COUNTY OF LETHBRIDGE
IN THE PROVINCE OF ALBERTA

BY-LAW NO. 1356

A BY-LAW OF THE COUNTY OF LETHBRIDGE BEING A BY-LAW PURSUANT TO SECTION 633(1) OF THE MUNICIPAL GOVERNMENT ACT, CHAPTER M.26.1

WHEREAS Dr. David P. Koegler wishes to develop a country residential subdivision on a portion of his land located in the N.W. ¼ of Section 21, Township 8, Range 22, and West of the Fourth Meridian;

AND WHEREAS the County's Municipal Development Plan requires developers to prepare an Area Structure Plan to ensure sound development occurs;

AND WHEREAS the Municipal Development Plan also suggests country residential areas be located on poor quality farm land and adjacent to geotechnical sound coulee edges;

AND WHEREAS the landowner/developer has submitted the "**Koegler Area Structure Plan**" which contains engineering, survey and geotechnical information to support above conditions;

NOW THEREFORE BE IT RESOLVED that the Council of the County of Lethbridge does hereby adopt the **"Koegler Area Structure Plan"** attached as "Appendix A".

GIVEN first reading this 7th day of October, 2010.

Reeve

County Manager

GIVEN second reading this 4th day of November, 2010.

Reeve

County Manager

GIVEN third reading this 17th day of March, 2011.

Reeve

County Manager

AREA STRUCTURE PLAN
FOR
KOEGLER SUBDIVISION
NW 1/4 21-8-22-W4

Submitted to
County of Lethbridge

PREPARED FOR:
Dr. David Koegler
16 Sunrise Road
Lethbridge, AB T1J 4R9

Environmental
Agricultural
Structural
Civil
Municipal

HASEGAWA ENGINEERING

Consulting Professional Engineers
A Division of 993997 Alberta Ltd.

1220 31st Street North, Lethbridge, AB T1H 5J8
Bus: 403-328-2686 Fax: 403-328-2728 E-mail: office@hasegawa.ca

February 28, 2011

Our File #: 09-011

County of Lethbridge
905 – 4th Avenue South
Lethbridge, Alberta
T1J 4E4

VIA HAND DELIVERY

Attention: Nick Paladino

Re: Koegler Area Structure Plan

Dear Nick:

Hasegawa Engineering has received comments regarding the Koegler Area Structure Plan provided by the County of Lethbridge from the City of Lethbridge and others. The Area Structure Plan document has been revised to reflect the comments received. Fifteen (15) copies of the revised document are enclosed. A summary of the revisions and additional clarification appears below.

Off-site Roadway Improvements

With respect to the comments regarding improvements to Range Road 224 and Township Road 84, the Area Structure Plan document has been revised to clarify the Developer's proposal to address concerns about the current condition of the road.

Environmentally Sensitive Areas

With respect to the comments regarding Environmentally Sensitive Areas, the possibility of environmentally sensitive sites in the area surrounding the proposed development is acknowledged. It is proposed that a Historical Resources Impact Assessment HRIA be undertaken prior to approval of any subdivision of land within the Area Structure Plan area. This condition of approval can be included in the Development Agreement between the County of Lethbridge and the Developer.

Stormwater Management

With respect to the comments regarding stormwater management, the proposed development **will not** discharge storm runoff onto adjacent lands east of the site that are within the City of Lethbridge. Rather, runoff from the development will be collected in roadside ditches and lot line swales within the development and conveyed to the proposed stormwater management facility. From there, stormwater runoff will be discharged by means of a new outfall to the Oldman River. The new outfall will be subject to approval by Alberta Environment and the County of Lethbridge at the detailed design stage. The ASP document has been revised to clarify the proposed storm drainage infrastructure within the development site.

The ASP document has also been revised to clarify the method of estimation of the stormwater storage volume requirements, which has been completed in a manner that is consistent with the policy of the City of Lethbridge and the County of Lethbridge. Stormwater storage volume requirements have been established to attenuate runoff in excess of the 1:5 year pre-development flow up to and including flows resulting from a 1:100 year event for the post-developed condition.

Water Supply

The ASP document has been revised to clarify that the potable water distribution system will initially consist of individual cisterns for each lot. To date, discussions with the Sunwa Water Co-op and the City of Lethbridge have indicated that expansion of the existing Sunset Acres water system will not be considered until the new west Lethbridge reservoir is completed and a formal request has been received from the County by the City of Lethbridge and approved by City Council. Approval of the ASP is being sought on the basis of individual cisterns for each lot. However, the Developer is optimistic that a municipal supply will be available in the near future and is proposing to install the water distribution infrastructure within the development that will facilitate future connections to a municipal system.

Land Use Suitability

With respect to the comments concerning slope stability, a geotechnical drilling program has been undertaken to confirm the recommendations of the slope stability investigation completed by EBA Engineering Consultants in 2009. The supplemental information has been included with Appendix B of the Area Structure Plan. No change has been made with respect to the development setback line as a result of the new information.

We trust that the revised Area Structure Plan and the information above will be sufficient to allow the County Council to give 3rd reading to the Area Structure Plan. If you have any questions or comments, please feel free to contact the undersigned.

Yours truly,

Hasegawa Engineering

Jason A. Kellock, P. Eng.
Municipal Engineer
1220 – 31st Street North
Lethbridge, Alberta
T1H 5J8
Office: (403) 328-2686
Fax: (403) 328-2728
Cell: (403) 795-8359
jason.k@hasegawa.ca

PERMIT TO PRACTICE
HASEGAWA ENGINEERING
Signature
Date 3/7/2011
PERMIT NUMBER: P 8170
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this Area Structure Plan is to present a conceptual layout of the land owner's plans for development.

This document outlines a conceptual plan for a proposed subdivision located at NW 1/4 21-8-22-W4 (refer to Figure 1). The parcel under consideration is located adjacent the Oldman River Coulee in West Lethbridge (refer to Figure 2). The proposed subdivision is bordered by agricultural land to the north, the City of Lethbridge to the east and the Oldman River to the south and west. There is a parcel of undeveloped land also located south of this property.

The proposed land use is grouped country residential. The client proposes to develop approximately 10.5 hectares of coulee edge property from two parcels totaling 26.95 hectares and has previously subdivided a lot for his personal residence. An overview of the site and the proposed lot layout is provided in Figures 1 and 2. Proposed lot sizes are approximately 1 acre.

The developer proposes to dedicate the undeveloped portion of the land as Environmental Reserve. This is intended to match the County's land use bylaw requirements.

The client is proposing to develop the property into a subdivision that meets County planning goals and objectives.

2.0 PLANS AND DRAWINGS

In order to illustrate the location of the property, site drainage, and the proposed subdivision layout, five figures have been prepared. The figures are provided in Appendix A and are as follows:

1.1 Location Plan
2.1 Site Plan
3.1 Water Servicing Plan
4.1 Existing Ground Contours
5.1 Existing Ground Profiles

These maps are conceptual in nature and are to be used for planning purposes only. Upon ASP acceptance design drawing and plans will be prepared and submitted for review.

3.0 LAND USE CONCEPT

3.1 Development Objectives

The overall goal of the subdivision is to establish a framework for merging a country residential area with the natural beauty of the surrounding vista. The country residential area has been designed to minimize impact to the environment and as a result minimizes grading. This land use also conforms to the County land use bylaw for coulee edge development.

