MANITOBA HYDRO

Brandon Generating Station – Unit 5

Environmental Impact Statement

Volume 1 – Report

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EXECUTIVE SUMMARY

Manitoba Hydro has prepared this Environmental Impact Statement (EIS) as part of the Environment Act Licence Review (EALR) for Unit 5 at the Brandon Generating Station (Brandon G.S.). Manitoba Hydro is providing this EIS to the Director, Manitoba Conservation, who will review the current Environment Act Licence (1703R).

The Licence Review is a requirement of the current Environment Act Licence which specifies that the review be undertaken for operation of Unit 5 beyond 2006. The purpose of the review is to establish appropriate operating conditions and limits for the future operation of Unit 5. This EIS and the materials reviewed in the EALR process will form the benchmark and primary source of reference for the ongoing operation of the Unit and will be reflected in updated terms and conditions for the Environment Act Licence. The scope of the EALR has been predefined by the Director, Manitoba Conservation and does not include the operation of the Combustion Turbine Units 6&7 which are regulated under a separate licence (2497R).

Brandon Unit 5 commenced operation in 1969, and still utilizes the original major components, including a single 105 MW generating unit comprised of a boiler, a steam turbine-generator and accompanying auxiliary systems. The main components of Unit 5 are the steam generator, used to burn coal and heat water to produce steam, and the steam turbine, used to convert steam energy into electricity. The electricity enters Manitoba Hydro's grid through a transmission sub-station used for regulating voltages.

Major plant auxiliary systems include the water systems, coal-handling and ash-handling systems and particulate control systems. The major water systems utilize water withdrawn from the Assiniboine River and include: the water treatment plant that produces process water for the steam cycle and make-up water for the closed-loop cooling water system; the closed-loop cooling water system including a cooling tower, used to condense the steam exiting the steam turbine; service water used for ash handling and cooling of auxiliary equipment. Coal is delivered by train from its source in the Powder River Basin (Montana/Wyoming area) and is stockpiled on site to maintain a ready supply of fuel for the boiler. Particulate emissions from the combustion process are controlled by an Electrostatic Precipitator (ESP) located between the boiler and the exhaust stack.

Liquid effluents from the operation of Unit 5 include discharge from the ash lagoon and station drain, heated cooling water discharge from the cooling water compressor and surface runoff from the site and coal storage area. Sanitary wastes are directed to the City of Brandon municipal system.

The sources of air emissions include: the Unit 5 exhaust gas stack; the cooling tower; dust from coal handling operations and ash storage. In addition, the EIS has evaluated the combined emissions from Unit 5 and Units 6&7 stacks.

The air emissions from coal combustion in Unit 5 primarily consist of common contaminants such as oxides of nitrogen (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2) and particulate matter (SPM, PM_{10} and $PM_{2.5}$). There are also trace organic and inorganic substances released. The combustion of coal also results in greenhouse gas (GHG) emissions. Emissions of water vapour from the cooling tower include dissolved solids.

Several modifications to Unit 5 will be undertaken following the licence review process: redevelopment of the ash lagoon through the addition of new cells; the installation of a Continuous Emissions Monitoring System (CEMS) for NO_x and SO_2; and modifications to the station drains system.

The assessments conducted in the EIS have been designed to be intentionally conservative (i.e. the predicted environmental effects resulting from the operation of Unit 5 are likely overestimated). Primarily, inherent uncertainty is accounted for by utilizing conservative underlying assumptions and assessment methodology. For example, assessments assume Unit 5 will operate at maximum output continuously which overestimates long-term effects from Unit 5. In addition, conservative assumptions are used regarding the characteristics of future coal supplies. The result is the assessments conducted establish a robust benchmark for the Environment Act Licence ensuring the EIS remains applicable under a range of future operations.

The preparation of this EIS not only considers the requirements of the Environment Act, but also considers Manitoba Hydro's more broad economic and social responsibilities under the Manitoba Hydro Act and the guiding principles of the Sustainable Development Act and Manitoba Hydro's Environmental Management Policy, which includes ISO 14001 certification.

Water

During operation of Unit 5, water is withdrawn from the Assiniboine River for several plant processes. Construction of a cooling tower in the mid-1990s greatly reduced the volume of water withdrawn from the Assiniboine River. Given the small proportion of flow that is withdrawn (even under extreme low flow conditions <10% of the total flow is withdrawn) and the presence of a screen on the water intake, water withdrawal by Brandon G.S. does not significantly affect aquatic life in the river.

Unit 5 produces four wastewater streams: (i) discharge from the station drain; (ii) effluent from the ash lagoon; (iii) discharge from the compressor cooling water; and (iv) surface runoff from the coal storage area. Based on the volume and nature of the effluents, discharge from the compressor cooling water and surface runoff are expected to have no detectable effect on water quality in the Assiniboine River.

The largest wastewater stream is from the ash lagoon. Water is used to sluice ash from the combustion of coal to the ash lagoon, where the ash settles and the decant water is discharged to a ditch that flows into the Assiniboine river. The wastewater contains substances present in the raw river water combined with material from the ash that does not settle in the ash lagoon. Laboratory tests using rainbow trout show that the wastewater is not toxic under normal operating conditions. Comparisons of wastewater to environmental guidelines and the river water indicate that there is no significant negative effect on river water quality.

The station drain receives effluent from a variety of sources, including drains within the station, and blowdown from the boilers. Comparison of effluent quality to environmental guidelines and the river water indicates that there is no significant negative effect on river water quality.

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 Manitoba Water

Quality Standards, Objectives and Guidelines (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).

Air

Using the maximum possible emission rate, in combination with background ambient concentrations, the air quality assessment concludes that the Manitoba Maximum Acceptable Ambient Air Quality Objectives for maximum predicted carbon monoxide (CO) and sulphur dioxide (SO_2) concentrations would not be exceeded at any time. Realistic assessment of nitrogen oxide (NO_x) conversation rates to nitrogen dioxide (NO_2) also indicate that the Manitoba Maximum Acceptable Ambient Air Quality Objectives for NO_2 would also be achieved. Maximum predicted concentrations of fine particulate matter emitted from the Unit 5 stack represent just 1-2% of the Manitoba Maximum Acceptable Guideline for inhalable particulate matter (PM_{10}), as well as 1-2% of the Canada-Wide Standard for respirable particulate matter ($PM_{2.5}$). Predicted concentrations of selected volatile organic compounds (VOCs) and trace inorganic elements are below any ambient air quality objectives, guidelines or standards established in Ontario or other Canadian provinces.

Conservatively estimated emission rates for total suspended particulate matter (SPM) and PM_{10} from fugitive coal dust at the Brandon G.S. boundary, may approach provincial Maximum Acceptable objectives and guidelines, adding to exceedences near the Brandon G.S. that already result from other sources such as agricultural activity and open burning. However, the emission estimates used for the dispersion modelling analysis do not fully account for all management practices for controlling dust emissions that are employed at Brandon G.S. Consequently, the magnitude of the reductions in concentrations from these control measures is uncertain and the predicted concentrations are likely overestimated. Nevertheless, even using the maximum fugitive dust emission estimates, predicted concentrations at the nearest residences east and west of the plant are negligible.

Maximum predicted concentrations of trace organics are 1 million to 100 million times lower than those observed in downtown Winnipeg for polycyclic aromatic hydrocarbons (PAH), while dioxins and furans are 1 billion to 100 billion times lower than levels observed in downtown Winnipeg. Mercury emissions from the combustion of coal in Unit 5 contribute only 2-4% of the total estimated mercury deposition in the Brandon area, with the remainder being transported to the region from other sources in North America and overseas (i.e., Asia). Manitoba Hydro has voluntarily adopted a 20 kg per year mercury emission limit prior to the implementation of mandatory limits of the same magnitude in 2010.

Carbon dioxide (CO_2) is the primary greenhouse gas (GHG) emitted from Unit 5. Although total emissions will vary from year-to-year, at 100% of capacity, Unit 5 can produce about 1.04 megatonnes per year (Mt/yr) of CO_2-equivalent GHG. However, on average, annual emissions from the Unit will be much lower. Since 1990, Unit 5 has contributed less than 0.5% of Canada's GHG emissions. Manitoba Hydro has been committed to voluntarily reducing average corporate GHG emissions to 6% below 1990 levels in the 1991 to 2007 period. Manitoba Hydro will continue to manage its GHG emissions, including emissions from Unit 5, on a voluntary basis until such time as a mandatory system is implemented.

Noise

The sound level contributions from the Brandon G.S. are below those stipulated in the operating Licence (No. 1703R) for the facility, and below the daytime and nighttime limits in Manitoba. The results also show that noise levels at the nearest residential receptors are predicted to be marginally higher during unit start-up versus regular steady operation.

Risk Assessment

Two risk assessment analyses were conducted: human health and environmental. The human health risk analysis of possible short-term (acute) effects (e.g., respiratory health effects) and long-term (chronic) effects arising from Unit 5 operations indicates there will be no incremental measurable, adverse effects on human health. The environmental risk assessment also found no incremental measurable adverse effects.

Physical Environment

An assessment of the existing physical environmental conditions that include terrestrial biology, wildlife and habitat, hydrology, hydrogeology and groundwater, was conducted within the property boundaries of the Brandon G.S. The two Brandon G.S. operational areas that have the potential to affect the physical environment are the ash lagoon and coal storage area. Much of the physical environment has already been disturbed by human presence, the original development and ongoing operations of the Brandon G.S. The results of Manitoba Hydro's ongoing groundwater monitoring program indicate that there are higher levels of trace elements in some of the monitoring wells between the ash lagoon and the Assiniboine River. However, it is predicted the residual effect of continued ash lagoon operation is negligible to small after mitigative measures are/were implemented. Supplemental monitoring has been proposed to confirm that the effect is negligible. Adverse effects due to groundwater seepage to the river are not expected. With mitigation and monitoring, it is concluded there are no significant, adverse effects to wildlife, vegetation or groundwater from the operation of Unit 5.

Socio-economic Environment

Environmental effects associated with the continuing operation of Brandon G.S. have been identified as minimal; therefore, negative socioeconomic impacts that may arise as a result of station-related environmental effects are also expected to be minor in nature. Positive socioeconomic effects relate to station employment (up to 88 staff at the Brandon G.S., 89% of whom live in Brandon or the R.M. of Cornwallis, an additional 21 indirectly employed in Winnipeg, and approximately five employed by CP Railway to support coal handling). It is estimated that operation of Unit 5, through salaries, local material and equipment purchases, directly contributes $5-6 million per year to the local economy and an additional $1-2 million per year in Winnipeg. Additional economic benefits are realized by the City of Brandon in grants in lieu of taxes.

Environment Act Licence Clause Review

The current Environment Act Licence contains reference to the installation of equipment or the completion of studies and reports that have long since been undertaken and therefore are not relevant to future operation of the Unit. The objective of the EALR is to reconcile licence terms and conditions governing Unit 5 with prevailing regulations and standards, and current operating practices. Therefore, Manitoba Hydro has provided a clause-by-clause review of the existing licence terms and where appropriate suggested revisions to clauses that have become outdated, or removal of clauses that no longer apply.

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LIST OF ACRONYMS

BOD_5 – biological oxygen demand (5 day)

CAC – Common Air Contaminant

CAEAL – Canadian Association for Environmental Analytical Laboratories

CCME – Canadian Council of the Ministers of the Environment

CCW – Circulating Cooling Water

CEMS – continuous emission monitoring system

CEPA – Canadian Environmental Protection Act

CF – capacity factor

CH_4 - methane

CO – carbon monoxide

CO_2 – carbon dioxide

COPC – contaminants of potential concern

CW – cooling water

CWS – Canada-wide Standards

DAHS – data acquisition handling system

DFO – Department of Fisheries and Oceans Canada

EALR – environment act licence review

EC – Environment Canada

ECR – environmental commitment and responsibility program

EIS – environmental impact statement

EMS – environmental management system

ERC – emergency response crew

ERP – emergency response plan

ESP – Electrostatic Precipitator

GHG – greenhouse gas

G.S. – Generating Station

GWh – gigawatt-hour

Hg - Mercury

ISO – International Organization for Standards

MESA – Manitoba Endangered Species Act

MBCA – Migratory Birds Convention Act

MW - megawatt

MWAT – maximum weekly average temperature

MWQSOG – Manitoba Water Quality Standards, Objectives and Guidelines

MWS – Manitoba Water Stewardship

N_2O – nitrous oxide

NO_2 – nitrogen dioxide

NO_X – oxides of nitrogen

PAH – polynuclear aromatic hydrocarbon

PCB – polychlorinated biphenyl

PM – particulate matter

$PM_{2.5}$ – particulate matter (2.5 micrometres or smaller)

PM_{10} – particulate matter (between 2.5 and 10 micrometres)

PR – provincial road

PRB – Powder River Basin coal supply

PTH – provincial trunk highway

QA/QC – quality assurance/quality control

RCM – reliability centred maintenance

RM – rural municipality

SARA – Species at Risk Act

SO_2 – sulphur dioxide

SPM – suspended particulate matter

TEOM – tapered element oscillating microbalance

TDS – total dissolved solids

TSP – total suspended particulates

TSS – total suspended solids

US EPA – United States Environmental Protection Agency

UV - ultraviolet

VCR – Voluntary Challenge and Registry

VOC – volatile organic compound

WHMIS – Workplace Hazardous Materials Information System

YOY – young-of-the-year

CHAPTER 1

ENVIRONMENT ACT LICENCE REVIEW

1.0 ENVIRONMENT ACT LICENCE REVIEW

This document is an Environmental Impact Statement (EIS) that has been prepared as part of the Environment Act Licence Review (EALR) for Brandon Generating Station Unit 5 (Unit 5). Manitoba Hydro is providing this EIS to the Director, Manitoba Conservation, to facilitate review of the Environment Act Licence for Unit 5 operation at the Brandon Generating Station (Brandon G.S.). The purpose of the EIS and the EALR process is to establish appropriate operating conditions and limits for the future operation of Unit 5. The Licence Review process allows for the updating of the terms and conditions of the current Environment Act Licence to reflect future Unit 5 operations, recognizing environmental improvement activities that have taken place during the term of the current licence. The successful completion of the Licence Review will establish clear and consistent terms and conditions to govern the ongoing operations of Unit 5 within the context of Manitoba Hydro's integrated power generation and transmission system.

1.1 REGULATORY FRAMEWORK

The first four units at the Brandon Generating Station entered service between 1957 and 1958, with Unit 5 coming on-line in 1969. Since that time, the station has undergone several provincial environmental licencing reviews. Formal environmental, regulatory approvals for the Brandon Generating Station date back to April, 1972 when the Manitoba Hydro-Electric Board submitted an application to the Clean Environment Commission ("CEC") for a licence to operate the station. This eventually resulted in the issuance of CEC Order No. 340 on March 19, 1974 by the Commission. This approval dealt entirely with station effluents entering the Assiniboine River.

The first full Environmental Impact Assessment (EIA) was completed in 1976 (Environmental Impact Assessment of the Operations of the Brandon Generating Station, James F. MacLaren Ltd.). Specific terms and conditions regarding air emissions were established on April 22, 1984 with the issuance of CEC Order No. 1039. This order was subsequently revised in 1986 as Order No. 1039 VC and was significantly updated afterwards on January 26, 1989 as Environment Act Licence No. 1246. Licence No. 1246 was entirely focused on air quality related issues.

