Memorandum

RE: Summary of the Nicholson Area Groundwater Monitoring Program

western water ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

TO: Hamish Kassa (CSRD) **DATE:** July 28, 2014 RVISED Sept 23

FR: Bryer Manwell, M.Sc. P.Eng. **REFERENCE:** 14-024-18 – M1

This memo provides a summary of the Columbia Shuswap Regional District (CSRD) sponsored groundwater monitoring program performed at Nicholson between 2005 and 2013. The objective of the program is to assess the potential impact on groundwater from operation of private sewage disposal systems (PSDS).

In 2010 significant changes were made to the program to address the water quality monitoring results from the first four years; specifically, an expansion of the monitoring well network to focus on the Nicholson subdivision was implemented. The program changes were made to help facilitate better monitoring of spatial and temporal effects of PSDS in the Nicholson area. Since that time, sampling has occurred for the expanded network biannually in spring and fall at 23 domestic wells in the Nicholson, Habart, and Canyon Creek subdivisions (see attached figure for locations). Sampling has been discontinued for 2014, as the CSRD feels the water quality issues at Nicholson are understood; therefore, moving forward, it is best to put time and budget into potentially correcting the known problem.

Nicholson residents operate PSDS and many obtain water from private, on-site groundwater wells. Currently, the monitoring program does not record information about the amount of water being drawn from the wells, cycling schedules, or routine maintenance and decontamination schedules. During the 2010 sampling, a survey was performed to assess the approximate locations of the septic fields belonging to the residents whose wells were sampled at that time. In several cases the monitored residential wells are located directly down-gradient of their own septic fields or neighbours' septic fields. We see that water supply wells and septic fields are in close proximity to each other throughout the monitored areas. The combination of the hydrogeological setting (i.e. the shallow water table) and the proximity of the septic fields to wells has created a situation where there is risk for well water quality to be impacted by PSDS in the Nicholson area. The Nicholson area continues to show widespread indication of impact from PSDS

The contamination detected to-date is likely caused by flooded septic tanks, coarse (gravel) deposits between the septic fields and the water table, and/or thin vertical separation between the bottom of the septic fields and the water table. The coarse soil deposits found in the area (gravel is shown in most well logs reviewed) do not allow for PSDS effluent to be fully renovated before the affected groundwater reaches the wells. The water quality results to-date show septic impact at numerous locations.

Of the 23 wells sampled in 2013, 11 had exceedances of GCDWQ MAC values (thresholds based on health concerns) and two had an exceedances of GCDWQ AO values (a threshold based on aesthetic concerns).

Nitrate concentrations greater than 3 mg/L, which are indicative of anthropogenic impacts, were detected in 11 wells in 2013. It is apparent that the majority of wells sampled at the Nicholson subdivision have displayed nitrate concentrations above 3 mg/L at some point during sampling between 2010 and 2013. However, only Loc-16 at the Habart subdivision has shown high nitrate over time. The nitrate contamination is most prevalent at the Nicholson subdivision.

LOC-30 located in the Nicholson subdivision, sampled in the spring of 2013, showed a nitrate concentration of 12.9 mg/L, which exceeds the GCDWQ MAC of 10 mg/L. This nitrate concentration is the highest on record, since the modification to the sampling network, which occurred in 2010. The elevated nitrate, particularly at the Nicholson subdivision, is believed to be due to septic impact. Electrical conductive, and chloride (a conservative ion associated with human activity) concentrations are statistically higher at Nicholson compared to Habart and Canyon Creek subdivisions.

Bacteriological parameters continue to be detected at Nicholson. Since monitoring began in 2005, *E. coli.* has been detected at 2 wells, fecal coliforms at 3 wells, and total coliforms in 33 wells. In 2013, total coliform counts above the GCDWQ MAC were detected in 11 wells, and an *E. coli.* count above the GCDWQ MAC was detected in LOC-28 in the spring. The widespread detection of bacteriological parameters and, in particular, presence of *E. coli.* If further demonstration that septic system operation is impacting the groundwater quality.

Wells in the Nicholson subdivision continue to show the highest levels of contamination; as indicated by more frequent counts of microbiological indicators, along with higher concentrations of nitrate, chloride and electrical conductivity. Based on data from 2010 to 2013, the wells at the Nicholson subdivision have higher average concentrations of chloride (58 mg/L) and nitrate (5 mg/L) than the Habart or Canyon Creek wells. Likely, the Nicholson subdivision shows higher impact due to a higher water table in the aquifer underlying the subdivision. The Habart Subdivision ranks second behind the Nicholson subdivision with respect to indicators of septic contamination. The Canyon Creek wells show the least contamination, with lower average concentrations of chloride, conductivity, sulphate, and nitrate than both other subdivisions.

Taking into account the monitoring program results to-date and the hydrogeological setting, all drinking water wells across the site should be considered at risk for fecal contamination. It is possible that any well at the site could have one or more exceedances of *E. coil.* or other septic-related drinking water contaminants at some point during its lifespan. Given these issues, we believe drinking water from all shallow wells should be disinfected. Until disinfection systems are in place, options include boiling water prior to use, using an alternate water source, or performing regular water testing to confirm that each residence's water supply meets the drinking water guidelines. Note, boiling water does not reduce the nitrate concentrations; however, boiling water can reduce the presence of pathogenic bacteria.

Options to improve drinking water quality in the area include installing deeper wells or point of use water treatment. Specifically water treatment should aim to reduce particulate size to enable adequate disinfection, followed by removal of nitrate. One water treatment scheme to address the water quality issues at individual homes is as follows:

- Remove particulates to 0.5 micron in size by filtration, so that UV light can effectively disinfect the water;
- UV disinfection (for pathogenic bacteria removal); and
- Reverse osmosis (for point of use (POU); i.e. the kitchen tap water) to remove nitrate.