The current layout has been developed to not impact the coulee and allow for an appropriate slope stability setback. As a result, the safe development setback line was determined by EBA Consulting Engineers (refer to Figure 2 and Appendix B).

3.2 Proposed Land Use and Population Predictions

The distribution of land use within the proposed ASP is shown in Table 1 below. Population projections for the ASP area are provided in Table 2. The projected number of dwelling units is 19 as shown on the Site Plan. The developable residential area is approximately 7.7 hectares giving an overall residential density of 1.8 units/hectares and a projected total population of 67.

No municipal reserve (MR) has been allotted for this development. It is proposed that cash be provided in lieu of MR. The coulee land below the development setback line will be designated environmental reserve.

Table 1: Land Use Statistics

	Acres (ha)	Percent
Developable Area	**27.06(11.34)**	**42.1%**
Roads & Right-of-Ways	5.59 (2.64)	8.4%
Single Family Residential Lots	20.2 (8.16)	30.3%
Public Utility Lots	1.29(0.52)	1.9%
Environmental Reserve	**38.57 (15.61)**	**57.9%**
Gross Area	**66.6 (26.95)**	**100%**

Table 2: Population Projections

	Dwelling Units	Persons per Unit	Total Population
Developable Area +/- 11.34 ha	19	3.5	67

4.0 SERVICING

In order to determine the viability of this development, preliminary evaluations have been performed with respect to servicing. Key service items include sewer, water, natural gas, telephone, television, and electric. Additional information on key services is included in this section.

4.1 Sanitary Sewer System

Sanitary sewage will be handled individually on each lot with a private sewage disposal system. County development requirements indicate that prior to building on a lot a soil test is required to determine the suitability of soil for supporting a septic field system. A preliminary soil study has been performed for this property (refer to Appendix B). As part of that study soil samples were collected and sent for grain size and hydrometer analysis. Two samples were submitted to AMEC for analysis and the results are included in Table 1 below. The results of this analysis indicate that the soils meet AENV guidelines for use of individual septic systems.

Table 1 Soil Analysis Results

Sample ID	Soil type	Suitable for Septic Field	Design infiltration rate l/m^2/day
SB 2	Sandy, clayey, silt	yes	13.7
SB 3	Clayey, sandy, silt	yes	13.7

Percolation testing was conducted in three locations. The results of these tests also indicated that the observed infiltrations rates meet AENV guidelines where septic fields are permissible (refer to Appendix B). Two additional soil borings were advanced (SBw1, SBw2) to a depth of 8 ft. No water was observed in either boring indicating that no water was observed within a 5 ft depth of a potential septic field. Prior to constructing any septic field sampling and analysis will be required on each lot as required by AENV regulations.

4.2 Water System

Water systems will be installed by the Developer to provide potable water and water for firefighting purposes to the development. This section covers how each of these water supply issues will be addressed.

4.2.1 Potable Water

Initially, potable water will be the responsibility of each lot purchaser. Each owner will be required to install a pump and cistern and make arrangements to have water delivered to that cistern. There are several sources of truck delivered potable water in the greater Lethbridge area.

The developer has contacted Sunwa Water Co-op regarding supply of potable water to the proposed development. The Co-op has indicated that they do not have capacity to provide service to a new development at the present time. The Developer has also contacted the City of Lethbridge regarding future provision of potable water to the area. The City has indicated that water supply to the proposed development would be provided through the Co-op and that an application to increase the allocation of water to the Co-op would be required to service the proposed development. However, the City would not consider such an application until it has completed improvements to the water transmission and storage system on the west side of the City including an additional storage reservoir and an additional water transmission main across the Oldman River. Once these projects are complete the City may reevaluate its position regarding supply of additional water in the County west of the City.

If a municipal source of potable water is available at a later date and it can be provided to the lots within the proposed development at reasonable cost, a communal water system may be established by the residents. It is likely that the future system would utilize low pressure distribution piping and require the use of cisterns for storage and pressurization for each lot. To facilitate the future connections to a municipal potable water system, the Developer has proposed to install a four inch potable water distribution pipe within the proposed development. The proposed potable water distribution system is shown on Figure 3. The water system would be designed in accordance with the County of Lethbridge and Alberta Environment standards and would be subject to approval at the detailed design stage.

A water delivery from the Lethbridge Northern Irrigation District (LNID) may also be a future option. The LNID delivers irrigation water to the area where the development is located. Recently, the water license issued to the LNID by Alberta Environment was amended to allow for the delivery of water for other purposes subject to certain limits. The LNID has demonstrated itself to be amiable to being approached for delivery of water for various purposes. However the decision to grant such a delivery rests with the governing board for the LNID and each application is dealt with individually.

4.2.2 Fire Protection

Fire protection requirements are expected to be 4000 l/min for a two hour period. Based on this flow, storage shall be provided to accommodate a minimum of 507,000 l. A 530,000 l cistern or pond is proposed for fire water storage (refer to Figure 3). A 200mm diameter water main will be provided throughout the development and connected to hydrants to provide a supply of water for firefighting purposes. Hydrants will be spaced at a maximum of 200 meters and the fire protection system will be supplied by pumper truck. The fire protection system for the development will be designed to conform to the County engineering standards including NFPA 1142.

Water for fire protection will be obtained from a well near the development (refer to Figure 3 for the proposed location). Alberta Environment does not normally respond in writing regarding the diversion of water for the purpose of fire suppression. Section 1(g) of the Water (Ministerial) Regulation is very clear in that 'a diversion of water for the purposes of firefighting' does not require a license. However, the common interpretation of this clause is that the water must be used for firefighting at the time of diversion.

Therefore any diversion from any natural source (be it a well or flowing water on the surface) to fill a storage area which would be used for a fire in the future would require authorization from Alberta Environment. The usual method of applying for this water is a temporary diversion license. This type of authorization is available for one time diversion should volume/flow be available from the source. These authorizations are issued out of the Lethbridge Alberta Environment office and would apply for at the time of diversion. In addition to the standard information required for a temporary diversion license, the details of the storage area will be provided to Alberta Environment. These details will demonstrate the storage area has been designed and constructed to minimize losses. (e.g. lined, covered etc.)

4.3 Gas

Natural gas distribution infrastructure in the area surrounding the site is operated by ATCO Gas. The developer will pay for the installation of natural gas distribution infrastructure to each lot. Atco Gas will distribute natural gas within the development and lot purchasers will be able to select a retailer for natural gas supply.

4.4 Electrical Power

Fortis will provide services to the proposed subdivision and underground services to each property line.

4.5 Telephone

Telus will provide services to the lots, but each individual owner must apply for the service when building.

4.6 Shaw Cable

There is no cable television available in the area, however, small satellite dishes may be installed by the lot owner.

5.0 ROADS

The primary access to the subdivision will be from Range Road 224 to the northwest corner of the site (refer to Figure 2). Some area residents have expressed concern about the condition of Range Road 224 between Township Road 84 and the proposed development and the condition of Township Road 84 between Range Road 224 and the City of Lethbridge.

The cost for a simple asphalt overlay has been estimated at approximately $\$10/m^2$. Based on this unit rate, the estimated cost to overlay Range Road 224 from Township Road 84 to the edge of the development is approximately $54,000. In the absence of an off-site levy, the Developer has proposed to contribute $5,000.00 per lot, for a total of $95,000 towards improvements to Range Road 224 and Township Road 84 to the edge of the Development. These funds would be transferred from the Developer to the County as lots are sold and would be used by the County to fund improvements to the existing roadway. The amount and timing for collection of funds for off-site improvements will be confirmed in the Development Agreement between the County and the Developer.

