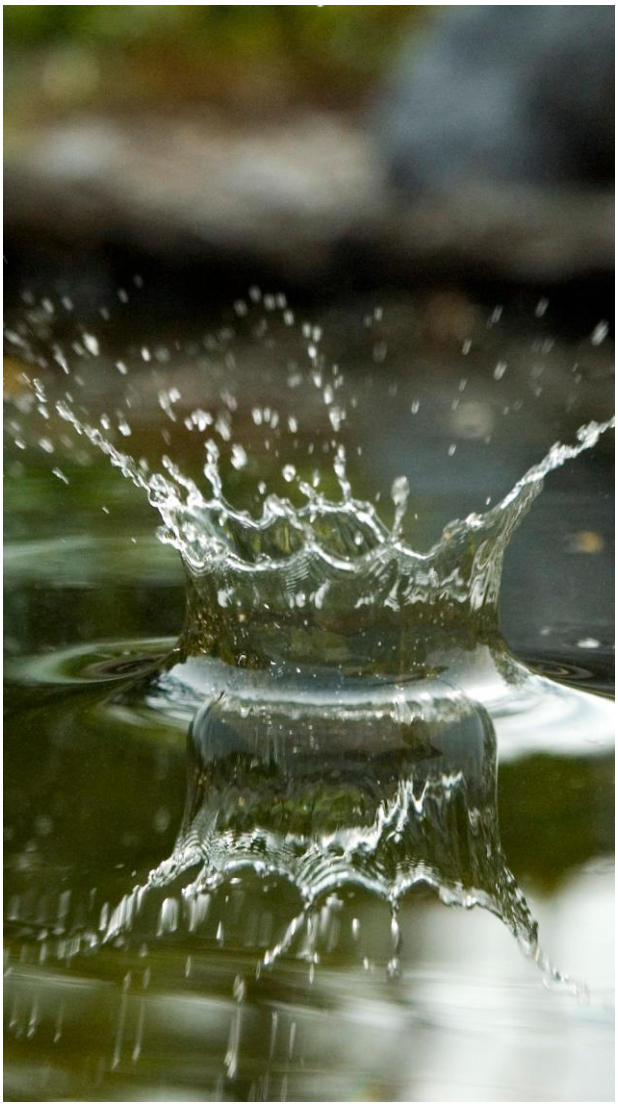
Part Eight

Falconbridge Drinking Water System



The Falconbridge well supply is a groundwater system comprised of three drilled wells – Wells #5, 6 and 7 – with a serviced population of approximately 750.

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Chapter 41 - Falconbridge Drinking Water System

The Falconbridge Well Supply is a groundwater system comprised of three drilled wells (Wells #5, 6 and 7), each of which is 457 cm in diameter and 54 m deep. The raw water at these wells is treated using chlorine gas for disinfection.

Treated water from the pumphouse enters one of two distribution lines. The first is the "Eastern" main, which is the primary distribution line. It is approximately 10 km in length and supplies the Town of Falconbridge as well as a number of industrial sources, including the Xstrata Nickel Smelter Complex. The second transmission line is the "Western" main, which is approximately 1.5 km in length and supplies the Nickel Rim Mining Complex.

This distribution system was originally constructed by Falconbridge Limited in 1961. It is now owned and operated by the City of Greater Sudbury. The serviced population is approximately 720. Operations of the system are monitored online by City of Greater Sudbury operators at the Wanapitei Water Treatment Plant. See Map 8.1 for the distribution system. Table 8.1 summarizes water usage within the Falconbridge drinking water system between 2002 and 2007.

