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Livingstone Ventures Ltd.

Gold Creek Area Structure Plan

Prepared by:

AECOM Canada Ltd.

Date: March 2009

G511-001-00 / RPT-08-054

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Revision Log

Revision #	Date	Issue / Revision Description
--	November 08	Draft One
1	February 09	Draft Two
2	March 09	Sanitary Revision
3	April 09	Final

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1. Introduction

1.1 Purpose

The purpose of the Gold Creek Area Structure Plan is to establish a planning framework for a future grouped country residential development in the Municipality of Crowsnest Pass north of the Town of Frank.

1.2 Location and Area

Located in the southwest corner of Alberta, the Municipality of Crowsnest Pass is nestled in the Canadian Rocky Mountains. The Gold Creek grouped country residential development (Gold Creek development) is located approximately 3.82 km north of the Town of Frank, on the eastern half of SW ¼ Sec 8-8-3-W5M (refer **Figure 1**). The total area contains approximately 39.22 ha (96.92 ac) of sparsely forested pasture land. Existing local amenities within the regional municipality include the Frank Slide Interpretive Centre, the Bellevue Underground Mine and the Crowsnest Museum. Also of note is the abandoned turn-of-the-century mining town of Lille, located approximately five kilometres north of the development.

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PROPOSED DEVELOPMENT

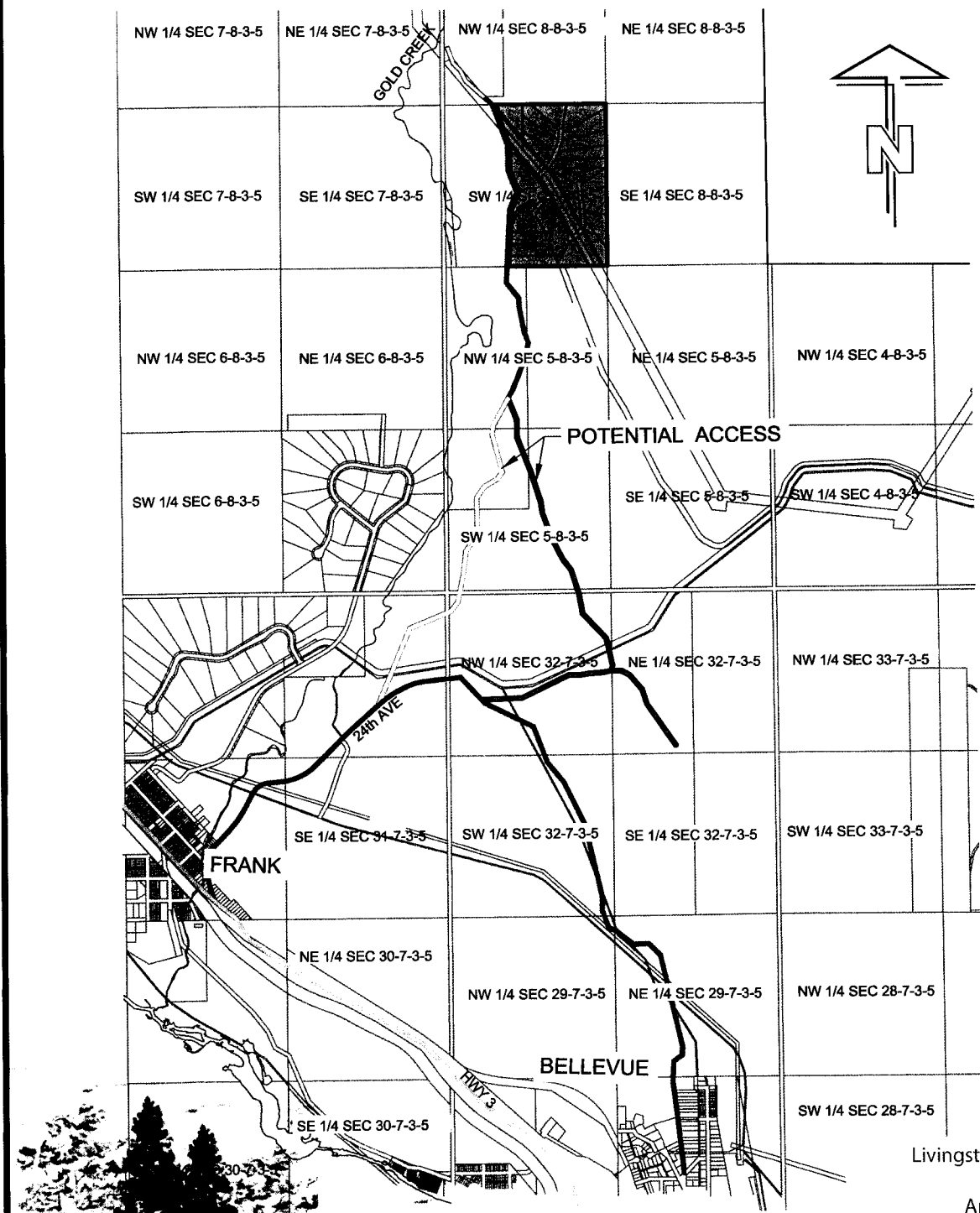
EXISTING DEVELOPED R.O.W

UNDEVELOPED R.O.W

DEVELOPED-PRIVATELY OWNED

HIGHWAY

ROADWAY



Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Context Map

Figure 1

2. Statutory Compliance

2.1 Municipal Development Plan

The Municipality of Crowsnest Pass Municipal Development Plan Bylaw No. 556/01 (MDP) is a high-level policy document that provides overall direction for future development in the Municipality of Crowsnest Pass. The MDP acts as a guide for future land use development and provides a framework for decision making. Furthermore, the MDP works to maintain and enhance the community's quality of life.

Within the Municipal Development Plan the subject lands are not graphically designated. However, a text amendment to the MDP may be required in tandem with the adoption of this plan to ensure continuity of all municipal documents.

This Area Structure Plan is being prepared as per the guidelines contained within the MDP, which indicate that prior to approving the re-districting of a parcel, an Area Structure Plan is required to be adopted, in tandem with Land Use Bylaw Amendment.

2.2 Land Use Bylaw

The Municipality of Crowsnest Pass Land Use Bylaw No. 632/04 (LUB) defines land use districts for all lands within the municipality. All lands within this plan area are currently designated as Non-Urban. Therefore an amendment of the LUB is required prior to subdivision and further development to a grouped country residential use. As indicated within the LUB, an Area Structure Plan must accompany the application for a LUB amendment for a country residential development that would create more than two parcels. The items detailed within this document are intended to satisfy the requirements of the Municipality of Crowsnest Pass LUB Country Residential Land Use District Regulations.

This plan contains planning and preliminary engineering details satisfying the requirement to accompany a LUB amendment to Grouped Country Residential from Non-Urban with an Area Structure Plan. As the lots will be individually serviced with water wells, the Grouped County Residential district definition allows parcels to be a minimum of 1.2 ha in size. In order to effectively provide access to the lots given the contouring of the site, some residential setbacks may be requested to be varied upon issuance of a development permit. **Figure 2** on the following page presents the proposed land use as per the Municipality of Crowsnest Pass LUB.

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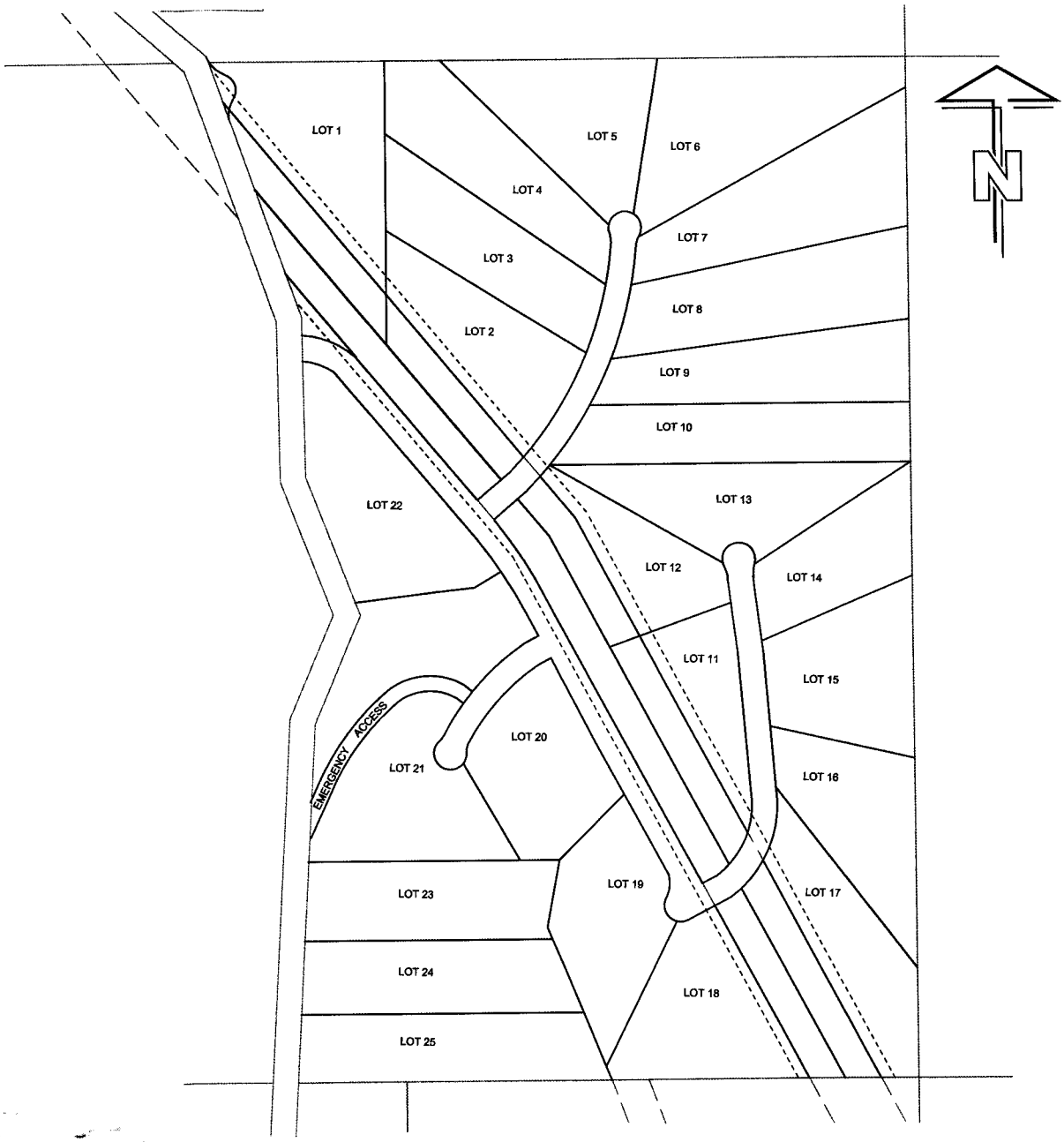
LEGEND

STUDY BOUNDARY

RESIDENTIAL (25 LOTS)

RESERVE/ALTALINK EASEMENT



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Gold Creek - CNP
Area Structure Plan

Proposed Land Use

Figure 2

3. Site Conditions

3.1 Site Features

Deriving its name from Gold Creek, a small mountain creek that runs parallel to the west of the proposed development; the site of the Gold Creek development offers an idyllic view of the surrounding Rocky Mountains and the Town of Frank below. The natural drainage pattern in the immediate area follows existing contours, flowing west down the side of the mountain towards Gold Creek (refer **Figure 3**). Gold Creek itself will be left untouched, as it is not located within the site boundaries.

According to Alberta Agriculture and Food, the predominant soil classification for the site is Soil Class 6-T, indicating that soils in this class are capable only of producing perennial forage crops and that agricultural improvement practices are not feasible due to the topography of the site.

Other than a constructed but undrilled natural gas well, located in the SE corner of the development area, the only man-made structure remaining is an AltaLink transmission line that runs diagonally through the site.

3.2 Archaeological Features

As per the findings of the Historical Resources Impact Assessment (**Appendix A**), there is little evidence of significant archaeological features where the Gold Creek development is located. Due to the slope of the site it is considered unlikely that material remains exist as the likely pre-contact trade corridor would be adjacent to Gold Creek itself.

3.3 Biogeographical Features

The Crowsnest Pass has three (3) major ecological areas; a grassland area, a mixed forest area, and a high alpine region. The Gold Creek development is situated within the mixed forest ecological area, in which flora such as the Jack Pine, White Spruce, and Poplar, as well as Goldenrod, Yellow Paintbrush, and various shrubs and herbs typically exist in an undisturbed state. Fauna such as Brown Bats, Ravens, Mule and White-tailed Deer, as well as numerous Shrews, Rodents and carnivores, including Grey Wolves, Grizzly Bears and Cougars can be found within this ecological area – as is typical in biomes throughout the Rocky Mountains.

Given that the Gold Creek ASP area is currently being utilized as bush pasture, ongoing cattle grazing has significantly impacted the natural state of the landscape as well as the presence of wildlife within the development site. To date, cattle roam freely throughout the parcel and have uncontrolled access to the springs and ephemeral streams onsite.

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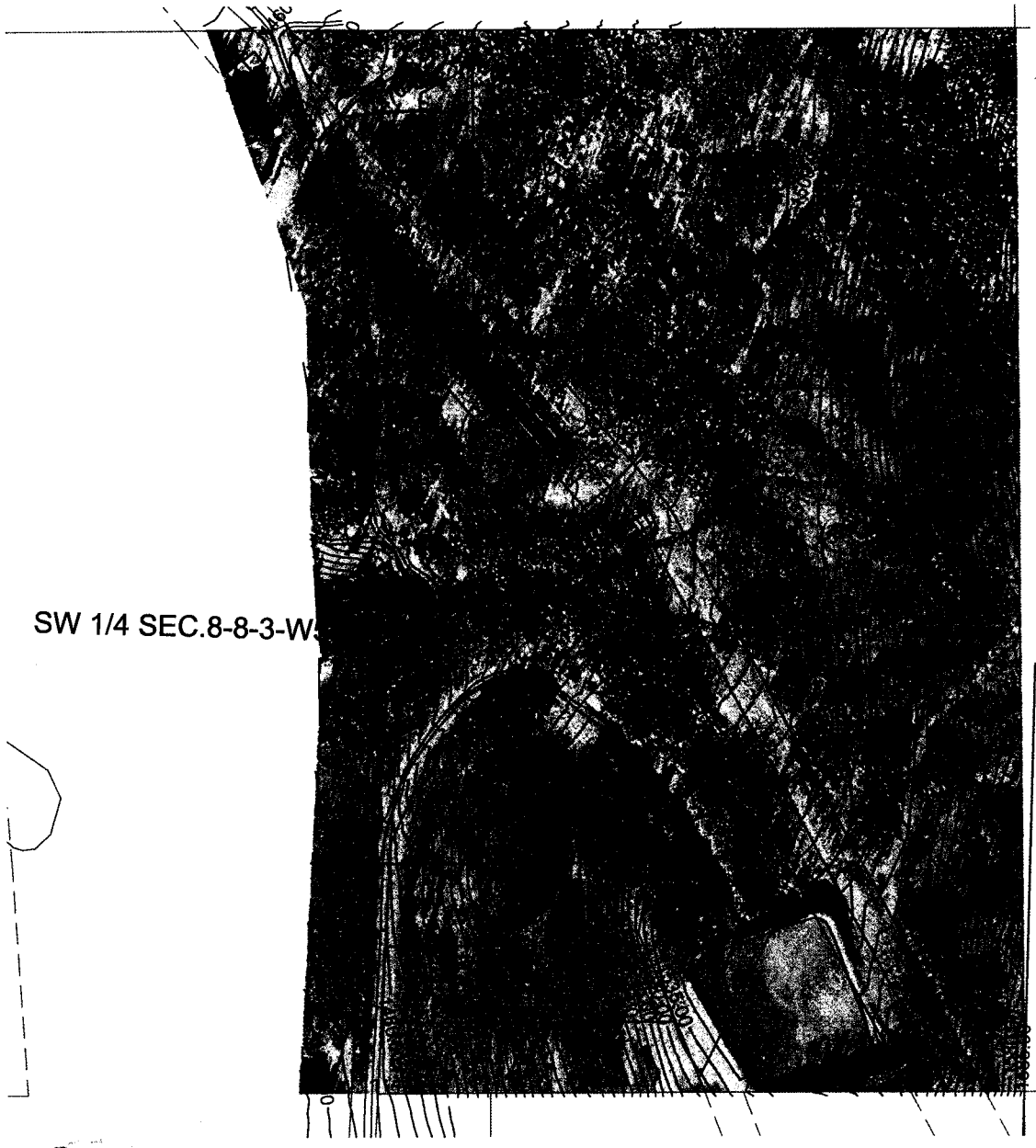
GRAVEL ROAD	———	BUILDING	———
EPHEMERAL DRAW/SPRING	———	POLES	
TRAIL	———	ALTA LINK POLES	□



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Gold Creek - CNP
Area Structure Plan

Existing Conditions

Figure 3

4. Development Concept

4.1 Concept Design Assumptions

It is the intent of the developer to retain as much existing foliage as possible in order to enhance the integration of the development into the surrounding environment. As such, Gold Creek will establish a new standard for grouped country residential development in the Municipality of Crowsnest Pass. The unique shape and form of the site presents an opportunity to create 25 exclusive home sites with minimal disturbance to the natural biodiversity (refer **Figure 4**)[1]. The desire to utilize Low Impact Development techniques and design principles will serve to enhance the manner in which the Gold Creek development is integrated into the surrounding environment.

Typical Low Impact Design principles guiding development are:

- Protected water quality
- Reduced flooding
- Protected habitat and biodiversity
- Protected and recharged aquifers contributing to the Oldman River basin

The preservation of the natural environment inherent to the Gold Creek development will be further reflected in engineering and home construction. Low Impact Design will be utilized to manage engineering elements related to stormwater quality and erosion protection (See Section 6).

Confirmation of the stability of side slopes has been established by a geotechnical engineer based on the contours, slope gradient and evidence of slope stability of each site in order to ensure the stability of each residential dwelling. As well, the orientation of the dwellings and the location of roadways will be sensitive to the existing topography.

4.2 Land Use Concept

The sinuous design of the internal road respects the contour of the site and creates an interesting variety of sizes and orientations on which the individual lots are situated (refer **Figure 5**). All 25 country residential lots are a minimum of 1.2 hectares in size and, through the retention of the natural contour of the land, the majority of the houses can be developed with walkout basements (refer **Figure 6**). A variety of pedestrian experiences and passive recreational opportunities will be available to residents within Gold Creek. Opportunities such as hiking, golf, fishing and hunting will enhance the overall quality of life enjoyed by residents.

Municipal Reserve for the Gold Creek development is approximately 3.16 hectares or 8.06% of the Gross Area. Municipal Reserve in conjunction with the easement required for the AltaLink transmission lines will provide open space within the development creating an informal trail system for residents to enjoy.

[1] *Final development concept to be determined by Council*

4.3 Architectural Controls

Architectural controls are important component to the development process and provide consistency throughout a neighbourhood creating a strong sense of place for residents. As such, it is the intent of the developer to implement a log home inspired motif throughout the Gold Creek Development.

Log Homes can utilize:

- Full log or pre-cut wooden walls
- Low-pitched roof
- Wide eaves with triangular brackets
- Exposed roof rafters
- Porch with thick wooden or stone columns
- Wooden or stone porch supports
- Numerous windows
- Some windows with stained or leaded glass, and
- Detached garages

4.4 Fire Protection and FireSmart

In order to ensure that the Gold Creek development is adequately protected in the unlikely event of a fire, two (2) 20,000 gallon (75.72m^3) fibreglass tanks, each on a hydrant (or, if need be, multiple tanks equalling a 40,000 gallon capacity), shall be incorporated onsite into provide fire protection. Furthermore, additional fire protection shall be provided through the adoption of principles inherent to the FireSmart philosophy.

The FireSmart philosophy focuses on mitigating the likelihood of large, high-intensity, high-severity fires and the risk associated with the use of prescribed fire. According to Alberta Sustainable Resources Development (SRD) FireSmart zoning mechanism, the Gold Creek development falls within the Wildlife Urban Interface Zone (WUI).

Upon referring to the LUB, it becomes apparent that the majority of the development site (approximately 55%) is designated as a "Low Fuel" area, and the remainder of the site is comprised of "Non Fuel" (20%), "Moderate Fuel" (20%), and in the northeastern-most corner, "Extreme Fuel" (<5%). Due to the presence of both moderate and extreme fuel areas within the site, the development component of the FireSmart philosophy has been kept in high regard throughout the fabrication of the development concept.[2]

4.5 WildSmart

WildSmart is a proactive conservation strategy that encourages communities to reduce negative human-wildlife interactions. The mitigation of negative human-wildlife interactions can be promoted through vegetation management and basic lifestyle guidelines that encourage harmonious interaction.

[2] ***Development:*** *Is the construction of new homes or subdivisions being developed in a "FireSmart" manner? Assess the infrastructure as it relates to roadway access, water supply, utilities placement, building materials and design, and forested areas adjacent and within the community.*

Commitment to WildSmart principles will ensure that the Gold Creek development encourages the safety of humans and wildlife alike.

WildSmart guidelines include:

- Securely store garbage and/or recycling in bear-proof bins
- BBQ's should be kept clean and drip pans taken inside
- For the safety of you and your dog, walk dogs on a leash.

4.6 Phasing

The entirety of the Gold Creek Development will be constructed in one phase, therefore mitigating ongoing construction activities for future years.

4.7 Development Statistics

As indicated in Table 1, approximately 8 % of the land area within the Gold Creek development is being set aside for Municipal Reserve. Furthermore, internal circulation requirements and development setbacks account for a combined 49.08 percent of the gross developable area, leaving approximately 50.91 percent of the gross developable area available for residential development. Due to topographical servicing constraints 25, 1.2 hectare lots are being proposed. Utilizing demographic ratios specific to professional planning, this works out to an approximate population of eighty-two (82) people of which fifteen (15) are school age youth (see Table 2).

Table 1: Approximate Development Statistics - Gold Creek

Use	Hectares	%	Units	Population	Density*
Gross Area	**39.22**				
Municipal Reserve	3.16	8.06%			
Gross Developable Area	**36.06**				
Development Setback	14.66	40.65%			
Circulation Requirements	3.04	8.43%			
Remaining Developable Area	**18.36**	**50.91%**	**25**	**82**	2.27

Note: Approximate Residential Acreage Density 2.5 units / ha; Population Density Acreage Residential 3.3 persons/unit. Development statistics subject to change pending development concept adoption
*PPGDH; Persons per Gross Developable Hectares

Table 2: Student Composition - Gold Creek

Grade	Number of Students
ECS to grade 6	8
Grade 7 to grade 9	3
Grade 10 to grade 12	4
Total Student Generation	**15***

Note: Estimated # of Students per Dwelling Unit; Cohort 1 = 0.33; Cohort 2 = 0.14; Cohort 3 = 0.14
*Demographic data truncated

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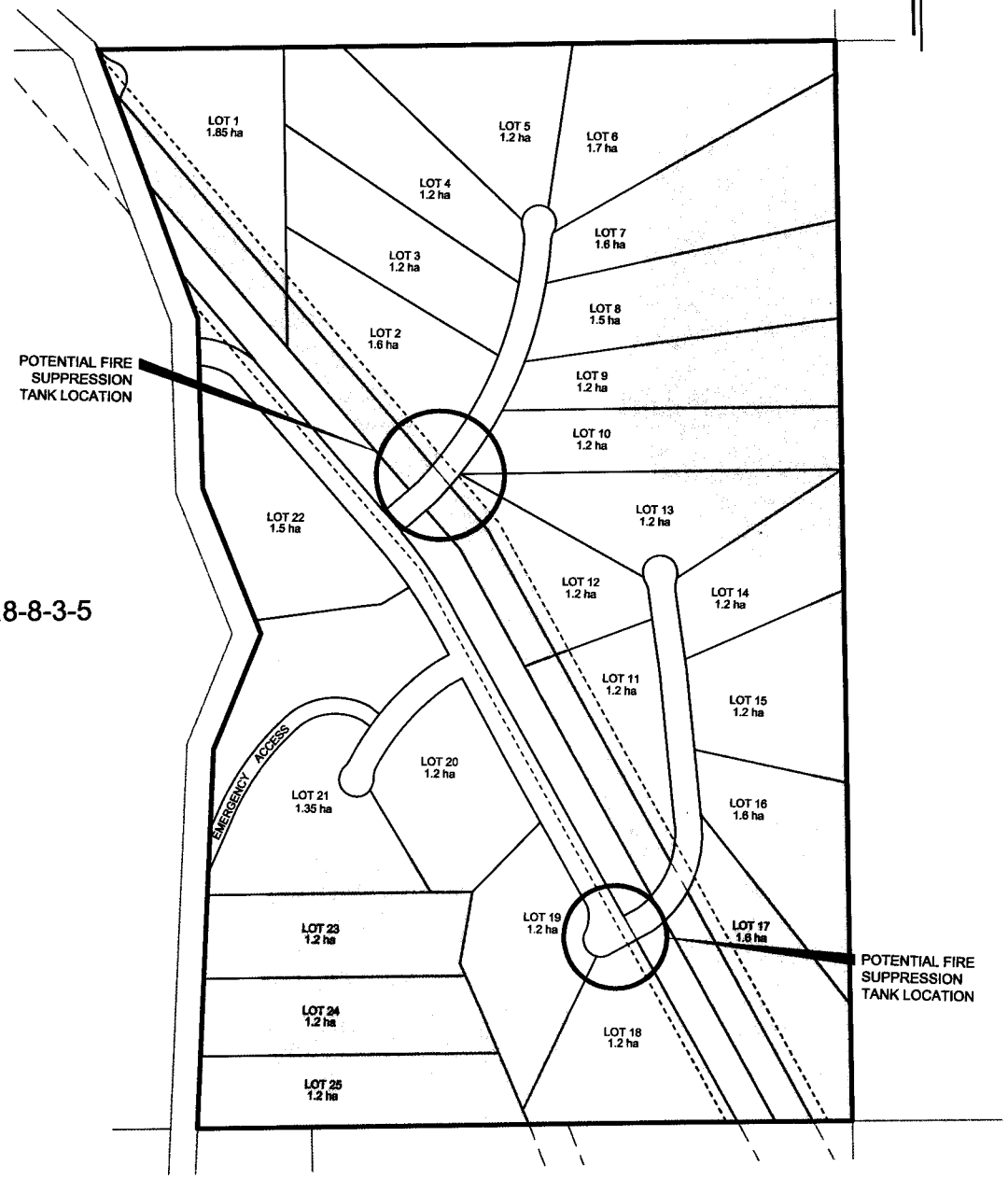
LEGEND

STUDY BOUNDARY	(39.22ha.)	
DEVELOPABLE LAND	(18.36ha.)	
DEVELOPMENT SETBACK	(14.66ha.)	
RESERVE	(3.16ha.)	
CIRCULATION	(3.04ha.)	



FINAL DESIGN SUBJECT TO SUBDIVISION APPROVAL

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Gold Creek - CNP
Area Structure Plan

Development Concept

Figure 4

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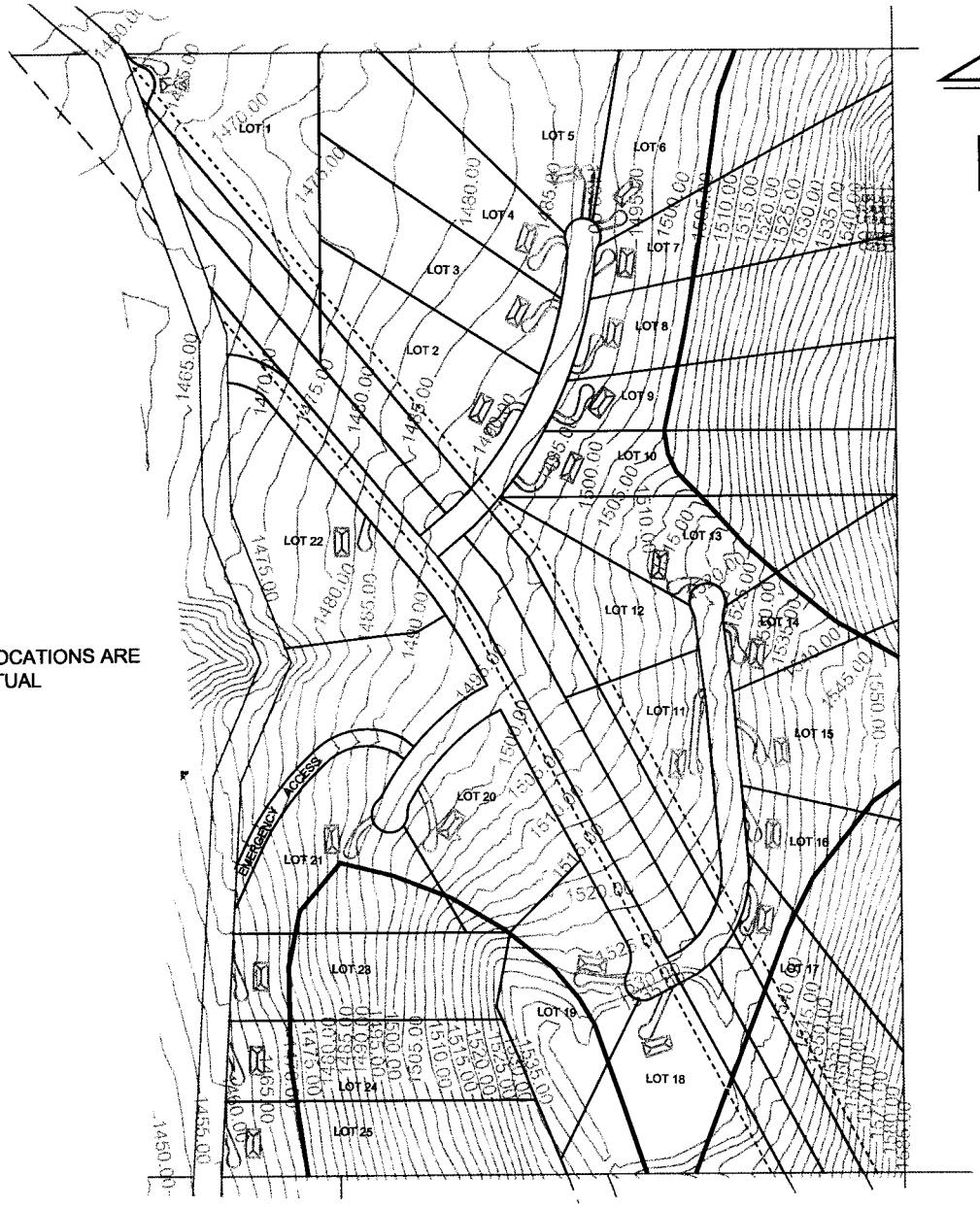
LEGEND

HOUSE

DRIVEWAY

DEVELOPMENT SETBACK



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NOTE:
HOUSE LOCATIONS ARE CONCEPTUAL

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House and Driveway Concept

Figure 5

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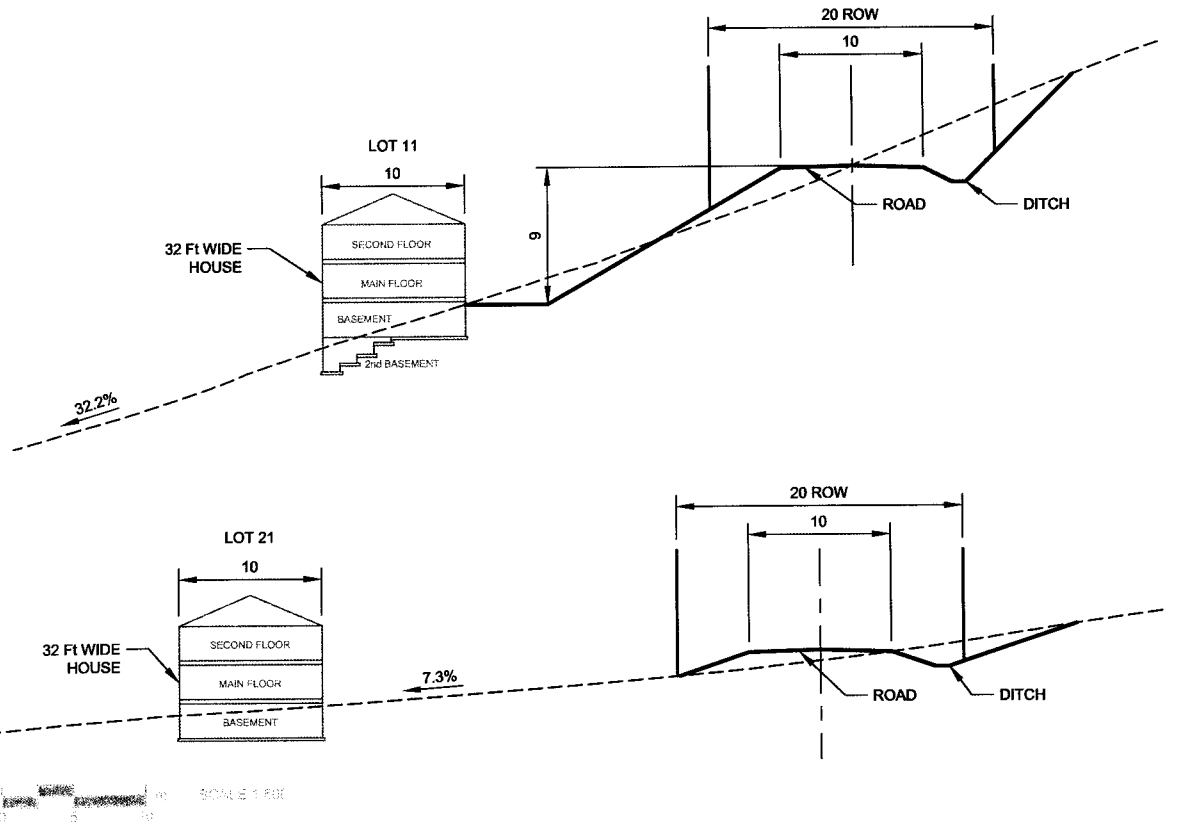

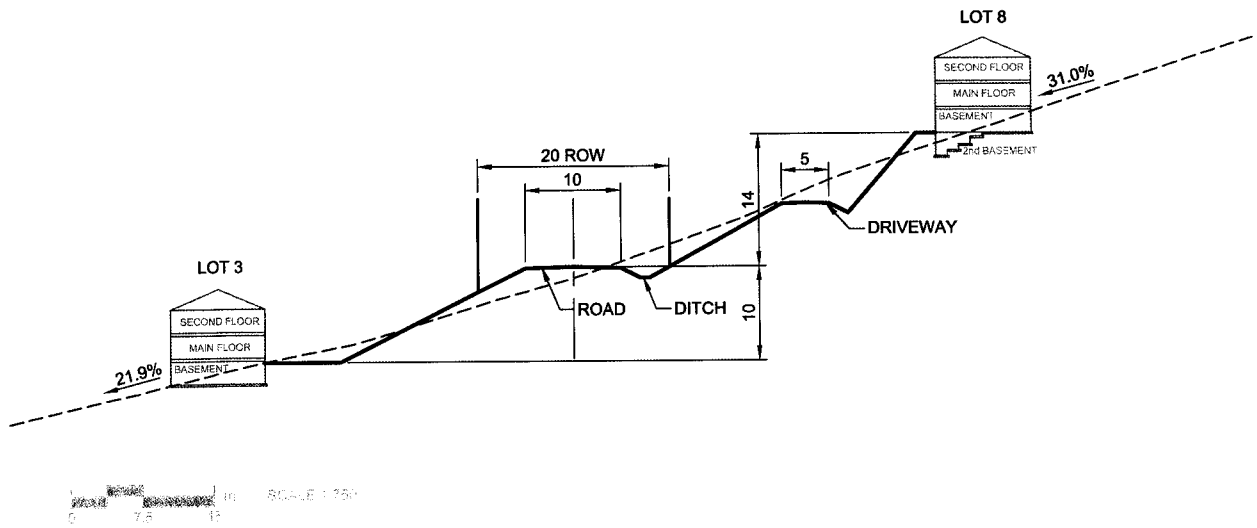

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Gold Creek - CNP
Area Structure Plan

House Cross Sections

Figure 6

5. General Servicing

5.1 Transportation

Access to the Gold Creek development will be provided via the reconstruction of roadway 5524 O (including the segment titled 831 1842). As part of this reconstruction, currently utilised portions of the existing roadway will be upgraded to municipal standard (refer **Figure 7**).

In order to facilitate traffic to and from the development, a minor realignment to roadway 5524 O is proposed within **Figure 8**.

An internal roadway will be developed to municipal standards in anticipation of the right-of-way becoming a road allowance upon subdivision approval. The majority of the lots within the development will be serviced from this internal road. In order to ensure emergency access to the site, two points of access/egress will connect the internal roadway to roadway 5524 O.

Documentation supporting the existence of roadway 5524 O (including the segment titled 831 1842), can be found within **Appendix B**.

5.2 Sanitary

Upon reviewing the Percolation Test Report (**Appendix C**), it is apparent that the variable water table and percolation rates found onsite limit the adoption of a standard onsite sewage treatment system in some areas. Despite these limitations, different technologies exist that can provide alternative sewage treatment options, including:

- store and pump or "holding" tank systems
- prefabricated onsite decentralised collection and treatment systems, also known as Manufactured Sewage Treatment Systems (MSTS)
- septic mounds, and
- traditional septic systems on applicable lots

Notwithstanding the above options, the developer will adopt store and pump tank systems based upon direction received from the Council of the Municipality of Crowsnest Pass in conjunction with geotechnical recommendations from AECOM staff.

5.3 Shallow Utilities

Shallow utilities such as natural gas, power, and telephone are available for extension into the plan area from adjacent lands. Gas, power and telephone lines will be located within the road right-of-way or through easements on private land.

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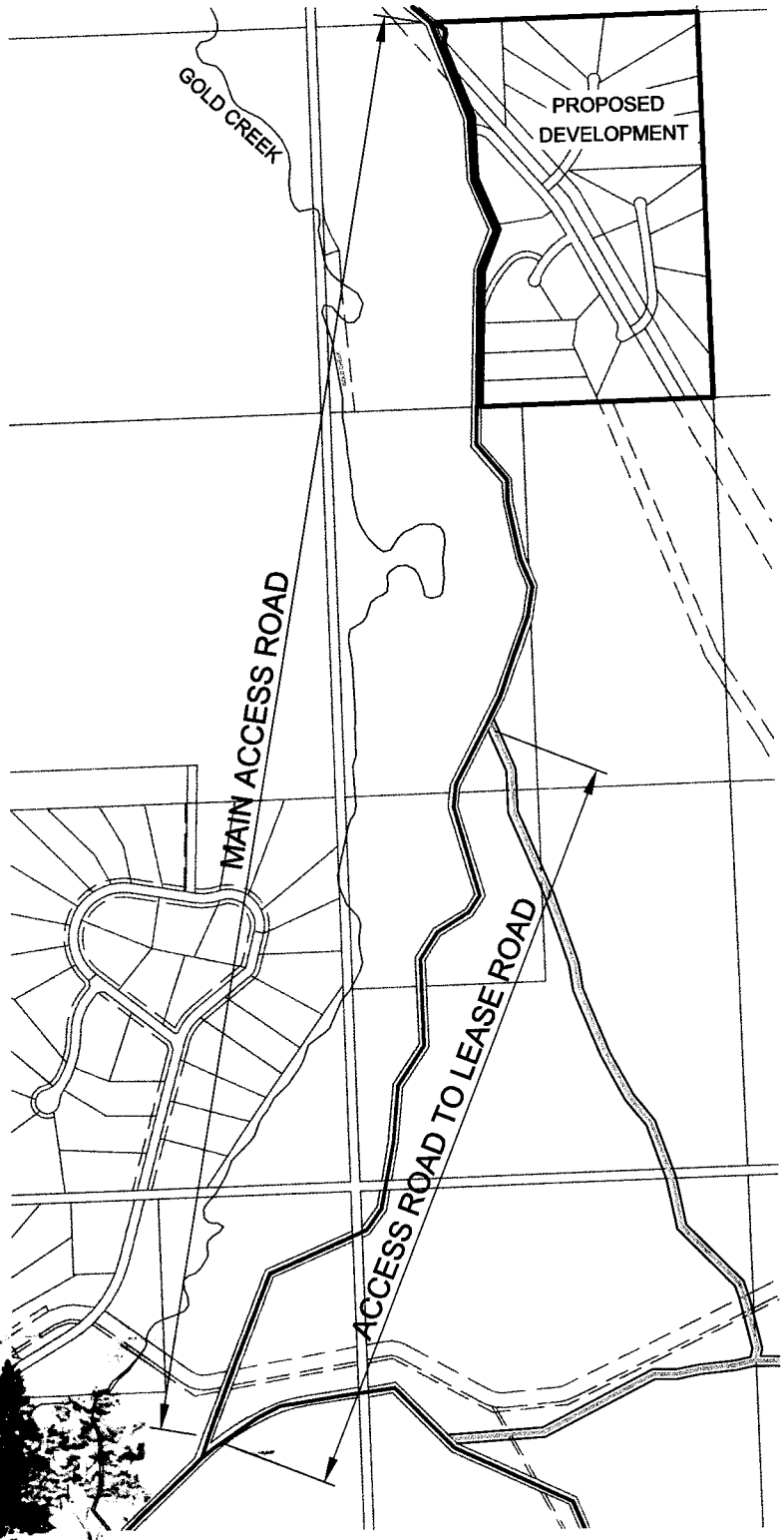
PROPOSED DEVELOPMENT BOUNDARY

EXISTING DEVELOPED R.O.W

UNDEVELOPED ACCESS ROAD

DEVELOPED-PRIVATELY OWNED LEASE ROAD



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Gold Creek - CNP
Area Structure Plan

Access Roadway

Figure 7

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Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Roadway Realignment

Figure 8

6. Stormwater Management

6.1 Overview

The following information has been paraphrased from the Conclusion and Recommendations section of the Stormwater Management Report found within **Appendix D**.

As is typical in rural residential development, all drainage in the Gold Creek development will be overland. The overall storm design for the Gold Creek development was based on the Pincher Creek, Alberta 1:100 year, 24 hour event. Stormwater calculations performed were based on an average imperviousness of 30% due to the steep nature of the flow area for the pre-development 1:100 year storm event. For the post 1:100 year storm event, the imperviousness was assumed to be 80% for the building areas and an average of 35% for the rest gravel and grass areas. For the Gold Creek development, building coverage in the lot areas was assumed to be 2% post development. As such, the overall increase in imperviousness is very small, and this minimal increase does not warrant the installation of a stormwater storage facility. The total runoff volume and peak flow discharge rate from the three inlets increases by 11% and 18% to Gold Creek, with one inlet decreasing and two inlets increasing after the development of the site.

As a result of these findings, it is proposed that a 450 mm Corrugated Steel Pipe (CSP) culvert be installed to replace the existing 300 mm CSP culvert at the outlet B* (refer **Figure 2** within **Appendix D**) due to the development of the site. Where flows are required to cross streets or concrete swales, culverts will be provided depending on the rate of runoff that must be discharged. The road cross-section within the development will be designed to contain runoff resulting from a Pincher Creek, Alberta 1:100 year, 24 hour storm event within the road right-of-way. Where any ponding is predicted to cross onto private property, appropriate restrictive covenants and/or easements will be registered. Runoff flows over the road will not exceed Alberta Environment's depth-velocity guidelines. Where these guidelines cannot be met, runoff will be routed into dedicated open channels.

As well, the existing native vegetation should be retained as much as possible to reduce the possibility of erosion and sedimentation. The overland flow routes should incorporate best management practices to reduce suspended solids entering the downstream system. In addition to this, concentrated discharges will be avoided wherever possible. Where concentrated flows at outfalls cannot be avoided, appropriate engineered armoring should be provided to maintain the channel bed and sides (e.g. rip-rap or geotextiles).

7. Gold Creek Hydrogeological Assessment

7.1 Overview

The following information has been paraphrased from the Conclusions and Recommendations section of the Gold Creek Hydrological Assessment found within **Appendix E.**

Calculations for water level drawdown in the Gold Creek development area show that over a 20 year period the aquifer within the fractured shale of the Blairmore formation will not fall by more than 26 meters. The high elevation re-charge area of the aquifer is large and subject to high levels of precipitation which provide good conditions for a long term water supply in the deep aquifer.

The water tested does not contain measurable levels of fecal or total coliforms. All the parameters to be tested for in routine water chemistry analysis show levels within the Health Canada Guidelines, with the exception of high levels of manganese. Manganese can be treated using simple domestic treatment systems. It should be noted that the removal of manganese is an aesthetic objective, as high levels of Manganese turn clothes grey and do not represent a health concern

The aquifer that the subject well accesses is a confined aquifer, which is indicated by the pressure that can be measured at the well head. The fact that the aquifer is confined and the dip of the bedrock formations indicate that the aquifer is not in hydraulic communication with any surface water flows.

The water quantity is ample for the proposed development, and should not cause an impediment to the project

It is recommended that the water quality be re tested, and if the analysis is consistent with the previous test, that plans are instituted to address aesthetic concerns by installing commercially available devices to remove manganese from the water to conform to the Health Canada Guidelines. Water quality should be tested on an annual basis, as manganese levels may decrease over time due to higher oxygen levels in the water.

