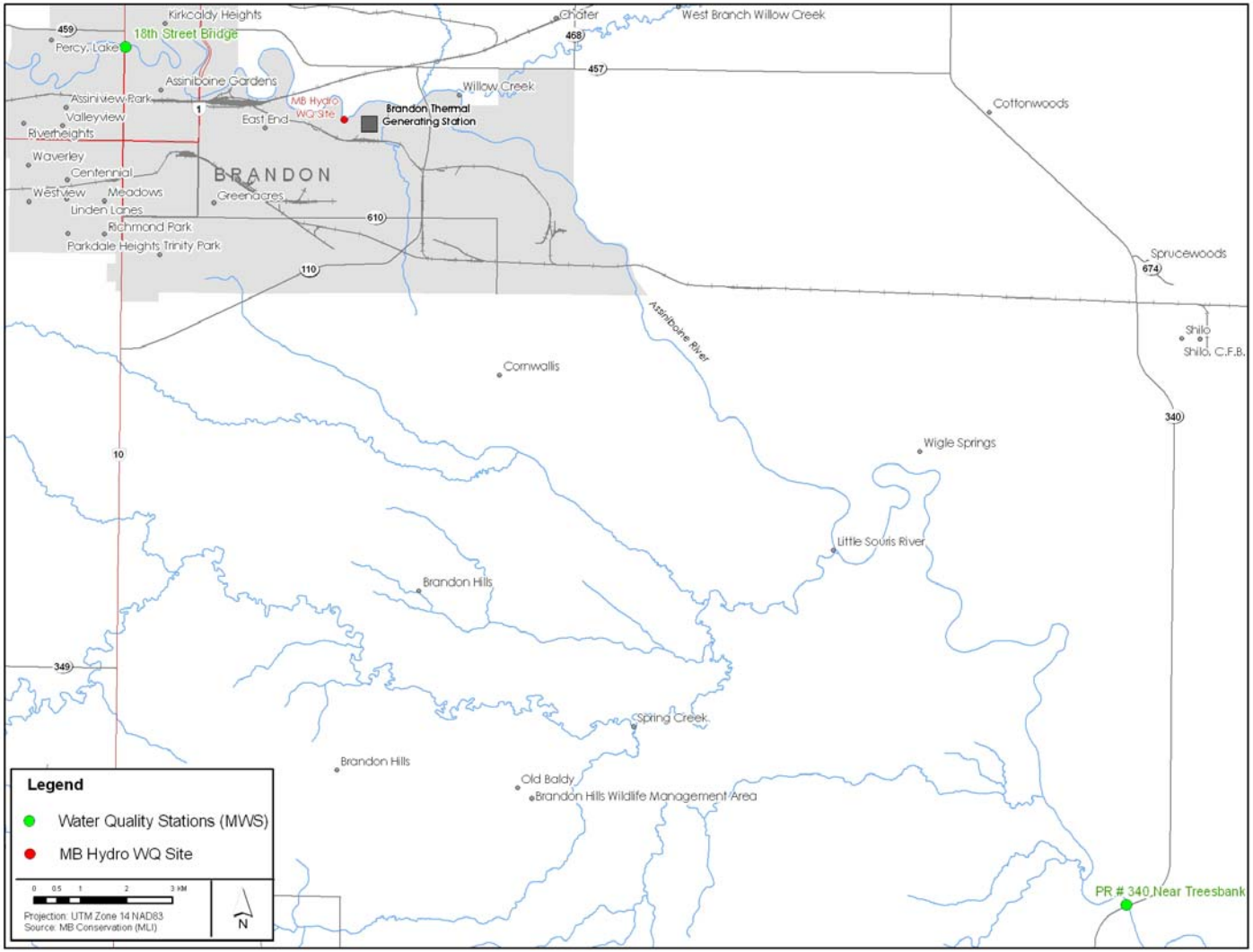
**Figure 4-1 Manitoba Water Stewardship Sampling Sites at the Brandon 18th Street Bridge and PR 340 near Treesbank and the Manitoba Hydro Sampling Site at the Brandon G.S.**



The following paragraphs summarize ambient conditions for parameters of interest with respect to effluents from Unit 5 as presented in Table 4-2:

pH: The range of pH values was 7.0 – 9.1 pH units. The maximum value was above all MWQSOGs.

Total Dissolved Solids (TDS): The range of TDS recorded at the 3 stations was 300 - 1010 mg/L. The maximum value exceeded the MWQSOGs for irrigation and drinking water.

Total Suspended Solids (TSS): TSS in the Assiniboine River is extremely variable and ranged from 2 - 669 mg/L at the 3 sites. There are no MWQSOGs for absolute values of TSS (only for allowable increases above background).

Hardness: Hardness ranged from 136 - 745 mg/L. There are no MWQSOGs for hardness.

Sulphate: Sulphate ranged from 82 – 467 mg/L and was below the MWQSOGs.

Phosphorus: Phosphorus ranged from 0.040 – 1.170 mg/L. Median and maximum concentrations at all three locations exceeded the MWQSOG.

Iron: Iron ranged from 0.10 – 14.4 mg/L. Median and maximum iron concentrations exceeded the MWQSOGs for drinking water and aquatic life, and maximum concentrations exceeded the MWQSOG for irrigation.

Boron: Boron ranged from 0.05 – 0.52 mg/L. Maximum values were within the MWQSOGs (the maximum value at the Treesbank station was marginally above the lowest MWQSOG for irrigation).

Arsenic: Total arsenic ranged from 0.0012 – 0.0100 mg/L. Maximum values were below all MWQSOGs.

Copper: Total copper ranged from 0.0017 – 0.0470 mg/L. Maximum values may exceed the MWQSOGs.

Lead: Total lead ranged from <0.0002 - 0.0158 mg/L. Maximum values were above the MWQSOG for drinking water and may be above the MWQSOG for the protection of aquatic life.

Zinc: Total zinc ranged from <0.002 – 0.150 mg/L. Maximum values were below the MWQSOGs.

Cadmium: Total cadmium ranged from < 0.00004 – 0.01480 mg/L. Maximum values were above the MWQSOGs for drinking water, aquatic life and irrigation.

Selenium: Total selenium ranged from <0.0002 – 0.0040 mg/L. Maximum values were above the MWQSOG for the protection of aquatic life at the two MWS sites. The detection limit used by Manitoba Hydro was greater than the MWQSOG and so comparisons could not be made.

Residual chlorine: Residual chlorine was measured only by Manitoba Hydro. Values in the Assiniboine River are often above the acute MWQSOG. It is possible that this represents an artificially high reading due to interferences of substances in the river with the analytical test.

### 4.1.3 AQUATIC HABITAT AND BIOTA

Over its entirety, the Assiniboine River provides a wide diversity of aquatic habitat. The range of flow regimes includes swiftly flowing water in glides and riffles, and calm shallow pools along shores and back eddies associated with the leeward sides of islands within the river. Bottom substrate ranges from mud/silt to rubble and boulder.

Within the 18 km reach of the Assiniboine River situated between the Brandon G.S. and the confluence with the Little Souris River, there is a diversity of flow regimes that includes riffle-pool and glide-pool segments. Bottom substrate is predominantly gravel and cobble, but finer sediments and large cobble occur regularly throughout the reach, as well. Measurements of stream width and depth along a 7 km segment of this reach immediately downstream of the Brandon G.S. range from 24 to 92 m in width and from 0.47 to 1.33 m in depth (Hughes et al. 1992).

Cessation of once-through cooling in 1996 affected the local environment (e.g., the large thermal plume was no longer present) and likely caused changes in the distribution of local biota. Most of the studies of invertebrates and fish in the vicinity of the Brandon G.S. have been related to the assessment of thermal effects (e.g., Hughes et al. 1992, Stewart et al. 1990), and are no longer applicable. The City of Brandon conducted a multi-year study of the Assiniboine River (1999-2003) related to inputs of nutrients and subsequent effects to the aquatic environment in the river (Cooley et al. 2003; Schneider-Vieira et al. 2003). This study found that the river was nutrient rich, with abundant attached algae on all suitable substrates, and experienced periodic oxygen depletion.

A total of 46 fish species, representing 14 families, occur in the Assiniboine River near Brandon (Appendix G – Aquatic Species Inhabiting the Assiniboine River Near Brandon; McCulloch and Franzin 1996; Toews and Schneider-Vieira 1999; and Stewart and Watkinson 2004). None of these species are listed as rare or threatened in Manitoba, but the silver chub is listed on schedule 1 of the *Species at Risk Act* (SARA) and chestnut lamprey and the bigmouth shiner are listed as special concern on schedule 3 of the SARA. Species on schedule 3 are not currently protected under SARA. Species which prefer larger rivers (e.g., emerald shiner, flathead chub, freshwater drum, and goldeye) are frequently found in the mainstem of the Assiniboine River; conversely, species which favour smaller streams (e.g., blacknose dace, creek chub, and bigmouth shiner) are often found in tributaries such as the Cypress River (Lawrence and Bernhardt 1998). Golden and blackchin shiners, and brook stickleback are usually found in oxbow lakes associated with the Assiniboine River. Black crappie and carp are among the known introduced species.

The majority of the species commonly found in the Assiniboine River are categorized as cool water species, being tolerant of summer water temperatures typical of southern Manitoba (20°C - 28°C) (Lawrence and Bernhardt 1998).

Relative abundance of individual species within the Assiniboine River near Brandon has not been determined; however, some generalizations have been inferred from various studies and anecdotal information. The sand shiner is the most abundant forage species captured in the Assiniboine River mainstem (McCulloch and Franzin 1996). Sucker species (predominantly white sucker and shorthead redhorse) are the most abundant rough fish captured, and walleye and mooneye are the most frequently captured game species.

Burbot, which spawn under the ice during February to March, are the only winter spawning species in the Assiniboine River. Most fish species in the Assiniboine River spawn during spring. The earliest spawners are mooneye, northern pike, sauger, walleye, and yellow perch which spawn between late April and May at water temperatures ranging between 3ºC and 13°C. The sucker species spawn during late May and June, and at relatively higher temperatures. Minnow (Cyprinidae) and catfish (Ictaluridae) species spawn during late June or early July when water temperature approaches 20°C.

Specific spawning locations near Brandon have not been thoroughly studied or documented, but it is believed that mooneye spawn in the Assiniboine River within the Brandon city limits (Glenn and Williams 1975), and walleye spawn in the rapids downstream of the Brandon G.S. (Lawrence and Bernhardt 1998). Due to the wide diversity of aquatic habitats available in the Assiniboine River downstream of Brandon, it is likely that most fish species documented near Brandon also spawn locally.

Suitable over-wintering habitat consisting of sufficient depth and dissolved oxygen to support fish generally occurs within deep pools which predominantly exist along the outside bends of river meanders (Nelson and Franzin 2000). Radio-tagged walleye found within a pool at the Assiniboine River/Willow Creek confluence during the winter of 1997/1998 suggest that other species may also overwinter at this location (Lawrence and Bernhardt 1998).

