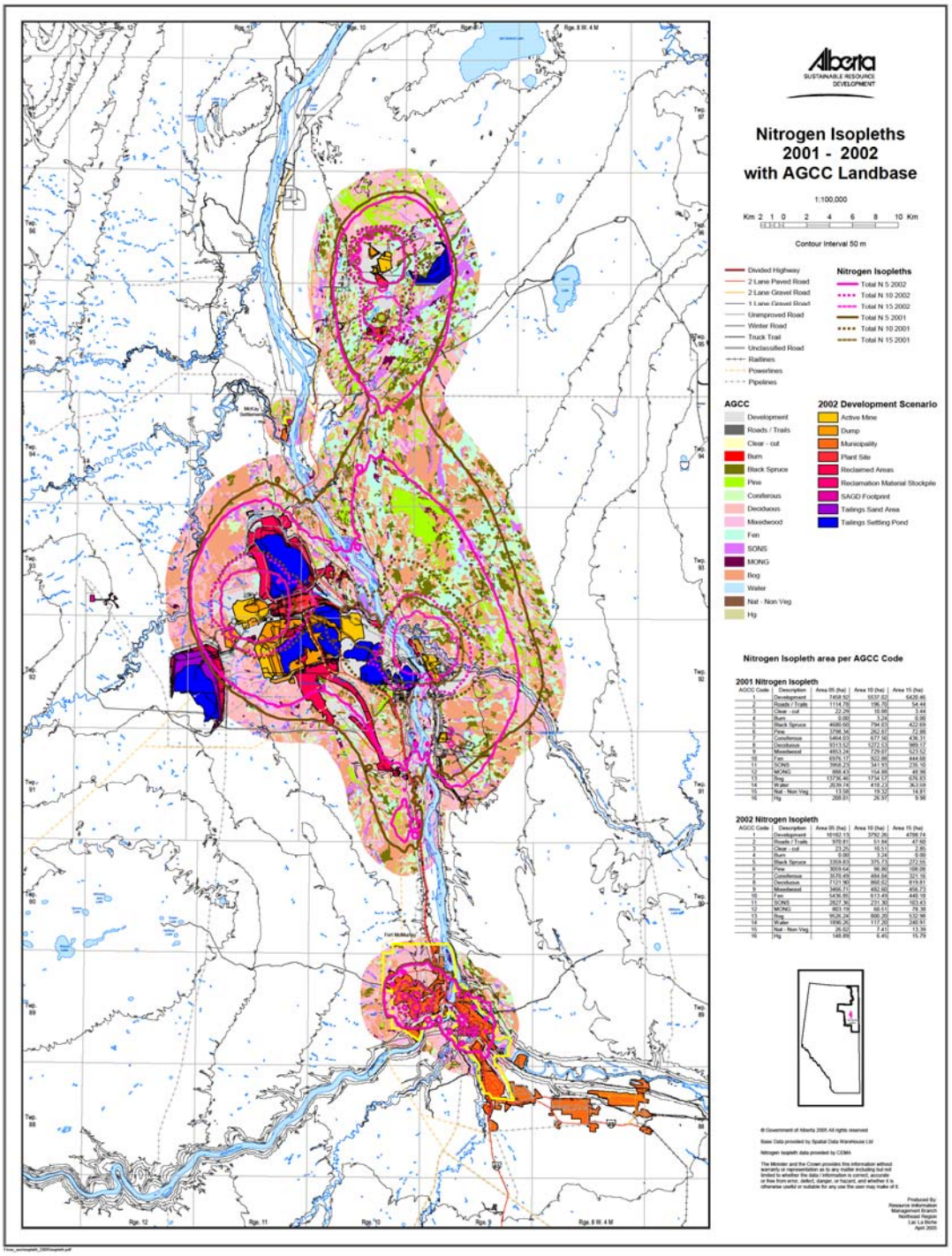

Figure 2-14: Model Estimated Nitrogen Deposition Isopleths (5, 10 and 15 kgN/ha/yr) in Emission Levels and Area of Different Vegetation Covers Falling within Each Isopleth (NSMWG 2005)

Estimates of current general regional nitrogen deposition, based on the above studies and monitoring, appear to range from 3 to 4 kg N/ha/yr to 5 to10 kg N/ha/yr with the uncertainty around possible ammonia deposition being the major contributor to this large range in current nitrogen deposition estimates. Figure 2-9 indicates that between 20,000 (at a critical load of 5 kg N/ha/yr) and 3,000 ha (at a critical load of 10 kgN/ha/yr) of sensitive ecosystem/vegetation types (i.e., bogs, black spruce and coniferous), on Fort McKay traditional lands could be currently being affected by nitrogen deposition. While the model predictions used in Figure 2-14 are likely high (see NSMWG (2005)) they do not of include all nitrogen species (e.g., HONO, NH_3 and NH_{4+}) and may therefore be underestimates of total nitrogen deposition. Based on the current information available related to nitrogen deposition in the region it appears that current levels on Fort McKay's traditional lands in the vicinity of current mining developments may be at effect levels and therefore regional nitrogen deposition is a current concern to Fort McKay (a **yellow** situation).

- ***PAI*** – Acid deposition, like nitrogen deposition, results from the wet and dry deposition of chemical species that have the potential to result in pH changes to soils groundwater and surface water. PAI inputs to soils above certain "critical levels" can result in chemical and biological changes that lead to adverse effects on vegetation. CEMA (2006b) has recommended that all nitrogen deposition not be considered as acidifying. The recommendation was that all nitrogen above 10 kg N/ha/yr and 25% of the first 10 kg N/ha/yr deposition be included in PAI determinations. This change in determining PAI has resulted in reduced PAI estimates. Fort McKay was involved in developing this recommendation and supports the approach. Considerable monitoring (WBEA 2007b) and modeling work (project EIA's and WBEA dry deposition determinations) related to acid deposition in the region has been undertaken all of which would indicate that current PAI levels are below effects levels except perhaps in very close proximity to emission sources. Fort McKay is therefore not concerned that current PAI levels are having a significant adverse effect.