In 1992, Manitoba Hydro submitted a proposal to upgrade Unit 5 to assure reliable operation into the twenty-first century. This proposal was accompanied by a plan to remove Units #1-4 from service by 1996. The proposal included a comprehensive EIA of all aspects of the operation of Unit 5 (Environmental Impact Assessment, 1992) and a full regulatory review under the Environment Act. This review resulted in the issuance of Environment Act Licence No. 1703 in 1993, which was a comprehensive licence containing terms and conditions regarding air, water and solid waste, and with the pending retirement of Units #1-4, became applicable solely to the operation of Unit 5. As part of this review, a closed-loop cooling system and electrostatic precipitator were installed on Unit 5. This licence was revised on February 14, 1994 as Licence No. 1703R and currently governs the operation of Unit 5 and its related systems.

In 2001, Manitoba Conservation issued Licence No. 2497 for the operation of two gas or fuel oil fired, Combustion Turbine Generating Units (Units 6&7) at the Brandon G.S. (260 MW rated power). The licence considers only development and operations that are incremental to that covered by 1703R. The licence for the operation of Units 6&7 was subsequently revised in 2003 as Licence No. 2497 R.

Generally, the current licence (1703R) contains:

- Limits for stack emissions and fugitive dusts;
- Limits for liquid effluents;
- Monitoring and reporting requirements for stack emissions, liquid effluents and groundwater; and
- The requirement for additional studies and information.

Licence No. 1703R is copied in Appendix A of this report, and is more closely examined in Chapter 9.

In addition to the licence issued under the Manitoba Environment Act, operation of the Unit 5 is governed by other regulatory authorities such as DFO, Transport Canada and Water Stewardship.

1.2 PURPOSE OF LICENCE REVIEW

A condition of Manitoba Environment Act Licence 1703R is that it be reviewed by Manitoba Conservation if Unit 5 is to continue operation beyond the year 2006 (Clause 44). Since Manitoba Hydro intends to continue operation of the Unit, the Licence Review is being conducted to satisfy this requirement. Manitoba Hydro also sees the Licence Review as an opportunity to conduct a comprehensive review of Unit 5 and all of its systems to ensure that they are operating in accordance with prevailing and anticipated, future regulations and standards set by the Provincial and Federal Governments.

This Licence Review gives Manitoba Hydro the opportunity to assess its environmental performance and to identify and obtain approval to carry out potential improvements. The Licence Review is an opportunity to update the terms and conditions of the entire Environment Act Licence to ensure alignment of ongoing operations, environmental controls and operating practices with current environmental science. The economic viability of continued operations of Brandon Unit 5 and the effective planning for future electricity demands in the province is contingent on obtaining clear and concise licence terms and conditions for ongoing operation.

This EIS, prepared as part of the EALR process and submitted to Manitoba Conservation, supports the revisions to the current licence terms and conditions that are suggested in Chapter 9. This EIS is comprehensive, and supersedes Manitoba Hydro's 1992 EIA submission.

1.3 LICENCE REVIEW SCOPE

The study scope for the Licence Review and the EIS has been chosen to directly correspond to the scope of the existing Environment Act Licence (1703 R) which currently governs the operation of Unit 5. With the retirement of Units 1-4, as generators, in 1996, Licence 1703 R became applicable solely to the operation of Unit 5 and the associated balance of the station, and until 2002 constituted "the Brandon G.S.". With the addition of Units 6&7 in 2002, the Brandon G.S. is now defined as including all three of these units and their operations. However, Unit 6&7 operation is governed under a separate licence (2497R) and is not considered as part of this review unless otherwise specified. The term “Unit 5” is used throughout this report and refers to the generating unit and the directly associated plant infrastructure and its operations that are the primary focus of this report and review. Where the term “Brandon G.S.” is used, the reference is usually broader, referring to the site, property or building infrastructure in general. “Unit 6&7” refers to infrastructure or operations of units 6&7 generally governed under Licence 2497R. (Figure 2-2)

Correspondence with Manitoba Conservation dated May 18, 2004 and June 9, 2004 (provided in Appendix B) established the scope of this Licence Review to include a detailed environmental impact assessment that would form the benchmark and source of reference for the future operation of Unit 5 on coal. A clause-by-clause review of the current licence as it relates to future operation of Unit 5 has also been completed and is included in Chapter 9. Manitoba Conservation advised that Manitoba Hydro implement a public consultation process during the preparation of the EIS to ensure opportunity for public participation and input. Public input has been considered throughout the development of this EIS. For the specific results of Manitoba Hydro’s public consultations, refer to Chapter 3.

Manitoba Conservation also advised Manitoba Hydro that a formal submission under Section 11 of the Manitoba Environment Act was not required. All correspondence between Manitoba Hydro and Manitoba Conservation can be found in Appendix B.

1.3.1 TEMPORAL SCOPE

The time frame (temporal scope) assumed in the assessments of environmental effects of the operation of Unit 5 is from the present day until at least 2019. This assumption is based on Manitoba Hydro’s current power resource plan, which identifies the most effective means to serve Manitoba’s forecasted electrical demands into the future. Currently, there are no plans for decommissioning Unit 5. These will be developed closer to the actual date of decommissioning.

1.3.2 SPATIAL SCOPE

The study area for the EIS encompasses the land upon which the Brandon G.S. has been constructed as well as the area surrounding the site that may be impacted by operation and maintenance of the facility. This area beyond the station boundary varies depending on the environmental component being examined. For example, the spatial scope for the air quality assessment includes a 30 x 30 km area (Figure 5-4 in Chapter 5) centred on the Brandon G.S. The aquatic assessment includes specific upstream and downstream sections of the Assiniboine River. The noise assessment analyzes noise emissions at the property boundary and considers the nearest residential receptor locations to Unit 5. The chapters dealing specifically with air, aquatic and terrestrial study aspects explain spatial scope considerations in more detail.

1.3.3 LICENCE REVIEW SCOPE

This EIS includes an updated environmental impact assessment of current and future operations, and discusses foreseeable modifications and upgrades to Unit 5 and the associated plant only. This EIS also includes foreseeable changes to environmental regulations applicable to Unit 5 within the context of the environmental assessment.

The EIS does not include assessment of the operations directly related to Units 6 and 7 as they are regulated under a separate licence, except for the assessment of cumulative air emissions effects in Chapter 5. In the case of water withdrawal, where infrastructure is common to the operation of both Unit 5 and Units 6&7, efforts were made to distinguish between the respective operations where appropriate. Operations of Unit 5 and Units 6&7 are also independent, although central operational control for Units 6&7 takes place from within a common control room located in the original Brandon G.S. building. Refer to the air, aquatic and physical environment chapters for additional details.

Other than regional air quality, this report does not address local environmental effects arising from sources other than Unit 5 and the Brandon G.S., such as future developments that may occur at the Brandon G.S. or in the surrounding area. The report does not include an assessment of environmental effects associated with coal transportation from the mine to the station; it does include an assessment of coal unloading and handling at the station.

1.4 ENVIRONMENTAL ASSESSMENT METHODOLOGY

Assessments conducted to produce this report have been designed to be conservative (i.e. the predicted environmental effects resulting from the operation of Unit 5 are likely overestimated). In principle, assumptions used in the assessments are intended to be conservative to encompass inherent uncertainty and variability in systems being assessed. For example, conservative assumptions are made regarding operating forecasts and coal chemistry. Therefore, the EIS is applicable to a broad range of possible future conditions, establishing a robust benchmark for the Environment Act Licence.

Air and aquatic assessments conservatively assume that the station will be operating at its maximum theoretical output; full-output operation for all hours of a given year, or the equivalent of 920 GWh/yr (the maximum theoretical output at 100% capacity factor). This assumes that the station will be operated at its full output all of the time, resulting in more annual generation than is practically feasible from the station in any given year, or will be accumulated over the remaining life of the station. The maximum theoretical generation assumption does not account for maintenance, any licence limits, or reductions in operations from voluntary commitments. Recent historic operation is in the order of one half of the maximum theoretical generation (for additional information on future operations, see Section 2.3). Using the maximum theoretical generation therefore is an intentionally conservative underlying assumption that simplifies the assessment process, but which consistently produces an overestimate of effects for the scenarios examined under all circumstances.

The assessment of environmental effects considered not only Manitoba Hydro’s current source of coal, but also the future use of different coals by examining an upper bound set of coal parameters derived from various different coal sources. Because the configuration of burners in use at a given time can also affect air quality assessments, different burner configurations were considered in the studies and assessments were conducted with the lowest efficiency configuration, even though this configuration is not regularly used. The individual environmental effects chapters deal with these assumptions in more detail and discuss other assessment-specific assumptions. Uncertainty in the assessments is also qualitatively addressed in each chapter.

1.5 OTHER REGULATORY CONSIDERATIONS

In addition to the Environment Act Licence that directly governs the operation of the station through the enforcement of appropriate limits and operating conditions, Manitoba Hydro, as a Crown corporation, is governed by the Manitoba Hydro Act. Under the Act, the corporation is charged with responsibilities that include the provision of safe, reliable, economical and environmentally responsible supply of energy for Manitoba, and to earn revenues to keep rates low for Manitobans through the export of power and the provision of energy-related services. As indicated by the Act, the responsible supply of electricity in the province involves many considerations and a balancing of economic, social and environmental objectives.

Unit 5 is a low cost source of supply that complements the hydraulic, gas-fired, and wind resources that make up Manitoba Hydro's integrated system. The Unit also provides operational benefits and contributes to the efficient and effective operation of the overall system in ways that could not be duplicated with other resources.

In consideration of social and environmental factors in the planning and general operation of its system, Manitoba Hydro is guided by the Provincial Sustainable Development Act and has its own Sustainable Development Policy and Principles directly aligned with the Provincial Act. Manitoba Hydro also has its own Environmental Management Policy (Please refer to Section 8.3 for additional details), which includes International Standards Organization 14001 certification.

Plans to continue to operate Unit 5 have considered these various regulatory responsibilities. Furthermore, Unit 5 is a very small generating unit compared to most other coal fired generating stations in Canada or the United States. The Unit's relatively small size, combined with efficient operating practices, the use of low-sulphur coal, effective environmental controls, and emissions management policies minimize the effects of the station on the environment. Through the preparation of this submission, Manitoba Hydro is satisfied that the continued operation of Unit 5 is consistent with the objectives of the Manitoba Hydro Act, and Manitoba Hydro's Sustainable Development and Environmental Management Policies.

1.6 STUDY TEAM

A study team comprised of Manitoba Hydro, UMA Engineering Ltd., North/South Consultants Inc. and SENES Consultants Limited has prepared this EIS. UMA was the lead consultant responsible for overall coordination of the preparation of the EIS. North/South was responsible for the aquatic assessment component of the EIS and SENES was responsible for the air quality and risk assessment components. Manitoba Hydro staff contributed to the preparation of the EIS throughout the process, including providing information regarding past, present and future Unit 5 facilities and operations.

1.7 REPORT ORGANIZATION

The EIS is contained within three volumes. Volume 1 contains the Environmental Impact Statement for Unit 5 Operations, along with supporting tables and figures. Volumes 2 and 3 are comprised of the appendices.

The EIS (Volume 1) is organized in the following chapters:

Executive Summary a summary of the EIS;

Chapter 1 Introduction to Unit 5 Environmental Act Licence Review (EALR) scope, process, methodology and regulatory framework;

Chapter 2 Unit 5 history, operation, plant processes, proposed modifications, inputs and outputs;

Chapter 3 Information on the public consultation phase of the EIS;

Chapter 4 The environmental setting, environmental effects, mitigation, monitoring and significance of residual effects on the aquatic environment for Brandon Unit 5;

Chapter 5 The environmental setting, environmental effects, mitigation, monitoring and significance of residual effects on the air and noise environment for Unit 5. This Chapter also includes an environmental and human health risk assessment for the air emissions from Unit 5;

Chapter 6 The environmental setting, environmental effects, mitigation, monitoring and significance of residual effects on the physical environment for Unit 5;

Chapter 7 Socio-economic environment for Unit 5, mitigation, monitoring, and significance of residual socio-economic effects related to Unit 5;

Chapter 8 Mitigation, monitoring and significance of residual effects for Workplace health and safety, emergency response and environmental management for Unit 5;

Chapter 9 A clause-by-clause review of the current Environment Act Licence for Unit 5; and

Chapter 10 References.

CHAPTER 2

BRANDON GENERATING STATION – UNIT 5

2.0 BRANDON GENERATING STATION – UNIT 5

This Chapter introduces Unit 5 and explains in some detail its history, major facilities, operations and major processes including intended modifications, inputs and outputs.

2.1 HISTORY OF BRANDON GENERATING STATION

The Brandon Generating Station consists of three (3) thermal generating units and was built to supplement hydroelectric generating stations. The generating station originally operated 5 coal-fired units until 1996 when Units 1-4 were taken out of service. Unit 5 remains the only coal-fired unit in operation and was commissioned in 1969. Units 6&7 are natural gas/oil fired combustion turbine-generators that were commissioned in 2002. Significant dates for the Brandon G.S. are summarized in Table 2-1.

Table 2-1 Brandon G.S. Chronology of Significant Dates

Year	Event
1957	33 MW, Unit 1 was commissioned and came on-line.
1958	33 MW, Units 2, 3 and 4 were commissioned and came on-line.
1969	105 MW, Unit 5 was commissioned and came on-line.
1974	First provincial environmental approval received. Several additional environmental approvals issued by the Province between 1972 and 1994.
1976	First full environmental impact assessment of the Brandon G.S. was conducted.
1992	33 MW, Unit 4 was taken out of generating service.
1993	The current Environmental Act Licence (No. 1703) was issued by Manitoba Environment. Subsequently revised to 1703R in 1994.
1996	33 MW, Units 1, 2 and 3 were taken out of generating service. Unit 5 Electrostatic Precipitator (ESP) was installed to capture >98% of particulate matter (ash) exiting the boiler and closed-loop cooling system was installed.
1997	105 MW, Unit 5 switched from Saskatchewan Lignite to Powder River Basin Sub-Bituminous coal.
2002	With the conversion of the Selkirk G.S. to burn natural gas, Brandon G.S. Unit 5 is the only coal-fired generating unit remaining in the Manitoba Hydro fleet.
2002	130 MW, Units 6&7, dual fuel combustion generators (natural gas and fuel oil) were commissioned and came on-line.
2005	33 MW, Units 1, 2, 3 and 4 were retired.
2006	Review of Brandon G.S. Environmental Act Licence No. 1703R.

2.2 EXISTING STATION FACILITIES

The Brandon G.S. is located on the outskirts of the City of Brandon (Figure 2-1). The site occupies approximately 180 ha and is located on the eastern outskirts of the City of Brandon.