## 4.2 ENVIRONMENTAL EFFECTS, MITIGATION AND MONITORING

The assessment has been conducted on the basis of the maximum theoretical generation from Unit 5, which is equivalent to operation at maximum capacity of 105 MW for a full year (see Section 1.4 for additional details). Specifically, the volumes of water withdrawn from the Assiniboine River and discharged in effluent streams are based on measurements and estimates obtained during recent periods of time when Unit 5 was operating at or near maximum capacity. Since commissioning of the cooling tower in 1996, no water has been used for once-through cooling, and the cooling tower blowdown has been directed to the ash lagoon.

### 4.2.1 WATER QUALITY

#### 4.2.1.1 Current Conditions

As described in Section 2.7.2, operation of Unit 5 produces four effluent streams. Effluent from the ash lagoon and station drain is routinely monitored and potential effects to river water quality are discussed below.

Discharge from the compressor heat exchangers to the river is typically 1 to 2 ºC above ambient river temperature; the minor increase in temperature associated with this small discharge (< 1% of total river flow under extreme low flow conditions) is considered to have a negligible effect and is not considered further.

The quality of surface runoff from the coal storage area was monitored from January 1994 to February 1995 and sampled when water was present in the runoff ditches (i.e., two occasions in March 1994 only). Water quality variables measured in runoff samples were within the range of values measured in the Assiniboine River upstream of the G. S. (i.e., provincial water quality monitoring site and/or the Manitoba

Hydro water intake site) and/or were below water quality guidelines for the protection of aquatic life and drinking water. Manitoba Conservation terminated the requirement for surface water monitoring and reporting in 1996. Therefore, monitoring was discontinued and this effluent stream is not considered further in this document.

Potential effects of the discharge of station drain and ash lagoon effluent on aquatic biota in the Assiniboine River, as well as on other uses (e.g., for irrigation) were determined by comparisons to:

i. licence limits, for parameters for which there are limits;

ii. the Environment Canada Environmental Codes of Practice Effluent Guidelines for Steam Generating Facilities (Environment Canada 1986) (hereafter referred to as EC guidelines), where different from licence conditions;

iii. background levels in the river to assess whether concentrations in the plume would differ from the river; and

iv. the applicable MWQSOGs at the end-of-pipe and after full effluent mixing in the river under various flow conditions.

The latter analysis considered the combined effect of drain and ash effluents, as the input points of the two effluents to the Assiniboine River are in close proximity. As MWQSOGs apply to in-stream conditions and not directly to effluent, comparisons of effluent quality to MWQSOGs at the end-of-pipe were conducted as a screening exercise, to eliminate parameters that already meet MWQSOGs before mixing with river water. Results of these analyses are presented in detail in Appendix H (Potential effects of Ash Lagoon and Station Drain Effluents on Water Chemistry in the Assiniboine River) and are summarized below. The analysis was based on measurements of effluent quality and river water quality conducted by Manitoba Hydro for the period 1996-2004.

#### 4.2.1.1.1 Station Drain

The station drain discharges directly to the Assiniboine River just upstream of the municipal ditch receiving the ash lagoon effluent. As described in Section 2.7.2.1, the station drain receives effluent from a variety of sources. Effluent is passed through an oil mitigation system prior to discharge.

The Environment Act Licence specifies discharge limits on pH, oil and grease, and acid soluble copper. The effluent is monitored weekly for pH, total dissolved solids, hardness, sulphates, total phosphorous, soluble boron, total iron, acid soluble copper and oil and grease.

As discussed in Appendix H, pH, oil and grease and acid soluble copper were generally within licence limits (pH exceeded licence limits in 0.4% of the samples and copper in 1.5% of the samples).

With the exception of iron, which was generally less concentrated in the effluent than the river, concentrations of parameters measured in the station drain were higher than in the Assiniboine River. Iron concentrations in the effluent exceeded the EC guideline (1000 µg/L) in approximately half the samples and were always above the MWQSOG, but in the majority of samples, this was due to high background levels in the river and inputs of station drain effluent would not worsen conditions in the river.

The MWQSOGs provide limits on pH and total phosphorus for the protection of aquatic life. These were typically exceeded in the effluent, indicating that conditions within the mixing zone would be somewhat degraded (effects in the fully mixed portion of the river are considered below in conjunction with the ash lagoon effluent). Boron and copper concentrations in the effluent were always below the MWQSOGs, indicating that adverse effects related to these parameters, even within the mixing zone, are unlikely.

#### 4.2.1.1.2 Ash Lagoon

As described in Section 2.7.2.3, effluent from the ash lagoon consists of the decant water from a mixture of the non-combustible residue of the coal, wastes from the water treatment process (water softening and demineralization) and blowdown from the cooling tower.

The Environment Act Licence specifies that the pH of the ash lagoon effluent should not be less than 6.5 or greater than 9.0[7] pH units, the suspended solids should not exceed background conditions in the Assiniboine River by more than 25 mg/L, and the total chlorine residual should be less than 0.2 mg/L. The Environment Act Licence requires weekly monitoring during periods of discharge of pH, total dissolved solids, total suspended solids, hardness, sulphates, phosphorus, iron, and residual chlorine and biweekly monitoring of boron, arsenic, copper, lead, zinc, cadmium and selenium.

After installation of a pH control system in mid 2001, pH in the effluent exceeded the licence limit of 9.0 pH units in approximately 20% of samples, though the EC guideline of 9.5 was exceeded in <5% of samples[8]. Based on comparison to suspended sediment concentrations measured on the same day in the river, the ash lagoon effluent exceeded the Environment Act Licence limits on total suspended solids in approximately 19% of the samples, though at other times suspended sediment concentrations were comparable to levels in the river. Levels of residual chlorine were always well below the Licence limit. As discussed in Section 4.2.1.2 (Future Operation), planned improvements to the pH control system, as well as the construction of new lagoon cells, are expected to improve the effluent quality in terms of pH and suspended sediments.

As with the station drain effluent, iron concentrations in the ash lagoon effluent were generally lower than in the river, and exceedences of the MWQSOG and EC guideline were generally due to high background concentrations in the river.

The concentrations of most other parameters were generally higher in the ash lagoon effluent than in the Assiniboine River. As with the station drain effluent, pH and total phosphorus regularly exceeded the MWQSOGs for aquatic life, indicating that conditions within the mixing zone would be somewhat degraded.

Substances such as boron, arsenic, zinc, copper, lead, and cadmium were present at concentrations greater than or comparable to levels in the river, but generally levels in the effluent did not exceed the MWQSOGs (< 5% of samples were above the MWQSOGs), indicating that adverse effects due to elevated levels of these parameters, even within the mixing zone, were unlikely.

[7] During initial commissioning of the cooling tower, the allowable limit was 10 pH units.
[8] Prior to installation of the pH control system, the effluent generally was above the licence and EC limits.

Selenium concentrations were much higher in the ash lagoon effluent than in the Assiniboine River (median values in the effluent generally ranged from 2-60 µg /L vs a median river concentration of <0.2 µg /L) and were substantially above the MWQSOG for the protection of aquatic life of 1 µg/L. These levels are not expected to be acutely toxic as the maximum measured concentration of selenium in ash lagoon effluent (60 µg/L) is an order of magnitude lower than the lowest species mean acute toxicity for freshwater biota (461.4 µg/L for the freshwater amphipod (*Hyalella azteca*), as reported in a recent review of selenium toxicity by the USEPA 2004). In addition, as discussed below, ash lagoon effluent is generally not acutely toxic (e.g., the concentration of selenium in the effluent collected in September 2004 was 38 µg/L and the effluent was not acutely toxic).

To assess the potential toxicity of the ash lagoon effluent to biota within the mixing zone, samples of the effluent were collected in September 2004 and January 2005 and subjected to assays for acute (using rainbow trout) and chronic toxicity (Appendix H). Ash lagoon effluent was not acutely or chronically toxic to any of the standard test organisms. Subsequent testing of ash lagoon effluent toxicity conducted in 2005 and 2006 found similar results under normal operating conditions. However, two samples collected during abnormal operation (malfunction of pH control system leading to elevated pH) were acutely toxic[9].

#### 4.2.1.1.3 Combined Effect of Effluents on the Assiniboine River

In order to assess the effect of the input of station drain and ash lagoon effluent on water quality in the Assiniboine River as a whole (i.e., after the effluents are fully mixed within the river), the concentration of various parameters was calculated based on upstream concentrations in the river and loading from the two effluent streams (Appendix I – Characterization of Ash Lagoon Effluent Quality and Toxicity). Effects for the period 1996-2004 were determined based on the overall median discharge from the station during periods of operation for this period (7798 $m^3$/d). The analysis of future effects was based on a somewhat higher discharge (8741 $m^3$/d), which represents all flows resulting from operation of Unit 5 presented in Figure 2-4 (raw water flow). Effluent quality for the period 1996-2004 was based on median values measured during the specific month of interest, while effluent quality for future conditions was based on median values for the period 1996-2004 (with the exception of pH, which was based on the median of samples collected after installation of the pH control system). Appendix I describes estimated effects for the period 1996-2004, and effects that could occur under median and low flow ($30Q_{10}$, $7Q_{10}$ and $1Q_{10}$) conditions in the river.

As described in Appendix I, inputs of effluent had negligible to small effects on fully mixed concentrations in the river for flows recorded during 1996-2004 and under the median and low flow scenarios, and did not increase concentrations in the river above the MWQSOGs, except where these were already exceeded (e.g. phosphorus) for all parameters except selenium.

Inputs of ash lagoon effluent did result in substantial increases in selenium concentrations. Selenium concentrations measured by MWS at the Brandon 18th Bridge are typically very low and the median is less than the detection limit; under these conditions the input of selenium in the ash lagoon effluent does not result in an exceedence of the MWQSOG. However, on occasion, much higher background levels of selenium are recorded, and under these conditions, the input of selenium in the ash lagoon effluent may result in an exceedence, or an increase in the magnitude of an exceedence, of the MWQSOG under low

[9] Operational procedures have since been amended to avoid a recurrence of these elevated pH events.

flow conditions. For example, under extreme low flow conditions (1Q10 flows in November), the projected increase in selenium levels is 0.58 µg /L. Under median background concentrations of selenium (<0.2 µg /L), this increase would not result in exceedence of the MWQSOG of 1 ug/L. Under maximum background concentrations of selenium (3.9 µg /L), this increase would further elevate levels in the river above the MWQSOG. Elevated selenium levels are not expected to have a significant effect on biota in the fully mixed portion of the river as marked increases are short term (occur under low flow conditions) and are well below the lowest observed effect level (LOEL) of 10 µg/L (CCME 1987).

Overall, the combined effect of the station drain and ash lagoon effluents is expected to have a negligible effect on water quality after full mixing within the Assiniboine River. This conclusion is based on the observation that the addition of the effluent does not generally cause exceedence of the MWQSOGs and, when background concentrations in the river are already above the MWQSOGs, the incremental increase in concentration is generally small (<5% of the total). As discussed above, increases in selenium are more marked, but not expected to have a significant effect on biota in the river.

