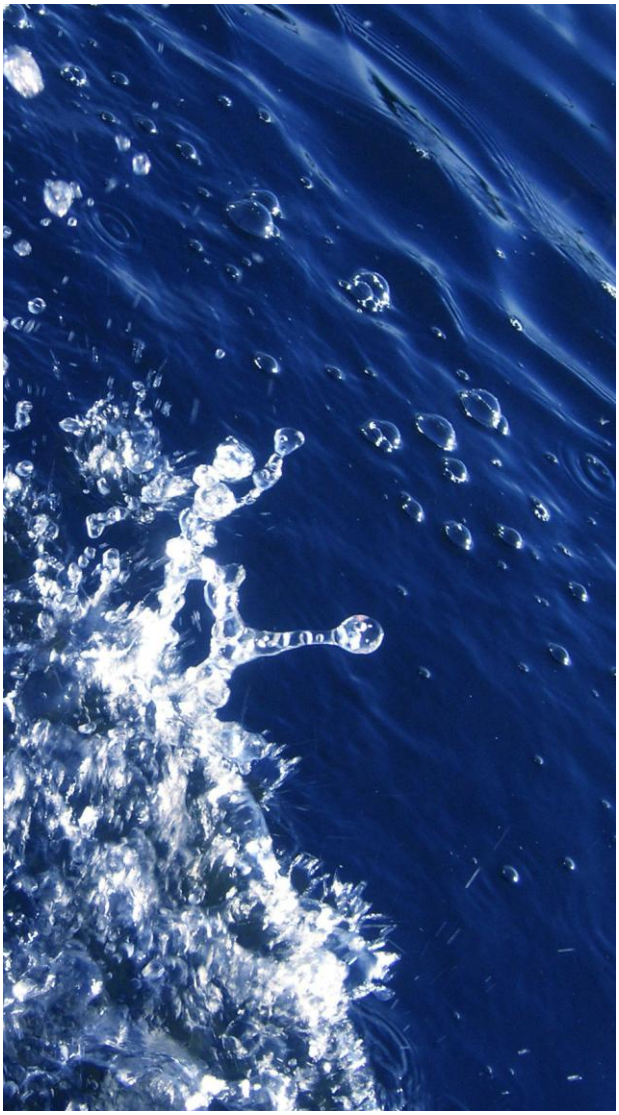

Part Four

The Wanapitei River Drinking Water System

The City of Greater Sudbury's major water producer is located on the Wanapitei River, just upstream of the Trans-Canada Highway in the community of Wahnapitae.

Approved on September 2, 2014
Minor edits on March 1, 2017
Amendments on March 16, 2021

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Chapter 21 - Wanapitei River Drinking Water System

The City of Greater Sudbury's major water producer is located on the Wanapitei River, just upstream of the Trans-Canada Highway in the town of Wahnapitae. The intake is a Type C[1] intake according to the Technical Rules (2009). Approximately 60% of the City's water supply is produced by the intake, which services the communities of Coniston, Wahnapitae, New Sudbury and parts of downtown Sudbury and Garson. The community of Markstay is also serviced by this intake; however it is located outside of the watershed and is not considered part of the Source Protection Area. The Wanapitei drinking water system is connected with the David Street drinking water system by the Ellis reservoir located in the heart of the City of Sudbury. See Chapter 16 and Map 3.1 for a description of the David Street distribution system.

The intake is located on the western bank of the river and is constructed of two concrete wet wells situated at the bottom of the river. It is 50 m upstream from the Canadian Pacific Railway (CPR) line and a number of residences are located nearby.

The water is pumped through coarse and fine mesh screens and pre-chlorinated before being transferred 2 km west to the Wanapitei Water Treatment Plant. Coagulants are added before clarification and sent through four filters of sand and anthracite coal. The water is post-chlorinated and given additions of fluoride, polyphosphate and lime before distribution. Table 4.1 provides a summary of pumping rates for the Wanapitei River intake for the period 2000-2008.

