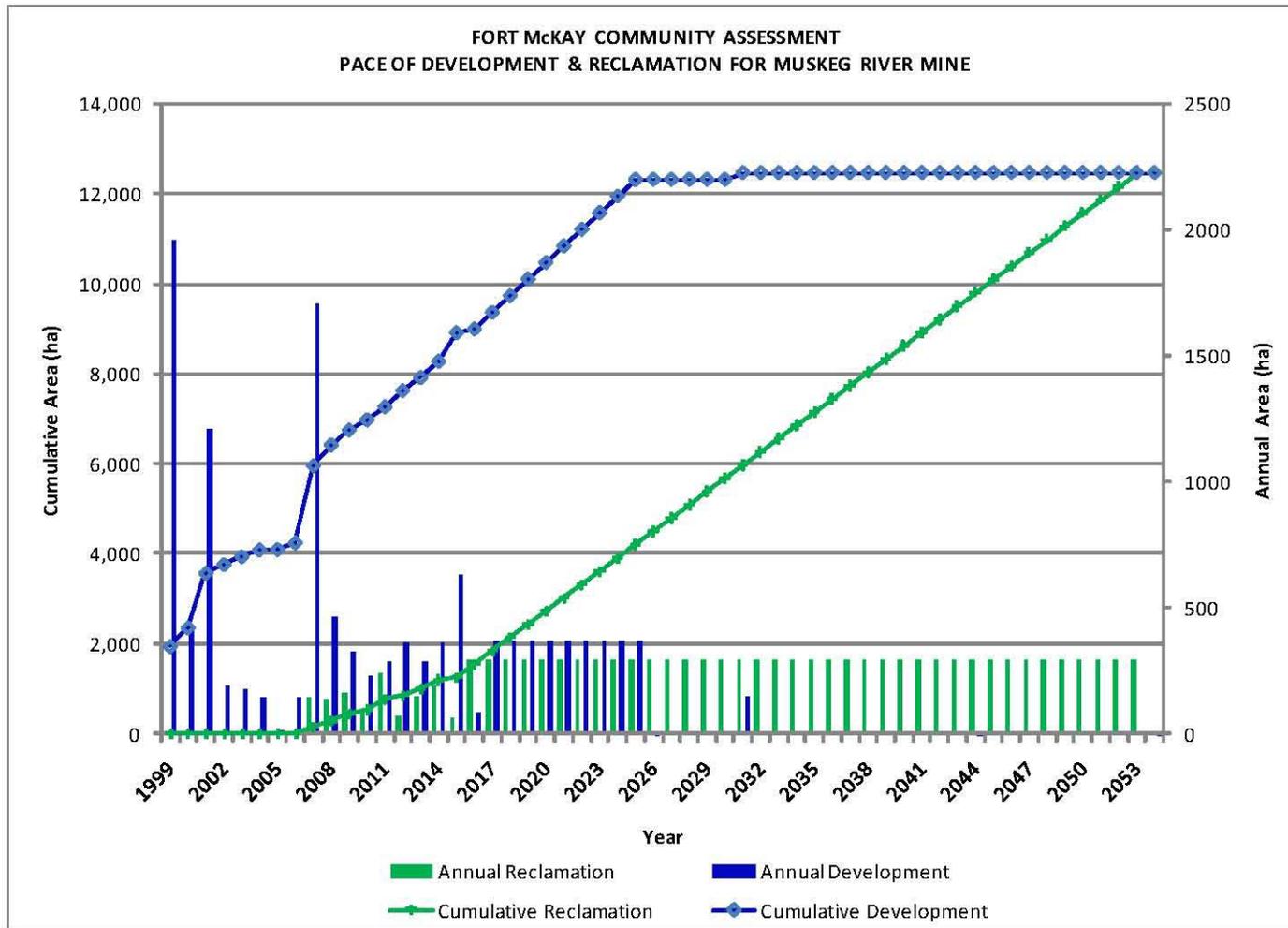




**Sources:**  
 Shell Canada Limited. 2007. Application for the approval of the Jackpine Mine Expansion and Pierre River Mine Project. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 5. Appendix 5-2. Section 3.2. Annual Mining and Reclamation Progressions.

