

Suite 304-1912 Enterprise Way
Kelowna, BC, Canada V1Y 9S9
TEL: +1.778.484.1777
www.piteau.com

FILE: 3989-TM1

TECHNICAL MEMORANDUM

DRAFT: July 13, 2018

FINAL: July 19, 2018

TO: Mr. Lance Graham
Kingsvale Cattle Company Ltd.

FROM: Remi Allard, P. Eng.
Email: rallard@piteau.com

RE: Hydraulic Connection Between Irrigation Well at 2321 Peterson Road with
the Coldwater River, near Merritt, BC

Piteau Associates Engineering Ltd. (Piteau) was retained by Mr. Lance Graham of Kingsvale Cattle Company Ltd. to provide an opinion regarding the hydraulic connection between an irrigation well on his farm and the nearby Coldwater River. The civic address of the Graham Hay Sales Farm (the "Subject Property"), is 2321 Peterson Road, Merritt, BC. The legal address is DL 306 EXC PLS A253 KAP46043 & KAP46044 (PID 014-670-691). The irrigation well is recorded in the BC WELLS database as well tag number (WTN) 103997 and is located at UTM (Zone 10) coordinates 648988E / 5535024N.

In 2017, the BC Ministry of Forests Lands and Natural Resource Operations and Rural Development (FLNRORD) informed Mr. Graham that the irrigation well on his property could not be used due to the probable impacts of pumping from the well on the water levels and flow in River.

The well is 89.9 m deep and is located 120 m east of and at roughly 3 m higher in elevation than the River. Mr. Graham has been using the well since August 2015 to irrigate hay crops on his agricultural land each year from late April to early October.

A plan of the Subject Property showing the location of the irrigation well and the River is presented in Figure 1.

The work scope for this assignment is to review records for water wells in the area, to assist with the completion of a pumping test on the well, analyze the data and prepare a hydrogeological report regarding the possible hydraulic connection between the well and the River.



REGULATORY FRAMEWORK

Referring specifically to the regulatory requirements imposed by FLNRORD, the evaluation of hydraulic connectivity is required for water licensing decisions under the BC *Water Sustainability Act* (WSA). The WSA references hydraulic connection between water in a stream and groundwater in an aquifer. Under the WSA a Decision Maker must determine whether the aquifer is "reasonably likely" to be hydraulically connected to surface water.

"Hydraulic connection", for the purpose of water allocation and use, means the reasonable likelihood that pumping of groundwater from a well will eventually result in a change in the flow of a stream or spring, or change in the level of a lake, pond, wetland that overlies or borders the aquifer, over a time period and to an extent that the Decision Maker must take into account the Environmental Flow Needs (EFNs) of the stream or whether the rights of other authorized users on the stream are likely to be detrimentally affected.

"Reasonable likelihood" is the test that should meet a certain level of probability and should be based on evidence that directly links the connection between the pumping well to the surface water body or stream. "Change in the flow of a stream or spring or change in the level of a lake, pond or wetland" reflects the significance of the impact, as well as ability to detect the impact.

The most basic, but useful, information for assessing likelihood of hydraulic connection between water in a stream and an aquifer is the aquifer type. Aquifer type has been determined for "classified" aquifers in BC according to the BC Aquifer Classification System (Kreye et al, 1998). Those aquifers that have been classified can be viewed via the BC Water Resources Atlas or iMAPBC (Province of British Columbia, 2018). A detailed explanation of aquifer types is available on the BC Ministry of Environment web site (Wei et al, 2009).

Aquifer type is based on geology. Where information is limited, aquifer type can be interpreted from the location of the well and from the lithologic description in the well construction report, or reports for nearby wells. For example, groundwater occurring in unconfined sand and gravel deposited along a river (Type 1 aquifer) will likely be in hydraulic connection with the river. Type 4b or 4c, which are confined aquifers that are separated from an overlying or bordering stream by a confining layer that is continuous, are likely not hydraulically connected to the overlying or bordering surface water body or stream.

Evidence that may indicate a confined aquifer is hydraulically connected to a surface water body may also include a reduction in streamflow or water levels linked to pumping from the confined aquifer, stabilization of the drawdown in the pumping well during pumping, or changes in temperature, all indicative of the pumping well drawing water from the surface water body or stream.

BACKGROUND

The Subject Property is located roughly 22 km south of Merritt BC, along the eastern flank of the Coldwater River within an approximately 1 km wide valley surrounded by hills that extend up to 400m higher elevation than the base of the Valley. The River and Subject Property are at 770 meters above sea level (m-asl) and the uplands extend to 1150 m-asl. The base of the Valley,



including the River and the Subject Property is approximately 325 m wide and filled with alluvium. The elevation change from the east end of the Subject Property to the River is 4 m and therefore the bottom of the valley is relatively flat.

The Coldwater River flows in a north direction towards Merritt, along the western limits of the Subject Property. The average width of the River in the immediate area is 18 m. Based on data available from Environment and Natural Resources Canada hydrometric station No. 08LG048 (Coldwater River near Brookmere), which is roughly 11 km south, the flow in the river is roughly 2.0 m³/sec from late fall to early spring and reaches a maximum of roughly 70 m³/sec during freshet. During irrigation season (August and September), when the irrigation well is utilized almost continuously, the flow in the river averages roughly 1.0 m³/s.

Summer flow in the Coldwater River is expected to be less than the pre-freshet flow rate. However, actual flow is expected to be higher than the recorded flow at Station No. 08LG048 as the catchment area at this station is 316 km², whereas flow in the River adjacent to the Subject Property will be higher due to contributions from Voght Creek (216 km²) and Gillis Creek (< 8 km²).

There is an abandoned oxbow, or former river channel, that meanders through the Subject Property. Portions of the oxbow accumulate water, which is derived from runoff and hydraulic connection to a surficial unconfined aquifer and in turn the River. The irrigation well is located 120m east of the River and is roughly 1m higher than the oxbow, which surrounds the well. the well is utilized entirely for irrigation purposes for 150 days from April to October each year and is pumped at roughly 37.8 L/s (600 USgpm). The annual volume pumped from the well is estimated at 490,000 m³.

The location of the irrigation well, Coldwater River and oxbow are shown in Figure 1.

HYDROGEOLOGY

A review of the BC Water Resources Atlas (WRA) and the active listings on the BC Water Science Series reveals that the provincial government has not completed mapping and classification of aquifers in the Coldwater River Valley, including the immediate area of the Subject Property. However, the Province did commission a review of the aquifers in the Nicola and Coldwater river watersheds (Gorski et al, 2018) which recommends the establishment of a new aquifer in the area. The proposed aquifer is a confined glaciofluvial aquifer generally present below 15 m-bgs, ranging from 5 to 10 m thickness. The proposed name is the Coldwater Valley Aquifer.

The Gorski Report refers to the probable existence of two additional high yield aquifers at greater depth in the area, acknowledging that there is only one relatively deep well in the area and that any connectivity or continuity of these aquifers with the Coldwater Valley Aquifer are undetermined. Based on the review of the records in the WRA, the deep well referred to in the Gorski report is the irrigation well on the Subject Property. The irrigation well was drilled in May 2010 and is completed to 89.9 m (295 ft) depth, which is significantly deeper than the proposed Coldwater Valley Aquifer. Based on a review of the drillers log for the well, the geology encountered and an interpretation of the hydrogeological units beneath the Subject Property is summarized as follows:



Depth (m-bgs)		Hydrogeological Unit	Description
From	To		
0	2.4	1 - Unconfined aquifer	Sand and Gravel - wet
2.4	33.5	2 – Aquitard	Clay - wet
33.5	43.3	3 - Coldwater Valley Aquifer	Sand and gravel - wet
43.3	54.9	4 – Aquitard	Sand and gravel -dry
54.9	77.1	5 – Aquitard	Sand, gravel, silt, clay -dry
77.1	89.9	6 - Irrigation well source aquifer	Sand and gravel - water bearing

The irrigation well is completed with a 3.6 m long section of well screen in Unit 6, which is a confined aquifer that extends from 77.1 m-bgs to 89.9 m-bgs. Immediately overlying the aquifer are two aquitards, units 4 and 5, that represent a 33.8 m (111 ft) thick unit of dry sand and gravel. Unit 3, which is a sand and gravel aquifer present from 33.5 m-bgs to 43.3 m-bgs is the Coldwater River Aquifer. This is overlain by another aquitard from 2.4 m-bgs to 33.5 m-bgs. There is a shallow unconfined aquifer at ground surface. A record for the well was downloaded from the BC WELLS database. The well is referred to as well tag number (WTN) 103997.

There are 5 additional wells located within the base of the valley within 1 km of the irrigation well. Logs from the WRA for the wells, including the irrigation well, are included in Appendix A.