Upon commencement of drilling additional wells, the driller should be aware that there could be other aquifers in formations at different depths. If other aquifers are located that may not be in connection with the subject aquifer, the possibility of exploiting these should be investigated separately from this study.

8. Geotechnical Assessment

8.1 Overview

Geotechnical recommendations for the following areas can be found in the Geotechnical Assessment Brief within **Appendix F**:

- General Recommendations
- Slope Related Development Guidelines
- Foundation Recommendations
- Soil Swell Prevention
- Site Drainage
- Sulphate Attack and Corrosion Control
- Excavation
- Backfill

9. Implementation

This ASP will be considered in tandem with an LUB amendment to change the district for the subject parcels from a Non-Urban Area to Grouped Country Residential. Once adopted by Council, the new land use will facilitate residential development on the subject parcels.

The residential development will proceed true to the standard subdivision procedure with signing of development and servicing agreements as a condition of subdivision. The staging of the development will be carried out as per the phasing section within this ASP, with architectural and landscape controls and the provision to utilize low flow fixtures registered as caveats on the subsequent titles.

10. Public Participation

To date the project proponents have actively engaged neighbours throughout the ASP preparation process in order to ensure that any concerns about the development have been addressed.

In addition to this, Alberta Environment was contacted about the hydrological work that would occur onsite.

Finally, the Department of Fisheries and Oceans (DFO) was contacted in order to ascertain if there were any limits to the development due to the proximity to Gold Creek and how to carry out work activities due to this proximity. It was determined that the development's distance from Gold Creek did not negatively impact the creek.

An open house was held on December 8th 2008, recommendations resulting from the open house were incorporated into the ASP.

Reference Materials

The following reference materials were used in the creation of this plan:

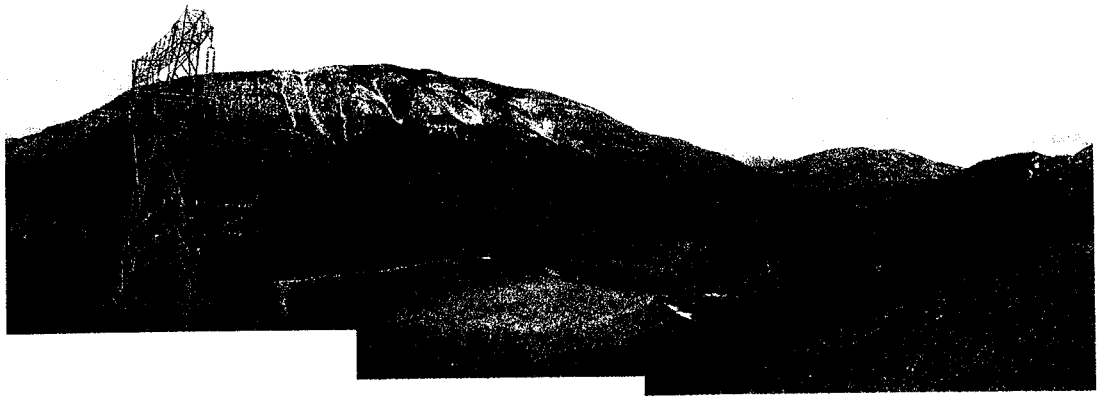
- Alberta Environment "Stormwater Management Guidelines", 1999
- Alberta Sustainable Resource Development, FireSmart Zones; http://www.srd.gov.ab.ca/wildfires/firesmart/zones.aspx
- Bow Valley WildSmart Community Program; http://wildsmart.ca/index.htm
- The Flora and Fauna of the Crowsnest Pass; http://www.uleth.ca/vft/crowsnest/florafauna.html
- The Municipality of Crowsnest Pass Municipal Development Plan Bylaw No. 556/01
- The Municipality of Crowsnest Pass Land Use Bylaw No. 632/04

Appendix A

Historical Resources Impact Assessment

Arrow
Archaeology
Limited

HISTORICAL RESOURCES IMPACT ASSESSMENT
FINAL REPORT



GOLD CREEK SUBDIVISION
SW 1/4 SEC 8-8-3 W5M
FRANK, ALBERTA

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P.O. BOX 27029
LETHBRIDGE, AB T1K 6ZB8

Archaeological Research Permit 2007-089

DON BORAS

September 2008

ACKNOWLEDGEMENTS

The authors would like to thank Cory Armfelt of UMA Engineering for retaining Arrow Archaeology Limited. We would also like to extend our thanks to developers Mike Hoffman and Rick Derricott for their assistance during the preliminary survey.

Cover Photo: Panoramic view of development area from SE corner.
Undeveloped well pad near centre of frame to right of transmission tower.

Report Authors Don Boras

MANAGEMENT SUMMARY

This report summarizes the results of a Historical Resources Impact Assessment (HRIA) undertaken by Arrow Archaeology Limited for UMA Engineering (agent for Livingston Ventures Ltd.) of Lethbridge, Alberta. The HRIA examined a proposed subdivision development ca. 3.7 km northeast of the community of Frank in the Municipality of Crowsnest Pass. The legal description and size of the development follows:

Gold Creek Subdivision
LSDs 3, 4, 5 and 6 S8 T8 R3 W5M

The proposed subdivision is located along the west-face of the Livingston Range on sloping terrain ca. 500 m east of Gold Creek in the Crowsnest Pass region of southwestern Alberta. Roughly 45 ha. will be impacted.

The HRIA was triggered by lands with Historical Resource Values of 3, 4 and 5 (archaeology, history) in the Section overlapped by the proposed development, although there were no previously identified sites located in within the development footprint.

No previously unidentified historical, archaeological or palaeontological resources were discovered during this survey.

Recommendation

We recommend that clearance under the *Historical Resources Act* be granted for this project. No additional archaeological, historical or palaeontological exploration or mitigation work is recommended or required in the areas that will be impacted by the proposed development.

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INTRODUCTION

Personnel from Arrow Archaeology Limited conducted an Historical Resources Impact Assessment (HRIA) under Permit 2007-089 in the summer of 2008. Don Boras was permit holder and conducted the fieldwork, assisted by archaeological technician Dave Hastie. The HRIA covered a proposed subdivision development located approximately 3.7 km northeast of the community of Frank in the Municipality of Crowsnest Pass. The names and legal descriptions and Historical Resource Values of areas overlapped by the development are listed below:

LSD 3 S8 T8 R3 W5M	HRV 3 (A), 4 (A), 5 (A)
LSD 4 S8 T8 R3 W5M	HRV 3 (A), 4 (A, H), 5 (A)
LSD 5 S8 T8 R3 W5M	HRV 3 (A), 4 (A), 5 (A)
LSD 6 S8 T8 R3 W5M	HRV 3 (A), 4 (A), 5 (A)

Total impacted area – ca. 45 ha.

This HRIA was completed for:

UMA Engineering Ltd.
514 Stafford Drive North
Lethbridge, AB T1 H 2B2
Contact: Cory Armfelt, Regional Manager, Land Use Planning

The HRIA was triggered by lands with Historical Resource Values of 3, 4 and 5 (archaeology) and 4 (history) in the areas overlapped by the proposed development.

The HRIA was intended to locate and assess historical resources within or adjacent to the proposed well site and access road developments and provide recommendations for avoidance, mitigation and preservation of any such resources. The survey for historical resources included a search for fossils and fossiliferous bedrock.

This final report presents the results of the Historical Resources Impact Assessment, provides background data, describes the project, reports on methodologies employed and makes recommendations regarding historical resource impacts.

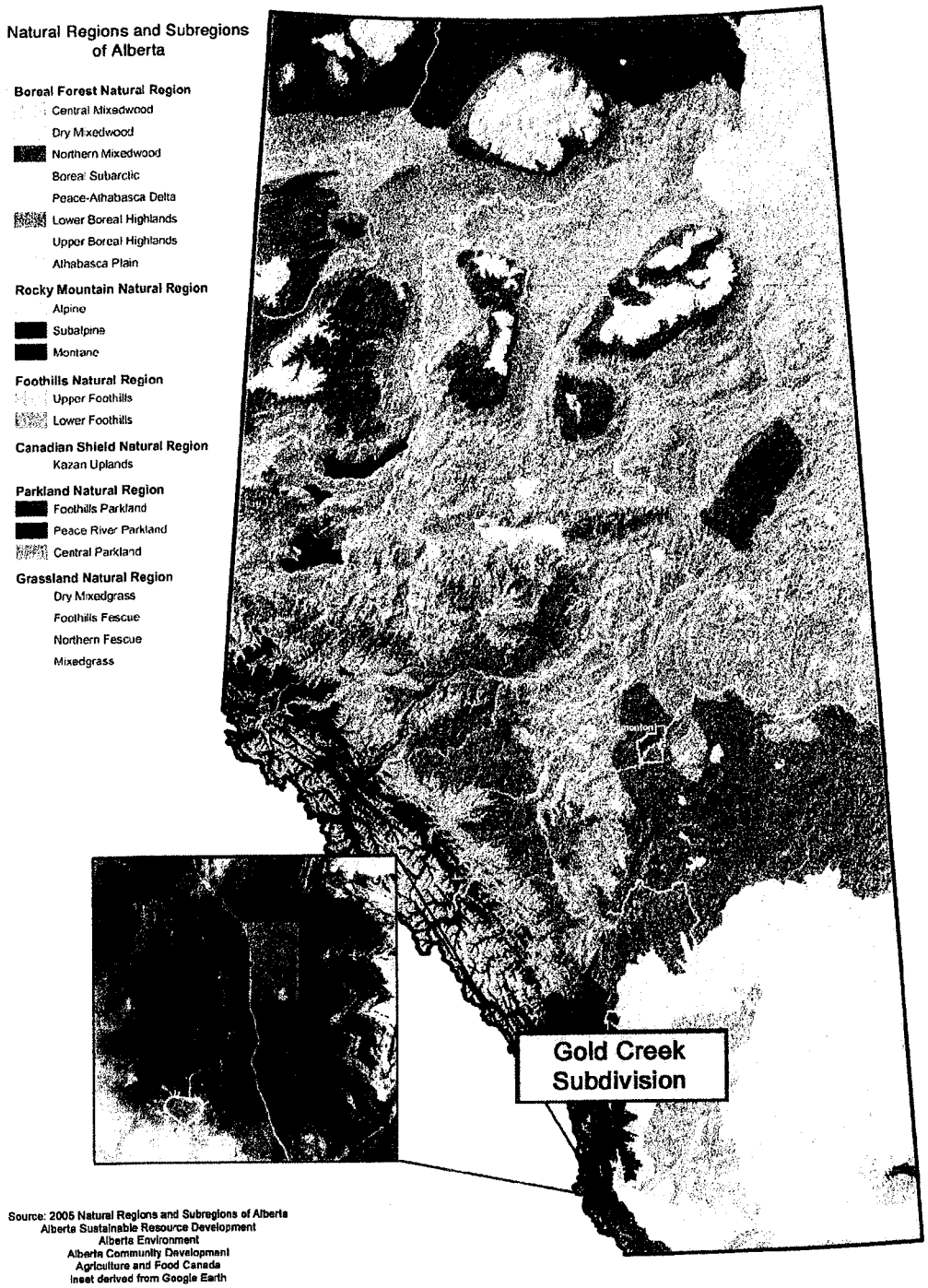


Figure 1. Map of development in relation to Natural Regions of Alberta.

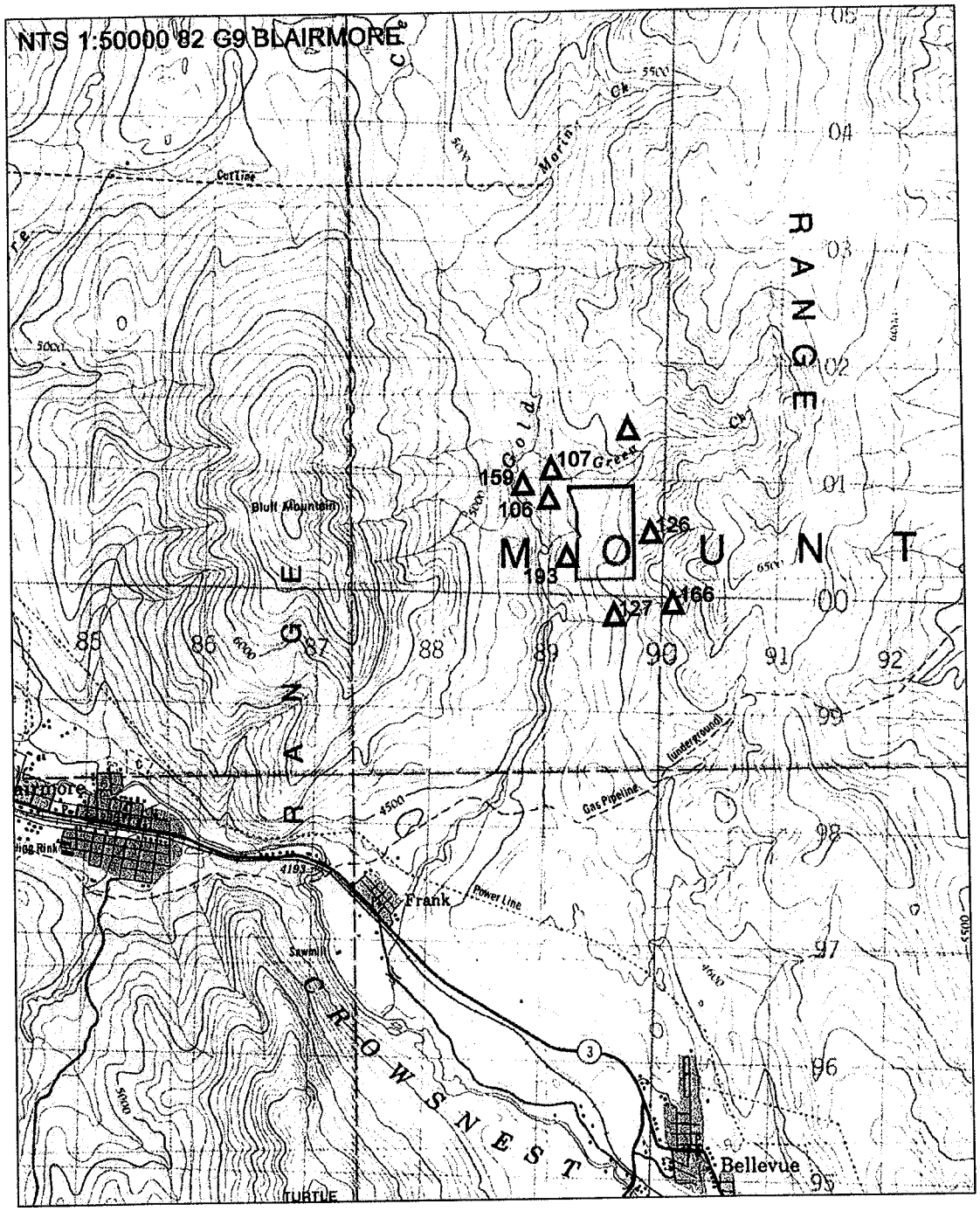


Figure 2. General location of proposed Gold Creek subdivision, located in Borden block DjPo. The yellow triangles indicate the locations of nearby archaeological sites and their Borden numbers.

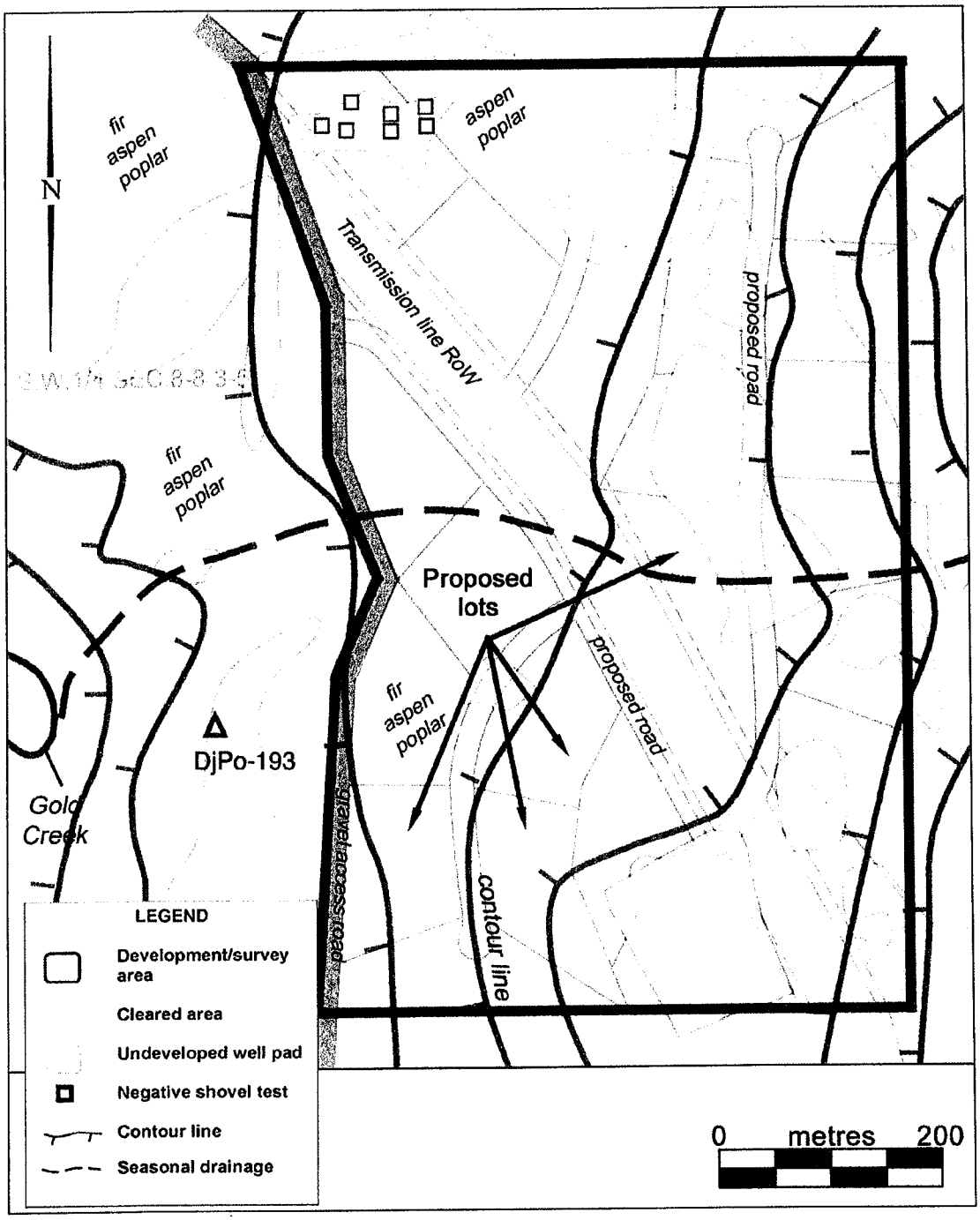


Figure 3. Survey map of proposed Gold Creek subdivision and access roads showing location of shovel tests conducted during this survey. The location of nearby site DjPo-193 is also indicated.

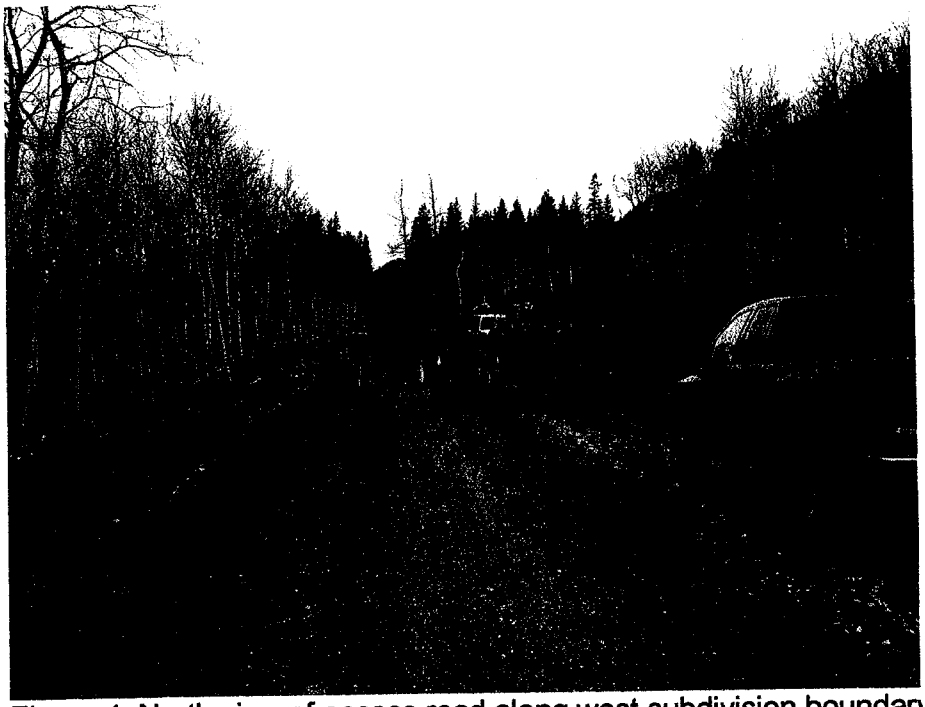


Figure 4. North view of access road along west subdivision boundary.

Figure 5. South view showing typical west-facing slope in southern portion of development.

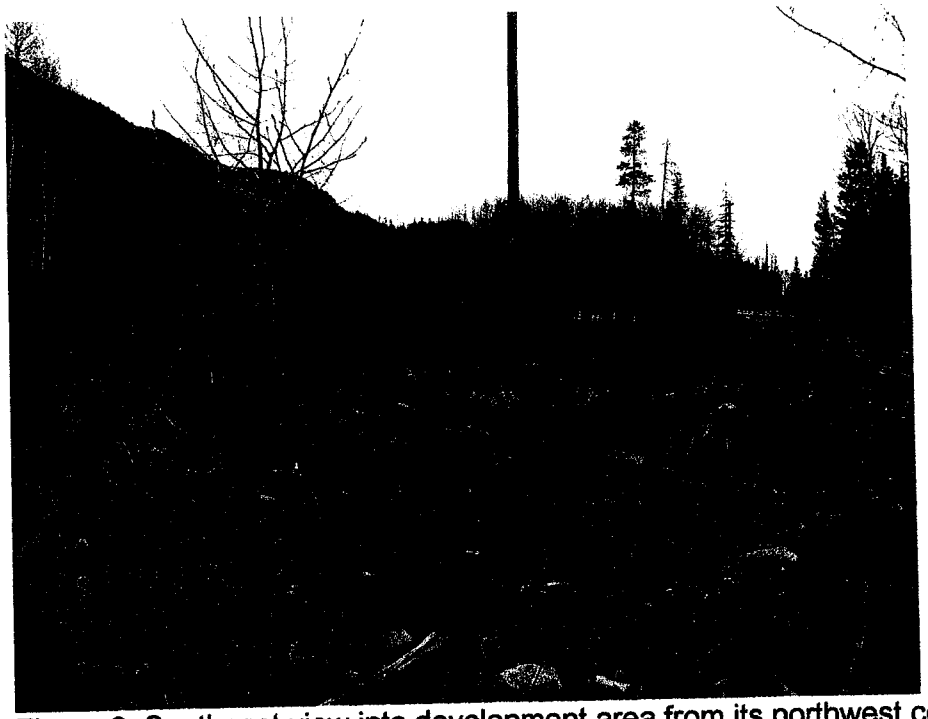


Figure 6. Southeast view into development area from its northwest corner.

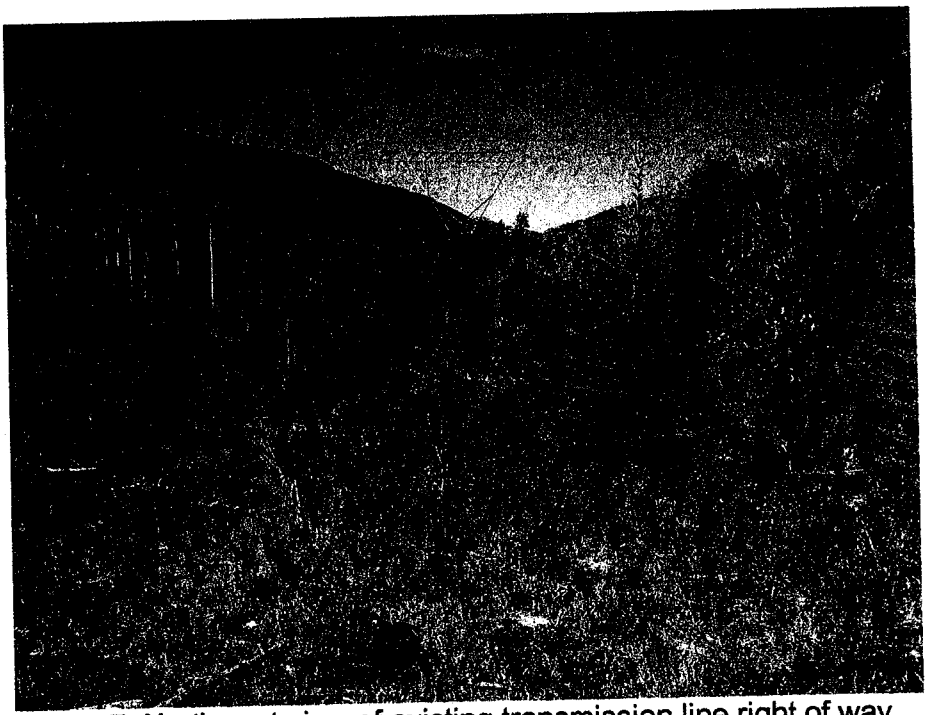


Figure 7. Northwest view of existing transmission line right of way.

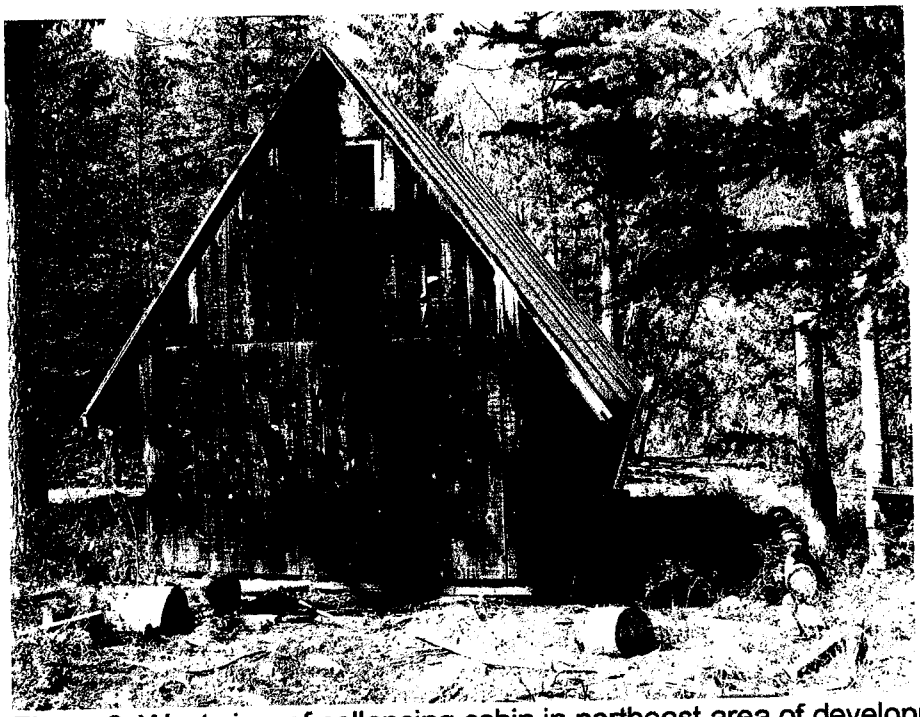


Figure 8. West view of collapsing cabin in northeast area of development.

Figure 9. Bricked fire-pit associated with cabin in Figure 8.

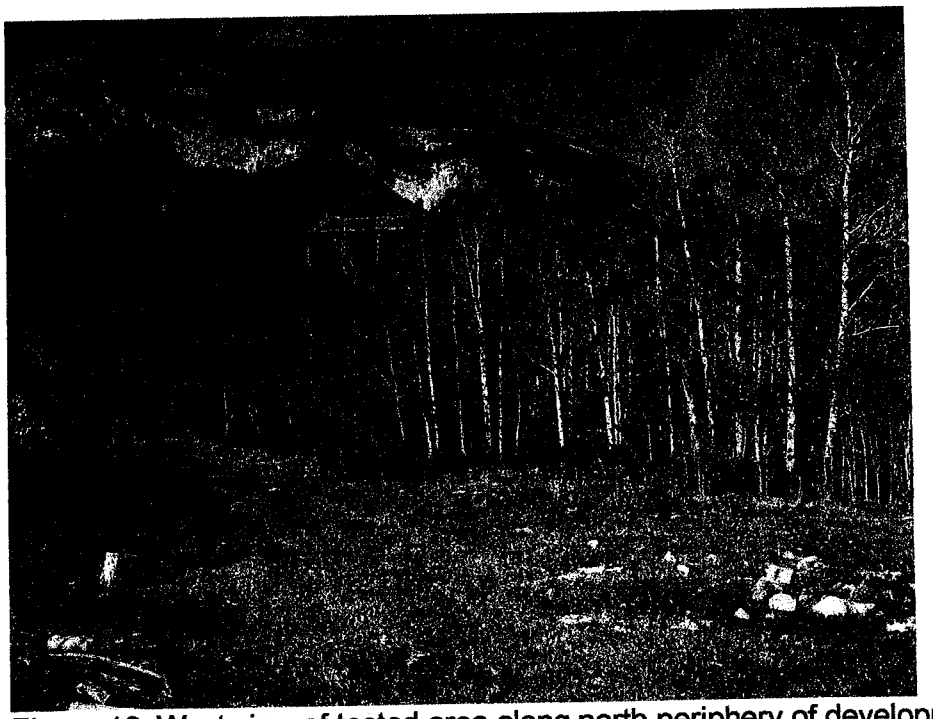


Figure 10. West view of tested area along north periphery of development. Modern hearth visible in lower right corner reflects ongoing recreational use of area.

ENVIRONMENTAL AND CONTEXTUAL DATA

Land Use

The proposed development is located in an intermontane valley area that has already seen significant development. A 50 m swath has been cleared along a major power transmission line right of way that cuts diagonally across the proposed subdivision area from its northwest to southeast corner; several large steel transmission line towers are located within the development area. A roughly 1.6 ha (ca. 140 x 115 m) undeveloped well pad owned by Talisman Energy of Calgary is located along its southeast boundary. The pad has been excavated to ca. 4-5 m below the surrounding terrain, and plans are to use it as a staging area for road construction prior to eventual reclamation (*pers. com* Mike Hoffman). There are large, cleared tracts throughout the development area associated with road development and recreational use; numerous private recreational properties are located in the immediate area. A road connecting to Highway 3 at the town of Frank ca. 4 km southwest provides access to the area. The newly refurbished Frank Slide Interpretive Centre is located ca. 3.2 km south.

Project Description

The proposed subdivision involves the development of ca. 25 serviced lots of about 1.2 ha (2 acres) in size, including road construction and upgrades of existing roads. The development area overlaps roughly 70% of the SW 1/4 of Section 8 Twp 3 Rng 3 W5M, extending ca. 800 m along the west-facing valley slope overlooking Gold Creek. The development overlaps one significant west-flowing tributary of Gold Creek, as well as several seasonal drainages; another tributary, Green Creek, is located just outside its northern boundary. The development will involve topsoil removal, scraping and leveling for the proposed lots and access roads, as well as subsurface disturbance associated with foundation and basement construction.

General Description of Project Area

The proposed subdivision is located within the Crowsnest Pass as the area is defined geographically and geologically. The Crowsnest Pass is a significant west to east trending valley and pass running through the Front Range of the Rocky Mountains. This project is located near the eastern end of the Pass, approximately 23 km east of the continental divide and 17 km east of Crowsnest Lake. The area is roughly 14 km east of where the north to south trending Allison Creek Valley empties into the Crowsnest Valley. Allison Valley is notable geologically because it divides the Palaeozoic High Rock Range from Crowsnest Mountain, the upper portion of which is Palaeozoic limestone and the lower portion of which is Mesozoic sandstones and shales. The older rock overlying younger material on Crowsnest Mountain is due to low angle reverse faulting commonly referred to as a thrust fault. Crowsnest Mountain is part of the Lewis Thrust (Beaty 1975). Arguably, the most historically significant geological feature in the area is Turtle Mountain, the site of a massive rockslide in April 1903 that destroyed the eastern portion of the mining town of Frank, AB. One of the dominant geological structures of Turtle Mountain is the Turtle Mountain anticline (the other is the Turtle Mountain Thrust), a break-thrust fold comprised of extensively fractured rocks, notably Palaeozoic carbonates. A recent EUB study suggests that slope failure could eventually result in another major rockslide towards Bellevue (Langenberg et al 2007).

The subdivision area is roughly 16 km southeast of Crowsnest Mountain and is located east of Gold Creek, a relatively short drainage that flows into the Crowsnest River ca. 4.7 km southwest. Over time, glacial processes, running water and gravity have moved material from north to south and this material has been deposited within the creek valley, resulting in surface and near surface sediments that include pebble and cobble-sized rocks of Palaeozoic limestone, Cretaceous sandstones and other glacially transported materials such as conglomerates and quartzites.

The development is located in the valley between the Livingston and Blairmore Ranges. Terrain overlapped by the development ranges from steeply sloping to some areas of level to sublevel ground. The elevation of the survey area varies from approximately 1480 to 1550 masl ascending ca. 70 m from north to south within the development area. Local topography is the result of the complex interaction of folding and faulting of the underlying bedrock, including the effects of the Lewis Thrust, Pleistocene Epoch cordilleran glacial and periglacial processes and Holocene Epoch alluvial and colluvial processes. Local bedrock is primarily eroded Mesozoic Age sandstones and shales. Older more resistant (Palaeozoic) limestone cobbles and boulders are common in the area and are derived from the Lewis Thrust process described above. The softer Cretaceous shales that are part of the local Mesozoic bedrock are visible in exposures near the project area, but are rare as cobbles or other clasts at or near the surface. There are some bedrock exposures along Green Creek to the north of the subdivision. Local topography is a function of a combination of the shape of the underlying bedrock, uneven morainal surfaces and/or local fluvial processes.

Soils and near surface sediments within the survey area are variable depending upon vegetation, their catenary position and the depth of bedrock. Some areas have moderately developed dark brown to black Chernozems and other areas have Brunisols, while soils under stands of spruce and Douglas fir have Podzolic profiles. These classifications are based on the definitions of these soils in *The Canadian System of Soil Classification* (Agriculture Canada Expert Committee on Soil Survey, 2nd Ed., 1987). In general, the surface and near surface sediments are stony with gravel to cobble sized clasts very common at and near the surface.

The proposed subdivision overlaps west-sloping terrain to the east of Gold Creek. Large expanses have been cleared for energy development, road construction and recreational use. As noted, there is a large, abandoned well pad in the southeast portion of the development

Vegetation

The general area, including the survey area is part of the Montane Natural Subregion, the largest portion of which spans the lower elevations along the eastern slopes of the Rocky Mountains (Downing and Pettapiece 2006), including the Crowsnest Pass and portions of the southern Alberta foothills between ca. 1250 and 1700 metres above sea level. Specific ecological conditions in this region vary due to local topography, surficial geology, and microclimates along the eastern slopes and in the foothills of the Rocky Mountains.

Natural vegetation in the project area is variable with stands of trees interspersed with grassed areas. The dominant coniferous tree in the area is *Pseudotsuga menziesii* (Douglas fir), often found with stands of *Pinus flexilis* (limber pine) along upper slopes and rocky ridges. *Populus tremuloides* (aspen) is also common. Picea glauca (white spruce), *Populus balsamifera* (balsam poplar), *Alnus tenuifolia* (river alder) and *Salix* ssp. (willows) are typically found in moister areas. Other vegetation in the area includes *Juniperus communis* (common juniper), *Shepherdia canadensis* (soopolallie; a.k.a. bearberry or buffalo berry), *Anemone patens* ssp (prairie crocus), *Arctostaphylos uva-ursi* (kinnikinnick), *Rosa acicularis* (prickly rose) and *Cirsium arvens* (Canada thistle). Common grasses include *Festuca scabrella* (rough fescue) *Calamagrostis rubescens* (pinegrass) and some *Stipa* species (needle grasses) (Downing and Pettapiece 2006, Looman 1982).

Fauna

Culturally important fauna in the general area in the relatively recent past would have included *Odocoileus virginiaus*, (white-tailed deer), *Odocoileus hemionus* (mule deer) *Alces alces* (moose), *Rangifer tarandus* (woodland caribou), *Ursus americanus*, (black bear), *Ursus arctos* (grizzly bear), *Ovis canadensis* (bighorn sheep) *Cervus elephus* (wapiti), *Canis latrans* (coyote), *Canis lupus* (wolf) as well as other large and small mammals. The area would have supported grazing bison (*Bison bison*) herds in the past

Previous Archaeological Studies

The project is located in Borden Block DjPo. Prior to this survey, 207 sites had been recorded in this block, including 57 campsites, 17 workshops, 17 artifact scatters, 17 settlements, 15 quarries, 14 isolated artifact finds, 12 stone features, 11 mines, eight homesteads, six town sites, five kill sites, three structures, two kill site/settlements, two industrial, and single farm, police post, railroad, road, burial, rock shelter, rock art and dump sites. There are also four palaeontological sites. Some of the significant historical sites in the area include the Frank Slide Provincial Historic site (DjPo-39), the Greenhill Mine site (DjPo-38), the Village of Lille, (DjPo-112), Mohawk Collieries and Mine (DjPo-119), the Frank zinc smelter (DjPo-122), and Livingstone Quarry No. 1 (DjPo-137). There was one site in close proximity to the current project: DjPo-193 – an isolated point find located west side of the access road delineating the southwestern boundary of the development. This site was not revisited during this survey.

The Glenbow Museum recorded DjPo-1 and 2 in the 1960s, while the University of Calgary documented 134 additional sites during the 1970s. Most of the subsequent sites were recorded under the auspices of industry and government HRIAs.

RESEARCH STRATEGY AND METHODOLOGY

The general research strategy was outlined in the permit application submitted to and approved by Historic Resources Management, Alberta Department of Culture and Community Spirit,

Prior to conducting fieldwork, an archival search was conducted to determine the presence of recorded historical resources in the area and topographic maps were examined to determine the presence of landforms considered to have high potential to contain archaeological or other historical resources.

Site discovery procedures consisted of 100% coverage of the proposed development site via pedestrian and ATV survey. The survey was conducted in

two parts: a preliminary ATV and pedestrian survey done in cooperation with developers Mike Hoffman and Rick Derricott and UMA manager Corey Armfelt on May 5, 2008, and more detailed study of earmarked areas with archaeological potential conducted by Boras and archaeological field technician Dave Hastie during subsequent field visits in the summer of 2008. Surface visibility ranged from poor (patchy snow cover at the time of the initial survey precluded detailed surface examination in some areas) to excellent (adjacent to the abandoned well pad, the cleared recreational areas and along the transmission line right of way).

Natural and artificial exposures such as roads, animal trails, creek banks and erosional surfaces were examined. Seven 40 x 40 cm shovel tests were conducted along a parallel pair of low, north-facing benches overlooking Green Creek at the north end of the property. Backdirt from these tests was screened through 6 mm mesh. Based on our observations and the results of these tests, our opinion is that there is little possibility of deeply buried cultural materials in the non-tested areas.

The nature of the local geomorphological conditions and natural and artificial exposures indicate that the conducted examination was, in our opinion, sufficient to detect and locate buried historical resources. The field surveys also included a search of the areas for palaeontological resources and/or fossiliferous bedrock.

The proposed development and surrounding areas were photographed.

RESULTS AND RECOMMENDATIONS

The following results and recommendation cover both the archaeological and palaeontological surveys that were conducted for this site.

The proposed development overlaps surfaces that have been altered by glaciofluvial and some Holocene aeolian processes as well as recent mechanized human activity. Based on creek slope exposures, the bedrock is within 10 to 60 cm of the surface, but may be deeper in some areas.

Seven shovel tests were conducted along two level to semi-level benches in a previously cleared area immediately adjacent to the development's northern boundary. These confirmed high levels of subsurface disturbance – reflected by a button, modern nails, a wire spring and a carpet tack found at depths of 10-30 cm in an apparent dump area. Clay/till layers were encountered at depths of 35-70 cm, with the thicker soil layers associated with tests closest to Green Creek. A wooden bridge across a nearby drainage, deteriorating cabin, bricked firepot, embedded cinderblock walkways and a recently constructed privy indicated that the area continues to be the site of extensive recreational use. This was further underscored by the disappearance of an outhouse that had been present at the time of the initial survey as well as the presence of several modern trailers and associated semi-permanent camping structures in a treed area on the north side of Green Creek. With no snow cover and excellent surface visibility during the September 11, 2008 survey, the extent of bulldozed access trails and disturbed nature of the cleared terrain in this area was clearly evident. The high degree of previous disturbance precluded the need for further subsurface testing.

Walking along the transmission line route revealed similar conditions: extensive mechanical clearing associated with significant accumulations of wooden and stone debris. The powerline route also reflected the generally sloping nature of the terrain, which descended towards the valley floor at 7-10°, consistent with conditions observed in the remaining treed areas. Surveys in the central and southern portions of the development area revealed similar conditions, with increasing slopes and recent disturbance reflecting its minimal archaeological potential.

No new archaeological sites were identified during the survey, and no palaeontological specimens or sites were located in or near the development area.

Recommendation Summary

No additional archaeological, historical or palaeontological investigation is recommended or required within the areas to be impacted by the proposed development. We therefore recommend that clearance under the *Historical Resources Act* be granted for this project, and that it be permitted to proceed as currently planned.

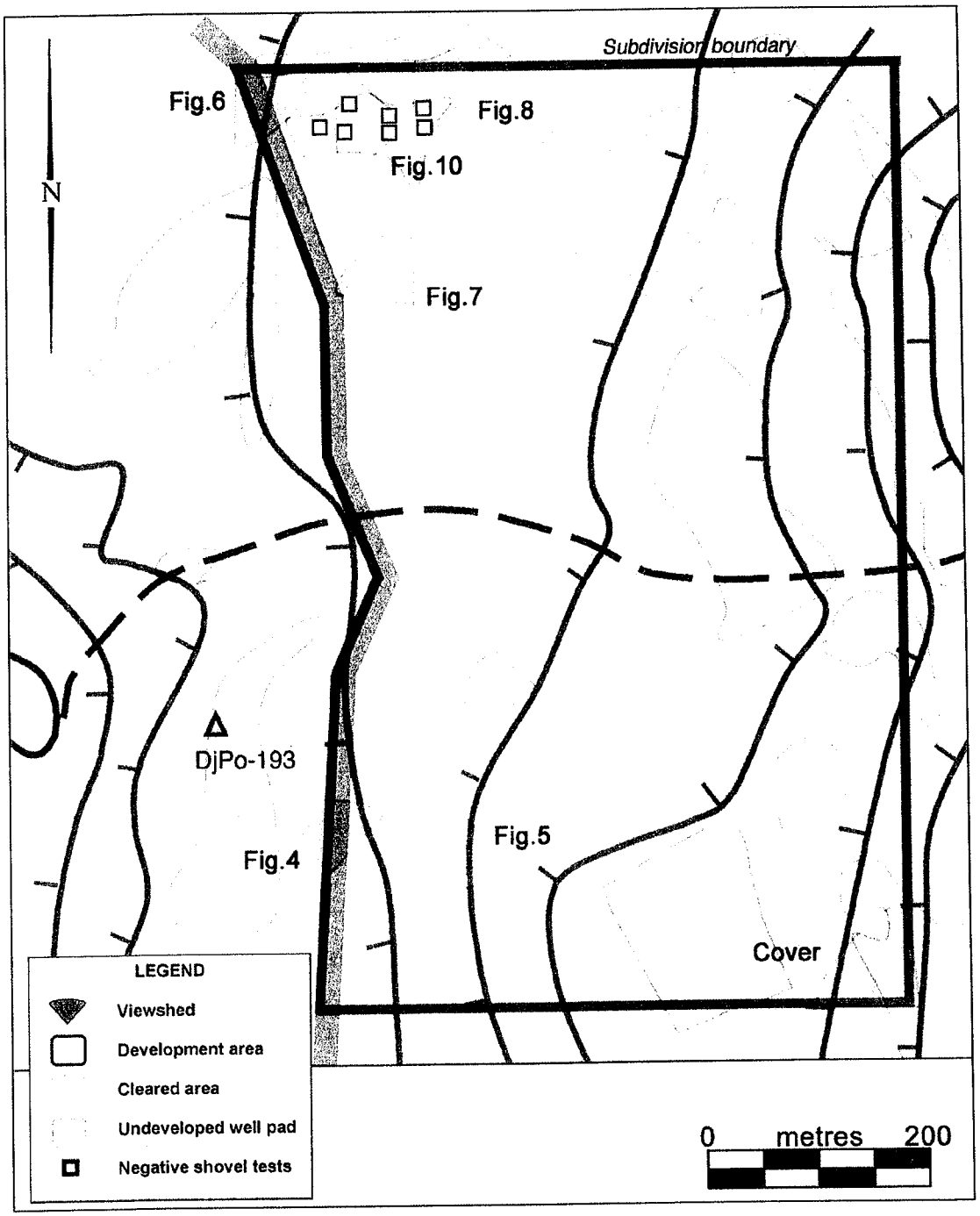


Figure 11. Viewshed map of photographs included in this report.