Current Case Summary

Overall there is sufficient information to indicate that current ambient air quality levels of NO/NO_2, NH_3 and/or nitrogen deposition levels may be approaching, at, or even above, vegetation affect levels. Fort McKay is therefore concerned that further regional industrial development has the potential to adversely impact the vegetation on its traditional lands.

Base Case

For the Base Case the following assessments, as related to possible vegetation impacts of existing and approved developments, were made:

- ***SO_2*** – Fort McKay used Shell's (2007) Base Case which assessed the areas that would have annual ambient current annual average SO_2levels above 10 µg/m^3, 20ug/$m^3$and 30 µg/m^3 based on high, medium and low vegetation sensitivity areas (EIA Vol. 3,Section 5.5.4.3, p.5-213, Dec. 2007). The 10 µg/m^3 criteria used for high sensitivity vegetation was predicted to be exceeded in an area of 327ha that occurred near developments. There were no predicted exceedences in the medium to low sensitivity vegetated areas. The criteria used and resultant predictions are considered reasonable. Fort McKay does not therefore have concerns regarding the impacts of the Base Case SO_2 emissions on vegetation within its traditional lands. However, since localized impacts from SO_2 emissions on vegetation are possible under the Base Case, this issue needs to be a consideration in both the Shell approvals and in SO_2 emission management requirements for future new projects (a **green** situation).

- ***NOX*** – assessing the impact of predicted ambient annual NOx levels under the Base Case is challenging because all the available modeling is based on NO_2 but the vegetation effect criteria of the WHO (2000), which is used by Fort McKay, is based on NOx. To address this issue the WHO value for NOx effects on vegetation of 30 µg/m^3 (annual average) was divided by 2 to give a critical level of 15 µg/m^3 for NO_2 which is based on the assumption that, NOx is comprised of 50% NO_2 on a regional basis. This approach has been used in previous EIAs (e.g., the Imperial Kearl Project EIA). Using this criteria and regional Base Case annual average NO_2 model predictions from:

  - the Petro-Canada McKay River Expansion EIA (2005), which were calculated by Golder (2009) for Fort McKay,
  - the Shell EIA (2007), and
  - and the Imperial Kearl EIA (2005)

  The following approximate areas that may be subject to vegetation effects associated with regional NOx emissions were estimated:

  a. all or part of 73 townships (from Petro-Canada McKay River Expansion EIA (2005) NO_2 predictions)

  b. all or part of 42 townships (approximately 308,000 ha by graphical integration; from Shell EIA (2007) NO_2 predictions)

  c. 152,851 ha (this is value presented in the EIA for the Kearl project; from Imperial Kearl EIA (2005).

  The potential vegetation effects areas calculated using the annual NO_2 contour isopleth data provided by Golder (2009) are in generally agreement with the modeled effects area presented in the Imperial Kearl and indicate that a very

large area within Fort McKay's traditional lands is either at risk or already being impacted (a **red** situation).

- ***Ozone*** – No EIAs have quantitatively assessed Base Case ozone levels and therefore Fort McKay had no data upon which to assess Base Case scenario predictions ozone. A future emission scenario ozone modeling run was conducted by Environment Canada in 2005/2006 (see Current Scenario ozone discussion above for details) and this included a future emissions scenario ozone modeling run. The results of this modeling are discussed under the Planned Development Case.

- ***NH_3***– Regional ammonia level predictions under the Base Case were not part of Shell's assessment. Also insufficient information on ammonia emissions from current and approved projects is available to allow Fort McKay to assess the potential regional annual ammonia level increases that will result from the Base Case. Increases would be expected and as noted under the Current Scenario and levels may already be at or near effect levels (a **yellow** situation).

- ***Nitrogen Deposition*** – The model predicted area exceeding Fort McKay's 8 kgN/ha/yr regional critical load for nitrogen, is approximately 55,000 ha under the Base Case. Approximately 5500 ha of this is outside current or approved project development areas. These areas are based on graphical integration using the nitrogen deposition isopleths provided by Golder (2009) and in the Shell (2007) EIA - Vol. 3, Figure 5.5-6, p.5-223, Dec. 2007; Figure 2-15).

  In its assessment of the eutrophication impacts of nitrogen deposition, Shell indicated that: "In total, 145,011 ha of vegetated areas fall within the 0.25 and 2.0 keq N/ha/yr isopleths (all land cover classes)." (Shell 2007,EIA Vol. 3, p. 5-218, Dec. 2007). If the nitrogen deposition levels are assumed to decrease proportionally between these two deposition levels as a function of the square of distance, then the Shell EIA data would translate to approximately 64,000 ha above the deposition level of 8 kg N/ha/yr (0.57 keq/ha/yr), which is in general agreement with the graphical integration estimate. Much of this area is within current or planned development areas. In the Imperial Kearl EIA (2005), critical nitrogen loads of 15 and 20 kg N/ha/yr (based on vegetation cover) were used and a Base Case area exceedence of these critical loads was predicted to be 6210 ha. It needs to be noted again that nitrogen deposition is difficult to model and that modeling is likely over-predicting nitrogen deposition (NSMWG 2005) for the nitrogen species being modeled but that models do not include nitrous acid, ammonium and ammonia, which are likely significant regional sources of nitrogen deposition. Therefore it is assumed that model predictions may be giving an approximate estimate of total regional nitrogen deposition for the various development scenarios. Using Fort McKay's criteria of 95% protection, 5500 ha above the regional critical loads translates to approximately translates

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Figure 2-15: Base Case Predictions and Application Case Predictions of Areas Exceeding an Annual Nitrogen Load of 8 kgN/ha/yr

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to approximately 3.5% of the Base Case disturbed area on Fort McKay's traditional lands (based on regional disturbance data from Shell EIA - Vol. 5, Section 7, p. 7-27, Dec. 2007). Normally this would be a **green** situation but due to the uncertainties associated with predicting N deposition the current scenario is considered a **yellow** situation.