Table 8.1 – Summary of water usage in the Falconbridge drinking water system for 2002-2007

	Wells 5, 6 and 7
Daily Permitted Amount (m^3/day)	4,251
Monthly Permitted Amount (m^3/month)	129,301
Average Actual Monthly Volume (m^3/month)	59,943
Percentage of Monthly Permitted Volume	46%
Maximum Actual Monthly Volume (m^3)	79,142
Percentage of Monthly Permitted Volume	61%
95th Percentile (m^3)	74,058
Percentage of Monthly Permitted Volume	57%

Chapter 42 - Falconbridge Contributing Area

The Falconbridge wells are not impacted by the presence of surface water; therefore, the watershed for the wells was estimated as the boundary of the contributing aquifer.

The aquifer is located along the Wanapitei Esker. Bedrock topography slopes to the east and west of the aquifer. Rainfall and snowmelt that run off from the bedrock slopes contribute recharge to this aquifer, resulting in the contributing catchment including the adjacent hilltops. The southern limit was defined by the estimated groundwater divide and the northern boundary was set as a 500 m buffer down gradient of the delineated capture zone. The estimated catchment area to these wells was calculated to be 57 km^2. See Map 8.2 for the contributing area.

Chapter 43 - Water Budget and Quantity Assessment

The Falconbridge drinking water system lies within the Wanapitei watershed. As previously described in Chapter 23, the Wanapitei watershed was given a water quantity stress level of low and did not need to progress to the next level of a water quantity assessment. Given the isolated nature of the municipal wells, it was decided by the Greater Sudbury Source Protection Area technical team that a Tier 1 water budget should be completed for each drinking water system. The methodology applied is described in greater detail in Chapter 3.

43.1 Falconbridge Water Budget

A summary of the water budget is illustrated in Table 8.2. No major streamflows were identified in this area. The average annual recharge in the Falconbridge well area was calculated to be 412 mm, equivalent to the annual water surplus.

Table 8.2 – Water budget for the Falconbridge watershed

	Water Balance Element (mm)							
Month	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Water Surplus	Water Deficit
January	2.8	61.8	6.1	8.9	0.0	0.0	8.9	0.0
February	3.1	48.4	13.8	16.9	0.0	0.0	16.9	0.0
March	19.5	45.6	68.2	87.7	0.0	0.0	87.7	0.0
April	51.2	13.0	126.3	177.5	19.5	19.5	158.0	0.0
May	80.8	1.0	8.6	89.3	75.0	73.6	15.7	0.0
June	78.4	0.0	0.0	78.4	110.7	101.8	0.0	-23.4
July	78.8	0.0	0.0	78.8	130.5	107.7	0.0	-28.9
August	85.3	0.0	0.0	85.3	112.5	91.2	0.0	-6.0
September	107.1	0.0	0.0	107.1	69.3	67.2	39.9	0.0
October	81.9	2.4	2.4	84.4	30.1	30.1	54.3	0.0
November	45.1	33.3	19.4	64.4	0.8	0.8	63.6	0.0
December	9.8	55.8	15.0	24.8	0.0	0.0	24.8	0.0
Annual Total	643.7	261.3	259.9	903.5	548.3	491.8	469.9	-58.2
Annual Recharge								**411.7**

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

43.2 Falconbridge Water Quantity Stress Assessment

The summary of the water quantity stress assessment is presented in Table 8.3. For these wells, it was assumed that water pumped was 100% consumed from the groundwater aquifer system. In 2005, approximately 20% of the water removed by these three wells was distributed to the town of Falconbridge, while the remainder was provided to industrial operations. The water removed by all the municipal groundwater wells was approximately 13 mm in 2005, which represented about 40% of the permitted pumping rate.

Groundwater stress was calculated to be relatively consistent throughout the year, as demand does not show seasonal variation. Monthly maximum groundwater stress was 6.5% in June for present conditions. This stress level was increased to 6.6% under the future municipal demand scenario. On an annual basis, average groundwater stress was 5.3% under the present scenario and increased to 5.4% under the future demand scenario. Each calculated groundwater stress level was well below the 20% monthly maximum and 10% annual average thresholds. As such, the Falconbridge contributing area was characterized as 'low' stress.

