PROPOSED WILLOW BEACH DEVELOPMENT, RDOS, BC

PRELIMINARY HYDROGEOLOGY ASSESSMENT

Prepared By:
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Prepared For:
Infinity Properties

January 26, 2021

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Version Control and Revision History				
Version	**Date**	**Prepared By**	**Reviewed By**	**Notes/Revisions**
A	January 12, 20	MPS	LR	Draft for internal review
0	January 26, 2021	MPS	LR	Draft for Client Review

1.0 INTRODUCTION

Ecoscape Environmental Consultants Ltd. (Ecoscape) has been retained by Infinity Properties (the Client) to complete a baseline hydrogeological assessment of the proposed Willow Beach Development (the Site) located north of Osoyoos, BC (Figure 1). The Site comprises two adjacent parcels, as follows:

1) 9330 – 202 Avenue (PID 002-036-738)
   Lot 1, Plan KAP 22229, DL 2450S, Similkameen Division of Yale Land District, Portion L 677, FOR WILLOW BEACH MHP BAYS C/REF 70008.012 ET AL, 17714 WILLOW BEACH Manufactured Home Park
   Zoning: Tourist Commercial One (CT1s) and Residential Multiple Family (RM1) (RDOS Zoning Bylaw No. 2451 – 2008).

2) No civic address
   Lot 675, Plan 2066, District Lot 2450S, Land District Similkameen Division of Yale, Except Plan 22229 43613 H9726
   Zoning: Agriculture One (AG1) (RDOS Zoning Bylaw No. 2451 – 2008).

The Regional District of Okanagan-Similkameen (RDOS) experienced region-wide flooding in 2017 and 2018. Given the Site's proximity to Osoyoos Lake and the Okanagan River, the RDOS has requested the completion of a hydrogeological assessment to support the approval process from the proposed development.

The RDOS does not have a standard terms of reference for hydrogeology studies; however, based on correspondence with Development Engineering Supervisor Mr. Stephen Juch, P.Eng, we understand the RDOS is particularly interested in how high groundwater events will be mitigated by site grading and infrastructure design. The contents of this report are largely based upon the *Terms of Reference for Professional Reports and Planning Services* (TOR) used by the Regional District of Central Okanagan (RDCO, Appendix B). This process document was selected because it is widely used as a template in the Okanagan Valley for environmental studies (e.g., RDCO, City of Kelowna, and City of West Kelowna all use very similar documents).

Section 8.0 of the RDCO's TOR document recommends the following:

- Review all available information from previous well drilling;
- Assess pre-development groundwater conditions, including identification of natural springs, description of hydrogeology and vulnerability of aquifers, and identification of connections between groundwater and surface water;
- Identify existing and potential groundwater recharge/discharge areas;

- Identify potential contaminants and provide recommendations for managing contaminant sources;
- Include recommendations for groundwater management; and
- Assess, map and discuss anticipated post development groundwater conditions.

This assessment intends to address these Section 8.0 TOR recommendations and provides details that may be useful for shallow groundwater and stormwater management and drainage planning.

This report does **not** address other considerations in the TOR document, such as geotechnical development requirements for steep slopes or grades, potential flooding impacts for floodplain developments, and these studies may affect conclusions and recommendations made in this assessment. This report does **not** address groundwater supply or effluent disposal to ground as it is understood that the development will connect to municipal water and sanitary systems. This report does **not** address potential impacts, such as slope stability, mold or human health issues, that may result from high groundwater levels. Finally, this report does **not** address the potential for soil, groundwater or soil vapour contamination from previous land use and historical site activities (e.g. Phase I and II Environmental Site Assessment).

A detailed set of terms and conditions pertaining to this report are included as Appendix A.

1.1 Proposed Development

A preliminary lot layout plan and a site grading plan have been provided by the Client. Based on these and ongoing correspondence with the Client, we understand the development will consist of the following:

- Construction and servicing of 74 residential lots;
- Construction of a public roadway from Highway 97 through to the north end of the Site, parallel to the lake; and
- Construction of a private strata road which will loop of the public road to access lots further from the lake.

The Site is approximately 28 ha in size, of which approximately 19 ha or 69% of the Site is proposed to be dedicated to conservation efforts. Portions of the development area will be also be dedicated to parkland, and common property (along the beach and near the development centre).

The critical flood level construction elevation is 280.7 m above sea level (masl), and we understand nearly 50,000 m^3 of fill will be required to raise the proposed lot grades. We also understand that roadways and residences will be installed several meters above the natural grade at the Site, and that significant pre-load compaction will be required to satisfy geotechnical constraints at the Site.

Proposed stormwater management will largely rely on on-site bioswales with oil-water separators installed at all discharge points from onsite roads.

Water is currently provided to the Site by a supply well (Well Tag No. 83816), and wastewater is disposed in a communal septic holding tank, which is pumped and removed from the Site on a regular basis; however, we understand the proposed development will be connected to the municipal water and wastewater system and the current septic system will be decommissioned as per *Municipal Wastewater Regulation* requirements.

The preliminary lot layout and site grading plans provided by the Client are included in Appendix C.

2.0 OBJECTIVES AND SCOPE

Typical of any development, alteration of the Site landscape and land use have the potential to disrupt natural pre-development groundwater flow and drainage patterns. The purpose of this assessment was to gather and assess information regarding the current subsurface conditions at the Site to acquire a better understanding of the pre-development hydrogeological conditions as well as the anticipated post-development impacts to groundwater movement at the Site, including the effects of stormwater disposal, residential irrigation, and site grading.

The Site has potential challenges with respect to groundwater and stormwater management and mitigation of impacts to groundwater and nearby aquatic resources given its low-lying topography and the nearly ubiquitous occurrence of shallow groundwater and low permeability soils.

This report intends to evaluate the following questions:

- How will the current Site constraints, including shallow groundwater and low permeability soils affect Site design, layout and servicing?
- What are the existing groundwater management issues on Site, and what are the additional groundwater and stormwater management issues anticipated to stem from site alterations and development? How will increased water added to the Site from residential landscape irrigation and onsite stormwater disposal affect local groundwater occurrence and groundwater flow?
- Will Site development affect the nearby aquatic resources, and if so, how?

The level of detail for this assessment is intended to support development planning, and additional investigations (e.g. test pits, percolation tests, piezometers, etc.) may be necessary prior to detailed stormwater and groundwater management infrastructure design and installation.

3.0 METHODS

This assessment included a desktop review of relevant background information and a subsurface assessment.

3.1 Desktop Review

Ecoscape complied, reviewed, and analyzed the following information:

- Topographic, bedrock geology and surficial geology maps;
- Climate data;
- Aerial imagery;
- Water well logs available from the BC Ministry of Environment and Climate Change Strategy (ENV) water wells database and Water Resource Atlas (WRA)
- Reports pertaining to previous hydrogeological investigations completed at and near the Site; and
- General site information provided by the Client.

3.2 Subsurface Assessment

Sampling and monitoring tools were employed to collect detailed stratigraphic and hydrogeologic information to supplement desktop findings for the Site.

The following tasks were completed as part of this hydrogeological field assessment:

- Installed fourteen (14) monitoring wells, ranging in depth from 2.11 m to 10.88 m below ground surface (mbgs) to assess overburden stratigraphy, groundwater table depth, and groundwater flow direction;
- Installed five (5) piezometers paired with five (5) stilling wells at Quintal Oxbow, Pond 1, Pond 2, and unnamed oxbow lake, and the man-made drainage channel to evaluate recharge/discharge function at the surface water bodies on Site (Figure 2);
- Surveyed location and elevation of monitoring wells, piezometers, and stilling wells;
- Conducted hydraulic conductivity testing via single well response tests (i.e., slug tests) at eight (8) monitoring well locations; and
- Monitored surface water and groundwater levels to assess seasonal fluctuations and groundwater flow conditions.

3.2.1 Borehole Drilling and Monitoring Well Installation

Subsurface stratigraphy was assessed by drilling fourteen (14) boreholes at the locations mapped in Figure 2. Boreholes were strategically placed across the Site to obtain spatially representative groundwater level and flow direction data at the Site.

The boreholes were drilled on October 2 to 4, 2017 by Mudbay Drilling using a track-mounted Sonic DB320 drill rig. This type of drilling applies a high-frequency vibration coupled with a downward hydraulic pressure to advance a rotating casing. A continuous core of the encountered sediments was collected within an inner core tube, and was made available for retrieval at the ground surface. Boreholes were advanced to depths ranging from 3.66 m to 31.09 mbgs. Borehole logs were prepared for each drilling location, containing descriptions of soil type, colour, texture, and moisture content, along with other observations. Copies of the borehole logs are included in Appendix D.

To facilitate depth to groundwater measurements, the boreholes were converted to monitoring wells by installing 0.05 m (2-inch) diameter flush-threaded Schedule 40 PVC pipe with #25 slotted sections at the well terminus. Each well screen was sealed at the bottom using a threaded cap, and each well was sealed at the top with a lockable J-plug cap. Boreholes extending deeper than the monitoring well were plugged with a bentonite seal until approximately 0.3 m below the well bottom. The annulus of the screened section was backfilled with washed silica sand to approximately 0.3 m above top of screen and was hydraulically isolated by way of bentonite seal above the screen to approximately 0.6 m from the surface. Approximately 0.3 m of silica sand was installed above the bentonite seal to ensure adequate drainage around the well and wells were protected with a steel stick-up monument secured with concrete. Well completion details are included in the borehole logs (Appendix D).

3.2.2 Piezometers and Stilling Wells

Five (5) piezometers paired with five (5) stilling wells were installed in each water body on September 6, 2017, at locations mapped on Figure 2. The purpose of the nested piezometers and stilling wells was to determine the water level in each water body, and to assess groundwater-surface water interactions (i.e., vertical hydraulic gradients) between underlying groundwater and the water bodies.

Piezometers were installed manually by “driving” 0.05 m (2-inch) Schedule 40 PVC to targeted depths. Each piezometer was constructed with a 0.2 m section of #25 slotted PVC screen. Stilling wells extending to the bottom of the water body were affixed to each piezometer, and were constructed of Schedule 40 PVC with 1.5 m sections of #25 slotted PVC screen.

Piezometer completion details are summarized as follows:

- At P1, located in the drainage channel, the screen was installed from approximately 0.4 m to 0.6 m below the bottom of the channel.
- At P2, located in the Unnamed Oxbow Lake, the screen was installed from approximately 0.6 m to 0.8 m below the bottom of the lake.
- At P3, located in Pond 2, the screen was installed from approximately 0.4 to 0.6 m below the bottom of the pond.
- At P4, located in Pond 1, the screen was installed from approximately 0.8 to 1.0 m below the bottom of the pond.
- At P5, located in the Quintal Oxbow, the screen was installed from approximately 0.8 to 1.0 m below the bottom of the oxbow.

3.2.3 Well Elevation Survey and Water Elevation Measurements

Ground surface and top of riser elevation at each newly installed piezometer, stilling well and monitoring well (collectively referred to as wells) were surveyed on November 21, 2017. Three test wells previously installed at the Site (Golder, 2007) were also surveyed. Finally, surface water elevation at each waterbody was surveyed.

Groundwater and surface water levels were monitored at all well and piezometer locations between October 2017 and April 2020 using a combination of automated and manual measurement methods.

All wells and piezometers were instrumented with Onset® Hobo® Data Loggers (level logger). The level loggers were suspended into the water column within the wells and set to record water level fluctuations at two-hour intervals. The level loggers are not vented to the atmosphere, and therefore record total pressure (i.e., atmospheric + height of water column). As such, data obtained from the level loggers were corrected for atmospheric pressure using data obtained from a level logger suspended in the air at SW-4.

Static water level measurements were manually taken from the top of well riser at each well on eleven (11) separate occasions using an electric water level tape, to verify the accuracy of information collected by the level loggers. Manual water levels obtained from the wells are summarized in Appendix E.

3.3 Hydraulic Conductivity Estimates from In-Situ Single Well Response Tests

To evaluate the in-situ hydraulic conductivity of the screened intervals, falling head and rising head slug tests were conducted at MW1, MW4S, MW5S, MW6, MW7, MW8S, MW9 and MW10. The falling-head slug tests involved the addition of a slug to the subject monitoring well followed by a measurement of the rate of change in water level over time. Rising-head tests were completed by removing the slug from the well and once again measuring the rate of change in water level over time.

Water levels for the slug tests were measured automatically using a data logger. Slug tests were repeated three times for each monitoring well, and water level response data was analyzed using the Hvorslev (1951) method or Bouwer and Rice (1976) method. K values were estimated using Aqtesolv™ software. Slug test analysis reports are included in Appendix F.

4.0 SITE DESCRIPTION AND REGIONAL SETTING

The Site is located at the south end of the Okanagan Valley and is bound by Osoyoos Lake to the southeast, Highway 97 to the southwest, an oxbow river (former Okanagan River channel) and Okanagan River to the north, and conservation lands to the northwest (South Okanagan Wildlife Management and Ducks Unlimited) (Figure 1). The Site is approximately 30 hectares in area.

The Site is situated on the Okanagan River Floodplain, which prior to land clearing activities was occupied by floodplain channels, wetlands and forest. During the 1950s, the Okanagan River was straightened and diked and a segment of the river, currently known as the Quintal Oxbow, was isolated immediately northeast of the Site boundary. Since the River was diked, seasonal flooding at the Site was drastically reduced, allowing for mobile home park construction in 1970. A drainage channel and two (2) ponds were constructed at the Site's northern portion, which remains otherwise unoccupied, in an attempt to mitigate flood issues in low-lying areas.

A mobile home park and associated services including roads and groomed beaches still occupy the southwest portion of the Site (Figure 2), and several out-buildings, sheds, roads, and trails surrounded by cattail marsh, ditches and waterbodies occupy the remainder of the Site.

4.1 Climate

The Site is hot and dry being situated in a Bunchgrass Biogeoclimatic Zone and in a rain shadow on the lee-side of the Cascade Mountains. Based on data collected between 1981 to 2010 by Environment Canada from the Osoyoos West Station (No. 1125865), average annual total precipitation (rain and snow) in the area is 323.2 mm with an average of 279.4 mm of rainfall. The highest precipitation typically occurs between May and June, which is generally followed by a moisture deficit during the late summer. The daily average temperature for January and July were -0.7 °C and 21.9 °C, respectively.

Average climate data for the area was obtained from Environment Canada. Based on data collected between 1981 to 2010 from the Osoyoos West Station (No. 1125865), the average annual total precipitation (rain and snow) is 323.2 mm with an average of 279.4 mm of rainfall. The highest precipitation typically occurs between May and June, which is generally followed by a moisture deficit during the late summer. The daily average temperature for January and July were -0.7°C and 21.9°C, respectively.

A water balance completed by Pottinger Gaherty Environmental Consultants Ltd. (PGL) in their 2007 Environmental Impact Assessment (PGL, 2007) suggested that precipitation at Osoyoos only exceeds potential evapotranspiration (PET) during the four winter months. Precipitation is significantly less than PET during the remainder of the year.

Based on measurements of annual precipitation compared with estimated evapotranspiration (ET) at Farmwest's Osoyoos North station the Site and nearby surrounding area have a significant net water deficit during the summer months (Farmwest, 2021). For 2020, effective precipitation[1] at Farmwest's Osoyoos North station, was 13 mm while evapotranspiration was 1040 mm, resulting in a soil moisture deficit of about 1027 mm, with most occurring between April and October. The historical average water deficit for the area is about 873 mm/year.

4.2 Physiography and Surface Water Features

The Site is situated in the Okanagan Valley bottom within the Okanagan River floodplain and is generally flat, with elevations ranging from approximately 278 m to 282 masl. The western valley sides rise abruptly near the Site while the eastern valley side gradually rises towards the Haynes' Lease Ecological Reserve.

Much of the Site experiences considerable seasonal flooding influenced by the combination of high groundwater, lake, and river levels (PGL, 2012; Ecoscape, 2018). Outside of the high water period, permanently wetted ponds, oxbows, ditches and wetlands persist that maintain hydrologic and functional connections to each other.

As shown on Figure 2, seven (7) key water features are located on and adjacent to the Site.

The Quintal Oxbow extends along the north and east Site boundary and was originally a segment of the Okanagan River until isolated by diking activities during the 1950s. A natural unnamed oxbow is situated at the Site's north central portion, and was historically connected to the Okanagan River. Osoyoos Lake is situated along the southern and eastern boundary of the Site. Okanagan River is situated east of the Site and flows south into Osoyoos Lake.

Two ponds are situated in the eastern portion of the Site. The northernmost pond (Pond 1) is situated in a naturally low-lying area, and may therefore be native, however there is evidence that this pond was altered by excavation. The second pond (Pond 2) was excavated sometime after 1977 (PGL, 2012).

[1] Effective Precipitation (EP) is the amount of precipitation that is actually added and stored in the soil. During drier periods less than 5mm of daily rainfall would not be considered effective, as this amount of precipitation would likely evaporate from the surface before soaking into the ground.

A drainage channel was historically constructed at the northern portion of the Site in attempt to mitigate flood issues in low-lying areas.

Two licensed points of diversion/water intakes are situated near the site as follows:

- PD53990 – licensed for extracting 277,425 m^3/year and located on the Okanagan River north of the Site. This intake has traditionally been used for conservation purposes in wetland areas surrounding the Quintal Oxbow.
- PD74854 – licensed for extracting up to 3,699 m^3/year and located within the Osoyoos Lake marina channel near the east end of the Site.

4.3 Regional Geology

Bedrock geology at and near the Site likely consists of Osoyoos Lake Gneiss (Okulitch, 2013). These metamorphic rocks comprise granodiorite rich with hornblende-biotite.

Nasmith's "*Late Glacial History and Surficial Deposits of the Okanagan Valley, BC*" (1962) provides a well-rounded framework which explains surficial geology in the Okanagan Valley. Surficial topography and geology in the Okanagan Valley primarily comprises complex glacially-derived gullies, stream channels, alluvial fans and deltas, with sediments comprised of lacustrine silts and clays, along with deposits of gravel, sand, silty sand, clay, and till. Nasmith suggests the Site is underlain by Okanagan River Floodplain sediments, comprise mainly sand, silt and swamp deposits, which overlay glacial Lake Oliver silt and clay.

4.4 Hydrogeology and Nearby Groundwater Use

According to the BC WRA, ENV-mapped unconfined sand and gravel Aquifer No. 254 IIA underlies the Site. This aquifer was mapped within Quaternary deposits in the Okanagan River floodplain and was shown as extending from Osoyoos Lake north to Tugulnuit Lake, near Oliver, BC. The aquifer was considered to be highly productive, highly vulnerable, and under moderate demand at the time of mapping. Depth to water was generally shallow, ranging from 0.3 to 114.0 m, with an average of 6.4 mbgs. Groundwater flow was assumed to generally follow the Okanagan River course, flowing south towards Osoyoos Lake. Because the river floodplain is generally flat, hydraulic gradients were assumed to be low. The aquifer was assumed to be recharged by direct precipitation and runoff water from the uplands located east and west of the aquifer (ENV 2020).

Based on WRA mapping, seven (7) wells exist on the Site, as described in Table 1. The first four (4) wells listed in the table are test wells installed by Golder in 2007 (i.e., TW07-1 to TW07-4). Well Tag No. 83816 supplies water to the mobile home park, and the remaining two wells were not observed on the Site.

Table 1: On-Site Water Wells					
Well Tag Number	Well ID	Well Use	Total Drilled Depth (m)	Estimated Well Yield (US gpm)	Static Water Level (m below top of casing)
87678	TW07-4	Private Domestic	184	50	0 (artesian)
91676	TW07-1	Private Domestic	85	5	No water
91678	TW07-3	Private Domestic	29	90	0.9
91682	TW07-2	Private Domestic	20	80	0.9
19248	-	Irrigation	4.9	-	1.2
83816	-	Water Supply	3.1	-	unknown
16860	-	Private Domestic	3.1	250	0.6

Seven (7) offsite wells are reported within 500 m of the Site boundary. These wells are situated along the west side of Osoyoos Lake (Figure 1).

5.0 PREVIOUS REPORTS

The following previously completed studies were reviewed during this assessment:

- Golder Associates Ltd. (2007). *Groundwater Availability Assessment, Test Well Construction and Evaluation, Willow Beach, Osoyoos, BC.*
- EBA Engineering Consultants Ltd. (2007). *Preliminary Geotechnical Report. Proposed Willow Beach Residential Development Near Highway 97 and Road No. 22, Osoyoos, British Columbia.*
- EBA Engineering Consultants Ltd. (2012). *Updated Geotechnical Report. Proposed Willow Beach Residential Development Near Highway 97 and Road No. 22, Osoyoos, British Columbia.*
- Pottinger Gaherty Environmental Consultants Ltd. (2007). *Environmental Impact Assessment, Willow Beach, Osoyoos, BC.*
- Pottinger Gaherty Environmental Consultants Ltd. (2012). *Updated Environmental Impact Assessment, Willow Beach, Osoyoos, BC.*

5.1 Groundwater Availability Assessment, Test Well Construction and Evaluation (Golder, 2007)

Golder's 2007 groundwater assessment evaluated subsurface conditions at and near the Site, and provided an opinion on the viability of using groundwater as a source of potable water, irrigation water and fire supply water for the Site.

Golder drilled five (5) wells at the Site (TW07-1 to TW07-5) at locations shown on Figure 2. Sediment characteristics and stratigraphy at each Golder test well was generally as follows:

TW07-1 (well not screened)

- 0 - 6 m – sand and gravel
- 6 - 85 m – silty clay

TW07-2 (well screen at 18.9 – 20.1 m bgs)

- 0 - 4.5 m – sand
- 4.5 - 17.5 m – silt and clay
- 17.5 – 20.5 m – sand and gravel
- 20.5 – 61 m – silt and clay

TW07-3 (well screen at 28-29.3 m bgs)

- 0 - 3 m – sand
- 3 - 13.5 m – sand and clay
- 13.5 - 27.5 m – clay
- 27.5 - 29.7 m – sand and gravel
- 29 m – silty clay

TW07-4 (well not screened)

- 0 - 1.5 m - sand and gravel
- 1.5 - 7.5 m – gravel
- 7.5 - 10 m sand and gravel
- 10 - 176 m – silty clay
- 176 - 184 m - bedrock

TW07-5 (well screen at 7.9 to 9.1 m bgs)

- 0 - 1.5 m – sand and gravel
- 1.5 - 7.5 m – gravel
- 7.5 - 10 m – sand and gravel

Aquifer tests were completed in each well to assess well yield and aquifer characteristics. Based on these tests, three (3) distinct aquifers were identified on Site, as described in Table 2.

Table 2: Aquifers Identified on Site by Golder (2007).						
Aquifer	**Location**	**Depth (mbgs)**	**Water Depth**	**Thickness (m)**	**Transmissivity (m^2/day)**	**Hydraulic Conductivity (m/sec)**
Shallow, unconfined sand and gravel (ENV Mapped Aquifer 254)	Near the southwest corner of the mobile home park (TW07-5)	3 to 10	Near Surface	3 to 10	400 to 4,000	$5x10^{-3}$ to $5x10^{-4}$
Unmapped Confined sand and gravel	West end of the Site, between the manmade channel and Quintal Oxbow (TW07-2 and -3)	18 to 28	Near Surface	1.8 to 2.4	1,300	$6x10^{-3}$
Unmapped Deep weathered bedrock	Near the southwest corner of the mobile home park (TW07-4)	176	Artesian	unknown	20	unknown

5.2 Preliminary and Updated Geotechnical Report (EBA, 2007 and 2012)

In 2007, EBA excavated twenty (24) test pits to depths ranging from 1.8 to 4.5 mbgs to assess Site soil and groundwater. Soil samples were collected from each test pit and were analyzed for moisture content, grain size and organic content. EBA generally described Site soils as follows:

Topsoil

- 0.2 to 0.6 m thick at ground surface

Fill

- 0.5 to 1.5 m bgs
- Moist to wet, brown to dark brown fill materials including silt, sand, gravel, and a mixture of clay, sand and organic matter

Buried Topsoil and Peat

- 0.2 to 0.6 m thick, directly below the fill materials
- A 0.3 m thick peat layer was encountered immediately north of the unnamed oxbow

Native Sand/Silt Deposits

- Situated directly below buried topsoil or peat
- Some interlayered gravel and clay encountered near the west end of the Site and south of the Quintal Oxbow

- High organic content observed throughout, including rootlets
- The sand and silt deposits were brown to grey, most to wet, and cohesionless
- The sand was fine to medium

All test pits exhibited groundwater seepage and cave-sloughing conditions. Depths to groundwater seepage points ranged from 0.5 to 2 mbgs.

EBA noted the 1:200 year flood level for the Site was established as 279.87 m asl at the Site.

5.3 Environmental Impact Assessment (EIA) and EIA Update (PGL, 2007 and 2012)

The 2007 EIA, which included a comprehensive variety of environmental surveys and investigations, was initially conducted to support a RDOS rezoning application.

Water quality in and around the Site was summarized by PGL as follows:

- Okanagan River and Osoyoos Lake have historically ranged from being moderately to highly rich in nutrients (i.e., mesotrophic to eutrophic) between 1973 and 2003. Quintal Oxbow is mesotrophic (similar to Okanagan River), and on-Site ponds are generally nutrient rich and low in oxygen;
- Summer water temperatures of Okanagan River and in the upper layer of Osoyoos Lake regularly exceed *British Columbia Approved Water Quality Guidelines* for the protection of Aquatic Life. Osoyoos Lake is prone to a combination of warm temperatures and low dissolved oxygen in water, impacting fish migration to upstream spawning grounds in Okanagan River. Quintal Oxbow temperatures are slightly cooler in winter, and warmer in spring than the Okanagan River, likely due to increased surface water residence time.
- The on-Site ponds and Quintal oxbow have shown signs of anthropogenic impacts, including increased ammonia levels.
- The shallow unconfined aquifer is prone to contamination from surface sources, but has only shown slightly elevated nitrate levels.

Historically, reconnection of remnant Okanagan River oxbow features to the mainstem channel were under consideration by regulators and stakeholders, including the Osoyoos Oxbow Restoration Society, as discussed in Section 3.3. PGL consulted with the ENV and the federal Department of Fisheries and Oceans (DFO) regarding the potential to include oxbow restoration as part of future site development. However, it was later concluded that reconnecting the oxbows, which contain non-native invasive species, may introduce these species to other waterbodies. As such, oxbow reconnection was not completed. However, it was acknowledged that the remnant oxbows still possess high ecological and hydrogeological value, and should be protected/enhanced during future Site development.