- ***PAI*** – the PAI isopleths and impact area estimates from Shell (2007) were used by Fort McKay in its assessment of Base Case PAI impacts. The estimated area exceeding soil-series-specific critical loads is1,836 ha of soils outside existing and approved developments. This exceedence occurs within Fort McKay's traditional lands. The areas where these exceedences occur are shown on Figure 2-11. CEMA is currently conducting a Base Case acid deposition model run as part of its Acid Deposition Management Framework (CEMA 2004) implementation. The results of this modeling should be available by January 2010. CEMA is also developing a dynamic time-to-effect acid deposition model as part of its Acid Deposition Management Framework (CEMA 2004) implementation and this model should be ready for regional use in the 2011/2012 period. Until results from this more detailed type modeling are available, Fort McKay considers the current Base Case model PAI estimates and impact area calculations to be the best available information. Based on this available information, Fort McKay is not concerned regarding PAI exceedences under the Base Case scenario (a **green** situation) but nevertheless considers that the predictions warrant an emphasis on rigourous emission management.

Base Case Summary

These Base Case assessments would indicate that the nitrogen emissions associated with this level of development are such that they could result in adverse impacts on significant areas of vegetation due to NOx, NH_3 and possibly ozone.

Application Case

The following is Fort McKay's assessment of the potential impacts of Shell's proposed Jackpine Mine Expansion and Pierre River Mine projects on regional vegetation.

- ***SO_2*** –Shell is proposing to use asphaltenes as the fuel source for two large co-generation units (one at the Jackpine Mine Expansion project and one at the Pierre River Mine). Asphaltenes have relatively high sulphur content (in the 5% range). The proposed projects would therefore increase regional sulphur dioxide emissions and ambient SO_2 levels and could have a SO_2 related direct (fumigation) impact on vegetation. Shell assessed this possibility and concluded that an additional 7 ha of sensitive vegetation (lichens) could be impacted by the proposed projects. Fort McKay's concurs with these estimates and does not

consider the SO_2 related vegetation impacts that might be associated with the proposed projects to be significant (a **green** situation).

- ***NOX*** – based on the use of a 15 µg/m^3NO_2 isopleth (see NO_2 section under Base Case) the area possibly adversely impacted by Base Case + Application Case NOx emissions includes all or part of 45 townships and by graphical integration covers approximately 280,000 ha. This represents a project related increase in possibly affected area of 19,000 ha. Shell's proposed combined project development area (Jackpine Mine Expansion and Pierre River Mine) is 21,339 ha and therefore the potentially affected undeveloped area represents approximately 90% of the proposed development which is much higher than the 5% impact criteria being used by Fort McKay (see section 3.2.5.4). This indicates that a very large area within Fort McKay's traditional lands could be affected from the NOx emissions associated with Shell's proposed project (a **red** situation).

- ***Ozone*** – As noted under the Base Case discussion, Fort McKay's assessment of possible ozone related impacts was limited because the issue was not assessed quantitatively by Shell and has not been assessed quantitatively in any recent EIAs. Therefore, no numeric Application Case predictions are available for ozone. Increased regional emissions of NOx and VOCs, resulting from proposed projects like Shell's, have been modeled in terms of future ozone levels and significant increases and potential impacts identified. The results of this modeling are discussed under the Planned Development Case. It is Fort McKay's assessment that the potential impact of Shell's proposed projects on future regional ozone levels and vegetation impacts cannot be considered as negligible and need to be considered when establishing emission limits for the project (a **yellow** situation).

- ***NH_3*** – As noted under the Base Case scenario discussion, regional ammonia level predictions were not part of Shell's assessment and no ammonia emissions from the proposed projects were identified. There is therefore insufficient information on Base Case and Application Case ammonia emissions to allow Fort McKay to assess the potential regional annual ammonia level increases that could result from the Application Case. As noted under the current scenario, existing ambient ammonia levels may already be at, or near, effect levels and therefore, this a potential impact issue requiring further evaluation (a **yellow** situation).

- ***Nitrogen Deposition*** – Based on Fort McKay's use of 8 kg N/ha/yr as a regional critical load for nitrogen, and graphical integration of the regional area with nitrogen deposition isopleths above this value (provided by Golder (2009) and Shell (2007) – see Figure 2-10), the model predicted area exceeding 8 kg N/ha/yr is approximately 55,000 ha under the Base Case scenario and approximately 60,000 ha under the Application Case scenario. The proposed projects would therefore increase the area with a nitrogen loading of greater than 8 kg N/ha/yr by approximately 5,000 ha. This increase occurs in the areas

adjacent to the two proposed mines and approximately 2000 ha of this land is outside current or approved project development areas and Shell's proposed project areas. Shell's proposed combined project development area (Jackpine Mine Expansion and Pierre River Mine) is 21,339 ha and therefore the potentially affected undeveloped area represents approximately 9% of the proposed development which is higher than the 5% impact criteria being used by Fort McKay (see Section 2.2.5.4). This indicates that a significant area within Fort McKay's undisturbed traditional lands could be affected from the N deposition associated with Shell's proposed project emissions (a **red** situation).