WTN15220, which is located 900 m to the north and along the River, encountered Unit 3. The Coldwater Valley Aquifer, from 12.2 to 13.9 m-bgs). The aquifer may be thicker at this location as it was not recorded on the log why drilling stopped at 13.9 m-bgs depth. Unit 3 is also noted in WTN 88032, WTN 88034, WTN 88067 and WTN 90076. None of the other wells in the area have been drilled sufficiently deep to encounter Unit 6, which is the aquifer intersected by the irrigation well. Therefore, the footprint area of the Unit 6 aquifer is currently unknown. Given that the Coldwater Valley Aquifer (Unit 6) being deeper and confined by Unit 2 which is classified as a type 4b aquifer, this aquifer is interpreted to also be a type 4b aquifer. A copy of the aquifer classification worksheet for the Coldwater Valley Aquifer from the Gorski Report is presented in Appendix B.

A summary of information for the wells along with the interpreted depths for prominent hydrogeologic units in the area is presented as follows:



Summary of Hydrogeologic Units in Wells Near the Subject Property

WRA Well Tag Number (WTN)	103997	88032	88034	88067	15220	90076
Proximity to WTN 103997	0	425	800	800	910	240
1 - Unconfined aquifer	0.0 - 2.4	0.0 - 4.3	0.0 - 1.8	0.0 - 4.3	0.0 - 3.5	0.0 - 3.0
2 - Aquitard	2.4 - 33.5	4.3 - 13.1	1.8 - 12.8	4.3 - 13.4	3.5 - 12.8	3.0 - 12.2
3 - Coldwater V. Aquifer	33.5 - 43.3	13.1 - 18.3	12.8 - 18.3	13.4 - 18.3	12.8 - 13.9	12.2 - 18.3
4 - Aquitard	43.3 - 54.9	-	-	-	-	-
5 - Aquitard	54.9 - 77.1	-	-	-	-	-
6 - Irrigation Well aquifer	77.1 - 89.9	-	-	-	-	-

Note: all depths and distances are in meters

PUMPING TESTS

The objective of the pumping test on the irrigation well was to stress the aquifer under worst case conditions when the River is at or near the lowest seasonal level and when groundwater levels (and recharge) are expected to be the lowest.

Two pumping tests were completed on the irrigation well in April 2018, prior to the onset of freshet flow in the Coldwater River. During testing, water level measurements were taken in the irrigation well and in the River. Observations in the unconfined aquifer were completed in a 4 m deep observation well that was excavated approximately 20 m to the southeast of the irrigation well. A second surface water monitoring station was established within the oxbow channel approximately 60 m to the northeast of the irrigation well. All water level measurements at each location were referenced to a common surveyed elevation datum. Water from the irrigation well was discharged to the River at the north end of the Subject Property, downstream of the water monitoring location established on the River. The location of the observation well and monitoring point along the oxbow are also shown in Figure 1.

The first test was completed on April 10 and 11, 2018, for 24 hours. The second test was completed on April 21 and 22, 2018 for 49 hours. The pumping rate for both tests was 48.9 L/s (775 USgpm). This rate is higher than what the well is normally pumped at as there were no irrigation pivots attached to the discharge pipe and the thus the system pressure against flow was reduced.



Water levels and temperature in the irrigation well, observation well and in the Coldwater River were monitored with pressure transducers equipped with internal dataloggers. Manual measurements were also taken at these locations and at the monitoring station in the oxbow. All transducer measurements were adjusted for atmospheric pressure changes as monitored on site with a barometric logger. Discharge from the irrigation well was determined by measuring distance and vertical drop of the water stream at the end of the discharge pipe, which was used to calculate flow using a formula for open pipe flow (Driscoll, 1986).

The first test was determined to be unsuccessful as the pumping level in the irrigation well extended below the depth at which the transducer was placed, which biased the data from this location during the latter part of the test. Following the constant discharge test, the recovery of the water levels was monitored for recovery to static (non-pumping) water levels. A copy of the data for the second pumping test are presented in Appendix C.

In addition to water level measurements at the River, real time data for Hydrometric station 08LG048 BC were used to verify that flow in the River was relatively constant during each test period. Plots of mean daily discharge and flow for April at station 08LG048 BC are included in Appendix D. A summary of the daily precipitation in Merritt for April 2018 indicates that cumulative rainfall was above normal, however no significant rainfall events occurred during or immediately prior to the testing on the irrigation well (Appendix D).

A plot of measured drawdown in the irrigation well, observation well and the River is presented in Figure 2. The maximum drawdown in the pumped (irrigation) well was 32.3 m (106.0 ft). There was no drawdown in the observation well nor in the River. Manual measurements at the monitoring station in the oxbow showed no water level change and are therefore not included on the plot.

The temperature of surface water in the River was cyclical during testing, fluctuating between 2 and 4 degrees Celsius, depending on the time of day. The temperature in the irrigation well (Unit 6 Aquifer) was relatively constant at approximately 9.8 degrees Celsius, whereas the temperature in the observation well (Unit 1 unconfined aquifer) was constant at approximately 4 degrees Celsius. The temperature difference between the surface water in the River and the Unit 6 aquifer ranged from 5.8 to 7.8 degrees Celsius, which is significant.

ANALYSIS OF RESULTS

Aquifer Properties

The pumping test data was analyzed to determine fundamental aquifer parameters using AQTESOLV®, a computer software program developed by Geraghty and Miller, Inc. The software was used to determine if the aquifer is confined and/or leaky, and to develop estimates for transmissivity and storage coefficient and hydraulic conductivity. The transmissivity of the aquifer was determined using the Moench (1985) and Theis (1935) methods. The calculated transmissivity values ranged from 1950 m²/day (2,100 ft²/day) to 227 m²/day (2,450 ft²/day). The storage coefficient was estimated to be 1×10^{-5} (no units) as there was no observation well in the Unit 6 aquifer, and hence no distance-drawdown data to support a calculation. Using transmissivity and aquifer thickness, the hydraulic conductivity of the aquifer is determined to be



in the order of 58 m/day (190 ft/day), which is relatively high. Using the Moench (1985) solution (Case 2) for leaky confined aquifers, the clay layer above the aquifer was determined to be non-leaky. The Aqtesolv plots are included in Appendix E.

A review of the drawdown plots in Figure 2, indicates that no obvious recharge boundary was encountered during testing. If the Coldwater River were to act as a recharge boundary, or "infinite" source of water, the irrigation well would begin to source water directly from the stream, and no further drawdown would be observed. Flow would be non-radial and the calculated derivative of the drawdown would change. None of these conditions were observed.

Aquifer-Stream Connectivity

In order to estimate the time required for the drawdown in the irrigation well to intercept the River, calculations were performed using the Theis (1935) equation. Using a 115 m (375 ft) distance between the irrigation well and the River, an estimated specific storage of $1e-5$, hydraulic conductivity of 58 m/day (190 ft/day), aquifer thickness of 10.0 m (33 ft) and a pumping rate of 47.3 L/s (750 USgpm), the drawdown cone would be expected to intercept the River very quickly. The calculation indicates 0.5 m of drawdown at the River is expected within 1 minute and 1.25 m of drawdown after 1 hour of pumping. However, there was no drawdown observed in the River during pumping of the irrigation well. The Theis calculations are presented in Appendix F.

CONCLUSION

The aquifer that hosts the irrigation well is not hydraulically connected to the Coldwater River based on the following information:

- The source aquifer which hosts the Irrigation Well (hydrogeological Unit 6) is a confined, Type 4B aquifer, that is geologically isolated from the River;
- The Coldwater Valley Aquifer (Unit 3) that lies above the Unit 6 Aquifer at shallower depth, has been characterized by others using the BC Aquifer Classification System as a Type 4B aquifer, and is also considered to be geologically isolated from the River;
- Pumping tests completed on the Irrigation Well during low flow (pre-freshet) conditions, did not lower the level or flow in the River or within a shallow aquifer (Unit 1) present on the Subject Property; and
- The temperature of water pumped from the Irrigation Well was a constant 9.8 degrees Celcius during testing, whereas the temperature in the River fluctuated between 2 and 4 degrees Celcius, depending on the time of day. If water pumped from the well was induced flow from the River, the temperature would be expected to trend towards the temperature of the river, becoming colder.



LIMITATIONS

This investigation or assessment has been conducted using a standard of care consistent with that expected of scientific and engineering professionals undertaking similar work under similar conditions in BC. No warranty is expressed or implied.

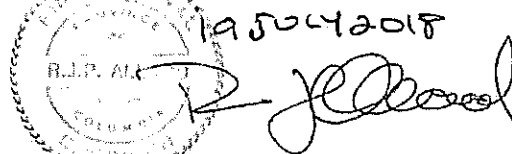
This memorandum is prepared for the sole use of Mr. Lance Graham of Graham Hay Sales in Merritt, BC. Any use, interpretation, or reliance on this information by a third party, is at the sole risk of that party. Piteau Associates Engineering Ltd. accepts no liability for such unauthorized use.

