



GOLDER

TECHNICAL MEMORANDUM

DATE 21 March 2019

Reference No. 18108595-001-TM-Rev0

TO Mike Simpson, MA RPF, Senior Regional Manager
Fraser Basin Council

FROM Kevin Bennett

EMAIL kevin_bennett@golder.com

PART 1 OF NICOLA VALLEY GROUNDWATER FLOW MODELING PROJECT

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) is pleased to provide this technical memorandum outlining the methods, results and associated assumptions for Part 1 of the groundwater flow modeling project (referred to as Phase 3) for the Nicola Valley. The results provided here were presented to the Fraser Basin Council (FBC), the BC Ministry of Forests Lands Natural Resource Operations and Rural Development (FLNRORD) and the BC Ministry of Environment and Climate Change Strategy (ENV) on 7 March 2019. Attachment 1 provides a copy of the presentation slides.

Golder completed aquifer mapping of the study area (Phase 1 in Gorsky et. al., 2018) in 2017 and 2018 and mapped 13 additional aquifers, increasing the total number of mapped aquifers in the Nicola Watershed to 25. In 2018 Golder compiled available hydrogeological data and develop a conceptual model and numerical modelling strategy for the Nicola Valley (Phase 2 in Golder 2018). Development of a preliminary, regional, scoping-level numerical groundwater flow model (Phase 3) for the study area is the next step to inform provincial water management strategies on groundwater and surface water management including; allocation and curtailment decision making, identifying surface water-groundwater interactions and understanding environmental flow needs. The work scope for Phase 3 was outlined in Golder's proposal dated 30 October 2018.

Part 1 of the Phase 3 work scope entailed additional data compilation and interpretation to resolve some of the key data gaps and uncertainties identified in Phase 2, also outlined in the Phase 3 proposal. The data gaps resolved here are those that were proposed to be addressed by Golder, as separate from those that were proposed to be addressed by FBC (or FLNRORD/ENV).

2.0 SCOPE OF WORK

The scope of work for Part 1 included the following items:

- Development of a bedrock surface topographic map.
- Development of 3D hydrostratigraphic layers and aquifer extents (top and bottom surfaces as well as lateral extents) using interpolation software (Leapfrog).
- Development of a high-resolution topographic map for the valley area.
- Identification of the reach locations where baseflow can be estimated, for the main watercourses within the valley, and estimation of average annual baseflow rates from groundwater for these reaches.

The following sections describe, for each of the above items, the approach taken to address them, and the results produced.

3.0 BEDROCK SURFACE TOPOGRAPHY

The total thickness of the valley bottom sediments is not known in most locations within the study area and a bedrock surface topography map does not exist. A digital map of this surface was produced using the estimation approach described in Phase 2 and the available information in the Leapfrog model within the proposed area to be included in groundwater flow model study. Based on the limited bedrock depth data within the valleys, the valley side slopes were used to extrapolate the bedrock surface below the unconsolidated valley sediments (see Attachment 1 Slide 4). Planes placed tangentially to the valley side slopes were positioned along the length of the valleys at locations where the angle of the valley side slope or the orientation of the valley changed. Approximately 150 planes were used to estimate the bedrock surface along the length on the study area. The estimated maximum depth of the bedrock was inferred to occur at the intersection of the planes from opposite sides of the valley. Points placed along the line of intersection of the planes delineated the valley trough, while additional points placed on the face of the planes below ground surface were used to produce a U-shaped bedrock surface within the valley. A bedrock surface mesh was generated from these points and from points of known depth-to-bedrock from available borehole logs and water well logs.

The bedrock surface elevation below the unconsolidated valley bottom sediments will form the base of the groundwater model domain, except for the Merritt Basin and the Lower Nicola Valley between Merritt and Spius Creek. The bedrock surface below the Merritt Basin was roughly estimated, using the approach described above, to be between 400 m to 500 m deep; however, the log for the deepest well in this area only extends to a depth of 170 m, in which no bedrock contact is documented. Given the unknown nature of sediments below this depth, a horizontal plane at a depth of 200 m below ground surface (approximately 400 m above sea level (masl)) was used as the base of the model within this area. Similarly, the nature of the deposits below approximately 110 m is unknown in the Lower Nicola; thus, the basal surface implemented in the Merritt Basin area was extended into the Lower Nicola Valley. The resultant basal surface is shown on Slide 5 in Attachment 1.

4.0 HYDROSTRATIGRAPHIC LAYERS

The valley bottom sediments within the study area form the aquifer complex of interest. They contain both known (and defined) aquifers as well as potentially unknown aquifers. The aquifer complex as a whole is inferred to be channel-shaped, on the order of 110 km long, 500 m to 1000 m wide and 20 to 200 m deep.

Digital maps (3D surfaces) of the primary hydrostratigraphic layers and the aquifer extents were produced using the Leapfrog model from Phase 1. Initially, a detailed evaluation of the stratigraphy was completed for the four main geographic areas within the study area. The assumptions applied to limit the vertical and lateral extent of the key hydrostratigraphic units in these main geographic areas, based on the available data, are provided below. Following this evaluation, the hydrostratigraphic models from each of these areas were linked at appropriate contacts to produce a contiguous model of hydrostratigraphy for the study area.

4.1 Merritt Basin to Nicola Lake

As described in Phase 1, the Merritt Basin is the largest depositional basin in the Nicola watershed and, as a result, the stratigraphy underlying the Merritt area is also the most continuous, with extensive glaciolacustrine deposits separating thick layers of sand and gravel. Although there are a limited number of deep wells, one unconfined and two confined aquifers separated by glaciolacustrine deposits were delineated in Phase 1.

The stratigraphy in the Joeyaska area southeast of the City of Merritt is complex and considerable variability is observed in the well records. The delineation of the aquifers in this area are still considered preliminary. The irregularly distributed sand and gravel deposits associated with both the Joeyaska Shallow and Joeyaska Deep aquifers generally follow the valley slope, with the thickest deposits occurring near the slope base. In proximity to Nicola Lake an unconfined sand and gravel aquifer associated with an alluvial fan deposit is present. These surficial deposits are separated from the underlying confined glaciofluvial sand and gravel aquifer (Conicola) by the extensive glaciolacustrine deposits seen throughout the valley.

In the delineation of the hydrostratigraphic units within the Merritt Basin, the following assumptions were made (see Slides 7 and 8 in Attachment 1):

- Given the lack of data below 170 m depth, the Lower Merritt Aquifer is inferred to extend to 200 m below ground surface (~ 400 masl). The unknown unconsolidated deposits below this depth were conservatively considered to act collectively as a basal aquitard that is situated between the Lower Merritt Aquifer and the inferred bedrock surface. The top of unknown basal unit will be treated as the base of the groundwater flow model within the Merritt Basin.
- Based on the elevation of the permeable layers below the Unicola and Conicola Aquifers, it is inferred that the Lower Merritt Aquifer extends beyond the mapped aquifer boundary towards Nicola Lake. This was suggested as a possibility in Phase 1.
- Based on the similar elevations and lithology of the Middle Merritt and the Conicola Aquifers, the permeable units will be considered contiguous for modelling purposes.

- As previously indicated, both Joeyaska aquifers have significant variability in the distribution and elevation of the deposits. For modelling purposes, the shallow aquifer deposits have been considered continuous within the aquifer boundary. Similarly, the confined deposits have been considered continuous within the respective aquifer boundary.

4.2 Lower Nicola Area

The Lower Nicola Area, where Guichon Creek meets the Nicola River Valley, has been subject to a complex glacial history which resulted in the formation of stacked confined and unconfined aquifers in the area. There are sequences of alternating permeable and glaciolacustrine deposits which prograde distally from Guichon Creek. The permeable deposits at depth are inferred to be associated with outwash deposits. Wells screened in the deep outwash deposits are commonly characterized by flowing artesian conditions. As noted in Phase 1, there were evidence of deeper gravel aquifers beneath those currently mapped; however, these were not delineated during the initial aquifer mapping phase.

In the delineation of the hydrostratigraphic units within the Lower Nicola area, the following assumptions were made (see Slides 9 and 10 in Attachment 1):

- The uppermost unmapped gravel unit underlying the Lower Nicola Outwash was limited to a 500 m diameter area and was centered on the two wells which extended to these the lower gravel layers. This unmapped deposit may extend further in the valley; however, there is insufficient data available at this time to delineate this deposit further.
- Lower Nicola Outwash, Lower Nicola, Stumbles Creek and Stumbles Creek confined aquifers are generally constrained to the mapped aquifer boundaries delineated in Phase 1.
- Given the lack of data below 110 m depth, the unknown unconsolidated deposits below this depth were conservatively considered to act collectively as a basal aquitard that is situated between the unmapped deep gravel unit and the inferred bedrock surface. The surface of this unknown basal unit will be treated as the base of the groundwater flow model within the Lower Nicola Valley.

4.3 Lower Nicola Valley – Spences Bridge Area

The Lower Nicola Valley to Spences Bridge Area comprises the valley area from the Lower Nicola Area to the confluence of Nicola and Thompson Rivers at Spences Bridge. Subsurface data is limited along the length of the valley and well depths generally become shallower towards Spences Bridge. The Canford Aquifer is generally mapped between 25 m and 50 m below the ground surface while the Agate Aquifer deposits are generally encountered between 20 m and 60 m below the ground surface. In some areas, particularly near the confluence of Spius Creek, the bedrock surface was roughly estimated, using the approach described in Section 3 above, to be up to 100 m deep, with no available information below 80 m depth to confirm this. An extensive glaciolacustrine layer overlies the permeable deposits throughout the length of the valley. Areas of surficial modern alluvium are distributed discontinuously across the surface of the valley.