Roads within the subdivision will comply with County engineering standards and drawings for a subdivision road with open drainage and a 20 m right-of–way throughout. Roads will be paved and meet County standards to allow for truck access. Shared driveways to lots are proposed to minimize potential conflicts with drainage.

Due to the predicted small population of the development and the rural nature of the development a traffic impact study (TIA) has not been prepared for this development. A TIA will be provided if requested by the County.

6.0 SITE DRAINAGE AND GRADING

All drainage onsite must conform to County, and Alberta Environmental requirements. Documents referred to when completing this analysis included Alberta Environment Storm Water Management Guidelines (1999). This document also includes descriptions

of Best Management Practices (BMPs) which are used to mitigate peak runoff values. These practices combined with the dry pond, will provide control and containment of storm runoff over the entire development. As can be seen in Figures 4 and 5 of the ASP, drainage on the existing ground generally flows towards the northeast.

6.1 Site Drainage

Existing Conditions

Stormwater runoff from the subject lands presently flows uncontrolled over the edge of the Oldman River Valley and is concentrated in existing coulee draws before reaching the Oldman River. Runoff is received by the subject property from lands north and east of the site. Pre-development storm drainage patterns are described in greater detail in the Hydrogeological and Site Drainage Analysis completed for the site by Hasegawa Engineering and attached to this document as Appendix C.

Post-development

A detailed drainage analysis was performed for the site to compare pre and post-development storm drainage patterns. The results of this analysis are included in Appendix C to this document. A summary of the findings of this report appear below.

The roadside ditches of the internal roadways will provide the primary channels for storm drainage within the proposed development. The developed portions of the lots will generally drain into the roadside ditches. However, the rear of the lots bordering the coulee will drain by sheet flow directly into the coulee, similar to the existing drainage patterns. A lot line swale will be created along the northern edge of the site adjacent to Lots 15 and 16 to intercept surface runoff reaching the site from the north and direct it to the roadside ditches within the development. Runoff collected from the development will be conveyed through the roadside ditches and swales to the stormwater management facility.

Stormwater runoff will be detained in the stormwater management facility and released to the Oldman River valley through an outlet control structure. The outlet control structure will be designed to limit the peak release rate to the peak pre-development runoff rate for a 1:5 year 4 hour design storm. The stormwater management facility will consist of a dry pond, which will be designed to drain completely during dry weather. During a storm event, runoff in excess of the pre-development release rate will be detained by the control structure within an active storage volume in the dry pond.

To determine the required active storage volume of the pond, a hydrologic model of the site was prepared using the PC SWMM hydrologic modeling software package. The hydrologic model was used to estimate the pre-development release rate for a 1:5 year, 4 hour storm event. The hydrologic model of the site post-development was then analyzed using a 1:100 year 24 hour design storm event. The stormwater management facility was sized to detain runoff and reduce the post-development peak flow rate to no more than

the pre-development release rate. Detailed methods and results of surface runoff analysis are provided in Appendix C.

The results of the hydrologic modeling indicate a peak post development runoff rate of approximately 3.36 m^3/s from the development to the stormwater management facility and a required storage volume of 2,177 cubic meters to attenuate the peak runoff from the site. Figure 3 shows the proposed dry pond footprint. As noted above, the outlet control structure and dry pond will attenuate the peak runoff from the site. A drain pipe from outlet structure will be required to drain the pond to the coulee during and after a rain event. A 6 meter right-of-way between lots will provide access for storm drain outlet to the coulee. The hydrologic model will be reviewed during the detailed design stage to confirm the required capacity of the overland drainage system and culverts.

7.0 SOLID WASTE DISPOSAL

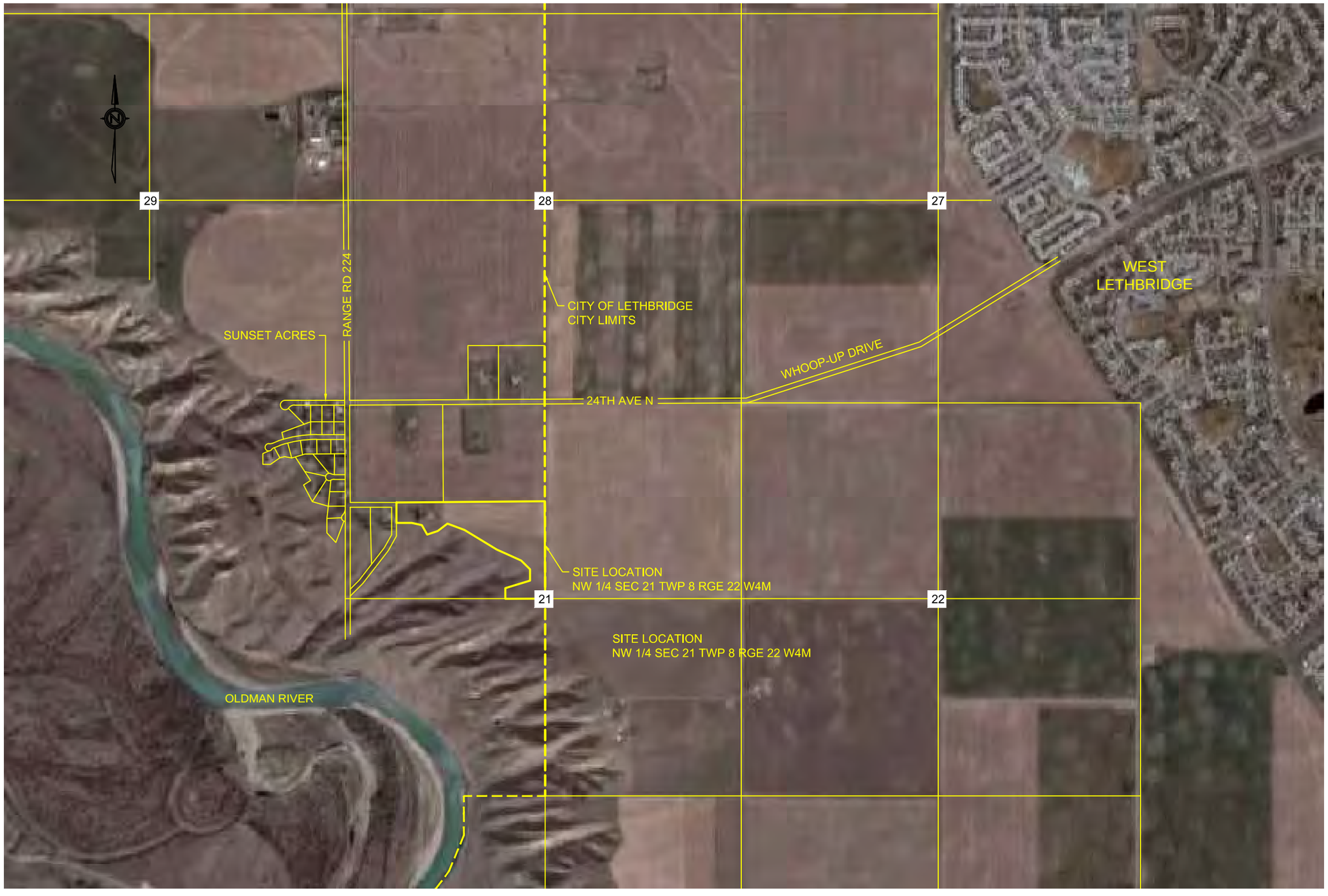
Lot purchasers will be responsible for making arrangements for solid waste disposal. The City of Lethbridge Regional Solid waste facility is located approximately 23km driving distance from the development. Alternatively, lot purchasers may contract with a private solid waste hauler.

