FILE COPY

THE COUNTY OF VERMILION RIVER IN THE PROVINCE OF ALBERTA

BYLAW 14-32

A bylaw of the County of Vermilion River in the Province of Alberta to adopt the Area Structure Plan for Robinwood Estates (Lot 1, Block 1, Plan 1218TR in SE-33-49-1-W4M)

WHEREAS the Council of the County of Vermilion River deems it to be in the public interest to adopt the Robinwood Estates Area Structure Plan for Lot 1, Block 1, Plan 1218TR in SE-33-49-1-W4M;

NOW THEREFORE the Council of the County of Vermilion River, duly assembled, hereby enacts as follows:

THAT the Robinwood Estates Area Structure Plan for Lot 1, Block 1, Plan 1218TR in SE-33-49-1-W4M, being Schedule "A" attached to and forming part of this Bylaw, be adopted.

SHOULD any provision of this Bylaw be determined to be invalid, then such provisions shall be severed and the remaining bylaw shall be maintained.

THIS Bylaw shall come into force and effect upon receiving third and final reading and having been signed by the Reeve and Chief Administrative Officer.

Read a first time this 9 day of December, 2014

Advertised the 14 day of January, 2015 in the Meridian Booster AND the 22 day of January, 2015 in the Lloydminster Source

PUBLIC HEARING held the 27 day of January, 2015 at 1:00 p.m.

READ A SECOND TIME THIS 10th DAY OF February, 2015.

READ A THIRD TIME AND FINALLY PASSED THIS 10th DAY OF February, 2015.

SIGNED by the Reeve and Chief Administrative Officer this 18th day of February, 2015.

REEVE

CHIEF ADMINISTRATIVE OFFICER

Robinwood Estates Area Structure Plan

November 1, 2014

Submitted to:

County of Vermillion River

Submitted by:

McElhanney

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Appendix C	Desktop Hydrogeological Assessment – Thurber Engineering
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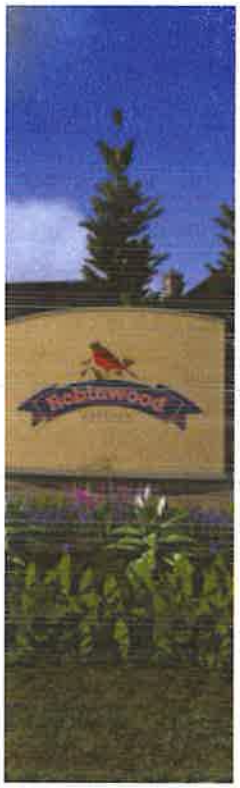


1.0 Introduction

1.1 Overview

The Robinwood Estates Area Structure Plan is intended to provide guidance for the development of a proposed 12 lot country residential development on Plan 1218TR, Block 1, Lot 1, in the County of Vermillion River. The Area Structure Plan is a document approved as a bylaw by the County of Vermillion River and will describe the future allocation of land-use and servicing provisions on the site.

1.2 General

The Area Structure Plan (hereinafter referred to as the "Plan") as provided for in the Municipal Government Act, shall describe how the land can be subdivided and developed in a coordinated way. It shall comply with the provisions of the County of Vermilion River Municipal Development Plan and County of Vermilion River Land Use Bylaw No. 07-13 and shall ensure that development occurs in a way that is safe, efficient and aesthetically pleasing.

1.3 Location

The Plan area is located at SE33-49-1-W4M, Lot 1, Block 1, Plan 1218TR, in the County of Vermillion River, Alberta. The plan area contains approximately 20 acres (8.09 ha) of land. The site is located approximately 1 mile south of highway 16 and 1 mile west of the City of Lloydminster's west boundary. The subject site is accessed by Range Road 13 to the east. The subject site is in agricultural use, currently cultivated for grain crops and farming operations surround the site in all directions. Please refer to Map 1: Site Location.

1.4 Vision

Robinwood Estates is envisioned as a gated country residential development with lot sizes ranging from 1.4 - 1.9 acres. This high quality development will provide residents with the opportunity for rural living, while still providing easy access to Highway 16 and the City of Lloydminster. The subdivision will provide architectural controls to create a unique development with a gated entrance, uniform fencing, landscaping, and consistency among housing styles to create a well designed, high quality community.

ROBINWOOD ESTATES AREA STRUCTURE PLAN

0 150 300 450 600m

NORTH

LEGAL DESCRIPTION:

PLAN 1218TR, BLOCK 1, LOT 1

COUNTY OF VERMILLION RIVER

Legend:

Site Boundary

City of Lloydminster Boundary

MAP 1 SITE LOCATION

1.5 Existing Policy Framework

Overview

The subject site is located within the boundaries of three Statutory Plan Overlays within the County. These include the County of Vermillion River and City of Lloydminster Intermunicipal Development Plan, the Central Area Structure Plan, and the Robinwood Acres Area Structure Plan. The site is also located within the study area of the City of Lloydminster Growth Study. In addition to these plans, the Robinwood Estates ASP must abide by the policies listed under the County's Municipal Development Plan and Land Use Bylaw. Policies relevant to the Robinwood Estates ASP area are listed below. Please refer to Map 2 - Policy Influences.

Provincial Policy Context

Municipal Government Act

Part 633(1) (2) of the Municipal Government Act outlines the requirements of an Area Structure Plan. It states that for the purpose of providing a framework for subsequent subdivision and development of an area of land, a council may by bylaw adopt an area structure plan.

An area structure plan

a) must describe

i) the sequence of development proposed for the area

ii) the land uses proposed for the area, either generally or with respect to specific parts of the area

iii) the density of population proposed for the area either generally or with respect to specific parts of the area, and

iv) the general location of major transportation routes and public utilities, and

b) may contain any other matters the council considers necessary

County of Vermillion River Municipal Development Plan Bylaw No. 13-13, 2013

The County of Vermillion River Municipal Development Plan provides guidance for the future growth and development of the County. Map 2 of the County MDP identifies the subject site as within the 'Residential Area' and within the Statutory Plan Area Overlay area surrounding the City of Lloydminster.

The following MDP Policy excerpts relate most directly to the Robinwood Estates Area Structure Plan. The Robinwood Estates ASP is consistent with the policies listed under the County's Municipal Development Plan.

4.2 Residential Area

Policy 4.2.1.2 Residential subdivisions should be located in proximity to gas, electrical, and telephone lines which have existing spare capacity to sustain the additional usage.

Policy 4.2.1.3 Residential subdivisions shall have direct access to existing maintained roads. Multi-lot residential subdivisions shall be encouraged to locate in proximity to paved County roads or provincial highways.

Policy 4.2.1.4 Where a subdivision for residential purposes is proposed, the developer shall be required to enter into a development agreement with the County wherein the developer agrees to be responsible for all the costs associated with the subdivision and development.

Policy 4.2.1.5 Documentation indicating that satisfactory arrangements have been made regarding the development's sewage disposal system may be a condition of approval for country residential development.

Policy 4.2.1.7 A multi-lot country residential subdivision shall be considered to be any subdivision which will create five (5) or more parcels for residential and/or agricultural use on a quarter section.

Policy 4.2.1.8 Where provided for in the Land Use Bylaw, the minimum lot size in residential area may be as low as 0.2 ha (0.5 ac.), provided that the entire lot is suitable for residential development.

Policy 4.2.1.11 The County will require an Area Structure Plan be prepared and approved prior to the approval of any amendment to the Land Use Bylaw to allow a multi-lot country residential subdivision where the land being proposed for development that is 20.0 ac. (8.09 ha) or greater in area, except that the County may require the preparation of a conceptual plan or outline plan if:

(a) the preparation of an Area Structure Plan is considered by the County to be impractical or inappropriate given:

(i) the small scale of the lands and lots proposed for development; or

(ii) the existing fragmentation of the quarter section in which the development is located.

Policy 4.2.1.12 Council's consideration of Land Use Bylaw amendments for multi-lot country residential use development will include the following criteria:

(a) The site should possess features such as trees, ravines, hilly terrain or other topographical features which would provide an attractive residential environment. When the amendment is to allow a currently vacant parcel from a quarter section, the site should not normally include cultivated land or good quality agricultural land. Where a site is fully or partially treed, all possible means will be undertaken to retain the maximum amount of tree cover.

(b) The density of development shall be directly related to the development capability of the land resources, such as potable water supply, topography, vegetation, soil and drainage. In this regard, proponents for multi-lot country residential development may be required to provide the County with an assessment of environmental constraints on the site and the means whereby negative impacts on the natural environment may be mitigated.
(c) Unless the proposed parcel is for the second or third parcel to be subdivided from a quarter section, access to individual lots will be provided by internal roads or service roads developed to standards acceptable to the County, and not directly onto Provincial Highways or County grid roads.
(d) There shall be an adequate supply of potable water for the development as proposed. The supply may be provided by wells or by other options, such as by hauling or by communal systems, in accordance with Provincial regulations. If the well option is to be considered, the Council will ask that the report required under the Water Act for multi-lot residential subdivisions be provided at the Land Use Bylaw amendment stage for its consideration. If the communal system is to be considered, Council will require that the creation or expansion of such systems be undertaken at the developer's cost, and not at the County's cost.
(e) Sanitary sewage shall be treated and/or disposed of in accordance with Provincial requirements. In this regard, the Council will ask that information be provided at the Land Use Bylaw amendment stage for its consideration. If a communal system is to be considered, Council will require that the creation or expansion of such systems be undertaken at the developer's cost, and not at the County's cost.

Policy 4.2.2.2 Multi-lot country residential developments should be clustered or grouped to reduce potential land use conflicts and minimize servicing costs.

Policy 4.2.3.1 The County will require the proponent of a multi-lot country residential development to identify all municipal servicing costs associated with the development. The assignment of these costs between the County and the developer will be the basis of a development agreement to be entered into prior to a subdivision approval or upon the issuance of a development permit. Normally, however, all development servicing costs associated with the development, including the provision of internal roadway systems to a high standard and the upgrading of other County roads leading to the site in order to provide good access to the residential site will be the responsibility of the developer.

Policy 4.2.3.2 The development process for multi-lot country residential development shall ensure that storm water is managed in accordance with good engineering practices and both Provincial and County requirements.

Policy 4.2.3.5 Documentation indicating that arrangements satisfactory to the County have been made regarding the development's water supply, sewage disposal, and storm water management systems, including access to the systems for maintenance and any necessary easements, shall be conditions of approval for multi-lot country residential development.

County of Vermillion River # 24 and City of Lloydminster Intermunicipal Development Plan, 2008

The subject site is within the boundary of the County of Vermillion River-City of Lloydminster Intermunicipal Development Plan (IDP), which outlines future growth and development within the fringe areas of the City of Lloydminster. Specifically the site is located within the Central Urban Expansion Area according to Map A of the IDP. The Central Urban Expansion area is intended to be the first area to be converted to urban densities for the next 30 years. This area will include primarily residential growth with retail commercial, secondary commercial and a minor industrial land uses. The subject site is located within the Central ASP area according to Map D of the IDP, although the Robinwood Acres ASP area is not part of the area designated for Limited Country Residential Use according to the IDP.

Map B of the IDP shows a future arterial running north-south along Range Road 13, directly east of the subject site.

The below IDP policies relate specifically to the Robinwood Acres ASP area, in which the subject site is situated:

4.2 General Land Use and Subdivision Policies

Existing uses continued

c) Parcels within the IDP area that are currently zoned for Business (B and B2), Industrial (M) and Country Residential (CR-1) may continue with those uses identified in the County Land uses Bylaw. New applications for subdivision and development are subject to any amendments to the land use bylaw as may arise from the implementation of this IDP.

4.3 Urban Expansion Area (UE) Policies

Existing Uses

4.3 b) Robinwood Acres, located in SE 33-49-1-W4M will remain zoned as Country Residential One (CR-1). Additional subdivision of Robinwood Acres is possible under the provisions of the CR-1 district. The Central ASP will address future subdivision design for this area.

Robinwood Acres

4.3 q) Robinwood Acres, located in SE33-49-1-W4M will remain zoned as Country Residential One (CR-1). Additional subdivision of Robinwood Acres is possible under the provisions of the CR-1 district. As urban development expands westward, landowners will be offered the opportunity to decide whether they wish to undertake an Area Redevelopment Plan (ARP) and prepare to re-subdivide the country subdivision to urban densities or remain unchanged. This option would be available to landowners upon written request to the County to undertake an ARP. The Central ASP will further address future subdivision design for this area.

The Robinwood Estates ASP meets the intent of the IDP as it allows for future residential growth in an area designated primarily for residential land use and abides by the above policies.

Robinwood Acres Area Structure Plan

The subject site is located within the boundaries of the Robinwood Acres Area Structure Plan which designates the area for residential development.

Robinwood Lot 2 Area Structure Plan

The subject site is located directly north of the Robinwood Lot 2 Area Structure Plan boundary. The Robinwood Lot 2 ASP proposes 3 country residential lots, plus the remaining existing country residential lot to the south of the subject site. All lots are accessed from White Fence Road. There are no policies of concern listed under the Robinwood Lot 2 ASP as the country residential uses proposed in the Robinwood Estates ASP are compatible with land uses in the area.

Central Urban Expansion Area Structure Plan, 2008

The Central Urban Expansion Area Structure Plan is intended to direct the implementation of the Vermilion River County/City of Lloydminster Intermunicipal Development Plan (IDP) as it applies to approximately five sections of land at the extreme western edge of City of Lloydminster. The Robinwood Estates ASP is located within the boundaries of the Central Urban Expansion ASP. The majority of the Central UE Plan is devoted to the transition from rural to urban land use over time.

The Conceptual Urban Layout Map of the Central UE ASP shows UE Urban Expansion Limited Country Residential development directly to the north and east of the Robinwood Estates site and approximately 800 metres south of the subject site. Land further west and northwest of the site is illustrated as green space. As the surrounding area develops into urban residential densities it will eventually demand urban services for water, sewer, and stormwater. The Robinwood Acres ASP area itself is left with no future land use designation as it is already within an ASP boundary and will abide by the policies listed under the Robinwood Acres ASP. The Robinwood Estates plan area is already zoned for country residential development and will meet County and Provincial guidelines with respect to water and sewer servicing, and stormwater management.

The following policy relates to the Robinwood Acres ASP area, which encompasses the Robinwood Estates ASP plan area:

> *Policy 4.5 With respect to Robinwood Acres (SW 33-49-1-W4M), the Central UE ASP serves to identify the major planning components surrounding Robinwood Acres so that these are known to the landowners should they decide to participate in the eventual urbanization of the area and embark upon an area redevelopment plan in accordance with relevant IDP policy and the provisions of the MGA.*

The Central Urban Expansion ASP refers readers to the policies listed under section 4.3 of the County of Vermillion River-City of Lloydminster IDP:

> *Policy 4.12 All applicable policies in Section 4.3 of the IDP, by virtue of this Policy, are formally incorporated and form part of the Central UE Plan.*

City of Lloydminster Growth Study, 2013

The City of Lloydminster Growth Study determines growth directions within and beyond city limits to accommodate Lloydminster's future growth over the next 30 years. The subject site is located within the study area for the Growth Study (within the central urban expansion sub-area).

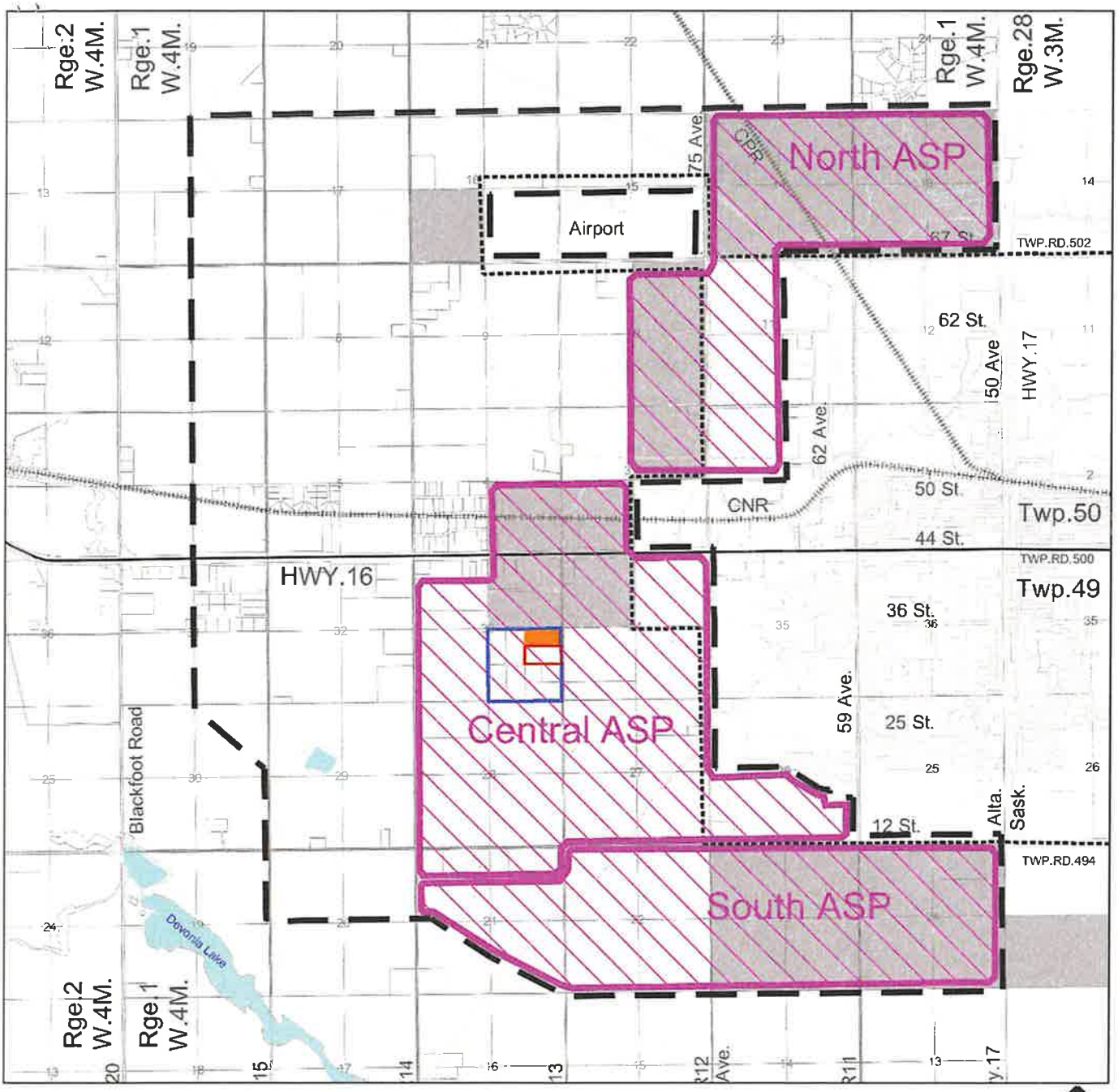
Map 4 – Opportunities and Constraints of the growth study, illustrates the subject site as a 'Residential' land use opportunity.

Map 7 of the Growth Study illustrates proposed annexation areas outside City limits. The subject site is not within an annexation area but is directly south of the west annexation area, comprising of four quarter sections of land immediately west of the City on either side of Highway 16 planned for non-residential development.

Figure 2.1 of the City of Lloydminster Servicing Assessment, which accompanies the growth study, illustrates the subject site and residential area surrounding the subject site with a 12 point Overall Utility (Storm, Wastewater, Water) Servicing Assessment scoring which indicates long term development potential. Scores from 1-7 are classified as short term development potential, 8-11 medium term development potential, and 12-15 long term.

County of Vermillion River Land Use Bylaw No. 13-14, 2013

The current County of Vermillion River Land Use Bylaw designates the parcel as Country Residential One (CR1) District. The Purpose of this District is to allow multi-lot country residential development. Single family dwellings as proposed in this ASP are a Permitted Use under this district. The district specifies a minimum lot area of 1 acre. The minimum lot size within the Robinwood Estates development is 1.4 acres, with the largest being 1.9 acres.



ROBINWOOD ESTATES AREA STRUCTURE PLAN

LEGAL DESCRIPTION:

PLAN 1218TR, BLOCK 1, LOT 1

COUNTY OF VERMILLION RIVER

Legend:

- **Site Location**
- **City of Lloydminster/County of Vermillion River IDP Boundary**
- **City of Lloydminster Boundary**
- **Area Structure Plan Boundaries**
- **Proposed Annexation Areas (From Lloydminster Comprehensive Growth Strategy Map 7)**
- **Lot 2 Robinwood Acres ASP**
- **Robinwood Acres ASP**

MAP 2 POLICY INFLUENCES

2.0 Existing Site Conditions

2.1 Existing and Surrounding Land Use

The subject site is currently in agricultural use, cultivated for grain crops. There are no dwellings and/or buildings on the parcel. The subject site is currently designated as Country Residential One District (CR1) according to the County of Vermillion River Land Use Bylaw No. 13-14. The purpose of the CR1 District is to allow multi-lot country residential development with a minimum lot area of one acre. Please refer to Map 3: Existing Land Use Districts map.

Surrounding Land Use - There is an existing residence and barn on the parcel directly south of the site. Farming operations surround the site in all directions. The property to the north includes a residence and barn with horses, the land to the east is being operated as an elk farm, and the lands to the south and west are also agricultural lands with residencies and barns.

2.2 Topography, Drainage, Vegetation and Habitat

The Plan area is relatively flat, with a gentle topography sloping slightly towards the drainage channel in the middle of the site. The drainage channel flows to the north from the site and has been heavily impacted by agricultural activity.

The subject site is within the Aspen Parklands region which consists of open grasslands alternating with groves of trees. Specifically the site is located in the Central Parkland Natural Sub-region which is a transitional ecosystem between prairie and boreal forest. The area is generally described as being relatively flat agricultural land. The site is currently being cultivated and in agricultural use. There are trees located along the north and west perimeters of the site. Please refer to Map 4: Topography and Natural Features.

Relatively flat agricultural land

Gentle slope towards drainage channel

2.3 Phase I Environmental Site Assessment

A Phase I Environmental Site Assessment was completed by McElhanney Consulting Services for the plan area, which included a site visit, interviews with the landowner and surrounding landowners, evaluation, and reporting. The evaluation took into consideration the subject site and the 19 acre parcel to the south of the site. The assessment concludes that current and historical activities are unlikely to have impacted the environmental media at the site. No further environmental assessment is recommended at this time. No areas of concern were flagged on the subject site.

For further information please refer to **Appendix A** under a separate cover.

2.4 Soils

The County of Vermillion River Land Report - Rural Farmland Assessment gives an RFA rating of 27% on the 20 acre subject site and CLI Pasture Ratings of Classes 6 and 7. The soils within the Plan area have been identified as Canada Land Inventory (CLI) Class 2. According to discussions with the County, as the lands are within an existing area structure plan and a growth area designated for future residential use, the agricultural ratings do not apply even if the lands are currently being used as crop or pasture lands.

2.5 Geotechnical Analysis

A Geotechnical Assessment was undertaken for the Plan area by Solid Earth Geotechnical Inc. The full report can be found in **Appendix B** under a separate cover. Eight boreholes were drilled onsite to evaluate the subsurface soil and groundwater conditions at the site and provide geotechnical considerations and recommendations for site development, foundation and basement systems for single family houses, and roadway construction.

The subsurface soils encountered at the borehole locations generally consisted of cultivated topsoil followed by clay till. Sand layers were encountered inter-bedded within the clay till at several borehole locations. Cultivated topsoil was encountered at the ground surface of all borehole locations and was generally less than 250 mm thick.

Groundwater depths onsite ranged between 0.7 and 1.3 metres below existing ground surface.

2.6 Geotechnical Recommendations

The subsurface conditions at the site were considered favourable for site grading, roadway construction, and for the construction of single family residential units. Shallow footings and slab-on-grade floors are considered suitable for the single family dwellings at the site.

Due to the shallow groundwater table onsite, it is recommended that considerations be given to elevating the houses' footprints above the current grades by building a clay pad to allow the houses to be constructed with the basement floor above the groundwater table. For further recommendations on site grading, drainage, roadways, basements, foundations, and lot grading please refer to the Geotechnical Report located in **Appendix B**.

2.7 Site Suitability Testing for Wastewater Disposal Systems

The geotechnical report completed by Solid Earth Geotechnical Inc. evaluated the overall suitability of subsurface conditions (soil and groundwater) for the use of on-site wastewater disposal systems, in accordance with the guidelines of the Safety Codes County (SCC) *"Alberta Private Sewage Systems Standard of Practice, 2009."*

The predominant soils across the majority of the site were medium plastic clay till and based on grain size distribution analysis, the soils were classified as "Sandy Clay Loam, which is deemed suitable by the SCC *"Alberta Private Sewage Systems Standard of Practice, 2009."*

A shallow groundwater table was measured across the site, which is considered restrictive for the use of conventional on site wastewater disposal and treatment systems. However, alternate disposal systems, such as raised treatment fields, holding tanks, or Class 2 packaged sewage treatment plants are an option onsite. The Robinwood Estates subdivision proposes mounded (raised) wastewater disposal and treatment systems in accordance with the recommendations of the geotechnical report.

For further information, please refer to the Geotechnical Report located in **Appendix B**.

2.8 Groundwater Potential

A Desktop hydrogeological assessment for groundwater potential and quality onsite was completed by Thurber Engineering Ltd. Based on the information reviewed in relation to the proposed subdivision development area, there is a potential for a groundwater based water supply.

The approximate AQ20 beneath the proposed development area is in the order 300m3/day in relation to 41 m3/day for up to 12 lots. However, the capability of a water well to supply such quantity can only be confirmed by completing one pumping well and one observation well within the new development area and performing a pumping test. The average water well depth in the area is 70 m. The existing groundwater quality data shows that the water may not be potable as compared to the CDWQ criteria but treatment could likely make it potable.

The assessment recommends that a pumping test comprising of 24 hours pumping and 24 hour of recovery be performed onsite. A groundwater sample should also be collected as part of the pumping test in order to assess groundwater quality. The Phase II analysis/pump test will be completed at the subdivision stage of the project.

For further information please refer to **Appendix C** under a separate cover.

2.9 Existing Transportation Features

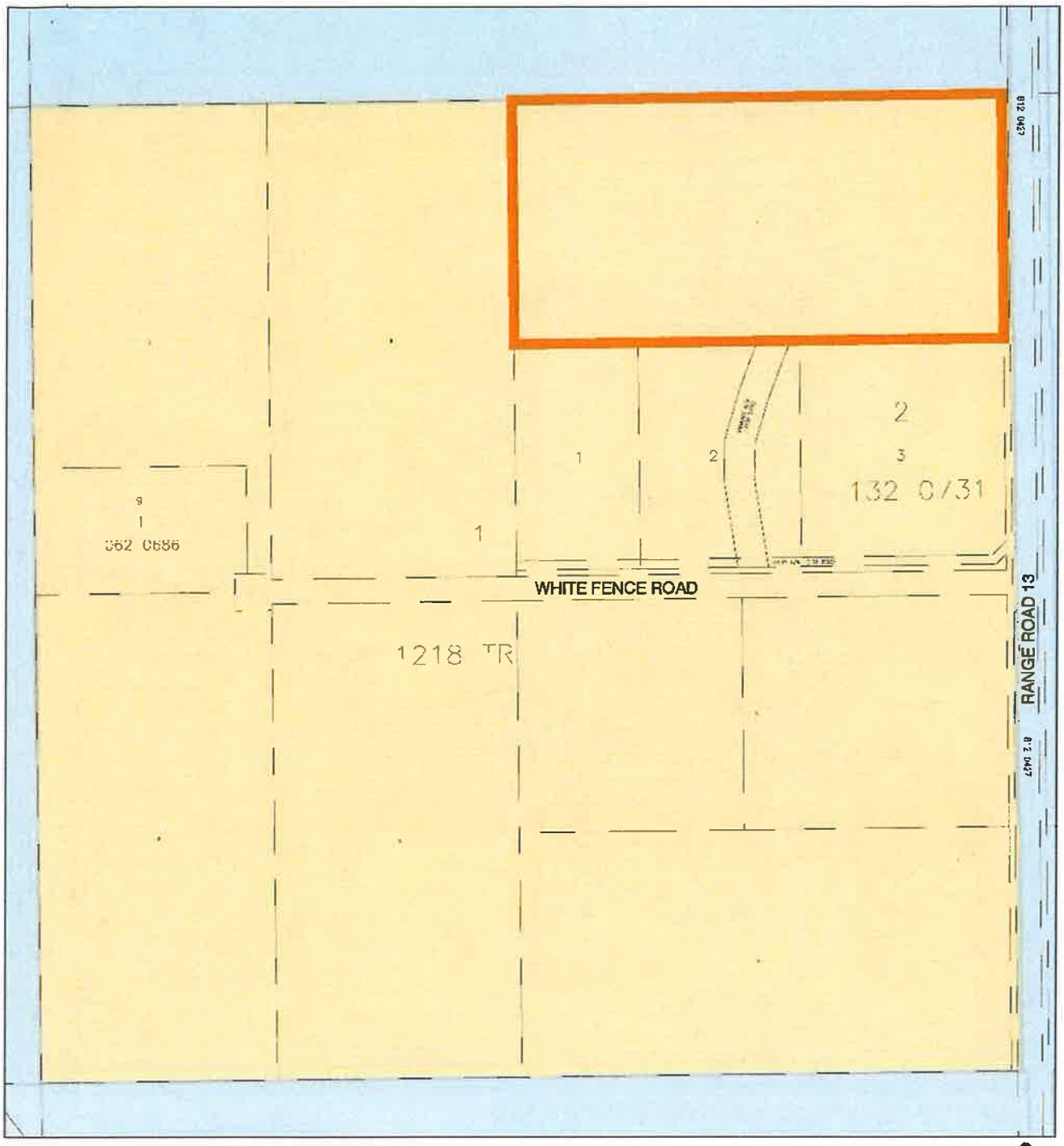
Access to the site will be from Highway 16 to the north and then south on Range Road 13 to the east of the site. Highway 16 is a four lane divided highway with a posted speed of 110 km/hr in the vicinity of Range Road 13. Range Road 13 is currently a gravel roadway with a posted speed limit of 50 km/hr. The existing Highway 16 / Range Road 13 intersection is stop controlled on the north and south legs, with no acceleration or deceleration lanes along Highway 16. White Fence Road is situated approximately 400 metres south of the subject site and provides access to 3 country residential lots. Please refer to Map 5: Transportation Features.

Alberta Transportation has a long term proposal for the re-alignment of Highway 16 approximately 1.5 miles southwest of the site with a potential interchange at SW1-50-2-W4M.

2.10 Shallow Utilities

The adjacent and surrounding lands have access to natural gas, telephone, and power. A low pressure ATCO natural gas line extends along the White Fence road right of way to the south of the site. There are gas mains in the area but there will be a need for a main extension to service the proposed 12 lots.

ATCO Electric provides power to the residences in the area through a north-south three phase overhead power line along the east side of RR13. Conversations with ATCO electric indicate that there are no issues providing power to the subject site.