Table 8.3 – Water quantity stress assessment for the Falconbridge watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Recharge	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	0.55	0.06	0.004	0.019	0.02	0.02	4.70	4.78
February	0.55	0.06	0.004	0.018	0.02	0.02	4.38	4.46
March	0.55	0.06	0.004	0.017	0.02	0.02	4.30	4.38
April	0.55	0.06	0.005	0.022	0.03	0.03	5.37	5.47
May	0.55	0.06	0.004	0.016	0.02	0.02	4.06	4.13
June	0.55	0.06	0.006	0.026	0.03	0.03	6.46	6.57
July	0.55	0.06	0.005	0.022	0.03	0.03	5.57	5.66
August	0.55	0.06	0.006	0.025	0.03	0.03	6.13	6.24
September	0.55	0.06	0.006	0.024	0.03	0.03	5.95	6.05
October	0.55	0.06	0.005	0.021	0.03	0.03	5.31	5.40
November	0.55	0.06	0.004	0.019	0.02	0.02	4.73	4.81
December	0.55	0.06	0.006	0.026	0.03	0.03	6.41	6.52
Annual	**0.55**	**0.06**	**0.005**	**0.02**	**0.03**	**0.03**	**5.28**	**5.37**

43.3 Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For all groundwater sources the estimated uncertainty is low.

Chapter 44 - Falconbridge Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Falconbridge drinking water system.

44.1 Falconbridge Wellhead Protection Areas and Vulnerability Scoring

The wellhead protection areas were delineated according to Rules 47 through 50 and followed the methodology outlined in Chapter 2. The resulting vulnerable areas are illustrated on Map 8.3 for each well in the Falconbridge drinking water system. The maximum time of travel to the Falconbridge wells is less than five years, therefore for these wells, there is only WHPA-A, WHPA-B and WHPA-C.

Vulnerability scoring for the wellhead protection areas followed Rules 82 through 85 and the methodology outlined in Chapter 2. Map 8.4 illustrates the vulnerability scoring for the Falconbridge drinking water system.

The variability in vulnerability scores in the Falconbridge WHPA, as illustrated on Map 8.4, is a reflection of the intrinsic susceptibility index for this area. There is higher groundwater vulnerability in the west part of the WHPA where the higher intrinsic susceptibility index is high, and likewise, lower groundwater vulnerability in the east part of the WHPA where the intrinsic susceptibility index is lower. More detail on the intrinsic susceptibility index is available in Chapter 2 and on Map 2.9.

Table 8.4 – Summary of wellhead protection area delineation uncertainty for the Falconbridge drinking water system

Geological Factors	Depth to aquifer, thickness of overburden	Sufficient data from MOECC, MNDM, Vale and City of Greater Sudbury databases
	Soil and Rock Characteristics	Data entry estimations, reporting inconsistencies, averaging by assigning Geologic Survey of Canada codes, very few grain size analyses
Hydrogeological Factors	Hydraulic Parameters	Difference between calculated hydraulic conductivity and value assigned in the model, low density of data, no porosity data
	Hydraulic Head Measurements	Questionable accuracy of values in WWIS, no data from some areas
	Recharge	Recharge assigned according to top layer
	Boundary Conditions	Rivers assigned constant head; no sensitivity analyses
Methodological Factors	Model Used for WHPA Delineation	MODFLOW /MODPATH are industry standards. Only saturated zone flow considered. Natural attenuation not considered.
	Model Calibration and Sensitivity Analysis	Calibrated hydraulic conductivity and recharge only; no sensitivity analyses
	Pump Rate Used for Model	95th percentile of monthly pumping rate is considered a conservative estimate
	Capture Zones Delineation	Low uncertainty because steady state reached within 5 years.