CLOSING

We trust the above is adequate for your current needs. If you have any questions regarding the above, or we can be of further service, please do not hesitate to contact us.

Respectfully submitted,

PITEAU ASSOCIATES ENGINEERING LTD.

195042018


Remi J.P. Allard, M. Eng., P. Eng.
Principal Hydrogeologist

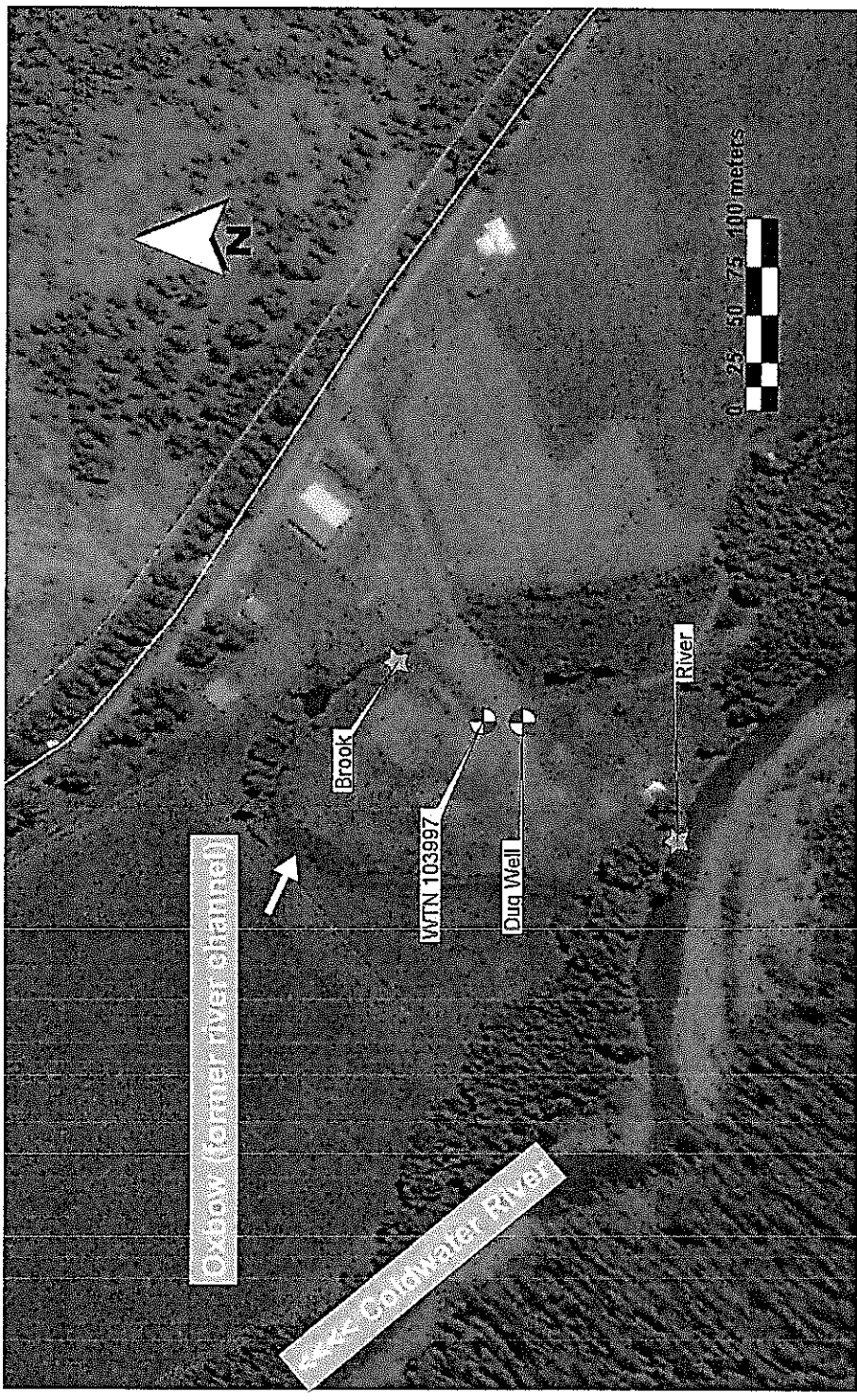
RA/dyc
Att.



REFERENCES

- AQTESOLV® for Windows® 95/98/NT/2000/XP version 3.50 Professional. Developed by Glenn Duffield, HydroSOLVE, Inc. © ARCADIS Geraghty & Miller, Inc. 1996-2003.
- Driscoll. 1986. Groundwater and Wells, Appendix 16E. Johnson Screens, St Paul, Minnesota, USA
- Gorski et al. 2018. Nicola Watershed Aquifer Mapping and Classification. British Columbia Ministry of Environment Water Science Series, WSS2018-xx (in draft). Prov. BC., Victoria, BC
- Government of Canada. 2018. Ministry of Environment and Natural Resources Canada real time Hydrometric Network. Accessed June 2018 online at https://wateroffice.ec.gc.ca/google_map/google_map_e.html?map_type=real_time&search_type=province&province=BC
- Kreye et al. 1998. An Aquifer Classification System for Groundwater Management in British Columbia, BC Ministry of Environment, Water Management Division, Victoria.
- Moench, A.F., 1985. Transient flow to a large-diameter well in an aquifer with storative semiconfining layers, Water Resources Research, vol. 21, no. 8, pp. 1121-1131.
- Province of British Columbia. 2014. Water Sustainability Act. [SBC 2014]. Queen's Printer, Victoria, British Columbia, Canada
- Province of British Columbia. 2016. Determining the Likelihood of Hydraulic Connection. Guidance for Determining the Effect of Diversion of Groundwater on Specific Streams. British Columbia Ministry of Environment Water Science Series, WSS2016-01. Prov. BC., Victoria, BC
- Province of British Columbia. 2018. BC Water Resources Atlas. Accessed June 2018 online at <http://maps.gov.bc.ca/ess/hm/wrbc/>
- Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.
- Wei, M., D. Allen, A. Kohut, S. Grasby, K. Ronneseth, and B. Turner. 2009. Understanding the Types of Aquifers in the Canadian Cordillera Hydrogeologic Region to Better Manage and Protect Groundwater. Streamline, Watershed Management Bulletin, Vo. 13, No. 1. Forrex Forum for Research and Extension in Natural Resources, British Columbia.

FIGURES

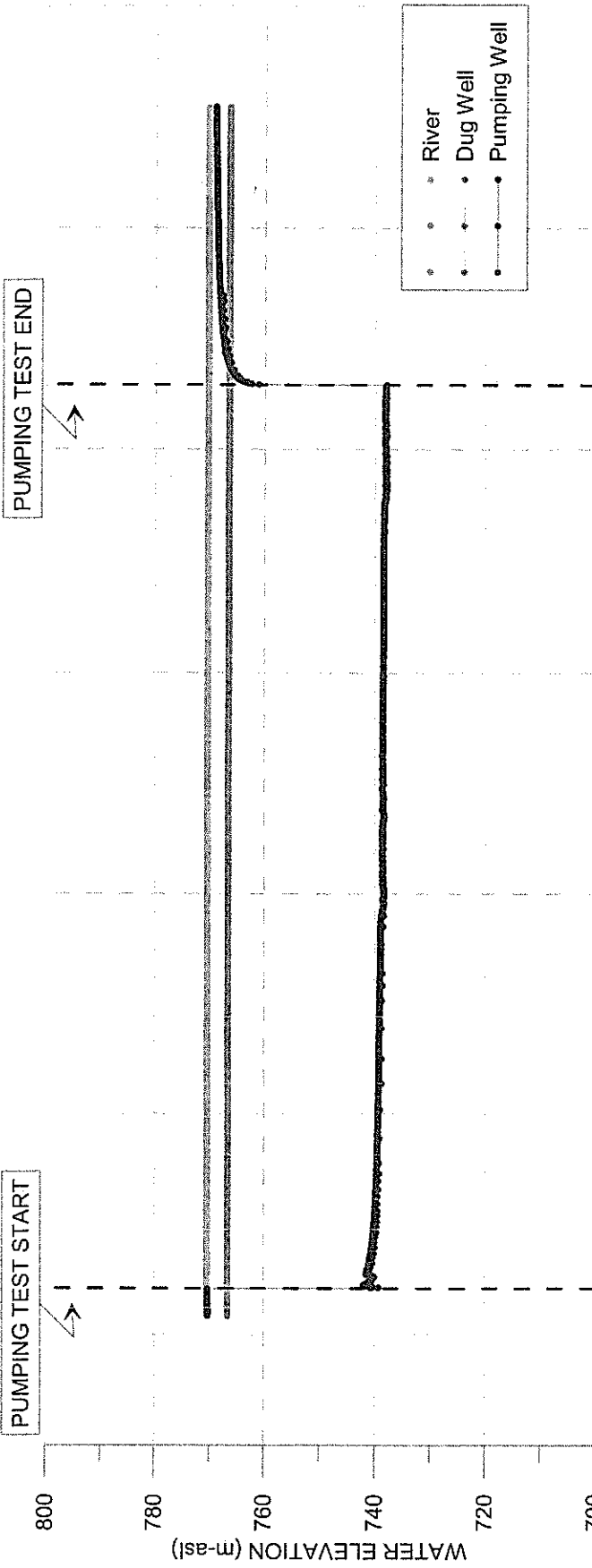
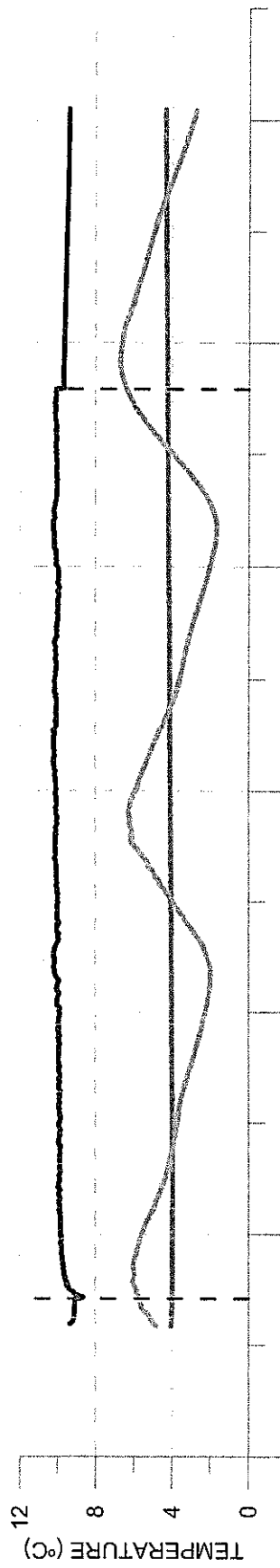