The total capacity of the station is 365 MW and consists of three active generating units:

- **Unit 5** 105 MW Unit 5 coal-fired steam generating unit commissioned in 1969; and
- **Units 6&7** Each 130 MW simple cycle natural gas/oil fired combustion turbine- generators commissioned in 2002

2.2.1 STATION LAYOUT

Figure 2-2 provides a current aerial photograph of the station site. Major station components are labelled on the figure, and include:

- steam generation powerhouse;
- cooling tower
- circulating cooling water (CCW) pumphouse (retired);
- Cooling tower water treatment plant
- raw water pumphouse;
- raw water intake
- coal unloading and handling facilities;
- heavy equipment and locomotive garages;
- long term coal stockpile;
- short term coal stockpile (live coal stockpile);
- ash lagoon with effluent discharge structure
- Unit 1&2 stack (retired);
- Unit 3&4 stack (retired);
- Unit 5 stack;
- switchyard;
- groundwater observation wells;
- water treatment plant;
- Unit 6&7 powerhouse;
- fuel oil unloading and storage facility; and
- station drain outfall.
- Assiniboine River weir
- natural gas regulating station

The Manitoba Hydro property surrounding the Brandon G.S. is accessed by Victoria Ave. E., and by the Canadian Pacific (CP) Railway. The roadway is a paved all-weather road developed to highway standards, and is an important link in the regional transportation system.

Figure 2-1 Site Location Plan

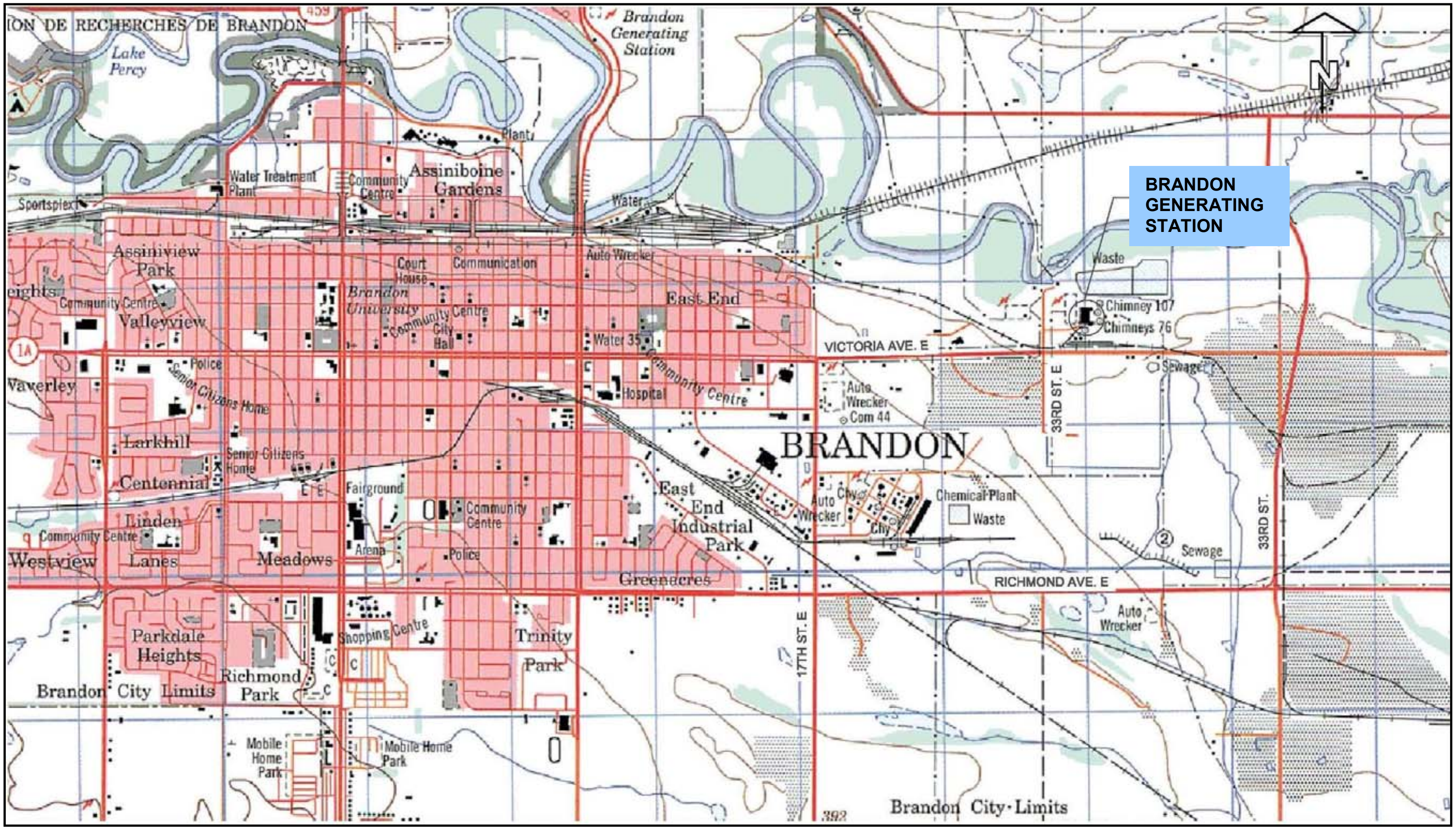
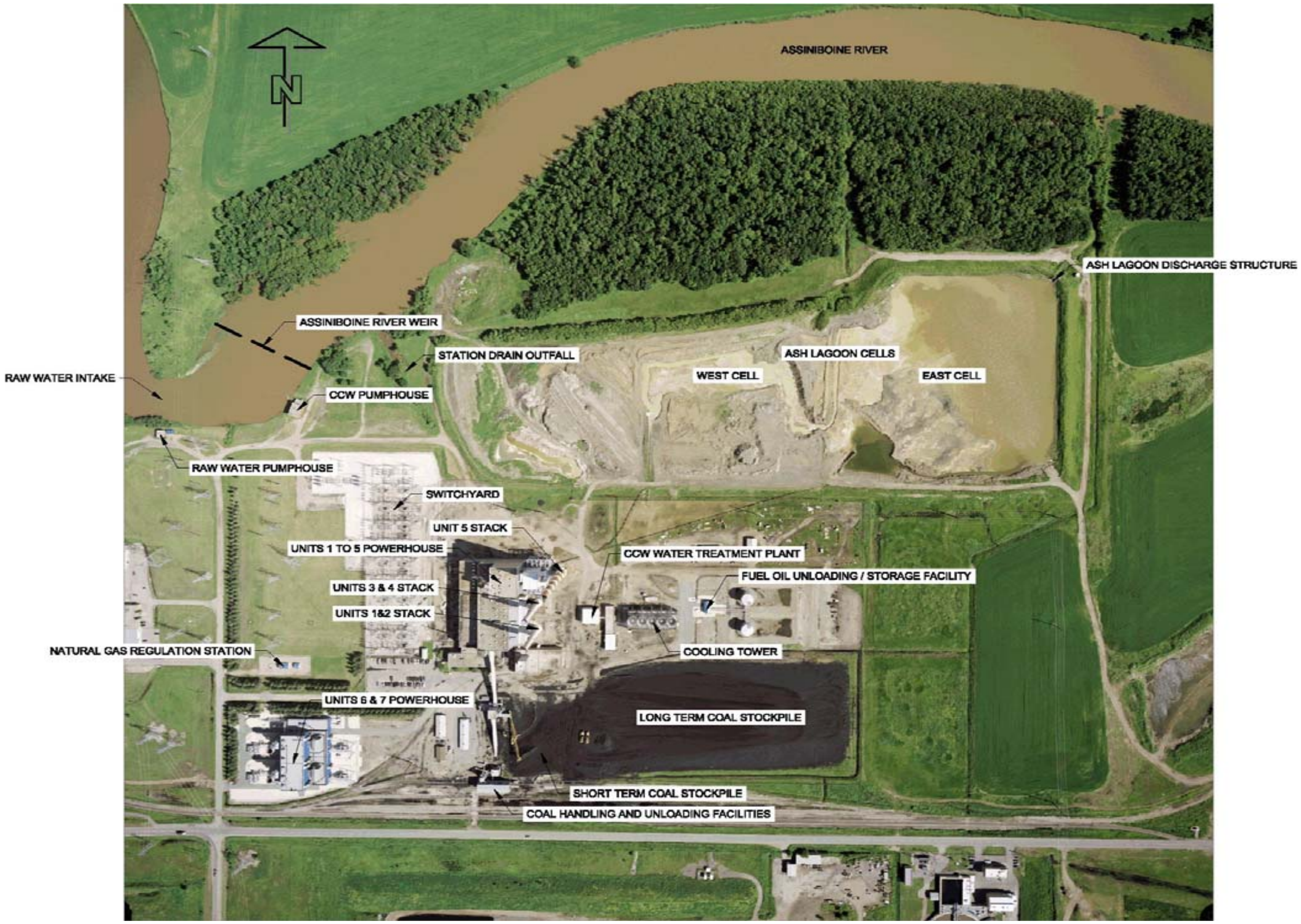


Figure 2-2 Current Aerial Photograph of the Brandon G.S.



2.3 FUTURE OPERATION

For the period beyond 2006, Unit 5 will operate in accordance with the terms and conditions of the prevailing Environment Act Licence, and will meet all voluntary and mandatory emissions commitments and limits. Annual generation from Unit 5 will vary according to changes in water conditions, domestic demand and load growth, weather, changes in the timing of generating resource additions and retirements, prolonged generation or transmission outages, emerging export sales opportunities, the cost of fuel and the cost of importing power.

Recent historical generation levels have been in the order of one-half of the maximum theoretical generation assumption of 920 GWh/year used throughout the assessments. For the period 1995 to 2000, average annual generation from Unit 5 was 250 GWh/year. For the period of 2001 to 2004, operation was approximately 420 GWh/year.

Long-term operation is expected to remain balanced, with periods of higher than average operation offset by periods when the Unit is not needed or is off-line for maintenance. In the future, Manitoba Hydro will remain committed to managing its GHG emissions on a voluntary basis until such time as mandatory regulations are imposed. Similarly, Manitoba Hydro's recent commitment to a voluntary cap on mercury emissions may limit the operation of the Unit in certain years (see Sections 5.3 for air emissions mitigation discussion).

In the long-term, therefore, average Unit 5 operation is expected to remain well below the maximum capability of Unit 5 (the maximum theoretical generation). It should be noted that climate change is not likely to cause dramatic changes to Manitoba's demand for power over the next 15 years. Therefore, it is also very unlikely that the physical changes in the climate will affect the expected usage of Unit 5 in the future.

2.4 PROCESS DESCRIPTION

The process of generating electricity using thermal energy has been used for over a century. Chemical energy is converted into electrical energy by burning a feedstock fuel (coal in the case of Unit 5) to produce steam which, in turn, drives a steam turbine generator.

The main components of a thermal electricity generation process are the steam generator, the steam turbine and the electrical generator. The electrical energy enters Manitoba Hydro's grid through a transmission sub station used for regulating voltages. Figure 2-3 is a simplified process flow diagram showing the major process streams:

- input of coal to the discharge of combustion by-products to the atmosphere and ash lagoon;
- production of steam and conversion of steam energy to electricity;
- use of cooling water to condense steam exiting the steam turbine and cool auxiliary equipment; and
- use of raw water to transport ash to the ash lagoon.

Water systems, include: the water treatment plant, that produces process water for the steam cycle; a circulating cooling water (CCW) circuit (including the cooling tower), used to condense the steam exiting the steam turbine; and raw water systems for cooling auxiliary equipment, fire fighting and sluicing ash from the boiler to the ash lagoon.

Liquid effluents include water treatment wastes, ash lagoon discharge, site run-off.

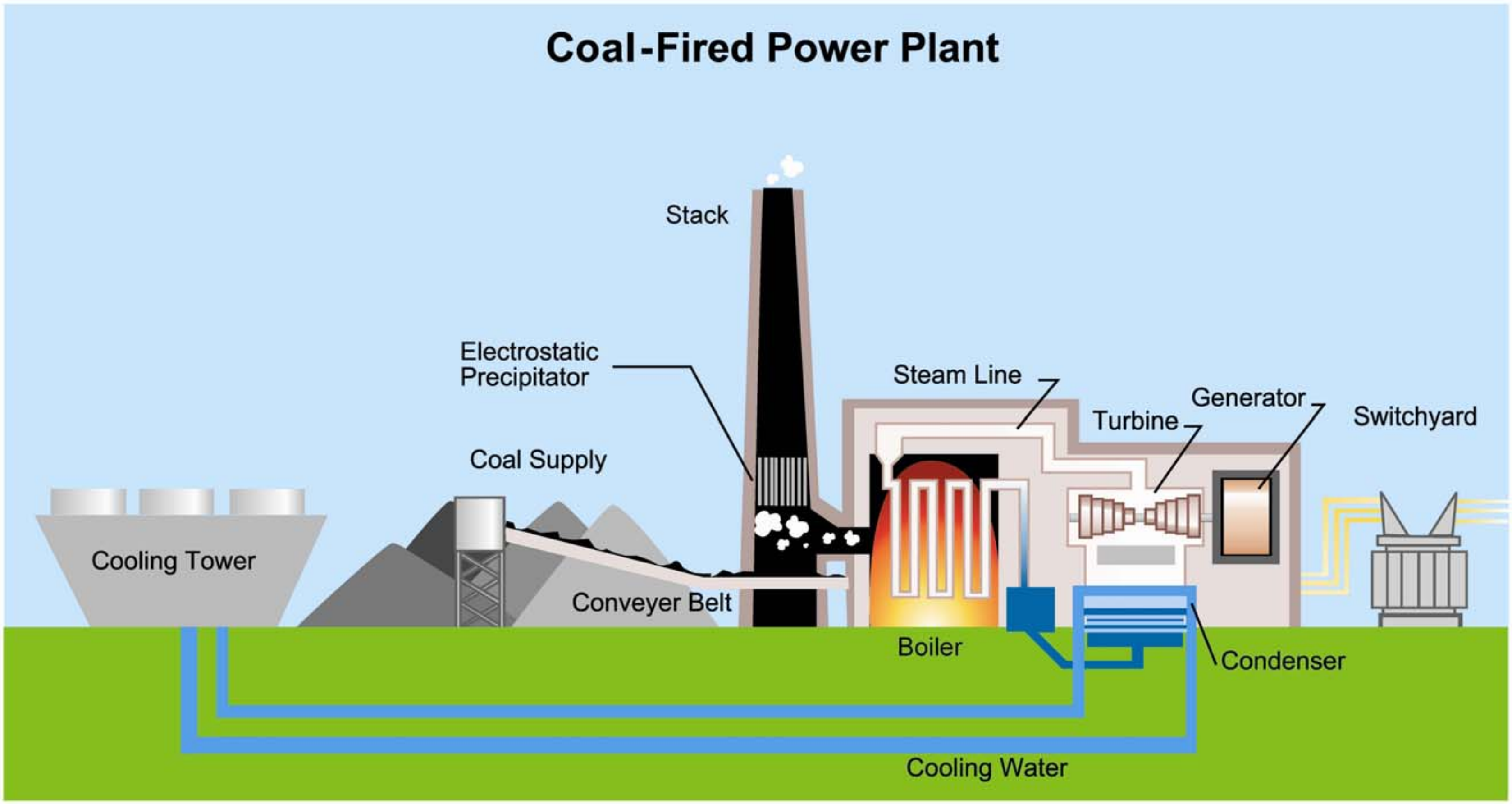
Combustion gases (water vapour, carbon dioxide, oxides of nitrogen and sulphur, traces of mercury and other chemical compounds) are released to the atmosphere via the boiler stack. An Electrostatic Precipitator (ESP) is installed at the stack inlet to capture >98% of particulate matter (ash) exiting the boiler.

Table 2-2 summarizes operating parameters for Unit 5.

