FINAL

REPORT

Hydrogeological Development Suitability Study

Greater Bragg Creek Area Structure Plan Review

Submitted to:

Rocky View County

262075 Rocky View Point
Rocky View County, AB, T4A 0X2

Submitted by:

WSP Canada Inc.

3300 237 4th Avenue SW

Calgary, AB

T2P 4K3

CA0048988.7843

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Reference No. PO 32354

Dalia Wang, Planner
Rocky View County
262075 Rocky View Point
Rocky View County, AB
T4A 0X0

Dear Dalia:

As per the request by Rocky View County, we have prepared this report of the Hydrogeological Suitability Study for the Bragg Creek Development and Expansion Areas. We hope it meets your needs and expectations and those of your team.

We appreciate the opportunity to work on such an interesting and important project, and look forward to potential collaboration in the future.

Yours sincerely,

WSP Canada Inc.

David Parsons, M.Sc., P.Geol.
Lead Hydrogeologist

DP/jr/ef

WSP ref: CA0048988.7843

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1 INTRODUCTION

WSP Canada was retained by Rocky View County (the County) to complete a Hydrogeological Development Suitability Study, which will contribute to informing the development of an updated Area Structure Plan (ASP) for the Greater Bragg Creek area. The existing ASP lays a foundation that addresses community values, environmental integrity, and sustainable growth. However, with evolving environmental, infrastructure, and population dynamics, there is a need for an updated ASP. This study will underpin the new ASP by assessing hydrogeological and geotechnical factors that directly influence development suitability across the plan area. The hydrogeological assessment consists of multidisciplinary fields to determine areas suitability for development and identifying areas where additional precautions or restrictions are necessary due to environmental sensitivity or geological challenges. The study focused on:

- Flood and Groundwater Management - assessing flood risks, drainage patterns, and groundwater levels to develop effective flood mitigation strategies and protect water resources.
- Geotechnical Suitability - evaluating soil conditions, stability, and potential geohazards to ensure safe and cost-effective construction and foundation design.
- Environmental Preservation - identifying key natural resources and implementing strategies to minimize ecological impact, preserve habitats, and comply with environmental regulations.
- Potable Water and Wastewater Infrastructure Feasibility - analyzing the capacity of existing water supply and wastewater systems to meet demand and evaluating options for sustainable infrastructure development.

2 BACKGROUND AND OBJECTIVES

The primary objective of this study is to deliver a detailed assessment of hydrogeological conditions within the Bragg Creek Hamlet Growth Area and Expansion Area (the Study Area), the boundaries of which are illustrated on Figure 1. This involved determining areas suitable for development and identifying areas where additional precautions or restrictions are necessary due to potential environmental sensitivity or geological challenges, based on desktop assessment. The overall scope of work encompassed the following key components:

- Data Collection and Review – Compilation of previous hydrogeological, geotechnical, and environmental studies, including the assessment of relevant records from the Bragg Creek Hamlet Expansion Strategy and other publicly available resources on the County’s website.
- Hydrogeological Analysis – Surface and groundwater conditions within the Study Area were assessed, taking into account the extent and yield capabilities of aquifers, groundwater flow regimes, and recharge and discharge areas, particularly in relation to seasonal variations in water levels and flood risk. Historical data and analytical methods were used to visualize and evaluate existing conditions and potential impacts on areas identified for future development.
- Geotechnical Evaluation – WSP identified areas where subsurface geological materials could limit development potential due to risks such as slope instability or subsidence. The analysis incorporated data such as subsurface composition, groundwater conditions, and topography to pinpoint areas requiring specialized construction techniques or those deemed unsuitable for development.
- Impact Assessment and Mitigation Strategies – The preliminary assessment evaluated potential impacts of the proposed development on water resources, infrastructure, and the environment. Mitigation measures were recommended for sensitive areas, aligned with the ASP’s environmental goals and informed by Rocky View County’s low-impact development principles and Alberta’s Water for Life Strategy.

3 HYDROGEOLOGICAL STUDY

3.1 Groundwater Resource Evaluation and Aquifer Assessment

3.1.1 Area Geology

The bedrock geology and surficial deposits within the Study Area are shown on Figure 2.

3.1.1.1 Bedrock Geology

The bedrock geology in the Study Area is a complex series of repeated units formed by northwest-southeast trending thrust faults and folds of the Foreland Fold and Thrust Belt (Rocky Mountain Thrust Belt). Bedrock formations broadly sub-crop parallel to the regional deformation structures. The bedrock units in this area are Upper and Lower Cretaceous in age. The Upper Cretaceous units are identified as the Wapiabi Formation and Cardium Formation, and the Lower Cretaceous unit consists of the Blairmore Group (Figure 1).

The geological formations are described by Prior et al. as follows:

Upper Cretaceous

- Wapiabi Formation – shale, mudstone, silty shale, argillaceous siltstone, and siltstone (some platy, some with rusty-brown weathering, some calcareous); local bentonite layers and local siderite concretions (isolated or along horizons, locally abundant); includes fine-grained, massive to cross-bedded sandstone of the Marshybank Member (lower part of formation) and the fine- to coarse-grained sandstone and argillaceous siltstone of the Chungo Member (upper part of formation); rare, thin chert-pebble layers; marine to locally nonmarine deposits.
- Cardium Formation – Quartz sandstone (commonly thick bedded to massive), silty sandstone, siltstone, shale, and pebble conglomerate; marine deposits.

Lower Cretaceous

- Blairmore Group – Conglomerate and quartzose sandstones at the base, grades to sandstone, siltstone, mudstone, and limestone in the overlying formations.

3.1.1.2 Surficial Geology

The surficial geology of the Bragg Creek area consists primarily of Pleistocene-aged glacial deposits, with moraine, fluvial, and glaciolacustrine deposits being the dominant units (Figure 2). Fluvial deposits, including a mix of poorly to well-sorted, stratified to massive sand, gravel, silt, clay, and organic sediments are found beneath areas of low surface elevations adjacent to the Elbow River. In some areas, fluvial deposits incorporate a significant amount of colluvial material. Glacial moraine deposits consist of diamicton (till) deposited directly by glacial ice, which includes a mixture of clay, silt, and sand, along with minor pebbles, cobbles, and boulders (AGS 2024). These deposits include blocks of bedrock, stratified sediments, or lenses of glaciolacustrine and/or glaciofluvial material in some locations (AGS 2024). Lastly, the glaciolacustrine deposits, include sediments that are rhythmically laminated to massive fine sand, silt, and clay, sometimes containing debris released by melting floating ice. Littoral sediments are typically massive to stratified, well-sorted silty sand, pebbly sand, and minor gravel, commonly found in beaches, bars, and deltas (AGS 2024)

3.1.2 Water Wells and Groundwater Licences in Project Area

A total of 179 records were identified within the Study Area through a review of the Alberta Water Well Information Database (AWWID, Appendix A). Table 1 presents a summary of Domestic use wells, and Table 2 summarizes Observation, Municipal, and Unknown use wells.

It should be noted that the total number of records does not directly correspond to the number of active water wells, as the dataset includes entries related to water quality sampling, decommissioned wells, reconditioned or deepened wells, and test holes. Additionally, some active wells may not be captured due to incomplete reporting at the time of drilling. After filtering out records unlikely to represent active wells, the estimated number of active wells within the Project Area is approximately 70 to 80. Furthermore, the mapped well locations should be considered approximate, as many records provide location data only to the legal subdivision or quarter section level.

There is one active groundwater diversion licence, as shown in Table 3. The licence serves various purposes and allocates an annual groundwater volume of 1,230 m^3/year to the Bavarian Inn. It is assumed that the rest of the water wells in the Study Area are operated under exemptions to the *Water Act* for household use or traditional agricultural use of groundwater. These types of exemptions limit diversions to 1,250 m^3/year and 6,250 m^3/year, respectively.

Numerous springs have been identified in the surrounding areas by Borneuf (1980) and others. Only one spring is recorded in the water well database for the Study Area, in the NW quarter of Section 12. The precise location of this spring is unknown based on the available information; however, it is likely that it occurs as a contact spring at the base of a slope, either in the vicinity of Park Place/Park Pointe, or on the north side of the Elbow River, south of Centre Avenue.

3.1.3 Potential Aquifers in Study Area

Groundwater in the Study Area is primarily stored in shallow alluvial aquifers adjacent to the Elbow River. These aquifers exhibit seasonal variations in groundwater flow direction, which are closely tied to river discharge levels. During periods of low river discharge, groundwater tends to flow sub-parallel to the river, while during high discharge periods, the flow direction can shift, indicating complex interactions between surface water and groundwater systems.

Sandstone units within the Upper and Lower Cretaceous deposits are the primary bedrock aquifers in the Study area. Deformation of bedrock units resulted in sub horizontal and near-vertical orientation of depositional units as well as truncations of aquifer units by faulting can limit the lateral continuity and therefore yield capacity of these aquifers. Drilling reports from AWWID indicate that bedrock units with a well-developed fracture network (typically near the top of bedrock) may also act as secondary bedrock aquifers.

The locations of water wells, historical boreholes and hydrogeological cross-section lines are shown on Figure 3. Hydrogeological cross-sections A-A’ (Figure 4), B-B’ (Figure 5), and C-C’ (Figure 6), show the distributions of geological materials, well screen intervals, and water levels in selected boreholes and water well records in the Study Area.

3.1.3.1 Surficial Aquifers

Surficial aquifers are typically within shallow fluvial and glaciofluvial units composed of sands and gravels; these aquifers are expected to have limited lateral and vertical extents in the Study Area due to the topography and nature of the depositional environment. Surficial deposits and associated aquifers generally occur at depths of less than 17 metres below ground level (mGL). Thirty-seven AWWID records have been interpreted as being completed in the surficial aquifers. Sand and gravel deposits of varying depths were noted above bedrock across the Study Area. Recommended or tested flow rates from 25 wells completed within surficial aquifers ranged from 1.1 to 114 L/min, with an average of approximately 34 L/min.

Mapped groundwater yields in surficial aquifers in the Study Area range between 5 and 25 imperial gallons per minute (igpm), or 30 to 160 m^3/d (Borneuf 1980, HCL 2002). The Bow River basin, of which the Elbow River is a tributary, is closed to new surface water allocations. This includes groundwater that is considered directly connected to surface water, so groundwater diversions from alluvial aquifers in the Bragg Creek townsite are limited to existing allocations and may be subject to holdbacks.

In the Hamlet Expansion Area, extensive surficial sand and gravel-bearing deposits of up to 40 m depth covered by a thin veneer of fine-grained materials are indicated in the water well records and may represent buried paleochannel or glacial meltwater lake deposits within sandy tills that are/were connected to channels that drain southeast to Priddis Creek (Figure 2). A gravel pit is located to the west of the Study Area in NE Section 07, and SE Section 18 of Twp 23 Rng 4 W5M and appears to also represent similar deposits connected to the Priddis Creek sub-watershed (Figure 2). Limited water level measurements from the water wells completed in these deposits are available; however, the data that is available indicate a deep local water table and deep saturated intervals of limited thickness within these granular deposits immediately above the bedrock. The AWWID records indicate the wells in the Hamlet Expansion Area are mostly screened in the underlying bedrock sandstones.

3.1.3.2 Bedrock Aquifers

Sandstone units within the Blairmore and the Alberta Group deposits are expected to be the primary bedrock aquifers in the Study Area; however, drilling reports from AWWID indicate that fine-grained bedrock units with a well-developed fracture network may also act as secondary aquifers. Due to the complex regional folding and faulting of the bedrock in the Study Area, the low permeability units are expected to act as confining layers and barriers to groundwater flow. Hydraulic connectivity between sandstone units will be controlled by the extent of fracture development within the low permeability units. Mapped groundwater yields from the Study Area (Borneuf 1980, HCL 2002) are between 1 igpm and 5 igpm (0.1 to 0.4 L/s, 5 to 30 m^3/d) in the bedrock aquifers. Data from the AWWID records indicates the following about wells completed within the bedrock:

- Water well depths ranged from 18 to 90 m, with an average depth of 35 m; the majority of the wells are installed to withdraw groundwater from interbedded shale and sandstone bedrock units.
- Water well pumping rates were assessed in records from 1966 – 2022; recommended pumping rates (as indicated in the records by the water well drillers) range from 1.14 to 90.92 L/min, with an average rate of 18.95 L/min. The approximate locations of these groundwater wells and their recommended pumping rates are shown on Figure 7. Water well records are included in Appendix A and Tables 1 and 2.
- Across the Study Area, there are multiple sets of records that show a combination of test holes, dry holes, or new wells have been drilled near one another and terminated at various depths; indicating that the depth to viable aquifers is inconsistent across the Study Area. A comparison of drilled well depths and recommended pumping rate data further indicated that there is no apparent correlation between well depth and recommended pumping rates.

3.1.3.3 Groundwater Recharge

Of the 179 well records in the Bragg Creek Hamlet Growth and Expansion Areas, approximately 143 have data to indicate the depth of screened, open, or perforated intervals, in addition to lithology logs. Disregarding decommissioned wells, it is estimated there are on the order of 70 to 80 active water wells in the Study Area. Other than the single licensed water well for the Bavarian Inn, it is assumed that the active water wells in the Study Area are operated under exemptions to the *Water Act* for household use or traditional agricultural use of groundwater. These types of exemptions limit diversions to 1,250 m^3/year and 6,250 m^3/year, respectively. If a volume of 1250 m^3/year is being diverted from 80 of these wells, that represents an annual groundwater requirement of approximately 100,000 m^3/year. This estimated volume only includes water wells within the boundaries of the Study Area; however, it is unlikely that all of these wells are fully active and being used constantly throughout the year. It is also possible that many are not being used at all or have been abandoned.

The catchment area for Bragg Creek (waterbody), Iron Creek, and areas of the Study Area and adjacent areas that drain to the Elbow River represent approximately 60 km^2. Average annual precipitation in Bragg Creek is approximately 410 mm/year, and therefore equates to a volume of almost 24,000,000 m^3/year in the catchment area. An assumption of 10% groundwater recharge equals over 2,400,000 m^3/year, which well exceeds the estimated groundwater usage for the Study Area. This proportion of groundwater recharge (10%) was previously assumed for the Jumpingpound Creek watershed to the north and was comparable to separate estimates of recharge obtained from baseflow separations for that area (AMEC, 2011). This estimate also does not include potential recharge occurring further upstream of the Study Area boundaries within the Elbow River catchment.

3.1.4 Water Quality

The Greater Bragg Creek Area was evaluated for water quality using laboratory results administered by Alberta Health Services (AHS) for private well water (Appendix B). Groundwater samples were collected from private wells between 2002 and 2018, with the wells categorized by depth into surficial and bedrock aquifers. What are classified as surficial aquifer wells in the Study Area generally include those with depths ranging from 0.0 to 17 mGL, while wells deeper than 17 mGL are likely installed in a bedrock aquifer and extend to depths up to 54 m. The water quality results included various groundwater parameters, including major ions and general chemistry analytes, trace metals, and bacteria.

The average pH for the surficial aquifer was 8.09, while the bedrock aquifer had a similar but slightly higher average pH of 8.23. Total Dissolved Solids (TDS) concentrations averaged 490 mg/L for the surficial aquifer and 436 mg/L for the bedrock aquifer. Electrical conductivity (EC) averaged 877 µS/cm for the surficial aquifer and 786 µS/cm for the bedrock aquifer. Chloride concentrations were 60.0 mg/L in the surficial aquifer and 39.5 mg/L in the bedrock aquifer, both of which are within typical ranges, although slightly elevated compared to background values.

The water type in the surficial aquifer is primarily Calcium Bicarbonate, with minor contributions from Calcium Chloride, Sodium Bicarbonate, Calcium Sulphate, and Sodium Chloride waters. The bedrock aquifer, in contrast, contains a more even mix of Calcium Bicarbonate and Sodium Bicarbonate water type, with lower relative concentrations of other major ions. Figure 8 presents a Piper plot illustrating the geochemical composition of the groundwater samples, categorized by their respective sources.

Overall, the water quality in the Study Area can be considered suitable for domestic consumption, agriculture, and other development-related uses; however, there are concerns regarding groundwater hardness, which may impact well screens, plumbing fixtures and other infrastructure, and may be of concern to individuals with health issues related to bones and joints.

The Sodium Absorption Ratio (SAR) of local groundwater was assessed using the equation below

$$\mathrm{SAR} = \frac{Na^{+}}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

Analyte concentrations were obtained from Alberta Health Services and converted from mg/L to meq/L. The Sodium Adsorption Ratio (SAR) for the surficial aquifer was calculated at 1.11 meq/L, and for bedrock aquifer, at 1.89 meq/L. These values reflect the relative proportion of sodium to calcium and magnesium in both shallow and groundwater sources. SAR values of this magnitude are considered low, indicating minimal risk of sodium-related impacts on subsurface soils and ground structures. SAR greater than 8 may be conducive to reduced permeability of surface soils over time which would impact the function of disposal fields or stormwater infiltration features (AENV, 1996).

To evaluate the potential for scaling and corrosion in water systems that divert and convey local groundwater, the Langelier Saturation Index (LSI) and Ryznar Stability Index (RSI) were calculated. The LSI estimates whether water will precipitate or dissolve calcium carbonate: a positive LSI indicates a tendency for scaling, while a negative value points to potential corrosion. The RSI is derived from water chemistry parameters including pH, calcium, TDS, bicarbonate, and temperature; assumed temperatures were 15°C for the surficial aquifer and 10°C for the bedrock aquifer.

The calculated RSI for the surficial aquifer was 6.4, suggesting the water is stable with low likelihood for corrosion. Similarly, the bedrock aquifer showed an RSI of 6.8, indicating only a slight difference from the surficial aquifer and similarly low risk. The LSI for the surficial aquifer was calculated at 0.83, while the bedrock aquifer had an LSI of 0.73. These positive values indicate that both water sources are supersaturated with respect to calcium carbonate, suggesting a moderate tendency to form scale buildup on surfaces such as piping, fixtures, and well casings/screens.

3.2 Site Suitability for Development

Site Suitability for Development is generally determined by the composition and drainage capacity of the natural surficial materials and soils, severity of surface slopes, and depths to water table and bedrock. As discussed above, surficial geological materials that characterize the Study Area include:

- Fine- and coarse-grained alluvial sands and gravels, occurring in the valley bottoms and in adjacent areas as terraces.
- Thin, fine-textured glaciolacustrine deposits on top of bedrock (Bayrock et. al. 1980). Scheelar and Veauvy (1977) interpret these materials to be morainal blanket deposits of glacial origin. These generally occur on the higher ground to the south of the Elbow River (including most of the Hamlet Expansion Area).
- At elevated areas to the north and southwest of the Elbow River, surface materials are mainly comprised of sandy till (Moraine) deposits on top of bedrock, and colluvium consisting of soil and rock creep materials occurs at the highest elevations. The occurrence of these deposits is very limited within the Study Area.

Figure 2 shows the general distribution of the surficial materials described above. The following subsections discuss the suitability for development in the areas where each of them occurs.

3.2.1 Fine and Coarse Textured Alluvial Deposits

The alluvial deposits in the region occur in and along the river channels and in adjacent terraces and are typically 2 to 7 m thick (Bayrock et al. 1980). Drilling data in the Study Area indicate typical thicknesses of alluvial sands and gravels of between 2 m and 5 m. Floodplain-deposited silty sands at ground level and overlying the coarser fluvial channel material are also commonly found at the low elevations adjacent to the river in the valley bottom. The areas where these occur are characterized by:

- Shallow water table due to low elevation and proximity to the Elbow River.
- High permeability, which gives them a high infiltration/drainage capacity and low risk for frost heave, however, these materials also are conducive to seepage induced by flooding. Drainage is also limited by shallow water tables and shallow bedrock in the area.
- The gravel deposits in these areas can be a source of aggregate, where practical (Shetsen 1981).
- The fine and coarse alluvial and floodplain deposits may be suitable as road fill.
- They generally occur on level- to gently sloping topography on the valley bottom and terraces near the base of adjacent slopes.

Due to the risks from shallow water tables and seepage/flooding risks, these areas are not generally recommended for homes with basement levels, on-site septic systems, or passive stormwater or low impact development (LID) facilities. These areas may be more suitable for recreation areas, limited agriculture, and non-residential buildings and roadways. Buildings/residential developments could be considered for higher elevation areas further from the river and/or using added fill on top of grade, slab on grade or raised foundations, or flood protection structures where practical. Excavations in these noncohesive granular materials can be prone to sloughing/caving as well (Scheelar and Veauvy, 1977).