REFERENCES CITED

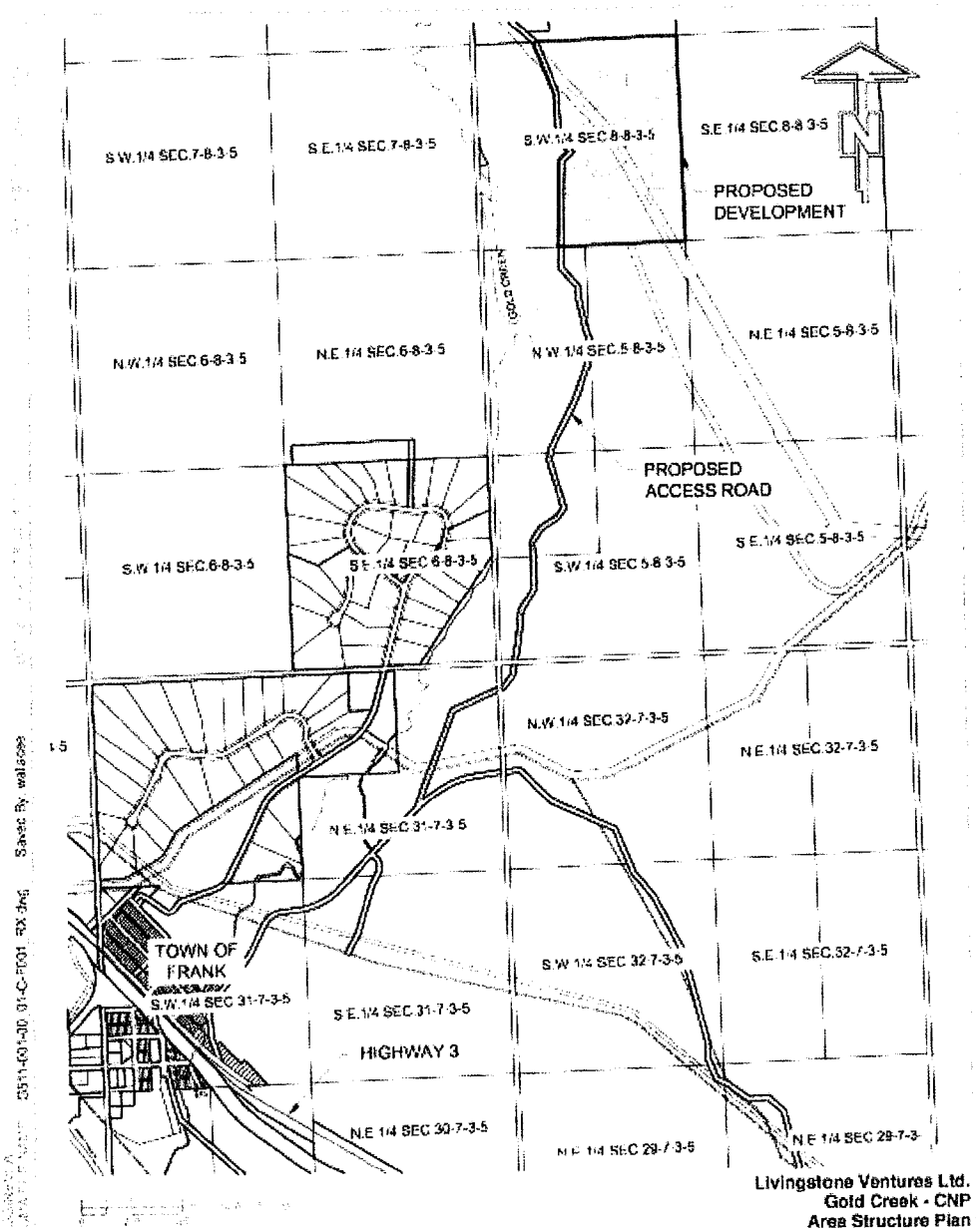
Agriculture Canada Expert Committee on Soil Survey
1987 *The Canadian System of Soil Classification*, 2nd ed., Research Branch, Agriculture Canada, Ottawa.

Langenberg, C. W., D. Paña, B. C. Richards, D. A. Spratt and A. Lamb
2007 *Structural Geology of the Turtle Mountain Area near Frank, Alberta. EUB/AGS Earth Sciences Report 2007-03.* Alberta Energy and Utilities Board, Alberta Geological Survey, Edmonton, AB

Looman, J.
1982 *Prairie Grasses Identified and Described by Vegetative Characters.* Agriculture Canada Publication 1413, Ottawa.

Downing, D.J and W.W. Pettapiece
2006 *Natural Regions and Subregions of Alberta.* Natural Regions Committee 2006. Government of Alberta. Pub. No. T/852

APPENDIX A –Survey Plans

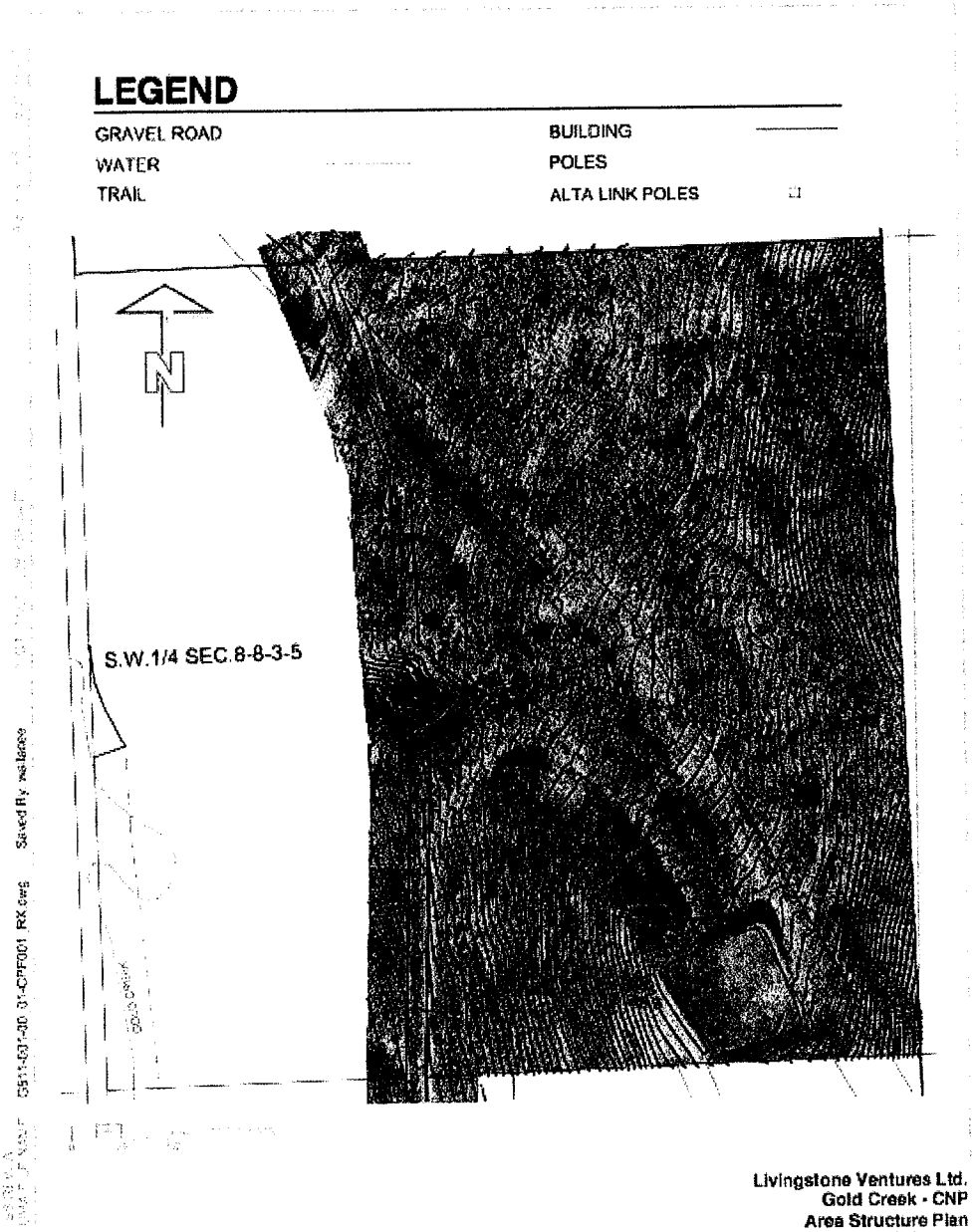


Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

General Location

UMA

Figure 1



Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Existing Conditions
Site Plan
Figure 1

UMA

Appendix B

Roadway 5524 O Supporting Information

brown okamura & associates ltd.

STREET ADDRESS: 514 STAFFORD DRIVE N., LETHBRIDGE, ALBERTA T1H 2B2
MAILING ADDRESS: P.O. BOX 655, LETHBRIDGE, ALBERTA T1J 3Z4

TELEPHONE: (403) 329-4688
FAX: (403) 320-9144

January 13, 2009

TO WHOM IT MAY CONCERN

This is to advise that Road Plan 5524 O located in W ½ Sections 5 and 8, Township 8, Range 3, West 5 Meridian and N.W. ¼ Section 32, Township 7, Range 3 West 5 Meridian in the Municipality of Crowsnest Pass was registered in Land Titles records on May 8, 1906.

A search of Land Titles records on January 13, 2009 indicates an exception for Road Plan 5524 O on the Certificate of Titles for each of the quarter sections affected by the road plan. This confirms that Road Plan 5524 O is as of today's date in Land Titles Office records as a public road and under the administration and control of the Minister of Transportation.

Yours very truly,

BROWN OKAMURA & ASSOCIATES LTD.

R.F. Baker, ALS

File 4145

PLAN

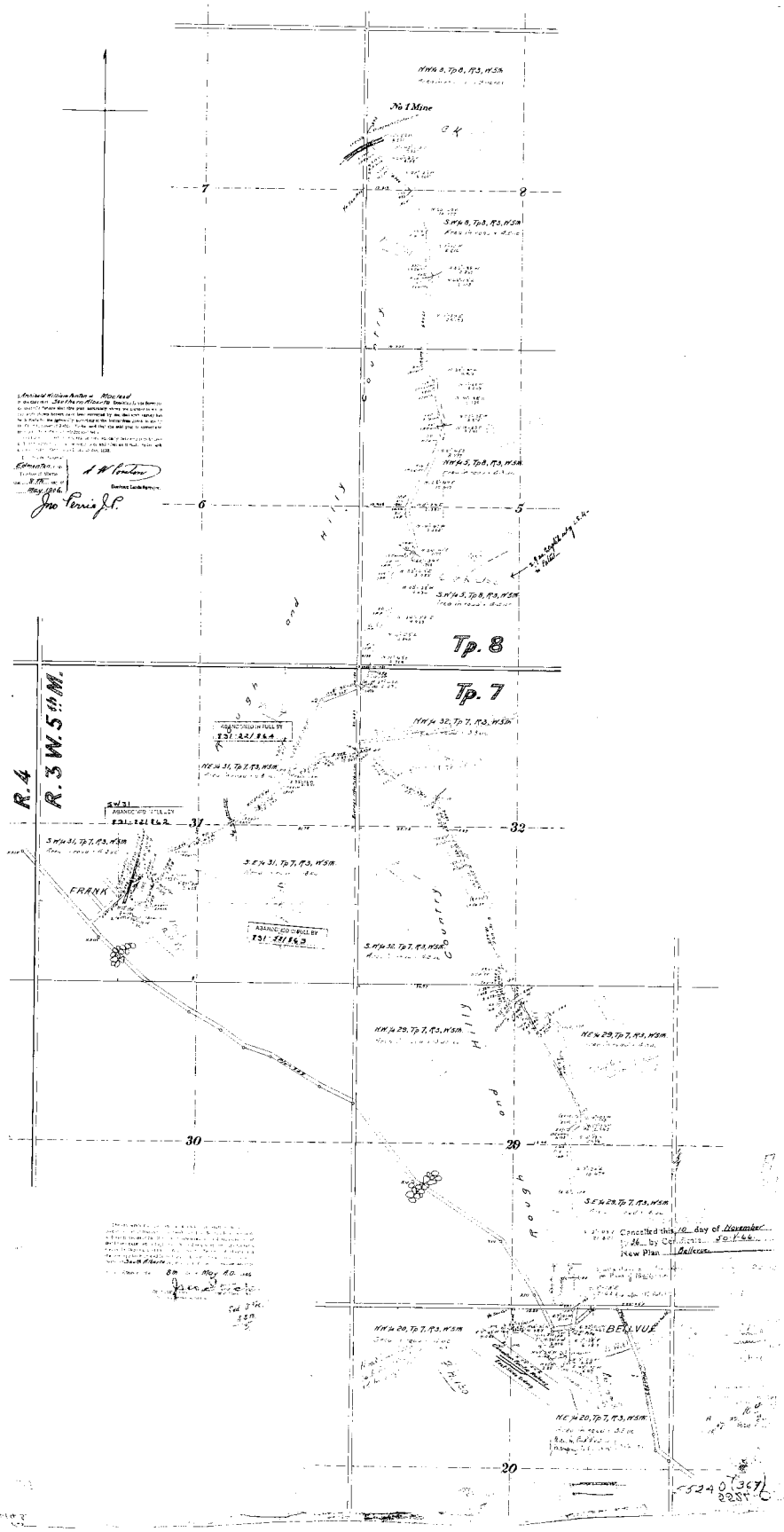
SHEWING SURVEY OF NEW ROAD

IN

Tps 7 & 8, R3, W5th M.

1905.

Scale 8 ch = 1 inch — by A.W. Ponton, D.L.S.



Alberta Spatial Information System

11:54AM Monday January 12, 2009

Appendix C

Percolation Test Report

UMA | AECOM

UMA Engineering Ltd.
514 Stafford Drive North
Lethbridge, AB T1H 2B2
T 403.329.4822 F 403.329.1678 www.uma.aecom.com

August 21, 2008

File Name: G511-001-00 4.4

Mr. Mike Hoffman
Livingstone Ventures Ltd.
3885 9th Ave North
Lethbridge, AB T1H 6G6

Dear Mr. Hoffman:

Re: Percolation Testing for On-site Wastewater Treatment System Evaluation Gold Creek Subdivision – SW ¼ 8-8-3-W5M

As per your request, UMA Engineering Ltd. conducted percolation testing on July 15 and 16, 2008, to evaluate the potential for the use of standard on-site treatment (septic) systems for the proposed subdivision known as Gold Creek.

Scope of Work

The purpose of the testing was to establish general percolation rates and water table levels for the design of on-site wastewater treatment systems (septic fields) for the proposed subdivision located at SW ¼ 8-8-3-W5M. The data is intended to establish field conditions and to evaluate the potential for the use of standard septic field type private sewage systems across the proposed site. Where favorable conditions prevail, general system design criteria for installation of these systems would also be developed.

UMA conducted eight percolation tests on selected lots across the proposed subdivision. The tests consisted of installing 0.20 m diameter test holes to a depth of 0.9 m to perform standard percolation tests. A second 3.0 m deep test hole was installed and fitted with slotted standpipe style piezometers to determine water table depth at each test location. Test procedures were conducted according to the Alberta Private Sewage Systems Standard of Practice (Alberta Municipal Affairs 1999). This publication will be referred to as "the Standard" within this letter report. Please note that, according to the Standard, the tests performed herein are for subdivision approval purposes only and should not be used for on-site septic system design purposes unless the septic system is located at the location where the actual tests were performed.

Methodology

The percolation holes were presoaked for 24 hours prior to conducting the percolation tests. The average percolation rates and water table depths observed at the site are summarized in Table 1 below. A map of the proposed subdivision development and the test hole locations is provided on Figure 1, which is attached to this letter report.

Observations

Test hole # P01010 percolated at a rate of approximately 1.67 minutes per 25 mm (inch), and the rate at test hole # P01008 was approximately 1.82 minutes per inch. Water percolated at both of these holes at a rate that is higher than is allowed by the Standard.

In addition to the percolation rates, the Standard states that in an effluent disposal system there must be a vertical separation from the point of effluent infiltration into the soil and the water table of at least 1.5 m (60"). At test hole locations # P01005, # P01006, # P01010, and # P01011 the water table level was measured at less than 1.85 m (72") below ground level. Since the minimum depth of a lateral trench in a septic field is 0.3 m (12"), and the minimum distance between a lateral trench and the water table is 1.5 m (60"), mitigation measures will have to be taken in order for the septic field installations to comply with the Standard at these locations. Furthermore, local frost conditions may make it necessary to locate lateral trenches deeper than the minimum 0.3 m (12"). In this case, depending on the required depth of these laterals, water table level could also be an issue with test holes # P01001 and # P01009.

Table 1: Gold Creek Percolation Test Data and Water Table Depth (in) July 15 and 16, 2008

Hole #	Water Table Depth (in)	Water percolation rate (min/in)	Mitigation Required	Nature of Problem
P01003	81.00	9.60	no	none
P01004	dry hole	24.00	no	none
P01005	67.00	15.00	yes	high water table
P01006	27.00	10.00	yes	high water table
P01008	dry hole	1.82	yes	high percolation rate
P01009	89.00	7.74	no	none
P01010	71.00	1.67	yes	high water table and high percolation rate
P01011	44.00	5.71	yes	high water table

Both high water table and high percolation rate issues were observed at test hole site # P01010, which is an unusual circumstance. Percolation tests conducted at two separate time scales at this location verified the consistency of these results. One possible explanation for this condition is rapid lateral flow conditions in the upper soil profile through preferential flow pathways, which could be caused by vegetative root networks, lateral soil/ rock fractures or course soil lenses.

Discussion and Conclusion

High water table and percolation rates were determined to severely limit the use of standard on-site sewage treatment systems within the proposed subdivision. However, according to the Standard, there are a number of potential options that could be used to provide proper treatment of household sewage at this location, as follows:

- Treatment mounds
- Sand filters
- Open discharge systems
- Store and pump tank systems

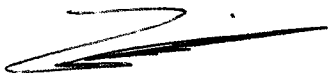
UMA | AECOM

- Packaged sewage treatment plants
- Sewage or effluent treatment lagoon(s)

In any case, the above noted treatment system options require proper design and construction to appropriately mitigate these site limitations and enable the proposed lots to comply with the Standard. Any system employed at these sites will need to account for site slope limitations and soil conditions. If store and pump tank systems are employed, water conservation and grey water separation options should be considered in the design of residential structures to minimize storage and maximize water reuse.

Sincerely,

UMA Engineering Ltd.



Zan Gullickson, B.Sc.
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ZG:cms

Encl.

UMA | AECOM

Signature Page

REPORT PREPARED BY:

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UMA ENGINEERING LTD.

REPORT REVIEWED BY:

PROFESSIONAL ENGINEER ALBERTA
WILLIAM R. MACMILLAN

Aug 22/08

W.R. (BILL) MACMILLAN, P.ENG., P.AG., M.SC.
REGIONAL MANAGER
EARTH AND ENVIRONMENTAL
UMA ENGINEERING LTD.

PERMIT TO PRACTICE
UMA ENGINEERING LTD.
Signature _____
Date Aug 22, 2008
PERMIT NUMBER: P329
The Association of Professional Engineers, Geologists and Geophysicists of Alberta.

UMA | AECOM

Disclaimer

The attached Report (the "Report") has been prepared by UMA Engineering Ltd. ("UMA") for the benefit of Livingstone Ventures Ltd. ("Client") in accordance with the agreement between UMA and Client (the "Agreement") for the services described therein, and is subject to the budgetary, time and other constraints and limitations set forth therein.

The information and data contained in the Report, including without limitation the results of any inspections, sampling, testing and analyses and any conclusions or recommendations of UMA (the "Information"), represent UMA's professional judgment in light of the knowledge and information available to it at the time of preparation of the Report. UMA has not updated the Report since the date that the Report was prepared. Further, UMA has relied upon the accuracy of the information provided to it by Client in order to prepare the Report and UMA has not independently verified the accuracy of such information, nor was it required to do so. Thus, UMA shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared which may affect the information contained therein, or for any inaccuracies contained in information that was provided to UMA by Client.

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Appendix D

Stormwater Management Report

AECOM

Livingstone Ventures Ltd.

Gold Creek Subdivision
Stormwater Management Plan

Prepared by:

UMA Engineering Ltd. doing business as AECOM
514 Stafford Drive N.
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Date: October 31, 2008

Project Number: G511-001-00 / RPT-08-055

AECOM

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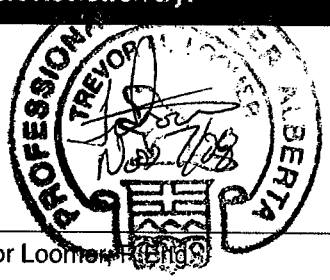
Signature Page

Report Prepared By:	Report Reviewed By:
Shouling Chen	
Shouling Chen, E.I.T.	Trevor Loomer, P.Eng.

Executive Summary

This report addresses the stormwater servicing requirements for the Gold Creek Subdivision. It assesses the capacity and other related stormwater issues of the existing ditches, highlights current hydraulic concerns, and provides stormwater management objectives to guide development.

The study provides an understanding of how the existing drainage system operates, and the impact development would have on the existing system. It is to be used as a planning document to provide a framework for development, as well as provide an overview of the proposed system to meet the current stormwater objectives of the Gold Creek Subdivision and Alberta Environment.

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Appendix

1. Introduction

The purpose of the stormwater management plan is to:

- Delineate the drainage basin and catchment areas based on topographic information
- Determine pre/post development runoff characteristics for a 1 in 100 year, 24 hour design storm
- Compare, based on the 1 in 100 year, 24 hour duration design storm, the discharge of the runoff in the rate and volume from the development site
- Recommend design concepts for use in the detailed design.

2. Stormwater Management

2.1 Existing Site Conditions

The study area includes approximately 39.22 ha of developable land. Based on the site topography and the discharge location, the pre development study area contained within the overall catchment boundary has been divided into three catchments marked as A, B and C with the discharge location A*, B* and C*. Contours and natural drainage routes, within the study area, are shown in **Figure 1**.

Overall, the site is very steep with an average grade of approximately 20% from east to west, and most drainage from the three catchments is conveyed as sheet flow to the west, eventually flowing to Gold Creek. The average pre development runoff imperviousness was assumed to be 30%, due to the steep nature of the flow area. According to the site structure planning, there is going to be 2% building coverage in the lot after the development.

The intent of the development is to make the landscape as close to existing as possible to minimize the affects of stormwater runoff. The overall increase in imperviousness is very small, and this minimal increase does not warrant the installation of a stormwater storage facility.

2.2 Drainage Concept

Urbanization of the existing undeveloped lands will result in an increase in the rate and volume of runoff from the development area. A high percentage of impervious area (buildings, roads, etc.) increases the volume of runoff and peak flows. Peak flows also increase with the introduction of drainage courses such as streets, curb and gutters, swales and ditches.

The proposed Gold Creek area development has been divided into three parts to discuss stormwater management, as shown on **Figure 2**. Since there is no underground storm system, both the minor and major events are conveyed by the streets, ditches and swales.

Also Best Management Practises (BMPs) should be incorporated into the drainage system to improve the quality of the storm effluent prior to discharging into adjacent streams. The control of stormwater quantity is necessary in order to minimize the ecological changes downstream of the urbanized area.

2.3 Stormwater Design Parameters

Since the Gold Creek Subdivision does not have an underground storm system, the conveyance system will consist of streets, ditches and swales. The design parameter used to design these conveyance systems will be the Pincher Creek, Alberta 1:100 year, 24 hour design storm. The post development runoff was calculated based on the following assumptions:

- Assume 2% building coverage in the lot area with an average imperviousness of 80%
- Assume the rest - 98% gravel and grass area with an average imperviousness of 35%.

According to AENV Stormwater Management Guidelines, 1999, it is necessary to detain the difference between the post and pre development runoff on site. The Pincher Creek, Alberta IDF parameters used are provided in **Table 1**. An hyetograph of the design storm is provided in **Figure 3**.

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TOTAL AREA = 39.22 ha.	
AREA	TOTAL
A	18.65 ha.
B	12.64 ha.
C	7.93 ha.

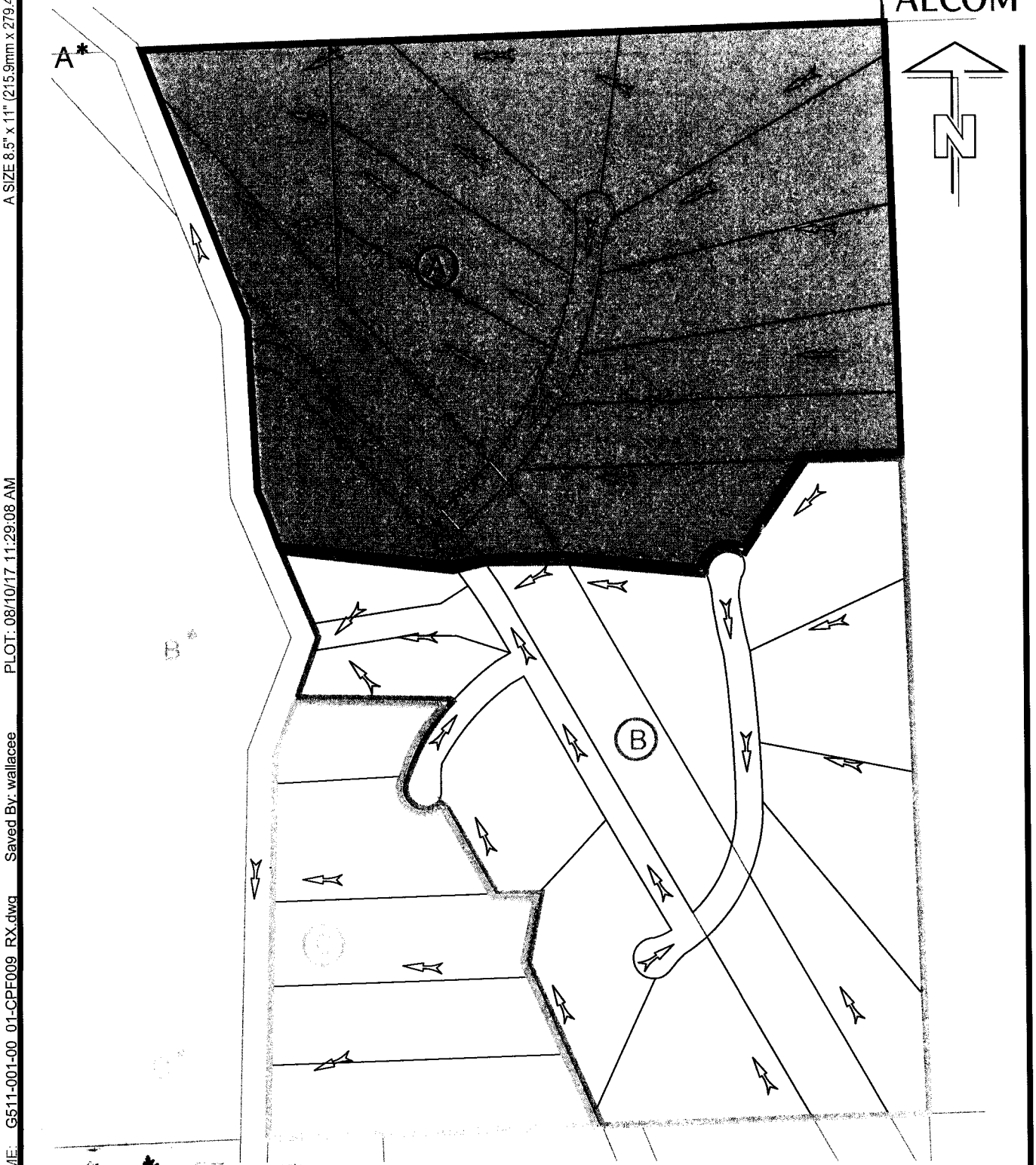
Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Pre Development Drainage Site Plan

Figure 1

ISS/REV: A
UMA FILE NAME: G511-001-00_01-CPF008_RX.dwg Saved By: wallacee PLOT: 08/10/17 11:30:21 AM A SIZE 8.5" x 11" (215.9mm x 279.4mm)

AECOM



TOTAL AREA = 39.22 ha.	
AREA	TOTAL
A	18.62 ha.
B	15.02 ha.
C	5.58 ha.

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

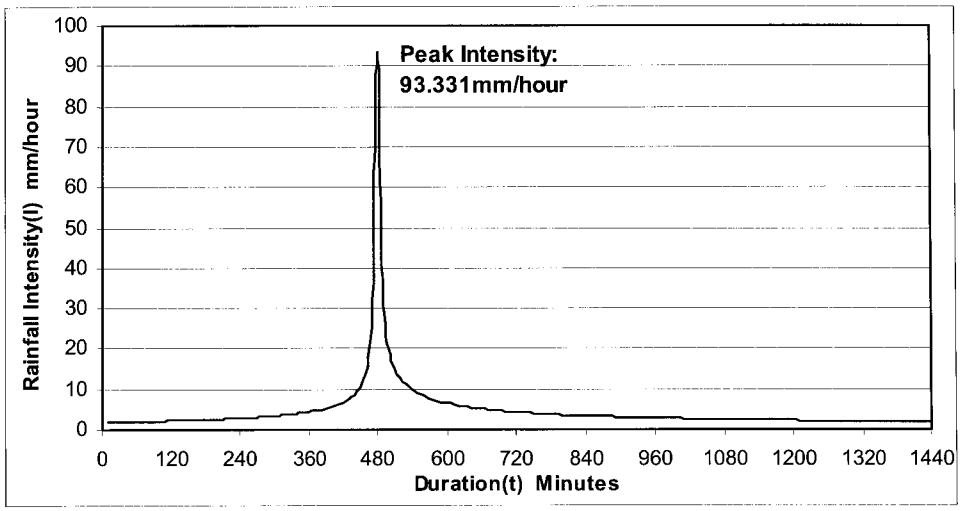
Post Development Drainage Site Plan

Figure 2

Table 1 IDF Parameters for Pincher Creek, Alberta
(100 Year 24 Hour)

Storm Event	IDF Parameters			Total Runoff (mm)
	a	b	c	
1:100 Year Event	424.284	1.50	0.620	112.05

Figure 3 Hyetograph for the Pincher Creek, Alberta Design Storm
(100 Year 24 Hour)



2.4 Computer Modelling

For water quantity, XP SWMM 2000 was chosen to simulate runoff from the Pincher Creek, Alberta 1:100 year design storm event. The difference of the peak discharge rate and the runoff volume at the three discharge locations between post and pre development is compared in **Table 2**.

Table 2 Post and Pre Development Discharge Comparison
(100 Year 24 Hour)

Description	Runoff (m^3)				Peak Flow (m^3/s)			
	A*	B*	C*	TOTAL	A*	B*	C*	TOTAL
Pre development	9,150	6,250	3,990	**19,390**	1.91	1.36	1.06	**4.33**
Post development	10,140	8,320	3,130	**21,590**	2.17	1.99	0.95	**5.11**
Percentage Increase	11%	33%	-22%	**11%**	14%	46%	-12%	**18%**

Based on the results from the XP SWMM model, the runoff volume and peak discharge rate decreased at the location C*, while increased at the locations of A* and B*. The model and the results are attached as **Appendix A**.

2.5 Development Impacts

The average imperviousness will increase from 30% pre-development to 36% post development based on the assumptions, which results an overall increase of the total runoff by 11% and peak flow discharge rate by 18% to Gold Creek based on the XP SWMM model.

For the Gold Creek Subdivision, there are three inlets to Gold creek. The development impacts on outlet C* could be ignored due to the decreasing of the runoff volume and peak discharge rate. For outlet A*, the runoff volume contributing to A* outlet will increase 11% and the peak flow discharge rate will increase 14%. The most impacted outlet, due to the development of the site, will happen at outlet B*, the runoff volume and the peak discharge flow will increase 33% and 46% respectively. The size of the existing CSP culvert at outlet B* is 300 mm. It is proposed to install a 450 mm CSP culvert to replace the existing 300 mm CSP culvert.

2.6 Water Quality

Due to the minimal increase in imperviousness and the topography of the site, no opportunity exists to incorporate a wet pond facility for stormwater treatment. Also the site is serviced by surface drainage with a high slope, which limits the BMPs available for treatment. The drainage routes will provide some treatment for the removal of suspended solids from the runoff. The existing native vegetation should be retained as much as possible to reduce the possibility of erosion and sedimentation.

Since this is a rural development, the lot grading should be kept to a minimum to reduce the overland flow velocity, which will increase the particle settlement. An infiltration trench or bioswale would also provide significant treatment for the stormwater.

3. Conclusions and Recommendations

- As is typical in rural residential development, all drainage will be overland. The overall storm design was based on the Pincher Creek, Alberta 1:100 year, 24 hour event.
- Stormwater calculations performed in this study were based on an average imperviousness of 30% due to the steep nature of the flow area for the pre-development 1:100 year storm event. For the post 1:100 year storm event, the imperviousness was assumed to be 80% for the building areas and an average of 35% for the rest gravel and grass areas.
- It was assumed 2% building coverage in the lot areas after development.
- The overall increase in imperviousness is very small, and this minimal increase does not warrant the installation of a stormwater storage facility.
- The total runoff volume and peak flow discharge rate from the three inlets increases by 11% and 18% to Gold Creek, with one inlet decreasing and two inlets increasing after the development of the site.
- It is proposed to install a 450 mm CSP culvert to replace the existing 300 mm CSP culvert at the outlet B* due to the development of the site.
- Where flows are required to cross streets or concrete swales, culverts will be provided, depending on the rate of runoff that must be discharged.
- The road cross-section will be designed to contain runoff resulting from a Pincher Creek, Alberta 1:100 year, 24 hour storm event within the road right-of-way.
- Where any ponding is predicted to cross onto private property, appropriate restrictive covenants and/or easements will be registered. Runoff flows over the road will not exceed Alberta Environment's depth-velocity guidelines. Where these guidelines cannot be met, runoff will be routed into dedicated open channels.
- The existing native vegetation should be retained as much as possible to reduce the possibility of erosion and sedimentation. The overland flow routes should incorporate BMPs to reduce suspended solids entering the downstream system.
- Concentrated discharges will be avoided wherever possible. Where concentrated flows at outfalls cannot be avoided, appropriate engineered armoring to maintain the channel bed and sides should be provided (e.g., rip-rap, geotextile and so on).

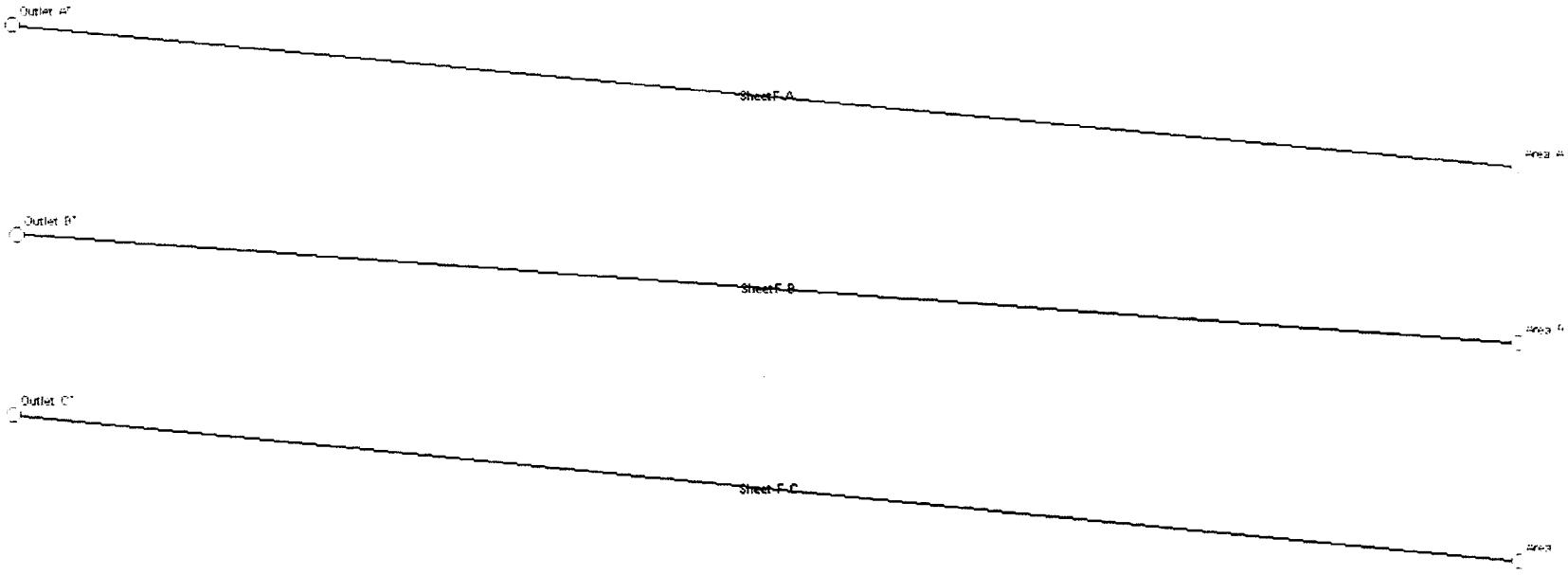
Appendix A

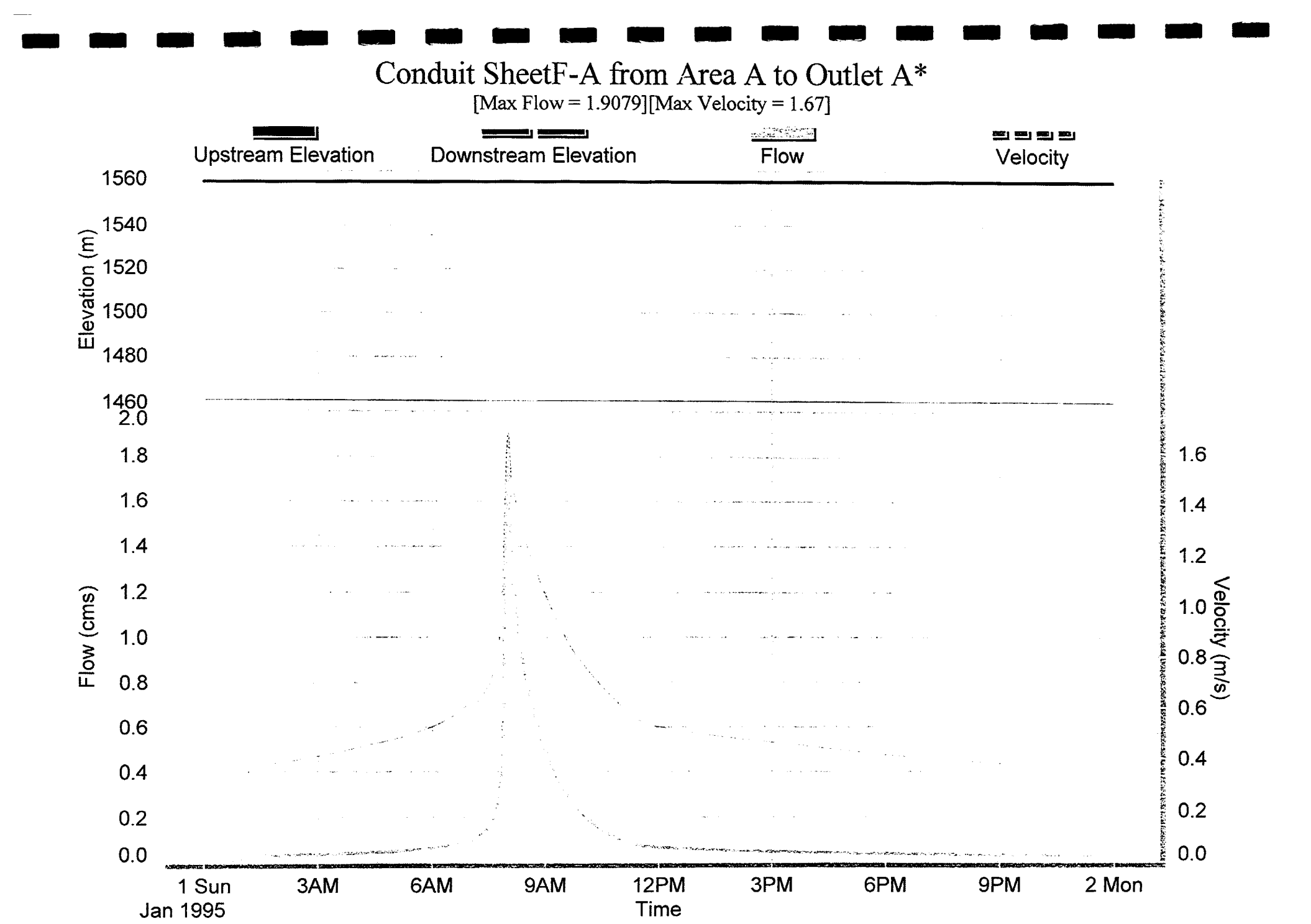
XPSWMM Model and Results

- 1:100 Year Pre Development
- 1:100 Year Post Development

1:100 Year Pre Development

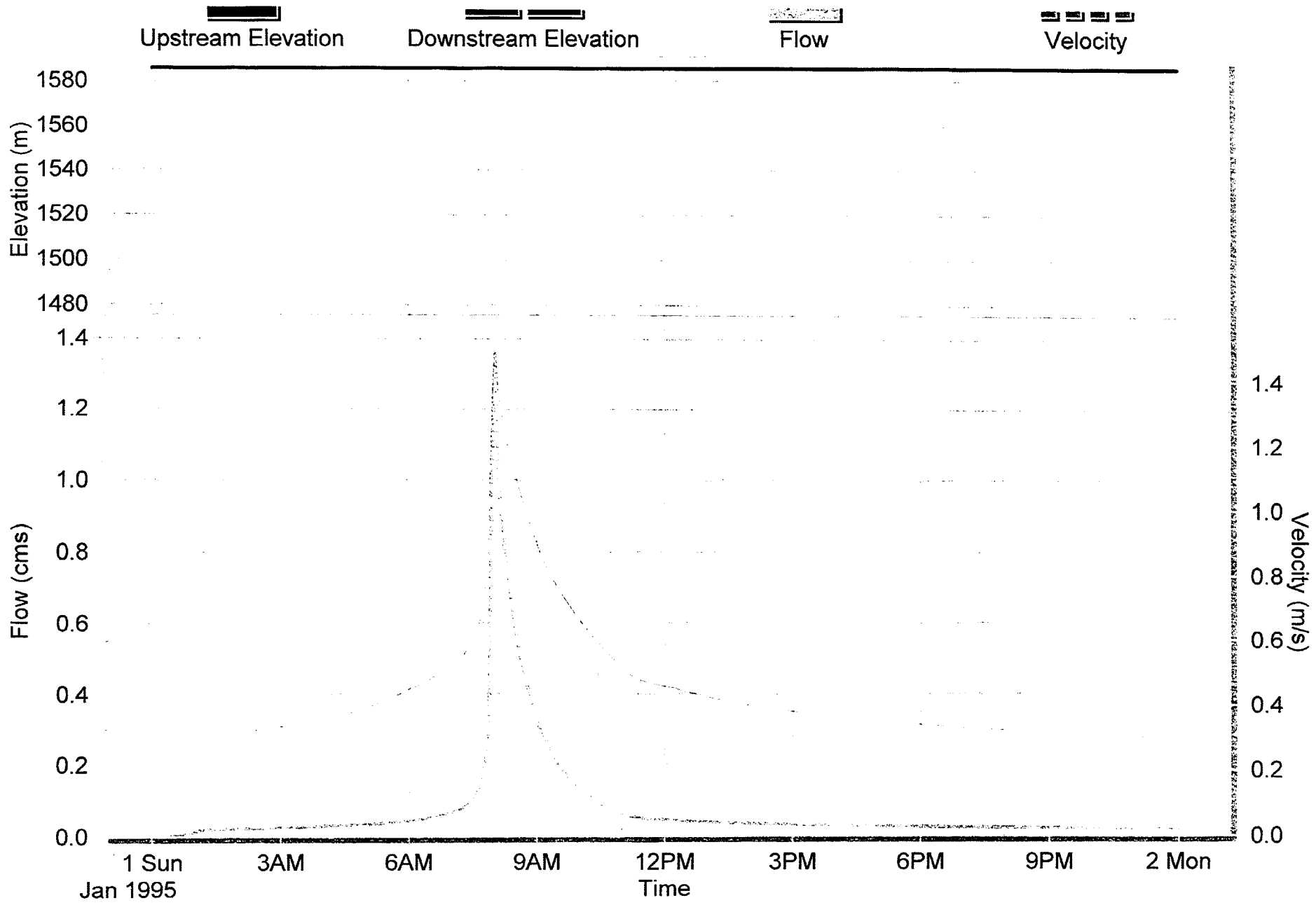
XPSWMM Model – 1:100 Year Pre Development Model