More information is available on Health Canada's website (http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/escherichia coli/index-eng.php#a713). A water quality treatment specialist or engineer should be consulted to determine the best method of water treatment and disinfection for individual systems.

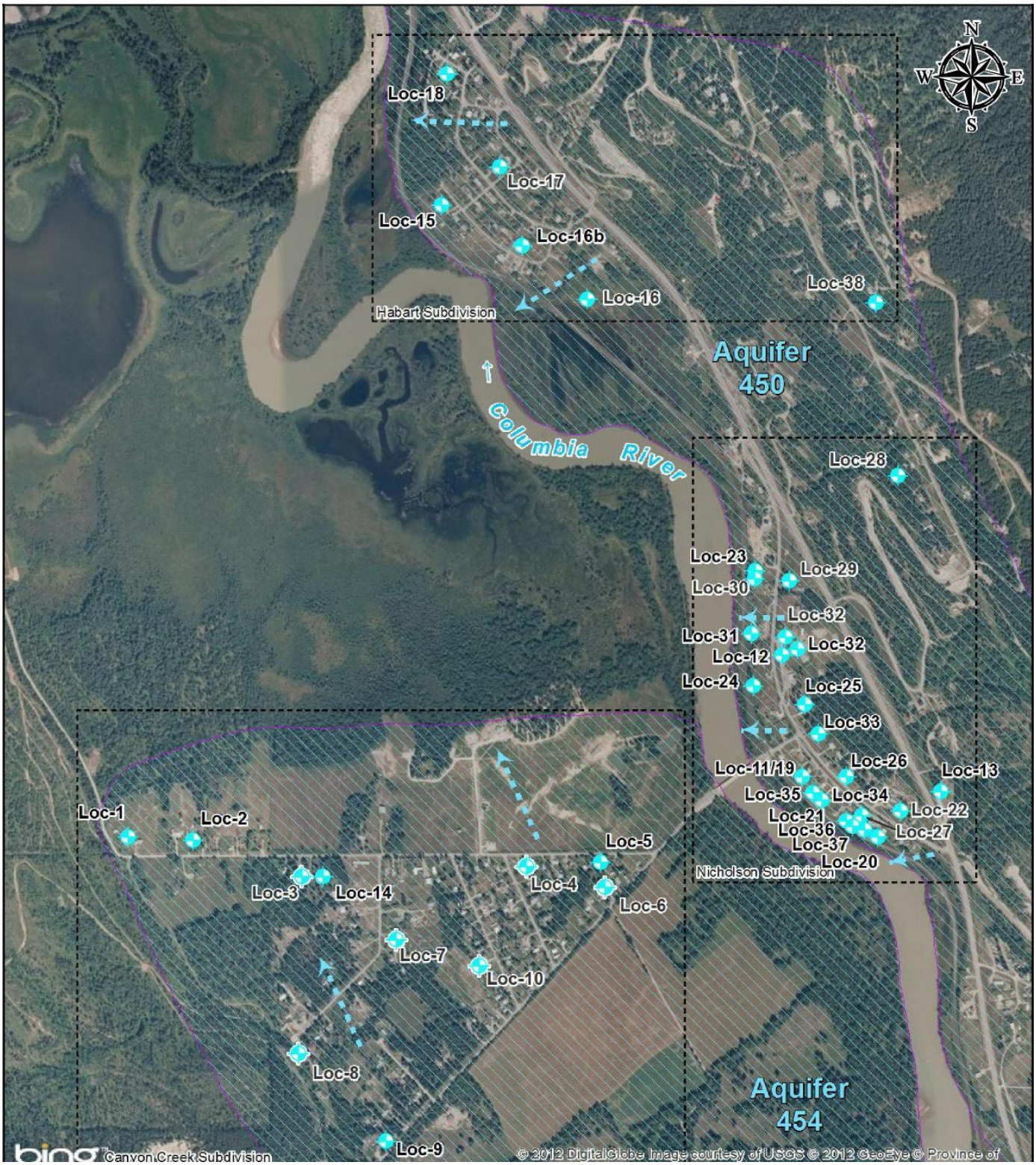
The following table summarizes exceedances in drinking water quality guidelines in 2013.

Water Quality Exceedances for 2013

Sampling Location	Guideline	Exceedances
LOC-1	GCDWQ MAC	Total coliforms (counts)
LOC-9	GCDWQ MAC	Total coliforms (counts)
	GCDWQ AO	pH [F]
LOC-12 Nicholson	GCDWQ AO	Temperature [F]
LOC-15 Habart	GCDWQ MAC	Total coliforms (counts)
LOC-16 Habart	GCDWQ MAC	Total coliforms (counts)
LOC-16b	GCDWQ MAC	Total coliforms (counts)
LOC-19 Nicholson	GCDWQ MAC	Total coliforms (counts)
LOC-24 Nicholson	GCDWQ MAC	Total coliforms (counts)
LOC-27 Nicholson	GCDWQ MAC	Total coliforms (counts)
LOC-28	GCDWQ MAC	E. coli (counts), Total coliforms (counts)
LOC-30	GCDWQ MAC	Nitrate (as N), Nitrate + Nitrite (as N) (calculated), Total coliforms (counts)
LOC-31	GCDWQ MAC	Total coliforms (counts)

Note:

GCDWQ AO	Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives
GCDWQ MAC	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations



Map with Sample Locations