8.0 ARCHITECTURAL CONTROLS

The following controls are designed to ensure an aesthetically pleasing environment. The intent is to create the subdivision such that it enhances the natural beauty of its surroundings. The following criteria will apply:

1. Earth tones and/or neutral colors, as determined by the Development Officer, are to be used on all physical structures.
2. Wire fences, chain link excepted, are not permitted.
3. Fences in front yards of residences need to be limited to one meter in height or less.
4. Each residence is to be a minimum of 1300 square feet on the main floor. Pre-fabricated homes may be allowed, but will be approved on a case by case basis.
5. Each property owner is to be responsible for upkeep of utility right-of-way along property frontage.

APPENDIX A
FIGURES



METERS 0 1000 2000
0 500 1500 2000

PERMIT TO PRACTICE
HASEGAWA ENGINEERING LTD.
Signature _____
Date _____
PERMIT NUMBER: P 582
The Association of Professional Engineers, Geologists and Geophysicist of Alberta

PROFESSIONAL ENGINEER ALBERTA M.HASEGAWA

NOTES

Contractor to check and verify all dimensions before construction, any errors and omissions shall be reported to the engineer immediately

Drawing shall not be used for construction until approved

Do not scale the drawing

All construction shall be in accordance with the latest codes, may it be construction, mechanical, etc

HASEGAWA
CONSULTING PROFESSIONAL ENGINEERS
1220 - 31 Street North
Lethbridge, Alberta T1H 5J8
Ph: 403-328-2686
Fax: 403-328-2728
Email: office@hasegawa.ca

CLIENT: DAVID KOEGLER

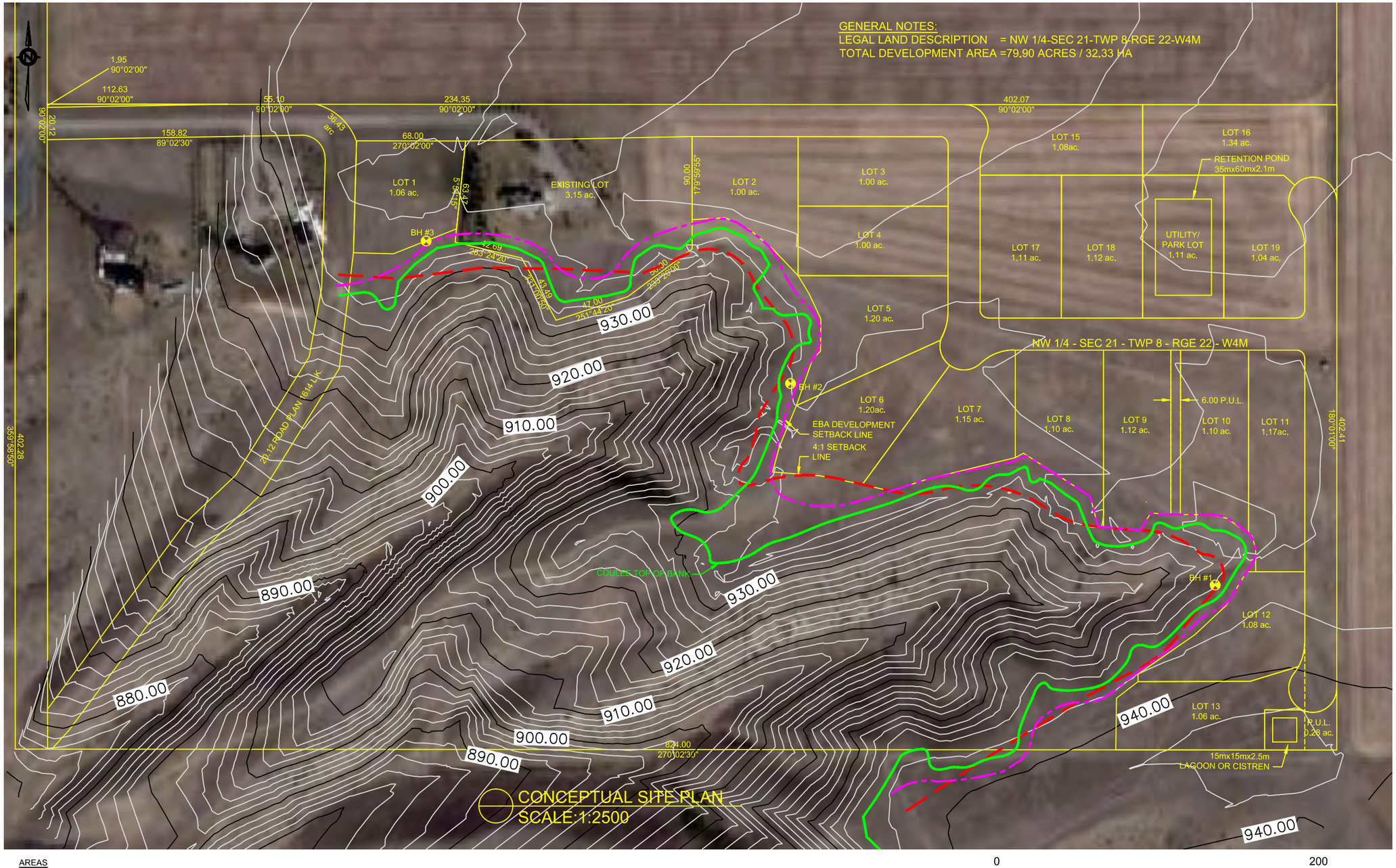
PROJECT TITLE: KOEGLER SUBDIVISION AREA STRUCTURE PLAN

DRAWING TITLE: LOCATION PLAN

DRAWING STATUS: FOR APPROVAL

#	REVISION	DATE	BY

DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
SCALE	NTS
PROJECT NUMBER	09011
VERSION NUMBER	IFA1-1
DATE DRAWN	FEB 17, 2011
SHEET NUMBER	1.1



AREAS

ROADS ALLOWANCE = 8.53 Ac.

PROPOSED LOTS = 19.93 Ac.

EXISTING LOTS = 8.02 Ac.

UTILITY LOTS & PUL = 1.54 Ac.

ENVIRONMENTAL RESERVE = 41.88 Ac.

TOTAL AREA = 79.90 Ac.