#### 4.2.1.2 Future Operation, Mitigation and Monitoring

It is anticipated that the current monitoring of the quality of station drain and ash lagoon effluent will continue during future operation. Modifications to flow metering identified as part of this Licence Review and described in Appendix F (Raw Water System Review) will improve the reliability of measurements of station drain and ash lagoon effluent quantity.

Existing mitigation measures to ensure that the discharge of effluents does not have a significant adverse effect to water quality in the Assiniboine River will continue. In addition, measures described below will improve the quality of effluent, in particular to address periodic exceedences of licence conditions.

Station Drain

As discussed in Section 2.5.3 modifications will be made to the station drain system to re-direct effluent from the boiler wet bottom seal, boiler blowdown and chemical waste sump overflow from the station drain to the ash lagoon. These modifications will prevent effluent containing either ash or chemical additives from being directly discharged directly to the river.

Operation of Ash Lagoon

Brandon G.S. has recently revised station operating procedures to ensure effective treatment of ash lagoon pH and TSS effluent. The procedure contains the following provisions:

- Pre-discharge calibration of the effluent real-time pH measurement probe.
- Effluent sample collected during initial minimum flow discharge and sent to the on-site lab for immediate verification that sample and probe pH observations match.
- Effluent collected and sent to the on-site lab for TSS and pH assessment. Assiniboine River sample also collected and assessed for TSS for comparison.
- Once the samples are assessed and confirmed to be within licence limits, the outfall valve is opened to a position such that the level of the ash lagoon is maintained as high as possible to maximise residence time and settling volume.

In addition to the above procedures, the continuous real-time pH sensor is alarmed to notify station operators if pH is approaching the licence limit. There is also a $CO_2$ header low-pressure alarm to indicate the $CO_2$ supply needs replenishment.

The above procedures are in addition to sampling and reporting conducted to fulfil Environment Act Licence requirements.

Construction of New Ash Lagoon Cells

As discussed in Section 2.5.1, new ash lagoon cells will be constructed. The new lagoon cells will be configured with secondary and tertiary cells and sized to ensure adequate effluent retention time to allow particulate material to settle. As a result, suspended solid effluent quality is expected to improve. In addition, an improved system to control pH will be included in the new design. Based on experience gained in operating the existing ash lagoon, the proposed new ash lagoon will be designed to significantly reduce the probability of exceedences.

New Coal Sources

In future, it is possible that coal sources will be different from those used during 1996-2004, which formed the basis of the effluent quality used in this assessment. To determine whether other coal types could potentially alter the conclusion in the analysis described above, the levels of selected substances in the ash of several potential coals were compared. As part of the initial screening, coals with high levels of selenium were omitted from the pool of potential coal sources. The sensitivity analysis did not identify other parameters that would be of concern (Appendix I – Characterization of Ash Lagoon Effluent Quality and Toxicity).

### 4.2.2 WATER WITHDRAWAL

#### 4.2.2.1 Current Conditions

The percentage of water withdrawn from the Assiniboine River under various flow conditions is provided in Table 4-3. Water usage by the Brandon G.S. is based on values provided in Figure 2-4 for Unit 5 alone and in conjunction with Units 6&7. The current Licence Review pertains to Unit 5, but total flows are also shown to assess the combined effects of all 3 units. These flows are likely maximal continuous values, as they are based on the design capacity of various components of the water systems as well as measured maximum flow rates[10]. Units 6&7 account for approximately 18% of the total water usage. Under median flows, raw water withdrawal in all months by Unit 5 alone is less than 2% of the total river flow; even with the addition of units 6&7 water withdrawal remains less than 2% with the exception of September, which is slightly higher (2.3%). Under extreme low flows (1Q10), operation of Unit 5 may withdraw up to 8% of the river's flow (<10% for all units combined). The majority (70%) of this water is eventually returned to the river via either the ash lagoon or station drain discharge; the remainder is lost to evaporation to the atmosphere.

[10] Occasional short term withdrawal rates may be higher if operation of the fire pumps occurs concurrently with operation of all 3 units.

In the late winter, spring and early summer periods (April – June), when entrainment of larval fish is of the most concern, water withdrawal by Unit 5 is less than 1% of Assiniboine River median flows, increasing to <6% under low flows.

**Table 4-3 Percentage of flow withdrawn from the Assiniboine River under median, $30Q_{10}$, $7Q_{10}$ and $1Q_{10}$ flows based on a raw water intake of 19,444 $m^3$/d (0.22 $m^3$/s) for Unit 5 alone and 23,947 $m^3$/d (0.28 $m^3$/s) for periods when all 3 units are in operation. (Note that units 6&7 operate infrequently)**

| | MEDIAN | | $30Q_{10}$ | | $7Q_{10}$ | | $1Q_{10}$ | |
|---|---|---|---|---|---|---|---|---|
| | Unit 5 | Total | Unit 5 | Total | Unit 5 | Total | Unit 5 | Total |
| January | 1.5 | 1.9 | 3.5 | 4.3 | 3.7 | 4.5 | 3.7 | 4.6 |
| February | 1.5 | 1.8 | 4.0 | 4.9 | 3.6 | 4.5 | 3.7 | 4.5 |
| March | 1.1 | 1.4 | 3.9 | 4.8 | 7.2 | 8.9 | 8.0 | 9.8 |
| April | 0.4 | 0.5 | 2.3 | 2.9 | 3.7 | 4.6 | 5.7 | 7.0 |
| May | 0.4 | 0.5 | 3.4 | 4.2 | 3.9 | 4.8 | 4.3 | 5.3 |
| June | 0.7 | 0.8 | 3.9 | 4.8 | 4.6 | 5.6 | 5.0 | 6.1 |
| July | 0.8 | 1.0 | 4.0 | 5.0 | 5.1 | 6.3 | 5.6 | 6.9 |
| August | 1.4 | 1.7 | 5.9 | 7.3 | 5.7 | 7.1 | 5.9 | 7.2 |
| September | 1.9 | 2.3 | 6.7 | 8.3 | 7.5 | 9.2 | 8.0 | 9.8 |
| October | 1.5 | 1.9 | 5.2 | 6.4 | 7.5 | 9.2 | 8.0 | 9.8 |
| November | 1.4 | 1.7 | 3.9 | 4.8 | 4.9 | 6.0 | 6.2 | 7.6 |
| December | 1.5 | 1.9 | 3.6 | 4.4 | 4.0 | 4.9 | 4.3 | 5.2 |

#### 4.2.2.1.1 Impingement and Entrainment

The number and size of fish either impinged or entrained on water intakes depends on the proportion of total flow withdrawn, the location of the intake, intake screen mesh size, and water velocity through the intake. The small percentage of total flow withdrawn is generally expected to limit the number of fish potentially impinged (i.e., trapped on the screen surface by the inflowing water) or entrained (i.e., drawn through the screen and into the station). The location of the intake, in the middle of the river channel in the middle of the water column, may also reduce the number of fish vulnerable to entrainment and impingement.

In spring 2002, potential effects related to impingement and entrainment of fish were further reduced through the installation of a fish protection system based on specifications provided in DFO (1995) and a design developed in consultation with DFO. The DFO approval specified a maximum water withdrawal rate of 0.226 $m^3$/s and a maximum approach velocity of 0.038 m/s. As a result of the increase in the estimated water withdrawal determined during the course of this Licence Review (Section 2.6.1), the design of the fish protection system was assessed. It was determined that: (1) during peak water withdrawal, the approach velocity and flow specified in the authorization for the intake screen may be exceeded; and (2) the maximum approach velocity and flow specified in the authorization may have been exceeded even at the previously estimated water withdrawal rates based on the specified intake size and screen type.

Measurements of intake velocity (75 mm above the screen) recorded velocities of 0 to 0.02 m/s (Golder Associates Ltd. 2003a). In further reviewing the probable flow pathways at a horizontal bottom intake, Manitoba Hydro has determined that this study may not have accurately measured velocity. Therefore, Manitoba Hydro is planning to assess the performance of the fish protection system and determine compliance with the DFO authorization for the system.

Monitoring of impingement and entrainment with the new screen in place was conducted in July 2002 (Golder Associates 2003a) and in May to July of 2003 (Golder Associates 2003b). No fish were collected from within the pumphouse (i.e., past the screen) and the authors concluded that impingement on the screen was also not significant.

Given the small volume of water withdrawn, the location of the water intake, and further mitigation provided by the screen on the water intake, water withdrawal is expected to result in negligible losses to local fish populations due to impingement and entrainment.

#### 4.2.2.1.2 Weir

As discussed in Section 2.6.1.1, when the station operated using large volumes of water for once-through cooling, a weir approximately 1.2 m high was maintained downstream of the cooling water intake. This structure was not maintained after installation of the cooling tower in the mid 1990s and currently consists of a band of stones approximately 0.6 m high. Five years ago, Golder (2001) reported that B. Wright (pers. com.) felt that the weir likely interferes with some fish movements, but maintains the water depth and provides a popular angling area for local residents. The area downstream of the water intake structure at the weir was known as a location for catching stocked lake sturgeon.

As discussed in Section 2.6.1.2, Manitoba Hydro recently completed an investigation of the condition of the weir and current effects on water levels and flows. Results of water velocity and depth modeling are presented in Appendix J – Velocities at the Brandon G.S. Weir on the Assiniboine River. Under high, median and low flow conditions, areas of low velocity of sufficient depth occur to provide for fish passage.

### 4.2.2.2 Future Operation Mitigation and Monitoring

There are no anticipated changes to the volume of water withdrawn so effects of future operation are expected to remain the same as those described above.

As discussed in Section 2.6.1.1, Manitoba Hydro is currently reviewing the performance of the water intake and will discuss results with DFO; the fish protection system will be modified if it is determined that modifications are required to protect local fish populations.

Manitoba Hydro is currently investigating whether a weir is still required to maintain water levels at the raw water intake.

## 4.3 SUMMARY OF RESIDUAL EFFECTS

Table 4-4 summarizes residual effects of operation of the Unit 5, and describes each effect in terms of the magnitude, spatial extent of area affected, duration, frequency, and potential for a measurable effect to the local fish community.