ROBINWOOD ESTATES AREA STRUCTURE PLAN

0 50 100 150 200m

LEGAL DESCRIPTION:

PLAN 1218TR, BLOCK 1, LOT 1

COUNTY OF VERMILLION RIVER

Legend:

- **Site Boundary**
- **Urban Expansion (UE)**
- **Country Residential One (CR1)**

MAP 3 EXISTING LAND USE DISTRICTS

ROBINWOOD ESTATES AREA STRUCTURE PLAN

LEGAL DESCRIPTION:

PLAN 1218TR, BLOCK 1, LOT 1

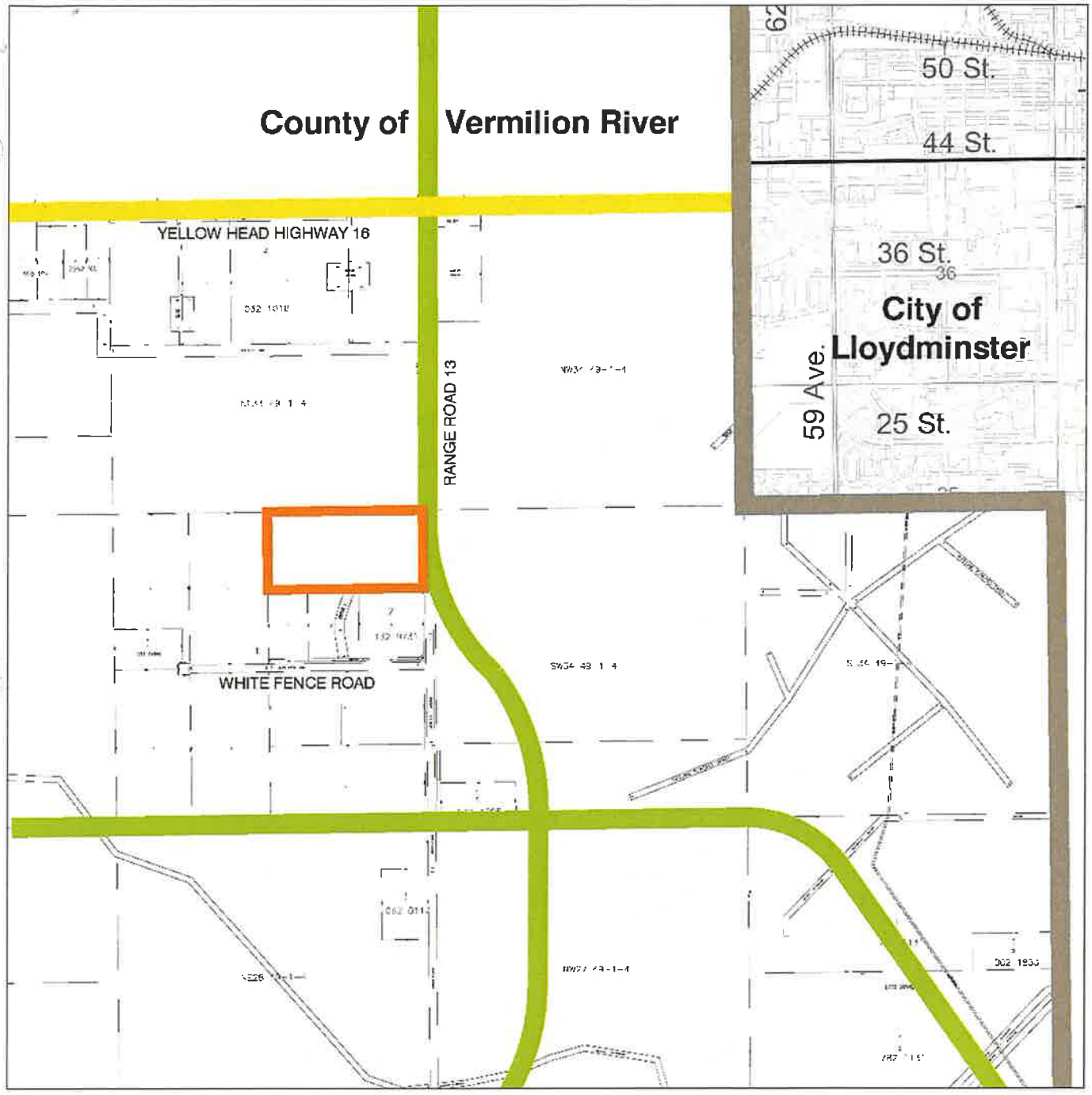
COUNTY OF VERMILLION RIVER

Legend:

Site Boundary

NOTE:
Contour interval is 0.2m

MAP 4 TOPOGRAPHY AND NATURAL FEATURES



ROBINWOOD ESTATES AREA STRUCTURE PLAN

0 150 300 450 600m

NORTH

LEGAL DESCRIPTION:

PLAN 1218TR, BLOCK 1, LOT 1

COUNTY OF VERMILLION RIVER

Legend:

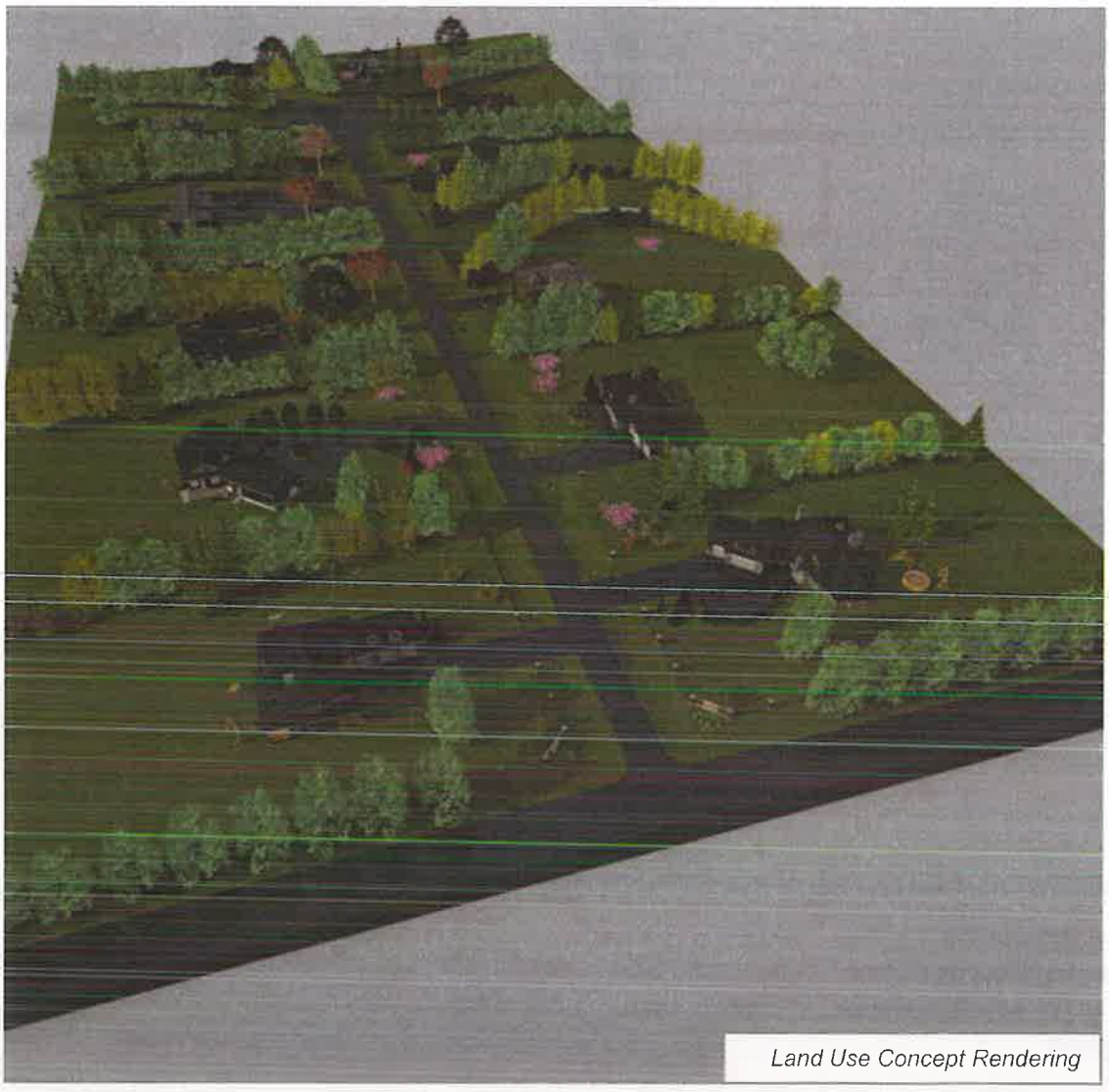
- Site Boundary
- City of Lloydminster Boundary
- Future Arterial
- Provincial Highway

MAP 5 TRANSPORTATION FEATURES

3.0 Future Land Use Concept

3.1 Overview

Robinwood Estates is envisioned as a high quality, gated country residential development with lot sizes ranging from 1.4 - 1.9 acres. The development is ideally situated with close access to Highway 16 and the City of Lloydminster for local services to residents, while still providing residents with rural living opportunities. Architectural controls will ensure that the site is developed at a high standard and will be appealing to future buyers.



Land Use Concept Rendering

3.2 Residential lots

The Robinwood Estates concept plan is illustrated on Map 6: Concept Plan. The plan proposes 12 Country Residential One (CR1) lots ranging from 1.4 acres to 1.9 acres in size. A gated entrance is proposed into the subdivision with uniform fencing along the front yards of the internal subdivision road, creating a unique roadside appearance. A community association will control the appearance and maintenance of the entrance gate, landscaping, and internal fencing. The developer proposes architectural controls to maintain consistency among the proposed housing and fencing within the development.

Land Use Concept Rendering

Please note that the lot layout configuration on the Concept Plan Map is conceptual in nature and the final subdivision lotting scheme will be configured to reflect detailed engineering design at the subdivision stage.

3.2.1 Residential Policy

a) *The future land-use concept for the site is identified on* ***Map 6****. Future subdivision and development will be in accordance with the policies within this plan and the lot layout illustrated on* ***Map 6****.*

b) *The Future Land-Use Concept Map is conceptual. Detailed lot configuration and final road alignment will be designed prior to subdivision approval.*

c) *In accordance with the County of Vermillion River Land Use Bylaw No. 13-14, single family residential parcels will be a minimum of one acre in size. Most lots onsite will range between 1.4 acres and 1.9 acres in size.*

d) *Architectural controls will be created for the development during the subdivision stage of the project, to control housing size, style, and colour. These controls will be implemented by the community association.*

Land Use Concept Rendering

3.3 Landscaping

The Robinwood Estates development proposes a 6 metre landscaping easement on the east boundary of the site, along Range Road 13. An entrance gate is proposed from Range Road 13 into the subdivision and uniform fencing is proposed along the internal subdivision road on lot frontages. A detailed landscaping and fencing plan will be provided to the County at the subdivision/development permit stage.

3.4 Municipal Reserve

Cash-in-lieu of Municipal Reserve land has already been paid for the site at the time the property was originally subdivided. At the subdivision stage the County will review previous subdivisions on the quarter section to confirm this payment.

3.4.1 Municipal Reserve & Landscaping Policy

a) *At the time of subdivision, past Municipal Reserve payment will be confirmed with the County.*

b) *A landscaping plan, in accordance with County policy, will be submitted to the County during the subdivision stage of the project. This plan will detail landscaping guidelines for the entrance feature and gate, fencing, tree and shrub planting, screening, and roadways.*

3.5 Drainage Easement

A 25 metre wide drainage easement is proposed for the existing drainage channel flowing to the north in the central portion of the site. The drainage channel has been heavily impacted by agricultural activity. The drainage easement is adjacent to four lots onsite, however as the drainage easement may be a constraint to development, lots adjacent to the proposed easement are greater than one acre in size to allow for a larger building envelope.

3.5.1 Drainage Easement Policy

a) *A 25 metre wide drainage easement will be located in accordance with* ***Map 6****. No development is permitted within this drainage easement and the drainage channel must remain in its natural state.*

ROBINWOOD ESTATES AREA STRUCTURE PLAN

LEGAL DESCRIPTION:
PLAN 1210TR, BLOCK 1, LOT 1
COUNTY OF VERMILLION RIVER

Legend:
Site Boundary

SITE STATISTICS		
	acs	h
TOTAL SITE AREA	20.0	8.1
TOTAL DEVELOPABLE AREA	18.1	7.3
ROAD AREA	1.9	0.8

TOTAL NUMBER OF LOTS = 12

0 10 20 30 40 50 60 70 80m

McElhanney

4.0 Transportation and Access

4.1 Site Access

Access to the site will be from Highway 16 to the north and then south on Range Road 13 to the east of the site. A 20 metre right of way internal subdivision road extends west from Range Road 13 to provide access to the 12 proposed residential lots. The road finish is proposed to be asphalt with a 9.0 meter minimum surface.

Alberta Transportation has a long term proposal for the re-alignment of Highway 16 approximately 1.5 miles southwest of the site with a potential interchange at SW1-50-2-W4M, southwest of the site.

4.1.1 Transportation and Access Policy

a) *Access to the development will be from Range Road 13 as shown on* ***Map 6****.*

b) *The proposed internal subdivision road will be constructed by the developer to County of Vermillion standards. The roadway will have a 20 metre right of way and a minimum 9 metre asphalt surface.*

4.2 Traffic Analysis

McElhanney Consulting Services Ltd. completed a Conceptual Traffic Analysis for the subject site **(Appendix D)**. Existing traffic volumes were projected to a 25 year horizon using a 2.0% annual growth rate. The analysis shows an average of 115 vehicle trips per day for single family detached housing. These trips were assigned to the Highway 16 / Range Road 13 intersection with the assumption that 20% of the trips would be coming and going along Highway 16 to and from the west, while the remaining 80% would access the site from Highway 16 to the east.

An intersection treatment analysis and intersection performance analysis (Synchro) were carried out to evaluate the impact of the proposed residential development as described below:

Intersection Treatment Analysis

The intersection of Highway 16 and Range Road 13 is currently a minor road intersection on four-lane divided highway and will therefore not require further upgrades to accommodate the development traffic.

Left turn treatment analysis was conducted for the future combined volumes at Range Road 13, as per the Highway Geometric Design Guide. No left turn lane is required. No right turn lane is required according to the analysis.

Intersection Performance Analysis (Synchro)

Intersection performance analysis was conducted with Synchro software. The intersection is anticipated to continue operating at an adequate Level of Service in un-signalized configuration (with stop controls on the range road) for the 25 year horizon.

Overall, the analyses show that the potential impact to Highway 16 will be minimal. The intersection of Highway 16 and Range Road 13 will operate adequately, thus, no immediate improvements will be required.

For further information please refer to the Traffic Analysis in **Appendix D** under a separate cover.

5.0 Site Servicing

5.1 Water and Sanitary Servicing

Servicing is to be provided on-site for each lot created to the satisfaction of the County and Alberta Environment and Sustainable Resource Development. Each lot will have a water well for potable water. Based on the desktop groundwater assessment report there is a potential for a groundwater based water supply for the proposed residential uses. However, the capability of a water well to supply such quantity can only be confirmed by completing one pumping well and one observation well within the new development area and performing a pumping test. This pump test will be completed at the subdivision stage.

Each lot will be independently serviced with an approved septic tank/mounded field sanitary system in accordance with the recommendations of the Geotechnical Report **(Appendix B)** and Alberta Provincial requirements. The predominant soils across the

majority of the site were medium plastic clay till and based on grain size distribution analysis, the soils were classified as "Sandy Clay Loam, which is deemed suitable by the SCC *"Alberta Private Sewage Systems Standard of Practice, 2009."* A shallow groundwater table was measured across the site, which is considered restrictive for using conventional on site wastewater disposal and treatment systems, however mounded treatment fields are proposed onsite as an alternative.

5.1.1 Water and Sanitary Servicing Policy

a) *Each lot will be independently serviced with an approved septic tank/mounded field sanitary system in accordance with the recommendations of the Geotechnical Report and Alberta Provincial requirements.*

b) *Each lot will have a water well for potable water. At the subdivision stage, a pump test will be completed onsite to confirm water well supply.*

5.2 Stormwater Management

The Robinwood Estates storm water concept will convey the storm water runoff to the rear of the proposed lots with ultimate discharge to the existing channel (Map 7). Due to the large size of the lots and the minimal impact to the storm water flow rates post development, storm water retention is not proposed. Lots will be graded from front to back to allow the storm water to flow to the rear of the lots. A 6.0m wide grassed swale will convey the storm water towards the existing creek. The grassed swale will provide a means of sedimentation removal and treatment prior to the discharge.

5.2.1 Stormwater Management Policy

a) *Stormwater will be managed onsite though rear lot easements and will discharge to the existing drainage channel.*

b) *Dwellings shall maintain a minimum 3.0m setback from the drainage channel.*

c) *Individual septic fields or mounds shall be setback a minimum distance of 6.0m from the drainage channel.*

d) *Driveways shall maintain a minimum of 3.0m setback from the drainage channel.*

ROBINWOOD ESTATES PRELIMINARY GRADING PLAN

LEGAL DESCRIPTION:
PLAN 1218TR, BLOCK 1, LOT 1

NOTE: Contour interval is 0.2m

5.3 Shallow Utilities

Each new lot will be serviced with power and gas from the franchise utilities in the area. There is sufficient capacity in the existing overhead power and gas lines. The existing overhead power line will provide power service to the proposed lots.

There is an existing gas line on Range Road 13 to provide gas service to the proposed lots. ATCO gas proposes to extend a gas main along the proposed subdivision road to service the new lots.

5.3.1 Shallow Utilities Policies

a) *The developer is responsible for the installation of shallow utilities such as natural gas, power, and telephone in consultation with utility providers.*

6.0 Community Services

6.1 Fire Protection

According to discussions with the County Planner and the Fire Chief, fire water storage is not necessary onsite as response to the area would be from the Blackfoot Fire Department along with back up from the City of Lloydminster.

6.2 Education

The subject site is within the Buffalo Trails Public Schools Division. The following County schools are within proximity to the plan area:

- Kitscoty Elementary School
- Kitscoty Jr/Sr High School

6.3 Police

The County of Vermilion River Enforcement Services Program provides enforcement services to the area. This service consists of two Community Peace Officers and one Administrative Assistant. The RCMP provides policing services for the area from the following locations:

- Kitscoty RCMP Detachment, 5010 - 50 Street Kitscoty, AB T0B 2P0
- Vermillion RCMP, 5115 - 50 Avenue Vermilion, AB T9X 1A9
- Lloydminster RCMP, 4201 - 47 Avenue, Lloydminster, SK S9V 2C7

6.4 Health Care

Although the site is located in close proximity to the City of Lloydminster Health District, where possible Alberta Health Services will be used first, with the closest being the Vermillion Health Centre (5720 50 Avenue, Vermilion, Alberta, T9X 1K7).

7.0 Plan Implementation & Phasing

The Robinwood Estates Area Structure Plan will be adopted by the County of Vermilion River as a bylaw. Following first reading of the ASP, the County will advertise the proposed bylaw and hold a public hearing on the proposal. The subject site is currently designated as CR1 and therefore a redistricting application and Land Use Bylaw amendment is not required.

Following ASP approval, the developer will submit a subdivision application for the site and enter into development agreement with the County according to the provisions of the Municipal Government Act. The site is proposed to be developed in one phase.

7.1.1 Implementation Policy

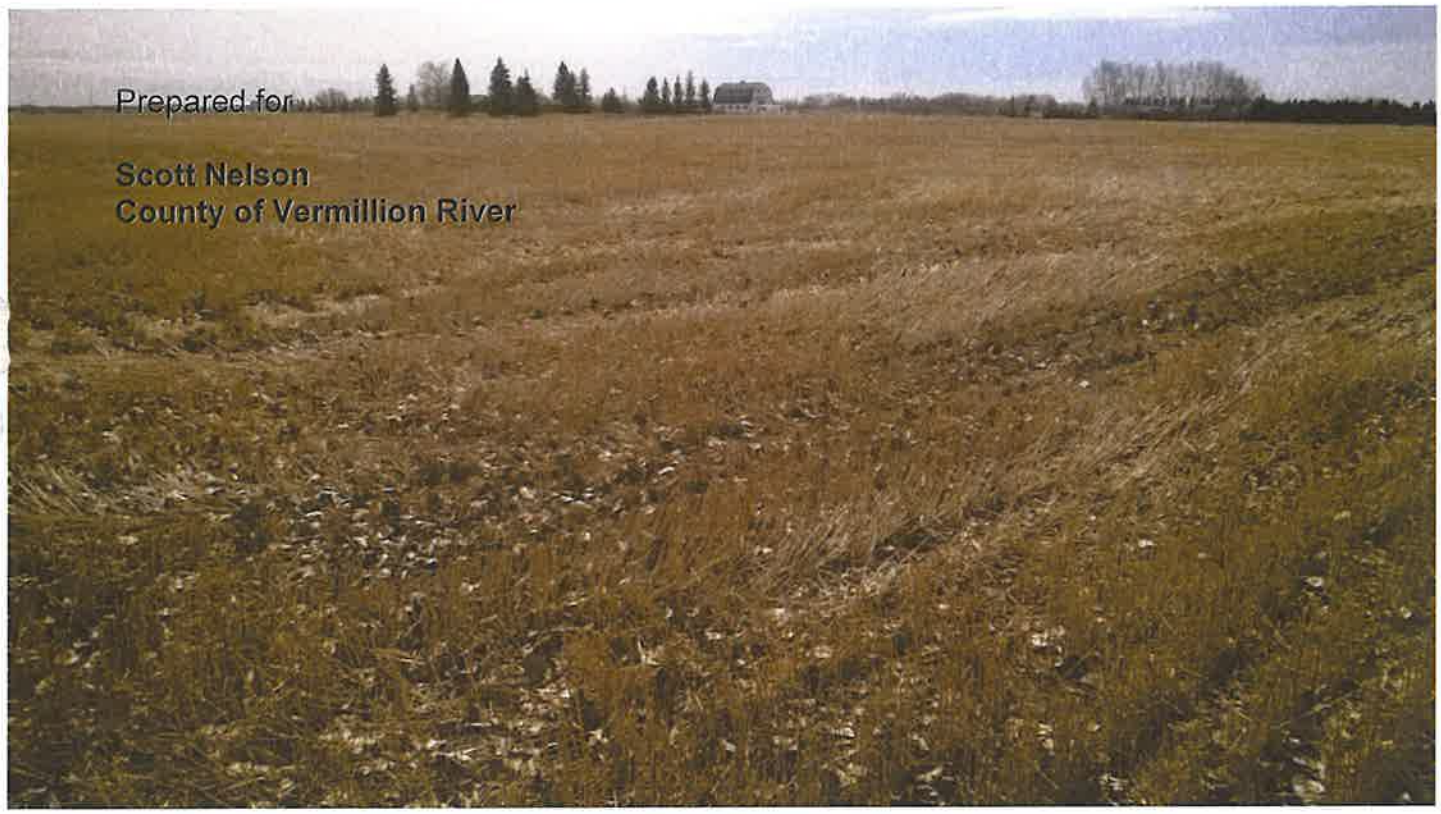
a) *The Robinwood Estates site will be developed in one phase. Following ASP adoption, the developer will submit a subdivision application to subdivide the lands according to the Area Structure Plan.*

b) *At the time of subdivision approval, the developer will enter into a development agreement with the County of Vermillion River.*

9 May 2014

Prepared for
Scott Nelson

Phase I Environmental Site Assessment (ESA) Of the Property at SE33-49-1W4M in the County of Vermillion River, Alberta



Prepared by

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2511-00463-00

Executive Summary

McElhanney Consulting Services Ltd. (McElhanney) was retained by the County of Vermillion (the Client), to conduct a Phase I Environmental Site Assessment (Phase I ESA) on the property located at SE33-49-1-W4M, Lot 1, Block 1 in the County of Vermilion River, Alberta. Visual observations were made of land at and adjacent to the Site. A comprehensive review of historical records and a site visit, about the Site were completed. This review indicated that the likelihood of environmental media being contaminated as a result of historical and current activities was low risk for the area reviewed in this study.

Our assessment indicates that current and historical activities are unlikely to have impacted the environmental media at the Site. No further environmental assessment is recommended at this time. Should development activities impact the house, barn or septic field than additional studies may be required as necessary.

Should the current owner of the structures on the site decide to pursue redevelopment and the existing structures be demolished and/ or renovated there will be need for a hazardous materials assessment to be completed.

The presence of a former and existing disposal field for septic on the Site will require decommissioning or reclamation to be handled in accordance to the practices and procedures outlined in the Alberta Private Systems Sewage Systems 2009 Standard of Practice.

A gas pipeline right of way was observed on the southwest corner of the Site and is assumed to run through the property. The pipeline was not evaluated as part of this investigation but should be properly assessed prior to any ground disturbances activities.

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Appendices

1. Introduction

McElhanney Consulting Services Ltd. (McElhanney) was retained by the Scott Nelson (the Client), to conduct a Phase I Environmental Site Assessment (Phase I ESA) on the property located at SE33-49-1-W4M, Lot 1, Block 1 in the County of Vermillion, Alberta (the Site) (see *Figure 1*). This report presents the results of the Phase I ESA.

Figure 1. The Site (red outline) at SE33-49-1W4M in the County of Vermillion, AB.

2. Assessment Methodology

2.1 SCOPE OF WORK

The scope of work was to conduct a Phase I ESA in accordance with *CSA Standard Z768-01* (Reaffirmed 2012). The objective of the study was to qualitatively identify the risk of actual or potential contamination of environmental media (soil, water or air) on or adjacent to the Site.

The following specific tasks were undertaken:

- Review of relevant records including historical environmental reports, a search of relevant Provincial and Federal databases, and reviews of available aerial photographs for the Site;
- Completion of a site visit to review the existing site conditions and document the property and surrounding area; and
- Preparation of this report documenting the findings, summarizing recommendations (if any) and stating the limitations of this study.

The assessment included a search of regulatory databases as defined in Section 4. Searches included properties bordering all extents of the subject site.

It should be noted sampling and analysis of environmental media (soil, water or air) was not undertaken as part of this study.

3. Site Visit

McElhanney personnel conducted a site visit on May 1, 2014. Field reconnaissance was limited to visual and olfactory observations. Observations were limited to exterior elements of the Site, including dwellings and outbuildings. The following sections summarize observations. Site photos (Photo 1 to Photo 16) taken during the project are provided in *Appendix A*.

3.1 GENERAL PROPERTY DESCRIPTION

During the Site reconnaissance the property was visually reviewed for the existing site features. The Site is located west of Lloydminster on the southeast quarter of Section 33, Township 049, Range 1, west of the 4th Meridian. The Site is bounded by White Fence Road to the south and Range Road 13 to the east, agricultural land to the east and north. There is a residential building in the southeast of the Site.

The area is within the Aspen Parklands which consists of open grasslands alternating with groves of trees. Specifically it is located in the Central Parkland Natural Subregion which is a transitional ecosystem between prairie and boreal forest. It was generally described as being relatively flat agricultural land. Access is gained to the Site through a driveway located on Range Road 13 (see Figure 1).

At the time of the Site visit the property was owned by three owners. Mr. Scott Nelson owns the northern half of the parcel and retained McElhanney for the Phase I ESA. Scott's father, Mr. Ray Nelson, was the original property owner who built the house and farm where Scott was raised. Three years ago Mr. Nelson passed away and the property was subdivided into three parcels. The SE portion of the property including the house and barn was purchased by Jim and Eileen Kelly who rent the house out to the current residents. The SW portion of the property is owned by Tracey Clotts.

The site investigation looked at the entire quarter section of land, however, the proposed sub development is intended for the northern half of the property owned by Scott Nelson. Photos 1 through 4 show the arable land that has historically and is currently cultivated for grain crops. The wetland in the southeast corner of the property can be seen in photo 5. There is a creek running through the center of the property that flows

to the north. The creek has been heavily impacted by agricultural activity and is not easily distinguishable on the Site (seen in photo 6). The house and barn located in the southeast portion of the quarter section can be seen in photos 7 and 8. Vehicle storage and farm equipment storage are located around the barn and are shown in photos 9 through 12. Lastly a new septic field was recently constructed and can be seen in photos 13 & 14.

Neighboring properties to the north include as residence and barn with horses, the land to the east is an elk farm and the lands to the south and west are also agricultural lands with residencies and barns.

3.2 SITE OBSERVATIONS

3.2.1 Stains

The presence of stains on road surfaces or porous media such as soil and gravel may be indicative of environmental contamination caused by leaks or spills. There was no indication of staining at the Site during the site visit.

3.2.2 Site Vegetation

Stressed vegetation or an absence of vegetation may be regarded as viable bio-indicators for the presence of contaminated environmental media. The portion of the Site near the residential dwelling contained maintained landscaped of grass lawn while the majority of the Site was active agricultural land. The south east corner of the land was a pasture that had wetland vegetation on it including willows, and sedges. A dense thicket of shrubs was located on the furthest SE portion of the subject area. There was evidence of minor stressed and absent vegetation on the Site to the south and west of the barn (photo 10 & 11). Former and current vehicle and equipment storage is suspected to be a contributing factor to the missing vegetation. In addition it is suspected that the fill material used to make the platform on which the barn was built may also be a contributing factor to the stressed vegetation (e.g. lack of organic material). However this is considered to not be an area of potential environmental concern.

3.2.3 Imported Fill

Imported fill presents environmental concern if the location and quality of fill is unknown. There appears to be areas of fill of unknown origin associated with the footprints of the buildings and the driveway. This is not considered to be an area of potential environmental concern.

3.2.4 Pits and Lagoons

Pits and lagoons may warrant environmental concern if they are used to collect streams of waste water or liquid waste streams. No pits or lagoons were observed at the Site or on adjacent properties. Ditching adjacent to the roads on the east and south of the property were observed to have standing water. To the north of the property there was a dugout fed by the creek running through the center of the Site. It is

understood that the dugout is used by a neighbour's farm for water. Adjacent to the dugout was a fenced area for horses.

3.2.5 Waste Water or Liquid Discharges

Waste water or liquid discharges from subject and neighbouring properties may warrant environmental concern if these waste streams migrate into uncontaminated areas. Observations showed no presence of waste water or liquid discharges that could affect environmental media in the inspected area. It was noted that waste water from the Site discharged into a septic field.

3.2.6 Hazardous Materials

The interior of structures within the Site were not assessed for the presence of hazardous materials such as lead paint, urea foam formaldehyde insulation, asbestos, mercury switches, polychlorinated biphenyls (PCBs), or radon.

The age of the residence appeared to be constructed in the early late 1970's and based on the age, hazardous materials may have been used in construction materials. Detailed hazardous material assessments should be completed for all suspect structures within the Site should any demolition activities, renovations, or other disturbances to building components be required.

3.2.7 Septic Systems

The Site contains a septic field for the residence. Prior to the land being subdivided into three portions there was a septic field used by the original owner. Once the subdivision occurred the septic field was no longer located on the property of the house. Recently a new septic field was constructed and can been seen in photos (13 & 14). We recommend any and all decommissioning or reclamation shall be handled in accordance to the practices and procedures outlined in the Alberta Private Systems Sewage Systems 2009 Standard of Practice should development occur in areas where the current or former septic field are located.

3.2.8 Pesticide Use

Historical aerial photos show the lands comprising the Site and surrounding areas being utilized for agricultural purposes since at least 1950. Grazing was used as a mechanism to keep out willows from growing on the pasture land in the past. Interviews with the current property owner who grew up on the land since the early 1970's indicated that he believes that there is a possibility that pesticides were applied to the crops at one point in time. However, he has no memory of any event in which pesticides were applied, what type or what the application rate was. Given the lands agricultural practices the potential for pesticide use extends across the entire Site and many of the surrounding areas.