- ***PAI*** – the PAI isopleths and impact area estimates from Shell (2007) were used by Fort McKay in its assessment of Application Case PAI impacts. The estimated area exceeding soil-series-specific critical loads in the Base Case was 1,836 ha of soils outside existing and approved developments and the area is 1,829 ha in the Application Case. Shell indicates that this decrease is not related to emissions management but is attributed to the modeled location of the Jackpine mine fleet, which was relocated in the Application Case (Shell EIA Vol. 3, p.5-226, Dec. 2007). Fort McKay considers the Application Case model PAI estimates and impact area calculations to be the best available information. Based on this available information, Fort McKay is not concerned regarding PAI exceedences under the Application Case (a **green** situation) but nevertheless considers that the predictions warrant an emphasis on rigorous emission management particularly since 806 ha of this area is woodland caribou habitat with high lichen food value (Shell EIA Vol. 3, p.5-234, Dec. 2007); see Figure 2-16.

Application Case Summary

This Application Case scenario assessment would indicate that nitrogen emissions associated with Shell's proposed projects are such that they could contribute to adverse impacts on significant areas of vegetation due to NOx and nitrogen deposition effects and possibly ozone. The potential project impacts on vegetation due to NH_3 and ozone are difficult to assess because of the lack of data.

Planned Development Case (PDC)

The following is a summary of Fort McKay's assessment of the potential impacts of current and approved, Shell's proposed Jackpine Mine Expansion and Pierre River Mine projects and other planned developments on regional vegetation.
Table 2-57summarizes the difference in regional emissions between the Application Case and Planned Development Case as provided in Shell's EIA (2007). The estimated increases in SO_2, NOx and VOC (as relates to ozone formation) emissions are of interest in terms of potential impacts on vegetation.

Table 2-57: Estimated Increase in Regional Emissions Associated with the Planned Development Case

Parameter	Application Case Emissions (t/d)	Planned Development Case Emissions (t/d)	Increase in Regional Emissions (t/d) (and as a percentage)
SO_2	281.94	326.67	44.8 (16%)
NOx	495.55	633.90	138.4 (28%)
CO	439.29	511.43	72.1 (16.4%)
$PM_{2.5}$	31.69	39.44	7.8 (24.6%)
VOCs	707.23	880.38	173.2 (24.5%)
TRS	7.90	9.33	1.4 (17.7%)

- ***SO_2***–Annual maximum regional average SO_2 levels predicted in the Shell (2007), Synenco (2007) and Petro-Canada (2005) EIAs under a Planned Development Case scenario were all below 10 µg/m^3. If these predictions are accurate, and if future SO_2 emissions are correct, then Fort McKay does not consider the SO_2 related vegetation impacts that might be associated with the current Planned Development Case to be significant (a **green** situation).

- ***NOX*** – Based on the use of a 15 µg/m^3NO_2 isopleth (see NO_2 section under Base Case) the area possibly adversely affected under the PDC includes all or part of 48 townships and by graphical integration covers approximately 310,000 ha. This represents a 30,000 hectare increase over the Application Case predictions. From the Petro-Canada EIA (2005) the predicted area above an annual average NO_2 value of 15 µg/m^3 is approximately 750,000 ha under the PDC. Based on the Synenco EIA (2007), the predicted area above an annual average NO_2 value of 25 µg/m^{3}is approximately 300,000 ha under the PDC (Synenco did not provide a 15 µg/m^3 isopleth so a 25 µg/m^3 was used). The much larger areas predicted to have annual NO_2 levels above 15 µg/m^3 in the Petro-Canada and Synenco EIAs, versus the Shell (2007) EIA reflect different model inputs/approaches. The disturbance associated with the PDC is difficult to accurately determine but the predicted undisturbed area with NO_2 levels above 15 represents a very large percentage of the disturbance area and definitely exceeds Fort McKay's 5% criteria (a **red** situation).

- ***Ozone*** – As noted under the Base Case discussion, ozone was not assessed quantitatively by Shell and therefore no numeric PDC predictions are available for ozone. However, a future emission scenario ozone modeling run was conducted by Environment Canada (2007) and this included a future emissions scenario ozone modeling run. This model run can be considered to represent a PDC. This modeling indicated the potential for the area of the region where SUM 60 levels were above 2000 ppb-hrs to substantial increase and for some areas to

Figure 2-16: Base Case Predicted PAI Exceedences

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have SUM 60 values above 4400 ppb-hrs (the recommended "management" level) and some areas to have SUM 60 values above 6600 ppb-hrs (the recommended "exceedence" level; CEMA 2007). Future levels of ozone may therefore have an adverse impact on regional vegetation (a **yellow** situation).

- ***NH_3*** – As noted under the Base Case and Application Case scenarios Shell did not include an assessment of ammonia in its EIA and there is insufficient information to allow Fort McKay to assess the potential regional annual ammonia level increases that could result from planned development projects. As noted under the current scenario, existing ambient ammonia levels may already be at, or near, effect levels and therefore, a potential effect issue requiring further evaluation (a **yellow** situation).

- ***Nitrogen Deposition*** – Shell did not assess the impact of the Planned Development Case emissions on regional nitrogen deposition and therefore Fort McKay was unable to assess the area that might exceed an 8 kg N/ha/yr critical load for nitrogen under this case. An estimate of the area that might exceed an 8 kg N/ha/yr critical load for nitrogen under the PDC was obtained using the approximate 28% increase in NOx emissions associated with planned projects and linearly extrapolating from the area above the 8 kg N/ha/yr from the Application Case. This extrapolation approach would give an area of approximately 9,750 ha exceeding this critical load. In the absence of more details on the individual planned development projects it is not possible to assess whether or not all or some of these planned projects would exceed Fort McKay's 5% impact criteria (see section 2.2.5.4). Based on the 9,750 ha exceedence area the PDC impact is considered significant by Fort McKay (a **red** situation).