Table 4.1– Summary of pumping rates for the Wanapitei River intake for 2000-2008.

	Pumping Rate
Permitted Rate	22,201,344 m^3/year
Maximum Annual	12,695,047 m^3
Average Annual	11,817,789 m^3
Average Monthly	984,816 m^3

[1] A Type C intake is located in a river and neither the direction nor velocity of flow of the water at the intake is affected by a water impoundment structure.

Chapter 22 - Wanapitei River Intake Watershed Description

The Wanapitei River intake watershed covers approximately 2,782 km^2. This watershed extends north to the headwaters of the Greater Sudbury Source Protection Area, reaching to the Arctic Divide. The main feature of the watershed is Lake Wanapitei, which is the largest lake in the Source Protection Area, covering 132 km^2. The watershed is mostly forested and consists of approximately 268 km^2 of lakes.

Surficial geology in the Wanapitei River watershed is dominated by bedrock and thin till. Overburden of greater than 1 m in depth is generally the glaciofluvial deposits associated with the Wanapitei Esker south of Lake Wanapitei and sand dunes in the headwaters of the catchment.

The river is approximately 257 km long with an approximate elevation change of 230 m. The river north of Lake Wanapitei has two main tributaries, the west and the east. The western branch drains a number of large tributaries including Scotia Lake plus Meteor, Raven, Rosie, Silvester, Unwin, Barnet and Demott Creeks in the northernmost reaches of the watershed. The river downstream of Lake Wanapitei is regulated by the Lake Wanapitei Dam, Moose Rapids Dam and the Stinson Dam. Map 4.1 illustrates the subwatersheds and the locations of the dams in the Wanapitei River intake watershed.

Chapter 23 - Wanapitei River Watershed Water Budget and Stress Assessment

The Wanapitei River drinking water system lies within the Wanapitei watershed. As previously described in Chapter 13, the Wanapitei River watershed was given a water quantity stress level of low and therefore did not need to progress to the next level of water quantity assessment. Nonetheless, a Tier 1 water budget was created for the watershed contributing to the Wanapitei River intake and it is presented below. The methodology applied is described in greater detail in Chapter 3. A brief summary of the water budget and stress assessment are presented below. For a detailed account of all methodology, assumptions and associated calculations, refer to Appendix 2.

23.1 Wanapitei River Intake Water Budget

A summary of the Wanapitei River intake water budget is presented in Table 4.2. For the period of 1970-2005, the Wanapitei River intake watershed had an average annual moisture surplus of 368 mm. Surface runoff, stream discharge and groundwater recharge all display the largest peak during spring melt and again when soils are saturated in the fall months. The spring freshet did not produce a large discharge peak in April, which is attributed to the large storage volume behind control dams as well as in Lake Wanapitei.

Average annual recharge was calculated to be 225 mm/yr. However, most of this was calculated to have occurred in April (148 mm) and is likely overestimated. This is primarily because the soil moisture budgeting technique moved water into groundwater storage although it is more probable that this water was stored in surface water reservoirs. On an annual basis, baseflow comprised 29% of total streamflow.

