COMPREHENSIVE MONITORING PROGRAM AND ENVIRONMENTAL IMPACT ASSESSMENT

Ken and Brenda Regehr

Pollution Prevention Order
File #108432

December 2016

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1 Introduction

1.1 BACKGROUND

Associated Environmental Consultants Inc. (Associated), with Ruth McDougall, P.Ag., and Doug McFarlane, CCA, were retained by Ken and Brenda Regehr (Regehr Farms) to implement a Comprehensive Monitoring Program and an Environmental Impact Assessment (EIA) for nitrates and other nitrogen compounds in the soil and groundwater in Hullcar Aquifer 103. The focus of the Comprehensive Monitoring Program and EIA is the agricultural operations located at 4516 Hullcar Road in Armstrong, BC, with the exception of the operations of Purple Springs Nursery Ltd. (Purple Springs). The requirements for the monitoring program and EIA are specified in the Terms of Reference and the Pollution Prevention Order issued by the BC Ministry of Environment (MOE) on June 8, 2016 (File AMS#108432, MOE 2016a).

1.2 TERMS OF REFERENCE

The first requirement (Requirement 1) of the Pollution Abatement Order (the Order) was to develop a Terms of Reference (TOR) and work plan for the monitoring program and EIA. The Order applies to the following area (the Lands):

- District Lot 48, Kamloops Division of Yale Land District, Parcel Identifier 011-227-486, other than that portion occupied by Purple Springs; and
- Lands used from time to time for agricultural operations that are part of or associated with the agricultural operations of the above lands and are owned or controlled by Ken and Brenda Regehr.

The TOR and work plan was submitted by Associated to MOE on behalf of Regehr Farms on September 23, 2016. The TOR and work plan was accepted on September 23, 2016, with conditions.

The Order states that "the usefulness of the environment has been impaired due to the presence of nitrates in the groundwater as the presence of nitrates is causing the groundwater in the unconfined aquifer that lies in part underneath the Study Area (commonly referred to Hullcar Aquifer 103) to be unfit for potable water for specific persons in the population." The Order stems from the Hullcar Aquifer Inter-Ministry Action Plan developed in March 2016, where one of the goals of the Action Plan is to determine as accurately as possible the sources of nitrate to the Hullcar Aquifer and the potential for human health effects on domestic water users of aquifer. The TOR and work plan and the MOE acceptance letter and conditions are provided in Appendix A, and are intended to identify the methods that were used to meet this goal.

Requirement 2 in the Order is to implement the monitoring program and to complete the EIA. The results of the monitoring program and EIA are presented in this report.

1.3 GOALS OF THE MONITORING PROGRAM AND EIA

The overall goal of the Comprehensive Monitoring Program and EIA was to determine whether the existing agricultural operations in the Study Area are having an adverse effect on Hullcar Aquifer 103 and connected surface water by increasing the concentrations of nitrate-N and other nitrogen compounds to levels that are a hazard to human health (Requirement 2 of the Order).

1.4 REGULATORY CONTEXT

The Order is pursuant to section 81 of the *Environmental Management Act* (EMA) (SBC 2003 c. 53), and manure management is subject to the *Agricultural Waste Control Regulation* (AWCR) (BC Reg. 131/92) under the EMA. Fundamentally, the EMA prohibits pollution, and the Order indicates that pollution in this case has been caused by the introduction of agricultural waste to the environment. The AWCR defines **pollution** as “the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment.”

With respect to groundwater and surface water, a key indication that pollution has occurred is an exceedance of water quality guidelines or objectives applicable to the Hullcar Aquifer; specifically, Health Canada’s Guidelines for Canadian Drinking Water Quality (GCDWQ) (Health Canada 2014).

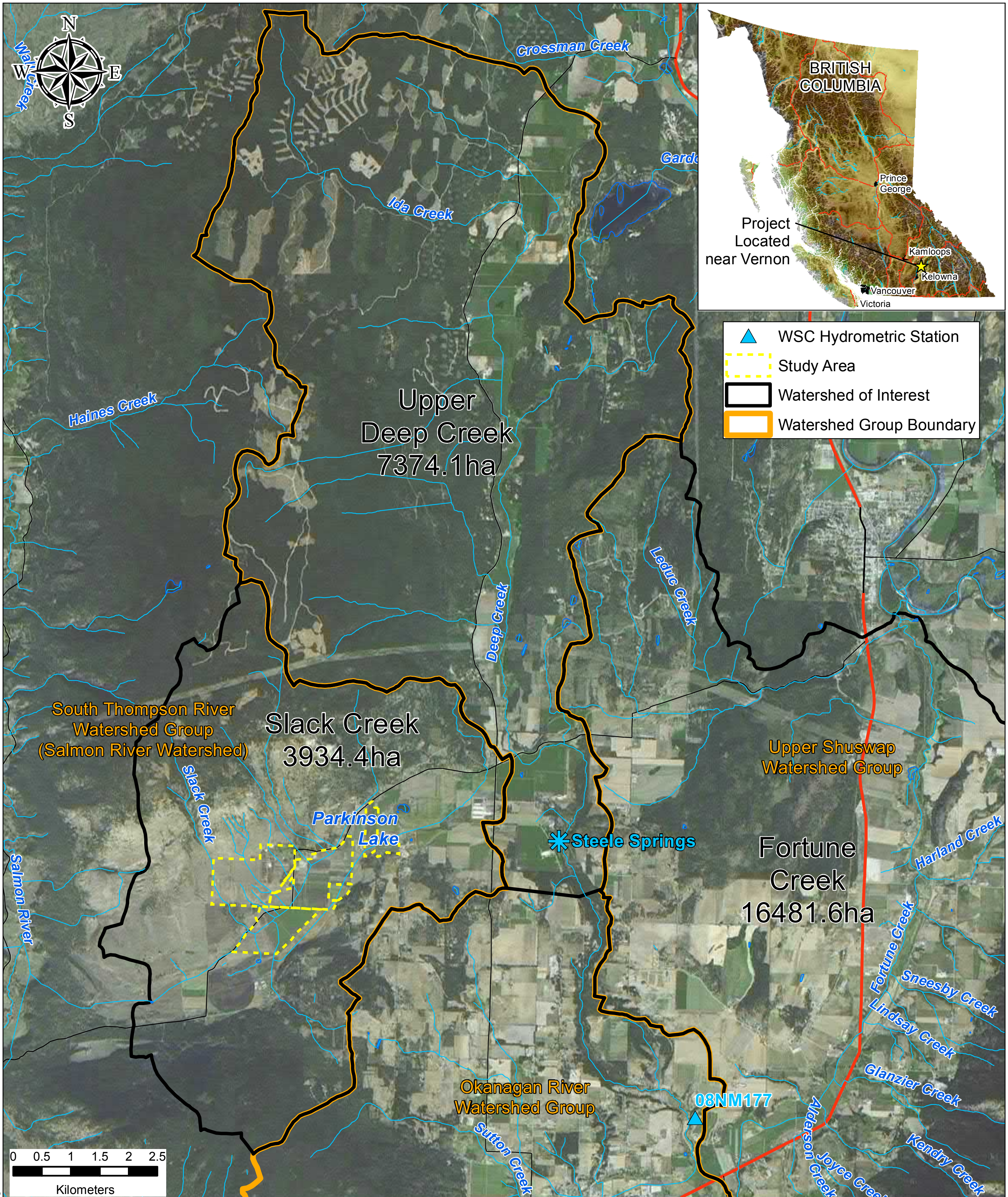
1.5 SPATIAL AND TEMPORAL BOUNDARIES OF THE EIA

Regehr Farms operates a feedlot with about 3,800 head of feeders and 340 cow/calf pairs over the winter months. Figure 1-1 shows the location of the properties relative to the mapped watersheds and surface waterbodies. Figure 1-2 shows the extent of the Study Area, which includes lands owned or rented by Regehr Farms.

The spatial extent of the Study Area is the lands identified in the Order, shown in yellow on Figure 1-2. The vertical extent of the Study Area is from the land surface to the bottom of Hullcar Aquifer 103.

The Order is for pollution prevention. Therefore, the objective of the EIA in the Order is to assess current agricultural practices and their potential to adversely affect groundwater. Regehr Farms has been following a nutrient management plan since 2013. Therefore, the EIA examined records on land use and nutrient management relevant to our assessment since that time. Accordingly, the temporal boundaries of the EIA are from 2013 to present (i.e., as indicative of current operations), although the potential effects of nutrient management practices before 2013 are also evaluated.

A large portion of land east of District 48 (i.e., the parcel of land on which the feedlot is located) is managed by Purple SpringsNursery. Regehr Farms is a partnership owned by Ken and Brenda Regehr. Purple Springs Nursery is an incorporated company; however, both businesses have an overlap in ownership, and staff have access to both properties.



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Associated Environmental

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FIGURE 1-1: LOCATION OF STUDY AREA

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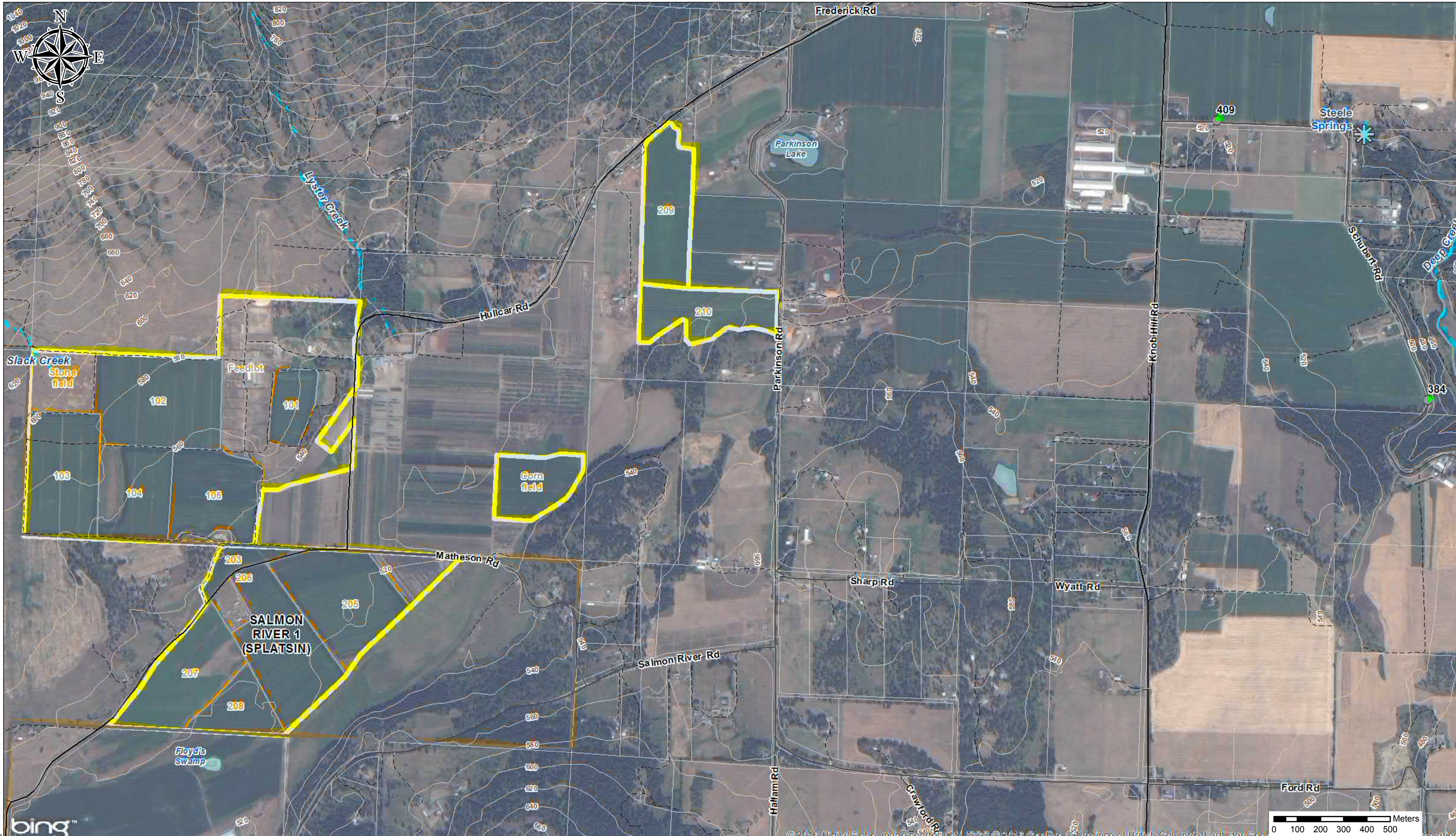

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- Study Area – Regehr Feedlot and Farm
- Field
- Indian Reserve
- Parcel boundary
- Contours (m asl)
- Stream - definite
- Stream - intermittent
- MOE observation well

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FIGURE 1-2: EXTENT OF STUDY AREA

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1.6 ENVIRONMENTAL ASSESSMENT PROCESS

The environmental assessment process included the following tasks:

- Characterizing the existing (baseline) environmental conditions at the Study Area and underlying aquifer, considering climate, soils, surficial geology, aquifer characteristics, and water quality. Baseline characterization includes design and implementation of the monitoring program.
- Describing farm operations at the Study Area, particularly manure and nutrient management.
- Assessing the effects of current (since 2013) farm operations on the receiving environment (specifically Hullcar Aquifer 103), considering the magnitude, timing, duration, and reversibility of any adverse effects. As noted above, Regehr Farms began implementation of a nutrient management plan in 2013 that is intended to optimize nutrient use on farm land.
- Assessing the effects of farm operations and nutrient management before 2013 on the environment to determine whether there are residual effects on Hullcar Aquifer 103 in the Study Area from the pre-2013 operations.
- Identifying management practices or other mitigation measures to avoid or minimize the identified adverse effects. The EIA will include the recommended preliminary mitigation strategy, with the details to be developed later as part of the Action Plan.
- Determining if there are likely any residual effects that cannot be reasonably mitigated.
- Developing a monitoring program to assess the effectiveness of the mitigation measures.

2 Comprehensive Monitoring Program

The Comprehensive Monitoring Program followed the tasks identified in Table 3-1 of the TOR and work plan (Appendix A).

2.1 SUMMARY OF BACKGROUND INFORMATION

2.1.1 Climate

Climate normals data are available for Silver Creek (Climate STN ID 1167337), which is located approximately 8 km northwest of the Study Area at an elevation of 419 m. Table 2-1 summarizes the 1981-2010 climate normals data available for the climate station. During this period, the recorded average annual temperature and total precipitation at this station were 7.7ºC and 557.1 mm/year, respectively (Environment Canada 2016). Like most of the valley bottom areas in the BC Southern Interior, there is a significant soil moisture deficit from April to September, when potential evapotranspiration exceeds precipitation (Table 2-1). This deficit is offset at Regehr Farms and on most local farms through irrigation. Surplus moisture from autumn rain and spring snowmelt infiltrates to ground, providing the mechanism for the downward migration of water. If irrigation exceeds crop demands the excess water may also infiltrate below the rooting zone.

Table 2-1
Climate normals (1981–2010) data for Silver Creek

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Temperature													**Yearly Average**
Monthly Average (°C)	-3.4	-1.1	3.1	8.4	12.6	16.1	19.1	18.4	13.5	6.7	1.5	-2.7	7.7
Precipitation													**Yearly Total**
Total Rainfall (mm)	16.7	14.8	21.6	29.0	48.7	51.4	44.8	33.8	34.0	47.8	39.2	15.3	397.1
Total Snowfall (cm)	43.5	16.3	12.2	0.9	0.0	0.0	0.0	0.0	0.0	1.3	33.0	52.9	160.0
Total Precipitation (mm)	60.2	31.1	33.8	29.9	48.7	51.4	44.8	33.8	34.0	49.1	72.2	68.2	557.1
Reference Evapotranspiration (mm)[1]	0	4	32	76	131	156	181	152	85	31	3	0	851
Climate Moisture Deficit[2]	60.2	27.1	1.8	-46.1	-82.3	-104.6	-136.2	-118.2	-51.0	18.1	69.2	68.2	-293.9 (-538 for April-Sept)

Notes:

[1] Reference evapotranspiration was estimated using the Priestley-Taylor approach, following Shuttleworth (1993). Sunshine hour data from Kamloops Airport climate station (Climate STN ID 11637800) were used in the absence of sunshine data at Silver Creek climate station. Based on available relative humidity data from Kamloops Airport climate station, a coefficient of 1.74 was used to represent arid conditions.

[2] A negative value in climate moisture deficit means that reference crop water demand is not met by precipitation.

2.1.2 Hydrology

The Study Area is located within the Salmon River watershed and the Slack Creek sub-basin (3,934.4 ha). The Salmon River is a tributary of Shuswap Lake. Shuswap Lake flows into South Thompson River, within the Fraser River basin. East of the Study Area is the Upper Deep Creek watershed, which contributes to Deep Creek, which flows south towards Okanagan Lake.

Slack Creek (Figure 1-2) is an intermittent stream located northwest of the Study Area, and is a ‘losing stream’ where it enters the northwest corner of the Study Area, meaning that flow from the surface infiltrates to groundwater. The farthest the creek has reached in the past 20 years is the southeast corner of the Stone Field (see Figure 1-2) where all of the surface water flow infiltrates to groundwater (B. Lichti, personal communication, 2016). Lyster Creek (Figure 1-2) is also an intermittent stream, which loses all of its surface flow at around the 620 m asl elevation, except during a few weeks in the spring.

Parkinson Lake is a small lake (surface area approximately 2 ha) located northeast of the Study Area. A small unnamed pond (surface area approximately 0.4 ha) located south of the Study Area is commonly referred to as Floyd’s Swamp.

2.1.3 Surficial Geology and Soils

The surficial geology within the Study Area results from the Fraser. The valley bottoms within the Study Area are dominated by stream terrace and kettle terrace deposits (sand and gravel). Towards the valley walls (including the area around the feedlot and Fields 101 to 105), the deposits include fan (poorly sorted gravel, sand, silt, and clay) and undifferentiated moraine (till with minor sand and gravel) (Fulton 1975). In these valley well areas, slow groundwater movement is expected, because poorly sorted deposits and till have low porosity, and will therefore have low hydraulic conductivity. For example, till has hydraulic conductivities in the range of $1X10^{-12}$ m/s to $1X10^{-6}$ m/s, compared to a sand which typically has a hydraulic conductivity of 1×10^{-4} m/s (Freeze and Cherry 1979).

The soils of the Study Area are mapped by the provincial government as follows:

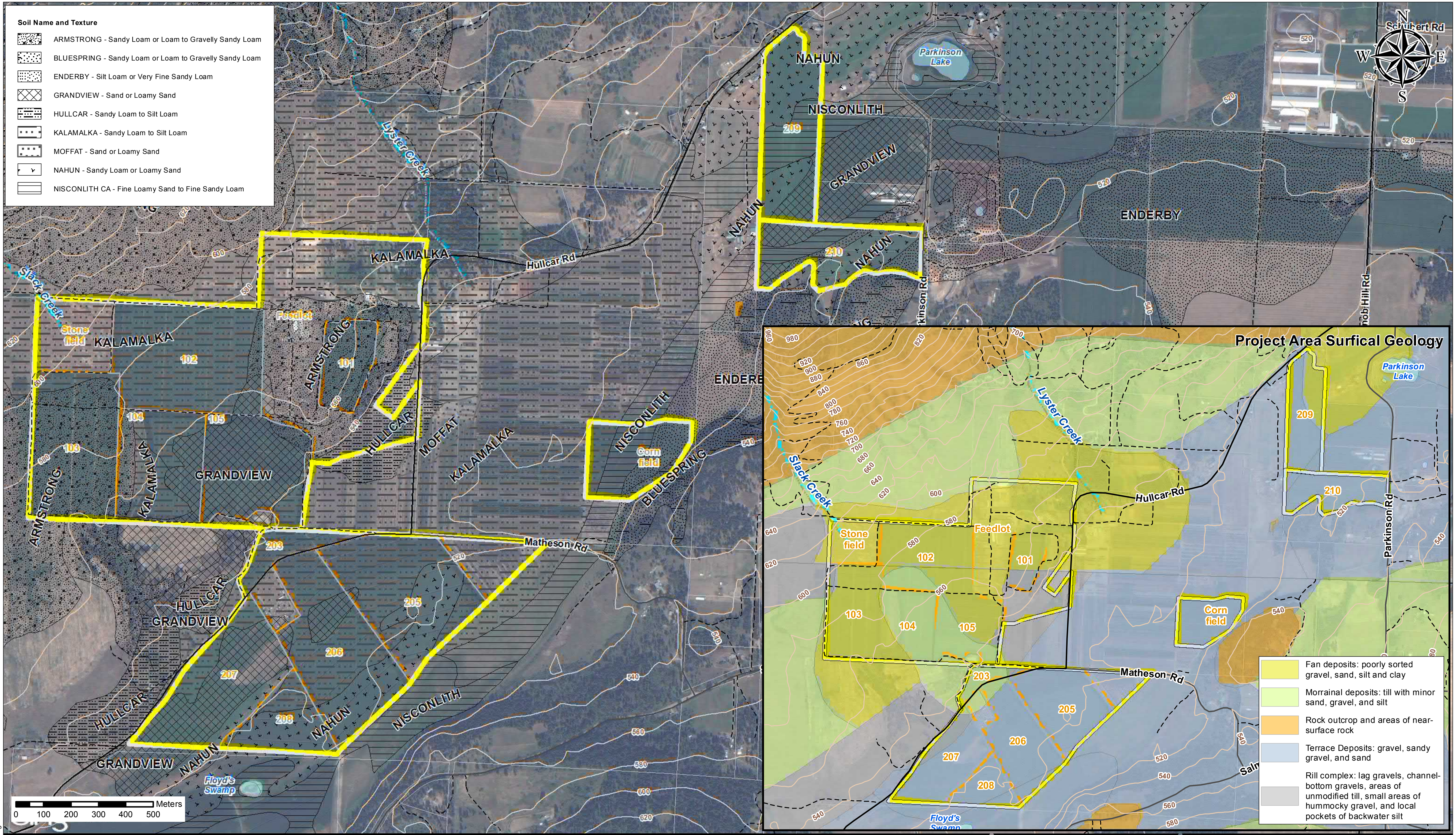
- In the area of the feedlot, the soils are primarily Armstrong (sandy loam or loam to gravelly sandy loam) and Kalamalka (sandy loam to silt loam) (Wittneben 1986, Gough et al. 1994). These are well draining soils; however, they all contain silt and clay because loam is 33% silt, 33% sand, and 33% clay. In a feedlot, the trampling action of cattle mixes manure with the soil and causes a compacted surface to build up. The compacted surface acts to minimize infiltration and prevent seepage of nutrients into the soil and groundwater underneath. A silty soil underneath a feedlot in particular will compact and seal well (Alberta Agriculture and Forestry 2000). More discussion of the compacted layer is presented in Section 2.5.4.
- In the area of the fields, the soils range from loam to sand, and include both poorly draining and well draining soils. In the well-draining soils, potential for infiltration to ground and eventually groundwater is more likely.

Figure 2-1 presents the surficial geology and soil series within the Study Area. Table 2-2 summarizes the soil series on the fields within the Study Area based on BC government mapping.

Table 2-2
Summary of predominant soil types based on provincial mapping

<table>
<tr><th>Soil Series</th><th colspan="2">Depth and Texture</th><th>Characteristics</th><th>Area (ha) within the Study Area (and %)</th></tr>
<tr><td>Kalamalka</td><td>(0-75 cm) Loam or silt loam</td><td>(>75 cm) gravelly sandy loam or gravelly loam</td><td>Medium to moderately fine-textured fluvial fan deposits. Surface and subsurface stoniness varies from non-stony to moderately stony. The soils are well drained. (Wittneben 1986).</td><td>90.6 (42%)</td></tr>
<tr><td>Armstrong</td><td>(0-50 cm) Sandy or silt loam</td><td>(50-100 cm) Gravelly sandy or silt loam</td><td>Deep, medium to moderately coarse-textured glacial till deposits, which are usually capped with sandy to loamy, wind-blown surface deposits. The soils are well drained (Wittneben 1986).</td><td>42.3 (19%)</td></tr>
<tr><td>Grandview</td><td>(0–50 cm) Loamy sand</td><td>(>50 cm) Medium to coarse sand</td><td>Deep gravel-free and stone-free sandy, coarse-textured fluvioglacial deposits and minor fluvial fan deposits. These Orthic Brown soils are well to rapidly draining and have low to very low water holding capacity (Witteneben 1986).</td><td>35.2 (16%)</td></tr>
<tr><td>Nahun</td><td>(0–25 cm) Sandy loam, loamy sand</td><td>(>25 cm) Very gravelly loamy sand, gravelly sand</td><td>Developed on moderately coarse glaciofluvial deposits. Rapidly drained with a low water storage capacity and a low to very low nutrient-holding capacity (Wittneben 1986).</td><td>30.5 (14%)</td></tr>
<tr><td>Nisconlith</td><td>(0-55 cm) Silty clay loam, clay loam, or loam</td><td>(>55 cm) Fine sandy loam with silt loam and gravelly sandy loam.</td><td>A Rego Humic Gleysol soil 10 – 50 cm thick made up of loam or clay loam over interbedded fluvial deposits. Poorly to very poorly drained with high groundwater tables (Witteneben 1986).</td><td>9.1 (4.2%)</td></tr>
<tr><td>Enderby</td><td rowspan="2">(0–20 cm) Silt loam or very fine sandy loam</td><td rowspan="2">(>20 cm) Silt loam with bands of silty clay loam and loamy sand</td><td rowspan="2">Fine-textured stratified glaciolacustrine sediments as its parent material. Subsurface is moderately saline. Well to moderately well drained (Witteneben 1986).</td><td>4.0 (1.8%)</td></tr>
<tr><td>Hullcar</td><td>4.3 (2.0%)</td></tr>
<tr><td>Bluespring</td><td>(0-20 cm) Sandy Loam or Loam</td><td>(>20 cm) Gravelly Sandy Loam</td><td>Developed in a sandy to loamy eolian veneer overlying glacial till. Surface textures are finer while subsoil textures are coarser. Soils are Orthic Dark Brown and are well drained with moderate water holding capacity (Witteneben 1986)</td><td>2.1 (1.0%)</td></tr>
</table>

Notes:
Loam: 40%-40%-20% of sand-silt-clay
Sandy Loam: at least 50% sand by volume
Loamy Sand: at least 70% sand by volume



Associated Environmental

Study Area – Regehr Feedlot and Farm

Field

Parcel boundary

Bedrock outcrop

Contours (m asl)

Stream - definite

Stream - intermittent

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FIGURE 2-1: SOILS AND SURFICIAL GEOLOGY MAPPING

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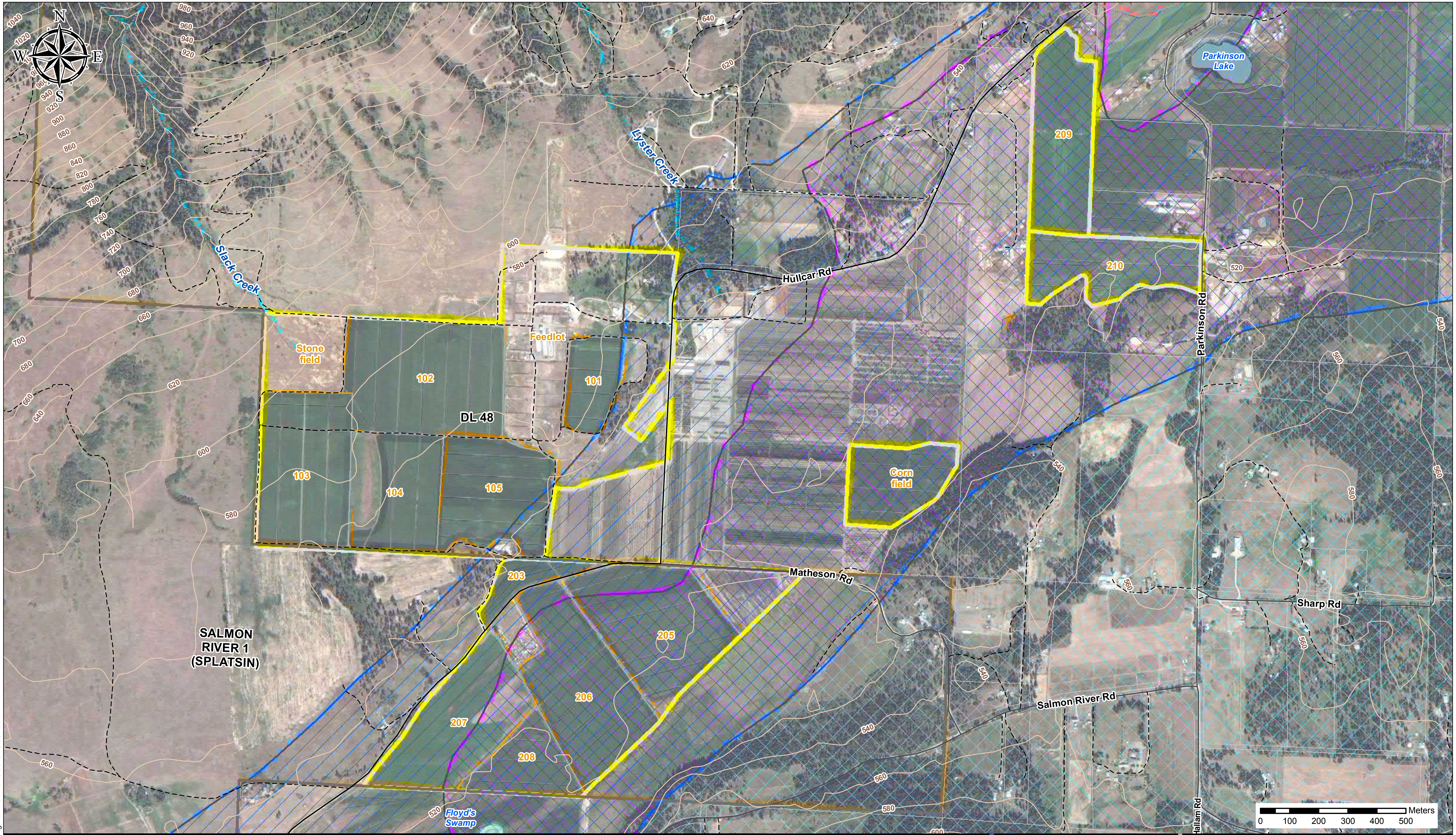
2.1.4 Aquifers

The BC Water Resources Atlas indicates several aquifers near the Study Area (MOE 2016b). The locations of these aquifers are shown in Figure 2-2 and the characteristics are summarized in Table 2-3. Based on our review of the hydrogeology and soils data of the area and the information we received from the water operator at Purple Springs, as well as the site visit conducted by Marta Green, P.Geo., the feedlot is situated on a gentle east-facing slope and neither Aquifer 102 nor Aquifer 103 is beneath the feedlot.

Aquifers 102 and 103 were mapped in 1999 by the BC Ministry of Environment. The aquifer boundaries are defined by area of development, geomorphic boundaries, surficial geology mapping, and borehole data. Note that, because these aquifers are large, the mapping may be inaccurate at the individual property level. However, MOE is currently updating the mapping of aquifers in the North Okanagan, which may provide improved information at a later date. Regardless of the mapping accuracy, precipitation that falls on the feedlot likely infiltrates the ground and any precipitation that exceeds evapotranspiration will eventually migrate down-gradient and enter Aquifer 102 or 103.

Table 2-3
Summary of aquifers in and surrounding the Study Area

MOE Number	Aquifer Type	Size (ha)	Vulnerability
102	Sand & gravel confined	>1,200	Low
103	Sand & gravel unconfined	>1,400	High
104	Bedrock	200	Moderate
355	Bedrock	>1,550	Low



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Associated Environmental

Legend		
Study Area – Regehr Feedlot and Farm	Parcel boundary	Stream - definite
Field	Contours (m asl)	Stream - intermittent
Indian Reserve	Bedrock outcrop	Aquifer 102: Hullcar Confined
Aquifer 103: Hullcar Unconfined	Aquifer 355	Aquifer 104

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FIGURE 2-2: MAPPED AQUIFERS

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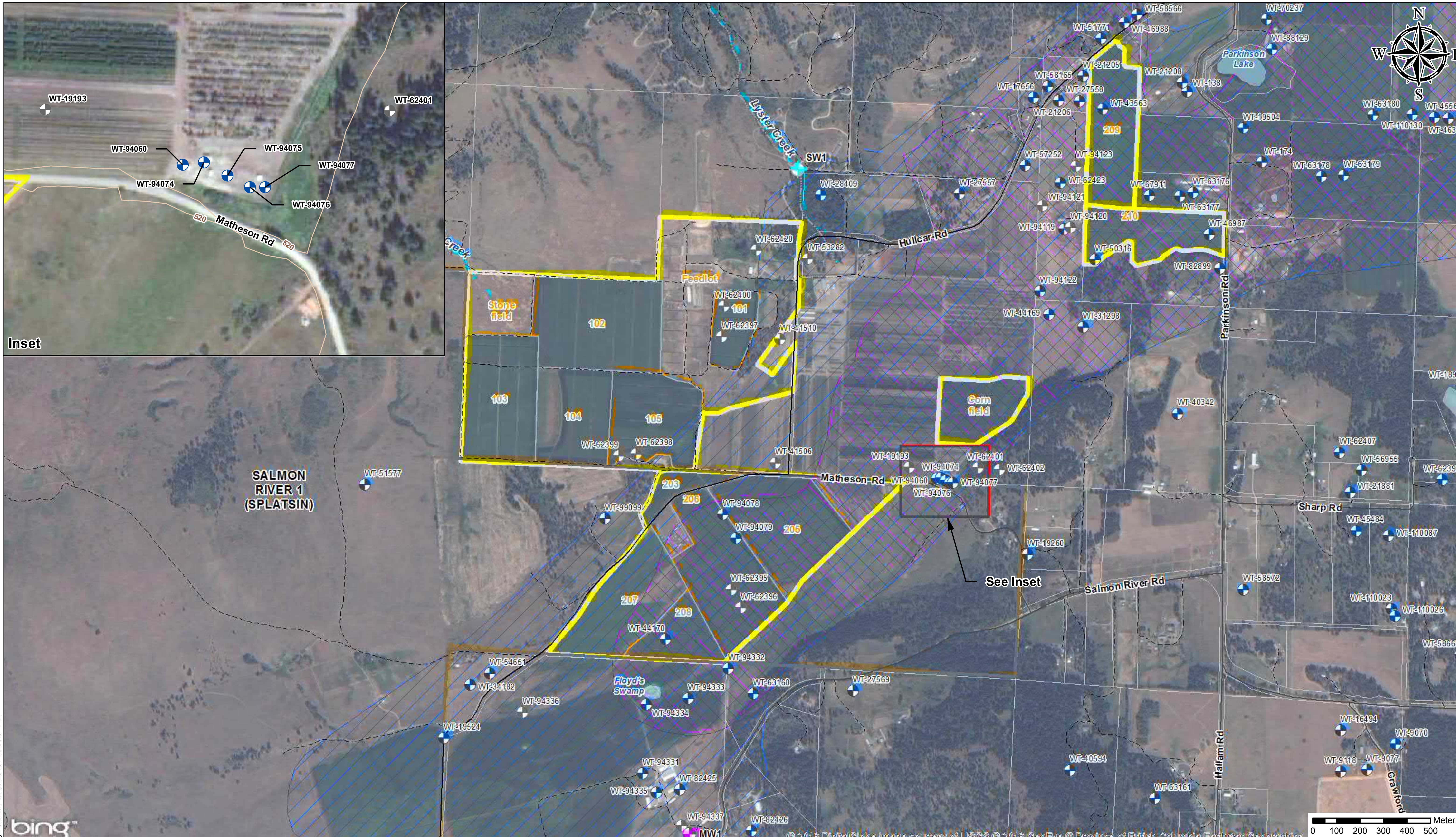
2.1.5 Wells

There is no community water supply system in the Study Area, although there are many water wells registered with a well tag number on BC MOE's Water Resources Atlas within 300 m (MOE 2016b). The BC Water Resources Atlas database includes the location of each well and the well log assigned to each location, and each well log is assigned a well tag number. However, the accuracy of the locations of these wells may be poor. For instance, the well location may be inaccurate, there may be duplicates (i.e., two well tag numbers for one well), or there may be a known well where no well is recorded in the database. However, because there are homes and irrigated fields near the Study Area, the wells are likely used for domestic, irrigation, and livestock watering.

Figure 2-3 shows the wells that are registered on the BC Water Resources Atlas (MOE 2016b). The "MOE registered well – not found" indicates that there is no well at this location based on observations by Purple Springs staff. The "MOE registered well – location not verified" indicates that the area was not visited by Purple Springs staff, and it is not known whether there is a well at that location.

Figure 2-4 shows the wells that were surveyed in 2016 by Associated and other Regehr contractors, which are noted as "Project wells." At these locations, wells are known to be present. Table 2-4 lists the Project wells located within the Study Area, and Table 2-5 lists the Project wells outside of the Study Area, all of which were surveyed as part of the EIA. The topographic contours indicate that Project wells 6, 13, 17, and 21 are located down-gradient to the Regehr Farm. There are 9 known wells located within the Study Area (Table 2-4), and 22 known wells within 300 m outside of the Study Area. The wells are used for both irrigation and domestic purposes, and the aquifer appears to be unconfined with layers of fine sand to fines (silt/clay) above the screened interval. Note that because fines (silts/clays) were not present consistently throughout the borehole logs, this adds some uncertainty when we interpret driller's lithology when silt/clay is described on the well log. A "silt/clay" layer described by a driller may in fact be a fine sand. Available well logs for the Project wells are provided in Appendix B. Also, note that we did not attempt to match the actual well to a well tag number assigned to well logs on the BC Ministry of Environment's well log database, unless the owner of the well provided us with a well log.

As shown on Figure 2-4, one Project well (Project well 19) is in the vicinity of the Regehr feedlot. This well was drilled into bedrock in 2000 and no high-yielding aquifer was intercepted. The well was therefore backfilled with bentonite by the driller.