Conduit SheetF-A from Area A to Outlet A*
[Max Flow = 1.9079][Max Velocity = 1.67]
Upstream Elevation
Downstream Elevation
Flow
Velocity
Elevation (m)
1560
1540
1520
1500
1480
1460
Flow (cms)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Velocity (m/s)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 Sun
Jan 1995
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Mon
Time

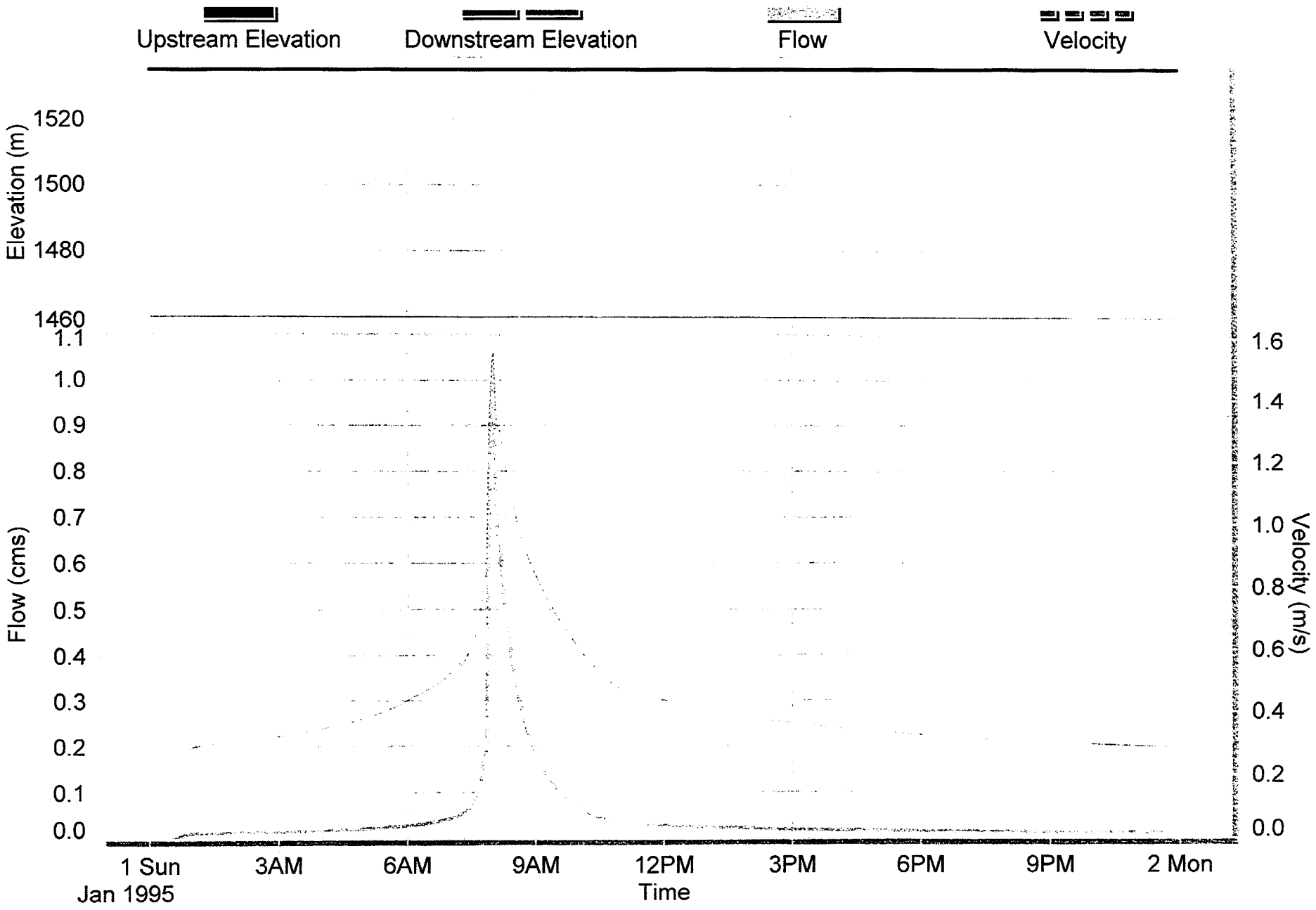
Conduit SheetF-B from Area B to Outlet B*

[Max Flow = 1.3646][Max Velocity = 1.49]



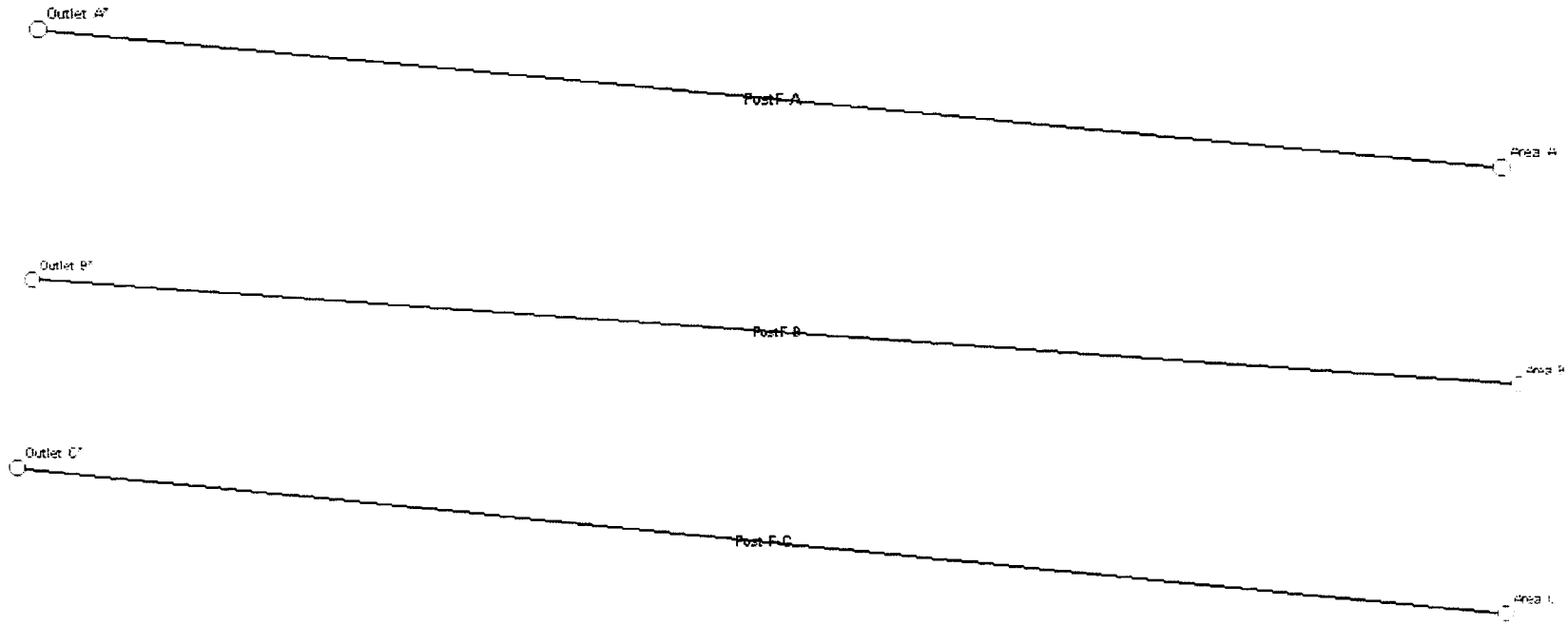
Conduit Sheet-F-C from Area C to Outlet C*

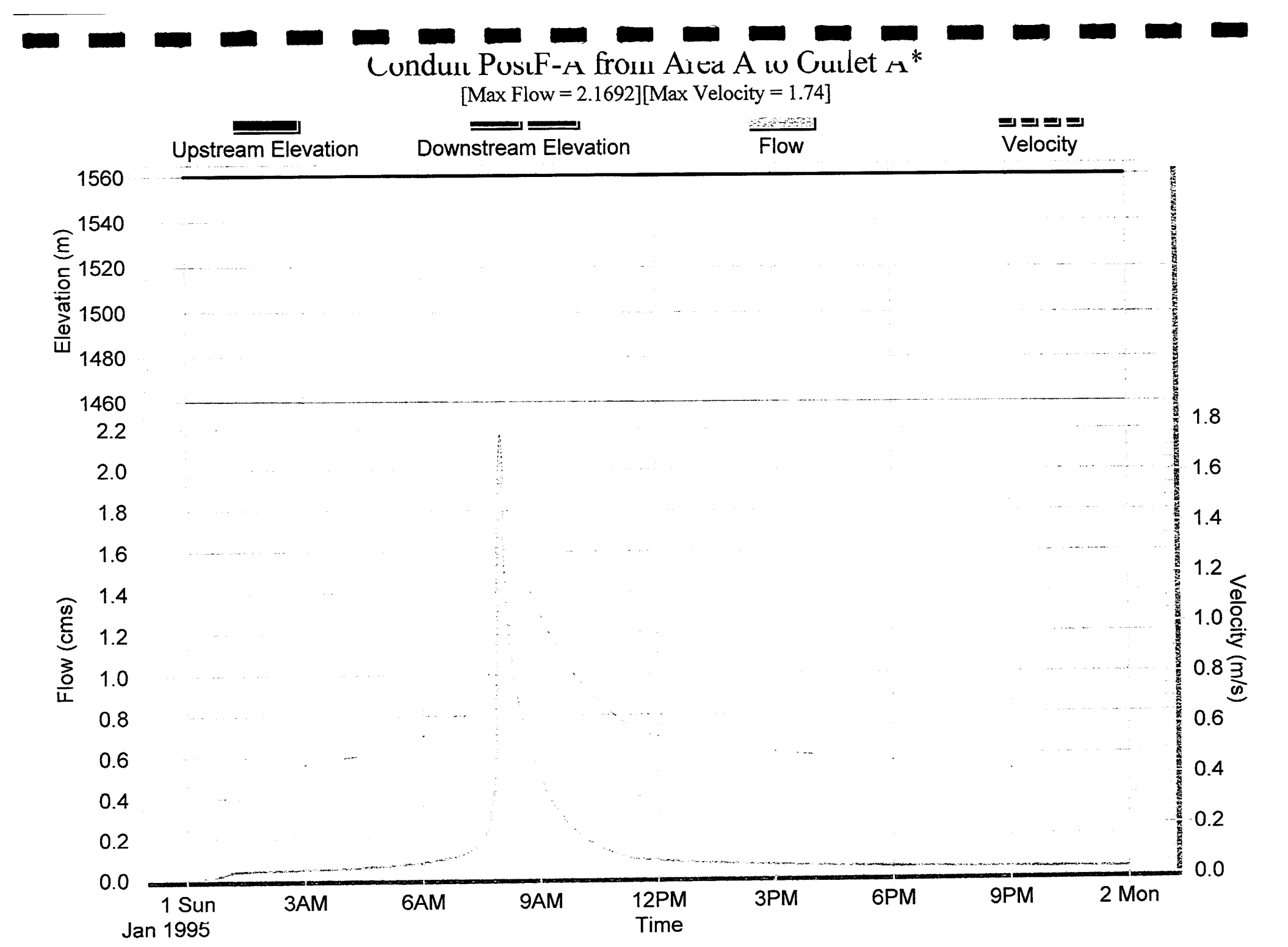
[Max Flow = 1.0578][Max Velocity = 1.55]



1:100 Year Post Development

XPSWMM Model – 1:100 Year Post Development Model




Conduit PostF-A from Area A to Outlet A*
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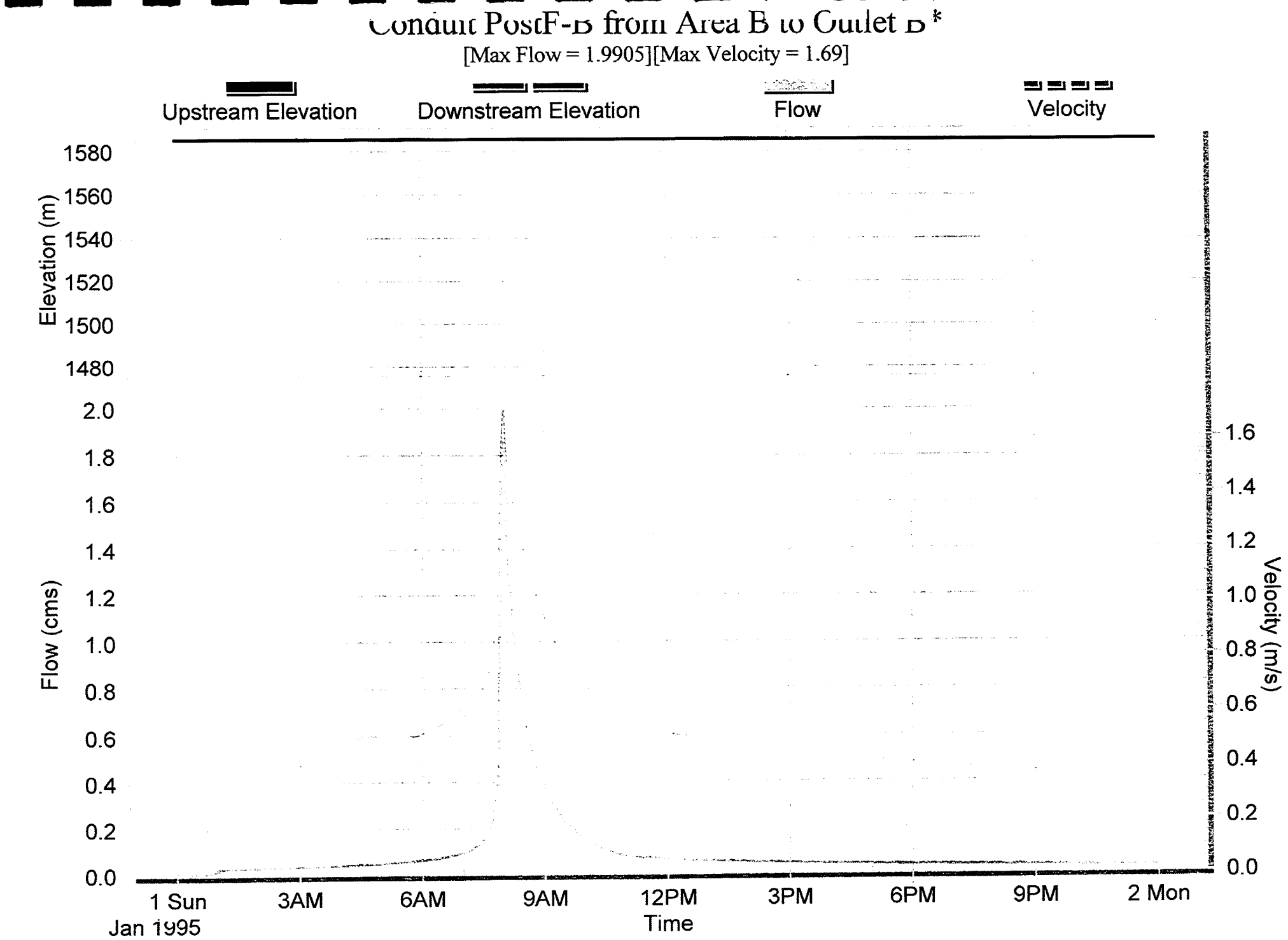
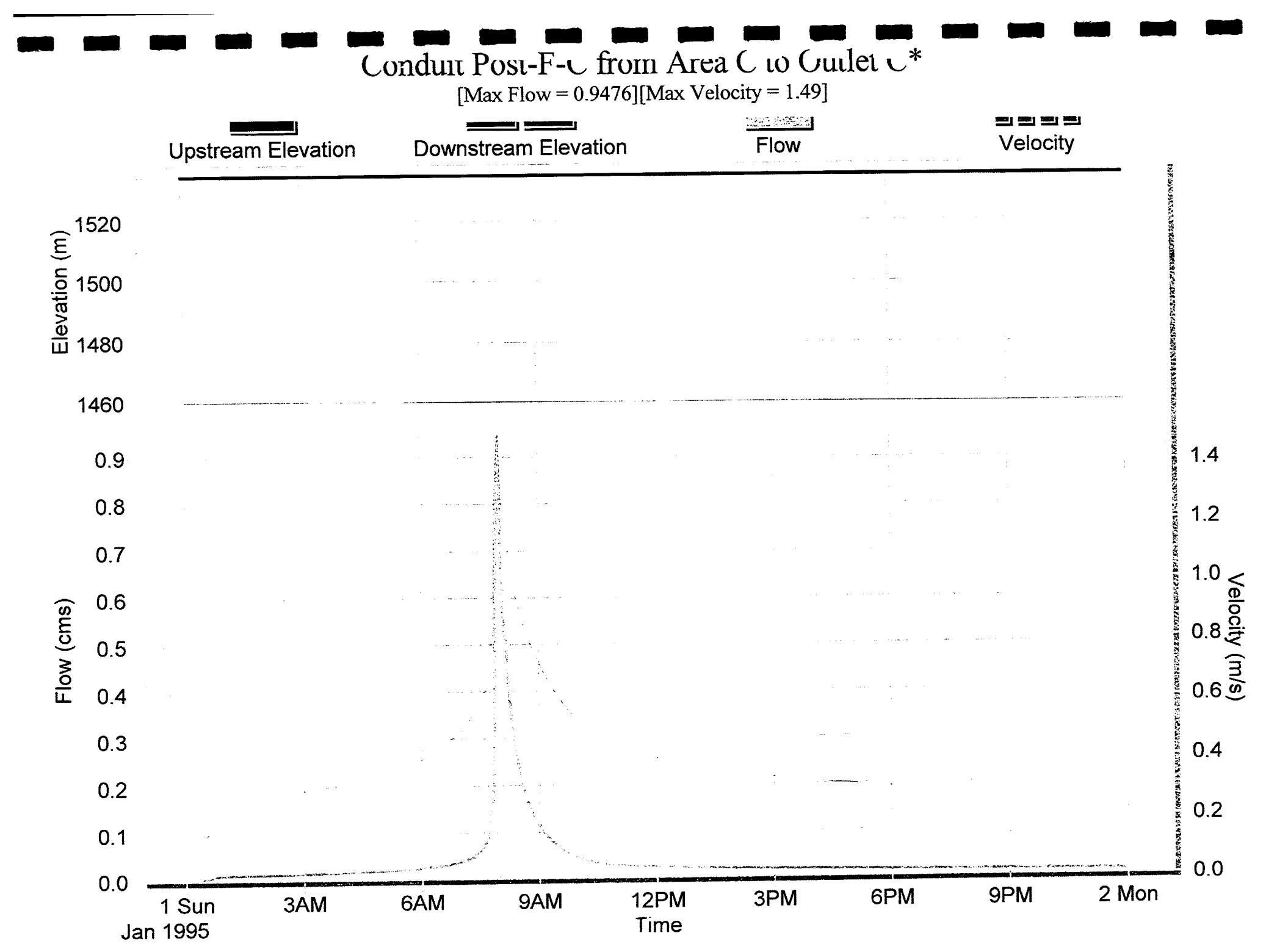
Upstream Elevation
Downstream Elevation
Flow
Velocity
Elevation (m)
1560
1540
1520
1500
1480
1460
Flow (cms)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Velocity (m/s)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 Sun
Jan 1995
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Mon
Time


Conduit PostF-B from Area B to Outlet B*
[Max Flow = 1.9905][Max Velocity = 1.69]
Upstream Elevation
Downstream Elevation
Flow
Velocity
Elevation (m)
1580
1560
1540
1520
1500
1480
Flow (cms)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Velocity (m/s)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 Sun
Jan 1995
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Mon
Time


Conduit Post-F-C from Area C to Outlet C*
[Max Flow = 0.9476][Max Velocity = 1.49]
Upstream Elevation
Downstream Elevation
Flow
Velocity
Elevation (m)
1520
1500
1480
1460
Flow (cms)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Velocity (m/s)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 Sun
Jan 1995
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Mon
Time

AECOM

Appendix E

Hydrogeological Assessment

AECOM

Livingstone Ventures Ltd.

Gold Creek Hydrogeological Assessment

Prepared by:

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Date: October 2008

Statement of Qualifications and Limitations

Revision Log

Revision #	Revised By	Date	Issue / Revision Description

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PROFESSIONAL GEOLOGIST OF ALBERTA
WADE K. HUSAK
Nov 12/08

PERMIT TO PRACTICE
UMA ENGINEERING LTD.
Signature
Date Nov. 12/08
PERMIT NUMBER: P329
The Association of Professional Engineers, Geologists and Geophysicists of Alberta.

Executive Summary

Livingstone Ventures Ltd. is proposing to develop a residential subdivision on the eastern part of the SW ¼ Sec 8-8-3-W5M in the Crowsnest Pass. This is north of the town of Frank and is northeast of the existing residential subdivision of Valley Ridge Estates. This report is the result of an initial water well test that was undertaken in order to evaluate the potential for groundwater as the primary water source for up to 25 residences planned for the area. The adjacent Valley Ridge Estates subdivision exclusively uses privately owned water wells for each property, which draw water primarily from the fractured sandstone of the Blairmore formation. Water from these wells is of very good quality for human consumption, and flow rates have been shown to be at least adequate for domestic use.

The Draft Environmental Guidelines for the Review of Subdivisions in Alberta states that a water well must be able to produce at least 3.42 m^3/day/household that it is to service. A pumping test consisting of 48 hours of pumping at 2.3 m^3/hour, followed by a 48-hour recovery period, was undertaken. An analysis of a well in each proposed lot pumping at 3.42 M3/day over a period of 20 years showed a maximum drawdown of 26 meters. Other wells in the area have also tested positively (Valley Ridge Estates), and after several years of pumping for domestic use, the results of these tests have been borne out. Testing of water quality was carried out at an accredited lab and the results show that treatment to remove manganese may be desirable for aesthetic purposes.

It is recommended that the application for subdivision for this area should not be delayed by either the water quality or quantity. The aquifers of the Blairmore formation in the local area have been shown to have an adequate supply of good quality water for domestic purposes.

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Appendices

1. Introduction

1.1 Scope of Work

AECOM was retained by Livingstone Ventures Ltd. to perform an aquifer and well assessment of their property located on the eastern half of NW 8-8-3-W5M. This property is being considered for development into a residential subdivision. The aquifer assessment consisted of drilling two water wells to test a potential aquifer for the development to use as a water source. The location of the site is shown on Figure 1 in **Appendix A**. The two new water wells were drilled in two different proposed lots so that the wells can be used as domestic wells when the site is subdivided and fully developed. The locations of these wells on the project property are shown in Figure 2 in **Appendix A**.

The scope of work for the project included:

- Drilling and installing a production well
- Drilling and installing an observation well in the same aquifer as the production well
- Conducting a 48 -hour pump test and recovery test on the production well
- Measuring water levels in the production well and the observation well manually and with data loggers
- Collecting a groundwater sample during the pump test to be submitted for analysis
- Completing an aquifer assessment report.

1.2 Background Information

Livingstone Ventures is applying for a subdivision permit for the east portion of the eastern half of NW 8-8-3-W5M. Located in the southwest corner of Alberta, the Municipality of Crowsnest Pass is nestled in the Canadian Rocky Mountains. The Gold Creek country residential development is located approximately 3.82 kilometres north of the Town of Frank. The total area contains approximately 38.54 hectares (95.2 acres) of forested pasture land. The forest cover ranges from dense in some areas to clearings, both man-made and natural. A high voltage power line passes through the property, which has resulted in the removal of forest cover under the line. An access road was built several years ago in preparation for deep petroleum exploratory drilling by Talisman Energy. This drilling initiative has been abandoned, but the road remains serviceable, as well as a graded, level area at the upper end of the road, initially intended to support drilling operations.

This report summarizes an investigation into the suitability of the groundwater in the area of the proposed subdivision for domestic use. Groundwater sources would be required to supply water for up to 25 households when the subdivision is completed.

2. Regional Setting

2.1 Topography and Climate

The proposed development site is completely contained within the subalpine sub region of the Rocky Mountain Natural Region. The study site is located approximately 4 km northeast of the famous Frank Slide in the Crowsnest Pass of southern Alberta. Elevation in the area ranges from less than 1300 metres above sea level (masl) at the valley floor at the village of Frank, to over 2000 masl at the peaks of the surrounding mountains. The elevation generally decreases towards the east, and only 18 km to the east cereal and forage crops are grown. T he site is currently used as free range cattle pasture.

The climate follows the distinguishing characteristics of the Cordilleran Ecoclimatic Province. As such, winters are cold, and the summers are short and cool, with the mean annual temperature at only -0.5°C. Average precipitation for this area averages approximately 750 mm per year. This level of precipitation does not limit plant growth, but it may be limited by thin or non existent soils at higher elevations. Plant growth is abundant where there have been favourable conditions for soil formation and retention. Prevailing wind flow is from the southwest, which often gives this area a warming Chinook during the winter months.

2.2 Regional Geologic Setting and Geomorphic Description

This mountainous region in the Crowsnest Pass has been subject to multiple faulting, fold fracture events and glaciations over millions of years. In many parts of the upper slopes of the mountains exposed bedrock is visible. The lower slopes and valleys are covered with overburden, the most recent of which consists of Pleistocene glacial till and boulders. The overburden is loose and uncemented, providing a suitable substrate for the formation of productive soils. The till may be up to 60 m deep in valley areas, normally decreasing in depth higher up the valley sides as steepness of the slopes increases. Upper bedrock consists of grey and greenish-grey sandstone, green, silty mudstone, grey sandstone, and quartzite-pebble conglomerate of the Blairmore group dating to the early cretaceous period. The Blairmore group overlies formations of the Kootenay group dating to the late Jurassic period, which consist of dark grey and black sandstone and shale, and may contain some quantities of bituminous coal. (Geologic Survey of Canada Map, 1829A). In turn, the Kootenay group overlies the Fernie formation, which consists of dark grey to black shale, thin beds of grey sandstone, and thin beds of black limestone. This formation dates to back to the early Jurassic period some 165 million years ago (mya). These layers of bedrock are easily visible and identifiable on the upper, exposed slopes of the Crowsnest Valley. Above the proposed development site, the slope angle of these sedimentary deposits has been measured at up to 60 degrees from the horizontal by AECOM staff.

2.3 Regional Hydrogeology

Until recently, there has been very little detailed hydrogeological investigation into the aquifers in the area of the proposed Gold Creek development. The recent development of the Valley Ridge Estates subdivision across the valley to the southwest of the Gold Creek Development has provided some information as to the regional groundwater characteristics in the area. Although this development may reside in formations that are dissimilar to the Livingstone Venture site, it does offer some insight into the

variability of the regional terrain. There are existing local water wells (Appendix B), only three of which are currently on the Government of Alberta website. Information on these wells was provided by the driller, Camfield Drilling. This list shows that water wells in the Gold Creek area, although capable of producing ample flows for domestic purposes, access water at highly variable depths. This is due partly to the extensive folding and resulting fracturing of the rock layers that has taken place during the previous orogeny. The fracturing of the rock layers during the mountain building process provides multiple and complex cavities and courses for snow melt and surface water to infiltrate and re-charge groundwater aquifers. Adding to the complexity of the aquifer system is the extensive deposits of colluvium that has accumulated during the preceding epochs. This process has provided the necessary conditions required to form water bearing cavities in areas that lie above the more intact layers of deep bedrock.

3. Local Geology and Hydrogeology

3.1 Local Geology

Layers of sandstone, shale and limestone noted in Section 2.2 have been forced by prehistoric tectonic movement into steep slopes above the proposed development site. Periods of glaciation, weathering, erosion, and mass wasting have caused deep layers of eroded deposits to accumulate in the area of the property as well as in the entire valley. These materials have covered the bedrock formations on the lower areas of the valley, which has helped to provide a suitable environment for the formation of productive top soils. Areas lower in elevation tend to have thicker deposits, with the high slopes having thin overburden deposits or showing exposed bedrock layers which are partially intact. Measurement of the slope angles and direction of the slope of the bedrock layers was calculated to allow calculation of overburden depth. On the upper slopes, layers of sandstone and shale have eroded away to expose older layers of black limestone, as confirmed by map 1829A of the Geological Survey of Canada. The well at the proposed project site accesses an aquifer located in a fractured shale formation. Close examination of the layers of shale bedrock on the upper slopes indicate that these are the same bedrock layers that form the aquifer, which is recharged at these higher elevations.

3.2 Local Hydrogeology

The aquifer accessed during the drilling of the water wells for the proposed residential development has been identified as a "closed aquifer". That is, the water in the aquifer is tightly contained within the fractured shale formation by aquicludes both above and below the aquifer. Evidence of this comes partly by measuring the head that the well water produces at the ground surface. The observation well had a head of over 4.5 meters above the ground level. Corroborating this evidence are comparisons between the well logs and the exposed bedrock on the upper slopes, which shows that the wells are indeed located in a layer of hard, brown fractured shale. Shale and clay above the aquifer are believed to act as an aquiclude, preventing the water from rising to the ground surface in the absence of a bore hole.

When the slope and dip angles of exposed bedrock are measured and extended, it is seen that the formations that contain the aquifer descend to levels well below Gold Creek itself. The water pressure that is evident at the well head indicates that the aquiclude that contains the aquifer also extends to the lower elevations. This means that based on the measured slope of the bedrock formations, this aquifer does not feed into any of the surface water courses of the valley below, such as Gold Creek or the Crowsnest River.

Thick glacial deposits, combined with normal pedogenic processes and a favourable climate have resulted in an environment where a well-developed regime of interflow with the upper surface of the overburden soils is supported. This allows Gold Creek, to the west of the proposed development site, to maintain a substantial flow of water even in the late summer when there is no snow melt to feed it. Even small tributaries of Gold Creek are able to sustain local populations of trout over the summer months. Summer rains readily percolate into the soil covering upper rock layers and then into the cavities and crevices below. This subsurface water may re-enter the surface regime, as is evidenced at springs within the property. Alternatively, this interflow may re-enter the surface regime directly at the level of the lower streams and creeks.

4. Field Investigation

4.1 Drilling

Camfield Drilling Services Ltd., a certified water well drilling contractor from Lethbridge, Alberta drilled the pumping well between July 15 and July 24, 2008. The well was drilled using a 6 inch diameter bit to a depth of 140 feet. The driller logged the hole, and variations in lithology were recorded as the hole was bored. The following describes the lithology at the depths indicated.

- 0 to 3 feet — loam
- 3 to 6 feet — sand and silt
- 6 to 12 feet — till and gravel
- 12 to 58 feet — lacustrine silt
- 58 to 63 feet — till and gravel
- 63 to 82 feet — till and clay
- 82 to 88 feet — brown, soft shale
- 88 to 125 feet — soft shale
- 125 feet to 140 feet — brown hard shale

The observation well was drilled by the same contractor between July 24 and August 13, 2008 to a depth of 160 feet. The well was drilled using a 6 inch diameter bit to a depth of 160 feet. The driller logged the hole, and variations in lithology were recorded as the hole was bored and are summarized below:

- 0 to 3 feet — loam
- 3 to 58 feet — till and rock
- 58 to 95 feet — till and gravel
- 95 to 103 feet — till and clay
- 103 to 160 feet — brown shale

The water well drilling logs are in **Appendix C**.

4.2 Well Installation

In the pumping well, a steel casing with an outside diameter of 6.625 inches and an inside diameter of 6.125 inches was installed to a depth of 88 feet. The casing is installed by hammering the casing down into the borehole, which is a tight interference fit, as the outside diameter of the casing is slightly larger than the borehole. A driving shoe on the lower end of the casing facilitates the procedure. The upper 6 meters of the casing are packed with bentonite clay, to seal any cavities between the casing and the bore hole.

In the observation well, a steel casing with an outside diameter of 6.625 inches and an inside diameter of 6.125 inches was installed to a depth of 105 feet. The casing in the observation well was installed using the same procedure as was used in the pumping well.

4.3 Pump Test

A 48 hour pump test was conducted on the pumping well beginning on August 13th, 2008. The well was pumped at a rate of 10 imperial gallons per minute (Igpm) continuously for 48 hours. The water level of the pumping well was measured using a manual water tape using a time interval regime that is more stringent than Government of Alberta standards. The water level of the observation well was measured using two electronic pressure transducer type water level loggers. Periodic manual measurements using the hand held water tape were taken for verification purposes.

The pumping test was followed by a 48 hour recovery test. The water level of the pumping well was measured using a manual water tape at time intervals that AECOM has developed which are more stringent than the Government of Alberta standards. The water level of the observation well was measured using two electronic pressure transducer type water level loggers, as well as periodically taking measurements using the hand held water tape for verification purposes. The record of water level data is in **Appendix D**.

A water sample was collected for routine chemical and coliform analysis four hours previous to the end of the pumping phase of the test at the pumping well. The sample was submitted to AGAT Laboratories shipping depot in Claresholm, Alberta within two and one half hours of collection.

5. Aquifer Assessment

5.1 Hydraulic Characteristics

The data from the 48-hour pump and recovery test was analyzed using Waterloo Hydrogeologic Inc.'s AquiferTest Pro 4.2 software.

The Moench Fracture Flow method (1984,1988) and Copper and Jacob method were used to determine the transmissivity and storativity of the aquifer using the drawdown data from the 48-hour pump test. The recovery data for the 48-hour pump test was analyzed using the Theis Recovery, AGARWAL + Theis and AGARWAL + Moench Fracture Flow methods. The graphs associated with these methods can be found in **Appendix F**.

The pump test drawdown curve (**Appendix F**) reveals that the water level in the pump well dropped 24 m in the first twelve hours and then slowly continued to drop 5 m over the next 36 hours of pumping. The recovery curve showed a quick rise and then a slow and steady rise in the water level. It took the full 48 hours for the well to recover to 90% of the static water level. The observation well drawdown data produced curves with a consistent rate of drawdown and recovery.

Table 5.1.1 presents the calculated transmissivities and storativities for the aquifer based on the methods outlined above.

Table 5.1.: Aquifer Transmissivity and Storativity

Method	Well	Transmissivity (m^2/day)	Storativity
Moench Fracture Flow	Pump Well	1.0	2.7×10^{-3}
Moench Fracture Flow	Observation Well	0.8	9.2×10^{-5}
AGARWAL + Moench Fracture Flow	Pump Well	1.3	-
AGARWAL + Moench Fracture Flow	Observation Well	1.0	-
Copper and Jacob	Pump Well	0.8	3.7×10^{-1}
Copper and Jacob	Observation Well	3.0	1.1×10^{-4}
AGARWAL + Theis	Pump Well	1.5	5.0×10^{-1}
AGARWAL + Theis	Observation Well	0.7	2.1×10^{-4}
Theis Recovery	Pump Well	1.1	-
Theis Recovery	Observation Well	3.0	-

These methods found similar transmissivity values ranging from 0.7 to 3.0 m^2/day. The storativity values ranged from 5.0×10^{-1} to 9.2×10^{-5}. The transmissivity and storativity values were also calculated by comparing the field results found during the 48-hour pump test to the distance-drawdown calculation using the expanded Cooper and Jacob modified non-equilibrium equation (1946). The distance-drawdown graph can be found in **Appendix G**. The results of this calculation indicate a transmissivity value of 3.0 m^2/day and a storativity result of 1.0×10^{-5} show a 33 m drawdown at the well (as compared to approximately 29.5 m during the pump test) and a 9.7 m drawdown at the observation well (as compared with 9.5 m drawdown during the pump test). A transmissivity value of 3.0 m^2/day is the highest value

found using the various AquiferTest analyses, but reflects the results found in the field. This value will be used in this report. The storativity value found in the distance drawdown calculation is more conservative than the AquiferTest results, but will be used in this report.

5.2 Chemical Analysis

A water sample was collected for chemical analysis immediately before the end of the pumping phase of the test at approximately 5:00 AM on August 15th. The sample was collected in a sterile container supplied by AGAT laboratories and delivered to their shipping depot in Claresholm, Alberta the same morning. The water was tested for routine water chemistry and for fecal and total coliforms. Coliform count was below a detectable level, and routine water chemistry showed all but one required parameter to be within Health Canada Guidelines. The levels were higher than is recommended by Health Canada in the "Guidelines for Canadian Drinking Water Quality: Summary Table". The well water should be re-tested to be sure that the high levels as indicated in the initial test were not an anomaly. If the measured amount of manganese in two analyses is consistent, a manganese removal treatment process should be implemented for aesthetic purposes. Analysis results and chain of custody record are in **Appendix E**.

6. Well Assessment

6.1 Field and Office Verified Well Survey

Only one other water well is within 1 km of any proposed well locations on the project site. This water well is located approximately 865 meters to west of the project, down the slope towards Gold Creek. According to the owner this well is used only occasionally, usually on weekends during the summer months for domestic purposes only. The owner said this well is only 12 to 13 meters deep, and is not registered, nor is it on any government documents or websites. At this depth, the aquifer accessed by this well is located in an unconsolidated aquifer well above the level of the consolidated bedrock aquifer that is the subject of this report.

Other wells in the area are located primarily in the "Valley Ridge Estates" subdivision to the south, on the other side of the valley. A field verified well survey of these wells was not undertaken due to the distance from the subject well, but more importantly, because they are on the opposing slope of the Gold Creek syncline. This locates these wells in an area that is dissimilar to the subject well. For instance, all the wells but two in this area access aquifers in a sandstone formation, rather than in a shale formation. Of the other two, one accesses an aquifer in glacial till and is less than 11 meters deep. When this is taken into consideration, and located at a significantly lower elevation than the subject well, we can only surmise that these wells do not access the same aquifer as the subject well. A summary table of all the wells in the vicinity of Valley Ridge Estates is included in **Appendix B**.

6.2 Distance-Drawdown Estimate

The distance-drawdown curves were calculated for 1 year and 20 years of pumping at different pumping rates. The drawdown amounts and distance-drawdown curves are presented in **Appendix G**. The distance-drawdown was calculated using the expanded Cooper and Jacob modified non-equilibrium equation (1946):

$$s = 0.183Q/T[\log(2.25Tt/r^2S)]$$

Where:
- s = drawdown, in m
- Q = pumping rate, in m^3/day
- T = transmissivity, in m^2/day
- t = elapsed time, in days
- r = well radius, in m
- S = storativity

The distance-drawdown was calculated using the transmissivity value and storativity value determined previously in this report.

Three discharge rates were used; 3.42 m3/day (0.52 Igpm), 32.7 m3/day (5 Igpm) and 65.5 m3/day (10 Igpm) to evaluate the sensitivity of the aquifer to the discharge rate.

The evaluation determined that a single well's drawdown cone could theoretically affect wells up to 15 kilometres away over a 20 year continuous pumping period at 3.42 m^3/day (0.52 Igpm).

The effect of all 30 proposed lots having a well pumping at 3.42 m^3/day (0.52 Igpm) for 20 years and 49.25 m^3/day (7.5 Igpm) for 1 hour was calculated using AquiferTest Pro 4.2 software. The pump rate of 3.42 m^3/day (0.52 Igpm) is from Alberta Environment's *Draft Environmental Guidelines for the Review of Subdivisions in Alberta* (1996). The pumping rate of 49.25 m^3/day (7.5 Igpm) is from *Water Wells...That Last for Generations* workbook that states that a household peak pumping ranges from 34.2 to 65.5 m^3/day (5 to 10 Igpm). An average of two was taken and used to assess the aquifer at peak pumping periods. The pumping rate of 49.25 m^3/day (7.5 Igpm) is typical of pumps that are installed in residential wells. The 20 year time frame was used to determine long term effects of pumping and the 1 hour time frame was used to determine the effects of peak period pumping.

A well was positioned in the center of each lot for the analysis. Over 20 years, the maximum drawdown that would be seen is approximately 26 m at 3 wells in the center of the property. The drawdown decreases further away from the property with a drawdown of approximately 24 m at the subdivision boundary. The peak period pumping will have a maximum drawdown of 17 m and will not affect groundwater levels much beyond the subdivision property. Figure 1.0 in **Appendix G** indicates the amount of drawdown that all the wells would produce over 20 years and Figure 2.0 in **Appendix G** indicates the amount of drawdown that all the wells would produce in one hour of maximum pumping.

6.3 Well Efficiency

The well efficiency can be determined based on the difference between the theoretical and the actual specific capacity in the pumping well at a given time. The theoretical specific capacity was calculated using the following equation:

$$Q/s = 4\pi T/[2.3 \log((2.25Tt)/(r^2S))]$$

Where: Q/s = specific capacity
T = transmissivity, in m^2/day
t = elapsed time, in days
r = well radius, in m
S = storativity

Using the calculated aquifer values, the result of this calculation was a specific capacity of 1.9 m^3/day/m. The actual specific capacity of the well was calculated by dividing the pumping rate by the drawdown. The actual specific capacity of the well was calculated to be 2.2 m^3/day/m. The efficiency of the well is calculated to be 116%. Well efficiency is generally expected to be between 60 and 80%. The higher than expected well efficiency could be the result of using conservative transmissivity and storativity values for the aquifer or due to the above surface artesian conditions in both the pumping and observation well causing an overestimating the available specific capacity.

6.4 Sustainable Yield

The Q_{20} value represents the sustainable yield for a 20 year period for the aquifer based on the pumping rate. The Q_{20} value was calculated using the Farvolden Method:

$Q_{20} = [0.68TH_A][F]$

Where: Q_{20} = sustainable yield for a 20 year period, in m^3/day
T = transmissivity, in m^2/day
H_A = available head, in m
F = safety factor, assumed to be 70%

H_A was calculated by finding the difference between the top of the aquifer (40.5 metres below surface) and the static water level (0.87 metres above surface), which works out to 41.37 metres.

The result of the Farvolden Method calculation is a sustainable yield of 59 m^3/day (9 Igpm). Note that this represents what the aquifer can produce, not necessarily what the well can produce. Also, this value does not take into account any effects on neighbouring wells or all of the subdivision wells being pumped simultaneously.

7. Conclusions

Calculations for water level drawdown show that over a 20 year period the aquifer within the fractured shale of the Blairmore formation will not fall by more than 26 meters.

The high elevation re-charge area of the aquifer is large and subject to high levels of precipitation which provide good conditions for a long term water supply in the deep aquifer.

The water tested does not contain measurable levels of fecal or total coliforms. All the parameters to be tested for in routine water chemistry analysis show levels within the Health Canada Guidelines, with the exception of high levels of manganese. Manganese can be treated using simple domestic treatment systems and the guideline is an aesthetic objective; high levels of manganese will turn clothes grey. It does not represent a health concern.

The aquifer that the subject well accesses is a closed aquifer, which is indicated by the pressure that can be measured at the well head.

The fact that the aquifer is confined and the dip of the bedrock formations indicate that the aquifer is not in hydraulic communication with any surface water flows.

8. Recommendations

The water quantity is ample for the proposed development, and should not cause an impediment to the project

It is recommended that the water quality be re tested, and if the analysis is consistent with the previous test, that plans are instituted to address aesthetic concerns by installing commercially available devices to remove manganese from the water to conform to the Health Canada Guidelines.

Water quality should be tested on an annual basis, as manganese levels may decrease over time due to higher oxygen levels in the water.

Upon commencement of drilling additional wells, the driller should be aware that there could be other aquifers in formations at different depths. If other aquifers are located that may not be in connection with the subject aquifer, the possibility of exploiting these should be investigated separately from this study.