In the delineation of the hydrostratigraphic units within the Nicola River Valley between the Lower Nicola Area and Spences Bridge, the following assumptions were made (see Slides 11 and 12 in Attachment 1):

- Given the limited data below 80 m, the unknown basal unit from the Lower Nicola Area was extended below the Canford and Agate Aquifers at a depth of approximately 75 m below ground surface.
- The Canford and Agate Aquifers likely extend most of the length of the valley and, for modelling purposes, are considered contiguous (not truncated at the aquifer boundaries) given the similar elevations of the deposits. These permeable units were inferred to pinch out towards Spences Bridge based on the silt bluffs visible along the valley sides.
- Permeable unconfined units of the West of Merritt Aquifer are constrained to the mapped aquifer boundary.
- Permeable modern alluvium deposits are distributed discontinuous throughout the valley; however, they are not considered to be associated with the mapped aquifers.
- Permeable units associated with the Spences Bridge Aquifer are constrained to the mapped aquifer boundary.

4.4 Coldwater River Valley

The Coldwater River Valley contains tightly constrained unconsolidated valley deposits with discontinuous undifferentiated glacial tills and morainal deposits lining the valley walls. A number of the domestic and community wells within the Coldwater River Valley are low yielding bedrock wells (Paul's Basin Aquifer and Kingsvale Aquifer). As discussed in Phase 1, a deep well in the Coldwater Valley north of Kingsvale intersects two permeable layers below the mapped confined Coldwater Valley Aquifer, suggesting that deeper permeable units likely underlie the mapped aquifer; however, insufficient data was available at that time to delineate these deeper permeable units. A newly drilled water supply well north of the confluence of the Coldwater River Valley with Paul's Basin intersected a permeable layer at a similar elevation to the uppermost of the two permeable layers observed below the Coldwater Valley Aquifer.

In the delineation of the hydrostratigraphic units within the Coldwater River Valley, the following assumptions were made (see Slides 13 and 14 in Attachment 1):

- The permeable deposits of the Coldwater Valley Aquifer are constrained to the mapped aquifer boundary.
- The uppermost of the two permeable units below the Coldwater Valley Aquifer, intersected by the deep well near Kingsvale, is contiguous with the confined permeable layer intersected in the newly drilled well WTN 116263) near the confluence with Paul's Basin. This layer was incorporated as a potential aquifer and labelled the 'Permeable Valley Deposit'
- Due to a lack of stratigraphic data, the deepest of the two permeable deposits below the confined Coldwater Valley Aquifer was not included as a hydrostratigraphic unit.
- Intertill deposits of the Kwinshatin Aquifer are constrained to the mapped aquifer boundary.

- Discontinuous permeable intertill deposits at variable elevations exist between the Kwinshatin and the Joeyaska Aquifers; however, the connectivity between the deposits is unknown. Therefore, these deposits have not been included as hydrostratigraphic units.

5.0 TOPOGRAPHIC DATA

LiDAR topographic data for the Nicola River Valley was provided to Golder by FLNRORD on 31 January 2019 in a raster format. The point density of this dataset ranges from 0.5 m to less than 3.0 m and it covers most of the Nicola Valley area but does not include the Coldwater River valley (see slide 15 in Attachment 1). The LiDAR dataset exceeds the maximum file size that could readily be utilized for modelling purposes. Therefore, the LiDAR dataset at +0.5 m resolution was resampled to a 2 m resolution. In addition, in order to obtain topographic coverage for the Coldwater River valley, the pre-existing DEM dataset, described in Phase 2 as having a 20 m spacing between measurement points, was reduced to cover only this area. This reduced DEM dataset was then stitched to the modified LiDAR dataset. A combined topographic surface based on the modified LiDAR dataset and DEM dataset (where LiDAR is not available) was produced that will form the upper surface of the groundwater flow model. This dataset will also be used to estimate hydraulic heads and surface water level elevations from water level records where elevation surveys were not conducted.

6.0 ESTIMATED BASEFLOW

Baseflow was estimated as the weighted average of the mean monthly flow for the months of December, January and February. Estimated baseflows for the main water courses within the study area were calculated from the Water Survey Canada hydrometric data gathered during the data compilation study (Golder 2018). Estimated mean monthly flows developed for ungauged tributaries were developed as part of a water budget developed for the Nicola River from Merritt to the Spius Creek confluence (Golder 2016) and as part of the Phase 2 study (Golder 2018).

The difference in the December-to-February mean monthly flow estimates between the upstream and downstream hydrometric station on either end of the reach, minus tributary inflow within the reach, was considered to represent net groundwater flow into the river for that reach. Estimated baseflows and changes in baseflow from groundwater recharge along river reaches are summarized in Table 1, Table 2 and Table 3. The reaches for which baseflow estimates were calculated are shown on slide 17 in Attachment 1.

Table 1: Estimated baseflow in Coldwater River – Brookmere to Merritt

WSC Station	WSC Sta No.	Period of Record	UTM East (m)	UTM North (m)	Baseflow (m3/sec)
Coldwater R at Merritt	08LG010	1911-2018	657103.0	5553142.1	3.27
Coldwater R near Brookmere	08LG048	1965-2018	640780.2	5555622.4	2.53
Estimated tributary inflow	N/A				0.16
Coldwater near Brookmere to Coldwater at Merritt - net baseflow					0.58 (gaining)

Table 2: Estimated baseflow in Nicola River – Nicola Lake to Nicola near Merritt (u/s Guichon Creek confluence).

WSC Station	WSC Sta No.	Period of Record	UTM East (m)	UTM North (m)	Baseflow (m ³ /sec)
Nicola River near Merritt	08LG007	1958-2007	650519.8	5556815.6	5.43
Nicola River at Outlet Nicola Lk	08LG065	1983-2018	666513.7	5559238.7	1.60
Tributaries:					
Coldwater R @ Merritt	08LG010	1911-2018	657103.0	5553142.1	3.27
Clapperton Ck	NA				0.05
Nicola at Outlet Nicola Lk to Nicola near Merritt - net baseflow					0.51 (gaining)

Table 3: Estimated baseflow in Nicola River –Nicola near Merritt to Nicola near Spences Bridge

WSC Station	WSC Sta No.	Period of Record	UTM East (m)	UTM North (m)	Baseflow (m ³ /s)
Nicola River near Spences Bridge	08LG006	1958-2011	626211.7	5576919.0	9.88
Nicola River near Merritt	08LG007	1958-2007	650519.8	5556815.6	5.43
Tributaries:					
Guichon Ck near Mouth	08LG007	1985-2010	651309.2	5556992.5	0.23
Spilus Ck near Canford	08LG008	1971-2011	640780.2	5555622.4	3.72
Stumbles Ck	NA				0.04
Ungauged (Nuatich, Shakelly, Gordon, Shackan, Skuhun, Skeitkut)	NA				0.11
Nicola near Merritt to Nicola near Spences - net baseflow					0.35 (gaining)

7.0 DATA GAPS & UNCERTAINTY

Based on the results of this Part 1 work scope, the primary data gaps and uncertainties with respect to the information and mapping produced that will be used to support the development a numerical groundwater flow modelling are as follows.

- **Unknown Sediment Type:** There are several locations within the study area where the type of valley bottom sediments is unknown. Without drilling records, these sediments were assumed to act collectively as an aquitard (i.e., the 'unknown unit'). The absence of this information will result in uncertainty in the total volume/capacity of the valley bottom aquifer system, but based on the approach taken, will likely underestimate the capacity. This approach is considered to be conservative.
- **Thickness (Depth) of the valley bottom sediments:** The total thickness of the valley bottom sediments within the study area is not known in most locations. The absence of this information will result in uncertainty in the total volume/capacity of the valley bottom aquifer system. An estimation method has been applied (described in Section 3.0); however, confirmation would require drilling records at selected locations. The approach taken to limit the model base within the Merritt Basin and the Lower Nicola Valley between Merritt and Spius Creek to the top of the unknown unit is considered conservative.
- **Topography:** The current topographic dataset for the Coldwater River Valley is based on a 20 m contour interval. Lidar mapping or finer resolution DEM would be beneficial in this area, particularly since the topographic dataset will be used to estimate the surface water level elevations in the rivers between hydrometric stations. Large errors in the river heads will impact the relative accuracy of the model predictions.

The primary implications of the data gaps and uncertainties outlined above are the under or over-estimation of the capacity of the aquifer system, with a tendency towards its under-estimation. Although alternative approaches have been applied to provide best guess estimates for data gaps, the preferred approach is to obtain direct measurements where possible.

8.0 LIMITATIONS

This report was prepared for the exclusive use of the Fraser Basin Council and may be shared with the BC Ministry of Forests Lands Natural Resource Operations and Rural Development and the BC Ministry of Environment and Climate Change Strategy. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Golder Associates Ltd. (Golder) accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The report is based on data and information collected during investigations conducted by Golder and is based solely on the condition of the Site at the time of the investigations as described in this report, supplemented by historical data provided to Golder as described in this report. Golder has relied in good faith on information provided by third parties. We accept no responsibility for any deficiency, misstatements, or inaccuracies contained in this report as a result of omissions, misinterpretations, or fraudulent or negligent acts of others.

