

5.8 Burwash Landing - Kluane First Nation Public Water Supply System

The community of Burwash Landing is located on the Alaska Highway at km 1700, approximately 285 km northwest of Whitehorse, in an area known as the Shakwak trench between Kluane Lake and the steep slopes of the Kluane Range mountains. The community bulk water delivery system, with water sourced from a deep sub-permafrost groundwater well, is owned and operated by the Kluane First Nation (KFN). The system serves a population of approximately 72 people (Yukon Bureau of Statistics 2016), and is classified as a Large Public Drinking Water Supply System under the Yukon Drinking Water Regulations – Guidelines for Part I – Large Public Drinking Water Systems (YG 2007) and is also regulated under the Yukon Drinking Water Regulations - Guidelines for Part II - Bulk Delivery of Drinking Water (YG 2007).

New sub-permafrost water wells were drilled in 2015, and a new water treatment plant (with greensand filtration for manganese removal, and chlorination) is scheduled for construction in 2017.

5.8.1 Hydrogeology

Burwash Landing is underlain by glaciofluvial sediments with a thin, overlying veneer of silt (Rampton 1977). Water wells are typically completed at depths ranging from 45 m bgs to 60 m bgs in a sub-permafrost aquifer. Well KFN-F, the groundwater well currently serving the KFN's Burwash Landing distribution system, is completed in a confined sand and gravel overburden aquifer below a permanently frozen (permafrost) silt and clay unit. Two wells (KFN-M and KFN-N) drilled and constructed in 2015 were completed at a similar depth in a confined sand and gravel aquifer overlain by frozen silt and clay till with materials similar to those encountered by KFN-F. A similar aquifer has been encountered at approximately the same depth by well KFN-J suggesting that there is an aerially extensive aquifer in which the wells are completed.

None of the wells in Burwash Landing encountered bedrock; thus, depth to bedrock in the area is unknown. It is anticipated that the depth to bedrock may be up to several hundreds of metres based on the completion depth of KFN-L, a deep geothermal exploration well, in a sand aquifer approximately 385 m bgs.

The regional groundwater flow direction is north-easterly from the topographic highs of the Kluane Range to the topographic low of Kluane Lake (Tetra Tech 2006).

As part of the 2012 LPDWSA, Tetra Tech completed a semi-quantitative analysis of the aquifer vulnerability based on the methodology presented in the Technical Terms of Reference for Groundwater Studies (Ontario Ministry of Environment 2001). The ISI method resulted in a score of 226 for the deep sub-permafrost aquifer at KFN-F and 219 for KFN-G. Aquifers with ISI values greater than 80 are considered to have low intrinsic susceptibility to surface sources of contamination (Ontario Ministry of Environment 2001), and the high ISI scores calculated at the two wells are an indication that the aquifer underlying the site has a low to very low vulnerability to potential surface-based contamination due to a highly impermeable layer of frozen, fine-grained materials overlying a deep confined aquifer.

As KFN-J, KFN-L, KFN-M, KFN-N appear to be completed in one aerially extensive groundwater aquifer in the area, the vulnerability is expected to be similarly low throughout the aquifer.

5.8.2 Summary of Wells

The well logs for the KFN's Burwash Landing current and proposed public water supply system are included in the GIS map and database portion of this project. The following tables summarize the completion characteristics of the Burwash public water supply wells.

Table 5-20: KFN Burwash Landing Public Water Supply, Well KFN-F Summary

Well Construction Parameters	Details	Source
Date of construction	The well was completed by Midnight Sun Drilling Co. Ltd. in August 1981	Tetra Tech 2012a
Total well depth	61 m bgs	
Casing	6" (152 mm) OD Steel Well Casing	
Casing depth	59.7 m bgs	Well Log
Well screen	20 slot (0.51 mm) well screen (length and interval unknown)	Tetra Tech 2012a
Static water level	12.0 m bgs (February 2005)	
Sanitary seal	Bentonite gout seal installed in 2012	
Wellhead completion	Pitless Unit	
Wellhead stickup	~0.7 m ags	Stantec & Tetra Tech 2012
Well rated capacity	0.23 L/s (3 IGPM) long term safe sustainable yield, or 0.75 L/s (10 IGPM) short term	Tetra Tech 2005
Well GUDI status	Very likely non-GUDI	Tetra Tech 2012a
Well Construction Comments:	Well was upgraded to meet Canadian Groundwater Association Well Construction Guidelines.	

Table 5-21: KFN Burwash Landing Public Water Supply, Well KFN-M Summary

Well Construction Parameters	Details	Source
Date of construction	Well was completed by Midnight Sun Drilling Inc. in October 2015	Tetra Tech 2015
Total well depth	57.3 m bgs	
Casing	6" (152 mm) ID Steel Well Casing	
Casing depth	54.3 m bgs	
Well screen	0.4 m 25 slot (0.64 mm) exposed from 54.3 m bgs to 54.7 m bgs 1.3 m 18 slot (0.46 mm) exposed from 54.7 m bgs to 56.0 m bgs 1.3 m 20 slot (0.51 mm) exposed from 56.0 m bgs to 57.3 m bgs The total exposed screen length is 3.05 m	
Static water level	~1.5 m bgs (October, 2015)	

Table 5-21: KFN Burwash Landing Public Water Supply, Well KFN-M Summary

Well Construction Parameters	Details	Source
Sanitary seal	Portland cement seal to 6.0 m bgs	
Wellhead completion	Not yet connected – intended to be completed with Pitless Unit connection	
Wellhead stickup	0.9 m ags	Tetra Tech 2015
Well rated capacity	0.83 L/s (11 IGPM)	
Well GUDI status	Non-GUDI	
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.	