9. References

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Appendix A

Figures

- Figure 1: Location of Planned Development
- Figure 2: Observation & Pumping Water Well Locations

A SIZE 8.5" x 11" (215.9mm x 279.4mm)

PLOT: 08/11/05 9:09:35 AM

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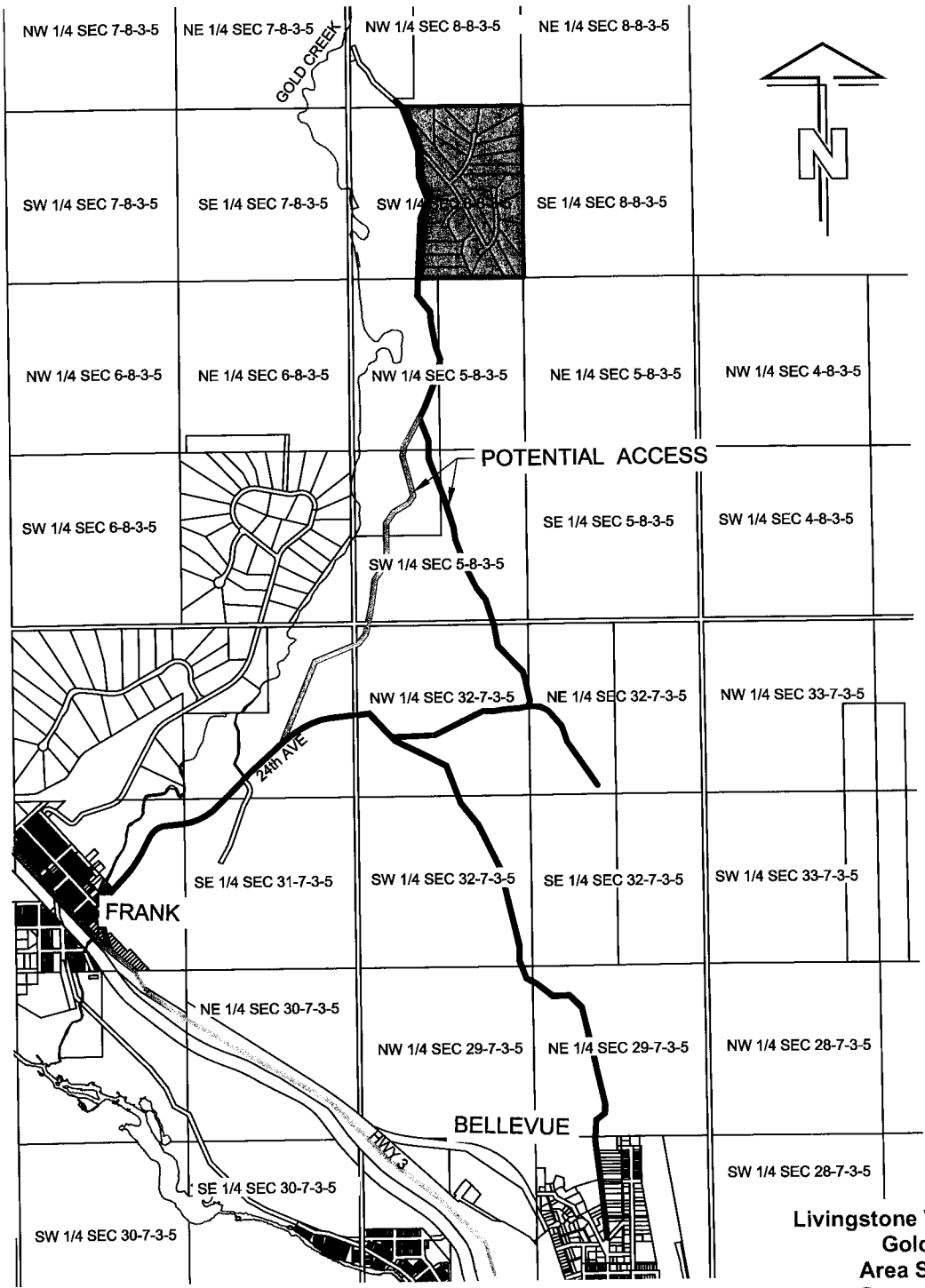
UMA FILE NAME:

ISS/REV: A

LEGEND

PROPOSED DEVELOPMENT		DEVELOPED-PRIVATELY OWNED	
EXISTING DEVELOPED R.O.W		HIGHWAY	
UNDEVELOPED R.O.W		ROADWAY	



Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Context Map

UMA | AECOM

Figure 1

LEGEND

OBSERVATION WELL LOCATION ⊡ PUMPING WELL LOCATION ⊕

ISS/REV: A
UMA FILE NAME: G511-001-00_01-B-F004_RX.dwg Saved By: gullicksonz PLOT: 08/10/24 11:12:03 AM
A SIZE 8.5" x 11" (215.9mm x 279.4mm)

UMA | AECOM

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Observation & Pumping Water Well Locations

Figure 2

Appendix B

Water Wells in the Gold Creek Area

Appendix B: Water Wells in the Gold Creek Area

AECOM

Owner	Land Location	Lot/Block	Driller	Year Drilled	Total Depth (m)	Aquifer Type	Completion Interval (m)	Depth to Water	Available Head	Discharge (m^3/day)	Spec. Cap. (m^3/d/m)	Use
Koentges, R.	NW-31-7-3-W.5		unknown	1987								Domestic
Koentges Subdivision	SE-6-8-3-W.5	Site 2	Camfield Drilling	1997	10.7	Till	6.1-10.7	2.40	3.60	43.20	11.93	Domestic
Koentges Subdivision	SE-6-8-3-W.5	Site 3	Camfield Drilling	1997	71.6	Sandstone	4.6-71.6	21.00		43.20	6.80	Domestic
Koentges Subdivision	SE-6-8-3-W.5		Camfield Drilling	1997	61.0	Sandstone	6.1-61	43.40		17.80	20.70	Domestic
Mckernan, Peter	SE-6-8-3-W.5		Camfield Drilling	1999	42.7	Sandstone	9.1-42.7			32.70		Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 7	Camfield Drilling	1999	109.7	Sandstone	12.2-107.7			26.20		Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 15	Camfield Drilling	1999	48.8	Sandstone	12.2-48.8	4.70	7.5	104.80	78.80	Domestic
Valley Ridge Estates	SE-6-8-3-W.5		Camfield Drilling	2002	89.9	Sandstone	77.7-89.9	18.10	59.60	53.30	1.32	Domestic
Cooper	SE-6-8-3-W.5	Lot 21	Camfield Drilling	2003	140.2	Sandstone	12.2-140.2	9.10		144.00	2.40	Domestic
Duke, Ron	SE-6-8-3-W.5	Lot 25	Camfield Drilling	2003	103.6	Sandstone	4.3-103.6	45.70		52.40	0.70	Domestic
Koentges Subdivision	SE-6-8-3-W.5	Lot 31	Camfield Drilling	2003	67.1	Sandstone	30.5-31	21.00	9.50	8.20	0.27	Domestic
Peterson, Gordon	SE-6-8-3-W.5	Lot 26	Camfield Drilling	2003	42.7	Sandstone	6.1-42.7	18.30		65.00	1.58	Domestic
Stickel, Gordon	SE-6-8-3-W.5	Lot 19	Camfield Drilling	2003	36.6	Shale	8.2-36.6	11.60		39.30	2.11	Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 4	Camfield Drilling	2003	30.5	Sandstone	6.1-30.5	5.50	0.60	58.30	1.94	Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 3	Camfield Drilling	2003	42.7	Sandstone	7.6-42.7	12.20		98.20	3.22	Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 2, Phase 2	Camfield Drilling	2003	73.2	Sandstone	7.6-73.2	25.00		29.50	0.82	Domestic
Valley Ridge Estates	SE-6-8-3-W.5		Camfield Drilling	2003	45.7	Sandstone	18.3-45.7	7.60	11.70	45.80	3.34	Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 1, Phase 2	Camfield Drilling	2003	54.9	Sandstone	9.4-54.9	16.20		20.50	6.02	Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 5, Phase 2	Camfield Drilling	2003	42.7	Sandstone	9.1-42.7	24.70		98.20	2.91	Domestic
Valley Ridge Estates	SE-6-8-3-W.5	Lot 18	Camfield Drilling	2003	67.1	Sandstone	10.0-67.1	19.80		52.40	1.20	Domestic
Wingenback, Ben	SE-6-8-3-W.5	Lot 20	Camfield Drilling	2003	48.8	Sandstone	12.2-48.8	14.00		43.20	1.44	Domestic
Wingenback, Wayne	SE-6-8-3-W.5	Lot 29	Camfield Drilling	2003	48.8	Sandstone		3.70		26.60	0.89	Domestic
Wong, Morley & Evelyn	SE-6-8-3-W.5	Lot 10	Camfield Drilling	2003	103.6	Sandstone	18.3-103.6	38.10		205.00	9.33	Domestic
Valley Ridge Estates	NE-36-7-4-W.5		Camfield Drilling	2007	55.8	Sandstone	51.8-61.5	3.10	48.70	53.30	6.88	Domestic

AECOM

Appendix C

Water Well Drilling Reports

Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.
The information contained in this "Water Well Drilling Report" is unverified by Alberta Environment

Alberta Environment

Well I.D.:	1170244
Map Verified:	Hand Held Auto 20-30m
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: CAMFIELD DRILLING SERVICES LTD.		Drilling Company Approval No.: 38398
Mailing Address: 1280 4 AVE S	City or Town: LETHBRIDGE AB CA	Postal Code: T1J 0R2
WellOwner's Name: LIVINGSTONE VENTURES LTD.	Well Location Identifier: SITE #1	
P.O. Box Number: 2702	Mailing Address:	Postal Code: T1K 6Z8
City: LETHBRIDGE	Province: AB	Country: CA

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
SW	08	008	03	5

Location in Quarter
FT from N Boundary
FT from E Boundary
Lot Block Plan

Well Elev: 4899 FT
How Obtain: Hand Held Auto 20-30m

3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Materials Used: Unknown
Method of Drilling: Downhole Hammer
Flowing Well: Yes
Rate: 1 Gallons
Gas Present: No
Oil Present: No

Proposed well use: Domestic
Anticipated Water Requirements/day 300 Gallons

6. Well Yield

Test Date (yyyy/mm/dd): 2008/08/13
Start Time: 11:00 AM
Test Method: Water Levels Only
Non pumping static level: 0 FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of 3 ~~inches~~ casing to ground level: 1-2.
Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery
Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

OBSERVATION WELL ONLY AT THIS POINT
Recommended pumping rate: 5 Gallons/Min
Recommended pump intake: 120 FT
Type Pump Installed
Pump Type:
Pump Model:
H.P.:
Any further pumptest information? No

4. Formation Log

Depth from ground level (feet)	Lithology Description
3	Loam
58	Till & Rocks
95	Till & Gravel
103	Till & Clay
160	Brown See Comments Shale

5. Well Completion

Date Started(yyyy/mm/dd): 2008/07/24	Date Completed (yyyy/mm/dd): 2008/09/05
Well Depth: 160 FT	Borehole Diameter: 6 Inches
Casing Type: Steel	Liner Type: Unknown
Size OD: 6.625 Inches	Size OD: Inches
Wall Thickness: 0.25 Inches	Wall Thickness: Inches
Bottom at: 105 FT	Top: FT Bottom: FT
Perforations from: FT to: FT from: FT to: FT from: FT to: FT	Perforations Size: Inches x Inches Inches x Inches Inches x Inches
Perforated by: Unknown	
Seal: Driven & Hole Plug from: FT	to: FT
Seal: Unknown from: FT	to: FT
Seal: Unknown from: FT	to: FT
Screen Type: Unknown from: FT to: FT	Screen ID: Inches Slot Size: Inches
Screen Type: Unknown from: FT to: FT	Screen ID: Inches Slot Size: Inches
Screen Installation Method: Unknown	
Fittings Top: Unknown	Bottom: Unknown
Pack: Unknown Grain Size:	Amount: Unknown
Geophysical Log Taken: Retained on Files:	
Additional Test and/or Pump Data Chemistries taken By Driller: No Held:	Documents Held:
Pitless Adapter Type: Drop Pipe Type: Length: FT	Diameter: Inches
Comments:	

7. Contractor Certification

Driller's Name: KEVIN BLAND
Certification No.: VC3171
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

The information contained in this "Water Well Drilling Report" is collected by Alberta Environment

Well I.D.:	1170243
Map Verified:	Hand Held Auto 20-30m
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: CAMFIELD DRILLING SERVICES LTD.		Drilling Company Approval No.: 38398
Mailing Address: 1280 4 AVE S	City or Town: LETHBRIDGE AB CA	Postal Code: T1J 0R2
WellOwner's Name: LIVINGSTONE VENTURES LTD.	Well Location Identifier: Site #2	
P.O. Box Number: 2702	Mailing Address:	Postal Code: T1K 6Z8
City: LETHBRIDGE	Province: AB	Country: CA

2. Well Location

1/4 or LSD	Sec	Twp	Rge	West of M
SW	08	008	03	5

Location in Quarter
FT from N Boundary
FT from E Boundary
Lot Block Plan
Site1
Well Elev: 4915 FT
How Obtain: Hand Held Auto 20-30m

3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Method of Drilling: Downhole Hammer
Flowing Well: Yes
Gas Present: No
Materials Used: Unknown
Rate: 1 Gallons
Oil Present: No
Proposed well use: Domestic
Anticipated Water Requirements/day 300 Gallons

6. Well Yield

Test Date (yyyy/mm/dd): 2008/08/13
Start Time: 918:00 PM
Test Method: Pump
Non pumping static level: 0 FT
Rate of water removal: 10 Gallons/Min
Depth of pump intake: 115 FT
Water level at end of pumping: 97.6 FT
Distance from top of 3 inches casing to ground level: ISE.

Depth To water level (feet)	Elapsed Time Drawdown Minutes:Sec	Recovery
1.24	1:00	9.26
3.35	2:00	88.8
5.4	3:00	86
8.2	4:00	83.7
10.1	5:00	81.9
12.2	6:00	80.4
14.5	7:00	79
16.2	8:00	77.9
17.3	9:00	76.3
19.3	10:00	75.9
20.1	12:00	74.2
21.5	14:00	72.6
23.5	17:00	70.8
25.3	20:00	69.2
29.6	30:00	65
32.8	40:00	61.9
35.3	50:00	59.46
37.4	60:00	57.4
39.4	70:00	55.7
41	80:00	54.1
42.5	90:00	52.8
43.8	100:00	51.5
45.1	110:00	50.4
46.2	120:00	49.4

Total Drawdown: 97.6 FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: 5 Gallons/Min
Recommended pump intake: 115 FT

4. Formation Log

Depth from ground level (feet)	Lithology Description
3	Loam
6	Sand & Silt
12	Till & Rocks
58	Till & Gravel
63	Lacustrine Silt
82	Till & Gravel
88	Till & Clay
125	Brown Soft Shale
140	Brown Hard Shale

5. Well Completion

Date Started(yyyy/mm/dd): 2008/07/15
Date Completed (yyyy/mm/dd): 2008/07/24
Well Depth: 140 FT
Borehole Diameter: 6 inches
Casing Type: Steel
Liner Type: Unknown
Size OD: 6.625 Inches
Size OD: Inches
Wall Thickness: 0.25 Inches
Wall Thickness: Inches
Bottom at: 88 FT
Top: FT Bottom: FT
Perforations
Perforations Size:
from: FT to: FT Inches x Inches
from: FT to: FT Inches x Inches
from: FT to: FT Inches x Inches
Perforated by: Unknown
Seal: Driven & Hole Plug
from: FT to: FT
Seal: Unknown
from: FT to: FT
Seal: Unknown
from: FT to: FT
Screen Type: Unknown
Screen ID: Inches
from: FT to: FT
Slot Size: Inches
Screen Type: Unknown
Screen ID: Inches
from: FT to: FT
Slot Size: Inches
Screen Installation Method: Unknown
Fittings
Top: Unknown
Bottom: Unknown
Pack: Unknown
Grain Size:
Amount: Unknown
Geophysical Log Taken:
Retained on Files:
Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held:
Documents Held:
Pitless Adapter Type:
Drop Pipe Type:
Length: FT
Diameter: Inches
Comments:
WATER PRODUCING IN HARD LENSES IN SHALE FROM 133-138

7. Contractor Certification

Driller's Name: KEVIN BLAND
Certification No.: VC3171
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection

Appendix D

Pumping Test and Recovery Test Data

UMA | AECOM
UMA Engineering Ltd.
17007-107 Ave
Edmonton, AB
(780)486-7000

Pumping Test - Water Level Data

Project: Gold Creek Wells

Number: G511-001-00-01

Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Pumping Test: Pumping Test 1	Pumping Well: Pump Well
Test Conducted by: Zan Gullickson	Test Date: 8/13/2008	Discharge: variable, average rate 5 [U.K. gal/min]
Observation Well: Pump Well	Static Water Level [m]: -0.20	Radial Distance to PW [m]: -

	Time [min]	Water Level [m]	Drawdown [m]
1	0	-0.205	0.00
2	0.5	0.20	0.405
3	1	0.38	0.585
4	1.5	0.60	0.805
5	2	1.02	1.225
6	2.5	1.31	1.515
7	3	1.63	1.835
8	3.5	2.07	2.275
9	4	2.49	2.695
10	4.5	2.80	3.005
11	5	3.08	3.285
12	5.5	3.30	3.505
13	6	3.72	3.925
14	6.5	4.13	4.335
15	7	4.43	4.635
16	7.5	4.79	4.995
17	8	4.95	5.155
18	8.5	5.12	5.325
19	9	5.28	5.485
20	9.5	5.43	5.635
21	10	5.90	6.105
22	11	5.86	6.065
23	12	6.12	6.325
24	13	6.35	6.555
25	14	6.57	6.775
26	15	6.77	6.975
27	16	6.97	7.175
28	17	7.17	7.375
29	18	7.35	7.555
30	19	7.53	7.735
31	20	7.71	7.915
32	22	8.02	8.225
33	24	8.32	8.525
34	26	8.57	8.775
35	28	8.82	9.025
36	30	9.03	9.235
37	32	9.24	9.445
38	34	9.44	9.645
39	36	9.63	9.835
40	38	9.83	10.035
41	40	10.00	10.205
42	45	10.40	10.605
43	50	10.77	10.975
44	55	11.14	11.345
45	60	11.41	11.615
46	70	12.01	12.215
47	80	12.50	12.705
48	90	12.95	13.155
49	100	13.36	13.565
50	110	13.74	13.945
51	120	14.09	14.295

UMA | AECOM
UMA Engineering Ltd.
17007-107 Ave
Edmonton, AB
(780)486-7000

Pumping Test - Water Level Data

Project: Gold Creek Wells

Number: G511-001-00-01

Client: Livingstone Ventures Ltd.

	Time [min]	Water Level [m]	Drawdown [m]
52	130	14.44	14.645
53	140	14.71	14.915
54	150	15.00	15.205
55	160	15.27	15.475
56	170	15.52	15.725
57	180	15.76	15.965
58	190	16.40	16.605
59	200	16.77	16.975
60	210	17.06	17.265
61	220	17.31	17.515
62	230	17.57	17.775
63	240	17.79	17.995
64	270	18.40	18.605
65	300	18.95	19.155
66	330	19.75	19.955
67	360	20.45	20.655
68	390	21.10	21.305
69	420	21.35	21.555
70	450	21.76	21.965
71	480	22.12	22.325
72	540	22.75	22.955
73	600	23.09	23.295
74	660	23.50	23.705
75	720	23.94	24.145
76	780	24.22	24.425
77	840	24.49	24.695
78	900	24.80	25.005
79	960	25.09	25.295
80	1020	25.32	25.525
81	1080	25.52	25.725
82	1140	26.09	26.295
83	1200	26.60	26.805
84	1260	26.94	27.145
85	1320	27.12	27.325
86	1380	27.34	27.545
87	1440	27.50	27.705
88	1560	27.72	27.925
89	1680	27.99	28.195
90	1800	28.22	28.425
91	1920	28.42	28.625
92	2040	28.61	28.815
93	2160	28.84	29.045
94	2400	29.24	29.445
95	2640	29.49	29.695
96	2880	29.76	29.965
97	2880.5	28.78	28.985
98	2881	28.23	28.435
99	2881.5	27.56	27.765
100	2882	27.08	27.285
101	2882.5	26.64	26.845
102	2883	26.22	26.425
103	2883.5	25.86	26.065
104	2884	25.53	25.735
105	2884.5	25.25	25.455
106	2885	24.97	25.175
107	2885.5	24.74	24.945

UMA | AECOM
UMA Engineering Ltd.
17007-107 Ave
Edmonton, AB
(780)486-7000

Pumping Test - Water Level Data

Project: Gold Creek Wells

Number: G511-001-00-01

Client: Livingstone Ventures Ltd.

	Time [min]	Water Level [m]	Drawdown [m]
108	2886	24.52	24.725
109	2886.5	24.28	24.485
110	2887	24.11	24.315
111	2887.5	23.91	24.115
112	2888	23.74	23.945
113	2888.5	23.58	23.785
114	2889	23.41	23.615
115	2889.5	23.26	23.465
116	2890	23.13	23.335
117	2891	22.87	23.075
118	2892	22.62	22.825
119	2893	22.39	22.595
120	2894	22.15	22.355
121	2895	21.95	22.155
122	2896	21.78	21.985
123	2897	21.58	21.785
124	2898	21.42	21.625
125	2899	21.25	21.455
126	2900	21.10	21.305
127	2902	21.81	22.015
128	2904	20.54	20.745
129	2906	20.28	20.485
130	2908	20.06	20.265
131	2910	19.83	20.035
132	2912	19.62	19.825
133	2914	19.42	19.625
134	2916	19.22	19.425
135	2918	19.05	19.255
136	2920	18.88	19.085
137	2925	18.49	18.695
138	2930	18.13	18.335
139	2935	17.80	18.005
140	2940	17.51	17.715
141	2950	16.97	17.175
142	2960	16.50	16.705
143	2970	16.09	16.295
144	2980	15.71	15.915
145	2990	15.37	15.575
146	3000	15.06	15.265
147	3010	14.77	14.975
148	3020	14.51	14.715
149	3030	14.26	14.465
150	3040	14.03	14.235
151	3050	13.83	14.035
152	3060	13.61	13.815
153	3070	13.41	13.615
154	3080	13.22	13.425
155	3090	13.04	13.245
156	3100	12.88	13.085
157	3110	12.72	12.925
158	3120	12.55	12.755
159	3150	12.15	12.355
160	3180	11.74	11.945
161	3210	11.40	11.605
162	3240	11.09	11.295
163	3270	10.80	11.005

UMA | AECOM
UMA Engineering Ltd.
17007-107 Ave
Edmonton, AB
(780)486-7000

Pumping Test - Water Level Data

Project: Gold Creek Wells

Number: G511-001-00-01

Client: Livingstone Ventures Ltd.

	Time [min]	Water Level [m]	Drawdown [m]
164	3300	10.54	10.745
165	3330	10.29	10.495
166	3360	10.07	10.275
167	3420	9.67	9.875
168	3480	9.29	9.495
169	3540	8.97	9.175
170	3600	8.66	8.865
171	3660	8.38	8.585
172	3720	8.13	8.335
173	3780	7.87	8.075
174	3840	7.64	7.845
175	3900	7.42	7.625
176	3960	7.22	7.425
177	4020	7.03	7.235
178	4080	6.82	7.025
179	4140	6.62	6.825
180	4200	6.44	6.645
181	4260	6.27	6.475
182	4320	6.14	6.345
183	4440	5.78	5.985
184	4560	5.45	5.655
185	4680	5.13	5.335
186	4800	4.82	5.025
187	4920	4.53	4.735
188	5040	4.25	4.455
189	5280	3.69	3.895
190	5520	3.17	3.375
191	5760	2.73	2.935

AECOM

Appendix E

Laboratory Analytical Results

AGAT Laboratories

2910 12TH STREET NE
CALGARY, ALBERTA
CANADA T2E 7P7

PH: (403)735-2005
FAX: (403)735-2771
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 08C288353
PROJECT NO: G511-001-00-13

CLIENT NAME: UMA ENGINEERING LTD.

ATTENTION TO: Michael Steed

Microbial Analysis

DATE SAMPLED: Aug 15, 2008 | DATE RECEIVED: Aug 18, 2008 | DATE REPORTED: Aug 19, 2008 | SAMPLE TYPE: Water

	Unit	G / S	RDL	G511-001-00-13 1050578
Fecal Coliforms (MF)	Coliforms/100ml		1	<1
Total Coliforms (MF)	Coliforms/100ml		1	<1

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

AGAT Laboratories

2910 12TH STREET NE
CALGARY, ALBERTA
CANADA T2E 7P7

PH: (403)735-2005
FAX: (403)735-2771
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 08C288353
PROJECT NO: G511-001-00-13

CLIENT NAME: UMA ENGINEERING LTD.

ATTENTION TO: Michael Steed

Routine Chemistry Water Analysis

DATE SAMPLED: Aug 15, 2008 | DATE RECEIVED: Aug 18, 2008 | DATE REPORTED: Sep 04, 2008 | SAMPLE TYPE: Water

	Unit	G / S	RDL	G511-001-00-13 1050578
pH		6.5-8.5	NA	8.1
p - Alkalinity (as CaCO3)	mg/L		5	<5
T - Alkalinity (as CaCO3)	mg/L		5	440
Bicarbonate (as CaCO3)	mg/L		5	440
Carbonate (as CaCO3)	mg/L		5	<5
Hydroxide (as CaCO3)	mg/L		5	<5
Electrical Conductivity	uS/cm		1	861
Chloride	mg/L	250	0.03	0.44
Fluoride	mg/L	1.5	0.01	<0.01
Nitrate	mg/L	45	0.08	<0.08
Nitrite	mg/L	3.2	0.03	1.02
Sulfate	mg/L	500	0.03	56.0
Calcium	mg/L		0.3	82.8
Magnesium	mg/L		0.2	31.8
Sodium	mg/L	200	0.6	75.6
Potassium	mg/L		0.6	0.7
Iron	mg/L		0.001	0.019
Manganese	mg/L	0.05	0.001	1.12
% Difference Cation/Anion	%			8.88
Anion Sum (Water)	meq/L			8.41
Calculated Electrical Conductivity	uS/cm			879
Calculated TDS	mg/L			511
Cation Sum (Water)	meq/L			10.1
Ion Balance				1.19
Nitrate + Nitrite (as Nitrogen)	mg/L			0.311
Nitrate-N	mg/L			<0.017
Nitrite-N	mg/L			0.311
Total Hardness	mg CaCO3/L			338

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME 2007 (D Water)
1050578 < - Values refer to Method Detection Limits.

Certified By:

CHAIN OF CUSTODY RECORD

AGAT Laboratories Limited
2910-12th Street NE
Calgary, Alberta T2E 7P7
http://webearth.agatlabs.com

Phone: 403-735-2005
Fax: 403-735-2771
Toll free: 800-661-7174
www.agatlabs.com

LABORATORY USE ONLY
Arrival Condition: ☐ Good ☐ Poor (complete "notes")
Arrival Temperature: _____ AGAT Job Number: _____
Notes: _____

Report To:
Company: UMA Engineering
Contact: Michael Steed
Address: 17007 - 107 Ave
Edmonton AB
Phone: 780-486-7016 Fax: 780-486-7070
LSD: _____
Client Project #: 6511-001-60-13

Report Information - reports to be sent to:
1. Name: Michael Steed
Email: michael.steed@uma.accom.com
2. Name: _____
Email: _____

Report Format
☑ Single Sample per page
☐ Multiple Samples per page
☐ Excel Format Included

Turnaround Time (TAT) Required
Rush TAT: (please provide prior notification)
☐ 24 to 48 hours
☐ 48 to 72 Hours
Regular TAT:
☑ 5 to 7 Working Days
DATE REQUIRED: _____

Invoice To: SAME (Y) / N) - circle
Company: _____
Contact: _____
Address: _____
Phone: _____ Fax: _____
PO/AFE#: _____

Regulatory Requirements (Check One):
CCME - Soil
☐ Agri
☐ Industrial
☐ Res / Park
☐ Commercial
☐ Alberta Tier 1
☐ Guide 50
☐ B.C. Regs
☐ Upstream Oil and Gas
CCME - Water
☑ Canadian Drinking Water
☐ FWAL

Sample Identification	Sample Matrix	Date/Time Sampled	Comments- Site/ Sample Info. Sample Containment	Detailed Salinity	CCME PHC, BTEX / F1-F4	Metals	AB Class 2 Landfill	Routine Potability Package	Microtox	[illegible]	Tot. Coliforms				# OF CONTAINERS	PRESERVED (Y/N)	CONTAMINATED/HAZARDOUS (Y/N)	
	Water							✓		✓	✓				3			

Samples Relinquished By (print name & sign): Ian Gullickson
Date/Time: 08/05/15 7:24 AM
Samples Received By (print name & sign): [illegible]
Date/Time: 08/08/15 7:23 AM

Samples Relinquished By (print name & sign): _____
Date/Time: _____
Samples Received By (print name & sign): _____
Date/Time: _____

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

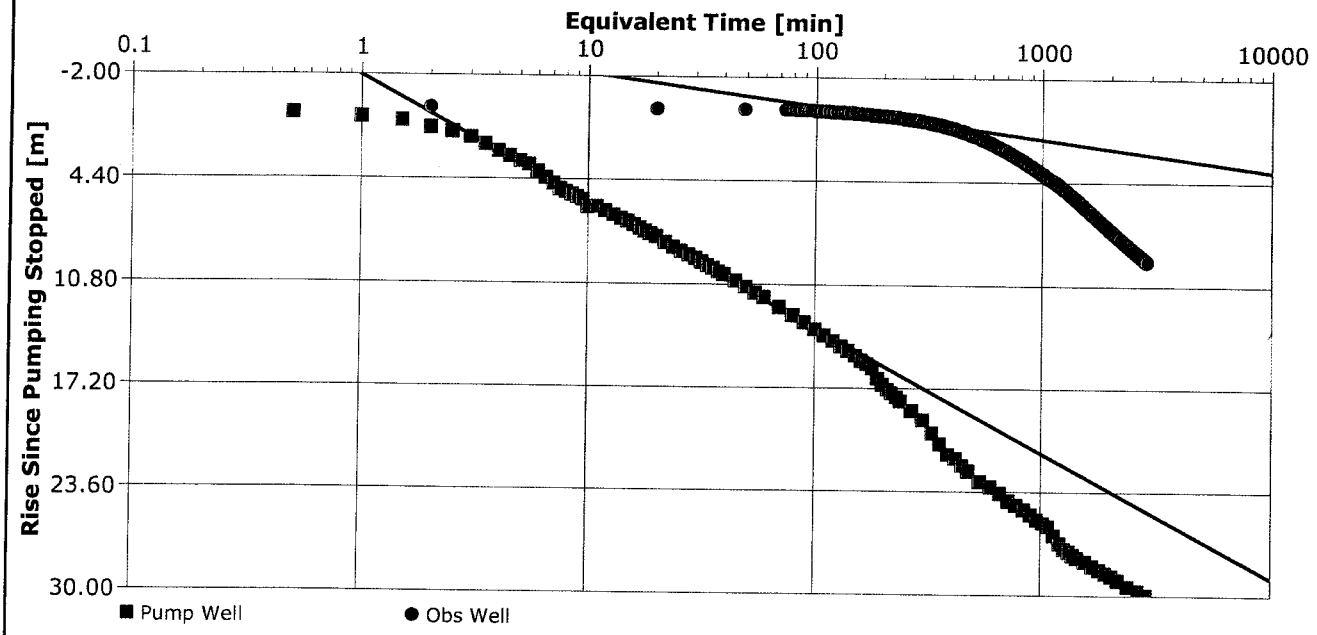
PAGE _____ of _____
NO: 0047802

Appendix F

Pumping Test Analysis Graphs

UMA Engineering Ltd. 17007-107 Ave Edmonton, AB (780)486-7000	**Pumping Test Analysis Report**
	Project: Gold Creek Wells
	Number: G511-001-00-01
	Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Pumping Test: Pumping Test 1	Pumping Well: Pump Well
Test Conducted by: Zan Gullickson		Test Date: 8/13/2008
Analysis Performed by:	Cooper and Jacob	Analysis Date: 9/24/2008
Aquifer Thickness: 1.50 m	Discharge: variable, average rate 5 [U.K. gal/min]	

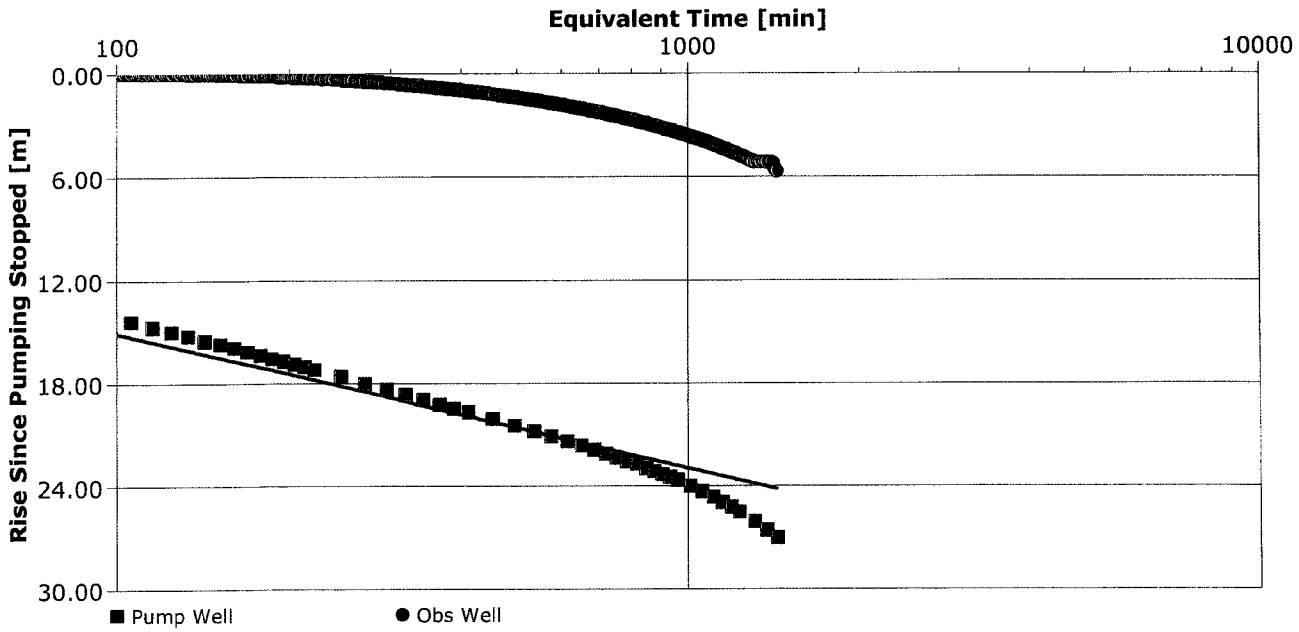


Calculation after Cooper & Jacob

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Pump Well	7.76×10^{-1}	5.18×10^{-1}	3.74×10^{-1}	0.08	
Obs Well	3.05×10^{0}	2.03×10^{0}	1.14×10^{-4}	72.8	
Average	1.91×10^{0}	1.28×10^{0}	1.87×10^{-1}		

UMA Engineering Ltd. 17007-107 Ave Edmonton, AB (780)486-7000	**Pumping Test Analysis Report**
	Project: Gold Creek Wells
	Number: G511-001-00-01
	Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Pumping Test: Pumping Test 1	Pumping Well: Pump Well
Test Conducted by: Zan Gullickson		Test Date: 8/13/2008
Analysis Performed by:	AGARWAL + theis	Analysis Date: 9/24/2008
Aquifer Thickness: 1.50 m	Discharge: variable, average rate 5 [U.K. gal/min]	

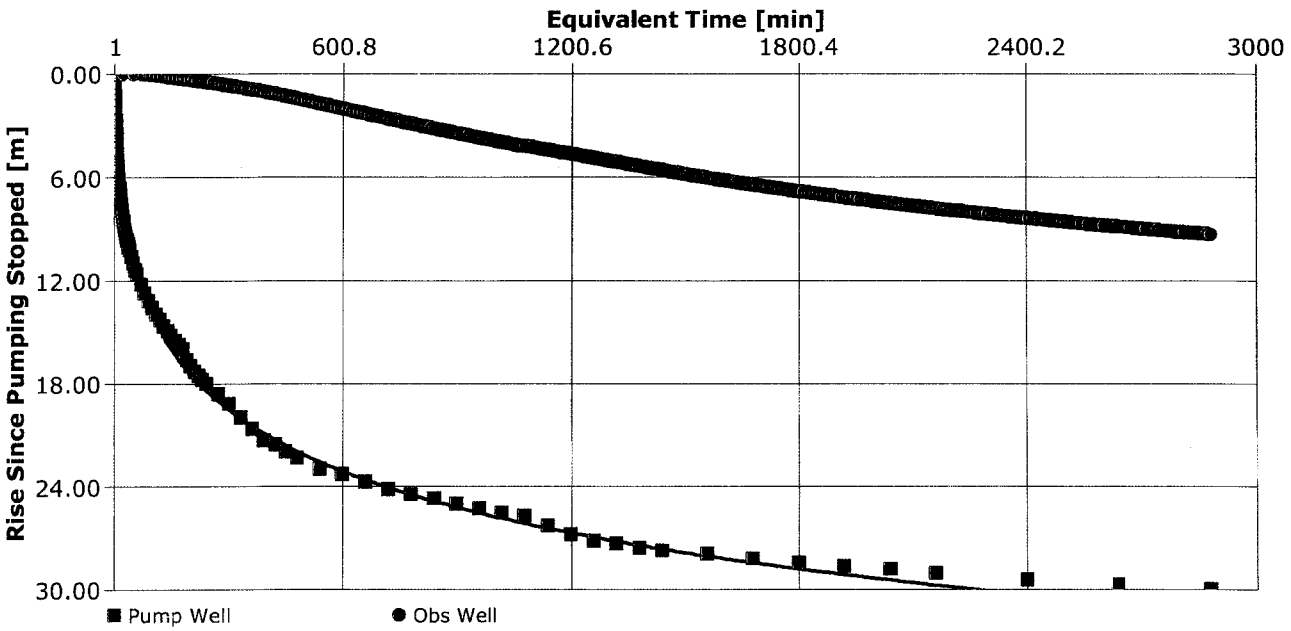


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Pump Well	1.52×10^{0}	1.02×10^{0}	5.00×10^{-1}	0.08	
Obs Well	6.60×10^{-1}	4.40×10^{-1}	2.05×10^{-4}	72.8	
Average	1.09×10^{0}	7.28×10^{-1}	2.50×10^{-1}		

UMA Engineering Ltd. 17007-107 Ave Edmonton, AB (780)486-7000	**Pumping Test Analysis Report**
	Project: Gold Creek Wells
	Number: G511-001-00-01
	Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Pumping Test: Pumping Test 1	Pumping Well: Pump Well
Test Conducted by: Zan Gullickson		Test Date: 8/13/2008
Analysis Performed by: MS	Moench Fracture Flow	Analysis Date: 9/8/2008
Aquifer Thickness: 1.50 m	Discharge: variable, average rate 5 [U.K. gal/min]	

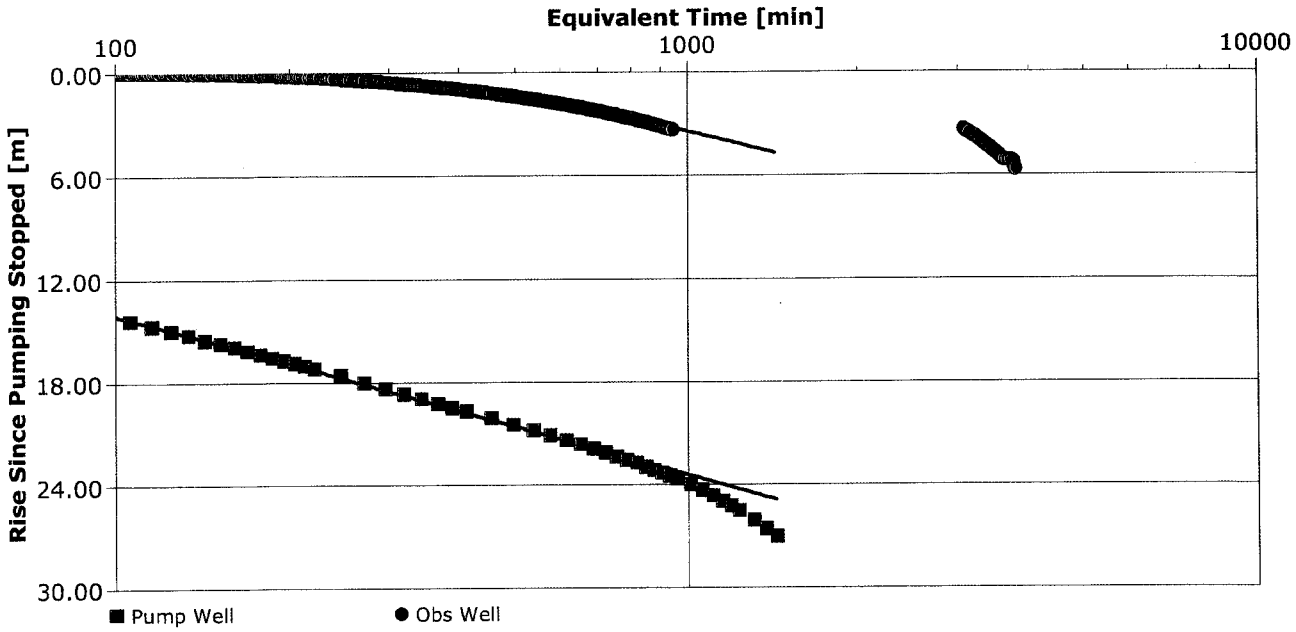


Calculation after Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Sigma	Gamma	SF	Radial Distance to PW [m]
Pump Well	1.00×10^{0}	6.67×10^{-1}	2.71×10^{-3}	7.08×10^{2}	1.45×10^{-3}	1.00×10^{-7}	0.08
Obs Well	8.00×10^{-1}	5.33×10^{-1}	9.20×10^{-5}	1.12×10^{0}	1.58×10^{0}	3.16×10^{-2}	72.8
Average	9.00×10^{-1}	6.00×10^{-1}	1.40×10^{-3}	3.55×10^{2}	7.93×10^{-1}	1.58×10^{-2}	

UMA Engineering Ltd. 17007-107 Ave Edmonton, AB (780)486-7000	**Pumping Test Analysis Report**
	Project: Gold Creek Wells
	Number: G511-001-00-01
	Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Pumping Test: Pumping Test 1	Pumping Well: Pump Well
Test Conducted by: Zan Gullickson		Test Date: 8/13/2008
Analysis Performed by: MS	AGARWAL + Moench Fracture Flow	Analysis Date: 9/19/2008
Aquifer Thickness: 1.50 m	Discharge: variable, average rate 5 [U.K. gal/min]	



Calculation after AGARWAL + Moench Fracture Flow

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Sigma	Gamma	SF	Radial Distance to PW [m]
Pump Well	1.28×10^{0}	8.53×10^{-1}	6.43×10^{2}	6.96×10^{-1}	1.00×10^{-7}	0.08
Obs Well	1.02×10^{0}	6.83×10^{-1}	1.80×10^{2}	1.00×10^{-1}	1.00×10^{0}	72.8
Average	1.15×10^{0}	7.68×10^{-1}	4.12×10^{2}	3.98×10^{-1}	5.00×10^{-1}	

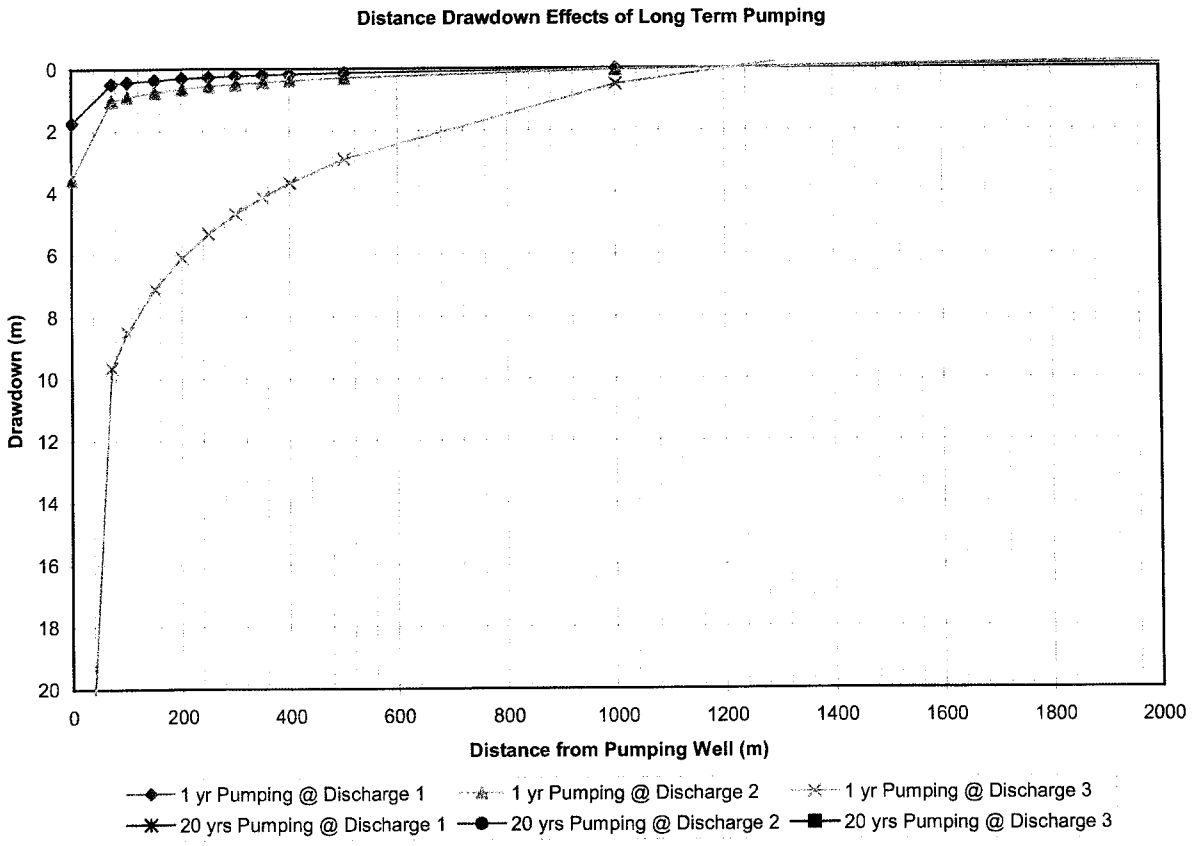
Job No.:	G511-001-00-01	Client:	Livingston Ventures Ltd.
Project:	Hydrogeological Assessment	Pumping Well:	pump well
Date:	3-Nov-08		

UMA | AECOM

Transmissivity:	3 m^2/day	Storativity:	0.00001
Aquifer Thickness:	1.5 m	Hydraulic Conductivity:	