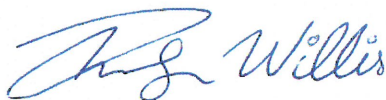
Golder makes no warranty, expressed or implied, and assumes no liability with respect to the use of the information contained in this report at the subject Site, or any other site, for other than its intended purpose. If new information is discovered during future work, including excavations, borings or other studies, Golder should be requested to re-evaluate the conclusions of this report and provide amendments as required prior to any reliance upon the information presented herein.

The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services

9.0 CLOSURE

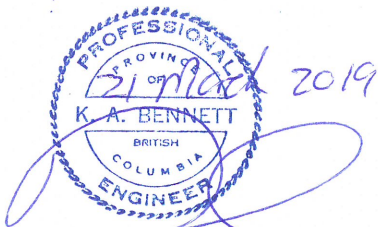
We trust that this technical memorandum and attached summary presentation will support future numerical modelling studies for the study area. Should you have any questions, please do not hesitate to contact the undersigned.

Golder Associates Ltd.



Robyn Willis, EIT
Junior Geological Engineer

Reviewed by:



Kevin Bennett, MSc, PEng
Senior Groundwater Engineer



Connie Romano, MSc, PGeo
Associate, Senior Hydrogeologist

KB/CR/asd

Attachment 1: Powerpoint Slides Presented on 7 March 2018

[https://golderassociates.sharepoint.com/sites/32594g/deliverables/issued to client_for wp/18108595-001-tm-rev0/18108595-001-tm-rev0-part1_nicola valley gw model-21mar_19.doc](https://golderassociates.sharepoint.com/sites/32594g/deliverables/issued%20to%20client_for%20wp/18108595-001-tm-rev0/18108595-001-tm-rev0-part1_nicola_valley_gw_model-21mar_19.doc)

10.0 REFERENCES

Golder Associates Ltd. (Golder 2016), MOE Groundwater Science Study, Lower Nicola Valley Groundwater Budget, 7 March 2016.

Golder Associates Ltd. (Golder 2018), Data Compilation Plan to Support Numerical Modeling Strategy, Nicola River Project, 28 June 2018.

Gorski NG, Willis RK, Sacré JA, and Bennett KA. 2018. Nicola Watershed Aquifer Classification and Mapping. Water Science Series, WSS2018-XX. Prov. BC, Victoria, BC

ATTACHMENT 1

**Powerpoint Slides Presented on
7 March 2018**



GOLDER

Nicola Valley Project Phase 3

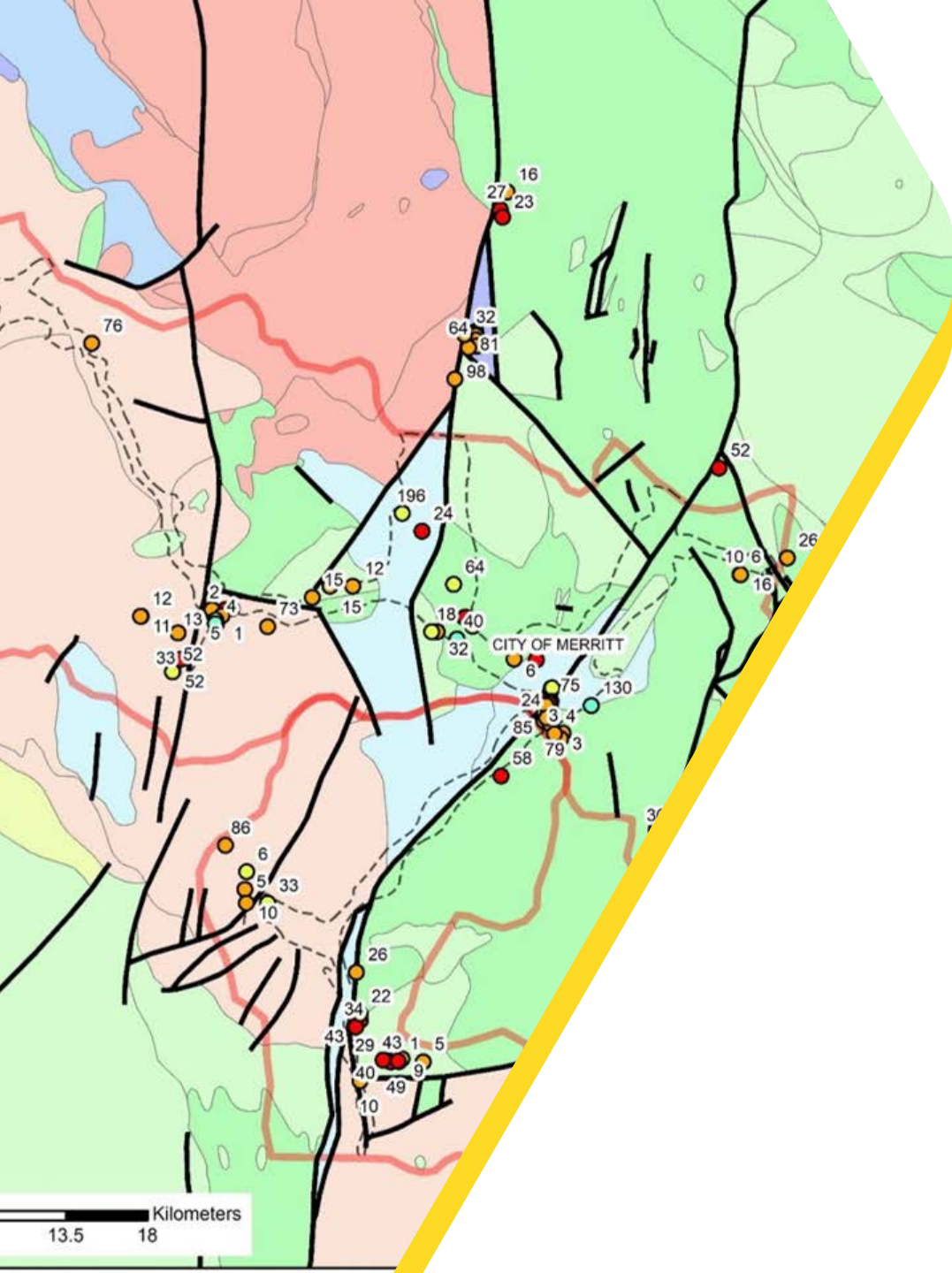
GROUNDWATER FLOW MODEL –PART 1

Presented on March 7th, 2019

Outline

WORK SCOPE AND OBJECTIVES

- Bedrock Surface (model base)
- 3D Hydrostratigraphic Layers
 - Merritt Basin
 - Nicola River Valley
 - Lower Nicola – Stumbles Creek
 - Stumbles Creek to Spences Bridge
 - Coldwater River Valley
- High Resolution Topographic Surface
- Baseflow Estimates for Main Water Courses



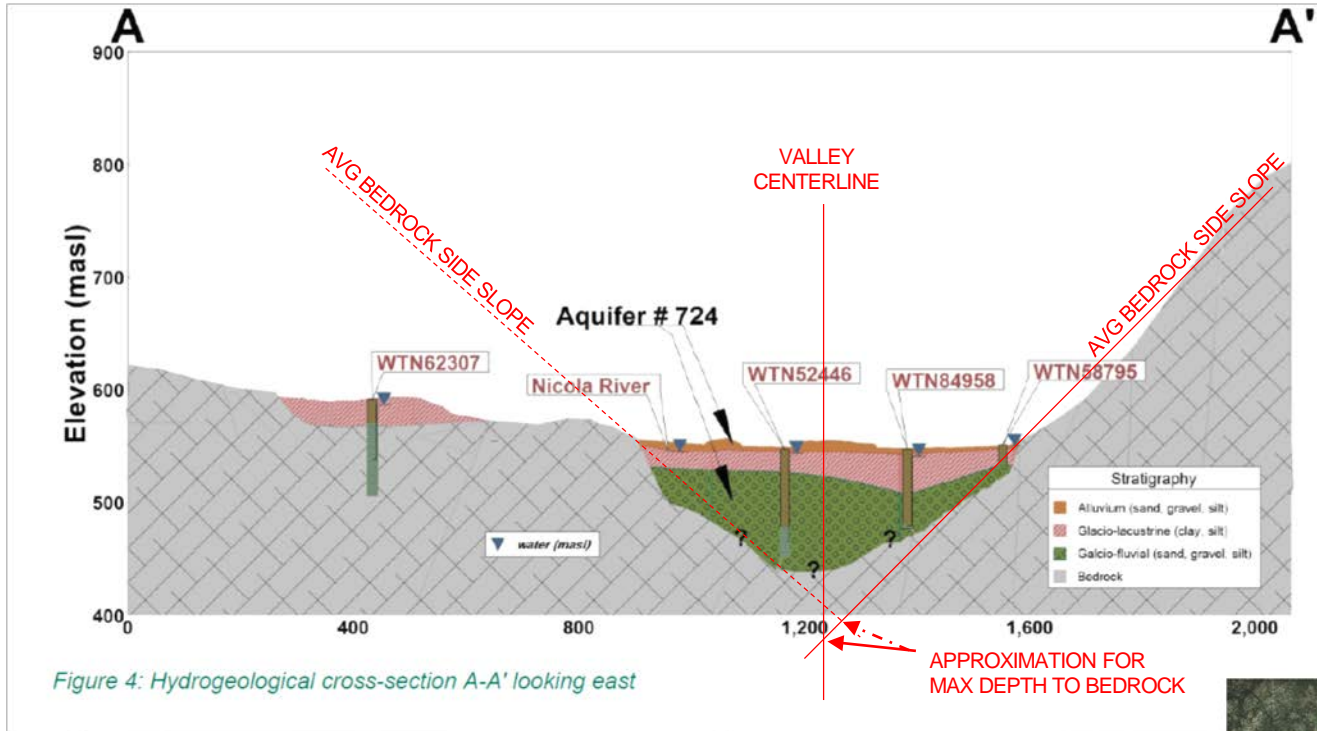
BEDROCK SURFACE

(FOR MODEL BASE)