Table 4.2 – Water budget for the Wanapitei River intake watershed

	Water Balance Element (mm)									
Month	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Streamflow	Baseflow	Runoff	Recharge
January	1.9	61.8	3.8	5.7	0	0	33.5	10.1	23.5	0
February	1.6	48.3	8.2	9.9	0	0	31.6	9.5	22.1	0
March	14.0	48.3	55.0	69.0	0	0	42.2	10.6	31.7	41.5
April	41.2	17.3	156.9	198.2	18.6	18.6	42.5	10.6	31.9	147.7
May	75.9	1.8	14.7	90.5	73.7	72.6	42.7	10.7	32.0	9.9
June	75.4	0.2	0.2	75.6	109.0	101.6	34.0	8.5	25.5	0.6
July	80.1	0	0	80.1	127.1	109.2	19.9	8.0	12.0	0
August	83.8	0	0	83.8	109.8	92.6	13.2	6.6	6.6	0.9
September	94.2	0.3	0.3	94.5	67.8	65.7	14.8	5.9	8.9	1.9
October	73.6	4.6	4.1	77.8	29.2	29.2	25.7	7.7	18.0	5.6
November	36.0	35.2	20.2	56.2	0.6	0.6	34.0	9.2	24.8	16.6
December	6.5	57.4	10.2	16.6	0	0	35.7	10.7	25.0	0
Annual Total	584.2	275.2	273.6	857.7	535.7	490.1	369.9	108.0	261.9	224.6

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

23.2 Wanapitei River Intake Stress Assessment

The results from the Wanapitei River intake stress assessment are summarized in Table 4.3. Surface water demand for the Wanapitei River watershed is highest during winter and late summer. Most of the surface water demand was a result of the consumption of water that is transferred from the Wanapitei Basin to the Vermilion Basin (NDCA 2006a). In August, calculated surface water stress for present and forecasted use was 14.9% and 15.6% respectively, therefore the watershed was given a classification of "low" stress.

Municipal Use

Municipal supply removals from this watershed include the surface water intake at the Wanapitei River and groundwater removals in Falconbridge. Separate, smaller groundwater systems also supply the community of Skead Heritage Homes and the Sudbury Airport. Some of the water removed at the Wanapitei Water Treatment Plant is transferred to the Vermilion watershed (through the connection with the David Street distribution system) to the west, as well as the Sturgeon River watershed to the east (through the water supply to Markstay).

Water removed from the Wanapitei River has averaged $1x10^7$ m^3/yr and removals have remained relatively stable for the period of 2000-2005. Agreements between the City of Greater Sudbury and Ontario Power Generation limit the amount of water that can be removed from the Wanapitei River to ensure adequate flow towards the downstream generating stations.

Permit to Take Water

As of February 2008, excluding the municipal supplies, there are 13 available permit to take water records in the Wanapitei River intake watershed. Seven of these permits are for surface water removals, three are for groundwater removals and three are for both groundwater and surface water. Permits that fell under the 'both' category were assumed as groundwater removals. Excluding the municipal water supplies the total permitted amount of these removals was estimated as $7.2x10^7$ m^3/yr for surface water and $2.4x10^6$ m^3/yr for groundwater takings. The consumed amounts were estimated to be $4.4x10^6$ m^3/yr for surface water and $7.8x10^5$ m^3/yr for the groundwater removals.

Agricultural Use

De Loe (2002) estimated 29 farms and an annual water removal of 137,579 m^3/yr in the Wanapitei River watershed. It was assumed that all water for agriculture was from groundwater, occurred only during summer months and was 80% consumptive (Aqua Resource 2005). Therefore, the total water consumed for agriculture in the Wanapitei River watershed was estimated at 110,063 m^3/yr.

Non-permitted and Rural Use

Approximately 1,500 people in the Wanapitei River watershed within the City of Greater Sudbury are without municipal water service (CGS, 2003). There are 168 available well records in the basin, all of which were considered non-consumptive. The majority of these well records are located along the Wanapitei Esker between Lake Wanapitei and the intake.

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 the Wanapitei water source, the estimated uncertainty is low.