- ***PAI*** – Fort McKay used the projected increase in acidifying emissions i.e., SO_2 and NOx, to estimate the impacts of PAI under the PDC. This approach was partly necessitated by the lack of a PDC PAI assessment in the Shell EIA (2007) that could be used to provide data for Fort McKay's assessment. A 30% increase in the area exceeding critical soil PAI levels under the PDC versus the Application Case was estimated. This estimate was based on using the full 16% estimated increase in SO_2 emissions and one-half of the 28% i.e., 14%, of the estimated increase in NOx emissions to give a very approximate estimate of the increase in area where PAI levels would exceed critical soil PAI levels. Using this method gives an additional 550 ha that would exceed critical soil PAI levels as a result of planned projects and a total area of 2,379 ha that would exceed critical soil PAI levels under the PDC. In the Imperial Kearl EIA (2005) it was estimated that PAI critical loads were exceeded on 21,751 ha under the PDC (Vol.7 p. 3-65). See Figure 2-12, which was taken from the Imperial Kearl EIA (2005) and shows the areas where soil PAI exceedences were predicted under the PDC. This larger prediction of impacted area is at least partly the result of all nitrogen deposition being included in the PAI. Fort McKay does not consider PAI exceedences under

the PDC as significant (a **green** situation) but nevertheless considers that the predictions warrant an emphasis on rigourous emission management.

Planned Development Case Summary

This Planned Development Case assessment indicates that the emissions associated with current and approved projects, Shell's proposed projects and planned regional developments are collectively such that they could contribute to adverse impacts on significant areas of vegetation due to NOx, ozone and nitrogen deposition effects. The potential project impacts on vegetation due to NH_3 are difficult to assess but ambient monitoring indicates concentrations at potential effect levels.

2.5.6 Overall Conclusions of Impacts of Emissions on Vegetation Assessment

The assessment of the effects of current and approved projects, application and Planned Development Case emissions on regional vegetation and Fort McKay's reliance on this vegetation to support its traditional land uses is complicated by a number of factors. These include:

- no Alberta or RMWB ambient air quality criteria that are specifically directed at vegetation effects management/protection which leads to the use of criteria from other jurisdictions or the use of Alberta criteria that are perhaps not appropriate which leads to assessment conclusions that range from no effects to significant effects simply based on the use of different assessment criteria,
- the difficulties in modeling dry nitrogen deposition and the fact that current modeled nitrogen deposition does not include all nitrogen species that may contribute to regional nitrogen deposition (e.g., ammonia, ammonium and nitrous acid),
- the exclusion of ammonia from regional assessments despite the relatively high, and much higher than generally assumed, regional ambient ammonia levels that have been measured in the region since ammonia passive monitoring commenced in 2005 and the lack of oil sands related ammonia emission data to help assess the source(s) of these ambient ammonia levels,
- simplified assumptions regarding the contribution of project emissions to ozone formation, lack of rural regional ozone monitoring and the lack of consideration given to Environment Canada's recent ozone modeling results, and
- uncertainties around nitrogen emissions from mine fleets, which makes quantitative assessments of nitrogen impacts difficult.