LEGEND

- DEVELOPMENT SETBACK LINE ESTABLISHED BY EBA ENGINEERING
- TOP OF COULEE SETBACK LINE ESTABLISHED BY HASEGAWA ENGINEERING BASED ON 4:1 SLOPE FROM COULEE BOTTOM
- COULEE TOP OF BANK

NOTES

This is a copyright drawing and shall not be reproduced in any form without written permission of the engineer

Contractor to check and verify all dimensions before construction, any errors and omissions shall be reported to the engineer immediately

Drawing shall not be used for construction until approved

Do not scale the drawing

All construction shall be in accordance with the latest codes, may it be construction, mechanical, etc

HASEGAWA
CONSULTING PROFESSIONAL ENGINEERS
1220 - 31 Street North
Lethbridge, Alberta T1H 5J8
Ph: 403-328-2686
Fax: 403-328-2728
Email: office@hasegawa.ca

CLIENT: DAVID KEOGLER

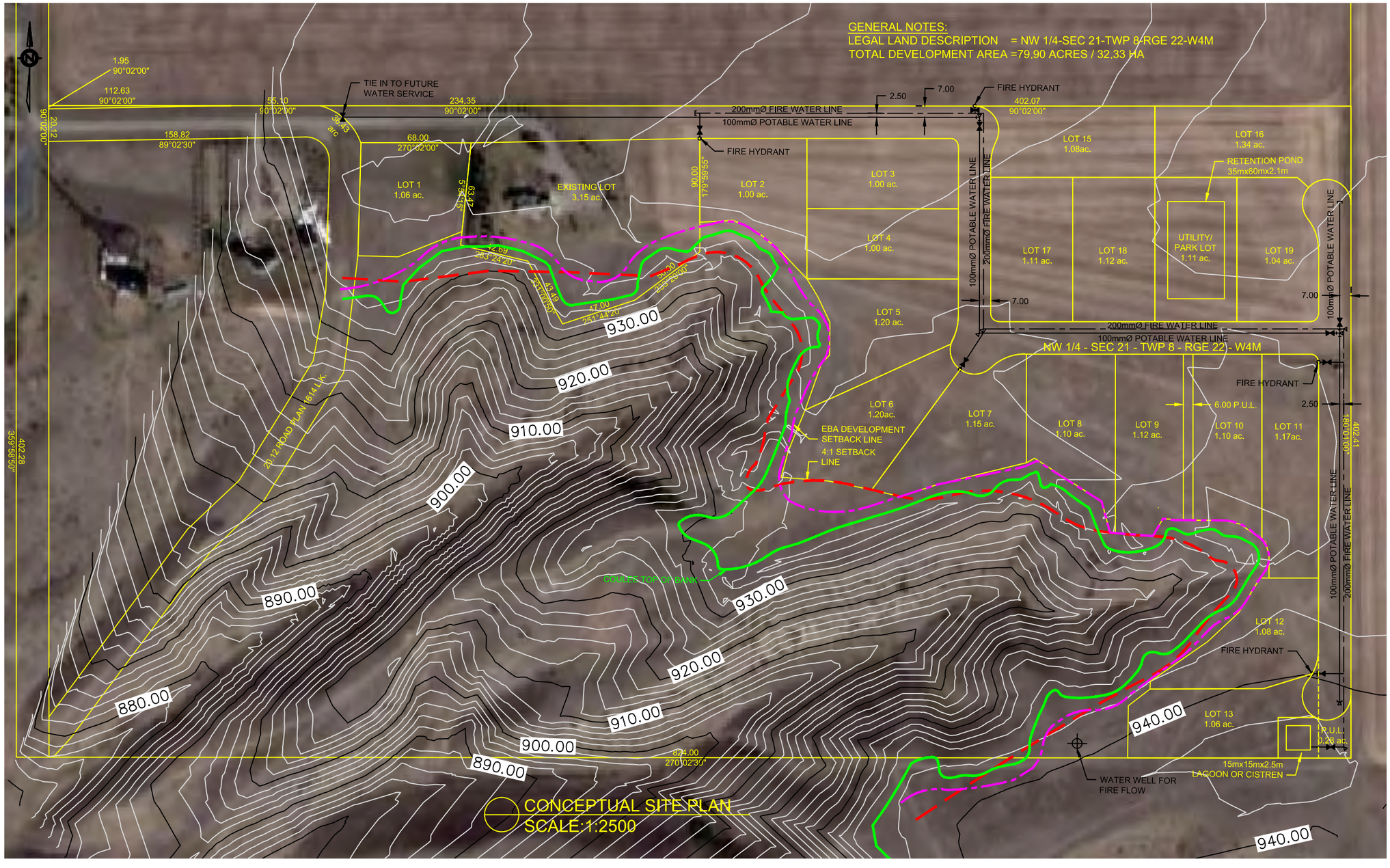
PROJECT TITLE: KEOGLER SUBDIVISION AREA STRUCTURE PLAN

DRAWING TITLE: SITE PLAN

DRAWING STATUS: FOR APPROVAL

#	REVISION	DATE	BY

DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
SCALE	1:2500
PROJECT NUMBER	09011
VERSION NUMBER	IFA1-1
DATE DRAWN	FEB 16, 2011
SHEET NUMBER	2.1



NOTES

This is a copyright drawing and shall not be reproduced in any form without written permission of the engineer

Contractor to check and verify all dimensions before construction, any errors and omissions shall be reported to the engineer immediately

Drawing shall not be used for construction until approved

Do not scale the drawing

All construction shall be in accordance with the latest codes, may it be construction, mechanical, etc

HASEGAWA
CONSULTING PROFESSIONAL ENGINEERS

1220 - 31 Street North
Lethbridge, Alberta T1H 5J8
Ph: 403-328-2686
Fax: 403-328-2728
Email: office@hasegawa.ca

CLIENT: DAVID KEOGLER

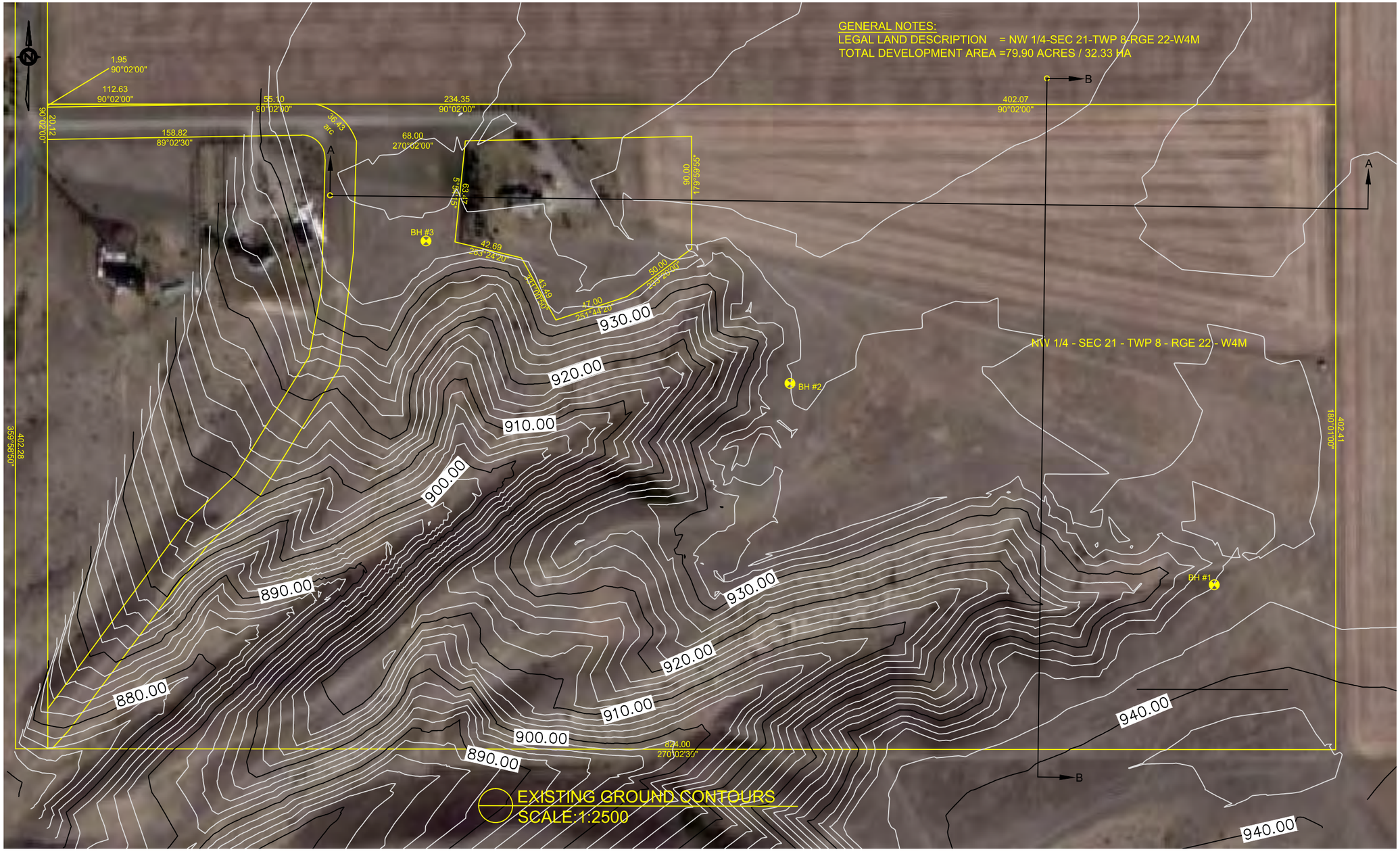
PROJECT TITLE: KEOGLER SUBDIVISION AREA STRUCTURE PLAN