3.2.9 Polychlorinated Biphenyls (PCBs)

PCBs may be present in electrical components such as pad-mounted or overhead transformers. There was a utility pole with a transformer located near the house on the property. Based on the age of the house it is

suspected that the transformer has the potential to contain PCB's (photo 15). Should this section of the Site be impacted by the proposed development, the transformer should be reviewed for PCB content by a qualified person and disposed of accordingly.

3.2.10 Underground Storage Tanks (USTs)

Underground storage tanks have the potential to affect soil and or groundwater if the contents of the USTs leak into the surrounding environment. Potential indicators of USTs include the presence of vent pipes, concrete pads and stressed vegetation. Physical searches of the study area may be augmented with a review of fire insurance maps which may show the locations of storage tanks, both above and beneath ground, for a given study area. Other than a suspected septic holding tank as part of the septic treatment system our observation of the areas revealed no such physical indicators of USTs.

3.2.11 Above-Ground Storage Tanks (ASTs)

The presence of above-ground storage tanks (ASTs) could pose environmental concern if leakage onto underlying soils had occurred.

Our observations and interview with the owner revealed no AST on the Site. However, during the site inspection a couple of ASTs on the adjacent properties were observed. AST's observed included: an above-ground fuel tank in the yard to the west of the property near the garage (photo 16). Across Range Road 13 on the Elk farm 3 ASTs were observed near the out buildings. One was a horizontal cylindrical tank approximately 10,000L in size and the other two were identical conical white vertical tanks. It is suspected that either fuel or propane is stored in the horizontal tank for use in the farm operation. Both neighbouring tanks are not considered an environmental concern based on their distance from the proposed development on the Site. To the west the tank is approximately 100 m away, to the east the tanks are approximately 300 m away from the proposed development.

4. Environmental Setting

4.1 CLIMATE AND RAINFALL

Climatic conditions at the Site were inferred based on data provided by Environment Canada, Canadian Climate Normals 1981-2010. Recorded climate conditions for the Lloydminster Alberta station were considered representative of the Site based on their proximity to that station.

Mean monthly temperatures recorded between 1981 and 2010 ranged between -18.9 degrees Celsius (°C) in January to 23.1 °C in July. Annual precipitation was 408.8 mm with monthly average lows of 9.8 mm in February and highs of 75.3 mm in July.

4.2 REGIONAL GEOLOGY

Information provided by the Alberta Geological Survey (AGS) indicates that two soil types exist within the Site. Surficial Geology maps published by the Geological Survey of Canada and Soil survey reports for Alberta were reviewed to determine soil types at the Site. One soil type was identified at the Site. Drilling records for the water well were obtained as part of our review and can be used to supplement the information for the surficial geology as the drilling record describes the materials to a depth of 250 feet. Soil and bedrock descriptions for the Site are presented in Table 1 and the soil classification map is provided in *Appendix B*.

Table 1 Summary of soil types identified at the Site

Strata	Material	Comments
Soil	Fluted Moraine: Till	Glacially streamlined sediment, mainly till, terrain varies from alternating furrows and ridges to elongate smoothed hills which parallel the inferred local ice flow direction; includes flutes drumlins, and drumlinoids.
Bedrock	Sedimentary rock	Containing Sandstone, Siltstone and Shale

4.3 TOPOGRAPHY AND INFERRED GROUNDWATER MOVEMENT

Direction of groundwater flow may be inferred based on local topography at the Site. This is an estimate only, and *in situ* groundwater characterization should be undertaken if such information is required. Topography information provided by Natural Resources Canada indicates that elevation at the western boundary of the site approximately 2200m (*Figure 2*). This elevations is maintained across the Site. Inferences to groundwater movement cannot be made based on surface topography conditions at the Site.

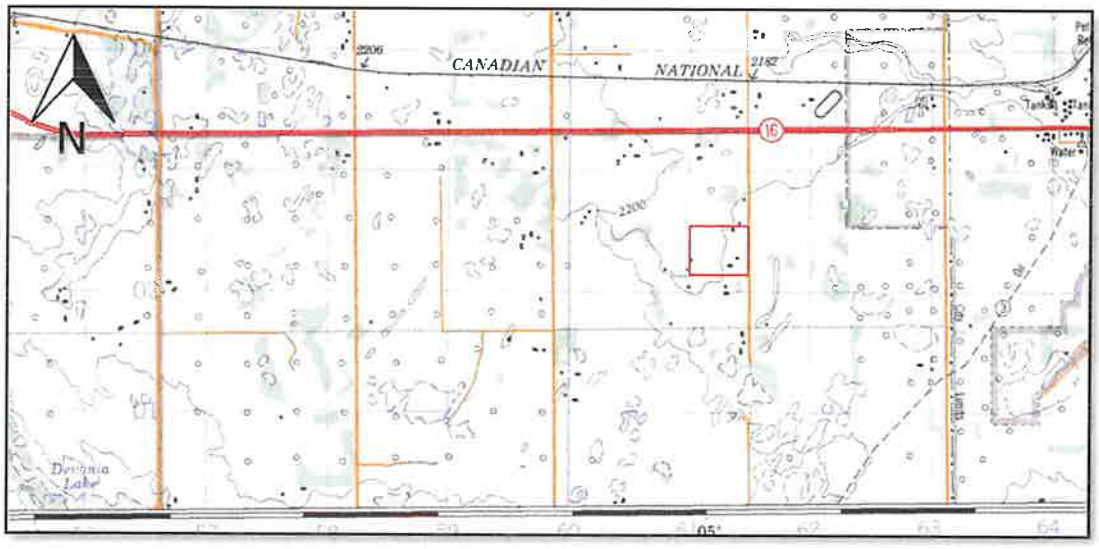


Figure 2. Topographic map from natural Resources Canada shows almost no variation in topography across the Site (red outline)

4.4 WATER RESOURCES

4.4.1 Water Well Information System Database

Local topography and interviews with the owner and neighbour's suggests that surface water flows towards the north. EcoLog Environmental Risk Information Services (ERIS) was retained to search the Water Well Information System database and determined that there was 1 water wells listed that lies within 70 m of the center of Site. The results of the ERIS search are located in *Appendix C*. On site observations and information from interviews determined that the residency on the property has 2 wells located near the house.. The newer one was drilled within the last five years by McAllister Drilling and is suspected to be Well 12003448 that was listed in the ERIS search results as the date of the well installation and the drilling company match the information from the Client. It is also assumed that each residency on properties adjacent to the Site has water wells that were not identified in the ERIS search.

4.4.2 Surface Water and Water bodies

Several wetland features with standing water were observed within the Site. Two areas s in particular where noted in the southeast corner of the property and an altered unnamed creek was observed running through the approximate center of the property. It appears that the creek flows to the north (seen in *Figure 2*) but the channel was not easily distinguishable. The creeks features appeared to have been altered by historical agricultural activity on the Site and does flows into the neighbour's dugout on the north of the property. Flow continues to the northeast towards Lloydminster.

5. Records Review

Several historical records were reviewed to assess the environmental conditions and current or historical land use activities at the Site. The following sections summarize the findings of this review.

5.1 AERIAL PHOTOGRAPH INTERPRETATION

Historical aerial photographs were obtained from ERIS. A limited selection of aerial photographs was available for review. The selection of photos reviewed was for the years 1924, 1950, 1956, 1959, 1970, 1984, and 2004. A summary of our review is presented in *Table 2* and copies of aerial photos reviewed are provided in *Appendix D*.

Table 2 Aerial photograph interpretation

Year	Photo Reference	Site Area	Adjacent properties
1924	CA51-71	The Site cannot be distinguished by the authors as there are no notable landmarks visible for reference.	The area appears to be mostly undeveloped aspen parklands with roads or railway visible
1950	A12519-78	The Site is mostly cleared of trees and shrubs with the creek running through the center.	The surrounding properties also appear to be mostly farmland with small stands of woodlands.
1956	A15247-61	Observations similar to those in 1950.	Observations similar to those in 1950.
1959	A16472-128	Observations similar to those in 1956.	Observations similar to those in 1956.
1970	A24483-124	Building consistent with single family dwelling is visible on the Site.	The property to the south, west and north of the Site have buildings consistent with single family dwellings and farming operations.
1984	A26443-161	Observations similar to those in 1976.	Observations similar to those in 1976.
2004	Google earth	Observations similar to those in 1984.	New building and drive way visible on the perimeter of the Site to the N side.

5.2 DATABASE REVIEW OF ENVIRONMENTAL RECORDS

EcoLog Environmental Risk Information Services (ERIS) was retained to perform a 250 m radius search of several environmental inventories and databases from the centre of the Site. A copy of ERIS' search results are provided in *Appendix C*.

There was no listings for the Site. The ERIS search yielded 1 positive results for the surrounding properties for a water well which has been discussed in Section 3.3.3.

5.3 FEDERAL CONTAMINATED SITES INVENTORY

A search of the Federal Contaminated Sites Inventory yielded no records of registered sites within the Site.

5.4 FIRE INSURANCE RECORDS

Historical fire insurance maps may provide insight into historical activities of a Site and more specifically they may document instances of storage tank burial or uses of other products at a Site that may warrant environmental concern and/or further investigation.

Fire insurance records for the Site were not searched for this assessment as their unlikely to be available due to the property being in a rural setting.

5.5 INTERVIEW

During the site visit, Scott Nelson, the current owner of the northern half of the land was interviewed. Scott's father, Mr. Ray Nelson, owned the land and built the house and barn in the early 1970's. Mr. Nelson owned the entire quarter section and Scott was raised on the property. Upon his father's passing three years ago, the property was subdivided into three parcels. Scott now owns the northern half of the quarter section and the southern half was sold privately to two separate owners.

The barn was built for horses and feed was stored the upper portion. Asides from tools and very limited amounts of motor oil for the tractor, the barn was mainly used for the livestock. The fenced area of the property (the SE) was used as pasture for the horses. The SW corner was used for hay and the northern half was and is currently cultivated into agricultural crops.

The septic field for the house was on a portion of the property that no longer belonged to the current owners of the house, thus a new septic field was constructed and can been seen in photos (13 & 14). Other than the septic tank, Scott did not report any other underground storage tanks or a history of any above ground tanks.

Scott said that the household waste has been managed by using three burn barrels in the past and the current owners appears to be using the same waste disposal technique (photo 12). Scott also indicated that recently a new well had been drilled (prior to his father's death) as the former well had water quality problems. He remembered that the water would frequently be dark in colour and he believed that this was a result of suspected high iron content.

Scott does not remember seeing pesticides sprayed on the property while growing up but conceded that there was a possibility that they would have been used at one point despite him not having memory of any

occurrences. In addition he reported that the insulation in the house was made from fibre glass and that he did not believe that Asbestos was in the house construction materials.

The neighbour to the west of the property, Cathy Fisher, was interviewed during the site visit. Cathy has lived on the land for 27 years and her mother in law was the original owner and farmer who purchased the land in 1972. Cathy gave information regarding the names of the current owners and that the property was subdivided 3 years prior. She also was able to confirm that the large pile of soil was for the new septic field for the house. During the interview, she mentioned that the creek running through the property runs to the north and the volume of water is influenced by snow melt. She said that she believes the majority of the water in the creek is underground and that it was rumored forty years ago the volume was high enough to canoe through towards town.

Cathy mentioned that the landowners to the east of Range Road 13 ran an Elk Farm and the owner was the sister of Ray Nelson. She also reported that the SW corner of the Site was previously used for Hay but had been fallow for three years (since the passing of Mr. Nelson). In addition she said that the current owners allow neighbours horses to use their pasture occasionally but no horses were currently living on the site. Cathy's property has two houses, a garage, some outbuilding and an above ground fuel storage tank located behind the barn (photo 16).

A third interview was conducted with Terry, a farmer at the Elk Farm to the east of the Site. Terry indicated that Brian Harvard has been renting the house of the Site for about three years. He was able to confirm that the creek flowed to the north and that high water levels would cause flow to come across the road and onto his pasture.

Terry was able to confirm that the barn on the Site was used for horses and to store feed upstairs. He reported that the Elk Farm has been in operation for 18 years and prior to that the land was cultivated for grain.

6. Conclusion

McElhanney was retained by Scott Nelson to conduct a Phase I ESA of the property located at SE23-49-1-W4M just west of Lloydminster, AB. McElhanney conducted visual observations of land in and adjacent to the subject site, a comprehensive review of historical records, and a site visit.

Based on our comprehensive assessment of the Site, it was concluded that there was a low potential for contamination to exist at the Site or neighbouring properties.

Our assessment indicates that current and historical activities likely have not impacted the environmental media at the Site. The areas around the barn that have missing vegetation are typical of storage activities and are not located in the area of the proposed development.

A gas pipeline right of way was observed on the southwest corner of the Site and is assumed to run through the property. The pipeline was not evaluated as part of this investigation but should be properly assessed prior to any ground disturbances activities.

7. Recommendations

It is McElhanney's opinion that, based on the findings of this Phase I ESA, historical and current site activities presented there is a low risk of impacting environmental media at the Site and further environmental investigation is not warranted at this time. Should development activities impact the house, barn and/or the septic field, then further investigations may be required as necessary.

8. Limitations of Report

This report was prepared by McElhanney Consulting Services Ltd. ("McElhanney") for the exclusive use of Scott Nelson and may not be reproduced in whole or in part without the prior written consent of McElhanney, or used or relied upon in whole or in part by a party other than Mr. Nelson. Any unauthorized use of this report, or any part hereof, by a third party, or any reliance on or decisions to be made based on it, are at the sole risk of such third parties. McElhanney accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report, in whole or in part.

This report is intended to provide a preliminary assessment of potential environmental concerns at the subject properties. This report is not meant to represent a legal opinion regarding compliance with applicable laws nor to judge the acceptability of risk associated with any potential contamination. Note that environmental statutes, regulations and guidelines, and the interpretation of such environmental statutes, regulations and guidelines, are subject to change over time and such changes, when put into effect, could alter the conclusions and recommendations noted in this report.

The investigation program followed the standard of care expected of professionals undertaking similar work in Alberta under similar conditions. No warranties, either express or implied, are made as to the professional services provided and included in this report.

This report is based on data and information collected during the investigation conducted by McElhanney Consulting Services Ltd. personnel or agents, and is based solely on the conditions of the subject properties at the time of the Site work completed, as described in this report. McElhanney has relied in good faith on information provided by individuals and third parties noted in this report. McElhanney accepts no responsibility for any deficiency, misstatements or inaccuracy contained in this report as a result of omissions or errors in information provided by third parties or for omissions, misstatements or fraudulent acts of persons interviewed. The compliance of past owners with applicable environmental statutes, regulations or guidelines was not within the scope of the services provided for this report.

Achieving the objectives stated in this report has required us to arrive at conclusions based upon the best information presently known to us. No investigative method can completely eliminate the possibility of obtaining partially imprecise or incomplete information; it can only reduce the possibility to an acceptable level. Professional judgment was exercised in gathering and analyzing the information obtained and in the formulation of the conclusions. Like all professional persons rendering advice, we do not act as absolute

insurers of the conclusions we reach, but we commit ourselves to care and competence in reaching those conclusions

The scope of work for this Phase I ESA did not include any subsurface investigation and testing (of soils, groundwater or other materials), and it was based on a limited review of regulatory files. The findings cannot be extended to portions of the Site which were unavailable for observation at the time of McElhanney's field investigations. If new information is discovered in the future during site excavations, building demolition or other activities, or if additional subsurface investigations or testing are conducted by others, McElhanney should be requested to re-evaluate the conclusions of this report and to provide amendments as required prior to any reliance upon the information presented herein.

9. Professional Statement

In conformance with applicable regulations we confirm that:

- This Phase I ESA Report has been prepared in accordance with the Act and regulations; and
- The undersigned have demonstrable experience in investigation of the type of contamination at the Site for which this statement applies and are familiar with the investigation carried out at the Site.

Yours truly,

MCELHANNEY CONSULTING SERVICES LTD.

Sandra Hemstock, MSc
Biologist

Brian S. White, P.Eng
Senior Environmental Engineer

Appendix A

Select Site Photos

Photo 1: View of arable land from the southwest corner looking north. An Atco gas pipeline right of way.

Photo 2: The back of the View from the northwest corner looking south east at the house and barn.

Photo 3: View from the northeast corner looking south.

Photo 4: View from driveway looking at the ditches along Range Road 13 and the northeast corner of the property.

Photo 5: Wetland located in the southeast corner of property.

Photo 6: Creek running through center of the property flowing towards the north.

Photo 7: Single family residence located on the southeast portion of the property.

Photo 8: Barn and vehicle storage area located on the southeast portion of the property.

Photo 9: Storage area to the south of the barn

Photo 10: Former and current vehicle storage behind the barn.

Photo 11: Area of stressed vegetation beside the barn.

Photo 12: Garbage burn barrels along driveways with view of new septic field in the background.

Photo 13: Area of cleared soil for new septic field.

Photo 14: New septic field.

Photo 15: Power pole and transformer for residence.

Photo 15: Above ground fuel storage tank on the neighbours property to the west.

Appendix B

Soil Classification Map & Geotechnical Report

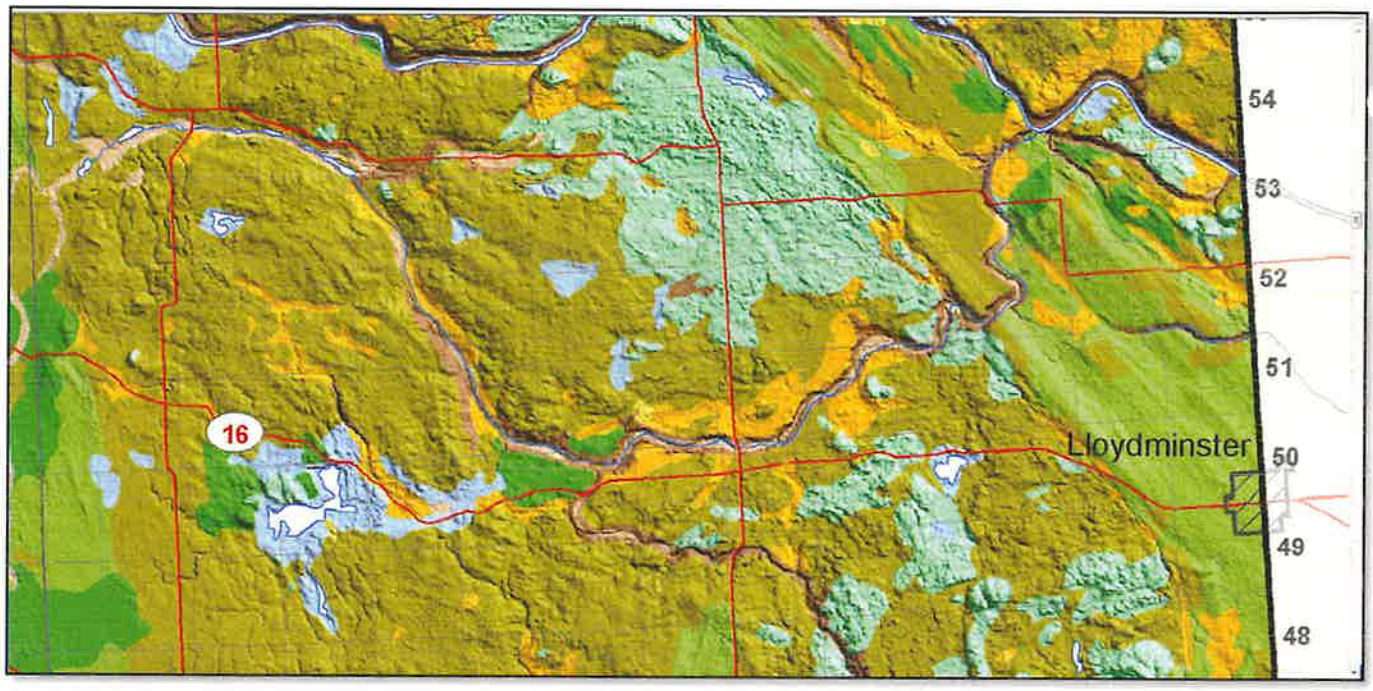


Figure 3 Regional Surficial Geology map maintained by the Alberta Geological Survey shows one soil type within the Site.

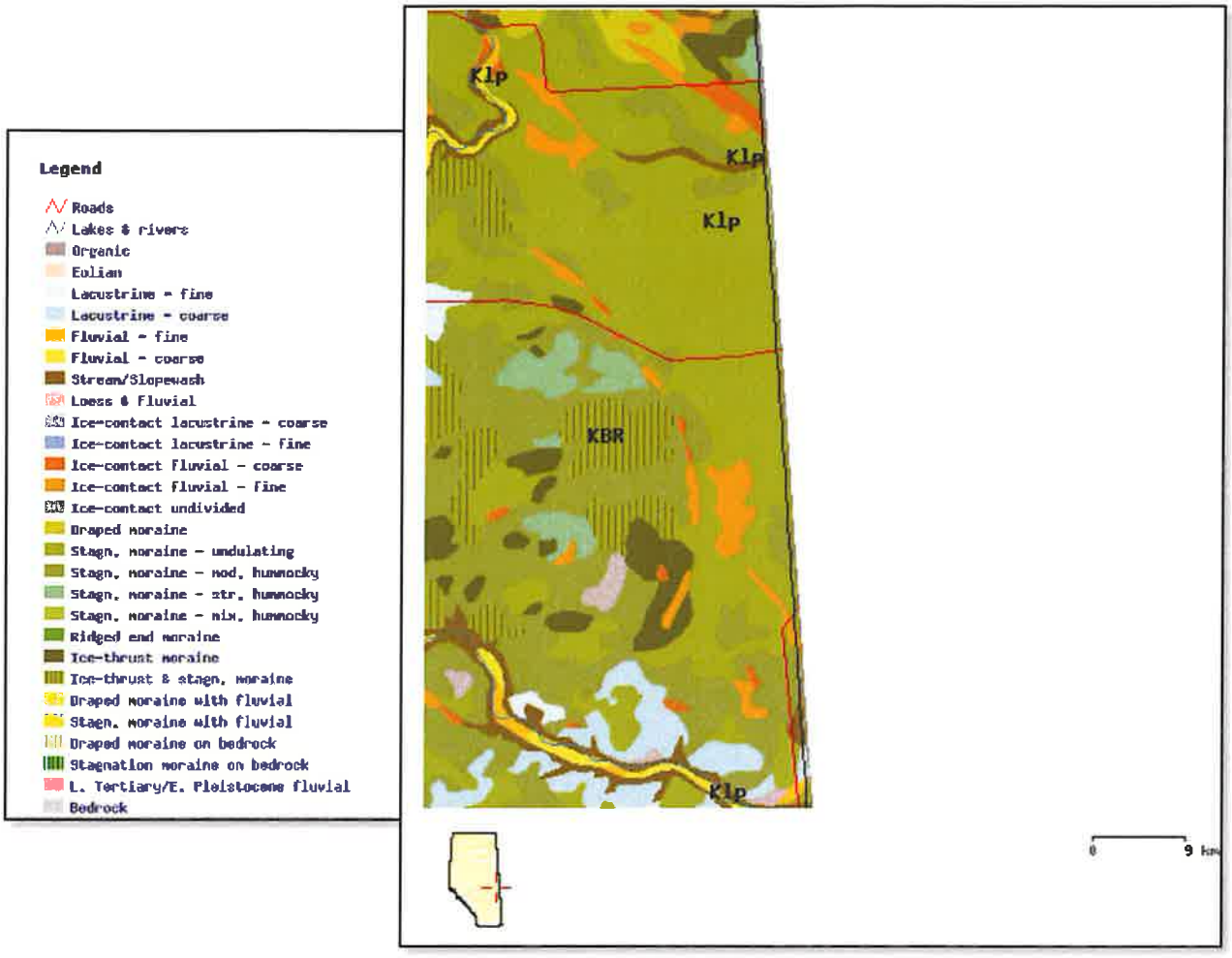


Figure 4 Regional Surficial Geology map maintained by the Alberta Geological Survey shows one soil type within the Site (stagnant, moraine – undulating).

Appendix C

ERIS Database Report

ENVIRONMENTAL RISK INFORMATION SERVICE

DATABASE REPORT

Project Property:	*20 Acre County of Vermilion River n/a Llyodminster AB*
Report Type:	*Standard Report*
Order #:	*20140417076*
Requested by:	*Mcelhanney Consulting*
Date:	*April 29, 2014*

Ecolog ERIS Ltd.
Environmental Risk Information Service Ltd. (ERIS)
A division of Glacier Media Inc.
P: 1.866.517.5204
E: info@erisinfo.com

www.erisinfo.com

Table of Contents

Executive Summary

Property Information:

Project Property:		*20 Acre County of Vermilion River* *n/a Llyodminster AB*
Coordinates:		
	Latitude:	*53.268594*
	Longitude:	*-110.081249*
	UTM Northing:	*5,902,543.78*
	UTM Easting:	*561,273.64*
	UTM Zone:	*UTM Zone 12U*
Elevation:		*2,178 FT* *664.00 M*

Order Information:

Order No.:	*20140417076*
Date Requested:	*29/04/2014*
Requested by:	*Mcelhanney Consulting*
Report Type:	*Standard Report*

Additional Products:

Aerial Photographs	*National Collection - Digital (PDF)*

Executive Summary: Report Summary

Database	Name	Searched	Project Property	Within 0.25 km	Total
AGR	Agriculture and Fisheries - Certificates of Approval	Y	0	0	0
AOGW	Alberta Oil and Gas Wells	Y	0	0	0
AUWR	Automobile Wrecking & Supplies	Y	0	0	0
CAWD	Waste Management Facilities - Certificates of Approval	Y	0	0	0
CFO	Confined Feeding Operations	Y	0	0	0
CHEM	Chemical Processing Operations - Certificates of Approval	Y	0	0	0
CONV	Compliance and Convictions	Y	0	0	0
EAS	Enforcement Action Summary	Y	0	0	0
EEM	Environmental Effects Monitoring	Y	0	0	0
EHS	ERIS Historical Searches	Y	0	0	0
EIIS	Environmental Issues Inventory System	Y	0	0	0
ESAR	Environmental Site Assessment Repository	Y	0	0	0
FAC	Facility List	Y	0	0	0
FCON	Federal Convictions	Y	0	0	0
FCS	Contaminated Sites on Federal Land	Y	0	0	0
FIS	Field Inspection Incident Report	Y	0	0	0
FOOD	Food Processing Operations - Certificates of Approval	Y	0	0	0
FST	Fuel Storage Tanks	Y	0	0	0
GEN	Waste Generators Summary	Y	0	0	0
GPP	Gas Processing Plants	Y	0	0	0
HELP	Alberta Environment's H.E.L.P. (Help End Landfill Pollution) Program Database	Y	0	0	0
IAFT	Indian & Northern Affairs Fuel Tanks	Y	0	0	0
LDS	Identification and Verification of Active and Inactive Land Disposal Sites	Y	0	0	0
LDSI	Land Disposal Sites on Indian Reserves	Y	0	0	0
LUM	Lumber Related Operations - Certificates of Approval	Y	0	0	0
MINE	Canadian Mine Locations	Y	0	0	0
MMB	Metals, Minerals and Building Materials Operations - Certificates of Approval	Y	0	0	0
MNR	Mineral Occurrences	Y	0	0	0
NATE	National Analysis of Trends in Emergencies System (NATES)	Y	0	0	0
NDFT	National Defence & Canadian Forces Fuel Tanks	Y	0	0	0
NDSP	National Defence & Canadian Forces Spills	Y	0	0	0
NDWD	National Defence & Canadian Forces Waste Disposal Sites	Y	0	0	0
NEES	National Environmental Emergencies System (NEES)	Y	0	0	0
NPCB	National PCB Inventory	Y	0	0	0
NPRI	National Pollutant Release Inventory	Y	0	0	0
OAM	Operating and Abandoned Mines	Y	0	0	0
OGW	Oil and Gas Wells	Y	0	0	0

Database	Name	Searched	Project Property	Within 0.25 km	Total
ORP	Alberta Orphan Wells	Y	0	0	0
AP	Canadian Pulp and Paper	Y	0	0	0
PCFT	Parks Canada Fuel Storage Tanks	Y	0	0	0
PCG	Petrochemical, Coal and Gas Operations - Certificates of Approval	Y	0	0	0
PES	Pesticide Register	Y	0	0	0
PITS	Conglomerate and Waste Management Facilities	Y	0	0	0
PSP	Alberta Private Sewage Disposal Permits	Y	0	0	0
REC	Hazardous Waste Receivers Summary	Y	0	0	0
RST	Retail Fuel Storage Tanks	Y	0	0	0
SCT	Scott's Manufacturing Directory	Y	0	0	0
SPEC	Special Operation Classifications - Certificates of Approval	Y	0	0	0
WDS	Inventory of Waste Disposal Sites	Y	0	0	0
WSTE	Wastewater Operations	Y	0	0	0
WWIS	Water Well Information System	Y	0	1	1
	Total:		0	1	1

Executive Summary: Site Report Summary – Project Property

Map Key	DB	Company/Site Name	Address	Dir/Dist m	Elev diff m	Page Number

No records found in the selected databases for the project property.

Executive Summary: Site Report Summary – Surrounding Properties

Map Key	DB	Company/Site Name	Address	Dir/Dist m	Elev Diff m	Page Number
1	WWIS		AB	SW/70.0	0.00	10

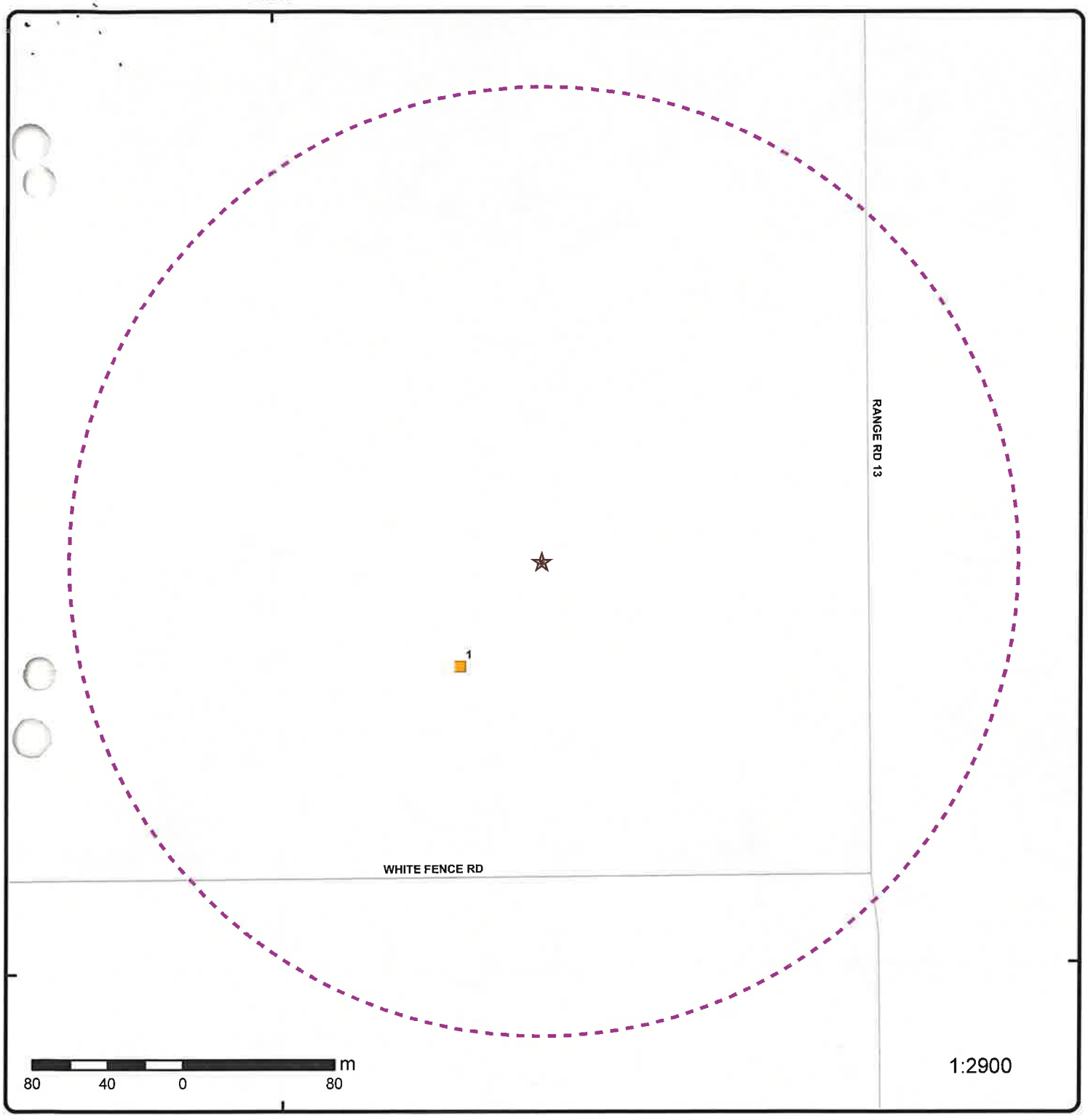
Executive Summary: *Summary By Data Source*

WWIS - Water Well Information System

A search of the WWIS database, dated 1880-Sep 2013 has found that there are 1 WWIS site(s) within approximately 0.25 Kilometers of the project property.