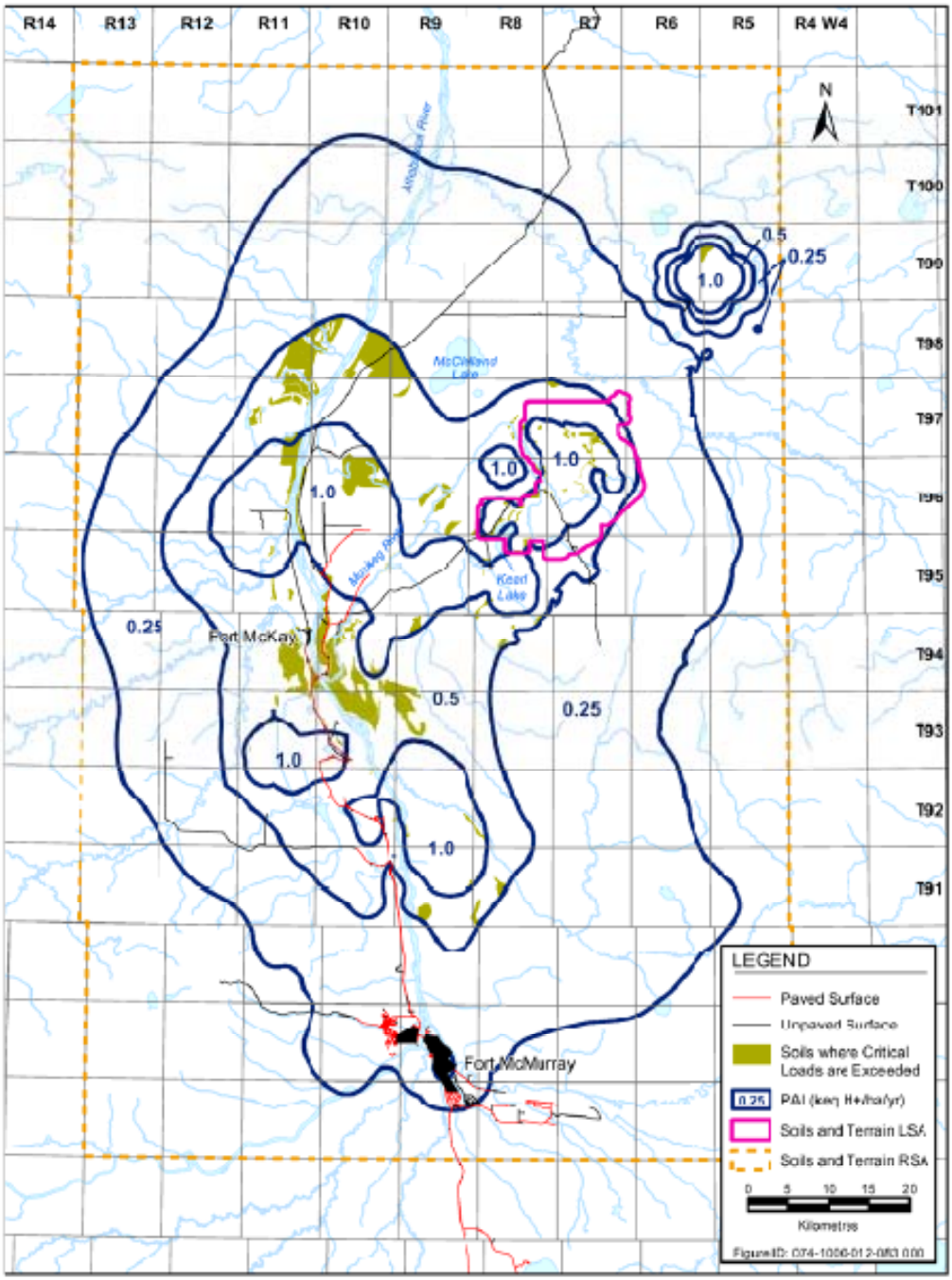

Figure 2-17: PDC Predicted PAI Exceedences[1]

[1]From Imperial Kearl EIA, Vol. 7, p. 3 64, July 2005

These information, criteria and model limitations reduce the certainty with which assessment conclusions can be made regarding the impacts that current and future regional emissions may have on vegetation. There is however a number of conclusions regarding current and possible future impacts of air emissions on vegetation, which are:

- SO_2 emissions at current and future predicted levels do not appear to represent a significant threat to regional vegetation through fumigation (direct) exposure,
- NOx emissions represent a significant potential threat, and may already be at effect levels in certain areas, through fumigation (direct) exposure effects, through nitrogen deposition and associated eutrophication (fertilization) effects and through contribution to ozone formation and direct effects of ozone,
- increased future VOC emissions may contribute to ozone formation with subsequent ozone-related vegetation effects of ozone,
- regional ambient ammonia concentrations are at environmentally significant levels and the sources/causes of these levels, anthropogenic and/or biogenic, need to be determined, and
- current and predicted PAI are not at levels that are likely to have significant adverse effect.

These conclusions are summarized in Table 2-58 for each of the assessment scenarios the **green-yellow-red** issue significance rating is identified for each issue and scenario.

Overall the potential vegetation impacts of regional nitrogen emissions from existing, approved, Shell's proposed and planned projects are considered high (a **red** significance level). This impact potential is an issue that needs to be addressed through the rigorous management of NO_X emissions (and VOC emissions from the standpoint of O_3 formation) and an understanding of sources and potential impacts of ammonia emissions. The significance of NH_3 impacts is difficult to assess and is given a **yellow** level with more study required.

Table 2-58: Summary of Fort McKay's Assessment of the Impact of Regional Emissions on Vegetation for each Development Scenario and the Actions Currently Required

Issue	Case /Scenario Assessment					General Comment –Position
	Background	Current	Base Case	Application Case	Planned Development Case	
SO_2	No issues/ effects	Minimal issues/effects and very local in nature				No action required unless future SO_2 emissions increase above forecasts
NOx	No issues/ effects	Potential direct effects but likely local in extent	Likely direct effects local to regional in extent		Strong likelihood of direct effects regional in scope	Emission control actions required
Ozone	No issues/ effects	Minimal issues/effects	Some possible effects but likely small in extent	Some possible effects	Likely effects with areal extent uncertain	NOx and VOC emission control actions required
NH_3	No issues/ effects	Uncertainty around significance or effects of current levels	Uncertain			Additional study required
Nitrogen deposition	No issues/ effects	Potential effects but likely local in extent	Likely effects local to regional in extent	Likely effects local to regional in extent	Strong likelihood of effects regional in scope	Emission control actions required
Potential Acid Input	No issues/ effects	Potential effects but likely local in extent	Potential effects but likely local in extent	Potential effects but likely local in extent		Continued monitoring and full implementation of Acid Deposition Management Framework

2.5.7 Shell's Proposed NOx and VOC Emissions Management

Shell has indicated that it will undertake a number of air emission management measures at its proposed projects. Many of these will reduce the emissions of NOX and/or VOCs which contribute to the potential for air emission-related effects on vegetation. These measures include (Shell 2007, EIA Vol. 3 Section 2.2.5.2, pp. 2-12 to 53, Dec. 2007):

- above-ground storage tanks will conform to Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Above-ground Storage Tanks,
- plant-wide fugitive emissions identification and control using the protocol recommended by the Canadian Association of Petroleum Producers Management of Fugitive Emissions at Upstream Oil and Gas Facilities, as well as other relevant guidelines and codes of practice, aimed at minimizing fugitive emissions,
- flaring will be minimized for the Project (e.g., upset/emergency conditions, start-up and commissioning) and will comply with the Alberta Energy and Utilities Board Directive 060,
- Tailings Solvent Recovery Unit (TSRU) tailings deposition will be managed to maintain an annual average rate of 4 volumes of solvent per1,000 volumes of bitumen produced,
- cogeneration units and auxiliary boilers will meet the Emission Guidelines for Oxides of Nitrogen (NOX) for New Boilers, Heaters and Turbines using Gaseous Fuels Based on a Review of Best Available Technology Economically Achievable (BATEA) – Interim Guideline (AENV 2007),
- asphaltene-fired cogeneration units: will achieve 75% NOX control efficiency through the use of selective catalytic reduction (SCR) NOX control technology (note: this type of NOX control appears to consistent with AENV's draft revised Policy 1 for Emission Standards for the Use of Non-gaseous Fossil Fuels for Steam Generation in In-Situ Bitumen or Heavy Oil Recovery Projects; AENV 2008b) and the emission limits proposed (Shell 2009, Vol. 1, Question 230, pp. 11-24 to 27) are better than those in the draft revised Policy 1, and
- vehicles in the mine fleet will meet applicable emission standards at the time of purchase and mine maintenance procedures will ensure fleet vehicles are regularly maintained.