Table 4.3 – Water quantity stress assessment for the Wanapitei River intake watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Median	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	33.94	26.92	0.29	0.43	0.72	0.75	10.25	10.71
February	35.77	26.15	0.28	0.43	0.72	0.75	7.46	7.8
March	43.43	34.94	0.29	0.43	0.72	0.76	8.52	8.91
April	43.91	23.72	0.29	0.43	0.72	0.76	3.58	3.74
May	36.36	11.95	0.29	0.43	0.72	0.76	2.96	3.1
June	35.0	10.06	0.32	0.43	0.75	0.79	3.02	3.16
July	19.0	9.78	0.32	0.43	0.75	0.79	8.14	8.52
August	11.99	6.98	0.31	0.43	0.75	0.78	14.9	15.6
September	12.45	6.6	0.3	0.43	0.74	0.77	12.64	13.23
October	25.5	9.14	0.29	0.43	0.72	0.75	4.39	4.59
November	38.52	18.03	0.29	0.43	0.72	0.75	3.5	3.66
December	36.75	24.35	0.3	0.43	0.73	0.76	5.88	6.15

Chapter 24 - Wanapitei River Water Quality Risk Assessment

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

24.1 Wanapitei River Intake Protection Zones

There are three intake protection zones (or IPZs) delineated for each surface water intake. Rules 58 to 71 and Chapter 2 describe the methodology to be applied for each type of intake.

Intake Protection Zone 1

The minimum protection zone for a Type C intake is semi-circle with a radius of 200 m situated over top of the intake with a 10 m extension downstream of the intake (Rule 70). The centre point of the semi-circle is the point of entry of the raw water. Where the zone abuts land, a 120 m setback is applied.

The IPZ-1 for the Wanapitei River intake is illustrated in Map 4.2.

Intake Protection Zone 2

The delineation of IPZ-2 is based on a 2 hour time of travel to reflect the response time of an operator to shut down the water treatment plant in the event of an adverse water quality condition (Rule 65). Bankfull flow[2] conditions were encouraged by the MECP to be used to determine a 2 hour time of travel delineation for an IPZ–2.

The Wanapitei River changes frequently through its reaches from steep sided slopes to low lying wetland areas. This kind of topography makes it difficult to determine what a bankfull condition is as it varies widely throughout the river. Instead, return period flood discharges were estimated to determine the appropriate flow conditions to calculate the IPZ-2 delineation. A two year return period was assumed to be a suitable flow condition to apply to the IPZ-2 delineation. The land portion of IPZ-2 was extended to capture the drainage ditch transport pathway along Highway 17.

In the Wanapitei River, the intake is located near the downstream end of the modeled reach. Field work was carried out on the river in order to improve the local understanding of river geometry upstream of the WTP intake and to reduce uncertainty. The surveyed reach extended approximately 5.5 km upstream of the WTP intake until a set of rapids was encountered.

[2] Bankfull flow is considered the maximum amount of flow a stream channel can contain without spilling over the banks. Typically, bank full flow conditions are observed once every two years.

The 2 hour time of travel based on the above methodology was estimated to be approximately 3,200 m. Map 4.3 shows the extent of the IPZ-2. For a more detailed review of the methodology, assumptions and calculations please refer to the report on the IPZ-2 Update for the Vermilion and Wanapitei River Intakes in Appendix 2.

Intake Protection Zone 3

Intake protection zone 3 (IPZ-3) is the area within each surface water body that may contribute water to the intake with a 120 m set back from the high water mark (Rule 70). The IPZ-3 for the Wanapitei River intake extends to the Arctic Divide, includes Lake Wanapitei, the east and west branches of the Wanapitei River, and stretches approximately 120 km from the intake. See Map 4.4 for an illustration.

Intake Protection Zone Delineation Uncertainty

As required by Rule 108, an uncertainty analysis of the delineation of intake protection zones and vulnerability scoring are presented in Table 4.4.