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Associated Environmental

Study Area – Regehr Feedlot and Farm	Parcel boundary
Field	Stream - definite
Indian Reserve	Stream - intermittent
Aquifer 102: Confined	MOE registered well (not found)
Aquifer 103: Unconfined	Monitoring well
MOE registered well (location not verified)	

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FIGURE 2-3: REGISTERED WATER WELLS

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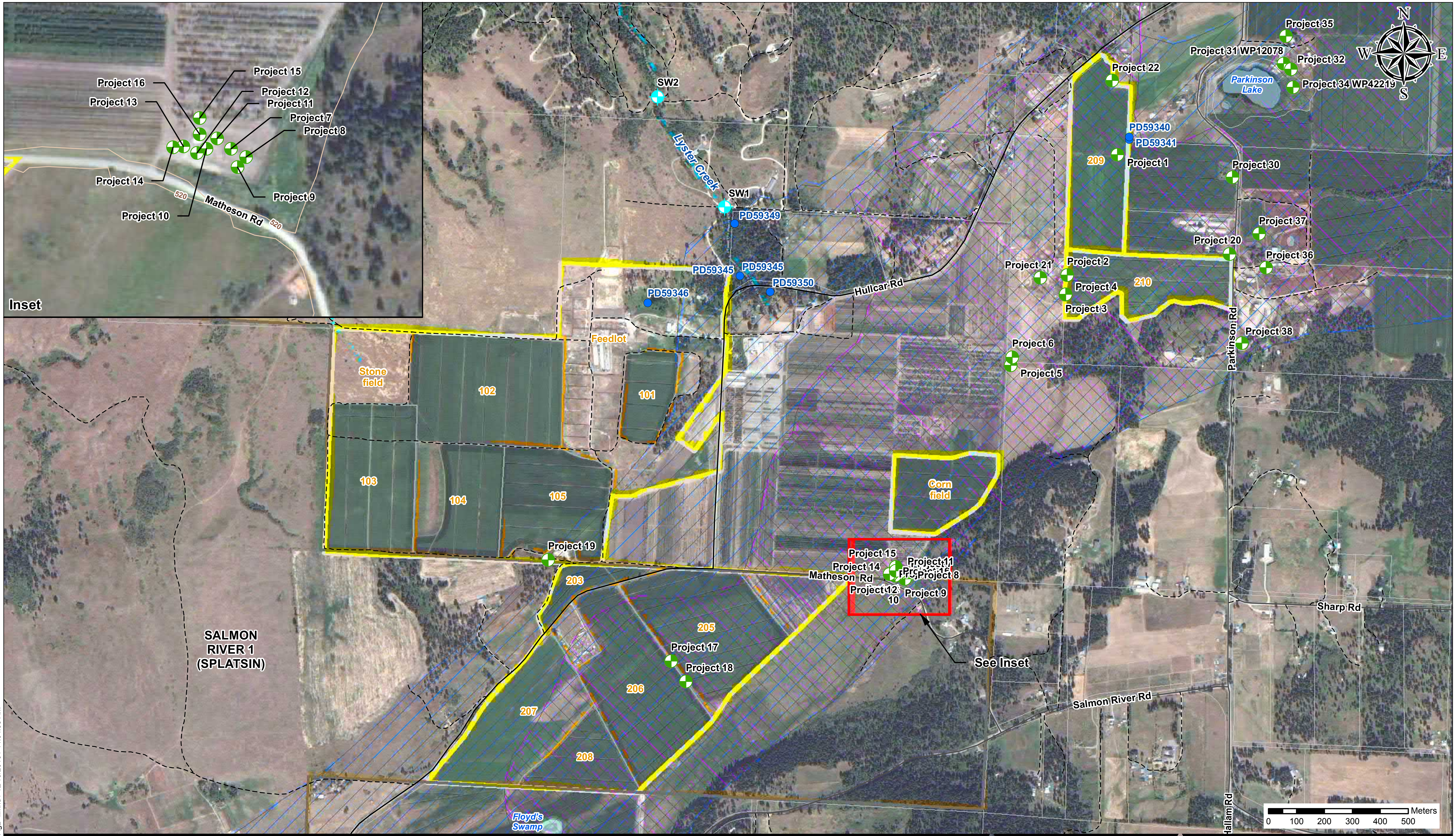

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Associated Environmental

Study Area – Regehr Feedlot and Farm
Field
Indian Reserve
Parcel boundary
Stream - definite
Stream - intermittent
Aquifer 102: Confined
Aquifer 103: Unconfined
Project wells (surveyed)
Surface water site
Surface water points of diversion

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FIGURE 2-4: PROJECT WELLS AND POINTS OF DIVERSION

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Table 2-4
Wells verified to be located within the Study Area

Project Well Number	Well Plate ID	Well Tag Number	Common Well name	Well Use	Well Depth (ft)	Depth to water (ft)	Casing diameter (inch)	Aquifer based on lithology from well logs	well log available
1	none	unknown	Swann Irrigation	Irrigation	51	7	8	unconfined	n - only from pump specs
2	none	unknown	Friesen old irrigation well	Irrigation	54	16	8	unconfined	n - only info from wall of pump-house
3	none	unknown	Rossworn Right-of-way well (on Friesen land, but well owned by Rossworn)	Irrigation and Domestic	na	na	na	na	no
4	none	unknown	Rossworn Right-of-way well (on Friesen land, but well owned by Rossworn)	Irrigation and Domestic	na	na	na	na	no
17	none	94078	Gerald's #2	Irrigation	76	27	12	unconfined sand	y - driller forms
18	none	94079	Gerald's #1	Irrigation	na	na	12	na	no
20	none	none	Freisen Domestic	Domestic	60	33	5	unconfined sand and gravel	y - MOE forms
22	none	unknown	Swann Domestic	Domestic	60	na	6	unconfined	no
19	none	unknown	150mm- testhole East Field Well	Closed. Backfilled with bentonite chips. Stickup and cover still present.	500		6	Bedrock	y - MOE forms

Table 2-5
Wells surveyed within 300 m outside of the Study Area

Project Well Number	Well Plate ID	Well Tag Number	Common Well name	Well Use	Well Depth (ft)	Depth to water (ft)	Casing diameter (inch)	Aquifer based on lithology from well logs	well log available
5	none	unknown	Caravan old irrigation well	Irrigation - not in service	na	na	8	na	no
6	none	unknown	White Irrigation	Irrigation - in service	60	NA	8	unconfined to semiconfined	no
7	25872	unknown	Purple Springs Wellfield Domestic	Domestic	70	54	6	unconfined with some fines (clay 3 to 16 ft)	y - driller forms
8	none	unknown	Purple Springs Wellfield Domestic	Domestic	70	na	6	unconfined	y - driller forms and MOE forms
9	none	94075 and 94076 (matching descriptions)	Purple Springs Wellfield	Irrigation	72	12.5	12inch casing/8inch screen	unconfined with fine sand 29-56ft	y - driller forms
10	lost	unknown	Purple Springs Wellfield	Irrigation	na	na	8	na	no
11	28065	unknown	Purple Springs wellfield: East Well #1 2009	Irrigation	78	22	12	unconfined with fines 0-15 ft	y - driller forms
12	none	unknown	Purple Springs Wellfield	Irrigation	na	na	8	na	no
13	none	unknown	Wellfield shallow: between Red Pumphouse	Irrigation	62.5	31.82	8	unconfined sand and gravel with fines 0-35 ft, and 45-55 ft	y - driller forms
14	none	unknown	Purple Springs Wellfield: West Red Pumphouse	Irrigation	na	na	na	na	no
15	35119	unknown	Purple Springs Wellfield	Irrigation	68	22	8	unconfined sand and gravel with fines 0-15 ft	y - driller forms
16	28066	unknown	Purple springs wellfield: West well #2 2009	Irrigation	95	21	12	unconfined sand and gravel with fines 0-15 ft	y - driller forms
21	none	unknown	White Domestic	Domestic	40	20	6	unconfined sand	y - MOE forms
30	none	unknown	unknown	unknown	na	na	6	unknown	unknown
31	12078	unknown	unknown	unknown	na	na	nm	unknown	unknown
32	none	unknown	unknown	unknown	na	na	nm	unknown	unknown
33	4223	unknown	unknown	unknown	na	na	6	unknown	unknown
34	42219	unknown	unknown	unknown	na	na	12	unknown	unknown
35	none	unknown	unknown	unknown	na	na	6	unknown	unknown
36	none	unknown	unknown	unknown	na	na	6	unknown	unknown
37	none	unknown	unknown	unknown	na	na	6	unknown	unknown
38	none	unknown	unknown	unknown	na	na	6	unknown	unknown

2.1.6 Observation Wells

There are two MOE Groundwater Observation Wells (MOE 2016c) in the area within Hullcar Aquifer 102 and 103 (Table 2-6). Based on the validated groundwater level data from these observation wells, the seasonal fluctuation of the potentiometric surface in both aquifers is about 0.5 to 1.0 m depending on the climate conditions in a specific year (Table 2-6). In addition, the water level in Hullcar Aquifer 103 increased by 0.2 m/year between 2012 and 2016, and the potentiometric level in Hullcar Aquifer 102 decreased by 0.2 m/year over the same period. OBS 384 and OBS 409 correspond to the Environmental Monitoring System (EMS) IDs E275523 and E288429, respectively (MOE 2016d). Available nitrate-N data indicate concentrations ranging from 0.002 to 0.015 mg/L in OBS 409 between 2012 and 2015 (MOE 2016d). There was only one nitrate-N concentration recorded for OBS 384 in 2015, which was 3.29 mg/L.

Table 2-6
Summary of OBS wells 409 and 384

	OBS 409	OBS 384
Well Tag Number (WTN)	104830	93924
Date installed	November 2, 2011	March 12, 2008
Depth to top of screen from ground surface (m bgs)	21.9	90.2
Aquifer	Hullcar Aquifer 103 Unconfined sand and gravel	Hullcar Aquifer 102 Confined sand and gravel
Dates of validated data collection	September 22, 2012 to September 14, 2016	April 7, 2008 to September 13, 2016
Approximate rate of annual potentiometric surface change (m/year)	+0.2	-0.2
Fluctuation in potentiometric surface from annual lows and early summer highs (m)	0.7 to 1.2	0.6 to 1.1
Fluctuation in potentiometric surface from spring lows to early summer highs (m)	0.37 to 1.02 (average 0.66)	Not calculated

2.1.7 Nearest Receptors

A receptor survey is currently being conducted by Golder Associates as part of a regional Hullcar Aquifer Study for the Ministry of Forests, Lands and Natural Resources (FLNRO), but the results are not yet available. Associated's scope of work was to review the receptor survey to identify the nearest existing drinking water wells and springs. As an alternative, a preliminary inventory of receptors was completed for this assessment based on a review of air photos and interviews with the current farm operator and people familiar with the area.

2.1.7.1 Drinking Water Receptors - Groundwater

The nearest community water supply is the Steele Springs Waterworks District (Steele Springs), located approximately 4.9 km east of the feedlot, but it does not distribute water to the vicinity of the Study Area. Residents in the vicinity of the Study Area receive their drinking water from private wells or surface water sources.

There are four known drinking water wells within the Study Area, and at least three known drinking water wells within 300 m of the Study Area (Tables 2-4 and 2-5 and Figure 2-4). There are likely a number of other unregistered wells used for domestic purposes in the surrounding the Study Area.

2.1.7.2 Livestock and Irrigation Receptors - Groundwater

There are irrigation wells throughout the Study Area and surrounding area (Tables 2-4 and 2-5). Some of these wells likely also provide water for livestock watering, given that hobby farms and two feedlots are present in the area.

2.1.7.3 Surface Water Receptors

There are five current surface water licences at five points of diversion (PODs) within 300 m of the study area (Table 2-7 and Figure 2-4). One additional POD is registered on Lyster Creek, although the licence status is “cancelled”. Based on information available in online resources and local knowledge, these watercourses do not appear to be fish-bearing (MOE 2016e, 2016f). Table 2-7 lists the PODs, stream name, licensee, and licenced use. All are registered for either domestic or irrigation purposes.

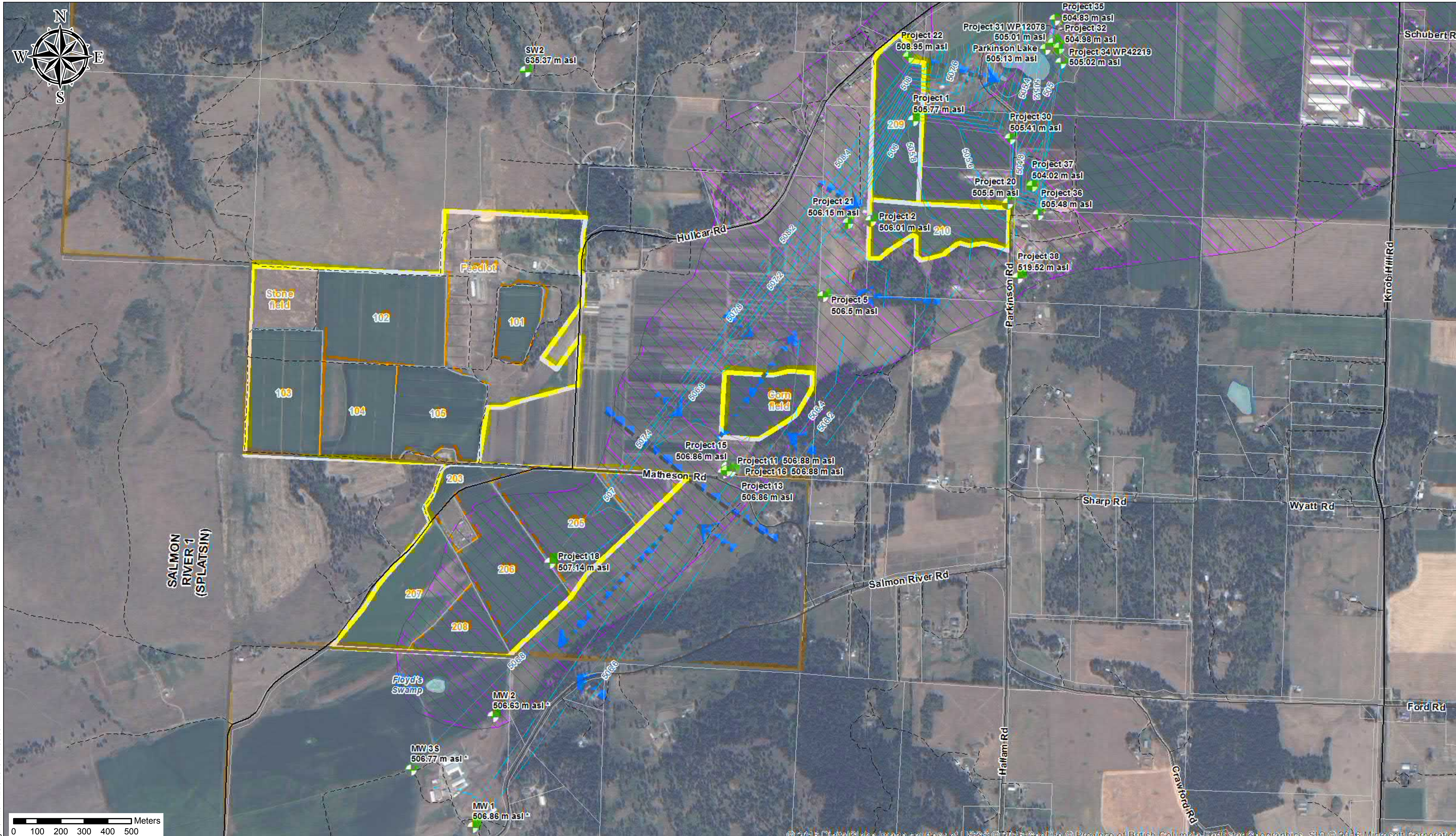
Steele Springs, a community water supply, is located about 5 km away from the feedlot (Figure 1-1).

Table 2-7
Summary of surface water points of diversion within 300 m of the study area.

POD	Licence Number	Stream Name	Licensee	Licenced Use	Licenced Volume (m^3/day)
Licence Status: *Current*					
PD59345	C056392	Milum Spring	Milum John S & Susan G 4504 Hullcar Rd Armstrong BC V0E1B4	Domestic	4.55
				Irrigation: Private	67.6
PD59341	C041570	Annie Slough	Curtis George Edward 5058 Parkinson Rd. Armstrong BC V0E1B4	Irrigation: Private	162
PD59340	C041571	Annie Slough	Card Ivan R & Annette 5131 Parkinson Rd. Spallumcheen BC V0E1B4	Irrigation: Private	243
PD59346	C041923	Wiebe Spring	Regehr Kenneth J & Brenda L 4516 Hullcar Comp 1 RR 4 Armstrong BC V0E1B0	Domestic	11.4
PD59349	C056396	Lyster Creek	Milum John S & Susan G 4504 Hullcar Rd Armstrong BC V0E1B4	Irrigation: Private	38.9
Licence Status: *Cancelled*					
PD59350	C056394	Lyster Creek	Regehr Kenneth J & Brenda L 4516 Hullcar Comp 1 RR 4 Armstrong BC V0E1B0	Irrigation: Private	1.69

2.2 GROUNDWATER FLOW DIRECTION AND GRADIENT

On December 1, 2016, water levels were measured from 19 of the Project wells within and around the Study Area, and the water elevation of Parkinson Lake. The top of casing and ground elevations of wells were surveyed using a Trimble R8 GPS rover using a Can-net network referenced base station. The accuracy is 0.005 to 0.025 m horizontally and 0.010 to 0.035 m vertically depending on proximity to trees and how many satellites are being tracked. Figure 2-5 presents peizometric elevations and shows the calculated groundwater flow direction. Table 2-8 provides the measured groundwater elevations.



Associated Environmental

- Study Area – Regehr Feedlot and Farm
- Field
- Indian Reserve
- Parcel boundary
- Bedrock outcrop
- Aquifer 103: Unconfined
- Groundwater elevations (m asl) December 1, 2016
- Groundwater flow direction
- Water table contours (m asl)
- Groundwater divide

* Water levels measured on Oct 4-5, 2016

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FIGURE 2-5 MEASURED GROUNDWATER LEVELS AND GROUNDWATER FLOW DIRECTION

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Table 2-8
Groundwater elevations

Project Well Number	Northing (m)	Easting (m)	Ground Elevation (m asl)	Top of Casing Elevation (m asl)	Depth to Water Dec 1, 2016 (m btoc)	Piezometric Surface Elevation (m asl)
1	5597405	339917	508.590[1]	508.909	3.14	505.77
2	5596976	339736	510.135[1]	510.335	4.33	506.01
5	5596655	339534	509.570[1]	509.970	3.47	506.50
11	5595912	339138	510.211	510.878	4.00	506.88
13	5595906	339109	510.064	510.817	3.96	506.86
15	5595930	339124	509.718	511.187	4.33	506.86
16	5595916	339123	510.233	511.344	4.46	506.88
18	5595521	338372	514.696	514.896	7.76	507.14
20	5597050	340318	514.566	515.240	9.74	505.50
21	5596966	339639	511.075	511.783	5.63	506.15
22	5597673	339896	512.516	512.684	3.73	508.95
30	5597326	340328	512.531	512.708	7.30	505.41
31	5597733	340510	510.314	510.786	5.78	505.01
32	5597713	340537	509.751	510.490	5.51	504.98
34	5597648	340545	507.638	508.310	3.29	505.02
35	5597831	340518	513.147	513.650	8.82	504.83
36	5597003	340448	517.341[1]	517.991	12.51	505.48
37	5597124	340422	508.568	509.450	5.43	504.02
38	5596733	340361	521.879	522.381	2.86	519.52
Parkinson Lake						505.13

Notes:
[1] Ground elevation was measured as the floor elevation inside the pumphouse
m asl = metres above sea level
m btoc = metres below top of casing
n/a = not available

Groundwater flows towards the valley bottom to the southeast from the northwest side of the valley and to the northwest from the southeast side of the valley. Within the valley bottom, groundwater levels suggest a groundwater divide between Field 205 and Field Corn (Figure 2-5). To the west of this groundwater divide, groundwater flows southwest towards Salmon River. To the east of this groundwater divide, groundwater flows east towards Parkinson Lake. A gradient of 0.0008, a very low gradient, was measured from between Project 13 well and Parkinson Lake. With a clean sand (and a hydraulic conductivity of 1 X 10^{-4} m/s, and porosity 0f 0.25), the groundwater travel time to Parkinson Lake would be over 200 years, indicating very slow groundwater flow.

There may be a second groundwater divide in the region of Parkinson Lake and near Project well 37. In any event, these water levels suggest that the location of the watershed boundary between South Thomson (Salmon River watershed) and Okanagan River watershed (Deep Creek) may not be accurately known in this part of Spallumcheen, and further work is needed to better understand groundwater flow direction in the Hullcar Aquifer if such an understanding is needed at a regional scale.

2.3 WATER SAMPLING

2.3.1 Methods

Based on a review of the hydrogeology of the area and available wells, Associated selected eight wells (Figure 2-6) for the groundwater sampling program. The wells are either on the operations properties or nearby. Project wells 1, 2, 13, 17, 20, and 22 are located on properties owned or operated by Regehr Farms or Purple Springs Nursery. Only Project wells 6 and 21 are located on properties adjacent to the operations, 229 m and 137 m east of the property boundary to Purple Springs, respectively.

Marta Green, P.Geo., was accompanied by Mr. Berni Lichti of Purple Springs on September 27, 2016 to conduct groundwater sampling at the eight wells (Project wells 1, 2, 6, 13, 17, 20, and 21 [also called ‘White Domestic’ in the lab report], and 22). Mr. Lichti has been the water system operator for 23 years and is very familiar with the wells and water supply on site and the demand trends in the area.

Each well sampled is an existing well with an existing pump. Mr. Lichti operated the valves to turn the pumps on and off. In some cases, the sampling location was located up to 100 m away from the well. Ms. Green purged each well until constant field readings (e.g., pH, temperature, and conductivity) were measured, and then collected the samples following the standard methods described in the BC Field Sampling Manual (MWLAP 2013). The samples were shipped via chain of custody protocol to CARO Analytical Laboratories in Kelowna, BC, for analysis of the following parameters:

- Ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen, organic nitrogen, and total nitrogen;
- Total phosphorus, total dissolved phosphorus, and orthophosphate;
- Chloride; and
- Dissolved metals.

Ms. Green attempted to collect a surface water sample from Lyster Creek on September 27, 2016 (see location SW1 on Figure 2-3); however, the creek was dry. Slack Creek was also dry in the vicinity of the feedlot property at this time of year and therefore was not visited (B. Lichti, personal communication, 2016). Ms. Green returned on December 1, 2016, and the creek was still dry; as an alternative, a sample was collected further upstream at SW-2. SW-2 should be considered a background sample because it is upstream of the Study Area.

All water quality results were uploaded directly from the laboratory to Wireless Water™ Database Management Services. Through this application, results were tabulated and compared with the BC Approved and Working Water Quality Guidelines for irrigation, livestock, and drinking water (MOE 2015, 2016g) and the Guidelines for Canadian Drinking Water Quality (Health Canada 2014).

Results were also tabulated against Aquatic Life Guidelines for SW-2, a surface water sample. Results were not tabulated against Aquatic Life Guidelines because no aquatic life is present in groundwater. However, groundwater data was qualitatively assessed against aquatic life, because groundwater eventually discharges to surface water.

2.3.2 Results

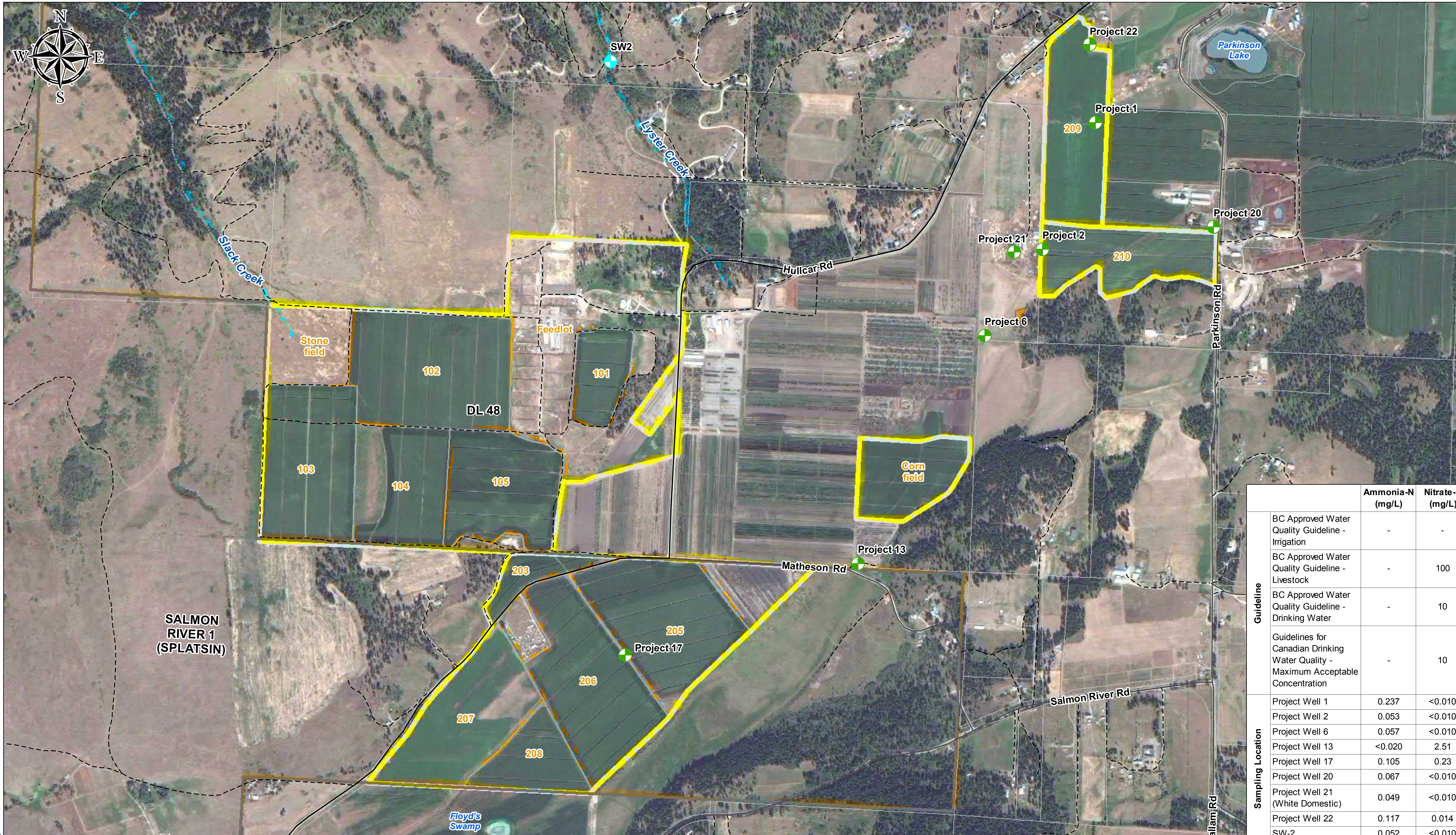
Table 2-9 includes the results for nitrogen parameters compared with the applicable guidelines. Figure 2-6 shows the spatial distribution of nitrate-N and ammonia concentrations. All results, tabulated and compared with guidelines, are provided in Table C-1 in Appendix C. Original laboratory reports are provided in Appendix D. **None of the samples had nitrogen concentrations that exceeded guidelines.** There are no guidelines for phosphorus in groundwater; therefore, phosphorus concentrations are not shown in the table below.

There were other exceedances of the Drinking Water, Irrigation, and/or Livestock Guidelines (Table C-1, Appendix C). For comparison of surface water against Aquatic Life Guidelines, see Table C-2, Appendix C). However, some parameters that were found to exceed guidelines are naturally occurring in aquifers in the BC Interior (e.g., iron, manganese, uranium). Because this assessment focused on the potential for contamination caused by nutrient (manure and fertilizer) applications, only the nitrogen species are discussed further.

Table 2-9
Nitrogen concentrations in groundwater and surface water samples in 2016

		Ammonia-N (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Organic Nitrogen (mg/L)	Total Nitrogen (mg/L)	TKN (mg/L)
Guideline	BCAWQG I	-	-	-	-	-	-
	BCAWQG L	-	100	10	-	-	-
	<u>BCAWQG DW</u>	-	10	1	-	-	-
	GCDWQ MAC	-	10	1	-	-	-
Sampling Location	Project 1[1]	0.237	<0.010	<0.010	0.136	0.373	0.37
	Project 2[1]	0.053	<0.010	<0.010	0.136	0.189	0.19
	Project 6[1]	0.057	<0.010	<0.010	0.171	0.228	0.23
	Project 13[1]	<0.020	2.51	0.087	0.175	2.77	0.18
	Project 17[1]	0.105	0.230	0.023	0.121	0.479	0.23
	Project 20[1]	0.067	<0.010	<0.010	0.166	0.233	0.23
	Project 21	0.049	<0.010	<0.010	0.127	0.176	0.18
	Project 22[1]	0.117	0.014	<0.010	0.107	0.238	0.22
	SW-2[2]	0.052	<0.010	<0.010	0.089	0.141	0.14

Notes:
BCAWQG I = BC Approved Water Quality Guidelines for Irrigation (no guidelines for nitrogen parameters)
BCAWQG L = BC Approved Water Quality Guidelines for Livestock watering
BCAWQG DW = BC Approved Water Quality Guidelines for Drinking Water
GCDWQ MAC = Guidelines for Canadian Drinking Water Quality Maximum Acceptable Concentration
[1] Sampled September 27, 2016; [2] Sampled December 1, 2016.



		Ammonia-N (mg/L)	Nitrate-N (mg/L)
Guideline	BC Approved Water Quality Guideline - Irrigation	-	-
	BC Approved Water Quality Guideline - Livestock	-	100
	BC Approved Water Quality Guideline - Drinking Water	-	10
	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentration	-	10
Sampling Location	Project Well 1	0.237	<0.010
	Project Well 2	0.053	<0.010
	Project Well 6	0.057	<0.010
	Project Well 13	<0.020	2.51
	Project Well 17	0.105	0.23
	Project Well 20	0.067	<0.010
	Project Well 21 (White Domestic)	0.049	<0.010
	Project Well 22	0.117	0.014
	SW-2	0.052	<0.010

Associated Environmental

Study Area – Regehr Feedlot and Farm
Field
Indian Reserve
Parcel boundary
Bedrock outcrop
Stream - definite
Stream - intermittent
Sampled well - meets guidelines
Sampled surface water - meets guidelines

0 100 200 300 400 500 Meters

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FIGURE 2-6 CONCENTRATIONS OF AMMONIA & NITRATE-N IN GROUNDWATER & SURFACE WATER

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Table 2-10 provides a summary of the lithology between sampled wells. Where no lithology was available, the lithology from the nearest well log was provided (and noted if this was the case). The lithological data indicate the irrigation and drinking water wells are installed in unconfined sand and gravel. Some of the well logs describe fine sand and fines at layers above the screened interval of the well, indicating that there may be some fine layers between the ground surface and the depth of the screened interval.

Table 2-10
Lithology of sampled wells

Project Well Number	Common Well Name	Well Depth (ft)	Depth to water (ft)	Aquifer based on geology from well logs	Lithology from Well Log
1	Swann Irrigation	51	7	unconfined	No lithology available. From nearby well WT67911, 350 m SE: clean sand (0-60 ft). From WT43563 100 m NW: sand (0-15 ft), gravel (15-35 ft), hard clay, rocks and sand (35-50 ft), hard clay (50-60 ft), hard sand and clay (60-100 ft).
2	Friesen old irrigation well	54	16	unconfined	No geology available. From nearby well WT62423 (250 m NW): Sand and gravel (0-6 ft), gravel (6-40 ft), silty sand (40-56 ft). From WT50316 200 m SE: clay and rocks (0-4 ft), sand (4-40 ft), sand and gravel (40-60 ft).
6	White Irrigation	60	NA	unconfined with fines	No geology available: from WT44169, located 20 m SE: top soil (0-8 ft), gravel (8-12 ft), water-bearing sand and gravel (12-14 ft), silty clay like gravel and sand (14-25 ft), water-bearing sand and gravel (25-70 ft), silty sand (70-75 ft).
13	Wellfield shallow	62.5	31.82	unconfined with fines	Silt to gravel (0-35 ft), clean gravel (35-40 ft), coarse sand and some gravel (40-45 ft), silt/fine sand/coarse sand (45-50 ft), gravel and some clay (50-55 ft), gravel and cobbles (55-60 ft), clean gravel (60-65 ft).
17	Gerald's	76	27	unconfined	Dry sand (0-29 ft), water-bearing sand (29-76 ft).
20	Freisen Domestic	60	33	unconfined	Top soil (0-4 ft), sand gravel (4-45 ft), coarse sand (45-60 ft).
21	White Domestic	40	20	unconfined	Sand and gravel (0-6 ft), gravel (6-40 ft), silty sand (40-56 ft).
22	Swann Domestic	60	NA	unconfined	No geology available. From nearby well WT51771, 150 m NW: gravel and sand (0-85 ft).

2.4 POST-HARVEST SOIL SAMPLING RESULTS

As part of the Ministry of Agriculture Post-Harvest Soil Nitrate Study in the Hullcar area, nine of the Regehr Farm cropped areas (consisting of 11 fields) were sampled by a Ministry contractor in the first two weeks of October 2016 and the data provided to the Regehr consulting team (BCMA 2016). Table 2-11 contains the soil nitrate and ammonium data from the testing project. Soil samples were collected at four depths (0-15 cm, 15-30 cm, 30-60 cm, and 60-90 cm) from all fields (Fields 103 and 104 were sampled as one, and Fields 207 and 208 were also sampled as one). All fields in the Study Area except Field 203 were tested. Field 203 is a small field that is similar in soil type and management to the fields around it so it was not sampled. Seven corn fields (or combined fields) and two alfalfa fields were included in the study.

To interpret the post-harvest soil nitrate data, the data have been compared to two different standards. The first is the BC Ministry of Agriculture's accepted target levels for post-harvest soil nitrate which considers only the residual nitrate in the top 30 cm of soil. The second is the Ministry's proposed risk scale based on the nitrate concentration in the sampling depth to 90 cm.

2.4.1 Comparison to Accepted BMP – Ministry of Agriculture Target Residual Soil Nitrate-N Levels to 30 cm Depth

The BC Environmental Farm Plan (EFP) Reference Guide contains target levels for post-harvest soil nitrate-N levels (BCARDC 2010a). This Guide includes target levels of <15 mg/kg of nitrate-N in fields growing perennial crops (alfalfa and grass) and <20 mg/kg on annually cropped land (silage corn and cereal land) in the 0-30 cm depth in the soil (calculated as the average of the 0-15 and 15-30 cm depths). The Guide indicates that these are appropriate levels post-harvest to minimize over-winter losses of nitrate. The Guide does not provide any guidance concerning post-harvest soil ammonium-N levels.

Table 2-11 contains the results of the fall 2016 post-harvest soil sampling at Regehr Farms for nitrate-N and ammonium-N. Soil nitrate-N levels in the 0-30 cm depth were at or below the Guide target maximum levels in all fields indicating that the operation meets BC guidelines with respect to post-harvest soil nitrate-N levels in crop land. The levels of nitrate-N at the 30-60 and 60-90 depths were also well below the target residual nitrate level for all fields (even though these target levels only apply to the 0-30 cm depth), indicating that there appeared to be very little nitrate leaching below the crop rooting zone during the 2016 cropping season.

Table 2-11
Post harvest nitrate-N concentration in Regehr Farms fields

Field ID	2016 Crop	Sampling Depth	Nitrate-N (NO_3-N)	Average Nitrate-N (NO_3-N) in 0-90 cm Depth	Ammonium-N (NH_4-N)
		cm	mg/kg	mg/kg	mg/kg
101	Corn silage	0-15	32	11.5	7
		15-30	8		5
		30-60	3		4
		60-90	3		4
102	Corn silage	0-15	19	9.0	3
		15-30	9		4
		30-60	2		2
		60-90	6		2
105	Corn silage	0-15	12	6.5	6
		15-30	5		6
		30-60	4		4
		60-90	5		5
206	Corn silage	0-15	14	4.75	8
		15-30	3		4
		30-60	1		5
		60-90	1		4
207 & 208	Corn silage	0-15	11	4.25	7
		15-30	4		5
		30-60	1		5
		60-90	1		3
209	Corn silage	0-15	6	5.75	5
		15-30	5		4
		30-60	6		3
		60-90	6		2
210	Corn silage	0-15	10	11.5	4
		15-30	16		3
		30-60	12		2
		60-90	8		2
103 & 104	Alfalfa	0-15	11	6.0	6
		15-30	2		4
		30-60	10		4

Field ID	2016 Crop	Sampling Depth	Nitrate-N (NO_3-N)	Average Nitrate-N (NO_3-N) in 0-90 cm Depth	Ammonium-N (NH_4-N)
		cm	mg/kg	mg/kg	mg/kg
		60-90	1		4
205	Alfalfa	0-15	16	6.0	8
		15-30	6		4
		30-60	1		3
		60-90	1		3

2.4.2 Comparison to Draft BMP – Ministry of Agriculture Proposed Environmental Risk Rating to 90 cm Depth

The BC EFP Reference Guide contains no guidance on acceptable levels of nitrate in the 30-60 and 60-90 cm depths. In order to interpret the nitrate results from the entire 90 cm sampling depth, additional guidance was sought from the BC Ministry of Agriculture (D. Poon, personal communication, 2016). The Okanagan Agricultural Soil Study (Kowalenko et al. 2007) contains some draft recommendations for interpreting soil nitrate-N levels to the 60 or 90 cm depth; these have been included in this assessment to further assess the soil results. Table 2-12 includes the soil nitrate levels and management recommendations from this study. Table 2-11 contains the average soil nitrate-N levels in all fields to the 90 cm depth.

Table 2-12
Nitrogen management recommendations for soil nitrate-N concentrations to 90 cm depth

Environmental Risk Rating	Soil Nitrate-N Concentration to 90 cm Depth (mg/kg)	Soil Nitrate-N to 90 cm Depth (kg/ha)	Management Recommendations
Low	0-5	0-49	Continue with nitrogen management program
Medium	5-10	50-99	Consider changes to nitrogen management
High	10-20	100-200	Reduce nitrogen application without risk to crop quality or yield
Very high	>20	>200	Reduce nitrogen application without risk to crop quality or yield

Note: Adapted from Kowalenko et al. 2007. Values converted from kg/ha to mg/kg assuming a soil bulk density of 1150 kg/m^3.

Silage corn fields: When the average nitrate-N levels throughout the 90 cm sampling depth were considered, five of seven corn fields sampled had residual nitrate-N in the low to medium environmental risk range. Two of seven corn fields (Fields 101 and 210) had residual nitrate-N in the high environmental risk category although measured levels were at the low end of the high range. At high residual soil nitrate-N, Kowalenko et al. (2007) recommends to, "reduce nitrogen application without risk to crop quality or yield." Based on these draft recommendations, in which residual nitrate to 90 cm is considered rather than to the 30 cm depth as in the BC EFP Reference Guide, most corn fields were in the low to medium residual nitrate category.