PREPARED SOLELY FOR THE USE OF OUR CLIENT AND NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH PITEAU ASSOCIATES ENGINEERING LTD. HAS NOT ENTERED INTO A CONTRACT.

GRAHAM HAY SALES
SURFACE VS GROUNDWATER INTERACTION
COLDWATER RIVER, MERRITT, B.C.

**PITEAU ASSOCIATES**
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

PLAN OF SUBJECT PROPERTY SHOWING IRRIGATION WELL RIVER, OXBOW AND OBSERVATION POINTS		BY:	RA	DATE:	JULY 18
		APPROVED:	____/____	FIG:	1



4/21/18 6:00 4/21/18 18:00 4/22/18 6:00 4/22/18 18:00 4/23/18 6:00 4/23/18 18:00 4/24/18 6:00

PREPARED SOLELY FOR THE USE OF OUR CLIENT AND NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH PITEAU ASSOCIATES ENGINEERING LTD. HAS NOT ENTERED INTO A CONTRACT.

Test Start: 21-APR-18 14:30
Test Duration: 49 hours

GRAHAM HAY SALES
SURFACE VS GROUNDWATER INTERACTION
COLDWATER RIVER, MERRITT, B.C.

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

PUMPING TEST WATER ELEVATIONS AND TEMPERATURES
IN PUMPING WELL, DUG WELL, AND RIVER

BY:	SH/RA	DATE:	JUN 18
APPROVED:	— / —	FIG:	2

APPENDIX A



Ministry of
Environment

- ☒ Well Construction Report
☐ Well Closure Report
☐ Well Alteration Report

Ministry Well ID Plate Number:
Ministry Well Tag Number: **103997**
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information.

See reverse for notes & definitions of abbreviations.

Owner name:

Mailing address:

Well Location: Address: Street no. Street name Town Prov. Postal Code

☒ Legal description: Lot Plan D.L. Block Sec. Twp. Rg. Land District

☒ PID: ☒ Description of well location (attach sketch, if nec.):

NAD 83: Zone:
(see note 2)

UTM Easting:

UTM Northing:

m

m

Latitude (see note 3): **49° 56' 57"**

Longitude: **120° 55' 22"**

Method of drilling: ☒ air rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify):

Orientation of well: ☒ vertical ☐ horizontal Ground elevation: ft (asl) Method (see note 4):

Class of well (see note 5): **Water supply** Sub-class of well: **Non Domestic**

Water supply wells: indicate intended water use: ☐ private domestic ☐ water supply system ☒ irrigation ☐ commercial or industrial ☐ other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	8		Brown Sand & gravel			
8	20	S	Clay			mon.
20	110	M	Brown Clay & gravel			
110	135	S	Gray silty silt with fine to medium sand, wet			
135	142	S	Gray silt fine to medium sand & gravel, wet			
142	150	M	Gray sand & gravel			
150	180	S	Gray sand & gravel, fine sand			
180	200	S	Gray sand & gravel silt & clay			
200	240	S	Brown clay sand & gravel			

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
0	135		Casing pulled		
0	240	10	Steel	3/4	3-B

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Surface seal: Type: **Pentaplate chip's** Depth: **240** ft
Method of installation: ☐ Poured ☐ Pumped Thickness: in
Backfill: Type: Depth: ft
Liner: ☐ PVC ☐ Other (specify):
Diameter: in Thickness: in
From: ft (bgl) To: ft (bgl) Perforated: From: ft (bgl) To: ft (bgl)

Intake: ☐ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☐ Telescope ☐ Pipe size
Screen material: ☐ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☐ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☐ Ball ☐ Plug ☐ Plate ☐ Other (specify):
Filter pack: From: ft To: ft Thickness: in
Type and size of material:

Developed by:

☐ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
☐ Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

☐ Pumping ☐ Air lifting ☐ Bailing ☐ Other (specify):
Rate: USgpm Duration: hrs
SWL before test: **57** ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

☐ Fresh ☐ Salty ☐ Clear ☐ Cloudy ☐ Sediment ☐ Gas

Colour/odour: Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): **Jerry Opper**

Registration no. (see note 20): **100 030 5 2001**

Consultant (if applicable; name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the Water Act and the Ground Water Protection Regulation.

Signature of Driller Responsible: **Jerry Opper**

Final well completion data:

Total depth drilled: **240** ft Finished well depth: **240** ft (bgl)
Final stick up: in Depth to bedrock: ft (bgl)
SWL: **57** ft (btoc) Estimated well yield: USgpm
Artesian flow: USgpm, or Artesian pressure: ft

Type of well cap: **Welded** Well disinfected: ☐ Yes ☐ No

Where well ID plate is attached: **Casing**

Well closure information:

Reason for closure:

Method of closure: ☐ Poured ☐ Pumped

Sealant material: Backfill material:

Details of closure (see note 17):

Date of work (YYYYMMDD):

Started: **2010 12 15** Completed: **2010 12 17**

Comments:

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

white: Customer copy
pink: Driller copy
pink: Ministry copy
Sheet **1** of **1**



Report 1 - Detailed Well Record

Well Tag Number: 88032	Construction Date: 2007-09-29 00:00:00
Owner: HOOGENDOORN	Driller: J. R. Drilling
Address: 2321 PETERSON ROAD	Well Identification Plate Number: 24182
Area: MERRITT	Plate Attached By:
	Where Plate Attached: CASING
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
YALE (YDYD) Land District	Well Yield: 30 (Driller's Estimate) U.S. Gallons per Minute
District Lot: 306 Plan: Lot:	Development Method: Air lifting
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow: .01 U.S. Gallons per Minute
Quarter:	Artesian Pressure (ft):
Island:	Static Level: 3 feet
BCGS Number (NAD 83): 092H096144 Well: 5	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Domestic	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	Water Utility:
Diameter: inches	Water Supply System Name:
Casing drive shoe: Y Y	Water Supply System Well Name:
Well Depth: 60 feet	
Elevation: 2498 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: 36 inches	Flag: Y
Well Cap Type:	Material: Neat cement grout and bentonite mix
Bedrock Depth: feet	Method: Poured
Lithology Info Flag: Y	Depth (ft): 20 feet
File Info Flag: N	Thickness (in): 1 inches

- Return to Main
- Return to Search Options
- Return to Search Criteria

The Province disclaims all responsibility for the accuracy of information provided. Information provided should not be used as a basis for making financial or any other commitments.