Discharge 1:	3.42 m^3/day	Discharge 2:	7 m^3/day	Discharge 3:	65.5 m^3/day

Distance from Pumping Well (m):	Drawdown (m) - 2 days Pumping: Discharge 1:	Discharge 2:	Discharge 3:
0.075 Pump Well	1.7483	3.58	33.48
72 Obs. Well	0.50	1.03	9.65
100	0.44	0.91	8.51
150	0.37	0.76	7.10
200	0.32	0.65	6.11
250	0.28	0.57	5.33
300	0.25	0.50	4.70
350	0.22	0.45	4.16
400	0.19	0.40	3.70
500	0.15	0.31	2.93
1000	0.03	0.06	0.52
2000	-0.10	-0.20	-1.88



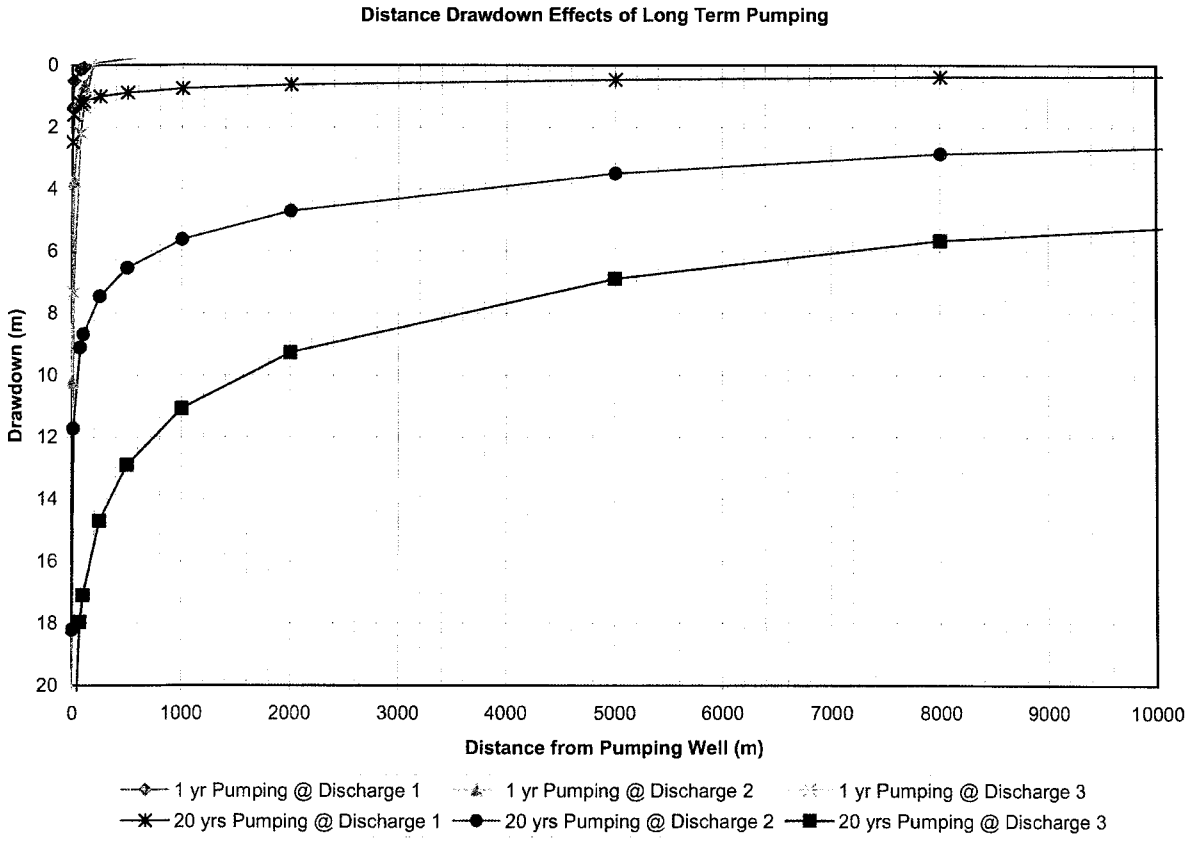
Job No.:	G511-001-00-01	Client:	Livingston Ventures Ltd.
Project:	Hydrogeological Assessment	Pumping Well:	pump well
Date:	13-Aug-08		

UMA | AECOM

Transmissivity:	3 m^2/day	Storativity:	0.00001
Aquifer Thickness:	1.5 m	Hydraulic Conductivity:	

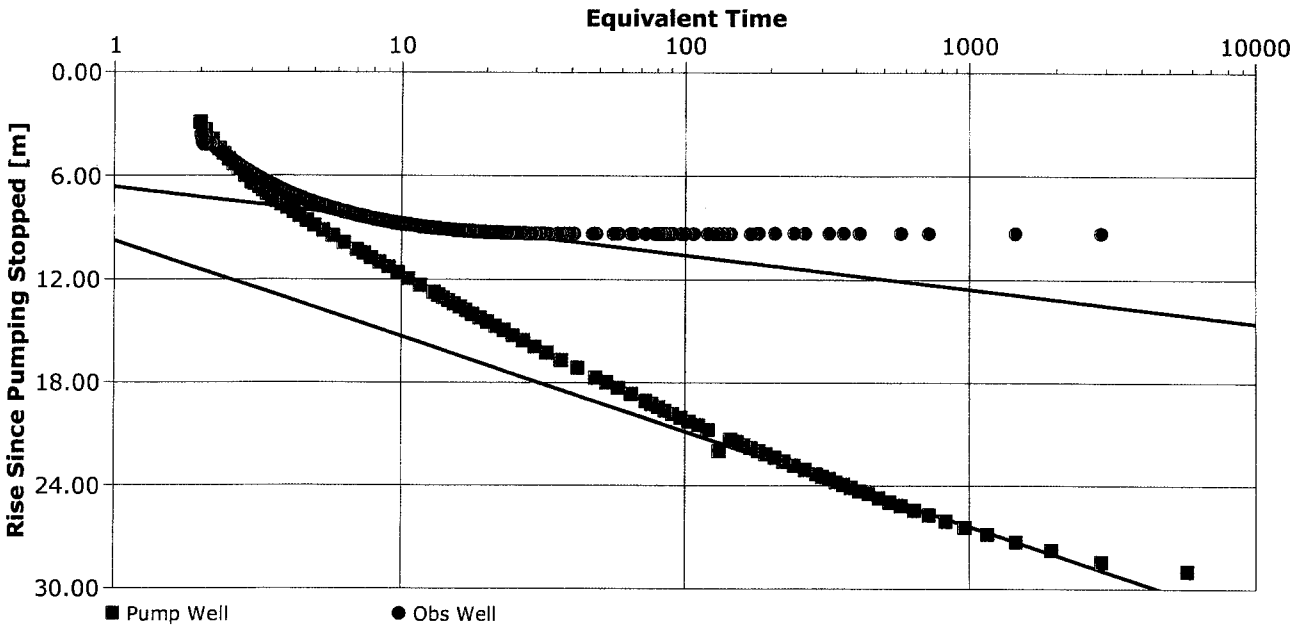
Discharge 1:	3.42 m^3/day	Discharge 2:	25 m^3/day	Discharge 3:	49.25 m^3/day

Distance from Pumping Well (m):	Drawdown (m) - 1 hour Pumping:			Drawdown (m) - 20 years Pumping:		
	Discharge 1:	Discharge 2:	Discharge 3:	Discharge 1:	Discharge 2:	Discharge 3:
0.075	1.3975	10.22	20.13	2.49	18.21	35.88
10	0.51	3.73	7.36	1.60	11.73	23.11
72	0.15	1.12	2.21	1.25	9.12	17.96
100	0.09	0.68	1.35	1.19	8.68	17.10
250	-0.07	-0.53	-1.04	1.02	7.47	14.71
500	-0.20	-1.45	-2.85	0.90	6.55	12.90
1000	-0.32	-2.37	-4.66	0.77	5.63	11.09
2000	-0.45	-3.28	-6.47	0.64	4.71	9.28
5000	-0.62	-4.50	-8.86	0.48	3.50	6.89
8000	-0.70	-5.12	-10.09	0.39	2.88	5.67
20000	-0.87	-6.33	-12.48	0.23	1.66	3.28
70000	-1.09	-7.99	-15.75	0.00	0.00	0.01



UMA Engineering Ltd. 17007-107 Ave Edmonton, AB (780)486-7000	**Pumping Test Analysis Report**
	Project: Gold Creek Wells
	Number: G511-001-00-01
	Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Pumping Test: Pumping Test 1	Pumping Well: Pump Well
Test Conducted by: Zan Gullickson		Test Date: 8/13/2008
Analysis Performed by: MS	theis recovery	Analysis Date: 9/24/2008
Aquifer Thickness: 1.50 m	Discharge: variable, average rate 5 [U.K. gal/min]	



Calculation after Theis & Jacob

Observation Well	Transmissivity [m²/d]	Hydraulic Conductivity [m/d]	Radial Distance to PW [m]	
Pump Well	1.08×10^{0}	7.21×10^{-1}	0.08	
Obs Well	3.02×10^{0}	2.01×10^{0}	72.8	
Average	2.05×10^{0}	1.37×10^{0}		

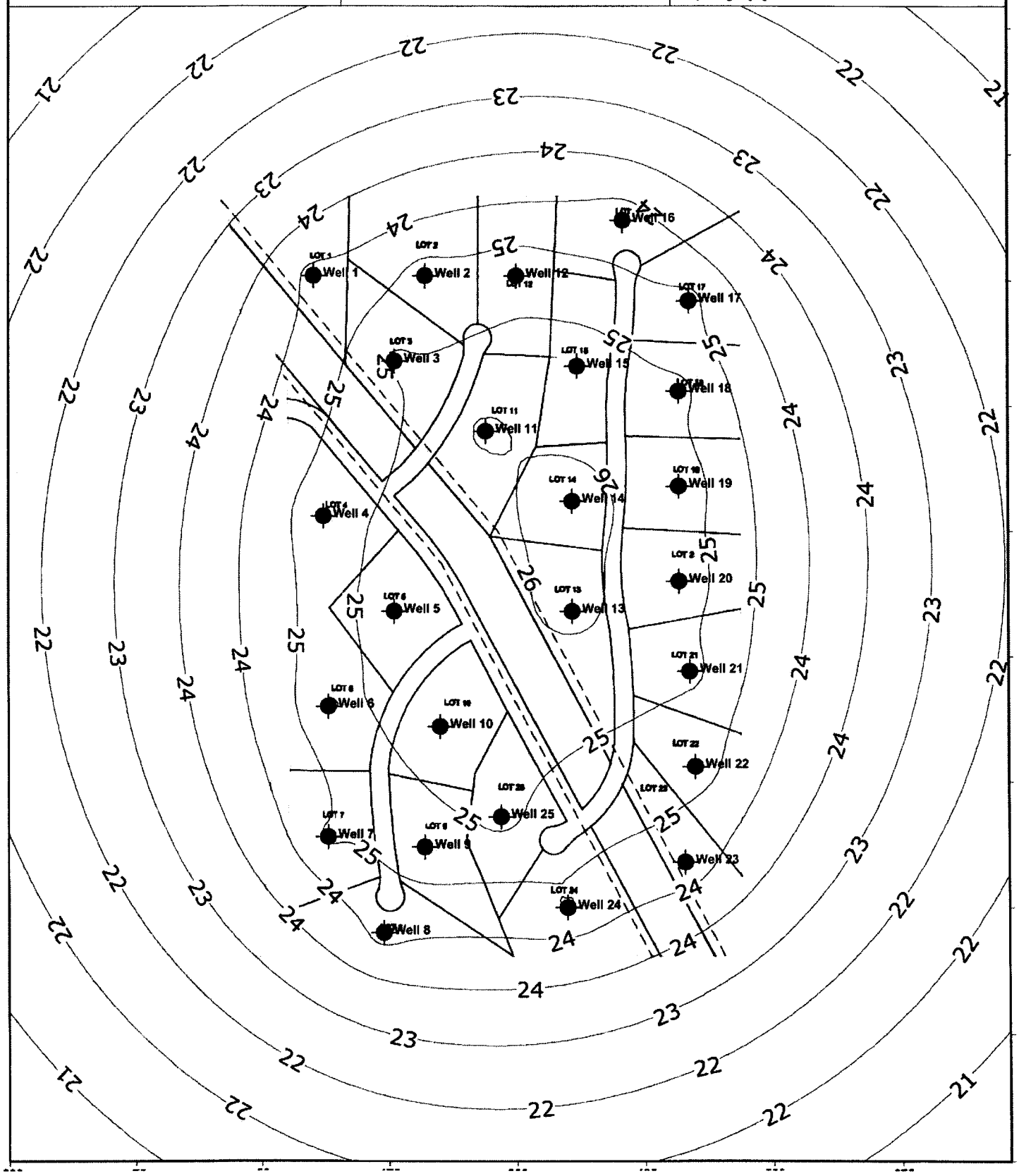
Appendix G

Drawdown Amount and Distance Curves

FIGURE 1

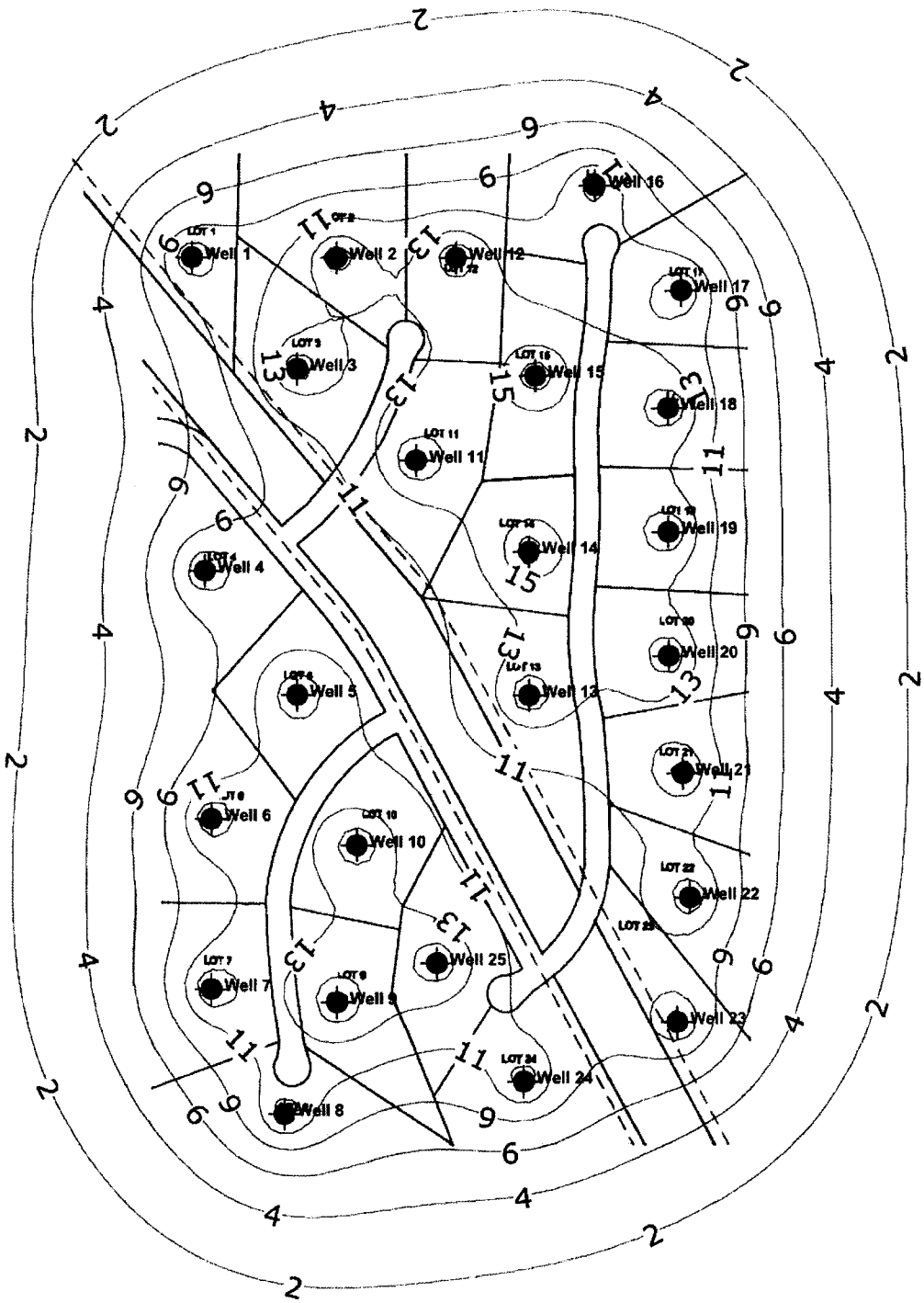
UMA Engineering Ltd. 17007-107 Ave Edmonton, AB (780)486-7000	**Site Plan** 20 Yr Drawdown at Proposed Wells (0.5 Igpm)
UMA	Project: Gold Creek Wells
	Number: G511-001-00-01
	Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Scale 1:5000	Map Origin [m] X: -200 Y: -200



UMA Engineering Ltd. 17007-107 Ave Edmonton, AB (780)486-7000	**Site Plan** 1 Hr Drawdown(m)at Proposed Wells(7.5 Igpm)
	Project: Gold Creek Wells
	Number: G511-001-00-01
	Client: Livingstone Ventures Ltd.

Location: Frank, Alberta	Scale 1:5000	Map Origin [m] X: -200 Y: -200



Appendix F

Geotechnical Evaluation

AECOM

Livingstone Ventures Ltd.

Gold Creek Geotechnical Evaluation

Prepared by:

UMA Engineering Ltd. doing business as AECOM
514 Stafford Drive North
Lethbridge, AB T1H 2B2

Date: November 2008

Statement of Qualifications and Limitations

Revision Log

Revision #	Revised By	Date	Issue / Revision Description

Signature Page

Report Prepared By:	Report Reviewed By:
Helen Sack	Nov 26/08
Helen Sack, E.I.T. **UMA Engineering Ltd.** doing business as **AECOM**	W.R. (Bill) MacMillan, P.Eng., P.Ag., M.Sc. **UMA Engineering Ltd.** doing business as **AECOM**

PERMIT TO PRACTICE
UMA ENGINEERING LTD.
Signature A. Holgate
Date Nov 26, 2008
PERMIT NUMBER: P329
The Association of Professional Engineers, Geologists and Geophysicists of Alberta.

Table of Contents

Appendices

1. Introduction

Livingstone Ventures Ltd. retained UMA Engineering Ltd. doing business as AECOM (AECOM) to conduct a geotechnical evaluation for the proposed Gold Creek development located northeast of the Town of Frank, Alberta. The purpose of the investigation was to determine the subsurface conditions at the site and to provide geotechnical recommendations for the design and construction of the development.

This report presents a summary of the field investigation, laboratory testing, and site conditions as well as geotechnical, materials and foundation design recommendations. A site plan is presented in **Appendix B** and test hole log data are presented in **Appendix A**.

2. Field Investigation

Eleven test holes were drilled on July 7th to 10th within the area on SW 08-08-03 W5M, east of the existing right of way (see **Figure 8**, **Appendix B**). The test holes were drilled to a maximum depth of eight metres.

AECOM staff supervised the drilling operation and soil textures were logged manually on site and representative disturbed soil samples were bagged and kept for laboratory analysis. Standard Penetration Tests (SPTs) were conducted at specified intervals within selected test holes to assist with the assessment of soil bearing capacity. Standpipe piezometers were installed in all test holes to monitor short term groundwater levels.

Percolation tests were performed on eight test holes on July 15th and 16th to assess the general suitability of the soils at the site for use of private sewage treatment (septic) systems within the proposed development. Percolation testing was conducted according to the *Alberta Private Sewage Systems Standard of Practice (1999)*. This consisted of installing eight 0.20 m diameter test holes to a depth of 0.9 m and performing falling water type percolation tests as set out in the standard. Watertable depth in the vicinity of the percolation test holes was measured within the standpipe piezometers (3.0 m depth minimum) that were located nearby.

Refer to the attached site map, percolation results table and test hole logs for detailed soil profile and groundwater level information.

3. Laboratory Testing

Moisture content determinations were conducted on all samples and test results are indicated on the attached test hole logs (**Appendix A**).

Table 3.1: Laboratory Tests

Test	Number	Data Location
Moisture Content	81	Borehole Logs
Atterberg Limits	4	Borehole Logs

Atterberg limit testing was conducted on four select samples to assess soil plasticity characteristics. The results are summarized in Table 3.2. Further information on these tests can be found in **Appendix C**.

Table 3.2: Atterberg Limit Test Results

Test Location	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index	Soil Classification
TH1 No. 3	27	20	7	CL – ML: Low Plastic Clay – Inorganic Silt
TH2 No. 6	29	13	17	CL: Low Plastic Clay
TH8 No. 6	21	21	0	MI or OL: Medium Plastic Inorganic Silt or Organic Silt
TH8 No. 8	32	18	14	CI: Medium Plastic Clay

4. Site Conditions

4.1 Subsurface Conditions

The geotechnical field test investigation generally characterized the subsurface stratigraphy at the site as having a 3.5 to 8 metre thick layer of glacial till materials. However, overburden depth is known to be up to 140 m deep in some locations at the site as a result of the water test wells drilled at the site, as shown in **Appendix A**. These glacial till soils are characterized as generally being low to medium plastic clay and silty clay materials. The tills are periodically interrupted by granular lenses composed of sand or weathered soft sandstone material that are generally les than 0.5 m thick. These granular lenses are evident in test hole logs at locations 3, 6, and 10 within 1.5 to 2 metres from surface. Other anomalies within the test hole logs include an interrupting silt layer in Test Hole 8, and a coal layer that occurs at the bottom of Test Hole 10. The native soils in the upper surface were generally very stiff to hard, with the exception of the materials found within tests holes and 10 according to SPT test results.

These results suggest that the on-site soils are highly variable with depth and location, as is often the case with glacial drift materials. Consequently, actual soil conditions found during on-site development should be expected to exhibit similar stratigraphic variation as that found during this investigation. This situation will create a need for good judgement with regard to geotechnical site conditions during site development and construction activities.

4.2 Groundwater Conditions

Soil moisture contents ranged from 4 - 21% and increase as testing moved downslope. Free water was found in several test holes at depths starting from 2 to 3.7 metres. A high water table was observed, as shown below in Table 4.2.1. The minimum depth of a lateral trench in a septic field is 0.3 m (12"), and the minimum distance between a lateral trench and the water table is 1.5 m (60") (refer to the Alberta Private Sewage Systems Standard of Practice, Alberta Municipal Affairs 1999). This high water table prevents use of standard septic systems for all lots as originally planned for the development, as four of eight water table levels measured less than 1.85 mbgl. The high water table should also be considered when planning construction practices for this site.

Table 4.2.1: Water Table Measurements
July 15 and 16, 2008

Hole #	Water Table Depth [m]
P01003	2.06
P01004	dry hole
P01005	1.70
P01006	0.689
P01008	dry hole
P01009	2.26
P01010	1.80
P01011	1.12

A map of the proposed subdivision development and the test hole locations is provided in **Figure 2**, **Appendix B**.

4.3 Percolation Test Results

AECOM conducted eight percolation tests on selected lots across the proposed subdivision. The tests consisted of installing 0.20 m (8 inch) diameter test holes to a depth of 0.9 m (3 feet) to perform standard percolation tests, as outlined in the Alberta Private Sewage Systems Standard of Practice (Alberta Municipal Affairs 1999). A second 3.0 m (9 feet) deep test hole was installed and fitted with slotted standpipe style piezometers to determine water table depth at each test location. The average percolation rates and water table depths observed at the site are summarized in Table 4.3.1 below. A map of the proposed subdivision development and the test hole locations are shown in **Figure 2**, **Appendix B**.

Table 4.3.1: Gold Creek Percolation Test Data and Water Table Depth (in) July 15 and 16, 2008

Hole #	Water Table Depth (m)	Water percolation rate (min/25 mm)	Mitigation Required	Nature of Problem
P01003	2.06	9.60	no	none
P01004	dry hole	24.00	no	none
P01005	1.70	15.00	yes	high water table
P01006	0.689	10.00	yes	high water table
P01008	dry hole	1.82	yes	high percolation rate
P01009	2.26	7.74	no	none
P01010	1.80	1.67	yes	high water table and high percolation rate
P01011	1.12	5.71	yes	high water table

Test Hole P01010 and P01008 both displayed a percolation rate higher than is allowed by the Standard. Both high water table and high percolation rate issues were observed at Test Hole P01010, which is an unusual circumstance. Percolation tests conducted at two separate time scales at this location verified the consistency of these results. One possible explanation for this condition is rapid lateral flow conditions in the upper soil profile through preferential flow pathways, which could be caused by vegetative root networks, lateral soil/ rock fractures or course soil lenses.

Please note that, according to the Standard, the percolation tests outlined here are for subdivision approval purposes only and should not be used for on-site septic system design purposes unless the septic system is constructed at the location where the actual tests were performed. Due to the adjustment of the original Area Structure Plan, the test locations do not match the desired septic field location for all lots. In the case that traditional septic sewage treatment systems are not suitable for an individual lot alternative systems, such as pump out storage tanks, mounds or pre-manufactured systems are generally a viable alternative. Where properties are used as seasonal or occasional residences, pump-out storage tanks are usually an inexpensive alternative to consider.

5. Slope Stability Evaluation

5.1 General

The intent of the slope stability assessment is to establish setback requirements relative to the topographic features and soil and water characteristics identified in the site investigation. AECOM conducted a geological site reconnaissance survey which included visual inspection of slopes and geological measurement of outcrop in the developing area and its extended vicinity to augment the geotechnical site investigation data. Therefore the slope stability analysis was conducted based on data from regional geological maps, the geological reconnaissance and drilling investigations and laboratory test results. The analysis included consideration for the possible impact of inherent slope stability issues

and the impact of subdivision development on the ultimate slope stability condition of the site. Subdivision site development considerations include projected load increases and changes to site grades and potential soil moisture content changes that may impact slope stability. The analysis was conducted with the objective of meeting an acceptable slope stability Factor of Safety (FS) with respect to representative soil and rock strength parameters under specific site characterization model scenarios. These model scenarios were used to assess existing slopes stability under various developmental setback conditions for the proposed project.

5.2 Methodology

The proposed development was divided into five areas based on topographic and geologic site characteristics for purposes of analysis. Four cross section lines were established across the development based on bedrock dip direction, as established in the site geological survey. Slope stability analysis was conducted along these established cross section lines to evaluate the stability of each site area.

The Geo Studio 2004 by Geoslope was used to analyze the slope stability relative to the critical slip surfaces. In particular, Slope/w, which uses the Limit Equilibrium method was the main analytic program employed in this study where the site conceptual model included soil sediments overlying bedrock at depth. The Equal-Area Projection method was used to analyze the stability of exposed rock outcrop areas upslope and to the east to the proposed development area. The site conceptual model used the geometric relationship between two main groups of discontinuities (i.e., rock joints) and their intersection lines relative to the bedrock and surface slopes as a basis for the analysis. The Slope/w model from the Geo Studio model suite was used to perform the slope analysis to establish potential failure planes and FS values using the appropriate site characteristic conceptual model.

5.3 Slope Stability Analysis

The site conceptual model for the slope stability analysis was developed based on geological reconnaissance survey, and the geotechnical site investigation. Visual observations of the slopes in the project area indicate the slopes are currently stable within the existing study area. Soil deposits throughout the project site area are of variable thickness and moisture content. Surficial deposit thickness varies between approximately two (2) and 40 meters.

Due to the variation in slope and overburden thickness, the development site was broken up into five separate areas to reflect the variation in site conditions **Figure 4**. The majority of the soils within the areas characterized by steeper slopes are thin (2 – 8 m), wet to moist clay and silty clay deposits overlying shallow bedrock. However, where the slopes are less steep there are deep (8 – 30^{+}m), wet to saturated clay till deposits overly the glacially carved bedrock floor. Soil strength parameters required for the Mohr-Coulomb slope stability analysis were estimated from published values as interpreted from in-situ and lab test data based on the local experience of AECOM staff and others with similar sites in the general area of this project.

The selected soil strength parameters used to develop the analytical model are indicated in stratigraphic profile sequence from ground surface downward for the different scenarios modeled, as follows:

Layer 1: Clay in Part 1, Part 2, Part 3, Part 4 (i.e., steep slopes)

Unit Weight:	19 kN/m3
Cohesive Intercept c':	10 kPa
Friction Angle Φ':	25°

Layer 2: Clay in Part 5 (i.e., shallow slopes)

Unit Weight:	19 kN/m3
Cohesive Intercept c':	5 kPa
Friction Angle Φ':	20°

Layer 3: Highly Weathered Shale (or Residual Clay) in Part 1, Part 2, Part 3, Part 4

Unit Weight:	20 kN/m3
Cohesive Intercept c':	0 kPa
Friction Angle Φ':	22°

Layer 4: Highly Weathered Shale (or Residual Clay) in Part 5

Unit Weight:	20 kN/m3
Cohesive Intercept c':	0 kPa
Friction Angle Φ'(Residual):	19°

Layer 5: Lightly Weathered Shale

Impenetrable

The four typical cross-section lines (see **Figure 4**) that were established from the topographic survey were used to conduct the slope stability analysis. The stability of the existing slopes was evaluated for both shallow (slip surface located within the upper clay soil layer) and deep seated (global) failures. The slip surface for the case of global failure along was established as being along the highly weathered shale upper bedrock surface.

Using the above noted parameters the slope stability analyses indicate that the existing slopes are relatively stable under existing conditions. A minimum slope stability of FS =1.2 was calculated for the Part 1 and Part 4 areas and an FS = 1.17 was determined for the Part 3 and Part 4 locations. The critical mode of slope failure for these areas was shown as deep seated (global) failure, where the slip surface will occur across the soil - weathered bedrock shale interface. While these FS values indicate that the upper slopes are now marginally stable, the minimal stability indicated by these low numbers suggests that failure could result due to small site condition changes on these steeper upper slopes. The minimum slope FS for the Part 5 area is greater than 2.0 for all failure modes assessed due to the relatively low dip angle of underlying bedrock. This calculated FS suggests that these lower slope areas are acceptably stable for development.

5.4 Discussion of Results

Due to the potential for failure on the steeper slopes within the proposed development AECOM undertook to develop a setback line for development within the proposed subdivision. The recommended setback line was developed based on the proposed post-development conditions using the previously described site conceptual model. A minimum FS =1.5 was used to select the minimum setback line each of the established site areas. Various water table scenarios were assessed to determine the impact on slope stability as impacted by water table fluctuations. Successive iteration of site development scenarios established the recommended safe developmental setback line position relative to the existing slope crests, as shown in **Figure 3, Appendix B**. No substantial change in stability was determined for the areas deemed as developable within the proposed project site.

Because the slope angle increases sharply upslope and to the east of the proposed development site (to the maximum angle of 60° on the crest of the slope) an assessment of the stability of this area was conducted. Thin layers of weathered siltstone and limestone outcroppings were observed along these slopes during the geological site investigation. Numerous pieces of broken -off rock, whose likely origin is from the upslope areas, were also noticed. This suggests some minor upslope failures may be occurring over time. Observation confirmed that two main groups of joints have developed within the rock mass at 50~60cm intervals. Additional tension cracks were also observed within these joints.

The Equal-area Projection Method indicted that the dip (ψi=20°) of the intersection line of the two joints observed is less than the dip (ψf=46.5) of the bedrock surface and the peak friction angle (Φ=25°) of the bedrock. Therefore, the rock outcrop above the proposed development is considered stable under current conditions with a factor of safety of approximately 1.2. While this slope is currently considered stable, the addition of any loads or further weathering of the rock has the potential to induce unstable slope conditions. Such circumstances could induce rock toppling conditions that may present a potential safety hazard to the development below.

6. Geotechnical Recommendations

6.1 General

Recommendations provided herein are based on field observations and laboratory test results. The bearing capacity analysis conducted for this report uses a factor of safety of three. Allowable foundation settlement depths were assumed to be no more than an anticipated maximum of 25 mm. A more rigorous foundation analysis and design should be conducted where bearing pressures from the structure are anticipated to exceed those suggested in this report. The following subsections deal with: foundation recommendations; soil swelling potential; site drainage; cement type; excavation; and backfill.

6.2 Slope Related Development Guidelines

The recommended setback line that established a slope stability FS of 1.5 for the proposed development is shown on **Figure 1** and the zone of restricted development is upslope of the setback line. Buildings and other structures should not be constructed beyond the setback lines; the areas above the setback line

should remain relatively undisturbed. AECOM recommends that the development setback lines shown on **Figure 1** should be established by field survey prior to any development of the proposed land. AECOM personnel should also be in attendance during the site survey to minimize interpretation errors.

It is important to recognize that the intention of the developmental setback is to minimize the possibility of future slope failures having a direct impact to the developed areas of the project site. They are not intended to prevent the occurrence of any potential slope failures across the site. Furthermore, while the stability of slopes within the confines of the recommended setback line is considered acceptable for normally expected natural events such as wind, rainfall, snowfall, etc, instability may occur during more extreme events.

Additional safety precautions which should be included in the design of the proposed development with respect to slope stability issues are outlined as follows:

- Take care to induce minimal disturbance of the proposed project site and any required slope increases should be avoided and/or undertaken with extreme caution.
- Field observation and analytical assessment indicates that additional weathering under extreme conditions could induce further failure of the uphill rock slopes. Structural reinforcement of these slopes (such as steel wire mesh draped over the face of slope and ring net fencing) should be established where development occurs downslope of these areas.
- Please note that the risks associated with avalanche have not been addressed herein but we recommend that the potential for avalanches from the mountains upslope of the development area should be taken into account when siting residential and other structures.
- Positive site grading should be established to ensure that surface drainage from the development is directed away from the proposed lots, as established within the development's storm water management system plan.
- Any fill excavated during development should not be disposed of within the development restriction zone unless directed otherwise by a qualified geotechnical engineer.
- Do not clear any vegetation, other than that required to establish planned site structures and appurtenances.
- Maintain vegetation cover along the crests and on the steeper slopes.
- Avoid irrigation or watering of vegetation anywhere within this proposed development as changes in the moisture content of soil overburden materials is likely to result in a general increase in the potential for slope failure that could result in damage to property, personal injury or death.

6.3 Foundation Recommendations

Foundation footing systems on this site should be founded on native, undisturbed soils or on appropriately compacted engineered fill. Test holes show that a minimum of 3.5 metres of silty clay or clay till materials overly bedrock across the developable areas of the project site and that some of the tills exhibit sand or weathered sandstone lenses within the soil profile. The foundation analysis conducted for this report uses a factor of safety of three and an anticipated maximum foundation settlement of 25 mm. A more rigorous

foundation analysis and design should be conducted where bearing pressures from the structure are anticipated to exceed those suggested in this report.

For heated structures, exterior shallow footings should be founded at a minimum depth of 1.5 m below final grade to protect against frost action. Footings in unheated sections of the building should be provided, with a minimum of 2.1 metres of soil cover to prevent frost damage. Interior pad footings should be founded with the top of the footing at the bottom of the floor slab. The allowable bearing capacities for various areas of the site are found in Table 5.2.1. Soil bearing capacity was calculated based on the SPT 'N' value from the proposed foundation grade, assuming that the foundation footings will be placed at approximately the recommended frost protection depth noted above.

Table 6.3.1: Computed Bearing Capacity * Based on SPT 'N' Blow Counts

Test Hole	Footing Depth (m)	Footing Width (m)	SPT 'N'	Kd	Computed Bearing Capacity (kPa)	Allowable Bearing (kPa; FS=3)
TH2 - setback	1.2	1.2	25.0	1.33	665	222
	1.2	1.2	18.0	1.33	479	160
TH3 - setback	1.2	1.2	42.0	1.33	1117	372
	1.2	1.2	40.0	1.33	1064	355
TH4	1.2	1.2	31.0	1.33	825	275
	1.2	1.2	36.0	1.33	958	319
TH5	1.2	1.2	7.0	1.33	186	62
	1.2	1.2	11.0	1.33	293	98
TH6 - setback	1.2	1.2	57.0	1.33	1516	505
TH8	1.2	1.2	20.0	1.33	532	177
	1.2	1.2	18.0	1.33	479	160
TH9 - setback	1.2	1.2	26.0	1.33	692	231
	1.2	1.2	14.0	1.33	372	124
TH10	1.2	1.2	13.0	1.33	346	115
TH11	1.2	1.2	27.0	1.33	718	239
	1.2	1.2	33.0	1.33	878	293
Average	**1.2**	**1.2**	**26.1**	**1.33**	**695**	**232**

As the soil bearing capacities vary substantially across the site, the calculated average bearing capacity (232 kPa) is not a reliable indicator of the actual bearing capacity that should be used for foundation design. Test Holes 2, 3, 6 and 9 were drilled within the area that is now designated as non-developable due to the slope stability setback recommendations. Therefore, the bearing capacities indicated for those locations should not be considered as valid for the purpose of residential structure foundation design.

The majority of the calculated bearing capacities are suitable for standard residential development (125 kPA) purposes. The exceptions to the general rule were the results from Test Holes 5 and 10. The calculated bearing capacity of the deep till soils at Test Hole 5 appears to be impacted by the higher soil moisture content of the shallow layers. Dewatering of this area may improve the soil bearing capacity; but appropriate testing should be performed to confirm bearing capacities during foundation construction. Alternatively, these wetter materials could be removed and replaced with engineered fill to improve site

conditions or a site specific foundation design could be considered. The geotechnical investigation in the area of Test Hole 10 identified a thin saturated sand lens near likely approximate foundation depth. This anomaly is the likely cause for the lower bearing capacity of the shallow soils in this area of the proposed development. It is recommended that such materials be removed and replaced with an appropriate engineered fill material where such anomalies are encountered during foundation construction to develop a competent foundation sub-grade conditions.

Where engineered fill is used as a foundation bearing surface, the materials should be constructed to a minimum 98% of the maximum Standard Proctor test compaction density under full-time supervision of a geotechnical engineer or qualified technician. Settlement of the structure should be anticipated where engineered fill is used for the foundation of residential structures of this type. Allowable bearing pressures on engineered fill should be adjusted to two thirds (2/3) of that for native soils, as per Table 5.2.1. If the bearing capacities of engineered fill are unacceptably low when adjusted in this manner a qualified geotechnical engineer should be consulted to develop an appropriate foundation design for any planned structures with consideration for applied loads and the actual bearing capacity of the soils. Where engineered fills are used for a foundation sub-grade it is recommended that the entire foundation subgrade be excavated and replaced with similar materials to avid differential settlement concerns.

All loose, disturbed, remoulded or sloughed material should be removed from the bearing surface of footing excavations. Footing excavations should be protected from rain, snow, drying, and ingress of free water at all times. **Do not** pour footings on frozen soils.

6.4 Soil Swell Prevention

The results of the moisture content testing and classification of foundation soils as low to medium plastic suggest a low potential for shrinking/swelling of the near surface soils. However, soil swelling can cause uplift of foundations, sidewalks and asphalt surfaces where water is allowed to infiltrate and accumulate in the subsurface. Therefore it is advised that site landscaping should be developed to ensure provide positive drainage away from foundations and the edges of surficial concrete to minimize the potential for damage to structures related to swelling. Design and construct final surface grades to attain positive drainage away from the structure to prevent soaking of the soils along the footings and walls. Irrigation of lawns or gardens should be avoided within 3 m of the building foundation. In any case, do not over irrigate and manage any irrigation activities near building foundations to prevent deep percolation of water into the subsoil.

6.5 Site Drainage

After construction is complete, including compaction of all backfill materials, grade the ground surface around each structure to ensure that surface water drains away from the structure. Slope the ground surface within 2 m of any structures to a minimum 5% gradient away from the building. Lot grading should be minimized to preserve existing vegetation and prevent excessive erosion. Where natural lot drainage presents a concern to building development, site grading or alternative measures, such as infiltration trenches, may be used to divert runoff from the building area. Direct all roof drains away from structures and extend downspouts to a minimum of 2 m from the building. The remainder of the lots should be graded to direct water downslope, with a minimum gradient of 2%. All foundations should be fitted with a perimeter drainage system to relieve groundwater from the immediate area of the foundation. All

foundation drains should be constructed with a positive downslope grade and a free outlet to surface or other appropriate outfall. Concentrated discharges should be avoided wherever possible; appropriate engineered armouring (ie: geotextile, rip-rap) should be provided if concentrated stormwater discharge is necessary. Stockpiled topsoil material may be reused for landscaping once site grades are established. Such soils should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90% of Standard Proctor Maximum Dry Density (SPMDD).

6.6 Sulphate Attack and Corrosion Control

Based on our experience with similar soils, it is anticipated that there will be moderate to severe concentrations of sulphates in the subsoils. Use Type 50, Sulphate Resistant Portland cement for all foundation concrete in contact with these subsoils. Follow the recommendations provided in CSA Standard A23.2 for sulphate exposure classification S-2. Specify any metals that will be in contact with these subsoil materials to provide adequate corrosion protection for use in a severely corrosive environment.

6.7 Excavation

Follow all Occupational Health and Safety guidelines when constructing and working in and around all excavations. Typically, this would mean that temporary vertical side slopes are allowed for excavations less than 1.5 m deep, and back sloping may be used for excavations deeper than 1.5 m. If sloughing of a trench wall is observed, side slopes of excavations less than 1.5 m deep should be sloped to 3:1 (vertical to horizontal) or flatter, and shoring may be needed for excavations deeper than 1.5 m where adequate back sloping is not possible.

6.8 Backfill

Foundation backfill consisting of native clay should be compacted to prevent settling and or ingress of water in or around the foundation. Imported gravel backfill may be used, but where infiltration of water is a concern, these materials should be capped with an impermeable material to prevent accumulation of water around foundations or utilities. Separate and remove all vegetation and organic soils from backfill materials prior to placement of engineered fill. Do not place backfill against structures until concrete foundation elements have developed sufficient strength and are laterally supported to resist earth pressures resulting from fill placement.

Standard Proctor tests can be performed on representative samples by AECOM to determine the appropriate compaction requirements for the native site soils. This will need to be completed prior to any compaction testing of backfill or engineered fill materials that may be required at the site.

7. Inspection

It is recommended that a qualified geotechnical engineer or technician be engaged to inspect foundation installations and to perform density tests on backfill materials.

8. Closure

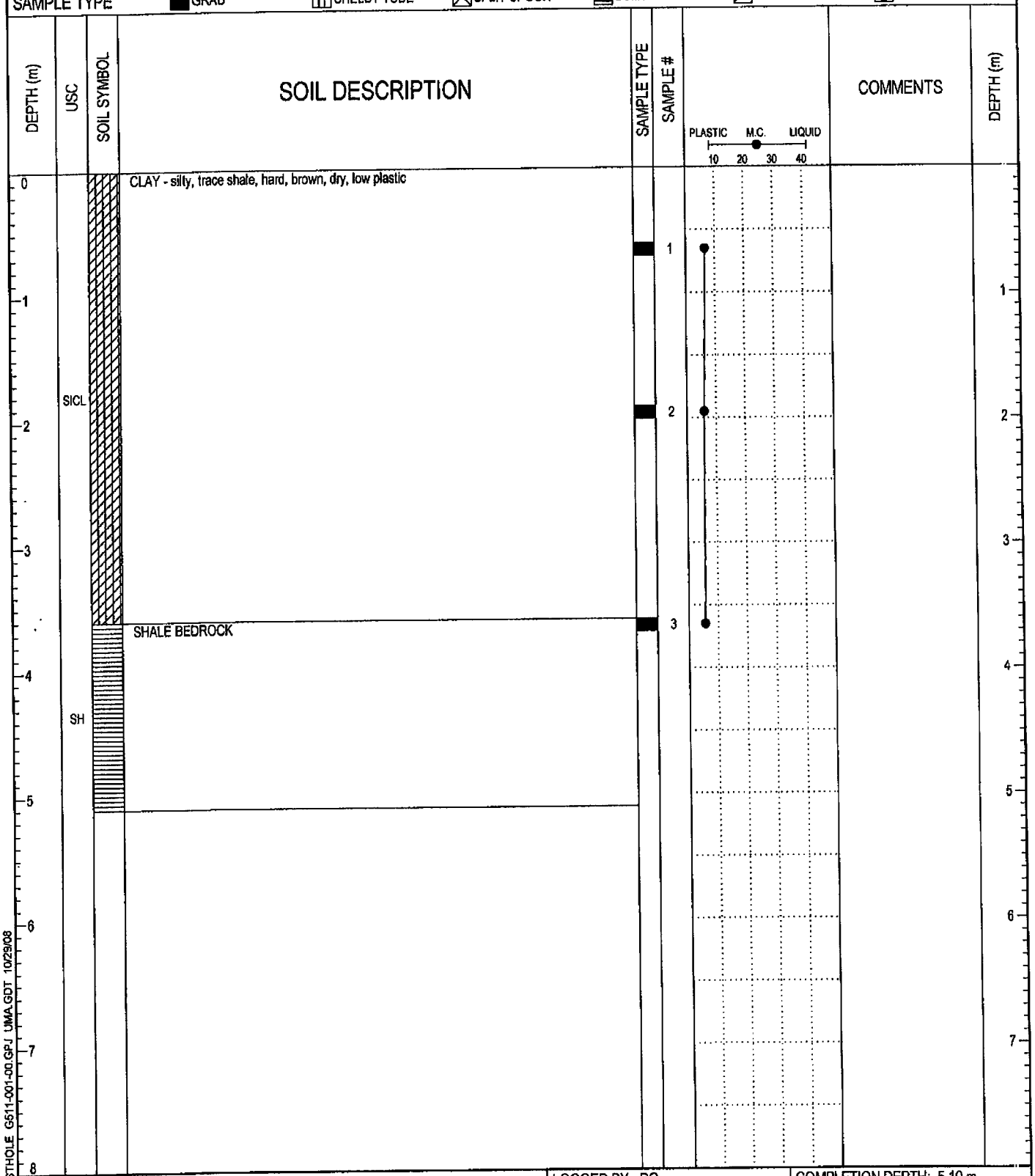
The recommendations given in the above sections are based upon interpreted conditions found in the eleven test holes drilled at this site. On-site soil conditions were observed to be highly variable – careful attention should be paid to individual lot conditions during development. Should individual lots with subsurface conditions other than those presented in this report be encountered during construction, the Client should notify our office so that the recommendations can be reviewed.