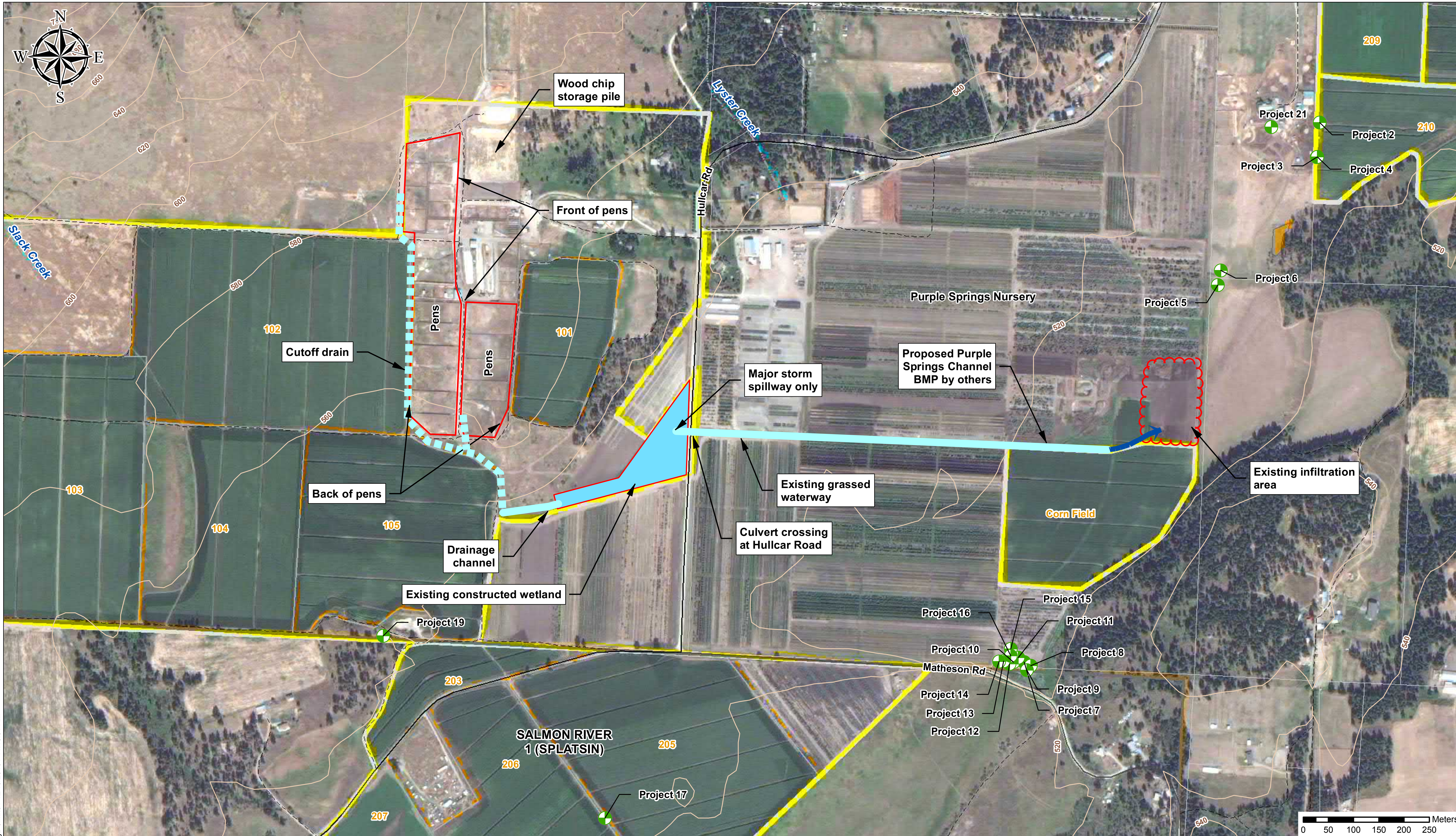
Alfalfa fields: When the concentration of soil nitrate-N in the 90 cm depth was compared with the Kowalenko et al. (2007) draft recommendations, both fields had residual nitrate in the medium environmental risk category. Based on these draft recommendations, which consider the residual nitrate to 90 cm rather than the 30 cm depth in the BC EFP Reference Guide, there was a medium level of residual nitrate in the soils in both alfalfa fields.

2.5 NITROGEN MANAGEMENT PRACTICES – CURRENT AND HISTORICAL

Ruth McDougall, P.Ag., Rod MacLean, P.Eng., and Lawrence Bird, M.Sc., visited the Regehr feedlot area and Purple Springs on October 17, 2016 to assess operational practices.

The temperature was around 15°C and it had been raining heavily for most of the day. The rainy conditions provided an ideal opportunity to observe and inspect stormwater drainage components of the feedlot operations, as well as water movement throughout the site.

The assessment team visited the study area and viewed the feedlot, on-site drainage, and fields and assessed the effectiveness and integrity of the manure management system/storage facilities. They discussed site drainage and drainage management with Rico Thorsen, who works for Purple Springs and is knowledgeable about the on-site drainage, and with Doug Macfarlane, Certified Crop Advisor (CCA) with Emerald Bay Ag Services, who has worked on nutrient management with the operation since 2013. Figure 2-7 shows the layout of the facilities.



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Associated Environmental

Study Area – Regehr Feedlot and Farm	Parcel boundary
Field	Contours (m asl)
Indian Reserve	Stream - definite
Stream - intermittent	Bedrock outcrop
Project wells	

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FIGURE 2-7 FACILITY LAYOUT

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2.5.1 Manure Management and Storage

On October 17th, the feedlot pens were empty except for a couple of younger cattle in one pen. Young feeders are reportedly brought into the feedlot in the fall and fed over winter (D. Macfarlane, personal communication, 2016). All mortalities, if any, are taken off site and handled by others.

The feedlot pens are located on two large sloped areas (Figure 2-7). The pens range in size, but are roughly 45 metres wide by 90 metres deep. Each pen is rectangular and sloped from back to front to a truck access path where feeding and handling take place. A load (estimated to be 3 cubic metres) of wood shavings (Photograph 1) is spread into each pen for bedding. We understand that the bedding and manure are removed in the spring and land applied as solid manure to the various fields as part of the Regehr Farms operation. Approximately 800 tonnes of the manure/wood chip combination are sent annually to the adjacent Purple Springs where it is composted for use in the nursery.

Photograph 1
Wood chips and observed stormwater drainage pattern (Oct. 17, 2016)

2.5.2 Manure Application Practices

In the spring, about 90% of the manure and wood chip solids are removed from the feedlots, loaded into conventional manure spreaders, and applied to fields at Regehr Farms. This is an acceptable time of year for manure application and an acceptable application method. The remaining approximately 10% of the feedlot manure is exported to Purple Springs where it is composted for use in the nursery.

2.5.3 Irrigation Practices

All cropped fields are irrigated using groundwater from wells located around the property. Fields are irrigated using a travelling gun system. The irrigation rate and schedule are based on operator experience. No further information was available about irrigation rates and frequency.

2.5.4 Stormwater Management

Stormwater management in feedlots is a very important component of the design of feedlots, because dry pens is important for animal health, welfare, and productivity. A smooth, firm surface with a 2 to 4 percent slope drains well. In densely populated pens, the trampling action of cattle and the accumulation of manure and urine will cause a compacted surface to build up. The compacted surface acts to minimize infiltration and prevent seepage of nutrients into the soil and groundwater underneath (Alberta Agriculture and Forestry 2000).

The slope of the feedlot is 4%. The feedlots drain effectively to the ‘front’ of each pen. Photograph 2 shows the stormwater routing from pen to pen. At the south end of the pens, the drainage is collected in a formal drain; routing downhill for approximately 500 m to a constructed wetland and stormwater treatment facility (Photograph 3). The combined stormwater and effluent is stored and treated naturally in the pond.

Photograph 2
Stormwater routing in feedlot pens

Photograph 3
Stormwater retention treatment facility (constructed wetland)

The stormwater wetland treatment facility was constructed in the early 1990'sand has been maintained on a regular basis by Purple Springs staff. From discussions with Mr. Rico Thorsen of Purple Springs Nursery, the Ministry of Agriculture was involved with providing the specifications and approvals of the facility, and advised that the occasional maintenance consists of removal of sediment and re-establishment of vegetation. There has been minimal maintenance completed in the last 5 years. There are no standards for the design of constructed wetlands in BC, however Best Management Practices (BMPs) descriptions are available as part of the Environmental Farm Plan information inventory (BCARDC 2010a), as well as those from other jurisdictions. Based on our observations, the wetland appears adequately sized to enable settling of most solids, but the top of the berm impounding the facility is uneven due to settlement. Since our discussions with operators, we understand that the berm is currently being re-established and raised to have a consistent elevation. The facility is protected from major storm events with a pipe spillway leading to a constructed drainage channel on the Purple Springs property (Figure 2-7).

The constructed wetland serves as a long-term water storage facility. Although there are no designs or as-built plans available regarding the construction of the wetland, based on observations during the site visit, the water was ponded at this location indicating the underlying soil has likely been augmented with years of fine-textured organic materials to create a more poorly draining soil. This facility relies on evaporation and transpiration from the plants to eliminate water from the system (see Table 2-1; there is a net annual moisture deficit in the Study Area). The reeds, cattails, and other vegetation likely reduce nutrient concentrations in the pond/wetland through the process of plant uptake, and some nitrogen is likely lost to the atmosphere through denitrification. Wetland sediments are particularly important sites of denitrification because their anaerobic nature promotes reduction of mineralized nitrogen to N_2 gas (Alldred and Baines 2016).

Although the wetland appears to hold water, there may be some seepage through to the underlying aquifer. Implications for groundwater quality are addressed in Section 3.4.2.

2.5.5 Wood Chip Storage

During the site inspection, the drain water meandering through the feedlot pens was “tea coloured.” There was white foam in some areas. Because of the rainfall conditions that day, the source of the discolouration was tracked to the wood chip storage pile on the north end of the feedlots. The source of the brown colour appeared to be tannins and other organic material from the chips.

The height of the wood chip pile was estimated to be more than 5 m. Drainage from the wood chip pile causes organics and tannins to enter the drain water (Photograph 4). This water gets collected and enters the constructed wetland downstream, where some breakdown of the organic matter likely occurs.

Photograph 4
Wood chip storage pile

2.5.6 Nitrogen Generation and Use on Farm

There are approximately 3,800 feeder cattle in the feedlot from November to March each year; the rest of the year the feedlot is empty. Regehr Farms also has a 340 head cow/calf operation on the same property. Regehr Farms produces feed for the feeder cattle and cow herd on approximately 150 ha of owned and leased crop land in the Hullcar area (see fields within the Study Area on Figure 1-2).

The number of livestock and the area of cropped land base at the Regehr Farms operation have not changed substantially for the past three years. We assume, therefore, that nitrogen generation and use on the farm has been the same during the period 2013 to 2016, which is the time period for this EIA.

This EIA considers nitrogen inputs on the Regehr Farms operation including nitrogen generated by livestock on the farm, use of chemical fertilizer, and use of manure generated off site (if any). It does not consider either nitrogen wet or dry deposition from the atmosphere or nitrogen inputs in irrigation water.

Manure Produced by Livestock on Site: The Regehr feedlot currently feeds approximately 3,800 feeder cattle for a five-month period each winter (November to March). The feedlot is mainly empty during the remainder of the year. Manure generated by the feeders remains in feedlot pens until removed in spring and applied to the operation's owned and leased crop land. Approximately 90% of the manure from the feeders is applied to the farm's owned and leased crop land, and 10% is exported to Purple Springs Nursery.

The Regehr Farms operation also has a 340 head cow herd. The cow herd spends five months of the year on summer range, and the remaining seven months on the home property or on a neighbouring property. Calves are sold in the fall when the cattle return from summer range. For two months in the spring, the cow herd is fed hay on the operation's crop land. This proportion of the total manure produced by the cow herd has been included in the estimated nitrogen inputs.

Table 2-13 lists the estimated total amount of nitrogen excreted by the livestock on site (based on excretion values from BC ARDC [2010b]) and the amount of nitrogen available for crop uptake after losses due to volatilization of ammonia and release from manure organic matter (AAFR 2006). Based on these calculations, an estimated 78,470 kg of nitrogen is land-applied annually in manure, and of this amount, an estimated 25,110 kg is estimated to be plant-available during the year of application.

The nitrogen that is not crop-available in the year of manure application becomes part of the soil's organic nitrogen pool, and will be released slowly over subsequent years. This remaining nitrogen (residual nitrogen) is accounted for by estimating annual nitrogen release from soil organic matter.

Other Nitrogen Inputs on Farm: The farm does not currently use any inorganic nitrogen fertilizer and has not used inorganic nitrogen fertilizer since 2013. The farm does not import any manure from off the farm. The farm exports approximately 800 tonnes/year of feedlot manure to Purple Springs (10% of the feeder manure). Aside from manure produced by livestock on site, there are no nitrogen inputs into the cropland except for the small amount from wet and dry atmospheric deposition, likely about 4-8 kg TN/ha/year (Brady and Weill 2010).

Table 2-13
Estimated nitrogen inputs and outputs – current (2016) and historic (2013 to 2015) operations

Source of Nitrogen	Calculation	Nitrogen (kg/yr)
1. Nitrogen produced by livestock on site		
Feeders	3,800 feeders @ 52 kg N excreted per year[1] * 150 days (0.42 of year)	82,333
Cows	340 cows @ 73 kg N excreted per year[1] * 60 days (0.17 of year) (Accounts for N deposited on crop land during winter feeding period. Remainder of year herd is on range or fed off property so no net N application to Study Area).	4,137
Total N produced by livestock on property	82,333 + 4,137	**86,470**
2. Nitrogen exported from Regehr Farms (study area) annually		
N exported	Approx. 800 tonnes/year of beef feedlot manure exported to Purple Springs, N content estimated at 10 kg/tonne[2].	8,000
3. Total nitrogen in manure applied to Regehr feedlot owned and leased crop land		
Beef feedlot + cow manure less amount exported	86,470 - 8,000	78,470
4. Nitrogen available to crops in year of manure application		
Plant-available N in year of application	32% of N available in year of application[2] Remainder of N accounted for as mineralized N from soil organic matter.	25,110

Notes
[1] Nitrogen excretion values are from BC Environmental Farm Plan Reference Guide (BCARDC 2010a).
[2] Available nitrogen values in beef manure are from Alberta Agriculture, Food and Rural Development (AAFR 2006).

2.5.7 Cropping and Manure Application Rate

Table 2-14 lists the crops grown, the estimated yield and nitrogen content, and the estimated uptake of nitrogen in crops for all fields cropped in 2016. Fields are identified on Figure 1-2. No actual crop yield or protein content information was available for this operation. Estimates of crop yield were obtained from Doug Macfarlane, Certified Crop Advisor, who does nutrient management planning for the operation. Literature sources were used to corroborate anecdotal yield estimates and to estimate crop nitrogen content, as follows: crop nitrogen removal is calculated as dry yield multiplied by percent nitrogen, and crop yield and nitrogen values were obtained from the following sources: AAFR 2006; Bittman and Kowalenko 2004; National Research Council 2001; Undersander et al. 2011; and Zebarth et al. 2000.

Most fields on Regehr Farms are used to grow corn for silage production, and remain in corn silage for several years. A small percentage of crop land is planted to alfalfa at any time, and fields are rotated between corn and alfalfa on a 4 to 5-year rotation to optimize nutrient use. Crop land is fertilized with manure from the feedlot. Manure is applied to fields based on the recommendations from Doug Macfarlane. Application rate recommendations are based on manure nitrogen analysis and soil test results from the previous fall’s soil sampling. The manure application rate is reportedly tracked by recording the number of truckloads of manure that are delivered per field. This practice indicates that the manure application rates recommended by the crop advisor are being followed by Regehr Farms, although no records were available.

The farm cropped 147.9 ha of owned and leased land in 2016. Of this, 66.7 ha were owned and the remainder was leased land. In 2016, the land base was planted to corn for silage production (105.6 ha) and alfalfa (42.3 ha). The area of land used for crops has remained similar for the past three years, as has manure use. The operation leases additional land as required to utilize manure based on recommendations from the crop advisor.

The estimated crop removal of nitrogen in 2016 varied from a low of 228 kg/ha for silage corn fields, to a high of 515 kg/ha for alfalfa (Table 2-14).

Table 2-14
Estimated crop yield, nitrogen content, and crop removal of nitrogen by field (2016)

Field ID	Area	Crop	Yield Estimate	Estimated Crop Nitrogen Content	Estimated Nitrogen Removal by Crop
	ha		dT/ha	%	kg/ha
101	7.0	Corn silage	17	1.34	228
102	20.7	Corn silage	17	1.34	228
103/104	25.5	Alfalfa	14	3.68	515
105	13.4	Corn silage	17	1.34	228
203	3.2	Corn silage	17	1.34	228
205	16.8	Alfalfa	14	3.68	515
206	17.9	Corn silage	17	1.34	228
207/208	21.2	Corn silage	17	1.34	228
209	10.9	Corn silage	17	1.34	228
210	11.3	Corn silage	17	1.34	228
Total	**147.9**				

Source: Macfarlane (2016)

2.5.8 Current and Historic Nitrogen Balance

To corroborate the post-harvest soil nitrate data (Section 2.4), a nitrogen balance was calculated for each field cropped by Regehr Farms (Table 2-15). The nitrogen balance in this report is a desktop study that calculates the balance between nitrogen inputs in manure and fertilizer at an operation, and crop uptake of those nutrients, to estimate whether the operation is in balance or has an excess or deficit of nitrogen. The study provides an estimate of the net nitrogen inputs and outputs for the year.

The desktop study was based on assumptions about crop yield and protein content, release of nitrogen from soil organic matter, and loss of nitrogen from manure before and during manure application. Results should therefore be considered a reasonable estimate of nitrogen balance on each field. Nitrogen balances are part of understanding nitrogen management at a farm, but should not be considered as accurate an indicator of field nutrient status as soil fertility test results. When considering risk of nitrate leaching to groundwater, site-specific soil fertility test results are more reliable than estimates based on published values because of the variability in soil and manure characteristics (see Section 2.4).

Note that "Positive nitrogen balance" means more nitrogen has been applied than the crop requires for uptake. When a positive nitrogen balance exists, there is excess nitrogen in soil, and leaching of this excess nitrogen to deep soils and groundwater can result.

Table 2-15
Nitrogen (N) balance calculations (2016)

Field ID	Crop	Estimated Total N Available to Crop				Estimated N Removal by Crop[4]	N Balance (Available N - Crop Uptake N)
		Manure N[1]	Fertilizer N[2]	Residual N from Soil[3]	Total N Available to Crop		
		kg/ha				kg/ha	kg/ha
101	Corn silage	288	0	90	378	228	150
102	Corn silage	115	0	90	205	228	-23
103/104	Alfalfa	0	0	90	90	515	-425
105	Corn silage	144	0	90	234	228	6
203	Corn silage	144	0	90	234	228	6
205	Alfalfa	216	0	90	306	515	-209
206	Corn silage	216	0	90	306	228	78
207/208	Corn silage	216	0	90	306	228	78
209	Corn silage	180	0	90	270	228	42
210	Corn silage	252	0	90	342	228	114

Notes:
[1] D. Macfarlane, personal communication, 2016
[2] D. Macfarlane, personal communication, 2016
[3] BCARDC 2010b
[4] from Table 2-14

Explanatory notes for Nitrogen (N) Balance (Table 2-15)

The "Estimated Total N Available to Crop" is the sum of three values, manure-origin nitrogen, fertilizer nitrogen, and nitrogen released from soil organic matter (Table 2-15). Manure and fertilizer application rate information was obtained from Macfarlane (D. Macfarlane, personal communication, 2016). Nitrogen content in manure was based on AAFR (2006).

The nitrogen released from soil organic matter (Residual N from soil) was calculated using the nitrogen release values from the Nutrient Management Guide (BCARDC 2010b) (Table 2-16). These values are based on the assumption that the organic matter from a manure application that does not decompose during the year of manure application breaks down and releases nitrogen in predictable amounts in future years depending on how frequently and heavily the field has been amended with manure and fertilizer. Table 2-16 contains the nitrogen release estimates used to calculate the amount of residual nitrogen released from the Regehr Farms' fields.

Table 2-16
Nitrogen release estimates

Fertility Status of Field	Nitrogen Released from Soil Organic Matter (kg/ha/yr)
High – annual amendment with manure at high rates, plus annual fertilizer application to meet crop nutrient requirements	90
Moderate – manure or fertilizer application every two years at moderate rates	45
Low – infrequent or no manure or fertilizer application	0

It was assumed that all fields in the study area have high fertility due to long-term application of feedlot manure, and therefore would be expected to release the full 90 kg/ha of nitrogen during the growing season. The 90 kg/ha of nitrogen released from soil organic matter was added to the amount expected to be released from manure in 2016 to give the estimated total available nitrogen for the growing season.

In 2016, manure was applied to all crop land except fields 103 and 104 (Table 2-15). The combined amount of nitrogen from manure and from mineralization from soil organic matter ranged from 90 to 378 kg per hectare per year. Most of the land base was planted to silage corn in 2016 and estimated crop uptake of nitrogen on these fields was 228 kg per hectare per year. The remaining cropped area was planted to alfalfa, which can utilize up to 515 kg of nitrogen per hectare per year.

The difference between nitrogen inputs from manure and from organic matter release, and nitrogen uptake in the crop is the nitrogen balance (last column of Table 2-15).

Summary of Nitrogen Balance Results

Seven of 10 fields farmed in 2016 had a calculated positive nitrogen balance (Table 2-15) ranging from 6 to 150 kg/ha for the year (nitrogen inputs exceeded uptake by crop). The remaining three fields had a calculated negative nitrogen balance in 2016. Of the seven fields with a calculated positive nitrogen balance, five were estimated to have less than 100 kg/ha nitrogen excess based on the results of the desktop study. Based on the proposed Kowalenko environmental risk scale, those fields with less than 100 kg/ha of residual nitrogen in the 0 to 90 cm depth are considered to be in the medium to low environmental risk class (Kowalenko et al. 2007) (see Table 2-12 for risk ranges, and Section 2.4 for a discussion of the proposed Kowalenko scale). Therefore, based on the desktop nitrogen balance study, eight of 10 fields were in the low to medium environmental risk category (three fields with negative nitrogen balance and five fields with positive nitrogen balance but in the low to medium environmental risk range).

Two fields (Fields 101 and 210) had a calculated positive nitrogen balance greater than 100 kg/ha. Fields with 100 to 200 kg/ha of post-harvest residual nitrogen are in the high environmental risk category based on the proposed Kowalenko environmental risk scale (Kowalenko et al. 2007). This is corroborated by the post-harvest soil nitrate data: These two fields were also found to have residual nitrate in the high environmental risk range (Section 2.4).

The results of the nitrogen balance desktop study suggest that the current nutrient provision in manure is acceptable in eight of 10 fields, and that the farm overall was close to nutrient balance for nitrogen in 2016. However, the two high environmental risk fields (Field 101 and 210) may have been a source of nitrate-N leaching to the underlying soils and possibly groundwater.

Because cropping and nutrient application has been similar at this operation for the past three years, we assume that the operation has been close to balance for nitrogen for three years.

3 Environmental Assessment

The results of the EIA will provide the information necessary to develop the Action Plan, which is Requirement 3 in the Order. The Action Plan will detail the mitigation measures that will be implemented to abate the environmental impacts identified in the EIA.

3.1 BACKGROUND – POTENTIAL HUMAN HEALTH EFFECTS OF NITRATE IN DRINKING WATER

Health Canada's Guidelines for Canadian Drinking Water Quality state that the maximum acceptable concentration of nitrate-N in drinking water is 10 mg/L (Health Canada 2013). Elevated nitrate consumption can lead to methaemoglobinemia, which is a blood disorder that affects the ability to transport and release oxygen throughout the body (Health Canada 2013). Its effects are most pronounced in infants, and as a result it is more commonly referred to as "blue-baby syndrome." There are also concerns that nitrate may impact thyroid gland function and be associated with cancer (Health Canada 2013). The maximum acceptable concentration (MAC) of 10 mg/L nitrate-N is designed to protect the health of the most sensitive users (i.e., bottle-fed infants). Health Canada recommends that levels be kept as low as reasonably practicable (Health Canada 2013). The BC Approved Water Quality Guideline is the same as the Health Canada MAC of 10 mg/L (MOE 2009).

Under the regulatory guidelines, the landowner is responsible for the nitrates contributed by its operation to soil, groundwater, and surface water. It is therefore important to quantify the concentration of nitrates in the water as it enters the property (i.e., the levels of nitrates prior to the effect from the operations on the Study Area).

The EIA therefore considers an adverse impact to be present if the agricultural operations from the Study Area are causing groundwater to exceed the 10 mg/L drinking water guideline in wells installed in Hullcar Aquifer 103, either alone or in combination with other human-caused sources. The EIA also considers the additive effect of other farm operations on the Study Area to the total nitrogen load in the aquifer, which is likely contributed by activities on other properties located over the aquifer.

3.2 SUMMARY OF BASELINE CONDITIONS

Nitrogen (N) is one of the key indicators of potential effects on water from agriculture/livestock operations. The proportions of the different forms of nitrogen within the measured total nitrogen (i.e., organic nitrogen, nitrate-N, nitrite-N, and ammonium-N) can provide information on the proximity to sources of contamination, and help to evaluate the potential for the types of possible effects (e.g., ammonia-N is toxic to fish if present in high enough concentrations).

Nitrogen is naturally added to soil primarily by biological nitrogen fixation, in which organisms convert atmospheric nitrogen (N_2) to ammonia (Brady and Weil 2010). Nitrogen fixation also occurs via lightning, which converts atmospheric nitrogen into ammonia and nitrate, which can then enter the soil with rainfall. Ammonia is typically transformed to the more stable form of nitrate through the process of nitrification. Nitrite is an intermediate product of the conversion. Because nitrate ions are negatively charged, they are not readily adsorbed by the predominantly negatively-charged colloids in soil and will move downwards with percolating water until reaching the groundwater table (Brady and Weil 2010). For these reasons, nitrogen in groundwater is typically found in the form of nitrate.

Determining the local baseline (i.e., before agriculture) concentration of nitrate for the Study Area is not possible because of the long history of farming in the area, but natural processes typically result in nitrate concentrations of less than 1 mg/L in groundwater in BC (MOE 2007). This finding is supported by a compilation of 11,660 results for nitrate-N across the Cordillera region (including most of BC, part of Alberta, and part of the Yukon and Northwest Territories), which had a median nitrate-N concentration of 0.05 mg/L. In addition, over 98% of the samples had a nitrate-N concentration of less than 10 mg/L (Rivera 2014). Generally, nitrate-N concentrations greater than 3 mg/L indicate contribution from human activities (Rivera 2014).

Background concentrations in various references vary from 0.05 mg/L to 3 mg/L. For an agricultural area, it is reasonable to expect a background concentration of nitrate-N of 1 mg/L. Based on this literature review, the background for an agricultural area is defined as 1 mg/L.

3.3 RECEPTOR DEFINITION

As stated in the Order, the specific substance causing pollution is agricultural waste, including manure and/or manure-laden effluent, from which nitrate is leaching into groundwater. The Order describes the presence of nitrates in the groundwater, which is causing Hullcar Aquifer 103, an unconfined aquifer, to be unfit for potable water. The drinking water wells in Hullcar Aquifer 103 and related surface water points of diversion that are used for drinking water are the “receptors.”

There are four drinking water wells within the Study Area (Project wells 3, 4, 20, and 22), and at least three drinking water wells within 300 m of the Study Area (Project wells 7, 8, and 21) (Section 2.1.5, Tables 2-4 and 2-5). There are likely additional drinking water supplies surrounding the Study Area.

There are also surface water licences at five PODs within 300 m that are registered for domestic, irrigation, and livestock purposes:

- There are 3 PODs on Lyster Creek and springs near Lyster Creek (Milum and Wiebe)
- There are two PODs on Milum Spring, which is near Parkinson Lake

The nearest community drinking supply is Steele Springs, located about 5 km east of the feedlot and in a different watershed.

3.4 EFFECTS ASSESSMENT

3.4.1 Agricultural Land Use Effects on Water Quality

An effect is defined here as evidence of one or more parameters in groundwater being present in concentrations that exceed background levels. If an effect is present, then the significance of the effect is then evaluated based on the characteristics of magnitude, reversibility, duration, and frequency, as follows:

- Magnitude refers to the severity of an environmental effect;
- Reversibility refers to whether an environmental effect can be reversed after the activity that caused the effect is stopped;
- Duration refers to how long the environmental effect lasts after the activity that caused the effect is stopped; and
- Frequency refers to how often the environmental effect occurs (adapted from EAO 2013).

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The results are summarised using the above characteristics, for groundwater and surface water, in the following sections.

3.4.1.1 Groundwater

Magnitude

Eight domestic and irrigation wells were tested for nitrogen parameters, including three of the known drinking water supply wells: Project wells 20, 21, and 22. **None of the concentrations exceed drinking water or livestock watering guidelines (Table 2-9).** All wells except Project well 13 had nitrate concentrations less than 0.5 mg/L, which is consistent with expected background levels (defined as ≤1 mg/L in Section 3.2). Total nitrogen and nitrate-N concentrations in Project well 13 were measured at 2.77 mg/L and 2.51 mg/L, respectively, which are within both the Drinking Water and Aquatic Life Guidelines. Since only one well out of eight showed an above-background effect, the overall magnitude of the effect is judged to be low.

A limitation in defining the magnitude of an effect on groundwater is that most of the wells that were sampled have the screen (water intake) set between 6 and 15 m below the water table (information on the depth of the screen is not available for two wells), and not at the water table, where any leaching from surface would first enter the aquifer. Because of this limitation, the current understanding of the effect on groundwater is most complete for the middle portion of the aquifer where the majority of drinking water and irrigation water wells are installed. Nevertheless, the available results reflect nitrogen concentrations in the groundwater that is actually used on the property, and those results indicate low significance of effects.

Reversibility and Duration

Based on the groundwater flow direction, Fields 101 and 205 and the constructed wetland are up-gradient of Project 13 well. Other agricultural practices are also located in the vicinity of Project 13 (Purple Springs Nursery). The evidence from the post-harvest soil sampling and nutrient balance indicate that effects from over-application of manure is reversible if the nitrogen inputs are brought into balance with crop demand.

Denitrification does not occur readily in aerobic aquifers. Because discharge to surface water (and then conversion to N_2 gas through denitrification) and dilution are the main ways for nitrate-N to escape the groundwater system, and the slow groundwater movement towards Parkinson Lake described in Section 2.2, nitrate-N in Project 13 will likely persist for decades. However, over time groundwater will discharge to surface water and the aquifer will be recharged with newer precipitation and irrigation water. Eventually, the uppermost portion of the aquifer (if currently affected) will return to background levels. Therefore, the effect on groundwater in the vicinity of Project well 13 is reversible.

The reversibility of nitrate-N is complicated by the total amount of residual of nitrate-N in the unsaturated zone. As presented in Section 2.4, residual nitrate-N is present in the unsaturated zone below the root zone in both fields 101 and 205 but at levels that are considered “environmentally low risk”. We do not have enough information to determine the rate of movement of nitrate-N through the unsaturated zone at this time, but with on-going deep soil post-harvest sampling, this will be further assessed.

Frequency

Only one sampling round was included as part of the approved terms of reference. Therefore, information on the temporal variation in groundwater quality is not available. As noted under reversibility/duration, after nitrate-N concentrations become elevated in groundwater it can take several years for it to flush through the system, so the effect would be more or less continuous but decline over time.

3.4.1.2 Surface Water

SW1, which is a point on Lyster Creek immediately upstream of the licensed surface water points-of-diversion, was dry in both September and December. A water quality sample was collected farther upstream where water was flowing (SW2). In SW2, Nitrate-N was not detected and ammonia-N concentration was 0.052 mg/L. As described in Section 2.1.2 and Section 2.3, two surface water bodies are present in a downgradient position from the Regehr Farms: Floyd’s Swamp is west of the southernmost fields, and Parkinson Lake is east of the northernmost fields. Sampling of these locations were not part of the approved terms of reference. Moreover, other Agricultural Operations exist between Regehr Farms and these surface water bodies. For these reasons, the effect on surface water from the Regehr Farms is difficult to assess, but can be based on the observed effect on groundwater (See Section 3.4.4 for a discussion of effects).

3.4.2 Farm Operation Effects

Subject to the limitations of our assessment as prescribed in the terms of reference, the operations appear to be compliance with the AWCR and generally meet current best practices. The first item noted below relates to maintenance requirements to maintain the operations to those standard, and the second item relates to a safety issue noted during the site inspection. In both instances, the operators were notified of the issues and plans were made to mitigate the issues:

1. The berm that retains water in the constructed wetland was observed to be of irregular elevation at the time of the site visit. As discussed in Section 2.2.3, since October 2016, Regehr Farms is currently re-establishing the berm and raising it to have a consistent elevation.

2. The shape and height of the wood chip pile is a safety concern, and there was evidence of previous combustion (wood burning). Regular maintenance is required to avoid a slump of material below, and particularly to remove the burned material in the “cavern” (as shown in Photo 2-5). Effort should aware be in place to prevent injury by removing hazards. See Section 3.6 for mitigation options.

As described in Section 2.5.4, the wetland appears to hold water, suggesting that the bottom has sealed through the accumulation of fine sediments. However, there may be some seepage through to the underlying aquifer. It is possible that any flux of nutrients through the base of the wetland is controlled by a combination of plant uptake and denitrification, although this has not been assessed. Recommendations to upgrade the wetland are provided in Section 3.5.2, and monitoring recommendations are in Section 4.1.

3.4.3 Nutrient Management Effects

The nutrient management effects section of this report consists of a review of post-harvest soil nitrate-N and ammonium-N soil data from all fields but one in the Study Area from fall 2016 (Section 2.4), and a desktop nitrogen balance study of the farm (Section 2.5). The desktop study was based on a mixture of on-farm measurements and published data.

The results of the post-harvest soil testing indicate that the operation is currently close to balance with respect to nitrogen (Table 2-15). The level of residual nitrate in the 0 to 30 cm soil depth on all fields was at or below the BC EFP Reference Guide target levels for post-harvest residual nitrate, which suggests that nitrogen application in manure in 2016 (no chemical fertilizer has been used for 3 years in the Study Area) was close to optimum and was not excessive at the farm scale. The post-harvest soil nitrate-N test results from fall 2016 were therefore compliant with existing BC Ministry of Agriculture guidelines.

The Kowalenko draft guidelines (an alternate standard proposed for adoption by the BC Ministry of Agriculture) were used to assess the levels of residual nitrate-N throughout the entire 90 cm sampling depth. All but two fields tested had residual soil nitrate-N levels in the low or medium range. Based on these guidelines, both alfalfa fields sampled had a “medium” level of residual nitrate, and five of seven corn fields had a “low or medium” level of residual nitrate (Tables 2-11 and 2-12). Low to medium residual soil nitrate-N under these guidelines is considered to pose low to moderate environmental risk.

Also based on these guidelines, two corn fields (101 and 210) had a level of residual nitrate-N at the low end of the “high” range. These two fields also had the highest calculated positive nitrogen balance (Table 2-15) as a result of a higher manure application rate in spring 2016 than other fields cropped in 2016.

Field 101: In this field, there was very little nitrate-N below the 0-15 cm depth (the depth to which manure is incorporated) suggesting there was little downward movement of nitrate during the growing season from irrigation or precipitation, and that there is little risk of over-winter leaching of nitrate below the root zone from this field. This field is within the area of Kalamalka soils and has a silt-loam soil texture.

Field 210: The residual nitrate-N in this field was distributed throughout the 90 cm sampling depth rather than being concentrated in the top 15 cm as it was in Field 101; there is more risk of nitrate leaching from this field, particularly as it is located on coarser textured soil (Nahun sandy loam or loamy sand). For this field alone, we recommend that the manure application rate is decreased in 2017 and until residual soil nitrate-N levels in fall decline to within the low to medium range on the draft Kowalenko scale. Irrigation rate and timing should also be monitored to ensure it is appropriate for the soil and crop in this field.

The results of the nitrogen balance desktop study generally corroborated the soil test results and demonstrated that the operation was close to nutrient balance in 2016 (nitrogen inputs are equal to nitrogen removal in crops) with the exception of Fields 101 and 210 (discussed above).

As the number of livestock and the area of cropped land base have been very similar for the past three years, we assume that the operation has been close to nitrogen balance since 2013 (Table 2-15).

3.4.4 Discussion of Effects

One (Project 13 wells) of eight drinking water or irrigation water wells sampled were above background concentrations (defined as <1 mg/L) for nitrate-N. The wells sampled have screens set 5 to 15 m below the water table. As a result, there is insufficient information to assess the effect on groundwater in the uppermost portion of the aquifer. However, because the known drinking water and irrigation wells in the vicinity of the Study Area are installed in the same portion of the aquifer as the wells that were sampled, the effect on the usefulness of the environment (as per the AWCR – Section 1.4) can still be assessed.

Based on post-harvest soil sampling data and a nutrient balance, the Operation was close to nutrient balance between 2013 and 2016, with the exception of Field 101 and 210. However, Field 101 has a loam texture, and very little nitrate-N present below the root zone. Field 210 showed presence of nitrate-N below the root zone, and has a sandy texture; however, concentrations of nitrate-N in Project 20 well (located on Field 210) were below background.

Subject to the limitations of our assessment as prescribed in the terms of reference, the operations appear to be compliance with the AWCR. Runoff from the feedlot enters a constructed wetland facility where it is retained. The reeds, cattails, and other vegetation likely reduce nutrient concentrations in the pond/wetland through the process of plant uptake, and some nitrogen is likely lost to the atmosphere through denitrification. As described earlier, wetland sediments tend to promote denitrification (Alldred and Baines 2016). Based on a site visit, the base material of the constructed wetland appears to be hold water, thus minimizing the potential for leaching to groundwater.

These results indicate that the Operations have had negligible effect on the usefulness of the environment (groundwater and surface water), except in groundwater in the vicinity of Project well 13, and in deep soil samples (and thus possibly groundwater) in Field 210. The magnitude of both effects is limited to an area around each location and no Guidelines have been exceeded. Based on the results of the Post-Harvest soil sampling and nutrient balance, the effects are reversible. Based on these characteristics, the significance of the effects on the usefulness on the Lands (i.e. groundwater as drinking and irrigation water receptors) is low.