Table 2-2 Brandon Generating Station Unit 5

Commissioned:	1969
Maximum Continuous Rating:	105 MW
Steam Production:	110.2 kg/s (875,000 lb/hr)
Steam Pressure:	8600 kPag (gauge) (1250 psig)
Steam Temperature:	510°C (950°F)
Fuel:	Sub-bituminous Coal
Sustained Fuel Consumption:	16.7 kg/s (132,250 lb/hr)

Figure 2-3 General Process Flow Diagram



2.4.1 STEAM GENERATION SYSTEM

The steam generator is a natural circulation water wall boiler. Coal is the primary fuel with fuel oil used for lighting off the burners and flame stabilization during low load operation. The coal is transported by the coal handling system to the coal pulverizers that grind the coal into a fine powder. The coal powder is transported to the twelve (12) boiler burners by pre-heated high velocity combustion air. The entire coal preparation/combustion system is managed by a computerized burner safety system that ensures safe combustion.

The ash resulting from the combustion of coal is collected in two streams via the ash management system. Heavy ash particles (bottom ash) fall to the bottom of the furnace area and light ash particles (fly ash) are captured in the ESP. The ESP captures >98% of the fly ash exiting the boiler.

Hot combustion gases (flue gases) exiting the boiler furnace pass through an air-to-air heat exchanger to preheat the combustion air. The combustion gases are discharged to the atmosphere through a 107 m (350 ft) high reinforced concrete stack.

The boiler water must be high purity to reduce the build-up of deposits in the boiler tubes as water is converted to steam. Trisodium phosphate to control deposit formation, sodium hydroxide to control pH, and hydrazine to scavenge water-borne oxygen are added to the boiler water. Solids that accumulate in the boiler water are removed through blowdown of a small percentage of the flow through the boiler into the station sump. High purity makeup water to replace the blowdown water is produced in the water treatment plant described below.

If the steam generator requires draining for maintenance, all boiler water solution is neutralized with sodium hypochlorite, drained to the chemical waste sump and subsequently discharged to the ash lagoon.

2.4.2 TURBINE GENERATOR SYSTEMS

The high temperature and high pressure steam exiting the boiler is directed to the turbine generator. The steam turbine extracts the energy contained in the steam and converts it to mechanical energy. As the steam enters the turbine it passes through a series of blades attached to the turbine shaft causing it to rotate. The spinning turbine shaft is coupled to an electrical generator producing electrical energy at a maximum rate of 105 MW on Unit 5.

The low pressure/low temperature steam exiting the turbine enters a tubular condenser where the steam is condensed so it can be pumped back into the steam generator system. The cooling water in the condenser is supplied by the circulating cooling water (CCW) system described below.

The electrical energy produced by the generator is transformed to the transmission line voltages and fed into the Manitoba Hydro transmission network.

Unit 5 can, if necessary, be temporarily operated as a synchronous condenser, to assist in managing transmission network stability. The alternator is physically disconnected from the steam turbine and operated as a large electrical motor. The electrical phase angle may be adjusted to maintain the optimal power factor for Manitoba Hydro's transmission network.

Operation as a synchronous condenser does not consume fuel and as such does not create air emissions or liquid effluent discharges and only requires small amounts of cooling water to cool the bearing lubricating oil and the hydrogen contained in the generator. This mode of operation occurs very rarely; the unit was last operated in this mode in 1986 and may not be necessary again in the future, as enhancements to the transmission network continue to be made.

2.4.3 COOLING WATER SYSTEMS

Low pressure, low temperature steam exiting the turbo-generator is condensed so it can be pumped back into the steam generator. Cooling water for the steam condenser is circulated in a closed loop CCW (Circulating Cooling Water) system. The heat energy in the cooling water is evaporated to atmosphere through a cooling tower. A small percentage of the cooling water is discharged (cooling tower blowdown) to the ash lagoon to aid in controlling the build-up of solids in the CCW system. Blowdown water and evaporative losses are replenished with soft water supplied by the water treatment plant.

Cooling water for auxiliary equipment and processes (i.e. pumps, fans and motors) is supplied via the CCW system described above, except for the station compressors which are cooled with water supplied by the raw water system.

The CCW system has a separate chemical treatment facility. This facility adds sodium hypochlorite, sulphuric acid and small amounts of specialty chemicals to control bio-fouling, pH and corrosion in the cooling systems.

2.4.4 COAL HANDLING SYSTEMS

Low sulphur sub-bituminous coal is shipped by rail from the Powder River Basin area (Montana and Wyoming) to the generating station. The coal is delivered in bottom dump hopper rail cars and is removed in an unloading shed. The coal is conveyed to the crusher house from which it is either diverted to the live coal stockpile or crushed to a maximum size of 20 mm and conveyed to the coal bunkers inside the main plant. The live stockpile supplies coal to Unit 5 between coal deliveries. As conditions warrant, some coal from the live stockpile may be moved into the long-term stockpile.

Coal dust collection systems capture fugitive dust during the handling operations to minimize hazardous accumulations.

2.4.5 ASH HANDLING SYSTEMS/ASH LAGOON

The fly ash collected by the ESP and the bottom ash at the bottom of the furnace are sluiced to the ash lagoon with water supplied by the raw water system. The lagoon is sized to provide sufficient resident time of the sluicing water to allowing settling of the ash particles before it discharges through a control structure. The control structure is designed to decant the water in the lagoon, adjust the pH (using CO_2 injection) and discharge it to a drainage ditch which flows to the Assiniboine River.

2.4.6 RAW WATER SYSTEM

The raw water supply to the generating station is supplied by three (3) water pumps located in the raw water pump house. The water is withdrawn from the Assiniboine River through a fish screen designed in consultation with the Federal Department of Fisheries and Oceans.

The raw water supplies the water treatment plant, boiler ash sluicing, fire fighting and service water systems (auxiliary equipment cooling).

2.4.7 WATER TREATMENT SYSTEMS

Water use and the resulting effluent streams at the Brandon G.S. are depicted in Figure 2-4. Domestic water is supplied from the City of Brandon water system. Water used for boiler makeup, ash sluicing, cooling tower make-up and general service is drawn from the Assiniboine River and passed through the water treatment plant prior to use.

Water produced by the water treatment plant is utilized for 2 purposes:

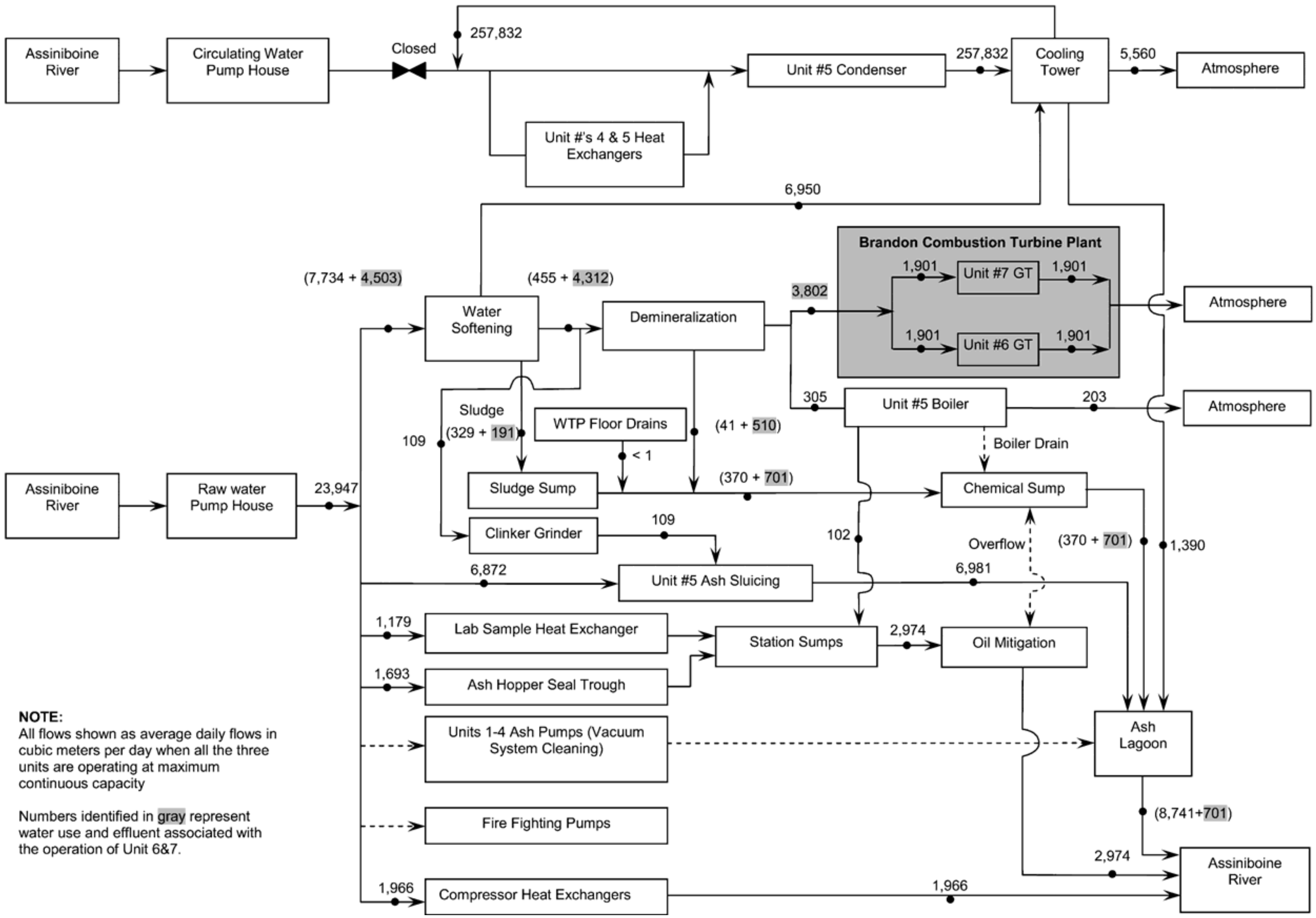
- Soft water primarily for cooling tower make-up and the auxiliary equipment bearing cooling system.
- High purity demineralized water for the boiler makeup (and Units 6&7 operation).

Soft water is produced by removing most suspended solids and some dissolved solids from the raw water by passing it through a solids contact reactor (Accelator) which removes calcium and magnesium salts (hardness), suspended solids, and colour by converting these components to solids and capturing them through the addition of lime and flocculant. The lime sludge effluent (largely calcium carbonate and magnesium hydroxide) is collected and pumped into the ash lagoon via the chemical waste sump.

Boiler makeup water must be high purity demineralized water to reduce build-up of deposits in the boiler during the production of steam. Nearly all remaining solids are removed from the soft water as it passes through the following equipment in the water treatment plant:

- Pressure filters remove the remaining suspended solids. Theses filters are regularly cleaned through a backwashing process with the effluent directed to the station chemical waste sump.
- Ion exchange units remove the remaining dissolved solids. When exhausted, the ion exchange units are regenerated by rinsing acid and caustic through them which strip the collected dissolved solids from the units. The regeneration waste is pumped to the chemical waste sump.
- The lime sludge, filter backwash effluent and regeneration effluent is collected in the chemical waste sump and pH adjusted. The contents are pumped to the ash lagoon where it mixes with the ash sluicing water and the suspended solids are allowed to settle out.

Figure 2-4 Brandon G.S. Raw Water Flows



NOTE:
All flows shown as average daily flows in cubic meters per day when all the three units are operating at maximum continuous capacity

Numbers identified in gray represent water use and effluent associated with the operation of Unit 6&7.

2.4.8 WASTEWATER (SEWAGE) SYSTEM

Domestic sewage from the Brandon G.S. is collected by the City of Brandon sewage system and treated at its treatment plant located south of the Brandon G.S.

2.4.9 MAINTENANCE AND OPERATIONS

The generating station utilizes a maintenance management system to schedule and retain records of all maintenance performed. These practices are undertaken to ensure equipment reliability, safety, and aesthetics. Unit 5 is operated and maintained in accordance with the Steam and Pressure Plants Act of the Province of Manitoba. Many systems undergo annual inspections and certifications as required by Federal/Provincial regulations and Manitoba Hydro operating and maintenance practices. Staff competency is maintained as required by provincial regulations, Manitoba Hydro requirements, and ISO 14001 Environmental Management System requirements.

2.4.10 BULK STORAGE

The main commodities that are stored in bulk storage areas are coal, ash, hydrogen gas, water treatment plant chemicals and petroleum products. Storage adheres to applicable regulations.

Sub-bituminous coal, from the Powder River Basin area in Montana and Wyoming, is delivered by rail. Coal is conveyed either into Unit 5 bunkers within the station or an active pile to be later fed into Unit 5 bunkers. When conditions arise that there is a significant amount of coal dust migrating towards the Station’s neighbours the following actions will take place:

- Wet down coal stockpile in high traffic areas as well as radial stacker discharge, if required, with water dependant on weather conditions, or
- Cease coal handling operations until such time conditions become more favourable.

Ash transported to the ash lagoon is stored in the lagoon and is either in long term storage or removed and utilized as approved by Manitoba Conservation.

There are two (2) above ground fuel oil storage tanks (total capacity 2.4 million litres). This fuel is used primarily as standby fuel for Units 6&7 in the event the natural gas supply is not available and secondarily for Unit 5 boiler light-off and low load flame stability.

The standby diesel generators utilized two 144 litre tanks, stored in the Units 6&7 powerhouse. One 946 litre tank is used for the Raw Water diesel driven pump. One 1364 litre tank is used for the diesel driven fire pump. There is one 4510 litre diesel tank for use of heavy equipment.

Chemical storage includes two bulk storage tanks contained within the water treatment plant. A solution of sodium hydroxide is contained in a 16,000 litre tank and sulphuric acid is stored in a 38,000 litre steel tank.

The cooling tower water treatment building contains the following chemicals stored in bulk. Four 900 litre plastic transportable tanks (totes), two containing Continuum (dispersant) and two containing Floguard (corrosion inhibitor); two 8000 litre fibre reinforced plastic tanks containing sodium hypochlorite; one

33,000 litre steel sulphuric acid tank, and; one 200 litre drum of antifoaming agent. All of these substances are utilized for cooling tower water treatment and each are within their own secondary spill containment.

The Brandon G.S. has a bulk hydrogen trailer system used to safely store and supply hydrogen gas required for generator operation. This system eliminates the need for the storage of a large number of gas cylinders inside the building. The tube trailer used for bulk storage is located outside and above ground to allow any potential leaks to dissipate readily.

2.5 PROPOSED MODIFICATIONS

The following modifications to Unit 5's processes and equipment will be undertaken following the licence review process.

- Ash lagoon redevelopment;
- Installation of a Continuous Emission Monitoring System (CEMS); and
- Stations drain modifications.

2.5.1 ASH LAGOON REDEVELOPMENT

New redundant primary as well as secondary and tertiary ash lagoon cells will be constructed to enable maintenance and cleaning of individual cells while Unit 5 is operational. The new lagoon cells will be constructed adjacent the existing east cell, sized to ensure adequate effluent retention time and will provide for secondary and tertiary polishing. In addition, an improved system to control pH will be included in the new design. These improvements will significantly improve the ability of the system to maintain compliance with the licence requirements.

Design details will be submitted to Manitoba Conservation for approval.