DRAWING TITLE: WATER SERVICING PLAN

DRAWING STATUS: FOR APPROVAL

#	REVISION	DATE	BY

DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
SCALE	1:2500
PROJECT NUMBER	09011
VERSION NUMBER	IFA1-1
DATE DRAWN	FEB 16, 2011
SHEET NUMBER	3.1



NOTES

This is a copyright drawing and shall not be reproduced in any form without written permission of the engineer

Contractor to check and verify all dimensions before construction, any errors and omissions shall be reported to the engineer immediately

Drawing shall not be used for construction until approved

Do not scale the drawing

All construction shall be in accordance with the latest codes, may it be construction, mechanical, etc

H-E HASEGAWA
CONSULTING PROFESSIONAL ENGINEERS

1220 - 31 Street North
Lethbridge, Alberta T1H 5J8
Ph: 403-328-2686
Fax: 403-328-2728
Email: office@hasegawa.ca

CLIENT
DAVID KEOGLER

PROJECT TITLE
KEOGLER SUBDIVISION AREA STRUCTURE PLAN

DRAWING TITLE
EXISTING GROUND CONTOURS

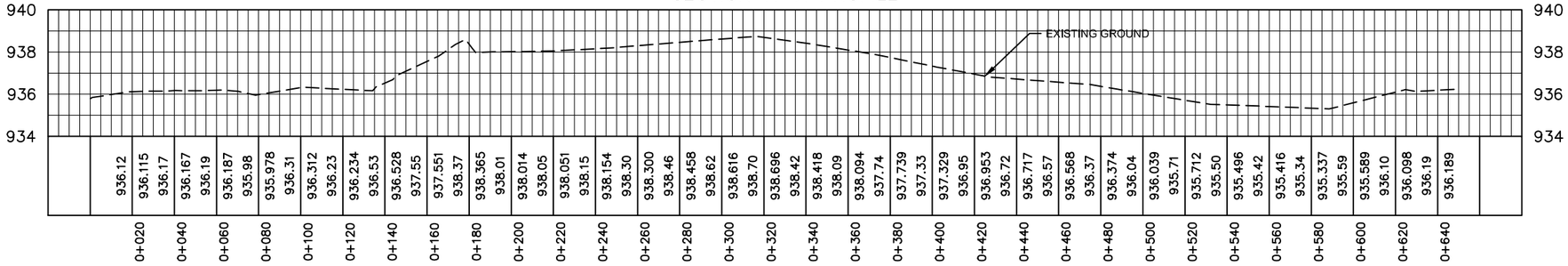
DRAWING STATUS
FOR APPROVAL

#	REVISION	DATE	BY

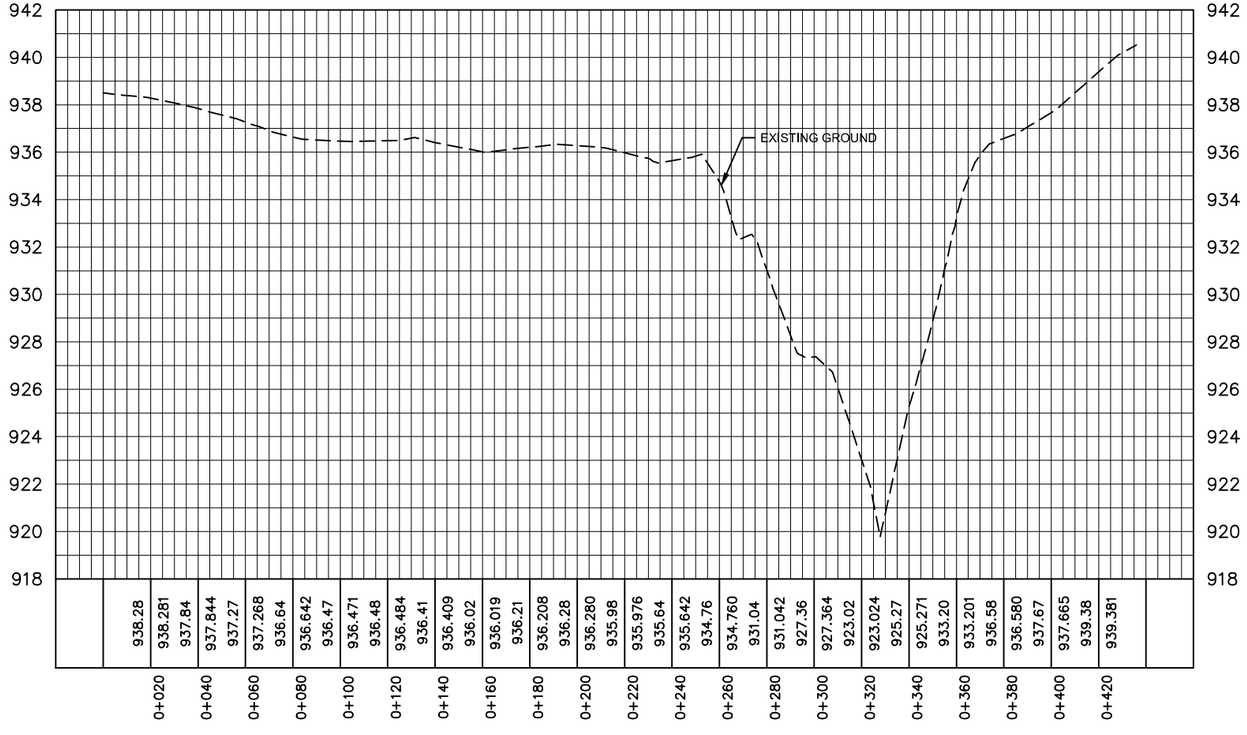
DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
SCALE	1:2500