Table 5-22: KFN Burwash Landing Public Water Supply, Well KFN-N Summary

Well Construction Parameters	Details	Source	
Date of construction	Well was completed by Midnight Sun Drilling Inc. in October 2015	Tetra Tech 2015	
Total well depth	57.8 m bgs		
Casing	6 1/8" (156 mm) ID Steel Well Casing		
Casing depth	54.7 m bgs		
Well screen	0.4 m 18 slot (0.46 mm) exposed from 53.8m bgs to 55.1 m bgs; 1.3 m 20 slot (0.51 mm) exposed from 55.1 m bgs to 56.4 m bgs 1.4 m 25 slot (0.64 mm) exposed from 56.4 m bgs to 57.8 m bgs The total exposed well screen length is 3.05 m		
Static water level	~1.5 m bgs (October 18, 2015)		
Sanitary seal	Portland cement seal to 6 m bgs		
Wellhead completion	Not yet connected – intended to be completed with Pitless Unit connection		
Wellhead stickup	0.9 m ags		
Well rated capacity	0.83 L/s (11 IGPM)		
Well GUDI status	Non-GUDI		
Well Construction Comments:	Well was constructed to meet Canadian Groundwater Association Well Construction Guidelines.		

5.8.3 Source Water Quality

Tetra Tech completed a review of the water quality from Well KFN-F during the 2012 LPDWSA; comments from are summarized below:

- The water from KFN-F was calcium-sodium-magnesium-bicarbonate type with a pH of approximately 8.3 and was considered hard with a measured hardness of approximately 130 mg/L (as CaCO₃);
- Manganese concentrations were above the GCDWQ AO in raw water samples from KFN-F for all sampling events. Manganese concentrations have remained consistent over time; and
- The turbidity from the raw water sample from the well was considered typical of a groundwater source. The turbidity of treated water samples, however, was relatively high at all treated water sampling points. As the turbidity of the treated water was higher than the raw water source, it was postulated that the turbidity may be related to precipitates of manganese and /or iron forming post chlorination.

Upon completion of water supply wells KFN-M and KFN-N in 2015, water samples were collected from the wells to characterize the water quality and potability. From the water quality results provided in the 2015 well completion report:

- To evaluate the quality of the analysis Tetra Tech calculated the ion balance (i.e. the balance between sum of anion and cation equivalent charges) of each water sample. Typically, an ion balance of within ± 10% is considered satisfactory. The calculated ion balances of KFN-M and KFN-N were both within ± 5%, suggesting that analytical errors are within acceptable limits and all major cations and anions present in the sample water were analyzed;
- The water from both KFN-M and KFN-N was classified as being hard and characterized as magnesium-sodium-calcium-bicarbonate-sulphate type water; and
- Analytical results were compared against the GCDWQ MAC and AO values, and the concentration of manganese exceeded the GCDWQ AO of 0.05 mg/L at both wells.

5.8.4 Water Treatment and Distribution

Table 5-23: KFN Burwash Landing Public Water Supply, Water Treatment and Distribution Details for Existing System		
Item	Details	Source
Owner/Operator	Kluane First Nation	YES, 2012
Water source	Groundwater	
Wells serving the system	KFN-F	
Treatment type	Chlorination for primary and secondary disinfection	
Population served	72	Yukon Bureau of Statistics 2016
Delivery method	Trucked	YES 2012
Age of system/last known update	New wells in 2015. New water treatment plant scheduled to be completed in 2017	Stantec & Tetra Tech 2017

As mentioned previously, a new water treatment plant with greensand filtration for manganese removal and chlorination is scheduled for construction in 2017.

5.8.5 Source Water Protection Planning

Tetra Tech completed an Aquifer and Wellhead Protection Plan (AWPP) for KFN in July 2007 which addressed risk to community water supply well KFN-F. Water supply wells KFN-J, KFN K, KFN-M, KFN-N, and warm water well KFN-L were not included in the 2007 plan as they did not exist at the time.

The KFN AWPP was based on Tetra Tech's risk based approach which is adapted from British Columbia's Environment (BC MoE) Tool Kit. The well capture zones in the community were predicted using numerical modelling. Tetra Tech used Visual MODFLOW developed by Waterloo Hydrogeological Inc. based on the USGS MODFLOW code to create three dimensional models of the well capture zones for the Burwash KFN community water wells. The model was used to simulate 1, 5 and 10 year capture zones for each well. Conservative assumptions were built into the groundwater flow model to create reasonable and realistic areas for wellhead protection planning.

Potential sources of contamination to the Burwash Landing public supply wells and aquifer were identified as part of the 2012 LPDWSA. These potential sources of contamination included ASTs for domestic heating fuel, septic truck holding bay, sewage holding tank and former location of septic leach pit and an unused well (KFN-G). Key conclusions and recommendations can be reviewed in the attached AWPP, included in the GIS map and database portion of this project.

A new AWHPP is currently being prepared for the two new community water supply wells (KFN-M and KFN-N) that are intended to replace KFN-F in 2018. As part of this AWHPP, well capture zones have been determined in consideration of the hydrogeological regime and planned pumping rates. The capture zone delineates an area around the wells that contributes water to the wells and will be the basis for development of the protection plan to reduce risks to water quality from these wells servicing the community system. Defined well capture zones are provided in the GIS database. The final AWHPP will address potential risk and risk management strategies related specifically to these wells in recognition of the delineated capture zone.

5.8.6 Water Supply Information Data Gaps

Tetra Tech has reviewed available data from KFN and YG Community Services as well as our internal database to complete this summary for KFN water systems. Work is currently underway to prepare a new AWPP to include the new water supply wells KFN-M and KFN-N and upon completion, the new AWPP should be included in the database when completed.