Equal/Higher Elevation	Address	Direction	Distance m	Map Key
	AB	SW	70.00	1

Lower Elevation	Address	Direction	Distance m	Map Key



Map

Order No: 20140417076

Address: n/a, Llyodminster, AB

- Project Property
- Buffer Outline
- Eris Sites with Higher Elevation
- Eris Sites with Same Elevation
- Eris Sites with Lower Elevation
- Eris Sites with Unknown Elevation
- Expressway
- Principal Highway
- Secondary Highway
- Major Road
- Local road
- Trail
- Proposed Road
- Ferry Route/Ice Road
- Industrial and Resource - Regions
- Main Line
- Sidetrack
- Transit Line
- Abandoned Line
- Pipelines and Transmission
- National Park
- Provincial or Territorial Park
- Other Park
- Golf Course or Driving Range
- Park or Sports Field
- Other Recreation Area

Aerial

Order No: 201404170

Address: n/a, Llyodminster, AB

Source: ESRI World Imagery, Updated December 2012

Detail Report

Map Key	Number of Records	Direction/ Distance m	Elevation m	Site	DB
1	1 of 1	SW/70.0	664.0	AB	WWIS

Well ID:	12003448	**Licence No.:**	
Date Started:	22-JUN-10	**Date Completed:**	23-JUN-10
Depth (ft):	250	**Elevation (ft):**	
Elevation Source:	Not Obtained	**Proposed Use:**	Domestic
Type of Work:	New Well	**Method of Drilling:**	Rotary - Mud
Flowing Well:	N	**Flow Rate:**	
Gas Present:	N	**Oil Present:**	
Water Requirements Per Day:		**DLS Coordinates:**	8-33-49-1-4
Lot:	2	**Block:**	1
Plan:	1218TR	**Owner Mailing Address:**	PO Box None
Drilling Company:	MCALLISTER DRILLING INC.	**Driller Mailing Address:**	BOX 1189, LLOYDMINSTER, AB, S9V 1G1

Details ---

Depth (ft):	18	**Material:**	Till
Colour:	Brown	**Description:**	
+			
Depth (ft):	84	**Material:**	Till
Colour:	Gray	**Description:**	
+			
Depth (ft):	141	**Material:**	Shale
Colour:	Gray	**Description:**	
+			
Depth (ft):	147	**Material:**	Sandstone
Colour:	Gray	**Description:**	Fine Grained
+			
Depth (ft):	156	**Material:**	Shale
Colour:	Gray	**Description:**	Sandy
+			
Depth (ft):	159	**Material:**	Sandstone
Colour:		**Description:**	
+			
Depth (ft):	160	**Material:**	Shale
Colour:	Gray	**Description:**	
+			
Depth (ft):	161	**Material:**	Siltstone
Colour:		**Description:**	
+			
Depth (ft):	167	**Material:**	Sandstone
Colour:		**Description:**	Dirty

Map Key	Number of Records	Direction/ Distance m	Elevation m	Site	DB
+					
Depth (ft):	170			Material:	Siltstone
Colour:				Description:	
+					
Depth (ft):	171			Material:	Sandstone
Colour:				Description:	
+					
Depth (ft):	174			Material:	Siltstone
Colour:				Description:	
+					
Depth (ft):	220			Material:	Sandstone
Colour:	Gray			Description:	Clean
+					
Depth (ft):	231			Material:	Sandstone
Colour:	Gray			Description:	Fine Grained
+					
Depth (ft):	233			Material:	Siltstone
Colour:				Description:	
+					
Depth (ft):	250			Material:	Shale
Colour:	Gray			Description:	Sandy

Unplottable Summary

DB	Company Name/Site Name	Address	City	Zip

No unplottable records were found that may be relevant for the search criteria.

Unplottable Report

No unplottable records were found that may be relevant for the search criteria.

Appendix: Database Descriptions

Ecolog Environmental Risk Information Services Ltd can search the following databases. The extent of Historical information varies with each database and current information is determined by what is publicly available to Ecolog ERIS at the time of update. ***Note:*** *Databases denoted with " * " indicates that the database will no longer be updated. See the individual database description for more information.*

Agriculture and Fisheries - Certificates of Approval: 1993-2012 Provincial AGR
This database contains approvals for processes pertaining to drying of alfalfa/forage/peat, feedlots, fish farms and feed/seed mills. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Alberta Oil and Gas Wells: 1883-Sept 2003* Provincial AOGW
The Alberta Energy Utilities Board maintains a database of all oil and gas wells drilled in the province of Alberta. The database contains information on well name, licensee name, licence number, location, status, total well depth and date of final drilling. Please note that this database will not be updated, information on wells drilled after September 2003 can be found in the Oil and Gas Wells (OGW) database under the 'Private Source Database' section.

Automobile Wrecking & Supplies: 2001-Jun 2010 Private AUWR
This database provides an inventory of all known locations that are involved in the scrap metal, automobile wrecking/recycling, and automobile parts & supplies industry. Information is provided on the company name, location and business type.

Waste Management Facilities - Certificates of Approval: 1993-2012 Provincial CAWD
This database contains approvals for processes pertaining to waste management facilities (hazardous waste manifesting, waste disposal/incineration/open burning/processing/storage/treatment). Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Confined Feeding Operations: 2002-Jun 2013 Provincial CFO
In 1991, the Natural Resources Conservation Board (NRCB) was created to review applications for approval of major natural resource development projects in Alberta. In January 2002, the NRCB was given the responsibility to regulate the Confined Feeding Operation industry. The Agricultural Operation Practices Act defines a confined feeding operation to be: "an activity on land that is fenced or enclosed or within buildings where livestock are confined for the purpose of growing, sustaining, finishing or breeding by means other than grazing, but does not include seasonal feeding and bedding sites." Under the AOPA regulations, all new or expanding confined feeding operations (CFOs) or manure storage facilities are required to make an application for Approval, Registration or Authorization to the NRCB before construction or expansion commences. Geographic coordinates were provided in DLS (Dominion Land Survey) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the Quarter section only.

Chemical Processing Operations - Certificates of Approval: 1993-2012 Provincial CHEM

This database contains approvals for processes pertaining to the manufacturing and use of chemical products and pesticides. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Compliance and Convictions: 1993-Jun 2013 Provincial CONV

This database summarizes the penalties and convictions handed down by the Alberta courts. This database identifies companies and/or individuals that have been found guilty of environmental offenses under Alberta's Environmental Protection Legislation. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Unfortunately, from state of the data, the location that the address pertains to cannot be confirmed.

Enforcement Action Summary: 2007-Feb 2012 Provincial EAS

This database created by ERCB summarizes high risk enforcement action 1, high risk enforcement action 2 (persistent noncompliance), high risk enforcement action 3 (failure to comply or demonstrated disregard), low risk enforcement action - global REFER and legislative/regulatory enforcement action. Fields will include licensee/company name, non-compliance event, date of enforcement, location, etc.

Environmental Effects Monitoring: 1992-2007* Federal EEM

The Environmental Effects Monitoring program assesses the effects of effluent from industrial or other sources on fish, fish habitat and human usage of fisheries resources. Since 1992, pulp and paper mills have been required to conduct EEM studies under the Pulp and Paper Effluent Regulations. This database provides information on the mill name, geographical location and sub-lethal toxicity data.

ERIS Historical Searches: 1999-Mar 2013 Private EHS

EcoLog ERIS has compiled a database of all environmental risk reports completed since March 1999. Available fields for this database include: site location, date of report, type of report, and search radius. As per all other databases, the ERIS database can be referenced on both the map and "Statistical Profile" page.

Environmental Issues Inventory System: 1992-2001* Federal EIIS

The Environmental Issues Inventory System was developed through the implementation of the Environmental Issues and Remediation Plan. This plan was established to determine the location and severity of contaminated sites on inhabited First Nation reserves, and where necessary, to remediate those that posed a risk to health and safety; and to prevent future environmental problems. The EIIS provides information on the reserve under investigation, inventory number, name of site, environmental issue, site action (Remediation, Site Assessment), and date investigation completed.

Environmental Site Assessment Repository: 1960-Sep 2013 Provincial ESAR

Environmental site assessments determine the quality of soil and groundwater of a site, particularly at retail gas stations and other commercial and industrial sites. A site assessment does not necessarily mean a site is, or ever was, contaminated. Alberta's Environmental Site Assessment Repository (ESAR) is an online, searchable database that provides scientific and technical information about assessed and/or reclaimed sites throughout Alberta. Search Alberta's ESAR using meridian, range, township, and section values at http://www.esar.alberta.ca/esarmain.aspx to gain access to reclamation certificates and/or associated files (applications, reports).

Facility List: Up to Jul 2013 Provincial FAC

This database contains a complete list of new, active and suspended facilities in Alberta including batteries, gas plants, meter stations, and other facilities. Information provided includes: facility id, facility name, operator name, sub type description, location, facility licence no, and operational status. Database now includes EDCT (Energy Development Category Type) Type and description.

Federal Convictions: 1988-Jun 2007* Federal FCON

Environment Canada maintains a database referred to as the "Environmental Registry" that details prosecutions under the Canadian Environmental Protection Act (CEPA) and the Fisheries Act (FA). Information is provided on the company name, location, charge date, offence and penalty.

Contaminated Sites on Federal Land: June 2000-Jan 2014 Federal FCS

The Federal Contaminated Sites Inventory includes information on all known federal contaminated sites under the custodianship of departments, agencies and consolidated Crown corporations as well as those that are being or have been investigated to determine whether they have contamination arising from past use that could pose a risk to human health or the environment. The inventory also includes non-federal contaminated sites for which the Government of Canada has accepted some or all financial responsibility. It does not include sites where contamination has been caused by, and which are under the control of, enterprise Crown corporations, private individuals, firms or other levels of government.

Field Inspection Incident Report: 1975-Feb 2014 Provincial FIS

Received from ERCB (Energy Resources Conservation Board) formerly the EUB (Energy Utilities Board), this database, which used to be called EISL (Environmental Information System Listing), contains reported environmental incidents beginning in 1975. Descriptions include noise infractions, air quality emissions, oil spills and failures for pipelines, wells, plants, and batteries. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Food Processing Operations - Certificates of Approval: 1993-2012 Provincial FOOD

This database contains approvals for processes pertaining to the manufacturing of food products. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Fuel Storage Tanks: 1985-Sep 2012 Provincial FST

Information in this database was collected according to Alberta Regulation AR 291/95 Storage Tank System Management and to AR 52/98 Fire Code which was formerly The Alberta Fire Code Regulation, 1992 (AR 204/92). This information was received from the Petroleum Tank Management Association of Alberta (PTMAA) which has regulated Storage Tanks since 1994.

Waste Generators Summary: 1993-Aug 2013 Provincial GEN

Under Alberta's Waste Control Regulation, Alta. Reg. 192/96, a generator is a person who consigns hazardous waste for storage, transport, treatment or disposal. As of 2007, Alberta Environment no longer provides detailed information on each waste generator, such as approval number, class, and class description.

Gas Processing Plants: Up to Feb 2014 Provincial GPP

The ERCB (Energy Resources Conservation Board) has an inventory of all Gas Processing Plants in Alberta, with information such as location, names of plant, facility type, operator name, facility license, design capacities, etc.

Alberta Environment's H.E.L.P. (Help End Landfill Pollution) Program Database: June 1988* Provincial HELP

The H.E.L.P. Data Tracking and Management Control System was created to provide tracking and management capabilities of industrial landfills in Alberta for the Department of Environment. Detailed information including company name, location, type of landfill, priority, score, status, use and much more is included in this database.

Indian & Northern Affairs Fuel Tanks: 1950-Aug 2003* Federal IAFT

The Department of Indian & Northern Affairs Canada (INAC) maintains an inventory of all aboveground & underground fuel storage tanks located on both federal and crown land. Our inventory provides information on the reserve name, location, facility type, site/facility name, tank type, material & ID number, tank contents & capacity, and date of tank installation.

Identification and Verification of Active and Inactive Land Disposal Sites: Oct 1982* Provincial LDS

In late 1981, Environment Canada and Alberta Environment initiated a project to identify and verify land disposal sites in the province of Alberta. A point scoring system was used to classify the sites into potential priority 1, priority 2 or priority 3 groups on the basis of the type of waste received at the sites and the site environment. Sites that, according to available information, may pose a hazard to public health and safety or the environment are classified as potential priority 1 sites.

Land Disposal Sites on Indian Reserves: Oct 1982* Provincial LDSI

In late 1981, Environment Canada and Alberta Environment initiated a project to identify and verify land disposal sites in the province of Alberta. This database specifically identifies land disposal sites on Indian Reserves. Information on each site is limited to: location, band, size and general comments.

Lumber Related Operations - Certificates of Approval: 1993-2012 Provincial LUM

This database contains approvals for processes pertaining to the manufacturing of wood products, pulp and paper including the associated water treatment processes. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Canadian Mine Locations: 1998-2009 Private MINE

This information is collected from the Canadian & American Mines Handbook. The Mines database is a national database that provides over 290 listings on mines (listed as public companies) dealing primarily with precious metals and hard rocks. Listed are mines that are currently in operation, closed, suspended, or are still being developed (advanced projects). Their locations are provided as geographic coordinates (x, y and/or longitude, latitude). As of 2002, data pertaining to Canadian smelters and refineries has been appended to this database.

Metals, Minerals and Building Materials Operations - Certificates of Approval: 1993-2012 Provincial MMB

This database contains approvals for processes pertaining to the manufacturing of building materials, metals, and mineral products. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Mineral Occurrences: 1993-2003* Provincial MNR

The AMDO (Alberta Mineral Deposits and Occurrences) application was created by the Minerals and Coal Geoscience Section of the Alberta Geological Survey as a database for mineral deposits in Alberta in the early 1990s. This is a one time inventory and will not be updated.

National Analysis of Trends in Emergencies System (NATES): 1974-1994* Federal NATE

In 1974 Environment Canada established the National Analysis of Trends in Emergencies System (NATES) database, for the voluntary reporting of significant spill incidents. The data was to be used to assist in directing the work of the emergencies program. NATES ran from 1974 to 1994. Extensive information is available within this database including company names, place where the spill occurred, date of spill, cause, reason and source of spill, damage incurred, and amount, concentration, and volume of materials released.

National Defence & Canadian Forces Fuel Tanks: Up to May 2001* Federal NDFT

The Department of National Defence and the Canadian Forces maintains an inventory of all aboveground & underground fuel storage tanks located on DND lands. Our inventory provides information on the base name, location, tank type & capacity, tank contents, tank class, date of tank installation, date tank last used, and status of tank as of May 2001. This database will no longer be updated due to the new National Security protocols which have prohibited any release of this database.

National Defence & Canadian Forces Spills: Mar 1999-Aug 2010 Federal NDSP

The Department of National Defence and the Canadian Forces maintains an inventory of spills to land and water. All spill sites have been classified under the "Transportation of Dangerous Goods Act - 1992". Our inventory provides information on the facility name, location, spill ID #, spill date, type of spill, as well as the quantity of substance spilled & recovered.

National Defence & Canadian Forces Waste Disposal Sites: 2001-Apr 2007* Federal NDWD

The Department of National Defence and the Canadian Forces maintains an inventory of waste disposal sites located on DND lands. Where available, our inventory provides information on the base name, location, type of waste received, area of site, depth of site, year site opened/closed and status.

tional Environmental Emergencies System (NEES): 1974-2003* Federal NEES

2000, the Emergencies program implemented NEES, a reporting system for spills of hazardous substances. For the most part, this system only captured data from the Atlantic Provinces, some from Quebec and Ontario and a portion from British Columbia. Data for Alberta, Saskatchewan, Manitoba and the Territories was not captured. However, NEES is also a repository for all previous Environment Canada spill datasets. NEES is composed of the historic datasets ' or Trends ' which dates from approximately 1974 to present. NEES Trends is a compilation of historic databases, which were merged and includes data from NATES (National Analysis of Trends in Emergencies System), ARTS (Atlantic Regional Trends System), and NEES. In 2001, the Emergencies Program determined that variations in reporting regimes and requirements between federal and provincial agencies made national spill reporting and trend analysis difficult to achieve. As a consequence, the department has focused efforts on capturing data on spills of substances which fall under its legislative authority only (CEPA and FA). As such, the NEES database will be decommissioned in December 2004.

National PCB Inventory: 1988-2008* Federal NPCB

Environment Canada's National PCB inventory includes information on in-use PCB containing equipment in Canada including federal, provincial and private facilities. All federal out-of-service PCB containing equipment and all PCB waste owned by the federal government or by federally regulated industries such as airlines, railway companies, broadcasting companies, telephone and telecommunications companies, pipeline companies, etc. are also listed. Although it is not Environment Canada's mandate to collect data on non-federal PCB waste, the National PCB inventory includes some information on provincial and private PCB waste and storage sites. Some addresses provided may be Head Office addresses and are not necessarily the location of where the waste is being used or stored.

National Pollutant Release Inventory: 1993-2011 Federal NPRI

Environment Canada has defined the National Pollutant Release Inventory ("NPRI") as a federal government initiative designed to collect comprehensive national data regarding releases to air, water, or land, and waste transfers for recycling for more than 300 listed substances.

Operating and Abandoned Mines: 2001, 2003* Provincial OAM

This data is based on the 2001 edition (revised in 2003), published by The Alberta Energy and Utilities Board (EUB) now The Energy Resources Conservation Board (ERCB). It was a one time inventory of Operating and Abandoned Coal Mines in Alberta. In 1905, Alberta began to catalogue coal mines by assigning a unique number to each operation. This database will provide information on location, mine #, mine name, mine company, life span, amount of coal produced, depth, thickness and other important information concerning the mine.

Oil and Gas Wells: 1988-Mar 2014 Private OGW

The Nickle's Energy Group (publisher of the Daily Oil Bulletin) collects information on drilling activity including operator and well statistics. The well information database includes name, location, class, status and depth. The main Nickle's database is updated on a daily basis, however, this database is updated on a monthly basis. More information is available at www.nickles.com.

Alberta Orphan Wells: Up to Jun 2013 Provincial ORP

Orphan wells are wells that have not been properly abandoned and whose operators are defunct or insolvent. In Alberta, orphan wells fall under the responsibility of the Orphan Well Association, which works under the authority of the EUB. The data includes Location, Well ID, License Name and License Number.

Canadian Pulp and Paper: 1999, 2002, 2004, 2005, 2009 Private PAP

This information is part of the Pulp and Paper Canada Directory. The Directory provides a comprehensive listing of the locations of pulp and paper mills and the products that they produce.

Parks Canada Fuel Storage Tanks: 1920-Jan 2005* Federal PCFT

Canadian Heritage maintains an inventory of all known fuel storage tanks operated by Parks Canada, in both National Parks and at National Historic Sites. The database details information on site name, location, tank install/removal date, capacity, fuel type, facility type, tank design and owner/operator.

Petrochemical, Coal and Gas Operations - Certificates of Approval: 1993-2012 Provincial PCG

This database contains approvals for processes pertaining to petroleum, coal, and oil and gas processing. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Pesticide Register: 1998-Jun 2013 Provincial PES

This is a list of all Registered Pesticide Vendors in Alberta (retail and wholesale). The pesticide vendor list is comprised of vendors who have both audited AWSA pesticide storage facilities as part of their operation, and those vendors that do not have an audited AWSA pesticide storage facilities. Non-audited retail and wholesale vendors may be selling products that are not covered by the AWSA program, or may be utilizing external AWSA pesticide warehouses. Registration numbers and expiry dates are identified for each operation. If a registration number is not present, the operation's vendor registration is in the process of renewal.

Conglomerate and Waste Management Facilities: 1993-2012 Provincial PITS

This database contains approvals for processes pertaining to the use of gravel pits, sand pits, and clay pits. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Alberta Private Sewage Disposal Permits: 2003-Jun 2013 Provincial PSP

These permits are private sewage disposal permits that have been issued to owners and contractors. They would include various types of installations including holding tanks, septic tanks, packaged treatment plants, sand filters, fields, mounds, lagoons and open discharges. In 2003 Alberta Municipal Affairs started collecting information and issuing permits using an electronic permitting system. These records include all private sewage disposal permits within the jurisdiction of Alberta Municipal Affairs.

Hazardous Waste Receivers Summary: 1993-Aug 2013 Provincial REC

A waste receiving location is any site or facility to which waste is transferred through a waste carrier. A receiver of regulated waste is required to register the waste receiving facility. This database represents receivers of regulated wastes under Alberta's Waste Control Regulation, Alta. Reg. 192/96. As of 2007, Alberta Environment no longer provides detailed information on each waste receiver, such as approval number, class, and class description.

Retail Fuel Storage Tanks: 1999-Jun 2010 Private RST

This database includes an inventory of retail fuel outlet locations (including marinas) that have on their property gasoline, oil, waste oil, natural gas and / or propane storage tanks.

Scott's Manufacturing Directory: 1992-Mar 2011 Private SCT

Scott's Directories is a data bank containing information on over 200,000 manufacturers across Canada. Even though Scott's listings are voluntary, it is the most comprehensive database of Canadian manufacturers available. Information concerning a company's address, plant size, and main products are included in this database.

Special Operation Classifications - Certificates of Approval: 1993-2012 Provincial SPEC

This database contains approvals for processes pertaining to classifications listed as special operations (i.e. locations owned/operated by municipalities, operations that involve the presence of pesticides). Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Inventory of Waste Disposal Sites: 1998* Private WDS

This one time inventory is a compilation of information collected from each region and pertains to active, regulated waste disposal sites within the province of Alberta. In the past, waste disposal sites were registered with both regional and health offices. That process was dissolved and regional landfills were developed. There is no central source of this information. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Wastewater Operations: 1993-2012 Provincial WSTE

This database contains approvals for processes pertaining to wastewater treatment systems. Please note that, as per the source of this database, some of the geographic information may pertain to a head office or mailing address and not necessarily the site of operations to which the certificate applies. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Water Well Information System: 1880-Sep 2013 Provincial WWIS

This database was collected from the Groundwater Information Center of the Natural Resource Service and contains over 387,000 records. Some geographic coordinates have been provided in ATS (Alberta Township Survey system) format but do not contain offsets that are necessary to pinpoint a specific location. Therefore, locations will be accurate to the quarter section only.

Definitions

Database Descriptions: This section provides a detailed explanation for each database including: source, information available, time coverage, and acronyms used. They are listed in alphabetic order.

Detail Report: This is the section of the report which provides the most detail for each individual record. Records are summarized by location, starting with the project property followed by records in closest proximity.

Distance: The distance value is the distance between plotted points, not necessarily the distance between the sites' boundaries". All values are an approximation.

Direction: The direction value is the compass direction of the site in respect to the project property and/or center point of the report.

Elevation: The elevation value is taken from the location at which the records for the site address have been plotted. All values are an approximation. Source: Google Elevation API.

Executive Summary: This portion of the report is divided into 3 sections:

'Report Summary'- Displays a chart indicating how many records fall on the project property and, within the report search radii.

'Site Report Summary'-Project Property'- This section lists all the records which fall on the project property. For more details, see the 'Detail Report' section.

'Site Report Summary-Surrounding Properties'- This section summarizes all records on adjacent properties, listing them in order of proximity from the project property. For more details, see the 'Detail Report' section.

Map Key: The map key number is assigned according to closest proximity from the project property. Map Key numbers always start at #1. The project property will always have a map key of '1' if records are available. If there is a number in brackets beside the main number, this will indicate the number of records on that specific property. If there is no number in brackets, there is only one record for that property.

The symbol and colour used indicates 'elevation': the red inverted triangle will dictate 'ERIS Sites with Lower Elevation', the yellow triangle will dictate 'ERIS Sites with Higher Elevation' and the orange square will dictate 'ERIS Sites with Same Elevation.'

Unplottables: These are records that could not be mapped due to various reasons, including limited geographic information. These records may or may not be in your study area, and were included as reference.

Appendix D

Aerial Photographs

Figure 5. Aerial Photo 1924

The Site and surrounding area appears to be mostly undeveloped aspen parklands with roads or railway visible.

McElhanney	Photo Reference: CA51-71
	Photo Year: 1924
	Interpreted By: SH
	Reviewed By: BW

Figure 6. Aerial Photo 1950

The Site is mostly cleared of trees and shrubs with the creek running through the center. The surrounding properties also appear to be mostly farmland with small stands of woodlands.

McElhanney	Photo Reference: A12519-78
	Photo Year: 1950
	Interpreted By: SH
	Reviewed By: BW

Figure 7. Aerial Photo 1956

Observations similar to those in 1950.

McElhanney	Photo Reference: A15247-61
	Photo Year: 1956
	Interpreted By: SH
	Reviewed By: BW

Figure 8. Aerial Photo 1959

Observations similar to those in 1956.

McElhanney	Photo Reference: A16472128
	Photo Year: 1959
	Interpreted By: SH
	Reviewed By: BW

Figure 9. Aerial Photo 1976

Building consistent with single family dwelling are visible of the Site. The property to the south, west and north of the Site have buildings visible that are likely single family dwellings or buildings related to farming.

McElhanney	Photo Reference: A24453-124
	Photo Year: 1976
	Interpreted By: SH
	Reviewed By: BW

Figure 10. Aerial Photo 1984

Observations similar to those in 1976.

McElhanney	Photo Reference: A26443-161
	Photo Year: 1984
	Interpreted By: SH
	Reviewed By: BW

Figure 11. Aerial Photo 2004

New building and drive way visible on the perimeter of the Site to the N side.

McElhanney	Photo Reference: Google Earth
	Photo Year: 2004
	Interpreted By: SH
	Reviewed By: BW

ASSESSMENT OF SOIL AND GROUNDWATER CONDITIONS

Proposed Robinwood Estates Rural Residential Subdivision
Portion of LSD 8-33-49-1 W4M (Lot 1, Block 1, Plan 1218TR)
County of Vermilion River, Alberta

Prepared for:

Anasazi Developments Inc.
St. Albert, Alberta

Date:

23 July 2014

Project File #: PG14-1140

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1.0 INTRODUCTION

This report presents the results of the soil and groundwater conditions assessment conducted for the proposed Robinwood Estates Residential Subdivision, located within Lot 1, Block 1, Plan 1218TR (within a portion of LSD 8-33-49-1 W4M) in the County of Vermilion River, Alberta. The assessment was carried out by SolidEarth Geotechnical Inc. (SolidEarth) at the request of Mr. Scott Nelson of Anasazi Developments Inc. (Anasazi Developments).

2.0 SITE AND PROJECT DESCRIPTION

The site was located within Plan 1218TR, Block 1, Lot 1, west of Lloydminster, Alberta. The site was bounded by agricultural cropland and a rural residence to the north, Range Road 13 to the east, agricultural cropland and a rural residence to the south, and agricultural cropland to the west.

At the time of the field investigation, the site was agricultural cropland. The site topography was generally rolling terrain, with a 25 m drainage easement running north to south through the middle of the site. Four photographs showing site conditions at the time of the field investigation are presented in Appendix A.

Based on information provided to SolidEarth, it was understood that the proposed subdivision will consist of 12 rural residential lots. The lot sizes vary between 1.4 and 1.9 acres, with the majority of the lots being in the 1.4 to 1.5 acre range. It was further understood that private in-situ wastewater disposal systems are proposed for all lots.

3.0 ASSESSMENT SCOPE AND OBJECTIVE

The scope of work completed by SolidEarth included drilling eight (8) boreholes within the proposed development area, conducting laboratory review and testing on recovered soil samples, measuring the groundwater levels at the borehole locations, undertaking geotechnical engineering analysis, and preparation of this report.

The objective of the assessment was to: (i) evaluate the subsurface soil and groundwater conditions at selected locations across the site; (ii) determine the overall suitability of subsurface conditions (soil and groundwater) for the use of in-situ wastewater disposal systems; and (iii) provide geotechnical considerations and recommendations for site development, foundation and basement systems for single family houses, and roadway construction.

The suitability of utilizing in-situ wastewater disposal and treatment systems has been completed in accordance with guidelines of the Safety Codes Council (SCC) *"Alberta Private Sewage Systems Standard of Practice, 2009"*. This assessment is considered a feasibility study for the general suitability of in-situ sewage management systems for the subdivision.

4.0 FIELD AND LABORATORY INVESTIGATION

4.1 GROUND DISTURBANCE AND SAFETY PERFORMANCE

Prior to field drilling, a SolidEarth representative completed internal ground disturbance procedures, which included placing an Alberta One Call. Before starting onsite work, a field hazard assessment was conducted by the SolidEarth representative and was communicated with all workers involved. The field program was completed without any near misses or incidents.

4.2 FIELD DRILLING AND TESTING

The borehole locations were selected and marked in the field by SolidEarth personnel. The locations were selected based on the proposed site development plan provided by McElhanney (the project planners/civil designers). The borehole location plan is presented as Figure 1.

SolidEarth subcontracted Border Drilling Ltd., of Lloydminster, Alberta to drill the boreholes. Drilling was completed using a track-mounted auger drill rig utilizing 150 mm solid-stem continuous flight augers.

The field investigation was undertaken on 3 June 2014 and consisted of drilling eight boreholes (BH14-1 through -8) within the proposed development area. The boreholes were drilled to depths ranging between 3.5 to 6.4 m below the existing ground surface.

During drilling, soil samples were collected at approximately 0.75 to 1.0 m intervals along the depth of the boreholes. Pocket penetrometer testing was conducted on selected cohesive soil samples to obtain an indication of the unconfined compressive strength of disturbed soil samples from the auger. Standard Penetration Tests (SPT's) were also conducted at selected depths (typically every 1.5 m) at all borehole locations to assess the in-situ strength of the soils encountered. The soil sampling and testing sequences are shown on the borehole logs.