PROJECT NUMBER	09011
VERSION NUMBER	IFA1-1
DATE DRAWN	FEB16, 2011
SHEET NUMBER	4.1

SECTION A–A PROFILE



SECTION B–B PROFILE



NOTES

Contractor to check and verify all dimensions before construction, any errors and omissions shall be reported to the engineer immediately

Drawing shall not be used for construction until approved

Do not scale the drawing

All construction shall be in accordance with the latest codes, may it be construction, mechanical, etc

HASEGAWA
CONSULTING PROFESSIONAL ENGINEERS
1220 - 31 Street North
Lethbridge, Alberta T1H 5J8
Ph: 403-328-2686
Fax: 403-328-2728
Email: office@hasegawa.ca

CLIENT: DAVID KEOGLER

PROJECT TITLE: KEOGLER SUBDIVISION AREA STRUCTURE PLAN

DRAWING TITLE: EXISTING GROUND PROFILES

DRAWING STATUS: FOR APPROVAL

#	REVISION	DATE	BY

DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
SCALE	1:2500
PROJECT NUMBER	09011
VERSION NUMBER	IFA1-1
DATE DRAWN	FEB16, 2011
SHEET NUMBER	5.1

APPENDIX B
SLOPE STABILITY REPORT
AND
SOIL TEST RESULTS

Environmental
Agricultural
Structural
Civil
Municipal

HASEGAWA ENGINEERING

Consulting Professional Engineers
A Division of 993997 Alberta Ltd.

1220 31st Street North, Lethbridge, AB T1H 5J8
Bus: 328-2686 Fax: 328-2728 E-mail: office@hasegawa.ca

TEST REPORT

JOB NAME:	Koegler – Percolation Test	DATE:	July 23, 2009
PROJECT #:	09-011	TIME:	13:50
LOCATION:	Sunset Acres – bordering west Lethbridge		
INSPECTED BY:	David Chalmers		
ATTACHED:	Drawing		
PURPOSE OF TEST:	Preliminary Percolation and Soil Testing		
ALSO IN ATTENDANCE:			

OBSERVATIONS & INFORMATION:

The proposed development consists of land on the coulee top on either side of the Koegler residence as shown on the attached drawing. Lot #1 is uncultivated land flanked by the Koegler residence on one side and the neighbor on the other side. The proposed development is designed for each house to have its own septic system. The remaining lots are on land that currently is either crop land or uncultivated prairie. There were no observed wetlands nor were any plant species present that would suggest subsurface water. There also was no visible groundwater seepage from the coulee side.

Three test holes were dug as shown on the attached drawing. The holes were placed so as to:

- test both cultivated land and native prairie
- vary the distance of hole locations from the coulee edge
- test differing elevations

Lot #1 has functioning septic systems on either side and so was assumed to also have suitable soil. Each test hole was 8 inches in diameter and 3 feet deep. The soil profile was very similar in each hole with the top 4-6 inches being organic top soil transitioning for the remainder of the hole into barely moist/dry sandy plastic clay.

Pre-soaking was started and each hole went through 20 gallons of water in the first two hours. The *Alberta Private Sewage Systems Standard of Practice Handbook* indicates that further pre-soaking was not required; nevertheless, the water reservoirs were

refilled and left overnight. On inspection the next morning, all reservoirs were empty with no water in any of the holes. Each hole was re-filled to 18" depth and the water level maintained for 4 hours – it was noted during this time that the percolation rate was noticeably slower. Percolation testing then proceeded as outlined in the *Alberta Private Sewage Systems Standard of Practice Handbook*. The results were consistent between holes and between test intervals – they are tabulated in Table 1 below. The results are within current standards which require the percolation rate to be at least 1 inch/hour (60 minutes/inch) but not faster than 12 inches/hour (5 minutes/inch).

Table 1 – Percolation Test Results

Percolation Test Hole	Drop in Water Depth, inches/30 min			Percolation Rate based on last reading inches/hr (min./inch)	Calculated Effluent Loading Rate gal/ft2/day (L/m2/day)
	Interval 1	Interval 2	Interval 3		
1	3 1/4	3 3/8	3 3/16	6 3/8 (9.4)	0.55 (26)
2	3 1/4	3 3/16	3 1/4	6 1/2 (9.2)	0.55 (27)
3	2 15/16	2 7/8	2 7/8	5 7/16 (11)	0.51 (24)

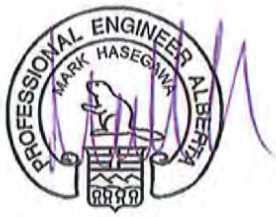
In addition, soil samples from the holes with the highest and lowest percolation rates were sent for laboratory analysis. The soils from these holes were then related to the *Alberta Private Sewage Systems Standard of Practice Handbook* soil classifications and allowable effluent loading rates. These results are in Table 2 below. As can be seen by the results, the soil in this area is suitable for individual septic fields.

Table 2 – Laboratory Soil Test Results

Percolation Test Hole	Soil Composition, %			Soil Classification	Allowable Effluent Loading Rate gal/ft2/day (L/m2/day)
	Sand	Silt	Clay		
2	10	71	19	Silt Loam	0.28 (13.7)
3	35	62	3	Silt Loam	0.28 (13.7)