2.5.2 CONTINUOUS EMISSIONS MONITORING SYSTEM

A Continuous Emissions Monitoring System (CEMS) will be installed on the boiler flue gas system. The CEMS will monitor, calculate and record oxides of nitrogen and sulphur dioxide. The system will be designed, installed and operated according to the "Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation" Report EPS 1/PG/7 (revised 2005) provided by the Federal Environmental Protection Service

2.5.3 STATION DRAIN MODIFICATIONS

Modifications will be made to the station drain system to re-direct effluent from the ash hopper seal troughs, boiler blowdown and chemical sump overflow from the station drain to the ash lagoon. These modifications will address items identified in Section 8.4 Effects of Malfunctions and Accidents that have been deemed unacceptable.

2.5.4 IMPLEMENTATION SCHEDULE

The schedule for implementation of these improvements assumes review of the Environment Act Licence is completed by spring 2007. Following completion of the Licence Review the following activities will be undertaken for each modification noted above:

- Preliminary engineering studies;
- Detailed engineering design;
- Obtain regulatory approval, if required;
- Equipment/material procurement;
- Installation contract procurement;
- Construction (including scheduling and coordination with generating system outage schedules); and
- Commissioning.

It is anticipated that implementation activities will commence in fall of 2007 and be completed by 2010.

2.6 INPUTS

The main inputs to Unit 5 that are used for the production of electrical energy are water and coal. These are discussed in the following sections, along with less significant inputs to the process.

2.6.1 WATER USE

A raw water balance diagram for the Brandon G.S. during periods when all three units are operating at maximum continuous capacity is shown in Figure 2-4 (although only Unit 5 is part of this Licence Review, Units 6&7 are included to provide total usage by the station). Flows are based both on design flows for equipment within the system, and measured raw water flows (Appendix F – Raw Water System Review). Flows shown in Figure 2-4 are applicable to both existing and future plant operation.

The two largest usages of water are to sluice ash and make-up to the cooling tower to replace water lost to evaporation and blowdown[1]. No flows are shown for once-through cooling or to units 1-4 as these systems are no longer in use. Flows to the fire-fighting pumps are not provided, as they are not related to normal generation processes.

Flows shown in Figure 2-4 have been updated from earlier estimates based on an improved flow metering system, which was installed in 2006 during the course of the Licence Review. Based on these revised flows, the instantaneous peak and yearly raw water requirements of Brandon G.S. exceed the *Water Rights Act Licence # 2001-049*; a request for a licence revision is currently under review by Manitoba Water Stewardship.

[1] Blowdown refers to water removed from the cooling tower to allow for fresh replacement water to maintain the appropriate ionic balance.

2.6.1.1 Raw Water Intake

Raw water for the station is withdrawn at an intake structure located on the Assiniboine river, 100 m upstream of a rock weir constructed to increase water levels at the site of the cooling water intake[2] (Figure 2-2). The pumphouse building is located on the south side of the river. The intake line, a 0.76 m (30 inch) diameter pipe, extends north into the river to the intake structure. The intake is a 3 X 3 m horizontal structure situated on a vertical pipe extending from the river bottom to about 3.0 m into the water column in the middle of the channel. As per approval MB-01-0571 issued by the Department of Fisheries and Oceans Canada (DFO) in January 2002, this structure was upgraded in spring 2002 to include a fish protection system based on specifications provided in DFO (1995) and a design developed in consultation with DFO. The DFO approval specifies a maximum water withdrawal rate of 0.226 m^3/s and a maximum approach velocity of 0.038 m/s. The intake is covered with 1.75 mm mesh, and is equipped with a high pressure air purging system for self-cleaning.

As a result of the increase in the estimated water withdrawal determined during the course of this Licence Review, the design of the fish protection system was re-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 intake size and screen type. Adequacy of the fish protection system will continue to be assessed in conjunction with the Water Rights Licence review, described in Section 4.2.2.2. Both initiatives are currently in progress. Design details for any necessary upgrades to the fish protection system will be provided to appropriate regulatory agencies, as required.

2.6.1.2 Weir

During the period that the station operated on once-through cooling a weir was required across the Assiniboine River to maintain water levels at the cooling water intake. The weir was not maintained for the regulation of water level after construction of the cooling tower in the mid-1990's reduced water requirements to a fraction of previous amounts. Currently, at the location of the weir, there is a band of stones to an elevation of approximately 0.6 m, with several gaps in the original structure.

2.6.2 COAL

Brandon G.S. Unit 5 uses coal as its primary fuel and since 1997 has used coal supplied from the Powder River Basin (PRB) in Montana and Wyoming. Manitoba Hydro switched from Saskatchewan supplied Lignite to the sub-bituminous coal in 1997 because PRB sources offered a more reliable source of coal with superior environmental characteristics that improved the operating performance of Unit 5. Current[3] coal is sourced from the Montana portion of the Powder River Basin.

Manitoba Hydro contracts separately for coal supply (from the mine) and delivery (from the railways). Contracts are arranged in advance to ensure supply and price security. Coal is delivered according to

[2] The cooling water intake has not been used since the cooling tower was commissioned and water was no longer required for once-through cooling.
[3] The term "Current coal" refers to the Spring Creek supply which was in use at the time of the EIS study period.

Manitoba Hydro's requirements. Regular deliveries are scheduled when Unit 5 is expected to be operating and delivery is reduced in times when Unit 5 is idle, to maintain a consistent stockpile. As a security of supply guarantee, an effort is made to keep about a 90 day supply (about 150,000 tons) of coal on the pile. Nevertheless the coal stockpile fluctuates between from about 100,000 tons to about 250,000 tons due to unpredictable events. Manitoba Hydro also sells coal, primarily to agricultural producers in Southwestern Manitoba who use it as a heating fuel.

Delivery is by unit train. Unit trains are trains that carry only one product (in this case coal) and operate in dedicated service for only one customer (in this case Manitoba Hydro). The Burlington Northern Santa Fe Railway (BNSF) accepts the coal at the mine and turns the train over to Canadian Pacific (CP) Railway at Minot, North Dakota. Coal trains are unloaded at the Brandon G.S. by Manitoba Hydro staff and the coal is stocked-out in an active pile.

The active pile is designed to hold somewhat more than an entire unit train of about 12,500 tons. As required, the coal can be reclaimed from the active pile and sent to the Unit 5 coal bunkers located in the station. If unit trains are being unloaded during times of little operation the coal is unloaded and sent to the much larger long storage pile with mobile equipment (scrapers) and packed for safe storage to be used at a later date.

Coal supply in the future may not come from the same mine as currently supplies Unit 5, although it is likely that future supplies will continue to be purchased from the Powder River Basin (PRB).

The PRB is large and therefore different mines in the basin may produce coals with different qualities, which affect the environment differently. To account for potential variability among coal sources, environmental assessments not only considered Manitoba Hydro's current source of coal, but also assumed that different sources of coal could be used, to ensure that results in the EIS remain applicable into the future. (For more information, see Section 1.4 – Environmental Assessment Methodology and Section 2.3 – Coal Quality, in Appendix K – Air Quality Assessment).

In addition to coal use, approximately one million litres of fuel oil per year is used during light-off, stabilization and shutdown procedures. Since emissions of various contaminants of potential concern (COPC) are higher for coal operations than for fuel oil operations, only the impacts due to coal-fired operations were considered in this assessment.

2.6.3 DANGEROUS GOODS

Brandon Unit 5 uses a variety of products that are purchased, stored, handled, and disposed of in accordance with the current Federal and Provincial legislation, such as Manitoba Regulation 282/87 under the Manitoba Dangerous Goods Handling and Transportation Act. These activities are not covered under the Environment Act Licence for Unit 5. The inventory of products is maintained in compliance with Manitoba Workplace Hazardous Material Information System (WHMIS) Regulation 52/88. This inventory is presented in Appendix C.

Table C-1 in Appendix C list the products currently received and stored in bulk quantities (over 20 kg or 20 litre containers). Storage of these products is restricted to specific areas of the station: the water treatment plant; cold stores; laboratory storage; generating building basement; electrical shop; and yard.

All products are stored indoors and in compliance with regulatory requirements to minimize the potential for release to the environment.

The products consumed in the highest volumes are found in three main classes: Class 2 – Compressed Gases; Class 3 – Flammable Liquids; and Class 8 – Corrosives. The Class 2 products are generally welding gases. The Class 3 products are comprised primarily of liquid fuels and petroleum-based solvents for parts degreasing. These products are generally stored in 20 litre pails or tanks in the boiler house and fanhouse. Lubricating oils and waste oils are stored in the oil storage building. The Class 8 products are used exclusively for water treatment purposes and are stored in the water treatment plant and boiler house. Sulphuric acid and caustic soda are stored in bulk and the remainder are stored in drum or pail lots. The hydrogen bulk storage system was described in Section 2.4.10.

2.7 OUTPUTS

In the production of electricity, the primary outputs from Unit 5 are air emissions, including noise, liquid effluent, ash and other solid waste. These are discussed in the following sections, along with very minor outputs from various secondary processes.

2.7.1 AIR EMISSIONS

The sources of air emissions considered in this assessment include:

- the Unit 5 exhaust gas stack;
- the Unit 5 cooling tower;
- fugitive dust from coal handling operations and residual ash storage; and
- the combined stack emissions from Unit 5 and Units 6&7.

The air emissions from sub-bituminous coal combustion in Unit 5 primarily consist of common contaminants such as oxides of nitrogen (NO_x) and carbon monoxide (CO), sulphur dioxide (SO_2) and particulate matter (SPM, PM_{10} and $PM_{2.5}$). There are also small quantities of some volatile organic compounds, hydrogen chloride (HCl), hydrogen fluoride (HF), and trace quantities of both organic compounds (e.g., polycyclic aromatic hydrocarbons, dioxins and furans) and inorganic elements (e.g., heavy metals) associated with the particulate matter. The combustion of coal also results in emissions of carbon dioxide (CO_2), and small quantities of other greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O). The emission rates for the common air contaminants, as well as for most of the inorganic (trace metal species) and organic compounds (polycyclic aromatic hydrocarbons (PAH), dioxins and furans) were derived from stack sampling tests conducted on Unit 5 in 2005.

Emissions from coal handling operations and residual ash storage consist of fugitive dust (i.e., particulate matter) and any associated trace elements contained in the coal and ash, as well as organic products of incomplete combustion associated with the ash. The elemental composition of the ash lagoon waste materials was provided by Manitoba Hydro, and is specific to Brandon Unit 5. Estimates of trace organic compounds (dioxins and furans) in the ash lagoon wastes were derived from a 1998 survey by the U.S. Environmental Protection Agency (US EPA) of co-managed wastes at 11 disposal sites in the United

States which were included in a waste characterization technical background report by the US EPA to Congress in 1999.

The sub-bituminous coal that is currently being used at Brandon Unit 5 has been supplied by the Spring Creek coal mine in the Montana portion of the Powder River Basin. The composition of the trace elements in the sub-bituminous coal from the Spring Creek mine was provided by the mining company, Kennecott Energy Company. However, data were not available for all of the trace elements from the mining company data on coal composition. Data on these elements were obtained from a database on coal quality (COALQUAL) compiled and maintained by the U.S. Geological Service. The data are available for each coal producing region in the United States. Therefore, data derived from the Powder River Basin are reasonably representative of the coal from the Spring Creek mine, located within this basin.

Manitoba Hydro contracts for coal supplies regularly and it is possible that Unit 5 will source coal from mines other than Spring Creek in the future. For this reason, Manitoba Hydro commissioned an analysis of coal quality to determine the composition of coal from various alternative candidate mines that could be used to supply fuel to Unit 5 in the future. Coals from a large number of mines were ranked in order of preference relative to Spring Creek coal, in the event that Spring Creek coal could not be purchased. Several alternative mines were identified as suitable for future use and Manitoba Hydro will only purchase coal from these mines, or mines that offer coals with similar characteristics to ensure that this assessment remains applicable during the future operation of Unit 5. After appropriate adjustments for differences in heating value and ash content of each candidate coal, the potential future emission rate of each element, plus SO_2 and particulate matter, were compared to that of Spring Creek coal, and the maximum ratios were used to provide estimates of maximum future emission rates from the Unit 5 stack, as well as for concentrations in fugitive dust from coal and ash storage. Therefore, the predicted ambient air concentrations and deposition rates from Unit 5 stack emissions and fugitive dust emissions presented in this report provide an assessment of both current and potential future effects from operations using any of the coals deemed to be suitable for use at the Brandon Unit 5. The values used for the human health and ecological risk assessments also considered risk due to operations with Spring Creek coal as well as for potential increases in emissions due to operations using other suitable coals.

Emissions from the cooling tower include water vapour and salt. The ‘salt’ is a measure of the total dissolved solids inherently found in water and includes common compounds such as sulphates and nitrates and elements such as calcium and magnesium.

Although Units 6&7 at the Brandon G.S. operate under a separate licence, and as such are not a formal part of the Unit 5 Licence Review, the combined effects on air quality from emissions due to Units 6&7 and Unit 5 were evaluated in this assessment because there is a potential for Units 6&7 to be operating at the same time that Unit 5 is operating. The air emission constituents from natural gas combustion primarily consist of water vapour, oxides of nitrogen (NO_x) carbon monoxide (CO), carbon dioxide (CO_2), and small quantities of methane and nitrous oxide (N_2O). Although natural gas is a relatively clean burning fuel, there are nevertheless trace quantities of other common combustion by-products emitted in the exhaust gas stream such as sulphur dioxide (SO_2) and suspended particulate matter (SPM). For example, the particulate matter generally consists of larger molecular weight hydrocarbons from incomplete combustion, as well as trace quantities of inorganic elements. There are also small quantities of some volatile organic compounds (VOCs). However, for the purposes of the Licence Review for Unit 5, the primary concern for the combined operations of Units 6&7 and Unit 5 relates to the need to evaluate any potential for exceedence of ambient air quality criteria from the emission of CO, NO_x and $PM_{2.5}$ from Units 6&7 in conjunction with the emission of these contaminants during operation of Unit 5.

2.7.1.1 Stack Emissions

The assessment of air quality effects due to Unit 5 operation was performed using three "Operating Scenarios". The three Operating Scenarios are comprised of a matrix of two sets of coal properties and two sets of burner row combinations. Table 2-3 provides a summary of the three Operating Scenarios.

The two sets of coal properties (i.e., heating value, sulphur content, ash content, trace metal concentrations) represented: 1) the current coal that is being used at the plant, and 2) the range of properties associated with coal from the several potential alternative suppliers that could be used in the future. Results for Operating Scenarios 1 and 2 (OS1 and OS2) represent the current coal used in Unit 5 and results for Operating Scenario 3 (OS3) represent the upper bound range of coal properties from the alternative suppliers.

Five different burner row combinations can be used in the Unit 5 boiler to facilitate maintenance; each combination produces different emission rates. The assessment was performed for: 1) the most efficient combination, and 2) the least efficient combination. The combination that provides the best boiler performance and produces the lowest NO_x and CO (as well as SO_2 and PM) emissions is operated approximately 60% of the time while the other combinations, including the one producing the least efficient operation and greatest emissions rates, are each operated approximately 10% of the time. Results for Operating Scenario 1 (OS1) represent the most efficient and most used combination, while results for Operating Scenarios 2 and 3 (OS2 and OS3) represent the least efficient and least used burner row combination. Appendix K (Air Quality Impact Assessment) discusses the formation of these operating scenarios in more detail.