A SolidEarth geotechnical technologist monitored the drilling operations and logged the recovered soil samples from the auger cuttings and the SPT samples. The soils were logged according to the Modified Unified Soil Classification System, which is described in the Explanation of Terms and Symbols in Appendix B. Due to the method by which the soil cuttings were returned to surface, the depths noted on the borehole logs may vary by ± 0.3 m from those recorded.

Groundwater seepage conditions were monitored during and immediately following completion of drilling. Slotted standpipe piezometers were installed in all boreholes at the completion of drilling to monitor short term groundwater levels. Groundwater levels were measured on 12 June and 7 July 2014.

The lateral coordinates (northing and easting) of the ground surface at the borehole locations, as recorded by SolidEarth using a hand held GPS unit, are shown on the borehole logs.

4.3 LABORATORY INVESTIGATION

All collected samples were submitted to the laboratory for further examination and testing. Laboratory testing conducted included visual examination and determination of the natural moisture content on all collected samples; and Atterberg limits, and grain size distribution tests on selected samples. At least one soil sample from each borehole was submitted for grain size distribution analysis which entails the determination of the percent of gravel, sand, silt, and clay sizes in the sample.

The results of the laboratory testing are presented on the borehole logs, Figures 2 through 9. The results of the grain size distribution analysis tests are summarized in Table 1.

5.0 SUBSURFACE CONDITIONS

The subsurface soils encountered at the borehole locations generally consisted of cultivated topsoil followed by clay till. Sand layers were encountered interbedded within the clay till at several borehole locations. A brief summary of the subsurface conditions is presented below. A detailed description of the subsurface conditions encountered at each borehole location is provided on the borehole logs. It is to be noted that soil conditions across the development area may vary from what was encountered at the borehole locations.

Cultivated topsoil was encountered at the ground surface of all borehole locations and was generally less than 250 mm thick. The topsoil was organic and black.

Clay till was encountered below the cultivated topsoil at all borehole locations. The clay till extended to beyond the exploration depths of all boreholes, except BH14-2 and -5 where sand was present at the termination depth. The clay till was generally classified as "clay, and sand, silty, trace gravel", was medium plastic, and moist.

Sand layers were encountered interbedded within the clay till at all borehole locations except BH14-1, -7, and -8 (the eastern portion of the site). The sand was generally fine grained and contained trace silt and trace clay. The thickness of the sand layers generally ranged between 1 and over 1.7 m.

The measured groundwater levels at the site are shown in Table 2 below. The groundwater levels are expected to fluctuate seasonally depending upon several factors that include the local geology, hydrogeology, and surface infiltration.

In clayey soils, the groundwater table generally takes time to recover and stabilize following the completion of drilling. The length of time required depends on the hydraulic conductivity of the clayey soil and the presence of fissures and seams in the soil matrix. Accordingly, the observed

depth of the groundwater table in the boreholes after a short period following drilling is generally deeper than the long-term stabilized levels.

Table 1: Results of the Grain Size Analysis Tests

Borehole No. / Sample Depth	Grain Size Distribution (% by Weight) Note 1			Soil Texture Classification Note 1
	% Sand & Gravel	% Silt	% Clay	
BH14-1 / 1.2 m – 1.5 m	49	24	27	Sandy Clay Loam
BH14-2 / 0.8 m – 1.1 m	51	24	25	Sandy Clay Loam
BH14-3 / 0.8 m – 1.1 m	48	25	27	Sandy Clay Loam
BH14-4 / 0.8 m – 1.1 m	52	25	23	Sandy Clay Loam
BH14-5 / 1.2 m – 1.5 m	52	26	22	Sandy Clay Loam
BH14-6 / 1.2 m – 1.5 m	56	22	22	Sandy Clay Loam
BH14-7 / 0.8 m – 1.1 m	54	23	23	Sandy Clay Loam
BH14-8 / 0.8 m – 1.1 m	48	28	24	Sandy Clay Loam

Note 1: Grain size distribution and soil classification are in accordance with the Canadian System of Soil Classification.

Table 2: Measured Groundwater Levels

Borehole No.	Depth of Borehole (mbgs)	Groundwater Level (mbgs) Note 1, Note 2		
		Upon Completion of Drilling (3 June 2014)	12 June 2014	On 7 July 2014
BH14-1	5.0	> 4.6	4.1	1.3
BH14-2	3.5	2.7	2.1	1.2
BH14-3	6.4	2.7	0.7	0.8
BH14-4	3.5	>2.7	0.4	0.7
BH14-5	5.0	> 4.6	0.9	0.8
BH14-6	3.5	> 3.4	1.7	1.3
BH14-7	5.0	> 4.6	0.6	0.7
BH14-8	3.5	>3.0	0.8	0.9

Note 1: mbgs – metres below existing ground surface
Note 2: > - indicates deeper than

6.0 GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS

Site Development

The subsurface conditions at this site were considered favourable for site grading, roadway construction, and for the construction of single family residential units. Shallow footings and slab-on-grade floors are considered suitable for the single family dwellings at this site.

The final site grading plan was not available for review at the time of preparation of this report and as such, the amount of cut and fill was unknown. Discussion of acceptable slope configuration (i.e., height and angle) and development next to slopes (i.e., setbacks) are not included in this report. The site grading and development plan, when completed, should be reviewed by the geotechnical engineer and the requirements for additional evaluations should be assessed.

Use of In-situ Wastewater Treatment Systems

The subsurface soil conditions were considered restrictive for the use of in-situ wastewater treatment systems. A shallow groundwater table was measured across the site, which will result in restrictions on acceptable wastewater treatment and management systems.

The predominant soils across the majority of the site were medium plastic clay till. Based on the grain size distribution analysis, these soils were classified as "Sandy Clay Loam" (in accordance with the Canadian System of Soil Classification), which is deemed suitable by the SCC "*Alberta Private Sewage Systems Standard of Practice, 2009*".

6.1 SITE DEVELOPMENT CONSIDERATIONS

6.1.1 Site Grading

During initial grading, all organics and topsoil should be stripped and removed from the development area. Organic material should not be mixed with mineral soils nor should it be used as engineered fill material. The topsoil may be stockpiled at an approved location for future landscaping use.

Very moist near surface soils were encountered at a few borehole locations. As such, soft subgrade conditions should be expected across the site. The soft subgrade is expected to be more pronounced following snow melt and heavy rain events. Where soft and wet subgrade conditions are encountered, the subgrade should be scarified, air dried, and re-compacted (if good weather conditions prevail) or the soft wet material removed and replaced with drier clay or granular material.

All exposed subgrade, following cut (in areas under cut) and prior to placement of engineered fill (in areas under fill) should be inspected by the geotechnical engineer. The inspection may

include a proof-roll test to confirm that deflections from construction traffic are minimal. This is particularly important in areas where subgrade support will be required (i.e., slab-on-grade or pavement). Soft and weak areas identified during inspection, should be strengthened and improved.

In areas where subgrade supported is required (building footprint, concrete aprons, and roadways), it is recommended that the upper 0.2 m of the native subgrade be strengthened/improved. Subgrade strengthening/improvement would include scarifying and re-compacting the subgrade as engineered fill with strict control of moisture content and density. Requirements for engineered fill are discussed below.

Engineered fill should consist of low to medium plastic clay or a well-graded granular material. Silt or sand which is uniformly graded, or which contains more than 10 percent passing the 0.080 mm sieve are not recommended as these materials are generally frost susceptible and are difficult to compact (require strict control of moisture content). All fill soils should be free from any organic materials, contamination, deleterious construction debris, and stones greater than 150 mm in diameter.

Engineered fill should be placed during non-frozen conditions. If winter construction is proposed, SolidEarth can provide additional recommendations once the overall development plan has been finalized.

All engineered fill should be compacted to a minimum of 98 percent of standard Proctor maximum dry density (SPMDD) within the buildings areas, and to a minimum of 95 percent SPMDD within the driveways and paved areas. The fill should be compacted in lift thicknesses of 300 mm (loose) or less and within two percent of the optimum moisture content (OMC). Engineered fill within the building footprints should extend at least 1 m, or the thickness of the fill, beyond the footprint of the building. Fill placement procedures and quality of the fill soils should be monitored by geotechnical personnel. Field monitoring should include compaction testing at regular frequencies.

Even for well compacted fill, some fill settlement under self-weight will occur. Settlement in the order of one to three percent of the fill thickness should be anticipated for engineered fill compacted to between 98 and 95 percent SPMDD. The majority of this settlement is expected to occur within the first year following construction.

6.1.2 Site Drainage

To minimize the potential for water ponding and saturation of the subgrade during and following construction, a minimum grade of two percent is recommended at the subgrade level to accommodate surface water runoff away from the buildings. It is also recommended that positive surface drainage be provided in the early stages of construction to prevent ponding of water and softening of the subgrade.

6.2 ROADWAY PAVEMENT STRUCTURES

It was understood that flexible asphalt pavement is being considered for this site. It was further understood that only highway-legal traffic will be allowed on the asphalt pavement structure.

6.2.1 Surface Water Management Considerations

The performance of the pavement structure will be enhanced to a greater degree with proper management of surface water. It is recommended that adequate slope be provided at the subgrade level, and that the pavement gravel base course material be properly drained into a positive gravity drainage system. This will reduce the risk of water ponding above the clay subgrade and potential of softening and/or volume change associated with the presence of excess water.

It is recommended that the roadway surfaces be elevated above the natural ground, and/or side ditches be provided along the length of the road alignment to provide positive gravity surface water management features. It is further recommended that the underside of the granular road surface be elevated at least 0.6 m above the bottom of the side ditches, and/or surrounding grades.

The separation between the underside of the granular road surface and surrounding grades should be increased if water storage is proposed within the side ditches. In general, if water will be stored for extended periods of time in the side ditches, then a minimum of 1 m separation should be maintained between the top of the stored water and the top of the subgrade.

A minimum grade of two percent is recommended at the subgrade level to accommodate surface water runoff away from the subgrade. The final pavement surface should also be properly sloped to promote surface water runoff away from the paved surface.

Positive drainage away from the pavement surface is particularly important during the spring thaw and snow melt season. If water from melting snow is allowed to remain on the paved surface and subsequently freezes, significant damage to the pavement (and formation of potholes) may be encountered.

6.2.2 Frost Susceptibility of Soils

Frost heave of the subgrade soils is generally related to the particle size distribution of the soils, moisture content, and the presence of a relatively shallow groundwater table. The near surface clayey soils encountered at the site were generally of medium plasticity. The grain size distribution of these soils generally consisted of between 22 and 27 percent by weight of clay size particles with the remaining portions as silt and fine sand size particles. These soils were generally considered to be low to moderately susceptible to frost heaving and formation of ice lenses.

The measured groundwater levels at the borehole locations ranged between 0.7 and 1.4 m below ground surface. Additionally, relatively high moisture contents were observed in the near surface soils at a few borehole locations.

With proper surface water management and drainage (as discussed above), the risk of frost heaving was considered moderate. It is to be noted that poor surface drainage and/or water inundating the subgrade soils will significantly increase the risk levels.

Due to the general variability in the soil makeup and groundwater seepage paths in clay till soil deposits, it is not possible to predict with certainty the magnitude of frost heaving at specific locations. It is generally recommended that an observational approach be adopted over the first two winter seasons to identify problematic areas.

Frequently, areas exhibiting the formation of ice lenses and frost heaving during one winter season will exhibit the same during subsequent winter seasons. If areas with problematic frost conditions are observed, then remedial measures may be implemented.

The most suitable remedial measure will have to be assessed on a case by case basis as it depends on the severity of the problem, service/use interruption of the affected area, and the sensitivity of the pavement structure to frost heaving. Remedial measures may include soil replacement, ground insulation, or periodic maintenance (in case of low use areas).

6.2.3 Pavement Section

Recommendations presented in Section 6.1.1 "Site Grading" regarding subgrade preparation and inspection should be followed. The recommended pavement section is based on having a stable subgrade.

The minimum recommended asphalt pavement section is provided in Table 3. Light duty refers to design traffic of $5x10^4$ Equivalent Single Axle Load (ESAL's).

Table 3: Asphalt Pavement Design for Light Duty Section

Material	Recommended Minimum Thickness (mm)
Hot Mix Asphalt	80
20 mm Crushed Granular Base Course (AT Designation 2 Class 20)	250

The granular base course (20 mm material) should be placed in maximum of 150 mm thick lifts and uniformly compacted to a minimum of 100 percent of SPMDD at moisture content within 2 percent of the soils' optimum moisture content. Reduced lift thickness may be required

depending on the capability of the compaction equipment available to achieve the required densities.

It is recommended that locations subjected to heavy static wheel loads, such as at dumpster enclosures, be constructed with concrete pavement instead of flexible asphalt pavement to minimize the potential for rutting which may occur in asphalt under these service conditions. At a minimum, a 175 mm thick concrete slab underlain by a minimum 150 mm thick layer of granular base course is recommended. The granular base course should be compacted to a minimum of 100 percent of SPMDD at moisture content within two percent of optimum.

6.3 CONSIDERATIONS FOR BASEMENT STRUCTURES

6.3.1 Basement Excavations

Sand layers interbedded within the clay till were encountered at all borehole locations, except BH14-1, -7, and -8. At the locations of BH14-2, -3, -4, the top of the sand was encountered between 1.5 and 1.8 m below the existing ground surface. The sand layers were generally more than 1 m thick.

Basement excavations are expected to be predominantly through the clay till soils, except at the general locations of BH14-2, -3, -4. At these locations, the bottom portion of the basement excavation may intercept sand.

For temporary excavations in the clay till that will be open for less than one month and up to 2 m deep, side slopes no steeper than 1 horizontal to 1 vertical (1H:1V) are recommended. Flatter side slopes may be required for deeper excavation or excavation extending into the sand and where water seepage is encountered. Excavations left open for more than one month should be checked regularly for drying and sloughing of the side slopes and for any tension cracks along top edges of the excavation.

Basement excavations should extend sufficient distance past the edge of the perimeter footings to provide adequate space and protection for the workers. If space does not permit the slopes to be cut back, some form of temporary shoring must be installed to protect workers in the excavation. The latest edition of the Construction Safety Regulations of the *Occupational Health and Safety Act of Alberta* should be followed.

Stockpiles of materials and excavated soil should be placed away from the crest of the excavation slopes by a distance equal to at least half the depth of the excavation. Similarly, wheel loads should be kept back at least 2 m from the crests of the excavation. Larger setback distances should be established for heavy trucks such as those hauling soil or concrete. Greater setbacks, and flatter side slopes, are recommended for excavations that remain open for extended periods of time.

6.3.2 Basement Sub-drainage System

It is generally recommended that basement floor slabs be placed at least 0.5 m above the groundwater table. The measured groundwater table at the time of the investigation ranged between 0.7 and 1.3 m below the existing ground surface. Seasonal fluctuations in the groundwater table elevation should be anticipated. As such, maintaining the basement floor level above the water table may not be practical unless the house footprint was raised above the existing grades, and a robust subdrainge system is implemented. Additional discussion is presented in Section 6.5 "Considerations for Lot Grading"

Where the basement excavation intercepts sand (general area of BH14-2, -3, -4), it is recommended that a clay cap be placed above the sand to reduce the long term intensity of groundwater seepage into the sub-drainage layer below the slab. The clay cap should be at least 0.5 m thick and placed across the excavation floor, and should extend along the side slopes a distance of at least 0.5 m above the top of the sand layer. The clay cap should be placed as engineered fill.

It is further recommended to place a layer of free draining gravel below the basement floor slab and a weeping tile drain around the perimeter of basement structures. The weeping tile should consist of a perforated rigid plastic pipe surrounded by a filter of free draining gravel, all enveloped in a non-woven, medium weight geotextile. Perimeter weeping tiles should be located with the pipe invert at or below the bottom of footing elevation.

The weeping tiles and the below slab drainage layer should be connected to a positive gravity drain or sump pump system that is connected to the storm or sanitary system, in accordance with local regulations.

6.3.3 Backfill Behind Basement Walls

Backfill soils behind the basement walls can exert significant horizontal pressure on the basement wall. Rather than heavily compacting the backfill around the basement walls, it is recommended to nominally compact the backfill recognizing that settlement of the backfill will occur, particularly in the first couple of years following construction. Backfill around basement walls should be sloped to shed water away from the structure. The slope of the backfill should be checked periodically to maintain the slope of the ground surface away from the foundation wall.

Backfilling should be delayed until the concrete has gained sufficient strength to support the horizontal loads. The top and bottom of the wall should be braced prior to backfilling. It is recommended to place the basement floor slab and floor joists prior to backfilling around walls. Backfill should be brought up evenly around the building perimeter to minimize differential horizontal pressures on the basement walls.

It is recommended that an approximately 0.5 m thick layer of free draining material be placed adjacent to the basement walls so that any water seepage into the building footprint can drain rapidly into the sub-drainage system and not pond behind the basement walls. The granular material should be hydraulically connected to the perimeter weeping tile. The top 0.3 m of the backfill around the building should consist of compacted clay to act as a seal against runoff water.

6.4 SHALLOW FOUNDATIONS FOR RESIDENTIAL HOUSES

Based on the information provided to SolidEarth, it was understood that the residential houses will incorporate below ground basement structures. Accordingly, the footing bearing surface is expected to be approximately between 1.5 and 2.5 m below the final site grades.

6.4.1 Foundation Design Method

The current design standard in foundation engineering is based on limit state design. Accordingly, geotechnical recommendations associated with such standard is provided in this report. If the traditional working stress method is preferred, then such recommendations may be provided upon request.

The *Canadian Foundation Engineering Manual* defines limit states "as conditions under which a structure or its component members no longer perform their intended function". Limit states are generally classified into two main groups: ultimate limit state and serviceability limit state. Below is a brief discussion on both states.

Ultimate Limit State (ULS)

Ultimate limit states are primarily concerned with collapse mechanisms for the structure and, hence, safety. For foundation design, the ULS consists of: ultimate bearing capacity failure, sliding, overturning, loss of stability, uplift, or large deformation.

The basic foundation design equation using ULS approach is presented as:

$$\Phi R_n \geq \Sigma \alpha_i S_{ni}$$ [1]

where:

- ΦR_n - is the factored geotechnical resistance
- Φ - geotechnical resistance factor
- R_n - the nominal (ultimate) geotechnical resistance determined using unfactored values for geotechnical parameters or performance data (such as pile load test)

[1] Page 136 of the Canadian Foundation Engineering Manual – 4th Edition, January 2007.

$\Sigma\alpha_i S_{ni}$ - is the summation of the factored overall load effects for a given load combination condition

α_i - is the load factor corresponding to a particular load

S_{ni} - is a specified load component of the overall load effects (e.g. dead load due to weight of structure or live load due to wind)

i - represents various types of loads such as dead load, live load, wind load, etc.

Geotechnical resistance factors as provided by the *National Building Code of Canada (NBCC)* for foundations are provided in Table 2. The critical design events and their corresponding load combination and load factors should be assessed and determined by the structural engineer.

Table 2: Geotechnical Resistance Factors for Foundations

Foundation Type	Loading Condition	Geotechnical Resistance Factor (ULS)
Shallow Foundation	vertical bearing resistance from semi-empirical analysis	0.5
	horizontal resistance against sliding Based on cohesion/adhesion Based on friction	 0.6 0.8

Serviceability Limit State (SLS) – Limit States Design

Serviceability limit states are primarily concerned with mechanisms that restrict or constrain the intended use, occupancy, or function of the structure under working loads. For foundation design, SLS are usually associated with:

- excessive foundation movements (e.g. settlement, differential settlement, heave, etc.)
- unacceptable foundation vibrations
- local damage or deterioration

In general, the SLS criteria can be expressed as follows:

Serviceability Limit ≥ Effect of Service Loads

The soil bearing pressure under SLS conditions is evaluated using unfactored geotechnical parameters (settlement and compressibility properties), such that the bearing pressure does not cause the foundation to exceed the specified serviceability criteria.

The soil-structure interaction and load-deformation characteristics of soils are non-linear and complex and depend on several considerations (e.g., foundations size and configuration, range

of movement, etc.). The number of possible combinations is infinite and generic design charts cannot be prepared. Specific design charts under SLS conditions can be provided upon request, once preliminary design requirements have been established.

6.4.2 Shallow Footings Design Parameters

Footings should be based on the native undisturbed clay till soils or on engineered fill. Footings founded within the native clay till may be designed using an SLS bearing pressure values of 75 kPa. These values are based on estimated footing differential settlements of less than 15 mm. The bearing pressures may be increased by a factor of three to obtain un-factored ultimate bearing resistance (ULS). The geotechnical resistance factors outlined in Table 3 should be used in the ULS design scenario.

Groundwater seepage into footing excavations should be anticipated during construction, particularly at the locations where sand layers are intercepted by the basement excavation. It is anticipated that at the majority of the locations, water seepage into the footing excavations could be controlled by a sump pump dewatering system.

All footings must comply with the Alberta Building Code and National Building Code of Canada minimum requirements. The minimum footing width should be 0.6 m regardless of bearing capacity considerations.

Bearing surface of perimeter footings in non-heated buildings or unheated portions of buildings should be provided with 2.5 m of soil cover. The soil cover may be reduced to 1.5 m in heated buildings. Interior footings of heated buildings may be based at 0.6 m below the underside of the slab. Thermal insulation may be used to limit the depth of frost penetration and reduce the thickness of required soil cover.

Footing excavations should be carried out using excavators with a smooth-edge trimming bucket. Final cleanup of footing subgrade soils by hand methods may be required.

No loose, disturbed, remoulded or slough material should be allowed to remain on the footing bearing surface. Should wet and/or soft soils be encountered at the design footing depth, the footing excavation should be deepened such that footings bear on competent soils.

Footing excavations must be protected from drying, desiccation, rain/snow, freezing, and the ingress of water. Footing subgrade soils that become frozen, dried, or softened, should be removed and replaced with concrete, or the footings should be extended to reach soil in an unaffected condition.

Any over-excavation of unsuitable soils could be brought back to design grades using lean-mix concrete (minimum 28 day compressive strength of 5 MPa) or an approved engineered granular fill. Engineered fills should extend laterally 1 m or equal to full depth of fill (whichever is greater)

beyond the edge of the footing and be compacted to 100 percent of the SPMDD at moisture content within two percent of the optimum moisture content.

It is recommend that the footing bearing surface excavation be inspected and approved by the geotechnical engineer prior to concrete placement to confirm soil conditions and bearing pressures.

6.5 CONSIDERATIONS FOR LOT GRADING

6.5.1 Footprints of Houses

As outlined in Section 6.3.2 "Basement Sub-drainage Systems", shallow groundwater table (between 0.7 and 1.3 m below the ground surface that existed at the time of the investigation) was measured across the site. Maintaining the current grades will result in the house basement floor being located below the groundwater table.

It is recommended that considerations be given to elevating the houses' footprints above the current grades by building a clay pad. This will allow the houses to be constructed with the basement floor above the groundwater table. The thickness of the pad will depend on the location and proposed basement elevation (i.e., full depth bungalow versus raised basement).

It is recommended that at a minimum a 1.2 m thick pad be constructed within the future houses' footprints, and restriction be placed on allowing houses with partially buried basements (1.5 m below final grade) only. The pad should be constructed as engineered fill as outlined in Section 6.1 "Site Grading", and the topside of the pad should extend at least 1 m beyond the footprint of the building. The side slopes of the pad should be sloped no steeper than 4 horizontal to 1 vertical.

6.5.2 Roof Leaders and Lot Grading

For residential lots, stormwater from roof leaders may be discharged onto the ground surface provided that a positive lot grading scheme is incorporated in each individual lot. With the exception of that portion immediately adjacent to the basement walls, the lot surface should be graded towards the streets at a gradient of one percent or more. For the portions adjacent to the basement walls, over which settlement of the backfill will occur, a minimum grade of three percent over a distance of 2 m is recommended.

Enforcement and maintenance of the lot grading plans will reduce the potential of surface water infiltration and the frequency of weeping tile sump discharge. Previous field studies have demonstrated that adverse grading adjacent to foundation walls (frequently from lack of maintenance after backfill has settled) can result in dramatically increased weeping tile flow during rain or snowmelt conditions. The landscape or pavement surface should be graded to promote positive drainage away from the basement wall.

6.5.3 Grade-Supported Driveways

Exterior driveways and sidewalks should be free-floating and should not be doweled into foundation elements. The separation joint at the sidewalk/building interface should be sealed in order to limit seepage of surface runoff into the subgrade soils. The subgrade beneath the exterior flatwork or concrete sidewalks adjacent to the building should be sloped away from the building at gradients of not less than two percent.

6.6 USE OF IN-SITU WASTEWATER DISPOSAL AND TREATMENT SYSTEMS

Discussions regarding site suitability for in-situ disposal and treatment systems provided in this section are based on the guidelines provided by the Alberta Environmental Protection "*Environmental Guidelines for the Review of Subdivisions in Alberta, 1998*" and the Safety Codes Council "*Alberta Private Sewage Systems Standard of Practice, 2009*", particularly as they relate to the depth of groundwater table and composition of the soil matrix.

The suitability of an in-situ wastewater disposal and treatment system at a given location will be governed by both the depth of the water table and the composition of the soil matrix below the effluent discharge elevation at that location.

6.6.1 Groundwater Table Considerations

The *Environmental Guidelines for the Review of Subdivisions in Alberta, September 1998*, defines a high water table as being within 1.8 m of the ground surface during the frost free period up until the end of August; and within 2.4 m of the ground surface during the remainder of the year. A high water table can cause waterlogging, and can adversely affect the functioning of a sewage disposal system. Shallow groundwater tables associated with a sewage disposal system can also contribute to shallow groundwater and/or surface water contamination.

As summarized in Table 2, the measured groundwater levels at all borehole locations were generally shallower than 1.8 m below the existing ground surface. The measured groundwater levels at the site were considered restrictive for using conventional in-situ wastewater disposal and treatment systems. Alternate disposal systems, such as holding tanks, Class 1 packaged sewage treatment plants, or raised treatment field will be required.

6.6.2 Soil Suitability Considerations

Generally, effluent is discharged into the ground at a depth equal to or shallower than 0.9 m below ground surface. At all borehole locations, clay till was encountered within the anticipated effluent discharge elevation, except BH14-06 where a 0.4 meter thick sand was encountered. Sand was encountered below the clay till at some locations, but the depth of sand was such that more than 0.6 m of clay till would be anticipated between the top of the sand and the anticipated effluent discharge elevation. As such, the suitability and treatment capacity of the clay till will be the governing soil matrix across the site.

As outlined in Table 1, the soil matrix encountered at or below the anticipated effluent discharge elevation consisted of Sandy Clay Loam at all borehole locations. These soils are generally considered favorable for using in-situ wastewater disposal and treatment systems.

7.0 TESTING AND INSPECTION

Recommendations presented in this report may not be valid if adequate engineering inspection and testing programs during construction are not implemented or if other building code requirements are not followed. Testing and inspection programs should consist of:

- full time monitoring and compaction testing during site grading and fill placement
- design review and bearing inspections for shallow footings

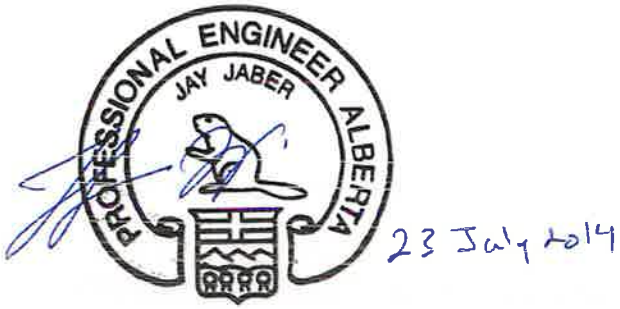
8.0 CLOSURE

The recommendations presented in this report are based on the results of soil sampling and testing and groundwater level measurement at eight borehole locations advanced at the site during this investigation. Soil conditions by nature can vary across any given site. If different soil conditions are encountered at subsequent phases of this project, SolidEarth should be notified immediately and given the opportunity to evaluate the situation and provide additional recommendations as necessary.

The recommendations presented in this report should not be used for another site or for a different application at the same site. If the intended application of the site is changed or if the assumptions outlined in this report became invalid, SolidEarth should be notified and given the opportunity to assess if the recommendations presented should be modified.

This report has been prepared for the exclusive use of Anasazi Developments Inc., and their authorized users for the specific application outlined in this report. No other warranties expressed or implied are provided. This report has been prepared within generally accepted geotechnical engineering practices.

Respectfully submitted,
SolidEarth Geotechnical Inc.