**Table 4-4 Residual Effects of Unit 5 Operation on the Aquatic Environment**

| Source of Effect | Description of Effect | Mitigation Measures | Residual Effect |
|---|---|---|---|
| Input of station drain and ash lagoon effluents to the Assiniboine River. | Discharge of an effluent containing elevated pH, TSS, metals, and other substances. | Station drain effluent is discharged through oil interceptors; in future certain effluent streams will be re-directed to the ash lagoon.<br><br>Ash lagoon effluent is settled and treated for pH; in future pH and TSS control measures will be improved. | For all parameters except selenium, input to river does not result in exceedence of the MWQSOGs. Where those are already exceeded in the river, changes are small. Increases in selenium are small. Within the mixing zone, concentrations are higher but toxicity tests indicate that the ash lagoon effluent is not acutely toxic. |
| Input of compressor cooling water to the Assiniboine River | Discharge of an effluent marginally warmer than the river water. | None required. | No detectable effect. |
| Surface runoff from the coal storage area to the Assiniboine River | Discharge of an effluent containing TSS and other substances. | None required. | No detectable effect. |
| Water withdrawal from the Assiniboine River | The proportion of total river flow that is withdrawn is less than 2% under median conditions, and increases to near 10% under extreme low flow conditions. Potential effects are related to:<br>• impingement and entrainment of adult and | A fish screen reduces both the entrainment and impingement of fish. Manitoba Hydro is planning to assess the performance of the fish protection system and determine compliance with the DFO authorization for the system. | Effect is negligible, as withdrawal is generally negligible and even under low flow conditions is less than 10% of the river volume. Effects are further reduced by the presence of a screen on the water intake. |

| Source of Effect | Description of Effect | Mitigation Measures | Residual Effect |
|---|---|---|---|
| | juvenile fish;<br>• entrainment of larval fish; and<br>• dewatering/alteration of habitat. | | |
| Weir in the Assiniboine River downstream of the water intake. | Remnant of weir affects water levels and flows in the vicinity of the weir. Water velocity and depth modeling indicate that fish can move upstream past the weir. | None required. | Negligible effect on fish passage. |

# CHAPTER 5

# AIR AND NOISE

# 5.0 AIR AND NOISE

This Chapter outlines the existing environmental setting at the Brandon G.S. site as it relates to air quality and emissions (including noise), provides an assessment of the environmental effects from operation of Unit 5, provides mitigation and monitoring recommendations where appropriate and assesses the significance of any residual effects. This Chapter also includes an environmental and human health risk assessment conducted on the air emissions from Unit 5.

The spatial scope for the air quality assessment includes a 30 x 30 km area (for example, Figure 5-4 centred on the Brandon G.S. The noise assessment analyzes noise emissions at the property boundary and considers the nearest residential receptor locations to Unit 5.

## 5.1 EXISTING ENVIRONMENT

### 5.1.1 CLIMATE

The region of southern Manitoba lies in the zone of continental climates. The climate is characterized by warm summers (extending from mid-June to mid-August) and winters with snow cover lasting less than four months (mid-November to mid-March). Autumn usually occurs during the months of September, October, and November. By the end of November, winter is well advanced in the northern part of the Province. The ground is normally covered with snow by mid-November. The nearest meteorological station which is representative of conditions at the Brandon G.S. is located approximately 6 km away at the Brandon Airport.

### 5.1.2 METEOROLOGY

Although surface winds (10 metres above ground) at the Brandon G.S. are reasonably well represented by the measured wind speed and direction at the Brandon airport, these winds do not necessarily represent winds at the height of the Unit 5 emission stack (106.7m) or of the thermally-buoyant emission plume at plume height. The nearest upper-air wind monitoring stations are located at Dauphin and The Pas in Manitoba, and Bismarck in North Dakota. Due to there distance from Brandon, the upper air winds at these locations may not provide a good representation of conditions over Brandon. To address this issue, mesoscale wind fields were obtained for 2003 from the Eta meteorological forecast model that is run operationally at the National Center for Environmental Prediction (NCEP) in Boulder, Colorado. The use of the Eta fields provided a high quality articulation of the upper air flow in the region. It should be noted that surface station data from the Brandon airport was still used to provide minor adjustments to the Eta surface winds near the station, and to provide local temperature and precipitation data on an hour-by-hour basis.

#### 5.1.2.1 Surface Winds

Figure 5-1 shows the distribution of surface wind speeds and directions near the Brandon G.S. in 2003. Westerly and west-northwesterly surface wind flow occurred most frequently at Brandon and nearby areas, while northerly and southerly winds are relatively infrequent. Calm conditions (wind speeds less than 0.5 m/s) occurred 7.2 % of the time. The annual average wind speed at Brandon was 3.6 m/s.

#### 5.1.2.2 Upper Level Winds

Figure 5-2 provides a summary of representative winds for a layer of the atmosphere between 100m and 200m above the surface. Winds at this elevation are representative of regional circulation patterns and are not strongly influenced by surface features. Emissions from elevated sources, such as the stack from Unit 5, are influenced by these winds to a greater extent than by surface winds.

Comparability between winds at the surface (which derive from surface station data) and winds in Layer 5 (which are derived from the Eta mesoscale model) is quite good. Within the earth's boundary layer, wind speeds tend to increase with height, and wind direction tends to rotate clockwise. The latter effect is known as the Ekman Spiral, and this effect is present in the difference between the surface winds in Figure 5-1 versus the winds at about 150 metres above the surface in Figure 5-2. Whereas the predominant winds at the surface are westerly, those above the surface have a strong north-westerly component. For this layer, the average wind speed in 2003 was 8.4 m/s, and there were few calms (0.2%).

**Figure 5-1 CALMET Surface (10m) Winds at Brandon Airport**

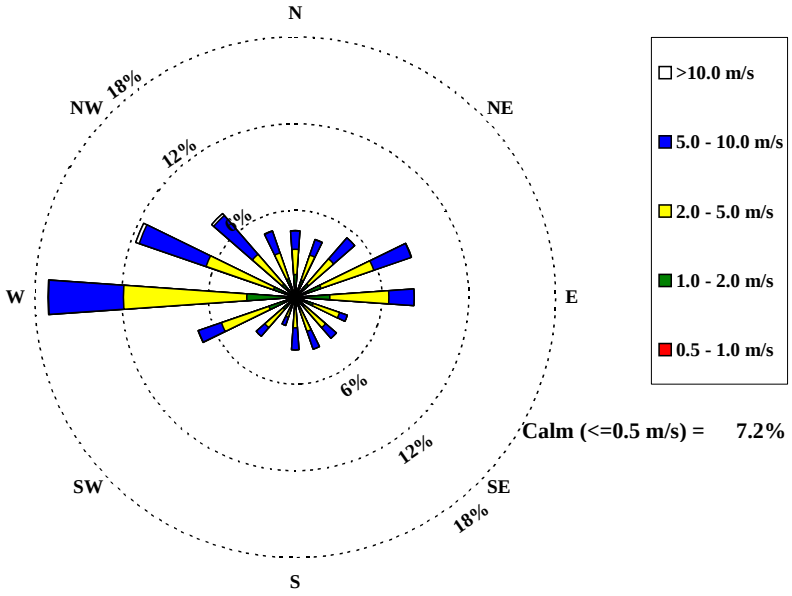
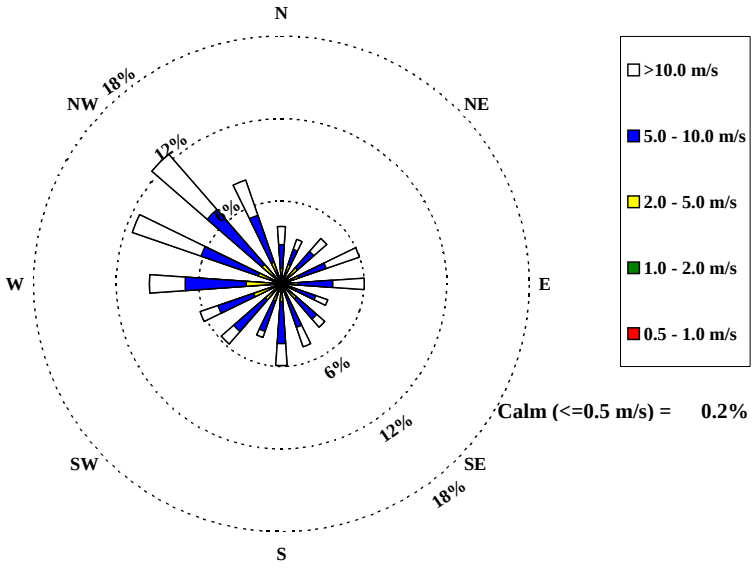



**Figure 5-2 CALMET Layer 5 (150m) Winds at Brandon Airport**



### 5.1.3 EXISTING AIR QUALITY

Nitrogen dioxide ($NO_2$) and particulate matter (as $PM_{10}$ and $PM_{2.5}$) are monitored at the Assiniboine Community College in Brandon. Table 5-1 provides a summary of $NO_2$, $PM_{10}$ and $PM_{2.5}$ concentrations reported for the period 1997 – 2004 . Ambient air quality criteria are also listed for comparison purposes.

**Table 5-1 Ambient Air Quality Levels in Brandon**

| Contaminant | Measured Concentrations (µg/m$^3$) 5131 Brandon Assiniboine Community College | | | | | | | | Criterion Value | Criterion Classification | Jurisdiction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | | | |
| **Nitrogen Dioxide** | | | | | | | | | | | |
| Mean | 11 | 15 | 17 | 13 | 10 | 11 | 11 | 10 | 100 | Maximum Acceptable Objectives | Manitoba |
| Max. 1-hour | 147 | 122 | 124 | 133 | 149 | 94 | 86 | 124 | 400 | | |
| Max. 24-hour | 55 | 58 | 62 | 56 | 56 | 51 | 49 | 57 | 200 | | |
| **$PM_{10}$** | | | | | | | | | | | |
| Mean | 16 | 23 | 21 | 20 | 22 | 22 | 23 | 21 | | | |
| Max. 24-hour | 49 | 127 | 153 | 202 | 131 | 229 | 154 | 157 | 50 | Guideline | Manitoba |
| **$PM_{2.5}$** | | | | | | | | | | | |
| Mean | | | | | 6 | 5 | 6 | 5 | | | |
| Max. 24-hour | | | | | 18 | 26 | 23 | 23 | | | |
| 98th percentile | | | | | 17[b] | 18 | 15 | 16 | | | |
| CWS parameter[a] | | | | | | | 17 | 16 | 30 | CWS [a] | National |

[a] CWS - Canada-Wide Standard: achievement based on the 98$^{th}$ percentile ambient measurement annually, averaged over three consecutive years

[b] June-December

The $NO_2$ monitoring data in Brandon indicate that the Manitoba Maximum Acceptable objectives have not been exceeded over the available period of monitoring data since 1997. The annual average $NO_2$ concentration is only about one-tenth of the Maximum Acceptable Objective required by Manitoba Conservation. Similarly, the maximum observed 1-hour and 24-hour average $NO_2$ concentrations in Brandon are only about one-quarter of the Provincial Maximum Acceptable Objectives.

Table 5-1 also summarizes the ambient monitoring data for particulate matter at Brandon for the period 1997-2004. No data are available for total suspended particulate matter (SPM). The measured maximum 24-hour average $PM_{10}$ concentrations at the Assiniboine Community College consistently exceed the Manitoba Guideline value of 50 µg/m$^3$. The primary cause for the high levels of $PM_{10}$ is believed to be related to fugitive dust emissions from agricultural activity in the area, as well as possibly due to seasonal burning of agricultural waste and stubble in fields. $PM_{2.5}$ concentrations, which are of greater concern with respect to human health, were not monitored in Brandon prior to 2001. The $PM_{2.5}$ concentrations over the period 2001-2004 are well below the Canada-Wide Standard (CWS) level.