Table 4.4 – Summary of uncertainty analysis for the Wanapitei River intake protection zones

IPZ	Level of Uncertainty	Comments
IPZ-1	High	This zone was delineated as a fixed radius surrounding the intake according to Rule 61. There has been some anecdotal evidence suggesting that due to wind direction and intensity, the surface of the river appears to flow upstream. With the close proximity of the highway and the rail line, it is uncertain if the prescribed delineation of the IPZ-1 is sufficient to protect the intake from a possible accident in these transportation corridors.
IPZ-2	Low	Field data provided insight into the characteristics of the river profiles upstream of the WTP intake. As a result, IPZ-2 delineation has a higher degree of confidence associated with it.
IPZ-3	High	The delineation for the IPZ-3 was prescribed under Rule 70. The resulting IPZ-3 includes the entire watershed to the Arctic Divide. As this represents a vast area with little detailed mapping information, there is little certainty regarding exact locations of the high water mark with which to delineate a 120 m setback from.

24.2 Vulnerable Areas Scoring

Vulnerability scoring for intake protection zones followed Rules 86 to 95 which require a source vulnerability factor and area vulnerability factor to be determined. Chapter 2 explains the methodology in detail. Due to the sheer size of the Wanapitei River intake protection zones, the area vulnerability factor was determined based on subwatershed. Each subwatershed was characterized and given one overall score as explained in the subsequent pages.

Source Vulnerability Factor

The Source Vulnerability Factor was scored a 1.0 out of a possible 0.9 or 1.0 for the following reasons:

- the intake is situated on the bank of the river
- the intake is very shallow
- periodic taste and odour issues reported by the treatment plant operators and the intake is very exposed to potential contaminants.

Area Vulnerability Factor

The area vulnerability factor for IPZ-1 is fixed at 10.

IPZ-2 is characterized by bedrock with sparse vegetation and relatively steep terrain. A score of 8 was given to this zone as it is within close proximity to the intake and has little attenuation capacity with the land cover present.

IPZ-3 was divided into a number of sections and subwatersheds. The area upstream of and including Lake Wanapitei was classified as having a very low vulnerability and a score of 1. The residence time of the lake is estimated to be approximately 2-4 years and is controlled by the Lake Wanapitei Dam at the outlet. Land cover in this region is heavily forested and the area is sparsely populated.

Downstream of Lake Wanapitei, the distance and travel time to the intake is much less and therefore the vulnerability increases. The closest subwatersheds, the Lower Wanapitei below Stinson Dam, the Emery Creek subwatershed and a small unnamed subwatershed, are given a score of 8. The subwatersheds are similar in land cover as IPZ-1 and 2 and have little attenuation capacity. The subwatersheds are also in close proximity to the intake.

Between the Stinson Dam and the Moose Rapids Dam, a score of 7 was given. The vulnerability of the landscape is moderate as the terrain is dominated by bedrock and is in close proximity to the intake. Above the Moose Rapids Dam, a score of 6 was given as the reach is farther from the intake than the previous reach and has similar land cover.

Summary of Vulnerable Area Scoring

Table 4.5 shows the source vulnerability and area vulnerability factors for the Wanapitei drinking water system intake protection zones.

Table 4.5 – Wanapitei River vulnerable area scoring

Intake Protection Zone	Source Vulnerability Factor	Area Vulnerability Factor	Vulnerability Score	Comments
IPZ-1	1.0	10	10	Fixed score
IPZ-2	1.0	8	8	Steep slopes Mostly bedrock Little attenuation capacity
IPZ -3 – Lower Wanapitei River (below Stinson Dam)	1.0	8	8	Varied topography Mostly bedrock with little vegetative cover
IPZ-3 – Emery Creek	1.0	8	8	
IPZ-3 - Unnamed	1.0	8	8	
IPZ-3 – Lower Wanapitei River (between Stinson and Moose Rapids Dam)	1.0	7	7	Mostly bedrock Varied topography
IPZ-3 – Lower Wanapitei (between Moose Rapids and Lake Wanapitei Dam)	1.0	6	6	Mostly bedrock
IPZ-3 Lake Wanapitei	1.0	1	1	Long residence time in Lake Wanapitei (2-4 yrs) Mostly undeveloped Forested land cover Some mine exploration and forestry activity in the upper reaches of the watershed
IPZ-3 – Parkin Creek	1.0	1	1	
IPZ-3 East Wanapitei	1.0	1	1	
IPZ -3 – Upper Wanapitei	1.0	1	1	
IPZ-3 Burwash Creek	1.0	1	1	
IPZ-3 – Silvestor Creek	1.0	1	1	
IPZ-3 – Rosie Creek	1.0	1	1	
IPZ-3 Meteor Creek	1.0	1	1	