23 July 2014

Thomas Feeley, P.Eng.
Geotechnical Engineer

Jay Jaber, M.Sc., P.Eng.
Senior Geotechnical Engineer
Managing Partner

APEGA Permit to Practice # 11884

Figures:

SCALE: NTS	DWN BY: TF	FIGURE No. 1	PROJECT NAME: Geotechnical Investigation Proposed Robinwood Estates Rural Residential Subdivision Portion of LSD 8-33-49-1 W4M County of Vermilion River, Alberta	CLIENT: Anasazi Developments Inc.
DATUM: XXX	DATE: July 2014	PROJECT NO: PG14-1140		
SolidEarth Geotechnical Inc. #105- 460 , Cold Lake, AB, T9M 1	SolidEarth GEOTECHNICAL		DRAWING TITLE: Borehole Location Plan	

Project Name: Robinwood Estate Rural Residential Subdivision
Client Name: Anasazi Developments Inc
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminister, Alberta
Northing: 5902738 Easting: 561362
Elevation:

Borehole #: **14-1**
Project #: PG14-1140
Logged By: JS / Reviewed By: TF
Driller: Border Drilling Ltd.
Drill Method: 150 mm Solid Stem Auger

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Completion Date: 3/6/14
Page 1 of 1

Depth (m)	SPT N Value / Plastic M.C. Liquid / Pocket Pen (kPa)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	SLOTTED PIEZOMETER	Additional Data & Notes	Depth (m)
0			OR	**TOPSOIL (150 mm)**, organic, black						0
				CLAY (TILL), and sand, silty, trace gravel, stiff, medium plastic, brown, moist		1				
1				- trace oxides, sand pockets		2	10			1
				CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam		3			Liquid Limit: 33 % Plastic Limit: 16 % Grain Size Distribution Gravel: 2 % Sand: 47 % Silt: 24 % Clay 27 %	
				- becoming very stiff		4	17			
2				- sand lenses						2
						5				
			CI							
				- becoming grey-brown						
3						6	25		SPT Sampler in contact with rock	3
				- becoming grey						
4						7				4
						8	20			
5				**COMPLETION DEPTH: 5.0 m below ground surface**					Water Level: 4.1 m below ground surface on 12 June 2014. 1.3 m below ground surface on 7 July 2014.	5
				At Completion No accumulation of water or slough material. Slotted standpipe installed to 4.6 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.						
6										6
7										7
8										

Sample Symbol: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

Backfill Symbol: Bentonite; Pea Gravel; Slough; Grout; Drill Cuttings; Sand

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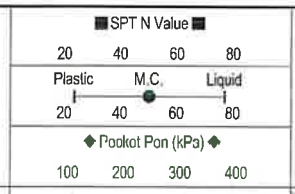
Project Name: Robinwood Estate Rural Residential Subdivision
Client Name: Anasazi Developments Inc
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminister, Alberta
Northing: 5902735 Easting: 561281
Elevation:

Borehole #: **14-2**
Project #: PG14-1140
Logged By: JS / Reviewed By: TF
Driller: Border Drilling Ltd.
Drill Method: 150 mm Solid Stem Auger

SolidEarth GEOTECHNICAL

Completion Date: 3/6/14
Page 1 of 1



Depth (m)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	SLOTTED PIEZOMETER	Additional Data & Notes
0		OR	**TOPSOIL (175 mm)**, organic, black					
			CLAY (TILL), and sand, silty, trace gravel, stiff, medium plastic, brown, moist		1			
			- becoming grey-brown, trace oxides					
1		CI	**CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam**		2	11		Grain Size Distribution Gravel: 2 % Sand: 49 % Silt: 24 % Clay 25 %
			- becoming very stiff, sand pockets		3			
2					4	19		
			SAND, fine grained, trace silt, trace clay, poorly graded, brown, clay nodules, moist					
					5			Grain Size Distribution Gravel & Sand: 57 % Silt and Clay: 43 %
3		SP	- becoming some clay, dense, wet		6	39		
			COMPLETION DEPTH: 3.5 m below ground surface					Water Level: 2.1 m below ground surface on 12 June 2014.
			At Completion Accumulation of water at 2.7 m below ground surface. Accumulation of slough at 3.1 m below ground surface. Slotted standpipe installed to 3.0 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.					1.2 m below ground surface on 7 July 2014.
4								
5								
6								
7								
8								

Depth (m)

Sample Symbol: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

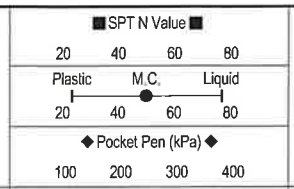
Backfill Symbol: Bentonite | Pea Gravel | Slough | Grout | Drill Cuttings | Sand

Project Name: Robinwood Estate Rural Residential Subdivision
Client Name: Anasazi Developments Inc
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminster, Alberta
Northing: 5902730 Easting: 561172
Elevation:

Borehole #: **14-3**
Project #: PG14-1140
Logged By: JS / Reviewed By: TF
Driller: Border Drilling Ltd.
Drill Method: 150 mm Solid Stem Auger

SolidEarth GEOTECHNICAL

Completion Date: 3/6/14
Page 1 of 1



Depth (m)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	SLOTTED PIEZOMETER	Additional Data & Notes
0		OR	**TOPSOIL (150 mm)**, organic, black					
			CLAY (TILL), and sand, silty, trace gravel, firm, medium plastic, brown, trace oxides, moist		1			
1		CI	- silt seams, sand pockets		2	6		Grain Size Distribution Gravel: 2 % Sand: 46 % Silt: 25 % Clay 27 %
			CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam		3			
2		SP	**SAND**, fine grained, trace silt, trace clay, dense, poorly graded, brown, wet		4	48		
			- becoming saturated		5			
3			**CLAY (TILL)**, sandy, silty, trace gravel, very stiff, medium plastic, grey-brown, trace oxides, sand seams, moist		6	23		
4			- becoming grey, seepage		7			
5		CI			8	18		SPT Sampler in contact with rock
6					9			
7			**COMPLETION DEPTH: 6.4 m below ground surface**		10	16		Water Level: 0.7 m below ground surface on 12 June 2014. 0.8 m below ground surface on 7 July 2014.
8			At Completion Accumulation of water at 2.7 m below ground surface. Accumulation of slough at 5.2 m below ground surface. Slotted standpipe installed to 5.2 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.					

Sample Symbol: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

Backfill Symbol: Bentonite | Pea Gravel | Slough | Grout | Drill Cuttings | Sand

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Project Name: Robinwood Estate Rural Residential Subdivision
Client Name: Anasazi Developments Inc
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminister, Alberta
Northing: 5902693 Easting: 561073
Elevation:

Borehole #: **14-4**
Project #: PG14-1140
Logged By: JS / Reviewed By: TF
Driller: Border Drilling Ltd.
Drill Method: 150 mm Solid Stem Auger

SolidEarth GEOTECHNICAL

Completion Date: 3/6/14
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SPT N Value
20 40 60 80
Plastic M.C. Liquid
20 40 60 80
Pocket Pen (kPa)
100 200 300 400

Depth (m)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	Additional Data & Notes	Depth (m)
0		OR	**TOPSOIL (225 mm)**, organic, black					0
			CLAY (TILL), and sand, silty, trace gravel, stiff, medium plastic, brown, trace oxides, very moist		1			
1		CI	- silt seams, sand pockets - becoming moist **CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam**		2	12	Grain Size Distribution Gravel: 2 % Sand: 50 % Silt: 25 % Clay 23 %	1
					3			
			- becoming grey-brown		4	44		
2			**SAND**, fine grained, trace silt, trace clay, dense, poorly graded, brown, moist					2
		SP			5			
3								3
		CI	**CLAY (TILL)**, sandy, silty, trace gravel, very stiff, medium plastic, grey-brown, trace oxides, moist		6	21		
4			**COMPLETION DEPTH: 3.5 m below ground surface** At Completion No accumulation of water or slough material. Slotted standpipe installed to 2.7 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.				Water Level: 0.4 m below ground surface on 12 June 2014. 0.7 m below ground surface on 7 July 2014.	4
5								5
6								6
7								7
8								

Sample Symbol: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

Backfill Symbol: Bentonite | Pea Gravel | Slough | Grout | Drill Cuttings | Sand

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Project Name: Robinwood Estate Rural Residential Subdivision	Borehole #: **14-5**
Client Name: Anasazi Developments Inc	Project #: PG14-1140
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminister, Alberta	Logged By: JS / Reviewed By: TF
Northing: 5902615 Easting: 561092	Driller: Border Drilling Ltd.
Elevation:	Drill Method: 150 mm Solid Stem Auger

SolidEarth GEOTECHNICAL

Completion Date: 3/6/14

SPT N Value: 20 40 60 80
Plastic M.C. Liquid: 20 40 60 80
Pocket Pen (kPa): 100 200 300 400

Depth (m)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	SLOTTED PIEZOMETER	Additional Data & Notes	Depth (m)
0		OR	**TOPSOIL (200 mm)**, organic, black						0
			CLAY (TILL), and sand, silty, trace gravel, stiff, medium plastic, brown, very moist		1				
1			- trace oxides, sand pockets - becoming moist		2	8			1
			- becoming grey-brown **CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam**		3			Liquid Limit: 33 % Plastic Limit: 15 % Grain Size Distribution Gravel: 2 % Sand: 50 % Silt: 26 % Clay 22 %	
2		CI	- becoming very stiff		4	16			2
			SAND, fine grained, trace silt, trace clay, poorly graded, brown, very moist		5				
3		SP							3
			CLAY (TILL), sandy, silty, trace gravel, very stiff, medium plastic, grey, trace oxides, sand pockets, moist		6	18			
4		CI			7				4
			SAND, fine to medium grained, trace silt, trace clay, very dense, poorly graded, brown, clay nodules, very moist		8	54			
5		SP	**COMPLETION DEPTH: 5.0 m below ground surface**					Water Level: 0.9 m below ground surface on 12 June 2014. 0.8 m below ground surface on 7 July 2014.	5
			At Completion Accumulation of water at 3.0 m below ground surface. No accumulation of slough material. Slotted standpipe installed to 4.6 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.						
6									6
7									7
8									

Sample Symbol: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

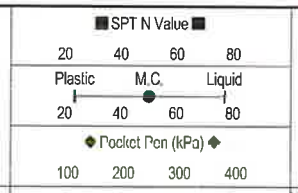
Backfill Symbol: Bentonite; Pea Gravel; Slough; Grout; Drill Cuttings; Sand

Project Name: Robinwood Estate Rural Residential Subdivision
Client Name: Anasazi Developments Inc
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminster, Alberta
Northing: 5902608 Easting: 561154
Elevation:

Borehole #: **14-6**
Project #: PG14-1140
Logged By: JS / Reviewed By: TF
Driller: Border Drilling Ltd.
Drill Method: 150 mm Solid Stem Auger

SolidEarth GEOTECHNICAL

Completion Date: 3/6/14
Page 1 of 1



Depth (m)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	SLOTTED PIEZOMETER	Additional Data & Notes	Depth (ft)
0		OR	**TOPSOIL**, some sand, some clay, organic, black		1				
		CI	**CLAY (TILL)**, and sand, silty, trace gravel, medium plastic, brown, moist						
1		SP	**SAND**, fine grained, some clay, trace silt, loose, poorly graded, brown, moist		2	6			1
			CLAY (TILL), and sand, silty, trace gravel, very stiff, medium plastic, brown, trace oxides, sand pockets, silt seams, moist		3			Grain Size Distribution Gravel: 3 % Sand: 53 % Silt: 22 % Clay 22 %	
2			**CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam**		4	22			2
		CI	- becoming grey-brown		5				
3					6	20			3
			COMPLETION DEPTH: 3.5 m below ground surface					Water Level: 1.7 m below ground surface on 12 June 2014. 1.3 m below ground surface on 7 July 2014.	
4			At Completion No accumulation of water or slough material. Slotted standpipe installed to 3.4 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.						4
5									5
6									6
7									7
8									

Sample Symbol: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

Backfill Symbol: Bentonite; Pea Gravel; Slough; Grout; Drill Cuttings; Sand

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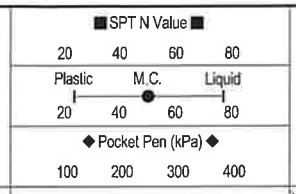
Project Name: Robinwood Estate Rural Residential Subdivision
Client Name: Anasazi Developments Inc
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminister, Alberta
Northing: 5902606 Easting: 561296
Elevation:

Borehole #: **14-7**
Project #: PG14-1140
Logged By: JS / Reviewed By: TF
Driller: Border Drilling Ltd.
Drill Method: 150 mm Solid Stem Auger

SolidEarth GEOTECHNICAL

Completion Date: 3/6/14
Page 1 of 1



Depth (m)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	SLOTTED PIEZOMETER	Additional Data & Notes
0		OR	**TOPSOIL (250 mm)**, organic, black					
			CLAY (TILL), and sand, silty, trace gravel, stiff, medium plastic, brown, moist		1			
			- trace oxides, sand pockets, silt seams **CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam**		2	10		Liquid Limit: 31 % Plastic Limit: 13 % Grain Size Distribution Gravel: 2 % Sand: 52 % Silt: 23 % Clay 23 %
					3			
			- becoming very stiff, grey-brown		4	19		
					5			
		CI						
			- becoming grey		6	29		SPT Sampler in contact with rock
					7			
			- becoming hard		8	32		
			COMPLETION DEPTH: 5.0 m below ground surface At Completion No accumulation of water or slough material. Slotted standpipe installed to 4.6 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.					Water Level: 0.6 m below ground surface on 12 June 2014. 0.7 m below ground surface on 7 July 2014.

Sample Symbol: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

Backfill Symbol: Bentonite | Pea Gravel | Slough | Grout | Drill Cuttings | Sand

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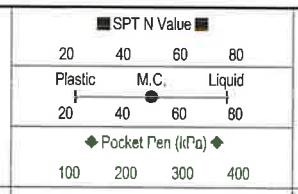
Project Name: Robinwood Estate Rural Residential Subdivision
Client Name: Anasazi Developments Inc
Site: Portion of LSD 8-33-49-1 W4M - West of Lloydminister, Alberta
Northing: 5902605 Easting: 561369
Elevation:

Borehole #: **14-8**
Project #: PG14-1140
Logged By: JS / Reviewed By: TF
Driller: Border Drilling Ltd.
Drill Method: 150 mm Solid Stem Auger

SolidEarth GEOTECHNICAL

Completion Date: 3/6/14
Page 1 of 1



Depth (m)	Soil Symbol	USCS	Material Description	Sample Symbol	Sample #	SPT (N-Value)	SLOTTED PIEZOMETER	Additional Data & Notes
0		OR	**TOPSOIL (250 mm)**, organic, black					
			CLAY (TILL), and sand, silty, trace gravel, stiff, medium plastic, brown, very moist		1			
			- trace oxides, sand pockets, silt seams - becoming moist **CANADIAN SYSTEM OF SOIL CLASSIFICATION: Sandy Clay Loam**		2	11		Grain Size Distribution Gravel: 2 % Sand: 46 % Silt: 28 % Clay 24 %
					3			
			- becoming very stiff, grey-brown		4	15		
		CI			5			
					6	17		
			COMPLETION DEPTH: 3.5 m below ground surface At Completion No accumulation of water or slough material. Slotted standpipe installed to 3.0 m below ground surface. Borehole backfilled with drill cuttings and a bentonite plug.					Water Level: 0.8 m below ground surface on 12 June 2014. 0.9 m below ground surface on 7 July 2014.

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8

Sample Symbol: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

Backfill Symbol: Bentonite; Pea Gravel; Slough; Grout; Drill Cuttings; Sand

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Appendix A

Site Photographs Taken During the Field Investigation

Photograph 1: Northwest corner looking east

Photograph 2: Northeast corner looking southwest

Photograph 3: Southwest corner looking north

Photograph 4: Southwest corner looking northeast

Appendix B

Modified Unified Soil Classification System Explanation of Terms and Symbols
Canadian System of Soil Classification - Soil Texture Classification Triangle

EXPLANATION OF TERMS & SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of the field investigation and laboratory testing are described on the following two pages.

1. VISUAL TEXTURAL CLASSIFICATION ON MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	> 200 mm	> 200 mm
Cobbles	75 mm to 200 mm	75 mm to 200 mm
Gravel	4.75 mm to 75 mm	5 mm to 75 mm
Sand	0.075 mm to 4.75 mm	Visible particles to 5 mm
Silt	0.002 mm to 0.075 mm	Non-plastic particles, not visible to naked eye
Clay	< 0.002 mm	Plastic particles, not visible to naked eye

2. TERMS FOR CONSISTENCY & DENSITY OF SOILS

Cohesionless Soils

DESCRIPTIVE TERM	APPROXIMATE SPT "N" VALUE
Very Dense	> 50
Dense	30 to 50
Compact	10 to 30
Loose	4 to 10
Very Loose	< 4

Cohesive Soils

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH	APPROXIMATE SPT "N" VALUE
Hard	>200 kPa	> 30
Very Stiff	100 to 200 kPa	15 to 30
Stiff	50 to 100 kPa	8 to 15
Firm	25 to 50 kPa	4 to 8
Soft	10 to 25 kPa	2 to 4
Very Soft	< 10 kPa	< 2

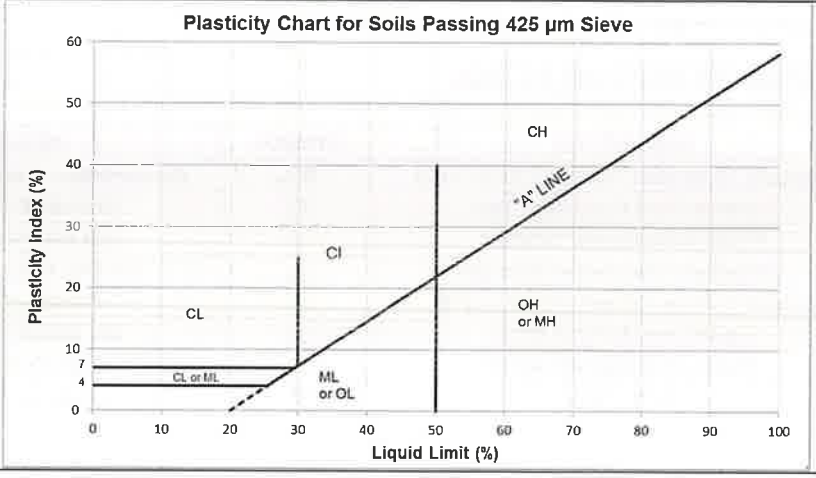
* SPT "N" Values – Refers to the number of blows by a 63.5 kg hammer dropped 760 mm to drive a 50 mm diameter split spoon sampler for a distance of 300 mm after an initial penetration of 150 mm.

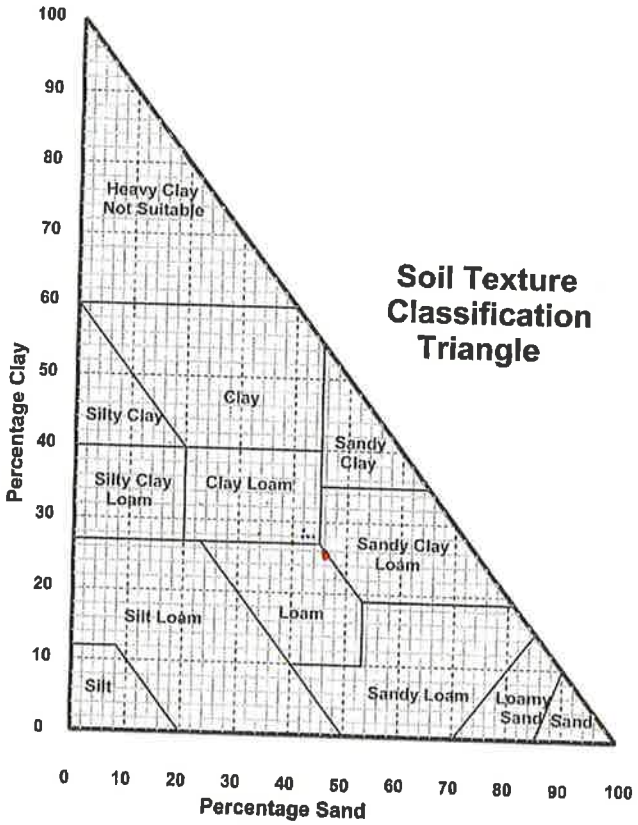
3. SYMBOLS USED ON BOREHOLE LOGS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
N(■)	Standard Penetration Test (CSA A119 1-60)	SO_4	Concentration of Water-Soluble Sulphate
N_d	Dynamic Cone Penetration Test	C_u	Undrained Shear Strength
pp (♦)	Pocket Penetrometer Strength	γ	Unit Weight of Soil or Rock
q_u	Unconfined Compressive Strength	γ_d	Dry Unit Weight of Soil or Rock
w (●)	Natural Moisture Content (ASTM D2216)	ρ	Density of Soil or Rock
w_L	Liquid Limit (ASTM D 4318)	ρ_d	Dry Density of Soil or Rock
w_P	Plastic Limit (ASTM D 4318)	▽	Short-Term Water Level
I_P	Plastic Index	▼	Long-Term Water Level

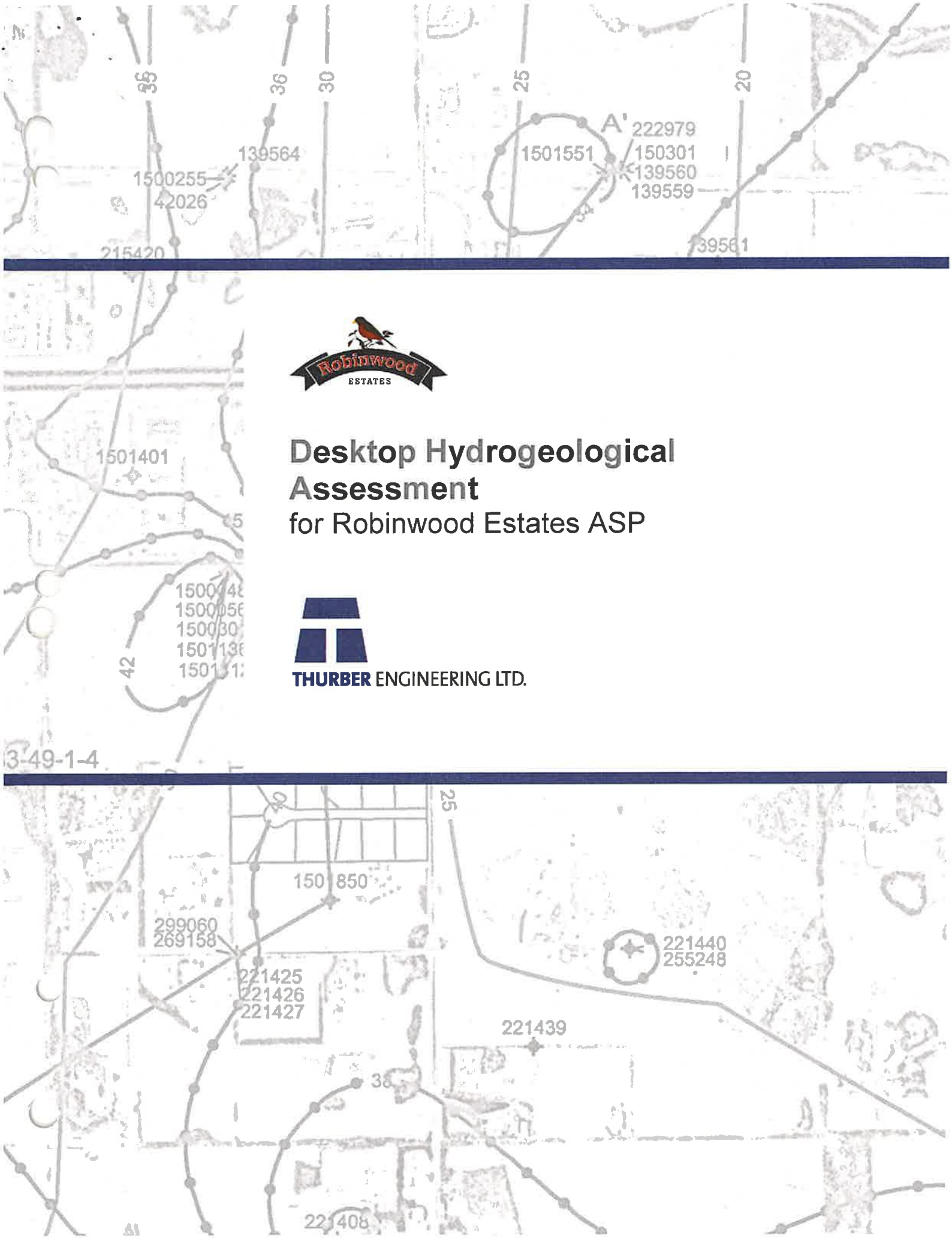
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75 µm)	GRAVELS (MORE THAN HALF COARSE GRAINS LARGER THAN 4.75mm)	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL GRADED GRAVELS AND GRAVEL SAND MIXTURES, LITTLE OR NO FINES	$C_u = D_{60}/D_{10} > 4$ $C_c = (D_{30})^2/(D_{10} \times D_{60}) = 1$ to 3	
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		GRAVELS (WITH SOME FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE I_p LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE I_p MORE THAN 7
	SANDS (MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75mm)	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = D_{60}/D_{10} > 6$ $C_c = (D_{30})^2/(D_{10} \times D_{60}) = 1$ to 3	
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ALL GRADATION REQUIREMENTS FOR SW	
		SANDS (WITH SOME FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE I_p LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE I_p MORE THAN 7
FINE GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75 µm)	SILTS (BELOW 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 50$ %	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50$ %	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS		
	CLAYS (ABOVE 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 30$ %	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		30 % < W_L < 50 %	CI	INORGANIC CLAYS OR MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50$ %	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS (BELOW 'A' LINE)	$W_L < 50$ %	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50$ %	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE	
BEDROCK			BR	SEE REPORT DESCRIPTION		





Note: Plotting the percentage of sand and clay provides the remaining percentage of silt.



Robinwood ESTATES

Desktop Hydrogeological Assessment

for Robinwood Estates ASP

THURBER ENGINEERING LTD.

THURBER ENGINEERING LTD.

June 6, 2014

File: 17-531-150

McElhanney
500, 999 – 8th Street SW
Calgary AB T2R 1J5
T5H 3H5

Attention: Ms. Jenny Wong

DESKTOP HYDROGEOLOGICAL ASSESSMENT
ROBINWOOD ESTATE - PLAN 1218TR BLOCK 1 LOT 1
COUNTY OF VERMILION, NEAR LLOYDMINSTER, ALBERTA
(SE 33-49-1 W4M)

Dear Ms Wong:

At the request of McElhanney, this letter report provides Thurber Engineering Ltd. (Thurber) desktop hydrogeological assessment of the groundwater potential and quality for the above noted area. The proposed Robinwood Estate subdivision development area covers approximately 8.1 hectares (20 acres) and is located approximately one kilometer west of Lloydminster as shown on Drawing 17-531-150-1 attached. Thurber understands that the subdivision would comprise of a maximum of 12 residential lots.

Use of this report is subject to the Statement of Limitation and Conditions that is included at the end of the text of this report. The reader's attention is specifically drawn to these conditions as it is considered essential that the conditions are followed for the proper use and interpretation of this report.

1. OBJECTIVES AND SCOPE OF WORK:

The objective of this desktop hydrogeological study was to evaluate the groundwater potential and quality and to identify the main aquifer(s) in the proposed subdivision development area. In order to meet this objective, Thurber's scope of work, as outlined in our May 8 2014 proposal, was generally as follows;

- Review available geological and hydrogeological reports
- Review water well records in Alberta Environment and Sustainable Resource Development (ESRD) Groundwater databases
- Prepare a hydrogeological cross-section
- Evaluate groundwater yields and assessing groundwater quality
- Prepare a report.

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2. AQUIFER POTENTIAL

2.1 Geology

Thurber reviewed the geology and bedrock topography of the subdivision area and vicinity from Bayrock[1], Carlson[2], and Atkinson[3]. In Section 33-49-1 W4M and surrounding sections the surficial geology consists mainly of clay till (stagnation moraine). The bedrock topography map (Carlson) of the general area indicates that the study area is located on bedrock plain approximately 6 km south from a large unnamed bedrock buried valley. According to Atkinson's map, depth to bedrock from the ground surface would be in the order of 20 m and 45 m as shown in Drawing 17-531-150-2 attached. Also based on ESRD's water well data the thickness of the unconsolidated surficial sediments generally ranges from 13 m to approximately 65 m.

The bedrock underlying the surficial sediments is comprised of sandstone, and shale of the Belly River Formation underlain by mudstones of the Lea Park Formation.

Thurber also reviewed Currie's[4] hydrogeology map. This hydrogeological map indicates that the major aquifer is developed within the lowest sandstones of the Belly River Formation.

2.2. Hydrogeology

The ESRD water well data bases were reviewed for the presence of water wells within 15 km^2 centered on the proposed subdivision development area in SE 33-49-1 W4M. There were 102 well records found and a representation of these wells is summarized in Table 2.1. The approximate well locations are shown on Drawing 17-531-150-1. The average water well depth in the area is approximately 70 m. According to ESRD's water well data base the majority of the wells found in the area are completed in the bedrock Belly River Formation.

Water well data from ESRD's data base in the vicinity of the subdivision was used to prepare cross-section A-A' shown on Drawing 17-531-150-3 attached. In general, cross section A-A' shows that the area consists of till underlain by bedrock. The bedrock is comprised of sandstone, siltstone and shale of the Belly River Formation.

2.3 Twenty Year Safe Yield ($_AQ_{20}$)

Currie's hydrogeological map and report indicated that the $_AQ_{20}$ (Twenty Year Safe Yield) in the surficial sediments could range from 163 m^3/day to 650 m^3/day. Some extreme $_AQ_{20}$ values were higher than 1000 m^3/day. Drawing 17-531-150-4 attached summarizes the $_AQ_{20}$ values in relation to the subdivision area.

---

[1] Bayrock, L, 1955, Glacial Geology of an Area in East-Central Alberta. Research Council of Alberta. Preliminary Report 55-

[2] Carlson, V.A and Currie, D.V. Bedrock Topography of the Vermilion Map Area, NTS 73E, Alberta. Alberta Research Council. 1973.

[3] Atkinson, N and Lyster, S. Map 551. Thickness of Quaternary and Neogene Sediment in Alberta, Canada. ERCB/Alberta Geological Survey. 2010.

[4] Currie, D.V. and N. Zacharko. Hydrogeology of the Vermilion Area, Alberta. NTS 73E. Alberta Research Council. Earth Sciences Report 75-5. 1976.

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Using a domestic household guideline of 1,250m^3/year[5] (3.4m^3/day) the assessed net water requirement for the proposed 12 lots subdivision would be in the order of 15,000m^3/year or 41m^3/day. The 41 m^3/day consumption would be within the ${}_AQ_{20}$ of 163 m^3/day to 650 m^3/day. It should however, be noted that the majority of the ${}_AQ_{20}$ values calculated from ESRD water well data base are based on short duration pumping tests (often of 2 hours or less) and would require longer duration pumping tests in order to confirm the ${}_AQ_{20}$.

2.4. Groundwater Quality

Thurber reviewed ESRD's database for water quality and summarized representative groundwater well chemistry in Table 2.2 attached. The groundwater in the subdivision area ranges from Sodium /Bicarbonate to Sodium- /Sulfate. Most of the iron concentrations do not meet the Canadian Water Quality Guideline 2012 (CDWQ) for iron of less than or equal to 0.3 mg/L as these concentrations can be as high as 7 mg/L. The TDS and sodium concentrations also do not meet the CDWQ criterion of less than or equal to 500 mg/L and 200 mg/L respectively.

The review of a number of chemical analyses indicates that some of the groundwater could be characterized as non-potable according to the parameters tested and the CDWQ criteria. The non-potability of the groundwater is based on a comparison to the CDWQ criterion and the groundwater could be treated.

3. CONCLUSIONS & RECOMMENDATIONS

Based on the information reviewed in relation to the proposed subdivision development area, there is a potential for a groundwater based water supply. The approximate ${}_AQ_{20}$ beneath the proposed development area is in the order 300m^3/day in relation to 41 m^3/day for up to 12 lots. However, the capability of a water well to supply such quantity can only be confirmed by completing one pumping well and one observation well within the new development area and performing a pumping test. The average water well depth is 70 m. The existing groundwater quality data shows that the water may not be potable as compared to the CDWQ criteria but treatment could likely make it potable.

It is recommended that the pumping test comprising of 24 hours pumping and 24 hour of recovery be performed. This length is required in order to assess the aquifer parameters, the ${}_AQ_{20}$ value and the potential impact of pumping on neighboring water supplies. A groundwater sample should also be collected as part of the pumping test in order to assess groundwater quality.

[5] Alberta Environment. Report Requirements for Subdivision Development Under Section 23 of the Water Act. April 28, 2008.

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4. CLOSURE

We trust this desktop study meets your present needs. Please call if you have any questions.