PROJECT					<b>JACKPINE MINE EXPANSION &amp; PIERRE RIVER MINE PROJECT</b>				
TITLE					<b>FORT McKAY COMMUNITY ASSESSMENT PACE OF DEVELOPMENT &amp; RECLAMATION FOR PIERRE RIVER MINE</b>				
PROJECT No. 08.1346.0006(5722)(20)					FILE No. 0813460006_5722_20_1-4.dwg				
DESIGN	JB	19/FEB/09	SCALE	AS SHOWN	REV.	0	<b>Figure 10-2</b>		
CADD	JG	19/FEB/09							
CHECK	JB	20/FEB/09							
REVIEW	WES	20/FEB/09							



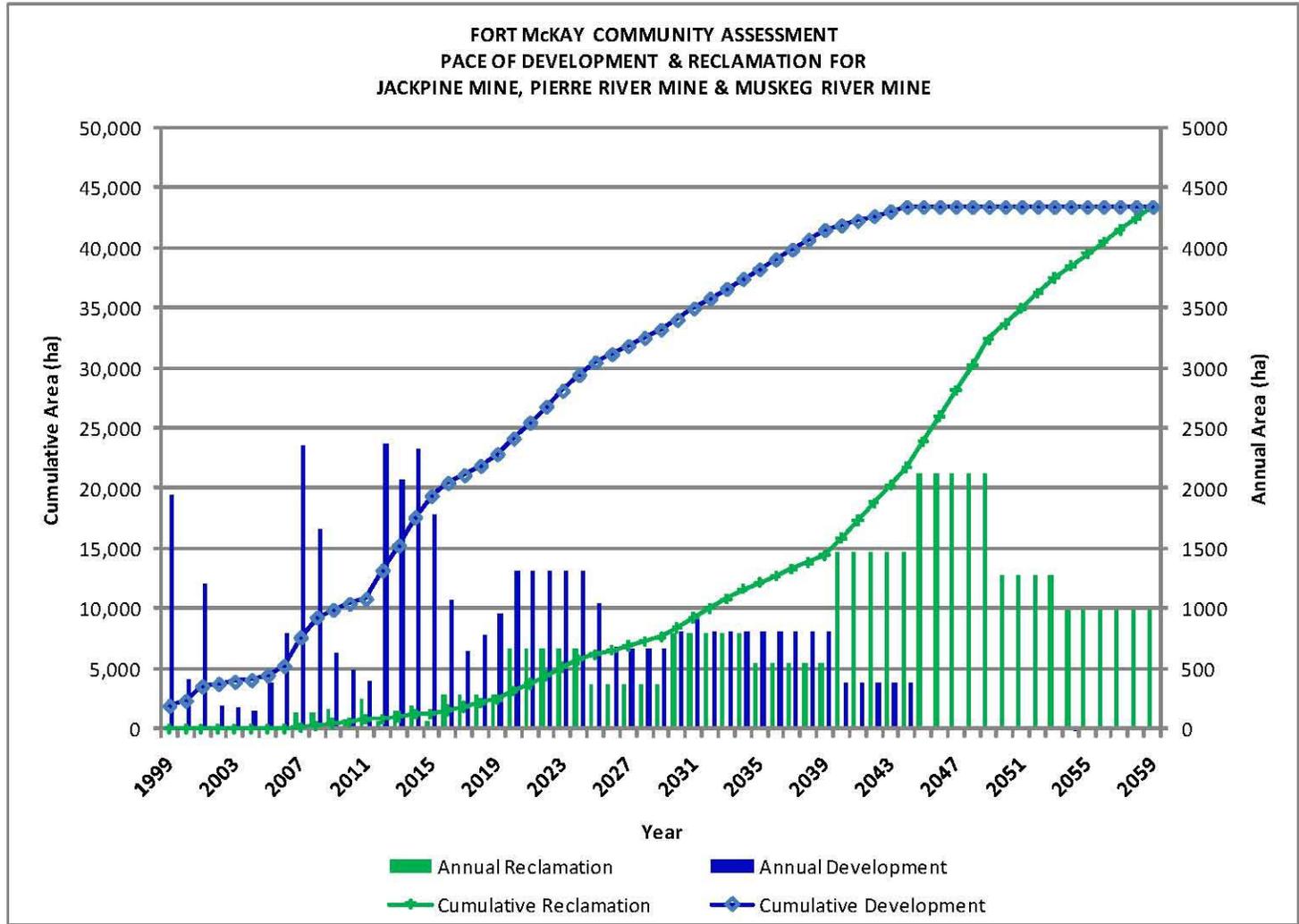


**Sources:**  
 Shell Canada Limited. 2005. Muskeg River Mine Expansion Project Application and Environmental Impact Assessment. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 1. Annual Mining and Reclamation Progressions.