3.5 MITIGATION OPTIONS

3.5.1 Groundwater

Based on the above assessment, Farm operations have had negligible effect on the usefulness of groundwater, except in the vicinity of Project 13 well. The significance of the effect is determined to be low, and the following recommendations are made to mitigate the effect:

- Continue to monitor Project well 13. Based on the reversibility of nitrate-N, the concentration of nitrate-N should decrease, albeit over a decade or more.
- Continue to sample Project wells 7 and 8 for nitrate-N and total N. These wells are near Project well 13 and are used for drinking water purposes.
- Consider installing a new monitoring well downgradient of the wetland, and sampling for analytes of interest to further assess the effectiveness of the wetland. The analytes of interest are to assess both nutrients from a feedlot and potential contaminants of concern from wood chip storage based on MOE's Wood Waste Landfills Guideline (2011): pH, conductivity, dissolved oxygen, oxidation-reduction potential, chloride, total coliforms, E. coli, nitrate, nitrite, ammonia, TKN, organic nitrogen, total nitrogen, iron, manganese, biological oxygen demand, phenols, and resin acids.
- When sampling groundwater from the new well, also collect a grab sample of water from the constructed wetland for comparison. The sample should be obtained as a composite of about five sub-samples from locations around the wetland.

3.5.2 Farm Infrastructure and Operations

Regehr Farms manages manure collection, manure handling and stormwater management in an efficient manner using the natural contours on the property. Recommended mitigation practices include:

- Perform annual maintenance of the constructed wetland, preferably in the fall, to remove excessive sediment (both mineral and organic) and assure that the culvert, pipe spillway, and berms are not plugged and in good condition.
- The constructed wetland is serving to minimize effects on downstream surface water and groundwater quality by trapping sediment and organic nutrients. The function of the wetland could be increased by planting more of the wetted area with native aquatic macrophytes such as cattail and bulrush. The plants will help to remove nitrate-N by uptake and by the promotion of denitrification in the rooting zone. As a general concept, the cattail or bulrushes would be planted in zones that are less than about 0.8 m deep, leaving some areas of open water.
- Store woodchips in smaller piles or in windrows to limit the height of the piles and thereby reduce the potential for the material to begin composting. This will also provide adequate access to reach the piles if evidence of composting or fire is observed.

3.5.3 Nutrient Management

Regehr Farms generates manure in its feedlot and from its cow herd. The manure is applied to approximately 150 ha of cropped land. In general, it appears that manure application is done at the correct rate and time for the soils and crops that are on-site. However, the soil sampling and nutrient balance results indicate that on-going management is needed to optimize nutrient applications and reduce the potential for effects on groundwater. Recommended mitigation practices include:

General

- Continue to use a qualified person (CCA or P.Ag.) to prepare an annual Nutrient Management Plan or Farm Book that is based on soil sampling results.
- Conduct annual post-harvest soil testing on all fields over Hullcar Aquifer 103 to 90 cm depth. Use the more conservative Kowalenko et al. (2007) draft recommendations to decide if residual nitrate levels are acceptable rather than the BC EFP Reference Guide target levels.
- Participate in the BC Ministry of Agriculture benchmark soil study. There is currently a lack of information on how much of the nitrate leaching losses observed in the area is due to fall and winter precipitation and how much to over-irrigation. This study will provide site-specific information on fall and winter precipitation losses.

Manure Management

- Reduce manure application rate on Field 210 in 2017 based on post-harvest soil nitrate-N results.
- Apply manure based on the field- and crop-specific recommendations from the annual Nutrient Management Plan or Farm Book.
- Test feedlot manure for nutrient content in spring prior to manure application and use a running average of all annual analyses to determine manure application rates.

Fertilizer Use

- Avoid the use of inorganic fertilizer nitrogen on fields overlying the Hullcar Aquifer unless insufficient manure is available to meet crop demands or if manure cannot practically be applied to a field. If inorganic fertilizer nitrogen is applied, it must be done based on a field sampling program and recommendations from a qualified person.

Irrigation

- Consider installing soil moisture sensors in representative fields to fine-tune the irrigation rate. Field 210 in particular would benefit from soil moisture monitoring because it had post-harvest residual nitrate in the high environmental risk category based on the proposed Kowalenko scale, had nitrate-N distributed throughout the 90 cm sampling depth and is located on a sandy soil.

4 Summary and Preliminary Action Recommendations

4.1 MONITORING AND ENVIRONMENTAL ASSESSMENT RESULTS SUMMARY

The Environmental Assessment indicates that the current farm management practices that were followed between 2013 and 2016 have had negligible effect on the usefulness of the environment (groundwater and surface water), except in groundwater in the vicinity of Project well 13, and in deep soil samples (and thus possibly groundwater) in the vicinity of Field 210. The magnitude of both effects is limited to an area around each location and no Guidelines have been exceeded. Based on the results of the Post-Harvest soil sampling and nutrient balance, the effects are reversible. Based on these characteristics, the significance of the observed negligible effect on the usefulness on the environment (i.e. groundwater as source of drinking and irrigation water) is judged to be low. This conclusion is supported by the following three lines of evidence:

- All wells sampled were at background concentrations (less than 1 mg/L) for nitrate-N, except Project 13 well, which had an above-background nitrate-N concentration of 2.51 mg/L, but still below the Guidelines for both drinking water and aquatic life. There is a measured groundwater divide west of Project 13 well. Groundwater at Project 13 well would flow very slowly towards the east. From one set of water level measurements, and assuming the hydraulic conductivity value for sand, the calculated travel time to Parkinson Lake is more than 200 years;

- Nutrient applications to fields were generally in balance with crop demands, with the exception of Fields 101 and 210. Project well 13 is downgradient from Field 101 which had post-harvest nitrate levels within the high environmental risk category according to Kowalenko et al. (2007). However, the residual nitrate in this field was concentrated in the surface 15 cm and this field has a silt loam texture, which appears to be adequately retaining nitrate. For these reasons, we do not believe that there has been significant leaching of nitrate from Field 101 over the past three years (2013-2016). Field 210 is of sandier texture and therefore more susceptible to leaching. However, water sampled from Project 20 well, located in Field 210, had nitrate-N concentrations within the range for background, indicating that any leaching to groundwater is limited in magnitude.

- Subject to the limitations of the scope of our assessment, as prescribed in the terms of reference, the operations appear to be compliance with the AWCR. The constructed wetland appears to hold water and acts to protect downstream surface water quality. Project well 13 is downgradient from the constructed wetland, and water quality could be affected if there is any seepage to ground from the wetland. By adding a new test well downstream of the wetland and obtaining grab samples of the pond water on a regular basis, the potential effect from a connection to the groundwater layer can be further assessed.

4.2 SUMMARY OF PRELIMINARY MITIGATION ACTION RECOMMENDATIONS

As per the terms of the Order, an Action Plan will be developed based on the findings of the monitoring program and EIA, and subsequent review and discussion by MOE. Section 3.6 presents mitigation options in three categories: groundwater, farm infrastructure and operations, and nutrient management.

Upgrades and maintenance of the constructed wetland are recommended. The berm was repaired in autumn 2016, but regular cleaning is recommended, with the material recycled for composting or land application. The margins of the wetland should be planted with cattails or bulrushes to increase plant uptake and promote denitrification.

Based on the results of the post-harvest soil sampling program, it appears that Regehr Farms is close to nutrient balance with the exception of Fields 101 and 210. By continuing to monitor nutrient applications and irrigation rate particularly on fields with coarse-textured soil, it is expected that the operation can reach nutrient balance.

With mitigation measures, it is expected that the nitrate-N concentrations in Project 13 to decrease; although we do not expect concentrations to start to decrease for several years given the unknown rate of nitrate-N movement (flux) through the unsaturated zone, and the slow groundwater travel time.

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Closure

This Comprehensive Monitoring Program and Environmental Impact Assessment report was prepared for Ken and Brenda Regehr. The services provided by Associated Environmental Consultants Inc. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Environmental Consultants Inc.

PROFESSIONAL PROVINCE OF M. C. GREEN #30867 BRITISH COLUMBIA GEOSCIENTIST
Dec 19 2016

Marta Green, P.Geo.
Senior Hydrogeologist

Hugh Hamilton, Ph.D., P.Ag.
Senior Scientist

Ruth McDougall, M.Sc., P.Ag.
Consulting Agrologist

Dec 19, 2016

Roderick T. MacLean, M.Sc., P.Eng.
Senior Agricultural Engineer

Appendix A – Terms of Reference and MOE Acceptance Letter

September 23, 2016

File: UA Hullcar Aquifer\K Regehr
AMS#108432

VIA EMAIL c/o Joe Klassen, Purple Springs

Kenneth John Regehr and Brenda Lynn Regehr
4516 Hullcar Rd
Armstrong, BC V0E 1B4

RE: Requirement 1: Terms of Reference and Work Plan
Pollution Prevention Order #108432

Requirement 1 of the Order requires a Terms of Reference for an Environmental Impact Assessment and a work plan be prepared by a qualified professional and submitted to the Director for approval. The Ministry of Environment has received the revised Terms of Reference and Work Plan (the Plan) for Ken and Brenda Regehr, which was prepared by Associated Environmental, dated September 23, 2016 and resubmitted under Pollution Prevention Order 108432 (the Order). This letter is my approval of the Terms of Reference and the Work Plan contingent on the following:

Introduction

The introduction and subsequent sections of the terms of reference refers to the "issuance of the Order was for Aquifer 103". The Pollution Prevention Order requires an EIA ToR and work plan "be developed for nitrates and other nitrogen compounds in the soil and groundwater on the Lands identified in this order." References in the ToR to the Lands subject to the EIA must be expanded to include "assess[ment] of the impact the …operations have on nitrates and other nitrogen compounds entering surface or groundwater" from the Lands.

Definitions

1. Section 2.2
   - An effect is a change or response in the environment as a result of the agricultural operation.
   - An impact is any effect to the environment that causes impairment of the environment and its uses.
2. Section 2.5
   - Baseline conditions are pre-existing environmental conditions <u>before</u> development at a site which are used to determine actual effects [of agricultural operation] through comparison of natural and existing conditions.

. . . /2

I direct your attention to Requirement 2 of the Order which states:

> Immediately upon approval of the terms of reference and work plan by the Director, cause a Qualified Professional to implement the comprehensive monitoring program and complete the comprehensive EIA according to the work plan and terms approved by the Director, but subject to any further directions or amendments to the work plan or terms of reference made by the Director.

As well, please be advised, per the recent Privacy Commissioners investigative report and orders to the Ministry of Environment regarding information pertaining to Spallumcheen water quality, the Final EIA report will be made available on the Ministry of Environment Hullcar Aquifer web page.

Yours truly,

C Zacharias Homer

Christa Zacharias-Homer
Deputy Director
for Director, Environmental Management Act

Cc: Devan Oldfield, P.Ag., Environmental Protection Officer, Compliance Team, Regional Operations Branch
Marta Green, P.Geo., Senior Hydrogeologist, Associated Environmental

TERMS OF REFERENCE AND WORK PLAN

Ken and Brenda Regehr

Pollution Prevention Order
File 108432

September 2016

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1 Introduction

1.1 BACKGROUND

Associated Environmental Consultants Inc. (Associated) was retained by Mr. Ken Regehr to complete the Terms of Reference (TOR) and work plan for a comprehensive monitoring program and an Environmental Impact Assessment (EIA) of the company's operations, focussing on the potential effects of nitrates and other nitrogen compounds in the soil and groundwater. The focus of the comprehensive monitoring program and EIA is the agricultural operations located at 4516 Hullcar Road in Armstrong, BC, with the exception of the operations Purple Springs Nursery Ltd. The requirements for the monitoring program and EIA are specified in the Pollution Prevention Order issued by the BC Ministry of Environment on June 8, 2016 (File 108432).

The Pollution Prevention Order was issued for Aquifer 103, an unconfined aquifer known as the Hullcar Unconfined Aquifer. The agricultural operations include a feedlot and corn and hay fields. The feedlot does not overlie Aquifer 103. However, precipitation that falls on a portion of the feedlot may infiltrate the ground and eventually migrate down-gradient and enter Aquifer 103 and downstream surface water bodies (if present). Further details on this assessment are provided in the sections below.

1.2 QUALIFIED PROFESSIONALS

The following Qualified Professionals will complete the comprehensive monitoring program and the EIA. They are listed here with their qualifications as reference. Resumes can be provided on request.

1. **Marta Green, P.Geo.** of Associated will be responsible for the groundwater component. Through education and experience in consulting for the past 16 years, Marta's skillset includes physical hydrogeology (e.g., well testing – pumping tests and slug tests), water quality, contaminant hydrogeology, and regional hydrogeological studies.
2. **Hugh Hamilton, PhD., P.Ag.** of Associated will provide guidance on monitoring design and EIA methodology, and provide senior review of the reports. He has been practicing in environmental and agricultural consulting in BC since 1990. His areas of practice include soil and water conservation, water quality, land use, and environmental impact assessment.
3. **Ruth McDougall, M.Sc., P.Ag.** will contribute to the soil and nutrient management component of the EIA. Ruth is an acknowledged expert in BC in the characterization and recycling of organic residuals to agricultural land. She has expertise in soil fertility and nutrient cycling in agricultural systems, having started in this line of work in 1990. Ruth has been involved in writing provincial guidelines for residuals recycling, and has produced Land Application Plans for the application of many residuals to agricultural land as well as Environmental Farm Plans for livestock operations.
4. **Doug Macfarlane, CCA**, will contribute to the soil and nutrient management component. He is a Certified Crop Advisor registered with American Soil Society of Agronomy and has many years of experience in BC.
5. **Rod MacLean, P.Eng.**, with Associated will contribute to the operations facilities management (not including lands where nutrients are applied) and drainage management component. Rod is a senior

engineer responsible for civil, municipal, and agricultural design services in the Okanagan, and has a long history of experience in addressing water supply conservation issues. Rod has completed a variety of irrigation and drainage assessments for both small farming operations and larger corporate facilities. He is currently the BC Director of the Canadian National Committee for Irrigation and Drainage (CANCID) and supports research across Canada.

1.3 BACKGROUND TO THE TERMS OF REFERENCE

Development of the TOR and work plan is intended to meet Requirement 1 of the Pollution Prevention Order (the Order) issued on June 8, 2016 by the Ministry of Environment (MOE) to Kenneth Regehr Holdings Ltd (File 108432). The Order applies to the following area (the Lands):

- District Lot 48, Kamloops Division of Yale Land District, Parcel Identifier 011-227-486, other than that portion occupied by Purple Springs Nursery Ltd; and
- Lands used from time to time for agricultural operations that are part of or associated with the agricultural operations of the above lands and are controlled by Ken Regehr Holdings Ltd. and Kenneth John Regehr.

Requirement 2 in the Order is to implement the monitoring program and to complete the EIA. The monitoring program and EIA will begin as soon as the TOR and work plan are approved by MOE.

2 Terms of Reference

2.1 GOALS OF THE MONITORING PROGRAM AND EIA

The Order states that “the usefulness of the environment has been impaired due to the presence of nitrates in the groundwater as the presence of nitrates is causing the groundwater in the unconfined aquifer that lies in part underneath the Lands (commonly referred to Hullcar Aquifer 103) to be unfit for potable water for specific persons in the population.” The Order also indicates that the EIA is to assess the impact the operation has on nitrates and other nitrogen compounds entering surface water or groundwater, and the monitoring program is to be designed to inform the EIA.

The TOR and work plan are intended to clearly identify the methods to meet these goals. The TOR:

- Outlines the regulatory context for the monitoring program and EIA (Section 2.2)
- Defines the spatial and temporal boundaries of the EIA (Section 2.3)
- Defines the environmental receptor that is the focus of the assessment (Section 2.4); and
- Defines the basic steps that will be completed to design and implement the monitoring program and complete the EIA (Section 2.5).

The monitoring program and EIA are described in the work plan (Section 3).

2.2 REGULATORY CONTEXT

The Order is pursuant to section 81 of the *Environmental Management Act* (EMA) (SBC 2003 c. 53), and manure management is subject to the *Agricultural Waste Control Regulation* (BC Reg. 131/92). Fundamentally, the EMA prohibits pollution, and the Order indicates that pollution in this case has been caused by the introduction of agricultural waste to the environment. With respect to groundwater and surface water, a key indication that pollution has occurred is an exceedance of water quality guidelines or objectives; specifically, Health Canada's Guidelines for Canadian Drinking Water Quality (Health Canada 2013) for the Hullcar Aquifer 103.

Health Canada's Guidelines for Canadian Drinking Water Quality state that the maximum acceptable concentration of nitrate-N in drinking water is 10 mg/L (Health Canada 2013). Elevated nitrate consumption can lead to methaemoglobinemia, which is a blood disorder that affects the ability to transport and release oxygen throughout the body (Health Canada 2013). Its effects are most pronounced in infants, and as a result it is more commonly referred to as "blue-baby syndrome." There are also concerns that nitrate may impact thyroid gland function and be associated with cancer (Health Canada 2013). The maximum acceptable concentration of 10 mg/L nitrate-N is designed to protect the health of the most sensitive users, i.e., bottle-fed infants. However, Health Canada recommends that levels be kept as low as reasonably practicable (Health Canada 2013). The BC Approved Water Quality Guidelines also state a maximum acceptable concentration of nitrate-N in drinking water of 10 mg/L (MOE 2009).

Under the regulatory guidelines, the landowner is responsible for the nitrates contributed by its operation to soil, groundwater, and surface water. It is therefore important to know the concentrations of nitrates in either groundwater or surface water as it enters the property (i.e., the levels of nitrates prior to the effect from the operations on the Lands). Therefore, if surface water bodies are present downgradient of the Lands, and Hullcar Aquifer 103 is discharging to the surface water bodies, then surface water guidelines would also apply, including aquatic life guidelines.

The EIA will also consider the additive effect of farm operations on the Lands to the total nitrogen load in surface water and groundwater, which is likely also being contributed by activities on other properties. We will consider a statistically significant change from baseline to be an "effect." If the statistically significant change results in a concentration above a relevant guideline, this will be considered an "impact." For example, if the background concentration in the area tends to be about 3.0 mg/L, and the Guideline for Canadian Drinking Water Quality is 10 mg/L, then if the agricultural operations from the Lands are causing groundwater in wells installed in the Hullcar Aquifer 103 to exceed 4.5 mg/L (i.e. a 50% increase), this would be considered an "effect" but not an "impact." Hullcar Aquifer 103 is actively farmed across its extent in this area; therefore, baseline concentrations will be established by sampling at least two wells upgradient of Hullcar Aquifer 103, or on the edge of Hullcar Aquifer 103 where possible (see Table 3-1 Task 3d for details), and other available background data.

2.3 SPATIAL AND TEMPORAL BOUNDARIES OF THE EIA

Ken and Brenda Regehr operate a feedlot with about 3,500 head of feeders and 370 cow/calf pairs over the winter months. The operation includes several properties that Ken and Brenda Regehr either own or rent (Figure 2-1).

The spatial extent of the study area is the lands identified in the Order. The spatial extent of the study is shown in yellow on Figure 2-1, and is referred to here as the Lands. The vertical extent of the study is from the land surface to the bottom of the Hullcar Aquifer 103.

The Order is for pollution prevention. Therefore, the objective of the EIA in the Order is to assess current agricultural practices and their potential to adversely affect groundwater. Kenneth Regehr Holdings Ltd. has been following a nutrient management plan for the past three years (since 2013). We will therefore examine records on land use and nutrient management relevant to our assessment since that time, but we will also include historical information as part of our assessment (for example, how long has the feedlot been in operation, approximate number of agricultural units on the land over time).

2.4 RECEPTOR

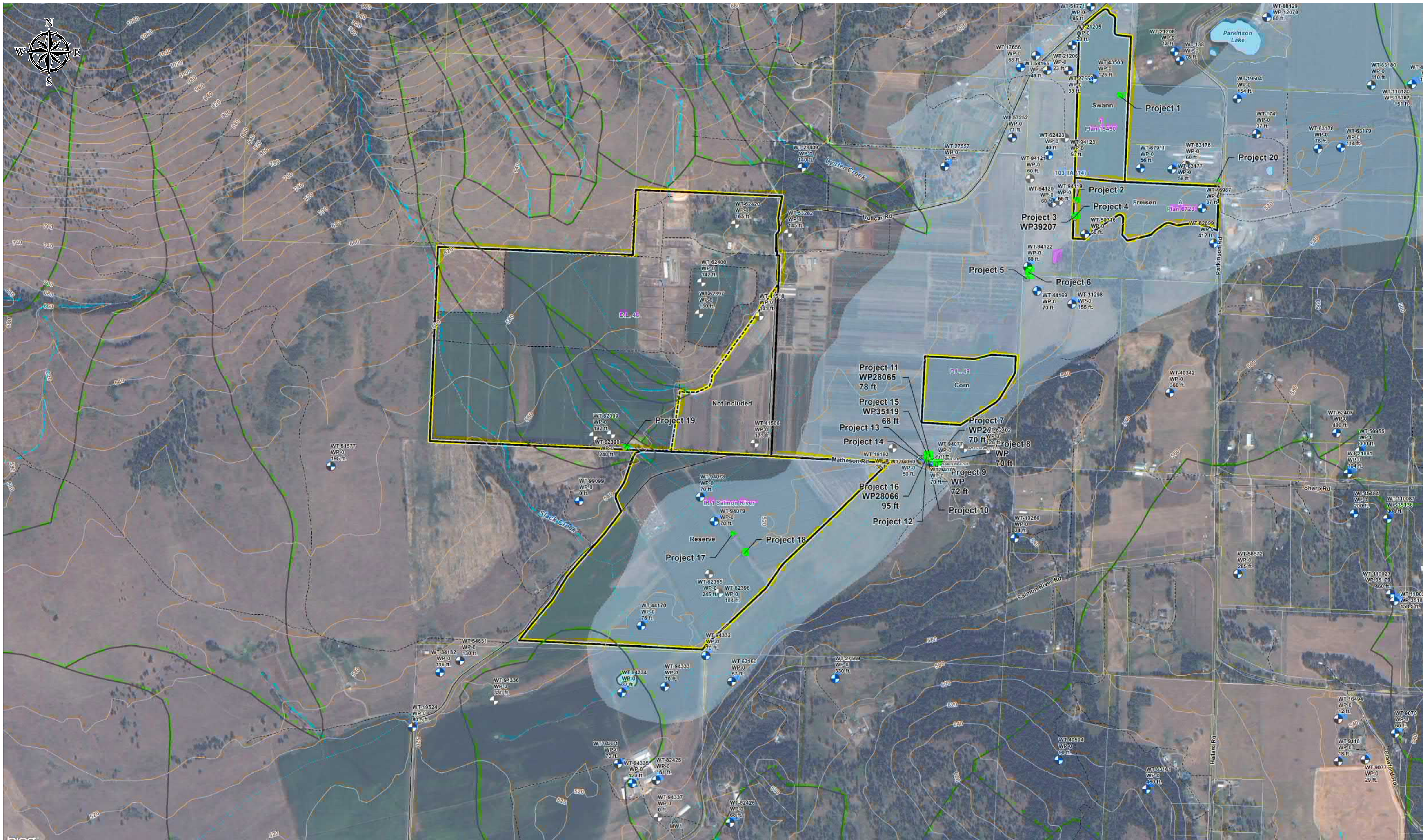
As stated in the Order, the specific substance causing pollution is agricultural waste, including manure and/or manure-laden effluent, from which nitrate is leaching into groundwater. The Order describes the presence of nitrates in the groundwater, makes the Hullcar Aquifer 103 unfit for potable water. We therefore will focus on the impacts from nitrogen (all species) on drinking water wells installed in the Hullcar Aquifer 103. The drinking water wells in the Hullcar Aquifer 103, which is an unconfined aquifer, are defined as the “receptors” of interest for the EIA. Other receptors, including aquatic life in surface water downstream of the Lands, will also be included, as appropriate.

2.5 ENVIRONMENTAL ASSESSMENT PROCESS

The environmental assessment process will include the following tasks:

- Characterize the existing (baseline) environmental conditions on the Lands and underlying aquifer, considering climate, soils, surficial geology, aquifer characteristics, and water quality.
- Describe farm operations on the Lands, particularly confined area operation (feedlots), manure and nutrient storage and management.
- Assess the effects of farm operations on the environment, considering the magnitude, timing, duration, and reversibility of any adverse effects.
- Identify management practices or other mitigation measures to avoid or minimize the identified adverse effects. The EIA will include the recommended preliminary mitigation strategy, with the details to be developed later as part of the Action Plan.
- Determine if there are any residual effects that cannot be reasonable mitigated.
- Develop a monitoring program to assess the effectiveness of the mitigation measures.

The implementation of these tasks is described in the work plan (Section 3).



Legend

- Subject properties
- Aquifer 103
- Study area
- Contours
- Bedrock outcrop
- Watershed boundary
- Surveyed well
- MOE registered well - location not verified in field
- MOE registered well - not found onsite

Notes:
WT - well tag number
WP - well plate identifier
300 ft - depth to bottom

0 100 200 300 400 500 Meters

Associated Engineering

PROJECT NO.: 2016-8112.000
DATE: September 2016
DRAWN BY: BdJ

FIGURE 2-1: LIMITS OF STUDY AREA

Kenneth Regehr Holdings Ltd.
Comprehensive Monitoring Plan

regehr.mxd / 9/19/2016 / 3:51:00 PM

3 Work Plan

The work plan includes two phases:

- Development and implementation of a comprehensive monitoring program; and
- The EIA.

The comprehensive monitoring plan is designed to inform the EIA, and will form the basis for later monitoring to evaluate the effectiveness of the Action Plan. The work plan for the comprehensive monitoring program and EIA is described in Table 3-1.

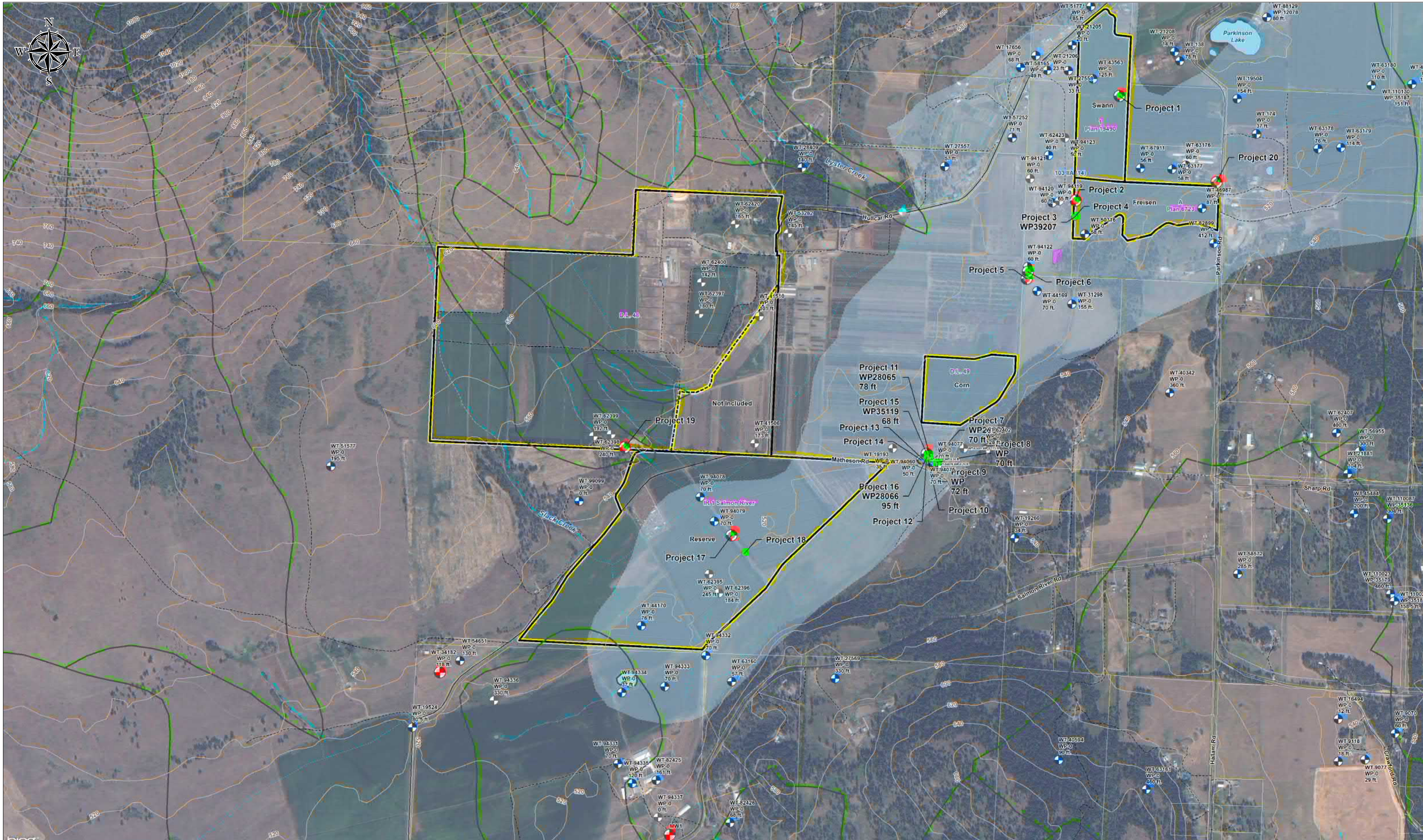
The results of the EIA will provide the information necessary to develop the Action Plan, which is Requirement 3 in the Order. The Action Plan will detail the mitigation measures that will be taken to prevent the potential environmental impacts identified in the EIA.

Table 3-1
Proposed work plan

Phase	Task	Description
Phase 1: Comprehensive Monitoring Plan	**Task 1: Review background information and complete a site visit and inspection of facilities including Feedlot**	a) Review nutrient management plans (including review of methods and protocols for historic sample collection), groundwater monitoring records, soil and climate information for the farm, historic soil nutrient data where available, facility drawings, surface water, groundwater movement and recharge information, farm history including use, annual agricultural units per year, changes in farm practice and any other pertinent historical information that is available. b) Calculate average monthly potential evapotranspiration and irrigation demand using climate and soils data. c) Conduct a site visit and review farming practices with landowner to document and compare to Agricultural Waste Control Regulation, and the BC Environmental Farm Plan Reference Guide where applicable: • Location of confined area operations (feedlots). • Location and size of manure storage facilities if applicable; • Location, size and management of field storage areas if applicable; • Location of on-site wells in Hullcar Aquifer 103; • Type, size and number of livestock on site, and seasonal variations; • Farmed land base – number and size of fields; • Cropping practices including crop types and rotations; • Manure and fertilizer application rates, import and export of manure on site; • Fields irrigated and irrigation rates and schedules; • Integrity of manure storage facilities and confined livestock area surfaces; and • Drainage management in confined livestock areas, other livestock areas and on cropped land base over aquifer. d) Review the results of the 2016 receptor survey to identify the nearest existing drinking water wells or springs. We have assumed that the receptor survey will be conducted by others as part of the Hullcar Aquifer Study. e) A map showing facilities, farmed land base, surface water bodies, aquifers, and wells will be provided.
	Task 2: Assess nitrogen management practices	a) Summarize sources of nitrates including but not limited to temporary and permanent manure storage areas, confined livestock areas, livestock seasonal feeding areas, cultivated fields, and pastures. This will include a map showing features and facilities. b) Describe farming operation including number of livestock, acres farmed over aquifer and elsewhere, crops grown, typical yields and nitrogen uptake by crops, manure handling system, manure storage type and capacity, manure use by field, manure brought from onsite, moved from off-site, and chemical N fertilizer use. c) Calculate estimated annual nitrogen loading on land-base over aquifer (tabulated by field), based on nutrient use information from operator and the scientific literature. d) Assess influences of precipitation, irrigation scheduling, and crops on the movement of nitrogen from surface soils to groundwater. e) Assess integrity of manure storage facilities and confined livestock areas. f) Assess adequacy of current drainage management in confined livestock areas, other livestock areas and cropped landbase. g) Determine the need for soil testing and soil sampling locations based on an understanding of the manure storage facilities and nutrient receiving sites as deemed necessary based on results of tasks 1 and 2.
	Task 3: Survey wells, and conduct water sampling	a) Measure groundwater levels and sample groundwater in 8 existing wells within or adjacent to Hullcar Aquifer 103, and under or downgradient of, the Study Area (as shown in red Figure 3-1). Collect groundwater samples using low flow sampling techniques. Conduct purging until consistent (stabilized) field-measured chemistry (e.g., electrical conductivity, pH, and temperature) is observed. Collect samples as per the British Columbia Field Sampling Manual (MWLAP 2013). b) Measure groundwater levels and sample groundwater in 2 existing wells up-gradient to the Study Area to assess baseline conditions, as follows: we will seek permission and sample two of the following wells or similar: Well tag 34182, Well tag 54651 on Figure 3-1, and/or an up-gradient proposed monitoring well (MW1) on the Grace-Mar property, just southwest of the Reserve field (as marked in red on Figure 3-1). c) Sample two surface water samples (Lyster Creek at Hullcar Road, and Slack Creek). No other surface water receiving environments have been identified; however, if a surface water receiving environment is located during the site visits or during a precipitation event during the timeframe of the study, we have allowed for collection of up to two additional surface water samples. d) Complete laboratory analysis of the water samples collected. Courier samples to an analytical laboratory for analysis of dissolved metals (for groundwater samples only), ammonia, nitrate, nitrite, total Kjeldahl nitrogen (TKN), organic nitrogen, and total nitrogen. e) Survey the top of casing and ground surface of each existing well(s) that will be used as part of the monitoring plan, with an accuracy of +/- 2 cm.
	Task 4: Analyse water data	a) Upload all water quality results directly from the laboratory to Wireless Water^{TM} Database Management Services, and then tabulate and compare results to baseline results and to applicable guidelines as identified during Task 1, including (but not limited to) the Guidelines for Canadian Drinking Water Quality and BC aquatic life, irrigation, and livestock watering guidelines. b) Upload results to EMS. We have assumed that location numbers for the EMS database will be provided to us by MOE once we provide a list of well plate identifiers and UTM coordinates that will be sampled to MOE.

	Task 5: Review post-harvest soil sampling results	a) Soil sampling will be conducted as part of nutrient management plans after crop harvest. Sampling will be undertaken at the recommended three depths 0-15, 15-30, and 30-60 cm. All samples will be analysed for nitrate, ammonium, organic matter, and TKN[1]. We will review the soil sampling results and provide interpretation.
Phase 2: Environmental Impact Assessment and Reporting	**Task 6: Conduct EIA**	a) Refine the identification of receptors and the spatial extent of the study area or limits of monitoring. b) Calculate descriptive statistics for the water and soil quality, and assess differences between wells/locations. For the soil data, we will use descriptive statistics to compare residual soil nitrate at varying depths in the soil within fields, and total residual nitrate and residual nitrate by depth between fields where applicable. For the water data, we will include an assessment of the well logs, including suitability of length and placement of screen for assessing water quality in Hullcar Aquifer 103, when completing our assessment of water quality results. c) Assess the likelihood that current (since 2014) agricultural operations on the Lands have caused nitrate-N concentrations in the aquifer to exceed baseline (causing an "effect"). If an effect has been caused, assess the likelihood the effect has caused an "impact" (exceeds guidelines). Identify the operations or management practices that have the potential to introduce nitrate to groundwater, given the understanding of the biophysical environment.
	Task 7: Draft comprehensive monitoring and EIA report	Compile the results of the comprehensive monitoring program and EIA into a draft technical report that will be submitted to MoE for review. The monitoring program section will describe tasks completed, methods applied, and results obtained, including the results on farm nitrogen balance and nitrogen loading practices, and groundwater sampling. Based on the technical assessment, the report will determine the likelihood that current farm practices are causing pollution, on their own or in combination with activities on other properties. The report will include the laboratory reports from the sampling programs in an appendix, and will include photographs, maps, and graphs. The details of action items for abatement/mitigation will not be included in the current scope. This will be a separate task, identified as the Action Plan in the Order, with a different schedule; and would be completed if an adverse effect on groundwater from the current farm practices is identified by the EIA. However, the report will provide a preliminary identification of pollution prevention strategies (actions) that would be put in place based on the EIA findings.
	Task 8: Finalize comprehensive monitoring and EIA report	The report will be finalized after receiving comments from MOE on the draft report.

[1] Analyses for these variables also enable the calculation of total N and organic N.



Legend

- Subject properties
- Aquifer 103
- Study area
- Contours
- Bedrock outcrop
- Watershed boundary
- Proposed sampling locations - groundwater
- Proposed sampling locations - surface water
- Surveyed well
- MOE registered well - location not verified in field
- MOE registered well - not found onsite

Notes:
WT - well tag number
WP - well plate identifier
300 ft - depth to bottom

0 100 200 300 400 500 Meters

Associated Engineering

PROJECT NO.: 2016-8112.000
DATE: September 2016
DRAWN BY: BdJ

FIGURE 3-1: PROPOSED SAMPLING LOCATIONS

Kenneth Regehr Holdings Ltd.
Comprehensive Monitoring Plan

4 Schedule

Requirement 2, the completion of the comprehensive monitoring program and EIA, was requested in the Order to be completed by August 1, 2016. Our original TOR and Work Plan proposed a revised schedule to submit the results of the monitoring program and EIA on September 20, 2016. However, since then, we have reviewed in detail the tasks required to complete the EIA and propose that the draft monitoring program and EIA be prepared by November 28, 2016, and the final monitoring program and EIA report by Dec 12, 2016, assuming comments are received by the MOE by Dec 5, 2016.

The main reason a change in the proposed schedule is required is because post-harvest soil sampling, based on the farmer's expectation of corn cutting for this year's harvest, will be completed by the end of September. The lab typically turns around the analysis within one week; however, this may be up to two weeks given the busy season. This means that we would not have the post-harvest sampling results to start our review until October 17, 2016 at the latest. We would therefore aim to have our draft report prepared six weeks after we receive the last of the laboratory results.

The revised proposed schedule is provided in Table 4-1.

Table 4-1
Proposed project schedule

ID	Task	Days	Start	End															
		80	**23-Sep-16**	**12-Dec-16**	23-Sep-16	30-Sep-16	7-Oct-16	14-Oct-16	21-Oct-16	28-Oct-16	4-Nov-16	11-Nov-16	18-Nov-16	25-Nov-16	2-Dec-16	9-Dec-16	16-Dec-16	23-Dec-16	30-Dec-16
Phase 1 - Comprehensive Monitoring Program			**23-Sep-16**	**17-Oct-16**															
1	Review background information and complete site visit	14	23-Sep-16	7-Oct-16															
2	Assess nitrogen management practices	14	23-Sep-16	7-Oct-16															
3	Survey wells, and conduct water sampling and analyses	14	7-Oct-16	21-Oct-16															
4	Analyse water data	7	21-Oct-16	28-Oct-16															
5	Review post harvest soil sampling results	3	14-Oct-16	17-Oct-16															
Phase 2 - Environmental Impact Assessment and Reporting			**17-Oct-16**	**12-Dec-16**															
6	Conduct EIA	21	17-Oct-16	7-Nov-16															
7	Draft Comprehensive Monitoring and EIA report	21	7-Nov-16	28-Nov-16															
8	Final Comprehensive Monitoring and EIA report	14	28-Nov-16	12-Dec-16															

Closure

This report was prepared for Ken and Brenda Regehr and outlines the TOR and work plan for the comprehensive monitoring program and EIA.