Appendix A

Borehole Logs

PROJECT: Gold Creek Development	CLIENT: Livingston Ventures	TESTHOLE NO: 1
LOCATION: As shown in drawing		PROJECT NO.: G511-001-00
CONTRACTOR: Beck Drilling & Environmental	METHOD: Solid Stem Auger	ELEVATION (m):

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ▮ CORE



LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG	COMPLETION DEPTH: 5.10 m
REVIEWED BY: BM	COMPLETION DATE: 7/7/08
PROJECT ENGINEER: Bill MacMillan	Page 1 of 1

PROJECT: Gold Creek Development	CLIENT: Livingston Ventures	TESTHOLE NO: 2
LOCATION: As shown in drawing		PROJECT NO.: G511-001-00
CONTRACTOR: Beck Drilling & Environmental	METHOD: Solid Stem Auger	ELEVATION (m):

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 20 40 60 80	PLASTIC M.C. LIQUID 10 20 30 40	COMMENTS	DEPTH (m)
0	OR		TOPSOIL							0
			CLAY - sandy, trace gravel, very stiff, black, damp, low - medium plastic		1					
1	CL				2	25				1
			CLAY - sandy, trace gravel, coal inclusions, stiff, black, damp, low - medium plastic							
2	CL				3					2
3			CLAY - trace gravel, trace shale, coal inclusions, stiff, brown, moist, low - medium plastic		4	18				3
	CL		CLAY - trace gravel, trace shale, trace coal inclusions, stiff, brown, damp, low plastic		5					
4					6					4
5	CL				7					5
					8					
6					9					6
	SH		SHALE BEDROCK							
7										7
8										

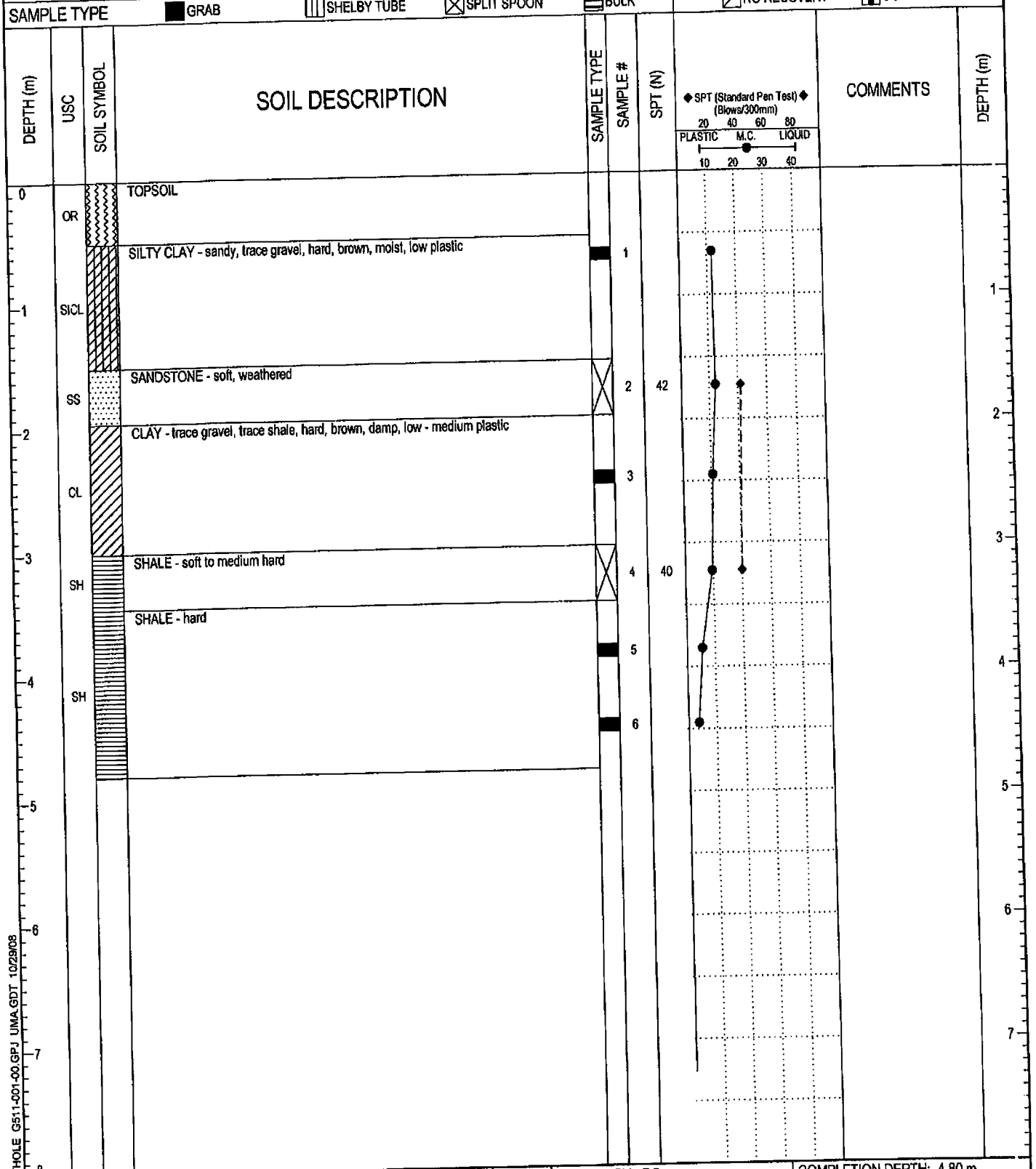
LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG	COMPLETION DEPTH: 7.00 m
REVIEWED BY: BM	COMPLETION DATE: 7/7/08
PROJECT ENGINEER: Bill MacMillan	Page 1 of 1

PROJECT: Gold Creek Development	CLIENT: Livingston Ventures	TESTHOLE NO: 3
LOCATION: As shown in drawing		PROJECT NO.: G511-001-00
CONTRACTOR: Beck Drilling & Environmental	METHOD: Solid Stem Auger	ELEVATION (m):

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ⊠ SPLIT SPOON ▤ BULK ⊘ NO RECOVERY ▮ CORE



LOGGED BY: RG	COMPLETION DEPTH: 4.80 m
REVIEWED BY: BM	COMPLETION DATE: 7/7/08
PROJECT ENGINEER: Bill MacMillan	Page 1 of 1

UMA | AECOM

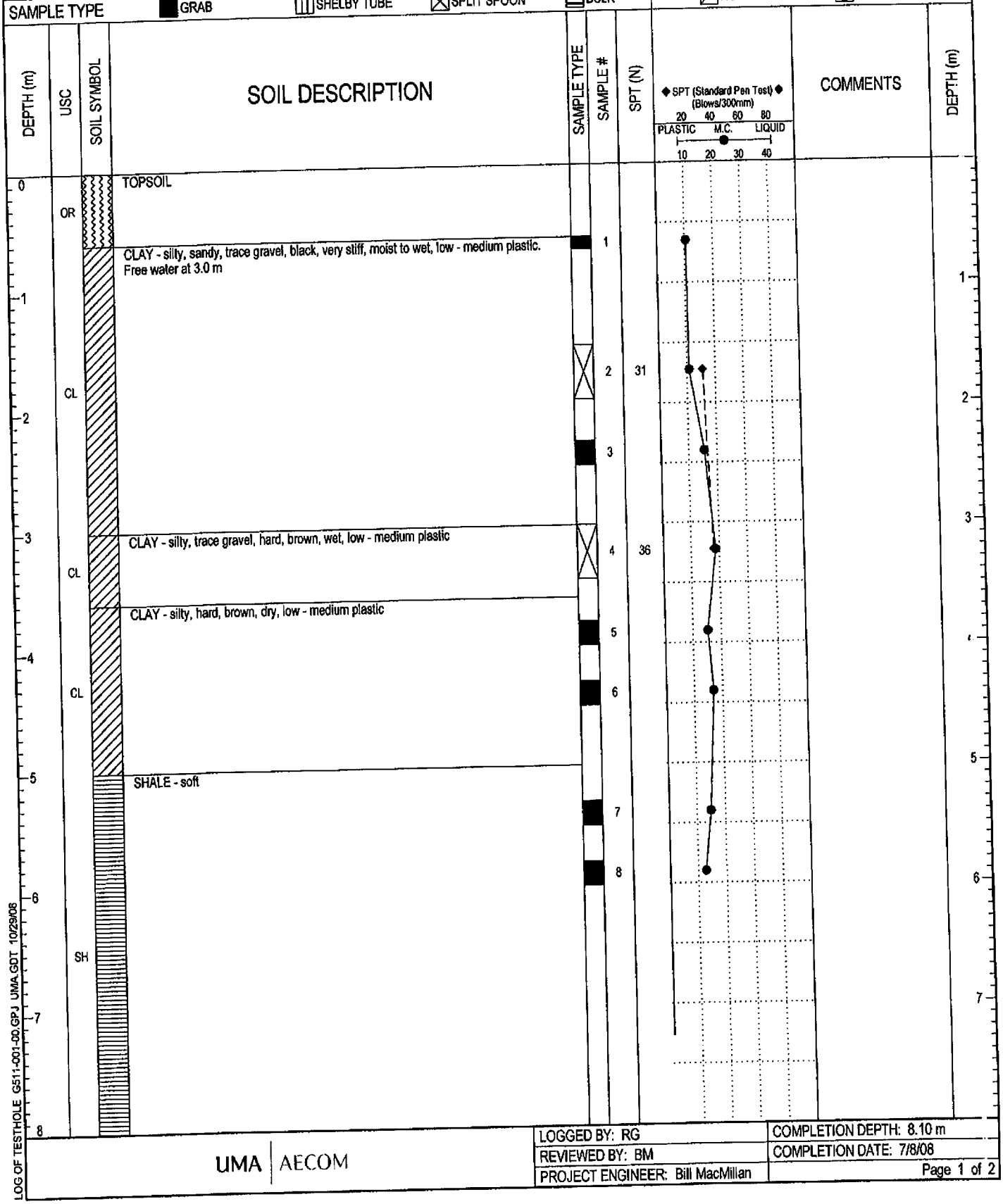
LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

PROJECT: Gold Creek Development | CLIENT: Livingston Ventures | TESTHOLE NO: 4

LOCATION: As shown in drawing | PROJECT NO.: G511-001-00

CONTRACTOR: Beck Drilling & Environmental | METHOD: Solid Stem Auger | ELEVATION (m):

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE



LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG | COMPLETION DEPTH: 8.10 m

REVIEWED BY: BM | COMPLETION DATE: 7/8/08

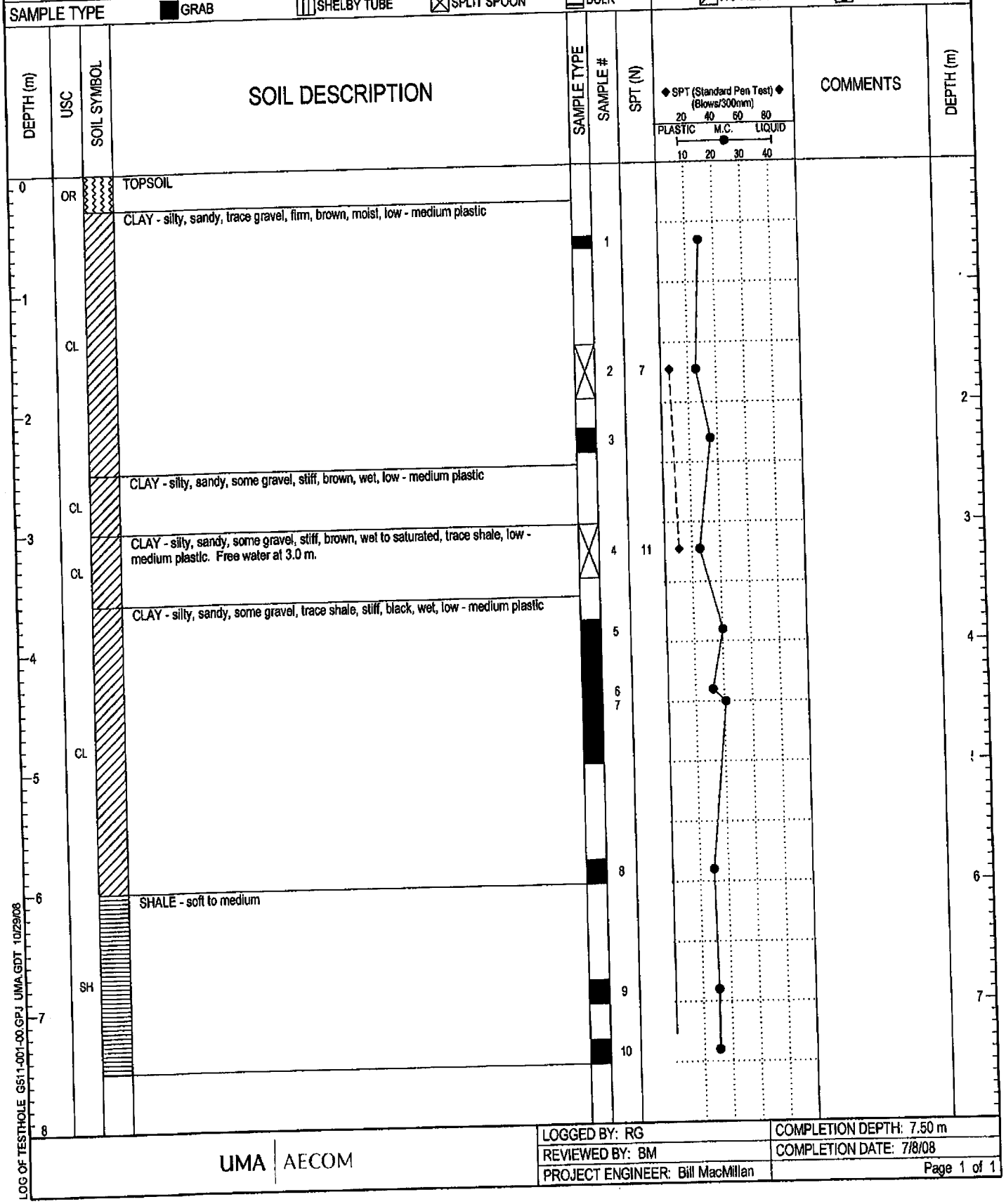
PROJECT ENGINEER: Bill MacMillan

PROJECT: Gold Creek Development | CLIENT: Livingston Ventures | TESTHOLE NO: 5

LOCATION: As shown in drawing | PROJECT NO.: G511-001-00

CONTRACTOR: Beck Drilling & Environmental | METHOD: Solid Stem Auger | ELEVATION (m):

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE



LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

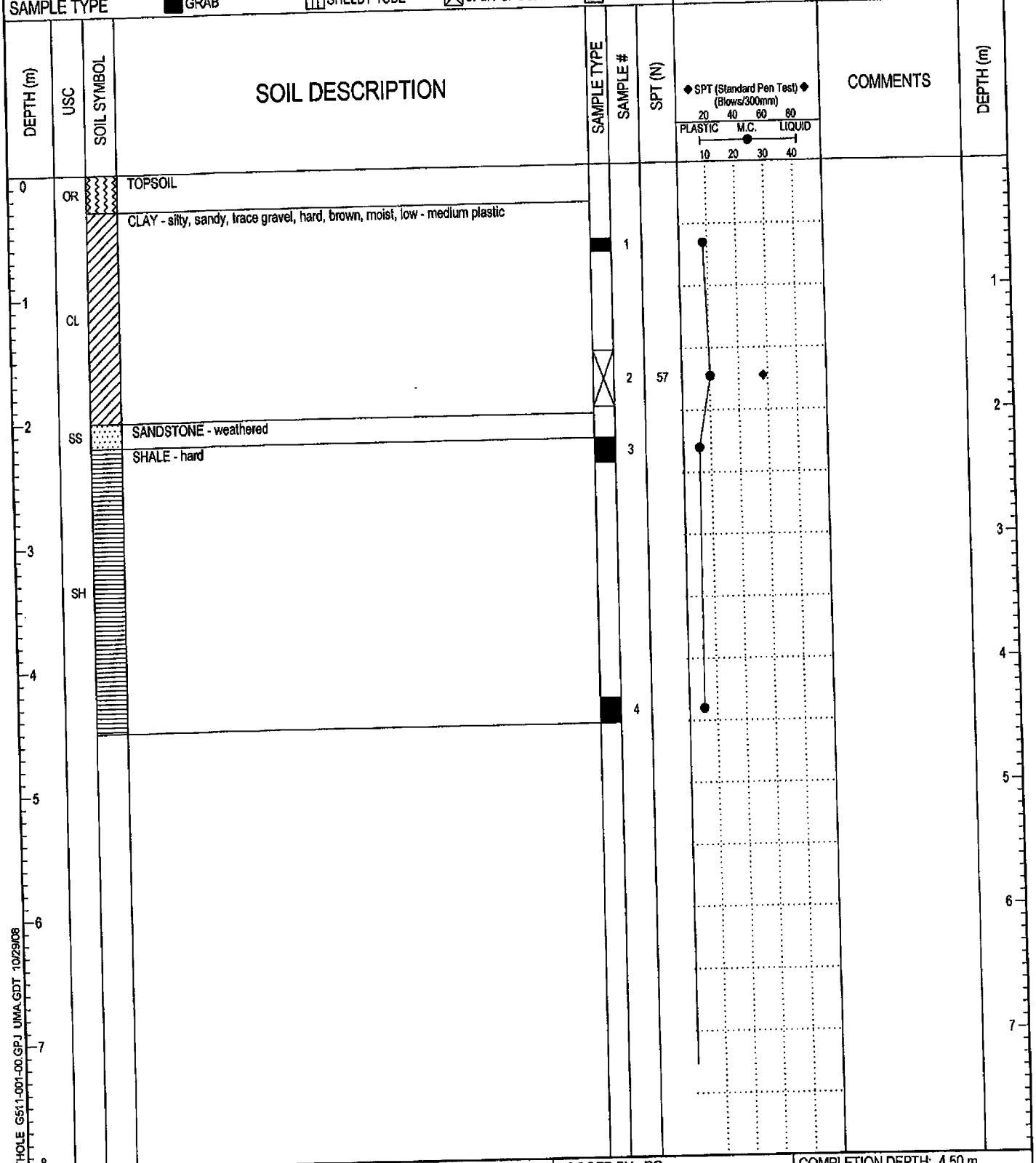
LOGGED BY: RG | COMPLETION DEPTH: 7.50 m

REVIEWED BY: BM | COMPLETION DATE: 7/8/08

PROJECT ENGINEER: Bill MacMillan | Page 1 of 1

PROJECT: Gold Creek Development	CLIENT: Livingston Ventures	TESTHOLE NO: 6
LOCATION: As shown in drawing		PROJECT NO.: G511-001-00
CONTRACTOR: Beck Drilling & Environmental	METHOD: Solid Stem Auger	ELEVATION (m):

SAMPLE TYPE: GRAB; SHELBY TUBE; SPLIT SPOON; BULK; NO RECOVERY; CORE



LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG	COMPLETION DEPTH: 4.50 m
REVIEWED BY: BM	COMPLETION DATE: 7/8/08
PROJECT ENGINEER: Bill MacMillan	Page 1 of 1

PROJECT: Gold Creek Development	CLIENT: Livingston Ventures	TESTHOLE NO: 7
LOCATION: As shown in drawing		PROJECT NO.: G511-001-00
CONTRACTOR: Beck Drilling & Environmental	METHOD: Solid Stem Auger	ELEVATION (m):

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ⊠ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ▮ CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	PLASTIC M.C. LIQUID (10 20 30 40)	COMMENTS	DEPTH (m)
0	OR		TOPSOIL					
	CL		CLAY - silty, sandy, gravely, very stiff, brown, damp, low - medium plastic	■	1			
1								1
			CLAY - silty, sandy, gravely, stiff, brown, moist, low - medium plastic	■	2			
2	CL			▥	3			2
3								3
			CLAY - silty, sandy, gravely, firm, brown, saturated, low - medium plastic. Free water at 3.7 m.	▥	4			
4								4
				▥	5			
5	CL							5
				▥	6			
6								6
				▥	7			
7								7
				▥	8			
8								

LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG	COMPLETION DEPTH: 7.50 m
REVIEWED BY: BM	COMPLETION DATE: 7/9/08
PROJECT ENGINEER: Bill MacMillan	Page 1 of 1

PROJECT: Gold Creek Development	CLIENT: Livingston Ventures	TESTHOLE NO: 8
LOCATION: As shown in drawing		PROJECT NO.: G511-001-00
CONTRACTOR: Beck Drilling & Environmental	METHOD: Solid Stem Auger	ELEVATION (m):

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ⊠ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ▮ CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)
0	OR		TOPSOIL			
	CL		CLAY - silty, sandy, some gravel, very stiff, brown, moist, low - medium plastic	■	1	
1	CL		CLAY - silty, sandy, trace gravel, coal inclusions, very stiff, brown, moist, low - medium plastic	⊠	2	20
2	CL		CLAY - silty, sandy, trace gravel, coal inclusions, very stiff, brown, low - medium plastic, moist to wet	■	3	
3	CL		CLAY - silty, sandy, trace gravel, very stiff, brown, saturated, low - medium plastic. Free water at 3.2 m.	⊠	4	18
				■	5	
4	MI		SILT - clayey, sandy, trace gravel, very stiff, black, medium plastic, moist to wet.	■	6	
5				■	7	
6	CI		CLAY - silty, sandy, trace gravel, trace shale, very stiff, black, medium plastic, moist to wet	■	8	
7						
8						

◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 20 40 60 80

PLASTIC M.C. LIQUID 10 20 30 40

COMMENTS

DEPTH (m) 0 1 2 3 4 5 6 7 8

LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG	COMPLETION DEPTH: 7.50 m
REVIEWED BY: BM	COMPLETION DATE: 7/9/08
PROJECT ENGINEER: Bill MacMillan	Page 1 of 1

PROJECT: Gold Creek Development	CLIENT: Livingston Ventures	TESTHOLE NO: 9
LOCATION: As shown in drawing		PROJECT NO.: G511-001-00
CONTRACTOR: Beck Drilling & Environmental	METHOD: Solid Stem Auger	ELEVATION (m):

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 20 40 60 80	PLASTIC M.C. LIQUID 10 20 30 40	COMMENTS	DEPTH (m)
0	OR		TOPSOIL							0
			CLAY - silty, sandy, some gravel, very stiff, brown, low - medium plastic, damp to moist		1					
1	CL				2	26				1
					3					
2										2
3			CLAY - silty, sandy, trace gravel, stiff, brown, moist, low - medium plastic		4	14				3
					5					
4					6					4
5	CL				7					5
					8					
6										6
					9					
7					10					7
8										

LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

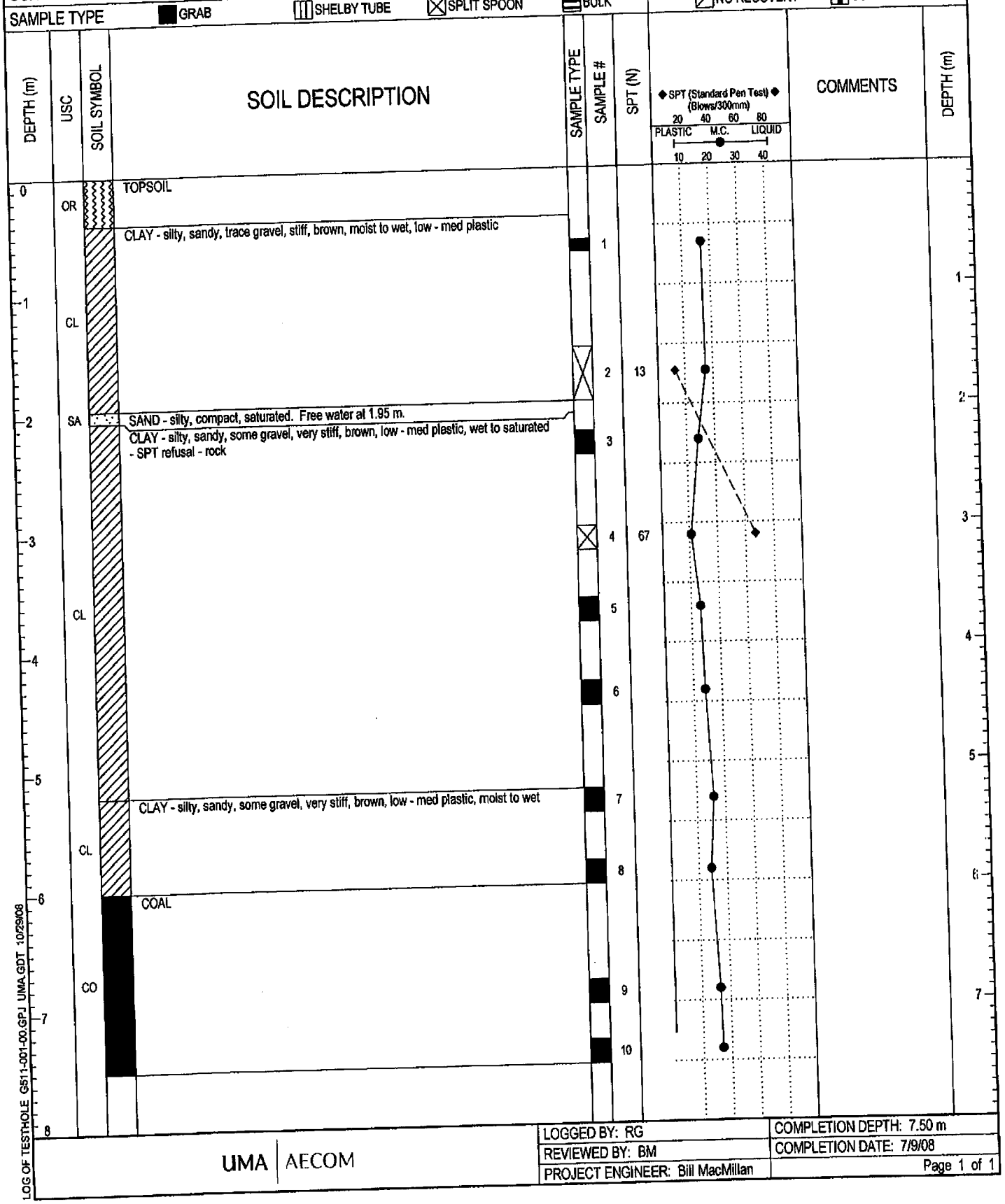
LOGGED BY: RG	COMPLETION DEPTH: 7.50 m
REVIEWED BY: BM	COMPLETION DATE: 7/9/08
PROJECT ENGINEER: Bill MacMillan	Page 1 of 1

PROJECT: Gold Creek Development | CLIENT: Livingston Ventures | TESTHOLE NO: 10

LOCATION: As shown in drawing | PROJECT NO.: G511-001-00

CONTRACTOR: Beck Drilling & Environmental | METHOD: Solid Stem Auger | ELEVATION (m):

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE



LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG | COMPLETION DEPTH: 7.50 m

REVIEWED BY: BM | COMPLETION DATE: 7/9/08

PROJECT ENGINEER: Bill MacMillan

PROJECT: Gold Creek Development | CLIENT: Livingston Ventures | TESTHOLE NO: 11

LOCATION: As shown in drawing | PROJECT NO.: G511-001-00

CONTRACTOR: Beck Drilling & Environmental | METHOD: Solid Stem Auger | ELEVATION (m):

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	SPT (Standard Pen Test) (Blows/300mm) 20 40 60 80	PLASTIC M.C. LIQUID 10 20 30 40	COMMENTS	DEPTH (m)
0	OR		TOPSOIL							0
			CLAY - silty, sandy, trace gravel, very stiff, brown, wet, low - med plastic		1					
1										1
	CL				2	27				
2										2
					3					
3	CL		CLAY - silty, sandy, trace gravel, hard, brown, saturated, low - med plastic. Free water at 3.1 m.		4	33				3
			CLAY - silty, sandy, trace gravel, hard, brown, wet, low - med plastic. Auger refusal at 4.2 m - possible bedrock.							
	CL				5					
4										4
5										5
6										6
7										7
8										

LOG OF TESTHOLE G511-001-00.GPJ UMA.GDT 10/29/08

UMA | AECOM

LOGGED BY: RG | COMPLETION DEPTH: 4.20 m

REVIEWED BY: BM | COMPLETION DATE: 7/10/08

PROJECT ENGINEER: Bill MacMillan | Page 1 of 1

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.
The information contained in this "Water Well Drilling Report" is unverified by Alberta Environment

Well I.D.:	1170244
Map Verified:	Hand Held Auto 20-30m
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: CAMFIELD DRILLING SERVICES LTD.		Drilling Company Approval No.: 38398
Mailing Address: 1280 4 AVE S	City or Town: LETHBRIDGE AB CA	Postal Code: T1J 0R2
WellOwner's Name: LIVINGSTONE VENTURES LTD.	Well Location Identifier: SITE #1	
P.O. Box Number: 2702	Mailing Address:	Postal Code: T1K 6Z6
City: LETHBRIDGE	Province: AB	Country: CA

2. Well Location

1/4 or LSD	Sec	Twp	Rge	West of M
SW	08	008	03	5

Location in Quarter
FT from N Boundary
FT from E Boundary
Lot Block Plan

Well Elev: 4899 FT
How Obtain: Hand Held Auto 20-30m

3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Method of Drilling: Downhole Hammer
Flowing Well: Yes
Gas Present: No
Materials Used: Unknown
Rate: 1 Gallons
Oil Present: No

Proposed well use: Domestic
Anticipated Water Requirements/day 300 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description
3	Loam
58	Till & Rocks
95	Till & Gravel
103	Till & Clay
160	Brown See Comments Shale

5. Well Completion

Date Started(yyyy/mm/dd): 2008/07/24
Date Completed (yyyy/mm/dd): 2008/09/05
Well Depth: 160 FT
Borehole Diameter: 6 Inches
Casing Type: Steel
Liner Type: Unknown
Size OD: 6.625 Inches
Size OD: Inches
Wall Thickness: 0.25 Inches
Wall Thickness: Inches
Bottom at: 105 FT
Top: FT Bottom: FT
Perforations from: FT to: FT
Perforations Size: Inches x Inches
from: FT to: FT Inches x Inches
from: FT to: FT Inches x Inches
Perforated by: Unknown
Seal: Driven & Hole Plug from: FT to: FT
Seal: Unknown from: FT to: FT
Seal: Unknown from: FT to: FT
Screen Type: Unknown from: FT to: FT
Screen ID: Inches
Slot Size: Inches
Screen Type: Unknown from: FT to: FT
Screen ID: Inches
Slot Size: Inches
Screen Installation Method: Unknown
Fittings
Top: Unknown
Bottom: Unknown
Pack: Unknown
Grain Size:
Amount: Unknown
Geophysical Log Taken:
Retained on Files:
Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held:
Documents Held:
Pitless Adapter Type:
Drop Pipe Type:
Length: FT
Diameter: Inches
Comments:

6. Well Yield

Test Date (yyyy/mm/dd): 2008/08/13
Start Time: 11:00 AM
Test Method: Water Levels Only
Non pumping static level: 0 FT
Rate of water removal: Gallons/Min
Depth of pump intake: FT
Water level at end of pumping: FT
Distance from top of 3 ~~Inches~~ casing to ground level: 1-2.
Depth To water level (feet)
Elapsed Time
Drawdown Minutes:Sec Recovery
Total Drawdown: FT
If water removal was less than 2 hr duration, reason why:

OBSERVATION WELL ONLY AT THIS POINT
Recommended pumping rate: 5 Gallons/Min
Recommended pump intake: 120 FT
Type Pump Installed
Pump Type:
Pump Model:
H.P.:
Any further pumptest information? No

7. Contractor Certification

Driller's Name: KEVIN BLAND
Certification No.: VC3171
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection

Water Well Drilling Report

Alberta Environment

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

The information contained in this "Water Well Drilling Report" is collected by Alberta Environment

Well I.D.:	1170243
Map Verified:	Hand Held Auto 20-30m
Date Report Received:	
Measurements:	Imperial

1. Contractor & Well Owner Information

Company Name: CAMFIELD DRILLING SERVICES LTD.
Drilling Company Approval No.: 38398
Mailing Address: 1280 4 AVE S
City or Town: LETHBRIDGE AB CA
Postal Code: T1J 0R2
WellOwner's Name: LIVINGSTONE VENTURES LTD.
Well Location Identifier: SITE #2
P.O. Box Number: 2702
Mailing Address:
Postal Code: T1K 6Z8
City: LETHBRIDGE
Province: AB
Country: CA

2. Well Location

1/4 or LSD	Sec	Twp	Rge	Westof M
SW	08	008	03	5

Location in Quarter
FT from N Boundary
FT from E Boundary
Lot | Block | Plan
Site1
Well Elev: 4915 FT
How Obtain: Hand Held Auto 20-30m

3. Drilling Information

Type of Work: New Well
Reclaimed Well
Date Reclaimed(yyyy/mm/dd):
Method of Drilling: Downhole Hammer
Flowing Well: Yes
Gas Present: No
Materials Used: Unknown
Rate: 1 Gallons
Oil Present: No
Proposed well use: Domestic
Anticipated Water Requirements/day 300 Gallons

4. Formation Log

Depth from ground level (feet)	Lithology Description
3	Loam
6	Sand & Silt
12	Till & Rocks
58	Till & Gravel
63	Lacustrine Silt
82	Till & Gravel
88	Till & Clay
125	Brown Soft Shale
140	Brown Hard Shale

5. Well Completion

Date Started(yyyy/mm/dd): 2008/07/15
Date Completed (yyyy/mm/dd): 2008/07/24
Well Depth: 140 FT
Borehole Diameter: 6 Inches
Casing Type: Steel
Liner Type: Unknown
Size OD: 6.625 Inches
Size OD: Inches
Wall Thickness: 0.25 Inches
Wall Thickness: Inches
Bottom at: 88 FT
Top: FT Bottom: FT
Perforations from: FT to: FT
Perforations from: FT to: FT
Perforations from: FT to: FT
Perforations Size: Inches x Inches
Perforations Size: Inches x Inches
Perforations Size: Inches x Inches
Perforated by: Unknown
Seal: Driven & Hole Plug from: FT to: FT
Seal: Unknown from: FT to: FT
Seal: Unknown from: FT to: FT
Screen Type: Unknown from: FT to: FT
Screen ID: Inches
Slot Size: Inches
Screen Type: Unknown from: FT to: FT
Screen ID: Inches
Slot Size: Inches
Screen Installation Method: Unknown
Fittings
Top: Unknown
Bottom: Unknown
Pack: Unknown
Grain Size:
Amount: Unknown
Geophysical Log Taken:
Retained on Files:
Additional Test and/or Pump Data
Chemistries taken By Driller: No
Held:
Documents Held:
Pitless Adapter Type:
Drop Pipe Type:
Length: FT
Diameter: Inches
Comments:
WATER PRODUCING IN HARD LENSES IN SHALE FROM 133-138

6. Well Yield

Test Date (yyyy/mm/dd): 2008/08/13
Start Time: 918:00 PM
Test Method: Pump
Non pumping static level: 0 FT
Rate of water removal: 10 Gallons/Min
Depth of pump intake: 115 FT
Water level at end of pumping: 97.6 FT
Distance from top of casing to ground level: 2.2

Depth To water level (feet) | Elapsed Time Drawdown Minutes:Sec | Recovery

1.24	1:00	9.26
3.35	2:00	88.8
5.4	3:00	86
8.2	4:00	83.7
10.1	5:00	81.9
12.2	6:00	80.4
14.5	7:00	79
16.2	8:00	77.9
17.3	9:00	76.3
19.3	10:00	75.9
20.1	12:00	74.2
21.5	14:00	72.6
23.5	17:00	70.8
25.3	20:00	69.2
29.6	30:00	65
32.8	40:00	61.9
35.3	50:00	59.46
37.4	60:00	57.4
39.4	70:00	55.7
41	80:00	54.1
42.5	90:00	52.8
43.8	100:00	51.5
45.1	110:00	50.4
46.2	120:00	49.4

Total Drawdown: 97.6 FT
If water removal was less than 2 hr duration, reason why:

Recommended pumping rate: 5 Gallons/Min
Recommended pump intake: 115 FT

7. Contractor Certification

Driller's Name: KEVIN BLAND
Certification No.: VC3171
This well was constructed in accordance with the Water Well regulation of the Alberta Environmental Protection

Appendix B

Figures

A SIZE 8.5" x 11" (215.9mm x 279.4mm)

PLOT: 08/10/30 3:10:27 PM

Saved By: wallacee

G511-001-00_01-CPF006_RX.dwg

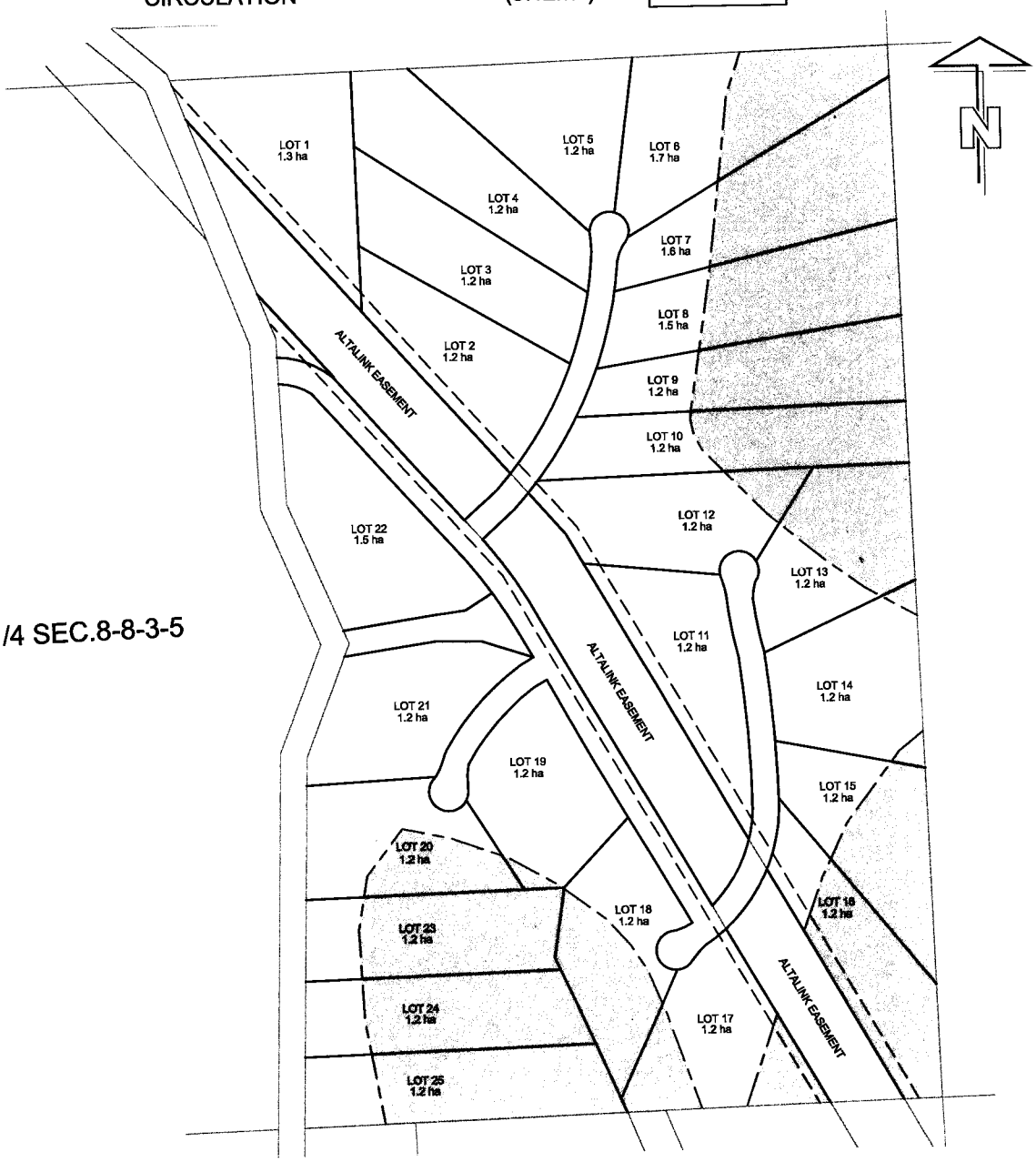
UMA FILE NAME:

ISS/REV: A

DRAFT

LEGEND

STUDY BOUNDARY	(39.22ha.)	
DEVELOPABLE LAND	(18.29ha.)	
DEVELOPMENT SETBACK	(13.31ha.)	
RESERVE/ALTALINK EASEMENT	(4.5ha.)	
CIRCULATION	(3.12ha.)	