- Depth to bedrock is mostly unknown
- Bedrock topography extrapolated from valley side slopes
- Exception is Merritt Basin where model base is the top of the “Unknown Unit”

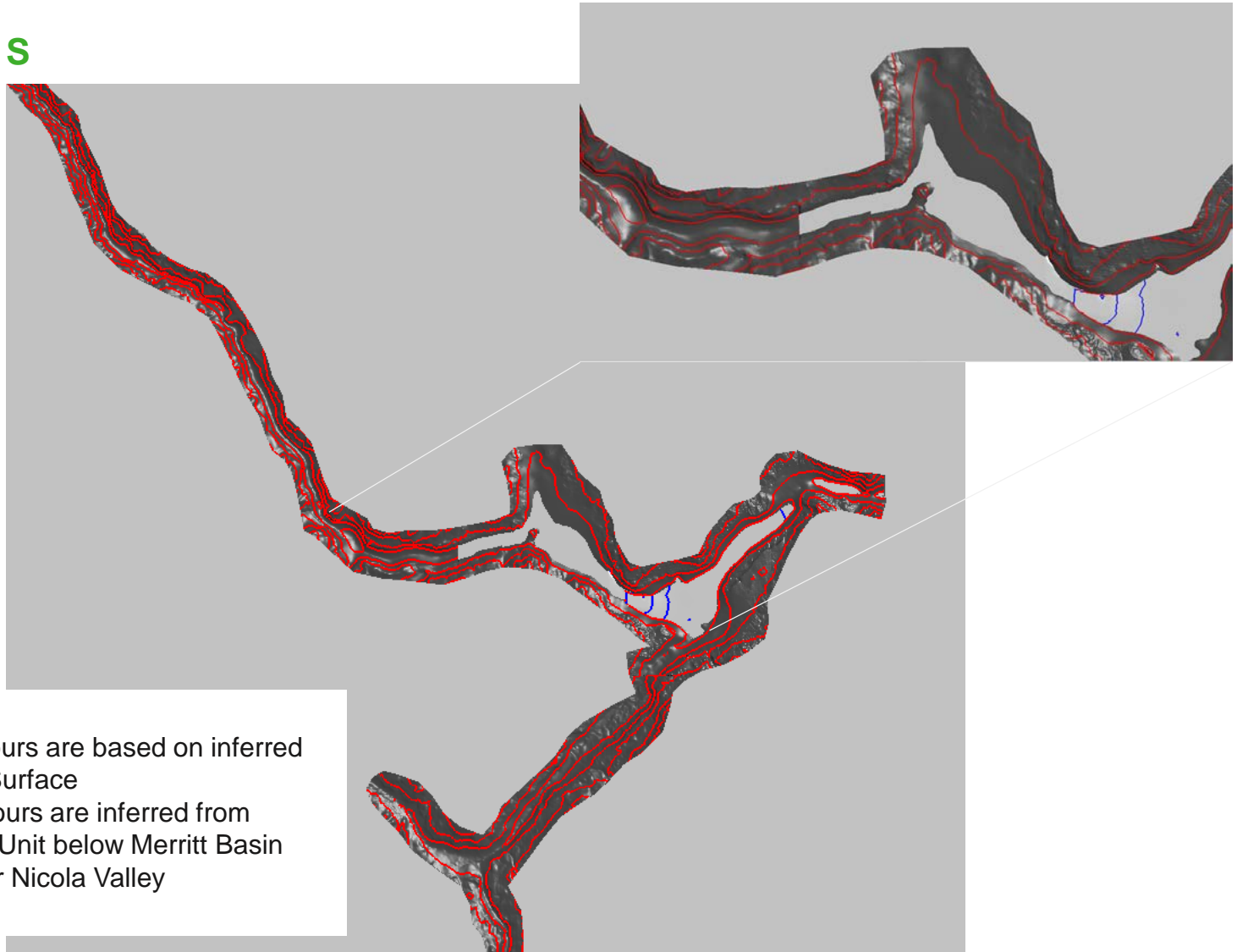
BEDROCK SURFACE

GENERAL DEVELOPMENT METHOD

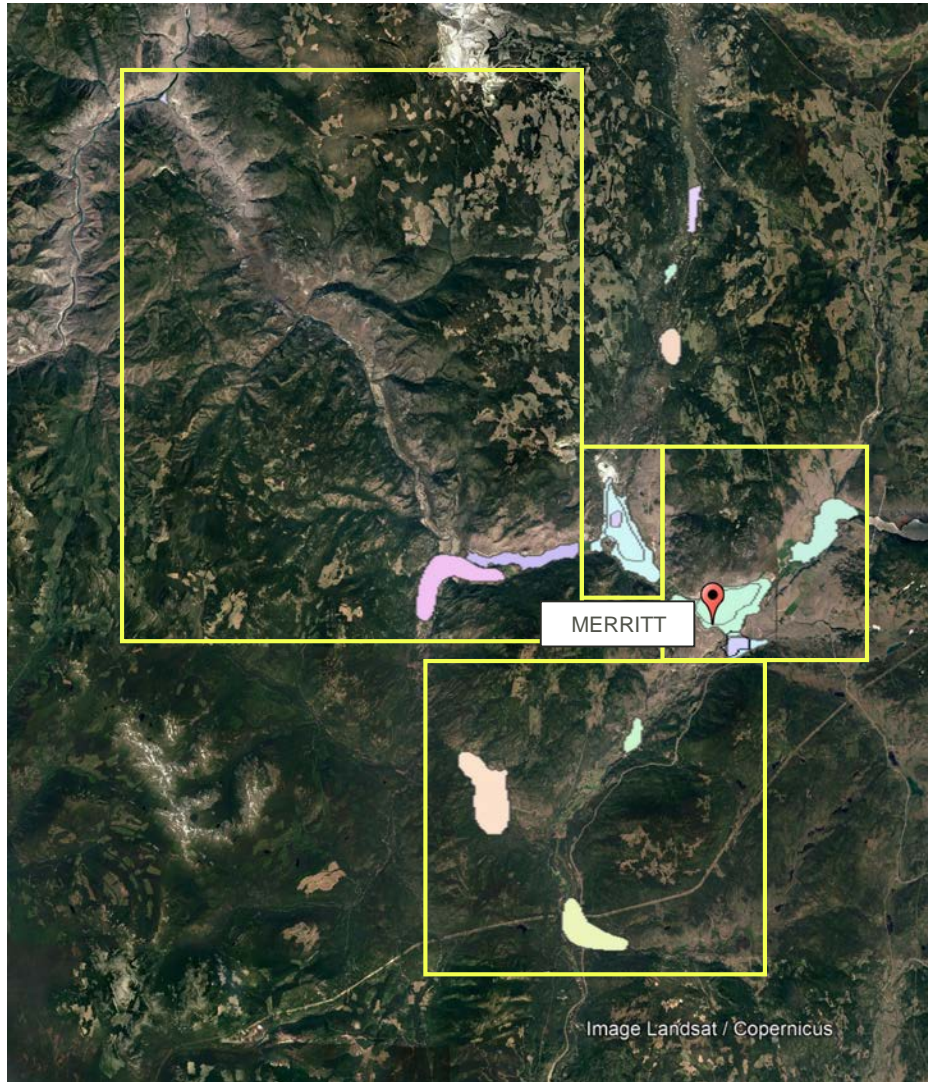


BEDROCK SURFACE AND MODEL BASE

RESULTS



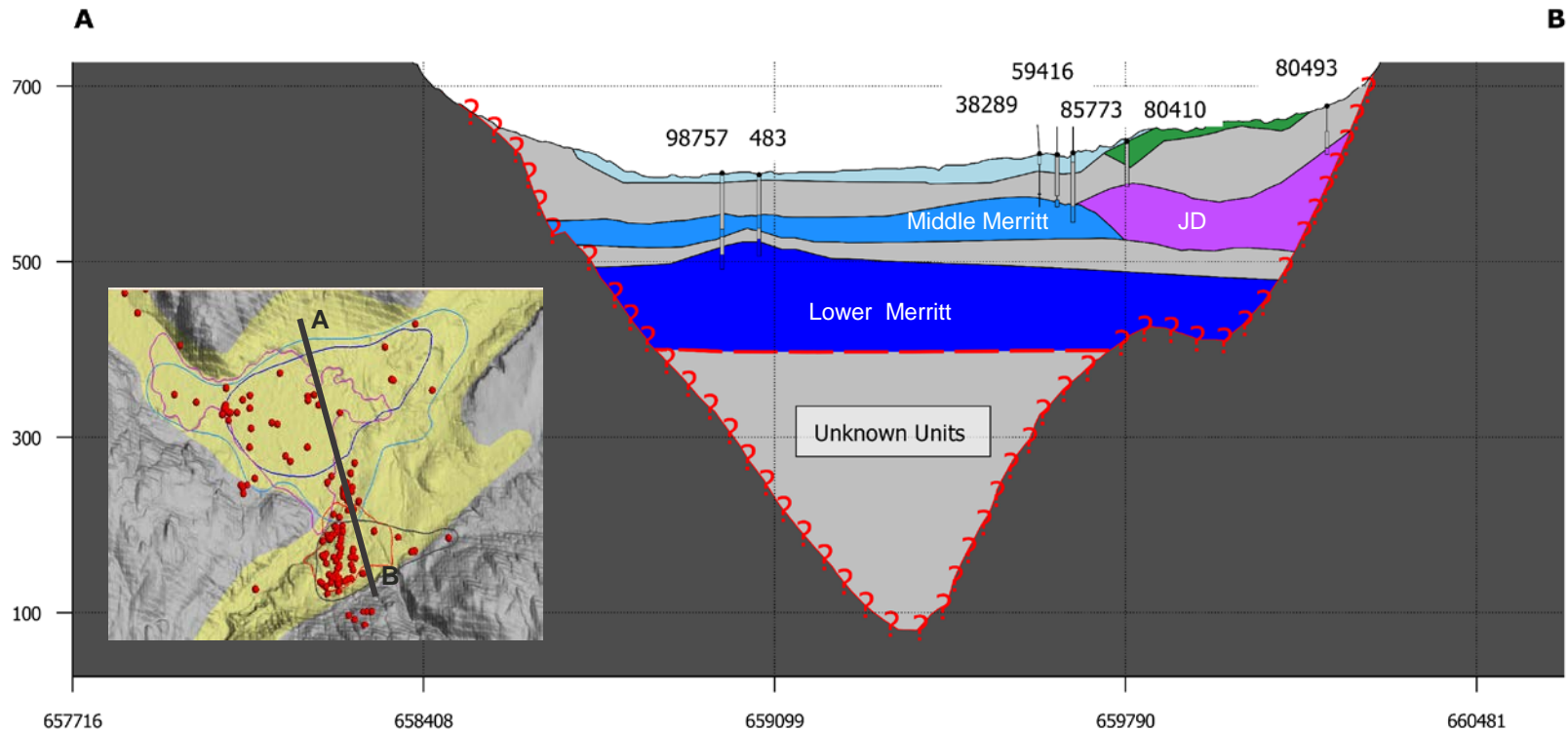
HYDROSTRATIGRAPHY



- Based on the Phase 1 (2017) Leapfrog model
- Four main geographic areas evaluated
 1. *Merritt Basin to Nicola Lake*
 2. *Lower Nicola Area – Stumbles Creek Area*
 3. *Stumbles Creek Area – Spences Bridge Area*
 4. *Coldwater River Valley*
- Assumptions made to limit extents of key units or features based on available data

Merritt Basin

CROSS SECTION 1 (LOOKING EAST NORTHEAST)



Legend

- Aquitard
- Joeyaska Deep Aquifer