There is currently no $SO_2$ monitoring in Brandon. $SO_2$ monitoring was discontinued in Brandon in 1989, but readings prior to that were too low to register (0.0 ppm). Therefore, it can reasonably be assumed

that the emissions from Unit 5 are the largest source of $SO_2$ emission in the area, and that the $SO_2$ concentrations calculated for Unit 5 based on dispersion modelling can be directly compared with the ambient air quality objectives for Manitoba, without consideration of additional background $SO_2$ levels.

Similarly, there is no CO monitoring for Brandon. There are only two stations that monitor CO in Manitoba, and both are located in Winnipeg. For the purpose of determining upper bound estimates of background CO concentrations, the observed values at Scotia and Jefferson (in Winnipeg) for the period 1995-2004 are listed in Table 5-2. Due to the higher traffic levels in Winnipeg, CO levels in Brandon are likely to be much lower than those listed in Table 5-2.

**Table 5-2 Measured CO Concentrations (µg/m$^3$) in Winnipeg**

| Averaging Period | 9118 WINNIPEG, SCOTIA & JEFFERSON | | | | | | | | | | Manitoba Objective | Classification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | | |
| Mean | 467 | 433 | 422 | 456 | 388 | 547 | 524 | 422 | 331 | 278 | | |
| Max. 1-hour | 5928 | 6156 | 4674 | 6612 | 7866 | 4674 | 7980 | 3192 | 3726 | 3016 | 35000 | Maximum Acceptable |
| Max. 8-hour | 4104 | 3078 | 3306 | 4560 | 3534 | 2736 | 3990 | 2280 | 1596 | 1705 | 15000 | |

For the same reason, Table 5-3 lists the mean concentrations of trace organic compounds measured at the Ellen Street monitoring station in downtown Winnipeg by Manitoba Environment in 1995-96. Only those PAHs relevant to emissions from Unit 5 are listed. There are no ambient air quality criteria specific to PAH or dioxin/furan concentrations, and the effects of these contaminants are addressed in this assessment through the risk assessment analyses. The levels of PAH, dioxins and furans measured in Winnipeg are simply provided here for comparative purposes. Since the PAH, dioxin and furan levels in the large urban area of Winnipeg are likely to be much higher than those in the rural area of Brandon, measured levels of several of these compounds are available for Estevan, Saskatchewan, and are provided in Table 5-4 for comparative purposes.

**Table 5-3 Mean Concentrations (ng/m$^3$) of Trace Organic Compounds Measured in Winnipeg (1995 - 1996)**

| Station 9119, Winnipeg (65 Ellen Street) | | | |
|---|---|---|---|
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | **Arithmetic Mean** | **Dioxins and Furans** | **Arithmetic Mean** |
| Benzo(a)pyrene | 0.113 | 2,3,7,8-TCDD | 0.002 |
| Benzo(b)fluoranthene | 0.462 | Total TCDD | 0.001 |
| Chrysene | 0.302 | Total PeCDD | not detected |
| Indeno(1,2,3-cd)pyrene | 0.176 | Total HxCDD | 0.116 |
| Benzo(g,h,i)perylene | 0.339 | Total HpCDD | 0.448 |
| Fluoranthane | 2.497 | Total OCDD | 1.022 |
| Naphthalene | 0.380 | Total PCDD | 1.587 |
| Phenanthrene | 11.764 | 2,3,7,8-TCDF | 0.021 |
| Pyrene | 2.069 | Total TCDF | 0.012 |
| | | Total PeCDF | 0.021 |
| | | Total HxCDF | 0.339 |
| | | Total HpCDF | 0.307 |
| | | Total OCDF | 0.111 |
| | | Total PCDF | 0.795 |
| | | Total PCDD/PCDF | 2.382 |

**Table 5-4 Observed Concentrations in Estevan, SK**

| **Compound** | **Mean Concentration** (µg/m$^3$) **Estevan** (Observed 1994-1997) |
|---|---|
| Benzo(a)pyrene | 3.00E-5 |
| Benzo(b)fluoranthene | 1.5E-4 |
| Indeno(1,2,3-cd)pyrene | 9.00E-5 |
| Total TCDF | N/A |
| 2,3,7,8-TCDF | 9.8E-9 |
| 2,3,4,7,8-$P_5$CDF | 5.1E-9 |

N/A – not available

Similarly, Table 5-5 lists mean concentrations for a selected set of volatile organic compounds (VOCs) measured in Winnipeg at the Ellen Street monitoring station by Manitoba Conservation for the period 1995-1996. More recent data on trace element concentrations in particulate matter (as $PM_{10}$) for the same location are listed in Table 5-6 for 2004. As with the PAHs and dioxins/furans, the data in Tables 5-5 and 5-6 are simply provided for comparative purposes.

**Table 5-5 Mean Concentrations (μg/m$^3$) of Selected Volatile Organic Compounds (VOCs) Measured in Winnipeg (1995 – 1996)**

| Compound | Arithmetic Mean |
|---|---|
| Benzene | 1.59 |
| Bromoform | 0.015 |
| Chlorobenzene | 0.015 |
| Chloroform | 0.13 |
| Ethyl benzene | 1.02 |
| Ethylene dibromide | 0.02 |
| Hexane | 1.1 |
| Tetrachloroethylene | 0.3 |
| Toluene | 5.9 |
| 1,1,1-Trichloroethane | 0.9 |
| Styrene | 0.3 |
| Xylenes | 4.9 |

**Table 5-6 Maximum and Mean Concentrations (μg/m$^3$) of Selected Trace Elements Measured in Winnipeg (2004)**

| Trace Element | NAPS No. 70119 65 Ellen Street | |
|---|---|---|
| | Maximum | Mean |
| Aluminium | 1.1123 | 0.2198 |
| Antimony | 0.0080 | 0.0007 |
| Arsenic | 0.0018 | 0.0004 |
| Barium | 0.0271 | 0.0130 |
| Cadmium | 0.0032 | 0.0004 |
| Chromium | 0.0281 | 0.0063 |
| Cobalt | 0.0076 | 0.0021 |
| Copper | 0.0355 | 0.0095 |
| Iron | 0.6877 | 0.1880 |
| Manganese | 0.0371 | 0.0103 |
| Mercury | 0.0040 | 0.0020 |
| Molybdenum | 0.0016 | 0.0008 |
| Nickel | 0.0094 | 0.0012 |
| Palladium | 0.0016 | 0.0002 |
| Lead | 0.0101 | 0.0036 |
| Selenium | 0.0026 | 0.0006 |
| Silver | 0.0014 | 0.0003 |
| Strontium | 0.0060 | 0.0016 |
| Tin | 0.0038 | 0.0008 |
| Vanadium | 0.0330 | 0.0066 |
| Zinc | 0.0612 | 0.0142 |

### 5.1.4 NOISE

The background noise environment at the residences closest to the Brandon Generating Station is generally characterized by traffic noise. This was determined through a background noise monitoring program conducted at two locations along 17th Street East, approximately 1.6 km from the station (see Figure 5-3). The purpose of the second monitoring location along 17th Street East was to assess the noise impact of road traffic along Victoria Avenue East, as well as of the transformers located at a switchyard southwest of the 17th Street East and Victoria Avenue East. For the receptors along 17th Street East, the continuous humming of energized transformers at nearby switchyards located at the Southeast corner of 17th Street East and Victoria Avenue East. (which are independent of Brandon Generating Station) also contributes to the background noise levels.

The noise monitoring consisted of continuous noise level measurements at Receptor Locations 1 and 2, taken during four operational scenarios of the Brandon Generating Station, namely:

1) when the Station is not operating;
2) during the start-up of coal-fired Unit 5;
3) during typical operation of Unit 5; and
4) during typical operation of Unit 5 together with typical operation of one of Units 6 or Unit 7.

Overall, a total of 111 continuous hours of monitoring were recorded at receptor monitoring Locations 1 and 2, between September 8th and 13th, 2004. The background noise levels are defined as those that were measured when the Brandon G.S. was not operating. The results of the background noise monitoring study are listed in Table 5-7.

**Figure 5-3 Selected Closest Receptor Locations**

**Table 5-7 Background Noise Monitoring Results (Brandon G.S. (Units 5, 6 & 7 Not Operating)**

| Monitoring Parameter | | Receptor Location 1 | Receptor Location 2 |
|---|---|---|---|
| **Daytime (7:00-19:00)** | Minimum hourly $L_{eq}$ | 50.3 dBA | 49.1 dBA |
| | Average $L_{eq}$ | 51.4 dBA | 50.3 dBA |
| **Nighttime (23:00-7:00)** | Minimum hourly $L_{eq}$ | 44.6 dBA | 41.4 dBA |
| | Average $L_{eq}$ | 48.2 dBA | 47.1 dBA |

No significant differences were observed in the minimum and maximum daytime and nighttime noise levels measured at the closest receptors at times when the station was under typical steady operation and when it was not operating. The lowest daytime and nighttime noise levels were measured while Units 5, and either Unit 6 or Unit 7 were operating. The lower minimum nighttime noise level measured when the Brandon G.S. was operating versus when it was not operating indicates that traffic noise is the dominant noise source, as the lower values were recorded during the weekend, when traffic flows are lighter. For more information, refer to Attachment A (Background Noise Assessment - Brandon G.S.) of the Noise Assessment Study found in Appendix L.

## 5.2 ENVIRONMENTAL EFFECTS

### 5.2.1 AMBIENT AIR QUALITY CRITERIA

The Province of Manitoba has adopted a set of time-based maximum pollutant concentration levels for the protection and preservation of ambient air quality. Criteria for each contaminant are classified as either objectives or guidelines depending upon several factors. The 'objective' classification is intended to be applied to those air pollutants that are sufficiently ubiquitous in presence (i.e., common contaminants) and potential environmental effect that national limits have been developed. The 'guideline' classification is used for those pollutants of a more localized presence for which provincial limits have been developed.

Manitoba air quality criteria are specified for the following two levels:

- The **Maximum Tolerable Level** which denotes a time-based concentration of air contaminant beyond which, due to a diminishing margin of safety, appropriate action is required to protect the health of the general population;
- The **Maximum Acceptable Level** that is deemed essential to provide adequate protection for soils, water, vegetation, materials, animals, visibility, personal comfort and well-being.

The selection of the appropriate level depends upon the degree of protection to be afforded to affected receptors. Maximum Tolerable Levels are only intended for evaluation purposes to identify the severity of an anthropogenic or natural phenomenon in order to protect public health and institute appropriate corrective action. In general, Maximum Acceptable Levels are not to be exceeded in any urban centre, including areas that are in the vicinity of industries with atmospheric emissions.

Table 5-8 lists the Manitoba air quality objectives for the common contaminants CO, $SO_2$, $NO_2$ and particulate matter, as well as the guidelines for a number of trace elements or compounds that may be emitted from the combustion of coal. Since the maximum predicted effects of emissions from Unit 5 occur near residential areas in and around the City of Brandon, the Maximum Acceptable Levels are the applicable criteria for comparison with predicted effects.