6.0 FIELD FINDINGS AND CONCEPTUAL UNDERSTANDING

6.1 Hydrostratigraphy

Soil conditions encountered in the eleven (11) boreholes were consistent with those noted during previous hydrogeological and geotechnical assessments, and were generally observed as follows:

Organic-rich Topsoil

- 0.2 to 0.5 m thick at MW1, MW2, MW3, MW7, MW8S/D, MW9, MW10, and MW11
- Not observed at MW4S/D and MW5S/D and MW6,

Fill (MW5S/D, MW6, and MW10)

- 0.5 to 1.5 m bgs
- Moist to wet, brown to dark brown fill materials including silt, sand, gravel, and a mixture of clay, sand and organic matter.

Buried topsoil and peat (MW5S/D and MW10)

- Approximately 1.5 to 2.0 mbgs; directly below fill material.

Native Sand Deposits

- Native fine to medium grained sand or silty sand was observed in most boreholes at depths ranging from approximately 0.5 to 4.0 mbgs.
- A 22 m thick sand deposit was observed at MW4D, and interbedded sand and silty sand was observed from 1.5 to 30.2 mbgs at MW5D.

Native Gravel Deposits

- Gravel and coarse grained sand was observed from 0.2 to 10.4 mbgs at MW8D

Native Silt and Clay Deposits

- Silt and/or clay was noted from 2.0 to 8.9 mbgs at MW1, 22.0 to 28.3 mbgs at MW4D, 4.5 to 28.3 mbgs at MW6, 3.3 to 11.9 mbgs at MW10 and 4.3 to 8.8 mbgs at MW11.

Deep Sand and Gravel Deposit (unmapped confined aquifer)

- A saturated sand and gravel deposit confined by clay was observed from approximately 28.3 to 29.9 mbgs at MW6
- This deposit likely represents the unmapped confined sand and gravel aquifer identified by Golder (2007) at TW07-2 and TW07-3.

In general, a surficial unconfined sand and gravel aquifer with variable thickness (consistent with shallow sand and gravel deposits) appears to underlie the entire Site. This aquifer is likely associated with ENV-mapped Aquifer No. 254, and based on the similarity between measured groundwater and surface water levels, this aquifer is inferred to be hydraulically connected to Osoyoos Lake, Quintal Oxbow, and the onsite waterbodies.

The shallow, unconfined aquifer appears to be underlain by a silt and clay aquitard, extending from the west end of the site (Golder's TW07-2) towards the western boundary of the mobile home park (Golder's TW07-4 and MW7). The areal extent of this aquitard, particularly in the north portion of the Site, remains unknown due to limited subsurface information; however, it appears to be absent near MW4S/D and MW5S/D.

An approximately 1.5 to 2.4 m thick semi-confined to confined sand and gravel aquifer was identified at MW6, and is consistent with that observed by Golder (2007) at TW07-2 and -3. This aquifer was encountered at depths ranging from approximately 18 mbgs at TW07-2 to 29.9 mbgs MW6, with silts and clays encountered above and below the aquifer. The areal extent of this aquifer is not known; however, the aquifer was not encountered at Golder test wells TW07-1 or TW07-4, located near the south Site boundary, suggesting this aquifer is likely limited to the west and possibly north end of the Site. The confined aquifer is likely hydraulically isolated from the unconfined aquifer and Osoyoos Lake because water levels within TW07-2 and TW07-3 (completed within the confined aquifer) fluctuated much less than those measured in the unconfined aquifer and in Osoyoos Lake.

6.2 Water Levels, Inferred Groundwater Flow Direction

Static groundwater and surface water levels were monitored at all well and piezometer locations between October 2017 and April 2020 using a combination of automated and manual measurement methods. Manual water levels obtained from the wells are summarized in Appendix E. Water levels recorded using level loggers in 2018 are graphed on Figure 5.

Based on measured groundwater elevations, groundwater flow appears to be strongly influenced by the hills south of the Site, with flow generally towards the northwest. Figures 3 and 4 display inferred groundwater elevation contours and groundwater flow direction based on water levels measured in March and November 2019, respectively.

Vertical hydraulic gradients were measured using nested monitoring wells and piezometers/stilling wells. Based on water levels measured at the nested monitoring wells neutral to slightly upward and downward vertical hydraulic gradients occur throughout the year, with no obvious seasonality. Water levels measured in the piezometer/stilling well nested locations generally indicated a downward vertical hydraulic gradient, which suggests that the monitored waterbodies provide recharge to the unconfined aquifer.

An upward vertical hydraulic gradient between the confined and unconfined aquifer is likely based on consistently measured static water levels at or above the ground surface at Golder test wells TW07-2 and TW07-3.

Groundwater and surface water levels generally fluctuated 2 to 2.5 m annually, with elevations ranging from approximately 277 to 279.4 masl. Water levels were typically highest in May and June, following freshet, and lowest in December (Figure 5). Groundwater levels were typically 0.1 to 1.4 mbgs, except during the spring and early summer months of 2018, at which time the Site flooded. Additional flooding will likely occur in the future.

7.0 ANTICIPATED POST-DEVELOPMENT CONDITIONS AND MITIGATION STRATEGIES

The above sections provide an overview of pre-development Site conditions. The following section provides a summary of anticipated post-development Site conditions, based on the desktop review, field observations, and information provided by the Client.

We understand the proposed development will include residential lots, roads and underground utilities. The average lot size will be approximately 730 m^2. Consistent with nearby surrounding properties, potable water to the Site will likely be provided by the RDOS, so individual wells are not anticipated for this development.

Residential development generally poses a low environmental risk to groundwater and aquatic resources; however, based on Ecoscape's experience, potential environmental impacts and nuisance issues may stem from altering site grades and vegetative cover, and from runoff and infiltration of stormwater and landscape irrigation, especially in areas where shallow groundwater may occur. This potential is further discussed below.

7.1 Road and Building Lot Construction and Site Regrading Impacts

To achieve development objectives, we understand that Site grading will require significant infilling, as shown in the preliminary grading plan (2422-03074-00; Appendix B), and the site grading calculations completed by Karm Poonian (2422-03074-00; Appendix B).

The grading plans indicate the bottom of residence floor joists are above the Osoyoos Lake flood level (280.7 masl) and that positive drainage is routed away from the buildings, as the proposed roads will be constructed at a minimum grade of 279.0 masl, and the front ridgeline of each lot will be at a minimum grade of 279.5 masl. The RDOS allows a 1.5 m crawlspace to be located below the underside of the 280.7m elevation of main floor.

As previously discussed, groundwater levels monitored between October 2017 and April 2020 generally fluctuated 2 to 2.5 m annually. Groundwater elevations were as high as 279.4 masl, which resulted in Site-wide flooding. Based on this, it is likely that some residence crawlspaces will be constructed below the seasonally high water table and that

crawlspace flooding or nuisance groundwater seepage will likely occur during the lifetime of the proposed development. Some sections of road, particularly those constructed at or near 279.0 masl will likely also flood periodically.

Depending on the timing of work, shallow groundwater may be encountered when the crawlspace areas and utility trenches are excavated. Where shallow groundwater is encountered during Site construction the following temporary measures may be warranted:

- Seepage interceptor trenches (or other groundwater diversion structures) to route surface flows away from the construction area.
- Sump pumps with appropriate filters to temporarily dewater shallow excavations.
- Water collected in and from these structures should be routed to solid pipe storm sewers, where accessible.
- Specific dewatering methods and locations can be determined by the contractor and environmental monitor at time of construction.
- Sediment-laden flows must not be conveyed directly to any watercourse, ditch, or drainage. If surface waters become turbid from flowing over exposed soils, the sediment-laden waters must be contained within the Site (i.e., conveyed to a sediment trap or sump). The trap or sump should be of sufficient capacity to collect waters and allow settling of fine materials prior to discharge, including in cases of pump malfunctions or other unforeseen circumstance.
- If flows are conveyed overland, exposed soils shall be covered with clean rock, poly sheeting, filter fabric, or similar materials to reduce the potential for sedimentation of the seepage flows. Surface waters conveyed by ditches must have velocity-reducing features incorporated, such as rock check dams, straw bales free of seeds, sand bags, or synthetic erosion control products.
- Where possible, clean water accumulated on Site should be re-used for construction purposes, such as dust-control, earthwork compaction, or watering vegetation (upon ENV approval).

In general, the construction of impervious surfaces, including roofs, decks, driveways and roads will result in a notable reduction of infiltration and groundwater recharge at the Site. Nonetheless, care should be taken to ensure pre-development drainages are maintained and not impeded by building construction (e.g., basements) and compacted fill, as these obstructions may result in nuisance seepages or ponding in previously “dry” areas.

Furthermore, although some crawlspaces and utilities will likely be constructed below the seasonally high water table, impacts to site-wide groundwater flow patterns are expected to be minimal. Some preferential flow paths may occur along utility trenches; however, these flows are unlikely to materially affect the local hydrogeological regime, net groundwater flux and water balance. In essence, although a building or utility is placed with

saturated porous sediments, groundwater can continue to readily migrate both beneath and around these structures.

7.2 Stormwater Disposal

7.2.1 Onsite Stormwater Disposal Potential

The *Guidebook to British Columbia Stormwater Planning* (BC MOE, 2002) (the Guidebook) suggests that runoff/stormwater should be infiltrated and attenuated at the individual lot level, where practical, through the use of best management practices, as doing so reduces potential impacts to downstream systems, replenishes shallow groundwater and base flow in streams, and encourages entrapment and treatment of stormwater pollutants. The use of large detention tanks/ponds and off-site disposal should only be considered once onsite measures have been maximized.

When evaluating a Site's suitability for stormwater disposal to ground (e.g., rock pits, infiltration galleries, etc.), the depth to limiting conditions such as low-permeability soils, bedrock and/or groundwater are primary considerations. Areas with less than 2 to 3 m depth to limiting conditions are generally not considered suitable for stormwater disposal to ground.

Based on the results of this assessment, shallow groundwater is ubiquitous in the development area, and Site conditions are generally not considered suitable for stormwater disposal to ground; however, every effort should be made to minimize impermeable surfaces and optimize opportunities for natural infiltration of precipitation. This is further discussed in Section 7.2.2.

7.2.2 Stormwater Impacts

Stormwater generated by the proposed residential development has the potential to impact both groundwater quality and quantity, and surface water quality.

Typical of most large-scale residential developments, groundwater quantity can be impacted by the construction of impervious surfaces such as roofs, driveways, and roadways, which may result in noticeably increased runoff volumes, shortened runoff periods, and reduced groundwater recharge, particularly if stormwater is routed offsite.

The Guidebook should be consulted during the stormwater planning process. Design, development and construction strategies to reduce the amount of impermeable area at the Site, thus increasing the area available for infiltration can be implemented by reducing road widths, cul-de sac radii, and construction sidewalks on one side of the road only. Site infiltration capacity can also be maintained by minimizing compaction of soils below lawn and garden areas. The Guidebook suggests that artificially increasing the thickness of absorbent soil (i.e. organics) and applying 30 cm of vegetated topsoil coupled with a lot-specific dry well or infiltration trench can reduce peak runoff by up to 70%.

Runoff originating solely from the building roofs will not be contaminated and no potential water quality effects on underlying groundwater and nearby waterbodies (Osoyoos Lake, Okanagan River, Quintal Oxbow, etc.) are expected from roof water discharge. Runoff is not expected to be routed towards the proposed conservation area northeast of the development areas, so impacts to the conservation area will likely be minimal. Additionally, deeper aquifer zones will likely be protected by thick layers of low hydraulic conductivity sediments and upward hydraulic gradients.

Runoff from the proposed driveways and roadways can include several types of potential contaminants. However, appropriate stormwater management techniques such as bioswales can promote water quality improvement by mimicking natural recharge, during which contaminants are filtered, adsorbed, and biodegraded as water percolates through subsurface media. Most common potential contaminants, primarily consisting of such as metals, suspended solids, petroleum compounds and glycols (antifreeze), will bind to soil in the unsaturated zone and not expected to migrate down into the water table (Weiss, LeFevre and Gulliver, 2008).

Therefore, although the proposed development has the potential to impact local groundwater and surface water resources, implementing rigorous and appropriate sediment and erosion control practices and procedures during construction, effectively capturing, managing, and infiltrating stormwater runoff, utilizing appropriate property landscaping along with effective stormwater management and disposal practices should minimize the potential for compromised local groundwater and surface water quality from stormwater runoff.

7.2.3 Landscape and Lawn Irrigation Impacts

Landscape irrigation is expected to occur on Site, given that residential land use is proposed. The extent and amount of irrigation will be highly contingent on factors such as lot size, and landscape design (i.e., traditional lawn and landscapes vs. xeriscape). Excess irrigation not lost to evapotranspiration, off-site runoff, or consumed by lawn and plants has the potential to infiltrate into Site soils, increasing the volume of water moving through the subsurface. This can lead to groundwater rising to the surface with subsequent discharge onto the ground surface (groundwater mounding).

Guidance provided in the *Regional District of North Okanagan – Greater Vernon Water Landscape & Irrigation WaterWise Handbook* (2010) suggests that the average household consumes approximately 1,000 L of landscape irrigation water per day in the summer months. Irrigation water use at the proposed development will likely be similar. This equates to a water loading of 74,000 L or 74 m^3 of irrigation water over the entire Site per day if 74 lots are constructed. Assuming irrigation water is spread over one third of each lot (typical area occupied by lawns and gardens), this amounts to approximately 4 mm/day or 120 mm/month (assuming 730 m^2 lot size). Using the assumption that landscape irrigation

will only occur between June and September, the Site is estimated to receive approximately 480 mm of irrigation water annually.

The high net water deficit at the Site (i.e., historical average of 873 mm/year) should provide ample capacity to store and then release the estimated 480 mm/year of irrigation water. Furthermore, during drier periods, irrigation water (assuming less than 5 mm/day) not taken up by plants will evaporate from the surface before soaking into the ground. However, locally perched groundwater and potential groundwater mounding and subsequent ponding is possible where excessively irrigated areas are situated above near-surface, low permeability, and/or saturated soils. As such, despite the large moisture deficit on Site, efforts should be made to include drought tolerant plants and shrubs such that landscape irrigation can be kept to a minimum, mimicking native Okanagan Valley climate and water balance.

8.0 CONCEPTUAL SHALLOW GROUNDWATER AND STORMWATER MANAGEMENT

8.1 Groundwater Seepage Management

A key goal for long-term groundwater management at the Site will be to intercept shallow groundwater from entering crawlspaces. We recommend that a sump pump with proper backflow prevention be installed within each crawlspace. Discharge from the pump should be routed to higher elevation gardens or grassed areas to promote infiltration.

8.2 Stormwater Management

Minor drainage systems are generally designed to accommodate routine (e.g. 10-year return period) stormwater and snowmelt. Minor stormwater should be managed at a lot-scale, where possible. Roof leaders should discharge to grassed areas or rain barrels rather than be collected and conveyed via curb and gutter or a subsurface piped system. Raised garden planters may be constructed as a contingency to accommodate excess building roof and driveway runoff. Garden boxes should be constructed without bottoms, and include a permeable soil mixture (e.g., 60% sand, 20% compost and 20% loam) to allow adequate drainage.

Driveway and roadway runoff should be managed using a series of bioswales, which use a combination of soil, plants and microbes to treat stormwater before it discharges to ground or to a waterbody. Given the Site's location, stormwater will likely be discharged to Osoyoos Lake. We recommend that a Continuous Deflection Separation (CDS) unit (or similar technology) be installed upgradient of each storm discharge location, with the intent of capturing and retaining gross pollutants (e.g. hydrocarbons), litter, grit and sediment. We also recommend that a vegetated biofiltration pond be constructed upgradient of each discharge location to provide additional polishing of contaminants that may pass through the CDS.

The above-listed stormwater disposal options are conceptual and can be field-fit as necessary. All stormwater facilities should be designed in a way that minimizes clogging and sediment build up, and/or allows for ease of maintenance.

9.0 CONCLUSIONS AND GENERAL RECOMMENDATIONS

Ecoscape has completed a preliminary hydrogeological assessment of the proposed Willow Beach subdivision based on our review of currently available information and on field assessment findings.

This report was completed in general accordance with the Regional District of Central Okanagan's *Terms of Reference for Professional Reports and Planning Services.*

Based on this work, Ecoscape provides the following conclusions:

- The Site is situated in the Okanagan Valley bottom within the Okanagan River floodplain and is generally flat, with elevations ranging from approximately 278 m to 282 masl. Much of the Site experiences considerable seasonal flooding influenced by the combination of high groundwater, lake, and river levels and this will likely continue into the future. Outside of the high water period, permanently wetted ponds, oxbows, ditches and wetlands persist that maintain hydrologic and functional connections to each other.
- Based on soil and groundwater conditions encountered in eleven (11) boreholes/monitoring wells, and those noted during previous hydrogeological and geotechnical investigations at the Site, a surficial unconfined sand and gravel aquifer with variable thickness (consistent with shallow sand and gravel deposits) appears to underlie the entire Site. This aquifer is likely associated with ENV-mapped Aquifer No. 254 IIA. Based on the similarity between measured groundwater and surface water levels, this aquifer is inferred to be hydraulically connected to Osoyoos Lake, Quintal Oxbow, and the onsite waterbodies.
- The shallow, unconfined aquifer appears to be underlain by a silt and clay aquitard, extending from the west end of the site (TW07-2) towards the western boundary of the mobile home park (TW07-4 and MW7). The areal extent of this aquitard, particularly in the north portion of the Site, remains unknown due to limited subsurface information; however, it appears to be absent near MW4S/D and MW5S/D.
- An approximately 1.5 to 2.4 m thick semi-confined to confined sand and gravel aquifer was identified at MW6, and is consistent with that observed by Golder (2007) at TW07-2 and TW07-3. This aquifer was encountered at depths ranging from approximately 18 mbgs at TW07-2 to 29.9 mbgs MW6, with silts and clays encountered above and below the aquifer. The areal extent of this aquifer is not known; however, the aquifer was not encountered at Golder test wells TW07-1 or TW07-4, located near the south Site boundary, suggesting this aquifer is likely

limited to the west and possibly north end of the Site. The confined aquifer is likely hydraulically isolated from the unconfined aquifer and Osoyoos Lake because water levels within TW07-2 and TW07-3 (completed within the confined aquifer) fluctuated much less than those measured in the unconfined aquifer and in Osoyoos Lake.

- Groundwater and surface water levels generally fluctuated 2 to 2.5 m annually between October 2017 and April 2020, with elevations ranging from approximately 277 to 279.4 masl. Water levels were typically highest in May and June, following freshet, and lowest in December. Groundwater levels were typically 0.1 to 1.4 mbgs, except during the Spring and early Summer months of 2018, at which time the Site flooded. Based on this, it is highly likely some residence crawlspaces will be constructed below the seasonally high water table. Crawlspace flooding or nuisance groundwater seepage will likely occur during the lifetime of the proposed development. Some sections of road (i.e., those constructed at or near 279.0 masl) will likely also flood periodically.
- Groundwater levels are expected to vary throughout the year, generally following a seasonal pattern. Groundwater levels in shallow, unconfined aquifers tend to increase in the early spring months, in response to snow melt and infiltration from precipitation and reach maximum levels in mid-spring to early summer (typically May and June). Shallow groundwater levels generally approach their lowest in September and October due to high-evapotranspiration rates and minimal recharge from precipitation during the summer months.
- Based on measured groundwater elevations, groundwater flow appears to be strongly influenced by the hills south of the Site, with flow towards the northwest.
- Vertical hydraulic gradients were measured using nested monitoring wells and piezometers/stilling wells. Based on water levels measured at the nested monitoring wells neutral to slightly upward and downward vertical hydraulic gradients occur throughout the year, with no obvious seasonality. Water levels measured in the piezometer/stilling well nested locations generally indicated a downward vertical hydraulic gradient, which suggests that the monitored waterbodies provide recharge to the unconfined aquifer. An upward vertical hydraulic gradient between the confined and unconfined aquifer is likely based on consistently measured static water levels at or above the ground surface at Golder test wells TW07-2 and TW07-3.
- Given the shallow depth to groundwater in some areas, it is likely groundwater will be encountered during construction. Where shallow groundwater is encountered during Site construction, improved drainage, seepage interceptor trenches or other temporary groundwater diversion structures may be required.
- Although some crawlspaces and utilities may be constructed below the seasonally high water table, impacts to site-wide groundwater flow patterns are expected to be minimal. Some preferential flow paths may occur along utility trenches; however, these flows are unlikely to materially affect the local hydrogeological regime, net groundwater flux and water balance. In essence, although a building or utility is

placed with saturated porous sediments, groundwater can continue to readily migrate both beneath and around these structures.

- Site conditions are generally not considered suitable for stormwater disposal to ground.
- Runoff originating solely from the building roofs will not be contaminated and no potential water quality effects on underlying groundwater and nearby waterbodies (Osoyoos Lake, Okanagan River, Quintal Oxbow, etc.) are expected from roof water discharge. Runoff is not expected to be routed towards the proposed conservation area northeast of the development areas, so impacts to the conservation area will likely be minimal. Additionally, deeper aquifer zones will likely be protected by thick layers of low hydraulic conductivity sediments and upward hydraulic gradients.
- Runoff from the proposed driveways and roadways can include several types of potential contaminants. However, appropriate stormwater management techniques such as bioswales can promote water quality improvement by mimicking natural recharge, during which contaminants are filtered, adsorbed, and biodegraded as water percolates through subsurface media. Most common potential contaminants, primarily consisting of such as metals, suspended solids, petroleum compounds and glycols (antifreeze), will bind to soil in the unsaturated zone and are not expected to migrate down into the water table.
- The high net water deficit at the Site (i.e., historical average of 873 mm/year) should provide ample capacity to store and then release the estimated 480 mm/year of irrigation water. Furthermore, during drier periods, irrigation water (assuming less than 5 mm/day) not taken up by plants will evaporate from the surface before soaking into the ground. However, locally perched groundwater and potential groundwater mounding and subsequent ponding is possible where excessively irrigated areas are situated above near-surface, low permeability, and/or saturated soils.

Overall, implementing rigorous and appropriate sediment and erosion control practices and procedures during construction, effectively capturing, managing, and infiltrating stormwater runoff, utilizing appropriate property landscaping along with effective stormwater management and disposal practices should minimize the potential for compromised local groundwater and surface water quality from stormwater runoff.

Based on these conclusions, Ecoscape provides the following recommendations:

- Ecoscape should review changes to the subdivision's design details and specifications as they arise, prior to construction;
- A sump pump with proper backflow prevention be installed within each crawlspace to mitigate potential groundwater seepage issues. Discharge from the pump should be routed to higher elevation gardens or grassed areas to promote infiltration.
- The *Guidebook to British Columbia Stormwater Planning* (BC MOE, 2002) should be consulted during the stormwater planning process.

- Minor stormwater should be managed at a lot-scale, where possible. Roof leaders should discharge to grassed areas or rain barrels rather than be collected and conveyed via curb and gutter or a subsurface piped system. Raised garden planters may be constructed as a contingency to accommodate excess building roof and driveway runoff.
- Driveway and roadway runoff should be managed using a series of bioswales, which use a combination of soil, plants and microbes to treat stormwater before it discharges to ground or to a waterbody. Given the Site's location, stormwater will likely be discharged to Osoyoos Lake.
- A Continuous Deflection Separation (CDS) unit (or similar technology) should be installed upgradient of each storm discharge location, with the intent of capturing and retaining gross pollutants (e.g. hydrocarbons), litter, grit and sediment. We also recommend that a vegetated biofiltration pond be constructed upgradient of each discharge location to provide additional polishing of contaminants that may pass through the CDS.
- Despite the large moisture deficit on Site, efforts should be made to include drought tolerant plants and shrubs such that landscape irrigation can be kept to a minimum, mimicking native Okanagan Valley climate and water balance.
- This report should be submitted to the RDOS in support of the subdivision application.

10.0 CLOSURE

This report has been prepared by Ecoscape Environmental Consultants Ltd. (Ecoscape) and is intended for the sole and exclusive use of Infinity Properties and the RDOS. for the purposes set out in this report. Ecoscape has prepared this report with the understanding that all available information on the past, present, and proposed conditions of the Property have been disclosed. Ecoscape has relied upon personal communications with the developer and other information sources to corroborate the documents and other records available for the Site. Infinity Properties. has acknowledged that in order for Ecoscape to properly provide the professional service, Ecoscape is relying upon full disclosure and accuracy of this information.

Any use of this report by a third party, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Ecoscape accepts no responsibility for damages, if any, suffered by any third party as a result of actions or decisions made based on this report.

Please be advised that Mr. Ringham is a member in good standing in the Professional Engineers and Geoscientists of British Columbia (EGBC) and he is acting within his area of expertise. This assessment has been completed in accordance with generally accepted engineering and environmental practice.

Respectfully Submitted
Ecoscape Environmental Consultants Ltd.,

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Reviewed By:

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Attachments: Photos
Figures
Appendices

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PHOTOS

Photo 1: Site wide flooding observed on May 20, 2018.

Photo 2: Site wide flooding observed on May 20, 2018.

Photo 3: Drilling monitoring wells at the Site using a sonic drill rig (October 2, 2017).

Photo 4: Typical mottling and gleying observed in shallow soils (October 2, 2017).

Photo 5: Looking north along the Site foreshore (September 17, 2018).

Photo 6: Looking northeast across the conservation area on the Site (May 19, 2018)

Photo 7: Looking at an existing test well on the Site (May 25, 2017).

Photo 8: Looking south across the proposed development area (August 8, 2018).

FIGURES

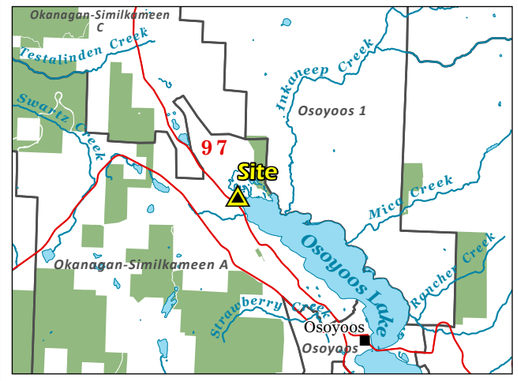
FIGURE 1
Site Location

Project:	Preliminary Hydrogeology Assessment
Location:	RDOS
Project No.:	17-2031.01
Prepared for:	Infinity Properties
Prepared by:	Ecoscape Environmental Consultants Ltd. Mike Schutten, M.A.Sc.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI World Imagery
Map Date:	January 12, 2021

LEGEND

- Site
- ENV-Mapped Well (WTN)
- ENV-Mapped Aquifer
- Cadastre

Regional Location of Site



DISCLAIMER
The data displayed is for conceptual purposes only and should not be interpreted as a legal survey or for legal purposes. If discrepancies are found between the data portrayed in this report and that of a legal survey, the legal survey will supersede any data presented herein.

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FIGURE 2
Site Layout and Monitoring Locations

Project:	Preliminary Hydrogeology Assessment
Location:	RDOS
Project No.:	17-2013.01
Prepared for:	Infinity Properties
Prepared by:	Ecoscape Environmental Consultants Ltd. Mike Schutten, M.A.Sc.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI World Imagery
Map Date:	January 11, 2021

LEGEND

- Nested Stilling Well and Piezometer
- Monitoring Well
- Golder Test Well (2007)
- ENV-Mapped Well (Well Tag Number)
- Waterbodies
- Proposed Lots
- Site Boundary

ECOSCAPE Environmental Consultants Ltd.

FIGURE 3
Inferred GW Flow Direction (Mar 2019)

Project:	Preliminary Hydrogeology Assessment
Location:	RDOS
Project No.:	17-2013.01
Prepared for:	Infinity Properties
Prepared by:	Ecoscape Environmental Consultants Ltd. Mike Schutten, M.A.Sc.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI World Imagery
Map Date:	January 11, 2021

LEGEND

- Inferred GW Flow Direction
- Groundwater Elevation Contours (masl)
- Monitoring Well (Mar 2019 GW Elevation [masl])
- Waterbodies
- Proposed Lots
- Site Boundary

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N

MW-2 277.88
MW-3 277.76
MW-4 277.60
MW-5 277.54
MW-6 277.75
MW-7 277.56
MW-8 277.99
MW-9 277.75
MW-10 278.11
MW-11 278.11
MW-1

277.8
277.9
278.0
278.1
277.6
277.7
277.5

Unnamed Oxbow
Outlet Oxbow
Pond 1
Pond 2
Drainage Channel
97th St
Fruitvale Way
202nd Ave
Lakehead Campsite Rd
Osoyoos Lake
97

0 20 40 80 120 160
Meters

314900 315000 315100 315200 315300 315400 315500 315600 315700 315800
5439400 5439300 5439200 5439100 5439000 5438900 5438800 5438700

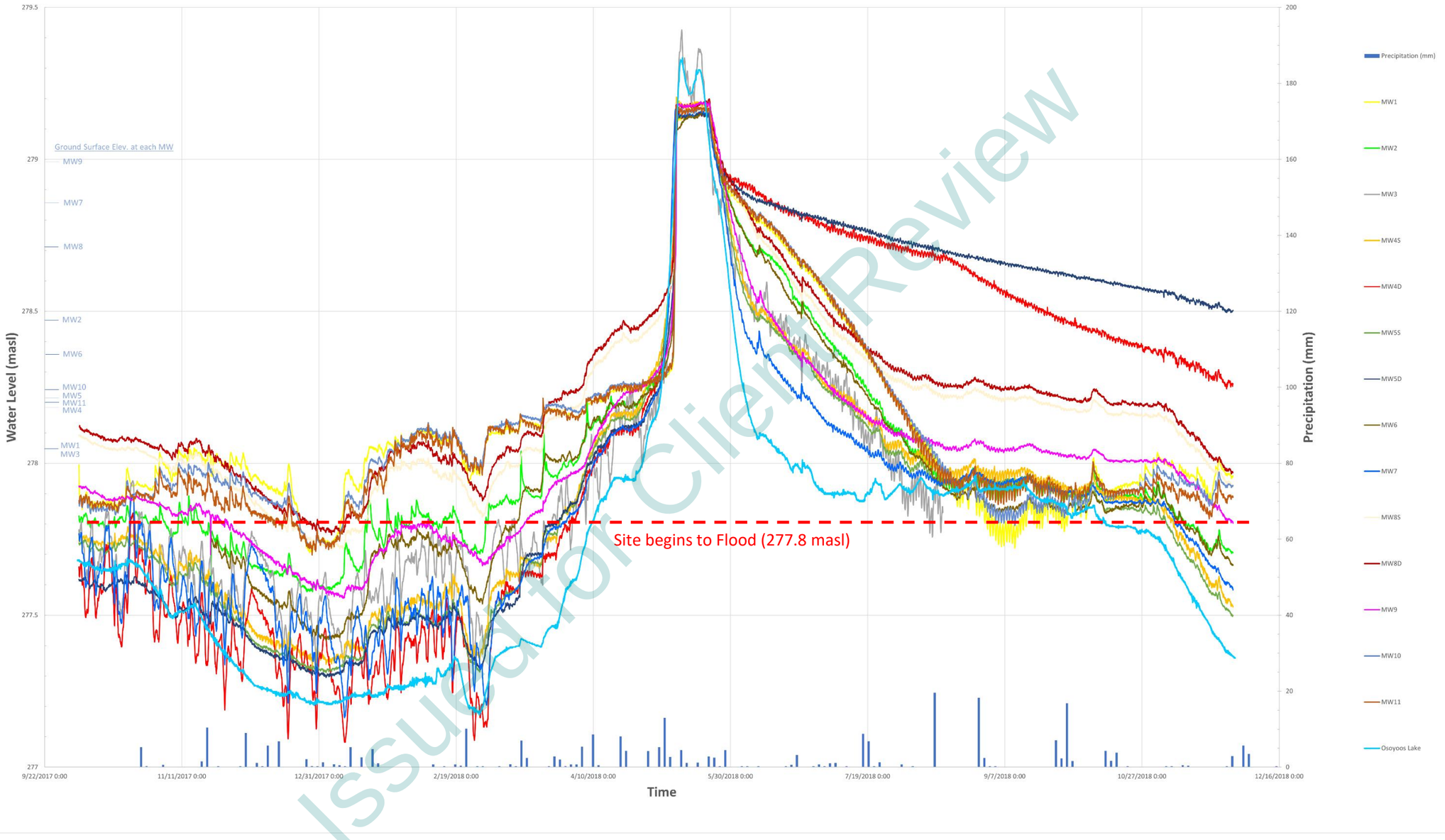
FIGURE 4
Inferred GW Flow Direction (Nov 2019)

Project:	Preliminary Hydrogeology Assessment
Location:	RDOS
Project No.:	17-2013.01
Prepared for:	Infinity Properties
Prepared by:	Ecoscape Environmental Consultants Ltd. Mike Schutten, M.A.Sc.
Coordinate System:	NAD83-UTM Zone 11
Imagery:	ESRI World Imagery
Map Date:	January 12, 2021

LEGEND

- Inferred GW Flow Direction
- Groundwater Elevation Contours (masl)
- Proposed Lots
- Monitoring Well (Nov 2019 GW Elevation [masl])
- Waterbodies
- Site Boundary

ECOSCAPE Environmental Consultants Ltd.



ECOSCAPE Environmental Consultants Ltd.	Project: Preliminary Hydrogeology Assessment		
	Title: Groundwater Levels over 2018		
	Client: Infinity Properties		Figure No: 5
	Location: RDOS		Project No: 17-2013.01
	Date: January 12, 2021	Dwn by: MPS / Ckd by: LR	Scale: N/A

APPENDIX A

GENERAL CONDITIONS

GENERAL CONDITIONS

This report applies and is subject to these "General Conditions".

1.0 Use of Report

This report concerns a specific site and a specific scope of work, and is therefore not applicable to any other sites or any other developments not referred to in the report. Any deviation from the specific site or scope or work would require a supplementary investigation and assessment.

Conclusions and recommendations contained in this report are solely intended for the use of Ecoscape's Client. Ecoscape bears no responsibility for the accuracy of information, the analysis of data or recommendations contained or referenced in this report when the report is utilized by or relied upon by any party other than Ecoscape's Client, unless otherwise authorized in writing by Ecoscape. Any unauthorized application of this report is at the discretion and sole risk of its user.

This report is subject to copyright, and therefore shall not be reproduced in part or in whole without prior written consent by Ecoscape. Additional copies of this report may be available upon request, if required, and will be supplied after receipt of payment for expenses associated with report production.

2.0 Limitations of Report

This report was derived solely from the conditions that were present on site during Ecoscape's investigation. The Client, and any other parties making use of this report with the express written consent of the Ecoscape and the Client, are aware that conditions affecting the environmental condition of the site can vary both temporally and spatially, and that the conclusions and recommendations included in this report are temporally sensitive.

The Client, and any other parties making use of this report with the express written consent of the Ecoscape and the Client, are also aware that conclusions and recommendations included within this report emanate from limited observations and information, and that both on-site and off-site conditions may vary, which in turn could affect the conclusions and recommendations that were made.

The Client is aware that Ecoscape is not qualified to, nor is it making any recommendations in terms of purchase, sale, investment or development of the subject property, as such decisions are the sole responsibility of the Client.

2.1 Information Provided to Ecoscape by Others

During the extent of the preparation and work carried out in this report, Ecoscape may have relied upon information provided by parties other than the Client. While Ecoscape strives to validate the accuracy of such information when instructed to do so by the Client, Ecoscape accepts no responsibility for the validity of such information which may affect the report.

3.0 Limitation of Liability

The Client acknowledges that property containing hazardous wastes and contaminants poses a high risk of claims brought by third parties stemming from the presence of those materials. Accounting for these risks, and in consideration of Ecoscape providing the requested services, the Client agrees that Ecoscape's liability to the Client, with respect to any issues relating to hazardous wastes or contaminants located on the subject property shall be limited to the following:

(1) With respect to any claims brought against Ecoscape by the Client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the Client to Ecoscape under contract, whether the action is based on breach of contract or tort;

(2) With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject property, the Client agrees to indemnify, defend and hold harmless Ecoscape from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by Ecoscape, whether the claim be brought against Ecoscape for breach of contract or tort.

4.0 Disclosure of Information by Client

The Client agrees to fully cooperate with Ecoscape with respect to the provision of all available information on the past, current, or proposed conditions on the site, including historical information respecting the use of the site. The Client acknowledges that in order for Ecoscape to properly provide the service, Ecoscape is relying on full disclosure and accuracy of any such information. Ecoscape does not accept any responsibility for conclusions drawn from erroneous, invalid, or inaccurate data provided to us by another party and used in the preparation of this report.

5.0 Standard of Care

Services performed by Ecoscape for this report have been completed in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgement has been applied in developing the conclusions and/or recommendations made in this report. No warranty or guarantee, express or implied, is made concerning the results, comments, recommendations, or any other portion of this report.

6.0 Notification of Authorities

The Client acknowledges that in certain instances the discovery of hazardous materials, contaminants or conditions and materials may require that regulatory agencies and other parties be informed and the Client agrees that notification to such parties or persons as required may be done by Ecoscape in its reasonably exercised discretion. Further, Ecoscape reserves the right to notify Provincial agencies when rare or endangered flora or fauna are observed, whether the species classifications are identified as such at the local, Provincial, or Federal levels of government.

7.0 Ownership of Instruments of Professional Service

The Client acknowledges that all reports, plans, and data generated by Ecoscape during the performance of the work and other documents prepared by Ecoscape are considered its professional work product and shall remain the copyright property of Ecoscape.

8.0 Alternate Report Format

Where Ecoscape submits both an electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Ecoscape's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by Ecoscape shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right to dispute that the original hard copy signed version archived by Ecoscape shall be deemed to be the overall original for the Project.
The Client agrees that both electronic file and hard copy versions of Ecoscape's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party other than Ecoscape. The Client warrants that Ecoscape's instruments of professional service will be used only and exactly as submitted by Ecoscape.

The Client recognizes and agrees that electronic files submitted by Ecoscape have been prepared and submitted using specific software and hardware systems. Ecoscape makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

APPENDIX B

REGIONAL DISTRICT OF CENTRAL OKANAGAN
TERMS OF REFERENCE FOR PROFESSIONAL REPORTS FOR PLANNING SERVICES

Planning Services

1450 K.L.O. Road
Kelowna, B.C. V1W 3Z4

Telephone: (250) 868-5227
Fax: (250) 762-7011
www.regionaldistrict.com

Terms of Reference
Professional Reports for Planning Services

May 2006

The purpose of this document is to describe the requirements for technical and professional reports submitted to meet requirements of land and development bylaws of the Regional District of Central Okanagan (RDCO)[1]. These requirements have been reviewed by local, regional and provincial agencies and associations.[2] The referenced reports are typically requested at time of neighbourhood planning, property rezoning, or subdivision to ensure that the property is suitable for the use intended.

Professional Reports may also be required for Development Permits to demonstrate how environmental and design objectives will be met or at time of Building Permit if the owner is seeking a design that does not coincide with earlier professional recommendations.

Applicants are encouraged to discuss the requirements below with RDCO Planning Services staff, and to coordinate these requirements with those of other departments and agencies. The requirements below are minimum standards, and allow staff to process an application for development without delay. They are intended as a reference to property development proponents in determining the scope of work required by qualified registered professionals. In all cases, qualified registered professionals need to prepare their reports through an integrative process whereby recommendations concerning one aspect of development (e.g. storm water management) are integrated with other aspects (e.g. fish habitat protection).

The requirements are detailed as follows:

General

1. Professional standards (applicable to all technical and professional reports)
2. Bonding (applicable to all remediation work)
3. Location of Project and Mapping

Specific

4. Geotechnical Study
5. Environmental Impact Assessment
6. Wildfire Hazard Assessment
7. Stormwater Management and Drainage Plans
8. Groundwater Management Assessments
9. Flood Protection
10. Visual Quality Assessments
11. Traffic Impact and Pedestrian Safety Studies

[1] This document can be found digitally at http://www.regionaldistrict.com/docs/planning/Handout%20TofRef%20Oct%202005.pdf
[2] BCSLA, AIBC, CAB, UDI, APEGBC, CHBA, COEAC, MOE, MOT, and MOF.

1.0 PROFESSIONAL STANDARDS

1. Reports are to be prepared by, **signed and sealed** by a Professional Registered in British Columbia (e.g. RPBio, PEng, MBCSLA, RPF, PGeo) and signed off within the document or by a covering letter bound into the document. A photocopy signature and seal is not accepted; an original signed and sealed report must be retained on Regional District files. The person and corporation who prepared the report must be identified, and the person or corporation who provided the funding, or at whose bequest the report was prepared must be identified.
2. The qualified professional personnel should include, at minimum, a Registered Professional Biologist with extensive experience with the ecosystems and wildlife species of the Okanagan region, with standard development practices and with published Best Management Practices. The professional must be prepared to work within a comprehensive design process where the development proposal adapts to requirements from multiple approval agencies.
3. The report must reflect the site conditions **prior** to disturbance and the anticipated site conditions post development.
4. The report must acknowledge off-site developments (both existing and those permitted by current regulation) and the impact these developments may have on the subject site.
5. The report must conform to all regional bylaws, federal and provincial legislation, regulations and standards.
6. Methods must be repeatable and results based on agency or scientific standards appropriate to the landscape being assessed.
    a. All personnel working on the report and their contributions must be acknowledged.
    b. Because disciplines are not equally standardized in all professions, a one-page Biography or C.V. of each professional and technical staff contributing to the results and interpretations in the report must be included as an addendum.
    c. The level of effort in terms of personnel and time spent on site evaluations must be clearly stated including time of year and length of site evaluations. Site conditions likely to be absent during the period of evaluation need to be documented and assessed by alternative methods.
    d. All data and non-standard methods contributing to the results and interpretations contained in the report must be included in the report or in appendices, either copies of hand-written field sheets or the data as entered in a digital format.

2.0 BONDING

If development conditions include mitigation, maintenance or monitoring plans, the applicant shall post a maintenance/monitoring bond or other security in a form and amount **determined by the qualified professional** and deemed acceptable by the RDCO. The bond shall be sufficient to guarantee that all required mitigation measures will be completed and furthermore continue to function properly as prescribed. Bonds shall also be required for restoration of significant natural features (i.e. ecological

corridors) and buffers not performed as part of a mitigation or maintenance plan. Bonding requirements shall be split into two (2) components: *Performance Bonds* and *Maintenance Bonds*.

2.1 Performance Bonds

Performance bonds guarantee the faithful performance and that work will be completed according to the contract terms and conditions. A performance bond will be required as a financial tool used to guarantee that in the event of a developer or contractor default, funds are available to finish the construction of prescribed environmental mitigative and compensative works.

2.2 Maintenance Bonds

Maintenance bonds may be required after construction to guarantee the performance / proper functioning of the works. The role of a maintenance bond is to protect against design defects and/or failures in workmanship, and to guarantee that the works constructed under the permit will be regularly and adequately maintained throughout the maintenance period. Thus, the maintenance bond guarantees that the faulty work of the developer or contractor will be corrected or defective materials will be replaced.

2.3 Bond Amount

The performance bond shall be in the amount of 125% of the estimated cost of the prescribed works (including monitoring). Maintenance bonds will be in the amount of 10% of the performance bond.

Bonds shall be in the form of a surety bond, assignment of savings account, or an irrevocable letter of credit guaranteed by an acceptable financial institution with terms and conditions acceptable to the RDCO attorney.

2.4 Duration

The duration of maintenance/monitoring obligations shall be established by the RDCO, based upon the nature of the proposed mitigation, maintenance or monitoring and the likelihood and expense of correcting mitigation or maintenance failures with respect to design and ecological function.

Performance bonds shall remain in effect until the RDCO has been notified, in writing, by the qualified professional that the standards bonded for have been met and substantial completion of the works has been satisfied. Once substantial completion of the works have been certified, the RDCO will withhold 10% of the credit as the maintenance bond. Maintenance bonds (10% of the performance bond) shall be held for a minimum of two (2) years (growing seasons) to ensure that the required mitigation has been fully implemented and demonstrated to function (ecologically or as designed). The maintenance bond may be held for longer periods if, throughout the initial 2-year period the persistent failure of the works is documented.

3.0 LOCATION OF PROJECT AND MAPPING

The proponent should commit to provide the following in the application:

1. Legal site description including plan number, lot number, and district lot. For large parcels, UTM coordinates of the site location where specific works will occur may be required.

2. Location map at appropriate scale (1:20,000) indicating the regional setting. This information should be overlaid on the most current cadastral map.

3. Site map at appropriate scale (minimum 1:200 and maximum 1:5,000) indicating the layout of project components and activities. This information should be overlaid on the most current cadastral map outlining all surrounding property boundaries. Map legends should show clear descriptions of all symbols used as per provincial standards.

4. Site profiles and cross sections in sufficient number to demonstrate terrain conditions prior to disturbance and intended conditions post development. When development is occurring on or near slopes that are greater than 20%, a topographic survey may be required. The survey is to show natural slope contours (at appropriate contour intervals of 1 to 5 meters) and the post development contours.

5. Maps should be presented in full-size, colour format and at least one copy must be printed to scale. Any additional copies at a reduced size must be clearly marked “Not to Scale”.

6. Site plans / sketches / colour photographs indicating project location, site features and activities identified in relation to easily identifiable landmarks such as those found on accompanying maps.

7. Proximity to designated environmentally sensitive areas such as those previously identified in RDCO documents (Official Community Plans or otherwise). This includes aquatic, terrestrial and hillside areas, watercourses and updated sensitive ecosystem inventory locations.

8. Where available, digital copies of supporting information presented should be provided in a format compatible with the ESRI platform (shapefiles) in NAD83 UTM Zone 11.

9. All image and data sources will be appropriately referenced and clearly indicate the date when this information was developed to certify that the most up-to-date information available was used in completing the relevant assessments.

4.0 GEOTECHNICAL STUDY

1. A geotechnical engineering review is required to assess slope stability on sites that exceed 25% natural grade, or otherwise identified as having geotechnical hazard (such as identified hazardous areas, erosion potential areas or floodplains).

2. A site survey will include topographic and features showing natural slope contours in 1 to 5 meter contour intervals, spot elevations, swales, knolls, ridgelines, bedrock outcrops, cliffs and slope transitions, seasonal and permanent watercourses, drainage routes, vegetation, top of bank and break lines.

3. The topographic survey will include current and future roads, site grading and post development contours.

4. The geotechnical engineer will determine whether the proposed development is feasible in a safe manner.

5. The geotechnical report will identify potential hazards to the subject land and to neighbouring properties from existing or future development.

6. Slope stability should be addressed such that there is no net decrease in overall slope stability resulting from the proposed development and off-site slope instabilities are mitigated to provide for safe occupation and use of nearby lands.

7. Where a potential hazard is identified, a construction management plan must be developed and monitored by the geotechnical engineer.

8. Where a potential hazard is identified, specific geotechnical assurance, provision of insurance, and the provision of bonding to secure the safe completion of on-site and off-site construction works will be required.

5.0 ENVIRONMENTAL IMPACT ASSESSMENT

1. Environmental Impact Assessments (EIA) should be performed generally in accordance with the B.C. Environmental Assessment Act (2002).[3] The policy, legislation, bylaw or regulatory framework (e.g. Sensitive Terrestrial Ecosystem Development Permit) that triggered the preparation of the Environmental Impact Assessment must be clearly described within the introductory section of the EIA. The Terms of Reference for any specific project will usually be required within the regulatory framework, and the associated regional policies. The regulatory/policy framework will determine the actual issues addressed in the EIA.

2. Assessments will be broken down into two phases:

    - **Inventory Phase**, or pre-planning phase, based on existing biological and physical conditions, or such conditions prior to any recent site disturbances; and,

[3] BC Environmental Assessment Act (May 30, 2002)

- **Impact Assessment and Mitigation Phase**, outlining the impact of proposed or intended developments to be addressed in the EIA. Not every EIA will address both phases, but the phase(s) being addressed will be identified in each EIA.

3. The time, number of personnel, and type of expertise of each person contributing to the assessment will be specified, and justification, or the reason for choosing this type and level of effort must be included. This will include the level of knowledge and/or inventory required to assess impacts to meet regulatory and policy requirements.

4. Pre-existing information for the site collected by government agencies or in the published literature will be gathered, assessed and presented.

5. Clearly identify gaps in the existing information and state the best ways to fill these information gaps. Provide additional fieldwork as identified to fill information gaps to reach the desired level of information to conduct the EIA. Information gaps may also be filled from local information sought from other interested parties including current and past owners, neighbors, and other local groups to make up for the typical short time-frame and limited fieldwork undertaken to complete EIAs.

6. Conduct field assessments to meet the policy and regulatory requirements and identify impacts on the environment.

7. Consider surrounding lands, and their uses and impacts in a Cumulative Impact Analysis. In most cases on very small parcels, individual environmental impacts may be small, and therefore difficult to measure and/or assess, or seem negligible in total impact. However, cumulative impacts of the same nature on adjacent lands, or all similarly-zoned land, or all land with similar future generalized use, may be large or even extreme. The RDCO can provide consultants with GIS files of zoning, future land uses and ecosystem inventories (at cost) that will allow for Cumulative Impact Assessments over entire community (or perhaps even larger) areas in a GIS framework.

8. Where facts are incomplete or surmised, the levels of confidence or reliability in the environmental knowledge will be assessed and documented. Knowledge gaps required for an assessment outlined in a specific TOR that could not be filled will be assessed and the impact of a lack of such knowledge documented.

5.1 Environmentally Sensitive Areas[4] (ESAs)

A fundamental task within the Inventory Phase is the stratification of communities occurring within the study area based on their environmental sensitivity. This is a key element in the planning process as it identifies area constraints and opportunities (avoidance/conservation, mitigation, and restoration) thus encouraging a more integrated and sustainable development plan. The following four-class rating system has been adopted by the RDCO and shall be applied to all ESA evaluations.

[4] Adapted from the works of J. Grods RPBio, L. Gyug RPBio, and M.Sarell RPBio.

ESA – 1 contain significant vegetation and wildlife characteristics representing a diverse range of sensitive habitat. These features contribute significantly to the overall connectivity of the habitat and ecosystems. Avoidance and conservation of ESA-1 designations should be the primary objective. If development should occur within these areas (**Only after it proves impossible or impractical to maintain the same level of ecological function**) compensation will promote no net loss to the habitat (typically with a 3:1 replacement of equivalent functioning habitat).

ESA – 2 or moderate significance, contribute toward the overall diversity and contiguous nature of the surrounding natural features. If development is pursued in these areas portions of the habitat should be retained and integrated to maintain the contiguous nature of the landscape. Some loss to these ESAs can be offset by habitat improvements to the remaining natural areas found on property.

ESA – 3 polygons delineated as low significance representing disturbed habitats or fragmented features. These areas contribute to the diversity to the landscape, although based on the condition and adjacency of each habitat the significant function within the landscape is limited. If development is pursued in these areas the impacts should be offset by habitat improvements in other more sensitive natural areas found on property.

ESA – 4 polygons delineated contributes little or no value to the overall diversity or vegetation, soils, terrain and wildlife characteristics of the area. Development is encouraged to be focused to these sites before consideration developing higher rated sites of the area. These areas shall not be considered as areas for restoration and enhancement or as recruitment as higher value ESA in offsetting development in other areas.

5.1.1 ESA Criteria.

A complex of factors may contribute to an areas environmental sensitivity rating. Although an exclusive ESA criterion has not been adopted by the RDCO, principle components will be required in evaluating communities/polygons. At a minimum, communities/polygons will be stratified and evaluated in terms of habitat/ecosystem rarity, wildlife habitat suitability, rare and endangered species' occurrence potential, functional condition (i.e., ecological connectivity, level of disturbance, seral stage, structural stage etc.), and fragility.

Stratifying ESAs will be completed from a primarily objective approach relying on existing information and a professional understanding about the functional requisites for respective wildlife, communities, and ecosystems. The specific criteria/rating system developed and used in the evaluation will be appended to the EIA report. Where ESA evaluations require a more subjective approach, a clearly articulated discussion/rationale will be provided (in the report).

5.2 Environmental Impact Mitigation and Enhancement

1. This will depend on the specific Terms of Reference (TOR) for any given project based on the regulatory and policy framework, which required the preparation of an EIA. The TOR will need to specify which impacts are being addressed, and the level or possible mitigation, enhancement and or replacement. These will clearly be based on the facts as based on the assessment (Inventory Phase).

2. Habitat or biological assessments completed to satisfy legal requirements of other levels of government (e.g. Riparian Areas Regulation) may be included within an EIA, but should be identified as to the requirements they are addressing and assessing, and their relationship to any RDCO requirements. This may include:

    a. Recommending environmental works that could mitigate fish, wildlife or environmental impacts, e.g. by providing modifications to development design, footprint, timing, equipment, or providing on/off site habitat or environmental improvements to avoid or minimize adverse impacts.
    b. Providing 'typical' design drawings in addition to text. The intent is to apprise other members of the development team of the technical considerations that need to be incorporated into the design.
    c. Providing improved or new fish, wildlife or environmental enhancement opportunities.
    d. Providing details stating how the works or strategies for mitigation and/or enhancement will be carried out and provide approximate cost estimates (See Bonding).

3. A mitigation or enhancement report is to include an Evaluation of Impacts as follows:
    a. Provide measurable parameters that will help establish whether the development has caused impacts, or that mitigation was actually achieved and successful.
    b. Identify who is accountable for potential impacts that might occur, and who would be responsible for unintended but foreseeable impacts.
    c. Identify who (e.g., agencies, departments, developers and/or personnel) will be responsible for monitoring potential impacts, and propose a monitoring schedule including identifying the expertise of personnel required to perform the monitoring. Provide recommendations for future assessments (procedure / protocol / TOR)
    d. All mitigative, restoration, and compensative prescriptions will include clearly articulated performance standards that are based on the best available science and that reflect the structural and functional objectives of projects.

5.3 Environmental Report and Data Deliverables:

In addition to hard copies provided to the RDCO for review by the Regional Board and relevant Advisory Committees.

a. A digital version (.pdf) of the complete document must also be provided such that all information contained within professional reports are available to the public. It is the intent that digital reports will be posted on the RDCO website and archived.
b. All new and/or updated information (e.g. Rare Element Occurrences and revised TEM polygons and databases) will be provided to appropriate groups and agencies such as the BC Conservation Data Center and the RDCO. All data will be provided in digital format such that it may be incorporated into current works in process such as the Sensitive Habitat Inventory and Mapping (SHIM), and Sensitive Ecosystem Inventory (SEI), both of which are paramount in providing current spatially accurate information used in responsible planning and development.

6.0 WILDFIRE HAZARD ASSESSMENT

1. The assessment must utilize the BC Ministry of Forests supported assessment methodology.
2. The assessment must be prepared by a Registered Professional Forester (RPF) licensed in BC specializing in forest wildfire assessments.
3. The assessment must evaluate the site as it pertains to the land use or subdivision proposed in the application not just the current land use.
4. The assessment of the site for susceptibility to wildfire requires evaluation from conditions both on and off-site including neighbouring lands that may present a wildfire hazard to the site in question.
5. The assessment and subsequent recommendations must consider evaluation of the proposal for wildfire susceptibility, site modification requirements and any requirements for subdivision or home construction.
6. The Wildfire Interface Development Permit Guidelines must be considered. A series of development permit design guidelines have been developed based upon the document "*FireSmart, Protecting Your Community from Wildfire*" supported by the Alberta Department of Sustainable Resource Development, the British Columbia Forest Service, Natural Resources Canada, most Canadian provinces and endorsed by the report of the Province of BC "*2003 Firestorm Provincial Review*".
7. Where a large remainder (e.g. a property greater than 8 hectares) abuts a lot 1 hectare in size or smaller, the wildfire hazard report must include methods for reducing hazard along that property line to "moderate" or less and must address management of the interface.
8. In most cases, the report will be registered as a restrictive covenant against title of the lot prior to subdivision.

7.0 STORMWATER MANAGEMENT AND DRAINAGE PLANS

A stormwater management plan will be required which establishes the hydrology, drainage, and stormwater quality of the subject site under existing conditions, identifies the impacts of the proposed development on these items, and recommends solutions to mitigate and manage these impacts. Several documents are required as part of a stormwater management plan, and may include some or all of the following:

1. A drawing showing the location of existing on and off-site stormwater management system, including natural drainage courses, streams, ponds, springs, etc..
2. A drawing showing the identification of tributary (upstream) drainage areas and major off-site drainage routes;
3. Drawings showing the proposed development layout and stormwater management system(s), including overland emergency drainage routes from all low points on the proposed roads;
4. Copies of consultation with the Ministry of Environment regarding any concerns or background information;
5. A topographical survey of pre-development conditions;
6. A report summarizing the stormwater management concepts, design criteria, and pertinent analyses (see next items);
7. Analyses showing the pre and post-development runoff peak flows and volumes from the critical rainfall events;
8. Analyses of the potential downstream problems (system capacities, erosion, flooding, fish habitat) considering both peak and low flow conditions;

9. A discussion of stormwater quality and drawings showing the location and details of proposed Best Management Practices; and
10. Liaison with a qualified professional to determine fish flow requirements (i.e. low flow and pond requirements.)

It is expected that both potential erosion and flooding will be controlled by way of the stormwater management system, and therefore, the stormwater management plan should also identify areas potentially susceptible to these issues and include recommendations to address possible concerns. It may also be desirable to discharge runoff to ground to reduce downstream impacts and to enhance groundwater recharge. These issues could necessitate a geotechnical study and report prepared by a qualified profession which includes the following:

1. A drawing showing potential flooding and/or erosion locations;
2. An investigation of infiltration capacities and recommended design parameters;
3. An investigation of soil stability under projected conditions, and
4. Recommended works and construction methods to prevent or mitigate potential issues.

8.0 GROUNDWATER MANAGEMENT ASSESSMENTS

Certain sites are subject to groundwater movement. In some areas, natural springs are known to occur. An environmental review of the development site should:

1. Include all available information from previous well drilling;
2. Assess of pre-development groundwater conditions;
3. Identify and map all natural spring locations;
4. Identify existing and potential groundwater recharge/discharge areas;
5. Include recommendations for groundwater management; and
6. Assess, map, and discuss anticipated post-development groundwater conditions.

A hydrogeological assessment will include:

1. An assessment of predevelopment groundwater conditions including identification of natural springs, description of the hydrogeology and vulnerability of aquifers, map of the capture zone, and identification of connections between ground and surface water;
2. Assess the anticipated post development situation with respect to groundwater;
3. Potential contaminants will be identified; and
4. Recommendations for managing contaminant sources will provide direction to future permitted land uses or development designs permitted on the site.

9.0 FLOOD PROTECTION

The foreshore of Okanagan lake as well as other areas within the RDCO such as creeks entering the valley are subject to flooding.

In order to reduce the potential damage that may occur should one of these watercourses overtop their banks, the RDCO and the province of BC have developed appropriate flood protection requirements for various forms of development.

On May 9, 2005, the Regional Board adopted Floodplain Regulations (Schedule N of Bylaw No. 871-96) which generally increases the floodproofing requirements for most forms of development.

1. The underside of any floor system, or the top of any *pad* supporting any space or room, including a *manufactured home*, that is used for dwelling purposes, business, or the storage of goods, which are susceptible to damage by floodwater must be above the applicable *flood construction level* specified herein:

    1.1 The following elevations are specified as *flood construction levels*, except that where more than one *flood construction level* is applicable, the higher elevation shall be the *flood construction level*:

        1.1.1 343.66 metres (1,127.49 ft) Geodetic Survey of Canada datum for land adjacent to Okanagan Lake;
        1.1.2 3.0 metres (9.8 ft) above the *natural boundary* of Mission Creek;
        1.1.3 1.5 metres (4.9 ft) above the *natural boundary* of any other *watercourse*.

    1.2 The specified *flood construction levels* shall not apply to:

        1.2.1 That portion of a *building* or *structure* used exclusively as a carport, garage or entrance foyer;
        1.2.2 Farm *buildings* excluding *dwelling units* and *buildings* for the keeping of animals;
        1.2.3 Hot water tanks and furnaces behind *standard dykes*;
        1.2.4 *Building* for the keeping of animals behind *standard dykes*;
        1.2.5 Heavy industry behind standard dykes; and
        1.2.6 On-loading and off-loading facilities associated with water-oriented industry and portable sawmills;

        Except that all main electrical switchgear for any of the uses listed above shall be no lower than the *flood construction level*.

2 Any landfill required to support a floor system or pad must not extend within any applicable *floodplain setback* specified herein:

    2.1 The following distances are specified as *floodplain setbacks*, except that where more than one *floodplain setback* is applicable, the greater distance shall be the *floodplain setback*:

        2.1.1 15.0 metres (49.2 ft.) from the *natural boundary* of Okanagan Lake;
        2.1.2 7.5 metres (24.6 ft.) from the *natural boundary* of a lake, swamp or pond;
        2.1.3 30.0 metres (98.4 ft.) from the *natural boundary of* Mission Creek;
        2.1.4 15.0 metres (49.2 ft.) from the *natural boundary* of any other nearby *watercourse*;
        2.1.5 7.5 metres (24.6 ft.) from the *natural boundary* of any *standard dyke* right-of-way, or *structure* for flood protection or seepage control.

3 Pursuant to the Local Government Act, and subject to the Provincial regulations or a local government plan or program developed under those regulations; the *Regional District* may exempt types of development from the requirements of *flood construction levels* and *floodplain setbacks* in relation to a specific parcel of land or a

permitted use, *building* or other *structure* on the parcel of land, if the *Regional District* considers it advisable; and

3.1 Considers that the exemption is consistent with the Provincial guidelines; or

3.2 Has received a report that the land may be used safely for the use intended, which report is certified by a person who is:

3.2.1 A professional engineer or geoscientist and experienced in geotechnical engineering and having appropriate errors and omissions and professional liability insurance; or
3.2.2 A person in a class prescribed by the minister charged with the administration of the Environmental Management Act.

4 The granting of the exemption, and the exemption, may be made subject to the terms and conditions that the *Regional District* considers necessary or advisable, including, without limitation:

4.1 Imposing any term or condition contemplated by the Provincial guidelines in relation to an exemption;
4.2 Requiring that a person submit a report described in Section 3.28, Subsection 3.2 above; and
4.3 Requiring that a person enter into a covenant under section 219 of the Land Title Act including a waiver of liability in favour of the Regional District in the event of any damage caused by flooding or erosion.

5 By the enactment, administration or enforcement of this bylaw the *Regional District* of Central Okanagan does not represent to any person that any *building* or *structure*, including a *manufactured home*, located, constructed, sited or used in accordance with the provisions of this bylaw, or in accordance with any advice, information, direction or guidance provided by the *Regional District* of Central Okanagan in the course of the administration of this bylaw will not be damaged by flooding.

10.0 VISUAL QUALITY ASSESSMENTS

1. Visual quality will be integrated into development design through inventory, analysis, interpretation and design conducted by a Landscape Architect.

2. Visual Quality Assessments shall be based on standard methodology such as that applied by Ministry of Forests, Ministry of Transportation, and/or applicable Official Community Plans and Development Permit guidelines.

3. The inventory will include the identification of visual sensitivity units occurring on the property, visual factors, site factors, ecological and management factors. The inventory will provide the basis of visual quality analysis, interpretation and development of design concepts.

4. Concepts are to be presented together with a report on constraints and opportunities, and a plan of implementation for each concept. Concepts must be illustrated in a 3-dimensional format.

5. In the case of a neighbourhood plan, the selected design concept will be included as part of the land use plan. In the case of a Hillside Development Permit Area, the selected design concept will govern subsequent issued development permits.

11.0 TRAFFIC IMPACT AND PEDESTRIAN SAFETY ASSESSMENTS

1. Traffic Impact Assessments must use the Ministry of Transportation supported methodology and trip generation rates (as a minimum). Reference the January 2005 Ministry of Transportation *Site Impact Analysis Study Recommended Terms of Reference.*

2. Pedestrian Safety Assessments must use a methodology supported by the Ministry of Transportation and RDCO and that is recognized by professionals specializing in transportation planning and pedestrian safety.

3. The assessment must be prepared by a professional engineer licensed in BC or a member of the Canadian Institute of Planning, specializing in transportation planning.
4. Regional District staff and, where applicable, Regional Transportation Demand Management, Agricultural Land Commission, and/or Westbank First Nation staff will participate in the *Scope Development Meeting* arranged between Ministry of Transportation and the development proponent.
5. The assessment evaluates the site as it pertains to the land uses or subdivision proposed in the application, not just the current land use, and not just new residential development.
6. The assessment requires evaluation of future conditions from other development approved in the region.
7. The assessment includes all modes of transportation including vehicular, transit, pedestrian and cyclist.
8. The assessment identifies conditions of the site that indicate that standard methodology, design standards, and / or trip generation rates may not apply.
9. The traffic impact study will be based upon the Road Network Plan approved in the RDCO Official Community Plan. Where recommendations indicate an alternate network road, the plan will not be accepted until an amendment to the Official Community Plan is adopted.
10. The assessment and subsequent recommendations must include specific implementation activities that are based on current provincial and regional district regulations (such as latecomer agreements, development cost charges, standard rights of way).

APPENDIX C

PRELIMINARY SITE GRADING PLANS

LEGEND - LAND USE	AREA
STRATA SINGLE FAMILY BASED ON RS-1	3.72 ha. (9.19 ac.)
STRATA SINGLE FAMILY RS-1S	0.85 ha. (2.11 ac.)
STRATA COMMON PROPERTY	1.75 ha. (4.34 ac.)
OPEN SPACE / PARK	0.36 ha. (0.89 ac.)
CONSERVATION CA	19.07 ha. (47.13 ac.)
STRATA ROAD (15m)	0.64 ha. (1.59 ac.)
MOTI ROAD (20m)	0.25 ha. (0.63 ac.)
TOTAL AREA*:	26.53 ha. (65.56 ac.)

OFF-SITE OPEN SPACE

PARCEL (from Regional District ok Okanagan-Similkamen)

* TOTAL AREA DOES NOT INCLUDE OFF-SITE OPEN SPACE IMPROVEMENTS OR DEDICATED ROADS, OR MINISTRY OF TRANSPORTATION and INFRASTRUCTURE (MOTI) RIGHT OF WAY (ROW) FROM CUL-DE-SAC.

LAYOUT ASSUMES STRATA SINGLE FAMILY

LOTS 1-60 BASED ON RS-1 ZONE
MIN LOT AREA 505m² WIDTH 16.0m

LOTS 61-74 RS-1S ZONE
MIN LOT AREA 505m² WIDTH 14.0m

YIELD:

RS-1	59
RS-1S	15
	74

NOTES:
- THIS DRAWING IS FOR PRELIMINARY LAYOUT ONLY, AND SUBJECT TO MUNICIPAL APPROVAL
- THE AREAS AND DIMENSIONS SHOWN ON THE DRAWINGS ARE SUBJECT TO DETAILED SURVEY AND CALCULATIONS, AND MAY VARY.
- THIS DRAWING IS NOT TO BE USED FOR LEGAL TRANSACTIONS

McElhanney
McElhanney Consulting Services Ltd.
13450-102 Ave.
Suite 2300
Surrey BC
Canada V3T 5X3
Tel 604-596 0391

0 1:2500 100

ORIGINAL DWG SIZE: ANSI B (11" x 17")

DRAFT

FOR DISCUSSION ONLY

Infinity Properties Ltd
205 - 6360 202 Street, Langley, BC V2Y1N2

Willow Beach
Development Concept
9330 202 Avenue, Osoyoos, BC
Regional District of Okanagan-Similkameen, BC
June 9, 2020

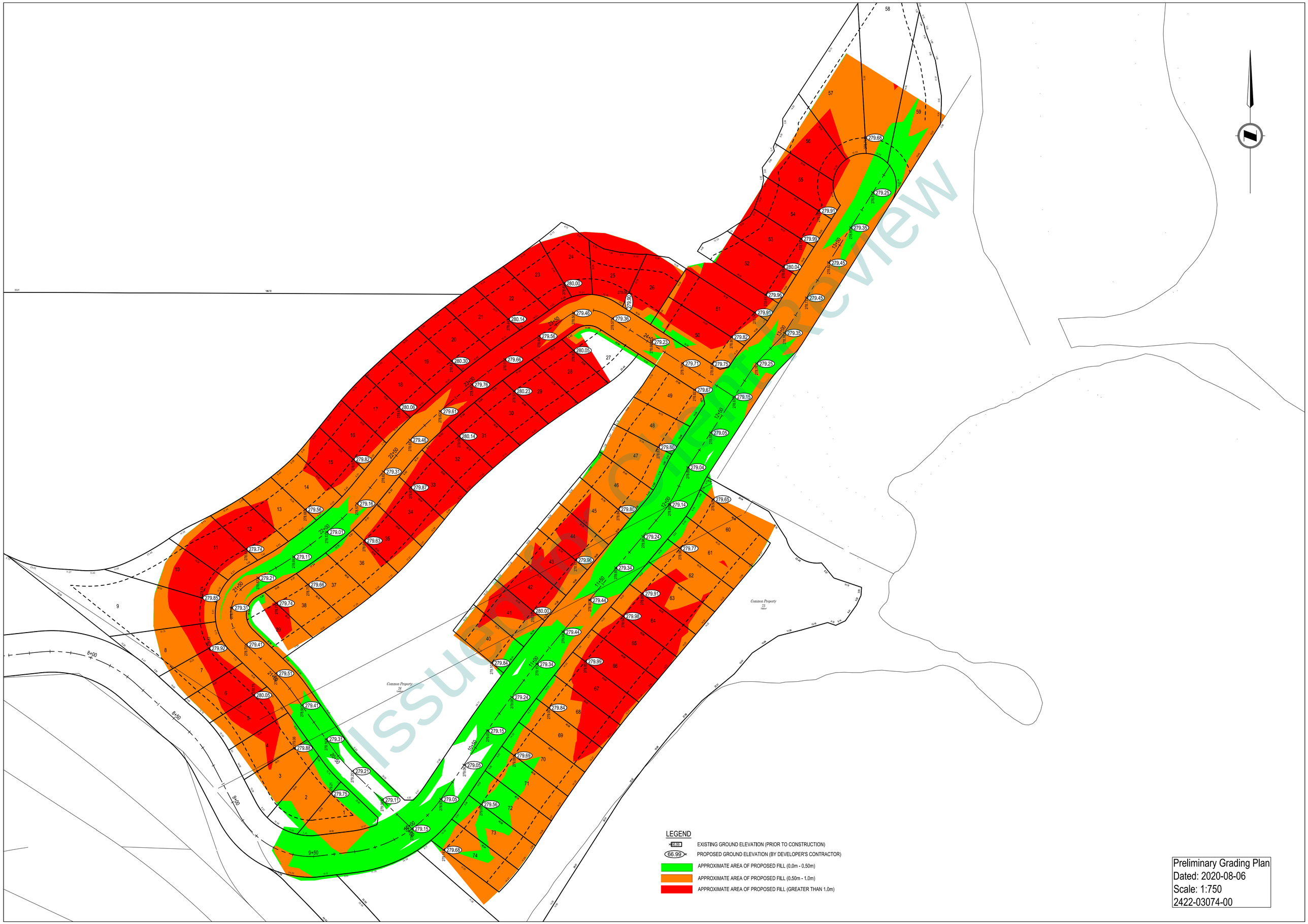
Drawing No.
Sketch 16

Project Number 2422-03074-0
Rev. 1

DESTROY ALL PRINTS BEARING PREVIOUS REVISION

DATE: 2020-06-09, 14:35 FILE: X:\2422\03074-00 - Infinity properties - Willow Beach\2422-03074-00\10.0 PLANNING\Sketches\20-04-20 2422-03074-0 Sketch 16.dwg

McElhanney B - 14-07-22


LEGEND
EXISTING GROUND ELEVATION (PRIOR TO CONSTRUCTION)
PROPOSED GROUND ELEVATION (BY DEVELOPER'S CONTRACTOR)
APPROXIMATE AREA OF PROPOSED FILL (0.0m - 0.50m)
APPROXIMATE AREA OF PROPOSED FILL (0.50m - 1.0m)
APPROXIMATE AREA OF PROPOSED FILL (GREATER THAN 1.0m)
Common Property
Preliminary Grading Plan
Dated: 2020-08-06
Scale: 1:750
2422-03074-00

Project Number: 2422-03074-00
Date: 8/6/2020
Created by: Karm Poonian
Reviewed by: Raymond Sull
Project: Willow Beach Development
Address: 9330 202 Ave, Osoyoos

Flood level construction **280.7** m

All home elevations to be above flood level. The bottom of the floor joist must be at the flood level
Assumed crawl space can be under the flood level

crawl space **1.22** m 4 ft

driveway slope	**6%**
Building Pad slope	**0%**
rear yard slope	**3%**

front yard setback	**7.5**	m
rear yard setback	**7.5**	m

0.45 m

minimum road profile **279.0** m required to ensure bottom of joist are above flood level
minimum front ridgeline **279.5** m required to ensure bottom of joist are above flood level

Cut/Fill Calcs	
	m3
Cut	45
Fill	48,150
Net Fill	**48,105**

Total plan area	57,500	m2
Fill Depth Req.	**0.84**	m

Notes:
1) Did not consider any removal of topsoil
2) Values are based on all roadways and lot grading and **compare top of asphalt surface to existing ground**
3) Extent of cut/fill volume include all lots 1-74 and the fronting roadways
4) Based on planning Sketch 16 Rev 1 dated 2020-06-09
5) Used above mentioned assumption when grading the lots and roadway

General Comments:
1) We are requiring a lot of fill to ensure we are above the flood level
2) To reduce the amount of fill required we can increase the crawl space depth to match existing ground more closely

APPENDIX D

BOREHOLE LOGS

ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB320 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 278.03	COMPLETION DATE: 10/4/2017 GROUND SURFACE ELEV (masl) 278.14 TOP OF RISER ELEV (masl) 279.00 UTM COORDINATES (NAD 1983 11N) Northing 5438947.00 Easting 315136.00	ECOSCAPE Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Wet, black, TOPSOIL, sandy silt and organic matter Wet, dark grey SILT (ML), some sand and trace clay Wet, dark grey SAND (SP), medium grained Moist, dark grey clayey SILT (ML), soft	0 1 2 3 4		Monument Concrete 2-inch ID Schedule 40 PVC riser Sand Bentonite Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-1 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.01 Page 1 of 2 Issued:

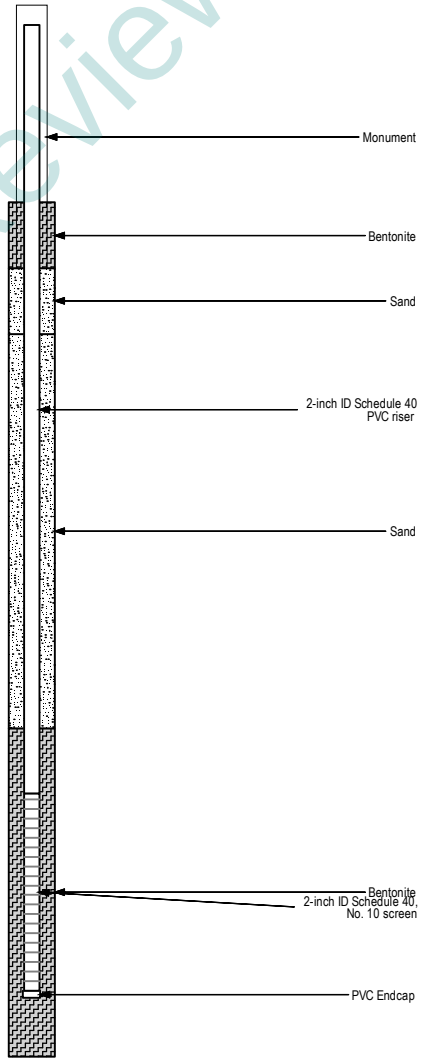
SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Moist, dark grey clayey SILT (ML), soft	5 6 7 8 9 10 11		Bentonite

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-1 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.01 Page 2 of 2 Issued:

ECOSCAPE REP Mike Schutten	COMPLETION DATE: 10/3/2017
DRILLING COMPANY: Mud Bay Drilling	GROUND SURFACE ELEV (masl) 278.20
DRILLING RIG: Sonic DB321	TOP OF RISER ELEV (masl) 279.02
DRILLING METHOD: Hollow Stem Auger	UTM COORDINATES (NAD 1983 11N)
HOLE DIAMETER (CM): 15.0	Northing 5439236.00 Easting 314979.00
WATER ELEVATION (masl): 277.51	

ECOSCAPE
Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE			
Wet, black, TOPSOIL, sandy silt and organic matter	0		
Wet, brown, silty SAND (SM), oxidized at 0.5m depth			
Wet, dark grey silty SAND (SP), fine to medium grained	1		
Wet, dark grey SAND (SP), medium grained	2		
	3		
Wet, dark grey SAND (SM) and silt			
Wet, dark grey SAND (SP), medium grained, some silt	4		



CLIENT:
Infinity Properties Inc.

LOG & RECORD OF WELL CONSTRUCTION MW-2

Baseline Hydrogeological Assessment
Willow Beach, Osoyoos, BC

Ecoscape Job No. 17-2013.02
Page 1 of 1
Issued:

ECOSCAPE REP Mike Schutten	COMPLETION DATE: 10/3/2017	ECOSCAPE Environmental Consultants Ltd.
DRILLING COMPANY: Mud Bay Drilling	GROUND SURFACE ELEV (masl) 278.40	
DRILLING RIG: Sonic DB322	TOP OF RISER ELEV (masl) 279.22	
DRILLING METHOD: Hollow Stem Auger	UTM COORDINATES (NAD 1983 11N)	
HOLE DIAMETER (CM): 15.0	Northing 5439147.00 Easting 315148.00	
WATER ELEVATION (masl): 277.70		

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Wet, black, TOPSOIL, sandy silt and organic matter Wet, dark grey silty SAND (SM), fine to medium grained, some clay Wet, dark grey SAND (SP), medium grained	0 1 2 3 4		Monument Concrete Sand 2-inch ID Schedule 40 PVC riser Bentonite Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap

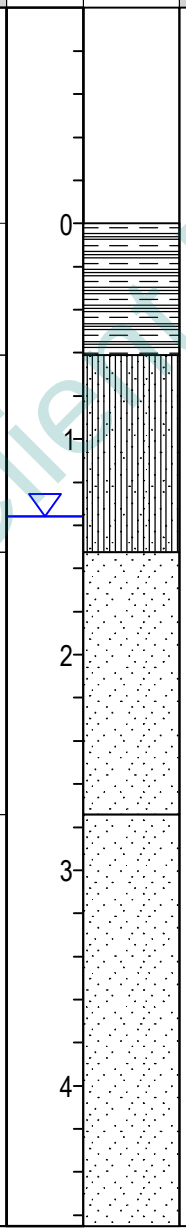
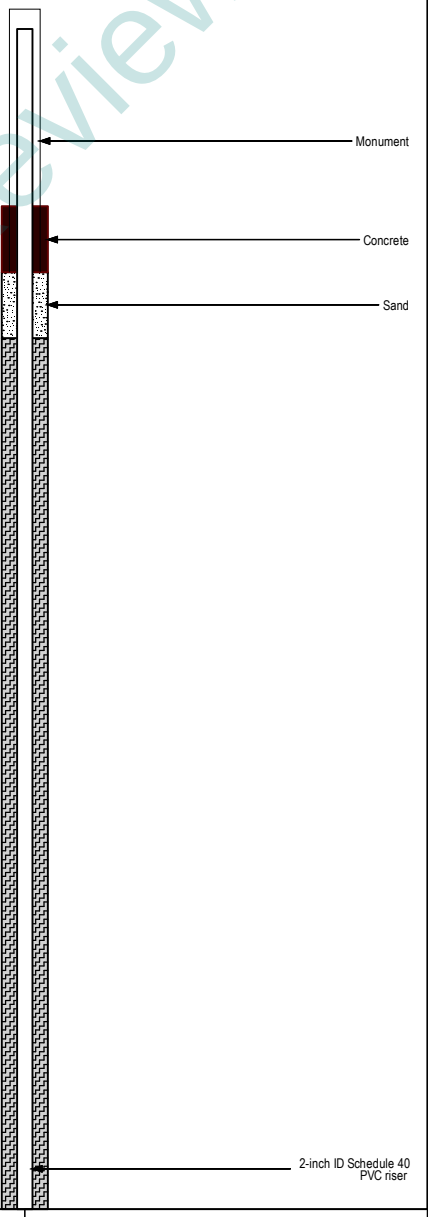
CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-3 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.03 Page 1 of 1 Issued:

ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB323 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 277.67	COMPLETION DATE: 10/3/2017 GROUND SURFACE ELEV (masl) 278.12 TOP OF RISER ELEV (masl) 278.93 UTM COORDINATES (NAD 1983 11N) Northing 5439153.00 Easting 315347.00	ECOSCAPE Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Moist, light grey organic CLAY (OH), mottled, trace rootlets Wet, dark grey silty SAND (SM), some organics Wet, dark grey SAND (SP), fine to medium grained, some silt, scattered woody debris Wet, dark grey SAND (SP), medium grained, woody debris at 5.20 m depth	0 1 2 3 4		Monument Concrete Sand 2-inch ID Schedule 40 PVC riser Bentonite Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-4S Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.04 Page 1 of 1 Issued:

ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB324 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 277.57	COMPLETION DATE: 10/3/2017 GROUND SURFACE ELEV (masl) 278.12 TOP OF RISER ELEV (masl) 278.93 UTM COORDINATES (NAD 1983 11N) Northing 5439153.00 Easting 315351.00	ECOSCAPE Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m) / LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Moist, light grey organic CLAY (OH), mottled, trace rootlets Wet, dark grey silty SAND (SM), some organics Wet, dark grey SAND (SP), fine to medium grained, some silt, scattered woody debris Wet, dark grey SAND (SP), medium grained, woody debris at 5.20 m depth		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-4D Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.05 Page 1 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey SAND (SP), medium grained, woody debris at 5.20 m depth	5		Bentonite
	6		
	7		
Wet, dark grey SAND (SP) coarse grained	8		
Wet, dark grey SAND (SP), fine to medium grained	9		
	10		Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap
	11		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-4D Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.05 Page 2 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey SAND (SP), fine to medium grained	12		
	13		
	14		
Black PEAT (PT)			
Wet, dark grey SAND (SP), fine to medium grained	15		
Moist to wet, dark grey SAND (SM) and silt	16		
Moist to wet, dark grey SAND (SP), medium grained	17		
	18		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-4D Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.05 Page 3 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Moist to wet, dark grey SAND (SP), medium grained	19		
Moist to wet, dark grey silty SAND (SM), woody debris scattered throughout	20		
Moist, dark grey clayey SAND (SC), moderately stiff			
Moist to wet, dark grey silty SAND (SM)	21		Bentonite
Moist to wet, dark grey sandy SILT (ML), woody debris at 22.8 m depth	22		
	23		
Moist to wet, dark grey clayey SILT (ML), some fine grained sand	24		
	25		

CLIENT:

Infinity Properties Inc.

LOG & RECORD OF WELL CONSTRUCTION MW-4D

Baseline Hydrogeological Assessment
Willow Beach, Osoyoos, BC

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey clayey SILT (ML), trace gravel	26		
	27		
Wet, dark grey clayey SILT(ML)	28		
	29		
	30		
	31		
	32		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-4D Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.05 Page 5 of 5 Issued:

ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB325 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 277.71	COMPLETION DATE: 10/2/2017 GROUND SURFACE ELEV (masl) 278.20 TOP OF RISER ELEV (masl) 278.99 UTM COORDINATES (NAD 1983 11N) Northing 5439131.00 Easting 315608.00	ECOSCAPE Environmental Consultants Ltd.

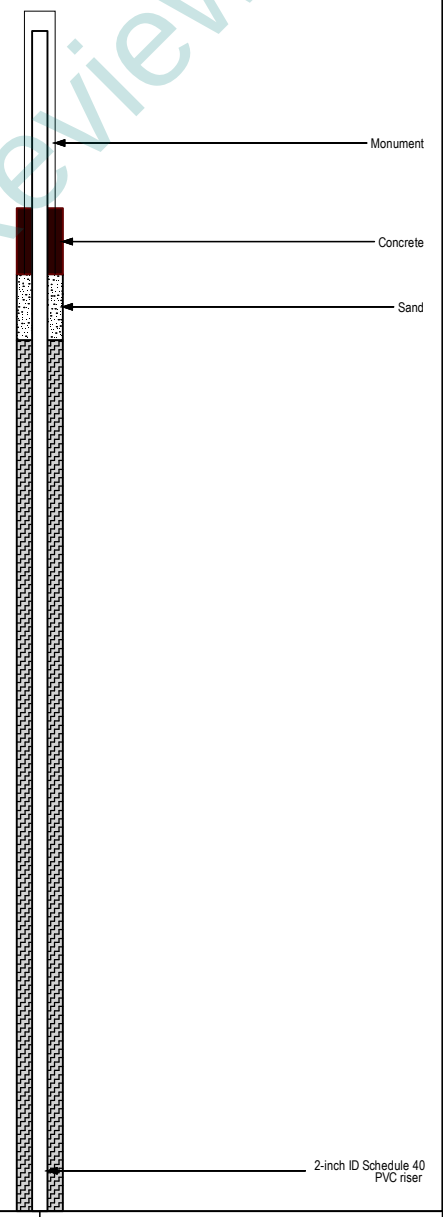
SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Moist, brown and grey FILL, intermixed sand, silt, clay and organics, mottled Moist to wet, dark grey, silty CLAY (CL), stiff Black PEAT (PT) Wet, dark grey SAND (SP), medium grained	0 1 2 3 4		Monument Concrete Sand 2-inch ID Schedule 40 PVC riser Bentonite Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-5S Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.06 Page 1 of 1 Issued:

ECOSCAPE REP Mike Schutten	COMPLETION DATE: 10/2/2017
DRILLING COMPANY: Mud Bay Drilling	GROUND SURFACE ELEV (masl) 278.20
DRILLING RIG: Sonic DB326	TOP OF RISER ELEV (masl) 279.01
DRILLING METHOD: Hollow Stem Auger	UTM COORDINATES (NAD 1983 11N)
HOLE DIAMETER (CM): 15.0	Northing 5439128.00 Easting 315611.00
WATER ELEVATION (masl): 277.61	

ECOSCAPE
Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE			
Moist, brown and grey FILL, intermixed sand, silt, clay and organics, mottled	0		
Moist to wet, dark grey, silty CLAY (CL), stiff	1		
Black PEAT (PT)			
Wet, dark grey SAND (SP), medium grained	2		
	3		
	4		



CLIENT:
Infinity Properties Inc.

LOG & RECORD OF WELL CONSTRUCTION MW-5D

Baseline Hydrogeological Assessment
Willow Beach, Osoyoos, BC

Ecoscape Job No. 17-2013.07

Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey SAND (SP), medium grained			
Moist to wet, dark grey SILT (ML), some sand and clay, moderately stiff	5		Bentonite
Wet, dark grey SAND (SP), medium grained	6		
	7		
Wet, dark grey silty SAND (SM), fine grained			
Wet, dark grey SAND (SP) medium grained	8		
	9		
	10		Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap
	11		
Wet, dark grey silty SAND (SM), fine grained, woody debris at 11.6 m depth			

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-5D Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.07 Page 2 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey silty SAND (SM), fine grained, woody debris at 11.6 m depth			
Wet, dark grey SAND (SP), medium grained	12		
Wet, dark grey silty SAND (SM), fine to medium grained	13		
Wet, dark grey SAND (SP), fine to medium grained, trace silt	14		
Wet, dark grey SAND (SP), fine to medium grained	15		
Wet, dark grey SAND (SP), fine to medium grained, some silt	16		
	17		
	18		
Moist to wet, dark grey SILT (ML), some sand and clay, moderately stiff			

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-5D Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.07 Page 3 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Moist to wet, dark grey SILT (ML), some sand and clay, moderately stiff	19		
Wet, dark grey SAND (SP), fine to medium grained	20		Bentonite
	21		
	22		
Wet, dark grey SAND (SM) and silt, woody debris throughout	23		
Wet, dark grey SAND (SP), fine grained, some silt	24		
Wet, dark grey, silty SAND (SM), fine grained, woody debris at 26.7 m depth	25		

CLIENT:

Infinity Properties Inc.

LOG & RECORD OF WELL CONSTRUCTION MW-5D

Baseline Hydrogeological Assessment
Willow Beach, Osoyoos, BC

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey, silty SAND (SM), fine grained, woody debris at 26.7 m depth	26		
Wet, dark grey SAND (SP), medium grained	27		
Wet, dark grey silty SAND (SM), fine grained	28		
Wet, dark grey SAND (SP), fine to medium grained	29		
Wet, dark grey silty SAND (SM), fine grained	30		
Wet, dark grey SAND (SP), fine to medium grained	31		
	32		

CLIENT:

Infinity Properties Inc.

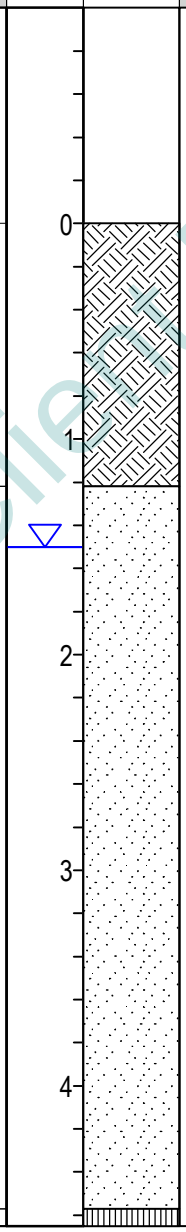
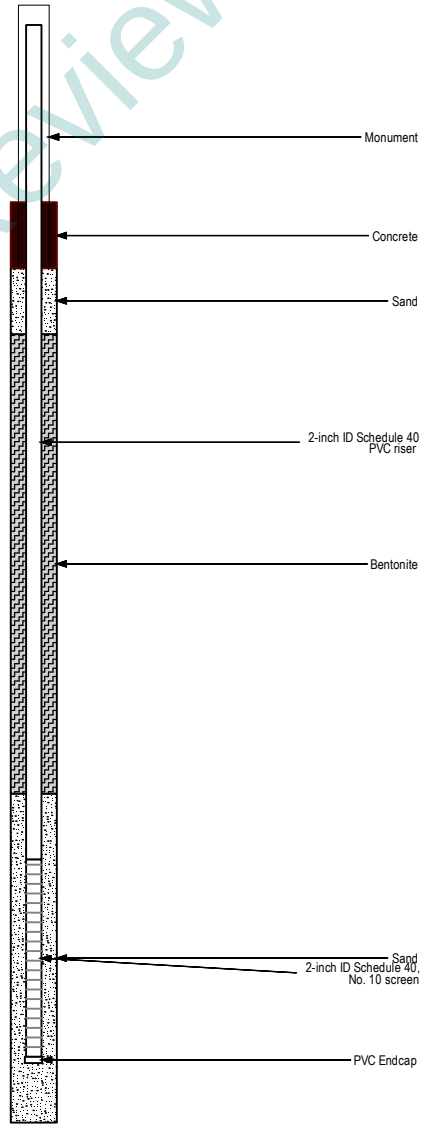
LOG & RECORD OF WELL CONSTRUCTION MW-5D

Baseline Hydrogeological Assessment
Willow Beach, Osoyoos, BC

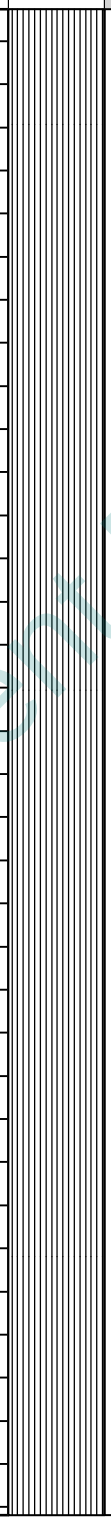
Ecoscape Job No. 17-2013.07

Issued:

ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB327 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 277.40	COMPLETION DATE: 10/2/2017 GROUND SURFACE ELEV (masl) 278.07 TOP OF RISER ELEV (masl) 278.90 UTM COORDINATES (NAD 1983 11N) Northing 5439009.00 Easting 315411.00	ECOSCAPE Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m) / LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Moist, brown sand and gravel (FILL) Wet, dark grey SAND (SP), medium grained, trace silt		

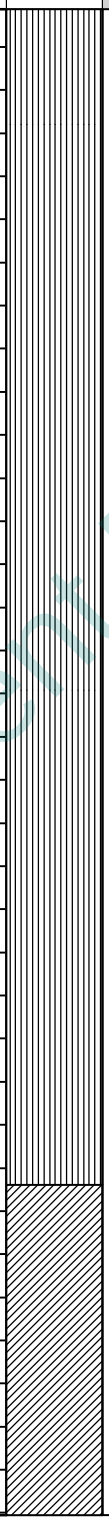
CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-6 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.08 Page 1 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey SILT (ML) and clay, trace fine grained sand	5 6 7 8 9 10 11		

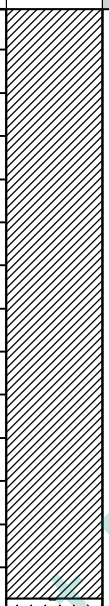
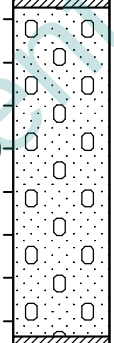
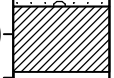
CLIENT:	LOG & RECORD OF WELL CONSTRUCTION MW-6	Ecoscape Job No. 17-2013.08
Infinity Properties Inc.	Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Page 2 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey SILT (ML) and clay, trace fine grained sand	12		
	13		
	14		
Wet, dark grey SILT (ML) and clay	15		
	16		
	17		
	18		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-6 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.08 Page 3 of 5 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey SILT (ML) and clay	19 20 21 22 23 24		
Wet, dark grey silty CLAY (CL)	25		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-6 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.08 Page 4 of 5 Issued:

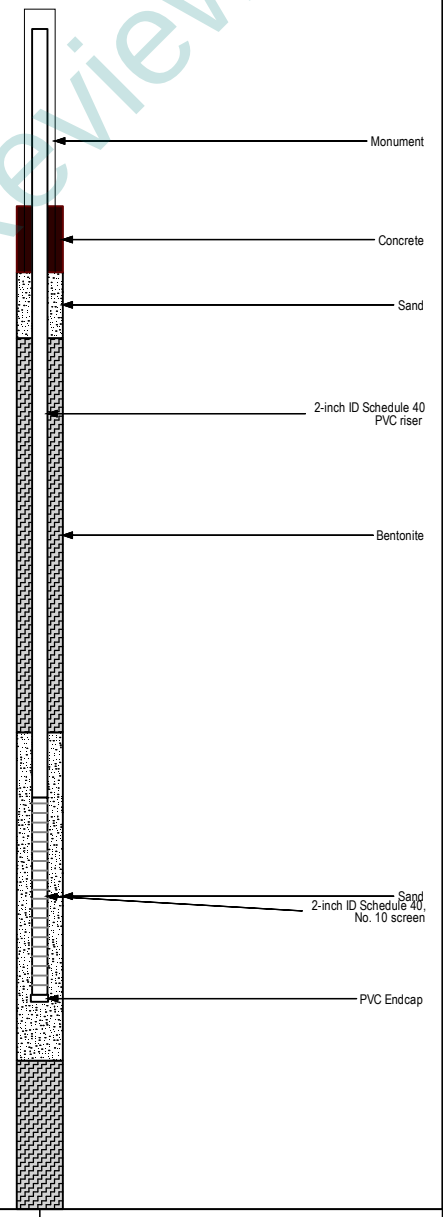
SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey silty CLAY (CL)	26		
	27		
	28		
Wet, dark grey GRAVEL (GW) and sand	29		
Wet, dark grey silty CLAY (CL)	30		
	31		
	32		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-6 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.08 Page 5 of 5 Issued:

ECOSCAPE REP Mike Schutten	COMPLETION DATE: 10/3/2017
DRILLING COMPANY: Mud Bay Drilling	GROUND SURFACE ELEV (masl) 280.00
DRILLING RIG: Sonic DB328	TOP OF RISER ELEV (masl) 280.96
DRILLING METHOD: Hollow Stem Auger	UTM COORDINATES (NAD 1983 11N)
HOLE DIAMETER (CM): 15.0	Northing 5438904.00 Easting 315570.00
WATER ELEVATION (masl): 278.90	

ECOSCAPE
Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE			
Moist, brown TOPSOIL, silty sand and organic matter	0		
Moist to wet, light brown SAND (SP), medium grained	1		
	2		
Wet, dark grey SAND (SP), medium grained	3		
Wet, dark grey SAND (SP), fine grained, some silt	4		
Black PEAT (PT)			



CLIENT:
Infinity Properties Inc.

LOG & RECORD OF WELL CONSTRUCTION MW-7

Baseline Hydrogeological Assessment
Willow Beach, Osoyoos, BC

Ecoscape Job No. 17-2013.09

Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey sandy SILT (ML)	5		
Wet, dark grey SILT (ML), some sand, decreasing with depth, woody debris at 7.0 m depth	6		
	7		
	8		Bentonite
	9		
	10		
	11		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-7 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.09 Page 2 of 2 Issued:

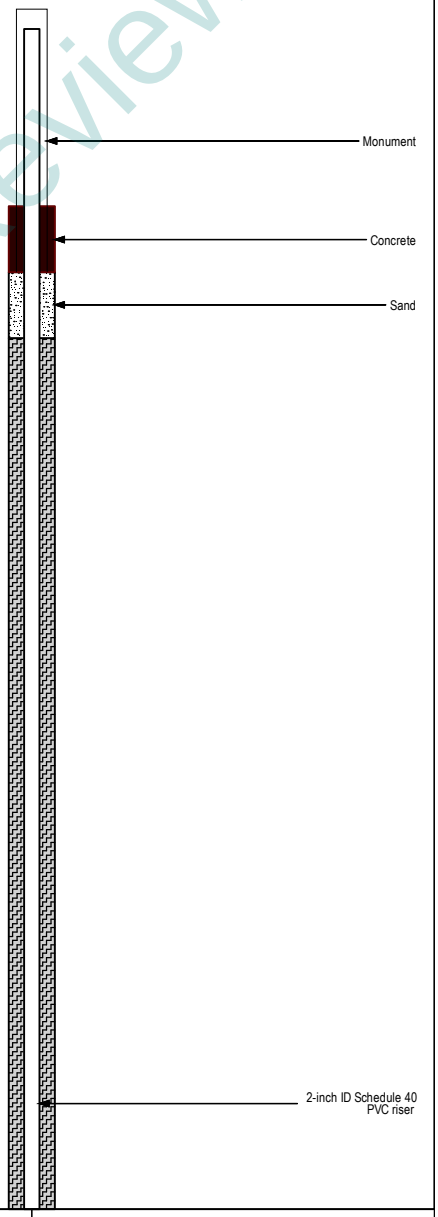
ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB329 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 278.13	COMPLETION DATE: 10/2/2017 GROUND SURFACE ELEV (masl) 278.75 TOP OF RISER ELEV (masl) 279.55 UTM COORDINATES (NAD 1983 11N) Northing 5438854.00 Easting 315245.00	ECOSCAPE Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Moist, brown TOPSOIL, silty sand and organic matter Moist to wet, grey GRAVEL (GW), some sand Wet, grey GRAVEL (GW) and coarse grained sand Wet, grey SAND (SW), coarse grained, some gravel Wet, grey GRAVEL (GW) and coarse grained sand Wet, dark grey SAND (SP), medium grained, some silt Wet, grey GRAVEL (GW) and coarse grained sand	0 1 2 3 4		Monument Concrete Sand 2-inch ID Schedule 40 PVC riser Bentonite Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-8S Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.10 Page 1 of 1 Issued:

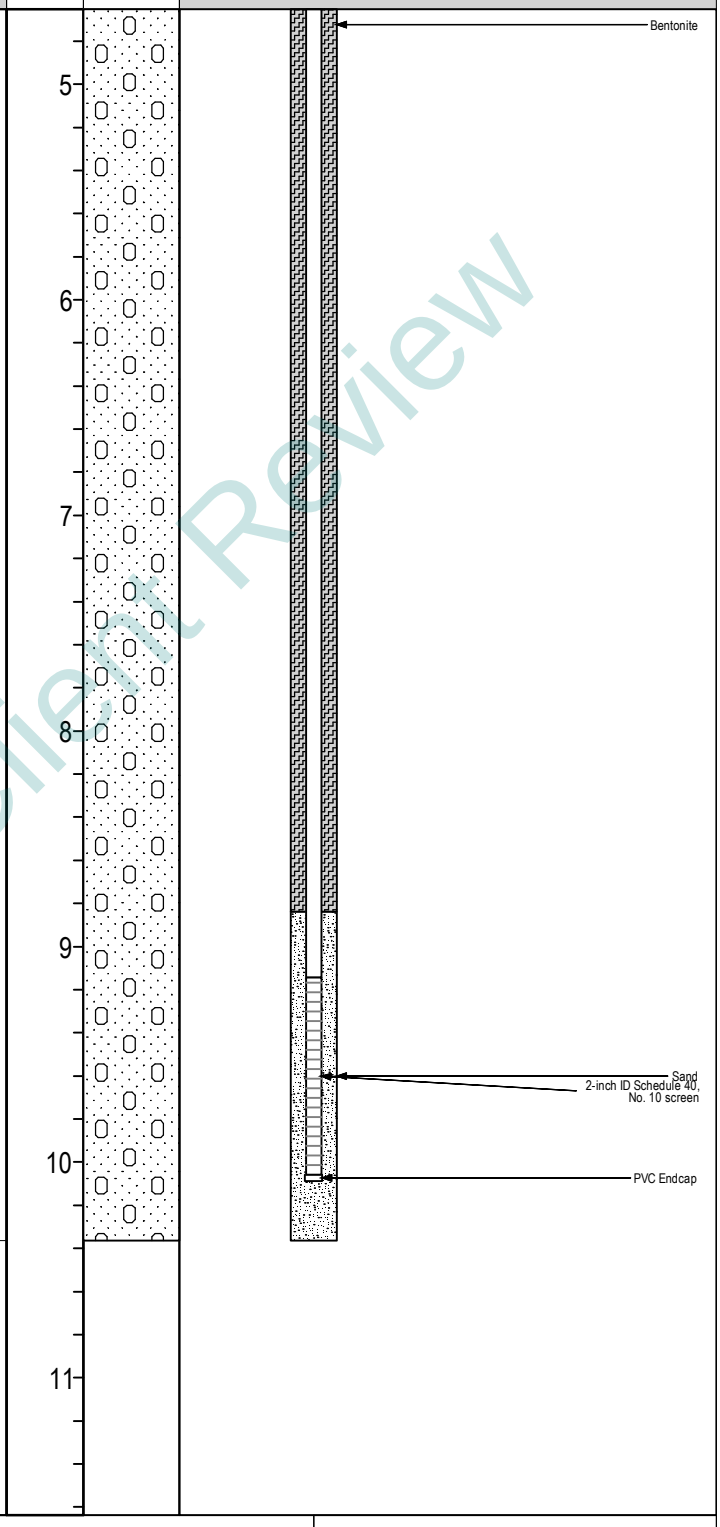
ECOSCAPE REP Mike Schutten	COMPLETION DATE: 10/4/2017	ECOSCAPE Environmental Consultants Ltd.
DRILLING COMPANY: Mud Bay Drilling	GROUND SURFACE ELEV (masl) 278.75	
DRILLING RIG: Sonic DB330	TOP OF RISER ELEV (masl) 279.55	
DRILLING METHOD: Hollow Stem Auger	UTM COORDINATES (NAD 1983 11N)	
HOLE DIAMETER (CM): 15.0	Northing 5438857.00 Easting 315247.00	
WATER ELEVATION (masl): 278.12		

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE			
Moist, brown TOPSOIL, silty sand and organic matter	0		
Moist to wet, grey GRAVEL (GW), some sand	1		
Wet, grey GRAVEL (GW) and coarse grained sand	2		
Wet, grey SAND (SW), coarse grained, some gravel	3		
Wet, grey GRAVEL (GW) and coarse grained sand			
Wet, dark grey SAND (SP), medium grained, some silt			
Wet, grey GRAVEL (GW) and coarse grained sand	4		



CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-8D Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.11 Page 1 of 2 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, grey GRAVEL (GW) and coarse grained sand			

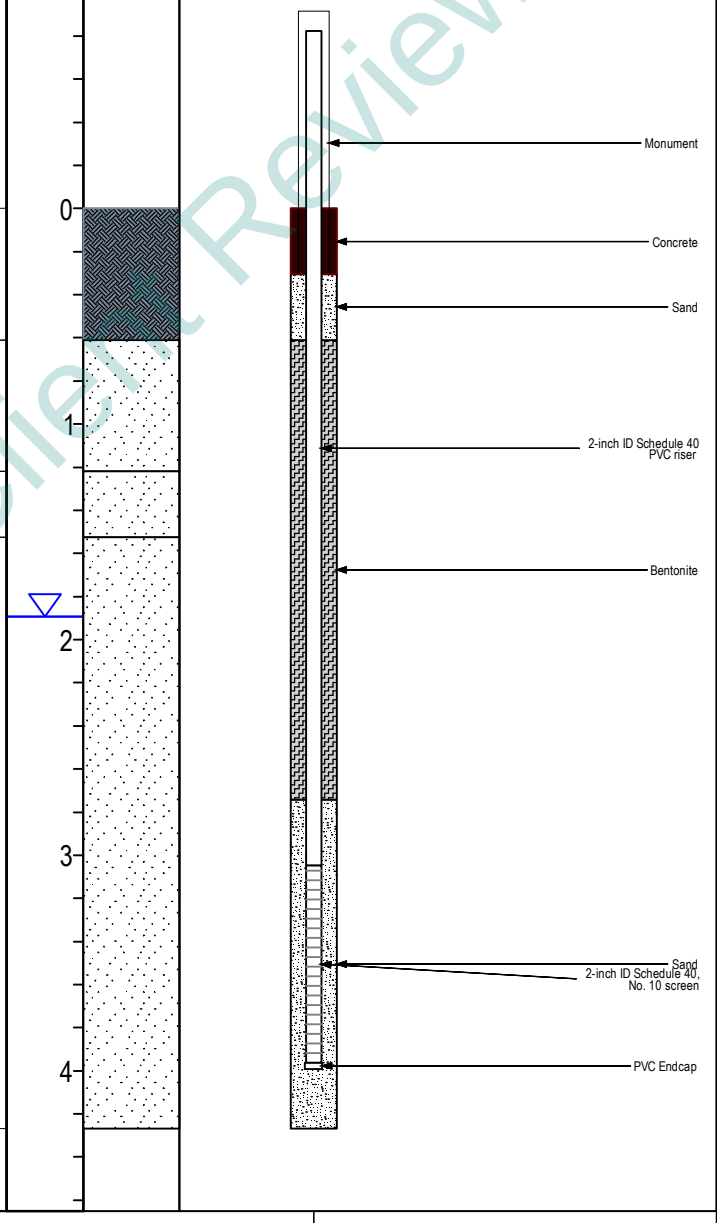


CLIENT:	LOG & RECORD OF WELL CONSTRUCTION MW-8D	Ecoscape Job No. 17-2013.11
Infinity Properties Inc.	Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Page 2 of 2 Issued:

ECOSCAPE REP Mike Schutten	COMPLETION DATE: 10/3/2017
DRILLING COMPANY: Mud Bay Drilling	GROUND SURFACE ELEV (masl) 280.00
DRILLING RIG: Sonic DB331	TOP OF RISER ELEV (masl) 280.82
DRILLING METHOD: Hollow Stem Auger	UTM COORDINATES (NAD 1983 11N)
HOLE DIAMETER (CM): 15.0	Northing 5438751.00 Easting 315423.00
WATER ELEVATION (masl): 278.93	

ECOSCAPE
Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE			
Dry to moist, dark brown TOPSOIL, silty sand, medium grained, organic matter	0		
Moist to wet, brown SAND (SP), medium grained, mottled	1		
Wet, light grey SAND (SP), medium grained, some silt			
Wet, dark grey SAND (SP), medium grained	2		
	3		
	4		



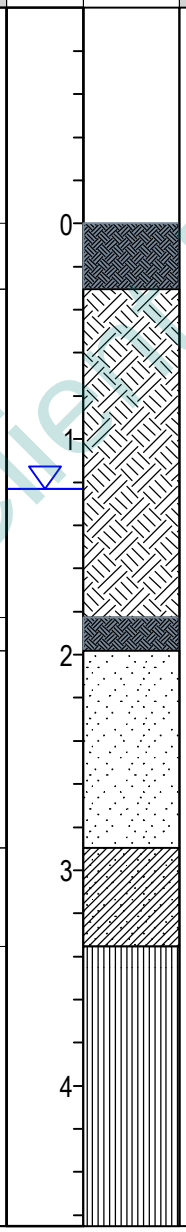
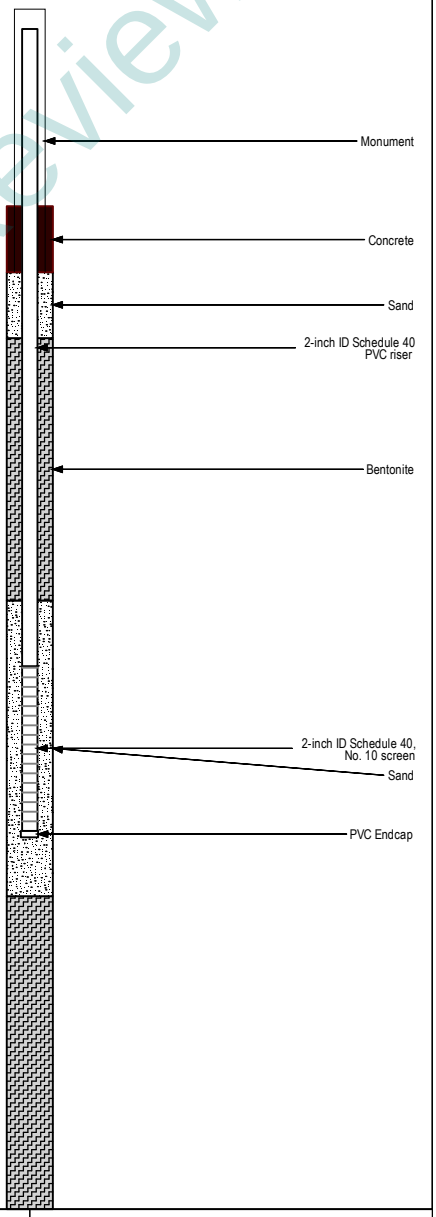
CLIENT:
Infinity Properties Inc.

LOG & RECORD OF WELL CONSTRUCTION MW-9

Baseline Hydrogeological Assessment
Willow Beach, Osoyoos, BC

Ecoscape Job No. 17-2013.12
Page 1 of 1
Issued:

ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB332 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 277.74	COMPLETION DATE: 10/4/2017 GROUND SURFACE ELEV (masl) 278.15 TOP OF RISER ELEV (masl) 278.97 UTM COORDINATES (NAD 1983 11N) Northing 5439006.00 Easting 315200.00	ECOSCAPE Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m) / LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Wet, black, TOPSOIL, sandy silt and organic matter Wet, grey FILL, intermixed sand, silt and organic matter Wet, black buried TOPSOIL Wet, dark grey SAND (SP), medium grained Wet, dark grey clayey SAND (SC), some silt Wet, dark grey clayey SILT (ML)		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-10 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.13 Page 1 of 3 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey clayey SILT (ML)	5 6 7 8 9 10 11		Bentonite

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-10 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.13 Page 2 of 3 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Wet, dark grey clayey SILT (ML)	12 13 14 15 16 17 18		

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-10 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.13 Page 3 of 3 Issued:

ECOSCAPE REP Mike Schutten DRILLING COMPANY: Mud Bay Drilling DRILLING RIG: Sonic DB333 DRILLING METHOD: Hollow Stem Auger HOLE DIAMETER (CM): 15.0 WATER ELEVATION (masl): 277.78	COMPLETION DATE: 10/4/2017 GROUND SURFACE ELEV (masl) 278.12 TOP OF RISER ELEV (masl) 278.97 UTM COORDINATES (NAD 1983 11N) Northing 5439080.00 Easting 315008.00	ECOSCAPE Environmental Consultants Ltd.

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
GROUND SURFACE Wet, black TOPSOIL, silt, clay and organic matter Wet, light grey clayey SILT (ML), stiff, mottled Wet, dark grey SAND (SP), fine grained, some silt Wet, dark grey SAND (SP), medium grained Wet, dark grey SAND (SP), fine grained Wet, dark grey SAND (SP), fine grained, some silt Moist to wet, dark grey clayey SILT (ML), organic material from 5.0 to 6.0 m depth	0 1 2 3 4		Monument Concrete Sand 2-inch ID Schedule 40 PVC riser Bentonite Sand 2-inch ID Schedule 40, No. 10 screen PVC Endcap

CLIENT: Infinity Properties Inc.	LOG & RECORD OF WELL CONSTRUCTION MW-11 Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Ecoscape Job No. 17-2013.14 Page 1 of 2 Issued:

SOIL DESCRIPTION	DEPTH (m)	LITHOLOGY	WELL CONSTRUCTION
Moist to wet, dark grey clayey SILT (ML), organic material from 5.0 to 6.0 m depth	5 6 7 8 9 10 11		

CLIENT:	LOG & RECORD OF WELL CONSTRUCTION MW-11	Ecoscape Job No. 17-2013.14
Infinity Properties Inc.	Baseline Hydrogeological Assessment Willow Beach, Osoyoos, BC	Page 2 of 2 Issued:

APPENDIX E

GROUNDWATER LEVEL TABLES

Willow Beach Water Level Database

Well ID	Logger Serial Number	Riser Geodetic Elevation (masl)	Ground Surface Geodetic Elecation	Depth to Bottom (mbtr)	Stickup (m)	Depth to Well Bottom below Surface (mbgs)	Screen Length (m)	Top of Screen (mbtr)
P1	20183748	279.159	-	2.46	-	-	-	-
SW1	20183750	278.809	-	1.70	-	-	-	-
P2	20183753	278.933	-	2.85	-	-	-	-
SW2	20183749	278.906	-	1.90	-	-	-	-
P3	20196491	279.007	-	2.87	-	-	-	-
SW3	20196520	278.957	-	2.09	-	-	-	-
P4	20183752	279.450	-	3.39	-	-	-	-
SW4	20183751	279.425	-	2.20	-	-	-	-
P5	20196519	279.132	-	3.03	-	-	-	-
SW5	20196493	278.964	-	1.85	-	-	-	-
TW07-2	20196404	278.982	-	19.36	-	-	-	-
TW07-3	20196403	279.178	-	29.35	-	-	-	-
TW07-5	20196400	279.268	-	9.96	-	-	-	-
MW-1	20158216	278.912	278.05	2.97	0.86	2.11	0.46	2.51
MW-2	20183494	279.304	278.48	4.45	0.82	3.63	0.91	3.54
MW-3	20158214	279.278	278.46	4.50	0.82	3.68	0.91	3.59
MW-4S	20183493	278.989	278.18	4.80	0.81	3.99	0.91	3.89
MW-4D	20196399	279.021	278.21	11.69	0.81	10.88	0.91	10.78
MW-5S	20183491	279.000	278.21	4.95	0.79	4.16	0.91	4.04
MW-5D	20196397	279.036	278.23	11.68	0.81	10.87	0.91	10.77
MW-6	20183452	279.188	278.36	4.87	0.83	4.04	0.91	3.96
MW-7	20183495	279.816	278.86	4.68	0.96	3.72	0.91	3.77
MW-8S	20183451	279.507	278.71	4.59	0.80	3.79	0.91	3.68
MW-8D	20196398	279.554	278.75	11.05	0.80	10.25	0.91	10.14
MW-9	20183453	279.813	278.99	4.60	0.82	3.78	0.91	3.69
MW-10	20183490	279.049	278.23	3.76	0.82	2.94	0.76	3.00
MW-11	20183492	279.050	278.20	4.43	0.85	3.58	0.91	3.52

Depth to Water Below Top of Riser (mbtr)

Well ID	6-Sep-16	3-Oct-17	4-Oct-17	21-Nov-17	7-Mar-18	14-Mar-18	29-Nov-18	21-Mar-19	22-May-19	1-Nov-19	22-Apr-20
P1	1.15	-	-	1.26	-	1.08	1.27	1.41	1.32	1.32	1.33
SW1	0.79	-	-	0.91	-	0.62	0.87	0.80	0.90	0.86	0.90
P2	1.74	-	-	1.29	-	1.37	1.33	1.47	1.07	1.19	1.25
SW2	0.96	-	-	1.23	-	1.25	1.22	1.37	1.01	1.03	1.16
P3	1.07	-	-	1.40	-	1.33	1.48	1.64	1.23	1.37	1.50
SW3	1.01	-	-	1.34	-	1.15	1.32	1.46	1.11	1.17	1.35
P4	2.59	-	-	1.84	-	1.87	1.88	1.95	1.59	1.74	1.79
SW4	1.49	-	-	1.80	-	1.82	1.92	1.96	1.58	1.65	1.76
P5	1.98	-	-	1.55	-	1.59	1.68	1.75	1.32	damaged	damaged
SW5	1.10	-	-	1.41	-	1.37	1.51	1.53	1.12	damaged	damaged
TW07-2	0.30	-	0.60	0.58	0.56	-	0.62	0.65	0.55	0.61	0.61
TW07-3	0.43	-	-	0.74	0.71	-	0.76	0.79	0.66	0.74	0.73
TW07-5	1.04	-	1.20	1.29	1.33	-	1.39	1.42	1.17	1.29	1.29
MW-1	-	-	0.97	0.88	-	0.77	0.95	1.07	1.19	1.03	1.17
MW-2	-	-	1.51	1.54	1.43	-	1.60	1.53	1.47	1.52	1.50
MW-3	-	-	1.52	1.58	1.52	-	1.67	1.61	1.36	1.52	1.51
MW-4S	-	-	1.26	1.40	1.40	-	1.47	1.45	1.10	1.26	1.23
MW-4D	-	-	1.36	1.49	1.49	-	0.77	1.22	1.24	1.10	1.33
MW-5S	-	1.28	-	1.43	1.46	-	1.51	1.46	1.12	1.28	1.27
MW-5D	-	1.40	-	1.55	1.53	-	1.54	0.80	0.87	0.98	1.17
MW-6	-	1.50	-	1.44	1.44	-	1.53	1.54	1.38	1.39	1.48
MW-7	-	-	2.06	2.18	2.26	-	2.23	2.30	1.93	2.06	2.14
MW-8S	-	1.42	-	1.51	1.52	-	1.59	1.63	1.40	1.52	1.52
MW-8D	-	-	1.43	1.52	1.53	-	1.60	1.64	1.42	1.53	1.54
MW-9	-	-	1.89	1.99	2.08	-	2.01	2.11	1.84	1.62	1.98
MW-10	-	-	1.19	1.07	0.94	-	1.12	1.07	1.29	1.18	1.27
MW-11	-	-	1.19	1.13	0.94	-	1.16	1.07	1.24	1.18	1.20

Depth to Water Below Ground (mbgs)

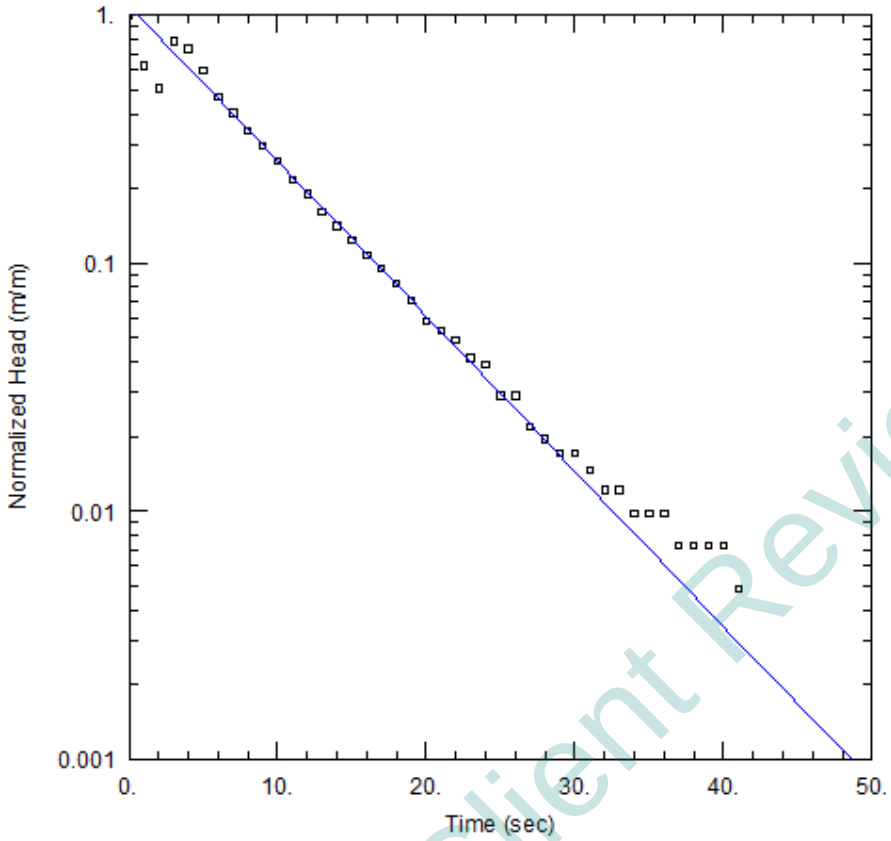
Well ID	6-Sep-16	3-Oct-17	4-Oct-17	21-Nov-17	7-Mar-18	14-Mar-18	29-Nov-18	21-Mar-19	22-May-19	1-Nov-19	22-Apr-20
MW-1	-	-	0.11	0.02	-	-0.09	0.09	0.21	0.33	0.17	0.31
MW-2	-	-	0.69	0.72	0.61	-	0.78	0.71	0.65	0.70	0.68
MW-3	-	-	0.70	0.76	0.70	-	0.85	0.79	0.54	0.70	0.69
MW-4S	-	-	0.45	0.59	0.59	-	0.66	0.64	0.29	0.45	0.42
MW-4D	-	-	0.55	0.68	0.68	-	-0.04	0.41	0.43	0.29	0.52
MW-5S	-	0.49	-	0.64	0.67	-	0.72	0.67	0.33	0.49	0.48
MW-5D	-	0.59	-	0.74	0.72	-	0.73	-0.02	0.06	0.17	0.36
MW-6	-	0.67	-	0.61	0.61	-	0.70	0.71	0.55	0.56	0.65
MW-7	-	-	1.10	1.22	1.30	-	1.27	1.34	0.97	1.10	1.18
MW-8S	-	0.62	-	0.71	0.72	-	0.79	0.83	0.60	0.72	0.72
MW-8D	-	-	0.63	0.72	0.73	-	0.80	0.84	0.62	0.73	0.74
MW-9	-	-	1.07	1.17	1.26	-	1.19	1.29	1.02	0.80	1.16
MW-10	-	-	0.37	0.25	0.12	-	0.30	0.25	0.47	0.36	0.45
MW-11	-	-	0.34	0.28	0.09	-	0.31	0.22	0.39	0.33	0.35

Geodetic Groundwater and Surface Water Elevation (mbgs)

Well ID	6-Sep-16	3-Oct-17	4-Oct-17	21-Nov-17	7-Mar-18	14-Mar-18	29-Nov-18	21-Mar-19	22-May-19	1-Nov-19	22-Apr-20
P1	278.01	-	-	277.90	-	278.08	277.89	277.75	277.84	277.84	277.83
SW1	278.02	-	-	277.90	-	278.19	277.94	278.01	277.91	277.95	277.91
P2	277.19	-	-	277.64	-	277.56	277.60	277.47	277.87	277.74	277.68
PW2	277.95	-	-	277.68	-	277.66	277.68	277.54	277.89	277.87	277.75
P3	277.94	-	-	277.61	-	277.68	277.53	277.36	277.78	277.64	277.50
SW3	277.95	-	-	277.62	-	277.81	277.64	277.50	277.85	277.79	277.61
P4	276.86	-	-	277.61	-	277.59	277.57	277.50	277.87	277.71	277.66
SW4	277.93	-	-	277.63	-	277.60	277.51	277.47	277.84	277.77	277.67
P5	277.15	-	-	277.58	-	277.54	277.46	277.38	277.81	-	-
SW5	277.87	-	-	277.55	-	277.60	277.46	277.44	277.85	-	-
TW07-2	278.68	-	278.38	278.40	278.43	-	278.37	278.34	278.44	278.37	278.37
TW07-3	278.75	-	-	278.44	278.47	-	278.42	278.39	278.52	278.44	278.45
TW07-5	278.23	-	278.07	277.98	277.94	-	277.88	277.85	278.10	277.98	277.98
MW-1	-	-	277.94	278.03	-	278.14	277.96	277.84	277.72	277.88	277.74
MW-2	-	-	277.80	277.77	277.87	-	277.70	277.78	277.83	277.79	277.80
MW-3	-	-	277.76	277.69	277.75	-	277.61	277.67	277.92	277.76	277.76
MW-4S	-	-	277.73	277.59	277.59	-	277.52	277.54	277.89	277.73	277.76
MW-4D	-	-	277.66	277.53	277.53	-	278.25	277.80	277.79	277.92	277.69
MW-5S	-	277.72	-	277.57	277.54	-	277.49	277.54	277.88	277.72	277.73
MW-5D	-	277.63	-	277.49	277.51	-	277.50	278.24	278.17	278.06	277.87
MW-6	-	277.69	-	277.74	277.75	-	277.66	277.65	277.80	277.80	277.71
MW-7	-	-	277.75	277.64	277.55	-	277.58	277.52	277.89	277.76	277.68
MW-8S	-	278.09	-	278.00	277.98	-	277.92	277.88	278.11	277.99	277.99
MW-8D	-	-	278.12	278.04	278.02	-	277.96	277.92	278.13	278.03	278.01
MW-9	-	-	277.92	277.82	277.74	-	277.80	277.70	277.97	278.20	277.84
MW-10	-	-	277.86	277.98	278.11	-	277.93	277.98	277.76	277.87	277.78
MW-11	-	-	277.86	277.92	278.11	-	277.89	277.98	277.81	277.87	277.85
Lake	277.89	277.68	277.68	277.44	277.37	277.41	277.36	277.43	277.87	277.64	277.66

APPENDIX F

SINGLE WELL REPONSE TEST RESULTS



FALLING HEAD TEST

Data Set:
Date: 04/23/18 Time: 14:35:44

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW4S
Test Date: March 7, 2018

AQUIFER DATA

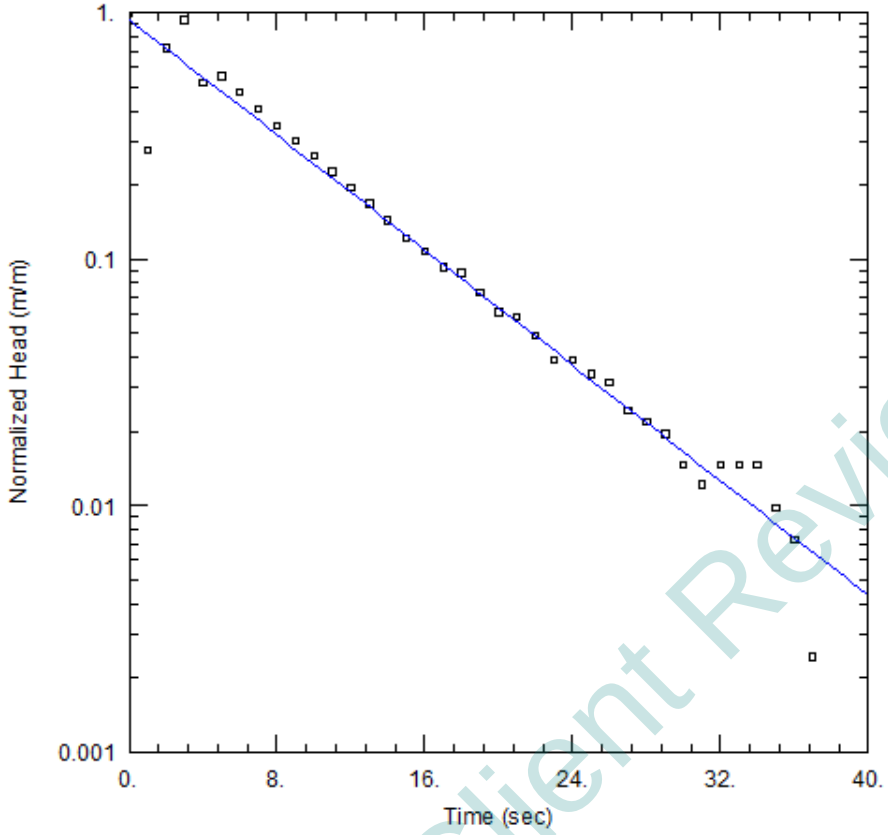
Saturated Thickness: 3.42 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW4S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.42 m
Casing Radius: 0.025 m
Static Water Column Height: 3.42 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002122 m/sec
y0 = 0.4489 m



RISING HEAD TEST

Data Set:
Date: 04/23/18 Time: 14:53:01

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW4S
Test Date: March 7, 2018

AQUIFER DATA

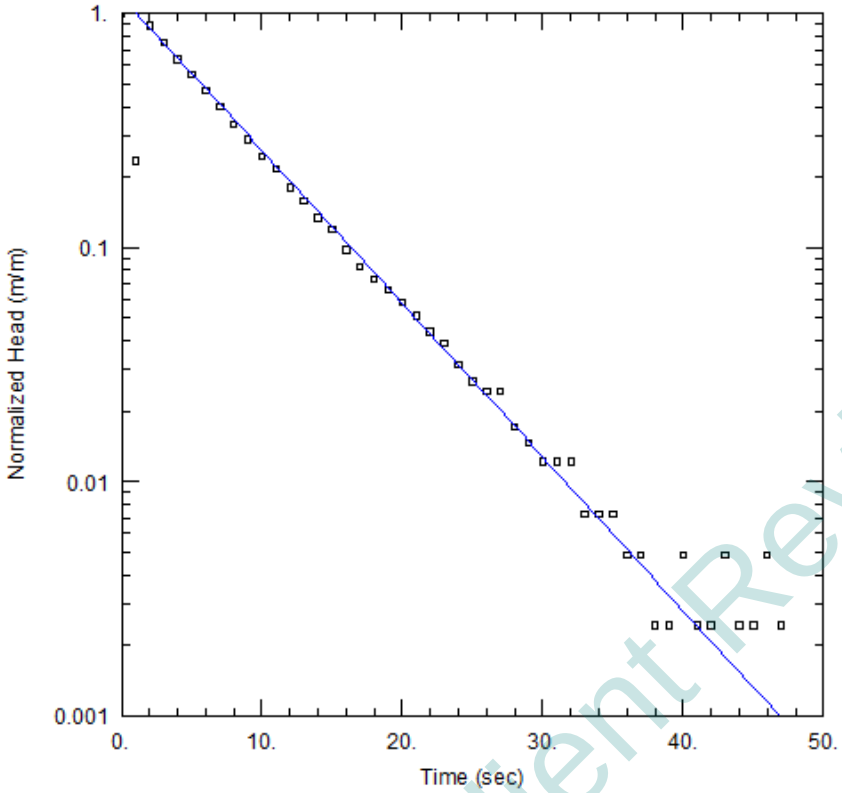
Saturated Thickness: 3.42 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW4S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.42 m
Casing Radius: 0.025 m
Static Water Column Height: 3.42 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001981 m/sec
y0 = 0.3836 m



FALLING HEAD TEST

Data Set:
Date: 04/23/18 Time: 15:00:02

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW4S
Test Date: March 7, 2018

AQUIFER DATA

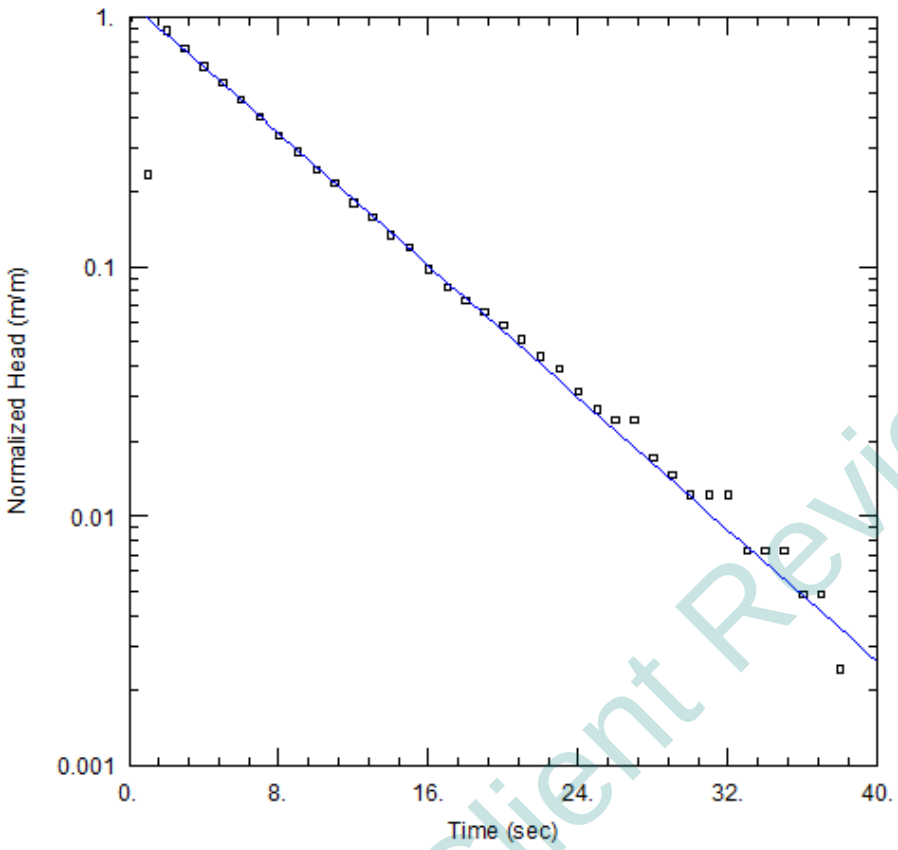
Saturated Thickness: 3.42 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW4S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.42 m
Casing Radius: 0.025 m
Static Water Column Height: 3.42 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002222 m/sec
y0 = 0.4839 m



RISING HEAD TEST

Data Set:
Date: 04/23/18 Time: 15:04:25

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW4S
Test Date: March 7, 2018

AQUIFER DATA

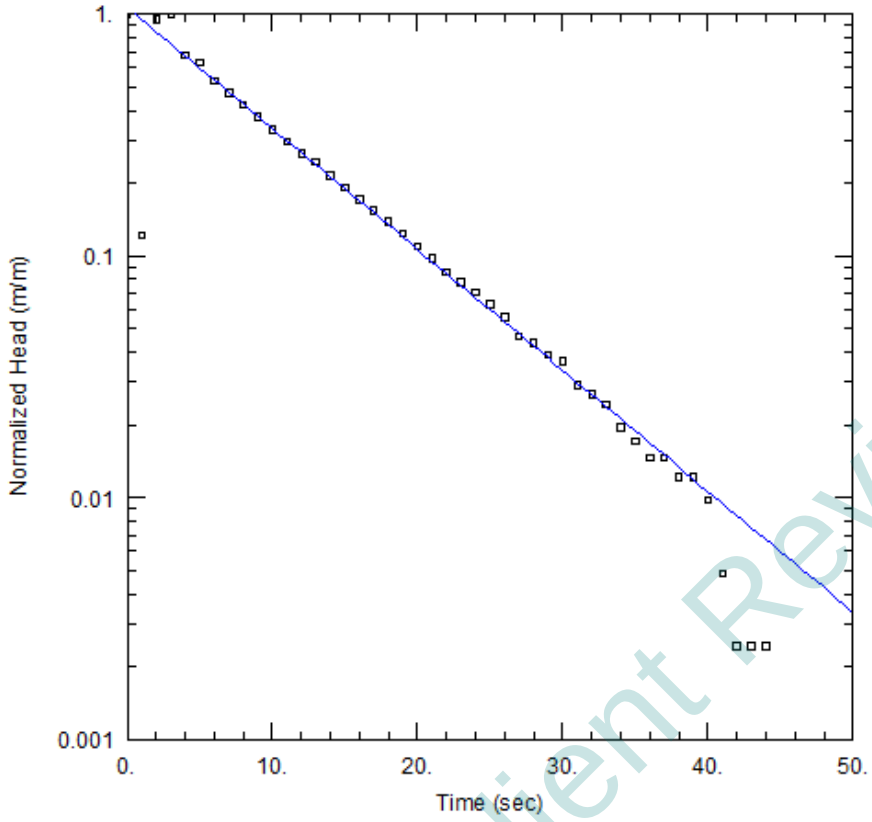
Saturated Thickness: 3.42 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW4S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.42 m
Casing Radius: 0.025 m
Static Water Column Height: 3.42 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002245 m/sec
y0 = 0.4759 m



FALLING HEAD TEST

Data Set:
Date: 04/23/18 Time: 15:26:40

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW5S
Test Date: March 7, 2018

AQUIFER DATA

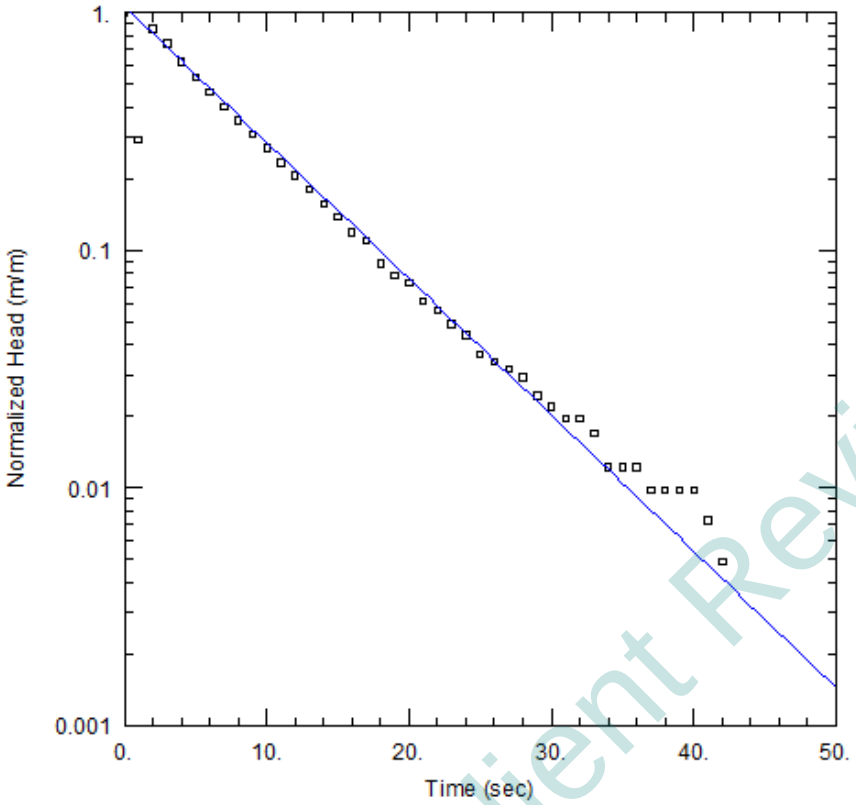
Saturated Thickness: 3.514 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW5S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.514 m
Casing Radius: 0.025 m
Static Water Column Height: 3.514 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001696 m/sec
y0 = 0.4363 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 11:46:11

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW5S
Test Date: March 7, 2018

AQUIFER DATA

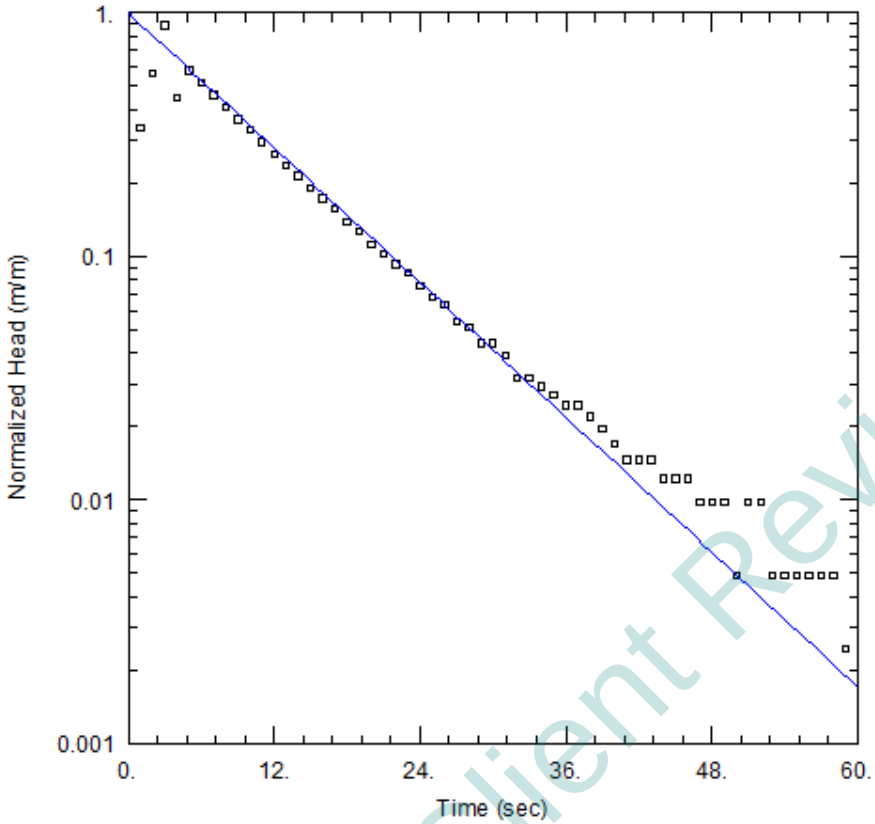
Saturated Thickness: 3.514 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW5S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.514 m
Casing Radius: 0.025 m
Static Water Column Height: 3.514 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001946 m/sec
y0 = 0.4379 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 11:50:35

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW5S
Test Date: March 7, 2018

AQUIFER DATA

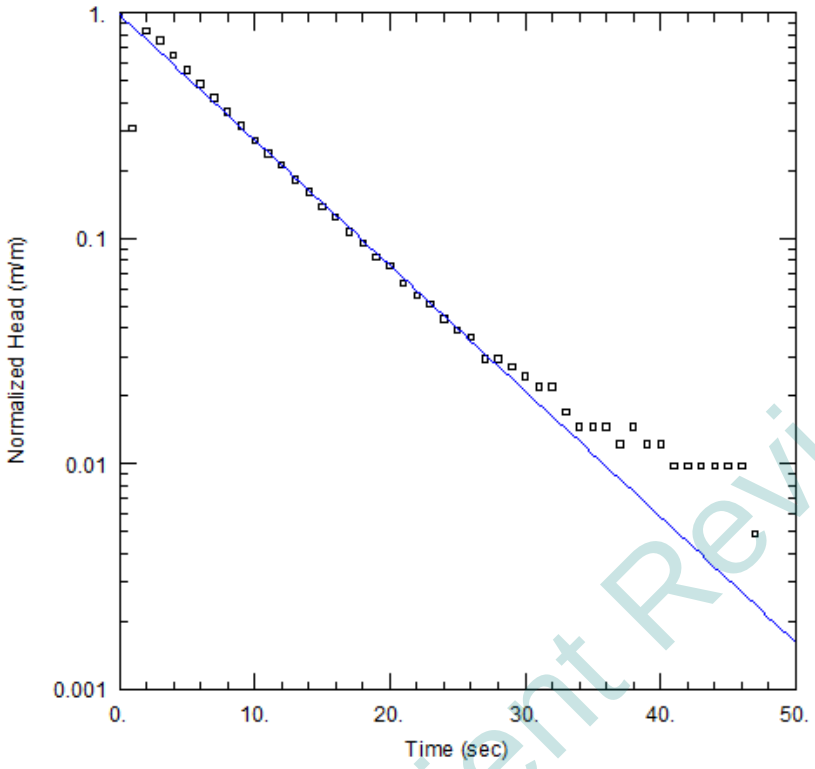
Saturated Thickness: 3.514 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW5S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.514 m
Casing Radius: 0.025 m
Static Water Column Height: 3.514 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001565 m/sec
y0 = 0.4099 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 13:50:28

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW5S
Test Date: March 7, 2018

AQUIFER DATA

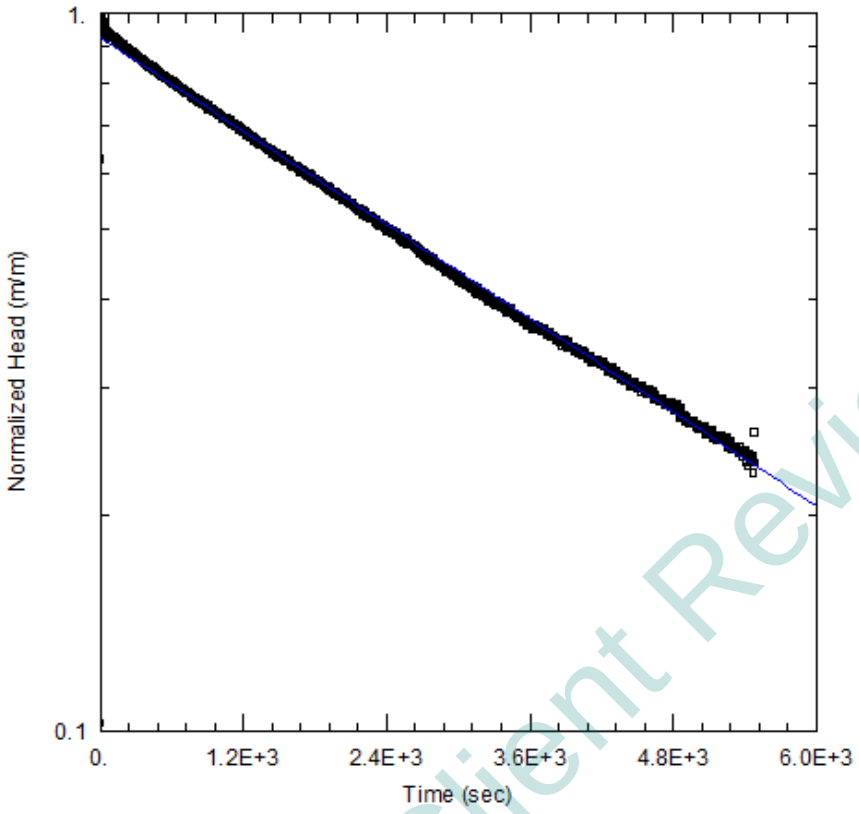
Saturated Thickness: 3.514 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW5S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.514 m
Casing Radius: 0.025 m
Static Water Column Height: 3.514 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.000189 m/sec
y0 = 0.4049 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 14:03:40

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW6
Test Date: March 7, 2018

AQUIFER DATA

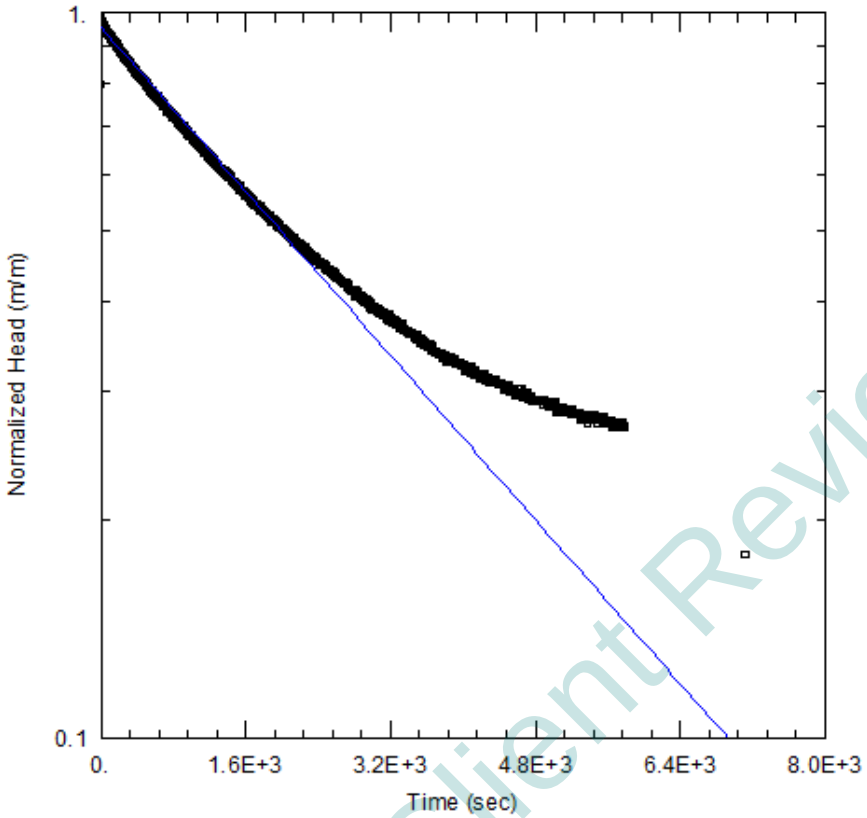
Saturated Thickness: 3.44 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW6)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.44 m
Casing Radius: 0.025 m
Static Water Column Height: 3.44 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 3.691E-7 m/sec
y0 = 0.3795 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 14:12:39

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW6
Test Date: March 7, 2018

AQUIFER DATA

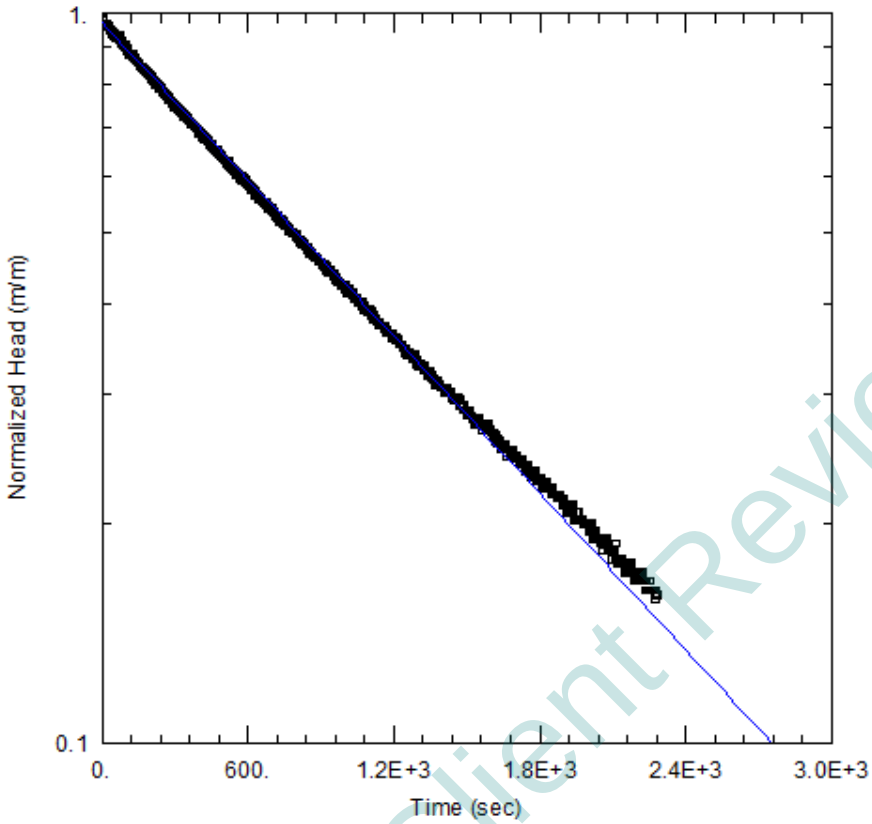
Saturated Thickness: 3.54 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW6)

Initial Displacement: 0.43 m
Total Well Penetration Depth: 3.54 m
Casing Radius: 0.025 m
Static Water Column Height: 3.54 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 4.804E-7 m/sec
y0 = 0.4114 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 14:38:11

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW7
Test Date: March 7, 2018

AQUIFER DATA

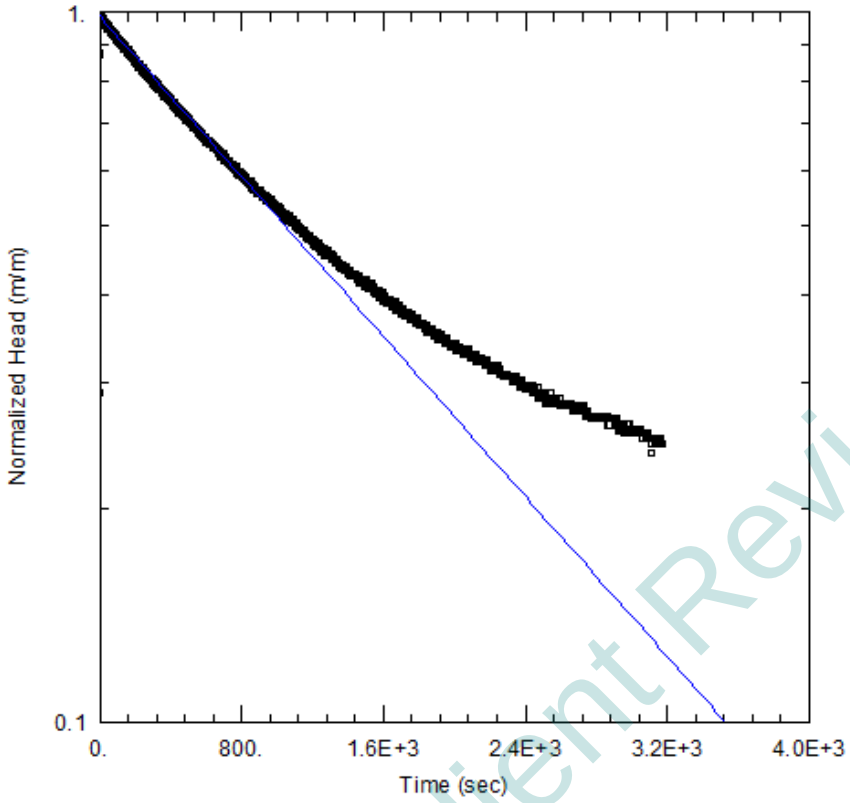
Saturated Thickness: 2.425 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW7)

Initial Displacement: 0.42 m
Total Well Penetration Depth: 2.425 m
Casing Radius: 0.025 m
Static Water Column Height: 2.425 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 1.216E-6 m/sec
y0 = 0.4085 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 14:42:29

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW7
Test Date: March 7, 2018

AQUIFER DATA

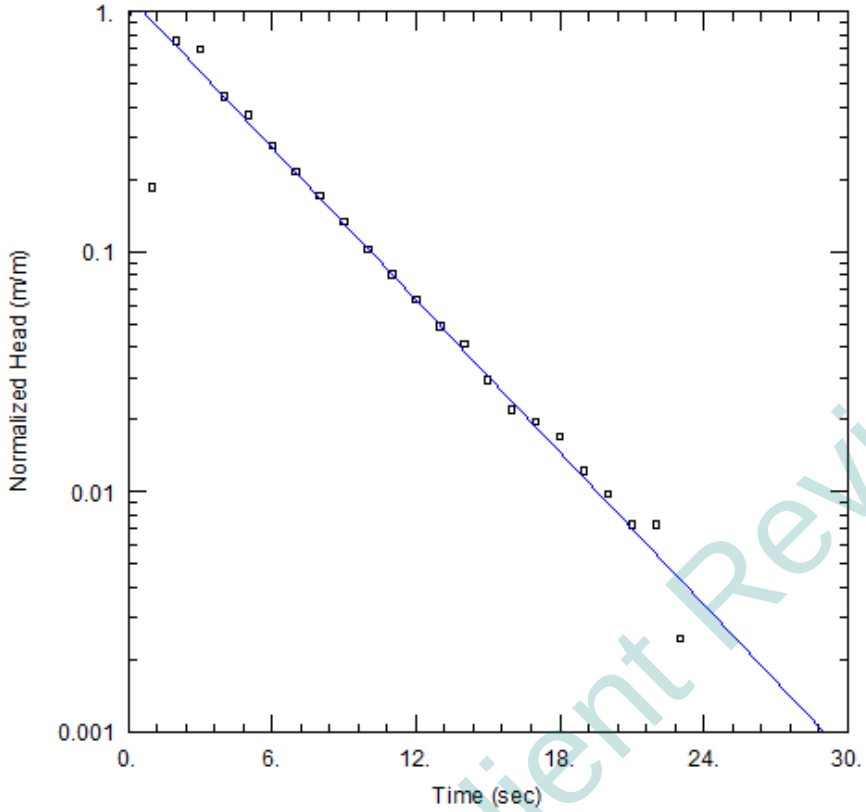
Saturated Thickness: 2.503 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW7)

Initial Displacement: 0.43 m
Total Well Penetration Depth: 2.503 m
Casing Radius: 0.025 m
Static Water Column Height: 2.503 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 9.557E-7 m/sec
y0 = 0.4244 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:00:49

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW8S
Test Date: March 7, 2018

AQUIFER DATA

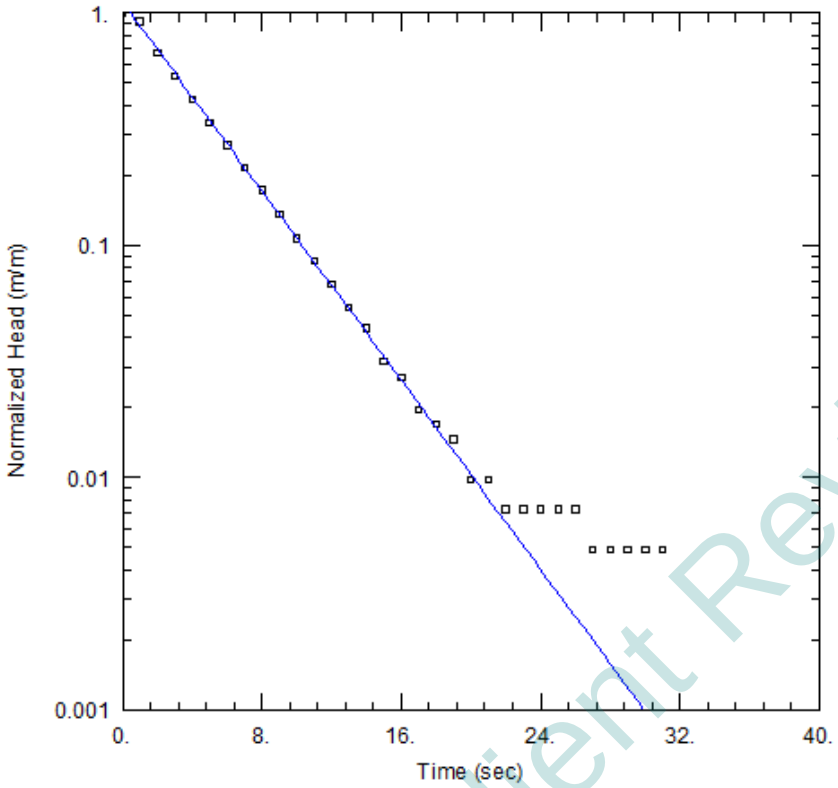
Saturated Thickness: 3.075 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW8S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.075 m
Casing Radius: 0.025 m
Static Water Column Height: 3.075 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0003591 m/sec
y0 = 0.4824 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:02:36

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW8S
Test Date: March 7, 2018

AQUIFER DATA

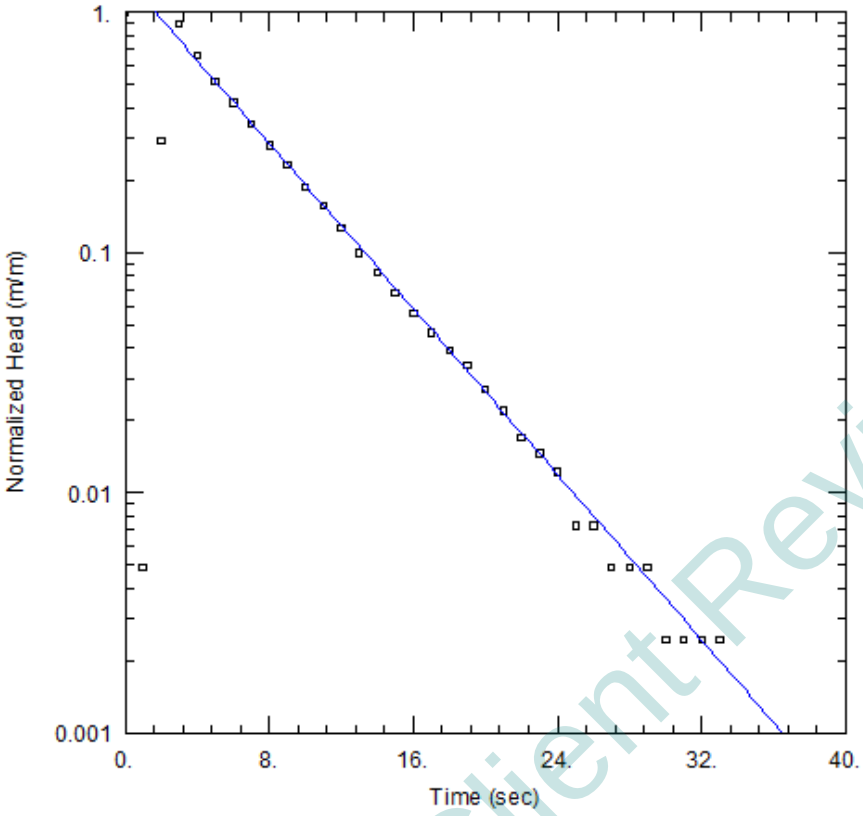
Saturated Thickness: 3.075 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW8S)

Initial Displacement: 0.41 m Static Water Column Height: 3.075 m
Total Well Penetration Depth: 3.075 m Screen Length: 0.91 m
Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev
K = 0.0003451 m/sec y0 = 0.4578 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:04:27

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW8S
Test Date: March 7, 2018

AQUIFER DATA

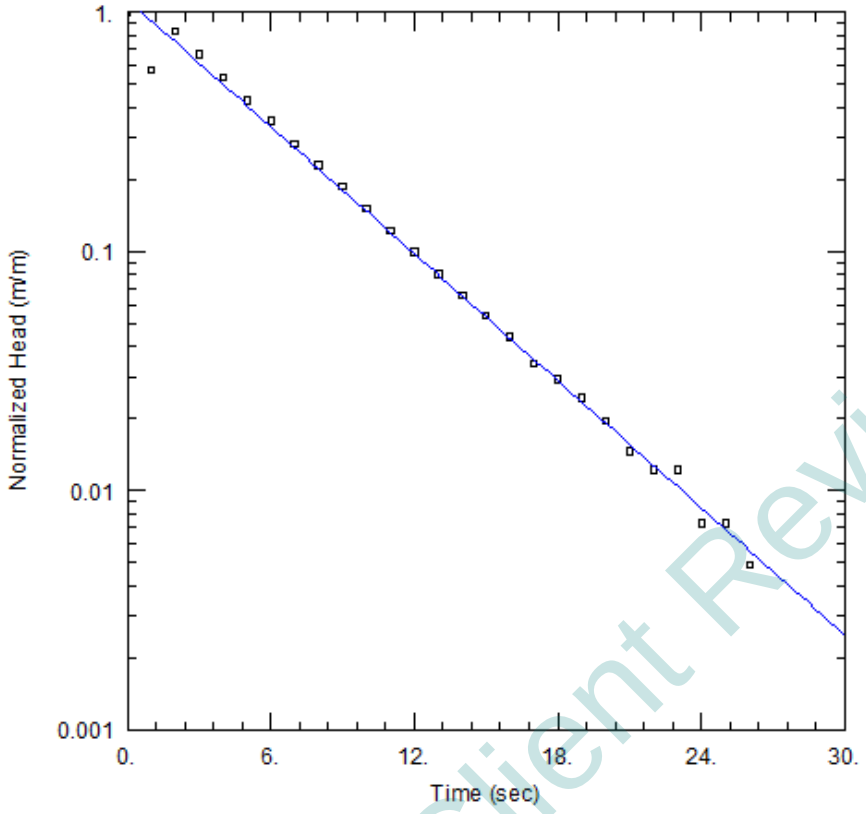
Saturated Thickness: 3.075 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW8S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.075 m
Casing Radius: 0.025 m
Static Water Column Height: 3.075 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002921 m/sec
y0 = 0.5725 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:07:23

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW8S
Test Date: March 7, 2018

AQUIFER DATA

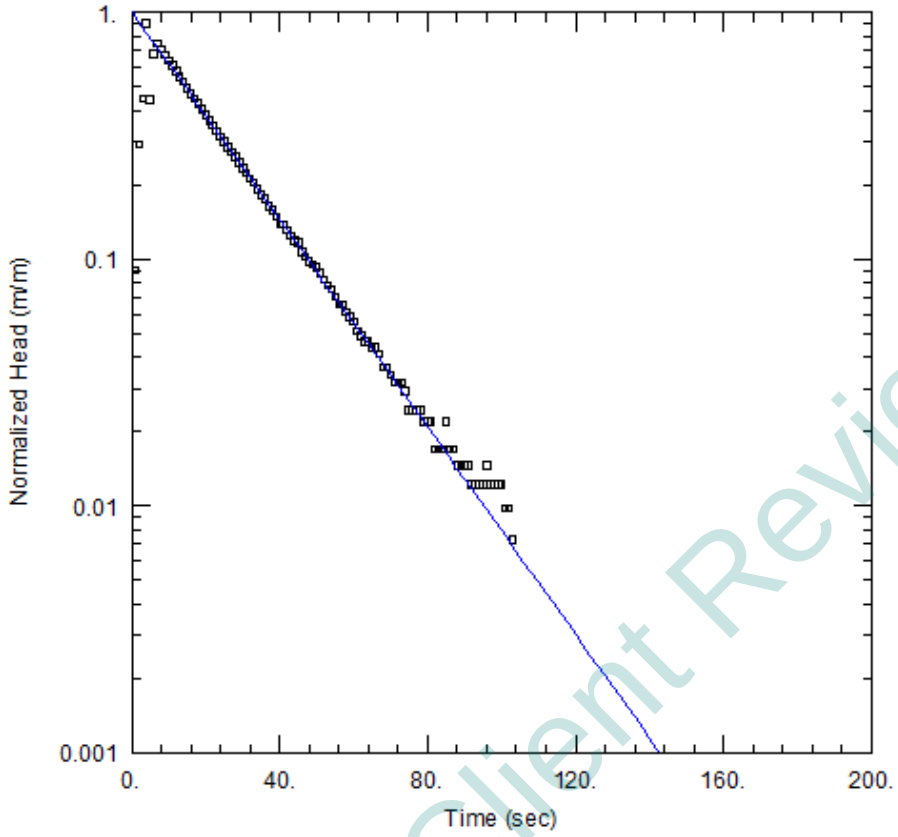
Saturated Thickness: 3.075 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW8S)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 3.075 m
Casing Radius: 0.025 m
Static Water Column Height: 3.075 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0003005 m/sec
y0 = 0.464 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:19:48

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: Mw9
Test Date: March 7, 2018

AQUIFER DATA

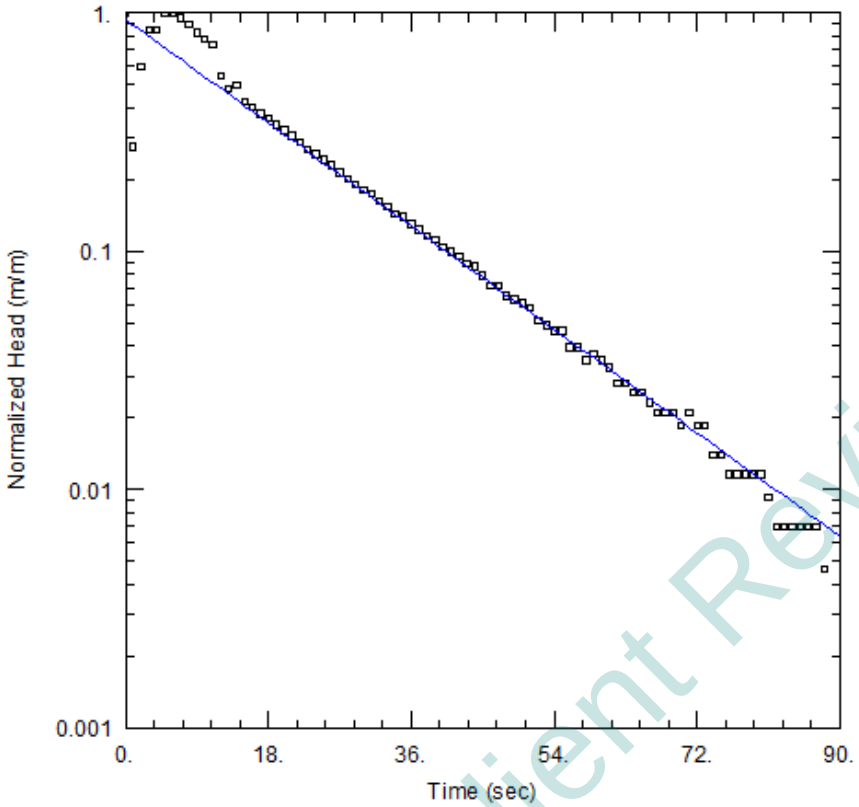
Saturated Thickness: 2.53 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW9)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 2.53 m
Casing Radius: 0.025 m
Static Water Column Height: 2.53 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 7.132E-5 m/sec
y0 = 0.4136 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:22:37

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW9
Test Date: March 7, 2018

AQUIFER DATA

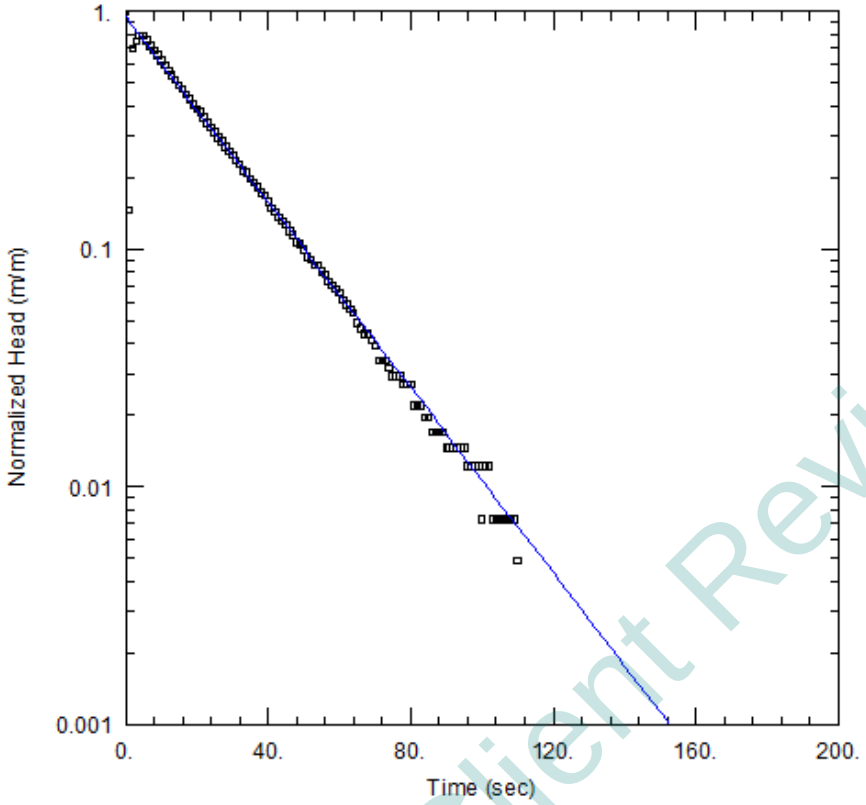
Saturated Thickness: 2.53 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW9)

Initial Displacement: 0.43 m
Total Well Penetration Depth: 2.53 m
Casing Radius: 0.025 m
Static Water Column Height: 2.53 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 8.17E-5 m/sec
y0 = 0.4034 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:25:03

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW9
Test Date: March 7, 2018

AQUIFER DATA

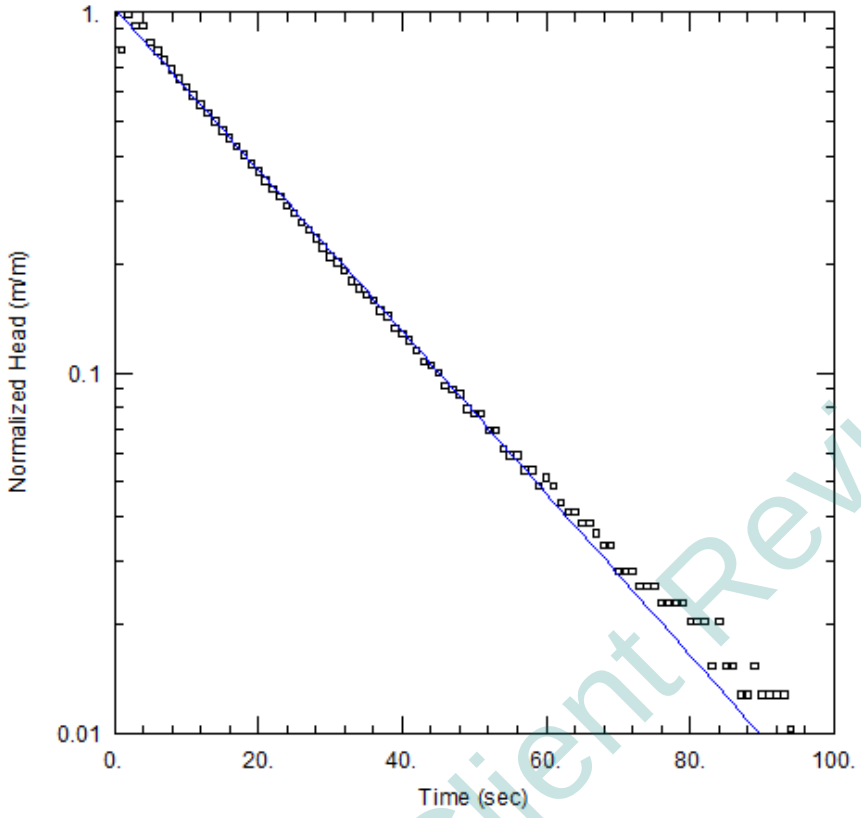
Saturated Thickness: 2.53 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW9)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 2.53 m
Casing Radius: 0.025 m
Static Water Column Height: 2.53 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 6.61E-5 m/sec
y0 = 0.3889 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:28:22

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW9
Test Date: March 7, 2018

AQUIFER DATA

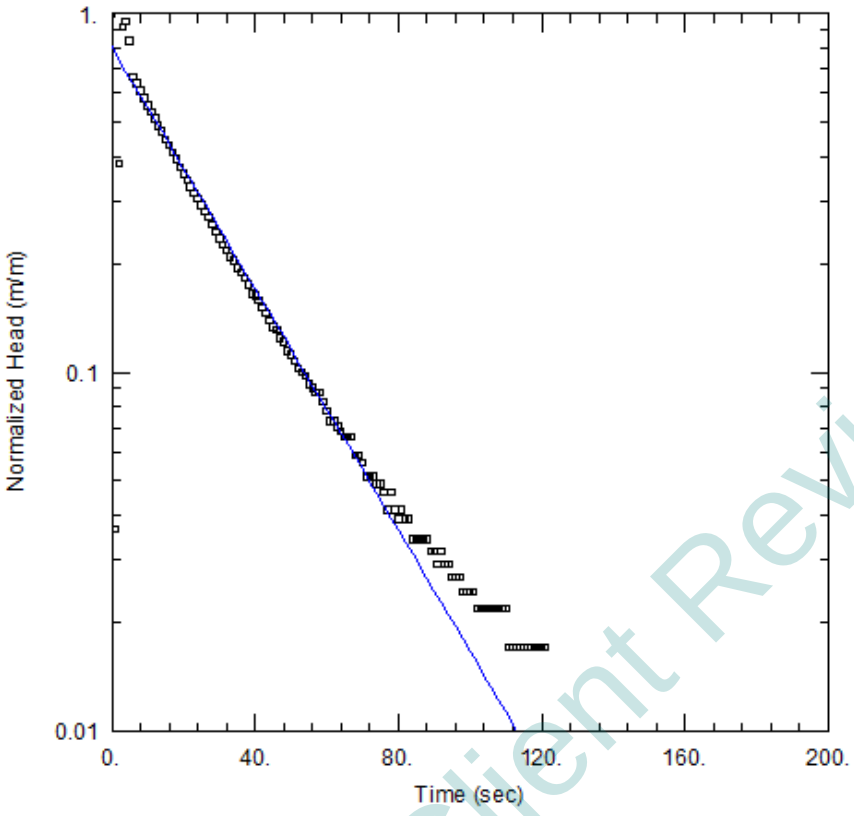
Saturated Thickness: 2.53 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW9)

Initial Displacement: 0.39 m
Total Well Penetration Depth: 2.53 m
Casing Radius: 0.025 m
Static Water Column Height: 2.53 m
Screen Length: 0.91 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 7.616E-5 m/sec
y0 = 0.4024 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:46:46

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW10
Test Date: March 7, 2018

AQUIFER DATA

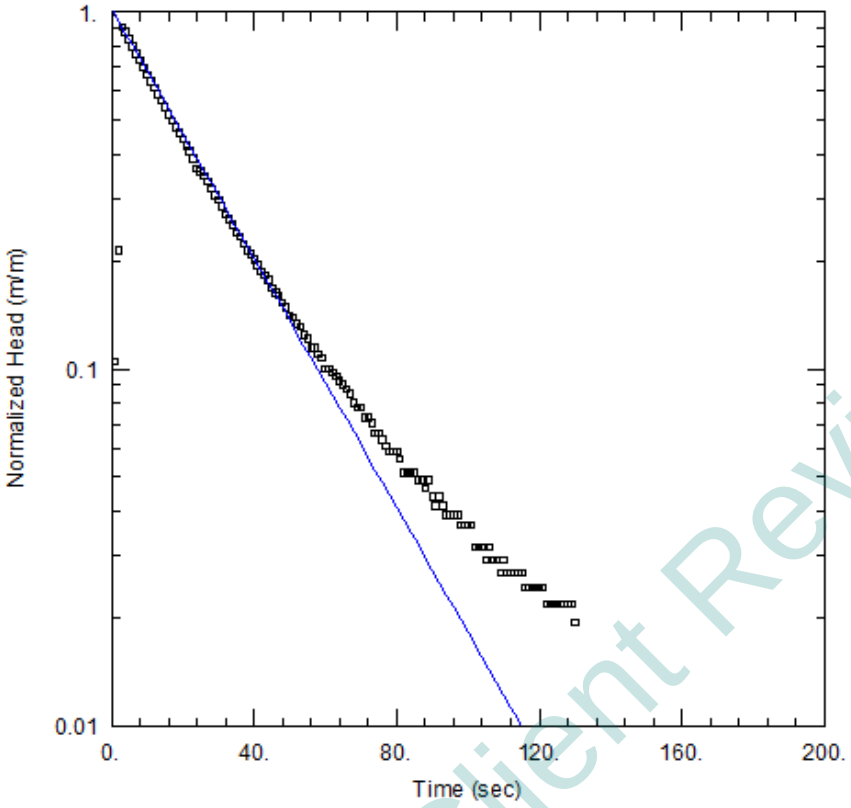
Saturated Thickness: 2.842 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW10)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 2.842 m
Casing Radius: 0.025 m
Static Water Column Height: 2.842 m
Screen Length: 0.76 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 5.445E-5 m/sec
y0 = 0.3308 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:48:52

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW10
Test Date: March 7, 2018

AQUIFER DATA

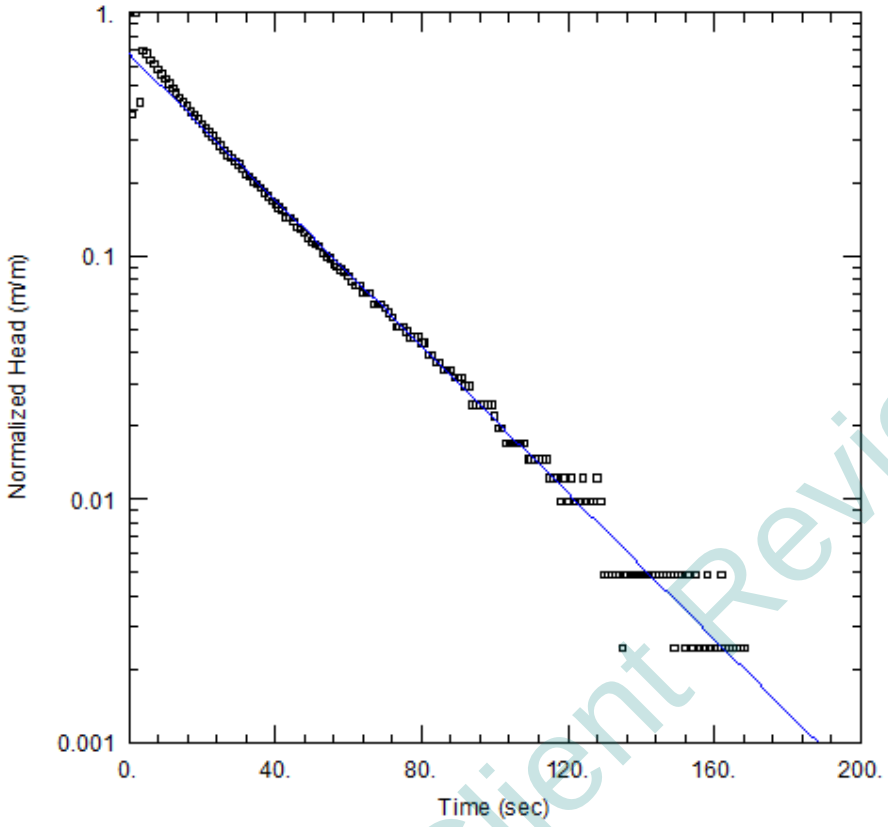
Saturated Thickness: 2.842 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW10)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 2.842 m
Casing Radius: 0.025 m
Static Water Column Height: 2.842 m
Screen Length: 0.76 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 5.655E-5 m/sec
y0 = 0.4206 m



FALLING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:51:47

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW10
Test Date: March 7, 2018

AQUIFER DATA

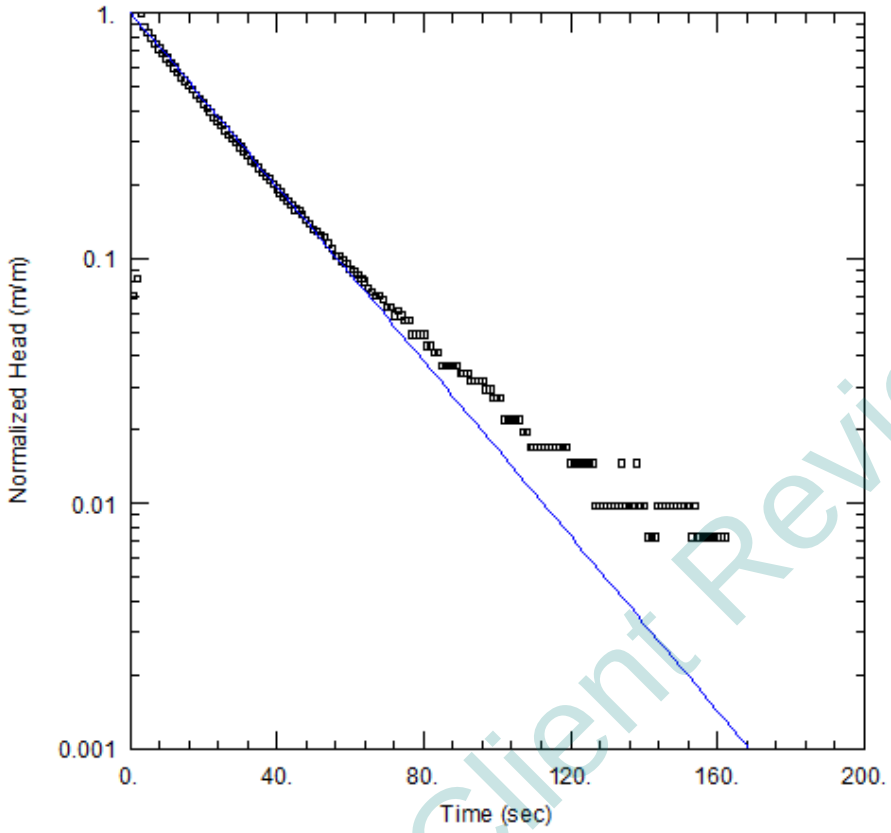
Saturated Thickness: 2.842 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW10)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 2.842 m
Casing Radius: 0.025 m
Static Water Column Height: 2.842 m
Screen Length: 0.76 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 4.867E-5 m/sec
y0 = 0.2789 m



RISING HEAD TEST

Data Set:
Date: 04/25/18 Time: 15:54:45

PROJECT INFORMATION

Project: 17-2013.01
Location: Willow Beach, Osoyoos
Test Well: MW10
Test Date: March 7, 2018

AQUIFER DATA

Saturated Thickness: 2.842 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW10)

Initial Displacement: 0.41 m
Total Well Penetration Depth: 2.842 m
Casing Radius: 0.025 m
Static Water Column Height: 2.842 m
Screen Length: 0.76 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev
K = 5.764E-5 m/sec y0 = 0.4165 m