- Joeyaska Shallow Aquifer
- Lower Merritt Aquifer
- Middle Merritt/Conicola Aquifers
- Upper Merritt Aquifer

Location

A: 657716, 5557118

B: 660654, 5549142

Scale: 1:30,000

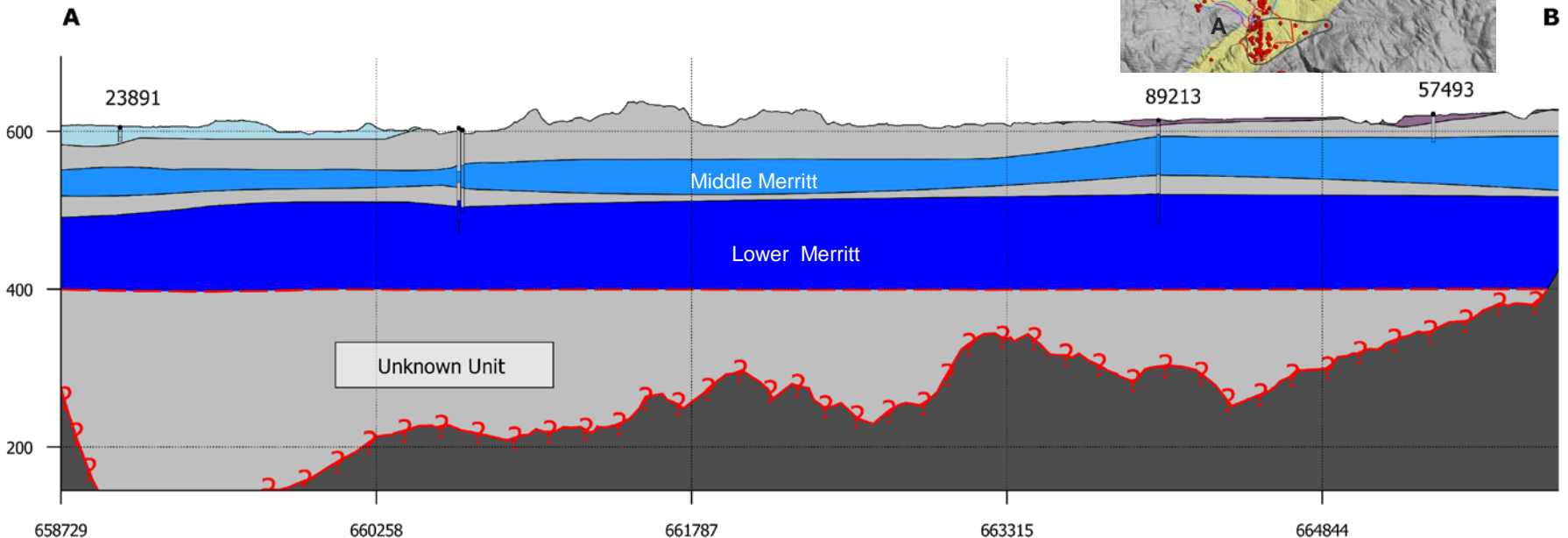
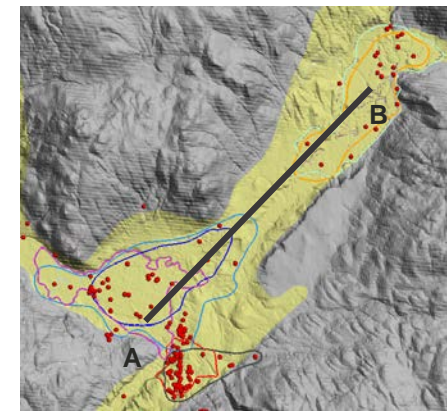
Vertical exaggeration: 5x

0m 1500m

- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- Limited data for Middle and Lower Merritt (approx. 5 wells intersect Lower Merritt)
- No data below 170 m bgs; Unknown Unit (approx. 400 masl) to be used as base of model in this location
- Some units are inferred to be continuous but likely not (eg Joeyaska Units (JD and JS))

Merritt Basin

CROSS SECTION 2 (LOOKING NORTHWEST)



Legend

- Aquitard
- Bedrock
- Lower Merritt Aquifer
- Middle Merritt/Conicola Aquifers
- Unicola Aquifer
- Upper Merritt Aquifer