**Table 5-8 Manitoba Ambient Air Quality Criteria**

| Contaminant | Criterion Classification | Averaging Period | Maximum Acceptable Level ($\mu g/m^3$) | Maximum Tolerable Level ($\mu g/m^3$) |
|---|---|---|---|---|
| $NO_2$ | Objective | 1-hour | 400 | 1000 |
| | | 24-hour | 200 | - |
| | | Annual | 100 | - |
| CO | Objective | 1-hour | 35,000 | - |
| | | 8-hour | 15,000 | 20,000 |
| $SO_2$ | Objective | 1-hour | 900 | - |
| | | 24-hour | 300 | 800 |
| | | Annual | 60 | - |
| SPM | Objective | 24-hour | 120 | 400 |
| | | Annual | 70 | - |
| $PM_{10}$ | Guideline | 24-hour | 50 | - |
| $PM_{2.5}$ | CWS[11] | 24-hour | 30 | - |
| Fluorides (as HF) | Guideline | 24-hour | 0.85 | - |
| Hydrogen Chloride | Guideline | 1-hour | 100 | - |
| Formaldehyde | Guideline | 1-hour | 60 | - |
| Phenol | Guideline | 1-hour | 63 | - |
| Styrene | Guideline | 24-hour | 400 | - |
| Arsenic | Guideline | 24-hour | 0.3 | - |
| Cadmium | Guideline | 24-hour | 2 | - |
| Copper | Guideline | 24-hour | 50 | - |
| Lead | Guideline | 24-hour | 2 | - |
| Nickel | Guideline | 24-hour | 2 | - |
| Zinc | Guideline | 24-hour | 120 | - |

[11] 98th percentile calculated annually, average over 3 consecutive years

Manitoba has defined criteria for only a limited number of pollutants that would be emitted from the Unit 5. Table 5-9 lists ambient air quality criteria for selected contaminants from other regulatory jurisdictions, which may be used to provide some measure for comparison with predicted concentrations due to Unit 5 releases. Most of these contaminants would be emitted in trace quantities.

**Table 5-9 Selected Ambient Air Quality Criteria from Other Jurisdictions**

| Contaminant | Criterion Classification | Averaging Period | Criterion ($\mu g/m^3$) | Jurisdiction |
|---|---|---|---|---|
| Benzene | Objective | 1-hour | 30 | Alberta |
| Toluene | AAQC (Odour) | 24-hour | 2000 | Ontario |
| Xylenes | Standard | 24-hour | 730 | Ontario |
| Naphthalene | AAQC (Health) | 24-hour | 22.5 | Ontario |
| Antimony | Standard | 24-hour | 25 | Ontario |
| Barium | AAQC | 24-hour | 10 | Ontario |
| Beryllium | Standard | 24-hour | 0.01 | Ontario |
| Boron | Standard | 24-hour | 120 | Ontario |
| Chromium | Objective | 1-hour | 1 | Alberta |
| | AAQC | 24-hour | 1.5 | Ontario |
| Cobalt | AAQC | 24-hour | 0.1 | Ontario |
| Lithium | Standard | 24-hour | 20 | Ontario |
| Manganese | AAQC | 24-hour | 2.5 | Ontario |
| Mercury | Standard | 24-hour | 2 | Ontario |
| Molybdenum | AAQC | 24-hour | 120 | Ontario |
| Selenium | AAQC | 24-hour | 6 | Ontario |
| Silver | Standard | 24-hour | 1 | Ontario |
| Strontium | AAQC | 24-hour | 120 | Ontario |
| Tin | Standard | 24-hour | 1 | Ontario |
| Titanium | Standard | 24-hour | 120 | Ontario |
| Vanadium | Standard | 24-hour | 2 | Ontario |

AAQC – ambient air quality criterion

### 5.2.2 AIR QUALITY MODELLING

The modeling domain for the air quality impact assessment consisted of 30 km by 30 km grid centered on the Brandon G.S.

The potential effects of air pollutant emissions from the Brandon G.S. on ambient air quality were evaluated using plume dispersion models to simulate the transport and diffusion of air pollutants that would be emitted from the boiler (Unit 5), sources of fugitive dust, cooling tower emissions and the combined emissions from Unit 5 and Units 6&7. The modelling methodology to be used for evaluating the emissions from these sources was first discussed with Manitoba Conservation to confirm the appropriateness of these methods for the purposes of Unit 5's Licence Review.

Ambient ground level concentrations were calculated for common contaminants (CO, $NO_2$, $SO_2$ and particulate matter), volatile organic compounds (VOCs), as well as trace organic (PAHs) and inorganic (e.g., metals) species. Deposition rates were calculated for particulate matter, as well as trace organic

and inorganic contaminants. The predicted concentrations of common air contaminants were compared with ambient air quality criteria adopted by Manitoba and with observed ambient air quality data from stations in Winnipeg. In addition, selected VOCs and trace contaminants were evaluated by comparison with air quality criteria adopted by the Canadian Council of Ministers of the Environment (CCME) or other provinces.

The results from the air quality assessment were also used to conduct screening-level human health and ecological (trees, plants, wild and domestic animals) risk assessments for those trace quantities of organic and inorganic emissions which are not covered by provincial or federal ambient air quality standards, objectives or guidelines. The risk assessments are discussed in Section 5.4.

#### 5.2.2.1 Unit 5 and Units 6&7 Emissions

Emissions from the Unit 5 exhaust stack, as well as the combined emissions from Unit 5 and Units 6&7, were modelled using the California Puff (CALPUFF) modelling system. CALPUFF is a sophisticated dispersion modelling system that was developed by Sigma Research Corporation (now part of Earth Tech Inc.) for the United States Environmental Protection Agency (USEPA). CALPUFF is listed as a preferred/recommended dispersion model in Appendix A of the USEPA *Guideline on Air Quality Models* (US EPA 2005). The CALPUFF model has previously been used for air quality assessment of the Selkirk G.S. (SENES 2001, 2005).

Dispersion modelling of Unit 5 emissions was performed using two sets of coal properties (i.e., heating value, sulphur content, ash content, trace metal concentrations): one set representing the current coal that is being used at Unit 5, and a second set representing the range of properties associated with coal from select potential alternative suppliers that could be used in the future. In addition, in order to account for the range of performance variation associated with the different burner row combinations in the boiler, dispersion modelling was performed for the most efficient combination and the least efficient combination. The predicted long-term (on an annual basis) and short-term (1-hour and 24-hour) air concentrations were conservatively estimated from full load operating conditions (i.e., 100 % capacity factor). Dispersion modelling was performed for three operating scenarios (referred to as OS1, OS2 and OS3; see Section 2.7.1.1) which represent, respectively:

- OS1 – lowest emission rates for common air contaminants under the most efficient (and most commonly used) operating conditions using current coal supplies;
- OS2 – highest emission rates for common air contaminants under the least efficient (and least commonly used) operating conditions using current coal supplies;
- OS3 – highest emission rates for all contaminants under the least efficient operating conditions using the upper-bound coal properties of alternative coal supplies that might be used in the future.

Due to an increased awareness and concern regarding deposition of mercury, separate modelling runs were completed using the CALPUFF model to assess annual deposition of oxidized, elemental and particulate-bound mercury from the Unit 5 exhaust stack.

#### 5.2.2.2 Fugitive Dust Emissions

The primary sources of fugitive dust emissions at coal-fired power plants are coal handling and storage, and ash handling and disposal. Fugitive ash and coal dust caused by wind erosion and handling and storage of coal and ash were assessed with the Industrial Source Complex Short Term Version 3 (ISCST3). Although the CALPUFF model is capable of modelling the dispersion of fugitive dust from large area sources, the deposition algorithm within the ISCST3 model is considered by the CALPUFF model's own developer to provide a better representation of plume transport from an area source.

Coal handling operations at the Brandon G.S. that can produce fugitive dust emissions consist of: 1) coal train unloading, 2) continuous drop of coal from the slew conveyor to the active coal storage area, 3) reclaim of the coal from the active coal storage area to the coal bunker for transfer to the combustion boiler, 4) removal of coal from active storage pile to long-term storage pile, 5) reclaim of coal from the long-term storage pile, and 6) wind erosion of the active and long-term storage piles. An hour-by-hour emissions estimation methodology was used with the goal of representing both continuous emissions due to coal handling activities and sporadic bursts of emissions due to erosion during high wind speeds. As such, dispersion modelling results are indicative of both long-term (monthly, annual) ambient air concentrations and deposition amounts and short-term maximum (24-hour) ambient air concentrations.

Ash from Unit 5 is sluiced to the ash lagoon. From aerial photographs of the site, it was estimated that over 80% of the ash lagoon's 5.66 hectares is either covered by water or will be covered by vegetation, such that wind erosion is only possible over the remaining 20%.

The chemical composition of the fugitive coal and ash emissions consists of trace elements contained in the coal and ash, as well as organic products of incomplete combustion associated with the ash. For the purposes of the air quality assessment, only the values listed for operational scenario OS3 were used for the calculation of maximum ambient air concentrations and deposition rates.

#### 5.2.2.3 Cooling Tower Emissions

The potential effects of cooling tower plumes include drift (i.e., salt) deposition, fogging, icing, and solar energy loss due to shadowing. Water and salt-related emissions from the cooling tower were assessed using the Seasonal Annual Cooling Tower Impacts (SACTI) model. The SACTI model has previously been used to model emissions from the (at that time) proposed cooling tower for assessed in the 1992 EIA.

### 5.2.3 SUMMARY OF AIR QUALITY EFFECTS

The following summary is taken from Appendix K – Air Quality Impact Assessment, where the detailed results of the air quality assessment and modeling for air emissions from the Brandon G.S. Unit 5 can be found. Please refer to Appendix K for details on how the assessment was completed and the methodology and parameters used for the modeling.

The location of maximum predicted air pollutant concentrations (1-hour, 24-hour and annual averages) for the Unit 5 stack and fugitive dust sources (24-hour and annual averages) are indicated in Figure 5-4. Figures 5-5- through 5-24 show the distribution of $NO_2$, $SO_2$ and particulate matter on isopleth maps.

Isopleth maps for CO from the Unit 5 stack are not included because the relative effect of CO emissions is so small. Isopleth maps for predicted effects of the cooling tower and the combined effects for Unit 5 and Unit 6&7 $NO_x$ emissions are provided in Appendix K.

Tables 5-9a and 5-9b provide a comparison of maximum incremental concentrations for contaminants of potential concern (COPC) with applicable guidelines or objectives.

The results of the dispersion modelling analysis for air contaminants indicate that the maximum predicted incremental impacts due to typical emissions from Unit 5 operations are below the Manitoba Maximum Acceptable Level air quality objectives or guidelines. An exception is that conservatively estimated emission rates for total suspended particulate matter (SPM) and inhalable particulate matter ($PM_{10}$) from fugitive coal dust may approach provincial Maximum Acceptable objectives and guidelines, adding to exceedences near the generating station that already result from other sources such as agricultural activity and open burning. Nevertheless, even at the relatively high dust emission estimates used in the assessment, predicted concentrations at the nearest residences east and west of the plant are negligible.