Intake Protection Zone Vulnerability Scoring Uncertainty

Uncertainty surrounding the vulnerable area scoring assignment is based on the ability for the vulnerability factors to effectively assess the relative vulnerability of the hydrological features. The vulnerability scores for the Wanapitei River intake protection zones were primarily based on land cover.

Table 4.6– Uncertainty analysis for the vulnerable area scoring

	Uncertainty	Comments
Source Vulnerability Factor	Low	The intake is situated on the banks of the Wanapitei River with high vulnerability to contamination from surrounding land uses.
Area Vulnerability Factor – Score of 6 to 8	Low	IPZs 2 and 3 have been scored relatively conservatively. There is sufficient information to assign scoring and high confidence that the factor will address any concerns to the intake.
Area Vulnerability Factor – Score of less than 6	High	It was assumed that the time of travel and the dilution were high enough. However, there is no data to confirm this assumption. In addition, there is no detailed mapping for the entire watershed.

24.3 Wanapitei Drinking Water Quality Threats Activities

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

The MECP has established an online tool that incorporates the Provincial Table of Drinking Water Threatsinto 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.

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Maps 4.2 to 4.4. According to the Technical Rules (2009):

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

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 area was assessed to be under 40% (low) and is illustrated on Map 4.5.

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 calculated. The percentage of impervious area in the Highway 17 corridor immediately upstream of the Wanapitei River intake is in the 8-80% range. Most of the impervious area in the rest of intake protection zones 1 and 2 is in the 1-8% range, with a small amount in the <1% range. The opposite is true for the rest of the watershed, where most of the impervious area is in the less than 1% range, with small amounts in the 1-8% range. The percentage of impervious area is illustrated in Map 4.6. The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2. The calculation of impervious surfaces led to the vulnerable area being designated as a significant threat or a moderate threat for the application of road salt depending on the vulnerability score.

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 vulnerable areas in the Wanapitei River intake watershed; therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated in Map 4.7.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. Table 4.7 shows the number of occurrences of this threat in different vulnerability areas.

Enumeration of Threats

Table 4.7 lists an estimate of the current number of drinking water threats in the Wanapitei River intake vulnerable areas in accordance with Rule 9 and the Drinking Water Threats Tables.

Table 4.7 – Drinking water quality threats for the Wanapitei River intake

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
IPZ-1			
The application of commercial fertilizer to land.		1	
The handling and storage of fuel.	1		
The application of road salt.	1		
Local threat: Transportation of hazardous substances along transportation corridors.	1	1	
IPZ-2			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			19
The application of commercial fertilizer to land.		1	
The application of road salt.		1	
Local threat: Transportation of hazardous substances along transportation corridors.	1	2	1
IPZ-3			
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.		1	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			86
The application of commercial fertilizer to land.		1	
The application of road salt.		1	
Local threat: Transportation of hazardous substances along transportation corridors.		2	4

24.4 Wanapitei Drinking Water Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Rule 126. 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 Maps 4.2 to 4.4.

At the time of report production, there are no known conditions present within the vulnerable areas for this drinking water system.

24.5 Wanapitei Drinking Water Quality Issues

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

There are no known drinking water quality issues at this time.

Chapter 25 - Data Gaps

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 constantly 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. Therefore, there will be a need to continue filling in identified data gaps and to carry out studies in the future. Data gaps for the Wanapitei River intake include:

- River bed cross sections and velocity profiles during higher discharge rates; and
- Detailed contaminant mixing effects at higher discharge rates.