Yours very truly,
Thurber Engineering Ltd.
N. Fernuik, M.Sc., P. Biol., P. Eng.
Review Principal

M. Butorac, B.Sc., P. Geol.
Senior Hydrogeologist
/lg

Attachments

- Statement of Limitations and Conditions
- Drawing 17-531-150-1 through 17-531-150-4
- Tables 2.1 and 2.2

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document, subject to the limitations provided herein, are only valid to the extent that this Report expressly addresses proposed development, design objectives and purposes, and then only to the extent there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation or to consider such representations, information and instructions.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS WE MAY EXPRESSLY APPROVE. The contents of the Report remain our copyright property. The Client may not give, lend or, sell the Report, or otherwise make the Report, or any portion thereof, available to any person without our prior written permission. Any use which a third party makes of the Report, are the sole responsibility of such third parties. Unless expressly permitted by us, no person other than the Client is entitled to rely on this Report. We accept no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without our express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and this report is delivered on the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by us. We are entitled to rely on such representations, information and instructions and are not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

(see over ...)

c) Design Services: The Report may form part of the design and construction documents for information purposes even though it may have been issued prior to the final design being completed. We should be retained to review the final design, project plans and documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the report recommendations and the final design detailed in the contract documents should be reported to us immediately so that we can address potential conflicts.

d) Construction Services: During construction we must be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RISK LIMITATION

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause an accidental release of those substances. In consideration of the provision of the services by us, which are for the Client's benefit, the Client agrees to hold harmless and to indemnify and defend us and our directors, officers, servants, agents, employees, workmen and contractors (hereinafter referred to as the "Company") from and against any and all claims, losses, damages, demands, disputes, liability and legal investigative costs of defence, whether for personal injury including death, or any other loss whatsoever, regardless of any action or omission on the part of the Company, that result from an accidental release of pollutants or hazardous substances occurring as a result of carrying out this Project. This indemnification shall extend to all Claims brought or threatened against the Company under any federal or provincial statute as a result of conducting work on this Project. In addition to the above indemnification, the Client further agrees not to bring any claims against the Company in connection with any of the aforementioned causes.

7. SERVICES OF SUBCONSULTANTS AND CONTRACTORS

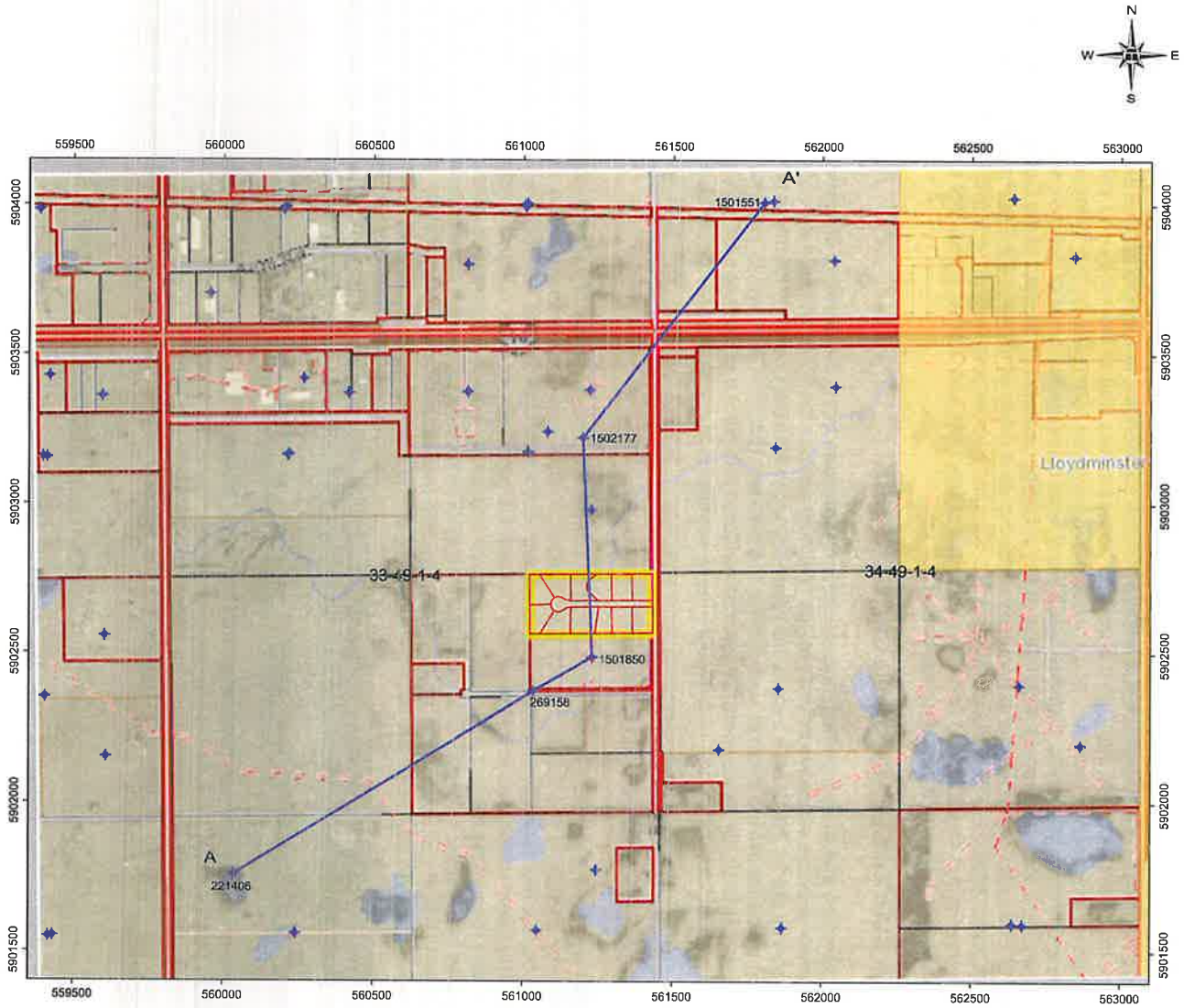
The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. We may arrange the hiring of these services as a convenience to our Clients. As these services are for the Client's benefit, the Client agrees to hold the Company harmless and to indemnify and defend us from and against all claims arising through such hirings to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

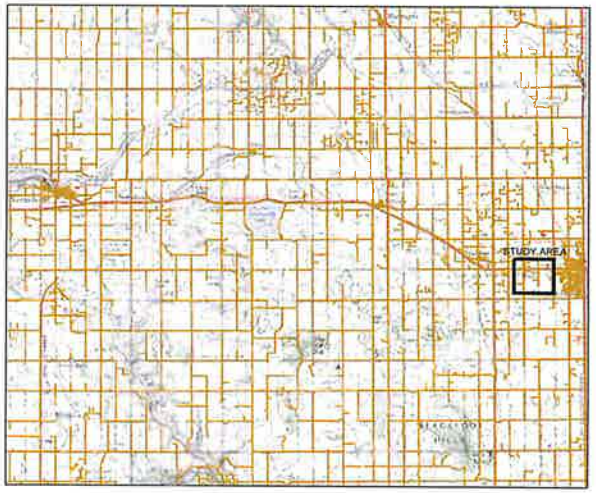
8. CONTROL OF WORK AND JOBSITE SAFETY

We are responsible only for the activities of our employees on the jobsite. The presence of our personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that we never occupy a position of control of the site. The Client undertakes to inform us of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general. These procedures may well involve additional costs outside of any budgets previously agreed to. The Client agrees to pay us for any expenses incurred as the result of such discoveries and to compensate us through payment of additional fees and expenses for time spent by us to deal with the consequences of such discoveries. The Client also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the Client agrees that notification to such bodies by us will not be a cause of action or dispute.

9. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on our interpretation of conditions revealed through limited investigation conducted within a defined scope of services. We cannot accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.





KEY MAP

LEGEND

PROPOSED SUBDIVISION

APPROXIMATE LOCATION OF WATER WELLS

0 200 400 600 800m

SCALE 1:15000

McElhanney

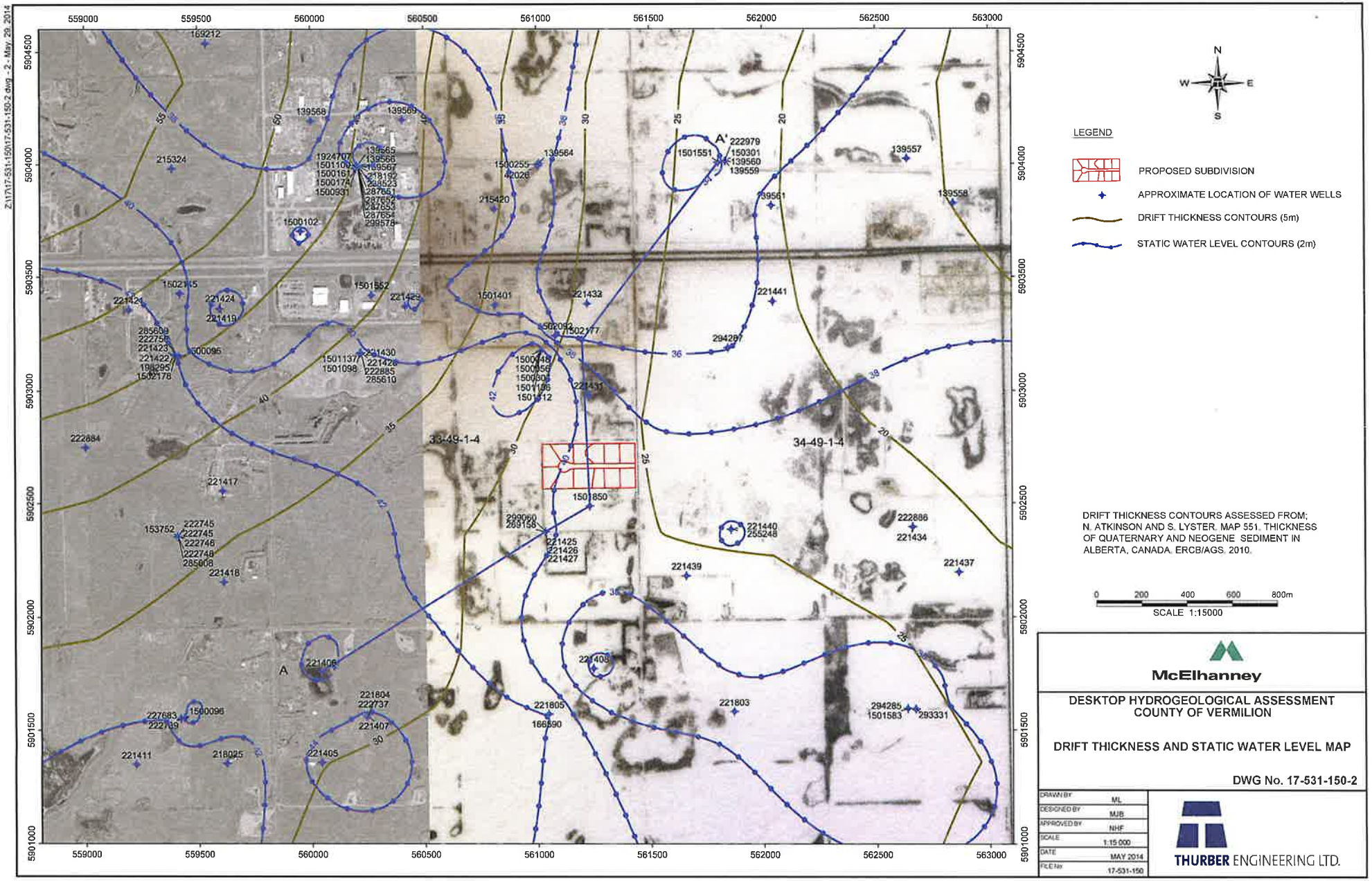
DESKTOP HYDROGEOLOGICAL ASSESSMENT
COUNTY OF VERMILION

SITE PLAN

DWG No. 17-531-150-1

DRAWN BY	ML
DESIGNED BY	MJB
APPROVED BY	NHF
SCALE	1:15 000
DATE	MAY 2014
FILE No.	17-531-150

THURBER ENGINEERING LTD.



McElhanney

DESKTOP HYDROGEOLOGICAL ASSESSMENT
COUNTY OF VERMILION

DRIFT THICKNESS AND STATIC WATER LEVEL MAP

DWG No. 17-531-150-2

DRAWN BY	ML
DESIGNED BY	MJB
APPROVED BY	NHF
SCALE	1:15 000
DATE	MAY 2014
FILE No	17-531-150

THURBER ENGINEERING LTD.

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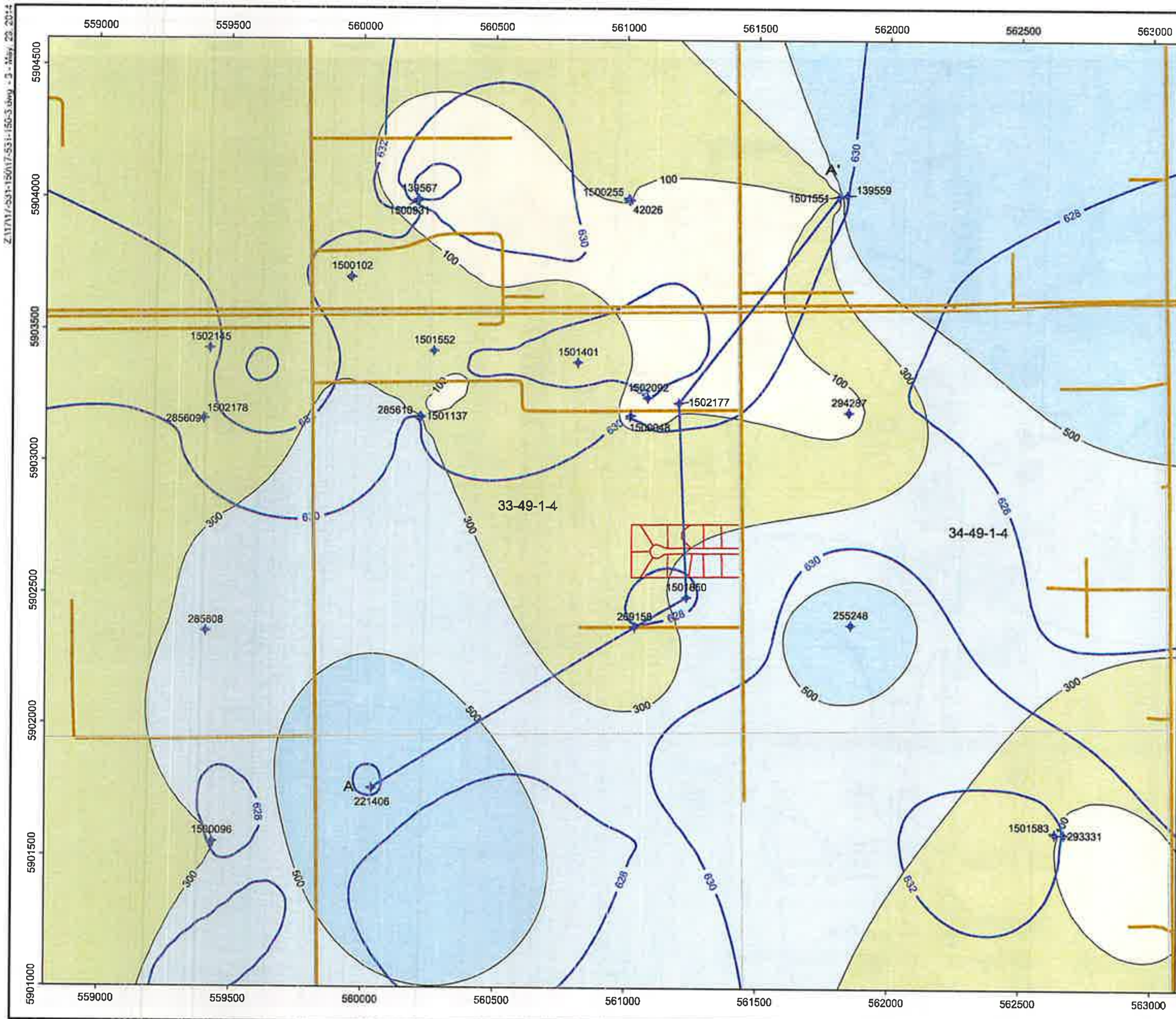

LEGEND

PROPOSED SUBDIVISION

APPROXIMATE LOCATION OF WATER WELLS

STATIC WATER LEVEL ELEVATION CONTOURS (2m)

Q20 m^3/YEAR

500
300
100
10

AQ20 DATA CALCULATED FROM WATER WELLS PUMPING DATA PROVIDED FROM ESRD GROUNDWATER DATABASE.

0 200 400 600 800m
SCALE 1:15000

McElhanney

DESKTOP HYDROGEOLOGICAL ASSESSMENT
COUNTY OF VERMILION

AQ20 MAP

DWG No. 17-531-150-3

DRAWN BY	ML
DESIGNED BY	MJB
APPROVED BY	NHF
SCALE	1:15 000
DATE	MAY 2014
FILE No	17-531-150

THURBER ENGINEERING LTD.

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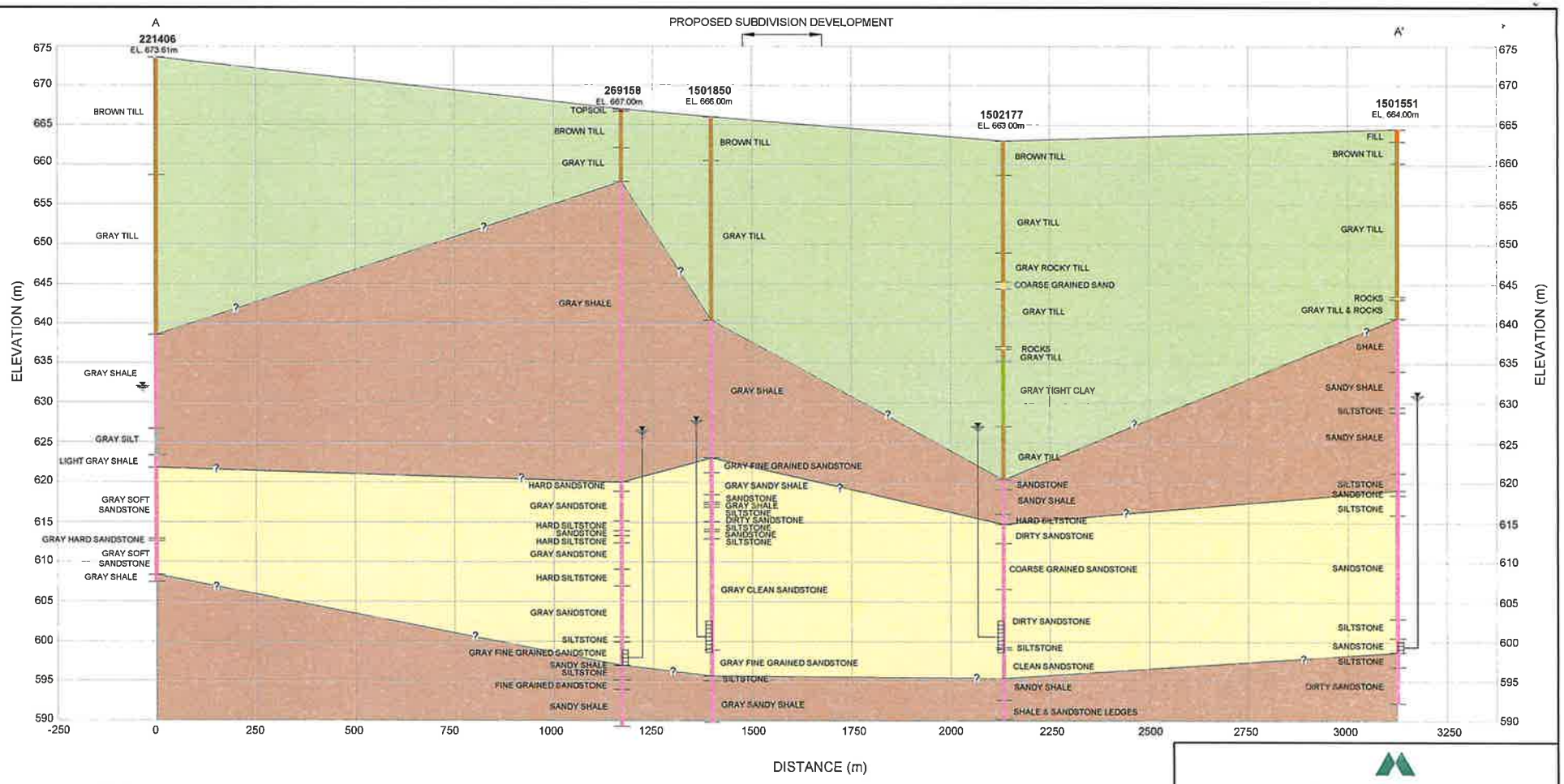

LEGEND

- WATER LEVEL
- WELL COMPLETION INTERVAL
- SURFICIAL DEPOSITS - TILL
- SHALE (UPPER SHALE IS PART OF BELLY RIVER FORMATION. LOWER SHALE IS PART OF LEAPARK FORMATION)
- SANDSTONE - AQUIFER (FORMED IN LOWER PORTION OF BELLY RIVER FORMATION)

McElhanney

DESKTOP HYDROGEOLOGICAL ASSESSMENT
COUNTY OF VERMILION

CROSS - SECTION A - A'

DWG No. 17-531-150-4

DRAWN BY	ML
DESIGNED BY	MJB
APPROVED BY	NHF
SCALE	H 1:10000 V 1:500
DATE	MAY 2014
FILE No	17-531-150

THURBER ENGINEERING LTD.

THURBER

TABLE 2.1 - WATER WELLS FROM ESRD GROUNDWATER DATABASE WITHIN 1.6km RADIUS FROM ROBINWOOD ESTATE

Well ID	OWNER-NAME	LOCATION	X-NAD83-UTM12	Y-NAD83-UTM12	ELEVATION(FEET)	TYPE OF WORK	PROPOSED-USE	DATE COMPLETED
42028	BRITTON, ROSE	SE-34-050-01-W4	561009.5	5903993.61		New Well	Domestic	21-Mar-01
135556	KROMREY, HARVEY	01-03-050-01-W4	562644.65	5903626.52		New Well	Domestic	14-Jun-61
135557		SE-33-050-01-W4	562640.25	5904520		Deepened	Unknown	
135558	BLACKWELL	01-3-50-1-W4	562644.05	5903626.52		Federal Well Survey	Unknown	
135559	UMPHREY, TED	SW-03-050-01-W4	561635.68	5904014.49	2180 ft	New Well	Domestic	30-Sep-71
135560	DANIEL, STANLEY C.	SW-03-050-01-W4	561635.68	5904014.49	2180 ft	New Well	Domestic	02-Nov-76
135561	DICKOUT, M	03-03-050-01-W4	562029.51	5903515.55		New Well	Unknown	29-Jun-64
135564	LITTLE	SE-04-050-01-W4	561012.69	5904005.11	2180 ft	Federal Well Survey	Unknown	
135565	PIERSON, R	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	14-Aug-62
135566	BERETTA ENT	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	12-Aug-81
135567	LEYEN OILWELL SVC	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	21-Oct-85
135568	PETANIC OIL SVC	05-34-050-01-W4	560004.41	5904183.47		New Well	Industrial	13-Nov-87
135569	CHRISTIE CORROSION CONTROL LTD	06-04-050-01-W4	560406.7	5904188.55		New Well	Domestic	21-Aug-89
152301	KERR, BARRY	SW-03-050-01-W4	561635.68	5904014.42		New Well	Stock	25-Mar-90
153752	HOFER, DAVE	SE-32-049-01-W4	559409.25	5902353.87		New Well	Domestic	16-Oct-90
185592	MCKECHNIE, DON	NE-29-049-01-W4	561040.93	5901570.27		New Well	Domestic	26-Feb-92
189212	GARY BLYTHE VACUUM LTD	09-05-050-01-W4	559539.02	5904339.95		New Well	Domestic	03-Sep-92
199295	STAM, A	NE-32-049-01-W4	559398.16	5903158.27		Chemistry	Domestic	
215324	CRAWFORD, CLAYTON	SE-05-050-01-W4	559387.48	5903993.46	2200 ft	New Well	Domestic	01-Sep-60
215420	BRITTON, H	02-04-050-01-W4	560514.17	5903921.41		New Well	Domestic	18-May-61
218026	SAMPSON, C	03-29-049-01-W4	559823.58	5901351.91	2183 ft	New Well	Domestic	13-Sep-76
218192	UNRAU, ABE	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	15-Jun-87
221405	STURGE	12-29-049-01-W4	560043.82	5901356.37	2165 ft	Federal Well Survey	Domestic & Stock	01-Jan-21
221406	DUCHAK, JOHN	13-28-049-01-W4	560038.63	5901758.61	2210 ft	New Well	Domestic	14-Sep-75
221407	WISAK, JOE	NW-28-049-01-W4	560242.4	5901560.03		New Well	Domestic	30-Mar-89
221408	THOMPSON	16-29-049-01-W4	561245.52	5901773.91	2113 ft	Federal Well Survey	Domestic & Stock	
221411	SCHMITZ, RON	10-29-049-01-W4	559221.24	5901346.9		New Well	Domestic	27-Apr-82
221417	HUTCHISON, GENE	01-33-049-01-W4	559606.88	5902587.51	2218 ft	New Well	Domestic & Stock	06-Sep-77
221418	BIDLICK	01-32-049-01-W4	559611.98	5902355.21	2182 ft	Federal Well Survey	Unknown	
221419	BLACKFORD, BILL	16-32-049-01-W4	559096.63	5903361.91		New Well	Domestic & Stock	20-Aug-74
221421	GARDEAN, FRED	11-32-049-01-W4	558194.51	5902856.63	2205 ft	New Well	Domestic	01-Aug-76
221422		NE-32-049-01-W4	559398.16	5903158.27		Well Inventory	Unknown	
221423	BECKLEY, DON	NE-32-049-01-W4	559398.16	5903158.27	2212 ft	New Well	Domestic	09-May-78
221424	STACEY	16-32-049-01-W4	559096.63	5903361.91	2197 ft	Federal Well Survey	Domestic & Stock	31-Jan-20
221425	JENSEN, ED	07-33-049-01-W4	561034.69	5902374.8	2830 ft	New Well	Domestic	10-Aug-71
221426	KINSFEL, GEORGE	SE-33-049-01-W4	561034.69	5902374.8		New Well	Domestic	17-Jun-72
221427	GARDEV ART	SE-33-049-01-W4	561034.69	5902374.8	2203 ft	New Well	Domestic	29-Jun-71
221428	SPRINKLE, SANDY	NW-33-049-01-W4	560219.74	5903169.02	2100 ft	New Well	Domestic	15-Sep-71
221429	DESCHOVER, E	14-33-049-01-W4	560418.31	5902272.83		New Well	Domestic	20-Dec-66
221430	BEACH, DON	NW-33-049-01-W4	560219.74	5903169.02		New Well	Domestic	21-Jun-84
221431	FISHER, DON	09-33-049-01-W4	561228.05	5902880.71		New Well	Domestic	01-Sep-72
221432	ROBINSON, HERB	16-33-049-01-W4	561222.92	5903382.56		New Well	Domestic & Stock	04-Oct-74
221433	GLEN, A.B.	16-33-049-01-W4	561222.92	5903382.56	2183 ft	Federal Well Survey	Domestic & Stock	
221434	WILCOX, BRUCE	02-34-049-01-W4	562868.94	5902295.51	2185 ft	New Well	Unknown	30-Jul-75
221437	ALTA GOVT #RCA TH 2	01-34-049-01-W4	562864.74	5902197.03		Test Hole	Investigation	31-Jan-58
221439	HERMAN, SAM	13-34-049-01-W4	561657.48	5902181.27	2195 ft	New Well	Domestic	25-Sep-76
221440	HERMAN, SAM	SW-34-49-1-W4	561856.25	5902301		New Well	Domestic	18-May-88
221441	DALE, J	11-34-049-01-W4	562044.31	5903333.25	2182 ft	Federal Well Survey	Domestic & Stock	
221803	MCROSS	NW-27-049-01-W4	561667.32	5901551.28	2197 ft	Well Inventory	Domestic	
221804	WISAK, JOE	NW-28-049-01-W4	560242.4	5901560.03	2156 ft	Chemistry	Domestic	
221805	MCISAAC	NE-28-049-01-W4	561046.93	5901570.27	2182 ft	Well Inventory	Domestic	
222737	STURGE, H	NW-28-049-01-W4	560242.4	5901560.03		Chemistry	Domestic	
222738	SAMPSON, WAYNE	NE-29-049-01-W4	559418.89	5901550.41	2160 ft	Chemistry	Domestic	
222745	GRADAUER	SE-32-049-01-W4	559408.21	5902353.87		Chemistry	Domestic	
222746	GRADAUER, FRED	SE-32-049-01-W4	559408.21	5902353.87		Chemistry	Domestic	
222748	BAILEY, TOM	SE-32-049-01-W4	559408.21	5902353.87	2208 ft	Chemistry	Domestic	
222750	UMPHREY, C	NE-32-049-01-W4	559398.16	5903158.27		Chemistry	Domestic	
222884	BECKLEY, DON	09-32-049-01-W4	559000.91	5902751.02	2210 ft	Chemistry	Domestic	
222885	BENOIT, CHRIS	NW-33-049-01-W4	560219.74	5903169.02		Chemistry	Domestic	
222886	LINDSAY, THOMAS	SE-34-049-01-W4	562560.94	5902395.51	2185 ft	Chemistry	Domestic	
222878	KERR, BARRY	SW-03-050-01-W4	561635.68	5904014.49		Chemistry	Domestic	09-Apr-87
227883	SAMPSON, WAYNE/LUCY	NE-29-049-01-W4	559419.89	5901550.61		New Well	Domestic	23-Aug-93
278523	VIG-AIR ENG	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	29-Nov-93
255248	ELKOW, TERRY	SW-34-049-01-W4	561856.25	5902301		New Well	Domestic	01-Sep-94
266158	WELL, KEITH	SE-33-049-01-W4	561034.69	5902374.8		New Well	Domestic	19-Aug-95
280606	HOUGHAM, JOHN	SE-32-049-01-W4	559409.25	5902353.87		New Well	Domestic	14-May-96
280608	ADAMS, KEN	NE-32-049-01-W4	559398.16	5903158.27		New Well	Domestic	27-Jun-96
280610	CHARTERS, LES	NW-33-049-01-W4	560219.74	5903169.02		New Well	Domestic	08-Mar-96
287651	GAS, CAL	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	26-Aug-97
287652	CORLAC INDUSTRIES	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	08-May-97
287653	CARTAGE, CARLS	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	09-Jul-97
287654	NORTH WEST PIPE	SW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	26-Nov-96
293331	MORIN, LYLE	NE-27-049-01-W4	562671.5	5901591.79		New Well	Domestic	27-Aug-98
294295	ROEERGE BROS TRANSPORT LTD	NE-27-049-01-W4	562636.78	5901594.22		New Well	Domestic	21-Jun-00
294297	ELKOW, TERRY THE CONTRACTING	NW-34-49-1-W4	561845.72	5903155.51		New Well	Domestic	22-Jun-00
299060	FISHER, DOWAIN	NE-33-049-01-W4	561014.68	5902374.88		New Well	Domestic	11-Jan-02
299578	CARE INDUSTRIES LTD	NW-04-050-01-W4	560208.11	5903994.68		New Well	Domestic	28-Jun-01
1500048	DARWISH HOLDINGS LTD	NE-33-049-01-W4	561011.37	5903175.36		New Well	Domestic	30-Aug-02
1500058	DARWISH HOLDINGS LTD	NE-33-049-01-W4	561011.37	5903175.36		New Well	Domestic	18-Sep-02
1500095	HOUGHAM, JOHN	NE-32-049-01-W4	559415.01	5903155.14		New Well	Domestic	27-Mar-02
1500096	THUNDER BIRD RANCH	NE-29-049-01-W4	559434.97	5901552.24		New Well	Domestic	21-Aug-02
1500102	BEXSON CONSTRUCTION (TNT)	4-4-50-1-W4	559955.79	5903703.18		New Well	Domestic	26-Aug-02
1500161	BEXSON CONSTRUCTION	SW-04-050-01-W4	560204.79	5903988.38		New Well	Domestic	27-Nov-02
1500174	MURLAND PROJECTS INC	SW-04-050-01-W4	560204.79	5903988.38		New Well	Domestic	04-Sep-03
1500255	BEXSON CONSTRUCTION LTD	SE-04-050-01-W4	561004.83	5903985.58		New Well	Other	05-Nov-03
1500534	KAM, KEN	NE-33-049-01-W4	561015.37	5903175.38		New Well	Other	04-May-05
1500931	REYNOLDS PLUMBING LTD	SW-04-050-01-W4	560204.79	5903988.38		New Well	Domestic	25-Nov-05
1501088	AGRENT	NW-33-049-01-W4	560215.18	5903165.18		New Well	Other	27-Oct-06
1501100	WELLCLEAN	SW-04-050-01-W4	560204.79	5903983.38		New Well	Other	28-Oct-06
1501136	SHANTON HOLDINGS LTD (S. FAIR	NE-33-49-1-W4	561015.37	5903175.38		New Well	Commercial	24-Aug-06
1501137	AG RENT	NW-33-49-1-W4	560215.18	5903165.18		New Well	Domestic	10-May-06
1501401	ELITE MECHANICAL / BEXSON CONST	15-33-49-1-W4	560814.59	5903377.29		New Well	Other	17-Oct-07
1501412	SCOTT BUILDERS (APEX OILFIELD)	NE-33-049-01-W4	561015.37	5903175.38		New Well	Other	07-Apr-08
1501551	BEXSON CONSTRUCTION (AMP) LTD	SW-03-050-01-W4	561804.88	5904005.36		New Well	Other	17-Oct-07
1501552	SWAYNE, TANIS & SCOTT	14-33-049-01-W4	560264.45	5903420.53		New Well	Other	16-Oct-07
1501553	SWARAN'S SUPERB HOMES	NE-27-049-01-W4	562636.78	5901594.22		New Well	Domestic	29-Sep-08
1501650	NELSON, RAY	9-33-49-1-W4	561230.81	5902483.41		New Well	Domestic	23-Jun-10
1502092	1467550 ALTA. LTD	16-33-49-1-W4	561081.2	5903287.98	2209 ft	New Well	Domestic	27-Aug-12
1502165	BEXSON CONSTRUCTION LTD	16-32-49-1-W4	559420.87	5903428.47		New Well	Other	27-Oct-12
1502177	HURICANE INDICITADEL MECH	16-33-49-1-W4	561169.43	5903223.11	2175.2 ft	New Well	Other	09-Aug-13
1502178	NORTH, FRED	NE-32-49-1-W4	559331.96	5903158.5		New Well	Domestic	08-May-13
1524707	STRAND CONSTRUCTION & DEV	SW-4-50-1-W4	560201.12	5903983.44		New Well	Domestic	07-Sep-12