Shell Canada Limited. 1997. Muskeg River Mine Project Application Approval. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 1: Project Description. Annual Mining and Reclamation Progressions.

PROJECT		<b>JACKPINE MINE EXPANSION &amp; PIERRE RIVER MINE PROJECT</b>			
TITLE		<b>FORT McKAY COMMUNITY ASSESSMENT PACE OF DEVELOPMENT &amp; RECLAMATION FOR MUSKEG RIVER MINE</b>			
PROJECT No. 08-1346-0006(5722)		FILE No0813460006_5722_20_1-4.dwg			
DESIGN	JB	19/FEB/09	SCALE	AS SHOWN	REV. 0
CADD	JG	19/FEB/09			
CHECK	JB	20/FEB/09			
REVIEW	WES	20/FEB/09			
			<b>Figure 10-3</b>		





**Sources:**

- 1) Shell Canada Limited. 2008. Application for the approval of the Jackpine Mine Expansion and Pierre River Mine Project. Environmental Assessment Update. Submitted to Alberta Energy and Utilities Board and Alberta Environment Appendix II. Section 3.2. Annual Mining and Reclamation Progressions.  
Shell Canada Limited. 2002. Application for Approval of the Jackpine Mine-Phase 1. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 1. Annual Mining and Reclamation Progressions.
- 2) Shell Canada Limited. 2007. Application for the approval of the Jackpine Mine Expansion and Pierre River Mine Project. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 5. Appendix 5-2. Section 3.2. Annual Mining and Reclamation Progressions.
- 3) Shell Canada Limited. 2005. Muskeg River Mine Expansion Project Application and Environmental Impact Assessment. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 1. Annual Mining and Reclamation Progressions.  
Shell Canada Limited. 1997. Muskeg River Mine Project Application Approval. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 1: Project Description. Annual Mining and Reclamation Progressions.

PROJECT					<b>JACKPINE MINE EXPANSION &amp; PIERRE RIVER MINE PROJECT</b>				
TITLE					<b>FORT MCKAY COMMUNITY ASSESSMENT PACE OF DEVELOPMENT &amp; RECLAMATION FOR JACKPINE MINE, PIERRE RIVER MINE &amp; MUSKEG RIVER MINE</b>				
PROJECT		No. 08.1346.0006(5722)(20)			FILE		No. 0813460006_5722_20_1-4.dwg		
DESIGN	JB	19/FEB/09		SCALE	AS SHOWN	REV.	0		
CADD	JG	19/FEB/09		<b>Figure 10-4</b>					
CHECK	JB	20/FEB/09							
REVIEW	WES	20/FEB/09							



by the ERCB on February 3, 2009. The Jackpine and Pierre River mine plans were developed prior to this directive being issued and will undoubtedly need to be modified to comply. In summary, the directive will require most, if not all of the fine tailings material produced to be placed in a dedicated disposal area in such a fashion that it can be readily reclaimed. When fully incorporated into these mine plans, the pace of reclamation is expected to increase, and the areas covered by end pit lakes may be reduced.

In the event that land is successfully reclaimed earlier there is a high likelihood that these reclaimed areas will remain within the active mining area and, therefore, still unavailable for traditional use activities.

The annual reclamation shown in Figure 10-1 through Figure 10-4 represents the date the land is proposed to be revegetated but some of the reclamation may not be successful and may require additional treatment. Even if the initial revegetation is successful it will often take an additional 20 to 25 years before these sites begin to mature into forests and 120 years before they would be considered old growth forests. How long it could take to create a functioning organic wetland on the reclaimed landscape is unknown, as this has not been done in the oil sands to date (Harris 2007). Even if marshes are established relatively quickly it could take hundreds or thousands of years for organic fens and bogs to develop on the reclaimed landscape, assuming they ever do develop from the marsh wetlands.

Reclamation is the only tool that Shell has to ultimately mitigate the impacts of mining on Fort McKay's traditional use. Reclamation objectives focus on the creation of equivalent capability for forestry at the expense of wetland ecosites; the latter are a valuable component supporting traditional use activities. Industry is trying to develop technology to re-create wetlands, and it is uncertain if organic wetland ecosites can be created on the reclaimed landscape. Current reclamation plans contain very few proposed wetland ecosites.