Figure 2-5 Schematic Diagram of Unit #5 Boiler 'B" Fuel Train

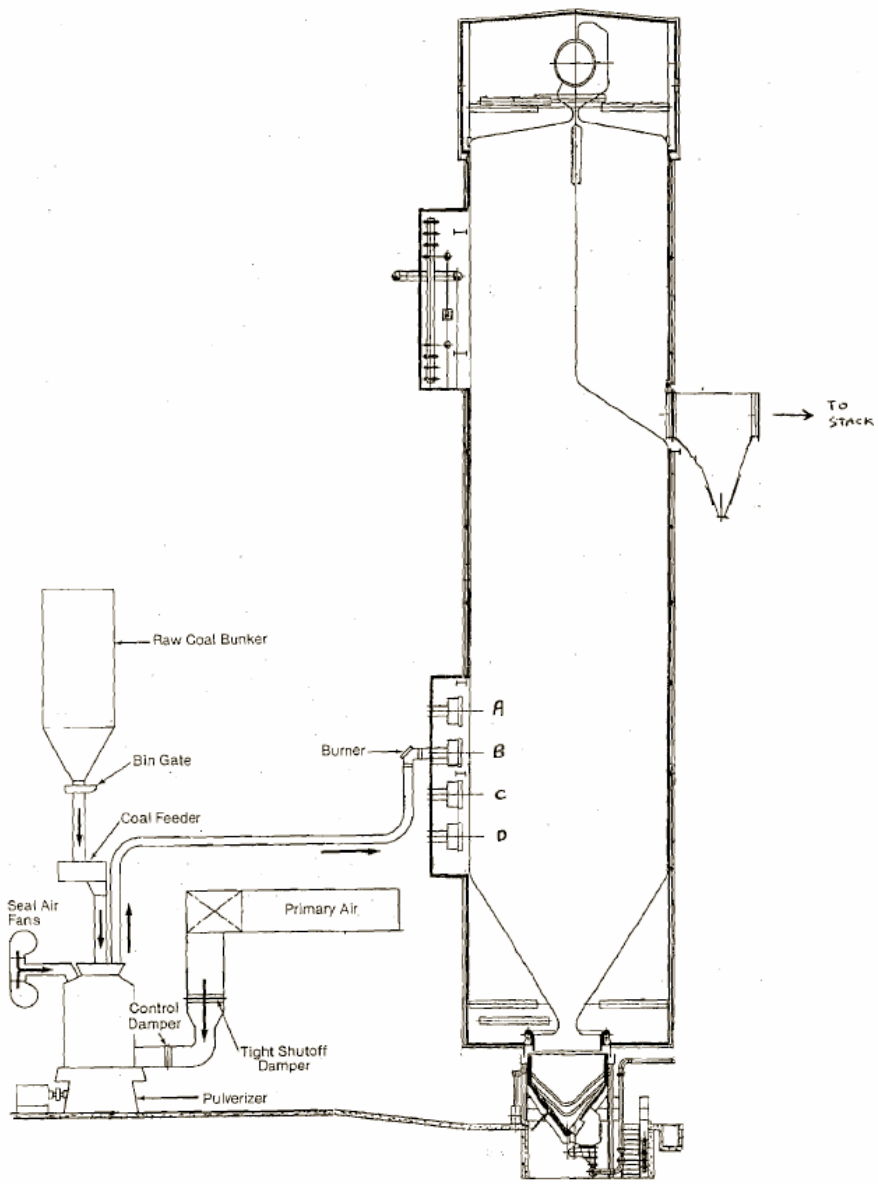


Table 2-3 Definition of Operational Scenarios

Operational Scenario	Coal Properties	Burner Row Combination
OS1	Current	Most Efficient (60% of time)
OS2	Current	Least Efficient (10% of time)
OS3	Upper Bound Emission Estimates of Future Coal	Least Efficient (10% of time)

The Unit 5 stack emission rates for common contaminants and mercury are listed in Table 2-4 in various units of measure. The emission rates are listed at the maximum sustained generation rate for the preferred operating scenario (OS1) and the least efficient operating scenarios (OS2 and OS3).

Table 2-4 Emission Rates of Common Air Contaminants and Mercury for Brandon G.S. Unit 5

Contaminants	Emission Rates[a]								
	g/s			kg/hr			kg/MWh[b]		
	OS1	**OS2**	**OS3[d]**	**OS1**	**OS2**	**OS3[d]**	**OS1**	**OS2**	**OS3[d]**
SPM	2.5	4.1	5.6	9.0	14.8	20.0	0.086	0.141	0.190
PM_{10}	2.3	3.8	5.1	8.3	13.7	18.5	0.079	0.130	0.176
$PM_{2.5}$	1.5	2.3	3.2	5.4	8.4	11.3	0.051	0.080	0.108
SO_2	68.5	72.1	95.8	246.6	259.6	345.3	2.349	2.472	3.289
NO_2[c]	87.8	116.0	116.0	316.2	417.6	417.6	3.011	3.977	3.977
CO	5.8	6.90	6.90	20.9	24.8	24.8	0.199	0.236	0.236
Hg[e]	0.0006	0.0006	0.0006	0.0026	0.0026	0.0026	0.00002	0.00002	0.00002

[a] maximum sustained generation rate (105 MW)
[b] heat output basis
[c] assuming 100% conversion of NO to NO_2
[d] based on alternative (upper bound) coal properties from Section 2.6.2
[e] based on emission cap of 20 kg/year

Appendix K provides a description of how the emission rates in Table 2-4 were derived. Appendix K also discusses constituents that are only emitted in trace amounts, such as volatile organic compounds, trace organic compounds (PAHs, dioxins/furans), and trace inorganic elements (e.g., heavy metals) or compounds (e.g., HF and HCl).

2.7.1.2 Fugitive Dust Emissions

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. Emission factors for these operations were based on emission equations published in a Canadian Council of Ministers of the

Environment (CCME) study of fugitive coal dust emissions, and on emission factors recommended by the US EPA (1995).

An hour-by-hour emissions estimation methodology was used with the goal of representing both continual emissions due to coal handling activities and sporadic bursts of emissions due to erosion during high wind speeds. As such, the assessment results are indicative of both long-term (monthly, annual) and short-term maximum (24-hour) ambient air concentrations and deposition amounts. Annual emission estimates of fugitive coal dust:

Wind erosion of the active storage pile:	5.59 tonnes
Unloading of the coal trains:	2.50 tonnes
Wind erosion of the long-term storage pile:	0.40 tonnes
Coal handling at the active storage pile:	0.21 tonnes

Wind erosion of the active coal storage pile occurs on relatively few days. A maximum emission rate of 130 g/s (470 kg/hour) was estimated for this source. Wind erosion of exposed areas of the ash lagoon was conservatively estimated to contribute a total of 4.7 tonnes of fugitive dust being emitted over a full year.

These emission estimates are considered to be conservative in that they likely overestimate actual emissions. Mitigation measures used by Manitoba Hydro cannot be accounted for in the dispersion/dust transport modelling. In particular, proactive management procedures that reduce or stop coal handling processes during periods with observed off-site dust transport and the interception of horizontal dust transport by terrain and vegetation surrounding the coal stockpile are not represented. This is because there is simply no practical method to determine how much reduction in emissions is/was achieved by the implementation of these measures. Similarly, there is no practical method in the dispersion modelling analysis for incorporating the effect of interception of fugitive emissions by surface features such as trees or buildings, or the effect of buildings on wind speed near the active storage coal stockpile.

Appendix K provides a description of how the above emission rates were derived, and provides estimates of the emission rates of trace constituents such as trace organic compounds (dioxins/furans), and trace inorganic elements (e.g., heavy metals) in the fugitive coal and ash dust emissions.

2.7.1.3 Cooling Tower Emissions

Based on the design description of the Unit 5 cooling tower, the emission rate of water vapour from the cooling tower (referred to as drift loss) was estimated as 0.001% of the total circulation rate of 47,300 US gal/min. The concentration of salt in the water of the cooling tower was determined to be 0.0044 g salt/g solution.

2.7.1.4 Unit 6&7 Emissions

Performance and emissions data collected for one of the two Brandon Combustion Turbine Units (Units 6&7) were used to characterize each generating unit operating on natural gas. To be conservative, the highest emission rates recorded were used in the modelling. Table 2-5 lists the emission rates used in the assessment. The actual measured emission rates for CO and NO_x for the Units 6&7 are much lower than the design values used listed in Table 2-5.

Table 2-5 Design Maximum Emission Rates of Common Air Contaminants for Units 6&7*

Air Contaminant	Emission Rate at 100% Load (g/s)	Emission Rate at 25% Load (g/s)
TSP	1.89	1.83
CO	1.89	189.56
NO_x (as NO_2)	29.33	29.33

* Maximum emission rates occurred with an ambient temperature of –20°C.

2.7.1.5 Noise

The general noise sources at Brandon Generating Station include:

- *Transformers:* At the Brandon Generating Station there are a total of 12 transformers emitting a low frequency, mono-tonal type of noise, which tends to travel long distances. When the Station is not operating and other activities such as coal car unloading and coal crushing are not occurring at the site, the transformers are the dominant noises source at the facility, as they are usually energized.
- *Switchyard:* The switchyard is located to the east of the turbine hall building, east of transformers. Under normal operating conditions, the noise emitted from the switchyard is inaudible, even in its close vicinity.
- *Steam Turbine Building:* The noise sources inside the turbine hall include Unit 5 steam turbine and generator, pumps, fans and vents. Except when doorways are open, the noise from the sources inside the building is only audible in close vicinity to the building.
- *Boiler Building:* The noise sources inside the boiler building include four coal pulverizer units, blow-down tank with muffler and rooftop vent, boiler, I.D. fans, F.D. fans, P.A. fans, station air compressors, pumps, fans and vents. When in operation, the noise from the boiler, coal pulverizers, pumps and fans are the dominant noise sources inside the building, with pulverizers and station air compressor being the chief sources on the main floor and the boiler on the higher floors.
- *Dust collectors:* There are three dust collectors at the facility, each of which operates only during unloading of cars, crushing of coal and loading of silos. The dust collectors for the coal car unloading building and coal crusher building are located outside of the building and thus when doors and overhead bay doors to the buildings are closed, the dust collectors are the dominant noise sources outside the buildings (especially to the north of the coal unloading building). The dust collector that serves the coal silos inside the main building (boiler building) is audible at longer distances than the other two dust collectors.
- *Conveyer Belts:* The noise associated with the enclosed belt conveyors used to transport coal from the unloading building to the crusher building and from the crusher building to the boiler building and stockpiles is mainly due to vibration of side cladding and the driver motors.

- *Coal Unloading Building:* Coal cars are unloaded in a metal-clad unloading building, located at the south end of the property, about 50 m north of Victoria Ave. East. The noise associated with the unloading operation (i.e., when shakers are operating) is significant, especially with the overhead bay doors open. Normally, during unloading operation both the east and west overhead doors are kept open as the rail cars are connected.
- *Coal Crusher Building:* The coal crusher is enclosed inside a concrete block building with one door opening to the east. Under normal operation mode, the door to the crusher building is kept closed. The noise from the crusher with the door closed is only audible in the close vicinity of the building. The crusher noise is not audible at the closest property boundary.
- *Mobile On-site Equipment:* A front-end loader and two scrappers operate when the coal crushing and handling systems are working. The noise associated with this operation is audible.
- *Cooling Towers:* A five-cell cooling tower is located to the east of the main building. The noise from the cooling tower is localized and thus not even audible from the rooftop of the main building about 100m away. Units 6&7 each have a four-cell dry cooling tower, located west of the Units 6&7 powerhouse. The noise associated with these dry cooling towers is audible only in their immediate vicinity.
- *Unit 6&7Building:* The two independently operated gas turbines (Units 6&7) are enclosed in a separate building. When operational, the noise associated with the stacks on these units is a low-frequency rumble that can be heard beyond the Units 6&7 powerhouse. The vibrating parts of the stack (e.g., platforms and side ladders) also create noise.
- *Natural Gas Pressure Reducer Building:* Natural gas enters the station at high pressure, and goes through a pressure reduction step prior to being used in Units 6&7. The noise associated with this source is directly proportional to the power output of Units 6&7.
- *Natural Gas Conditioner:* The temperature of the natural gas after going through the pressure reducer drops significantly. Before being fed to Units 6&7, the fuel gas is conditioned by raising its temperature to about 25°C. The gas is also passed through a knock-out vessel for condensate removal. The noise from the knock-out vessel and the fuel gas heater fan is audible outside the Units 6&7 building.

2.7.2 LIQUID EFFLUENT

Operation of Unit 5 produces four liquid effluent streams: (i) discharge from the station drain; (ii) effluent from the ash lagoon; (iii) discharge from the cooling water compressor; and (iv) surface runoff from the coal storage area. Sanitary wastes are directed to the City of Brandon's municipal system and are not considered further.

2.7.2.1 Station Drain

Effluent is passed through an oil mitigation system, which includes provisions for containment, oil/water separation and alarm annunciation, prior to discharge to the river. The station drain discharges to the Assiniboine River via two adjacent 600 mm drain pipes approximately 100 m downstream of the weir (Figure 2-2). The station drain receives effluent from several sources (Figure 2-4):

- blowdown from the Unit 5 boiler: the boiler water is high purity demineralized water with trisodium phosphate, sodium hydroxide and hydrazine added to prevent deposit formation and corrosion (Section 2.4.1). Solids accumulating in the boiler are removed in blowdown discharged to the station drain[4]. This waste stream is a small fraction of the total effluent directed to the station drain;
- overflow from the ash hopper seal troughs: the troughs are attached to the boiler bottom ash hopper (which is fixed to the floor) and are water-filled to allow boiler movement due to thermal expansion while maintaining a positive water seal. The overflow contains small amounts of ash;
- the lab sample heat exchanger: the exchanger is used to cool Unit 5 process waters for routine water chemistry sampling and analyses.;
- overflow from the chemical sump (as description of wastes directed to the chemical sump is provided in Section 2.7.2.3); and
- drains throughout the Brandon G.S. and storm sewers on the station site, which collect runoff from building roofs and parking lots (this last source is not shown on Figure 2-4).

The Environment Act Licence requires that the pH of the station drain effluent at discharge to the river is between 6.5 and 9.5 pH units, that the oil and grease content is not greater than 15 mg/L, and that the concentration of acid soluble copper is not greater than 0.5 mg/L. As well, the Licence requires measurement of the total volume discharged from the station drain each month, and monitoring of the effluent for pH, total dissolved solids, hardness (as $CaCO_3$), sulphates (as SO_4), total phosphorous, soluble boron, total iron, acid soluble copper, and oil and grease.

As discussed in Section 2.5.3, the station drain system will be modified to re-direct effluent from the ash hopper seal trough overflow, boiler blowdown, and chemical sump overflow from the station drain to the ash lagoon.

2.7.2.2 Compressor Heat Exchangers

The compressor heat exchangers discharge directly to the Assiniboine River. The discharged water is 1-2 ^{o}C above ambient temperatures in the river.