Further discussion of the predicted common air contaminant (CAC), volatile organic compound (VOC), trace inorganic (i.e., metals) and trace organic compounds (PAH, dioxins/furans) concentrations is provided below.

**Table 5-9a Maximum Predicted Incremental Concentrations (µg/m$^3$) of CACs Due to Unit 5 Emissions with Relevant Ambient Air Quality Criteria in Manitoba**

| Contaminant | Criterion Classification | Averaging Period | Criterion Value | Operational Scenario | Maximum Predicted Ground-level Concentration | Percent of Applicable Criterion |
|---|---|---|---|---|---|---|
| $NO_2$[1] Janssen Method | Objective | 1-hour<br>24-hour<br>annual | 400<br>200<br>100 | OS1 | 91.0<br>7.9<br>0.2 | 22.8%<br>4.0%<br>0.2% |
| $NO_2$[1] Janssen Method | Objective | 1-hour<br>24-hour<br>annual | 400<br>200<br>100 | OS2, OS3 | 119.0<br>10.4<br>0.2 | 29.8%<br>5.2%<br>0.2% |
| $NO_2$[2] 100% Conversion | Objective | 1-hour<br>24-hour<br>annual | 400<br>200<br>100 | OS1 | 243.0<br>17.8<br>0.6 | 60.8%<br>8.9%<br>0.6% |
| $NO_2$[2] 100% Conversion | Objective | 1-hour<br>24-hour<br>annual | 400<br>200<br>100 | OS2, OS3 | 322.0<br>23.6<br>0.9 | 80.5%<br>11.8%<br>0.9% |
| CO | Objective | 1-hour<br>8-hour | 35,000<br>15,000 | OS1 | 16.1<br>3.5 | 0.05%<br>0.02% |
| CO | Objective | 1-hour<br>8-hour | 35,000<br>15,000 | OS2, OS3 | 19.1<br>4.2 | 0.1%<br>0.03% |
| $SO_2$ | Objective | 1-hour<br>24-hour<br>annual | 900<br>300<br>60 | OS1 | 190.0<br>13.9<br>0.51 | 21.1%<br>4.6%<br>0.85% |
| $SO_2$ | Objective | 1-hour<br>24-hour<br>annual | 900<br>300<br>60 | OS2 | 200.0<br>14.6<br>0.54 | 22.2%<br>4.9%<br>0.8% |
| $SO_2$ | Objective | 1-hour<br>24-hour<br>annual | 900<br>300<br>60 | OS3 | 265.5<br>19.5<br>0.71 | 29.5%<br>6.5%<br>1.2% |
| $PM_{10}$ | Guideline | 24-hour | 50 | OS1 | 0.5 | 1.% |
| $PM_{10}$ | Guideline | 24-hour | 50 | OS2 | 0.8 | 1.6% |
| $PM_{10}$ | Guideline | 24-hour | 50 | OS3 | 1.1 | 2.2% |
| $PM_{2.5}$ | Canada-Wide Standard[3] | 24-hour | 30 | OS1 | 0.3 | 1.0% |
| $PM_{2.5}$ | Canada-Wide Standard[3] | 24-hour | 30 | OS2 | 0.5 | 1.7% |
| $PM_{2.5}$ | Canada-Wide Standard[3] | 24-hour | 30 | OS3 | 0.6 | 2.0% |

[1] Based on NO to $NO_2$ conversion rates from the Janssen Method
[2] Based on 100% NO to $NO_2$ conversion at stack top
[3] Canada-Wide Standard: achievement based on the 98$^{th}$ percentile measured annually, averaged over 3 consecutive years

**Table 5-9b Maximum Predicted Incremental Concentrations (µg/m$^3$) of Inorganic and Organic Compounds Due to Unit 5 Emissions with Relevant Ambient Air Quality Criteria**

| Contaminant | Jurisdiction/Criterion Classification | Averaging Period | Criterion Value | Operational Scenario | Maximum Predicted Ground-level Concentration | Percent of Applicable Criterion[a] |
|---|---|---|---|---|---|---|
| HCl | Manitoba Guideline | 1-hour | 100 | OS1, OS2, OS3 | 0.19 | 0.19% |
| HF | Alberta Objective | 1-hour | 4.9 | OS1, OS2, OS3 | 0.18 | 3.7% |
| | Manitoba Guideline | 24-hour | 0.85 | OS1, OS2, OS3 | 0.013 | 1.5% |
| Formaldehyde | Manitoba Guideline | 1-hour | 60 | OS1, OS2, OS3 | 0.006 | 0.01% |
| Benzene | Alberta Objective | 1-hour | 30 | OS1, OS2, OS3 | 0.030 | 0.1% |
| Naphthalene | Ontario - AAQC[5] (Health) | 24-hour | 22.5 | OS1, OS2, OS3 | 0.0006 | 0.003% |
| Styrene | Ontario Standard | 24-hour | 400 | OS1, OS2, OS3 | 0.00004 | 0.00001% |
| Toluene | Ontario - AAQC (Odour) | 24-hour | 2000 | OS1, OS2, OS3 | 0.0004 | 0.00002% |
| Xylenes | Ontario Standard | 24-hour | 730 | OS1, OS2, OS3 | 0.0001 | 0.00001% |
| **Trace Inorganics[a]** | | | | | | |
| Antimony | Ontario Standard | 24-hour | 25 | OS3 | 0.000011 | 0.00004% |
| Arsenic | Manitoba Guideline | 24-hour | 0.3 | OS3 | 0.00013 | 0.04% |
| Barium | Ontario - AAQC | 24-hour | 10 | OS3 | 0.029 | 0.3% |
| Beryllium | Ontario Standard | 24-hour | 0.01 | OS3 | 0.000016 | 0.16% |
| Boron | Ontario Standard | 24-hour | 120 | OS3 | 0.0049 | 0.004% |
| Cadmium | Manitoba Guideline | 24-hour | 2 | OS3 | 0.00001 | 0.0004% |
| Chromium | Alberta Objective<br>Ontario – AAQC | 1-hour<br>24-hour | 1<br>1.5 | OS3<br>OS3 | 0.0063<br>0.00046 | 0.6%<br>0.03% |
| Cobalt | Ontario - AAQC | 24-hour | 0.1 | OS3 | 0.00003 | 0.03% |
| Copper | Manitoba Guideline | 24-hour | 50 | OS3 | 0.0007 | 0.0014% |
| Lead | Manitoba Guideline | 24-hour | 2 | OS3 | 0.00015 | 0.007% |
| Lithium | Ontario Standard | 24-hour | 20 | OS3 | 0.0005 | 0.002% |
| Manganese | Ontario – AAQC | 24-hour | 2.5 | OS3 | 0.0007 | 0.03% |
| Mercury | Ontario Standard | 24-hour | 2 | OS3 | 0.0001 | 0.007% |
| Molybdenum | Ontario – AAQC | 24-hour | 120 | OS3 | 0.0004 | 0.0003% |
| Nickel | Manitoba Guideline | 24-hour | 2 | OS3 | 0.0004 | 0.02% |
| Selenium | Ontario – AAQC | 24-hour | 6 | OS3 | 0.0001 | 0.0017% |
| Silver | Ontario Standard | 24-hour | 1 | OS3 | 0.00003 | 0.003% |
| Strontium | Ontario – AAQC | 24-hour | 120 | OS3 | 0.006 | 0.005% |
| Tin | Ontario Standard | 24-hour | 1 | OS3 | 0.003 | 0.3% |
| Vanadium | Ontario Standard | 24-hour | 2 | OS3 | 0.0005 | 0.025% |
| Zinc | Manitoba Guideline | 24-hour | 120 | OS3 | 0.0001 | 0.0001% |

[a] Predicted concentrations for the operating scenarios OS1 and OS2 would be equal or lower

The results of the dispersion modelling analysis for air contaminants indicate that the maximum predicted incremental effects due to typical emissions from Unit 5 operations are below the Manitoba Maximum Acceptable Level air quality objectives or guidelines. Two exceptions to this conclusion are:

1) A hypothetical exceedance of the Maximum Acceptable 1-hour average $NO_2$ objective for the conservative (but scientifically unrealistic) assumption that all of the NO is immediately converted to $NO_2$ as it leaves the stack. For such an assumption, adding an assumed background concentration greater than 78 µg/m$^3$ to the maximum predicted $NO_2$ concentration would be expected to result in an exceedance of the objective level on no more than one hour per year. However, a realistic estimate of NO to $NO_2$ conversion indicates that the objective would never actually be exceeded under any operating conditions.

2) Conservatively estimated SPM emission rates for coal handling and storage suggest that the maximum predicted 24-hour average SPM concentrations may, on occasion, approach the provincial Maximum Acceptable objective at or near the fenceline. Coupled with the already high background SPM levels in the area, fugitive coal dust emissions may thus occasionally contribute to exceedances of the objective level. However, the emission estimates used for the dispersion modelling analysis do not fully account for all management practices for controlling emissions that are employed at Unit 5. Consequently, the magnitude of the maximum predicted fugitive coal dust concentrations is uncertain, but is likely overestimated in this assessment.

*Nitrogen Dioxide ($NO_2$)*

The Manitoba Maximum Acceptable objective value for 1-hour average $NO_2$ concentrations is 400 µg/m$^3$ (Table 5-9a). The highest $NO_x$ emissions from the Unit 5 boiler occur with the less efficient OS2[12] burner configuration. The OS2 configuration is only used approximately 10% of the time, compared with approximately 60% for the most efficient OS1 configuration.

The major portion (64%) of $NO_x$ emitted from the Unit 5 stack is emitted as NO, which is subsequently converted to $NO_2$ as the plume is transported downwind. For regulatory purposes, $NO_x$ emissions are often evaluated using an assumption that all of the NO is immediately converted to $NO_2$ when it leaves the stack. This is an overly conservative assumption because, in reality, it takes quite a bit of time for this conversion to occur in the atmosphere. For the purposes of this assessment, the predicted $NO_2$ effects due to Unit 5 $NO_x$ emissions have been evaluated using both the conservative assumption of 100% conversion at the stack tip, as well as using a more realistic conversion estimate (referred to in the assessment as the Janssen method).

The maximum predicted 1-hour average $NO_2$ concentration using the preferred OS1 burner configuration is 243 µg/m$^3$. Adding the estimated background $NO_2$ concentrations to the predicted concentration for Unit 5 for the preferred OS1 configuration would not result in any exceedance of the provincial Maximum Acceptable objective, regardless of which NO to $NO_2$ conversion scheme is used.

[12] Note that $NO_x$ emissions for the OS3 burner configuration are the same as for the OS2 configuration because the burner configurations are the same for both operating scenarios.