### 10.3.3 Concern – You Can't Put the Spirit Back Into the Land

Many people in the community of Fort McKay hold spiritual beliefs in the land and the plants and animals that occur on the land (Garibaldi, 2009 *In press*). In an effort to explain this value to the industry, one community member discussed the land in this way,

*Muskeg is connected through water to the rest of the earth. With that comes our spiritual values and how we are connected and respect the earth. (Fitzpatrick 2003)*

Community members have expressed the concern that when the landscape is reclaimed the land will lose "spirit" and medicines and other plants grown on the reclaimed sites will not be as effective (HTES, Fort McKay IRC 2010b).

Spirit in the Land also refers to specific valued sites that have been lost or will be lost through mining. This is a value that reclamation activities will be unable to mitigate and is a permanent cost of the mining activity.

#### **10.3.4 Concern – Reclaimed Land Will Not Be Safe for Animals or People**

The Community is apprehensive regarding the safety of reclaimed land for animals and people. This concern is shared by some western scientists that have examined the quality of the water that will flow off of the reclaimed land and will be contained in wetlands and lakes (*Section 5 – Water Quality and Fisheries Resources*). Salts and naphthenic acids have been shown to occur in these water sources and both of these groups of compounds are toxic to animals and people at concentrations that are predicted to occur on the reclaimed landscape. The salts will continue to leach out of the soils for decades, and this water will remain on site in wetlands and pit lakes. Dilution is anticipated to reduce the concentrations of the salts in these water bodies over time and allow for this water to be released off-site to the environment, but discharge criteria have yet to be set for any water release. There is little understanding about the fate and effects of naphthenic acids in this mine-impacted water. While biodegradation of these long chain hydrocarbons has been observed to occur over time, the resulting shorter chain hydrocarbons appear to be quite resistant to further biodegradation and may have long-term toxicity in water. As with salts, there is presently no discharge criteria established for the release of water containing these organic chemicals (*Section 5 – Water Quality and Fisheries Resources*). Discharge to the environment is generally expressed in Approvals as discharge off of the mined lands but this definition is not relevant to the Community of Fort McKay, since their use of the reclaimed land would include the use of the water on the reclaimed areas. Traditional use of the land did not include transporting water; water was available for use along the trails and at cabin locations (Fitzpatrick 2003). If the reclamation plans require water treatment in wetlands and lakes for an undetermined period of time after closure, this will greatly reduce the ability and willingness of Fort McKay in the use the land for traditional harvesting, etc. The treatment component of the water on the landscape is not well understood by the industry, either the mechanisms or the duration. Fort McKay is concerned that this unknown time factor will greatly increase the time that this land is unavailable for their use. Water that is of inadequate quality for “discharge” will likely not be adequate to support the animals and fish that Fort McKay has traditionally harvested from this area. Upland habitat alone cannot support wildlife, suitable water is also required.

#### **10.3.5 Concern – Muskeg is Important; Water is Important**

The Community has concerns about water during the mining operation and after closure. In this boreal forest landscape, water is often contained in muskeg (organic wetlands) and is known to be very important. A community member shared this information about their concern.

*The muskeg is why the earth breathes. My father passed down to me valuable information about the muskeg.... My father would tell you all that our body is like the earth. We need a heart to live. And he would tell you that the muskeg is your heart and that the mountains are your brain, and the creeks and the rivers are blood vessels...Muskeg is important to all animals. They depend on the water...Muskeg is very important to rivers and creeks and everything in them. Muskeg is connected through water to the rest of the earth (Fitzpatrick 2003).*

Both the amount and type of wetlands to be reclaimed on the post closure landscape will be significantly different from the Muskeg that exists prior to mining. Through increasing the area of uplands and lakes, wetlands are spatially reduced in the reclamation landscape. Technology does not exist to reestablish Muskeg type wetlands on the reclaimed landscape and concerns have been raised that the salinity of the water draining from the upland sites will be unsuitable for the plants critical for Muskeg development (Harris 2007).

Reclamation plans do not address the containment of soil materials that leach salts into drainage waters. These plans do not allow for water flowing from the pit lakes to feed wetlands: typically these pits are designed to discharge off-site directly into major rivers. If pit lakes (or other water treatment) can be demonstrated to be successful in effectively diluting/reducing the salinity of drainage water to enable it to meet discharge criteria, these non-saline waters could be directed into constructed organic wetlands within the reclaimed landscape and replace portions of the lost Muskeg. Discharge criteria have not yet been defined.

Either water treatment or containment of the soil strata that results in the water contamination should be employed to ensure that water on the reclaimed landscape meets water quality requirements for traditional uses to occur.