S.W.1/4 SEC.8-8-3-5

0 50 100 m SCALE 1:1000

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Development Concept Site Plan
Figure 1

UMA | AECOM

A SIZE 8.5" x 11" (215.9mm x 279.4mm)

PLOT: 08/10/30 3:49:00 PM

Saved By: wallacee

G511-001-00_01-CPF003_RX.dwg

ISS/REV: A
UMA FILE NAME:

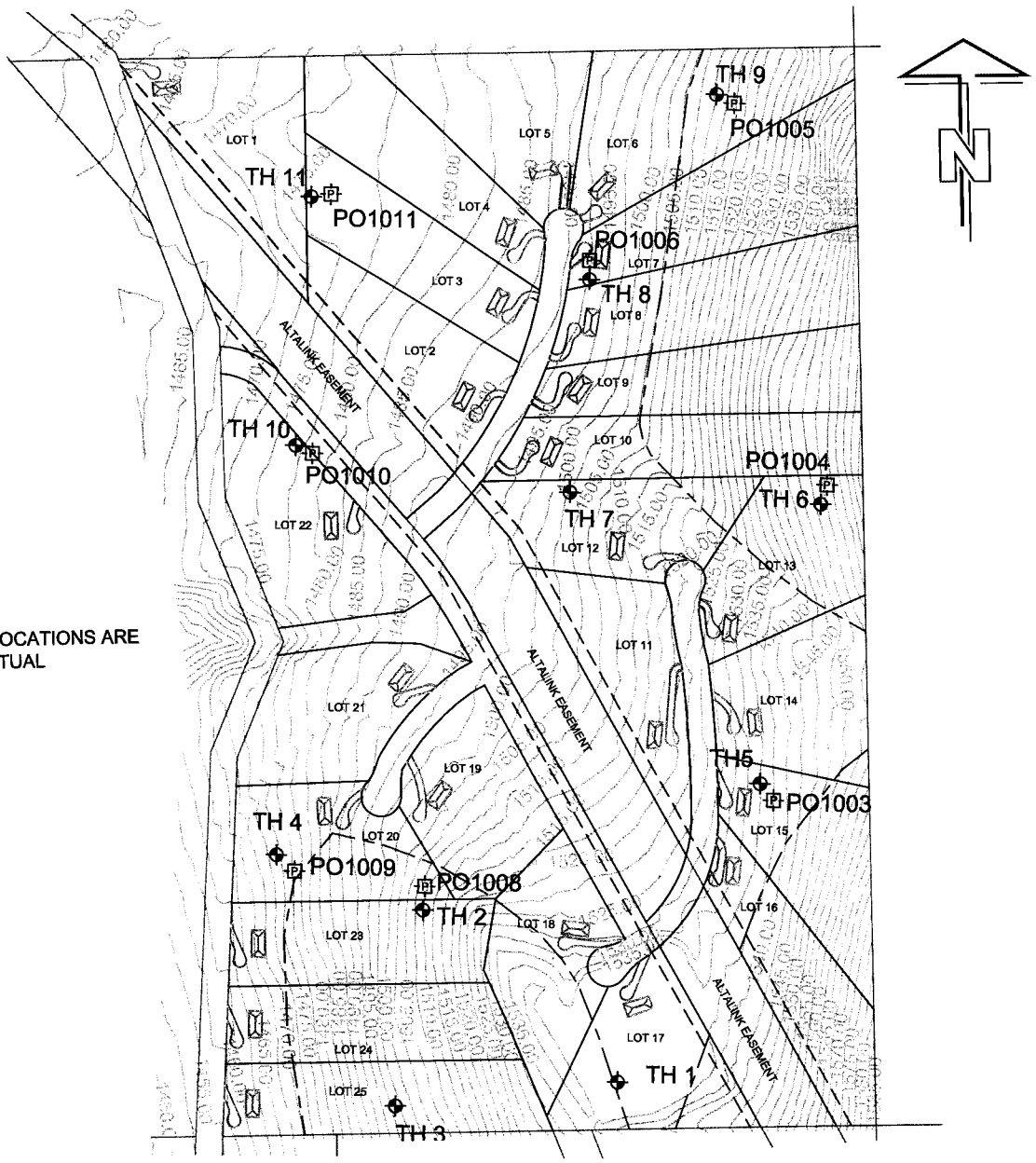
DRAFT

LEGEND

HOUSE

DRIVEWAY

DEVELOPMENT SETBACK



NOTE:
HOUSE LOCATIONS ARE CONCEPTUAL

UMA | AECOM

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

House and Driveway Concept
Figure 2

LEGEND

SOIL PERCOLATION TEST

SOIL BOREHOLE

SETBACK

ISS/REV: A
UMA FILE NAME: G511-001-00_01-B-F003_RX.dwg Saved By: wallacee PLOT: 08/10/30 3:12:59 PM
A SIZE 8.5" x 11" (215.9mm x 279.4mm)

UMA | AECOM

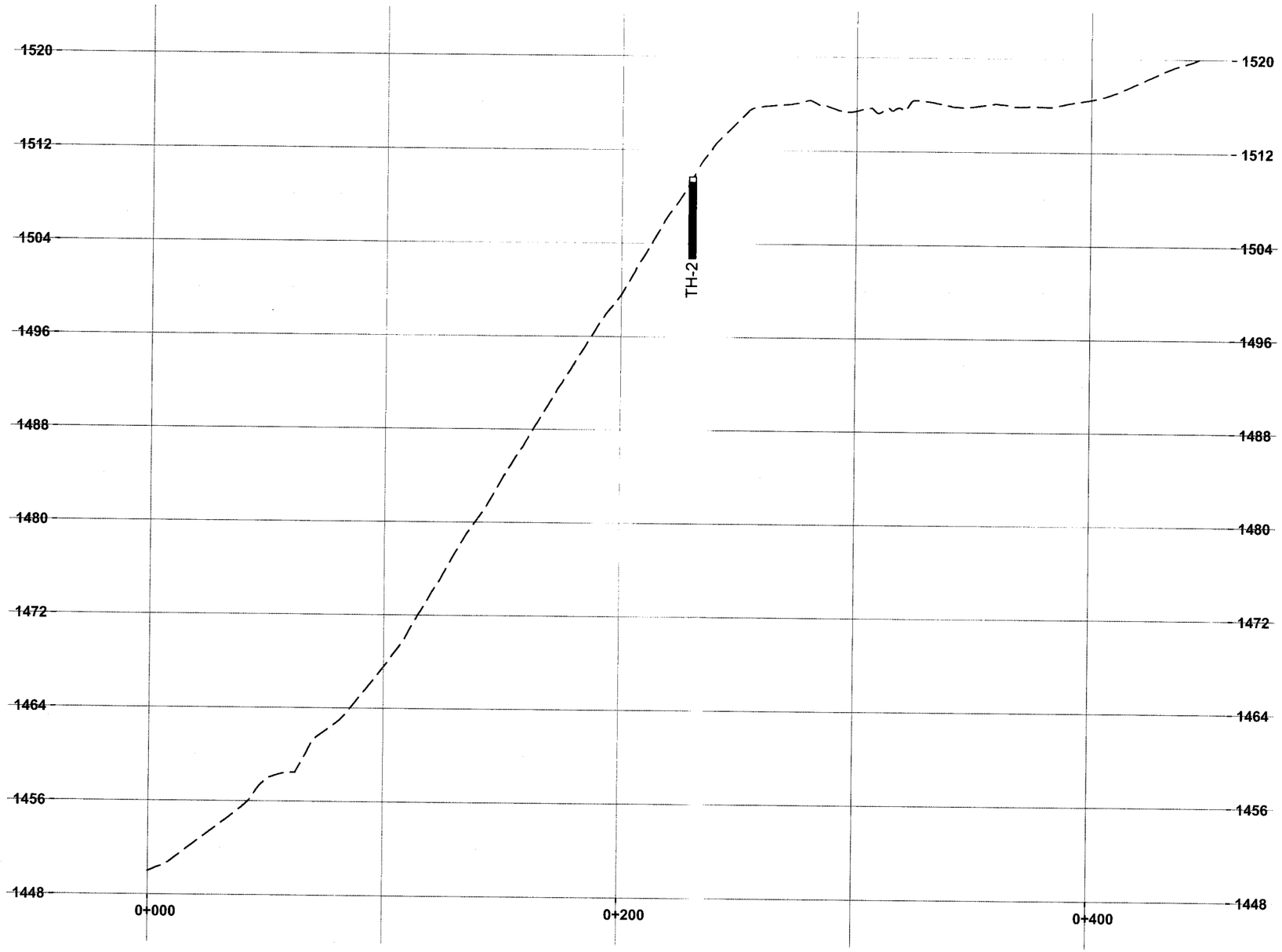
Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

Geotechnical Drill Hole Locations
Figure 3

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

UMA | AECOM

Figure 4



LEGEND

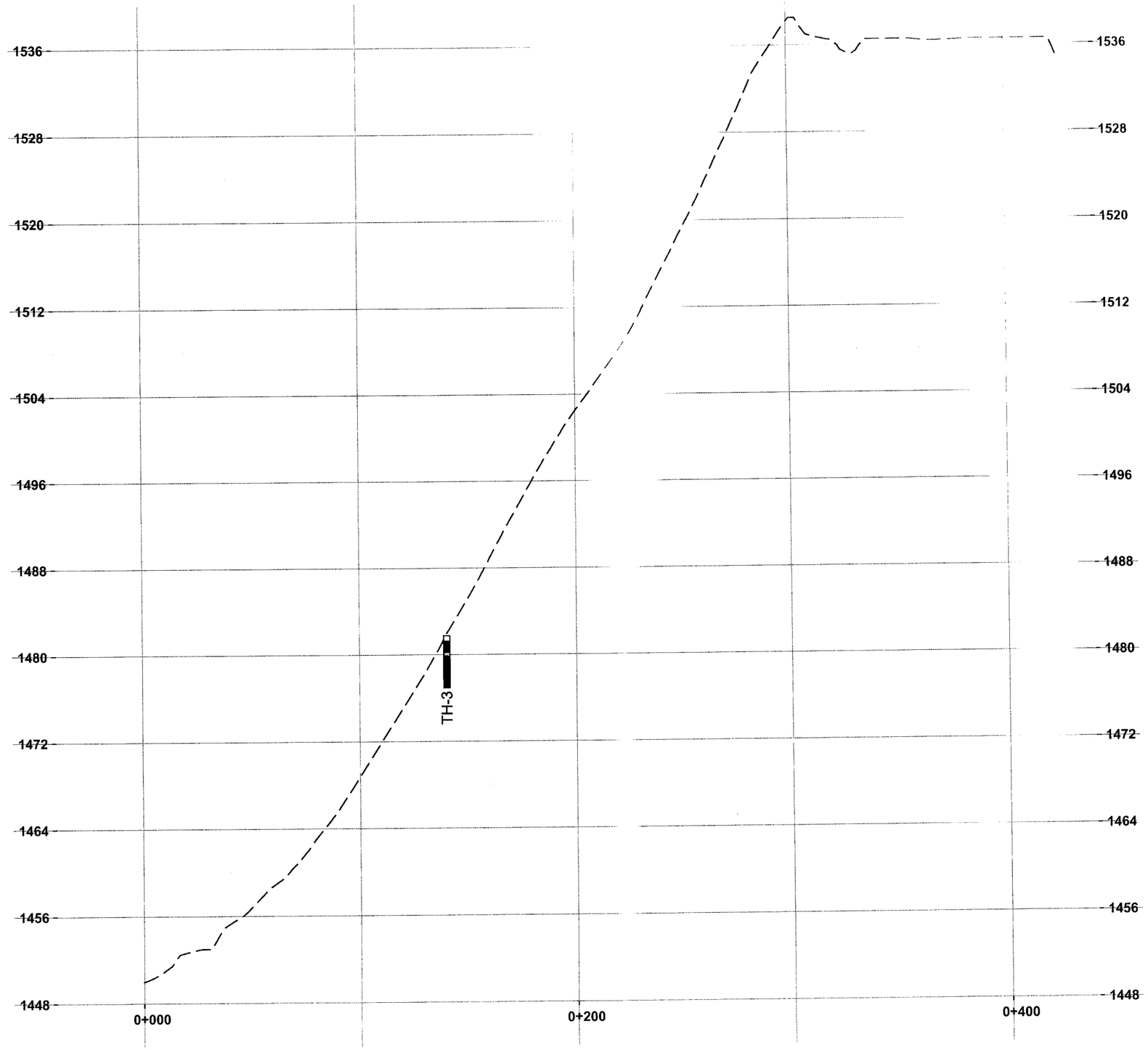
- TOPSOIL
- CLAY
- SAND
- SHALE
- SANDSTONE
- COAL

NOTES

ALL DIMENSIONS ARE IN METERS
UNLESS OTHERWISE INDICATED

UMA | AECOM

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan
SW 1/4 SEC8-8-3-W5M
Testhole Sections
Figure 5a



LEGEND

- TOPSOIL
- CLAY
- SAND
- SHALE
- SANDSTONE
- COAL

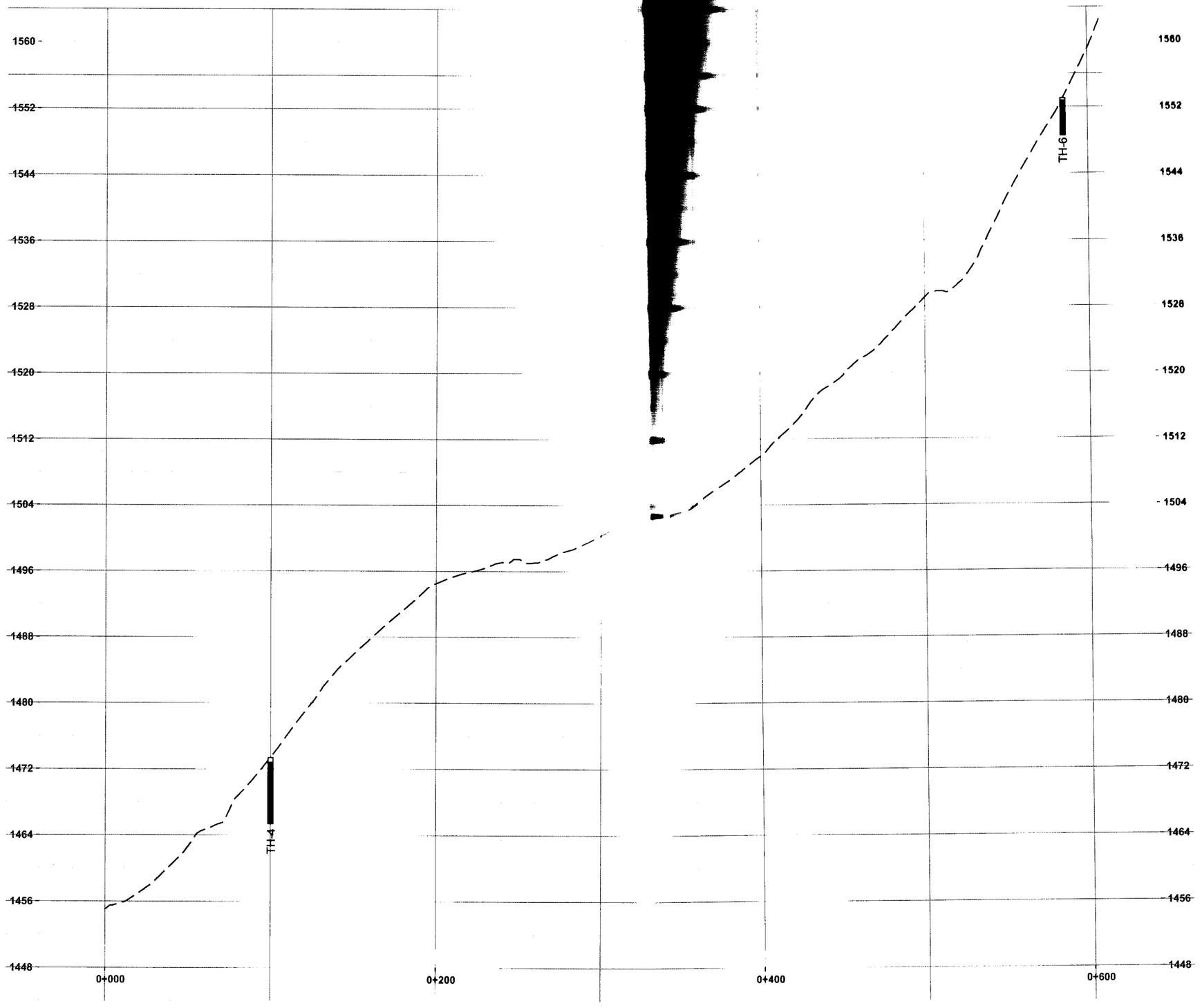
NOTES

ALL DIMENSIONS ARE IN METERS
UNLESS OTHERWISE INDICATED

UMA | AECOM

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan
SW 1/4 SEC8-8-3-W5M
Testhole Sections
Figure 5b

B SIZE 11" x 17" (279.4mm x 431.8mm)
PLOT: 08/10/30 3:28:28 PM
Saved By: wallacee
ISS/REV: A
UMA FILE NAME: G511-001-00_01-B-F001_RX.dwg



LEGEND

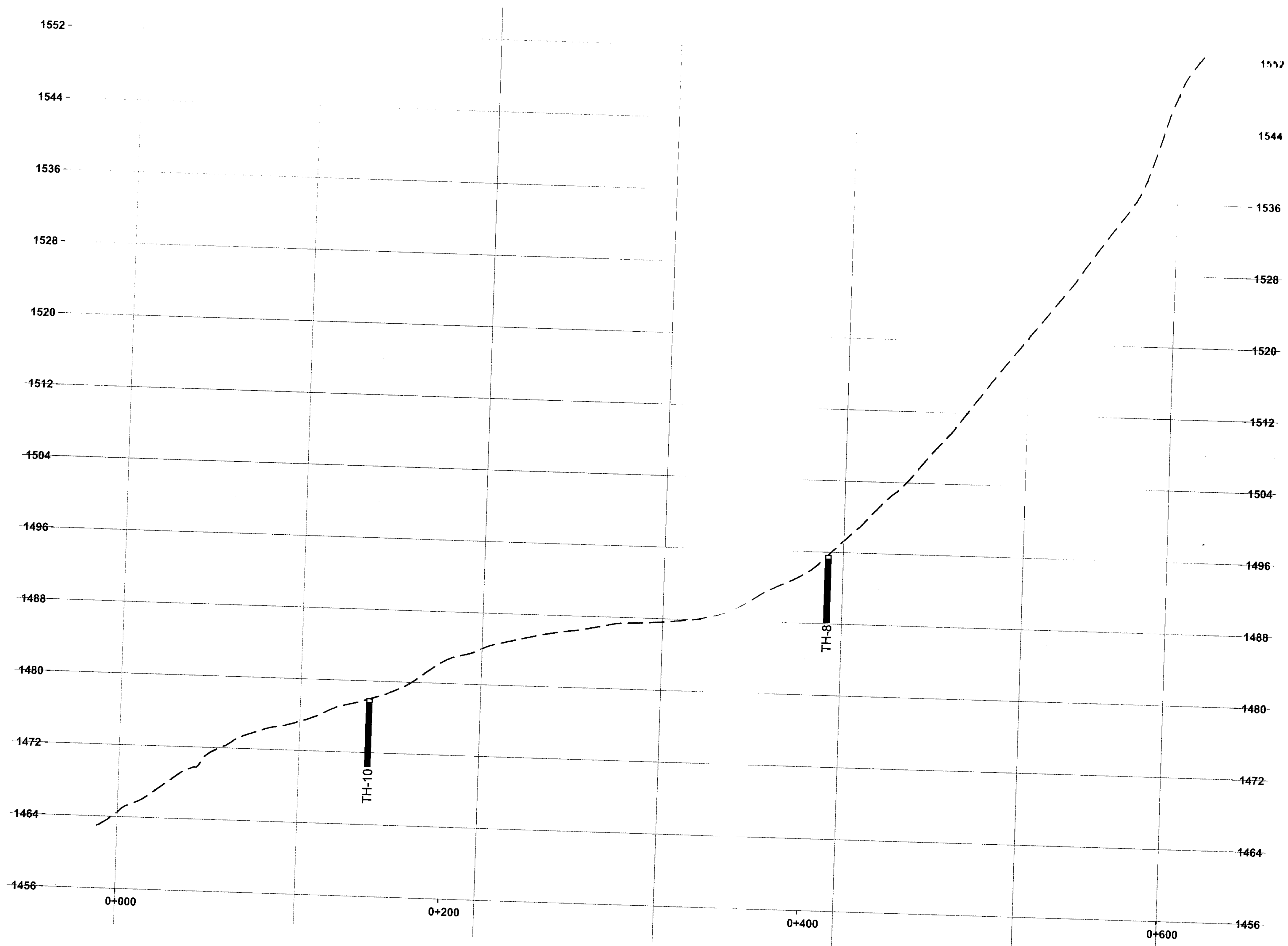
- TOPSOIL
- CLAY
- SAND
- SHALE
- SANDSTONE
- COAL

NOTES

ALL DIMENSIONS ARE IN METERS
UNLESS OTHERWISE INDICATED

UMA | AECOM

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan
SW 1/4 SEC8-8-3-W5M
Testhole Sections
Figure 5c



LEGEND

- TOPSOIL
- CLAY
- SAND
- SHALE
- SANDSTONE
- COAL

NOTES

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE INDICATED

ISS/REV: A
UMA FILE NAME: G511-001-00_01-B-F001_RX.dwg Saved By: wallacee PLOT: 08/10/30 3:29:11 PM

UMA | AECOM

Livingstone Ventures Ltd.
Gold Creek - CNP
Area Structure Plan

SW 1/4 SEC8-8-3-W5M

Testhole Sections

Figure 5d

Appendix C

Laboratory Test Results

WATER CONTENT

UMA | AECOM

CLIENT: Livingston Gold Creek.

PROJECT:

JOB No.:

DATE: July 11 /08 TECHNICAN: Monique Lessard

HOLE No.	1	1	1	2	2	2
DEPTH	0.6 -0.7	1.9 - 2.0	3.6 - 3.7	0.6 -0.7	1.5 - 1.95	2.2 - 2.4
SAMPLE No.	G1	G2	G3	G1	S2	G3
TARE No.	16.3	16.3	16.5	16.1	16.3	16.3
WT. SAMPLE WET + TARE	203.7	223.3	196.4	214.8	258.7	162.4
WT. SAMPLE DRY + TARE	192.0	211.5	186.9	197.7	236.7	143.5
WT. WATER	11.7	11.8	9.5	17.1	22.0	18.9
WT. TARE						
WT. OF DRY SAMPLE	175.7	195.2	170.4	181.6	220.4	127.2
WATER CONTENT W%	6.6	6.0	5.6	9.4	10.0	14.9
HOLE No.	2	2	2	2	2	2
DEPTH	3.0 - 3.45	3.8 - 4.0	4.3 - 4.5	5.5 - 5.6	5.8 - 6.0	6.5 - 6.6
SAMPLE No.	S4	G5	G6	G7	G8	G9
TARE No.	16.1	16.3	16.3	16.3	16.3	16.1
WT. SAMPLE WET + TARE	218.6	202.5	186.0	177.9	180.8	134.9
WT. SAMPLE DRY + TARE	191.5	190.7	169.8	168.7	171.6	127.7
WT. WATER	27.1	11.8	16.2	9.2	9.2	7.2
WT. TARE						
WT. OF DRY SAMPLE	175.4	174.4	153.5	152.4	155.3	111.6
WATER CONTENT W%	15.5	6.8	10.6	6.0	5.9	6.5
HOLE No.	3	3	3	3	3	3
DEPTH	0.6 -0.7	1.5 - 1.95	2.4 - 2.5	3.0 - 3.45	3.8 - 3.9	4.4 - 4.5
SAMPLE No.	G1	S2	G3	S4	G5	G6
TARE No.	16.0	16.0	16.1	16.1	16.3	16.2
WT. SAMPLE WET + TARE	223.4	245.3	175.1	238.4	147.6	162.7
WT. SAMPLE DRY + TARE	201.7	226.4	159.8	219.0	140.5	157.0
WT. WATER	21.7	24.9	15.3	19.4	7.1	5.7
WT. TARE						
WT. OF DRY SAMPLE	185.7	204.4	143.7	202.9	124.2	140.8
WATER CONTENT W%	11.7	12.2	10.6	9.6	5.7	4.0

WATER CONTENT

UMA | AECOM

CLIENT:						
PROJECT:						
JOB No.:						
DATE: July 11/08.				TECHNICAN: Monique		
HOLE No.	4	4	4	4	4	4
DEPTH	0.6-0.7	1.5-1.95	2.3-2.5	3.0-3.45	3.8-4.0	4.3-4.5
SAMPLE No.	G1	S2	G3	S4	G5	G6
TARE No.	15.8	15.9	16.2	16.2	15.8	15.7
WT. SAMPLE WET + TARE	222.4	235.3	259.0	243.0	183.1	176.0
WT. SAMPLE DRY + TARE	202.8	214.0	226.4	207.4	160.9	152.9
WT. WATER	19.6	21.3	32.6	35.6	22.2	23.1
WT. TARE						
WT. OF DRY SAMPLE	187.0	198.1	210.2	191.2	145.1	137.2
WATER CONTENT W%	10.5	10.8	15.5	18.6	15.3	16.8
HOLE No.	4	4	5	5	5	5
DEPTH	5.3-5.5	5.8-6.0	0.6-0.7	1.5-1.95	2.2-2.4	3.0-3.45
SAMPLE No.	G7	G8	G1	S2	G3	S4
TARE No.	15.6	16.1	16.1	15.9	16.3	16.2
WT. SAMPLE WET + TARE	136.1	139.2	208.3	210.3	194.5	228.5
WT. SAMPLE DRY + TARE	120.5	125.2	183.6	188.1	168.0	204.4
WT. WATER	15.6	14.0	24.7	22.2	26.5	24.1
WT. TARE						
WT. OF DRY SAMPLE	104.9	109.1	167.5	172.2	151.7	188.2
WATER CONTENT W%	14.9	12.8	14.7	12.9	17.5	12.8
HOLE No.	5	5	5	5	5	5
DEPTH	3.8-4.0	4.3-4.5	4.0-5.0	5.8-6.0	6.8-7.0	7.3-7.5
SAMPLE No.	G5	G6	G7	G8	G9	G10
TARE No.	16.1	16.2	16.3	16.1	16.1	16.1
WT. SAMPLE WET + TARE	226.4	217.4	228.1	314.8	297.3	268.6
WT. SAMPLE DRY + TARE	191.1	189.3	191.9	275.9	259.1	234.8
WT. WATER	35.3	28.1	36.2	38.9	38.2	33.8
WT. TARE						
WT. OF DRY SAMPLE	175.0	173.1	175.6	259.8	243.0	218.7
WATER CONTENT W%	20.2	16.2	20.6	14.97	15.7	15.5

WATER CONTENT

UMA | AECOM

CLIENT:						
PROJECT:						
JOB No.:						
DATE :			TECHNICAN :			
HOLE No.	6	6	6	6	7	7
DEPTH	0.6-0.7	1.5-1.95	2.2-2.4	4.3-4.5	0.6-0.7	2.2-2.4
SAMPLE No.	G1	S2	G3	G4	G1	G2
TARE No.	16.2	16.1	16.2	16.1	16.2	16.1
WT. SAMPLE WET + TARE	193.8	253.2	166.0	173.2	204.2	227.8
WT. SAMPLE DRY + TARE	179.7	231.3	157.5	164.9	189.6	202.8
WT. WATER	14.1	21.9	8.5	8.3	14.6	25.0
WT. TARE						
WT. OF DRY SAMPLE	163.5	215.2	141.3	148.8	173.4	186.7
WATER CONTENT W%	8.6	10.2	6.0	5.6	8.4	13.4
HOLE No.	7	7	7	7	7	7
DEPTH	2.8-3.0	3.6-3.7	4.3-4.5	5.0-5.2	5.8-6.0	6.6-6.7
SAMPLE No.	G3	G4	G5	G6	G7	G8
TARE No.	16.1	16.1	16.3	16.1	16.1	16.2
WT. SAMPLE WET + TARE	262.2	373.3	328.1	195.5	255.0	273.7
WT. SAMPLE DRY + TARE	238.2	334.5	286.3	174.8	222.1	236.4
WT. WATER	24.0	38.8	41.8	20.7	32.9	37.3
WT. TARE						
WT. OF DRY SAMPLE	222.1	318.4	270.0	158.7	206.0	220.2
WATER CONTENT W%	10.8	12.2	15.5	13.0	15.97	16.9
HOLE No.	8	8	8	8	8	8
DEPTH	0.6-0.7	1.5-1.95	2.2-2.4	3.0-3.45	3.6-3.7	4.3-4.5
SAMPLE No.	G1	S2	G3	S4	G5	G6
TARE No.	16.2	16.3	15.9	16.1	16.2	15.9
WT. SAMPLE WET + TARE	268.8	222.3	221.3	221.3	319.2	333.3
WT. SAMPLE DRY + TARE	248.4	200.1	193.8	194.4	282.8	293.0
WT. WATER	20.4	22.2	27.5	26.9	36.4	40.3
WT. TARE	[redacted]					
WT. OF DRY SAMPLE	232.2	183.8	177.9	178.3	266.6	277.1
WATER CONTENT W%	8.8	12.1	15.5	15.1	13.7	14.5

WATER CONTENT

UMA | AECOM

CLIENT:						
PROJECT:						
JOB No.:						
DATE :			TECHNICAN :			
HOLE No.	8	8	9	9	9	9
DEPTH	5.0-5.2	7.0-7.5	0.6-0.7	1.5-1.95	2.2-2.4	3.0-3.45
SAMPLE No.	G7	G8	G1	S2	G3	S4
TARE No.	16.2	16.2	16.0	16.2	15.8	16.1
WT. SAMPLE WET + TARE	139.1	125.8	152.2	253.7	184.4	238.8
WT. SAMPLE DRY + TARE	124.2	110.2	140.5	229.9	167.5	218.0
WT. WATER	14.9	15.6	11.7	23.8	16.9	20.8
WT. TARE						
WT. OF DRY SAMPLE	108.0	94.0	124.5	213.7	151.7	201.9
WATER CONTENT W%	13.8	16.6	9.4	11.1	11.1	10.3
HOLE No.	9	9	9	9	9	9
DEPTH	3.6-3.8	4.3-4.5	5.2-5.4	5.8-6.0	6.8-7.0	7.3-7.5
SAMPLE No.	G5	G6	G7	G8	G9	G10
TARE No.	16.1	16.1	15.9	16.1	15.9	15.9
WT. SAMPLE WET + TARE	218.5	239.7	229.6	172.0	175.3	152.8
WT. SAMPLE DRY + TARE	195.5	215.6	206.7	156.6	154.0	135.6
WT. WATER	23.0	24.1	22.9	15.4	21.3	17.2
WT. TARE						
WT. OF DRY SAMPLE	179.4	199.5	190.8	140.5	138.1	119.7
WATER CONTENT W%	12.8	12.1	12.0	10.96	15.4	14.4
HOLE No.	10	10	10	10	10	10
DEPTH	0.6-0.7	1.5-1.95	2.2-24	3.0-3.45	3.6-3.8	4.3-4.5
SAMPLE No.	G1	S2	G3	S4	G5	G6
TARE No.	15.9	16.1	15.8	16.0	15.8	15.8
WT. SAMPLE WET + TARE	216.2	216.4	232.7	256.2	196.1	216.7
WT. SAMPLE DRY + TARE	187.3	186.7	205.7	233.0	175.0	191.9
WT. WATER	28.9	29.7	27.0	23.2	21.1	24.8
WT. TARE						
WT. OF DRY SAMPLE	171.4	170.6	189.9	217.0	159.2	176.1
WATER CONTENT W%	16.9	17.4	14.2	10.7	13.3	14.1

WATER CONTENT

UMA | AECOM

CLIENT:						
PROJECT:						
JOB No.:						
DATE :			TECHNICAN :			
HOLE No.	10	10	10	10	11	11
DEPTH	5.0-5.2	5.8-6.0	6.8-7.0	7.3-7.5	0.6-0.7	1.5-1.95
SAMPLE No.	G7	G8	G9	G10	G1	S2
TARE No.	16.1	16.2	15.2	15.9	16.0	15.9
WT. SAMPLE WET + TARE	138.0	192.2	118.5	113.3	173.3	240.3
WT. SAMPLE DRY + TARE	121.2	169.9	103.9	99.2	156.6	219.4
WT. WATER	16.8	22.3	14.6	14.1	16.7	20.9
WT. TARE						
WT. OF DRY SAMPLE	105.1	153.7	88.7	83.3	140.6	203.5
WATER CONTENT W%	15.98	14.5	16.5	16.9	11.9	10.3
HOLE No.	11	11	11			
DEPTH	2.2-2.4	3.0-3.45	3.8-4.0			
SAMPLE No.	G3	S4	G5			
TARE No.	16.2	16.2	16.1			
WT. SAMPLE WET + TARE	241.5	271.7	218.1			
WT. SAMPLE DRY + TARE	217.6	247.6	193.7			
WT. WATER	23.9	24.1	24.4			
WT. TARE						
WT. OF DRY SAMPLE	201.4	231.4	177.6			
WATER CONTENT W%	11.9	10.4	13.7			
HOLE No.						
DEPTH						
SAMPLE No.						
TARE No.						
WT. SAMPLE WET + TARE						
WT. SAMPLE DRY + TARE						
WT. WATER						
WT. TARE						
WT. OF DRY SAMPLE						
WATER CONTENT W%						

ATTERBERG LIMITS

AECOM

CLIENT :	Livingstone Ventures Ltd.		
PROJECT :	Gold Creek - CNP		
JOB No. :	G511-001-00		
LOCATION :		SAMPLE:	1
BOREHOLE:	TH1 1G3	DEPTH :	3.6-3.7m
DATE :	9/Oct/08	TECHNICIAN :	CB

LIQUID LIMIT	1	2
No. of Blows		
Container No.	E	
Wt. of Wet Sample + Tare	23.85	
Wt. of Dry Sample + Tare	21.93	
Wt. of Water	1.92	
Tare of Container	14.83	
Wt. of Dry Soil	7.10	
Moisture Content	27.0%	
Liquid Limit	26.52	
PLASTIC LIMIT		
Container No.	A4	
Wt. of Wet Sample + Tare	15.41	
Wt. of Dry Sample + Tare	15.35	
Wt. of Water	0.06	
Tare of Container	15.05	
Wt. of Dry Soil	0.30	
Moisture Content	20.0%	
Material + #40 Sieve		
Material - #40 Sieve		
% Passing #40 Sieve		

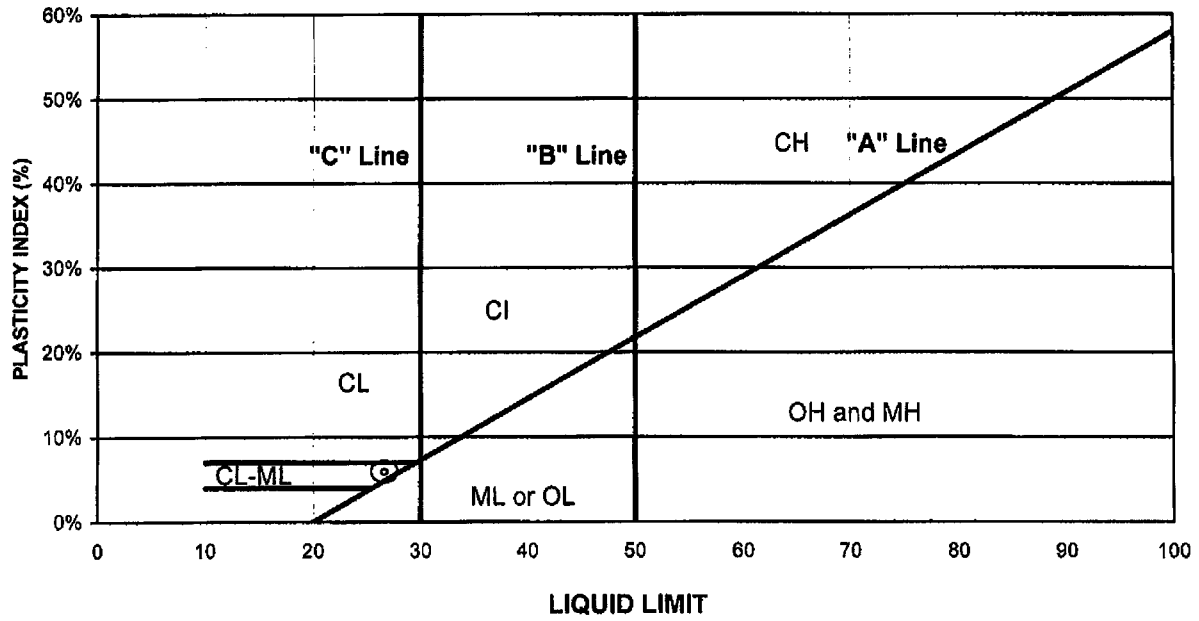
LIQUID CORRECTIONS	
X	FACTOR
20	0.9753
(21)	0.9807
22	0.9858
23	0.9907
24	0.9954
26	1.0044
27	1.0087
28	1.0128
29	1.0168
30	1.0208

Liquid Limit	27
Plastic limit	20
Plasticity index	7

REMARKS:

CL-ML Low Plastic Clay-Inorganic Silt

PLASTICITY CHART FOR SOIL PASSING #40 SIEVE



FORM: RPT1-G511-001-00-Atterberg1-081010
DATE: 10/31/2008

ATTERBERG LIMITS

AECOM

CLIENT :	Livingstone Ventures Ltd.		
PROJECT :	Gold Creek - CNP		
JOB No. :	G511-001-00		
LOCATION :		SAMPLE:	2
BOREHOLE:	TH2 2G6	DEPTH :	4.3-4.5
DATE :	9/Oct/08	TECHNICIAN :	CK

LIQUID LIMIT	1	2
No. of Blows		
Container No.	C	
Wt. of Wet Sample + Tare	25.00	
Wt. of Dry Sample + Tare	22.80	
Wt. of Water	2.20	
Tare of Container	15.35	
Wt. of Dry Soil	7.45	
Moisture Content	29.5%	
Liquid Limit	29.26	
PLASTIC LIMIT		
Container No.	G	
Wt. of Wet Sample + Tare	14.98	
Wt. of Dry Sample + Tare	14.95	
Wt. of Water	0.03	
Tare of Container	14.71	
Wt. of Dry Soil	0.24	
Moisture Content	12.5%	
Material + #40 Sieve		
Material - #40 Sieve		
% Passing #40 Sieve		

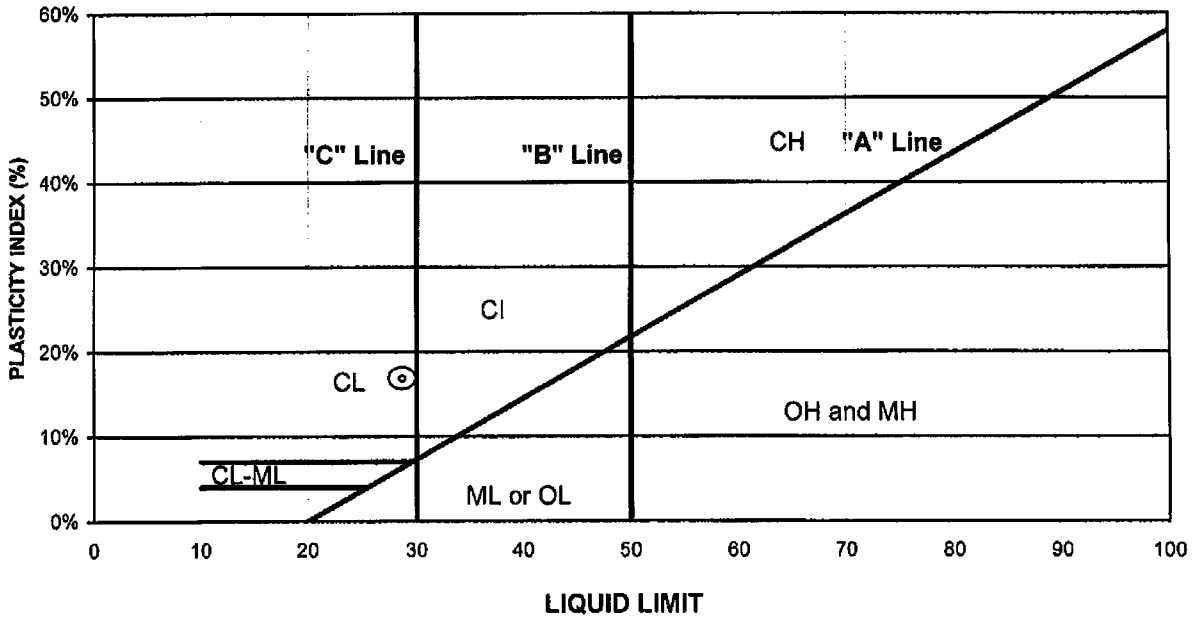
LIQUID CORRECTIONS	
X	FACTOR
20	0.9753
21	0.9807
22	0.9858
(23)	0.9907
24	0.9954
26	1.0044
27	1.0087
28	1.0128
29	1.0168
30	1.0208

Liquid Limit	29
Plastic limit	13
Plasticity index	17

REMARKS:

CL Low Plastic Clay

PLASTICITY CHART FOR SOIL PASSING #40 SIEVE



FORM: RPT1-G511-001-00-Atterberg2-081010
DATE: 10/31/2008

ATTERBERG LIMITS

AECOM

CLIENT :	Livingstone Ventures Ltd.		
PROJECT :	Gold Creek - CNP		
JOB No. :	G511-001-00		
LOCATION :		SAMPLE:	3
BOREHOLE:	TH8 8G6	DEPTH :	4.3-4.5
DATE :	9/Oct/08	TECHNICIAN :	CK

LIQUID LIMIT	1	2
No. of Blows		
Container No.	AZ	
Wt. of Wet Sample + Tare	24.92	
Wt. of Dry Sample + Tare	23.12	
Wt. of Water	1.80	
Tare of Container	14.69	
Wt. of Dry Soil	8.43	
Moisture Content	21.4%	
Liquid Limit	21.05	

PLASTIC LIMIT		
Container No.	AE	
Wt. of Wet Sample + Tare	14.99	
Wt. of Dry Sample + Tare	14.95	
Wt. of Water	0.04	
Tare of Container	14.77	
Wt. of Dry Soil	0.18	
Moisture Content	20.9%	

Material + #40 Sieve		
Material - #40 Sieve		
% Passing #40 Sieve		

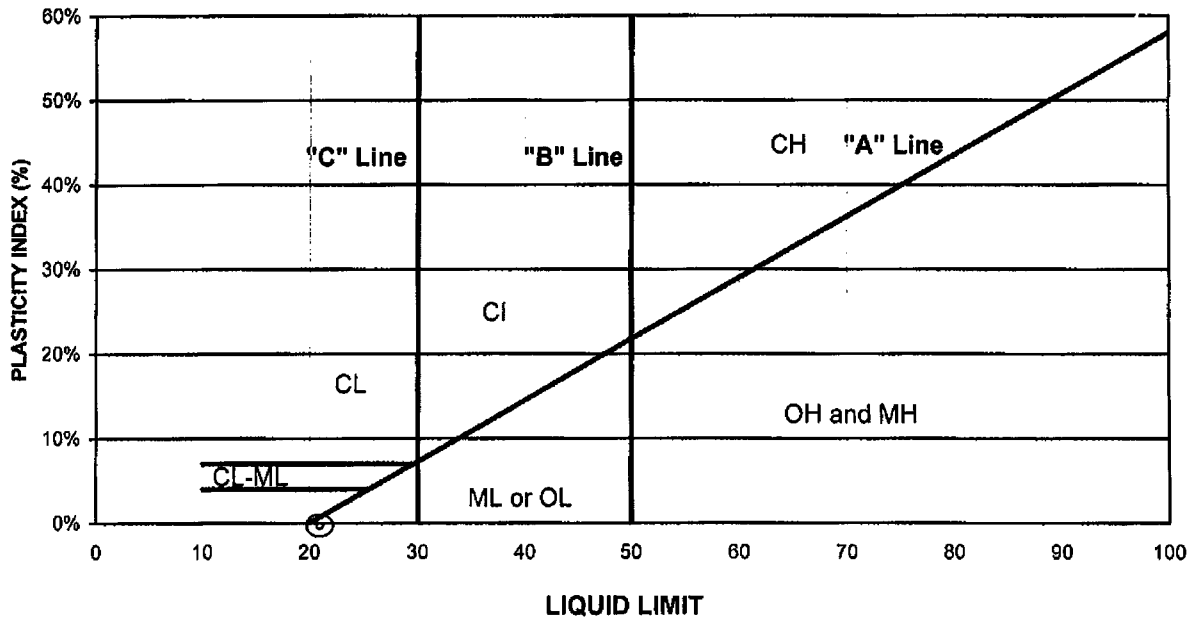
LIQUID CORRECTIONS	
X	FACTOR
20	0.9753
21	0.9807
(22)	0.9858
23	0.9907
24	0.9954
26	1.0044
27	1.0087
28	1.0128
29	1.0168
30	1.0208

Liquid Limit	21
Plastic limit	21
Plasticity Index	0

REMARKS:

MI or OL
54% passing #200 sieve

PLASTICITY CHART FOR SOIL PASSING #40 SIEVE



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ATTERBERG LIMITS

AECOM

CLIENT :	Livingstone Ventures Ltd.		
PROJECT :	Gold Creek - CNP		
JOB No. :	G511-001-00		
LOCATION :		SAMPLE:	3
BOREHOLE:	TH8 8G6	DEPTH :	4.3-4.5
DATE :	9/Oct/08	TECHNICIAN :	CK

LIQUID LIMIT	1	2
No. of Blows		
Container No.	AZ	
Wt. of Wet Sample + Tare	24.92	
Wt. of Dry Sample + Tare	23.12	
Wt. of Water	1.80	
Tare of Container	14.69	
Wt. of Dry Soil	8.43	
Moisture Content	21.4%	
Liquid Limit	21.05	
PLASTIC LIMIT		
Container No.	AE	
Wt. of Wet Sample + Tare	14.99	
Wt. of Dry Sample + Tare	14.95	
Wt. of Water	0.04	
Tare of Container	14.77	
Wt. of Dry Soil	0.18	
Moisture Content	20.9%	
Material + #40 Sieve		
Material - #40 Sieve		
% Passing #40 Sieve		

LIQUID CORRECTIONS	
X	FACTOR
20	0.9753
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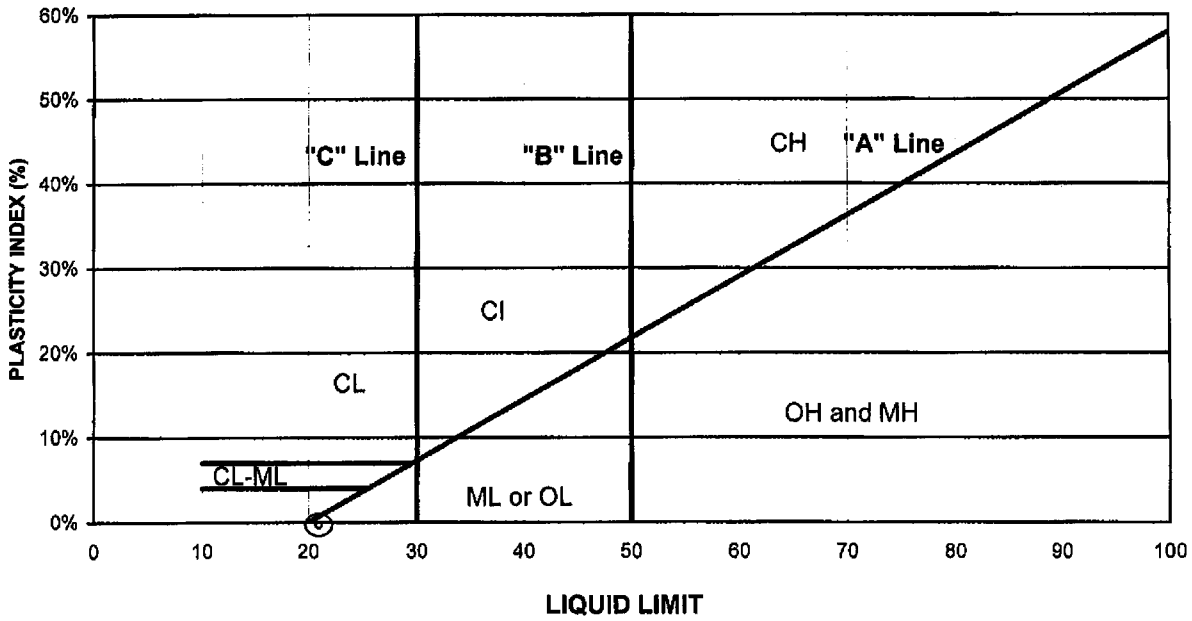
Liquid Limit	21
Plastic limit	21
Plasticity index	0

REMARKS:

MI or OL
54% passing #200 sieve

PLASTICITY CHART FOR SOIL PASSING #40 SIEVE



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