Report 1 - Detailed Well Record

Well Tag Number: 88034	Construction Date: 2007-09-30 00:00:00
Owner: HOOGENDOORN	Driller: J. R. Drilling
Address: 2321 PETERSON ROAD	Well Identification Plate Number: 24183
Area: MERRITT	Plate Attached By:
	Where Plate Attached: CASING
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
YALE (YDYD) Land District	Well Yield: 30 (Driller's Estimate) U.S. Gallons per Minute
District Lot: 306 Plan: Lot:	Development Method: Air lifting
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow: .01 U.S. Gallons per Minute
Quarter:	Artesian Pressure (ft): 0
Island:	Static Level: 3 feet
BCGS Number (NAD 83): 092H096144 Well: 2	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Domestic	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM): N
Construction Method:	Water Utility: N
Diameter: inches	Water Supply System Name:
Casing drive shoe: Y Y	Water Supply System Well Name:
Well Depth: 60 feet	
Elevation: 2498 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: 36 inches	Flag: N
Well Cap Type: PLATE	Material: Bentonite clay
Bedrock Depth: feet	Method: Poured
Lithology Info Flag: N	Depth (ft): 20 feet
File Info Flag: N	Thickness (in): 1 inches



Report 1 - Detailed Well Record

Well Tag Number: 88067	Construction Date: 2007-10-01 00:00:00
Owner: HOOGENDOORN	Driller: J. R. Drilling
Address: 2321 PEETERSON ROAD	Well Identification Plate Number: 24186
Area: MERRITT	Plate Attached By:
	Where Plate Attached: CASING
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
YALE (YDYD) Land District	Well Yield: 30 (Driller's Estimate) U.S. Gallons per Minute
District Lot: 306 Plan: Lot:	Development Method: Air lifting
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level: 4 feet
BCGS Number (NAD 83): 092H096144 Well: 1	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Domestic	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM): N
Construction Method:	Water Utility: N
Diameter: inches	Water Supply System Name:
Casing drive shoe: Y Y	Water Supply System Well Name:
Well Depth: 80 feet	
Elevation: 2498 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: 36 inches	Flag: N
Well Cap Type: PLATE	Material: Neat cement grout and bentonite mix
Bedrock Depth: 4 feet	Method: Poured
Lithology Info Flag: N	Depth (ft): 20 feet
File Info Flag: N	Thickness (in): 1 inches

924-0963.2.1

WATER RIGHTS BRANCH, DEPT. OF LANDS, FORESTS and WATER RESOURCES, VICTORIA, B.C.

LOCATION D.L. 1192 Yale District

OWNER'S NAME COLDWATER LUMBER CO. ADDRESS MERRITT B.C.

DRILLER'S NAME G.T.G. DATE OF COMPLETION NOV 1957

DEPTH 45' ELEVATION OF COLLAR 6" LENGTH TYPE

METHOD OF DIGGING DRILLED SCREEN ☐ SIZE OPENINGS DEVELOPED ☐ DESCRIBE

PERFORATED CASING ☐ LENGTH SIZE PUMP ☐ TYPE POWER

GRAVEL PACK ☐ LENGTH DIAM. SIZE GRAVEL, ETC.

PUMP ☐ TYPE PUMP PUMP HOUSE, ETC.

CAPACITY OTHER DATA

COSTS WELL PUMP

MAINTENANCE 8'2" ESTIMATED ELEVATION FLUCTUATION

DISTANCE TO WATER FROM TOP OF CASING 8'2" ESTIMATED ELEVATION FLUCTUATION

HIGH WATER MONTH LOW WATER MONTH OBSERVATION DATA ☐ FILE NO.

WATER USE 3 PEOPLE USE - 2 FAMILIES - OFFICE USE TO SERVE MORE

MAX. RATE WITHDRAWAL ☐ ESTIMATED ☐ MEASURED

TEMPERATURE PUMPS SAND ☐

CLOGS SCREEN ☐ TYPE DEPOSIT AQUIFER DATA FINE GRAVEL

LICENSE NO. DATE LICENSE AMOUNT

DATE APPLICATION USE

LOCATION SKETCH—INDICATE NORTH

CHARACTER OF SUPPLY MODIFIER

WATER USE

RELIABILITY OF DATA

GOOD FAIR POOR

HOUSEHOLD GARDEN STOCK COOLING IRRIGATION INDUSTRIAL WATERWORKS

SAND GRAVEL TILL

OTHER AQUIFER PRESENT

OTHER AQUIFER PRESENT

SUPPLY AQUIFER

WATER QUALITY

ANALYSIS

SOFT HARD HIGH IRON HIGH SULPHUR SALTY ALKALINE SALINE POLLUTED INADEQUATE QUALITY

DRY HOLE INADEQUATE QUANTITY PUMPING TEST

CAPACITY GPD

602

[illegible]

SAMPLE NO. _____ DATE _____

LAB

COLIFORM ORGANISMS

TOTAL BACTERIA

COLOUR _____ COLOUR _____

TASTE

PUMPING TEST SUMMARY

TEST BY

DATE _____ FILE NO. _____

SPECIFIC CAPACITY Amount of water vapor that can be held by a given mass of dry air at a constant temperature and pressure.

PERMIABILITY Measure of the ability of a material to allow fluids to pass through it.

STORAGE COEFF **POROSITY**

REMARKS[illegible]

Repetitive use of the word "and" in the title of the paper is a stylistic choice that is not necessary for clarity. The title is already clear and concise, and the use of "and" is redundant. The title should be revised to: "The Role of the Teacher in the Classroom".

OTHER DATA

SIZE ANALYSIS, ETC.

bioRxiv preprint doi: <https://doi.org/10.1101/2019.05.20.256101>; this version posted May 20, 2019. The copyright holder for this preprint (which was not certified by peer review) is the author/funder, who has granted bioRxiv a license to display the preprint in perpetuity. It is made available under aCC-BY-NC-ND 4.0 International license.

[illegible]

1000

10

(Handwritten scribbles)

1. The first part of the document is a title page. It contains the title of the document, the author's name, and the date of the document.

	PPM
Total Hardness	
Carbonate Hard	
Magnesium Hard	
Fe	
SO ₂	
Ca	
Mg	
Na	
K	
HCO ₃	
CO ₃	
Cl	
SO ₄	
NO ₃	
B	
E	
Total Dis-solids	
Total Alkalinity	
Suspended Solids	
Ph	

SIZE ANALYSIS, ETC.

CARD BY *D. F.* DATE *Jan. 1968*

CARD BY *di f* DATE *Jan. 1969*

[illegible]

.....



Report 1 - Detailed Well Record

Well Tag Number: 90076	Construction Date: 2007-09-30 00:00:00
Owner: HOOGENDOORN	Driller: J. R. Drilling Central Ltd. Partnership
Address: 2321 PETERSON ROAD	Well Identification Plate Number: 24185
Area: MERRITT	Plate Attached By: KELLY PELLETIER
	Where Plate Attached: CASING
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
YALE (YDYD) Land District	Well Yield: 30 (Driller's Estimate) U.S. Gallons per Minute
District Lot: 306 Plan: Lot:	Development Method: Air lifting
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow: .01 U.S. Gallons per Minute
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 092H096144 Well:	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well:	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	Water Utility:
Diameter: inches	Water Supply System Name:
Casing drive shoe: Y Y	Water Supply System Well Name:
Well Depth: 60 feet	
Elevation: 249 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: 36 inches	Flag: Y
Well Cap Type: PLATE	Material: Neat cement grout and bentonite mix
Bedrock Depth: feet	Method: Poured
Lithology Info Flag: Y	Depth (ft): 20 feet
File Info Flag: N	Thickness (in): 1 inches

Sieve Info Flag: N	Liner from	To:	feet
Screen Info Flag: Y			
Site Info Details:	WELL CLOSURE INFORMATION:		
Other Info Flag:	Reason For Closure:		
Other Info Details:	Method of Closure:		
	Closure Sealant Material:		
	Closure Backfill Material:		
	Details of Closure:		

Screen from	to feet	Type	Slot Size
54	60		60

Casing from	to feet	Diameter	Material	Drive Shoe
0	60	6	Steel	Y
0	20	8	Steel	Y

GENERAL REMARKS:
SWL at ground - artesian conditions present

LITHOLOGY INFORMATION:

From 0 to 10 Ft. Soft		brown sand
From 10 to 14 Ft.	COMPRESSED GRAVEL	SOFT/MEDIUM, GREY/BROWN
From 14 to 20 Ft. Soft	CLAY SILT	brown
From 20 to 40 Ft. Soft	CLAY SILT	brown
From 40 to 60 Ft. Medium		brown gravel

- [Return to Main](#)
- [Return to Search Options](#)
- [Return to Search Criteria](#)

Information Disclaimer

The Province disclaims all responsibility for the accuracy of information provided. Information provided should not be used as a basis for making financial or any other commitments.