### **10.3.6 Concern – Who Will Be Responsible for the Land When Mining is Complete?**

The mining and subsequent reclamation of disturbances at Pierre River Mine and Jackpine Mine Expansion is expected to extend over a 60-year period. The Fort McKay Community will continue to exist after mining is complete and the Community has concerns regarding who will be responsible for residual environmental issues at these mines after closure. Bonding can be put in place to ensure that funds exist to finance long-term environmental management, but Fort McKay's concerns are centered on the necessity for any intervention or management after mining and reclamation is completed. This includes (but is not limited to) such things as water treatment, management of engineered structures

such as dams or lake impoundments, soil erosion controls and water flow control structures. Fort McKay believes that these mining operations should be designed to be self-sustaining after reclamation and closure. On-going maintenance of structures in the designs approved for these projects is not an acceptable option to Fort McKay.

## 10.4 Fort McKay's Overall Conclusions and Recommendations

### 10.4.1 Conclusions

Reclamation of oil sands mining areas occurs so far in the future that multiple generations of Fort McKay people will be unable to exercise their rights on these lands. The pace of reclamation of the Jackpine Mine Expansion and the Pierre River Mines is very slow, generally as a result of mine plans that maintain most of the mine areas active throughout the life of these mines, resulting in much of the reclamation occurring near the end of mine life. After reclamation, the shape of the land and the proportions of the uplands and wetlands are changed and the muskeg (organic wetlands) is not replaced. Present technology does not allow for the reestablishment of the muskeg, an important component of the hydrology of the boreal forest. In the reclaimed landscapes, water is drained off the forested uplands into pit lakes where dilution and passive biological treatment is proposed to treat the water prior to release off of the mine area. This treatment is not yet proven by industry, it will require an undetermined period of time, and it does not address the quality of the water on the land upstream of the treatment wetlands or pit lakes. Placement of tailings materials into the pits prior to capping with water increases the salinity and organic compounds in the pit lake waters. Fort McKay does not support the placement of tailings in pit lakes.

Good water quality on the entire landscape is important to Fort McKay, this water is necessary to conduct traditional uses of the land and degraded water quality may not be adequate to support the animals and fish that have been traditionally harvested. The Community has also expressed concerns regarding the quality of plants and animals growing on the reclaimed areas and some community members have concerns regarding the loss of "spirit" in the land and subsequently the loss of effectiveness of medicines and other traditionally used plants and animals.

### 10.4.2 Project-Specific Recommendations

Fort McKay recommends that:

- Mine plans be developed that reduce and limit the area of disturbance and facilitate the progressive reclamation of the mined area. Out of pit tailings areas be restricted both in size and in the duration of use.
- A maximum area to be disturbed at any time at both the Pierre River Mine and Jackpine Mine Expansion be established with further disturbances being permitted only upon successful reclamation of previously disturbed areas.

- Land should be reclaimed within 10 years of initial disturbance to allow Fort McKay access back to or through the lands.
- Placement of tailings in end pit lakes be prohibited in favour of alternative methods of tailings disposal or avoidance of the creation of wet tailings through alternative technologies. Final landscape design modified to include more potential wetland areas and methods must be developed to reclaim muskeg (organic wetlands).
- Recreation in the post-mining landscape of the surface water and groundwater hydrologic conditions that existed prior to mining.

### 10.4.3 Cumulative Effects Recommendations

Fort McKay recommends:

- Establishment of criteria to determine reclamation success, including standards for water quality.
- Overburden or other mine waste materials with elevated sodium and sources of naphthenic acids and other elements of concern, be placed into landforms that are specifically constructed to keep these materials from interacting with surface water drainage or groundwater discharge.
- Development of reclamation planning and criteria, in consultation with Fort McKay, that is aimed at restoring the land for traditional and other uses by the Community and that incorporates the knowledge held by Fort McKay members regarding the land prior to disturbance: “to develop an end land use that which is most valuable to the people of Fort McKay and the broader region, it is useful to build ecosystem function with associated cultural practices” (Garibaldi 2006).
- Fort McKay be consulted and its approval sought prior to the issuance of any reclamation certificate on its Traditional Lands.
- Alternative accommodation measures including conservation offsets and protected areas be developed, in consultation with Fort McKay. Reclamation is not considered effective mitigation for the purpose of environmental assessment or management of adverse effects due to the (a) uncertainty of the effectiveness of current reclamation processes and technology, (b) the lack of knowledge and ability to restore organic wetlands, (c) the length of time reclamation will take, and (d) the inability to restore the land to its pre-disturbance state.

## 10.5 References

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