The services provided by Associated Environmental Consultants Inc. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Environmental Consultants Inc.

Marta Green, P.Geo.
Senior Hydrogeologist

Hugh Hamilton, Ph.D., P.Ag.
Senior Environmental Scientist

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Health Canada. 2014. Guidelines for Canadian Drinking Water Quality. Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. Available at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php

Oldfield, D. 2016. Personal communication (email conversation with Ruth McDougall). Environmental Protectino Officer, Ministry of Environment.

Appendix B – Available Well Logs for Project Wells

Project 1

Mountain View Electric Ltd.

Certified Electrical Contractors

GERARD DOORN - PHONE (250) 838-6455 - FAX (250) 838-6732 - PAT DOORN

COMMERCIAL, INDUSTRIAL, RESIDENTIAL WIRING AND MAINTENANCE

1009 BELEVEDERE STREET, BOX 467, ENDERBY B.C., V0E 1V0

E-mail: mtnview@jetstream.net

May 12, 2003

Quotation 16072

Irrigation well

Peter Swaan
Hullcar Road
Armstrong, B.C.
V0E 1B0

Re: **Irrigation Service & Pump Costing 30 HP 600V**

Dear Bernie,

Please find here revised costing for the pump installation and supply of a Goulds 30 Hp Submersible with the following design points.

Well depth	-	51 feet
Static	-	7 feet
Pumping Level	-	27 feet
Pump setting	-	42 feet
Pumping PSI	-	120 psi at wellhead

Goulds Pump Package - Supply Only

1	-	Goulds 7WAHC 4 stage High Capacity Wet End
1	-	Franklin 40HP 600V 3Phase motor 6"

Design point:

240 US gpm @ 395ft TDH
Requiring 30.3 BHP @ 78% Efficiency

280 US gpm @ 358ft TDH
Requiring 32.5 BHP @ 78% Efficiency
(Maximum BHP draw 34.5 allowable)

Goulds Pump Installation - Supply and Install

42'	-	4" Galvanized drop pipe
1	-	6" x 4" galvanized reducer bushing
2	-	4" x 6" galvanized nipples
1	-	4" Flo-Matic check valve FPT
1	-	8" Well seal with 4" drop
52'	-	6/4c Pump drop cable
1	-	6/4c splice kit with heatshrink tubing
1	-	4" galvanized Tee
1	-	4" galvanized plug w/ ¼" fittings for loss of prime switch and pressure gauge
1	-	loss of prime pressure switch
1	-	0-200 psi pressure gauge
1	-	4" brass Red & White gate valve 4" FPT
1	-	pump truck and installation labor

40 HP 600V 3Phase Irrigation Service - Supply and Install

1	-	25ft Class 5 service pole with guy anchor
1	-	Cutler Hammer Irrigation Service panel with meterbase, main breaker, magnetic starter and Hand-Off-Auto selector switch all mounted inside an EEMAC 3R enclosure (no pumphouse required)
1	-	Connect pump leads and pressure switch into panel
1	-	Inspection Permit included
1	-	all necessary installation materials to support panel and service entrance for 40HP 600V 3PH motor

This 30hp installation would work well with the way you and Peter have laid out your irrigation. Good flow with a 1" nozzle @ 60 psi equaling 230 US gpm. Please call me if you have any questions.

Thanks for allowing us to revise this installation costing.

Sincerely,

Pat Doorn

Info for Well log for Project 2 (Freise old irrigation well)

by Marta Green, Sept 26, 2016
onsite w/ Bernie Lichti
from info written on inside of PH =

Well 54 ft deep
Pump intake 35 ft
Static 16 ft (2014)
Pump 30 hp

#7

Wangler Drilling Ltd.

Ph. Toll Free. 1-800-624-7417
Local. 832-3264
Fax. 250-832-0563

7938 Cambie Rd.
Salmon Arm B.C.
V1E 2Y6

www.wanglerdrilling.com

COPY

Date : Oct. 2 & 5 /09
Owners name: Ken Regehr
Telephone: 250-546-8156
Address: 4516 Hullcar Rd., Armstrong, B.C.
cell: 250-828-9991
Location: Lot 49
Postal Code:

Formation & Remarks

0 to 3 ft. top soil
3 to 16 clays
16 to 54 wet fine to coarse sands with some grav
54 to 70 water bearing clean gravels
70 to 71.5 silt clays.

Well completion info.

Well identification tag # 25872

Total Depth: 70
Air lifted well at approx. - 80 gpm
Static Level: 12 ft.
Casing Size: 5 9/16" Schedule 80 Threade PVC
Screen: .080 & .050 stainless steel

Top of screen assembly @ 62.5

From 2 ft. to 60 1/2 ft.
From 60.5ft. to 70 ft.

1929 cm. 63' 4" To Top of Casing.

Note. Top of screen assembly is 62.5 ft. from top of PVC.

Well screen designed pumping maximum 240 IMP GPM.

Terms: Payment due upon receipt of this invoice

Note: Interest charged on over due accounts.

New Domestic
NW of Regehr P. House
B

Wangler Drilling: Bob, Adam, Eddie

GST # R 103 594 495

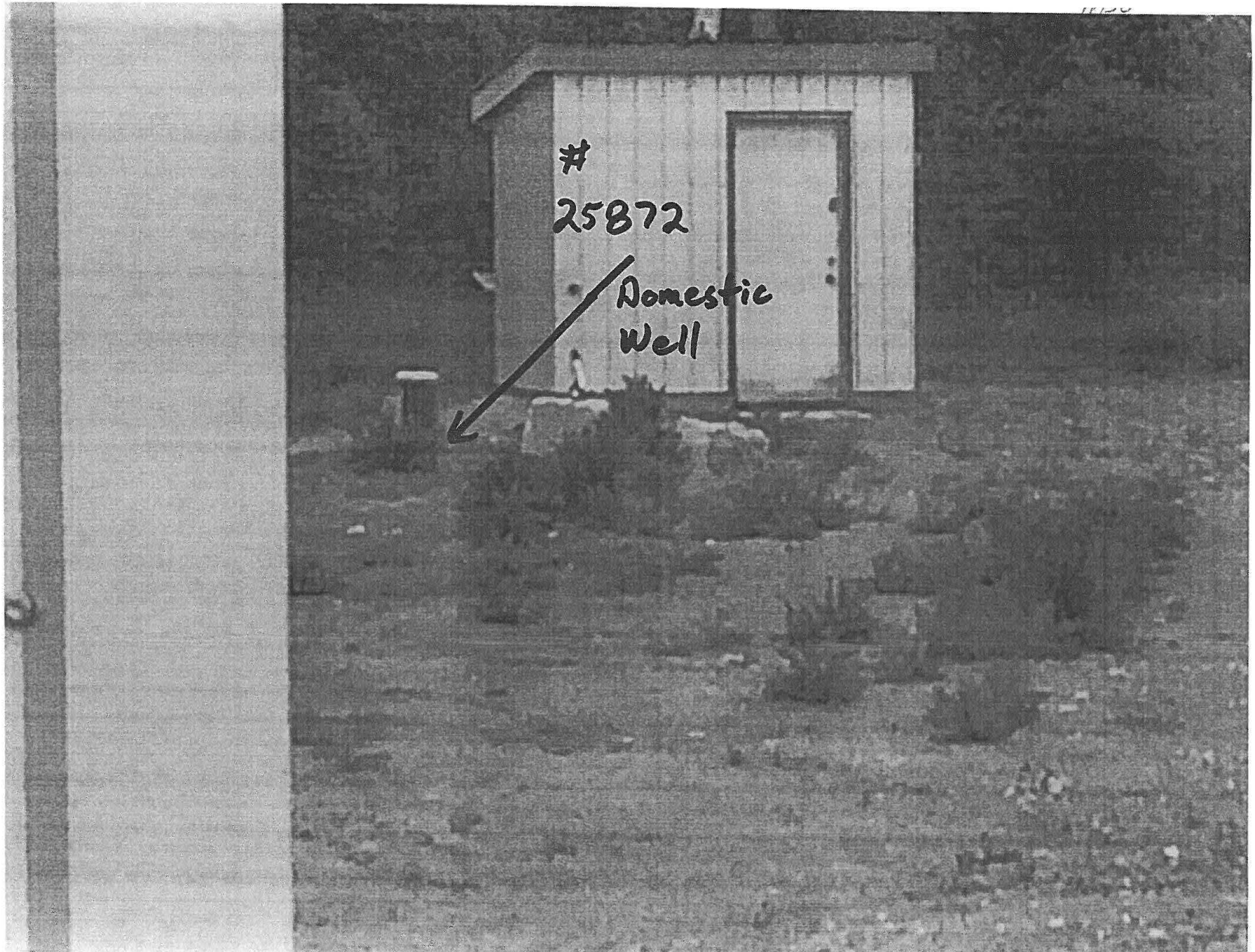
* Estimate only. For accuracy a pump test is required

Top of Screen to
Top of Casing. 63'4"

~~63'4" to Top of~~

Top of Casing To Bottom
of Pitless 7'6"

Bottom of Pitless to Top
of Screen
55'10"


#
25872
Domestic
Well


PROVINCE OF BRITISH COLUMBIA
WELL IDENTIFICATION NUMBER
25872

BRITISH COLUMBIA

BC Environment

Water Management Division

WATER WELL RECORD

Date 00/10/27 (YR MO DY)

NTS MAP | WELL No. | ELEV | Location Accuracy

UTM Z | E | N | UTM Date 19 | Well Type

Owners Name & Address: Ken Regehr

Legal Description & Address: Hullcar Rd. Armstrong

Descriptive Location: On sand berm N. of existing farm use well.

1. TYPE OF WORK 1 ☑ New Well 2 ☐ Reconditioned 3 ☐ Deepened 4 ☐ Abandoned

2. WORK METHOD 1 ☐ Cable tool 2 ☐ Bored 3 ☐ Jetted 4 ☑ Rotary a ☐ mud b ☑ air c ☐ reverse ☐ Other

3. WATER WELL USE 1 ☐ Domestic 2 ☐ Municipal 3 ☐ Irrigation 4 ☐ Comm. & Ind. ☐ Other Farm

4. DRILLING ADDITIVES None

5. MEASUREMENTS from 1 ☑ ground level 2 ☐ top of casing; casing height above ground level 2 ft.

FROM ft	TO ft	6. WELL LOG DESCRIPTION	SWL ft
0	60	Sand & gravel.	
60	70	Clean sand & gravel	

7. CONSULTANT None

Address

8. WELL LOCATION SKETCH

9. CASING: Materials 1 ☑ Steel 2 ☐ Galvanized 3 ☐ Wood 4 ☐ Plastic 5 ☐ Concrete ☐ Other

							units
Hole Diameter	6"						ins
Diameter	6 5/8"						ins
from	+2						ft
to	70						ft
Thickness	.188						ins
Weight	12.92						lb/ft

Pitless unit ____ ft 1 ☐ above 2 ☐ below ground level

1 ☑ Welded 2 ☐ Cemented 3 ☐ Threaded | 1 ☑ New 2 ☐ Used

Perforations:

Shoe (s): Steel

Open hole, from ____ to ____ ft Diameter ____ ins

Grout:

10. SCREEN: 1 ☑ Nominal (Telescope) 2 ☐ Pipe Size

Type 1 ☑ Continuous Slot 2 ☐ Perforated 3 ☐ Louvre ☐ Other

Material 1 ☑ Stainless Steel 2 ☐ Plastic ☐ Other

Set from 62 to 70 ft below ground level

RISER, SCREEN & BLANKS							units
Length	8'						ft
Diam. I D	5"						ins
Slot Size	20						ins
from	62						ft
to	70						ft

Fittings, top K-packer bottom plug.

Gravel Pack natural

11. DEVELOPED BY: 1 ☑ Surging 2 ☐ Jetting 3 ☑ Air 4 ☐ Bailing 5 ☐ Pumping ☐ Other

12. TEST 1 ☐ Pump 2 ☐ Bail 3 ☑ Air Date 00/10/27 (YR MO DY)

Rate 100 USgpm Temp ____ °C SWL before test ____ ft

Water Level ____ ft after test of ____ hrs

☐ DRAWDOWN in ft				☐ RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

13.

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
Submersible	55 ft	25 required USgpm

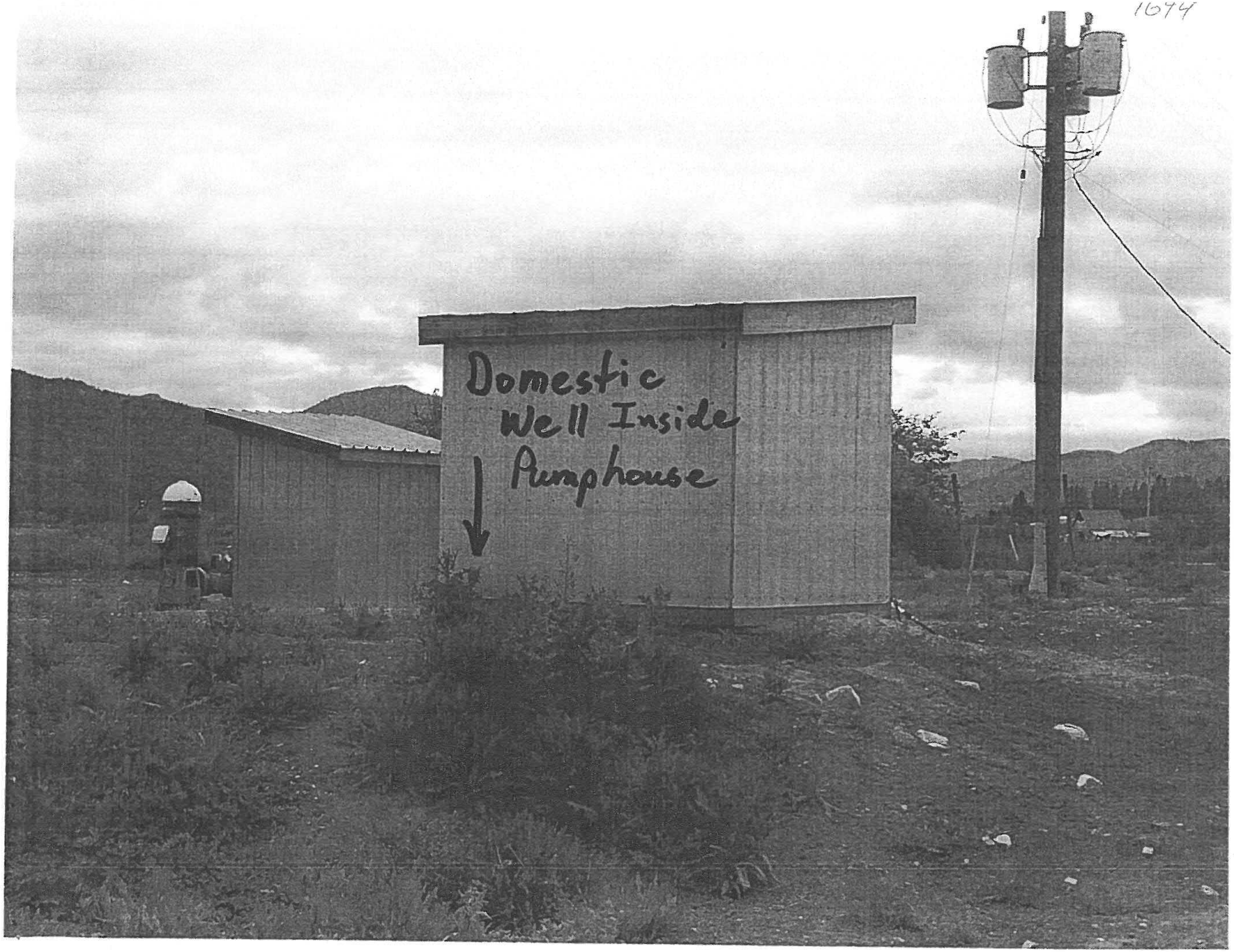
14. WATER TYPE: 1 ☑ fresh 2 ☐ salty 3 ☑ clear 4 ☐ cloudy

colour no smell no ; gas 1 ☐ yes 2 ☑ no

15. WATER ANALYSIS: 1 Hardness ____ mg/L 2 Iron ____ mg/L 3 Chloride ____ mg/L 4 pH ____

Field Date ____ Lab Date ____ (YR MO DY)

SITE I D No



1674

#9

TELEPHONE
~~(604) 853-2513~~

A & H Construction Ltd.

"Specializing in Water Wells, Soil Sampling, Exploration"

1681 SALTON RD.,
P.O. BOX 38,
ABBOTSFORD, B.C.
V2S 4N7

INVOICE 1496 - (B)

TO Mr Ken Regier 4516 - Hullcar Rd

ADDRESS R.R. #4 Armstrong B.C VOE 1BO

WELL DRILLED AT Farm Site - Armstrong B.C.

WELL COMPLETED Feb 21/92 INVOICE DATE Feb 25/92.

Machine Hours at ... per Hour		
Feet of Drilling at ... per Foot		
12" x 72'	Feet of Drilling & Casing at ... per Foot	
Feet of ... Casing at ... per Foot		
Feet of ... Casing at ... per Foot		
Feet of ... Casing at ... per Foot		
1 x 12"	Drive Shoes at ... each	
15' x 8"	Feet of 100 Slot Screen	
Installation of Screen		
Pump Testing ... Hours at ... per Hour		
Surging and Baling ... Hours at ... per Hour		

Other Charges:

Moving on Site and Setting Up Mobilize & Demobilize

Blasting

Other 1 - 12" x 8" "K" type Packer
8 - hours Set Screen &
Well Develope @ 100.00

Room and Board

Travelling and Tolls

TOTAL INVOICE PRICE

Notations Set 15' x 8" x 100 Slot Johnson
Stainless Steel Screen
1 - 12" x 8" "K" Packer & Bail Bottom
Well Producing Approx. - 2000 G.P.M.
Developed Well - 8 hours
Static Water Level - 12'-6"

INVOICE

LOG OF WELL

0 - 5'	top soil
5' - 29'	Gravel
29' - 56'	Fine Sand
56' - 72'	Gravel
72' -	Till

12'-6" Static H_2O

- Account due on presentation of this invoice. -

Interest at 1½% per Month (18% per Annum) on all accounts overdue 30 days.

TELEPHONE
~~(604) 853-2513~~

A & H Construction Ltd.

"Specializing in Water Wells, Soil Sampling, Exploration"

1681 SALTON RD.,
P.O. BOX 38,
ABBOTSFORD, B.C.
V2S 4N7

INVOICE 1496 - B

LOG OF WELL

0 – 5'	top Soil
5' – 29'	GRAVEL
12'-6"	Static H_2O
29' – 56'	fINE SAND
56' – 72'	GRAVEL
72' –	TILL

TO Mr Ken Regier 4516 - Hullcar Rd

ADDRESS R.R. #4 Armstrong B.C VOE 1B0

WELL DRILLED AT Farm Site - Armstrong B.C.

WELL COMPLETED Feb 21/92 INVOICE DATE Feb 25/92.

.... Machine Hours at .... per Hour

.... Feet of Drilling at .... per Foot

12" x 72' Feet of Drilling & Casing at .... per Foot

.... Feet of .... Casing at .... per Foot

.... Feet of .... Casing at .... per Foot

.... Feet of .... Casing at .... per Foot

1 x 12" Drive Shoes at .... each

15' x 8" Feet of 100 Slot Screen

Installation of Screen ....

Pump Testing .... Hours at .... per Hour

Surging and Baling .... Hours at .... per Hour

Other Charges:

Moving on Site and Setting Up Mobilize & Demobilize

Blasting ....

Other 1 - 12"x8" "K" type Packer
8 - hours Set Screen &
Well Develope

Room and Board ....

Travelling and Tolls ....

TOTAL INVOICE PRICE ....

Notations Set 15' x 8" x 100 Slot Johnson
Stainless Steel Screen
1 - 12" x 8" "K" Packer & Bail Bottom
Well Producing Approx. - 2000 G.P.M.
Developed Well - 8 hours
Static Water Level - 12'-6"

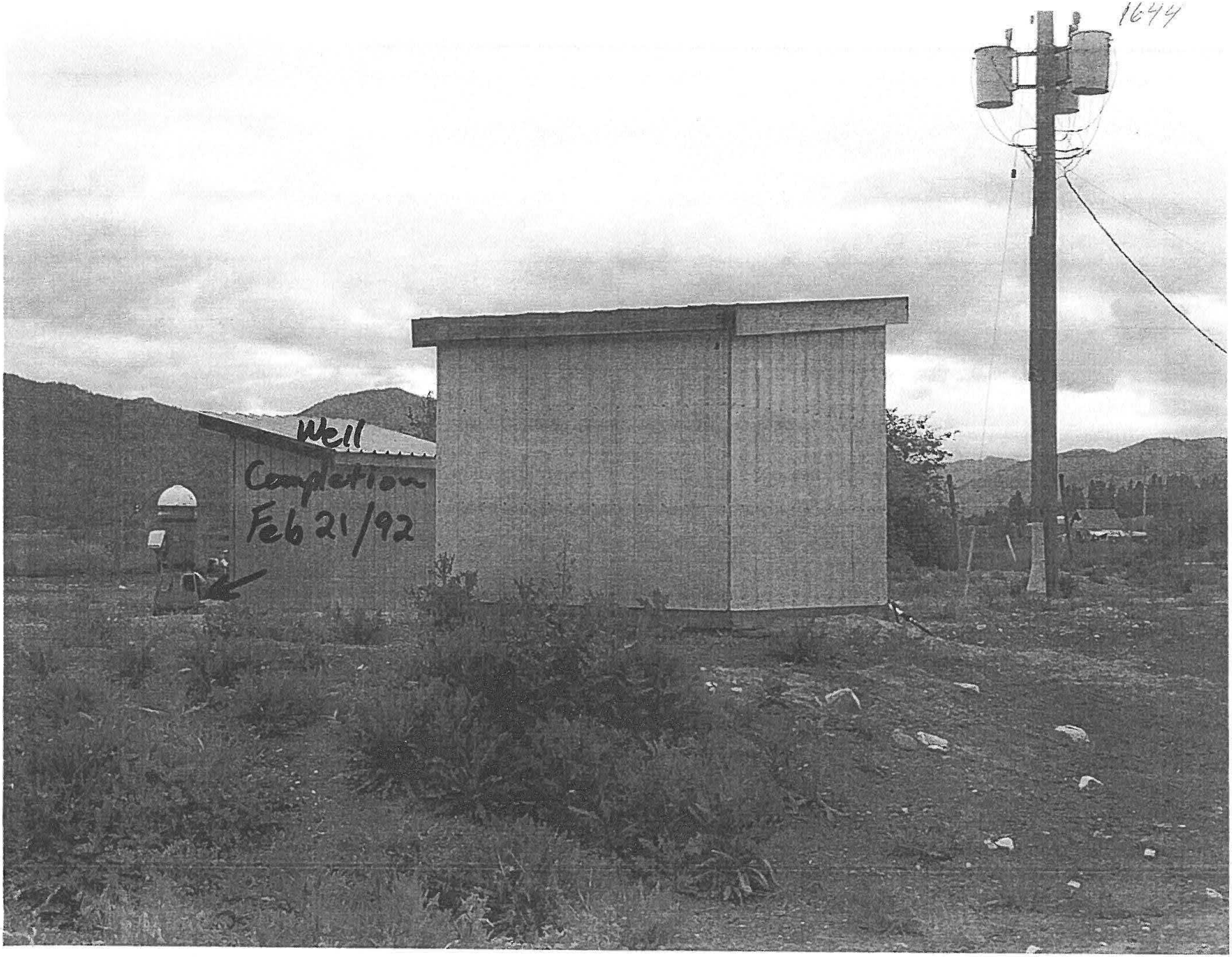
INVOICE

- Account due on presentation of this invoice. -

Interest at 1½% per Month (18% per Annum) on all accounts overdue 30 days.

Cash upon Well Completion.

1644



INTEGRITY DRILLING INC.

#11

6634 Hwy. 97A, Enderby, B.C. V0E 1V3 • Ph. 250-833-2111 • Fax 250-838-0154

Date Nov 30, Oct 1,2 Telephone 250 546 8150 / cell 260 0157

Owner's Name Purple Springs Fax 250 546 9155

Address 4516 Hullcar Rd

Location 50°29.585N 119° 16.076W Armstrong. Postal Code

Formation & Remarks: Elev. 1690

0-15 brown clay

15-78 sand & gravel grey

East Well #1 2009

WELL COMPLETION INFO TAG# 28065

Total Depth 77' 9" ft. *Air Lift (approx.) must be pump tested G.P.M.

Recommended Run G.P.M. Series Pump

Static Level 22 from top csg ft. Recommended Pump Setting @ 65 ft.

Casing Size 12¾ Type .250 steel Set From +4'3" to 69 ft.

Screen Size 120 thou Type 12" stainless steel Set From 67'9" to 77'9" ft.

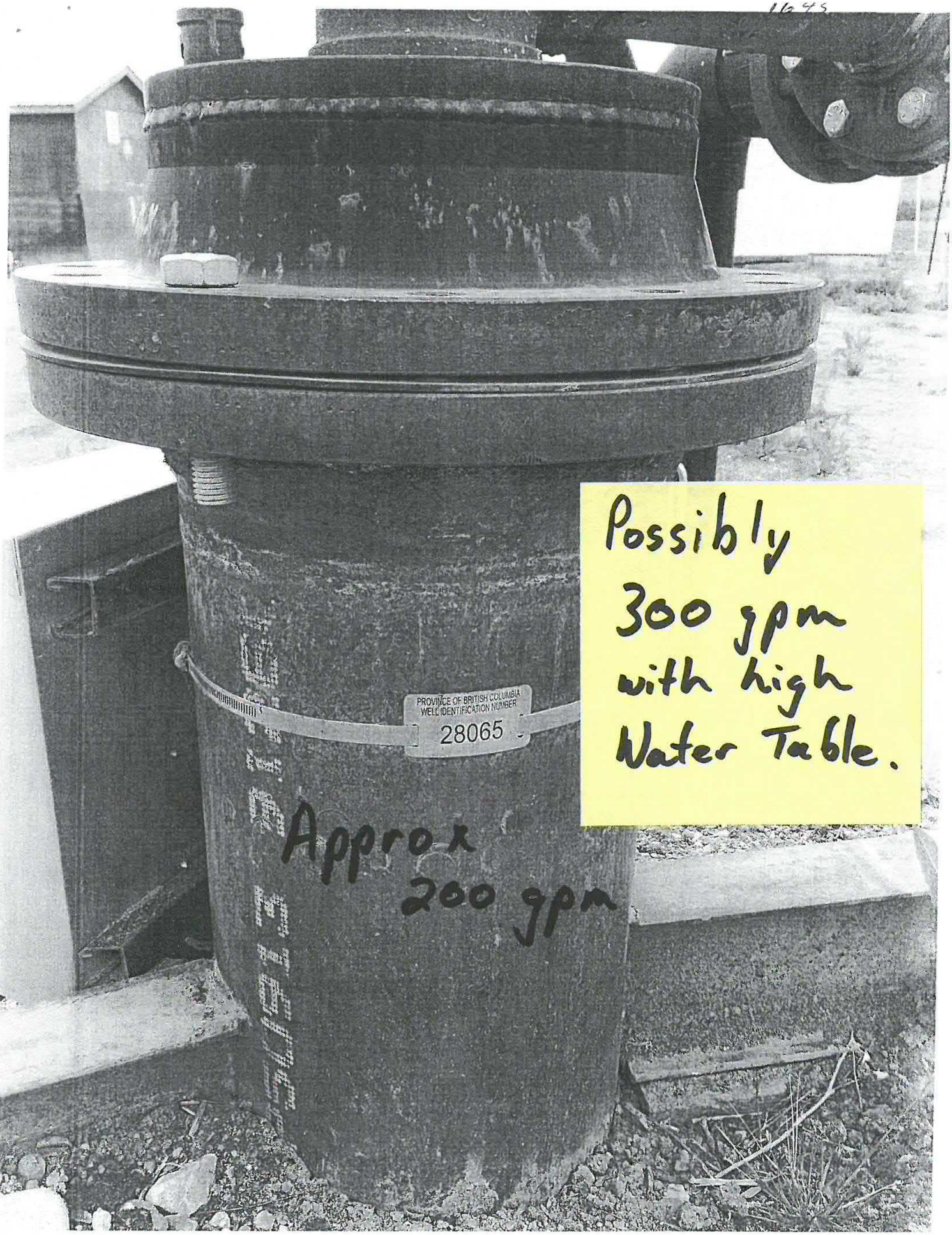
Customer Signature KBR [signature]

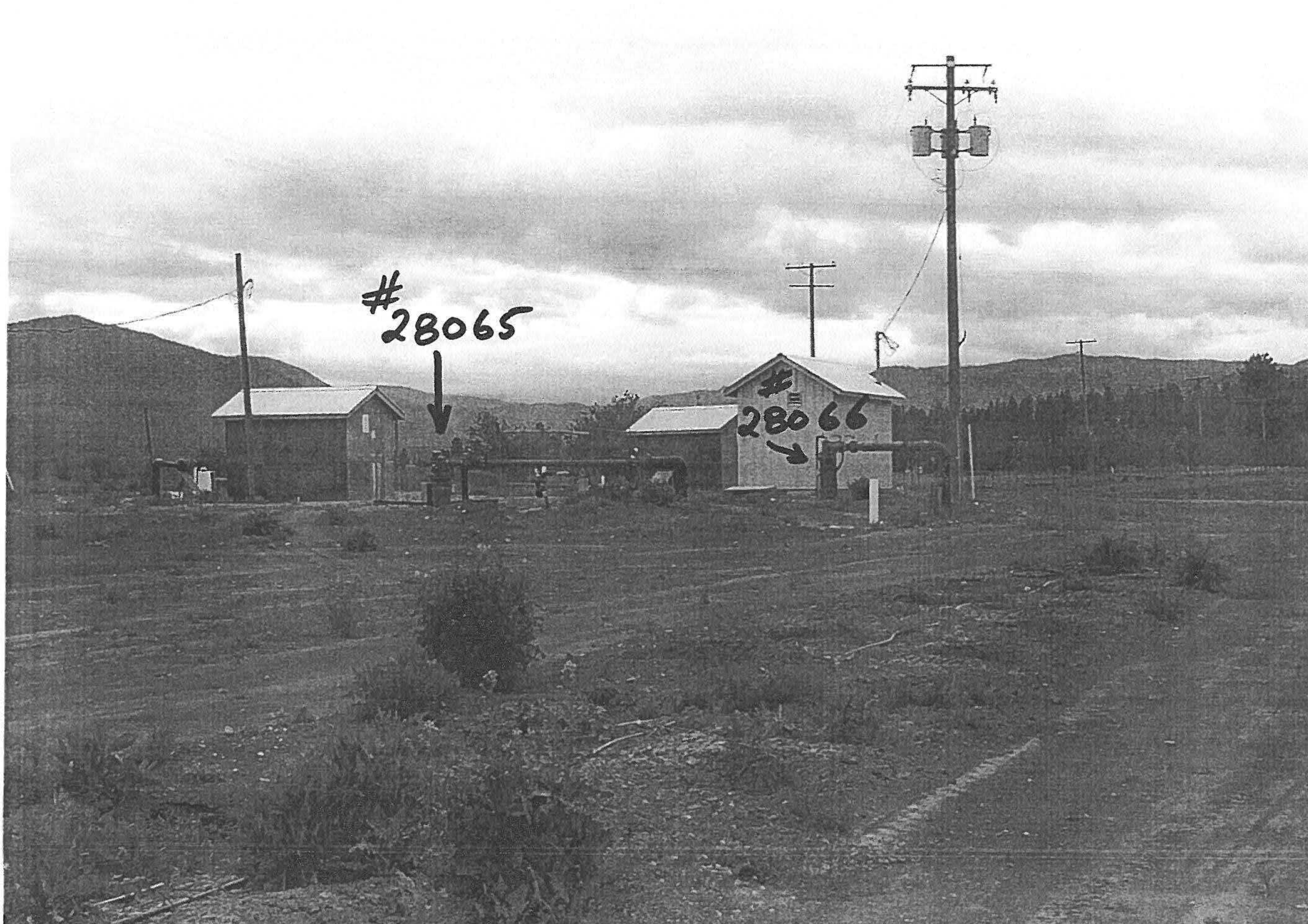
Integrity Drilling Darrell, Conrad, Stewart

GST #830 698 965

* Estimate only. For accuracy a pump test is required.

1645


PROVINCE OF BRITISH COLUMBIA
WELL IDENTIFICATION NUMBER
28065
Possibly 300 gpm with high Water Table.
Approx 200 gpm


#28065
#28066

#13

Integrity Drilling
Darrell Wangler

6634 Hwy. 97A, Enderby, B.C. V0E 1V3

website: www.integritydrilling.ca

Phone 250-833-2111
email: info@integritydrilling.ca

Date June 30, July 1-3, 2010

Owners: Purple Springs/Ken Regehr
Address: 416 Hullcar Rd Armstrong
Location 50* 29.580N / 119* 16.105W between 2 red pump houses
Email: bl@prnursery.com

Telephone 250-546-8156
Fax 250-546-9155
PC V0E 1B4

Formation & Remarks

20-30 silt to gravel
35 clear gravel
40 coarse sand (40-50 thou?) some gravel
45 silt/fine sand/coarse sand
50 gravel-some clay, mirky
55 gravel and cobbles
60 clean gravel
65 fine brown sand - 8-10 thou

Tag #

Elevation 1678 ft.

GPS 50*29.580N/119*16.105W

Total Depth 62 ft. from gr/62.5 from top casing

*Air Lift (approx) 135+

Recommended Run must be pump tested

GPM Series Pump

Static Level 9.69 m

Recomm. Pump Setting @ 54.5 from top of casing

Casing size 8 5/8 Type .188 steel Set frm 2.5 to 54

screen size 100, 80 thou Type stainless Set frm54-60, 60-62 to

Invoice

Additional Remarks and/or costs

70 fine brown sand and clay(5 gpm while drilling
75 fine brown sand and clay 8-10 thou, small bit of clay(5 gpm)
80 fine grey sand and gravel(1/2 and 1/2)
85 loon and sand

50° 29.580 N
119° 16.105 W

8" Well Between Red Pumphouses.

20 silt to gravel

25 " " "

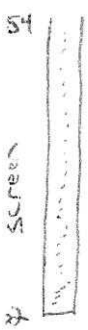
30 ~~clean gravel~~ " " "

35 clean gravel

40 coarse sand (40-50 thou?) some gravel

45 silt / fine sand / coarse sand

50 gravel - some clay (milky)



55 gravel & cobbles

60 clean gravel

65 fine brown sand (8-10 thou?) & some gravel

70 fine brown sand & clay (5 GPM Approx)

75 fine brown sand (8-10 thou)
tiny bit clay
producing 5 GPM

80 fine grey sand & gravel
½ & ½

85 loam & sand

90 loam & sand

95 " "

100 loam

Screen set fm
54 - 62 ft


West
Red
Pumphouse
East
Red
P.H.