APPENDIX B

AQUIFER CLASSIFICATION WORKSHEET

DATE: March 2018

AQUIFER REFERENCE NUMBER: 1164

DESCRIPTIVE LOCATION OF AQUIFER: Coldwater Valley Aquifer

NTS MAP SHEET: 092H096

BCGS MAP SHEET: 092H.096.3.2.1, 092H.096.1.4.3, 092H.096.1.4.4, 092H.096.1.4.2, 092H.096.3.2.2

AUTHOR: Golder Associates Ltd. - Nick Gorski, MSc / Kevin Bennett, PEng

CLASSIFICATION: III B

RANKING: 8

Aquifer Size: 0.8 km²

Aquifer Boundaries: The Coldwater Valley Aquifer is a confined glaciofluvial sand and gravel aquifer located in the Coldwater Valley just north of Kingsvale. It is delineated laterally based on the Coldwater Valley walls, and upgradient and downgradient based on the limits of observation in well records and the limits of flatter morphological expression of sediments in the valley. The top of the aquifer is commonly observed approximately 15 m below local ground surface in the valley, generally underlying 5 – 10 m of fine grained, glaciolacustrine or glacial till material. Observed aquifer thicknesses are 5 – 10 m thick. Continuity of the aquifer both upgradient in the valley and downgradient in the valley beyond the mapped limits is possible but not observed. One deeper well record in the area observed the potential for two additional underlying aquifers of high yield but these have not been mapped and any connectivity or continuity with the Coldwater Valley Aquifer are undetermined.

Aquifer Sub-type: 4b - Confined glaciofluvial sand and gravel aquifer

Observation Wells: None

Geologic Formation (overlying materials): The aquifer is overlain by up to 10 m of silts, clays and till with 0-5 m of modern alluvial deposits associated with the Coldwater River.

Geologic Formation (aquifer): Glaciofluvial sand and gravel deposits located in the Coldwater River Valley north of Kingsvale, most commonly observed between 15 – 30 m below local ground surface.

Confined / Partially Confined / Unconfined: Confined

Vulnerability: Moderate. Data is sparse in the area, but the aquifer is generally confined by up to 10 m of fine grained, low permeability material.

Productivity: Moderate (Geomean 1.9 L/s). Wells in the Coldwater aquifer are generally moderately yielding (0.3 to 3.0 L/s).

Depth to Water: Groundwater levels in wells are commonly near ground surface, with flowing artesian conditions commonly observed in several of the wells completed in this aquifer. (Average – 1.8 m bgs)

Direction of Groundwater Flow: Groundwater flow direction is assumed to be from nearby topographic highs and then ultimately upwards towards the topographic lows and surface water features in the valley, mediated by overlying deposits.

Recharge: Recharge is assumed to be predominantly via mountain block recharge from the surrounding highlands. Whether the Coldwater River is losing or gaining in this area is unknown.

Domestic Well Density: Moderate – 4-20 wells/km².

Type of Known Water Use: Drinking water (domestic), irrigation.

Reliance on Source: Primary.

Conflicts between Users: No documented conflicts.

Quantity Concerns: No documented concerns.

Quality Concerns: No documented concerns.

Comments: None.

Water Budget: None.

Groundwater Model(s): None.

References:

Berardinucci J. and K. Ronneseth, 2002. *Guide to Using the BC Aquifer Classification Maps for the Protection and Management of Groundwater*. BC Ministry of Water, Land and Air Protection, Water Air and Climate Change Branch, Water Protection Section.

Hy-Geo Consulting, Hodge Hydrogeology Consulting, and Azar & Associates. 2009. Provincial Observation Well Network Review British Columbia. Prepared for the BC Ministry of Environment Water Stewardship Division.

Wei, M., D. M. Allen, A. P. Kohut, S. Grasby, K. Ronneseth, and B. Turner. 2009. Understanding the Types of Aquifers in the Canadian Cordillera Hydrogeologic Region to Better Manage and Protect Groundwater. Streamline Watershed Management Bulletin, FORREX Forum for Research and Extension in Natural Resources.

Bobrowsky P., Cathro, M. and Paulen, R. 2001. Quaternary Geology Reconnaissance Studies 921/2 and 7. British Columbia Geological Survey, Geological Fieldwork 2001. Paper 2002-1.

Fulton, R.J. 1975. Quaternary Geology and Geomorphology, Nicola-Vernon Area, British Columbia. Geological Survey of Canada, Memoir 380.

AQUIFER CLASSIFICATION AND RANKING

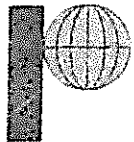
<u>Ranking Component:</u>	<u>Ranking Value</u>
Productivity:	2
Vulnerability:	2
Size:	1
Demand:	1
Type of Use:	2
Quality Concerns:	0
Quantity Concerns:	0
<hr/>	
Total:	8

Statistical Summary of Well Data for Aquifer

Total number of wells available for statistical analysis: 5

	Depth to Bedrock (m bgs)	Well Depth (m bgs)	Depth to Water (m bgs)	Reported Est. Well Yield (L/s)	Est. Thickness of Confining Materials (m)
Number of Wells	NA	5	2	4	5
Minimum	NA	13.9	1.2	1.9	5.5
Maximum	NA	24.4	2.4	1.9	9.5
Median	NA	18.3	1.8	1.9	7.9
Average	NA	18.6	1.8	1.9	7.7
Geometric Mean	NA	18.3	1.7	1.9	7.6

APPENDIX C



①

SECOND TEST

GRAHAM KAY SALES

SHEET 1
DATE 3989
JOB NO

BY LG CHKD RA

CLOCK TIME	ELAPSED PUMPING TIME (mins)	DEEP WELL	LOGGER A DUG WELL	LOGGER B RIVER	CHANNEL	PUMPING MEASURE	COMMENTS
APR 21 12:55 PM	—	9' 8" (116")	25"	59 1/8"	52"		TURND 1HR STOCK WATER PUMP OFF
2:30 PM	0	116"	25"	59"	52"		TURND 1HR STOCK WATER PUMP ON.
2:32 PM	2		25"	58			
2:34 PM	4		25"	59"	52"		
2:36 PM	6		25"				
2:38 PM	8		25"			14" x 1 1/2"	55 PSI TOP OF WELL
2:40 PM	10		25"	59"	52"		
2:50 PM	20		25"				
3:00 PM	30		25"	59 1/8"	52"	14" x 1 3/4"	65 PSI TOP OF WELL

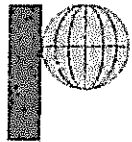


(2)

GRAHAM HAY SALES

SHEET 2
DATE
JOB NO 3989
BY LG CHKD RA

CLOCK TIME	ELAPSED PUMPING TIME (MIN)	DEEP WELL	LOGGER A DUG WELL	LOGGER B RIVER	CHANNEL	PUMPING MEASURE	COMMENTS
APRIL 21 3:30 PM	60		25"	59"	52"		
4:00 PM	90		25"		52"		
10:00 PM	450		26"	58 $\frac{5}{8}$ "	52"	14" x 1 $\frac{3}{4}$ "	
APRIL 22 7:00 AM	990		27"	58 $\frac{3}{4}$ "	52"	14" x 1 $\frac{3}{4}$ "	
10:00 AM	1170		27"	59"	52"		
11:30 AM	1260		27 $\frac{1}{4}$ "	59 $\frac{1}{8}$ "	52"	14" x 1 $\frac{3}{4}$ "	PUMP @ 65 PSI TOP OF CASING
2:45 PM	1455		27 $\frac{3}{8}$ "	59 $\frac{3}{8}$ "	52 $\frac{1}{8}$ "		
4:30 PM	1560		27 $\frac{1}{2}$ "	59 $\frac{1}{4}$ "	52 $\frac{1}{8}$ "		
6:00 PM	1650		27 $\frac{1}{2}$ "	59 $\frac{1}{4}$ "	52 $\frac{1}{8}$ "		
8:00 PM	1770		27 $\frac{3}{4}$ "	59 $\frac{1}{4}$ "	52 $\frac{1}{8}$ "	14" x 1 $\frac{3}{4}$ "	65 PSI TOP OF CASING



(3)

GOLAHAM HAY SALES

SHEET 3
DATE _____
JOB NO 3989
BY LG CHKD RA

CLOCK TIME	ELAPSED PUMPING TIME (MIN)	DEEP WELL	LOGGER A DUG WELL	LOGGER B RIVER	CHANNEL	PUMPING MEASURE	COMMENTS
APRIL 23 7:00 AM	2430		28 $\frac{1}{4}$ "	59 $\frac{1}{4}$ "	52 $\frac{1}{8}$ "	14" x 13 $\frac{1}{4}$ "	
10:30 AM	2640		28 $\frac{1}{4}$ "	59 $\frac{3}{8}$ "	52 $\frac{1}{8}$ "		64" TOP OF WELL
12:30 PM	2760		28 $\frac{3}{8}$ "	59 $\frac{3}{8}$ "	52 $\frac{1}{8}$ "	14" x 13 $\frac{1}{4}$ "	
3:30 PM	PUMP TURNED OFF 2940		28 $\frac{3}{8}$ "	59 $\frac{1}{2}$ "	52 $\frac{1}{8}$ "		
3:35 PM	—		28 $\frac{3}{8}$ "	59 $\frac{1}{2}$ "	52 $\frac{1}{8}$ "		
3:40 PM	—		28 $\frac{1}{2}$ "				
3:50 PM			28 $\frac{1}{2}$ "				
4:00 PM			28 $\frac{1}{2}$ "	59 $\frac{1}{2}$ "	52 $\frac{1}{8}$ "		
4:30 PM			28 $\frac{1}{2}$ "	59 $\frac{1}{2}$ "	52 $\frac{1}{8}$ "		
5:30 PM		18' 6" (222")	28 $\frac{5}{8}$ "	59 $\frac{1}{2}$ "	52 $\frac{1}{8}$ "		