To the south of the river valley and floodplain, in the Hamlet Expansion Area (SE ¼, Section 12), there are surficial granular deposits of possible fluvial/glaciofluvial or lacustrine origin extending to depths of up to 40m. These deposits appear to represent an abandoned/buried paleochannel or meltwater lake deposits potentially connected to tributary streams flowing to the southeast toward Priddis Creek. Aerial imagery shows that there is a gravel pit located to the east of the Hamlet Expansion Area, in an area of local sand and gravel deposits mapped by Shetsen (1981), which also appears to be connected to Priddis Creek drainage. Water tables in this area appear to be much deeper below ground level, and the areas where the granular surficial materials occur are likely well-drained. Topography is gently to moderately sloping and some areas may require cut/fill grading to permit residential development in some locations.

3.2.2 Fine Textured Glaciolacustrine/Till Deposits

The silty, relatively thin surficial materials deposited above bedrock at the higher elevations to the south and north of the valley bottom range from 3 to 6 m thick (Bayrock et. al 1980). They generally consist of clayey silt with minor sand and gravel. The high elevation areas where these deposits occur are characterized by:

- High fines content and low permeability may be below ideal infiltration capacity for stormwater, infiltration, and septic facilities in some areas; Scheelar and Veauvy (1977) describe the deposits as moderately well-draining.
- They generally occur on gently to moderately sloping topography.

- The local bedrock depth is variable and the water table is relatively deep, but perched conditions may exist in some areas.
- The silty composition of the deposits may make these materials prone to frost heave.

Slopes, moderate drainage and susceptibility to frost heave represent some risk for buildings, roadways, stormwater or septic facilities, and landfills in certain areas. For recreation sites and agriculture, the areas where these surficial deposits occur are generally suitable. Cut/fill/levelling would be required in some cases for expanded residential development. Excavations may be limited by shallow bedrock at higher elevations. Perched water tables may occur in some locations creating wet conditions and possible need to manage seepage during and after construction.

3.2.3 Sandy Till (Moraine) Deposits and Colluvium

Sandy till and colluvium deposits occur along the steeper slopes to the north and southwest of the Elbow River and are of limited extent and occurrence within the Study Area boundaries. These are characterized as sandy till/morainal veneer deposits consisting of approximately 50% sand. Colluvium occurs at the highest elevations with a 1.5 to 3 m thickness consisting of rock creep and weathered bedrock material directly above shale, siltstone, and sandstone bedrock. These deposits:

- Are generally well-drained and of relatively high permeability.
- Occur on moderate to steep slopes.
- Occur where bedrock is shallow. The water table where these deposits occur is generally deep, but perched conditions may exist.

The steep slopes and thin deposits above bedrock generally make these areas unsuitable for development, however, some developments may be sited where slopes are moderate. They may be suitable for limited use for recreation sites and agriculture. The occurrence of the surficial deposits that characterize these areas are of limited areal extent in the Hamlet Growth Area and are more common in areas further north and southwest of the Study Area boundaries.

3.3 Seepage Assessment and Risks Due to Flooding

Groundwater seepage was previously assessed by Amec Foster Wheeler (2017) to estimate potential underseepage beneath proposed flood berms along the Elbow River, to evaluate the necessary capacity of proposed drainage systems, and to determine the likelihood and extent of groundwater seepage appearing at surface in a 1:100-year flood event. Historical borehole and test pit data have been compiled to characterize the subsurface and the alluvial aquifer in the area of the Elbow R-river channel and flood plain to re-assess the extent of flooding due groundwater seepage beneath the flood berms. The previous assessment was based on the information available at the time from the immediate area and some simplifying assumptions. Here, underseepage during flood conditions will be reassessed using additional, more up-to-date information and revised assumptions.

It is understood that there have been instances of greater incursion of groundwater in some areas adjacent to the Elbow River than expected at times during the annual water cycle. This is believed to be partly due to the presence of the berm which has effectively narrowed and deepened the river channel in some areas, possibly resulting in higher local rise in the river level than expected during peak flows in spring. In addition, the permeable sand and gravel deposits are conducive to rapid seepage of flood water through the surficial deposits and under the berm that can reappear at ground surface.

Groundwater seepage rates and water table displacement were evaluated based on the hydraulic head changes produced by the expected rise and rate of change in the river level in a 1:100-year flood condition using river and flood stationing data from Amec Foster Wheeler (2017). The seepage estimates are determined based on one-dimensional flow in an unconfined aquifer developed by Edelman (1947), as described by Huisman and Olsthoorn (1983).

The calculations used for seepage estimates are as follows:

$u = 0.5*\sqrt{(S_y/Kb)}*(x/\sqrt{t})$ (1a)

$s_x = s_o*\mathrm{erfc}(u)$ (1b)

$q_o = (s_o/\sqrt{(\pi)}) * (\sqrt{(Sy*K*b)})*(1/\sqrt{(t)})$ (1c)

$E_2 = e^{-uu}$ (1d)

$q_x = q_o * E_2$ (1e)

Where:

S_y = specific yield
K = hydraulic conductivity (m/s)
b = aquifer thickness (m),
x = distance from flood-berm interface (m)
t = time (d)
s_o = river level rise (3.6 to 4.4 m) and s_x = head change at distance x from the interface (L)
q_o = seepage rate at the interface, and q_x = seepage rate at distance x (L^3/t)

Some assumptions were made to simplify the analytical calculations:

- The transition to the flood condition is instantaneous and the peak flood persists for up to 3 days.
- The surficial geology consists of a single layer of material, as described above, with a typical thickness observed in borehole logs of 4.0 m.
- Hydraulic conductivity (K) estimates for the sand/gravel surficial materials in the immediate area range from 5.0×10^{-5} to 8.5×10^{-4} m/s, based on particle size and slug test data collected during previous investigations.
- Distances (x) at which water table rise and seepage rates are calculated are relative to the flood/berm interface which is considered to be located at the stream-side toe of the berm.
- All seepage flux is assumed to be horizontal and parallel to the plane of section (orthogonal to the river channel).

The calculations produced multiple estimates of seepage flux and water table displacement for 2D sections through the river and floodplain area at the selected stationing locations. The calculations were automated using a spreadsheet. The results were calculated at various time steps, which are within the range that peak flooding would be expected to persist (approximately three days). Sensitivity of the calculations to uncertainty in parameters such as hydraulic conductivity and flood duration were assessed as well.

3.3.1 Results

Table 4 and Figure 9 present the estimated extent of daylighting of groundwater underseepage during flood conditions and extent of potential impacts to subsurface structures such as basements. The assessment neglects the potential barrier effects of materials such as road pavements or preferential pathways created by underground utilities. It also disregards collection and potential infiltration of direct surface precipitation and runoff.

The theoretical seepage calculations and results are included in Appendix C. The analysis indicates that impacts due to induced groundwater seepage in a 1:100year flood event may propagate between 50 to 100m laterally from the river channel and berm within a typical flood advance timeframe of 2 to 3 days.

Seepage fluxes in the subsurface at a distance of 50m from the river/berm interface (as calculated from equations 1c to 1e and summarized in Appendix C) are mostly between 8 and 9 m^3/d per lateral metre orthogonal to the direction of flow. Groundwater seepage reaching subsurface structures would represent a significant portion of these fluxes, depending on the depth/elevation of the structure relative to the water table rise and the configuration of the structure.

4 CONCLUSIONS

Bedrock aquifers composed of alternating shale and sandstone represent the primary source of domestic groundwater use in the area. Groundwater yield mapping and recharge estimates indicate that sufficient groundwater resources capable of providing provincially mandated domestic water volumes appear to exist across the Study Area; however, due to the complex regional folding and faulting of the bedrock geology, the depth and continuity of water bearing units may vary widely and productivity of water bearing units also is expected to vary.

Groundwater quality in bedrock aquifers in the Study Area is of generally acceptable quality and within guidelines for domestic consumption. Sodium Absorption Ratios in surficial and bedrock aquifers were within a range suggesting they were suitable for stormwater infiltration facilities and septic fields; however, other site suitability factors would also need to be favourable. It was also determined that groundwater hardness and carbonate stability indices indicate that scaling of plumbing and fixtures is a potential problem for new developments, and water hardness may also be of concern for individuals with health issues related to bones and joints.

Site suitability for new developments is variable across the Hamlet Growth and Expansion Areas, and all areas have some combination of shallow water tables, shallow bedrock depths, steep slopes, poorly draining surface soils, and risks of groundwater flooding that may be detrimental to development activities without cut and fill levelling, raised / pile-supported foundations or other interventions. The most desirable areas for residential developments are likely in the lowland valley area at distances of greater than 100m from the Elbow River, and in parts of the Hamlet Expansion Area (SE ¼ Section 12) where soils are well-draining and slopes are relatively moderate.

An updated assessment of the extent of flooding impacts due to induced groundwater seepage during a 1:100 year flood condition indicate that, provided the flood berms are effective at preventing overland flooding, possible daylighting of groundwater and basement seepage would be limited to a distance of between 50 and 100 m inland from the Elbow River flood berm in most areas, assuming direct precipitation and runoff contributions are relatively minor.

5 DATA GAPS AND RECOMMENDATIONS FOR FURTHER EFFORTS

The most significant data gaps are associated with the subsurface characterization of the Hamlet Expansion Area in SE-12-23-05 W5M. A field verified water well survey to confirm the existence and location of water wells and springs in that area should be conducted to provide additional detail to future hydrostratigraphic conceptual models. Also, a limited drilling programme and/or geophysical survey may be necessary to delineate/confirm the local stratigraphy, and areal distribution and thickness of fine- and coarse-grained surficial materials.

A number of geotechnical and groundwater monitoring boreholes and instrumentation have been installed in the past in the Hamlet of Bragg Creek, generally focussed on small areas including a gauging station site, and the water treatment plant. Data associated with these investigations was collected in various years and times of the year. It is recommended to conduct a field programme to fill gaps in these existing data sets by completing the following:

- Borehole drilling to further characterize the geology in the Hamlet Expansion Area.
- Conducting surface geophysical surveys where feasible, to supplement the drilling programme.
- Water level monitoring and in-situ testing for assessment of hydraulic parameters, including slug tests and / or pumping tests.

Assessment of the extent of flooding impacts may be refined by developing a 2D or 3D numerical surface water-groundwater model(s) for the area. Such models, in comparison to the analytical calculations described above, may better incorporate and account for the complexities of area geology, as well as timing of both flood advance and recession, and inputs from precipitation and runoff.

Installation and testing of water wells in proposed areas of development can be conducted to assess the feasibility of community or individual household water wells in new residential developments, the capabilities of local aquifers, and potential impacts on existing groundwater users in adjacent areas.

6 CLOSURE

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Signature Page

WSP Canada Inc.

Prepared by:

PROFESSIONAL GEOLOGIST
DAVID F. PARSONS
ALBERTA
09-25-2025
ID# 84982

David Parsons, M.Sc., P.Geol.
Lead Hydrogeologist

Reviewed by:

PROFESSIONAL GEOSCIENTIST
ALYSSA BARKER
ALBERTA
September 29 2025 ID# 73090

Alyssa Barker, P.Geo.
Group Manager / Lead Hydrogeologist

PERMIT TO PRACTICE
WSP CANADA INC.
RM SIGNATURE: ______
RM APEGA ID #: 73090
DATE: September 29 2025
PERMIT NUMBER: P007641
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Contributors:

Nishat Rahman, B.Sc., G.I.T.
Hydrogeologist in Training

DP/NR/AB/jr/ef

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The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

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Design recommendations given in this report are applicable only to the project and areas as described in the text and then only if constructed in accordance with the details stated in this report. The comments made in this report on potential construction issues and possible methods are intended only for the guidance of the designer. The number of testing and/or sampling locations may not be sufficient to determine all the factors that may affect construction methods and costs. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.

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This limitations statement is considered an integral part of this report.

Tables

Table 1: Well Records - Domestic

Well ID	Landowner	Date Completed	Total Drilled Depth (mGL)	Listed Well Type	Static Water Level (m)	Test Rate (L/min)	Test Rate (m^3/day)	Outer Well Diameter (cm)
Surficial								
341415	HERRON EST	1998-06-08	12.19	Test Hole-Decommissioned	2.83	9.09	13.09	0.00
341416	HERRON EST	1998-06-08	12.19	Test Hole-Decommissioned	2.65	1.14	1.64	0.00
349515	MERRITT, CARL	1987-02-09	12.19	Deepened	3.05	2.27	3.27	16.81
357782	ARCHER, CAREN/STEVE	1987-07-29	17.07	New Well	2.44	13.64	19.64	16.81
359886	THOMPSON, AL	1991-07-16	13.11	New Well	2.44	54.55	78.55	16.81
364932	GLASSFORD, A.R.	1992-05-14	15.24	New Well	10.97	36.37	52.37	16.81
379701	BUMSTEAD, BRIAN	1995-10-18	13.41	New Well	3.51	9.09	13.09	16.81
387456	MCARUTHER, JAMES	1966-09-07	5.18	New Well	1.52	113.65	163.66	15.57
387458	GRAVES, G.	1968-06-11	16.76	New Well	1.22	2.27	3.27	0.00
387459	ELSDON	1977-07-05	17.07	New Well	3.35	9.09	13.09	17.78
387464	COCKING, JIM	1981-11-02	12.50	New Well	4.57	43.19	62.19	14.12
387504	EARLY, JOHN	1975-06-11	12.19	New Well	2.74	18.18	26.18	13.97
387508	BISHOP, ROBIN	1969-09-01	6.71	New Well-Decommissioned	1.83	45.46	65.46	12.70
387510	CHALLICE, C.	1972-06-01	11.89	New Well	6.10	13.64	19.64	0.00
387511	B&G CONSTR	1972-11-01	9.14	New Well	2.44	90.92	130.92	15.24
387519	NEWLANDS, B.	1974-11-04	9.14	New Well	0.00	22.73	32.73	16.84
387520	KUNES, VUCLAV	1975-06-21	12.80	New Well	3.05	31.82	45.82	11.43
387625	RICHTER, PAUL	1974-01-01	10.06	New Well	3.05	4.55	6.55	15.88
387626	GRAHAM, E.	1970-11-01	11.28	New Well	4.88	45.46	65.46	0.00
387627	TEGHTMEYER, ROB	1975-02-24	9.45	New Well	3.35	68.19	98.19	0.00
387633	KOGMA, J.	1971-04-01	8.84	New Well	3.35	113.65	163.66	12.40
387635	JONES, COLIN	1970-11-01	6.40	New Well	3.66	27.28	39.28	15.24
418094	RIDLEY, HAROLD	1974-05-27	12.19	New Well	2.44	6.82	9.82	15.24
Bedrock								
341256	DALRYMPLE, LORNE #3832	1999-09-03	50.29	New Well	11.49	9.09	13.09	16.81
341491	FRENCH, KIM #3696	1999-03-31	24.38	New Well	11.89	22.73	32.73	16.81
349187	RUBEN, P. PALMER K.	1992-11-17	30.48	New Well-Decommissioned	10.67	6.82	9.82	16.81
349188	RUBEN P/PALMER K.	1992-11-23	19.81	New Well	9.75	18.18	26.18	16.81
349754	CARRUTHERS, BARRY 2673	1995-05-17	29.57	New Well	0.00	13.64	19.64	16.81
349764	AVERY, SUSAN #2698	1995-06-05	27.43	New Well	2.53	10.68	15.38	16.81
349765	AVERY, SUSAN #2695	1995-06-01	28.04	New Well	9.36	18.18	26.18	16.81
349769	HARE,RICHARD #2723 SITE 3	1995-06-29	32.00	New Well	19.29	36.37	52.37	16.81

Table 1: Well Records - Domestic

Well ID	Landowner	Date Completed	Total Drilled Depth (mGL)	Listed Well Type	Static Water Level (m)	Test Rate (L/min)	Test Rate (m^3/day)	Outer Well Diameter (cm)
349817	HARR, RICHARD #2680	1995-06-15	36.58	New Well	22.40	9.09	13.09	16.81
349818	HARE, RICHARD #2747	1995-07-28	33.53	New Well	20.70	22.73	32.73	16.81
351846	MCCLOY, TERRY	1990-07-07	32.00	New Well	12.19	9.09	13.09	14.12
352206	EAGER, ALAN	1990-09-18	44.20	New Well	3.05	13.64	19.64	16.81
357974	SHOULTS, IDA # 1599	1991-05-27	32.00	New Well	3.05	18.18	26.18	16.81
364931	GLASSFORD, A.R.	1992-06-05	18.90	New Well	11.58	27.28	39.28	16.81
387390	KLEIBER, W.	1970-11-01	19.81	New Well	4.88	7.96	11.46	16.51
387392	NEUFELD, VIC	1974-11-07	50.90	Deepened	17.98	9.09	13.09	15.88
	NEUFELD, VIC	1974-11-07	50.90	Deepened	27.13	45.46	65.46	15.88
387395	ALBERTSON	1968-06-06	28.96	New Well	10.36	13.64	19.64	13.97
387457	MCKEAGUE, D.	1967-09-08	36.58	Deepened	6.10	2.27	3.27	0.00
387463	KABATOFF, ALEX	1979-07-31	33.53	New Well	3.05	2.27	3.27	14.12
387490	KELLY, LAWRENCE	1976-07-03	18.29	New Well	1.98	13.64	19.64	17.78
387503	LOVE, H.G.	1968-06-04	18.29	New Well	3.05	4.55	6.55	15.24
387509	BISHOP, ROBIN	1969-09-01	21.34	New Well	2.13	45.46	65.46	12.70
387514	MCLENNAN, BOB	1977-03-07	34.75	New Well	13.72	4.55	6.55	14.12
387515	BRAUN, ERV	1976-07-06	25.91	New Well	4.88	10.23	14.73	14.12
387517	TRAVIS, STEVE	1979-07-08	21.34	New Well	4.57	45.46	65.46	14.12
387521	MCARTHUR, ARNOLD	1985-05-28	30.18	New Well	4.27	18.18	26.18	16.84
387591	ARCHER, STEVE #1	1987-07-28	28.96	Test Hole	2.44	4.55	6.55	16.84
387607	PEARMAIN, KEITH	1975-03-04	31.09	New Well	2.80	18.18	26.18	0.00
387617	DICK, LEO	1975-02-26	21.34	New Well	2.44	45.46	65.46	14.12
387628	WRATHALL, G.M.	1967-09-20	21.34	New Well	2.74	2.27	3.27	16.84
387631	BLAKLY, W.E.	1971-06-01	34.14	New Well	14.33	90.92	130.92	13.16
387645	BRAGG CREEK TRADING POST	1981-02-01	28.04	New Well	3.66	2.27	3.27	0.00
390232	LERNER, DENNIS	1968-06-21	29.26	New Well	3.35	9.09	13.09	0.00
458941	HOLSCHUH, CHARLIE#3338	2001-10-10	36.58	Deepened	3.35	2.27	3.27	16.81
491217	DEAN, DON	1998-07-14	24.38	New Well	1.52	90.92	130.92	16.81
1020214	RENAUD, ALAIN	1998-09-30	30.48	New Well	2.41	11.37	16.37	16.81
1021522	MCKEAGUE, DOUG	2007-08-07	49.68	New Well	0.00	18.18	26.18	16.81
1611155	FRENCH, KIM	2022-09-05	28.96	New Well	11.40	34.10	49.10	16.84
2066214	MACALLISTER, EDITH	2018-10-25	53.34	New Well	2.32	27.28	39.28	16.83
9546320	MINTY, DEV	2017-09-03	41.15	New Well	2.83	6.82	9.82	16.81
350053	MCHUGH, DAN	2016-08-30	89.92	Deepened	51.82	2.27	3.27	16.84
350053	EATON, LES #3359	1998-01-30	67.06	New Well	12.59	9.09	13.09	16.81
350053	MCHUGH, DAN	2007-09-10	71.63	Deepened	19.81	1.14	1.64	16.81
1022750	WAKEFIELD, DAVE & IRIS	2016-05-24	65.53	New Well	16.52	4.55	6.55	16.84

Table 2: Well Records - Miscellaneous

Well ID	Landowner	Date Completed	Total Drilled Depth (mGL)	Listed Well / Record Type	Static Water Level (m)	Test Rate (L/min)	Test Rate (m^3/day)	Outer Well Diameter (cm)
Surficial								
387504	EARLY, JOHN	1975-06-11	12.19	New Well	2.74	18.18	26.18	13.97
387623	KLINE, ROGER	1967-09-11	9.14	New Well	3.35	-	0.00	16.84
387633	KOGMA, J.	1971-04-01	8.84	New Well	3.35	113.65	163.66	12.40
465414	REID, CROWTHER & PARTNERS LTD	-	0.00	Spring	-	-	0.00	0.00
Bedrock								
387455	ELKANA RANCH LTD	1966-06-15	48.77	Dry Hole	-	-	0.00	12.70
387512	MCKEAQUE, D.K.	1981-07-08	48.77	Dry Hole	-	-	0.00	0.00
387591	ARCHER, STEVE #1	1987-07-28	28.96	Test Hole	2.44	4.55	6.55	16.84
387615	SHLAHT, ALF	1973-07-01	33.22	Dry Hole	-	-	0.00	0.00
2095057	MASCH, KLAUS	1961-07-01	21.34	Well Inventory	21.34	-	0.00	-

Note:
mGL = metres below ground level

Table 3: Water Licences

Allocation #	Priority	Licensee	Purpose	Diversion Quantity (m^3)	Diversion Rate (m^3/day)	Allocation Type
10751	1981-01-19-0001	Wintergreen Woods Water Utility Ltd.	Recreation	201,060	4924.8	Surface Water
13959	1976-07-30-0002	Rocky View County	Municipal	39,470	1382.4	Surface Water
14981	1974-08-20-0002	Elkana Residents Water Co-op Limited	Municipal	86,350	172.8	Surface Water
201198	2009-08-17-0002	Elkana Residents Water Co-op Limited	Municipal	0	864	Surface Water
16120	1981-04-10-0003	Bavarian Inn	Recreation	1,230	0.65	Groundwater
230328	1969-05-16-0001	Alberta Environment and Portected Areas	Government Holdback	617	86.4	Surface Water
237535	2009-08-17-0002	Alberta Environment and Portected Areas	Government Holdback	0	0	Surface Water
237537	1974-08-20-0002	Alberta Environment and Portected Areas	Government Holdback	0	0	Surface Water
DRALOC0011584	2009-08-17-0002	Rocky View County	Municipal	0	864	Surface Water
DRALOC0015195	1981-04-21-0001	G.S. Barbecue Steak Pit Ltd.	Commercial	18,500	86.4	Surface Water
DRALOC0015910	1964-10-21-0002	Rocky View County	Water Management	0	0	Surface Water

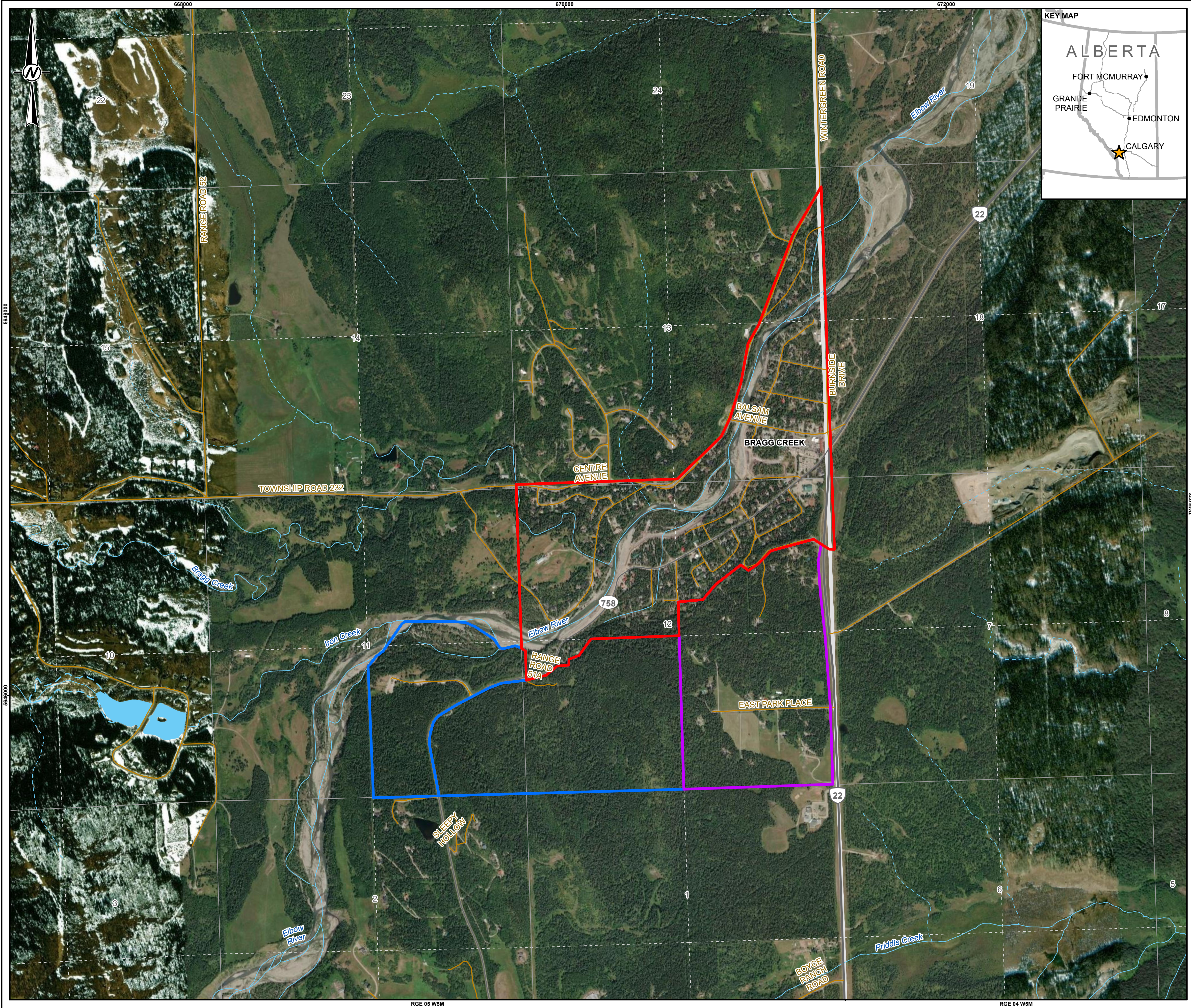
Table 4: Estimated Extent of Elbow River Flood Impacts (1:100 year event)

River Centerline Stationing (Figure 9)	Non-Flood River Level (masl)	Rise in River Level – 1:100 year flood (m)	Ground Surface Elevation (masl – approx.)	Distance (x) From River Flood Interface (m)	Phreatic Surface Elevation at 'x' (masl)		
					Base Case	Sensitivity Analysis	
					K = 8.0 x 10^{-4} m/s, S_y = 0.2, t = 3 d	Lower K K = 1 x 10^{-4} m/s	Less time (t = 2 d)
10+150	1307.5	3.8	1323	10	1310.96	-	1310.89
				50	1309.71	-	1309.40
				100	1308.53	-	1308.17
				150	1307.87	-	1307.66
				200	1307.60	-	1307.52
				300	1307.50	-	1307.50
10+700	1303	4.3	1306	10	**1306.92**	**1306.25**	**1306.84**
				50	**1305.50**	1303.51	**1305.15**
				100	**1304.17**	1303.01	1303.76
				150	1303.42	1303	1303.18
				200	1303.12	1303	1303.03
				300	1303.00	1303	1303
11+000	1301.5	4.1	1305	10	**1305.24**	**1304.60**	-
				50	**1303.89**	1301.99	-
				100	1302.61	1301.51	-
				150	1301.90	1301.50	-
				200	1301.61	1301.50	-
				300	1301.50	1301.50	-
11+550	1297.5	3.7	1302	10	**1300.87**	-	-
				50	1299.65	-	-
				100	1298.50	-	-
				150	1297.86	-	-
				200	1297.60	-	-
				300	1297.50	-	-
12+100	1293	4.0	1297.5	10	**1296.65**	-	-
				50	**1295.33**	-	-
				100	1294.08	-	-
				150	1293.39	-	-
				200	1293.11	-	-
				300	1293.00	-	-
12+450	1290.5	4.4	1294.5	10	**1294.51**	-	-
				50	**1293.06**	-	-
				100	1291.69	-	-
				150	1290.93	-	-
				200	1290.62	-	-
				300	1290.50	-	-
12+800	1287.1	4.2	1290.5	10	**1290.93**	-	-
				50	**1289.54**	-	-
				100	1288.24	-	-
				150	1287.51	-	-
				200	1287.21	-	-
				300	1287.10	-	-

Note:

bold type = water table rise at or near ground surface (within 2.2m bgs) at given distance, x.

Figures



LEGEND

- HAMLET GROWTH AREA
- HAMLET EXPANSION AREA
- BRAGG CREEK PROVINCIAL PARK
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- INDEFINITE WATERCOURSE
- WATERCOURSE
- INTERMITTENT WATERBODY
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCE(S)

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PROJECTED COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N

CLIENT
ROCKY VIEW COUNTY

PROJECT
HYDROGEOLOGICAL DEVELOPMENT SUITABILITY STUDY
GREATER BRAGG CREEK

TITLE
PROJECT LOCATION

CONSULTANT
wsp

YYYY-MM-DD	2025-04-16
DESIGNED	NR
PREPARED	PMT
REVIEWED	DP
APPROVED	DP

PROJECT NO.	REV.	FIGURE
CA0048988.7843	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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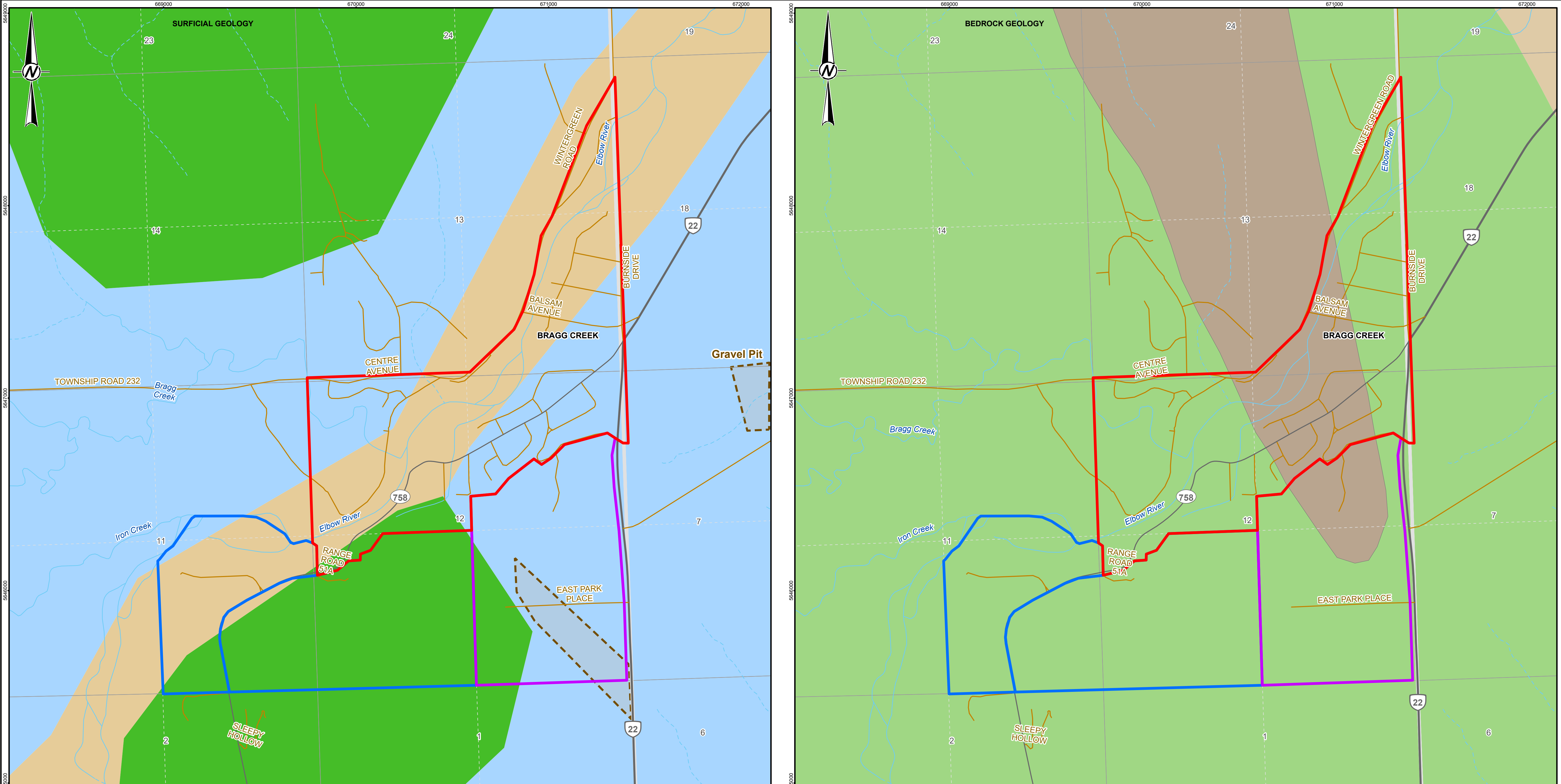

LEGEND

- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- INDEFINITE WATERCOURSE
- WATERCOURSE
- HAMLET OF BRAGG CREEK
- HAMLET EXPANSION AREA
- BRAGG CREEK PROVINCIAL PARK

SURFICIAL GEOLOGY

- GLACIOLACUSTRINE DEPOSITS (LG)
- INFERRED EXTENT OF IDENTIFIED COARSE GRANULAR DEPOSITS
- FLUVIAL DEPOSITS (F)
- MORAINE (M)

BEDROCK GEOLOGY

- BRAZEAU FORMATION
- ALBERTA GROUP (WAPIABI FORMATION, CARDIUM FORMATION, BLACKSTONE FORMATION)
- LUSCAR, BLAIRMORE, BULLHEAD AND FORT ST. JOHN GROUPS

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0 500 1,000
1:20,000 METRES

CLIENT
ROCKY VIEW COUNTY

PROJECT
HYDROGEOLOGICAL DEVELOPMENT SUITABILITY STUDY
GREATER BRAGG CREEK

CONSULTANT

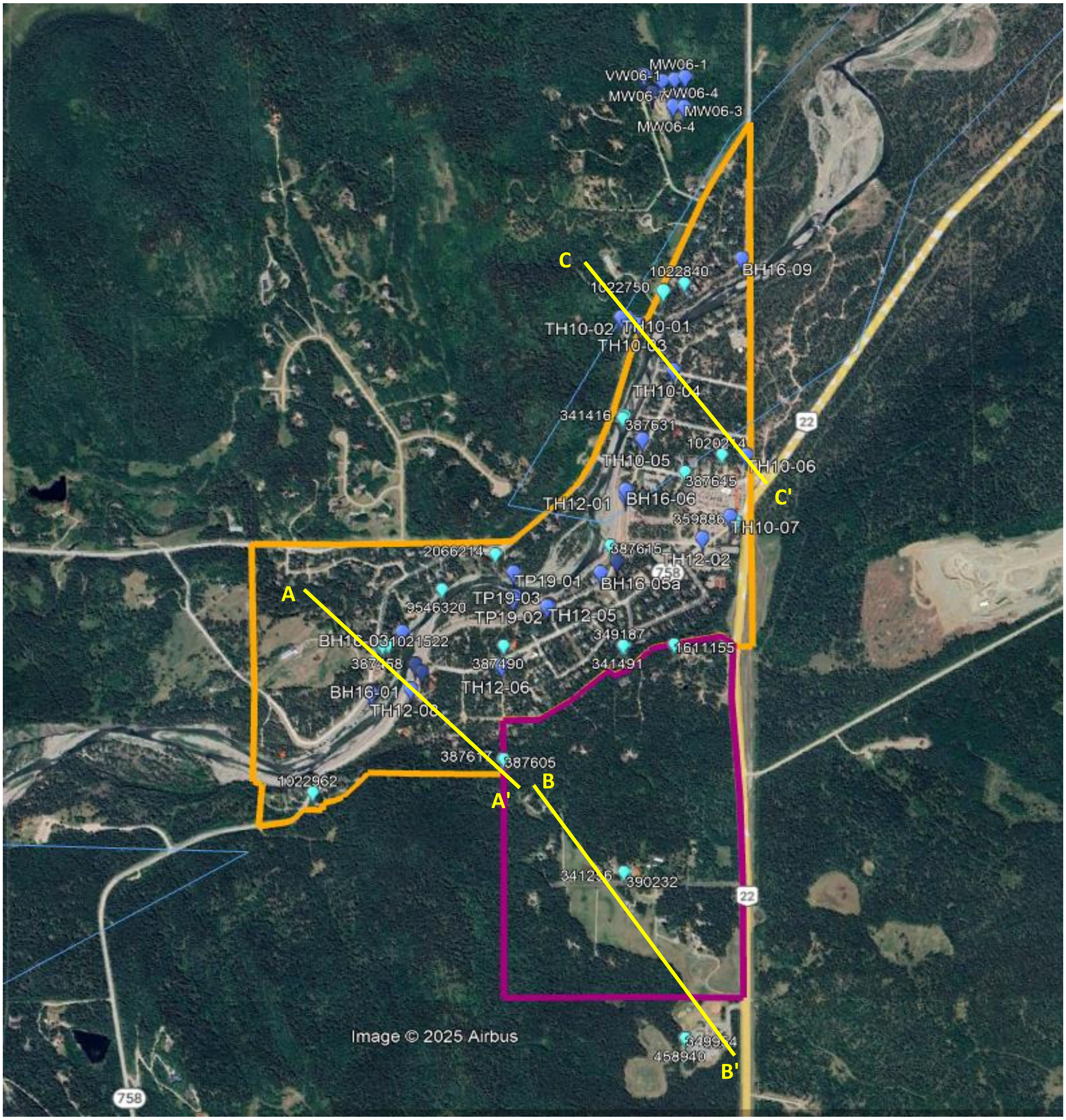
YYYY-MM-DD	2025-07-24
DESIGNED	NR
PREPARED	PMT
REVIEWED	DP
APPROVED	DP

TITLE
BEDROCK AND SURFICIAL GEOLOGY

PROJECT NO.	REV.	FIGURE
CA0048988.7843	0	2

PATH: I:\CLIENTS\ROCKYVIEW_COUNTY\CA0048988_7843\Mapping\01_Hydrogeology\CA0048988_7843_Hydrogeological_Development_Suitability_Study_Figures.aprx PRINTED ON: 2025-07-24 AT: 9:54:43 AM

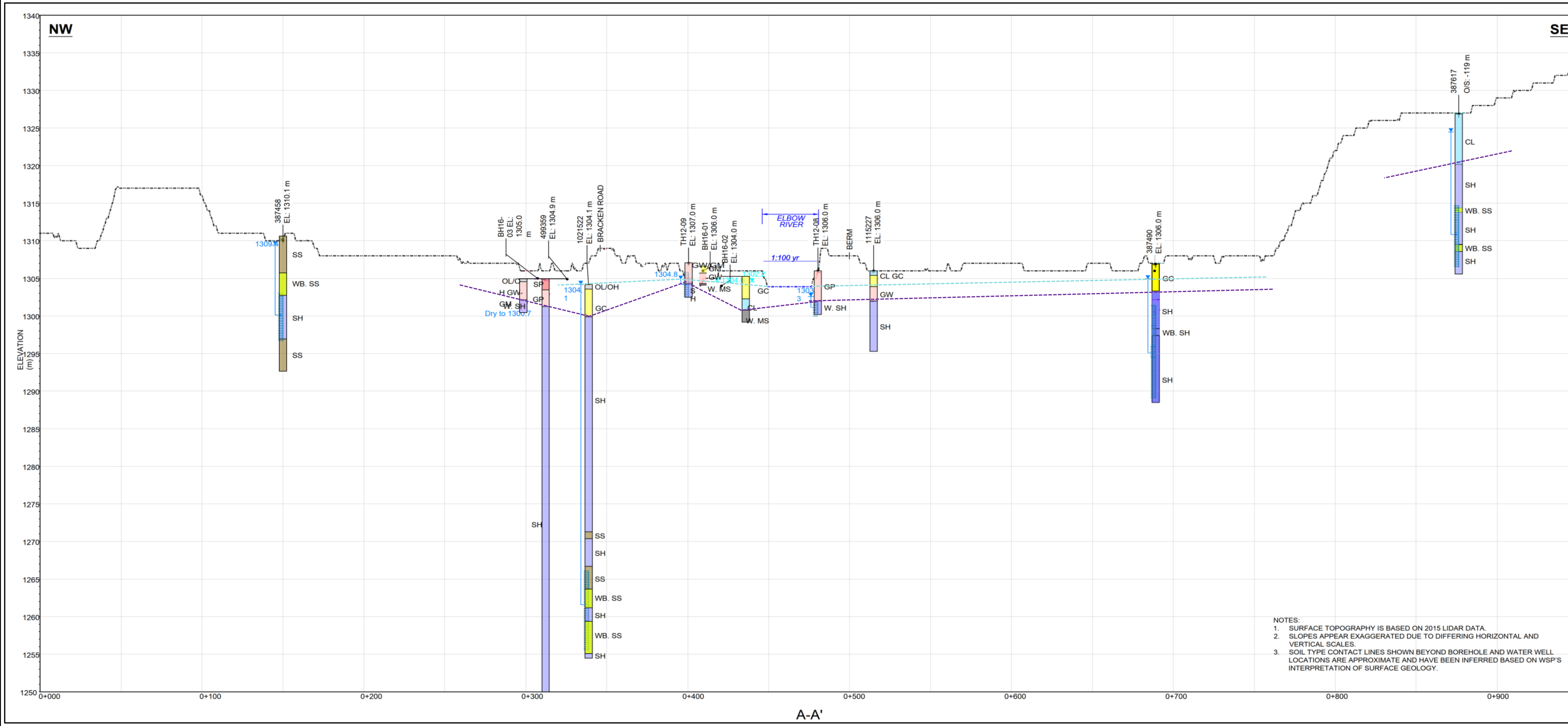
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



PROJECT:	Bragg Creek Hydrogeological Development Suitability
TITLE:	**Borehole and Section Plan**

CLIENT:
Rocky View County

DATE:	JOB No.:	FILE:	FIGURE No.:	REV.
June 2025	CA0048988	Figure-Section Plan.xlsx	3	0



NOTES:

1. SURFACE TOPOGRAPHY IS BASED ON 2015 LIDAR DATA.
2. SLOPES APPEAR EXAGGERATED DUE TO DIFFERING HORIZONTAL AND VERTICAL SCALES.
3. SOIL TYPE CONTACT LINES SHOWN BEYOND BOREHOLE AND WATER WELL LOCATIONS ARE APPROXIMATE AND HAVE BEEN INFERRED BASED ON WSP'S INTERPRETATION OF SURFACE GEOLOGY.

STRATIGRAPHY LEGEND:

GW	GRAVEL (WELL GRADED)
GP	GRAVEL (POORLY GRADED)
GM	GRAVEL (SILTY)
GC	GRAVEL (CLAYEY)
SW	SAND (WELL GRADED)
SP	SAND (POORLY GRADED)
SM	SAND (SILTY)
SC	SAND (CLAYEY)
ML	SILT (LOW PLASTIC)
MH	SILT (HIGH PLASTIC)
CL	CLAY (LOW PLASTIC)
CH	CLAY (HIGH PLASTIC)
OL/OH	ORGANIC SOILS
SH	SHALE
W. SH	WEATHERED SHALE
SS	SANDSTONE
W. SS	WEATHERED SANDSTONE
WB. SS	WATER-BEARING SANDSTONE
MS	MUDSTONE
W. MS	WEATHERED MUDSTONE

LEGEND:

- INFERRED TOP OF BEDROCK
- 1281.3 INTERPRETED GROUNDWATER ELEVATION
- 1304.1 STATIC GROUNDWATER ELEVATION
- SCREEN

0 50 100
1:1,500 METRES HORIZONTAL

0 10 20
1:300 METRES VERTICAL

PROJECT:	Bragg Creek Hydrogeological Study
TITLE:	Cross-Section A-A'
CLIENT:	ROCKY VIEW COUNTY
DATE:	July 2025
JOB No.:	CA0048988
FILE:	Cross-Sections_11x17_landscape.xlsx
FIGURE No.:	4
REV.:	0

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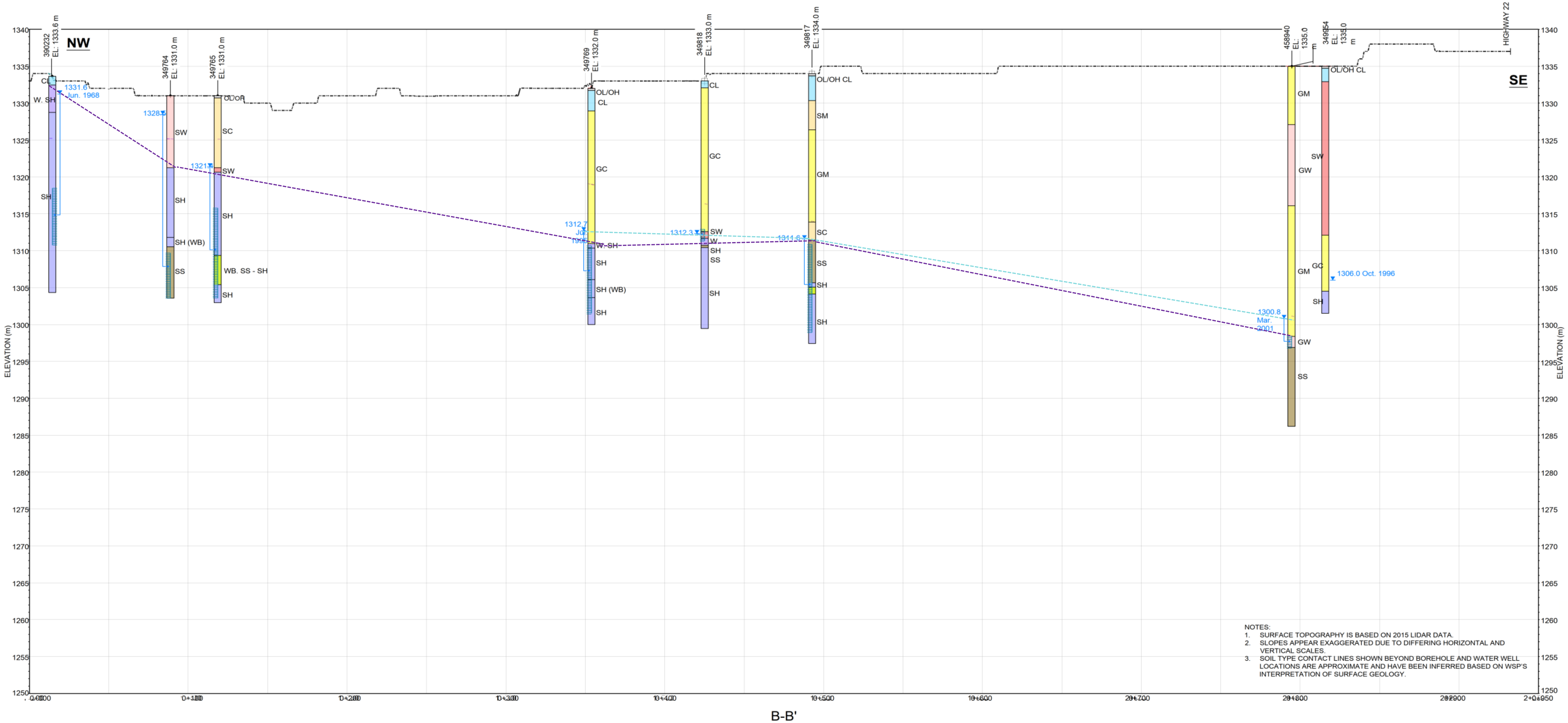

STRATIGRAPHY LEGEND:

- GW GRAVEL (WELL GRADED)
- GP GRAVEL (POORLY GRADED)
- GM GRAVEL (SILTY)
- GC GRAVEL (CLAYEY)
- SW SAND (WELL GRADED)
- SP SAND (POORLY GRADED)
- SM SAND (SILTY)
- SC SAND (CLAYEY)
- ML SILT (LOW PLASTIC)
- MH SILT (HIGH PLASTIC)
- CL CLAY (LOW PLASTIC)
- CH CLAY (HIGH PLASTIC)
- OL/OH ORGANIC SOILS
- SH SHALE
- W. SH WEATHERED SHALE
- SS SANDSTONE
- W. SS WEATHERED SANDSTONE
- WB. SS WATER-BEARING SANDSTONE
- MS MUDSTONE
- W. MS WEATHERED MUDSTONE

LEGEND:

- INFERRED TOP OF BEDROCK
- 281.3 INTERPRETED GROUND WATER ELEVATION
- 1304.1 Aug. 2007 STATIC GROUND WATER ELEVATION
- SCREEN

0 50 100
1:1,500 HORIZONTAL

0 10 20
1:300 VERTICAL

NOTES:

1. SURFACE TOPOGRAPHY IS BASED ON 2015 LIDAR DATA.
2. SLOPES APPEAR EXAGGERATED DUE TO DIFFERING HORIZONTAL AND VERTICAL SCALES.
3. SOIL TYPE CONTACT LINES SHOWN BEYOND BOREHOLE AND WATER WELL LOCATIONS ARE APPROXIMATE AND HAVE BEEN INFERRED BASED ON WSP'S INTERPRETATION OF SURFACE GEOLOGY.

PROJECT:	Bragg Creek Hydrogeological Study
TITLE:	Cross-Section B-B'
CLIENT:	ROCKY VIEW COUNTY
DATE:	July 2025
JOB No.:	CA0048988
FILE:	Cross-Sections_11x17_landscape.xlsx
FIGURE No.:	5
REV.:	0

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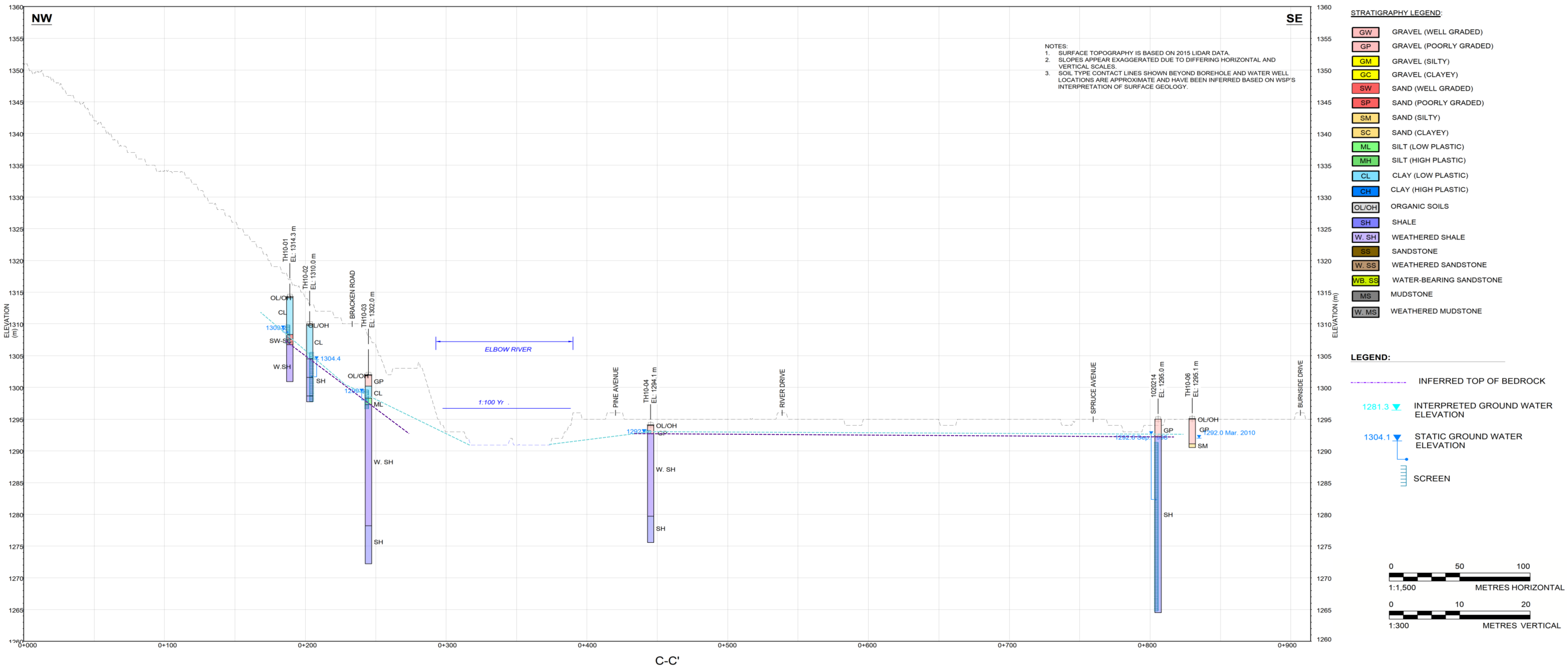

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CLIENT: ROCKY VIEW COUNTY	TITLE: Cross-Section C-C'				
	DATE: July 2025	JOB No.: CA0048988	FILE: Cross-Sections_11x17_landscape.xlsx	FIGURE No.: 6	REV.: 0

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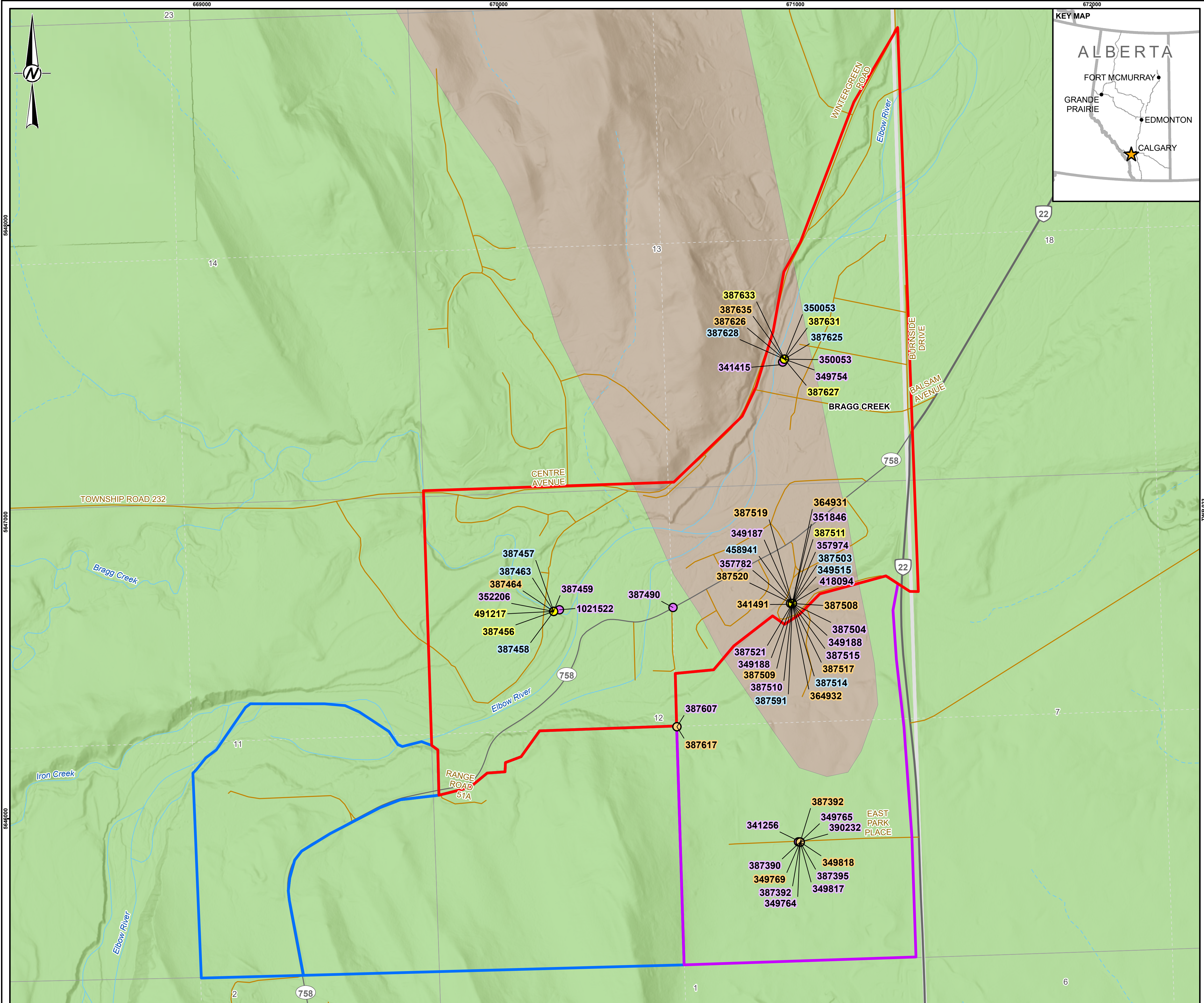

LEGEND

GROUNDWATER WELL - POST 1990 DEEPENED/NEW (RECOMMENDED RATE)

- 0.0 – 4.6 (L/min)
- 4.6 – 18.5 (L/min)
- 18.6 – 45.5 (L/min)
- 45.5 + (L/min)
- HAMLET OF BRAGG CREEK
- HAMLET EXPANSION AREA
- BRAGG CREEK PROVINCIAL PARK

BEDROCK GEOLOGY

- BRAZEAU FORMATION
- ALBERTA GROUP (WAPIABI FORMATION, CARDIUM FORMATION, BLACKSTONE FORMATION)
- LUSCAR, BLAIRMORE, BULLHEAD AND FORT ST. JOHN GROUPS

- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 300 600

1:13,000 METRES

REFERENCE(S)

BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. ATS DATA OBTAINED FROM ALTALIS, © GOVERNMENT OF ALBERTA 2025. ALL RIGHTS RESERVED.
PROJECTED COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N

CLIENT
ROCKY VIEW COUNTY

PROJECT
HYDROGEOLOGICAL DEVELOPMENT SUITABILITY STUDY
GREATER BRAGG CREEK

TITLE
GROUNDWATER WELLS - RECOMMENDED RATES

CONSULTANT

wsp

YYYY-MM-DD	2025-04-16
DESIGNED	NR
PREPARED	PMT
REVIEWED	DP
APPROVED	DP

PROJECT NO.	REV.	FIGURE
CA0048988.7843	0	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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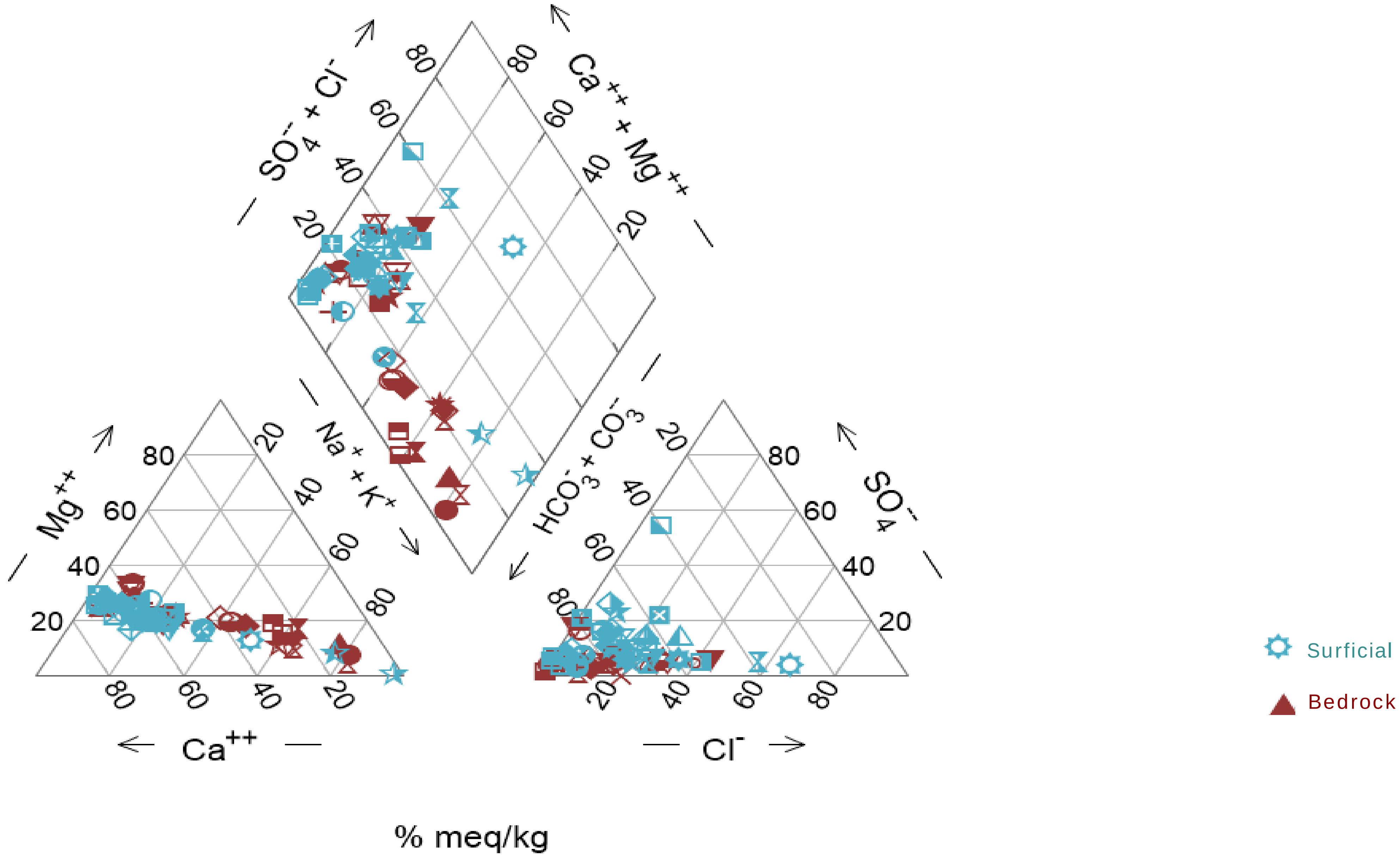


LEGEND

NOTE(S)

REFERENCE
NA

CLIENT
Rocky View County

CONSULTANT

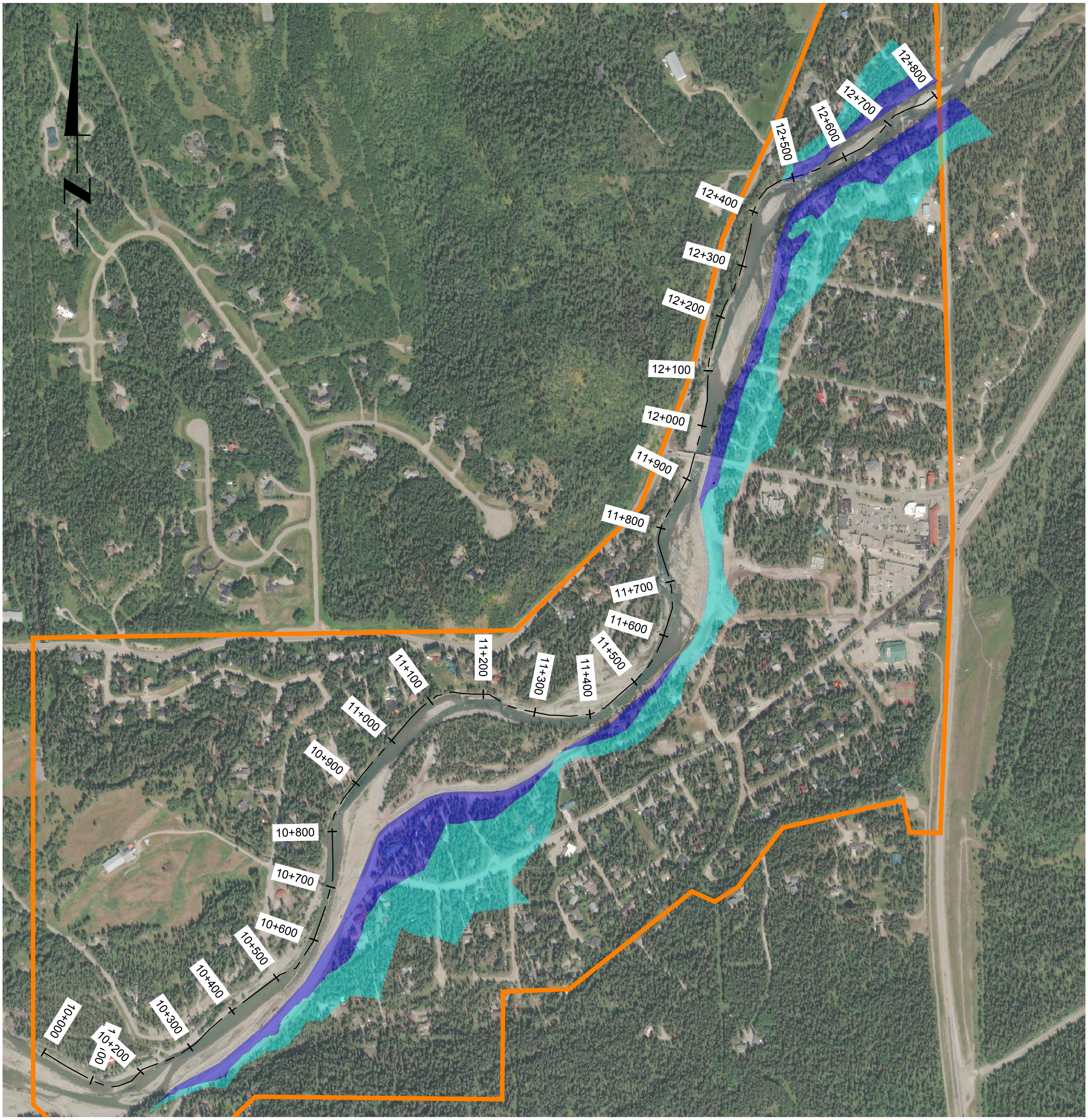
YYYY-MM-DD	2023-09-14
PREPARED	NR
DESIGN	NR
REVIEW	DP
APPROVED	DP

PROJECT
Hydrogeological Development Suitability Study Greater Bragg Creek

TITLE
Piper Plot - Shallow and Bedrock Aquifers

PROJECT No.	PHASE	Rev.	FIGURE
CA0048988.7843	2	0	8

File Name: C:\Users\wds_james.r.hughes\DC\ACCDocs\WSP Canada projects (AMER)\Canada Water-Small Projects\Project Files\CA0048988.7843 Bragg Creek Seepage\1 Deliverables\2 Figures\CA0048988.7843_FIG-01_E-0001.dwg Saved By: Hughes, James Plot Date: 250925 12:20 PM ANSI A 279mm x 216mm



LEGEND:

POTENTIAL GROUNDWATER DAYLIGHTING
1:100 YEAR FLOOD

POTENTIAL SEEPAGE IMPACTS TO BASEMENTS
1:100 YEAR FLOOD

HAMLET GROWTH AREA

SCALE
1:10 000
0 100 200 m

wsp	PROJECT NAME BRAGG CREEK HYDROGEOLOGICAL DEVELOPMENT STUDY	PROJECT NUMBER CA0048988
CLIENT ROCKY VIEW COUNTY	SHEET TITLE GROUNDWATER SEEPAGE ASSESSMENT 1:100 YEAR FLOOD	FIGURE NUMBER 9 ISSUE/REVISION 0

APPENDIX A

Water Well Reports

Alberta

Reconnaissance Report

View in Imperial

Export to Excel

Groundwater Wells

Please click the water Well ID to generate the Water Well Drilling Report.

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
341256	SE	12	23	5	5	AARON DRILLING INC.	1999-09-03	50.29	New Well	Domestic		11	5	DALRYMPLE, LORNE #3832	11.49	9.09	16.81
341415	SE	13	23	5	5	AARON DRILLING INC.	1998-06-08	12.19	Test Hole-Decommissioned	Domestic		4		HERRON EST	2.83	9.09	0.00
341416	SE	13	23	5	5	AARON DRILLING INC.	1998-06-08	12.19	Test Hole-Decommissioned	Domestic		6		HERRON EST	2.65	1.14	0.00
341491	NE	12	23	5	5	AARON DRILLING INC.	1999-03-31	24.38	New Well	Domestic		9	6	FRENCH, KIM #3696	11.89	22.73	16.81
349187	NE	12	23	5	5	AARON DRILLING INC.	1992-11-17	30.48	New Well-Decommissioned	Domestic		6		RUBEN, P. PALMER K.	10.67	6.82	16.81
349188	NE	12	23	5	5	AARON DRILLING INC.	1992-11-23	19.81	New Well	Domestic		7		RUBEN P/PALMER K.	9.75	18.18	16.81
349188	NE	12	23	5	5	AARON DRILLING INC.	1992-11-23	19.81	New Well	Domestic		7	7	RUBEN P/PALMER K.	9.75	18.18	16.81
349241	SE	13	23	5	5	AARON DRILLING INC.	1988-07-13	30.48	New Well-Decommissioned	Domestic		3		DON JOY MGMT			0.00
349515	NE	12	23	5	5	AARON DRILLING INC.	1987-02-09	12.19	Deepened	Domestic		2		MERRITT, CARL	3.05	2.27	16.81
349754	SE	13	23	5	5	AARON DRILLING INC.	1995-05-17	29.57	New Well	Domestic		7	33	CARRUTHERS, BARRY 2673	0.00	13.64	16.81
349764	SE	12	23	5	5	AARON DRILLING INC.	1995-06-05	27.43	New Well	Domestic		5	16	AVERY, SUSAN #2698	2.53	10.68	16.81
349765	SE	12	23	5	5	AARON DRILLING INC.	1995-06-01	28.04	New Well	Domestic		6	40	AVERY, SUSAN #2695	9.36	18.18	16.81
349769	SE	12	23	5	5	AARON DRILLING INC.	1995-06-29	32.00	New Well	Domestic		7	40	HARE,RICHARD #2723 SITE 3	19.29	36.37	16.81
349817	SE	12	23	5	5	AARON DRILLING INC.	1995-06-15	36.58	New Well	Domestic		14	16	HARR, RICHARD #2680	22.40	9.09	16.81
349818	SE	12	23	5	5	AARON DRILLING INC.	1995-07-28	33.53	New Well	Domestic		7	10	HARE, RICHARD #2747	20.70	22.73	16.81
349819	SE	12	23	5	5	AARON DRILLING INC.	1995-07-31	45.72	New Well-Decommissioned	Domestic		7		HARE,RICHARD #2733	21.03		16.81
349820	SE	12	23	5	5	AARON DRILLING INC.	1995-07-31	45.72	New Well-Decommissioned	Domestic		6		HARE, RICHARD #2716			16.81
349936	SE	13	23	5	5	AARON DRILLING INC.	1996-09-09	45.72	New Well-Decommissioned	Domestic		7		MOON, TOM #TH1	0.00		0.00
350053	SE	13	23	5	5	AARON DRILLING INC.	2016-08-30	89.92	Deepened	Domestic		6	18	MCHUGH, DAN	51.82	2.27	16.84
350053	SE	13	23	5	5	AARON DRILLING INC.	1998-01-30	67.06	New Well	Domestic		2	13	EATON, LES #3359	12.59	9.09	16.81

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
350053	SE	13	23	5	5	AARON DRILLING INC.	2007-09-10	71.63	Deepened	Domestic		2	1	MCHUGH, DAN	19.81	1.14	16.81
351846	NE	12	23	5	5	BAKER WATER WELLS	1990-07-07	32.00	New Well	Domestic		4		MCCLOY, TERRY	12.19	9.09	14.12
352206	NW	12	23	5	5	DOLOMITE DRILLING	1990-09-18	44.20	New Well	Domestic		12		EAGER, ALAN	3.05	13.64	16.81
354349	SE	12	23	5	5	UNKNOWN DRILLER		29.26	Chemistry	Domestic				PROUD, KELLY			0.00
357782	NE	12	23	5	5	KRIEGER DRILLING LTD.	1987-07-29	17.07	New Well	Domestic		5		ARCHER, CAREN/STEVE	2.44	13.64	16.81
357974	NE	12	23	5	5	AARON DRILLING INC.	1991-05-27	32.00	New Well	Domestic		5		SHOULTS, IDA # 1599	3.05	18.18	16.81
359886	1	13	23	5	5	ALBERTA SOUTHERN EXPLORATION DRILLING LTD.	1991-07-16	13.11	New Well	Domestic		2		THOMPSON, AL	2.44	54.55	16.81
361443	NE	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				KLEPACKI, CYNTHIA R			0.00
361444	NE	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				MAGEE, MIKE/JOANNE			0.00
363237	SE	13	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				BUCONJIC, APRIL/GORDAN			0.00
363666	NE	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				BRISCO, STUART/PHILIPPA			0.00
364931	NE	12	23	5	5	WATKINS DRILLING	1992-06-05	18.90	New Well	Domestic		3	28	GLASSFORD, A.R.	11.58	27.28	16.81
364932	NE	12	23	5	5	WATKINS DRILLING	1992-05-14	15.24	New Well	Domestic		3	9	GLASSFORD, A.R.	10.97	36.37	16.81
379701	9	12	23	5	5	ALBERTA SOUTHERN EXPLORATION DRILLING LTD.	1995-10-18	13.41	New Well	Domestic		5	16	BUMSTEAD, BRIAN	3.51	9.09	16.81
387385	SE	12	23	5	5	UNKNOWN DRILLER		25.91	Chemistry	Domestic				NEUFELD, VIC	25.91		0.00
387389	SE	12	23	5	5	UNKNOWN DRILLER		60.96	Chemistry	Domestic				MACLELLAN, GLEN	33.53		0.00
387390	SE	12	23	5	5	DEL'S DRILLING	1970-11-01	19.81	New Well	Domestic		9		KLEIBER, W.	4.88	7.96	16.51
387392	SE	12	23	5	5	DEL'S DRILLING	1974-11-07	50.90	Deepened	Domestic		4		NEUFELD, VIC	17.98	9.09	15.88
387392	SE	12	23	5	5	DEL'S DRILLING	1974-11-07	50.90	Deepened	Domestic		4		NEUFELD, VIC	27.13	45.46	15.88
387395	SE	12	23	5	5	PARSONS DRLG	1968-06-06	28.96	New Well	Domestic		6		ALBERTSON	10.36	13.64	13.97

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
387398	SE	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				JARDINE, DAVID			0.00
387400	2	12	23	5	5	UNKNOWN DRILLER		6.10	Chemistry	Domestic				WILSON, VERN O.C.	6.10		0.00
387452	NW	12	23	5	5	UNKNOWN DRILLER		8.53	Chemistry	Unknown				WEBSTER, EARL	4.27		0.00
387453	NW	12	23	5	5	UNKNOWN DRILLER		19.51	Chemistry	Domestic				ELSDON, S.			0.00
387454	NW	12	23	5	5	UNKNOWN DRILLER		18.29	Chemistry	Unknown				ECHLIN, R.			0.00
387455	NW	12	23	5	5	PARSONS DRLG	1966-06-15	48.77	Dry Hole			3		ELKANA RANCH LTD			12.70
387456	NW	12	23	5	5	PARSONS DRLG	1966-09-07	5.18	New Well	Domestic		3		MCARUTHER, JAMES	1.52	113.65	15.57
387457	NW	12	23	5	5	ADAIR D	1967-09-08	36.58	Deepened	Domestic		2		MCKEAGUE, D.	6.10	2.27	0.00
387458	NW	12	23	5	5	ADAIR D	1968-06-11	16.76	New Well	Domestic		5		GRAVES, G.	1.22	2.27	0.00
387459	NW	12	23	5	5	DEL'S DRILLING	1977-07-05	17.07	New Well	Domestic		4		ELSDON	3.35	9.09	17.78
387460	NW	12	23	5	5	UNKNOWN DRILLER		3.05	Chemistry	Domestic				DOCKER, C.	2.44		0.00
387461	NW	12	23	5	5	DEL'S DRILLING	1979-06-27	18.29	Dry Hole	Domestic		4		PAREL, A.J.			0.00
387462	NW	12	23	5	5	DEL'S DRILLING	1979-06-28	27.43	Dry Hole	Domestic		3		KABATOFF, ALEC			0.00
387463	NW	12	23	5	5	DEL'S DRILLING	1979-07-31	33.53	New Well	Domestic		3		KABATOFF, ALEX	3.05	2.27	14.12
387464	NW	12	23	5	5	KRIEGER DRILLING LTD.	1981-11-02	12.50	New Well	Domestic		7		COCKING, JIM	4.57	43.19	14.12
387465	NW	12	23	5	5	UNKNOWN DRILLER		18.29	Chemistry	Domestic				WORKMAN, RHONDA			0.00
387466	NW	12	23	5	5	UNKNOWN DRILLER		10.67	Chemistry	Domestic				SUKOVIEFF, D.F.			0.00
387467	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				CLARK, KIMBERLEY			0.00
387468	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				BAVARIAN INN			0.00
387469	NW	12	23	5	5	UNKNOWN DRILLER		9.14	Chemistry	Domestic				PENMAN, CHERYL/DAVE			0.00

Alberta

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
387470	NW	12	23	5	5	UNKNOWN DRILLER		3.66	Chemistry	Domestic				HIND, PETER			0.00
387471	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				MCKEAGUE, DOUG			0.00
387472	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				SPRING, G.			0.00
387473	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				EDWARDS, NORM/KATHLEEN			0.00
387474	NW	12	23	5	5	UNKNOWN DRILLER		3.66	Chemistry	Domestic	1			WINNITOY, W.			0.00
387476	NW	12	23	5	5	UNKNOWN DRILLER		1.83	Chemistry	Domestic				MCDOUGALL, R.			0.00
387477	NW	12	23	5	5	UNKNOWN DRILLER		46.33	Chemistry	Domestic				VARADI, JOSEF			0.00
387478	NW	12	23	5	5	UNKNOWN DRILLER		3.05	Chemistry	Domestic				COULAN			0.00
387480	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				DUNFORD, J.			0.00
387482	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				HARTFORD, CRAIG			0.00
387483	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				PERRY, LINDA			0.00
387484	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				SIMMERLING, KARL/CAROL ANNE			0.00
387485	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Unknown				FORMAN, ELAINE/RAYMOND			0.00
387486	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Unknown				CLEASE, HELEN/DENNIS			0.00
387487	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Unknown				LINDSKOG, CHRISTIE			0.00
387488	11	12	23	5	5	UNKNOWN DRILLER		18.29	Chemistry	Domestic				RAVENHILL, ROY D.			0.00
387489	NH	12	23	5	5	UNKNOWN DRILLER		8.84	Chemistry	Domestic				KOZMA, JOHN	3.35		0.00
387490	NH	12	23	5	5	DEL'S DRILLING	1976-07-03	18.29	New Well	Domestic		4		KELLY, LAWRENCE	1.98	13.64	17.78
387491	NH	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				SHERIN, RICHARD D.			0.00
387492	NH	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				MCKINLEY			0.00

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GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
387493	NH	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				REDMAN, D.			0.00
387494	NH	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				THE STEER INN			0.00
387495	NH	12	23	5	5	UNKNOWN DRILLER		10.67	Chemistry	Domestic				SUKCRIEFF, D.			0.00
387496	NH	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				PERROTT, STAN			0.00
387497	NE	12	23	5	5	ADAIR D	1968-05-21	30.48	New Well	Domestic		4		CANNIFF, ANDY	11.28		15.24
387498	NE	12	23	5	5	UNKNOWN DRILLER		3.96	Chemistry	Domestic				SHOULTS, GORDON			0.00
387499	NE	12	23	5	5	UNKNOWN DRILLER		3.66	Chemistry	Domestic				JENSEN, ROBERT			0.00
387500	NE	12	23	5	5	UNKNOWN DRILLER		3.66	Chemistry	Domestic				ADES, R.G.	3.20		0.00
387501	NE	12	23	5	5	UNKNOWN DRILLER		10.67	Chemistry	Domestic				KLOKEID, J.F.	1.83		0.00
387502	NE	12	23	5	5	UNKNOWN DRILLER		1.52	Chemistry	Domestic				KLOKEID, J.F.	0.76		0.00
387503	NE	12	23	5	5	ADAIR D	1968-06-04	18.29	New Well	Domestic		4		LOVE, H.G.	3.05	4.55	15.24
387504	NE	12	23	5	5	C.H. NELSON DRILLING LTD.	1975-06-11	12.19	New Well	Unknown		7		EARLY, JOHN	2.74	18.18	13.97
387505	NE	12	23	5	5	UNKNOWN DRILLER		16.76	Chemistry	Unknown				SYMES, W.E.	3.66		0.00
387506	NE	12	23	5	5	UNKNOWN DRILLER		9.75	Chemistry	Unknown				FULLERTON, STEVE	3.05		0.00
387507	NE	12	23	5	5	UNKNOWN DRILLER		5.18	Chemistry	Domestic				MCLENNAN, ROBERT	0.91		0.00
387508	NE	12	23	5	5	WATKINS DRILLING	1969-09-01	6.71	New Well-Decommissioned	Domestic		2		BISHOP, ROBIN	1.83	45.46	12.70
387509	NE	12	23	5	5	WATKINS DRILLING	1969-09-01	21.34	New Well	Domestic		4		BISHOP, ROBIN	2.13	45.46	12.70
387510	NE	12	23	5	5	OTHER	1972-06-01	11.89	New Well	Domestic		5		CHALLICE, C.	6.10	13.64	0.00
387511	NE	12	23	5	5	OTHER	1972-11-01	9.14	New Well	Domestic		4		B&G CONSTR	2.44	90.92	15.24
387512	NE	12	23	5	5	DEL'S DRILLING	1981-07-08	48.77	Dry Hole	Unknown		6		MCKEAQUE, D.K.			0.00

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GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
387513	NE	12	23	5	5	UNKNOWN DRILLER		10.67	Chemistry	Domestic				EARLY, JOHN F.	3.66		0.00
387514	NE	12	23	5	5	DEL'S DRILLING	1977-03-07	34.75	New Well	Domestic		6		MCLENNAN, BOB	13.72	4.55	14.12
387515	NE	12	23	5	5	DEL'S DRILLING	1976-07-06	25.91	New Well	Domestic		6		BRAUN, ERV	4.88	10.23	14.12
387516	NE	12	23	5	5	UNKNOWN DRILLER		6.10	Chemistry	Domestic				KERS, MARIE	4.57		0.00
387517	NE	12	23	5	5	WARD E DRLG CO LTD	1979-07-08	21.34	New Well	Domestic		3		TRAVIS, STEVE	4.57	45.46	14.12
387518	NE	12	23	5	5	UNKNOWN DRILLER		18.29	Chemistry	Domestic				BALL, MARILYN			0.00
387519	NE	12	23	5	5	GOODISON WATER WELL DRILLING	1974-11-04	9.14	New Well	Domestic		2		NEWLANDS, B.	0.00	22.73	16.84
387520	NE	12	23	5	5	ZIEGLER BROS. DRILLING LTD.	1975-06-21	12.80	New Well	Domestic		3		KUNES, VUCLAV	3.05	31.82	11.43
387521	NE	12	23	5	5	KRIEGER DRILLING LTD.	1985-05-28	30.18	New Well	Domestic		11		MCARTHUR, ARNOLD	4.27	18.18	16.84
387586	NE	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				DAVID, J.			0.00
387587	NE	12	23	5	5	UNKNOWN DRILLER		19.81	Chemistry	Domestic				HARDAGE, ROGER/VICKI			0.00
387589	NE	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				MICHOR, A.			0.00
387590	NE	12	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				HOMESTEAD ANTIQUES			0.00
387591	NE	12	23	5	5	KRIEGER DRILLING LTD.	1987-07-28	28.96	Test Hole	Observation		8		ARCHER, STEVE #1	2.44	4.55	16.84
387593	NE	12	23	5	5	UNKNOWN DRILLER		12.19	Chemistry	Domestic				JANKE, ED			0.00
387594	NE	12	23	5	5	UNKNOWN DRILLER		9.14	Chemistry	Domestic				TREASURY BRANCH			0.00
387595	NE	12	23	5	5	UNKNOWN DRILLER		22.86	Chemistry	Domestic				DAVIDS, PERRY			0.00
387596	NE	12	23	5	5	UNKNOWN DRILLER		3.66	Chemistry	Domestic				SWALES, M.	2.44		0.00
387597	NE	12	23	5	5	UNKNOWN DRILLER		70.10	Chemistry	Unknown				STUPNYCKYJ, LINDA/OLEH			0.00
387598	NE	12	23	5	5	ALBERTA SOUTHERN EXPLORATION DRILLING LTD.	1989-06-08	54.86	New Well	Domestic		21		DEFRAINE, BILL	0.00		16.84

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GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
387601	10	12	23	5	5	UNKNOWN DRILLER		36.58	Chemistry	Domestic				GRIFFIN, E.D.	6.10		0.00
387605	SE	12	23	5	5	OTHER	1974-01-01	7.32	New Well	Domestic		5		B&G CONSTR			15.24
387607		12	23	5	5	GOODISON WATER WELL DRILLING	1975-03-04	31.09	New Well	Domestic		5		PEARMAIN, KEITH	2.80	18.18	0.00
387615	15	12	23	5	5	DEL'S DRILLING	1973-07-01	33.22	Dry Hole	Unknown		7		SHLAHT, ALF			0.00
387617	SE	12	23	5	5	DEL'S DRILLING	1975-02-26	21.34	New Well	Domestic		9		DICK, LEO	2.44	45.46	14.12
387619		12	23	5	5	UNKNOWN DRILLER		3.05	Chemistry	Domestic				BRAGG CREEK SHOPPING CENTRE			0.00
387620	SE	13	23	5	5	UNKNOWN DRILLER		2.74	Chemistry	Domestic				WHITE, R.H.	2.44		0.00
387621	SE	13	23	5	5	UNKNOWN DRILLER		30.48	Chemistry	Domestic				DEGROOT, H.			0.00
387623	SE	13	23	5	5	ADAIR D	1967-09-11	9.14	New Well	Unknown		2		KLINE, ROGER	3.35		16.84
387625	SE	13	23	5	5	OTHER	1974-01-01	10.06	New Well	Domestic		4		RICHTER, PAUL	3.05	4.55	15.88
387626	SE	13	23	5	5	DEL'S DRILLING	1970-11-01	11.28	New Well	Domestic		4		GRAHAM, E.	4.88	45.46	0.00
387627	SE	13	23	5	5	DEL'S DRILLING	1975-02-24	9.45	New Well	Domestic		3		TEGHTMEYER, ROB	3.35	68.19	0.00
387628	SE	13	23	5	5	ADAIR D	1967-09-20	21.34	New Well	Domestic		2		WRATHALL, G.M.	2.74	2.27	16.84
387631	SE	13	23	5	5	PARSONS, DELBERT	1971-06-01	34.14	New Well	Domestic		9		BLAKLY, W.E.	14.33	90.92	13.16
387633	SE	13	23	5	5	PARSONS, DELBERT	1971-04-01	8.84	New Well	Unknown		4		KOGMA, J.	3.35	113.65	12.40
387635	SE	13	23	5	5	WATKINS DRILLING	1970-11-01	6.40	New Well	Domestic		1		JONES, COLIN	3.66	27.28	15.24
387637	SE	13	23	5	5	UNKNOWN DRILLER		3.66	Chemistry	Domestic				COX, HAROLD	2.44		0.00
387639	SE	13	23	5	5	UNKNOWN DRILLER		21.95	Chemistry	Domestic				BISHOP, R.E.	0.40		0.00
387641	SE	13	23	5	5	UNKNOWN DRILLER		12.19	Chemistry	Domestic				COX, HAROLD	3.05		0.00
387642	SE	13	23	5	5	UNKNOWN DRILLER		15.24	Chemistry	Domestic				MERRYFIELD, G.J.	4.88		0.00

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GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
387644	SE	13	23	5	5	UNKNOWN DRILLER		22.86	Chemistry	Domestic				DUNFORD, J.O.H.	6.10		0.00
387645	1	13	23	5	5	DEL'S DRILLING	1981-02-01	28.04	New Well	Domestic		5		BRAGG CREEK TRADING POST	3.66	2.27	0.00
387646	SE	13	23	5	5	UNKNOWN DRILLER		6.10	Chemistry	Domestic				ELSDON, M.S.			0.00
387647	SE	13	23	5	5	UNKNOWN DRILLER		4.27	Chemistry	Domestic				MERRYFIELD			0.00
387649	SE	13	23	5	5	UNKNOWN DRILLER		3.66	Chemistry	Domestic				TEGHTMEYER, ROB L.			0.00
387650	SE	13	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				FUSSEL, H.			0.00
387652	SE	13	23	5	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				KING, TAMMY			0.00
387653	SE	13	23	5	5	UNKNOWN DRILLER		3.96	Chemistry	Domestic				NICHOL, E.			0.00
387660	SE	13	23	5	5	UNKNOWN DRILLER		3.05	Chemistry	Domestic				PIKE, BOB			0.00
387661	SE	13	23	5	5	UNKNOWN DRILLER		3.96	Chemistry	Domestic				RODGER, BRUCE			0.00
387663	SE	13	23	5	5	UNKNOWN DRILLER		60.96	Chemistry	Domestic				SHOULTS, H.			0.00
389410	15	12	23	5	5	UNKNOWN DRILLER		6.10	Chemistry	Domestic	1			GIBSON, DEBBIE			0.00
389420	SE	12	23	5	5	UNKNOWN DRILLER		24.38	Chemistry	Domestic	1			BAR-B-QUE STEAK PIT	15.24		0.00
390232	SE	12	23	5	5	PARSONS DRILLING	1968-06-21	29.26	New Well	Domestic		3		LERNER, DENNIS	3.35	9.09	0.00
394246	SE	13	23	5	5	UNKNOWN DRILLER		4.57	Chemistry	Domestic	1			PERRY, R.T.			0.00
418094	NE	12	23	5	5	INTERPROVINCIAL DRILLING CONTRACTORS	1974-05-27	12.19	New Well	Domestic	2	5		RIDLEY, HAROLD	2.44	6.82	15.24
458941	NE	12	23	5	5	AARON DRILLING INC.	2001-10-10	36.58	Deepened	Domestic		7		HOLSCHUH, CHARLIE#3338	3.35	2.27	16.81
465414	NW	12	23	5	5	UNKNOWN DRILLER		0.00	Spring	Municipal				REID, CROWTHER & PARTNERS LTD			0.00
491217	NW	12	23	5	5	BAKER WATER WELLS	1998-07-14	24.38	New Well	Domestic		5	22	DEAN, DON	1.52	90.92	16.81
494766	NE	12	23	5	5	ALKEN BASIN DRILLING LTD.	1999-11-16	24.38	Test Hole-Decommissioned	Domestic		4		MILLS, ROBERT			0.00

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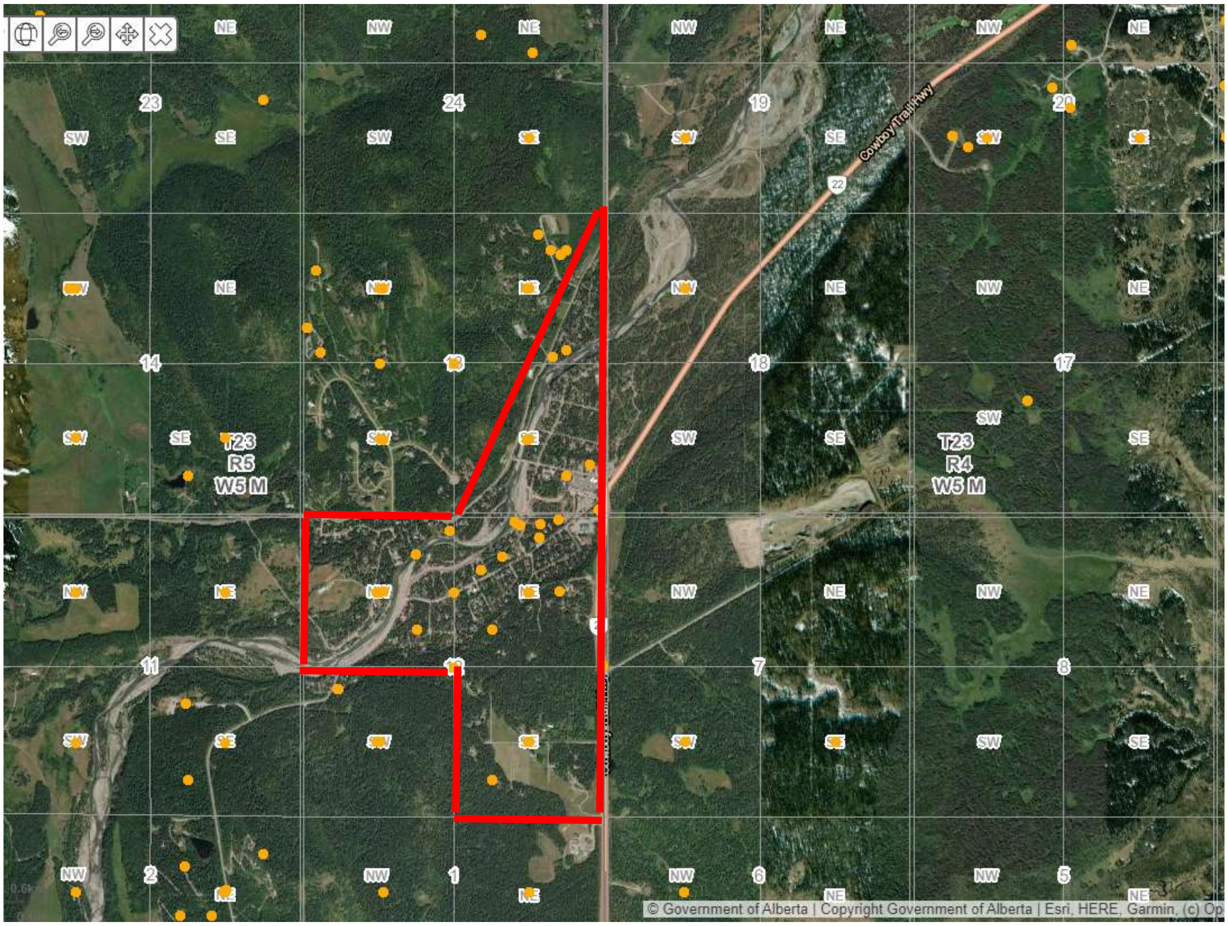
GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
499358	NW	12	23	5	5	ALKEN BASIN DRILLING LTD.	2001-08-28	30.48	Test Hole-Decommissioned	Domestic		2		ODELL, RANDY			0.00
499359	NW	12	23	5	5	ALKEN BASIN DRILLING LTD.	2001-08-28	60.96	Test Hole-Decommissioned	Domestic		3		ODELL, RANDY			0.00
1020214	1	13	23	5	5	DEL'S REGIONAL DRILLING	1998-09-30	30.48	New Well	Domestic		5	2	RENAUD, ALAIN	2.41	11.37	16.81
1020215	SE	13	23	5	5	AARON DRILLING INC.	2005-07-26	30.48	Existing Well-Decommissioned	Domestic		1		DOMANIC OILFIELD SERV	2.44		
1021522	NW	12	23	5	5	AARON DRILLING INC.	2007-08-07	49.68	New Well	Domestic		20	13	MCKEAGUE, DOUG	0.00	18.18	16.81
1022408	15	12	23	5	5	AARON DRILLING INC.	2014-02-10		Existing Well-Decommissioned	Unknown				SHEPERD, BILL			16.81
1022750	9	13	23	5	5	AARON DRILLING INC.	2016-05-24	65.53	New Well	Domestic		19	7	WAKEFIELD, DAVE & IRIS	16.52	4.55	16.84
1022840	9	13	23	5	5	AARON DRILLING INC.	2016-11-13	149.96	Dry Hole-Decommissioned	Unknown		21		LENNOX, PAIGE			
1023283	16	12	23	5	5	AARON DRILLING INC.			Existing Well-Decommissioned	Unknown				KING MAKER DEVELOPMENTS			
1023312	15	12	23	5	5	AARON DRILLING INC.			Existing Well-Decommissioned	Unknown				KINGMAKER DEVELOPMENTS			
1023313	16	12	23	5	5	AARON DRILLING INC.			Existing Well-Decommissioned	Unknown				KINGMAKER DEVELOPMENTS			
1023314	SE	12	23	5	5	AARON DRILLING INC.			Existing Well-Decommissioned	Unknown				KING MAKER DEVELOPMENTS			
1023374	16	12	23	5	5	AARON DRILLING INC.			Existing Well-Decommissioned	Unknown				KING MAKER DEVELOPMENTS			
1115227	NW	12	23	5	5	BAKER WATER WELLS	2011-09-22	10.67	Dry Hole-Decommissioned	Domestic		4		RIVERSIDE CHATEAU			
1611155	16	12	23	5	5	PETER NIEMANS WATER WELL DRILLING	2022-09-05	28.96	New Well	Domestic		6	26	FRENCH, KIM	11.40	34.10	16.84
2066214	14	12	23	5	5	WELL DONE WATERWELLS INC.	2018-10-25	53.34	New Well	Domestic		6	26	MACALLISTER, EDITH	2.32	27.28	16.83
2095057	SE	12	23	5	5	UNKNOWNDRILLINGCOMP11	1961-07-01	21.34	Well Inventory	Domestic & Stock		1		MASCH, KLAUS	21.34		
2096008	NE	12	23	5	5	UNKNOWNDRILLINGCOMP11		3.66	Well Inventory	Domestic		1		MCAUTHUR, ARNOLD G.			
9546320	14	12	23	5	5	AQUACLEAR DRILLING INC.	2017-09-03	41.15	New Well	Domestic		7	18	MINTY, DEV	2.83	6.82	16.81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APPENDIX B

Groundwater Chemistry

Appendix B - Groundwater Chemistry 2001-2004

SampleID	Date	Source	WellDepth	Alkalinity	Bicarbonat	Calcium	Carbonate	Chloride	Conductivity	Fluoride	Hardness	Hydroxide	Magnesium	Nitrate	Nitrite	pH	Potassium	Iron	Sodium	Sulfate	TDS	Latitude	Longitude	STRM
T017733	28-Aug-02	Well	100	304.4	371.3	91.37	0	13.3	602	0.1	310.55	0	20.01	1.5	0	7.73	1.41	0.18	6.62	14.6	331.46	50.943148	-114.571721	S12T23R5M5
T017619	7-Oct-02	Well	45	350.9	428.1	113.1	0	102.1	1045	0.2	371.52	0	21.64	3.4	0	7.93	4.5	0.22	62.67	34.6	552.69	50.943148	-114.571721	S12T23R5M5
T017670	6-Mar-03	Well	30	311.2	379.7	119.9	0	19.9	843	0.4	418.32	0	28.88	0.1	0	8.08	1.67	0.05	21.73	113.5	492.76	50.943148	-114.571721	S12T23R5M5
T031474	8-Jan-04	Well	29	276.3	337.1	160.1	0	292.8	1544	0.2	550.57	0	36.62	0	0	8.16	12.38	0.0078	81.95	30.4	780.16	50.943148	-114.571721	S12T23R5M5
T000015	10-Feb-02	Well	10	240.1	292.9	3.1	0	23.4	679	0.3	10.83	0	0.75	0.07	0	8.14	0.15	0.11	163.5	79.5	414.82	50.957696	-114.571717	S13T23R5M5
T002890	16-Jul-02	Well	10	377.2	460.2	125.3	0	46	955	0.2	427.73	0	27.89	2	0	7.95	2.26	0	34.71	67.9	532.52	50.957696	-114.571717	S13T23R5M5
T017584	25-Nov-02	Well	74	304.1	371	80.98	0	47	766	0.08	287.99	0	20.83	0	0	8.11	1.07	0.98	46.19	27.8	406.36	50.957696	-114.571717	S13T23R5M5
T017624	4-Dec-02	Well	160	318.1	354.4	14.9	16.5	2.1	615	1.9	60.97	0	5.77	0.46	0	8.63	0.81	0.5	126.7	10.8	354.29	50.957696	-114.571717	S13T23R5M5
T023258	24-Jan-03	Well	75	354.5	406	18.02	13	11.5	709	1	85.12	0	9.74	0	0	8.52	0.77	0.03	132.2	24.1	409.98	50.957696	-114.571717	S13T23R5M5
T024061	8-May-03	Well	56	358.7	437.6	86.61	0	22.9	732	0.8	321.97	0	25.67	0.06	0	8.03	1.68	0.61	30.3	16.8	400.01	50.957696	-114.571717	S13T23R5M5
T031534	24-Feb-04	Well	6	267.1	325.9	120.47	0	108	1048	0.3	397.55	0	23.49	9.3	0	8.04	3.22	0.2	56.61	62.8	544.43	50.957696	-114.571717	S13T23R5M5

Appendix B - Groundwater Quality - 2004-2006

SampleID	Date	Source	WellDepth	Alkalinity	Bicarbonate	Calcium	Carbonate	Chloride	Conductivity	Fluoride	Hardness	Hydroxide	Magnesium	Nitrate	Nitrite	pH	Potassium	Iron	Sodium	Sulfate	TDS	Latitude	Longitude	STRM
T041651	30-Apr-04	Well	10	306.5	373.9	112.3	0	60.5	822	0.2	372.86	0	22.45	0.3	-0.03	8.2	1.64	-0.01	31.5	41.4	454.14	50.943148	-114.571721	S12T23R5M5
T050758	3-Nov-04	Well	6	233.2	284.5	80.85	0	24.6	594	0.2	281.36	0	19.3	0.3	-0.03	8.01	1.21	0.31	15.71	46.4	328.46	50.943148	-114.571721	S12T23R5M5
T047230	3-Jun-05	Well	70	259.1	316.1	109.1	0	157.1	1072	0.2	382.95	0	26.84	4.1	-0.03	8.23	2.57	0.03	51.56	30.6	537.58	50.943148	-114.571721	S12T23R5M5
T052549	21-Sep-05	Well	17	379.4	462.8	105.1	0	108.2	1102	0.1	348.91	0	21	3.7	-0.03	8.02	4.42	-0.01	95.18	22.9	588.21	50.943148	-114.571721	S12T23R5M5
T062871	24-Nov-05	Well	90	271.6	327.7	42.65	1.8	28.6	595	0.3	161.1	0	13.26	-0.23	-0.03	8.3	0.86	0.05	69.42	8.6	326.63	50.943148	-114.571721	S12T23R5M5
T063518	16-Oct-06	Well	25	384.5	469.1	32.69	0	87.1	1043	0.5	127.62	0	11.17	-0.23	-0.03	8.1	1.09	0.02	201.1	24.9	589.31	50.943148	-114.571721	S12T23R5M5
T075388	7-Nov-06	Well	15	268.8	298	79.57	14.8	1	503	0.2	276.93	0	19	-0.23	-0.03	8.56	1.1	0.21	6.79	12.6	281.56	50.943148	-114.571721	S12T23R5M5
T031598	18-May-04	Well	65	359.4	438.5	114.1	0	58.4	901	0.7	430.97	0	35.47	-0.23	-0.03	8.06	1.43	0.11	25.92	46.4	498.09	50.957696	-114.571717	S13T23R5M5
T053923	23-Aug-05	Well	120	309.1	344.4	25.61	16.1	4.5	600	0.5	117.4	0	12.98	-0.23	-0.03	8.6	7.66	0.14	88.4	14.4	339.57	50.957696	-114.571717	S13T23R5M5
T063552	3-Apr-06	Well	-50	294.8	359.7	418.6	0	1507.5	5280	-0.1	1523.76	0	116.2	-0.23	-0.03	8.06	5.64	3.75	471.8	114.3	2810.93	50.957696	-114.571717	S13T23R5M5
T064199	3-Apr-06	Well	74	298.8	364.5	84.39	0	63	800	0.1	297.74	0	21.13	-0.23	0.1	8.12	1.32	0.05	51.12	22.5	422.96	50.957696	-114.571717	S13T23R5M5
T063790	11-Jun-06	Well	26	353	430.6	117.7	0	44	872	0.1	405.12	0	27.01	1.3	-0.03	8.11	2.55	0.04	29.18	48.3	482	50.957696	-114.571717	S13T23R5M5

Appendix B - Groundwater Chemistry - 2007 -2009

SampleID	Date	Source	WellDepth	Alkalinity	Bicarbonate	Calcium	Carbonate	Chloride	Conductivity	Fluoride	Hardness	Hydroxide	Magnesium	Nitrate	Nitrite	pH	Potassium	Iron	Sodium	Sulfate	TDS	Latitude	Longitude	STRM
T075430	23-Jan-07	Well	7	268.4	327.5	79.48	0	1.1	531	0.2	273.7	0	18.27	-0.23	-0.03	7.66	1.23	-0.01	7.01	18.3	286.57	50.943148	-114.571721	S12T23R5M5
T082730	28-Jan-08	Well	12	268.1	327.1	184.4	0	29.9	1193	0.2	637.31	0	42.95	1.7	-0.03	8.08	3.38	-0.01	22.89	348.7	795.01	50.943148	-114.571721	S12T23R5M5
T086275	16-Apr-08	Well	10	254.8	310.8	80.05	0	8.7	546	0.2	280.97	0	19.69	-0.23	-0.03	8.04	0.67	-0.01	8.21	26.5	296.94	50.943148	-114.571721	S12T23R5M5
T053999	23-Apr-08	Well	50	323.7	394.9	105.5	0	10.4	640	0.1	355.96	0	22.47	0.5	-0.03	8.15	2.03	0.02	5.91	10	351.08	50.943148	-114.571721	S12T23R5M5
T086274	27-May-08	Well	10	187.8	229.1	57.66	0	5	403	0.2	202.95	0	14.32	-0.23	-0.03	8.06	0.55	-0.01	4.8	15.9	211.18	50.943148	-114.571721	S12T23R5M5
T098724	14-Nov-08	Well	43	320.7	391.3	105.2	0	64.7	847	0.4	350.93	0	21.43	2.4	-0.03	7.84	5.5	2.9	45.2	24.3	461.55	50.943148	-114.571721	S12T23R5M5
T098851	22-Jan-09	Well	16	328.7	401	153.7	0	521	2280	0.3	519.64	0	32.99	9.7	-0.03	8.14	5.14	-0.01	257.7	38.6	1216.33	50.943148	-114.571721	S12T23R5M5
T085844	13-May-09	Well	10	272.5	332.4	115.5	0	114	889	0.3	379.91	0	22.22	1	-0.03	8.25	1.68	-0.01	40.54	24.6	483.29	50.943148	-114.571721	S12T23R5M5
T079835	3-Jun-07	Well	-50	292.1	356.4	80.97	0	-1	611	0.9	296.03	0	22.79	-0.23	-0.03	7.9	1.43	0.02	13.47	36.6	331.79	50.957696	-114.571717	S13T23R5M5
T082518	6-Sep-07	Well	25	350.1	427.1	141.2	0	40	919	0.1	477.15	0	30.25	1.5	-0.03	8.14	2.67	0.03	39.88	76.4	542.04	50.957696	-114.571717	S13T23R5M5
T085843	8-Feb-08	Well	-50	379.3	462.7	122.8	0	56.2	918	0.1	409.09	0	24.88	-0.23	-0.03	8.26	3.59	0.03	30.35	25.4	491.01	50.957696	-114.571717	S13T23R5M5
T065070	16-Jun-08	Well	105	389.8	475.6	54.73	0	80	974	0.2	206.46	0	16.95	-0.23	-0.03	8.14	0.74	0.01	150	-1	537.1	50.957696	-114.571717	S13T23R5M5
T075414	11-Aug-09	Well	80	364.8	445.1	91.46	0	10.9	711	0.8	329.31	0	24.51	0.3	-0.03	8.14	1.53	0.13	25.91	22	396.29	50.957696	-114.571717	S13T23R5M5

Appendix B - Groundwater Chemistry - 2010-2012

SampleID	Date	Source	WellDepth	Alkalinity	Bicarbonate	Calcium	Carbonate	Chloride	Conductivity	Fluoride	Hardness	Hydroxide	Magnesium	Nitrate	Nitrite	pH	Potassium	Iron	Sodium	Sulfate	TDS	Latitude	Longitude	STRM
T107478	11-Jan-10	Well	-50	267.3	326.2	126.5	0	209.5	1290	0.2	421.09	0	25.55	8	-0.03	8.28	4.3	-0.01	79.55	48.5	662.49	50.943148	-114.571721	S12T23R5M5
T115396	10-May-10	Well	120	336	385.6	35.35	12	6.2	621	0.5	151.64	0	15.39	-0.23	-0.03	8.5	1.34	0.2	84.26	10.3	355.23	50.957696	-114.571717	S13T23R5M5
T110532	27-May-10	Well	82	284.8	347.4	77.38	0	7.5	634	0.7	305.97	0	27.38	-0.23	-0.03	8.03	9.52	0.58	9.87	55.1	358.33	50.957696	-114.571717	S13T23R5M5
T125625	15-Nov-10	Well	-50	236.8	288.9	67.3	0	13.9	506	-0.1	254.69	0	21.04	0.8	-0.03	7.88	1.9	0.01	6.12	8.5	261.65	50.943148	-114.571721	S12T23R5M5
T125568	14-Mar-11	Well	74	305	372.1	92.11	0	90.1	856	-0.1	327.72	0	23.73	-0.23	-0.03	8.26	1.3	0.04	54.98	19.9	465.49	50.957696	-114.571717	S13T23R5M5
T115440	13-Apr-11	Well	39	313.4	382.4	97.96	0	22.4	656	-0.1	332.11	0	21.25	0.7	-0.03	8.13	1.78	0.02	6.95	9.7	348.86	50.943148	-114.571721	S12T23R5M5
T115386	18-Apr-11	Well	85	282.4	344.5	79.19	0	1.1	621	0.7	310.98	0	27.5	-0.23	-0.03	8.23	1.57	2.47	14.16	61.4	355.06	50.957696	-114.571717	S13T23R5M5
T119002	20-Apr-11	Well	-50	357	416.6	-0.1	9.3	7.2	704	0.9	0.33	0	-0.1	-0.23	-0.03	8.53	0.4	0.02	170.8	12.4	405.99	50.957696	-114.571717	S13T23R5M5
T115382	21-May-11	Well	30	228.8	279.1	50.42	0	15.7	511	0.2	170.62	0	10.86	0.3	-0.03	7.95	6.72	-0.01	42.48	18	282.01	50.943148	-114.571721	S12T23R5M5
T109243	10-Jun-11	Well	-50	267.5	326.3	90.9	0	71	793	0.2	326.8	0	24.24	-0.23	-0.03	8.22	1.23	0.15	41.05	31.8	421.01	50.943148	-114.571721	S12T23R5M5
T126753	12-Jun-12	Well	20	161.5	194.4	58.63	1.3	1.3	383	0.3	208.52	0	15.08	-0.23	-0.03	8.33	0.56	-0.01	2.13	40.3	215.27	50.943148	-114.571721	S12T23R5M5

Appendix B - Groundwater Chemistry - 2013-2015

SampleID	Date	Source	WellDepth	Alkalinity	Bicarbonate	Calcium	Carbonate	Chloride	Conductivity	Fluoride	Hardness	Hydroxide	Magnesium	Nitrate	Nitrite	pH	Potassium	Iron	Sodium	Sulfate	TDS	Latitude	Longitude	STRM	Well ID
T156851	8-Jan-13	Well	165	383.6	468	52.6	0	62	898	0.2	183.96	0	12.77	-0.23	-0.03	7.89	1.02	0.14	146.49	20.3	525.48	50.943148	-114.571721	S12T23R5M5	U
T134146	21-Jan-13	Well	160	411.2	499.2	50.06	1.2	59.7	897	0.2	171.79	0	11.36	-0.23	-0.03	8.3	1.13	0.9	147.44	19.7	536.29	50.943148	-114.571721	S12T23R5M5	U
T156840	28-Feb-13	Well	10	285.8	348.7	117.53	0	78	920	0.2	401.08	0	26.13	3.8	-0.03	8.25	2.86	0.01	48.51	104.1	552.62	50.957696	-114.571717	S13T23R5M5	U
T150802	4-Mar-13	Well	26	343.8	419.5	112.66	0	30.4	777	0.2	381.23	0	24.26	1	-0.03	8.16	2.29	-0.01	29.6	68.1	474.78	50.957696	-114.571717	S13T23R5M5	U
T150868	29-Apr-13	Well	-50	309.1	377.1	118.95	0	53.1	903	0.2	413.5	0	28.29	2.5	-0.03	8.26	3.17	-0.01	37.64	95.6	524.86	50.957696	-114.571717	S13T23R5M5	U
T152756	15-Jul-13	Well	-50	297.9	363.4	110.23	0	61.4	774	-0.1	361.9	0	21.04	-0.23	-0.03	8.09	2.29	-0.01	50.34	17.7	441.75	50.957696	-114.571717	S13T23R5M5	U
T162288	28-Jan-14	Well	160	349.4	412.3	59.28	6.9	51.2	824	0.2	206.12	0	14.11	-0.23	-0.03	8.41	1.1	0.05	145.54	21.5	502.52	50.943148	-114.571721	S12T23R5M5	U
T162318	19-Feb-14	Well	15	301.5	348.5	107.77	9.5	59.3	792	0.2	357.19	0	21.39	3.5	-0.03	8.47	5.92	-0.01	37.44	23.5	439.87	50.943148	-114.571721	S12T23R5M5	U
T162580	2-Apr-14	Well	130	370.2	435.3	40.48	8	2.4	661	0.7	161.97	0	14.78	-0.23	-0.03	8.43	1.36	0.06	108.91	3.5	394.28	50.943148	-114.571721	S12T23R5M5	U
T163568	16-Jun-14	Well	-50	324.3	395.6	31.29	0	9.7	631	0.2	110.66	0	7.9	0.6	-0.03	8.23	1.18	-0.01	117.66	10.2	373.19	50.943148	-114.571721	S12T23R5M5	U
T163547	18-Aug-14	Well	115	356.5	429.9	58.69	2.5	30	726	0.2	223.2	0	18.62	-0.23	-0.03	8.32	0.58	0.31	78.98	13.5	414.46	50.957696	-114.571717	S13T23R5M5	U
T150828	30-Sep-14	Well	50	429.4	523.8	190.2	0	104.9	1249	0.2	596.75	0	29.58	2.1	-0.03	7.7	4.26	-0.01	55.29	85.2	729.34	50.957696	-114.571717	S13T23R5M5	U
T161541	12-May-15	Well	10	328.4	400.7	139.37	0	86	897	0.2	456.23	0	26.28	0.6	-0.03	8.05	2.02	-0.01	24.15	44.9	520.65	50.943148	-114.571721	S12T23R5M5	U
T139027	22-Jun-15	Well	100	377.9	461	139.94	0	129	1158	0.7	511.16	0	39.27	0.3	-0.03	7.87	0.63	0.02	27.88	31.2	595.63	50.957696	-114.571717	S13T23R5M5	U
T139045	10-Aug-15	Well	74	294.8	359.7	110.97	0	93.9	873	0.1	373.11	0	23.32	-0.23	-0.03	7.8	5.2	-0.01	54.39	22.7	487.68	50.957696	-114.571717	S13T23R5M5	U

Appendix B - Groundwater Chemistry 2016-2018

SampleID	Date	Source	WellDepth	Alkalinity	Bicarbonate	Calcium	Carbonate	Chloride	Conductivity	Fluoride	Hardness	Hydroxide	Magnesium	Nitrate	Nitrite	pH	Potassium	Iron	Sodium	Sulfate	TDS	Latitude	Longitude	STRM	Well ID
T176835	16-Dec-15	Well	-50	361	440	83.8	0	2.6	706	0.4	337	0	31.1	-0.23	-0.03	8.1	1.3	0.24	39.6	30	405	50.943148	-114.571721	S12T23R5M5	U
T180597	25-Jan-16	Well	75	311	380	112	0	46.7	773	0.2	379	0	24.5	2.4	-0.03	8.1	1.7	-0.01	32.4	23.6	430	50.943148	-114.571721	S12T23R5M5	U
T139097	21-Mar-16	Well	115	333	406	59.8	0	26.1	733	0.1	225	0	18.4	-0.23	-0.03	8.1	0.59	0.16	78.2	11.6	395	50.957696	-114.571717	S13T23R5M5	350901
T190402	25-Apr-16	Well	8	325	396	116	0	55.4	900	0.2	392	0	25.1	2.2	-0.03	8	3.1	-0.01	31.8	59.1	487	50.957696	-114.571717	S13T23R5M5	U
T220769	11-Jul-16	Well	-50	220	269	90.6	0	3.4	556	0.3	305	0	19.1	0.3	-0.03	8	0.62	-0.01	2.8	73.8	323	50.943148	-114.571721	S12T23R5M5	U
T201833	6-Sep-16	Well	10	424	518	148	0	57.9	1030	0.2	501	0	32.1	1.2	-0.03	7.8	3.1	0.03	39.8	55.9	592	50.957696	-114.571717	S13T23R5M5	U
T207335	10-Apr-17	Well	14	231	282	89	0	128	882	0.1	322	0	24.1	-0.23	-0.03	8.2	1.3	0.02	51.6	18.7	452	50.957696	-114.571717	S13T23R5M5	U
T221306	30-May-17	Well	90	298	357	96.9	3.3	23.5	659	0.12	327	0	20.6	1.1	-0.03	8.3	1.8	0.06	8.8	15.6	347	50.943148	-114.571721	S12T23R5M5	U
T194280	26-Jun-17	Well	100	378	461	154	0	139	1175	0.6	589	0	49.4	-0.23	-0.03	8.2	0.53	0.04	31.7	30.2	633	50.957696	-114.571717	S13T23R5M5	U
T201765	24-Jul-17	Well	10	298	364	101	0	26	724	0.31	356	0	25.3	0.53	0.04	8.2	1.5	0.05	27.5	62.2	423	50.943148	-114.571721	S12T23R5M5	U
T150799	24-Oct-17	Well	120	276	315	59.6	10.5	23.5	607	0.33	227	0	19	-0.23	-0.03	8.6	1.3	0.04	68.8	17.1	355	50.957696	-114.571717	S13T23R5M5	1020257
T198753	13-Aug-18	Well	74	285	348	120	0	145	1017	-0.1	404	0	25.6	-0.23	-0.03	8.3	1.4	-0.01	54.6	19.9	538	50.957696	-114.571717	S13T23R5M5	U
T193134	28-Sep-18	Well	12	323	391	123	1.5	79	966	0.26	408	0	24.5	1	-0.03	8.3	2	0.01	45.1	69	537	50.943148	-114.571721	S12T23R5M5	U
T223650	5-Nov-18	Well	175	345	398	20.7	11.5	27.1	726	0.58	67.8	0	3.9	-0.23	-0.03	8.6	0.58	1.3	151	1.7	412	50.943148	-114.571721	S12T23R5M5	2066214

APPENDIX C

Analytical Calculations

Project: Bragg Creek
Location: Section 10+150

River Elev. = **1307.5**

Unsteady one-dimensional flow

Huisman, L. and T.N. Olsthoorn (1983) *Artificial Groundwater Recharge*. Pittman: London. 320pp.

u = 0.5*(sqrt(S_y/Kb))*(x/sqrt(t))

q_o = (s_o/sqrt(π)) * (sqrt(S_y*K*b))*(1/sqrt(t))

E_1 = erfc(u) $E_2 = e^{-u^2}$

s = S_o*E_1 q = q_o*E_2

Parameters		**Distance**		
K(m/s)=	8.00E-04	x_1(m)=	10	
b(m)=	4	x_2(m)=	20	
S_y=	0.2	x_3(m)=	30	
S_o(m)=	3.8	x_4(m)=	**50**	*
t(day)=	3	x_5(m)=	75	

q_o = 0.00010653 m^3/s **9.20439 m^3/d**

				Head Change (s_n at distance x_n)		Elev.			Seepage rate per metre m^3/s	m^3/d	L/min
u_1=	0.077641249	E_1=	0.912567	s_1=	3.467754	**1310.968**	E_2=	0.99399	q_1= 0.000105892	9.149069741	6.353521
u_2=	0.155282498	E_1=	0.826181	s_2=	3.139486	**1310.639**	E_2=	0.976176	q_2= 0.000103994	8.985100592	6.239653
u_3=	0.232923748	E_1=	0.74185	s_3=	2.819032	**1310.319**	E_2=	0.947192	q_3= 0.000100907	8.718322956	6.054391
u_4=	0.388206246	E_1=	0.583001	s_4=	2.215404	**1309.715**	E_2=	0.860102	q_4= 9.16286E-05	7.916714474	5.497718
u_5=	0.582309369	E_1=	0.410218	s_5=	1.558829	**1309.059**	E_2=	0.712422	q_5= 7.5896E-05	6.557413021	4.553759

Parameters		**Distance**		
K(m/s)=	8.00E-04	x_1(m)=	100	
b(m)=	4	x_2(m)=	150	
S_y=	0.2	x_3(m)=	200	
S_o(m)=	3.8	x_4(m)=	**300**	*
t(day)=	3	x_5(m)=	400	

q_o = 0.00010653 **9.20439 m^3/d**

				Head Change (s_n at distance x_n)					Seepage rate per metre m^3/s	m^3/d	L/min
u_1=	0.776412492	E_1=	0.272199	s_1=	1.034355	**1308.534**	E_2=	0.547268	q_1= 5.83017E-05	5.037268707	3.498103
u_2=	1.164618738	E_1=	0.099554	s_2=	0.378305	**1307.878**	E_2=	0.257603	q_2= 2.7443E-05	2.371075298	1.64658
u_3=	1.552824984	E_1=	0.02809	s_3=	0.106742	**1307.607**	E_2=	0.089702	q_3= 9.55613E-06	0.825649391	0.573368
u_4=	2.329237477	E_1=	0.000988	s_4=	0.003753	**1307.504**	E_2=	0.004404	q_4= 4.69119E-07	0.040531864	0.028147
u_5=	3.105649969	E_1=	1.12E-05	s_5=	4.27E-05	**1307.5**	E_2=	6.47E-05	q_5= 6.89738E-09	0.000595934	0.000414

Project: Bragg Creek
Location: Section 10+700

River Elev. = **1303**

Unsteady one-dimensional flow

Huisman, L. and T.N. Olsthoorn (1983) *Artificial Groundwater Recharge*. Pittman: London. 320pp.