LIQUID - TIGHT CONDUIT
Approx
400 gpm
No
Tag

#15

Integrity Drilling
Darrell Wangler

6634 Hwy. 97A, Enderby, B.C. V0E 1V3

website:
www.integritydrilling.ca

Phone 250-833-2111
email: info@integritydrilling.ca

Date: July 27,28 29 2011
Owners: Purple Springs Ken Regehr
Address: 4516 Hullcar Rd Armstrong
Location:
Email:

Telephone: 250-546-8156
Fax: 250-546-9155
PC: VOE-1B4

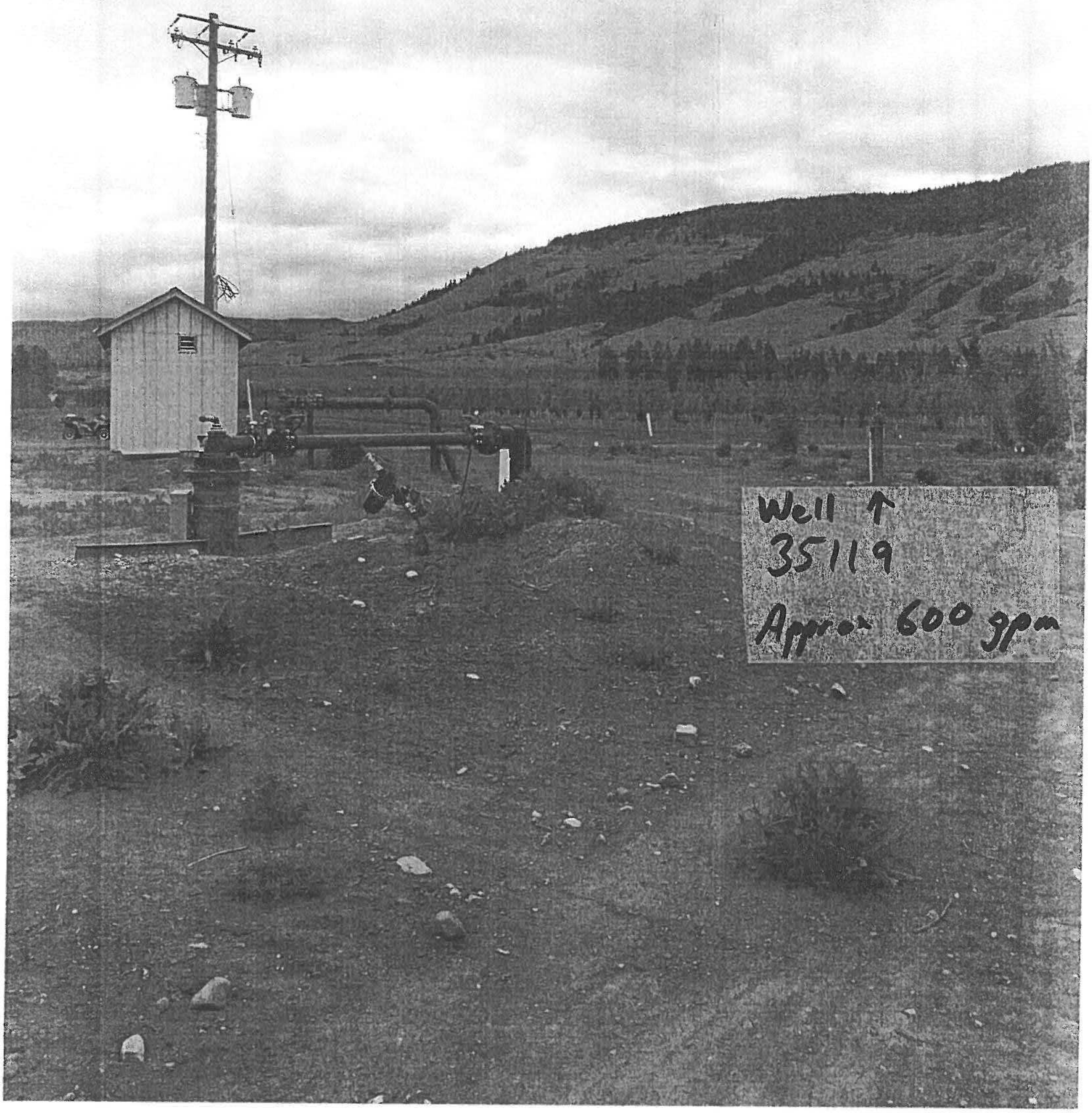
Formation & Remarks

0-15ft dirt & clay
15-20ft pea gravel& coarse sand
20-30ft fine sand
30-40ft fine sand & pea gravel
40-50ft clean coarse gravel
50-55ft coarse sand & pea gravel
55-62ft coarse sand & mirkey water
62-68ft coarse sand & pea gravel
68-78ft 15 thou sand
78-79ft 20+ thou sand 79-80ft clay

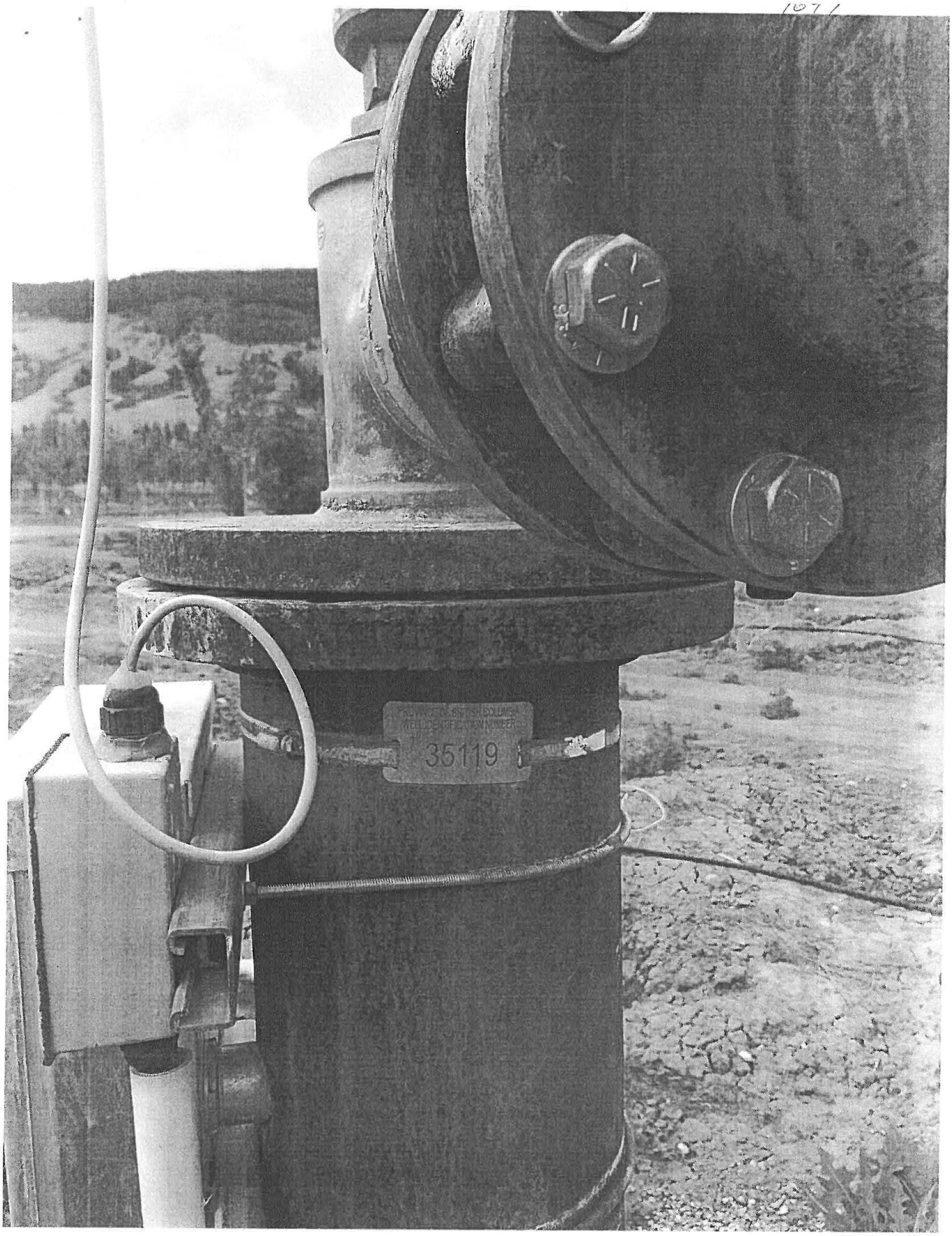
Tag # 35119 Elevation 1680ft
GPS 50* 29.591N 119* 16.078W
Total Depth 68ft
*Air Lift (approx) 100+
Recommended Run 100+
GPM Series Pump
Static Level 22ft
Recomm. Pump Setting @ 50 ft
Casing size 8 5/8 Type 0.25
Set frm 4ft 11in to 55ft
screen size 80,60,15 thou Type stainless
Set frm 55ft to 68ft

Additional Remarks and/or costs

53-55 packer & riser
55-64ft 80 thou screen
64-65ft 60 thou screen
65-68ft 15 thou screen


Well ↑
35119
Approx 600 gpm

1071


PROVINCE OF BRITISH COLUMBIA
WELL IDENTIFICATION NUMBER
35119

1632.

INTEGRITY DRILLING INC. #16

6634 Hwy. 97A, Enderby, B.C. V0E 1V3 • Ph. 250-833-2111 • Fax 250-838-0154

Date May 3,4,5,6,7,10 2010 Telephone 250 546 8156 /cell 260 0157

Owner's Name Ken Regehr / Purple Springs Fax 250 546 9155

Address 4516 Hulker Rd Armstrong

Location 50° 29.586N 119° 16.091W Elev 1690ft Armstrong Postal Code

Formation & Remarks:

0-15 brown clay

15-78 sand & gravel

78-94 sand

Deepening

WELL COMPLETION INFO TAG # 28066

Total Depth 95 ft. *Air Lift (approx.) G.P.M.

Recommended Run G.P.M. Series Pump

Static Level 21 Approx ft. Recommended Pump Setting @ ft.

Casing Size 12 3/4 Type .250 steel Set From Total csg & bottom flange to 70' 1" ft.

* Screen Size 100, 50 Type stainless steel Set From 69 to 95 ft.

COSTS:

Equipment Travel & Rigging	hrs.	per hr.	
Drilling overburden	ft.	per ft.	
Drilling bedrock	ft.	per ft.	
Develop well	hrs.	per hr.	
Pressure frac	hrs.	per hr.	
Materials installed in well			
Steel casing	ft.	per ft.	
PVC casing	ft.	per ft.	
Screens	X.	ea.	
K packer with Riser	X.	ea.	
Screen bottom	X	ea.	
Drive Shoe	X.	ea.	
Well cap	X.	ea.	
Grout	X.	ea.	
	X.	ea.	
	X.	ea.	
	X.	ea.	

Additional remarks and/or costs:

Deepen existing well

packer at 67½-69

100 thou screen 69-79

INTEGRITY DRILLING INC.

6634 Hwy. 97A, Enderby, B.C. V0E 1V3 • Ph. 250-833-2111 • Fax 250-838-0154

Date Dec 17/09
Telephone 250 546 8156 / cell 260 0757
Owner's Name Purple Springs / Ken Regehr
Fax 250 546 9155
Address 4516 Hallcor Rd Armstrong
Location 50° 29.586N 119° 16.061W
Postal Code

Formation & Remarks: Elev 1690

0-15 brown clay
15-78 sand & gravel 65 thou - pea gravel
78-94 SAND 65 thou

West Well #2 2009

COPY

1st Drilling.

WELL COMPLETION INFO TAG# 28066

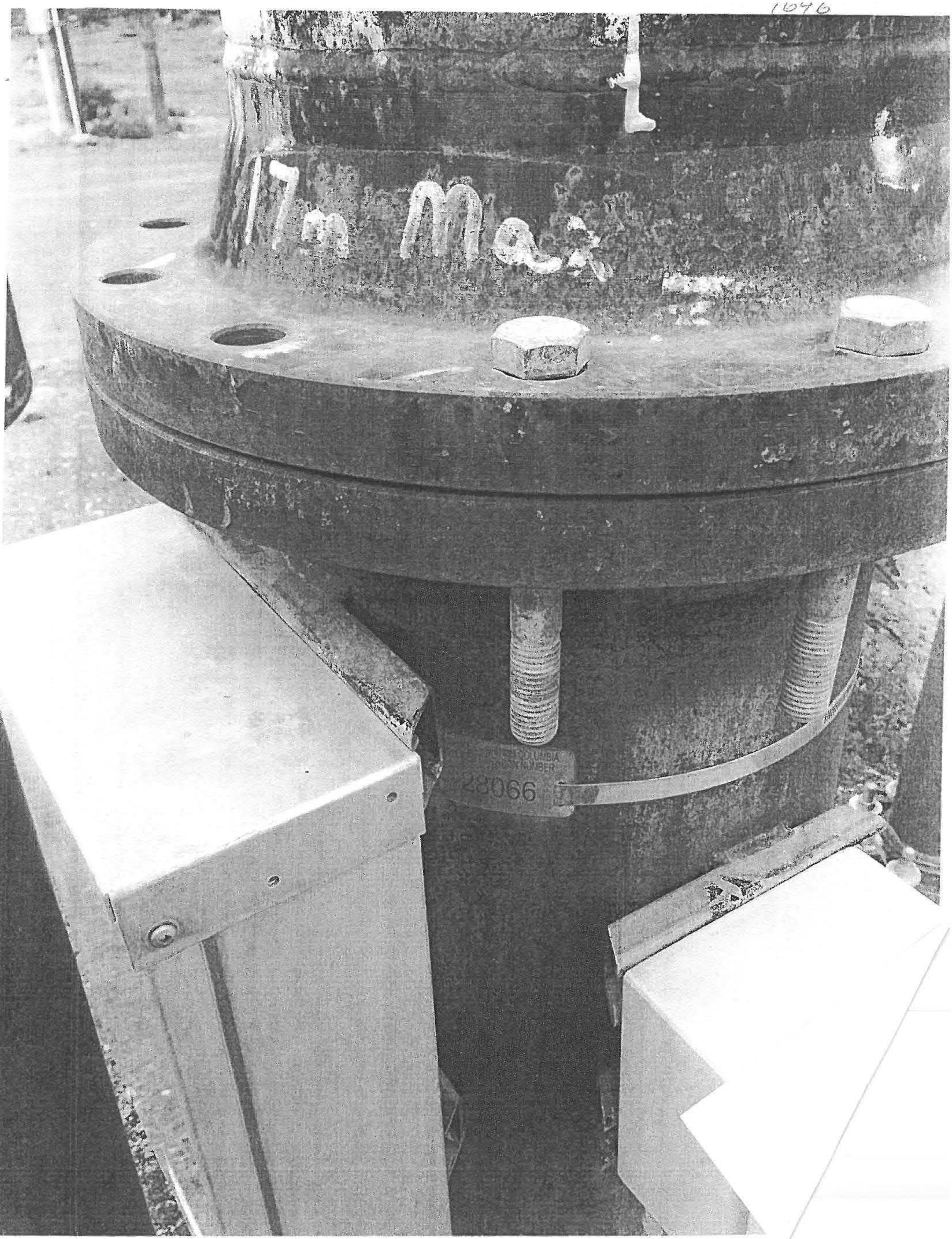
Total Depth 77½ ft.
*Air Lift (approx.) 200 G.P.M.
Recommended Run ? G.P.M. Series Pump
Static Level 21½ ft.
Recommended Pump Setting @ 65 ft. 72ft casing
Casing Size 12¾ Type .250 steel Set From 4½ from weld to 67½ ft.
Screen Size 100 thou Type stainless steel Set From 67½ to 77½ ft. 82 from weld

Additional remarks and/or costs:

* well is over 15000 due to 475 packer &
Appx 400 extra grout.
16,235 - 475 - 400 = 15,360
Set screen at 78-88 would not clean - Approx 12 hrs

1636

1046



1031

Project 17

THOMAS WELL DRILLING
& PUMP SALES LTD.

PUMPS AND WATER SYSTEMS

BOX 404, LUMBY, B.C.
V0E 2G0

TELEPHONE 547-2370

— INVOICE —

SOLD TO:
Ken Regehr
Armstrong, B.C.

DATE May 28 1980

TERMS: NET 10 DAYS — 2% PER MONTH INTEREST CHARGED ON ALL OVERDUE ACCOUNTS.

QUAN. ORDERED	DESCRIPTION	QUAN. SHIPPED	UNIT PRICE	AMOUNT
	TO BALANCE ACCOUNT RENDERED			
	Drill & case 12" hole			
	Drive Shoe			
	Screen - 15 feet			
	K packer			
	bail bottom			
	Welding ring			
	Set screen, develop well, set &			
	pull test pump			
	Pump test - including mobilization			
	of test pump			

AUTHORIZED DEALER FOR VALLEY PUMPS ★ WATER SYSTEMS

PUMPS AND
WATER SYSTEMS

THOMAS WELL DRILLING
& PUMP SALES LTD.

BOX 404, LUMBY, B.C.
V0E 2G0

TELEPHONE 547-2370

— INVOICE —

DATE April 30 1981

SOLD TO:
Mr. Ken Regehr,
Armstrong, B. C.

TERMS: NET 10 DAYS — 2% PER MONTH INTEREST CHARGED ON ALL OVERDUE ACCOUNTS.

QUAN. ORDERED	DESCRIPTION	QUAN. SHIPPED	UNIT PRICE	AMOUNT
	TO BALANCE ACCOUNT RENDERED			
	Drill & case 12" hole			
	Drive Shoe			
	20' of screen, including air freight			
	K. Packer			
	B. Bottom			
	Set screen, develop well, set & pull			
	test pump, pump test well.			

AUTHORIZED DEALER FOR VALLEY PUMPS * WATER SYSTEMS

Province of British Columbia   Ministry of Environment   Water Investigations Branch

WATER WELL RECORD

Date __ YR __ MO __ DY __

Legal Description & Address ______________________

Descriptive Location ______________________

Owners Name & Address Ken Regehr.

N T S MAP ______ ELEV ______ WELL No. ______

U T M Z ______ E ______ N ______ U T M Date 19 ___

1. TYPE OF WORK: 1 ☐ New Well 2 ☐ Reconditioned 3 ☐ Deepened 4 ☐ Abandoned

2. WORK METHOD: 1 ☐ Cable tool 2 ☐ Bored 3 ☐ Jetted 4 ☐ Rotary a ☐ mud b ☐ air c ☐ reverse 5 ☐ Other ______

3. WATER WELL USE: 1 ☐ Domestic 2 ☐ Municipal 3 ☐ Irrigation 4 ☐ Commercial & Industrial 5 ☐ Other ______

4. DRILLING ADDITIVES ______

5. MEASUREMENTS from 1 ☐ ground level 2 ☐ top of casing

FROM ft	TO ft	6. WELL LOG DESCRIPTION	SWL ft
0	39	dry Sand Gravel	
39	75	water Bearing Sand	

7. CONSULTANT ______

Address ______

8. WELL LOCATION SKETCH

9. CASING: Materials 1 ☐ Steel 2 ☐ Galvanized 3 ☐ Wood 4 ☐ Plastic 5 ☐ Concrete 6 ☐ Other ______

Hole Diameter							units
Diameter	12						ins
from							ft
to							ft
Thickness							ins
Weight							lb/ft

Pitless unit ______ ft 1 ☐ above 2 ☐ below ground level

1 ☐ Welded 2 ☐ Cemented 3 ☐ Threaded 4 ☐ New 5 ☐ Used

Perforations: ______

Shoe (s): ______

Open hole, from ______ to ______ ft Diameter ______ ins

Grout: ______

10. SCREEN: 1 ☐ Nominal 2 ☐ Pipe Size

Type 1 ☐ Continuous Slot 2 ☐ Perforated 3 ☐ Louvre 4 ☐ Other ______

Material 1 ☐ Stainless Steel 2 ☐ Plastic 3 ☐ Other ______

Set from ______ to ______ ft below ground level

SCREEN & BLANKS							units
Length							ft
Diam. I D	12	12	12	[illegible]			ins
Slot Size	80	40	40	40			ins
from							ft
to	54			76			ft

Fittings, top K bottom B.

Gravel Pack ______

11. DEVELOPED BY: 1 ☑ Surging 2 ☐ Jetting 3 ☐ Air 4 ☐ Bailing 5 ☑ Pumping 6 ☐ Other ______

12. TEST 1 ☐ Pump 2 ☐ Bail Date __ YR __ MO __

Rate 420 USgpm Temp ______ °C SWL before test 28 ft

65 ft after test of ______ hrs ______ mins

TIME in mins & DRAWDOWN in ft				TIME in mins & RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

13.

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
	70 ft	420 USgpm

14. WATER TYPE: 1 ☐ fresh 2 ☐ salty 3 ☐ clear 4 ☐ cloudy

colour ______ smell ______ ; gas 1 ☐ yes 2 ☐ no

15. WATER ANALYSIS: 1 ☐ Hardness ______ mg/ℓ 2 ☐ Iron ______ mg/ℓ 3 ☐ Chloride ______ mg/ℓ 4 ☐ pH ______

Field Date ______

Lab Date ______

SITE I D No

YR MO DY

16. FINAL WELL COMPLETION DATA

Well Depth 76 ft Water Flowing 430 US gpm

Static Water Level 27 ft Pressure Head ft

Back filled

Well Head Completion Capped

17. DRILLER PLEASE PRINT SURNAME Thomas FIRST NAME John

Signature

18. CONTRACTOR, Address

Thomas Welldrilling

Member, BCWWDA ☐yes ☐no ;

Project 19

BRITISH COLUMBIA

BC Environment

Water Management Division

WATER WELL RECORD

Date 0 0 / 1 0 / 2 6 (YR MO DY)

ITS MAP ____ WELL No. ____ ELEV ____ Location Accuracy ____

UTM Z ____ E ____ N ____ UTM Date 19 ____ Well Type ____

Owners Name & Address: Ken Regehr

Legal Description & Address: Hullcar Rd. Armstrong

Descriptive Location: South fenceline - 15' W. of old 4" well

TYPE OF WORK: 1 ☑ New Well 2 ☐ Reconditioned 3 ☐ Deepened 4 ☐ Abandoned

WORK METHOD: 1 ☐ Cable tool 2 ☐ Bored 3 ☐ Jetted 4 ☑ Rotary a ☐ mud b ☑ dir c ☐ reverse ☐ Other ____

WATER WELL USE: 1 ☑ Domestic 2 ☐ Municipal 3 ☐ Irrigation 4 ☐ Comm. & Ind. ☐ Other Farm

DRILLING ADDITIVES: None

MEASUREMENTS from 1 ☑ ground level 2 ☐ top of casing; casing height above ground level 2 ft.

FROM ft	TO ft	6. WELL LOG DESCRIPTION	SWL ft
0	40	Red sand	
40	155	Blue clay & sand	
155	180	Sand + gravel with silt	
180	250	Silt & clay with some rocks	
250	500	Shale bedrock	

West 1' of Domestic Booster House - South end of East Hill field.

CONSULTANT: None

Address ____

WELL LOCATION SKETCH

9. CASING: Materials 1 ☑ Steel 2 ☐ Galvanized 3 ☐ Wood 4 ☐ Plastic 5 ☐ Concrete ☐ Other ____

		units
Hole Diameter	6"	ins
Diameter	6 5/8	ins
from	+2	ft
to	250	ft
Thickness	.188	ins
Weight	12.92	lb/ft

Pitless unit ____ ft 1 ☐ above 2 ☐ below ground level

1 ☑ Welded 2 ☐ Cemented 3 ☐ Threaded | 1 ☑ New 2 ☐ Used

Perforations: NO

Shoe (s): Steel

Open hole, from 250 to 500 ft Diameter 6" ins

Grout: No

10. SCREEN: 1 ☐ Nominal (Telescope) 2 ☐ Pipe Size

Type 1 ☐ Continuous Slot 2 ☐ Perforated 3 ☐ Louvre ☐ Other ____

Material 1 ☐ Stainless Steel 2 ☐ Plastic ☐ Other ____

Set from ____ to ____ ft below ground level

RISER, SCREEN & BLANKS		units
Length		ft
Diam. I D		ins
Slot Size		ins
from		ft
to		ft

Fittings, top ____ bottom ____

Gravel Pack ____

11. DEVELOPED BY: 1 ☐ Surging 2 ☐ Jetting 3 ☑ Air 4 ☐ Bailing 5 ☐ Pumping ☐ Other ____

12. TEST 1 ☐ Pump 2 ☐ Bail 3 ☑ Air Date 0 0 / 1 0 / 2 6

Rate 1 USgpm Temp ____ °C SWL before test ____ ft

Water Level ____ ft after test of ____ hrs

☐ DRAWDOWN in ft				☐ RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

13. RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
Submersible	480 ft	4 gpm with process USgpm

14. WATER TYPE: 1 ☑ fresh 2 ☐ salty 3 ☑ clear 4 ☐ cloudy

colour no smell no ; gas 1 ☐ yes 2 ☑ no

15. WATER ANALYSIS: 1 Hardness ____ mg/L 2 Iron ____ mg/L 3 Chloride ____ mg/L 4 pH ____

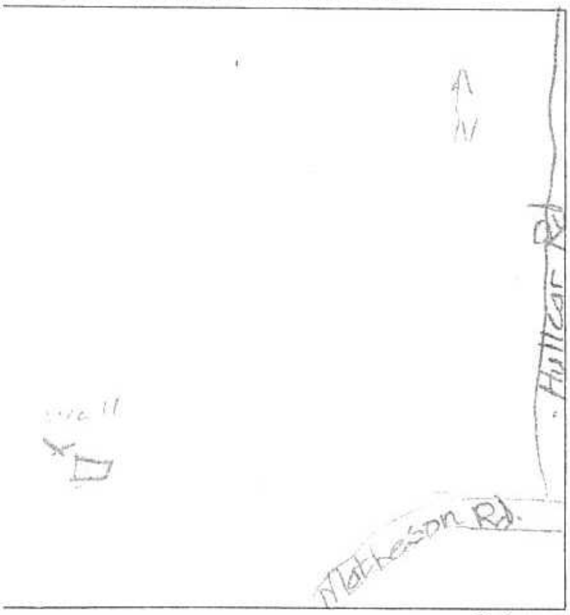
Field Date ____ Lab Date ____

SITE I.D. No. ____

CONSULTANT None

Address

WELL LOCATION SKETCH



14. WATER TYPE: 1 ☑ fresh 2 ☐ salty 3 ☑ clear 4 ☐ cloudy

colour no smell no ; gas 1 ☐ yes 2 ☑ no

15. WATER ANALYSIS: 1 Hardness mg/L

2 Iron mg/L 3 Chloride mg/L

4 pH Field Date

SITE I D No Lab Date YR MO DY

16. FINAL WELL COMPLETION DATA

Well Depth 500 ft Well Yield 1 US gpm

Static Water Level ft Artesian Flow US gpm Pressure Head ft

Back filled Bedrock chips

Well Head Completion Cap

17. DRILLER PLEASE PRINT SURNAME McGLADDERY FIRST NAME Dan

Signature

18. CONTRACTOR, DAN-GARE DRILLING LTD.

Address Box 1568

VERNON, B.C. V1T 8C2

Phone 250-549-3130

Member, BCWWDA ☑ yes ☐ no ;

07/25/02 12:59 ☎ 250 546 3603 Project 21

DOMESTIC ROBERT + JULIE WHITE longroadfarm@hotmail.com

Province of British Columbia Ministry of Environment and Parks Water Management Branch

WATER WELL RECORD

Date 92 08 07

Location Accuracy

N T S MAP | WELL No. | ELEV | Date 19 | Well Type

Owners Name & Address. Lawrence Harder

Legal Description & Address LOT A PL 5488 Sec. 26 TWP. 34 K.D.Y.D

Descriptive Location. 130' S of house

1. TYPE OF WORK 1 [✓] New Well 2 [ ] Reconditioned 3 [ ] Deepened 4 [ ] Abandoned

2. WORK METHOD 1 [ ] Cable tool 2 [ ] Bored 3 [ ] Jetted 4 [✓] Rotary a [ ] mud b [✓] air c [ ] reverse [ ] Other

3. WATER WELL USE 1 [✓] Domestic 2 [ ] Municipal 3 [ ] Irrigation 4 [ ] Comm & Ind [ ] Other

4. DRILLING ADDITIVES none

5. MEASUREMENTS from 1 [✓] ground level 2 [ ] top of casing

casing height above ground level 2 ft

FROM ft	TO ft	6. WELL LOG DESCRIPTION	SWL ft
0	6	Sand + Gravel	
6	40	Gravel	
40	56	Silty Sand	

7. CONSULTANT none

Address

9. CASING: Materials 1 [✓] Steel 2 [ ] Galvanized 3 [ ] Wood 4 [ ] Plastic 5 [ ] Concrete [ ] Other

						units
Hole Diameter	6 3/16	6 1/8				ins
Diameter	6 5/8	6 5/8				ins
from	+2	26				ft
to	26	36				ft
Thickness	.188	.250				ins
Weight	12.92	16.62				lb/ft

Pitless unit ft 1 [ ] above 2 [ ] below ground level

1 [✓] Welded 2 [ ] Cemented 3 [ ] Threaded | 1 [✓] New 2 [ ] Used

Perforations none

Shoe(s) steel

Open hole, from ____ to ____ ft Diameter ____ ins

Grout none

10. SCREEN: 1 [✓] Nominal (Telescope) 2 [ ] Pipe Size

Type 1 [✓] Continuous Slot 2 [ ] Perforated 3 [ ] Louvre [ ] Other

Material 1 [✓] Stainless Steel 2 [ ] Plastic [ ] Other

Set from 34 to 40 ft below ground level

RISER, SCREEN & BLANKS						units
Length	2	4				ft
Diam. I.D.	5	5				ins
Slot Size	0	25				
from	34	36				ft
to	36	40				ft

Fittings, top K packer bottom plug

Gravel Pack natural

11. DEVELOPED BY: 1 [✓] surging 2 [ ] Jetting 3 [✓] Air 4 [ ] Bailing 5 [ ] Pumping [ ] Other

12. TEST 1 [ ] Pump 2 [ ] Bail 3 [✓] Air Date 92 08 07

Rate 50 USgpm Temp. °C SWL before test.

Water Level ft after test of. hrs

DRAWDOWN in ft				RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

13. RECOMMENDED PUMP TYPE Submersible | RECOMMENDED PUMP SETTING 30 ft | RECOMMENDED PUMPING RATE 8 – 15 US

14. WATER TYPE: 1 [✓] fresh 2 [ ] salty 3 [✓] clear

colour. smell. gas 1 [ ] yes

15. WATER ANALYSIS: 1 Hardness | mg

2 Iron | mg/L 3 Chloride | mg

4 pH Field Date

Lab Date

OF WORK 3 [] Deepened 4 [] Abandoned

2. WORK METHOD 1 [] Cable tool 2 [] Bored 3 [] Jetted
4 [✓] Rotary a [] mud b [✓] air c [] reverse
[] Other

3. WATER WELL USE 1 [✓] Domestic 2 [] Municipal 3 [] Irrigation
4 [] Comm & Ind [] Other

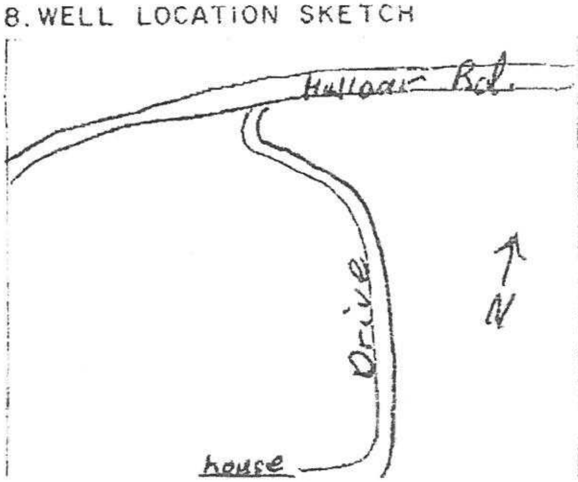
4. DRILLING ADDITIVES none

5. MEASUREMENTS from 1 [✓] ground level 2 [] top of casing
casing height above ground level 2 ft

FROM ft	TO ft	6. WELL LOG DESCRIPTION	SWL ft
0	6	Sand + Gravel	
6	40	Gravel	
40	56	Silty Sand	

7. CONSULTANT none
Address

8. WELL LOCATION SKETCH



Materials 4 [] Other

					units
Hole Diameter	6 3/16	6 1/8			ins
Diameter	6 5/8	6 5/8			ins
from	+2	26			ft
to	26	36			ft
Thickness	.188	.250			ins
Weight	12.92	16.62			lb/ft

Pitless unit ft 1 [] above 2 [] below ground level
1 [✓] Welded 2 [] Cemented 3 [] Threaded | 1 [✓] New 2 [] Used
Perforations none

Shoe(s) steel
Open hole, from to ft Diameter in
Grout none

10. SCREEN 1 [✓] Nominal (Telescope) 2 [] Pipe Size
Type 1 [✓] Continuous Slot 2 [] Perforated 3 [] Louvre
[] Other
Material 1 [✓] Stainless Steel 2 [] Plastic
Set from 34 to 40 ft below ground level

RISER SCREEN & BLANKS					units
Length	2	4			ft
Diam. I.D.	5	5			ins
Slot Size	0	25			ins
from	34	36			ft
to	36	40			ft

Fittings, top Kpacker bottom plug
Gravel Pack natural

11. DEVELOPED BY: 1 [✓] Surging 2 [] Jetting 3 [✓] Air
4 [] Bailing 5 [] Pumping [] Other

12. TEST 1 [] Pump 2 [] Bail 3 [✓] Air Date 920810
Rate 50 USgpm Temp. °C SWL before test
Water Level ft after test of hrs

[] DRAWDOWN in ft				RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

13. RECOMMENDED PUMP TYPE Submersible | RECOMMENDED PUMP SETTING 30 ft | RECOMMENDED PUMPING RATE 8 – 15 USgpm

14. WATER TYPE: 1 [✓] fresh 2 [] salty 3 [✓] clear
colour smell ; gas 1 [] yes 2 [✓] no

15. WATER ANALYSIS: 1 Hardness mg/L
2 Iron mg/L 3 Chloride mg/L
4 pH Field Date
Lab Date

SITE ID No

16. FINAL WELL COMPLETION DATA
Well Depth 40 ft Well Yield 50 US gpm
Static Water Level 20 ft Artesian Flow US gpm Pressure Head
Back filled Sand +
Well Head Completion welded cap

17. DRILLER SURNAME McGLADDERY FIRST NAME Dan
Signature Dan McGladdery

18. CONTRACTOR DAN-GARE DRILLING LTD.
Address

Appendix C – Tabulated Groundwater and Surface Water Quality Data (2016)

Table C-1
Regehr Farms Groundwater Quality Data - 2016

Analyte	Unit	Guideline							Project 1	Project 2	Project 6	Project 13	Project 17	Project 20	Project 21 (White Domestic)	Project 22
								Sampling Location	Project 1	Project 2	Project 6	Project 13	Project 17	Project 20	Project 21 (White Domestic)	Project 22
								Date Sampled	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16
								Lab Sample ID	6091999-03	6091999-04	6091999-01	6091999-05	6091999-06	6091999-07	6091999-02	6091999-08
								Client Sample Comment								
								Sample Type								
		BCAWQG I	BCWWQG I	*BCAWQG L*	*BCWWQG L*	BCAWQG DW	GCDWQ MAC	GCDWQ AO								
Field Results																
Conductivity	µS/cm	NG	700 [2.1]	NG	NG	NG	NG	NG	860	760	660	910	790	930	860	800
Oxidation reduction potential	mV	NG	NG	NG	NG	NG	NG	NG	70	42	77	11	53	90	48	28
pH		5.0 - 9.0 [1.1]	NG	5.0 - 9.5 [3.1]	NG	6.5 - 8.5 [5.1]	NG	7.0 - 10.5 [7.1]	7.55	7.26	7.29	8.20	9.86	7.36	7.35	7.63
Temperature	°C	N [1.2]	NG	N [3.2]	NG	15 [5.2]	NG	15	10.4	10.2	10.1	10.4	10.8	14.7	10.4	13.7
Turbidity	NTU	N [1.3]	NG	N [3.3]	NG	N [5.3]	N [6.1]	NG	0.42	0.64	0	0.09	1.37	0.82	0	0.64
Lab Results																
General																
Chloride	mg/L	100	NG	600 [3.4]	NG	250 [5.4]	NG	250	19.0	14.5	9.81	19.6	20.2	13.3	18.4	6.68
Hardness, total (dissolved as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	504	453	384	508	431	543	497	425
Metals																
Aluminum (dissolved)	mg/L	5 [1.4]	NG	5 [3.5]	NG	0.2 [5.5]	NG	N [7.2]	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Antimony (dissolved)	mg/L	NG	NG	NG	NG	NG	0.006	NG	<0.0001	0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.0001	<0.0001
Arsenic (dissolved)	mg/L	0.100 [1.5]	NG	0.025 [3.6]	NG	0.025 [5.6]	0.010 [6.2]	NG	0.0014	<0.0005	<0.0005	<0.0005	0.0007	0.0008	0.0013	0.0011
Barium (dissolved)	mg/L	NG	NG	NG	NG	NG	1.0	NG	0.055	0.078	0.062	0.057	0.067	0.112	0.084	0.069
Beryllium (dissolved)	mg/L	NG	0.100	NG	0.100	NG	NG	NG	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron (dissolved)	mg/L	0.5 [1.6]	NG	5 [3.7]	NG	5 [5.7]	5	NG	0.009	0.009	0.011	0.012	0.007	0.010	0.008	0.007
Cadmium (dissolved)	mg/L	NG	0.0051 [2.2]	NG	0.080 [4.1]	NG	0.005	NG	<0.00001	<0.00001	<0.00001	0.00007	<0.00001	<0.00001	<0.00001	<0.00001
Calcium (dissolved)	mg/L	NG	NG	NG	1000	NG	NG	NG	164	155	129	168	132	164	171	134
Chromium (dissolved)	mg/L	NG	0.0049 [2.3]	NG	0.050 [4.2]	NG	0.05	NG	<0.0005	0.0007	<0.0005	<0.0005	0.0006	<0.0005	0.0006	<0.0005
Cobalt (dissolved)	mg/L	NG	0.050 [2.4]	NG	1	NG	NG	NG	0.00007	<0.00005	0.00005	0.00043	0.00016	0.00009	<0.00005	0.00006
Copper (dissolved)	mg/L	0.200 [1.7]	NG	0.300 [3.8]	NG	0.500 [5.8]	NG	1.0	<0.0002	<0.0002	<0.0002	0.0013	<0.0002	0.0074	<0.0002	0.0002
Iron (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	0.3	0.963	1.34	1.53	0.013	1.00	2.34	1.22	0.089
Lead (dissolved)	mg/L	0.200 [1.8]	NG	0.100 [3.9]	NG	0.050 [5.9]	0.010	NG	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Lithium (dissolved)	mg/L	NG	0.75 [2.5]	NG	NG	NG	NG	NG	0.0054	0.0042	0.0046	0.0054	0.0064	0.0073	0.0050	0.0100
Magnesium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	22.6	16.3	14.7	21.3	24.4	32.5	17.2	22.0
Manganese (dissolved)	mg/L	NG	0.200	NG	NG	NG	NG	0.05	0.280	0.120	0.117	0.146	0.224	0.262	0.234	0.438
Molybdenum (dissolved)	mg/L	0.05 [1.9]	NG	0.05 [3.10]	NG	0.25 [5.10]	NG	NG	0.0036	0.0031	0.0036	0.0029	0.0028	0.0024	0.0021	0.0047
Nickel (dissolved)	mg/L	NG	0.200	NG	1	NG	NG	NG	0.0004	0.0005	<0.0002	0.0048	0.0009	0.0004	0.0003	0.0002
Selenium (dissolved)	mg/L	0.010 [1.10]	NG	0.0300 [3.11]	NG	0.010 [5.11]	0.05	NG	<0.0005	<0.0005	<0.0005	0.0027	0.0008	<0.0005	<0.0005	<0.0005
Silicon (dissolved, as Si)	mg/L	NG	NG	NG	NG	NG	NG	NG	12.2	11.6	12.5	8.5	10.4	13.6	12.2	10.5
Silver (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	200	16.2	10.1	9.19	22.5	18.4	16.5	9.24	26.1
Strontium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	1.71	1.07	0.891	1.09	0.982	1.77	1.27	2.80
Sulphur (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	69	46	28	66	50	79	59	74
Tellurium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thorium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tin (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Titanium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Uranium (dissolved)	mg/L	NG	0.010	NG	0.200	NG	0.02	NG	0.0186	0.0179	0.00033	0.0143	0.00851	0.00066	0.0116	0.00325
Vanadium (dissolved)	mg/L	NG	0.100	NG	0.100	NG	NG	NG	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (dissolved)	mg/L	1.000 [1.11]	NG	2.000 [3.12]	NG	5.0 [5.12]	NG	5.0	0.005	0.007	<0.004	0.004	<0.004	0.028	0.009	0.011

Table C-1
Regehr Farms Groundwater Quality Data - 2016

								Sampling Location	Project 1	Project 2	Project 6	Project 13	Project 17	Project 20	Project 21 (White Domestic)	Project 22
								Date Sampled	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16	27-Sep-16
								Lab Sample ID	6091999-03	6091999-04	6091999-01	6091999-05	6091999-06	6091999-07	6091999-02	6091999-08
								Client Sample Comment								
								Sample Type								
Analyte	**Unit**	**Guideline**														
		BCAWQG I	BCWWQG I	*BCAWQG L*	*BCWWQG L*	BCAWQG DW	GCDWQ MAC	GCDWQ AO								
Zirconium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nutrients																
Ammonia (total, as N)	mg/L	NG	NG	NG	NG	NG	NG	NG	0.237	0.053	0.057	<0.020	0.105	0.067	0.049	0.117
Nitrate (as N)	mg/L	NG	NG	100 [3.13]	NG	10 [5.13]	10	NG	<0.010	<0.010	<0.010	2.51	0.230	<0.010	<0.010	0.014
Nitrate + Nitrite (as N)	mg/L	NG	NG	100 [3.14]	NG	10 [5.14]	10 [6.3]	NG	<0.010	<0.010	<0.010	2.60	0.253	<0.010	<0.010	0.014
Nitrate + Nitrite (as N) (calculated)	mg/L	NG	NG	100 [3.15]	NG	10 [5.15]	10 [6.4]	NG	<0.014	<0.014	<0.014	2.60	0.253	<0.014	<0.014	<0.014
Nitrite (as N)	mg/L	NG	NG	10 [3.16]	NG	1 [5.16]	1	NG	<0.010	<0.010	<0.010	0.087	0.023	<0.010	<0.010	<0.010
Organic nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	0.136	0.136	0.171	0.175	0.121	0.166	0.127	0.107
Total nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	0.373	0.189	0.228	2.77	0.479	0.233	0.176	0.238
Total kjeldahl nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	0.37	0.19	0.23	0.18	0.23	0.23	0.18	0.22
Phosphorus (dissolved, by ICPMS/ICPOES)	mg/L	NG	NG	NG	NG	N [5.17]	NG	NG	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus (total, APHA 4500-P)	mg/L	NG	NG	NG	NG	N [5.18]	NG	NG	0.019	0.010	0.009	0.008	0.016	0.012	0.010	0.020
Phosphorus (dissolved, APHA 4500-P)	mg/L	NG	NG	NG	NG	N [5.19]	NG	NG	0.018	0.010	<0.002	0.004	0.011	0.012	0.007	0.012
Phosphorus, dissolved reactive	mg/L	NG	NG	NG	NG	NG	NG	NG	0.013	0.010	<0.005	0.005	0.009	0.012	0.005	0.012
Potassium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	8.00	7.00	6.30	9.70	9.12	7.23	6.75	8.43

Legend

<	Less than reported detection limit
N	Narrative type of guideline or standard, or Result Note.
NG	No Guideline
BCAWQG I	Highlighted value exceeds the BC Approved Water Quality Guidelines for Irrigation (BCAWQG I)
BCWWQG I	Highlighted value exceeds the BC Working Water Quality Guidelines for Irrigation (BCWWQG I)
BCAWQG L	Highlighted value exceeds the BC Approved Water Quality Guidelines for Livestock (BCAWQG L)
BCWWQG L	Highlighted value exceeds the BC Working Water Quality Guidelines for Livestock (BCWWQG L)
BCAWQG DW	Highlighted value exceeds the BC Approved Water Quality Guidelines for Drinking Water (BCAWQG DW)
GCDWQ AO	Highlighted value exceeds the Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)
GCDWQ MAC	Highlighted value exceeds the Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)

WIRELESS WATER

Table C-1
Regehr Farms Groundwater Quality – 2016
Guideline Notes

1. Notes for BC Approved Water Quality Guidelines for irrigation (BCAWQG I)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used.