Location

A: 658729, 5552307

B: 665991, 5558433

Scale: 1:30,000

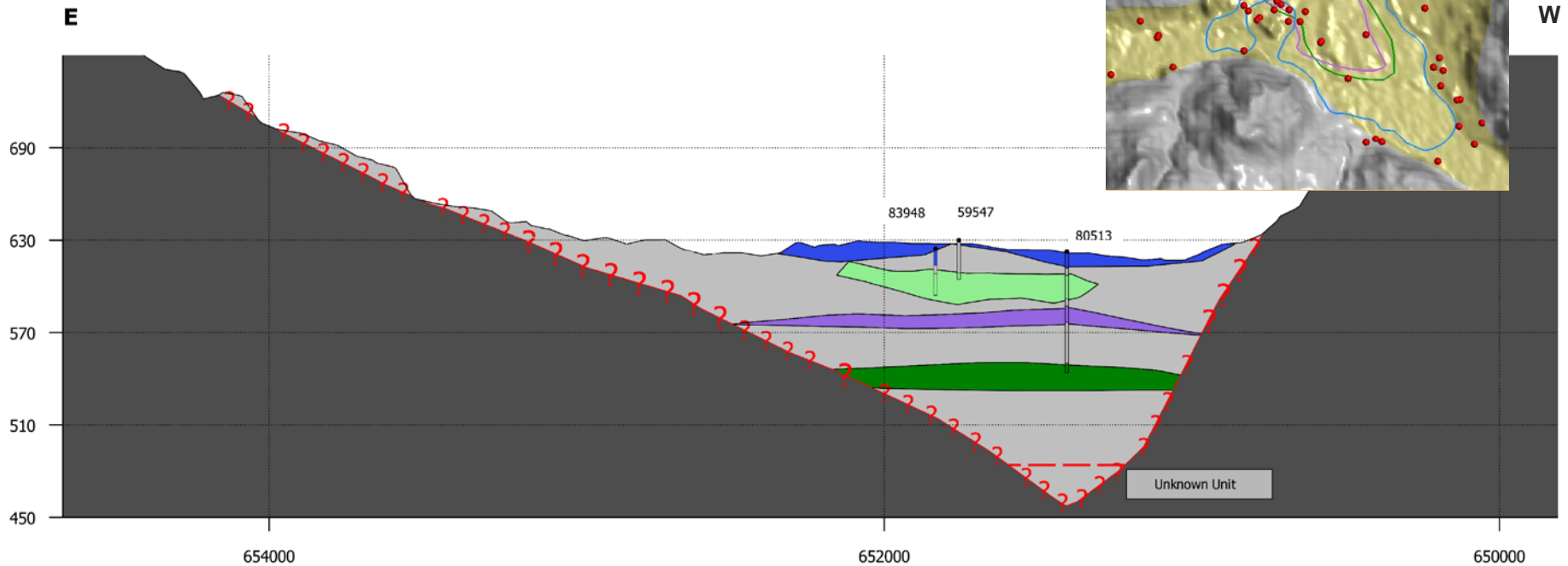
Vertical exaggeration: 5x

0m 1500m

- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- Middle Merritt and Conicola assumed to be connected for modelling purposes, rather than truncating two permeable units at the same elevation
- Lower Merritt is inferred to extend past the mapped aquifer boundary and continue below the Conicola Aquifer – suggested in Phase 1

Lower Nicola – Stumbles Creek

CROSS SECTION 1 (LOOKING NORTH)



- Legend
- Aquitard
 - Lower Nicola Aquifer
 - Lower Nicola Outwash Aquifer
 - Stumbles Creek Aquifer
 - Stumbles Creek Confined Aquifer

Location
 E: 654670, 5559100
 W: 649670, 5559100

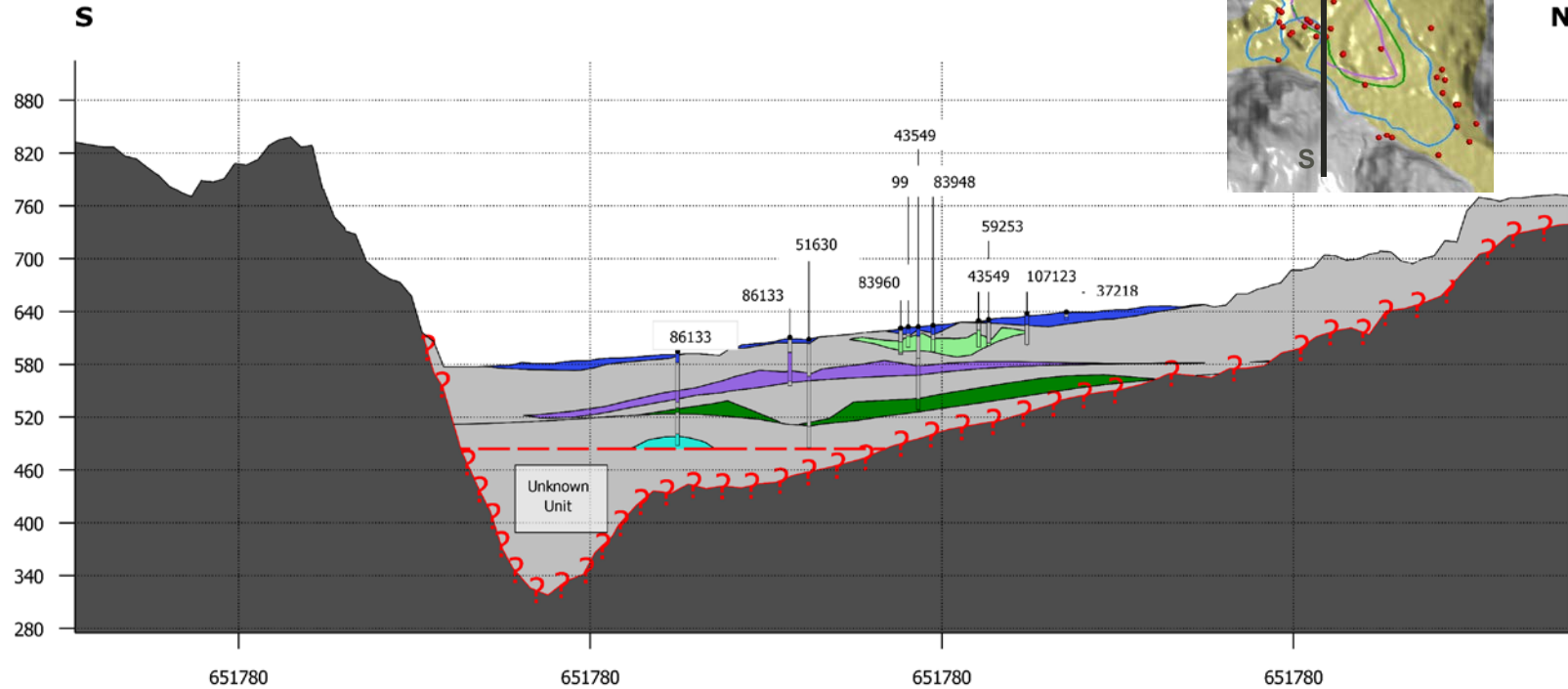
Scale: 1:15,000
 Vertical exaggeration



- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- No data below 110 m bgs; Unknown Unit to be used as base of model in this location

Lower Nicola – Stumbles Creek

CROSS SECTION 2 (LOOKING WEST)



- Legend
- Aquitard
 - Bedrock
 - Deep Gravel
 - Lower Nicola Aquifer
 - Lower Nicola Outwash Aquifer
 - Stumbles Creek Aquifer
 - Stumbles Creek Confined Aquifer

Location

E: 651780, 5554070

W: 651780, 5562570

Scale: 1:30,000

Vertical exaggeration: 5x

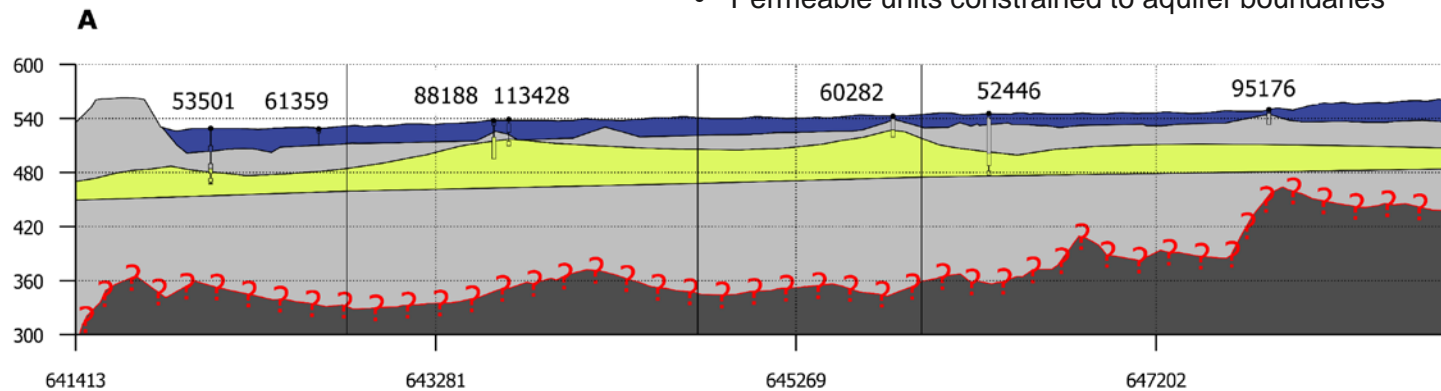


- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- No data below 110 m bgs; Unknown Unit to be used as base of model in this location
- Two wells intersect the lower confined artesian gravel layer (limited extent to 250 m radius in the wells)
- Unknown Unit extends to approximately Spius Creek

Stumbles Creek to Spences Bridge

CROSS SECTION 1 (LOOKING NORTH)

- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- Permeable units constrained to aquifer boundaries



- Legend**
- Agate Aquifer
 - Aquitard
 - Bedrock
 - Canford Aquifer
 - West of Merritt Aquifer