$u = 0.5*(sqrt(S_y/Kb))*(x/sqrt(t))$

$q_o = (s_o/sqrt(\pi)) * (sqrt(S_y*K*b))*(1/sqrt(t))$

$E_1 = erfc(u)$ $E_2 = e^{-u\wedge 2}$

$s = S_o*E_1$ $q = q_o*E_2$

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	10
b(m)=	4	x_2(m)=	20
S_y=	0.2	x_3(m)=	30
S_o(m)=	4.3	x_4(m)=	**50** *
t(day)=	3	x_5(m)=	75
q_o =	**0.00012055 m^3/s**		**10.4155 m^3/d**

				Head Change (s_n at distance x_n)		**Elev.**			**Seepage rate per metre** m^3/s	m^3/d	L/min
u_1=	0.077641249	E_1=	0.912567	s_1=	3.924038	**1306.924**	E_2=	0.99399	q_1= 0.000119825	10.35289471	7.18951
u_2=	0.155282498	E_1=	0.826181	s_2=	3.552577	**1306.553**	E_2=	0.976176	q_2= 0.000117678	10.16735067	7.06066
u_3=	0.232923748	E_1=	0.74185	s_3=	3.189957	**1306.19**	E_2=	0.947192	q_3= 0.000114184	9.865470713	6.851021
u_4=	0.388206246	E_1=	0.583001	s_4=	2.506904	**1305.507**	E_2=	0.860102	q_4= 0.000103685	8.958387431	6.221102
u_5=	0.582309369	E_1=	0.410218	s_5=	1.763938	**1304.764**	E_2=	0.712422	q_5= 8.58823E-05	7.420230524	5.152938

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	100
b(m)=	4	x_2(m)=	150
S_y=	0.2	x_3(m)=	200
S_o(m)=	4.3	x_4(m)=	300
t(day)=	3	x_5(m)=	400
q_o =	**0.00012055**		**10.4155 m^3/d**

				Head Change (s_n at distance x_n)					**Seepage rate per metre** m^3/s	m^3/d	L/min
u_1=	0.776412492	E_1=	0.272199	s_1=	1.170455	**1304.17**	E_2=	0.547268	q_1= 6.5973E-05	5.700067222	3.95838
u_2=	1.164618738	E_1=	0.099554	s_2=	0.428082	**1303.428**	E_2=	0.257603	q_2= 3.10539E-05	2.68305889	1.863235
u_3=	1.552824984	E_1=	0.02809	s_3=	0.120787	**1303.121**	E_2=	0.089702	q_3= 1.08135E-05	0.934287468	0.648811
u_4=	2.329237477	E_1=	0.000988	s_4=	0.004247	**1303.004**	E_2=	0.004404	q_4= 5.30845E-07	0.045865004	0.031851
u_5=	3.105649969	E_1=	1.12E-05	s_5=	4.83E-05	**1303**	E_2=	6.47E-05	q_5= 7.80493E-09	0.000674346	0.000468

Project: Bragg Creek
Location: Section 11+000

River Elev. = **1301.5**

Unsteady one-dimensional flow

Huisman, L. and T.N. Olsthoorn (1983) ***Artificial Groundwater Recharge*** **. Pittman: London. 320pp.**

$u = 0.5*(sqrt(S_y/Kb))*(x/sqrt(t))$

$q_o = (s_o/sqrt(\pi)) * (sqrt(S_y*K*b))*(1/sqrt(t))$

$E_1 = erfc(u)$ $E_2 = e^{-u^{\wedge}2}$

$s = S_o*E_1$ $q = q_o*E_2$

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	10
b(m)=	4	x_2(m)=	20
S_y=	0.2	x_3(m)=	30
S_o(m)=	4.1	x_4(m)=	**50** *
t(day)=	3	x_5(m)=	75

q_o = 0.00011494 m^3/s **9.93105 m^3/d**

				Head Change (s_n at distance x_n)		**Elev.**			**Seepage rate per metre** m^3/s	m^3/d	L/min
u_1=	0.077641249	E_1=	0.912567	s_1=	3.741525	**1305.242**	E_2=	0.99399	q_1= 0.000114252	9.871364721	6.855114
u_2=	0.155282498	E_1=	0.826181	s_2=	3.387341	**1304.887**	E_2=	0.976176	q_2= 0.000112204	9.694450639	6.732257
u_3=	0.232923748	E_1=	0.74185	s_3=	3.041587	**1304.542**	E_2=	0.947192	q_3= 0.000108873	9.40661161	6.532369
u_4=	0.388206246	E_1=	0.583001	s_4=	2.390304	**1303.89**	E_2=	0.860102	q_4= 9.88625E-05	8.541718248	5.931749
u_5=	0.582309369	E_1=	0.410218	s_5=	1.681894	**1303.182**	E_2=	0.712422	q_5= 8.18878E-05	7.075103523	4.913266

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	100
b(m)=	4	x_2(m)=	150
S_y=	0.2	x_3(m)=	200
S_o(m)=	4.1	x_4(m)=	300
t(day)=	3	x_5(m)=	400

q_o = 0.00011494 **9.93105 m^3/d**

				Head Change (s_n at distance x_n)					**Seepage rate per metre** m^3/s	m^3/d	L/min
u_1=	0.776412492	E_1=	0.272199	s_1=	1.116015	**1302.616**	E_2=	0.547268	q_1= 6.29045E-05	5.434947816	3.774269
u_2=	1.164618738	E_1=	0.099554	s_2=	0.408171	**1301.908**	E_2=	0.257603	q_2= 2.96096E-05	2.558265453	1.776573
u_3=	1.552824984	E_1=	0.02809	s_3=	0.115169	**1301.615**	E_2=	0.089702	q_3= 1.03106E-05	0.890832237	0.618633
u_4=	2.329237477	E_1=	0.000988	s_4=	0.004049	**1301.504**	E_2=	0.004404	q_4= 5.06154E-07	0.043731748	0.030369
u_5=	3.105649969	E_1=	1.12E-05	s_5=	4.6E-05	**1301.5**	E_2=	6.47E-05	q_5= 7.44191E-09	0.000642981	0.000447

Project: Bragg Creek
Location: Section 11+550

River Elev. = **1297.5**

Unsteady one-dimensional flow

Huisman, L. and T.N. Olsthoorn (1983) *Artificial Groundwater Recharge*. Pittman: London. 320pp.

$u = 0.5*(sqrt(S_y/Kb))*(x/sqrt(t))$

$q_o = (s_o/sqrt(\pi)) * (sqrt(S_y*K*b))*(1/sqrt(t))$

$E_1 = erfc(u)$ $E_2 = e^{-u^2}$

$s = S_o*E_1$ $q = q_o*E_2$

Parameters		**Distance**		
K(m/s)=	8.00E-04	x_1(m)=	10	
b(m)=	4	x_2(m)=	20	
S_y=	0.2	x_3(m)=	30	
S_o(m)=	3.7	x_4(m)=	**50**	*
t(day)=	3	x_5(m)=	75	
q_o =	**0.00010373**	**m^3/s**	**8.96217**	**m^3/d**

				Head Change (s_n at distance x_n)		**Elev.**			**Seepage rate per metre**		
									m^3/s	m^3/d	L/min
u_1=	0.077641249	E_1=	0.912567	s_1=	3.376498	**1300.876**	E_2=	0.99399	q_1= 0.000103105	8.908304748	6.186323
u_2=	0.155282498	E_1=	0.826181	s_2=	3.056868	**1300.557**	E_2=	0.976176	q_2= 0.000101258	8.748650577	6.075452
u_3=	0.232923748	E_1=	0.74185	s_3=	2.744846	**1300.245**	E_2=	0.947192	q_3= 9.82511E-05	8.488893405	5.895065
u_4=	0.388206246	E_1=	0.583001	s_4=	2.157104	**1299.657**	E_2=	0.860102	q_4= 8.92174E-05	7.708379882	5.353042
u_5=	0.582309369	E_1=	0.410218	s_5=	1.517807	**1299.018**	E_2=	0.712422	q_5= 7.38987E-05	6.384849521	4.433923

Parameters		**Distance**		
K(m/s)=	8.00E-04	x_1(m)=	100	
b(m)=	4	x_2(m)=	150	
S_y=	0.2	x_3(m)=	200	
S_o(m)=	3.7	x_4(m)=	300	
t(day)=	3	x_5(m)=	400	
q_o =	**0.00010373**		**8.96217**	**m^3/d**

				Head Change (s_n at distance x_n)					**Seepage rate per metre**		
									m^3/s	m^3/d	L/min
u_1=	0.776412492	E_1=	0.272199	s_1=	1.007135	**1298.507**	E_2=	0.547268	q_1= 5.67675E-05	4.904709005	3.406048
u_2=	1.164618738	E_1=	0.099554	s_2=	0.36835	**1297.868**	E_2=	0.257603	q_2= 2.67208E-05	2.30867858	1.603249
u_3=	1.552824984	E_1=	0.02809	s_3=	0.103933	**1297.604**	E_2=	0.089702	q_3= 9.30465E-06	0.803921775	0.558279
u_4=	2.329237477	E_1=	0.000988	s_4=	0.003654	**1297.504**	E_2=	0.004404	q_4= 4.56774E-07	0.039465236	0.027406
u_5=	3.105649969	E_1=	1.12E-05	s_5=	4.15E-05	**1297.5**	E_2=	6.47E-05	q_5= 6.71587E-09	0.000580251	0.000403

Project: Bragg Creek
Location: Section 12+100

River Elev. = **1293**

Unsteady one-dimensional flow

Huisman, L. and T.N. Olsthoorn (1983) *Artificial Groundwater Recharge*. Pittman: London. 320pp.

u = 0.5*(sqrt(S_y/Kb))*(x/sqrt(t))

q_o = (s_o/sqrt(π)) * (sqrt(S_y*K*b))*(1/sqrt(t))

E_1 = erfc(u) $E_2 = e^{-u^2}$

s = S_o*E_1 q = q_o*E_2

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	10
b(m)=	4	x_2(m)=	20
S_y=	0.2	x_3(m)=	30
S_o(m)=	4	x_4(m)=	**50** *
t(day)=	3	x_5(m)=	75
q_o =	**0.00011214** m^3/s		**9.68883** m^3/d

				Head Change (s_n at distance x_n)		**Elev.**			**Seepage rate per metre** m^3/s	m^3/d	L/min
u_1=	0.077641249	E_1=	0.912567	s_1=	3.650268	**1296.65**	E_2=	0.99399	q_1= 0.000111465	9.630599728	6.687916
u_2=	0.155282498	E_1=	0.826181	s_2=	3.304723	**1296.305**	E_2=	0.976176	q_2= 0.000109468	9.458000624	6.568056
u_3=	0.232923748	E_1=	0.74185	s_3=	2.967402	**1295.967**	E_2=	0.947192	q_3= 0.000106217	9.177182059	6.373043
u_4=	0.388206246	E_1=	0.583001	s_4=	2.332004	**1295.332**	E_2=	0.860102	q_4= 9.64512E-05	8.333383657	5.787072
u_5=	0.582309369	E_1=	0.410218	s_5=	1.640873	**1294.641**	E_2=	0.712422	q_5= 7.98905E-05	6.902540023	4.793431

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	100
b(m)=	4	x_2(m)=	150
S_y=	0.2	x_3(m)=	200
S_o(m)=	4	x_4(m)=	**300** *
t(day)=	3	x_5(m)=	400
q_o =	**0.00011214**		**9.68883** m^3/d

				Head Change (s_n at distance x_n)					**Seepage rate per metre** m^3/s	m^3/d	L/min
u_1=	0.776412492	E_1=	0.272199	s_1=	1.088795	**1294.089**	E_2=	0.547268	q_1= 6.13702E-05	5.302388113	3.682214
u_2=	1.164618738	E_1=	0.099554	s_2=	0.398216	**1293.398**	E_2=	0.257603	q_2= 2.88874E-05	2.495868735	1.733242
u_3=	1.552824984	E_1=	0.02809	s_3=	0.11236	**1293.112**	E_2=	0.089702	q_3= 1.00591E-05	0.869104622	0.603545
u_4=	2.329237477	E_1=	0.000988	s_4=	0.00395	**1293.004**	E_2=	0.004404	q_4= 4.93809E-07	0.04266512	0.029629
u_5=	3.105649969	E_1=	1.12E-05	s_5=	4.49E-05	**1293**	E_2=	6.47E-05	q_5= 7.2604E-09	0.000627298	0.000436

Project: Bragg Creek
Location: Section 12+450

River Elev. = **1290.5**

Unsteady one-dimensional flow

Huisman, L. and T.N. Olsthoorn (1983) *Artificial Groundwater Recharge*. Pittman: London. 320pp.

$u = 0.5*(sqrt(S_y/Kb))*(x/sqrt(t))$

$q_o = (s_o/sqrt(\pi)) * (sqrt(S_y*K*b))*(1/sqrt(t))$

$E_1 = erfc(u)$ $E_2 = e^{-u^2}$

$s = S_o*E_1$ $q = q_o*E_2$

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	10
b(m)=	4	x_2(m)=	20
S_y=	0.2	x_3(m)=	30
S_o(m)=	4.4	x_4(m)=	**50** *
t(day)=	3	x_5(m)=	75

q_o = 0.00012335 m^3/s 10.6577 m^3/d

				Head Change (s_n at distance x_n)	Elev.			Seepage rate per metre m^3/s	m^3/d	L/min
u_1=	0.077641249	E_1=	0.912567	s_1= 4.015295	**1294.515**	E_2=	0.99399	q_1= 0.000122612	10.5936597	7.356708
u_2=	0.155282498	E_1=	0.826181	s_2= 3.635195	**1294.135**	E_2=	0.976176	q_2= 0.000120414	10.40380069	7.224862
u_3=	0.232923748	E_1=	0.74185	s_3= 3.264142	**1293.764**	E_2=	0.947192	q_3= 0.000116839	10.09490026	7.010347
u_4=	0.388206246	E_1=	0.583001	s_4= 2.565204	**1293.065**	E_2=	0.860102	q_4= 0.000106096	9.166722022	6.365779
u_5=	0.582309369	E_1=	0.410218	s_5= 1.80496	**1292.305**	E_2=	0.712422	q_5= 8.78796E-05	7.592794025	5.272774

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	100
b(m)=	4	x_2(m)=	150
S_y=	0.2	x_3(m)=	200
S_o(m)=	4.4	x_4(m)=	300
t(day)=	3	x_5(m)=	400

q_o = 0.00012335 10.6577 m^3/d

				Head Change (s_n at distance x_n)				Seepage rate per metre m^3/s	m^3/d	L/min
u_1=	0.776412492	E_1=	0.272199	s_1= 1.197675	**1291.698**	E_2=	0.547268	q_1= 6.75073E-05	5.832626924	4.050435
u_2=	1.164618738	E_1=	0.099554	s_2= 0.438038	**1290.938**	E_2=	0.257603	q_2= 3.17761E-05	2.745455608	1.906566
u_3=	1.552824984	E_1=	0.02809	s_3= 0.123596	**1290.624**	E_2=	0.089702	q_3= 1.1065E-05	0.956015084	0.663899
u_4=	2.329237477	E_1=	0.000988	s_4= 0.004345	**1290.504**	E_2=	0.004404	q_4= 5.4319E-07	0.046931632	0.032591
u_5=	3.105649969	E_1=	1.12E-05	s_5= 4.94E-05	**1290.5**	E_2=	6.47E-05	q_5= 7.98644E-09	0.000690028	0.000479

Project: Bragg Creek
Location: Section 12+800 (NW and SE sides)

River Elev. = **1287.1**

Unsteady one-dimensional flow

Huisman, L. and T.N. Olsthoorn (1983) *Artificial Groundwater Recharge*. Pittman: London. 320pp.

u = 0.5*(sqrt(S_y/Kb))*(x/sqrt(t))
q_o = (s_o/sqrt(π)) * (sqrt(S_y*K*b))*(1/sqrt(t))
E_1 = erfc(u) $E_2 = e^{-u^2}$
s = S_o*E_1 q = q_o*E_2

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	10
b(m)=	4	x_2(m)=	20
S_y=	0.2	x_3(m)=	30
S_o(m)=	4.2	x_4(m)=	**50** *
t(day)=	3	x_5(m)=	75
q_o =	**0.00011775** m³/s	**10.1733**	**m³/d**

				Head Change (s_n at distance x_n)		Elev.			Seepage rate per metre m³/s	m³/d	L/min
u_1=	0.077641249	E_1=	0.912567	s_1=	3.832781	**1290.933**	E_2=	0.99399	q_1= 0.000117039	10.11212971	7.022312
u_2=	0.155282498	E_1=	0.826181	s_2=	3.469959	**1290.57**	E_2=	0.976176	q_2= 0.000114941	9.930900655	6.896459
u_3=	0.232923748	E_1=	0.74185	s_3=	3.115772	**1290.216**	E_2=	0.947192	q_3= 0.000111528	9.636041162	6.691695
u_4=	0.388206246	E_1=	0.583001	s_4=	2.448604	**1289.549**	E_2=	0.860102	q_4= 0.000101274	8.750052839	6.076426
u_5=	0.582309369	E_1=	0.410218	s_5=	1.722916	**1288.823**	E_2=	0.712422	q_5= 8.3885E-05	7.247667024	5.033102

Parameters		**Distance**	
K(m/s)=	8.00E-04	x_1(m)=	100
b(m)=	4	x_2(m)=	150
S_y=	0.2	x_3(m)=	200
S_o(m)=	4.2	x_4(m)=	300
t(day)=	3	x_5(m)=	400
q_o =	**0.00011775**	**10.1733**	**m³/d**

				Head Change (s_n at distance x_n)					Seepage rate per metre m³/s	m³/d	L/min
u_1=	0.776412492	E_1=	0.272199	s_1=	1.143235	**1288.243**	E_2=	0.547268	q_1= 6.44387E-05	5.567507519	3.866325
u_2=	1.164618738	E_1=	0.099554	s_2=	0.418127	**1287.518**	E_2=	0.257603	q_2= 3.03317E-05	2.620662172	1.819904
u_3=	1.552824984	E_1=	0.02809	s_3=	0.117978	**1287.218**	E_2=	0.089702	q_3= 1.0562E-05	0.912559853	0.633722
u_4=	2.329237477	E_1=	0.000988	s_4=	0.004148	**1287.104**	E_2=	0.004404	q_4= 5.185E-07	0.044798376	0.03111
u_5=	3.105649969	E_1=	1.12E-05	s_5=	4.72E-05	**1287.1**	E_2=	6.47E-05	q_5= 7.62342E-09	0.000658663	0.000457

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