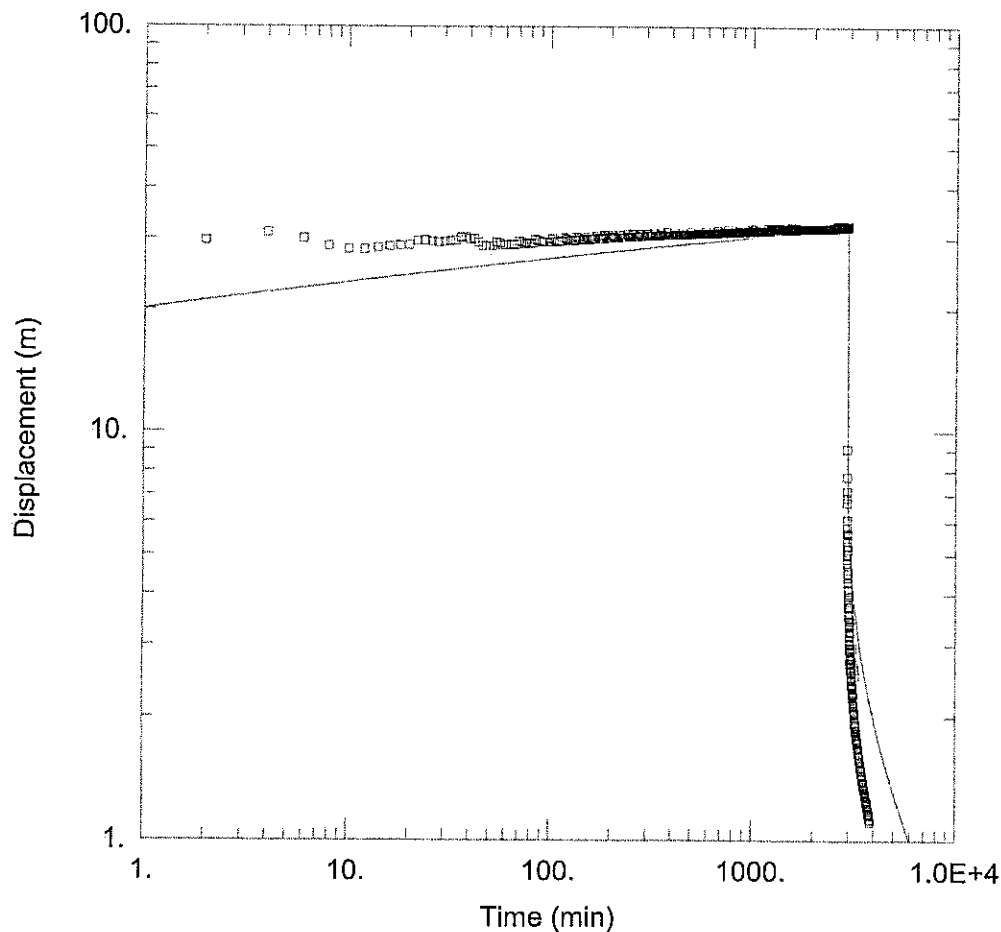
SHEET 4
DATE _____
JOB NO 3989
BY LG CHKD RA

[illegible]

APPENDIX D

Summary of Precipitation in Area of Subject Property for April 2018		
Subject Property is 2321 Peterson Road, Near Merrit, BC		
Nearest reporting Location is Merritt, BC		
Mean Monthly Precipitation for April :		15 mm
Date	Daily (mm)	Accumulated (mm)
April-01-18	0.3	
April-02-18	0	
April-03-18	0.4	
April-04-18	0	
April-05-18	1.7	
April-06-18	0	
April-07-18	6.9	
April-08-18	0	
April-09-18	0	
April-10-18	1.3	
April-11-18	0.2	
April-12-18	0	
April-13-18	4.9	
April-14-18	0.6	
April-15-18	1.8	
April-16-18	6.1	
April-17-18	0.7	
April-18-18	0	
April-19-18	0	
April-20-18	0	
April-21-18	0	
April-22-18	0	
April-23-18	0	
April-24-18	0	
April-25-18	0	
April-26-18	0	
April-27-18	0	
April-28-18	0	
April-29-18	10.6	
April-30-18	0	
Total (mm)	35.5	
Source: The weather Network		
https://www.theweathernetwork.com/ca		

APPENDIX E



WELL TEST ANALYSIS

Data Set: H:\Project\3989\graham hay.aqt

Date: 07/04/18

Time: 15:26:54

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Irrigat Well	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ irrigat well	0.15	0.15

SOLUTION

Aquifer Model: Confined

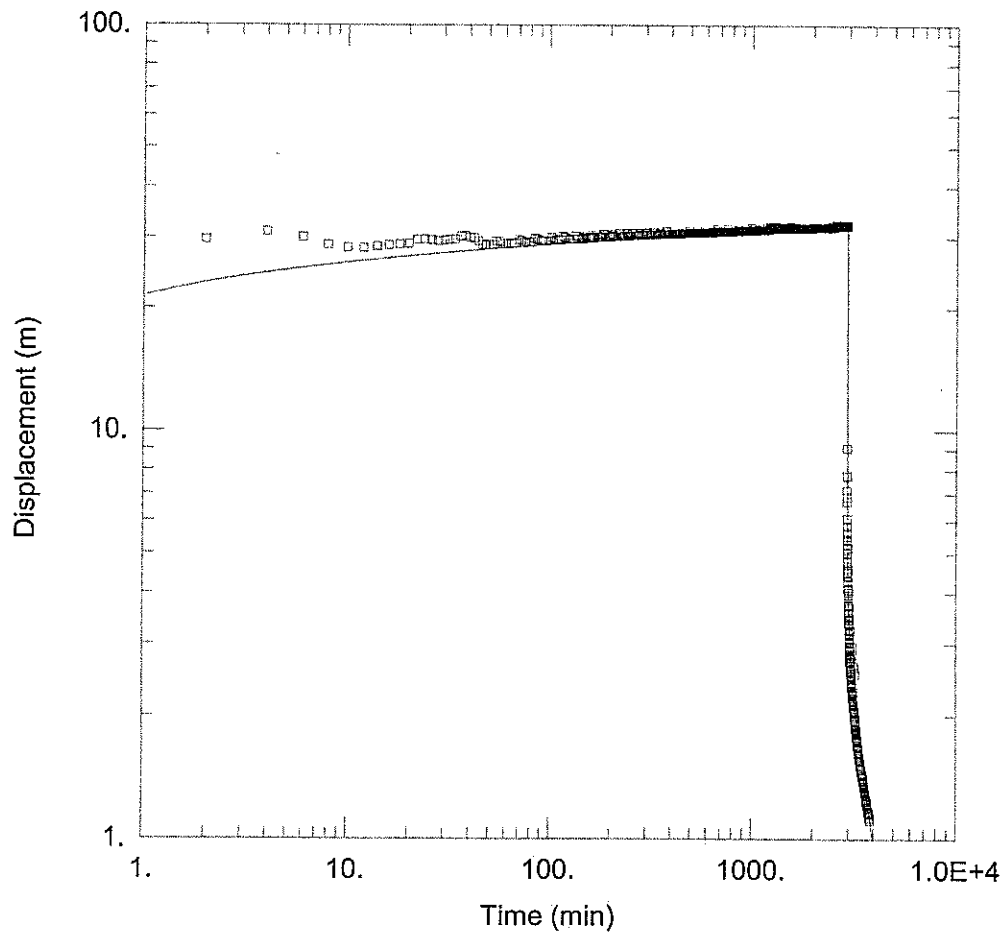
Solution Method: Theis

T = 2451.4 ft²/day

S = 1.0E-5

Kz/Kr = 0.75

b = 11.48 m



WELL TEST ANALYSIS

Data Set: H:\Project\3989\graham hay.aqt

Date: 07/04/18

Time: 15:25:32

AQUIFER DATA

Saturated Thickness: 11.48 m

Anisotropy Ratio (K_z/K_r): 0.75

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Irrigat Well	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ Irrigat well	0.15	0.15

SOLUTION

Aquifer Model: Leaky

Solution Method: Moench (Case 1)