Uncertainty Level

High Uncertainty | Moderate Uncertainty | Low Uncertainty

Vulnerable Area Delineation Uncertainty

Modeling groundwater flow is complex and requires good information and adequate data to be certain of the model results. The groundwater model represents a first step in providing a general understanding of groundwater flow conditions. A degree of uncertainty is always present when using a model to interpret real world situations. In general, geological, hydrogeological and methodological factors contribute to the level of uncertainty within a model. Table 8.4 summarizes the uncertainty in these factors for the Falconbridge drinking water system. For a detailed description of each factor, refer to Appendix 2.

As described in Table 8.4, there is generally a moderate level of uncertainty related to the groundwater model. The delineation of the wellhead protection areas used a conservative approach and thereby overestimates the size of the protection area. In general, the uncertainty associated with the groundwater model increases with the relative size of the protection area as the number of compounding factors increase. The Falconbridge wellhead protection areas are less than a 5 year time of travel and the overall uncertainty of the delineation is low.

Vulnerability Assessment Uncertainty

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection area (as explained in Chapter 2). Therefore, the uncertainty associated with each score is a function of these two variables. The uncertainty of the wellhead protection areas has been described above.

The ISI score is based in part on the presence or absence of an aquitard or confining layer above the aquifer. In the Falconbridge contributing area, there is no, or a very thin, aquitard, resulting in a highly vulnerable ISI score. There is great reliability in this information; therefore, the uncertainty of this score is low.

44.2 Falconbridge Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology is outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Map 8.4. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater can have the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater can have the potential for a moderate or low threat to occur.*
- Areas with a vulnerability score of 4 or greater can have the potential for a low threat to occur.*
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.*

*DNAPLs are an exception because they are always a significant threat in WHPA-A, B, C/C1 regardless of the vulnerability score.

The MOECC has established an online tool that incorporates the Provincial Tables of Circumstances into an interactive mapping tool, accessible via http://swpip.ca/. With the address search function, this tool lets you identify what vulnerable area(s) a property is located in and what the vulnerability score is at that location. It also identifies a list of circumstances of all is or would be significant, moderate or low drinking water threats. For more detailed instructions on how to use the above mentioned website refer to Appendix 5.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the Falconbridge wellhead protection areas was assessed to be under 40% (low) and is illustrated on Map 8.5.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, most of the Falconbridge WHPA has a 1-8% impervious area, as shown on Map 8.6. The calculation of impervious surface resulted in the vulnerable area being designated as a moderate threat or a low threat for the application of road salt depending on the vulnerability score, as shown in Table 8.6.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2. There are no agricultural lands in the Falconbridge wellhead protection area, therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated on Map 8.7.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. Table 8.5 shows the number of occurrences of this threat in different vulnerability areas.

Enumeration of Threats

Table 8.5 lists as estimate of the number of moderate and low drinking water quality threats in the Falconbridge drinking water system in accordance with the Drinking Water Threats Tables. At this time, there are no known significant drinking water threats for this system.

Table 8.5 – Drinking water quality threats for the Falconbridge drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
WHPA A & B, Areas with a vulnerability of 10			
The application of commercial fertilizer to land.		1	
The handling and storage of fuel.		1	
The application of road salt.		1	
WHPA B & C, Areas with a vulnerability of 8			
The application of commercial fertilizer to land.			1
The application of road salt.			1
Local threat: Transportation of hazardous substances along transportation corridors.		1	1
WHPA C, areas with a vulnerability of 6			
The application of road salt.			1

44.3 Falconbridge Drinking Water Threats Conditions

A drinking water condition is a situation resulting from a past activity and meeting the criteria laid out in Chapter 2. For a more detailed review of methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low threat condition could exist are the same as the areas where a potential threat could occur. For an illustration, please see Map 8.4.

Currently, there are no known conditions within the Falconbridge vulnerable areas.

44.4 Falconbridge Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

Currently, there are no known drinking water quality issues in the Falconbridge wells.

Chapter 45 - Data Availability

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is a continually evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity.