NURSERY GOLF AND COUNTRY CLUB

HYDROGEOLOGICAL ASSESSMENT

NURSERY GOLF AND COUNTRY CLUB

SW 07-041-26 W4M

JUNE 2017

WSP CANADA INC.
SUITE 1200
10909 JASPER AVENUE
EDMONTON, AB, CANADA T5J 3L9

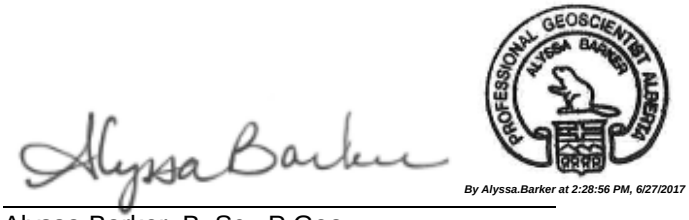
TEL.: +1 780 466-6555
FAX: +1 780 421-1397
WSP.COM

SIGNATURES

PREPARED BY

Annika Nilsson, M. Sc.,
Project Scientist, Environment

REVIEWED BY



By Alyssa.Barker at 2:28:56 PM, 6/27/2017

Alyssa Barker, B. Sc., P.Geo.
Program Manager, Environment

APEGA Permit Number P07641

PREPARED FOR

Wolfgang Hainzman
Nursery Golf and Country Club
PO Box 5210
Lacombe
AB T4L 1W9

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1 INTRODUCTION

WSP has completed a groundwater assessment for a proposed RV park development on the Nursery Golf Course and Country Club property (the Site), located north of the City of Lacombe, Lacombe County (County), Alberta, SW-07-41-26 W4M.

The objective of the limited groundwater assessment is to support a subdivision application, which has been submitted by Wolfgang Hainzman to the County of Lacombe. The well was drilled in 2017.

The required amount of water for the proposed RV park is 10 m^3/day and will be sourced from the new well drilled in 2017 (Well record - Appendix A).

1.1 SCOPE OF THE ASSESSMENT

The scope of this assessment was prepared to meet the requirements outlined in the *Recommended Information for Section 23 of the Water Act – Subdivision Reports* document published by the Government of Alberta (Alberta Environment, 2011).

For this hydrogeological assessment, WSP:

- Reviewed available background information including available reports and data contained in the Alberta Water Well Information Database
- Provided data and maps with required geological and hydrogeological information
- Identified surface waters, springs, and groundwater wells within 1.6 km of the site
- Interpreted pump test data from the source water well to determine local aquifer characteristics
- Summarized well completion details
- Evaluated the water quality
- Prepared this report to summarize all the findings of the hydrogeological assessment

2 SITE DESCRIPTION

The Site is located approximately 5 km north of the City of Lacombe, as shown on Figure 1, and covers approximately 65 ha (160 acres). The proposed RV park development is shown on Figure 2.

As shown on Figure 2, the proposed RV park is located in the south-central portion of the site. The local topography features low relief, with undulating slopes and small, local waterbodies as a result of glacial action in the area.

3 BACKGROUND INFORMATION

3.1 GEOLOGY

According to published geological mapping (Shetson, 1990), the site is underlain by ice-contact lacustrine and fluvial deposited sediments, consisting of sand, gravel, silt and clay, with local inclusions of glacial till. These sediments may be up to 25 m thick. There is an area of hummocky terrain, notable for small local rounded mounds and knolls, interspersed with small waterbodies. Hummocky terrain results when small, broken blocks of continental glacier ice are covered with surficial deposits and subsequently melt during deglaciation. The relief in hummocky terrain typically ranges from 5 to 15 m.

The upper bedrock underlying the surficial deposits in the County includes parts of the late Cretaceous Paskapoo Formation (Le Breton, 1971). The upper part of the Paskapoo River Group is divided onto the Dalehurst Member, the Upper and Lower Lacombe Members, and the Haynes Member (Demchuk and Hills, 1991). In the west-central portion of the County, the Lacombe Members form the uppermost bedrock deposits. The Upper Lacombe Member largely consists of shale interbedded with sandstone and has a maximum thickness of approximately 250 m. The Lower Lacombe Member consists of sandstone and coal layers. The bedrock geology underlying the County is presented on Figure 3.

A report on regional hydrogeology (Hydrogeological Consultants Ltd., 2001) indicated that the Buried Red Deer River Valley underlies the site, as shown on Figure 4. A buried valley is a valley which was eroded into the underlying bedrock surface, and which was subsequently infilled with surficial sediments such as glacial till, glaciolacustrine, or fluvial deposits. A buried valley may not have a surface expression, such as a topographically low area.

The Buried Red Deer River Valley is centrally located within the County and trends slightly northeast to southwest, as shown on Figure 4. It was eroded into the Upper Lacombe Member, prior to glaciation and was infilled with a variety of glacially derived deposits. It is approximately 9 km wide and has low local relief. The sand and gravel deposits associated with this bedrock low are expected to range from 30 to 50 m in thickness. The sand and gravel deposits are likely overlain by fine-grained sand, silt, and glacial till.

A geological cross-section illustrating the local overburden, bedrock geology, and static water levels, based on available well logs near the site, is presented on Figure 5. The geological interpretation shown on the cross-section was based on the available lithology and well log data obtained from the Alberta Water Well Information Database.

3.2 HYDROGEOLOGY

The aquifers underlying the County are generally given the same names as the material in which they are located. The saturated portions of the surficial deposits typically occur in sand and gravel deposits, which are referred to as the Upper or Lower Sand and Gravel Aquifers (Hydrogeological Consultants Ltd., 2001). The Upper Sand and Gravel Aquifer is not present in the vicinity of the site. The Lower Sand and Gravel Aquifer, while present, was not observed to be water-bearing in the Nursery Golf Course well.

Bedrock aquifer names reflect the geology underlying the site. In this area of the County, the Upper Lacombe and Lower Lacombe Aquifers are present. The Lacombe Aquifers may be up to 300 m in thickness. Water well drilling reports for wells in the vicinity indicate the presence of interbedded shale and sandstone deposits of the Upper Lacombe Aquifer.

Records of approximately 1,100 wells completed in the Upper Lacombe Aquifer are available for the County. The long-term yields of these wells range from 10 to over 100 m^3/day, as shown on Figure 6. There are also over 160 wells that have a reported yield in excess of 300 m^3/day, indicating that some areas of the bedrock are capable of supporting high yielding wells. Based on the drilling logs, water-bearing zones may range from 25 to 76 m below surface in the Upper Lacombe Aquifer. The static water levels reported at the time of drilling ranged from 8 to 79 m below surface.

3.3 GROUNDWATER QUALITY

Groundwater from the Upper Lacombe Aquifer is mainly sodium-bicarbonate or sodium-sulphate type, with total dissolved solids concentrations ranging from less than 500 mg/L to over 1,000 mg/L. Typically sulphate concentrations are less than 250 mg/L and chloride concentrations are less than 10 mg/L, indicating good quality groundwater. (Hydrogeological Consultants Ltd., 2001).

4 LOCAL GROUNDWATER AND SURFACE WATER USE

4.1 GROUNDWATER

A review of the Alberta Environment and Parks (AEP) water well records conducted in June, 2017 (AEP, 2017a) identified 20 registered water wells within a radius of approximately 1.6 km from the center of the Nursery Golf Course. The approximate location of these water wells is presented on Figure 7. The reconnaissance report listening the wells is presented in Appendix B.

Based on the drilling logs, well depths ranged from 9 to 104 m in depth. The static water levels reported at the time of drilling ranged from 4.8 to 79.3 m below surface. Generally speaking, deeper wells had lower static water levels, implying that regionally there is a downward component of groundwater flow in the bedrock aquifers underlying this portion of the County, as discussed above. Well yields at the time of drilling ranged from 39 to 393 m^3/day.

4.2 SURFACE WATER AND SPRINGS

A review of the regional hydrogeological report (Hydrogeological Consultants Ltd., 2001) indicated that there are no springs within a 1.6 km radius of the Nursery Golf Course.

Within a 1.6 km radius of the Nursery Golf Course, there is approximately 0.86 km^2 of surface water, which covers 10% of the area. The surface water areas are shown on Figure 8.

Authorized surface water users in the area were identified using the traditional Agriculture Viewer (AEP, 2017b) and are presented in Table 1.

Table 1 Authorized Surface Water Users in a Radius of 1.6 km from the Middle of SW-07-041-26 W4M

WATER SOURCE	AMOUNT OF WATER (m^3/year)	PRIORITY NO.	LOCATION
Unnamed Stream - Unclassified	55	1994-04-27-006	NE 01-041-27-W4
Unnamed Stream - Unclassified	295	1994-04-27-005	NE 01-041-27-W4
Unnamed Stream - Unclassified	22	1992-12-31-359	NE 12-041-27-W4
Unnamed Stream - Unclassified	16	1903-12-31-044	SE 13-041-27-W4
Whelp Brook Creek	329	1988-12-31-660	SW 18-041-26-W4

5 WELL COMPLETION DETAILS

A water supply well was drilled between March 29 and April 3, 2017, by JC Drilling Ltd. using a cable tool technology to a total depth of 96 metres below ground surface (mbgs) (315 feet). The lithology encountered during drilling is outlined in Table 2.

Table 2 Lithology Encountered During Drilling

DEPTH	DESCRIPTION
0 – 4.6 mbgs	Yellow Sand
4.6—7.6 mbgs	Grey Clay
7.6 – 25.0 mbgs	Gravel
25.0 – 61.3 mbgs	Gray Shale
61.3 – 63.7 mbgs	Green Shale
63.7 – 81.7 mbgs	Grey Shale
81.7 – 89.0 mbgs	Grey Salt and Pepper Sandstone
89.0 – 96.0 mbgs	Grey Shale

The well was completed with 15.24 cm (6-inch) steel surface casing set to depth of 31.5 mbgs. A 10.16 cm (4-inch) pvc well casing was installed between 29 and 96 mbgs, and the borehole was sealed with bentonite from 0 to 31.5 mbgs. Perforations were made by a saw between 84.0 to 96.0 mbgs, which screens across the Sandstone layer.

The static water level, measured on April 3, 2017, was 13.4 mbgs. A copy of the drilling report is provided in Appendix A.

5.1 CONSTANT RATE PUMP AND RECOVERY TEST

Testing of the aquifer was conducted on April 27, 2017. Testing included a 120 min drawdown test and a 120 min recovery test. Water was removed at a rate of 163 m^3/day (30 US gpm). Water levels in the water well were measured during the drawdown and recovery period.

Water level data collected during the pumping and recovery phases of the pump tests are shown in Appendix C.

5.2 TRANSMISSIVITY AND LONG-TERM SUSTAINABILITY

The aquifer is classified as confined due to the sequences of clay and shale overlying the water bearing Sandstone layer. The available head is 68.3 mbgs based on a non-pumping water level of 13.4 mbgs and the top of the aquifer at approximately 81.7 mbgs.

The data for the 2-hour constant rate test was analyzed to evaluate aquifer transmissivity using a software package called AquiferTest$^{7.0\ PRO}$, a commercially available product that includes various commonly used methods of drawdown data analyses. WSP used the pumping drawdown to assess the well and estimate aquifer transmissivity. The analyzed data and resulting graph are attached in Appendix C. The pumping test data indicated an aquifer transmissivity of 3.75 x 10^{-4} m^2/s.

The long-term sustainable yield (Q_{20}) of a groundwater well is ideally calculated using the Modified Moell Method (Maathuis and van der Kamp, 2006); however, this method requires step test data that is not available for this assessment. For comparison WSP calculated the long-term sustainable yield using both the Farvolden Method (Farvolden, 1959) and the Modified Moell Method (using estimated data from the drawdown graph – Appendix C). The following shows first the Farvolden Method and then the Modified Moell Method.

$$Q_{20} = (0.68)T(Ha) * 0.7$$

Where:

H_a = available head (68.3 m)
T = Transmissivity ($3.75*10^{-4}$)
0.7 = 70% safety factor

Transmissivity was determined from the pumping test data and using the Farvolden Method, the calculated long-term yield (Q_{20}) of the water well is estimated at 1053 m^3/day. The required amount of water for the proposed RV park is 10 m^3/day.

$$Q_{20} = \frac{Q \cdot H_A}{s_{100} + \left(s_{20\,\mathrm{yrs}} - s_{100}\right)_{\mathrm{theor}}} \times 0.7$$

Where:

Q = well pumping rate during the pumping test
H_a = available head
s_{100} = the drawdown at 100 minutes measured during the pumping test
$(s_{20\ yrs.} - s_{100})_{theor}$ = theoretical drawdown after 100 minutes and 20 years
0.7 = 70% safety factor

Using the Modified Moell Method and estimated theoretical drawdowns determined from the drawdown graph, the calculated long-term yield (Q_{20}) of the water well is estimated at 315 m^3/day. The required amount of water for the proposed RV park is 10 m^3/day.

Both methods indicate that there is adequate water quantity in the aquifer to supply the RV park. The Modified Moell Method is a more realistic value and is similar to values reported regionally by HCL (2001). The Farvolden Method is high due to the transmissivity value that was determined based on the short duration pumping test.

5.3 WATER QUALITY

A water sample was obtained from the water well by the owner of the Nursery Golf Course on May 19, 2017. The certificate of analysis is attached in Appendix D, the results were compared to the *Guidelines for Canadian Drinking Water Quality* (Health Canada, 2017). The results indicate that the water is high quality groundwater, with sodium that is slightly over the aesthetic objective and a slightly basic pH. These parameters are common in the Upper Lacombe Aquifer (HCL, 2001).

6 CONCLUSIONS AND RECOMMENDATIONS

The proposed RV park development on the Nursery Golf Course and Country Club property is intended to be supplied by water from a new water well that was drilled in 2017. The following information was determined by the hydrogeological assessment:

- The well was drilled into the Upper Lacombe Member of the Paskapoo Formation. The well screens a confined sandstone aquifer.
- Water levels measured during the drawdown and recovery phases of the 2-hour pumping test indicated that the aquifer is capable of supplying groundwater at a considerably higher rate than is required for this proposed development.
- The local groundwater quality from the well conforms to the *Guidelines for Canadian Drinking Water Quality* (Health Canada, 2017).
- Development of the RV park on the site will have no discernible impacts on surrounding well users or the aquifer.

Based on the information provided in this hydrogeological assessment, WSP believes that there is adequate water resources to supply the proposed RV park development at the Nursery Golf Course.

BIBLIOGRAPHY

- Alberta Environment (2011). *Guide to Groundwater Authorization.* March 2011
- Alberta Environment and Parks (2017a). *Alberta Environment and Sustainable Resource Development Groundwater Information System.* http://www.envinfo.gov.ab.ca/GroundWater/. Accessed: June 2017.
- Alberta Environment and Parks (2017b). *Authorization Viewer.* https://avw.alberta.ca/TraditionalAgricultureRegistrations.aspx Accessed: June 2017.
- Demchuk, Thomas and L.V. Hills (1991). *A Re-examination of the Paskapoo Formation in the Central Alberta Plains: the Designation of Three New Members*. Canadian Petroleum Geology, vol. 39, pg. 270 – 282.
- Hydrogeological Consultants Ltd. (2001). *Lacombe County, Part of the Red Deer River Basin, Regional Groundwater Assessment.* Prepared from Lacombe County, Agriculture and Agri-Food Canada, Prairie Farm Rehabilitation Administration.
- Health Canada (2017). *Guidelines for Canadian Drinking Water Quality.* Federal–Provincial Territorial Committee on Drinking Water. February 2017.
- Farvolden, R.N. 1959. Groundwater supply in Alberta. Alberta Research Council, unpublished report, 9 p.
- Le Breton, E. Gordon (1971). *Hydrogeology of the Red Deer Area, Alberta.* Research Council of Alberta, Edmonton, Alberta.
- Maathuis, H. and van der Kamp, G. (2006). *The Q_{20} Concept: Sustainable Well Yield and Sustainable Aquifer Yield*. Prepared for Alberta Environment, Saskatchewan Watershed Authority, Prairie Farm Rehabilitation Administration, and Prairie Provinces Water Board. Saskatchewan Research Council, SRC Publication No. 10417-4E06, July 2006.
- Shetson I. R. (1990). *Quaternary Geology, Central Alberta*. 1:50,000 Scale map.

FIGURES

LIST OF FIGURES

REGIONAL MAP

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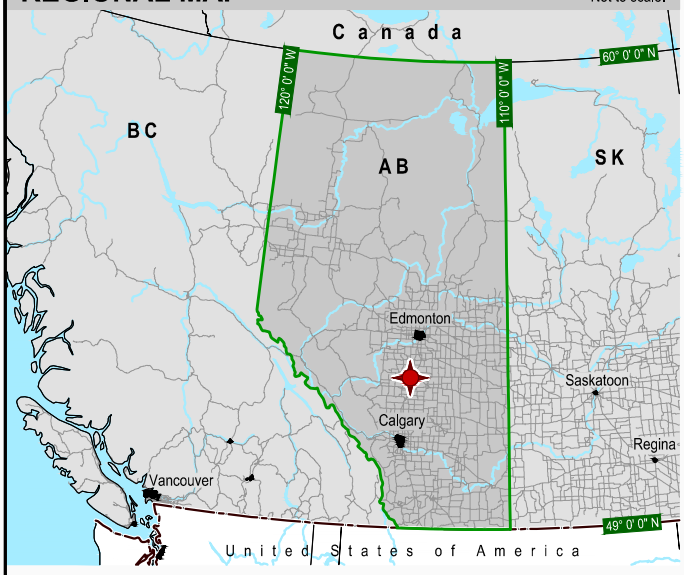


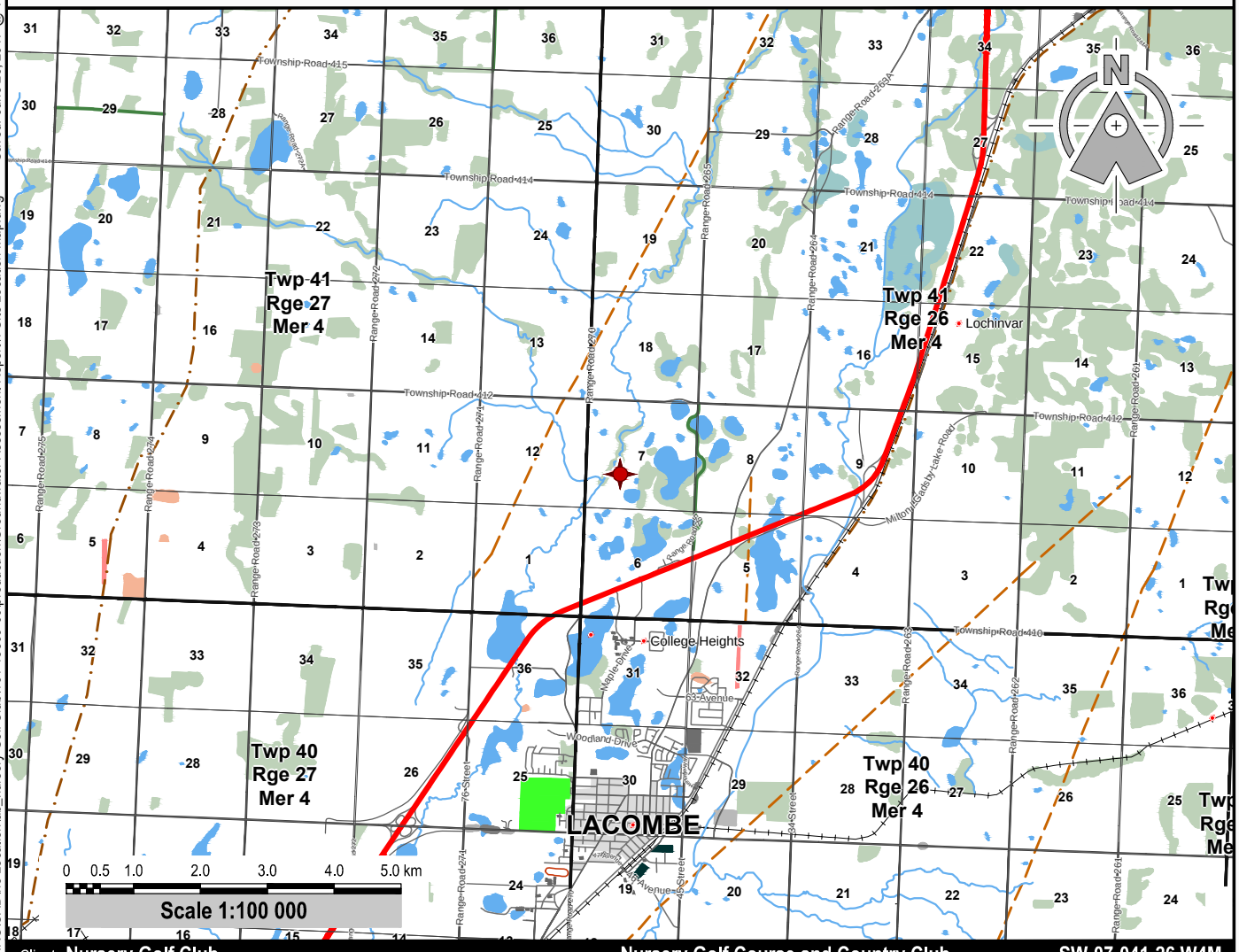
LEGEND

Generic legend.

- Site location
- Pipeline
- Railway
- River / creek
- Airport
- Building
- Built-up area
- Campground
- Golf course
- Mining
- Road
- Trail
- Transmission line
- Oil facility
- Park
- Sand
- Transmission facility
- Vegetation
- Waterbody
- Wetland

REFERENCE

Topographic Map(s) Obtained From Geogratis
© 1993 Her Majesty The Queen In Right Of Canada. Department Of Natural Resources
Coordinate System: UTM with NAD83 datum, Zone 12, Meter; Central Meridian 117d W



Client: **Nursery Golf Club**

Nursery Golf Course and Country Club

SW-07-041-26 W4M

Report by	AN
Drawn by	JH
Review by	AN
Date created	08.06.2017

Drawing Title

Site Location Map

Figure Number

1

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Drawing Title

Nursery Golf Course and Proposed RV Park Locations

Figure Number

2

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LEGEND	NOTE
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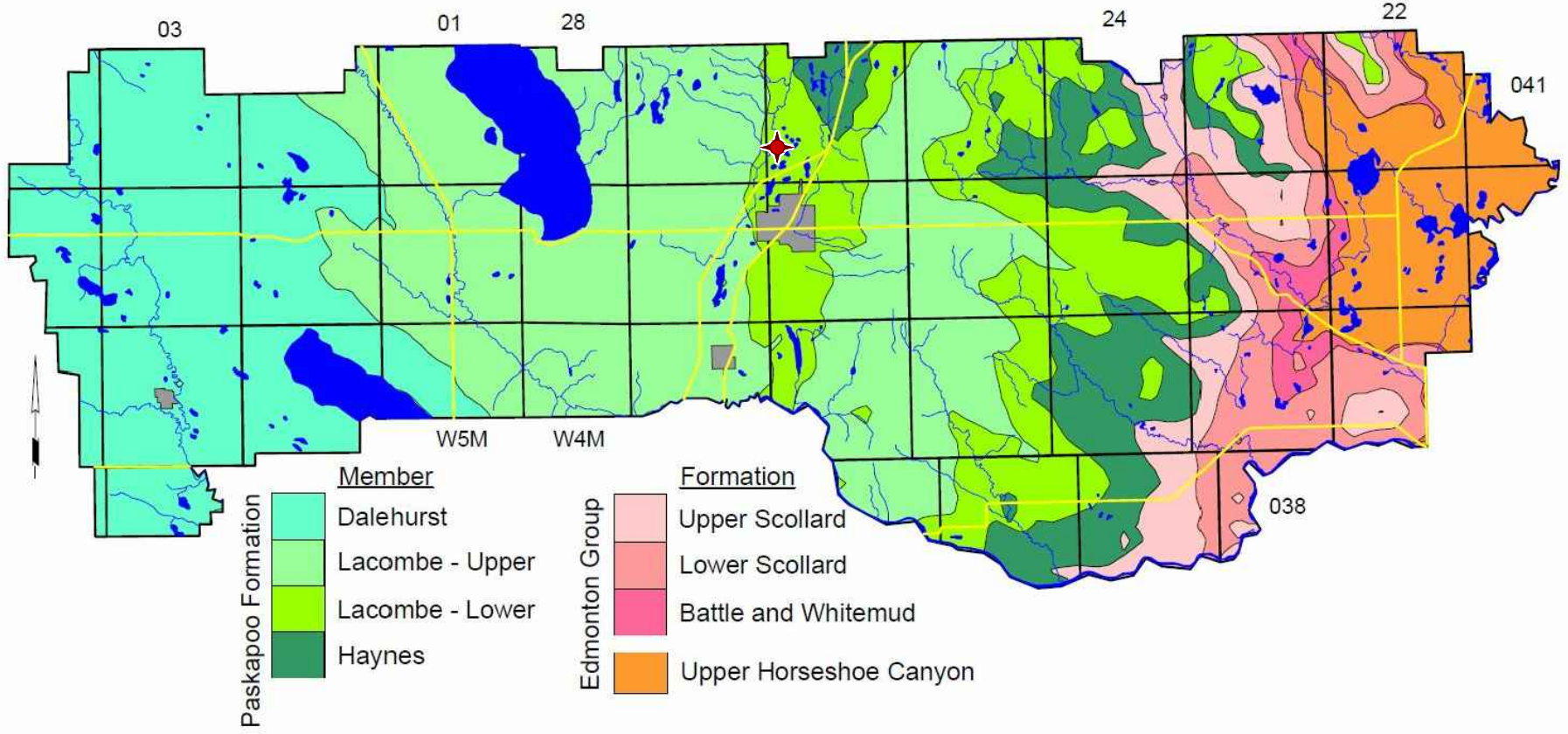

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Drawing Title: **Bedrock Geology Lacombe County**

Figure Number: **3**

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LEGEND	NOTE
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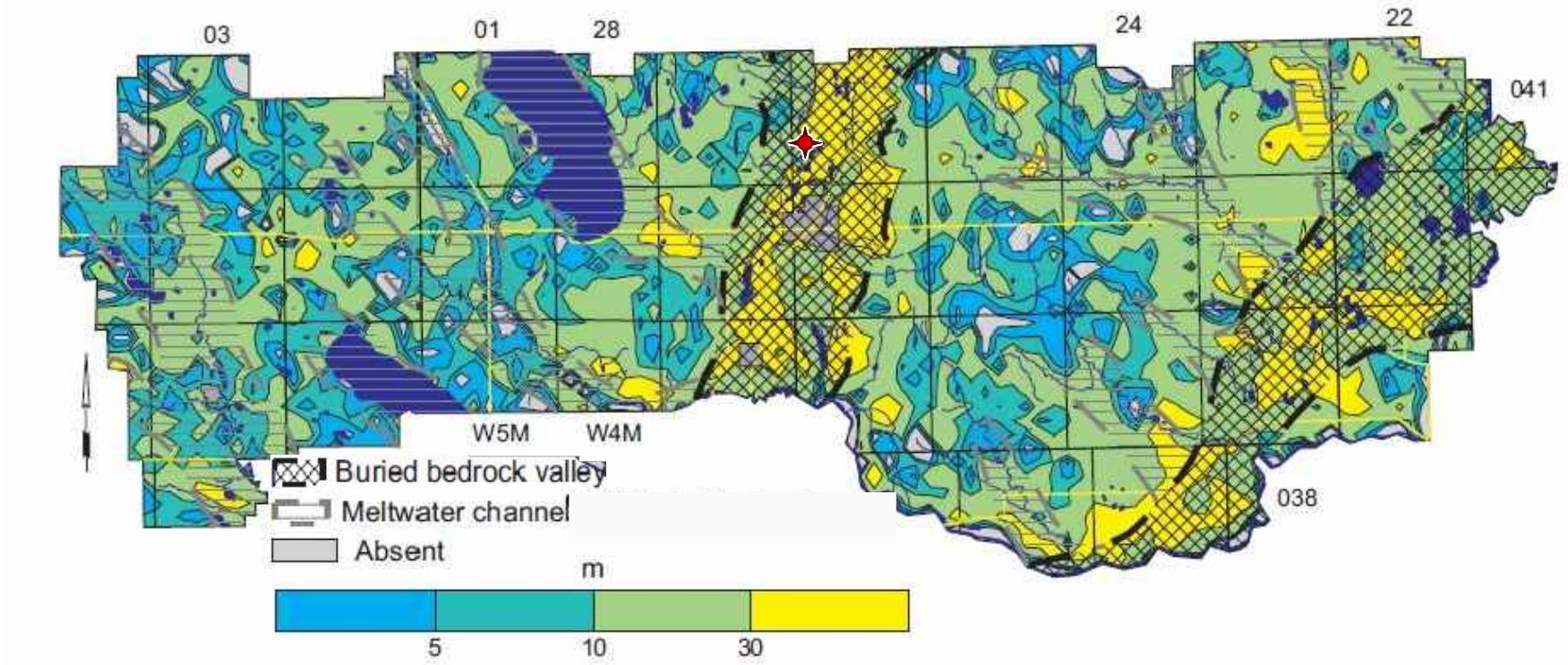

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Drawing Title

Thickness of Surficial Deposits
Lacombe County

Figure Number

4

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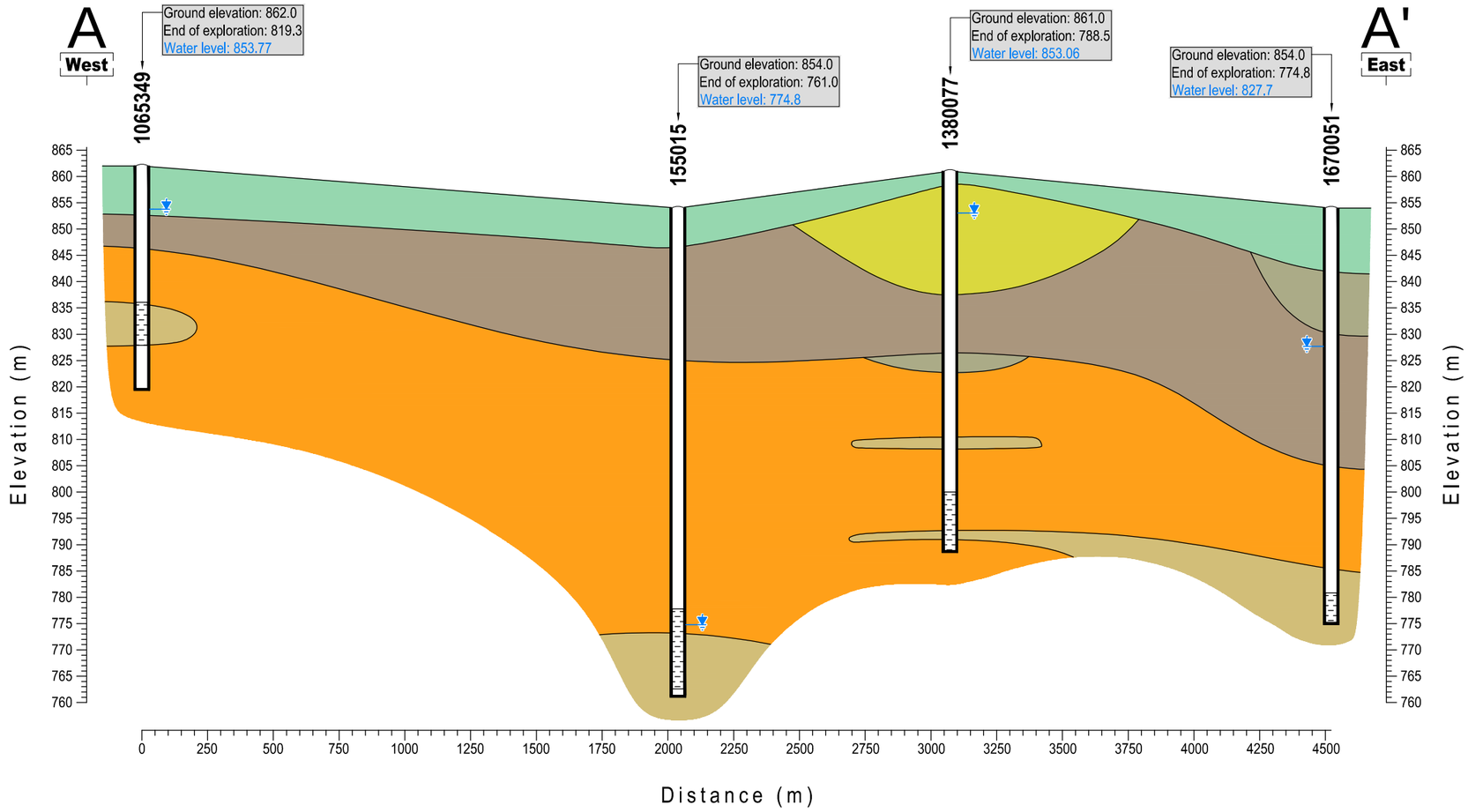

KEY PLAN

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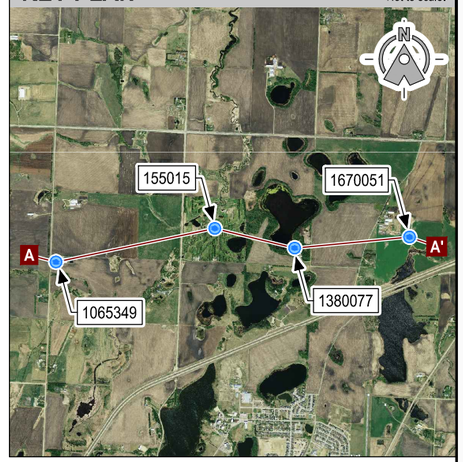

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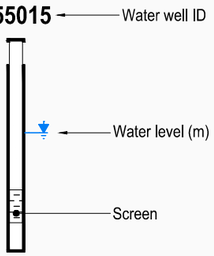

NOTES

1. The geologic and stratigraphic sections shown on this drawing are interpreted from borehole logs.
2. Stratigraphy is known with certainty only at the borehole locations. Actual stratigraphy and geologic conditions between boreholes may vary from that indicated on this drawing.
3. All site features are approximate.

0 0.1 0.2 0.4 0.6 0.8 1.0 km

Scale 1:20 000

Horizontal scale

0 5 10 20 30 40 50 m

Scale 1:1 000

Vertical scale

LEGEND

Clay, till, or clay + till	Sandstone
Gravel or sand + gravel	Shale
Grey sand	Yellow sand

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Drawing Title: **Geological Cross-Section A-A'**

Figure Number: **5**

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LEGEND	NOTE
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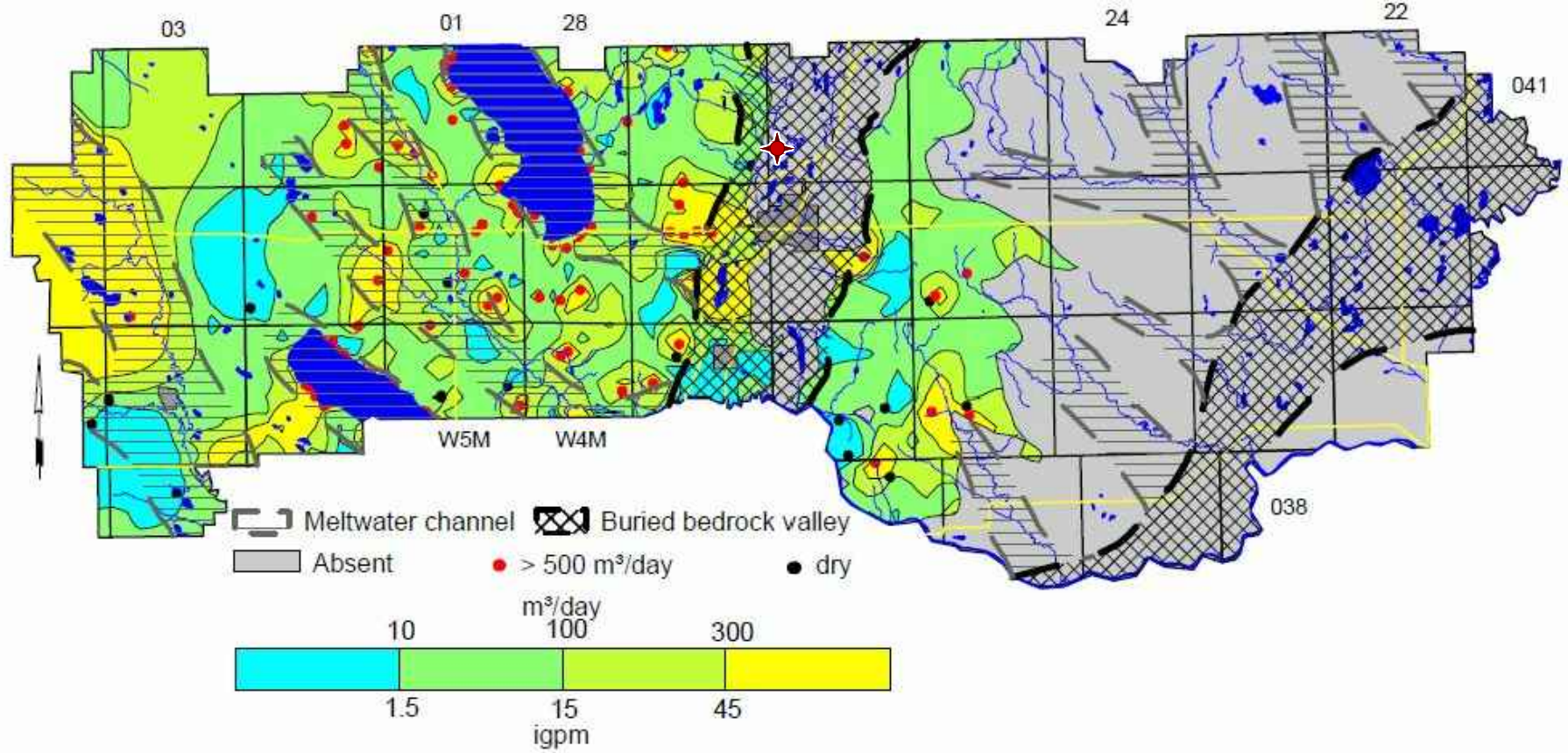

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Client: **Nursery Golf Club**		**Nursery Golf Course and Country Club**	**SW-07-041-26 W4M**
WSP	Report by AN Drawn by JH Review by AN Date created 08.06.2017	Drawing Title: **Apparent Well Yields in Upper Lacombe Aquifer Lacombe County**	Figure Number: **6**
WSP Ref.: **161-15869-00**		**Groundwater Assessment Report**	

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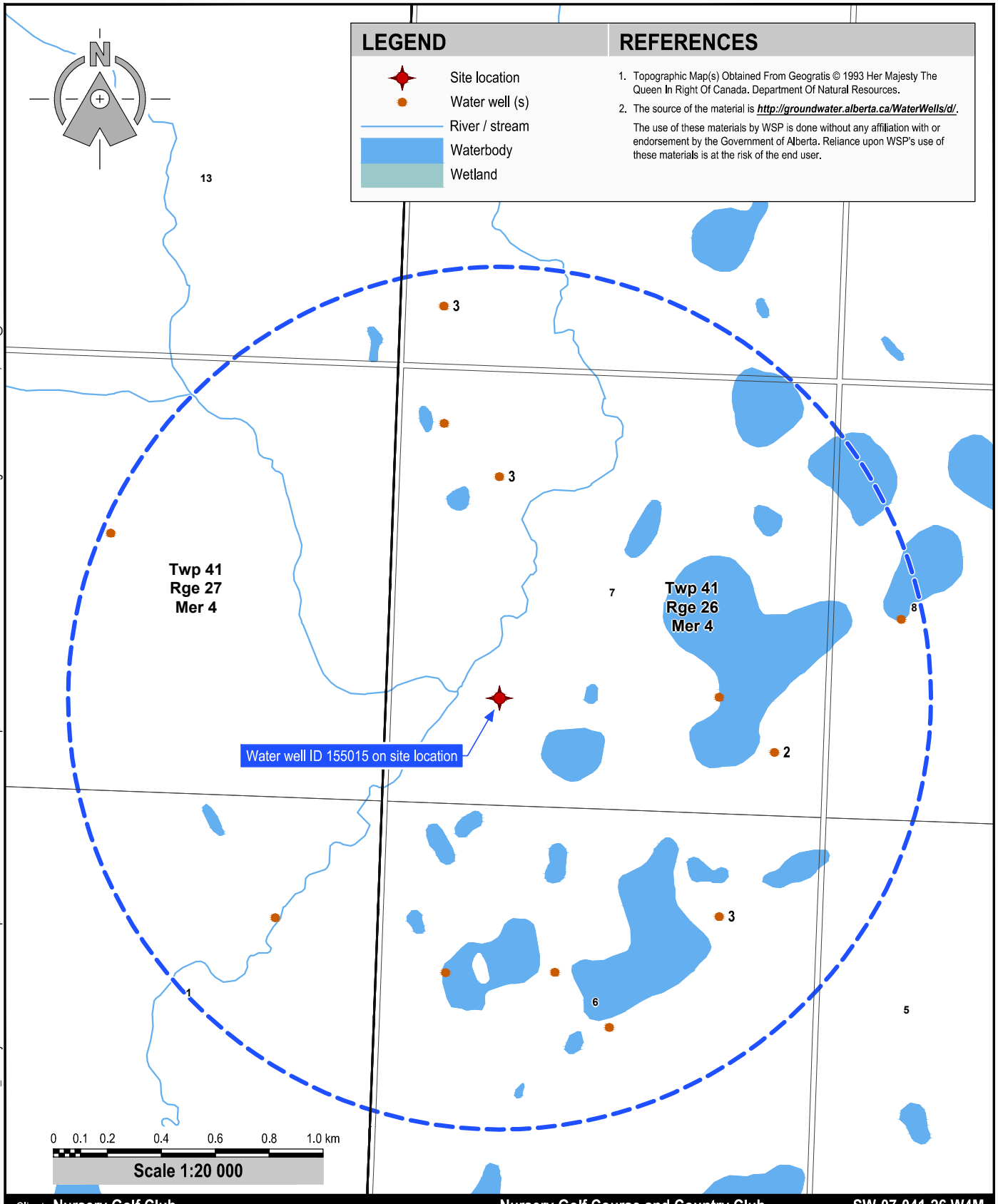

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Drawing Title

Water Wells Within 1.6 km of Site Location

Figure Number

7

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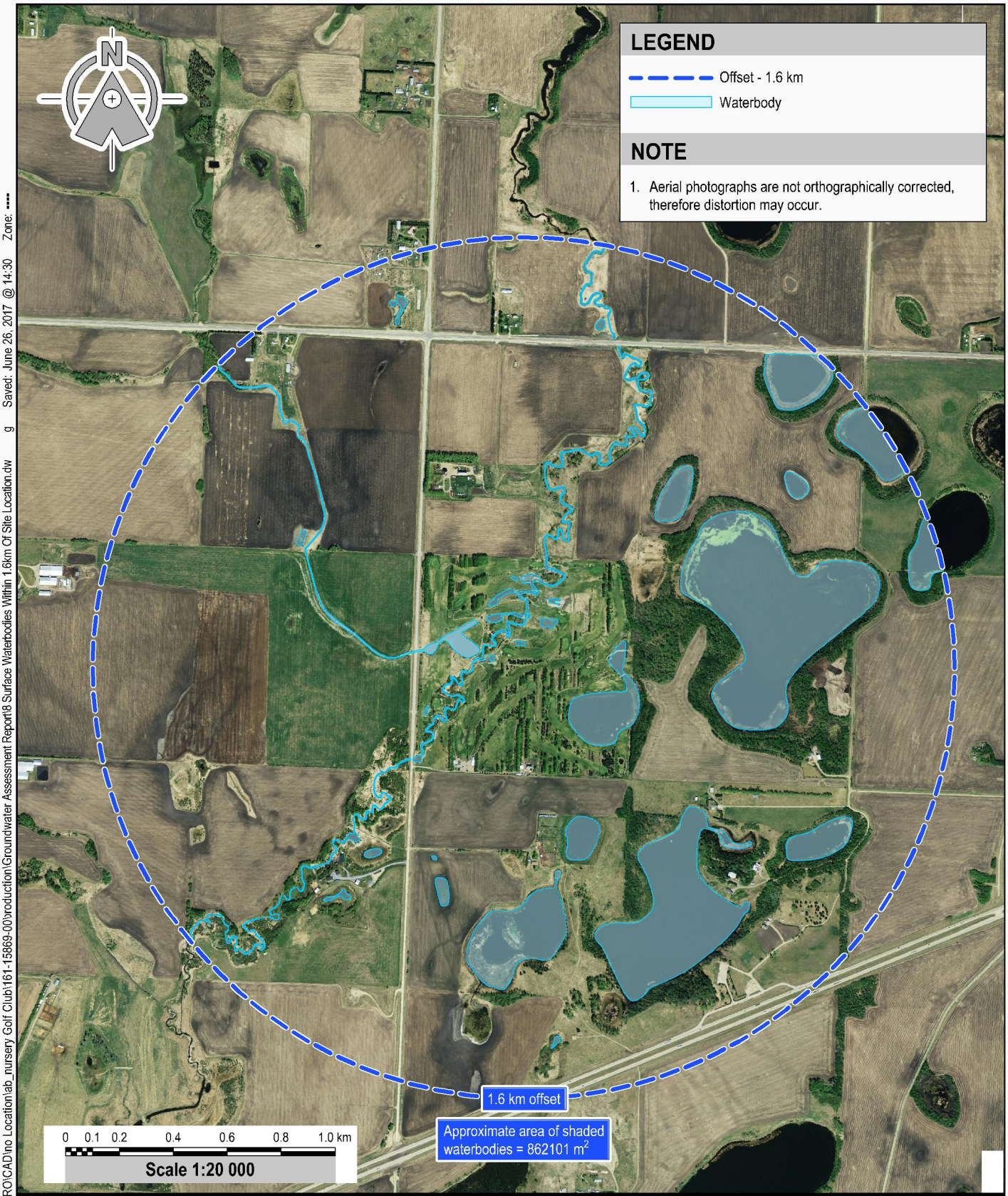

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Drawing Title

Surface Waterbodies Within 1.6km of Site Location

Figure Number **8**

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APPENDIX

A WATER WELL RECORD

Quarter: ☐ Lot:

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude: 52 30 43 Longitude: 113 44 45 Elevation: 2798

m/ft from ☐ N ☐ S m/ft from ☐ E ☐ W ☐ Hand Held Auto 20-30m ☐ Diff. Corr. Hand Held 5-10m ☐ Surveyed GPS <1m

2 Drilling Information

Method of Drilling:
☐ Auger
☐ Backhoe/Pug
☐ Boring
☐ Cable Tool
☐ Rotary (air)
☐ Rotary (mud)

Type of Work:
☐ New Well (Producing)
☐ Test Hole or ☐ New Well (Dry) Plugged:
Plugged with: ☐ Bentonite Slurry ☐ Bentonite Chips ☐ Cement
☐ Other (Specify):
Amount Used:
☐ Deepened Well
☐ Reconstructed Well - Well ID (if applicable):

Proposed Well Use:
☐ Household (up to 1250 m3/yr with residence on property)
☐ Other (Specify):
COMMERCIAL

(Note: All wells, except household wells, must be licenced by Alberta Environment to divert and use groundwater)

3 Formation Log

Measurements in: ☐ Metric ☐ Imperial

Depth from ground level	Indicate if Water Bearing	Lithology Description
15		YELLOW SAND
25		GREY CLAY
82	✓	GRAVEL
201		GREY SHALE
209		GREEN SHALE
268		GREY SHALE
292		GREY SALT + PEPPER SANDSTONE
315		GREY SHALE

4 Well Completion

Measurements in: ☐ Metric ☐ Imperial

Total Depth Drilled:	Finished Well Depth:	Start Date	End Date
315	315	17 03 29	17 04 03

Borehole:
Diameter: 6" From: 0 To: 315
Diameter: From: To:

Surface Casing: (if applicable)
☐ Steel
☐ Galvanized Steel
☐ PVC
☐ Fiberglass
☐ Cement
☐ Other
Size OD: 7"
Wall Thickness: .314
Bottom at: 103.40

Well Casing/Liner:
☐ Steel ☐ Galvanized Steel
☐ PVC ☐ Fiberglass
☐ Other:
Size OD: 4.5 Wall Thickness: .237
Top at: 95 Bottom at: 315
Perforations:
From: 275 To: 315
From: To:
Size: x
Perforated by: ☐ Machine ☐ Saw ☐ Drill ☐ Other:

Annular Seal: ☐ Bentonite Slurry ☐ Bentonite Chips ☐ Cement
Placed From: 0 To 103.40
Amount:
☐ Drive Shoe, at: 103.40 ☐ Welded Ring, at:
☐ Shale Trap, at: 275 - 100 ☐ Other, at:

Screen Type: ☐ Stainless Steel ☐ PVC
Size OD:
Interval From: To: Slot Size:
Interval From: To: Slot Size:
☐ Telescoped ☐ Attached to Casing
Top Fittings: ☐ Packer ☐ Coupler Bottom Fittings: ☐ Wash-down ☐ Bail ☐ Plug

Pack:
☐ Artificial/Mechanical ☐ Natural Grain Size: Amount:

5 Yield Test

Measurements in: ☐ Metric ☐ Imperial Taken From: ☐ Top of Casing ☐ Ground Level

Test Date:	Start Time:	Distance From Top of Casing to Ground Level:	Static Water Level:
17 04 03	09:00 am/pm	3' m/ft	47.12 m/ft

☐ Artesian Flow Rate: L/min or igpm
☐ Yes, flow control installed Describe:

Method of Water Removal:
☐ Pump
Pumping Rate: L/min / igpm
Depth Pumped From: m/ft
☐ Bailer
Water Removal Rate: 15 L/min / igpm
Depth Bailed From: 315 m/ft
☐ Air
Water Removal Rate: L/min / igpm
Depth Air Tested From: m/ft

If water removal period was <2 hours, explain why:

Recommended Pump Rate: 20+ L/min or igpm
Recommended Pump Intake Depth (From TOC): 100 m/ft
Pump installed ☐ Yes Depth:
Type: Model: H.P:

Did you Encounter: ☐ Saline Water (>4000 ppm TDS) Depth: m/ft
☐ Gas Depth: m/ft
Remedial Action Taken:

☐ Well Disinfected Upon Completion
Geophysical Log Taken:
☐ Electric ☐ Gamma
☐ Other (Specify):

Additional Comments on Well:

Sample Collected for Potability:
☐ Yes (☐ Result Attached)
☐ No

Depth to water level

Elapsed Time Minutes	Pumping	Recovery
0		51.97
1		50.16
2		49.56
3		49.24
4		49.05
5		48.90
6		48.78
7		48.67
8		48.59
9		48.53
10		45.40
12		48.34
14		48.25
16		48.15
18		48.02
20		47.98
25		
30		
35		
40		
50		
60		

6 Water Diverted for Drilling

Water Source:	Amount Taken:	Diversion Date:	Time:
CITY OF CALGARY	500 GAL	17 03 29	1000 am/pm

7 Contractor Certification

☐ Copy of Drilling Report Given to Owner

Name of Journeyman responsible for drilling/construction of well: Certification No:

JC DRILLING JIM CHRISTENSEN 65702

Water Well Drilling Report

Alberta ENVIRONMENT

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well I.D.	
GoA Well Tag No.	
Date Report Received	

❶ Well Identification and Location

Owner Name	Address	Town	Postal Code
NURSERY GOLF & COUNTRY CLUB	Box 5210	LACOMBE	T4L 1W9

Location 1/4 or LSD:	SEC:	TWP:	RGE:	W of MER:	Lot:	Block:	Plan:	Additional Description:
SW	7	41	26	W4				

Measured from Boundary of: ❑ Quarter ❑ Lot

|1|0|0| m/ft from ❑ N ☑ S |5|0|0| m/ft from ❑ E ☑ W

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude: 52 3043 Longitude: 113 4455 Elevation: 2798

❑ Hand Held Auto 20-30m ❑ Diff. Corr. Hand Held 5-10m ❑ Surveyed GPS<1m

❷ Drilling Information

Method of Drilling:
- ❑ Auger
- ❑ Backhoe/Dug
- ❑ Boring
- ☑ Cable Tool
- ❑ Rotary (air)
- ❑ Rotary (mud)

Type of Work:
- ☑ New Well (Producing)
- ❑ Test Hole or ❑ New Well (Dry) Plugged: YY MM DD
- Plugged with: ❑ Bentonite Slurry ❑ Bentonite Chips ❑ Cement
- ❑ Other (Specify):
- Amount Used: _____
- ❑ **Deepened Well** - **Well ID (if applicable):**
- ❑ **Reconstructed Well**

Proposed Well Use:
- ❑ Household (up to 1250 m3/yr with residence on property)
- ❑ Other (Specify): COMMERCIAL

(Note: All wells, except household wells, must be licenced by Alberta Environment to divert and use groundwater)

❸ Formation Log

Measurements in: ❑ Metric ☑ Imperial

Depth from ground level	Indicate if Water Bearing	Lithology Description
15		YELLOW SAND
25		GREY CLAY
82	✓	GRAVEL
201		GREY SHALE
209		GREEN SHALE
268		GREY SHALE
292		GREY SALT + PEPPER SANDSTONE
315		GREY SHALE

❹ Well Completion

Measurements in: ❑ Metric ☑ Imperial

Total Depth Drilled	Finished Well Depth	Start Date	End Date
315	315	17 03 29	17 04 03

Borehole:
Diameter: 6" From: 0 To: 315
Diameter: From: To:

Surface Casing: (if applicable)
- ☑ Steel
- ❑ Galvanized Steel
- ❑ PVC
- ❑ Fiberglass
- ❑ Cement
- ❑ Other

Size OD: 7" Wall Thickness: .314 Bottom at: 103.40

Well Casing/Liner:
- ❑ Steel ❑ Galvanized Steel
- ☑ PVC ❑ Fiberglass
- ❑ Other:

Size OD: 4.5 Wall Thickness: .237
Top at: 95 Bottom at: 315

Perforations:
From: 275 To: 315
From: To:
Size: X
Perforated by: ❑ Machine ☑ Saw ❑ Drill ❑ Other:

Annular Seal: ☑ Bentonite Slurry ❑ Bentonite Chips ❑ Cement
Placed From: 0 To 103.40
Amount:
❑ Drive Shoe, at: 103.40 ❑ Welded Ring, at:
❑ Shale Trap, at: 275 - 100 ❑ Other, at:

Screen Type: ❑ Stainless Steel ❑ PVC
Size OD:
Interval From: To: Slot Size:
Interval From: To: Slot Size:
❑ Telescoped ❑ Attached to Casing
Top Fittings: ❑ Packer ❑ Coupler Bottom Fittings: ❑ Wash-down ❑ Bail ❑ Plug

Pack:
❑ Artificial/Mechanical ❑ Natural Grain Size: Amount:

❺ Yield Test

Measurements in: ❑ Metric ☑ Imperial Taken From: ☑ Top of Casing ❑ Ground Level

Test Date	Start Time	Distance From Top of Casing to Ground Level	Static Water Level
17 04 03	09.00 am/pm	3' m/ft	47.12 m/ft

❑ Artesian Flow Rate: L/min or igpm
❑ Yes, flow control installed Describe:

Method of Water Removal:

❑ Pump	☑ Bailer	❑ Air
Pumping Rate: L/min / igpm	Water Removal Rate: 15 L/min / igpm	Water Removal Rate: L/min / igpm
Depth Pumped From: m/ft	Depth Bailed From: 315 m/ft	Depth Air Tested From: m/ft

If water removal period was <2 hours, explain why:

Recommended Pump Rate: 20+ L/min or igpm
Recommended Pump Intake Depth (From TOC): 100 m/ft

Pump installed ❑ Yes Depth:
Type: Model: H.P.:

Did you Encounter: ❑ Saline Water (>4000 ppm TDS) Depth: m/ft ❑ Gas Depth: m/ft

Remedial Action Taken:

Additional Comments on Well:

☑ **Well Disinfected Upon Completion**

Geophysical Log Taken:
❑ Electric ❑ Gamma
❑ Other (Specify):

Sample Collected for Potability:
❑ Yes (❑ Result Attached)
☑ No

Depth to water level

Elapsed Time Minutes	Pumping	Recovery
0		51.97
1		50.16
2		49.56
3		49.24
4		49.05
5		48.90
6		48.78
7		48.67
8		48.59
9		48.53
10		48.40
12		48.34
14		48.25
16		48.13
18		48.02
20		47.99
25		
30		
35		
40		
50		
60		
75		
90		
105		
120		

❻ Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date	Time
CITY OF LACOMBE	500 GAL	17 02 29	1000 am/pm

❼ Contractor Certification

❑ Copy of Drilling Report Given to Owner

Name of Journeyman responsible for drilling/construction of well: Certification No:

JC DRILLING JIM CHRISTENSEN 65702

Company Name:

☑ *I certify that this well was constructed in accordance with the Water (Ministerial) Regulation of the Water Act. All information in this record is true and describes the works and hydrogeologic conditions at the time of well completion only.*

Approval Holder Signature: Date: 17 04 05

(ENVIR 03/09) White copy: Alberta Environment Yellow copy: Well Owner Pink copy: Contractor

APPENDIX

B RECONNIASSANCE REPORT

Reconnaissance Report

View in Imperial

Export to Excel

Groundwater Wells

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

Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIAM (cm)
93373	12	06	041	26	4	SCHMIDT DRILLING LTD.	1963-06-04	85.34	New Well	Industrial		10		IMPERIAL OIL LTD	21.34	45.46	13.67
93374	11	06	041	26	4	GERMAN R E	1967-10-31	103.63	New Well	Unknown		6		CAN UNION COLLEGE	22.86	68.19	10.16
93375	NE	06	041	26	4	UNKNOWN DRILLER		60.96	Chemistry	Domestic				JUNIPER LODGE RESTAURANT	24.38		0.00
93376	NE	06	041	26	4	SCHMIDT DRILLING LTD.	1964-03-15	91.44	New Well	Industrial		12		SWAIN, M.	42.67	68.19	13.97
93377	NE	06	041	26	4	SCHMIDT DRILLING LTD.	1986-11-06	103.63	New Well	Domestic		9		DUNBAR, R.	34.44	272.77	16.84
93378	00	06	041	26	4	UNKNOWN DRILLER		0.00	Chemistry	Unknown				CAN UNION COLLEGE			0.00
93379	SE	07	041	26	4	SCHMIDT DRILLING LTD.	1984-07-24	51.82	New Well	Domestic & Stock		6		JOHNSON, L.	13.72	45.46	14.12
93380	NW	07	041	26	4	UNKNOWN DRILLER		60.96	Chemistry	Domestic				DOUGLAS, W.S.	5.49		0.00
93381	NW	07	041	26	4	UNKNOWN DRILLER		42.67	Chemistry	Domestic				DOUGLAS, W.S.	36.58		0.00
93382	NW	07	041	26	4	SCHMIDT DRILLING LTD.	1988-04-22	67.06	New Well	Domestic & Stock		14		DOUGLAS, GORDON	10.67	68.19	13.97
93383	13	07	041	26	4	UNKNOWN DRILLER		18.29	Federal Well Survey	Unknown				DOUGLAS, J.M.			0.00
93471	04	18	041	26	4	GERMAN R E	1963-07-28	33.53	New Well	Domestic		4		DOUGLAS, J.	5.49	27.28	10.16
93472	04	18	041	26	4	UNKNOWN DRILLER	1915-01-01	42.67	Well Inventory	Unknown		1			37.80		0.00
93473	04	18	041	26	4	UNKNOWN DRILLER		48.77	Federal Well Survey	Unknown				DOUGLAS, J.M.			0.00
155015	SW	07	041	26	4	FLINN DRILLING LTD.	1982-10-25	92.96	New Well	Irrigation		10		LACOMBE NURSERIES LTD/HAY,B.	79.25	45.46	14.12
237955	NE	01	041	27	4	ALKEN BASIN DRILLING LTD.	1994-04-18	60.96	New Well	Domestic		19	19	FELLER, HANS	15.24	27.28	13.97
274526	11	12	041	27	4	UNKNOWN DRILLER	1935-08-06	9.14	Federal Well Survey	Unknown				SCHELLING			0.00
294986	05	08	041	26	4	J.C. DRILLING	2000-05-24	64.01	New Well	Domestic		11	25	SNIHUR, ROB	4.82	45.46	16.81
1380070	1	7	41	26	4	J.C. DRILLING	2013-08-20	46.63	New Well	Domestic		10	20	BREITKREUZ, ALFRED	8.00	31.82	17.78
1380077	1	7	41	26	4	J.C. DRILLING	2013-08-30	72.54	New Well	Domestic		19	20	BREITKREUZ, ALFRED	7.95	45.46	17.78

Baseline Water Well Tests

Please click the water Test ID to generate the Baseline Water Well Test Report.

Test ID	GIC Well ID	LSD	QTR	SEC	TWP	RGE	M	Resource Company	Testing Date	Water Quality	Pump Test	Gas	Isotopes
1078130		6	SW	12	41	27	4		2007-03-22	-	Yes	-	-

APPENDIX

C PUMPING TEST ANALYSIS

WSP
1200, 10909 Jasper Avenue
Edmonton, Alberta
T5J 3L9

Pumping Test Analysis Report

Project: Nursery RV Park

Number: 161-15869-00

Client: Nursery Golf & Country Club

Location: SW-7-41-26-W4M	Pumping Test: Pumping Test 1	Pumping Well: Well 1
Test Conducted by:	Test Date: 4/27/2017	Discharge Rate: 163.5 [m³/d]
Observation Well: Well 1	Static Water Level [m]: 13.40	Radial Distance to PW [m]: -

	Time [min]	Water Level [m]	Drawdown [m]
1	0	13.60	0.20
2	1	15.39	1.99
3	2	15.88	2.48
4	3	16.18	2.78
5	4	16.31	2.91
6	5	16.43	3.03
7	6	16.55	3.15
8	7	16.64	3.24
9	8	16.70	3.30
10	9	16.73	3.33
11	10	16.73	3.33
12	12	16.76	3.36
13	14	16.82	3.42
14	18	16.88	3.48
15	20	16.98	3.58
16	25	17.07	3.67
17	30	17.16	3.76
18	35	17.19	3.79
19	40	17.22	3.82
20	50	17.22	3.82
21	60	17.19	3.79
22	75	17.31	3.91
23	85	17.46	4.06
24	105	17.53	4.13
25	120	17.65	4.25

WSP
1200, 10909 Jasper Avenue
Edmonton, Alberta
T5J 3L9

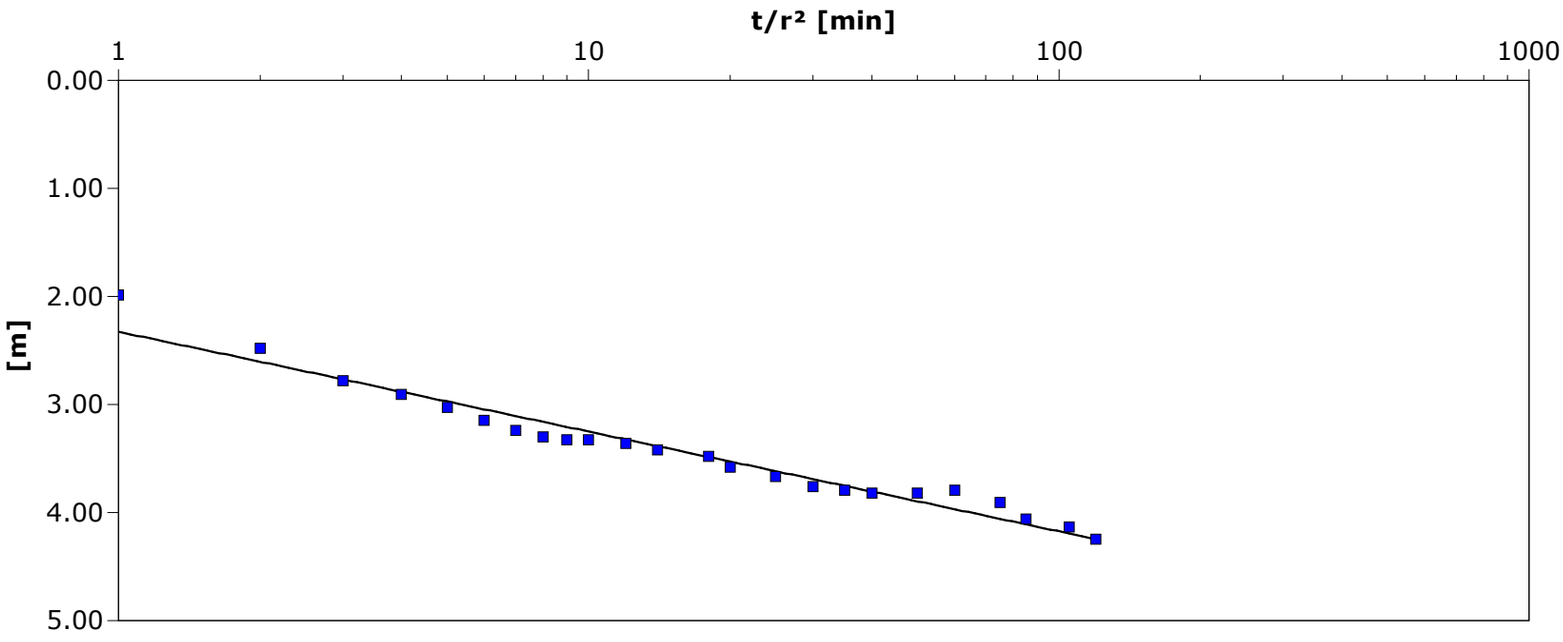
Pumping Test Analysis Report

Project: Nursery RV Park

Number: 161-15869-00

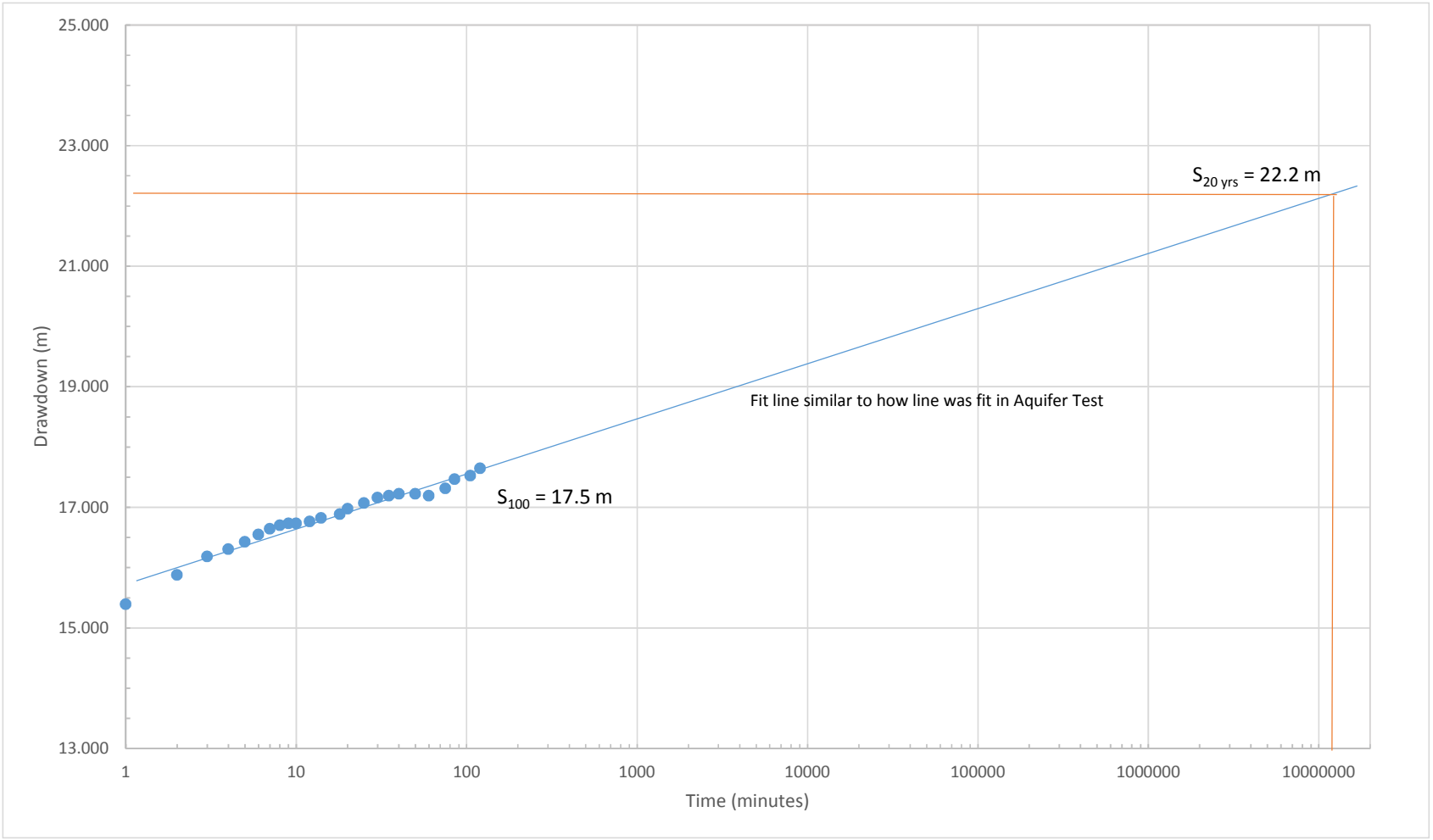
Client: Nursery Golf & Country Club

Location: SW-7-41-26-W4M	Pumping Test: Pumping Test 1	Pumping Well: Well 1
Test Conducted by:		Test Date: 4/27/2017
Analysis Performed by: A. Nilsson	New analysis 1	Analysis Date: 5/10/2017
Aquifer Thickness: 7.30 m	Discharge Rate: 163.5 [m³/d]	



Calculation using Theis

Observation Well	Transmissivity [m²/s]	Hydraulic Conductivity [m/s]	Storage coefficient	Radial Distance to PW [m]	
Well 1	3.75×10^{-4}	5.14×10^{-5}	4.73×10^{-2}	0.06	


25.000
23.000
21.000
19.000
17.000
15.000
13.000
Drawdown (m)
1
10
100
1000
10000
100000
1000000
10000000
Time (minutes)
$S_{20\ yrs}$ = 22.2 m
Fit line similar to how line was fit in Aquifer Test
S_{100} = 17.5 m

APPENDIX

D WATER QUALITY ANALYSIS

CERTIFICATE OF ANALYSIS

REPORTED TO	The Nursery Golf Club Box 5210 Lacombe, AB T4L 1W9	**TEL** **FAX**	(403) 392-7944
ATTENTION	Karl Dilllman	**WORK ORDER**	C705053
PO NUMBER		**RECEIVED / TEMP**	2017-05-19 09:39 / 10°C
PROJECT	Water	**REPORTED**	2017-05-29
PROJECT INFO	New Well Head	**COC NUMBER**	C705053

General Comments:

Central Labs' pledge is to provide quality service with precise and on-time results.

This Analytical Test Result shall not be reproduced except in full without the written authority of Central Labs . All samples will be disposed of after 30 days following analysis. Contact the lab if you require additional sample storage time. Unless otherwise specified, analytical testing was completed at Central Labs in Red Deer, Alberta. The results relate only to the item tested. Statistics, Detection Limits & Levels available upon request.

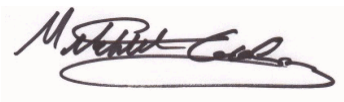
Work Order Comments:

Analysis was completed by a laboratory in Calgary, Alberta.

ND-not detected

Report Recipients:

Karl Dilllman (karl@nurserygolf.com)



Issued By: **Mitchell C. Golay, B.Sc., B.Ed.**
Business Development Manager

ANALYSIS INFORMATION

REPORTED TO	The Nursery Golf Club	**WORK ORDER**	C705053
PROJECT	Water	**REPORTED**	2017-05-29

Analysis Description	Method Reference (* = modified from) Preparation	Analysis	Location
Alkalinity in Water	N/A	SM 2320 B	Red Deer
Alkalinity parameters of water	N/A	Modified from SM 2320B	Red Deer
Ammonia in Water	N/A	N/A	Red Deer
Anions in Water	N/A	SM 4110	Red Deer
Cations in Water	N/A	SM 3120 B	Red Deer
Conductivity in Water	N/A	SM 2510 B	Red Deer
Electrical Conductivity of Water	N/A	Modified from SM 2510B	Red Deer
Odor (Subjective)	N/A	N/A	Red Deer
pH in Water	N/A	SM 4500-H+ B	Red Deer
pH of Water	N/A	Modified from SM 4500-H+ I	Red Deer
Potability package calculations	N/A	Modified from SM 1030E	Red Deer
Sodium Adsorption Ratio	N/A	CALC	Red Deer
Turbidity in Water	N/A	SM 2130 B	Red Deer

Method Reference Descriptions:

***	Other
Modified	Other
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

Glossary of Terms:

RDL	Reported Detection Limit
<	Less than the Reported Detection Limit (RDL)
mg/L	milligrams per Litre
uS/cm	microsiemens per centimeter

SAMPLE ANALYTICAL DATA

REPORTED TO The Nursery Golf Club
PROJECT Water

WORK ORDER C705053
REPORTED 2017-05-29

Analyte	Result	Guidelines for Canadian Drinking Water Quality (2017)	RDL	Units	Analyzed	Notes
Sample ID: The Nursery Golf Club - New Well Head (C705053-01) [Water] Sampled: 2017-05-19 00:00						
Alkalinity parameters of water						
Alkalinity, Phen.	29.2	N/A	2	mg/L	2017-05-23	
Alkalinity, Total	401.7	N/A	2	mg/L	2017-05-23	
Bicarbonate	418.4	N/A	2.5	mg/L	2017-05-23	
Carbonate	35.1	N/A	1.5	mg/L	2017-05-23	
Hydroxide	ND	N/A	0.5	mg/L	2017-05-23	
Anions in Water						
Chloride	10.83	AO ≤ 250	0.5	mg/L	2017-05-21	
Fluoride	1.41	MAC = 1.5	0.1	mg/L	2017-05-21	
Nitrate-N	ND	MAC = 10	0.01	mg/L	2017-05-21	
Nitrite-N	ND	MAC = 1	0.005	mg/L	2017-05-21	
Nitrite-N + Nitrate-N	ND	N/A	0.015	mg/L	2017-05-21	
Phosphate	0.21	N/A	0.1	mg/L	2017-05-21	
Sulphate	2.48	AO ≤ 500	0.5	mg/L	2017-05-21	
Cations in Water						
Calcium	0.8	N/A	0.1	mg/L	2017-05-23	
Hardness	2.0	N/A	0.1	mg/L	2017-05-23	
Iron	ND	AO ≤ 0.3	0.01	mg/L	2017-05-23	
Magnesium	ND	N/A	0.1	mg/L	2017-05-23	
Potassium	0.7	N/A	0.3	mg/L	2017-05-23	
Sodium	211.8	AO ≤ 200	0.1	mg/L	2017-05-23	
Electrical Conductivity of Water						
EC	763	N/A	1	uS/cm	2017-05-23	
pH of Water						
pH	9.1	AO = 7.0-10.5	0	NA	2017-05-23	
Potability package calculations						
Total Dissolved Solids (calculated)	473	N/A	10	mg/L	2017-05-24	

1700456

Central LABS

B5, 53 Burnt Park Drive Red Deer AB T4P 0J7

Ph: 403-348-TEST(8378) | TF: 1-888-750-5227 | Fax: 403-356-2952

"Accuracy & On-Time" http://www.c-labs.ca

WORK ORDER # C705053

Today's Date / Time:	May 19/17
Project Info: (name, location, ID, #, etc.)	
PO #:	

INVOICE TO:

Company / Name	The Nursery Golf Club
Mailing Address:	Box 5216
	Lacombe, AB T4L 1W9
Phone:	403-392-7944
Fax:	
Quote #:	

REPORT TO:

Mail:	Same as Invoice
Alt:	
E-mail:	Karl@NurseryGolf.com
E-mail:	
Fax:	

For full details, see Central Labs Ltd. website at http://www.c-labs.ca/services/

To service you better, complete the customer survey at http://www.surveymonkey.com/s/Y37KYZY

Analysis Sublet - Client Consent

Central Labs uses the services of accredited external laboratories for analyses which cannot be performed by Central Labs due to instrument breakdown or not set up to do the test. By signing below, you have given the consent to use the services of external laboratories when required.

Analysis Time:

E - Emergency ≤36 hrs

N - Normal ≤6 business days

Analysis & Timing

	Sample Name	Sample Date mm/dd/yy	Sample Time	Matrix (water / soil / sludge)	# Containers	Microtox	Microtox - Charcoal	Hydrocarbon - Total Extractable	Potable Water Chemistry	Total Coliforms & E.Coli	IRB / SRB (Coliforms)	Soil Typing (Basic)	Soil Typing / sand particle size	Class II Landfill	Detailed Salinity	CCME Metals - Dissolved	CCME Metals - Total	BTEX, F1-F4 / CCME Hydrocarbon	Septic Soils-Hydrometer/Sand	Sump Suitability	See Special Instructions
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	27
	Water Well	03/26/17	14:11	Water	3				E	E	N										
1	NEW well HEAD.	May 19		Water	1				N												
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					

Relinquished by:

Signature:

Print Name: Karl Dillman

Contact #:

Special Instructions:

PAID

OFFICE USE		
	IN	OUT
Date:	May 19/17	
Time:	9:39	
Temp °C:	9.5°C	
Received by:		

white copy-Central Labs yellow copy-client