$T = 2099.9 \text{ ft}^2/\text{day}$

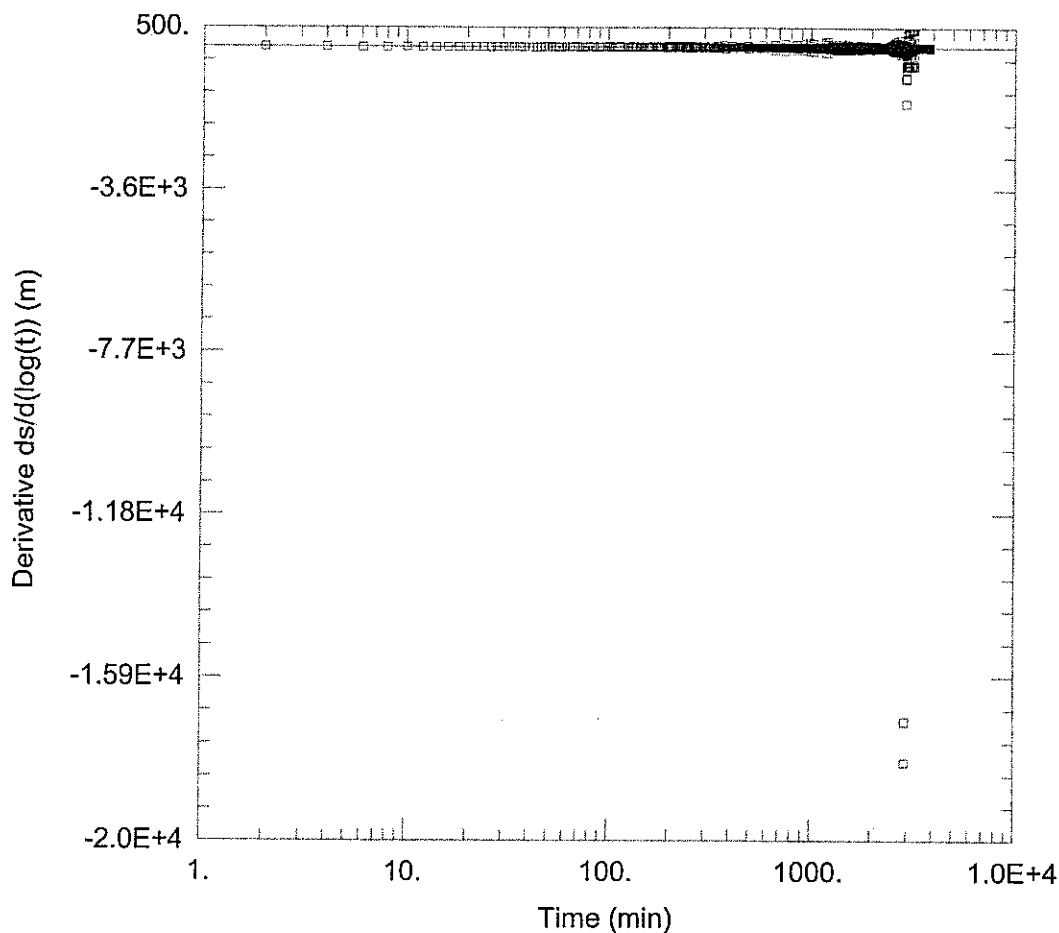
$S = 1.0E-5$

$r/B = 9.219E-5$

$\beta = 9.225E-5$

$Sw = -5.$

$r(w) = 0.15 \text{ m}$



WELL TEST ANALYSIS

Data Set: H:\Project\3989\graham hay.aqt

Date: 07/04/18

Time: 15:40:25

AQUIFER DATA

Saturated Thickness: 11.48 m

Anisotropy Ratio (K_z/K_r): 0.75

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Irrigat Well	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ irrigat well	0.15	0.15

SOLUTION

Aquifer Model: Leaky

Solution Method: Moench (Case 2)

$T = 2375.9 \text{ ft}^2/\text{day}$

$S = 1.0E-5$

$r/B = 10.$

$\beta = 1.0E-5$

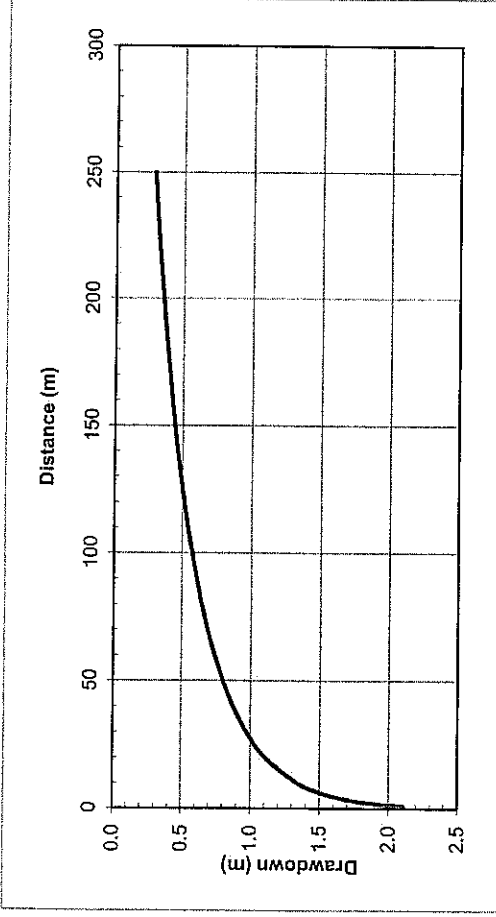
$Sw = -5.$

$r(w) = 0.15 \text{ m}$

APPENDIX F

Theis solution - distance drawdown estimates for Kingsvale Cattle Company Ltd.

Irrigation well
 Q (m3/s) 4.73E-02 pumping rate
 US gpm 750
 t (sec) 60 duration of pumping
 m3/day 4089
 days 0.0
 T (m2/s) 2.26E-02 transmissivity
 S 1.00E-05 storativity
 1951 m2/day



r (m)	u	s
0.1	1.846E-08	2.87
0.2	7.383E-08	2.64
1	1.846E-06	2.11
2	7.383E-06	1.88
4	2.953E-05	1.64
7	9.044E-05	1.46
10	0.0001846	1.34
20	0.0007383	1.11
30	0.0016611	0.97
40	0.0029531	0.88
50	0.0046142	0.80
60	0.0066444	0.74
70	0.0090438	0.69
80	0.0118123	0.65
90	0.0149499	0.61
100	0.0184567	0.57
110	0.0223326	0.54
120	0.0265777	0.51
130	0.0311918	0.49
140	0.0361751	0.46
150	0.0415276	0.44
160	0.0472492	0.42
170	0.0533399	0.40
180	0.0597997	0.38
190	0.0666287	0.37
200	0.0738268	0.35
210	0.0813941	0.34
220	0.0893304	0.32
230	0.097636	0.31
240	0.1063106	0.29
250	0.1153544	0.28

r (m)	u	s
260	0.124767	0.27
270	0.134549	0.26
280	0.144701	0.25
290	0.155221	0.24
300	0.16611	0.23
310	0.177369	0.22
320	0.188997	0.21
330	0.200993	0.20
340	0.213359	0.20
350	0.226095	0.19
360	0.239199	0.18
370	0.252672	0.17
380	0.266515	0.17
390	0.280726	0.16
400	0.296307	0.15
410	0.310257	0.15
420	0.325576	0.14
430	0.341264	0.14
440	0.357322	0.13
450	0.373748	0.12
460	0.390544	0.12
470	0.407709	0.12
480	0.425242	0.11
490	0.443145	0.11
500	0.461418	0.10
510	0.480059	0.10
520	0.499069	0.09
530	0.518449	0.09
540	0.538197	0.09
550	0.558315	0.08
560	0.578802	0.08

r (m)	u	s
570	0.5996583	0.08
580	0.6208835	0.07
590	0.6424778	0.07
600	0.6644413	0.07
610	0.6867739	0.06
620	0.7094757	0.06
630	0.7325465	0.06
640	0.7559866	0.06
650	0.7797957	0.05
660	0.803974	0.05
670	0.8285214	0.05
680	0.8534379	0.05
690	0.8787236	0.05
700	0.9043784	0.04
710	0.9304024	0.04
720	0.9567955	0.04
730	0.9835577	0.04
740	1.0106891	0.04
750	1.0381895	0.03
760	1.0660592	0.03
770	1.0942979	0.03
780	1.1229058	0.03

r (m)	u	s
790	1.151883	0.03
800	1.181229	0.03
810	1.210944	0.03
820	1.241029	0.02
830	1.271482	0.02
840	1.302305	0.02
850	1.333497	0.02
860	1.365058	0.02
870	1.396988	0.02
880	1.429287	0.02
890	1.461955	0.02
900	1.494993	0.02
910	1.5284	0.02
920	1.562175	0.02
930	1.59632	0.01
940	1.630834	0.01
950	1.665717	0.01
960	1.70097	0.01
970	1.736591	0.01
980	1.772582	0.01
990	1.808941	0.01
1000	1.84567	0.01