Shell is also proposing the following source and ambient monitoring as part of the proposed projects, which it indicates will be determined in consultation with WBEA and AENV:

- expand the existing Leak Detection and Repair Program to detect, measure and control emissions from equipment leaks from new facilities as per the Canadian Association of Petroleum Producers Management of Fugitive Emissions at Upstream Oil and Gas Facilities,
- continue to monitor VOCs through grab samples at ambient trailers per WBEA requirements, and
- continue to conduct fugitive emission surveys on the External Tailings Disposal Area (ETDA) and mine surfaces on site and at ambient trailers to quantify and speciate VOCs and TRS compounds by source.

Shell also indicates that it will:

- continue its active participation in the Wood Buffalo Environmental Association (WBEA) and the Terrestrial Environmental Effects Monitoring (TEEM) program for matters relating to monitoring and assessment of air emissions in the Oil Sands Region,
- work with AENV and WBEA members to understand regional monitoring requirements,
- meet the requirements of the Acid Deposition Management Framework developed through the NSMWG of CEMA and of the Trace Metals Management Framework developed through the Trace Metals and Air Contaminants Working Group (TMAC), also of CEMA.

These are all considered reasonable NO*X* and VOC emission management actions if there were no predicted impacts associated with these emissions. Since, based on Fort McKay's assessment, this is not the case, additional emission controls and management strategies are required and these are outlined under recommendation (Section 2.5.8).

2.5.8 Fort McKay's Recommendations

Based on the current potential for emission-related adverse effects on vegetation, and the clear potential for significant areas of adverse vegetation impacts under future emission scenarios, Fort McKay has a number of specific recommendations related to management of these potential impacts and adverse effects. These are:

2.5.8.1 NO*X* and VOC Emissions Management Recommendations

Project-Specific Recommendations

1. Solvent losses to its Jackpine Mine Expansion and Pierre River Mine tailings ponds be restricted to less than 3 bbl per 1,000 bbl of bitumen within five years

of commencing bitumen production at these mines. This will reduce the regional precursor concentrations of ozone forming compounds.

2. That Shell be required to undertake a detailed and ongoing emission characterization and quantification monitoring program from the tailings ponds at its Jackpine Mine Expansion and Pierre River Mine tailings and that this program be developed in conjunction with Fort McKay with the results of the monitoring reported to Fort McKay IRC at regular intervals. This will improve understanding and management of the potential health odour and environmental effects of tailings pond emissions.

3. Shell be required to develop and implement a comprehensive plant site fugitive emissions detection, monitoring/characterization program and associated repair and reduction program that includes periodic DIAL (Differential Absorption Lidar) or equivalent monitoring and that this program be developed in conjunction with Fort McKay, with the results of the monitoring reported to Fort McKay at regular intervals and upon request. This will enable better understanding and management of potential health, odour and environmental effecs of tailings pond emissions.

4. Shell be required to reduce the NO_X emissions from all gas-fired boilers, heaters and gas turbines that emit more than 100t/yr of NO_X and that these reductions be based on the use of post combustion selective catalytic reduction technology, or equivalent, which Shell is proposing for its asphaltene-fired co-generation units. This will reduce the regional precursor concentrations of ozone forming compounds.

Cumulative Effects Recommendations

5. All the hydrocarbon monitoring data that has been generated to date related to mine faces, tailings pond and fugitive bitumen processing and upgrading facility emissions be collected, collated and published to improve the availability of information and understanding of the VOC emissions from regional industrial operations and the potential impact of these emissions.

(Note: recommendations 1, 2, 3 and 5 are similar to those for odour management (see Section 2.4.7.1) and recommendation 4. is the same as provided in Section 2.3.3 (the Nitrogen Oxides Assessment Section).

2.5.8.2 Ammonia Monitoring Studies

Project-Specific Recommendations

1. A regional ammonia monitoring study be designed and implemented in consultation with Fort McKay to monitor both point and area emission sources in the region for ammonia using low detection ammonia monitors.

Cumulative Effects Recommendations

2. An assessment be undertaken in consultation with Fort McKay of the potential for ammonia releases from Shell's proposed projects and that methods be developed and implemented to minimize any such emissions.

2.5.8.3 Vegetation Effects Measurement and Management in the Regional Municipality of Wood Buffalo

Cumulative Effects Recommendations

1. To improve understanding of current and potential future regional air-related environmental effects and impacts, and the factors contributing to these effects and the development of mangement plans;

    a. Implementation of the recommendations and work plan work as outlined in CEMA's Interim Nitrogen (Eutrophication) Management Recommendations and Work Plan which requires the development of nitrogen critical loads for sensitive regional ecosystems;

    a. Implementation of CEMA's Acid Deposition Management Framework including full development and deployment of the time-to-effect dynamic acidification model for the entire region;

    b. Implementation of CEMA's Ozone Management Framework and using the results of the Framework's ozone model predictions in the development of regional ozone monitoring programs and ozone precursor emission management planning;

    c. Sensitive and spatially representative ecosystems be indentified and vegetation effects and exposure monitoring programs be developed that can accurately determine if, when and where adverse air-related vegetation effects are occurring and to validate and calibrate model predictions; and

    d. Development of ambient air quality critical limites/levels for NO, NO_2 and NH_3 based on potential impacts on vegetation relevant to Fort McKay and its Traditional Lands.