Location

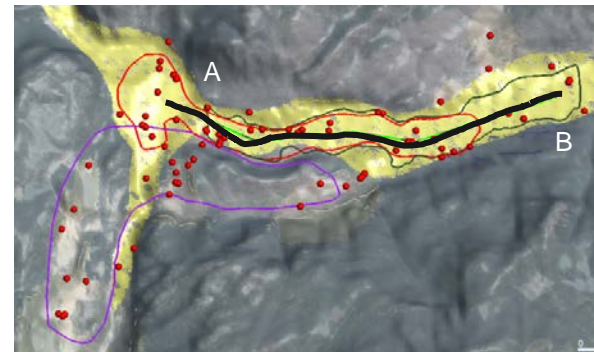
A: 641413, 5556526

B: 648763, 5556700

Scale: 1:30,000

Vertical exaggeration: 5x

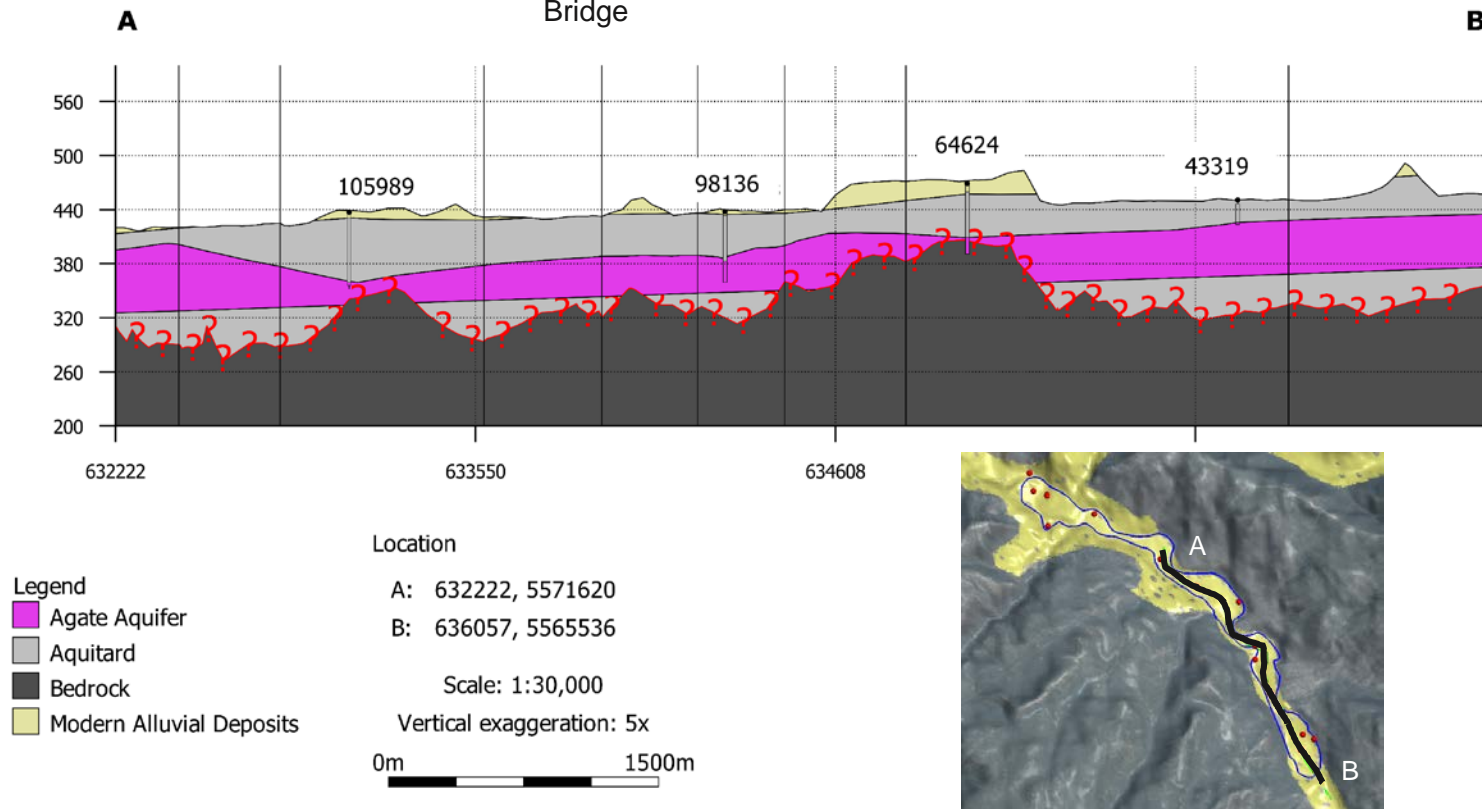
0m 1500m



Stumbles Creek to Spences Bridge

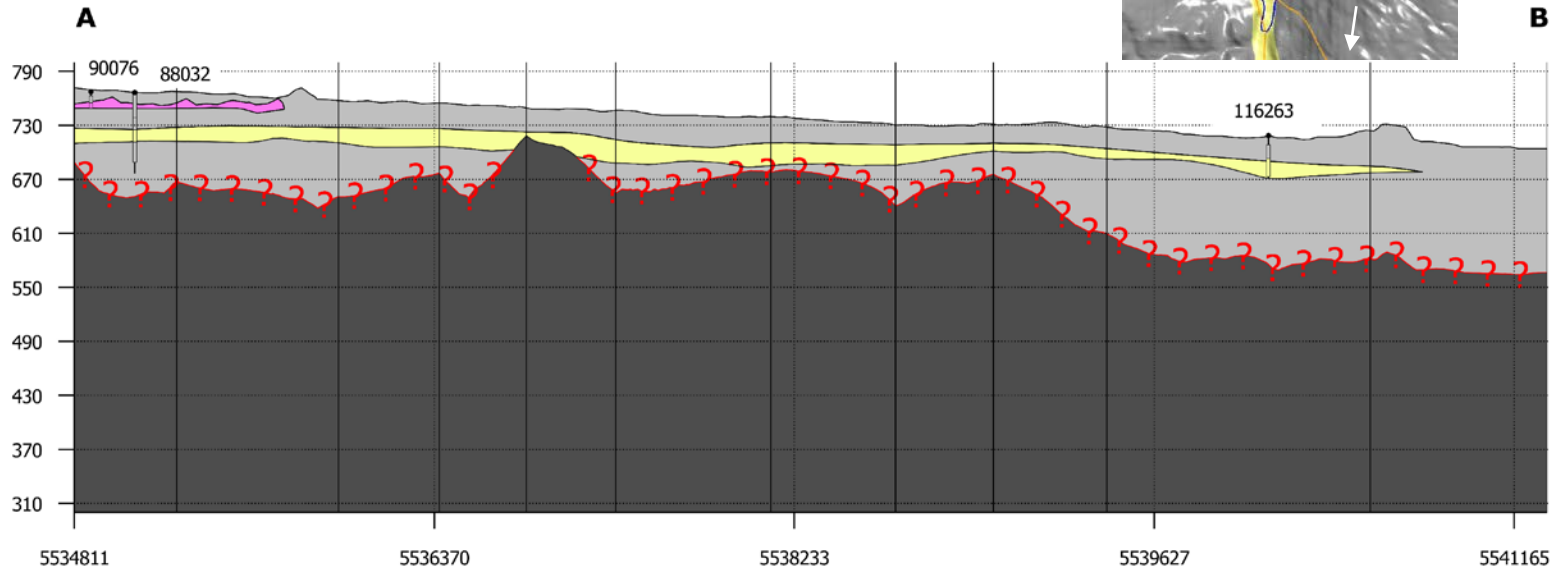
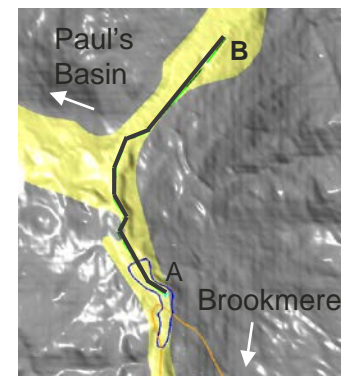
CROSS SECTION 2 (LOOKING NORTHEAST)

- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- Modern alluvial deposit are discontinuous throughout the valley
- Agate Aquifer pinches out near the silt bluffs in proximity to Spences Bridge



Coldwater Valley

CROSS SECTION 1 (LOOKING WEST)



- Legend**
- Aquitard
 - Bedrock
 - Coldwater Valley Aquifer
 - Permeable Valley Deposit