2.7.2.3 Ash Lagoon

The ash lagoon receives effluent from several sources (Figure 2-4):

- the fly ash collected by the ESP and bottom ash at the bottom of the furnace following combustion of the coal is mixed with raw water from the Assiniboine River and sluiced to the ash lagoon (Section 2.4.5). This waste stream comprises the majority of the effluent entering the ash lagoon;
- blowdown from the Unit 5 cooling tower. The evaporation of water causes the concentrations of dissolved solids to increase. In order to prevent scaling within the system a portion of the water is continuously replaced. The blowdown from the cooling tower has high levels of total dissolved

[4] If the boiler needs to be drained for maintenance, the water is directed to the chemical waste sump and then discharged to the ash lagoon.

solids, sodium hypochlorite, sulphuric acid and small amounts of speciality chemicals added to control bio-fouling, pH and corrosion (Section 2.4.3); and

- inputs from the chemical waste sump. The chemical waste sump receives wastes from softening and demineralization of raw water from the Assiniboine River to make it suitable for use in the station's cooling water and boiler systems (Section 2.4.7). The wastes consist of suspended and dissolved solids removed from the Assiniboine River water and acid and caustic used to regenerate the ion exchange units. When the Unit 5 boiler is drained, for maintenance, water is also directed to the chemical waste sump.
- in the ash lagoon, ash and other solids settle out. Decant water is discharged over a control structure where pH is adjusted to within licence limits using a CO_2 injector (Section 2.4.5). Effluent is discharged to a municipal ditch that also receives surface runoff from areas upstream of the station and the station site and discharge from the Koch Fertilizer Canada Ltd. (formerly Simplot Canada), and then flows to the Assiniboine River, entering approximately 800 m downstream of the station drain outfall.

The Environment Act Licence specifies that the pH of the ash lagoon effluent should not be less than 6.5 and greater than 9.0[5] 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. In addition, the Environment Act Licence requires the measurement of total volume of effluent discharged and 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.

Construction of additional lagoon cells are planned for 2007/2008 (Section 2.5.1).

2.7.2.4 Surface Runoff from the Coal Storage Area

Runoff from the coal storage piles is directed to drainage ditches on site which discharge to a municipal ditch and, ultimately, the Assiniboine River. As per the Environment Act Licence Clause 40, the water quality of this effluent stream was monitored until Manitoba Conservation advised that no further monitoring was required in 1996.

2.7.3 SOLID WASTE

Waste is managed through the Corporate Waste Streams & Disposition directive and the Hazardous Materials Management Handbook. Solid waste that is not suitable for reuse or recycling is disposed of by a licenced contractor. Recyclable material such as aluminium cans, cardboard, electronics, paper and scrap metal are sent to either Manitoba Hydro’s Waverley Service Centre or a local processor and reusable material such as toner, printer cartridges and wood pallets are returned to the supplier or Waverley Service Centre.

Spent resin from the water treatment plant is tested by leachate analysis for metals prior to disposal. If the leachate results meet the appropriate environmental quality criteria, the spent resin is disposed of at the local landfill. To date, every batch of resin that has been tested has met the quality criteria for disposal at

[5] During initial commissioning of the cooling tower, the allowable limit was 10 pH units.

the landfill. Theoretically, if the spent resin failed the leachate test, it would be treated as a hazardous waste and disposed of accordingly.

2.7.4 HAZARDOUS WASTE

Hazardous wastes generated at Brandon G.S. are managed by use of the Manitoba Hydro Hazardous Materials Management Handbook. The handbook covers safe practices for managing hazardous material in ways that protect the health and safety of employees, the public, and the environment.

PCBs at Brandon G.S. are managed according to the Hazardous Materials Management Handbook and the Code of Practice for The Storage of PCBs at Manitoba Hydro Facilities which are aligned with Manitoba Regulation 474/88R and the Canadian Environmental Protection Act (CEPA) SOR/92-507. Brandon G.S. has been designated a local PCB storage site. PCB materials cannot be stored on a local site for more than 30 days. The local storage site at Brandon G.S. meets the requirements for labelling, security, and containment. Records of PCB materials stored at this site are maintained according to the Code of Practice for The Storage of PCBs at Manitoba Hydro Facilities and are available for review by provincial or federal inspectors upon request.

Asbestos management follows the *Manitoba Hydro Code of Practice for Workers Working With or Around Asbestos or Man-made Mineral Fibre* as well as the appropriate Provincial guidelines. A workplace inventory of asbestos and asbestos containing material is maintained at site. Self-assessments are completed annually to ensure compliance with regulations and the code of practice. Properly trained and equipped staff are authorized to make repairs to and replace asbestos and asbestos containing material.

A 2003 independent audit performed by Decommissioning Consulting Services (DCS) reviewed the effectiveness of the Brandon G.S. asbestos management program in protecting employee health as well as meeting requirements of legislation. While some minor changes to the program were recommended, the assessment found that ”the programs are generally working effectively”. DCS went on to report that based on airborne asbestos fibre measurements and current cancer risk projection models, the estimated risks to workers at Brandon G.S. from asbestos would be ‘very much lower’ than current accepted risks in typical workplaces from all causes.

2.8 DECOMMISSIONING

Unit 5 and the entire Brandon G.S. do not have a formal decommissioning plan as there are no plans to close or salvage either. However, progressive decommissioning practices have occurred concurrently with station operations as specific plant infrastructure becomes redundant.

Some progressive decommissioning actions were undertaken in 2006 at the Ash Lagoon where a portion of the contents of the east cell were excavated and placed in the west cell. Ash in the west cell was contoured to minimize ponding and enhance positive drainage into the east cell. The 2006 activities can be considered a major step towards obtaining final west cell ash grades and contours prior to placement of a final soil cover over the ash.

Sale or salvage of retired Units 1 to 4 infrastructure are also currently under discussion with interested parties. In addition, a surplus, 60,000 L, underground petroleum storage tank was decommissioned in 2003 in compliance with applicable provincial regulations.

When a decision is made to decommission Unit 5, a Closure Plan will be developed and submitted to regulatory authorities for approval. This plan will recognize the existing decommissioning standards of the time. Decommissioning activities will likely take a number of years to develop and implement to maximize environmental effectiveness and re-use of materials and equipment.

CHAPTER 3

PUBLIC AND REGULATORY CONSULTATION

3.0 PUBLIC AND REGULATORY CONSULTATION

3.1 PUBLIC CONSULTATION PLAN

Consultation has been an integral part of the environmental assessment process for the EALR. A public consultation program was designed to provide an opportunity for people to obtain information about the Licence Review and to discuss concerns with representatives of Manitoba Hydro and its environmental consultants. The objectives of the public consultation program were to:

- Inform stakeholders, potentially interested parties and the public about the Licence Review process;
- Provide opportunities to interact with representatives of the Licence Review team;
- Identify issues and concerns to be addressed;
- Review the Environmental Impact Statement results; and
- Assist in identifying follow-up programs.

Manitoba Hydro has provided two opportunities for the public to learn about the EALR and to discuss it with representatives of the project planning team and environmental consultant team in the form of open houses and has posted information on its corporate website. Two public open houses were held at the Brandon G.S.; the first at the commencement of the Licence Review process and a second following the completion of the environmental studies undertaken in the preparation of the EIS. Questions and comments were received during both exercises and are summarized in the following sections. These open houses have increased the level of awareness for the community regarding the operational activities at Unit 5 and the EALR.

3.2 OPEN HOUSE #1

The first open house was held at the Brandon G.S. on June 29, 2004. The purpose of the first open house was to:

- Introduce the licence review process to local stakeholders;
- Provide information on Unit 5.;
- Inform stakeholders of plans to operate Unit 5 on coal until approximately 2020;
- Discuss the importance of Unit 5 to the Manitoba Hydro system;
- Provide information on the environmental studies being undertaken;
- Seek comments from public on issues to be included in environmental studies; and
- Seek comments from public on environmental and socioeconomic concerns regarding Unit 5.

3.2.1 OVERVIEW OF PUBLIC CONSULTATION ACTIVITIES

The public was informed of the consultation activities associated with the first open house through the following means:

Newspaper Advertisement - Advertisements providing information on the time and place of the open house was placed in the Brandon Sun Newspaper for two weekends prior to the date of the open house.

Contact List Notification – A contact list was developed to notify elected officials and organizations about the EALR/EIS and the open house. The contact list included elected officials, community planning officials, regulatory officials, community development organizations and environmental organizations.

Open House - Informational storyboard displays were set-up for viewing and discussion with representatives from the EALR project team and the environmental consultant team. The comments are summarized in Section 3.2.2 below.

Copies of the public consultation materials are included in Appendix D.

3.2.2 PUBLIC COMMENTS

Questions and comments received during the first open house are summarized in the tables below. Table 3-1 summarizes the 3 sets of written comments and questions received and indicates Manitoba Hydro's response. Appendix D contains copies of the original comment sheets received during the Open House.

Table 3-2 summarizes the verbal comments and questions received, and Manitoba Hydro's verbal response to those questions. Only verbal questions and comments not directly addressed by the storyboards were recorded for inclusion in the EIS.

Table 3-1 Written Comments/Questions received during Public Consultation for Open House #1

Question 1 Was this information useful in understanding the Licence Review? If not, what can be done to improve the presentation?

Attendee Comments	Manitoba Hydro's Response
Yes. Clear, concise and the graphics make info very easy to understand	No response required.
Useful information	No response required.
Yes, maybe a short video	No response required.

Question 2 Do you have specific concerns that you would like to see addressed in the environmental studies completed as part o the Licence Review?

Attendee Comments	Manitoba Hydro's Response
I don't, but general community concerns will likely focus on: quality and temperature of water discharged into the River; burning of coal and the impacts on our air quality; the amount of fugitive dust.	No response required.
The health of the River is essential. All effluent must be "cleaner" than what is there to ensure improved health of the River. Should be as clean as River ought to be. "Emissions to air must exceed Kyoto."	No response required.
No comment provided.	No response required.

Question 3 If you have a question or information request, please provide details of your question and your contact information so that we can respond.

Attendee Comments	Manitoba Hydro's Response
How often do we burn the coal and how does this frequency compare to the frequency in the early stages of the Unit 5 Licence? What would it mean to the Brandon facility and the overall Manitoba Hydro power production if the licence for Unit 5 was denied?	A written response was provided to the attendee. A copy of the response is contained in Appendix D
How can Hydro use geothermal sources on a large scale? (No need to answer me specifically)	Written responses were provided to two attendees. Copies of the responses are contained in Appendix D. The responses contained information packages on geothermal heat.

Attendee Comments	Manitoba Hydro's Response
Are there plans to eventually make hydrogen and burn it to make electricity instead of coal?	A written response was provided to the attendee. A copy of the response is contained in Appendix D

Table 3-2 Verbal Comments/Questions received during Public Consultation for Open House #1

Verbal Questions or Comments from Open House Attendees	Manitoba Hydro's Response Summary
One participant would have liked to see the operation of Brandon G.S. compared to the storyboard presenting the variable water inflows into Manitoba Hydro's hydraulic storage system.	No Response Required.
There is continued public perception that Brandon (G.S.) has or is switching from coal to gas.	The confusion may have resulted back in 2001 when Manitoba Hydro switched fuel in Selkirk from coal to natural gas and added Brandon Units 6&7 (the Gas Turbines) to the system. (As a result of this question, Manitoba Hydro has since endeavoured to clarify this misconception in its ongoing public consultation activities).
Is Manitoba Hydro investigating Wind Power?	Yes. Manitoba Hydro investigates a range of potential new resources. The attendee was directed to the Manitoba Hydro website and links to the Wuskwatim CEC Hearings if more detailed information was desired.
Can geothermal heat replace the Brandon G.S.?	This question arose as a result of the new subdivision in Wawanesa that has installed a subdivision-wide geothermal heat exchange system. It was indicated that the use of geothermal heat like that in Wawanesa does not produce electricity and therefore cannot "replace" Unit 5.
Will DFO get a copy of the EIS?	Yes. The distribution of the EIS by Manitoba Conservation was explained.

Verbal Questions or Comments from Open House Attendees	Manitoba Hydro's Response Summary
What's in the water that flows into the Assiniboine River from the ash lagoon?	The water is used to slurry ash from the boiler and carry it to the ash lagoon where the ash settles out and the water exits through the outlet structure. The quality of the effluent that leaves the lagoon must meet the criteria set out in the Environmental Licence.
Why aren't tours of the station available?	Due to the maintenance outage work in progress, public tours of the station are not practical. We plan to offer tours at the next open house.
Are you increasing capacity or the amount Brandon operates?	No, the station will remain the same capacity (105 MW) and Unit 5 will continue to operate as it has in the past, with operation averaging roughly the same amount.

3.3 OPEN HOUSE #2

The second open house was held at the Brandon G.S. on November 15, 2006. The purpose of the second open house was to:

- Respond to comments/concerns expressed at first open house;
- Provide information on Unit 5 and the EALR process;
- Present the environmental study results (air, noise, water, and land);
- Seek comments from public on environmental and socioeconomic concerns regarding Unit 5 (new issues or comments on assessed issues);
- Inform attendees of opportunity to review available documents pertaining to the EALR.

3.3.1 OVERVIEW OF PUBLIC CONSULTATION ACTIVITIES

In order to advertise the second Open House and to increase the level of public awareness, a greater variety of media was employed. Below is a list of advertisements and notification.

Newspaper Advertisements – Advertisements providing information on the time and place of the open house was placed in three Brandon Newspapers (Brandon Sun; Brandon Community News; Brandon Wheat City Journal) once a week for two weeks prior to the date of the open houses.

Radio Advertisements – Advertisements providing information on the time and place of the open house were broadcast on two Brandon radio stations (96AM Classic Rock and 880AM Country). They were played a total of six times per station the week of the open house. In addition, the Plant Manager of the Brandon G.S. provided radio interview with 880 AM Country (CKLQ) the morning of the open house.

Web Site – Notification of the open house was placed on Manitoba Hydro's website homepage for two weeks prior to the open house date. A brief summary of the EIS was placed on the website to provide context for the open house. All presentation materials (storyboards) from the open house were placed on the website following the open house. This information will continue to be available on the Manitoba Hydro website and the EIS will be available on the Province of Manitoba Public Registry or through Manitoba Hydro.

Contact List Notification – A contact list was developed to notify elected officials and organizations about the EALR/EIS and the open house. The contact list included elected officials, community planning officials, regulatory officials, community development organizations and environmental organization.

Open House – Informational storyboard displays were set-up for viewing and discussion with representatives from the EALR project team and the environmental consultant team. The comments are summarized in Section 3.3.2 below.

Brandon G.S. Tour – Tours of the Brandon G.S. were provided to interested open house attendees.

Copies of the public consultation materials are included in Appendix E.

3.3.2 PUBLIC COMMENTS

Questions and comments received during the second open house are summarized in the tables below. Table 3-3 summarizes the 2 sets of written comments and questions received and indicates Manitoba Hydro's response. Copies of the original comment sheets received are provided in Appendix E. No written responses were provided by Manitoba Hydro to comments received during the second Open House.

Table 3-4 summarizes the verbal comments and questions received, and Manitoba Hydro's verbal response to those questions. Only verbal questions and comments not directly addressed by the storyboards were recorded for inclusion in the EIS.

Table 3-3 Written Comments/Questions received during Public Consultation for Open House #2

Question 1 Was this information useful in understanding the Licence Review?