Well ID	DEPTH (m)	SURFACE-CASINGTYPE	SURFACE-CASING-SIZE-OD	SURFACE-CASING-BOTTOM-AT	SCREEN-TYPE	SCREEN-SIZE	SCREEN-SCREEN-FROM m	SCREEN-TO m	SCREEN-Length (m)	STATIC LEVEL (m)	TEST RATE (L/min)	TOP-OF-AQUIFER	Bottom-OF-AQUIFER	AVAILABLE-DRAWDOWN m	Aquifer Thickness	Bedrock	POTABILITY-SAMPLED	C-HYDRAULIC CONDUCTIVITY m/sec	Q20 LONG TERM SAFE YIELDS m³/day
42028	69.5	Plastic	5 in	221 ft	Stainless Steel	4 in	67.36	68.58	1.52	36.27	36.37	64.82	63.49	29.35	4.77	43.25	No	1.32E-06	75
135556	49.4	Unknown	4.5 in	145 ft		n/a	n/a	n/a	n/a	39.93	22.73				n/a		No	n/a	#VALUE!
135557	70.1	Unknown	6 in	230 ft		n/a	n/a	n/a	n/a	47.24	n/a				n/a		No	n/a	#VALUE!
135558	30.0		0 in	0 ft		n/a	n/a	n/a	n/a	n/a	n/a				n/a		No	n/a	#VALUE!
135559	64.0	Steel	5.5 in	190 ft		n/a	n/a	n/a	n/a	34.05	27.28	57.61	64.01	23.56	6.4	31.29	No	1.80E-04	1118
135560	64.0	Steel	4.5 in	184 ft		n/a	n/a	n/a	n/a	n/a	36.37				n/a		No	n/a	#VALUE!
135561	72.5	Unknown	4.5 in	238 ft		n/a	n/a	n/a	n/a	36.58	31.42				n/a		Yes	n/a	#VALUE!
135564	45.7		0 in	0 ft		n/a	n/a	n/a	n/a	4.88	n/a				n/a		No	n/a	#VALUE!
135565	54.0		0 in	0 ft		n/a	n/a	n/a	n/a	43.89	18.18				n/a		No	n/a	#VALUE!
135566	66.1	Plastic	5 in	190 ft	Stainless Steel	3 in	57.30	60.35	3.05	35.54	52.28	54.86	61.57	19.32	6.71	47.85	No	9.80E-06	31
135567	72.2	Plastic	5 in	195 ft	Stainless Steel	3 in	59.44	60.96	1.52	35.66	50.01	55.47	60.66	19.81	5.19	42.67	No	2.50E-06	11
135568	42.5	Plastic	5 in	183 ft	Stainless Steel	4 in	58.83	60.35	1.52	39.59	66.39				n/a		No	n/a	#VALUE!
135569	73.2	Plastic	5 in	228 ft	Stainless Steel	3 in	69.49	70.71	1.22	3.6	44.55				n/a		Yes	n/a	#VALUE!
152301	54.0	Plastic	5 in	173 ft		0 in	n/a	n/a	n/a	34.44	45.46				n/a		No	n/a	#VALUE!
153752	83.8	Plastic	5 in	265 ft	Stainless Steel	3 in	80.77	82.30	1.52	43.89	36.37				n/a		No	n/a	#VALUE!
185592	70.6	Plastic	5 in	218 ft	Stainless Steel	3 in	66.45	67.97	1.52	42.06	22.73				n/a		No	n/a	#VALUE!
189212	79.2	Plastic	5 in	220 ft	Stainless Steel	3 in	67.06	68.28	1.22	36.88	50.01				n/a		No	n/a	#VALUE!
199295	118.3		0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		No	n/a	#VALUE!
215324	65.5	Steel	4.5 in	212 ft		0 in	n/a	n/a	n/a	24.08	22.73				n/a		No	n/a	#VALUE!
215420	48.8		0 in	0 ft		0 in	n/a	n/a	n/a	39.32	27.28				n/a		No	n/a	#VALUE!
218026	93.3	Steel	4.5 in	268 ft	Stainless Steel	3 in	81.69	82.91	1.22	40.23	27.28				n/a		No	n/a	#VALUE!
218192	84.4	Plastic	5 in	220 ft	Stainless Steel	3 in	66.45	82.67	1.52	28.44	59.1	65.53	71.32	27.09	5.79	43.12	No	9.28E-06	60
221405	48.8	Steel	6 in	0 ft		0 in	n/a	n/a	n/a	44.81	13.64				n/a		No	n/a	#VALUE!
221406	66.1	Steel	5.5 in	179 ft		0 in	n/a	n/a	n/a	41.61	25	51.82	55.23	10.21	13.41	58.28	Yes	1.40E-04	768
221407	71.9	Plastic	5 in	210 ft	Stainless Steel	3 in	64.01	65.23	1.22	44.2	54.55				n/a		No	n/a	#VALUE!
221408	13.6	Unknown	0 in	0 ft		0 in	n/a	n/a	n/a	37.39	n/a				n/a		No	n/a	#VALUE!
221411	61.6	Steel	5.56 in	180 ft	Stainless Steel	3 in	54.86	57.30	2.44	29.87	68.19				n/a		No	n/a	#VALUE!
221417	68.3	Steel	4.6 in	217 ft	Stainless Steel	3 in	65.84	67.36	1.52	49.77	45.46				n/a		Yes	n/a	#VALUE!
221418	48.2	Unknown	6 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		No	n/a	#VALUE!
221419	85.3	Steel	4.6 in	232 ft	Stainless Steel	4.06 in	70.71	72.24	1.52	37.19	40.91				n/a		No	n/a	#VALUE!
221421	79.3	Steel	4.6 in	223 ft	Stainless Steel	1 in	67.67	68.19	1.22	31.7	27.28				n/a		No	n/a	#VALUE!
221422	45.1	Steel	6 in	120 ft		0 in	n/a	n/a	n/a	41.64	n/a				n/a		No	n/a	#VALUE!
221423	83.8	Steel	4.6 in	251 ft	Stainless Steel	3 in	76.50	77.72	1.22	48.16	36.37				n/a		No	n/a	#VALUE!
221424	54.9	Unknown	0 in	0 ft		0 in	n/a	n/a	n/a	30.48	n/a				n/a		No	n/a	#VALUE!
221425	85.3	Steel	4.6 in	229 ft	Stainless Steel	3 in	69.80	71.32	1.52	39.01	45.46				n/a		Yes	n/a	#VALUE!
221426	83.8	Steel	4.6 in	221 ft	Stainless Steel	3 in	67.36	68.58	1.22	40.23	45.46				n/a		No	n/a	#VALUE!
221427	79.2	Steel	5.5 in	200 ft		0 in	n/a	n/a	n/a	39.13	227.3	50.9	64.62	12.77	13.72	44.81	No	8.15E-04	6618
221428	83.8	Steel	5.5 in	233 ft		0 in	n/a	n/a	n/a	39.93	42.91	71.02	88.32	31.09	17.2	47.85	No	4.15E-05	925
221429	48.8	Steel	4.6 in	153 ft		0 in	n/a	n/a	n/a	37.8	n/a				n/a		Yes	n/a	#VALUE!
221430	n/a		0 in	0 ft		0 in	n/a	n/a	n/a	8.4	n/a				n/a		Yes	n/a	#VALUE!
221431	73.2	Steel	4.6 in	202 ft	Stainless Steel	3 in	61.57	63.09	1.52	42.06	68.19				n/a		No	n/a	#VALUE!
221432	79.2	Steel	4.6 in	255 ft	Stainless Steel	3 in	76.20	77.72	1.52	34.14	36.37				n/a		No	n/a	#VALUE!
221433	n/a	Unknown	24 in	0 ft		0 in	n/a	n/a	n/a	17.98	n/a				n/a		No	n/a	#VALUE!
221434	67.1	Steel	4.6 in	172 ft	Stainless Steel	3 in	52.43	53.64	1.22	29.82	27.28				n/a		No	n/a	#VALUE!
221437	79.2		0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		Yes	n/a	#VALUE!
221439	79.2	Steel	4.6 in	222 ft	Stainless Steel	3 in	67.36	68.58	1.22	29.62	54.55				n/a		Yes	n/a	#VALUE!
221440	70.1	Plastic	5 in	220 ft	Stainless Steel	3 in	67.06	68.28	1.22	36.88	100.01				n/a		No	n/a	#VALUE!
221441	48.8	Unknown	6 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		No	n/a	#VALUE!
221803	51.8		0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		No	n/a	#VALUE!
221804	45.8		0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		Yes	n/a	#VALUE!
221805	50.3	Unknown	6 in	0 ft		0 in	n/a	n/a	n/a	21.34	n/a				n/a		No	n/a	#VALUE!
222737	39.6		0 in	0 ft		0 in	n/a	n/a	n/a	8.1	n/a				n/a		No	n/a	#VALUE!
222738	54.1		0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		No	n/a	#VALUE!
222745	45.7		0 in	0 ft		0 in	n/a	n/a	n/a	41.15	n/a				n/a		No	n/a	#VALUE!
222746	n/a	Wood	0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		Yes	n/a	#VALUE!
222748	57.9		0 in	0 ft		0 in	n/a	n/a	n/a	21.34	n/a				n/a		Yes	n/a	#VALUE!
222750	74.7	Unknown	0 in	0 ft		0 in	n/a	n/a	n/a	54.86	n/a				n/a		Yes	n/a	#VALUE!
222884	54.9		0 in	0 ft		0 in	n/a	n/a	n/a	30.48	n/a				n/a		Yes	n/a	#VALUE!
222885	n/a		0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		Yes	n/a	#VALUE!
222886	57.3		0 in	0 ft		0 in	n/a	n/a	n/a	45.72	n/a				n/a		Yes	n/a	#VALUE!
222878	n/a		0 in	0 ft		0 in	n/a	n/a	n/a	n/a	n/a				n/a		No	n/a	#VALUE!
227883	88.4	Plastic	5 in	266 ft	Stainless Steel	3 in	81.08	82.30	1.22	42.06	22.73				n/a		No	n/a	#VALUE!
278523	71.9	Plastic	5 in	225 ft	Stainless Steel	3 in	68.58	69.82	1.22	35.87	54.55				n/a		No	n/a	#VALUE!
255248	79.2	Plastic	5 in	200 ft	Stainless Steel	4 in	60.96	63.40	2.44	40.17	45.46	58.22	63.4	18.85	5.18	13.11	No	1.60E-04	815
266158	77.7	Plastic	5 in	222 ft	Stainless Steel	4 in	67.67	70.10	2.44	40.54	36.37	67.06	70.1	29.52	3.04	9.14	No	2.00E-05	83
280606	80.8	Plastic	5 in	221 ft	Stainless Steel	4 in	67.36	69.80	2.44	42.37	36.37	65.84	77.11	23.47	11.27	35.97	No	2.94E-05	320
280608	75.3	Plastic	5 in	223 ft	Stainless Steel	4 in	67.36	69.80	2.44	43.59	68.19	54.25	75.29	10.66	21.04	41.45	No	3.00E-05	265
280610	73.8	Plastic	5 in	232 ft	Stainless Steel	4 in	70.71	71.93	1.22	34.75	31.82	65.23	71.93	30.48	6.7	54.86	No	8.10E-06	69
287651	80.8	Plastic	5 in	244 ft	Stainless Steel	4 in	74.37	77.42	3.05	40.23	36.37				n/a		No	n/a	#VALUE!
287652	79.2	Plastic	5 in	232 ft	Stainless Steel	4 in	70.71	73.15	2.44	38.58	45.44	67.06	73.15	30.48	6.09	64.01	No	2.29E-05	174
287653	76.8	Plastic	5 in	234 ft	Stainless Steel	4 in	71.32	73.76	2.44	38.58	40.91	70.1	76.5	33.52	6.4	42.06	No	3.70E-05	334
287654	78.3	Steel	5.5 in	226 ft	Stainless Steel	4 in	68.88	70.41	1.52	38.88	31.82	56.08	70.41	19.2	14.33	63.48	No	1.27E-05	144
293331	73.2	Plastic	5 in	223 ft	Stainless Steel	4 in	67.97	69.49	1.52	37.8	9.09	67.06	71.32	29.26	4.26	18.59	No	5.50E-06	29
294295	73.2	Plastic	5 in	160 ft	Stainless Steel	4 in	54.86	60.96	6.10	35.97	68.19	49.28	57.91	13.41	8.53	22.56	No	1.11E-04	841
294297	71.9	Plastic	5 in	206 ft	Stainless Steel	4 in	63.40	66.45	3.05	25.94	22.73	54.25	66.75	18.31	12.5	18.46	No	4.00E-06	38
299060	70.7	Plastic	4.5 in	225 ft	Stainless Steel	4 in	68.58	70.10	1.52	40.23	22.73	54.25	70.71	14.02	16.46	39.13	No	1.50E-05	182
299578	75.3	Plastic	5 in	232 ft	Stainless Steel	4 in	70.71	73.15	2.44	38.98	40.91	63.4	75.29	24.42	11.89	49.19	No	3.40E-05	416
1500048	79.2	Plastic	5 in	240 ft	Stainless Steel	4 in	73.15	76.20	3.05	39.18	27.28	68.88	77.42	30.7	8.54	32.52	No	7.40E-06	84
1500058	73.8	Plastic	5 in	218 ft	Stainless Steel	4 in	66.45	69.49	3.05	36.18	31.82	66.45	69.49	29.57	3.04	41.15	No	5.40E-05	201
1500095	67.3	Plastic	4.5 in	200 ft	Stainless Steel	4 in	60.96	64.01	3.05	n/a	27.28			#VALUE!	n/a		No	n/a	#VALUE!
1500096	71.9	Plastic	5 in	220 ft	Stainless Steel	4 in	67.06	70.10	3.05	44.81	22.73	55.47	70.71	10.66	15.24	11.02	No	4.35E-05	291
1500102	77.1	Plastic	5 in	232 ft	Stainless Steel	4 in	70.71	73.76	3.05	40.23	31.82	69.28	73.76	29.05	5.48	42.09	No	4.78E-05	303
1500161	61.6	Plastic	5 in	177 ft	Stainless Steel	4 in	53.95	60.05	6.10	37.43	81.83				n/a		No	n/a	#VALUE!
1500174	69.8	Plastic	5 in	220 ft	Stainless Steel	4 in	67.06	68.58	1.52	37.8	68.19	58.69	69.49	18.89	11.8	51.51	No	4.77E-05	474
1500255	72.2	Plastic	5 in	220 ft	Stainless Steel	4 in	67.06	70.10	3.05	36.58	45.46	64.01	71.32	27.43	7.31	44.5	No	1.31E-05	110
1500534	76.2	Plastic	5 in	210 ft	Stainless Steel	4 in	64.01	67.06	3.05	42.37	45.46	56.69	67.97	18.32	11.28	54.21	No	2.33E-05	153
1500931	60.4	Plastic	4 in	181 ft	Stainless Steel	4 in	55.17	58.22	3.05	36.09	90.92	48.33	60.35	9.15	14.02	38.58	No	8.07E-06	45
1501088	78.6	Plastic	5 in	229 ft	Stainless Steel	4 in	69.80	74.37	4.57	41.15	54.55	63.4	74.37	22.25	10.97	43.89	No	8.12E-05	614
1501100	72.5	Plastic	5 in	212 ft	Stainless Steel	4 in	64.62	67.67	3.05	37.19	45.46	63.7	72.54	26.51	8.84	42.67	No	3.62E-05	352
1501136	73.8	Plastic	5 in	224 ft	Stainless Steel	4 in	68.28	71.32	3.05	43.89	54.55	60.96	74.98	17.07	14.02	40.39	No	2.85E-05	281
1501137	72.2	Plastic	5 in	223 ft	Stainless Steel	4 in	67.97	71.02	3.05	39.93	45.46	66.71	72.24	26.82	5.49	43.28	No	7.30E-05	448
1501401	73.5	Plastic	5 in	215 ft	Stainless Steel	4 in	64.01	67.06	3.05	37.2	45.46	49.01	71.93	11.87	21.96	45.11	No	1.08E-05	187
1501412	73.2	Plastic	5 in	216 ft	Stainless Steel	4 in	65.84	70.41	4.57	36.67	45.46	69.06	70.41	24.29	5.45	45.11	No	1.26E-05	127
1501551	72.2	Plastic	5 in	209 ft	Stainless Steel	4 in	63.40	64.92	1.52	37.59	68.19	61.52	65.84	29.04	4.27	23.77	No	2.06E-05	101
1501552	75.6	Plastic	5 in	220 ft	Stainless Steel	4 in	67.06	73.15	6.10	39.62	68.19	65.23	74.07	25.61	8.84	46.63	No	1.46E-05	135
1501553	71.3	Plastic	5 in	188 ft	Stainless Steel	4 in	57.30	60.35	3.05	28.45	45.46	49.68	65.85	17.21	18.2	17.37	No	1.36E-05	142
1501650	76.2	n/a	n/a	n/a	Stainless Steel	4 in	64.01	67.06	3.05	36.27	54.55	53.04	70.41	16.77	17.37	25.69	No	3.00E-05	401
1502092	73.2	n/a	n/a	n/a	Stainless Steel	3 in	64.01	67.06	3.05	35.87	36.37	45.72	69.49	9.85	23.77	36.51	No	7.76E-06	75
1502165	76.2	n/a	n/a	n/a	Stainless Steel	4 in	69.80	72.85	3.05	45.75	68.19	55.17	72.85	14.31	17.68	47.24	No	2.11E-05	225
1502177	72.8	n/a	n/a	n/a	Stainless Steel	4 in	64.62	67.67	3.05	36.02	68.19	52.6	67.67	14.54	11.07	42.67	No	9.31E-06	95
1502178	79.2	n/a	n/a	n/a	Stainless Steel	3 in	70.71	75.29	4.57	40.54	68.19	70.1	76.81	29.56	6.71	19.51	No	1.56E-05	127
1524707	67.1	n/a	n/a	n/a	Stainless Steel	4 in	58.52	61.57	3.05	n/a	n/a				2		No	n/a	#VALUE!

Q20 high	6618
Q20 low	11
Q20 average	436

THURBER

TABLE 2.2 - GROUNDWATER CHEMICAL ANALISYS FROM ERSD GROUNDWATER DATABASE WITHIN 1.6km RADIUS FROM ROBINWOOD ESTATE

WellID	Well Owner	Well Depth:	Lab:	Analysis Date:	Water Level:	Sample Number:	Remarks:	Electrical Conductivity	Floride	PH	Ion Balance	Iron	Bicarbonate	Calcium	Silica	Potassium	Sulfate	Nitrate + Nitrate (NO2 + NO3)	Magnesium	Total Alkalinity	Chloride	Sodium	Total Dissolved Solids	Carbonate	Hydroxide	Nitrite	Nitrate	Total Hardness	Total Phosphorus:	Total Kjeldahl Nitrogen
139561	DICKOUT, M	72.54	UA	07-Dec-64	188 ft	6413581	WATER SUITABLE WHEN IRON SETTLES. IGNITION LOSS = 110 PPM.					2.9					253			560	35.0		1102		0	0.00	0.0	215	0	0
139569	CHRISTIE CORROSION CONTROL LTD	73.15	VG	04-Dec-86		14477-W		1380	0.18	7.7	0.94	0.51	599	50	15.3	3.688	235	-0.05	24.0	491	28.0	230	865		0	-0.05		223	0	0
221406	OUCHAR, JOHN	66.14	AE	15-Sep-80		8735-W		1353	0.23	8.2	0.68	4.1	371	26	15.4	3.988	371	-0.05	44.0	304	25.0	179	829		0	-0.05		245	0	0
221406	OUCHAR, JOHN	66.14	AE	23-Jan-76	165 ft	410	SAMPLED FROM HOUSE TAP.	1400	0.25	7.3	0.81	1.9	573	94		3.784	545	-0.10	39.0	470	24.0	213	1201		0	-0.10		397	0	0
221417	HUTCHISON, GENE	68.28	AE	19-May-78	190 ft	4705-W		1518	0.23	7.9	0.98	1.92	571	86	17.4	4.196	358	-0.05	37.0	469	22.0	223	1011		0	-0.05		367	0	0
221425	JENSEN, ED	85.34	AE	11-Mar-76	128 ft	1756-W	SAMPLED FROM KITCHEN TAP.	1675	0.19	8.1	1.05	0.9	608	20		2.556	315	-0.10	10.0	499	86.1	414	1147		0	-0.10		91	0	0
221429	DESCHOVER, E.	48.77					IGNITION LOSS = 202 PPM. NO2 = TRACE AMTS. SODA = 90 PPM.										225			775	30.0		964		0		1.6	390	0	0
221804	MISIAK, JOE	48.77	AE	02-Sep-80		8739-W		2260	0.15	8.1	1.02	0.15	518	5	14.5	4.4	827	-0.05	3.0	425	28.0	604	1726		0	-0.05		26	0	0
222737	STURGE, H.	36.58			20 ft		WATER SUITABLE WHEN IRON SETTLES. IGNITION LOSS = 444 PPM.					3.4					861			600	31.0		2352		0			930	0	0
222739	SAMPSON, WAYNE	54.25	AE	02-Sep-80		8737-W		1718	0.19	8.3	0.97	0.08	639	4	10.7	2.556	252	0.38	4.0	525	89.1	393	1061		0	0.16		26	0	0
222739	SAMPSON, WAYNE	54.25	VG	25-Sep-74		10707NB	SAMPLED FROM TAP.	1720	0.19	8.4	0.99	0.12	635	4	9.7	2.048	290	0.31	3.0	529	79.1	420	1117		0	-0.05		22	0	0
222745	GRADAUER	45.72					WATER HARD, SUITABLE WHEN IRON SETTLES. IGNITION LOSS = 240 PPM.					1.8					292			490	25.0		1080		0			500	0	0
222745	GRADAUER	45.72	UA	28-Apr-64		64-4686	WATER SUITABLE WHEN IRON SETTLES. IGNITION LOSS = 246 PPM.					7					248			490	25.0		1002		0	0.00	0.0	510	0	0
222746	GRADAUER, FRED	12.19	UA	20-Apr-64		64-4372	WATER SUITABLE WHEN IRON SETTLES. IGNITIOPN LOSS = 126 PPM.					4					29			280	4.0		342		0	0.00	0.0	290	0	0
222748	BAILEY, TOM	57.91	AE	23-Feb-78	70 ft	1532-W	SAMPLED FROM HOUSE TAP.	1571	0.19	7.9	1.05	0.17	549	40	10	3.784	305	-0.10	24.0	450	37.1	302	983		0	-0.10		200	0	0
222750	UMPHREY, C.	74.68	UA	20-Aug-69	65 ft	69-7724	IGNITION LOSS = 246 PPM. NO2 = TRACE AMTS. SODA = 348.7 PPM.		0.32			0.28					202			450	42.1		1030		0		0.2	121	0	0
222884	BECKLEY, DON	54.86	AE	02-Jun-76	100 ft	4496-W	SAMPLED FROM TAP.	1425	0.2	8	1.02	0.1	650	46		4.808	225	1.00	17.0	533	37.1	300	955		0	1.00		186	0	0
222885	BENOIT, CHRIS	0	VG	14-Mar-86		3228-W		1600	0.39	7.9	0.99	0.2	607	-1	15.9	1.74	307	-0.05	-1.0	498	26.0	365	1020		0	-0.05		-5	0	0
222886	LINDSAY, THOMAS	57.91	AE	10-Nov-76	150 ft	10572-W	SAMPLED FROM KITCHEN TAP.	860	0.2	9.1	1.17	-0.05	350	57		8.592	119	0.60	55.0	389	24.0	121	620		0	118.91		370	0	0
** - Canadian Council of Ministers of the Environment, August 2012. *Guidelines for Canadian Drinking Water Quality (TW-12) (CDWQ)*								---	1.5	6.5-8.5	---	0.3	---	---	---	---	---	11	---	---	250.0	200	500	---	---	1	10	---	---	---

Robinwood
ESTATES

Conceptual Traffic Analysis
for Robinwood Estates ASP

McElhanney

M E M O R A N D U M

TECHNICAL MEMORANDUM	Robinwood Estates ASP Conceptual Traffic Analysis
Date:	May 30, 2014
Our Reference:	2511-00463-0

To: County of Vermilion River

From: Patrick Wong, P.Eng., PTOE

This memorandum provides a summary of the conceptual traffic analysis for the proposed 12 lot country residential development in the County of Vermilion River, Alberta.

1.0 Background

The proposed 12 lot country residential development located 1.6 km south of Highway 16 along Range Road 13 west of Lloydminster, Alberta. The site is expected to consist of approximately 20 acres of space.

2.0 Road Network

Highway 16 is a four lane divided highway with a posted speed of 110 km/hr in the vicinity of Range Road 13, which will be used for access to the site.

Range Road 13 is currently a gravel two lane undivided roadway with a rural cross-section with ditches on either side. There is no posted speed limit within the study intersection and it is assumed that the speed limit is 50 km/hr. The existing Highway 16 / Range Road 13 intersection is stop controlled on the north and south legs, with no acceleration or deceleration lanes along Highway 16.

3.0 Existing Traffic Volumes

Manual traffic count volumes (2012) at Highway 16 / Range Road 13 intersection were obtained from the Alberta Transportation website.

The 2012 traffic volumes are presented in **Table 1**.

Table 1: 2012 Traffic Volumes (vph)

Period	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
AM Peak	3	552	5	28	649	7	7	0	17	14	0	3
PM Peak	1	796	7	14	680	23	7	1	60	39	2	1

4.0 Background Traffic

Existing traffic volumes were projected to a 25 year horizon using a 2.0% annual growth rate. Though the provincial growth average is closer to 2.5%, a lower value was used due to the low historical growth in the area, as shown by ATR data along Highway 16, west of Lloydminster.

Table 2: Historical Growth along Highway 16

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Avg. Growth
Hwy 16 AADT	885	910	914	973	983	980	1014	1047	1041	1060	1.9%

5.0 Site Trip Generation / Distribution

The Institute of Transportation's (ITE) Trip Generation Manual, 9th Edition, provides trip rates for Single-Family Detached Housing (code 210). The number of dwelling units (12) will be utilized for the independent variable in trip generation. **Table 3** shows the resulting trips generated from the development.

Table 3: Single Family Detached Housing Trip Generation

Time Period	Average Trip Rate (trips/dwelling unit)	Total Trips	In / Out (%)
AM Peak	0.75	9 vph	25 / 75
PM Peak	1.00	12 vph	63 / 37
AADT	9.52	115 vpd	50 / 50

These trips were assigned to the Highway 16 / Range Road 13 intersection with the assumption that 20% of the trips would be coming and going along Highway 16 to and from the west, while the remaining 80% would access the site from Highway 16 to the east.

6.0 Trip Analysis

Two analyses were carried out to evaluate the impact of the proposed country residential development.

i) Intersection Treatment Analysis

ii) Intersection Performance Analysis (Synchro)

Intersection Treatment Analysis

Alberta Transportation's Highway Geometric Design Guide (HGDG) provides criteria for the selection of an appropriate at-grade intersection treatment on a four lane divided highway.

The intersection of Highway 16 and Range Road 13 is currently minor road intersection on four-lane divided highway (Figure D-9.1b), and will therefore not require further upgrades to accommodate the development traffic.

Left turn treatment analysis was conducted for the future combined volumes at Range Road 13, as per the Highway Geometric Design Guide. No left turn lane is required.

Right turn lanes are warranted if the following three conditions are met:

1) Main Road AADT >= 1800 **(met)**
2) Intersecting Road AADT >=900 **(not met)**
3) Right turn volume >= 360 **(not met)**

Since only the first condition is met, a right turn lane is not required.

Intersection Performance Analysis (Synchro)

Intersection performance analysis was conducted with Synchro software. The level of Service (LOS) for the intersection of Highway 16 and Range Road 13 are shown in Table 4 for the projected traffic combined with the proposed development.

Table 4: 2039 Combined Scenario Intersection LOS

LOS	Intersection		South Leg	
	AM	PM	AM	PM
RR 13	A	C	A	D

The intersection is anticipated to continue operating at an adequate Level of Service in un-signalized configuration (with stop controls on the range road) for the 25 year horizon.

7.0 Conclusions

The purpose of this memorandum was to evaluate the potential transportation issues of the proposed 12 lot country residential development. In section 6, the analyses showed that the potential impact to Highway 16 will be minimal. The intersection of Highway 16 and Range Road 13 will operate adequately, thus, no immediate improvements will be required.

Please feel free to contact me (780-809-3282; pwong@mcelhanney.com) if you have any questions, or require additional information.

Sincerely,

Patrick Wong, P.Eng., PTOE

Transportation Engineer

cc: Ryan Betker, P.Eng., McElhanney Consulting Services