At the measured $NO_x$ emission rates for Unit 5 under the OS2 burner configuration, the highest off-site 1-hour average $NO_2$ concentration would be 322 $\mu g/m^3$, if the analysis is based on the assumption that all the NO is instantaneously converted to $NO_2$ as the exhaust gas leaves the stack. This value is predicted to occur on 1 hour per year at a location SE of the Brandon G.S., near the sewage treatment plant. However, 99.95 percent of the time the predicted $NO_2$ concentration would be less than 75 $\mu g/m^3$ at this location. Adding an estimated[13] background $NO_2$ concentration of 102 $\mu g/m^3$ to the maximum predicted concentration of 322 $\mu g/m^3$ suggests that the provincial objective of 400 $\mu g/m^3$ might be exceeded on no more than 1 day per year. A more realistic assessment of maximum potential $NO_2$ effects using the Janssen method indicates that the maximum predicted 1-hour average $NO_2$ concentrations due to Unit 5 emissions would be only 119 $\mu g/m^3$ for the OS2 configuration, and adding the background $NO_2$ concentration to this value would mean that the provincial objective would not in fact be exceeded at any time when operating in the OS2 configuration.

Air quality effects due to $NO_x$ emissions were also evaluated for the combined emissions of Unit 5 and Units 6&7. The maximum predicted 1-hour average $NO_2$ concentration is 360 $\mu g/m^3$, which is predicted to occur on only 1 day per year if it is assumed that all of the NO from Unit 5 and Units 6&7 is immediately converted to $NO_2$ upon leaving the stacks. If the background $NO_2$ concentration is assumed to be 102 $\mu g/m^3$, the provincial Maximum Acceptable objective of 400 $\mu g/m^3$ could be exceeded on one hour per year. If the more realistic Janssen conversion method is used, the maximum predicted 1-hour average $NO_2$ concentration for combined operations would be only 119 $\mu g/m^3$, and the provincial objective would not be exceeded.

Assuming 100% conversion of NO to $NO_2$ at the stack, the maximum predicted 24-hour average $NO_2$ concentration is estimated to be 24 $\mu g/m^3$ for OS2, and 17 $\mu g/m^3$ for OS1. If the highest 24-hour average $NO_2$ concentration of 57 $\mu g/m^3$ recorded in Brandon over the 5-year period 2000-2004 is assumed to be representative of background $NO_2$ levels at the maximum point of impingement for the Unit 5 plume, the combined effect of background levels plus emissions from Unit 5 would not exceed the Maximum Acceptable objective of 200 $\mu g/m^3$. The provincial Maximum Acceptable objective would also not be exceeded at any location even with the combined emissions of Unit 5 and Units 6&7.

The maximum predicted annual average $NO_2$ concentration due to emissions from Unit 5 is estimated to provide an insignificant contribution of less than 1 $\mu g/m^3$ to overall $NO_2$ levels in the Brandon area.

*Sulphur Dioxide ($SO_2$)*

For power generation using the current coal supplied from the Spring Creek mine, maximum predicted 1-hour average $SO_2$ concentrations range from 200 $\mu g/m^3$ for OS2 to 190 $\mu g/m^3$ for the preferred OS1. After reviewing the coal properties of a large number of other suppliers of coal, Manitoba Hydro screened out those that would not be considered acceptable on the basis of sulphur content. For alternative sub-bituminous coals that might be used in the future, the maximum 1-hour average $SO_2$ concentrations for OS3 would not exceed 266 $\mu g/m^3$. The results indicate that the provincial objective of 900 $\mu g/m^3$ would

[13] The background $NO_2$ concentration at the Assiniboine Community College monitoring station was estimated by subtracting the maximum predicted $NO_2$ concentration due to Unit 5 emissions at that location from the maximum observed $NO_2$ concentration during the period 2000-2004.

not be exceeded either for current or potential future operations using coal with a slightly higher sulphur content.

The maximum predicted 24-hour average $SO_2$ concentrations of 13.9 µg/m$^3$ for OS1 and 14.6 µg/m$^3$ for OS2 are well below the provincial Maximum Acceptable objective of 300 µg/m$^3$. Even if in the future Unit 5 were to burn a coal with 33% higher sulphur content, the predicted concentrations of 18.5 µg/m$^3$ and 19.5 µg/m$^3$ for the two operating scenarios, respectively, would still be well below the provincial objective of 300 µg/m$^3$.

The maximum predicted annual average $SO_2$ concentration due to emissions from the Unit 5 is estimated to provide an insignificant contribution of less than 1 µg/m$^3$ to overall $SO_2$ levels in the Brandon area.

*Carbon Monoxide (CO)*

The maximum predicted 1-hour average CO concentrations of 19.1 µg/m$^3$ for OS2 and 16.1 µg/m$^3$ for OS1 are insignificant compared with the provincial Maximum Acceptable objective of 35,000 µg/m$^3$. Similarly, the maximum predicted 8-hour average CO concentrations of 4.2 µg/m$^3$ for OS2 and 3.5 µg/m$^3$ for OS1 are insignificant compared with the provincial Maximum Acceptable objective of 15,000 µg/m$^3$.

Maximum predicted CO concentrations for combined emissions from Unit 5 and Units 6&7 results in higher, but still insignificant, 1-hour and 8-hour average CO concentrations due to the higher effects of the CO emissions from Units 6&7. The maximum predicted 1-hour average CO concentration for combined emissions is 192 µg/m$^3$, consisting primarily of 188 µg/m$^3$ from Units 6&7. Similarly, the maximum predicted 8-hour average CO concentration of 63 µg/m$^3$ for combined emissions is entirely derived from Units 6&7 because the contribution of Unit 5 emissions to total CO concentration is insignificant at the maximum point of impingement for the emissions from Units 6&7. Even with the higher predicted concentrations for the combined emissions from Unit 5 and Units 6&7, the provincial objectives for 1-hour and 8-hour averaged CO concentrations would not be exceeded at any time.

*Particulate Matter (SPM, $PM_{10}$ & $PM_{2.5}$)*

The Canada-Wide Standard (CWS) parameter for $PM_{2.5}$ is 30 µg/m$^3$ (98$^{th}$ percentile, averaged over three consecutive years). The value of the CWS parameter measured at the Assiniboine Community College in 2004 was 16 µg/m$^3$. Manitoba Conservation also uses a value of 30 ug/m$^3$ (100$^{th}$ percentile with no 3-year averaging) when evaluating emission sources for regulatory permitting. At the maximum point of impingement, the highest predicted 24-hour average $PM_{2.5}$ concentration due to emissions from the Brandon G.S. Unit 5 stack is less than 0.7 µg/m$^3$, which would make it undetectable by a standard $PM_{2.5}$ monitor. The predicted concentration at the Assiniboine Community College monitoring station would be less than 0.3 µg/m$^3$. Even with combined emissions from Unit 5 and Units 6&7, the maximum predicted $PM_{2.5}$ concentration would still be less than 1 µg/m$^3$.

The maximum predicted 24-hour average $PM_{2.5}$ concentrations for fugitive dust from coal and ash storage are conservatively estimated at 15 µg/m$^3$ and 1 µg/m$^3$, respectively. At the point of maximum predicted concentration, the 98$^{th}$ percentile 24-hour average concentration for fugitive coal dust is only 1.7 µg/m$^3$, while that for ash is much less than 1 µg/m$^3$. Although the maximum point of impingement for the Unit 5 stack emissions and fugitive coal/ash emissions do not occur at the same location, the CWS parameter in

the area would not be exceeded even if they did coincide and were added to the 98$^{th}$ percentile level of 16 µg/m$^3$ measured at the Assiniboine Community College in Brandon.

The Manitoba guideline value for 24-hour averaged $PM_{10}$ is 50 µg/m$^3$. For $PM_{10}$ emissions from the Unit 5 stack, the maximum predicted 24-hour average incremental concentration is less than 1 µg/m$^3$. Based on potential future coal supplies having up to 35% higher ash content, the maximum predicted 24-hour average $PM_{10}$ concentrations would be 1.1 µg/m$^3$ for OS2 and 0.7 µg/m$^3$ for the preferred OS1 burner configuration. These values are at or below the measurement accuracy of a $PM_{10}$ monitor. Therefore, the contributions of particulate matter emissions from the Unit 5 stack do not significantly contribute to the exceedances of the provincial $PM_{10}$ guideline of 50 µg/m$^3$ that have been consistently recorded at the $PM_{10}$ monitor in Brandon.

The maximum predicted $PM_{10}$ concentrations for fugitive dust emissions are conservatively estimated at: 1) 27 µg/m$^3$ for coal dust in a location approximately 200 metres south of Unit 5, and 2) 7 µg/m$^3$ for ash emissions along the northern boundary of the ash storage area. Ninety-nine percent (99%) of the time, the maximum contribution of fugitive coal dust to ambient $PM_{10}$ levels anywhere in the area would be less than 15 µg/m$^3$. Moreover, the maximum predicted $PM_{10}$ concentrations are less than 0.5 µg/m$^3$ at the Riverview Elementary School (i.e., in the closest residential area west of the Brandon G.S. and near the air quality monitoring station at the Assiniboine Community College), as well as at the nearest residence east of Unit 5. As such, the $PM_{10}$ concentrations due to fugitive dust emissions would not be measurable at the nearest residences, and the fugitive emissions from the Brandon G.S. alone would not be sufficient to cause the high $PM_{10}$ concentrations measured in Brandon.

The Manitoba objective value for 24-hour averaged SPM is 120 µg/m$^3$. The maximum 24-hour average incremental SPM concentrations of 0.8 µg/m$^3$ due to Unit 5 stack emissions is predicted to occur near the northwest corner of the Brandon G.S. property line**.** If the ash content of future coals that might be burned at Unit 5 were up to 35% higher than for Spring Creek coal, the maximum predicted concentration (for the OS3 scenario) would be 1.1 µg/m$^3$. As such, the maximum contribution of any of the coals that may be considered suitable for future use in Unit 5 to the SPM levels in the Brandon area (i.e., as inferred from the high measured $PM_{10}$ levels) is negligible.

Maximum predicted SPM concentrations for fugitive dust from the coal and ash storage areas are 105 µg/m$^3$ and 8 µg/m$^3$, respectively. Background SPM concentrations are unknown, but may be assumed to be above the Maximum Acceptable objective at least some of the time, based on observed $PM_{10}$ concentrations. In combination with background SPM concentrations, there is a potential for coal dust emissions from the coal storage area to occasionally contribute to such exceedances of the objective level at the fenceline. However, the estimate of fugitive coal dust contributions to ambient SPM concentrations in this assessment is considered to be conservative, in that the estimated SPM emission rates from the coal storage area cannot take into account all of the emission control measures that are used by Unit 5 operators to reduce any such emissions. Consequently, it is likely that the maximum predicted SPM emissions estimated for the modelling analysis overstate actual emission rates. Even so, predicted concentrations would be less than 80 µg/m$^3$ on all but one day per year. Ninety-nine percent of the time (i.e., 361 of 365 days per year), the maximum predicted contribution to ambient SPM levels due to fugitive coal dust would be less than 27 µg/m$^3$. Furthermore, the predicted SPM concentrations at the nearest residential areas west of Unit 5 due to fugitive dust from coal and ash storage of 0.5 µg/m$^3$ and