Location

A: 649255, 5534811
 B: 650741, 5541313

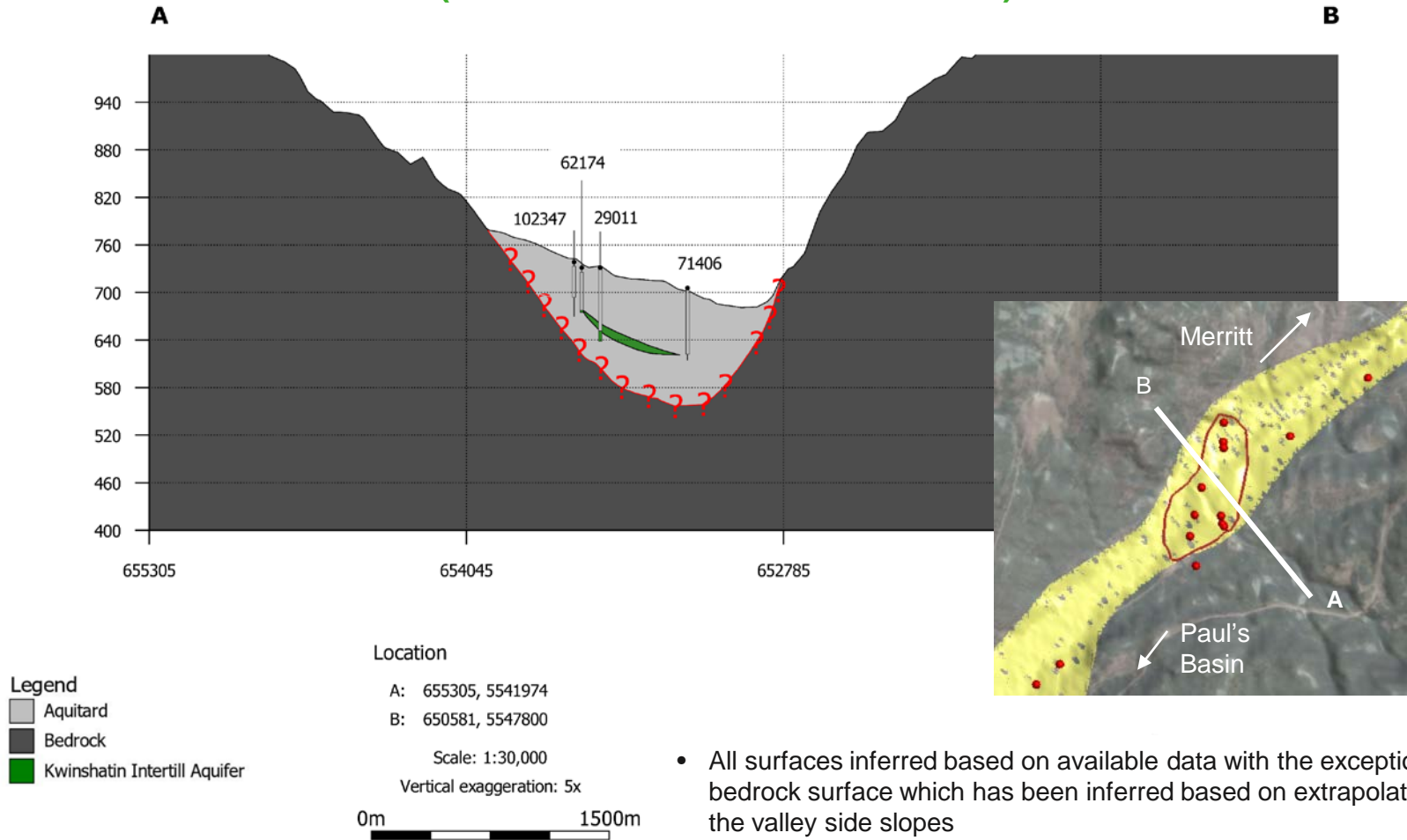
Scale: 1:30,000
 Vertical exaggeration: 5x

0m 1500m

- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- Coldwater Aquifer constrained to the mapped aquifer boundary
- Unmapped permeable deposits extend from Brookmere to Coldwater at Paul's Basin – new data from WTN 116263 (North of B)

Coldwater Valley

CROSS SECTION 2 (LOOKING SOUTHWEST)



- All surfaces inferred based on available data with the exception the bedrock surface which has been inferred based on extrapolation of the valley side slopes
- Intertill deposits are inferred to be continuous within the mapped aquifer boundary for purposes of the model

High Resolution Topographic Data

LIDAR AND DEM DATA

- Lidar dataset for the Nicola Valley area obtained and reduced (from +0.5 m to 2 m pt. density)
- To obtain full area coverage, the modified Lidar dataset stitched together with DEM data (20 m pt. density)
- Key dataset for best estimates of hydraulic heads and surface water level elevations from water level records where elevation surveys not conducted.

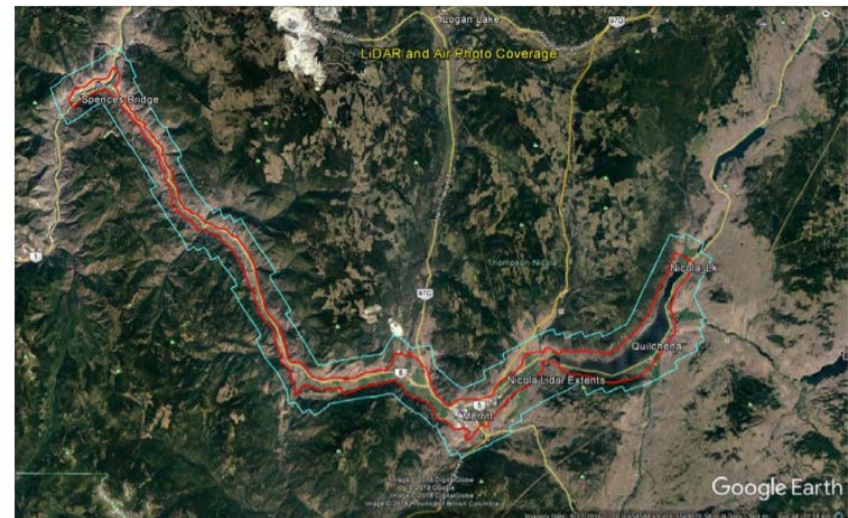
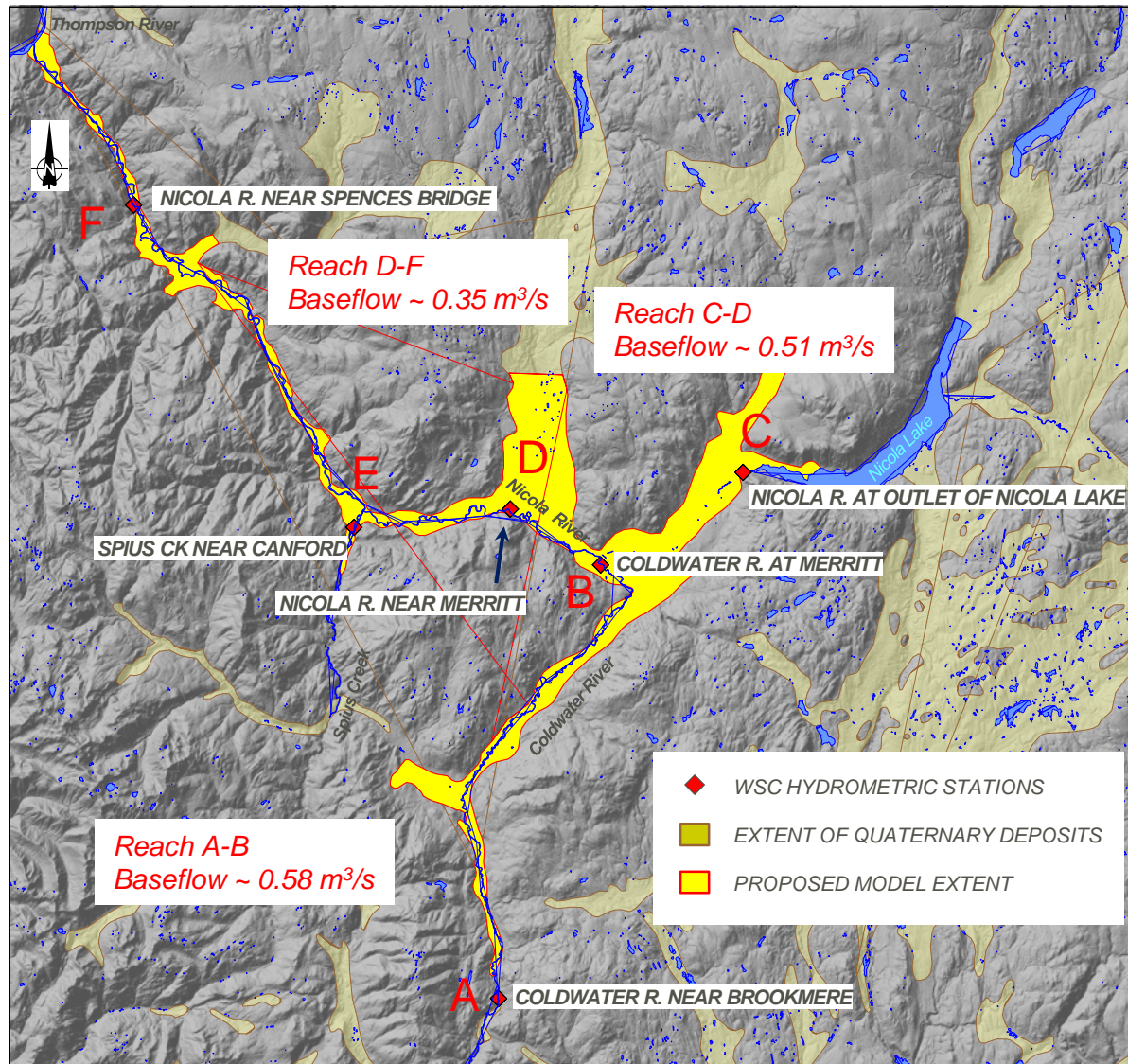


Figure 3 –LiDAR and Air photo coverage.



BASEFLOW ESTIMATES

- Baseflow estimated from avg of mean monthly flows from Dec to Feb
- Baseflow, for a specific river reach, estimated as diff. (or net) in flow between the upstream and downstream hydrometric station on either end of the reach, minus tributary inflow within the reach
- Hydrometric data for main watercourses from Water Survey Canada



Closure

NICOLA VALLEY PROJECT – PHASE 3 PART 1

Summary:

- ✓ Model base generated from inferred bedrock surface, except in Merritt Basin and Lower Nicola where it is taken as the top of Unknown Unit
- ✓ 3D hydrostratigraphic surfaces completed.
- ✓ High resolution topographic surface completed. To be used for model surface and for generating calibration targets.
- ✓ Baseflow estimated for defined stream reaches. To be used for model calibration.