Note 1.1 for pH:

The recommended criterion for irrigation waters is a pH ranging between 5.0 and 9.0. This guideline recognizes that soil acidity, alkalinity and salinity are a concern in agriculture.

Note 1.2 for Temperature:

The recommended guideline for temperature is + or - 1 degree Celsius change from natural ambient background.

Note 1.3 for Turbidity:

Induced turbidity should not exceed 10 NTU when background turbidity is less than or equal to 50 NTU, nor should induced turbidity be more than 20 % of background when background is greater than 50 NTU.

Note 1.4 for Aluminum (dissolved):

The guideline maximum for total aluminum is 5 mg/L. A separate guideline for dissolved aluminum is not provided.

Note 1.5 for Arsenic (dissolved):

The interim guideline for total arsenic is 100 µg/L.

Note 1.6 for Boron (dissolved):

The guideline for total boron depends on the crop, and varies from 0.5 mg/L to 6 mg/L. The most stringent guideline maximum of 0.5 mg/L, for very sensitive and sensitive crops, was used to identify exceedances for this report.

Note 1.7 for Copper (dissolved):

The guideline maximum for total copper is 200 µg/L.

Note 1.8 for Lead (dissolved):

For neutral and alkaline fine-textured soils the total lead concentration in irrigation water should not exceed 400 µg/L at any time. The concentration of total lead in irrigation water for use on all other soils should not exceed 200 µg/L at any time. / The most stringent guideline maximum was used in this report.

Note 1.9 for Molybdenum (dissolved):

The guideline maximum for total molybdenum for irrigation of forage crops is 0.05 mg/L. There is no guideline maximum for total molybdenum for irrigation of non-forage crops.

Note 1.10 for Selenium (dissolved):

The guideline for total selenium is 10 µg/L mean. The mean concentrations in the water column are based on at least 5 weekly samples taken over a 30-day period.

Note 1.11 for Zinc (dissolved):

The guideline maximum for total zinc for irrigation is as follows:
- Soil pH less than 6: 1000 µg/L.
- Soil pH equal to or greater than 6, and less than 7: 2000 µg/L.
- Soil pH greater than or equal to 7: 5000 µg/L. / The most stringent guideline maximum was used in this report.

2. Notes for Working Water Quality Guidelines for British Columbia for irrigation (BCWWQG I)

General Notes:

Reference: Working Water Quality Guidelines for British Columbia (2015). WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the “Notes” for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.

Note 2.1 for Conductivity:

The guideline varies from 700 to 5000 µS/cm depending on the type of crop. The most stringent guideline has been used for this report.

Note 2.2 for Cadmium (dissolved):

This is a Short-term maximum guideline.

Note 2.3 for Chromium (dissolved):

The guideline for Cr(VI) is 8 µg/L (total).
The guideline for Cr(III) is 4.9 µg/L (total).
The guideline of 4.9 µg/L for Cr(III) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.

Note 2.4 for Cobalt (dissolved):

Continuous or intermittent use on all soils.

Note 2.5 for Lithium (dissolved):

The guideline is 2.5 mg/L for non-citrus crops (May not be protective of barley and other cereal crops; 1.0 mg/L suggested for cereal crops). The guideline is 0.75 mg/L for citrus crops. / The most stringent guideline was used in this report.

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3. Notes for BC Approved Water Quality Guidelines for livestock (BCAWQG L)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used.

Note 3.1 for pH:

pH does not interfere with the palatability of water or the health of livestock.

Note 3.2 for Temperature:

The recommended guideline for temperature is + or - 1 degree Celsius change from natural ambient background.

Note 3.3 for Turbidity:

Induced turbidity should not exceed 5 NTU when background turbidity is less than or equal to 50 NTU, nor should induced turbidity be more than 10 % of background when background is greater than 50 NTU.

Note 3.4 for Chloride:

The water quality guideline for chloride for livestock watering is 600 mg/L.

Note 3.5 for Aluminum (dissolved):

The guideline maximum for total aluminum is 5 mg/L. A separate guideline for dissolved aluminum is not provided.

Note 3.6 for Arsenic (dissolved):

The interim guideline for total arsenic is 25 µg/L.

Note 3.7 for Boron (dissolved):

The guideline maximum for total boron is 5 mg/L.

Note 3.8 for Copper (dissolved):

The guideline maximum for total copper is 300 µg/L.

Note 3.9 for Lead (dissolved):

The guideline maximum for total lead is 100 µg/L.

Note 3.10 for Molybdenum (dissolved):

If livestock are consuming forages not irrigated, or if no molybdenum containing fertilizers are applied to grow feed consumed by livestock, then the guideline maximum for total molybdenum is 0.08 mg/L. For all other cases, the guideline maximum for total molybdenum is 0.05 mg/L. / The most stringent guideline maximum was used in this report.

Note 3.11 for Selenium (dissolved):

The guideline for total selenium is 30.0 µg/L mean. The mean concentrations in the water column are based on at least 5 weekly samples taken over a 30-day period.

Note 3.12 for Zinc (dissolved):

The guideline maximum for total zinc is 2000 µg/L.

Note 3.13 for Nitrate (as N):

Overview Report Update, September 2009.

Note 3.14 for Nitrate + Nitrite (as N):

The guideline maximum for nitrate as nitrogen is 100 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009.

Note 3.15 for Nitrate + Nitrite (as N) (calculated):

The guideline maximum for nitrate as nitrogen is 100 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009.

Note 3.16 for Nitrite (as N):

Overview Report Update, September 2009.

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4. Notes for Working Water Quality Guidelines for British Columbia for livestock (BCWWQG L)

General Notes:

Reference: Working Water Quality Guidelines for British Columbia (2015). WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the “Notes” for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.

Note 4.1 for Cadmium (dissolved):

This is a Short-term maximum guideline.

Note 4.2 for Chromium (dissolved):

The guideline for Cr(VI) is 50 µg/L (total). The guideline for Cr(III) is 50 µg/L (total). The guideline of 50 µg/L for Cr(VI), and for Cr(III) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.

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5. Notes for BC Approved Water Quality Guidelines for drinking water (BCAWQG DW)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used. Drinking water guidelines are, in some cases, for raw water before treatment.

Note 5.1 for pH:

Designed to minimize solubilization of heavy metals and salts from water distribution pipes and the precipitation of carbonate salts in the distribution system, and maximize the effectiveness of chlorination. However, natural source water outside the guidelines may be safe to drink from a public health perspective.

Note 5.2 for Temperature:

The guideline for maximum temperature for drinking water is 15 degrees.

Note 5.3 for Turbidity:

Turbidity guidelines for raw drinking water follow;
• Drinking Water - raw untreated:
For raw waters of exceptional clarity (less than or equal to 5 NTU) which normally do not require treatment to reduce natural turbidity, induced turbidity should not exceed 1 NTU and the total turbidity should not exceed 5 NTU at any time.
• Drinking Water - raw treated:
For raw waters which normally require some form of treatment to reduce natural turbidity to a level that complies with the standard for finished water (5 NTU) in British Columbia, induced turbidity should not exceed 5 NTU when background turbidity is less than or equal to 50 NTU. When background is greater than 50 NTU, the induced turbidity should not be more than 10% of background.

Note 5.4 for Chloride:

The guideline maximum for chloride in drinking water (for aesthetic reasons) is 250 mg/L.

Note 5.5 for Aluminum (dissolved):

The guideline maximum for dissolved aluminum is 0.2 mg/L (based on aesthetic considerations). This criterion would apply to both untreated raw water and raw water treated to remove suspended solids.

Note 5.6 for Arsenic (dissolved):

The interim guideline maximum for total arsenic in drinking water is 25 µg/L.

Note 5.7 for Boron (dissolved):

The guideline maximum for total boron in drinking water is 5 mg/L.

Note 5.8 for Copper (dissolved):

In raw drinking water with or without treatment, total copper should not exceed 500 µg/L.

Note 5.9 for Lead (dissolved):

In raw drinking water, with and without treatment, the total lead concentration should not exceed 50 µg/L at any time.

Note 5.10 for Molybdenum (dissolved):

The guideline maximum for total molybdenum in raw untreated drinking water is 0.25 mg/L.

Note 5.11 for Selenium (dissolved):

The guideline maximum for total selenium in drinking water is 10 µg/L.

Note 5.12 for Zinc (dissolved):

The guideline maximum for total zinc in drinking water is 5.0 mg/L.

Note 5.13 for Nitrate (as N):

Overview Report Update, September 2009

Note 5.14 for Nitrate + Nitrite (as N):

The guideline maximum for nitrate as nitrogen is 10 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009

Note 5.15 for Nitrate + Nitrite (as N) (calculated):

The guideline maximum for nitrate as nitrogen is 10 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009

Note 5.16 for Nitrite (as N):

Overview Report Update, September 2009

Note 5.17 for Phosphorus (dissolved, by ICPMS/ICPOES):

For lakes used as a source of drinking water, the total phosphorous concentration should not exceed 10 µg/L. No guideline is recommended for streams.

Note 5.18 for Phosphorus (total, APHA 4500-P):

For lakes used as a source of drinking water, the total phosphorous concentration should not exceed 10 µg/L. No guideline is recommended for streams.

Note 5.19 for Phosphorus (dissolved, APHA 4500-P):

For lakes used as a source of drinking water, the total phosphorous concentration should not exceed 10 µg/L. No guideline is recommended for streams.

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6. Notes for Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)

Note 6.1 for Turbidity:

Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ.
For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU.
For effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU.

Note 6.2 for Arsenic (dissolved):

Every effort should be made to maintain arsenic levels in drinking water as low as reasonably achievable.

Note 6.3 for Nitrate + Nitrite (as N):

The MAC for Nitrate (as N) is 10 mg/L

Note 6.4 for Nitrate + Nitrite (as N) (calculated):

The MAC for Nitrate (as N) is 10 mg/L

7. Notes for Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)

Note 7.1 for pH:

The operational guideline for pH is a range of 7.0 to 10.5 in finished drinking water.

Note 7.2 for Aluminum (dissolved):

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

Table C-2
Regehr Farms Surface Water Quality Data - 2016

										Sampling Location	SW-2
										Date Sampled	01-Dec-16
										Lab Sample ID	6120164-01
										Client Sample Comment	
										Sample Type	
Analyte	**Unit**	**Guideline**									
		BCAWQG AL	BCWWQG AL	BCAWQG I	BCWWQG I	*BCAWQG L*	*BCWWQG L*	BCAWQG DW	GCDWQ MAC	GCDWQ AO	
Field Results											
Conductivity	µS/cm	NG	NG	NG	700 [4.1]	NG	NG	NG	NG	NG	460
Oxidation reduction potential	mV	NG	NG	NG	NG	NG	NG	NG	NG	NG	6
pH		N [1.1]	NG	5.0 - 9.0 [3.1]	NG	5.0 - 9.5 [5.1]	NG	6.5 - 8.5 [7.1]	NG	7.0 - 10.5 [9.1]	8.42
Temperature	°C	19 [1.2]	NG	N [3.2]	NG	N [5.2]	NG	15 [7.2]	NG	15	5.1
Turbidity	NTU	N [1.3]	NG	N [3.3]	NG	N [5.3]	NG	N [7.3]	N [8.1]	NG	0.06
Lab Results											
General											
Chloride	mg/L	600 [1.4]	NG	100	NG	600 [5.4]	NG	250 [7.4]	NG	250	0.74
Hardness, total (dissolved as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	220
Metals											
Aluminum (total)	mg/L	NG	NG	5 [3.4]	NG	5 [5.5]	NG	NG	NG	N [9.2]	<0.005
Antimony (total)	mg/L	NG	0.009 [2.1]	NG	NG	NG	NG	NG	0.006	NG	<0.0001
Arsenic (total)	mg/L	0.005	NG	0.100 [3.5]	NG	0.025 [5.6]	NG	0.025 [7.5]	0.010 [8.2]	NG	<0.0005
Barium (total)	mg/L	NG	1	NG	NG	NG	NG	NG	1.0	NG	0.025
Beryllium (total)	mg/L	NG	0.00013	NG	0.100	NG	0.100	NG	NG	NG	<0.0001
Bismuth (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.0001
Boron (total)	mg/L	1.2	NG	0.5 [3.6]	NG	5	NG	5	5	NG	0.005
Cadmium (total)	mg/L	NG	NG	NG	0.0051 [4.2]	NG	0.080 [6.1]	NG	0.005	NG	0.00003
Calcium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	79.1
Chromium (total)	mg/L	NG	0.001 [2.2]	NG	0.0049 [4.3]	NG	0.050 [6.2]	NG	0.05	NG	<0.0005
Cobalt (total)	mg/L	0.110 [1.5]	NG	NG	0.050 [4.4]	NG	1	NG	NG	NG	<0.00005
Copper (total)	mg/L	Calc [1.6]	NG	0.200 [3.7]	NG	0.300	NG	0.500 [7.6]	NG	1.0	0.0006
Iron (total)	mg/L	1.0	NG	NG	NG	NG	NG	NG	NG	0.3	<0.01
Lead (total)	mg/L	Calc [1.7]	NG	0.200 [3.8]	NG	0.100	NG	0.050 [7.7]	0.010	NG	<0.0001
Lithium (total)	mg/L	NG	NG	NG	0.75 [4.5]	NG	NG	NG	NG	NG	0.0037
Magnesium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	5.56
Manganese (total)	mg/L	Calc [1.8]	NG	NG	0.200	NG	NG	NG	NG	0.05	0.0003
Molybdenum (total)	mg/L	2 [1.9]	NG	0.05 [3.9]	NG	0.05 [5.7]	NG	0.25 [7.8]	NG	NG	0.0010
Nickel (total)	mg/L	NG	Calc [2.3]	NG	0.200	NG	1	NG	NG	NG	0.0003

Table C-2
Regehr Farms Surface Water Quality Data - 2016

											Sampling Location	SW-2
											Date Sampled	01-Dec-16
											Lab Sample ID	6120164-01
											Client Sample Comment	
											Sample Type	
Analyte	**Unit**	**Guideline**										
		BCAWQG AL	BCWWQG AL	BCAWQG I	BCWWQG I	*BCAWQG L*	*BCWWQG L*	BCAWQG DW	GCDWQ MAC	GCDWQ AO		
Selenium (total)	mg/L	0.002 [1.10]	NG	0.010 [3.10]	NG	0.0300 [5.8]	NG	0.010 [7.9]	0.05	NG		<0.0005
Silicon (total, as Si)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		9.7
Silver (total)	mg/L	Calc [1.11]	NG	NG	NG	NG	NG	NG	NG	NG		<0.00005
Sodium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	200		3.81
Strontium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		0.652
Sulphur (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		16
Tellurium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		0.0002
Thallium (total)	mg/L	NG	0.0008 [2.4]	NG	NG	NG	NG	NG	NG	NG		<0.00002
Thorium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		<0.0001
Tin (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		<0.0002
Titanium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		<0.005
Uranium (total)	mg/L	NG	0.0085	NG	0.010	NG	0.200	NG	0.02	NG		0.00201
Vanadium (total)	mg/L	NG	NG	NG	0.100	NG	0.100	NG	NG	NG		<0.001
Zinc (total)	mg/L	Calc [1.12]	NG	1.000 [3.11]	NG	2.000	NG	5.0 [7.10]	NG	5.0		<0.004
Zirconium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		<0.0001
Nutrients												
Ammonia (total, as N)	mg/L	Calc [1.13]	NG	NG	NG	NG	NG	NG	NG	NG		0.052
Nitrate (as N)	mg/L	32.8 [1.14]	NG	NG	NG	100 [5.9]	NG	10 [7.11]	10	NG		<0.010
Nitrate + Nitrite (as N)	mg/L	32.8 [1.15]	NG	NG	NG	100 [5.10]	NG	10 [7.12]	10 [8.3]	NG		<0.010
Nitrate + Nitrite (as N) (calculated)	mg/L	32.8 [1.16]	NG	NG	NG	100 [5.11]	NG	10 [7.13]	10 [8.4]	NG		<0.014
Nitrite (as N)	mg/L	Calc [1.17]	NG	NG	NG	10 [5.12]	NG	1 [7.14]	1	NG		<0.010
Organic nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		0.089
Total nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		0.141
Total kjeldahl nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		0.14
Phosphorus (total, by ICPMS/ICPOES)	mg/L	N [1.18]	NG	NG	NG	NG	NG	N [7.15]	NG	NG		<0.02
Phosphorus (total, APHA 4500-P)	mg/L	N [1.19]	NG	NG	NG	NG	NG	N [7.16]	NG	NG		0.004

Table C-2
Regehr Farms Surface Water Quality Data - 2016

											Sampling Location	SW-2
											Date Sampled	01-Dec-16
											Lab Sample ID	6120164-01
											Client Sample Comment	
											Sample Type	
Analyte	**Unit**	**Guideline**										
		BCAWQG AL	BCWWQG AL	BCAWQG I	BCWWQG I	*BCAWQG L*	*BCWWQG L*	BCAWQG DW	GCDWQ MAC	GCDWQ AO		
Phosphorus (dissolved, APHA 4500-P)	mg/L	N 1.20	NG	NG	NG	NG	NG	N 7.17	NG	NG		0.004
Phosphorus, dissolved reactive	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		0.018
Potassium (total)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG		3.37

Legend

<	Less than reported detection limit
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
N	Narrative type of guideline or standard, or Result Note.
NG	No Guideline
BCAWQG AL	Highlighted value exceeds the BC Approved Water Quality Guidelines for Aquatic Life (BCAWQG AL)
BCWWQG AL	Highlighted value exceeds the BC Working Water Quality Guidelines for Aquatic Life (BCWWQG AL)
BCAWQG I	Highlighted value exceeds the BC Approved Water Quality Guidelines for Irrigation (BCAWQG I)
BCWWQG I	Highlighted value exceeds the BC Working Water Quality Guidelines for Irrigation (BCWWQG I)
BCAWQG L	Highlighted value exceeds the BC Approved Water Quality Guidelines for Livestock (BCAWQG L)
BCWWQG L	Highlighted value exceeds the BC Working Water Quality Guidelines for Livestock (BCWWQG L)
BCAWQG DW	Highlighted value exceeds the BC Approved Water Quality Guidelines for Drinking Water (BCAWQG DW)
GCDWQ AO	Highlighted value exceeds the Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)
GCDWQ MAC	Highlighted value exceeds the Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)

WIRELESS WATER

Table C-2
Regehr Farms Surface Water Quality – 2016
Guideline Notes

1. Notes for BC Approved Water Quality Guidelines for freshwater aquatic life (BCAWQG AL)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used. / For some parameters, guidelines are specified as two values: the maximum value or the acute criterion, and the 30-day average value or the chronic criterion. The maximum value was used in this report for parameters that have both guideline values.

Note 1.1 for pH:

pH less than 6.5: No statistically significant decrease in pH from background.
pH from 6.5 to 9.0: Unrestricted change permitted within this range.
pH over 9.0: No statistically significant increase in pH from background.
See BC MOE Overview Report for additional details.

Note 1.2 for Temperature:

The maximum daily temperature of 19 degrees Celsius is for streams with unknown fish distribution. See BC MOE Overview Report for additional details for streams with unknown fish distribution, and specific guidelines for streams with known fish distribution, and guideline for lakes and impoundments.

Note 1.3 for Turbidity:

When background is less than or equal to 8 NTU:
- Maximum Induced Turbidity of 8 NTU in 24 hours.
- For sediment inputs that last between 24 hours and 30 days (daily sampling preferred) the mean turbidity should not exceed background by more than 2 NTU.

Maximum Induced Turbidity of 5 NTU when background is between 8 and 50 NTU.
Maximum Induced Turbidity of 10% when background is greater than 50 NTU.

Note 1.4 for Chloride:

To protect freshwater aquatic life from acute and lethal effects, the maximum concentration of chloride (mg/L as NaCl) at any time should not exceed 600 mg/L.
To protect freshwater aquatic life from chronic effects, the average (arithmetic mean computed from five weekly samples collected over a 30-day period) concentration of chloride (mg/L as NaCl) should not exceed 150 mg/L.

Note 1.5 for Cobalt (total):

The interim maximum concentration for total cobalt is 110 µg/L to protect aquatic life in the freshwater environment from acute effects of cobalt.
The interim 30-day average concentration for total cobalt (based on five weekly samples) is 4 µg/L to protect aquatic life from chronic effects of cobalt.

Note 1.6 for Copper (total):

The maximum concentration of total copper should not exceed at any time the numerical value (in µg/L) given by the formula "0.094(hardness)+2", where water hardness is reported as mg/L CaCO3.
The 30-day average concentration of total copper (based on a minimum of 5 approximately weekly samples) should not exceed 2 µg/L when average water hardness over the same period (expressed as mg/L CaCO3) is less than 50 mg/L. When average water hardness is greater than 50 mg/L the 30-day average concentration should not exceed the numerical value (in µg/L) given by the formula "0.04(average hardness)", where water hardness is reported as mg/L CaCO3.

Note 1.7 for Lead (total):

The maximum guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO3 is set at 3.0 µg/L. When water hardness exceeds 8.0 mg/L CaCO3 the maximum guideline for lead at any time is given by the following equation:
Maximum Criteria (µg/L) = exp (1.273 ln(hardness) - 1.460).
The 30-day average guideline for total lead in water, when water hardness exceeds 8 mg/L as CaCO3, is as follows:
30-Day Average (µg/L) is less than or equal to 3.31 + exp (1.273 ln (mean hardness) - 4.704).
For hardness less than or equal to 8.0 mg/L there is no 30-day average guideline; hence the maximum concentration of 3.0 µg/L is used.

Note 1.8 for Manganese (total):

The maximum concentration of total manganese in mg/L at any time should not exceed the value as determined by the following relationship:
0.01102 hardness + 0.54
where water hardness is reported as mg/L of CaCO3.
The 30-day mean concentration of total manganese in mg/L should be less than or equal to the value as determined by the following relationship:
0.0044 hardness + 0.605
where water hardness is reported as mg/L of CaCO3.

Note 1.9 for Molybdenum (total):

The maximum concentration for total molybdenum is 2 mg/L.
The 30-day average concentration for total molybdenum (based on at least five weekly samples in a period of 30 days) is less than or equal to 1 mg/L.

Note 1.10 for Selenium (total):

The 30-day average water quality guideline for protection of aquatic life is 2 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.
The 30-day average alert concentration for the protection of aquatic life in sensitive ecosystems is 1 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

Note 1.11 for Silver (total):

The guideline maximum for total silver is:
0.1 µg/L maximum if hardness less than or equal to 100 mg/L
3.0 µg/L maximum if hardness greater than 100 mg/L.
The guideline 30-day average for total silver is:
0.05 µg/L as 30-day mean if hardness less than or equal to 100 mg/L
1.5 µg/L as 30-day mean if hardness greater than 100 mg/L.

Note 1.12 for Zinc (total):

The maximum concentration of total zinc (µg/L) at any time should not exceed 33 µg/L when water hardness is less than or equal to 90 mg/L as CaCO3.
When water hardness exceeds 90 mg/L CaCO3, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:
33 + 0.75 * (hardness - 90)
where water hardness is reported as mg/L of CaCO3.
The 30-day average concentration of total zinc (µg/L) at any time should not exceed 7.5 µg/L when water hardness is less than or equal to 90 mg/L as CaCO3.
When water hardness exceeds 90 mg/L CaCO3, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:
7.5 + 0.75 * (hardness - 90)
where water hardness is reported as mg/L of CaCO3.

Note 1.13 for Ammonia (total, as N):

The maximum guideline for ammonia varies as a function of pH and temperature. See Table 3 in Overview Report Update September 2009.
The 30-day average guideline for ammonia varies as a function of pH and temperature. See Table 4 in Overview Report Update September 2009. / The lab pH and field temperature results were used for determining the maximum ammonia for this report. If a lab pH result was not available then the field pH result was used.

Note 1.14 for Nitrate (as N):

The guideline maximum for nitrate (as N) is 32.8 mg/l.
The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.
Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 1.15 for Nitrate + Nitrite (as N):

The guideline maximum for nitrate (as N) is 32.8 mg/l.
The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.
Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 1.16 for Nitrate + Nitrite (as N) (calculated):
The guideline maximum for nitrate (as N) is 32.8 mg/l.
The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.
Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 1.17 for Nitrite (as N):

The guideline maximum for nitrite as N is:
0.06 mg/L if chloride less than 2 mg/L
0.12 mg/L if chloride is 2 to 4 mg/L
0.18 mg/L if chloride is 4 to 6 mg/L
0.24 mg/L if chloride is 6 to 8 mg/L
0.30 mg/L if chloride is 8 to 10 mg/L
0.60 mg/L if chloride is greater than 10 mg/L.
The guideline 30-day average for nitrite as N is:
0.02 mg/L if chloride less than 2 mg/L
0.04 mg/L if chloride is 2 to 4 mg/L
0.06 mg/L if chloride is 4 to 6 mg/L
0.08 mg/L if chloride is 6 to 8 mg/L
0.10 mg/L if chloride is 8 to 10 mg/L
0.20 mg/L if chloride is greater than 10 mg/L.

Note 1.18 for Phosphorus (total, by ICPMS/ICPOES):
Streams: None proposed for streams.
Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 1.19 for Phosphorus (total, APHA 4500-P):

Streams: None proposed for streams.
Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 1.20 for Phosphorus (dissolved, APHA 4500-P):

Streams: None proposed for streams.
Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

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2. Notes for Working Water Quality Guidelines for British Columbia for freshwater aquatic life (BCWWQG AL)

General Notes:

Reference: Working Water Quality Guidelines for British Columbia (2015). WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the “Notes” for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.

Note 2.1 for Antimony (total):

The guideline is for antimony (III).

Note 2.2 for Chromium (total):

The guideline for Cr(VI) is 1 µg/L (total). The guideline for Cr(III) is 8.9 µg/L (total). The guideline of 1 µg/L for Cr(VI) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.

Note 2.3 for Nickel (total):

The guideline for nickel in µg/L is determined as follows:
When the water hardness is 0 to ≤ 60 mg/L, the maximum is 25 µg/L
At hardness > 60 to ≤ 180 mg/L the maximum is calculated using the equation:
e raised to the power of {0.76[ln(hardness)] + 1.06}
At hardness >180 mg/L, the maximum is 150 µg/L
Where water hardness is reported as mg/L $CaCO_3$.
If the water hardness is unknown, the maximum is 25 µg/L.

Note 2.4 for Thallium (total):

30-day average, site-specific objective for the lower Columbia River, BC

3. Notes for BC Approved Water Quality Guidelines for irrigation (BCAWQG I)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used.

Note 3.1 for pH:

The recommended criterion for irrigation waters is a pH ranging between 5.0 and 9.0. This guideline recognizes that soil acidity, alkalinity and salinity are a concern in agriculture.

Note 3.2 for Temperature:

The recommended guideline for temperature is + or - 1 degree Celsius change from natural ambient background.

Note 3.3 for Turbidity:

Induced turbidity should not exceed 10 NTU when background turbidity is less than or equal to 50 NTU, nor should induced turbidity be more than 20 % of background when background is greater than 50 NTU.

Note 3.4 for Aluminum (total):

The guideline maximum for total aluminum is 5 mg/L. A separate guideline for dissolved aluminum is not provided.

Note 3.5 for Arsenic (total):

The interim guideline for total arsenic is 100 µg/L.

Note 3.6 for Boron (total):

The guideline for total boron depends on the crop, and varies from 0.5 mg/L to 6 mg/L. The most stringent guideline maximum of 0.5 mg/L, for very sensitive and sensitive crops, was used to identify exceedances for this report.

Note 3.7 for Copper (total):

The guideline maximum for total copper is 200 µg/L.

Note 3.8 for Lead (total):

For neutral and alkaline fine-textured soils the total lead concentration in irrigation water should not exceed 400 µg/L at any time. The concentration of total lead in irrigation water for use on all other soils should not exceed 200 µg/L at any time. / The most stringent guideline maximum was used in this report.

Note 3.9 for Molybdenum (total):

The guideline maximum for total molybdenum for irrigation of forage crops is 0.05 mg/L. There is no guideline maximum for total molybdenum for irrigation of non-forage crops.

Note 3.10 for Selenium (total):

The guideline for total selenium is 10 µg/L mean. The mean concentrations in the water column are based on at least 5 weekly samples taken over a 30-day period.

Note 3.11 for Zinc (total):

The guideline maximum for total zinc for irrigation is as follows:
- Soil pH less than 6: 1000 µg/L.
- Soil pH equal to or greater than 6, and less than 7: 2000 µg/L.
- Soil pH greater than or equal to 7: 5000 µg/L. / The most stringent guideline maximum was used in this report.

4. Notes for Working Water Quality Guidelines for British Columbia for irrigation (BCWWQG I)

General Notes:

Reference: Working Water Quality Guidelines for British Columbia (2015). WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the “Notes” for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.

Note 4.1 for Conductivity:

The guideline varies from 700 to 5000 µS/cm depending on the type of crop. The most stringent guideline has been used for this report.

Note 4.2 for Cadmium (total):

This is a Short-term maximum guideline.

Note 4.3 for Chromium (total):

The guideline for Cr(VI) is 8 µg/L (total).
The guideline for Cr(III) is 4.9 µg/L (total).
The guideline of 4.9 µg/L for Cr(III) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.

Note 4.4 for Cobalt (total):

Continuous or intermittent use on all soils.

Note 4.5 for Lithium (total):

The guideline is 2.5 mg/L for non-citrus crops (May not be protective of barley and other cereal crops; 1.0 mg/L suggested for cereal crops). The guideline is 0.75 mg/L for citrus crops. / The most stringent guideline was used in this report.

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5. Notes for BC Approved Water Quality Guidelines for livestock (BCAWQG L)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used.

Note 5.1 for pH:

pH does not interfere with the palatability of water or the health of livestock.

Note 5.2 for Temperature:

The recommended guideline for temperature is + or - 1 degree Celsius change from natural ambient background.

Note 5.3 for Turbidity:

Induced turbidity should not exceed 5 NTU when background turbidity is less than or equal to 50 NTU, nor should induced turbidity be more than 10 % of background when background is greater than 50 NTU.

Note 5.4 for Chloride:

The water quality guideline for chloride for livestock watering is 600 mg/L.

Note 5.5 for Aluminum (total):

The guideline maximum for total aluminum is 5 mg/L. A separate guideline for dissolved aluminum is not provided.

Note 5.6 for Arsenic (total):

The interim guideline for total arsenic is 25 µg/L.

Note 5.7 for Molybdenum (total):

If livestock are consuming forages not irrigated, or if no molybdenum containing fertilizers are applied to grow feed consumed by livestock, then the guideline maximum for total molybdenum is 0.08 mg/L. For all other cases, the guideline maximum for total molybdenum is 0.05 mg/L. / The most stringent guideline maximum was used in this report.

Note 5.8 for Selenium (total):

The guideline for total selenium is 30.0 µg/L mean. The mean concentrations in the water column are based on at least 5 weekly samples taken over a 30-day period.

Note 5.9 for Nitrate (as N):

Overview Report Update, September 2009.

Note 5.10 for Nitrate + Nitrite (as N):

The guideline maximum for nitrate as nitrogen is 100 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009.

Note 5.11 for Nitrate + Nitrite (as N) (calculated):

The guideline maximum for nitrate as nitrogen is 100 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009.

Note 5.12 for Nitrite (as N):

Overview Report Update, September 2009.

6. Notes for Working Water Quality Guidelines for British Columbia for livestock (BCWWQG L)

General Notes:

Reference: Working Water Quality Guidelines for British Columbia (2015). WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the “Notes” for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.

Note 6.1 for Cadmium (total):

This is a Short-term maximum guideline.

Note 6.2 for Chromium (total):

The guideline for Cr(VI) is 50 µg/L (total). The guideline for Cr(III) is 50 µg/L (total). The guideline of 50 µg/L for Cr(VI), and for Cr(III) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.

7. Notes for BC Approved Water Quality Guidelines for drinking water (BCAWQG DW)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used. Drinking water guidelines are, in some cases, for raw water before treatment.

Note 7.1 for pH:

Designed to minimize solubilization of heavy metals and salts from water distribution pipes and the precipitation of carbonate salts in the distribution system, and maximize the effectiveness of chlorination. However, natural source water outside the guidelines may be safe to drink from a public health perspective.

Note 7.2 for Temperature:

The guideline for maximum temperature for drinking water is 15 degrees.

Note 7.3 for Turbidity:

Turbidity guidelines for raw drinking water follow;
• Drinking Water - raw untreated:
For raw waters of exceptional clarity (less than or equal to 5 NTU) which normally do not require treatment to reduce natural turbidity, induced turbidity should not exceed 1 NTU and the total turbidity should not exceed 5 NTU at any time.
• Drinking Water - raw treated:
For raw waters which normally require some form of treatment to reduce natural turbidity to a level that complies with the standard for finished water (5 NTU) in British Columbia, induced turbidity should not exceed 5 NTU when background turbidity is less than or equal to 50 NTU. When background is greater than 50 NTU, the induced turbidity should not be more than 10% of background.

Note 7.4 for Chloride:

The guideline maximum for chloride in drinking water (for aesthetic reasons) is 250 mg/L.

Note 7.5 for Arsenic (total):

The interim guideline maximum for total arsenic in drinking water is 25 µg/L.

Note 7.6 for Copper (total):

In raw drinking water with or without treatment, total copper should not exceed 500 µg/L.

Note 7.7 for Lead (total):
In raw drinking water, with and without treatment, the total lead concentration should not exceed 50 µg/L at any time.

Note 7.8 for Molybdenum (total):
The guideline maximum for total molybdenum in raw untreated drinking water is 0.25 mg/L.

Note 7.9 for Selenium (total):
The guideline maximum for total selenium in drinking water is 10 µg/L.

Note 7.10 for Zinc (total):
The guideline maximum for total zinc in drinking water is 5.0 mg/L.

Note 7.11 for Nitrate (as N):
Overview Report Update, September 2009

Note 7.12 for Nitrate + Nitrite (as N):
The guideline maximum for nitrate as nitrogen is 10 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009

Note 7.13 for Nitrate + Nitrite (as N) (calculated):
The guideline maximum for nitrate as nitrogen is 10 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009

Note 7.14 for Nitrite (as N):
Overview Report Update, September 2009

Note 7.15 for Phosphorus (total, by ICPMS/ICPOES):
For lakes used as a source of drinking water, the total phosphorous concentration should not exceed 10 µg/L. No guideline is recommended for streams.

Note 7.16 for Phosphorus (total, APHA 4500-P):
For lakes used as a source of drinking water, the total phosphorous concentration should not exceed 10 µg/L. No guideline is recommended for streams.

Note 7.17 for Phosphorus (dissolved, APHA 4500-P):
For lakes used as a source of drinking water, the total phosphorous concentration should not exceed 10 µg/L. No guideline is recommended for streams.

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8. Notes for Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)

Note 8.1 for Turbidity:
Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ.
For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU.
For effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU.

Note 8.2 for Arsenic (total):
Every effort should be made to maintain arsenic levels in drinking water as low as reasonably achievable.

Note 8.3 for Nitrate + Nitrite (as N):
The MAC for Nitrate (as N) is 10 mg/L

Note 8.4 for Nitrate + Nitrite (as N) (calculated):
The MAC for Nitrate (as N) is 10 mg/L

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9. Notes for Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)

Note 9.1 for pH:
The operational guideline for pH is a range of 7.0 to 10.5 in finished drinking water.