2.6 Summary and Conclusions

This air assessment identified a number of significant air-related impact issues that need to be addressed, in some cases immediately addressed, to protect the quality of life in Fort McKay. Air impact issues have been, and continue to be, a major concern to the Community and this assessment confirmed that there are air issues that need to be given priority in terms of either immediate mitigative action or development of plans and strategies to address before critical impacts or effects occur. The following is a summary of the air assessment and its key conclusions.

The Fort McKay Specific Assessment was conducted by Fort McKay to better understand the past, current and possible influences of oil sands projects on the health and quality of life of its Community members. In the air quality portion of this assessment, possible air emission-related effects were assessed using criteria that were both scientifically credible and relevant to the Community in terms of its expectations, desires and needs. The air assessment focused on the effects of industrial air emissions on air quality and their associated health and environmental impacts on the Community of Fort McKay (Community) and the Community's Treaty Land Entitlement and traditional lands are considered.

The air quality issues of most interest to the community, and that were the specific focus of this air assessment, were:

- overall air quality deterioration and the possible related adverse health effects;
- odours, and
- potential adverse effects associated with acid deposition on regional vegetation and soils within Fort McKay's Treaty Land Entitlement and traditional lands.

The assessment criteria and impact significance rating was guided by Fort McKay's Healing the Earth Strategy (HTES) draft document. The HTES has air-related health impact criteria, odour criteria and "keeping clean areas clean" (KCAC) air quality targets for air quality parameters in the Community. Fort McKay's expectation is that every reasonable effort will be made to reduce and control industrial air emissions so that air quality impacts in the Community and on its traditional lands are minimized. The HTES does not yet include criteria for parameters related to vegetation and ecosystem effects. Therefore vegetation impacts related to SO_2, NO_X, ozone, ammonia, nitrogen deposition and Potential Acid Input (PAI) were evaluated using regional, provincial and/or national or international criteria.

The air-related impacts associated with industrial development were assessed for five scenarios/cases which were: Pre-development, Current, Base Case, Application Case and Planned Development Case. This five scenario/case approach provided a comprehensive perspective on how industrial emissions have, are and will possibly affect air quality and quality of life and the environment in the Community and on Fort McKay's traditional lands.

A color coded system was used to represent the significance of air quality issues under the five different assessment scenarios/cases (i.e., Pre-development, Current, Base, Application, and Planned Development). Issues with little or minor concerns were categorized as **Green**. Issues that are possibly significant are classified as **Yellow**. Lastly, issues that were significant and/or require immediate action are considered **Red**.

A number of **Red** and **Yellow** issues and actual or potential impacts were identified. These are:

- ***Odours*** – there are currently significant odour problems and issues in the Community which will multiply with increasing development and this issue is a **Red** situation requiring immediate action;
- ***SO_2*** – The periodic high releases of SO_2 in the region create the potential for SO_2 related air quality issues in Fort McKay and this is considered a **yellow** issue requiring further analysis. SO_2 impacts on vegetation are not considered an issue;
- ***NO_2/NOX*** – Regional NOX emission are predicted to increase significantly in the future and some possible exceedences of Fort McKay's HTES health and KCAC air quality criteria for the Community are predicted and therefore this is considered a **Yellow** issue. In terms of impact on vegetation there are potential direct effects that are likely local in extent (**Yellow**) under the Current and Base Case scenarios but there are likely direct effects local to regional in extent (**Red**) in the Application and Planned Development scenarios;
- ***$PM_{2.5}$*** – Regional $PM_{2.5}$ emissions and $PM_{2.5}$ precursors (that result in secondary $PM_{2.5}$ formation) are predicted to increase in the future and some possible exceedences of Fort McKay's HTES health and KCAC air quality criteria for the Community are predicted and therefore this is considered a **Yellow** issue;
- ***Ozone*** – Currently it appears that there are no vegetation-effect related issues with ozone (based on modelling) however some possible effects might occur under the Application and Planned Development cases (a **Yellow** situation);
- ***NH_3*** - There are some uncertainties around the possibility and significance of NH_3 effects on vegetation at current regional levels (a **yellow** situation), and the potential effects of NH_3 in the Base, Application, and Planned Development cases are also uncertain (a **yellow** situation);
- ***PAI*** – no issues were identified in that CEMA Acid Deposition Management Framework is adequately addressing/managing this issue;
- ***Nitrogen Deposition*** – Potential effects associated with nitrogen deposition were identified under the current scenario and base case which are likely local to be regional in extent in the Current and Base cases (a **yellow** situation), the

likelihood of these effects extending to regional in scope is stronger in the Application and Planned Development cases (a **red** situation);

For each air quality parameter, recommendations related to the understanding and management of air quality issues were provided by Fort McKay. These recommendations are directed at better assessment tools for predicting impacts (e.g., improvements to air dispersion and deposition models) and better air emission controls (e.g., post-combustion emission controls on the larger NO_X sources). Regarding odours a detailed odour management strategy is outlined.

Based on this air assessment, it is Fort McKay's view that industrial development can occur without significant air-related health, environment and quality of life impacts but that this is only possible if more rigorous air emission control and management strategies are pursued. Under the current approach to air emissions management and air quality protection a number of potentially significant air-related impacts might occur. As noted in this assessment, the current problems with odours in the Community are an example of the type of issues that are and might occur without better overall air quality management in the region. Fort McKay believes that its Healing the Earth Strategy provides a framework for addressing air quality issues in the Community and in the region.

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