Attendee Comments	Manitoba Hydro's Response
Yes	No response required
No comment	No response required

Question 2 Do you have specific concerns that were not addressed in the environmental studies completed as part of the Licence Review?

Attendee Comments	Manitoba Hydro's Response
No	No response required
No comment	No response required

Question 3 If you have a question or comment, please provide details and your contact information so that we can respond.

Attendee Comments	Manitoba Hydro's Response
The open house was an excellent information session. The posters and tours were very informative.	No response required
What a great tour. No questions.	No response required

Table 3-4 Verbal Comments/Questions received during Public Consultation for Open House #2

Verbal Questions or Comments from Open House Attendees	Manitoba Hydro's Response Summary
Where does MH get its coal from?	Brandon Unit 5 purchases coal from Montana that is called "Powder River Basin" coal.
How far does the plant's air emissions travel?	Several Open House storyboards illustrate the air emission modeling results in the vicinity of Brandon including NO_x, SO_2, Particulate Matter and fugitive dust.

Verbal Questions or Comments from Open House Attendees	Manitoba Hydro's Response Summary
Doesn't the Brandon G.S. use old technology?	The oldest coal-burning units (#1 to #4) that were built in the late 1950s have since been retired. Unit 5 was built in 1969 but had air emission controls installed for it between 1996 and 1997. The Combustion Turbines (Units 6&7) were installed in 2001.
Are you still burning Bienfait coal from Saskatchewan?	No, we no longer burn Saskatchewan lignite. We now burn sub-Bituminous coal from Montana that has a lower sulphur and ash content than Saskatchewan lignite coals.
How deep are the monitoring wells?	The details were not available at the time; however, the depth of the wells are between 9 to 12 metres (30 to 40) feet deep.
Is coal still burned here?	Yes.
How many homes can Brandon Unit 5 supply?	Approximately 100,000 homes.
Is the aquifer deep under the plant and deep under Brandon?	No. The aquifer in the vicinity of the station and around Brandon is called a shallow sand aquifer and is approximately 10 metres in thickness and lies almost immediately below the ground surface. The depth to the sand aquifer gets deeper as one approaches the Assiniboine River valley.
Why don't you burn coal from Sparwood, British Columbia?	Transportation costs are the largest part in determining where Manitoba Hydro purchases coal for Unit 5.
What steps are being taken within Manitoba Hydro to address security and the issue of terrorism?	Manitoba Hydro has a Corporate Security Officer who can initiate action levels (Yellow, Orange, Red). The level of security at the Brandon G.S. will be high.

Verbal Questions or Comments from Open House Attendees	Manitoba Hydro's Response Summary
You should have included a storyboard on consumption (i.e. consumption rates of water, coal, other materials).	No Response Required
Is the cooling tower used to cool the water before it is discharged to the river?	No, the cooling tower is a closed loop system much like the radiator on your car. It recirculates the cooling water used to condense steam and therefore none of the heated water from this process is discharged to the river.
Does the unit switch between burning natural gas and coal depending on the price of each fuel?	No, Unit 5 only burns coal and Units 6&7 burn natural gas or fuel oil.

CHAPTER 4

AQUATIC ENVIRONMENT

4.0 AQUATIC ENVIRONMENT

This chapter contains the following sections:

- a brief description of the existing aquatic environment in the Assiniboine River at the Brandon G.S.;
- an assessment of the effects to the aquatic environment of existing and future operation of Unit 5, considering existing and proposed mitigation measures and monitoring; and
- an assessment of residual effects.

The spatial scale of the assessment considers the Assiniboine River immediately upstream of the station (background conditions) and the river within the immediate zone of influence of the station, including the area of the water intake, the mixing zones of effluents discharged from the station and the downstream environment where these effluents are fully mixed. The description of the existing environment is based on water quality measurements from river water and effluent samples for the period 1996-2004. With respect to predicted effects of the future operation of the station, the temporal scale encompasses the present to at least 2019 (Section 2.3).

4.1 EXISTING ENVIRONMENT

The Brandon G.S. is located near the eastern boundary of the City of Brandon, Manitoba, on the southern shore of the Assiniboine River (Figure 2-1). The Assiniboine River is the source of all process water for Unit 5 and is the ultimate receiving environment for all liquid effluents.

The City of Brandon withdraws water at the upstream end of the city as a raw water supply for its municipal water supply. This is the only other major surface water withdrawal besides the G.S. at the City of Brandon. Further downstream, there are numerous licenced irrigation users, as well as withdrawal for municipal water supplies at Portage la Prairie and the R.M. of Cartier, and diversions to the La Salle River and Crescent Lake in Portage la Prairie, and, during periods of high flows, to Lake Manitoba via the Assiniboine River Floodway.

Point sources of effluent discharge to the river at the City of Brandon, in addition to the Brandon G.S., are the Koch Fertilizer Canada Ltd. facility located near the Brandon G.S., the Brandon Municipal Wastewater Treatment Facility and the Industrial Wastewater Treatment Facility that currently serves Maple Leaf Pork's Pork Processing Facility. The latter two point sources discharge downstream of the Brandon G.S. Other point sources are the streams and rivers that enter the Assiniboine River, that drain primarily agricultural land.

The Assiniboine River near Brandon is used for some primary recreation (i.e., swimming) and extensively for secondary recreation, including sport fishing and boating. There is no commercial fishing on the Assiniboine River within Manitoba. An important recreational area, Spruce Woods Provincial Park, is located along the Assiniboine River downstream of Brandon.

4.1.1 ASSINIBOINE RIVER HYDROLOGY

The Assiniboine River originates in west central Saskatchewan and flows southeast, exiting the province and continuing its southeasterly course through western Manitoba. The river course turns to the east near Virden and flows across two-thirds of southern Manitoba before entering the Red River within the City of Winnipeg. The mixed waters of the Red and Assiniboine rivers then flow north to the south end of Lake Winnipeg.

The Assiniboine River drainage basin encompasses approximately 154,000 km^2, including 91,300 km^2 in Saskatchewan, 21,600 km^2 in North Dakota, and 22,400 km^2 in Manitoba. It is the second largest watershed in southern Manitoba. At Brandon, the total drainage area contributing to the Assiniboine River is 86,000 km^2. The Assiniboine River's two major tributaries are the Qu'Appelle River in Saskatchewan (draining 51,000 km^2) and the Souris River in Manitoba (draining 61,100 km^2) which enters downstream of Brandon. Other significant tributaries upstream of Brandon include the Shell, Little Saskatchewan, and Birdtail rivers. Other significant tributaries downstream of Brandon include the Little Souris and Cypress rivers, and Epinette Creek. Willow Creek, a small stream, enters the Assiniboine River approximately 3 km downstream of the Brandon G.S.

Another significant contributor of water to the Assiniboine River is groundwater flow from the Assiniboine Delta Aquifer directly to the river. The estimated average flow of groundwater from this aquifer is 2.8 m^3/s (Assiniboine River Management Advisory Board, 1998). This groundwater enters the river system along the reach from just east of Brandon to near Treherne.

Primary flow within the Assiniboine River has been regulated since 1970 by the Shellmouth Dam, located 450 km upstream of the Brandon G.S. The dam and its reservoir (Lake of the Prairies) provide flood control and low flow augmentation for downstream communities. The dam is currently operated to provide a minimum of flow of 2.8 m^3/s at Brandon. River flows can also be augmented by release from Lake Wahtopanah, the reservoir upstream of the Rivers Dam on the Little Saskatchewan River. Within Brandon city limits, there are three water level control structures on the Assiniboine River: i) a rock rubble dam that directs water towards the intake for the City of Brandon Water Treatment Facility; ii) a fixed crest weir maintained by the City of Brandon to ensure sufficient water for the Water Treatment Facility; and iii) a rock rubble wier constructed by Manitoba Hydro previously ensured a sufficient water supply for operation of the Brandon G.S. when water was required for once-through cooling[6] (Bruederlin 1993).

Environment Canada has maintained a stream flow station (Stn. 05MH013) near Brandon since 1974. Flows undergo large annual fluctuations: for example median (i.e., fiftieth percentile) monthly flows range from 61 m^3/s in April to 12 m^3/s in September. Table 4-1 provides monthly median, $1Q_{10}$ (lowest flow rate over a one-day period that would be expected to occur within a ten-year period), $7Q_{10}$ (lowest flow rate over a seven-day period that would be expected to occur within a ten-year period) and $30Q_{10}$ (lowest flow rate over a thirty-day period that would be expected to occur within a ten-year period) flows in the Assiniboine River at Brandon for post-

[6] More information on this weir is provided in Section 2.6.1

1970 (i.e., with regulation at the Shellmouth Dam). Low flows are less than half of median flows for every month.

Table 4-1 Monthly Assiniboine River discharge (m^3/s)

Month	Median	$30Q_{10}$	$7Q_{10}$	$1Q_{10}$
January	14.89	6.44	6.14	6.03
February	15.49	5.60	6.18	6.11
March	19.60	5.74	3.11	2.83
April	61.25	9.65	6.04	3.96
May	53.15	6.55	5.78	5.27
June	33.51	5.78	4.92	4.51
July	28.71	5.56	4.43	4.02
August	16.11	3.79	3.92	3.83
September	12.16	3.34	3.00	2.83
October	14.72	4.32	3.00	2.83
November	16.10	5.77	4.60	3.65
December	14.61	6.27	5.60	5.29

4.1.2 WATER QUALITY

Manitoba Water Stewardship (MWS) has monitored water quality in the Assiniboine River since the mid-1960's. Table 4-2 summarizes water chemistry data (1996-2004) and the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOGs) (Williamson 2002) for surface water parameters pertinent to Unit 5. Sampling locations include two sites operated by MWS: the 18th St Bridge site located upstream of the Brandon G.S. and the Treesbank site downstream of the Brandon G.S. (Figure 4-1). Manitoba Hydro samples Assiniboine River water at the Brandon G.S. raw water intake, which is between the two MWS sites.

Table 4-2 Water quality (median and range) between 1996-2004 measured by MWS and Manitoba Hydro in the Assiniboine River

Parameter	MWS 18th St Bridge upstream of Brandon G.S.	MWS Near Treesbank downstream of Brandon G.S.	MB Hydro at water intake of Brandon G.S.	MWQSOGs
pH	8.22 (7.05 – 8.71)	8.16 (7.09 – 8.76)	8.35 (7.62 – 9.12)	Surface Water: Drinking[a] 6.5-8.5 Surface Water: Aquatic life 6.5-9.0 Surface Water: Recreation 5.0-9.0
Total Dissolved Solids (mg/L)	660 (300 – 1010)	670 (320 – 965)	694 (318 – 932)	Surface Water: Greenhouse irrigation 700 Surface Water: Field crop irrigation 1000 Surface Water: Drinking[a] <500 Surface Water: Livestock 3000
Total Suspended Solids (mg/L)	29 (2 – 669)	24 (<5 – 450)	26.5 (2 – 516)	Surface Water: Aquatic life for systems with a background concentration >25 mg/L, and <250 mg/L, no more than a 25 mg/L induced change from background is permitted
Hardness (mg/L)	356 (136 – 480)	368 (207 – 745)	396 (204 – 549)	There are no guidelines or objectives for hardness
Sulphate (mg/L)	226 (84 – 311)	229 (97 – 323)	235.6 (82.2 – 467)	Surface Water: Drinking[a] 500 Surface Water: Livestock 1000
Phosphorus (mg/L)	0.134 (0.045 – 1.170)	0.190 (0.043 – 0.683)	0.112 (0.040 – 0.528)	Narrative water quality guideline In streams total phosphorus should not exceed 0.05 mg/L
Iron (mg/L)	1.10 [total] (0.14 – 12.90)	0.93 [total] (0.10 – 11.90)	0.76 [total] (0.11 – 14.4)	Surface Water: Drinking[a] <0.3 Surface Water: Aquatic life 0.3 Surface Water: Irrigation 5.0
Boron (mg/L)	0.13 [total] (0.06 – 0.018)	0.14 [total] (0.05 – 0.52)	0.15 [soluble] (0.06 – 0.30)	Surface Water: Drinking[b] 5.0 Surface Water: Irrigation 0.5-6.0 Surface Water: Livestock 5.0
Arsenic (mg/L)	0.0048 [total] (0.0018 – 0.0100)	0.0048 [total] (0.0012 – 0.0087)	0.0039 [acid-soluble] (<0.0020 – 0.0160)	Surface Water: Aquatic life (chronic 4-days) 0.150 Surface Water: Aquatic life (acute 1-hour) 0.340 Surface Water: Drinking[b] <0.025 Surface Water: Irrigation 0.100 Surface Water: Livestock 0.025
Copper (mg/L)	0.0041 [total] (0.0018 – 0.0200)	0.0050 [total] (0.0017 – 0.0470)	0.002 [acid-soluble] (<0.002 – 0.080)	Surface Water: Drinking[a] <1.0 Surface Water: Aquatic life[c] 0.012-0.050 (dissolved); 0.012-0.052 (total) Surface Water: Irrigation 0.2-1.0 Surface Water: Livestock 0.5-5.0
Lead (mg/L)	0.0010 [total] (<0.0002 – 0.0158)	0.0010 [total] (<0.0002 – 0.0058)	<0.001 [acid-soluble] (<0.001 – 0.006)	Surface Water: Drinking[b] 0.01 Surface Water: Aquatic life[c] 0.004-0.020 (dissolved); 0.005-0.041 (total) Surface Water: Irrigation 0.2 Surface Water: Livestock 0.1

Parameter	MWS 18th St Bridge upstream of Brandon G.S.	MWS Near Treesbank downstream of Brandon G.S.	MB Hydro at water intake of Brandon G.S.	MWQSOGs
Zinc (mg/L)	0.010 [total] (0.002 – 0.040)	0.010 [total] (0.002 – 0.150)	0.010 [total] (<0.002 – 0.062)	Surface Water: Drinking[a] <5.0 Surface Water: Aquatic life[c] 0.153-0.648 (dissolved); 0.155-0.657 (total) Surface Water: Irrigation 1.0-5.0 Surface Water: Livestock 50
Cadmium (mg/L)	<0.00004 [total] (<0.00004 – 0.00010)	0.0001 [total] (<0.00004 – 0.01480)	<0.0001 [acid-soluble] (<0.0001 – 0.0002)	Surface Water: Drinking[b] 0.005 Surface Water: Aquatic life[c] 0.003-0.10 (dissolved); 0.003-0.012 (total) Surface Water: Irrigation 0.0051 Surface Water: Livestock 0.080
Selenium (mg/L)	<0.0002 [total] [d] (<0.0002 – 0.0039)	0.0006 [total]] [d] (<0.0002 – 0.0040)	<0.002 [total] (<0.002 – 0.011)	Surface Water: Drinking[b] 0.010 Surface Water: Aquatic life 0.001 Surface Water: Irrigation 0.020 – 0.050 Surface Water: Livestock 0.050
Residual Chlorine (mg/L)	-	-	0.04 (<0.020 – 0.170)	Surface Water: Aquatic life (chronic 4-day) 0.011 Surface Water: Aquatic life (acute 1-hour) 0.019

[a] Aesthetic objective
[b] Maximum or interim maximum acceptable concentration
[c] 4-day chronic objective dependant on hardness and calculated using the minimum and maximum measured hardness values. These are the most stringent of the objectives to protect aquatic life.
[d] Selenium values based on period 2002-2004 only.