Note 9.2 for Aluminum (total):

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

Appendix D – Laboratory Reports

CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9	**TEL** **FAX**	(250) 545-3672 (250) 545-3654
ATTENTION	Nicole Penner	**WORK ORDER**	6091999
PO NUMBER		**RECEIVED / TEMP**	2016-09-28 08:30 / 8°C
PROJECT	2016-8112.000	**REPORTED**	2016-10-18
PROJECT INFO	Regehr Farms	**COC NUMBER**	COC no#

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

This is a revised report. Refer to Appendix 3 for details

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Sara Gulenchyn, B.Sc, P.Chem. (sgulenchyn@caro.ca)

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6091999
PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analysis Description	Method Reference	Technique	Location
Ammonia, Total in Water	APHA 4500-NH3 G*	Automated Colorimetry (Phenate)	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Nitrogen, Total Kjeldahl in Water	APHA 4500-Norg D*	Block Digestion and Flow Injection Analysis	Kelowna
Phosphorus, Dissolved Reactive in Water	APHA 4500-P F	Automated Colorimetry (Ascorbic Acid)	Kelowna
Phosphorus, Total by Colorimetry in Water	APHA 4500-P B.5* / APHA 4500-P F	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	Kelowna
Phosphorus, Total Dissolved by Colorimetry in Water	APHA 4500-P B.5* / APHA 4500-P F	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	Kelowna

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA — Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
AO	Aesthetic objective
MAC	Maximum acceptable concentration (health based)
OG	Operational guideline (treated water)
mg/L	Milligrams per litre

Standards / Guidelines Referenced in this Report:

Guidelines for Canadian Drinking Water Quality (Oct 2014)

Website: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/pubs/water-eau/sum_guide-res_recom/sum_guide-res_recom-eng.pdf

Note: In some cases, the values displayed on the report represent the lowest guideline and are to be verified by the end user

REPORTED TO Associated Environmental Consultants Inc. (Vernon)
PROJECT 2016-8112.000

WORK ORDER 6091999
REPORTED 2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 6 (6091999-01) [Water] Sampled: 2016-09-27 11:05							
Anions							
Chloride	**9.81**	AO ≤ 250	0.10	mg/L	N/A	2016-09-30	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	N/A	2016-09-30	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	N/A	2016-09-30	
General Parameters							
Ammonia, Total (as N)	**0.057**	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.23**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.009**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	< 0.002	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	< 0.005	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**384**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	< 0.010	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**0.228**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.171**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.062**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.011**	N/A	0.004	mg/L	N/A	2016-09-30	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-30	
Calcium, dissolved	**129**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	**0.00005**	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**1.53**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0046**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**14.7**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.117**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0036**	N/A	0.0001	mg/L	N/A	2016-09-30	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**6.30**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**12.5**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**9.19**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**0.891**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**28**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-30	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 6 (6091999-01) [Water] Sampled: 2016-09-27 11:05, Continued							
Dissolved Metals, Continued							
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.00033**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Sample ID: White Domestic (6091999-02) [Water] Sampled: 2016-09-27 10:20							
Anions							
Chloride	**18.4**	AO ≤ 250	0.10	mg/L	N/A	2016-09-30	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	N/A	2016-09-30	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	N/A	2016-09-30	
General Parameters							
Ammonia, Total (as N)	**0.049**	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.18**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.010**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	**0.007**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	**0.005**	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**497**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	< 0.010	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**0.176**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.127**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	**0.0013**	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.084**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.008**	N/A	0.004	mg/L	N/A	2016-09-30	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-30	
Calcium, dissolved	**171**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**1.22**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0050**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**17.2**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.234**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0021**	N/A	0.0001	mg/L	N/A	2016-09-30	

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6091999
PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: White Domestic (6091999-02) [Water] Sampled: 2016-09-27 10:20, Continued							
Dissolved Metals, Continued							
Nickel, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	2016-09-30	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**6.75**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**12.2**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**9.24**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**1.27**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**59**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-30	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.0116**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Sample ID: Project 1 (6091999-03) [Water] Sampled: 2016-09-27 12:45							
Anions							
Chloride	**19.0**	AO ≤ 250	0.10	mg/L	N/A	2016-09-30	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	N/A	2016-09-30	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	N/A	2016-09-30	
General Parameters							
Ammonia, Total (as N)	**0.237**	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.37**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.019**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	**0.018**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	**0.013**	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**504**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	< 0.010	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**0.373**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.136**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	**0.0014**	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.055**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-09-30	

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6091999
PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 1 (6091999-03) [Water] Sampled: 2016-09-27 12:45, Continued							
Dissolved Metals, Continued							
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-30	
Calcium, dissolved	**164**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	**0.00007**	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**0.963**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0054**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**22.6**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.280**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0036**	N/A	0.0001	mg/L	N/A	2016-09-30	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-09-30	
Phosphorus, dissolved	**0.04**	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**8.00**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**12.2**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**16.2**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**1.71**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**69**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-30	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.0186**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Sample ID: Project 2 (6091999-04) [Water] Sampled: 2016-09-27 14:00							
Anions							
Chloride	**14.5**	AO ≤ 250	0.10	mg/L	N/A	2016-09-30	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	N/A	2016-09-30	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	N/A	2016-09-30	
General Parameters							
Ammonia, Total (as N)	**0.053**	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.19**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.010**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	**0.010**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	**0.010**	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**453**	N/A	0.50	mg/L	N/A	N/A	

SAMPLE ANALYTICAL DATA

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6091999
PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 2 (6091999-04) [Water] Sampled: 2016-09-27 14:00, Continued							
Calculated Parameters, Continued							
Nitrate+Nitrite (as N)	< 0.010	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**0.189**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.136**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.078**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-09-30	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-30	
Calcium, dissolved	**155**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**1.34**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0042**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**16.3**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.120**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0031**	N/A	0.0001	mg/L	N/A	2016-09-30	
Nickel, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	2016-09-30	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**7.00**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**11.6**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**10.1**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**1.07**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**46**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-30	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.0179**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	**0.007**	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Sample ID: Project 13 (6091999-05) [Water] Sampled: 2016-09-27 14:30							
Anions							
Chloride	**19.6**	AO ≤ 250	0.10	mg/L	N/A	2016-10-01	

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6091999
PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 13 (6091999-05) [Water] Sampled: 2016-09-27 14:30, Continued							
Anions, Continued							
Nitrate (as N)	**2.51**	MAC = 10	0.010	mg/L	2016-09-30	2016-09-30	
Nitrite (as N)	**0.087**	MAC = 1	0.010	mg/L	2016-09-30	2016-09-30	
General Parameters							
Ammonia, Total (as N)	< 0.020	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.18**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.008**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	**0.004**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	**0.005**	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**508**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	**2.60**	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**2.77**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.175**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.057**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.012**	N/A	0.004	mg/L	N/A	2016-09-30	
Cadmium, dissolved	**0.00007**	N/A	0.00001	mg/L	N/A	2016-09-30	
Calcium, dissolved	**168**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	**0.00043**	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	**0.0013**	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**0.013**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0054**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**21.3**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.146**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0029**	N/A	0.0001	mg/L	N/A	2016-09-30	
Nickel, dissolved	**0.0048**	N/A	0.0002	mg/L	N/A	2016-09-30	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**9.70**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	**0.0027**	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**8.5**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**22.5**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**1.09**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**66**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	**0.00002**	N/A	0.00002	mg/L	N/A	2016-09-30	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6091999
PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 13 (6091999-05) [Water] Sampled: 2016-09-27 14:30, Continued							
Dissolved Metals, Continued							
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.0143**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	**0.004**	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Sample ID: Project 17 (6091999-06) [Water] Sampled: 2016-09-27 15:15							
Anions							
Chloride	**20.2**	AO ≤ 250	0.10	mg/L	N/A	2016-10-01	
Nitrate (as N)	**0.230**	MAC = 10	0.010	mg/L	2016-09-30	2016-09-30	
Nitrite (as N)	**0.023**	MAC = 1	0.010	mg/L	2016-09-30	2016-09-30	
General Parameters							
Ammonia, Total (as N)	**0.105**	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.23**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.016**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	**0.011**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	**0.009**	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**431**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	**0.253**	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**0.479**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.121**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.067**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.007**	N/A	0.004	mg/L	N/A	2016-09-30	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-30	
Calcium, dissolved	**132**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	**0.00016**	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**1.00**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0064**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**24.4**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.224**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0028**	N/A	0.0001	mg/L	N/A	2016-09-30	
Nickel, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-09-30	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 17 (6091999-06) [Water] Sampled: 2016-09-27 15:15, Continued							
Dissolved Metals, Continued							
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**9.12**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**10.4**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**18.4**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**0.982**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**50**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-30	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.00851**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Sample ID: Project 20 (6091999-07) [Water] Sampled: 2016-09-27 11:55							
Anions							
Chloride	**13.3**	AO ≤ 250	0.10	mg/L	N/A	2016-10-01	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	2016-09-30	2016-09-30	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2016-09-30	2016-09-30	
General Parameters							
Ammonia, Total (as N)	**0.067**	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.23**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.012**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	**0.012**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	**0.012**	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**543**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	< 0.010	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**0.233**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.166**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.112**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.010**	N/A	0.004	mg/L	N/A	2016-09-30	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-30	

SAMPLE ANALYTICAL DATA

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6091999
PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 20 (6091999-07) [Water] Sampled: 2016-09-27 11:55, Continued							
Dissolved Metals, Continued							
Calcium, dissolved	**164**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	**0.0074**	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**2.34**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0073**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**32.5**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.262**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0024**	N/A	0.0001	mg/L	N/A	2016-09-30	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-09-30	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**7.23**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**13.6**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**16.5**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**1.77**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**79**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-30	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.00066**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	**0.028**	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Sample ID: Project 22 (6091999-08) [Water] Sampled: 2016-09-27 13:20							
Anions							
Chloride	**6.68**	AO ≤ 250	0.10	mg/L	N/A	2016-10-01	
Nitrate (as N)	**0.014**	MAC = 10	0.010	mg/L	2016-09-30	2016-09-30	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2016-09-30	2016-09-30	
General Parameters							
Ammonia, Total (as N)	**0.117**	N/A	0.020	mg/L	N/A	2016-10-01	
Nitrogen, Total Kjeldahl	**0.22**	N/A	0.05	mg/L	2016-09-30	2016-10-04	
Phosphorus, Total (as P)	**0.020**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Total Dissolved	**0.012**	N/A	0.002	mg/L	2016-09-29	2016-09-29	
Phosphorus, Dissolved Reactive	**0.012**	N/A	0.005	mg/L	2016-09-28	2016-09-30	
Calculated Parameters							
Hardness, Total (as CaCO3)	**425**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	**0.014**	N/A	0.010	mg/L	N/A	N/A	

SAMPLE ANALYTICAL DATA

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PROJECT	2016-8112.000	**REPORTED**	2016-10-18

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Project 22 (6091999-08) [Water] Sampled: 2016-09-27 13:20, Continued							
Calculated Parameters, Continued							
Nitrogen, Total	**0.238**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.107**	N/A	0.050	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Arsenic, dissolved	**0.0011**	N/A	0.0005	mg/L	N/A	2016-09-30	
Barium, dissolved	**0.069**	N/A	0.005	mg/L	N/A	2016-09-30	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Boron, dissolved	**0.007**	N/A	0.004	mg/L	N/A	2016-09-30	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-30	
Calcium, dissolved	**134**	N/A	0.2	mg/L	N/A	2016-09-30	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Cobalt, dissolved	**0.00006**	N/A	0.00005	mg/L	N/A	2016-09-30	
Copper, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-09-30	
Iron, dissolved	**0.089**	N/A	0.010	mg/L	N/A	2016-09-30	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Lithium, dissolved	**0.0100**	N/A	0.0001	mg/L	N/A	2016-09-30	
Magnesium, dissolved	**22.0**	N/A	0.01	mg/L	N/A	2016-09-30	
Manganese, dissolved	**0.438**	N/A	0.0002	mg/L	N/A	2016-09-30	
Molybdenum, dissolved	**0.0047**	N/A	0.0001	mg/L	N/A	2016-09-30	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-09-30	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-30	
Potassium, dissolved	**8.43**	N/A	0.02	mg/L	N/A	2016-09-30	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-30	
Silicon, dissolved	**10.5**	N/A	0.5	mg/L	N/A	2016-09-30	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-30	
Sodium, dissolved	**26.1**	N/A	0.02	mg/L	N/A	2016-09-30	
Strontium, dissolved	**2.80**	N/A	0.001	mg/L	N/A	2016-09-30	
Sulfur, dissolved	**74**	N/A	1	mg/L	N/A	2016-09-30	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-30	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-30	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-30	
Uranium, dissolved	**0.00325**	N/A	0.00002	mg/L	N/A	2016-09-30	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-30	
Zinc, dissolved	**0.011**	N/A	0.004	mg/L	N/A	2016-09-30	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-30	

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6I1774										
Blank (B6I1774-BLK1)				Prepared: 2016-09-30, Analyzed: 2016-09-30						
Chloride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
Blank (B6I1774-BLK2)				Prepared: 2016-10-01, Analyzed: 2016-10-01						
Chloride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
LCS (B6I1774-BS1)				Prepared: 2016-09-30, Analyzed: 2016-09-30						
Chloride	15.6	0.10	mg/L	16.0		97	90-110			
Nitrate (as N)	3.89	0.010	mg/L	4.00		97	93-108			
Nitrite (as N)	1.84	0.010	mg/L	2.00		92	83-110			
LCS (B6I1774-BS2)				Prepared: 2016-10-01, Analyzed: 2016-10-01						
Chloride	15.6	0.10	mg/L	16.0		98	90-110			
Nitrate (as N)	3.90	0.010	mg/L	4.00		98	93-108			
Nitrite (as N)	1.86	0.010	mg/L	2.00		93	83-110			
Dissolved Metals, Batch B6I1821										
Blank (B6I1821-BLK1)				Prepared: 2016-09-30, Analyzed: 2016-09-30						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							

Dissolved Metals, Batch B6I1821, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Blank (B6I1821-BLK1), Continued				Prepared: 2016-09-30, Analyzed: 2016-09-30						
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Duplicate (B6I1821-DUP1)		**Source: 6091999-01**		Prepared: 2016-09-30, Analyzed: 2016-09-30						
Aluminum, dissolved	< 0.005	0.005	mg/L		< 0.005				11	
Antimony, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				44	
Arsenic, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				8	
Barium, dissolved	0.062	0.005	mg/L		0.062			1	7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.007	0.004	mg/L		0.011				13	
Cadmium, dissolved	< 0.00001	0.00001	mg/L		< 0.00001				27	
Calcium, dissolved	124	0.2	mg/L		129			4	8	
Chromium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				14	
Cobalt, dissolved	< 0.00005	0.00005	mg/L		0.00005				10	
Copper, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				28	
Iron, dissolved	1.49	0.010	mg/L		1.53			3	14	
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	0.0045	0.0001	mg/L		0.0046			4	14	
Magnesium, dissolved	14.1	0.01	mg/L		14.7			4	6	
Manganese, dissolved	0.115	0.0002	mg/L		0.117			2	9	
Molybdenum, dissolved	0.0035	0.0001	mg/L		0.0036			3	19	
Nickel, dissolved	0.0002	0.0002	mg/L		0.0002				21	
Phosphorus, dissolved	0.02	0.02	mg/L		0.02				14	
Potassium, dissolved	6.25	0.02	mg/L		6.30			< 1	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	12.5	0.5	mg/L		12.5			< 1	12	
Silver, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				20	
Sodium, dissolved	8.69	0.02	mg/L		9.19			6	6	
Strontium, dissolved	0.898	0.001	mg/L		0.891			< 1	6	
Sulfur, dissolved	28	1	mg/L		28			< 1	26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	

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Dissolved Metals, Batch B6I1821, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Duplicate (B6I1821-DUP1), Continued	**Source: 6091999-01**			Prepared: 2016-09-30, Analyzed: 2016-09-30						
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	0.00032	0.00002	mg/L		0.00033			5	14	
Vanadium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	< 0.004	0.004	mg/L		< 0.004				11	
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	
Matrix Spike (B6I1821-MS1)	**Source: 6091999-02**			Prepared: 2016-09-30, Analyzed: 2016-09-30						
Antimony, dissolved	0.440	0.0001	mg/L	0.400	0.0001	110	76-114			
Arsenic, dissolved	0.218	0.0005	mg/L	0.200	0.0013	108	81-115			
Barium, dissolved	1.12	0.005	mg/L	1.00	0.084	104	80-113			
Beryllium, dissolved	0.104	0.0001	mg/L	0.100	< 0.0001	104	69-109			
Cadmium, dissolved	0.102	0.00001	mg/L	0.100	< 0.00001	102	83-110			
Chromium, dissolved	0.418	0.0005	mg/L	0.400	0.0006	104	85-115			
Cobalt, dissolved	0.417	0.00005	mg/L	0.400	< 0.00005	104	86-114			
Copper, dissolved	0.417	0.0002	mg/L	0.400	< 0.0002	104	82-119			
Iron, dissolved	3.35	0.010	mg/L	2.00	1.22	107	80-116			
Lead, dissolved	0.200	0.0001	mg/L	0.200	< 0.0001	100	83-112			
Manganese, dissolved	0.649	0.0002	mg/L	0.400	0.234	104	62-131			
Nickel, dissolved	0.404	0.0002	mg/L	0.400	0.0003	101	81-115			
Selenium, dissolved	0.0970	0.0005	mg/L	0.100	< 0.0005	97	79-115			
Silver, dissolved	0.102	0.00005	mg/L	0.100	< 0.00005	102	69-121			
Thallium, dissolved	0.0996	0.00002	mg/L	0.100	< 0.00002	100	84-115			
Vanadium, dissolved	0.405	0.001	mg/L	0.400	< 0.001	101	83-113			
Zinc, dissolved	1.06	0.004	mg/L	1.00	0.009	105	82-115			
Reference (B6I1821-SRM1)				Prepared: 2016-09-30, Analyzed: 2016-09-30						
Aluminum, dissolved	0.261	0.005	mg/L	0.233		112	58-142			
Antimony, dissolved	0.0505	0.0001	mg/L	0.0430		117	75-125			
Arsenic, dissolved	0.478	0.0005	mg/L	0.438		109	81-119			
Barium, dissolved	3.59	0.005	mg/L	3.35		107	83-117			
Beryllium, dissolved	0.225	0.0001	mg/L	0.213		106	80-120			
Boron, dissolved	1.75	0.004	mg/L	1.74		101	74-117			
Cadmium, dissolved	0.237	0.00001	mg/L	0.224		106	83-117			
Calcium, dissolved	8.0	0.2	mg/L	7.69		104	76-124			
Chromium, dissolved	0.479	0.0005	mg/L	0.437		110	81-119			
Cobalt, dissolved	0.140	0.00005	mg/L	0.128		110	76-124			
Copper, dissolved	0.918	0.0002	mg/L	0.844		109	84-116			
Iron, dissolved	1.43	0.010	mg/L	1.29		111	74-126			
Lead, dissolved	0.114	0.0001	mg/L	0.112		102	72-128			
Lithium, dissolved	0.110	0.0001	mg/L	0.104		106	60-140			
Magnesium, dissolved	7.88	0.01	mg/L	6.92		114	81-119			
Manganese, dissolved	0.376	0.0002	mg/L	0.345		109	84-116			
Molybdenum, dissolved	0.462	0.0001	mg/L	0.426		108	83-117			
Nickel, dissolved	0.912	0.0002	mg/L	0.840		109	74-126			
Phosphorus, dissolved	0.58	0.02	mg/L	0.495		117	68-132			
Potassium, dissolved	3.54	0.02	mg/L	3.19		111	74-126			
Selenium, dissolved	0.0321	0.0005	mg/L	0.0331		97	70-130			
Sodium, dissolved	20.9	0.02	mg/L	19.1		110	72-128			
Strontium, dissolved	0.972	0.001	mg/L	0.916		106	84-113			
Thallium, dissolved	0.0394	0.00002	mg/L	0.0393		100	57-143			
Uranium, dissolved	0.266	0.00002	mg/L	0.266		100	85-115			
Vanadium, dissolved	0.928	0.001	mg/L	0.869		107	87-113			
Zinc, dissolved	0.951	0.004	mg/L	0.881		108	72-128			

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B6I1699										
Blank (B6I1699-BLK1)				Prepared: 2016-09-28, Analyzed: 2016-09-30						
Phosphorus, Dissolved Reactive	< 0.001	0.005	mg/L							
Blank (B6I1699-BLK2)				Prepared: 2016-09-28, Analyzed: 2016-09-30						
Phosphorus, Dissolved Reactive	< 0.001	0.005	mg/L							
Blank (B6I1699-BLK3)				Prepared: 2016-09-28, Analyzed: 2016-09-30						
Phosphorus, Dissolved Reactive	< 0.001	0.005	mg/L							
LCS (B6I1699-BS1)				Prepared: 2016-09-28, Analyzed: 2016-09-30						
Phosphorus, Dissolved Reactive	0.101	0.005	mg/L	0.100		101	80-120			
LCS (B6I1699-BS2)				Prepared: 2016-09-28, Analyzed: 2016-09-30						
Phosphorus, Dissolved Reactive	0.104	0.005	mg/L	0.100		104	80-120			
LCS (B6I1699-BS3)				Prepared: 2016-09-28, Analyzed: 2016-09-30						
Phosphorus, Dissolved Reactive	0.098	0.005	mg/L	0.100		98	80-120			
General Parameters, Batch B6I1755										
Blank (B6I1755-BLK1)				Prepared: 2016-10-01, Analyzed: 2016-10-01						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B6I1755-BLK2)				Prepared: 2016-10-01, Analyzed: 2016-10-01						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B6I1755-BLK3)				Prepared: 2016-10-01, Analyzed: 2016-10-01						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
LCS (B6I1755-BS1)				Prepared: 2016-10-01, Analyzed: 2016-10-01						
Ammonia, Total (as N)	1.08	0.020	mg/L	1.00		108	86-111			
LCS (B6I1755-BS2)				Prepared: 2016-10-01, Analyzed: 2016-10-01						
Ammonia, Total (as N)	1.06	0.020	mg/L	1.00		106	86-111			
LCS (B6I1755-BS3)				Prepared: 2016-10-02, Analyzed: 2016-10-02						
Ammonia, Total (as N)	1.06	0.020	mg/L	1.00		106	86-111			
General Parameters, Batch B6I1769										
Blank (B6I1769-BLK1)				Prepared: 2016-09-29, Analyzed: 2016-09-29						
Phosphorus, Total (as P)	< 0.002	0.002	mg/L							
Phosphorus, Total Dissolved	< 0.002	0.002	mg/L							
Blank (B6I1769-BLK2)				Prepared: 2016-09-29, Analyzed: 2016-09-29						
Phosphorus, Total (as P)	< 0.002	0.002	mg/L							
Phosphorus, Total Dissolved	< 0.002	0.002	mg/L							
Blank (B6I1769-BLK3)				Prepared: 2016-09-29, Analyzed: 2016-10-04						
Phosphorus, Total (as P)	< 0.002	0.002	mg/L							
Phosphorus, Total Dissolved	< 0.002	0.002	mg/L							
LCS (B6I1769-BS1)				Prepared: 2016-09-29, Analyzed: 2016-09-29						
Phosphorus, Total (as P)	0.085	0.002	mg/L	0.100		85	75-112			
LCS (B6I1769-BS2)				Prepared: 2016-09-29, Analyzed: 2016-09-29						
Phosphorus, Total (as P)	0.089	0.002	mg/L	0.100		89	75-112			
Phosphorus, Total Dissolved	0.080	0.002	mg/L	0.100		80	80-120			

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B6I1769, Continued										
LCS (B6I1769-BS3)				Prepared: 2016-09-29, Analyzed: 2016-10-04						
Phosphorus, Total (as P)	0.092	0.002	mg/L	0.100		92	75-112			
Phosphorus, Total Dissolved	0.102	0.002	mg/L	0.100		102	80-120			
General Parameters, Batch B6I1879										
Blank (B6I1879-BLK1)				Prepared: 2016-09-30, Analyzed: 2016-10-04						
Nitrogen, Total Kjeldahl	< 0.05	0.05	mg/L							
Blank (B6I1879-BLK2)				Prepared: 2016-09-30, Analyzed: 2016-10-04						
Nitrogen, Total Kjeldahl	< 0.05	0.05	mg/L							
LCS (B6I1879-BS1)				Prepared: 2016-09-30, Analyzed: 2016-10-04						
Nitrogen, Total Kjeldahl	11.0	0.05	mg/L	10.0		110	80-120			
LCS (B6I1879-BS2)				Prepared: 2016-09-30, Analyzed: 2016-10-04						
Nitrogen, Total Kjeldahl	10.3	0.05	mg/L	10.0		103	80-120			

APPENDIX 3: REVISION HISTORY

REPORTED TO Associated Environmental Consultants Inc. (Vernon)
PROJECT 2016-8112.000

WORK ORDER 6091999
REPORTED 2016-10-18

Sample ID	Changed	Change	Analysis	Analyte(s)
6091999-01	2016-10-17	Added	Chloride by IC	
6091999-02	2016-10-17	Added	Chloride by IC	
6091999-03	2016-10-17	Added	Chloride by IC	
6091999-04	2016-10-17	Added	Chloride by IC	
6091999-05	2016-10-17	Added	Chloride by IC	
6091999-06	2016-10-17	Added	Chloride by IC	
6091999-07	2016-10-17	Added	Chloride by IC	
6091999-08	2016-10-17	Added	Chloride by IC	

CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9	**TEL** **FAX**	(250) 545-3672 (250) 545-3654
ATTENTION	Nicole Penner	**WORK ORDER**	6120164
PO NUMBER		**RECEIVED / TEMP**	2016-12-03 09:50 / 5°C
PROJECT	2016-8112.000	**REPORTED**	2016-12-09
PROJECT INFO	Regehr Farms	**COC NUMBER**	no num

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Sara Gulenchyn, B.Sc, P.Chem. (sgulenchyn@caro.ca)

ANALYSIS INFORMATION

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6120164
PROJECT	2016-8112.000	**REPORTED**	2016-12-09

Analysis Description	Method Reference	Technique	Location
Ammonia, Total in Water	APHA 4500-NH3 G*	Automated Colorimetry (Phenate)	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Nitrogen, Total Kjeldahl in Water	APHA 4500-Norg D*	Block Digestion and Flow Injection Analysis	Kelowna
Phosphorus, Dissolved Reactive in Water	APHA 4500-P F	Automated Colorimetry (Ascorbic Acid)	Kelowna
Phosphorus, Total by Colorimetry in Water	APHA 4500-P B.5* / APHA 4500-P F	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	Kelowna
Phosphorus, Total Dissolved by Colorimetry in Water	APHA 4500-P B.5* / APHA 4500-P F	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	Kelowna
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
AO	Aesthetic objective
MAC	Maximum acceptable concentration (health based)
OG	Operational guideline (treated water)
mg/L	Milligrams per litre

Standards / Guidelines Referenced in this Report:

Guidelines for Canadian Drinking Water Quality (Oct 2014)

Website: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/pubs/water-eau/sum_guide-res_recom/sum_guide-res_recom-eng.pdf

Note: In some cases, the values displayed on the report represent the lowest guideline and are to be verified by the end user

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6120164
PROJECT	2016-8112.000	**REPORTED**	2016-12-09

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SW-2 (6120164-01) [Water] Sampled: 2016-12-01 13:45							
Anions							
Chloride	**0.74**	AO ≤ 250	0.10	mg/L	N/A	2016-12-03	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	N/A	2016-12-03	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	N/A	2016-12-03	
General Parameters							
Ammonia, Total (as N)	**0.052**	N/A	0.020	mg/L	N/A	2016-12-05	
Nitrogen, Total Kjeldahl	**0.14**	N/A	0.05	mg/L	2016-12-06	2016-12-07	
Phosphorus, Total (as P)	**0.004**	N/A	0.002	mg/L	2016-12-06	2016-12-07	
Phosphorus, Total Dissolved	**0.004**	N/A	0.002	mg/L	2016-12-06	2016-12-07	
Phosphorus, Dissolved Reactive	**0.018**	N/A	0.005	mg/L	2016-12-03	2016-12-04	
Calculated Parameters							
Hardness, Total (as CaCO3)	**220**	N/A	0.50	mg/L	N/A	N/A	
Nitrate+Nitrite (as N)	< 0.010	N/A	0.010	mg/L	N/A	N/A	
Nitrogen, Total	**0.141**	N/A	0.050	mg/L	N/A	N/A	
Nitrogen, Organic	**0.089**	N/A	0.050	mg/L	N/A	N/A	
Total Metals							
Aluminum, total	< 0.005	OG < 0.1	0.005	mg/L	2016-12-07	2016-12-08	
Antimony, total	< 0.0001	MAC = 0.006	0.0001	mg/L	2016-12-07	2016-12-08	
Arsenic, total	< 0.0005	MAC = 0.01	0.0005	mg/L	2016-12-07	2016-12-08	
Barium, total	**0.025**	MAC = 1	0.005	mg/L	2016-12-07	2016-12-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Boron, total	**0.005**	MAC = 5	0.004	mg/L	2016-12-07	2016-12-08	
Cadmium, total	**0.00003**	MAC = 0.005	0.00001	mg/L	2016-12-07	2016-12-08	
Calcium, total	**79.1**	N/A	0.2	mg/L	2016-12-07	2016-12-08	
Chromium, total	< 0.0005	MAC = 0.05	0.0005	mg/L	2016-12-07	2016-12-08	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Copper, total	**0.0006**	AO ≤ 1	0.0002	mg/L	2016-12-07	2016-12-08	
Iron, total	< 0.01	AO ≤ 0.3	0.01	mg/L	2016-12-07	2016-12-08	
Lead, total	< 0.0001	MAC = 0.01	0.0001	mg/L	2016-12-07	2016-12-08	
Lithium, total	**0.0037**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Magnesium, total	**5.56**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Manganese, total	**0.0003**	AO ≤ 0.05	0.0002	mg/L	2016-12-07	2016-12-08	
Molybdenum, total	**0.0010**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Potassium, total	**3.37**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Selenium, total	< 0.0005	MAC = 0.05	0.0005	mg/L	2016-12-07	2016-12-08	
Silicon, total	**9.7**	N/A	0.5	mg/L	2016-12-07	2016-12-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Sodium, total	**3.81**	AO ≤ 200	0.02	mg/L	2016-12-07	2016-12-08	
Strontium, total	**0.652**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Sulfur, total	**16**	N/A	1	mg/L	2016-12-07	2016-12-08	
Tellurium, total	**0.0002**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-07	2016-12-08	

SAMPLE ANALYTICAL DATA

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	6120164
PROJECT	2016-8112.000	**REPORTED**	2016-12-09

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SW-2 (6120164-01) [Water] Sampled: 2016-12-01 13:45, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Uranium, total	**0.00201**	MAC = 0.02	0.00002	mg/L	2016-12-07	2016-12-08	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Zinc, total	< 0.004	AO ≤ 5	0.004	mg/L	2016-12-07	2016-12-08	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	

APPENDIX 1: QUALITY CONTROL DATA

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6L0179										
Blank (B6L0179-BLK1)				Prepared: 2016-12-03, Analyzed: 2016-12-03						
Chloride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
LCS (B6L0179-BS1)				Prepared: 2016-12-03, Analyzed: 2016-12-03						
Chloride	16.0	0.10	mg/L	16.0		100	90-110			
Nitrate (as N)	4.22	0.010	mg/L	4.00		106	93-108			
Nitrite (as N)	1.94	0.010	mg/L	2.00		97	83-110			
Duplicate (B6L0179-DUP1)		**Source: 6120164-01**		Prepared: 2016-12-03, Analyzed: 2016-12-03						
Chloride	0.67	0.10	mg/L		0.74			9	10	
Nitrate (as N)	< 0.010	0.010	mg/L		< 0.010				10	
Nitrite (as N)	< 0.010	0.010	mg/L		< 0.010				6	
Matrix Spike (B6L0179-MS1)		**Source: 6120164-01**		Prepared: 2016-12-03, Analyzed: 2016-12-03						
Chloride	16.3	0.10	mg/L	16.0	0.74	97	75-125			
Nitrate (as N)	4.20	0.010	mg/L	4.00	< 0.010	105	75-125			
Nitrite (as N)	1.88	0.010	mg/L	2.00	< 0.010	94	75-125			
General Parameters, Batch B6L0161										
Blank (B6L0161-BLK1)				Prepared: 2016-12-05, Analyzed: 2016-12-05						
Ammonia, Total (as N)	< 0.005	0.020	mg/L							
Blank (B6L0161-BLK2)				Prepared: 2016-12-05, Analyzed: 2016-12-05						
Ammonia, Total (as N)	< 0.005	0.020	mg/L							
LCS (B6L0161-BS1)				Prepared: 2016-12-05, Analyzed: 2016-12-05						
Ammonia, Total (as N)	0.963	0.020	mg/L	1.00		96	86-111			
LCS (B6L0161-BS2)				Prepared: 2016-12-05, Analyzed: 2016-12-05						
Ammonia, Total (as N)	0.922	0.020	mg/L	1.00		92	86-111			

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B6L0192										
Blank (B6L0192-BLK1)				Prepared: 2016-12-03, Analyzed: 2016-12-04						
Phosphorus, Dissolved Reactive	< 0.005	0.005	mg/L							
LCS (B6L0192-BS1)				Prepared: 2016-12-03, Analyzed: 2016-12-04						
Phosphorus, Dissolved Reactive	0.097	0.005	mg/L	0.100		97	80-120			
Duplicate (B6L0192-DUP1)	**Source: 6120164-01**			Prepared: 2016-12-03, Analyzed: 2016-12-04						
Phosphorus, Dissolved Reactive	0.018	0.005	mg/L		0.018				10	
Matrix Spike (B6L0192-MS1)	**Source: 6120164-01**			Prepared: 2016-12-03, Analyzed: 2016-12-04						
Phosphorus, Dissolved Reactive	0.028	0.005	mg/L	0.0111	0.018	90	70-130			
General Parameters, Batch B6L0297										
Blank (B6L0297-BLK1)				Prepared: 2016-12-06, Analyzed: 2016-12-07						
Phosphorus, Total (as P)	< 0.002	0.002	mg/L							
Phosphorus, Total Dissolved	< 0.002	0.002	mg/L							
LCS (B6L0297-BS1)				Prepared: 2016-12-06, Analyzed: 2016-12-07						
Phosphorus, Total (as P)	0.095	0.002	mg/L	0.100		95	75-112			
Phosphorus, Total Dissolved	0.095	0.002	mg/L	0.100		95	80-120			
General Parameters, Batch B6L0342										
Blank (B6L0342-BLK1)				Prepared: 2016-12-06, Analyzed: 2016-12-07						
Nitrogen, Total Kjeldahl	< 0.05	0.05	mg/L							
Blank (B6L0342-BLK2)				Prepared: 2016-12-06, Analyzed: 2016-12-07						
Nitrogen, Total Kjeldahl	< 0.05	0.05	mg/L							
LCS (B6L0342-BS1)				Prepared: 2016-12-06, Analyzed: 2016-12-07						
Nitrogen, Total Kjeldahl	1.07	0.05	mg/L	1.00		107	80-120			
LCS (B6L0342-BS2)				Prepared: 2016-12-06, Analyzed: 2016-12-07						
Nitrogen, Total Kjeldahl	1.07	0.05	mg/L	1.00		107	80-120			
Total Metals, Batch B6L0356										
Blank (B6L0356-BLK1)				Prepared: 2016-12-07, Analyzed: 2016-12-08						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6L0356, Continued										
Blank (B6L0356-BLK1), Continued				Prepared: 2016-12-07, Analyzed: 2016-12-08						
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Matrix Spike (B6L0356-MS1)	**Source: 6120164-01**			Prepared: 2016-12-07, Analyzed: 2016-12-08						
Antimony, total	0.433	0.0001	mg/L	0.400	< 0.0001	108	84-125			
Arsenic, total	0.206	0.0005	mg/L	0.200	< 0.0005	103	85-116			
Barium, total	1.03	0.005	mg/L	1.00	0.025	101	87-114			
Beryllium, total	0.101	0.0001	mg/L	0.100	< 0.0001	101	72-116			
Cadmium, total	0.100	0.00001	mg/L	0.100	0.00003	100	90-112			
Chromium, total	0.407	0.0005	mg/L	0.400	< 0.0005	102	89-120			
Cobalt, total	0.408	0.00005	mg/L	0.400	< 0.00005	102	88-120			
Copper, total	0.417	0.0002	mg/L	0.400	0.0006	104	88-125			
Iron, total	2.09	0.01	mg/L	2.00	< 0.01	104	88-119			
Lead, total	0.206	0.0001	mg/L	0.200	< 0.0001	103	89-118			
Manganese, total	0.396	0.0002	mg/L	0.400	0.0003	99	84-120			
Nickel, total	0.407	0.0002	mg/L	0.400	0.0003	102	87-119			
Selenium, total	0.103	0.0005	mg/L	0.100	< 0.0005	103	85-113			
Silver, total	0.103	0.00005	mg/L	0.100	< 0.00005	103	89-119			
Thallium, total	0.103	0.00002	mg/L	0.100	< 0.00002	103	92-119			
Vanadium, total	0.388	0.001	mg/L	0.400	< 0.001	97	87-117			
Zinc, total	1.02	0.004	mg/L	1.00	< 0.004	102	85-116			
Reference (B6L0356-SRM1)				Prepared: 2016-12-07, Analyzed: 2016-12-08						
Aluminum, total	0.302	0.005	mg/L	0.303		100	81-129			
Antimony, total	0.0555	0.0001	mg/L	0.0511		109	88-114			
Arsenic, total	0.122	0.0005	mg/L	0.118		103	88-114			
Barium, total	0.813	0.005	mg/L	0.823		99	72-104			
Beryllium, total	0.0508	0.0001	mg/L	0.0496		102	76-131			
Boron, total	3.34	0.004	mg/L	3.45		97	75-121			
Cadmium, total	0.0507	0.00001	mg/L	0.0495		103	89-111			
Calcium, total	11.8	0.2	mg/L	11.6		102	86-121			
Chromium, total	0.255	0.0005	mg/L	0.250		102	89-114			
Cobalt, total	0.0404	0.00005	mg/L	0.0377		107	91-113			
Copper, total	0.523	0.0002	mg/L	0.486		108	91-115			
Iron, total	0.53	0.01	mg/L	0.488		109	77-124			
Lead, total	0.209	0.0001	mg/L	0.204		103	92-113			
Lithium, total	0.404	0.0001	mg/L	0.403		100	85-115			
Magnesium, total	4.03	0.01	mg/L	3.79		106	78-120			
Manganese, total	0.109	0.0002	mg/L	0.109		100	90-114			
Molybdenum, total	0.212	0.0001	mg/L	0.198		107	90-111			
Nickel, total	0.259	0.0002	mg/L	0.249		104	90-111			

REPORTED TO Associated Environmental Consultants Inc. (Vernon)
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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6L0356, Continued										
Reference (B6L0356-SRM1), Continued				Prepared: 2016-12-07, Analyzed: 2016-12-08						
Phosphorus, total	0.23	0.02	mg/L	0.227		101	85-115			
Potassium, total	7.69	0.02	mg/L	7.21		107	84-113			
Selenium, total	0.132	0.0005	mg/L	0.121		109	85-115			
Sodium, total	8.02	0.02	mg/L	7.54		106	82-123			
Strontium, total	0.381	0.001	mg/L	0.375		102	88-112			
Thallium, total	0.0832	0.00002	mg/L	0.0805		103	91-114			
Uranium, total	0.0310	0.00002	mg/L	0.0306		101	85-120			
Vanadium, total	0.392	0.001	mg/L	0.386		102	86-111			
Zinc, total	2.59	0.004	mg/L	2.49		104	85-111			