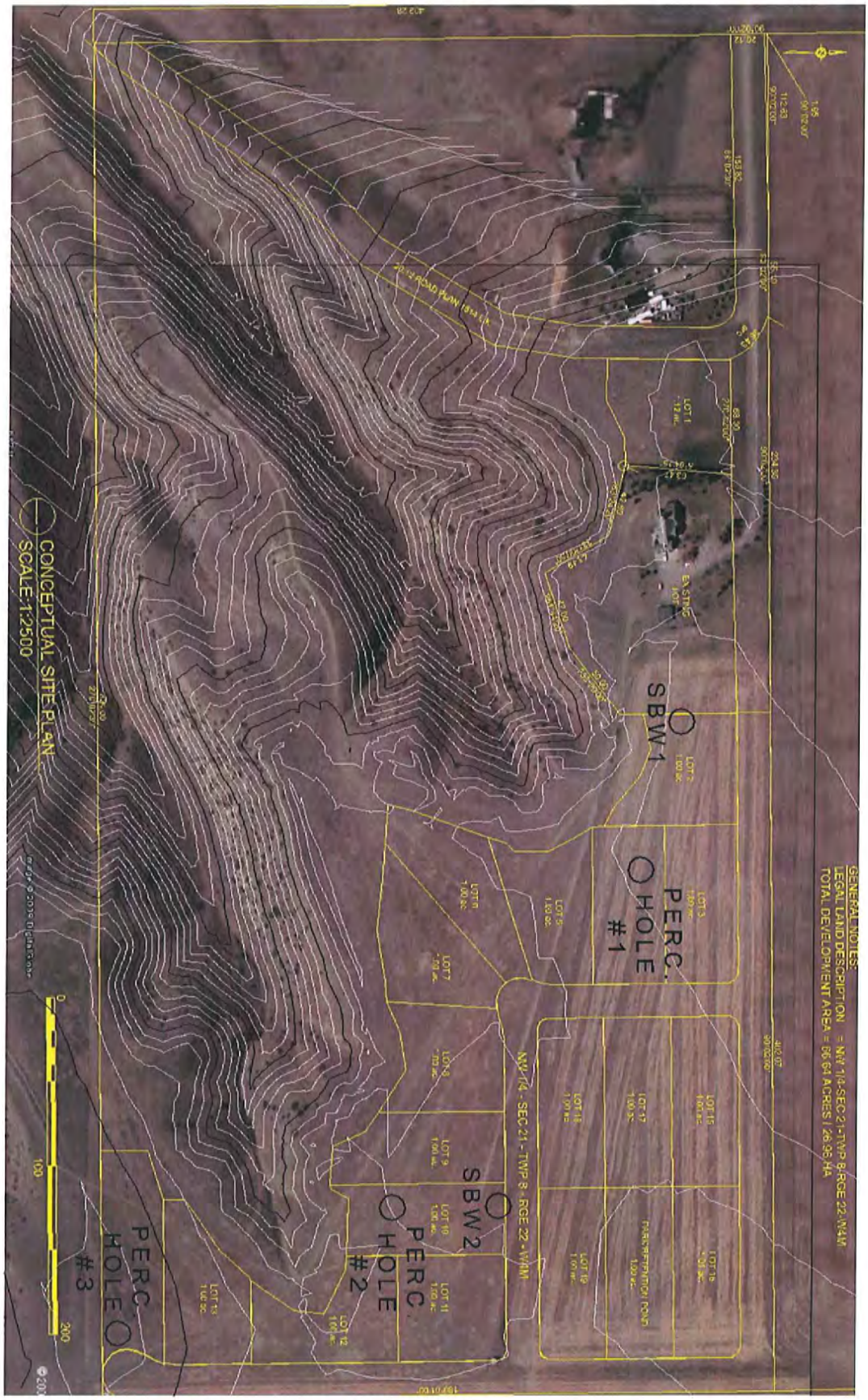
There are no visual indicators of subsurface water nor are there any nearby water wells that would indicate the depth to ground water. To provide reassurance that septic field laterals would remain at least 5 feet above ground water, two holes were bored to a depth of 8 feet (SBw1 and SBw2). The soil observed in SBw1 was a light brown, hard, sandy, silty, till that was slightly moist. The soil observed in SBw2 was tan, silty, sand and was dry. No water was observed in either soil boring.

It should be noted that this is a general test of the site and does not imply suitability for septic fields in any specific lot. Current standards require each lot to be tested using a minimum of two test holes before designing a septic system.



MARK HASEGAWA P. ENG.
HASEGAWA ENGINEERING

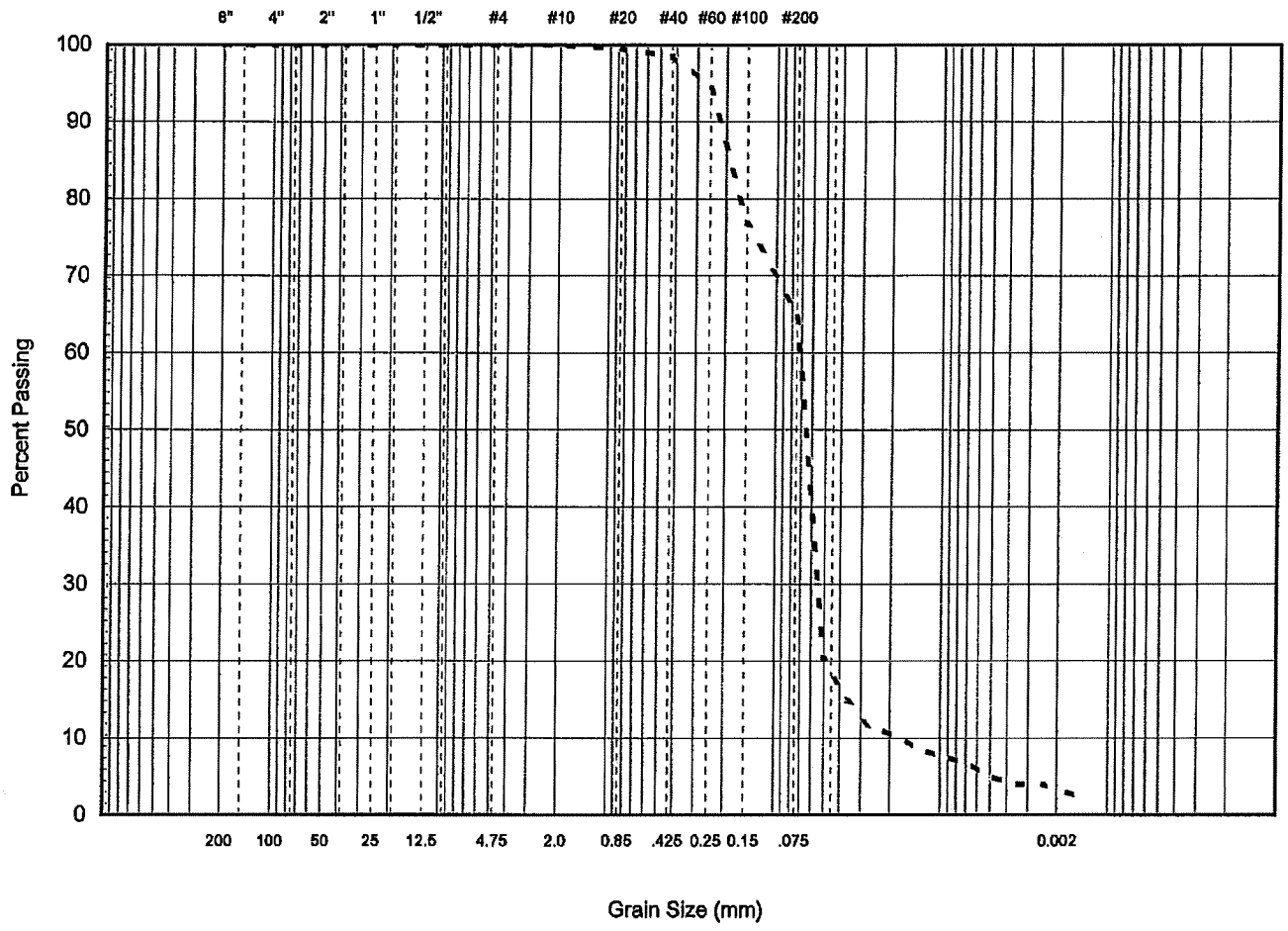
October 20, 2009
DATE


GENERAL NOTES:
LEGAL LAND DESCRIPTION = NW 1/4-SEC 21-TWP 8-RGE 22-W4M
TOTAL DEVELOPMENT AREA = 66.64 ACRES / 26.96 HA
CONCEPTUAL SITE PLAN
SCALE 1:2500
SBW1
SBW2
PERC. HOLE #1
PERC. HOLE #2
PERC. HOLE #3
NW 1/4 - SEC 21 - TWP 8 - RGE 22 - W4M
PARK/RETENTION POND
EXISTING ACR
0
100
200

HYDROMETER TEST

AMEC Earth & Environmental
a Division of AMEC Americas Limited

COBBLES	GRAVEL		SAND			SILT	CLAY
	Coarse	Fine	C	M	F		



Remarks:

Summary

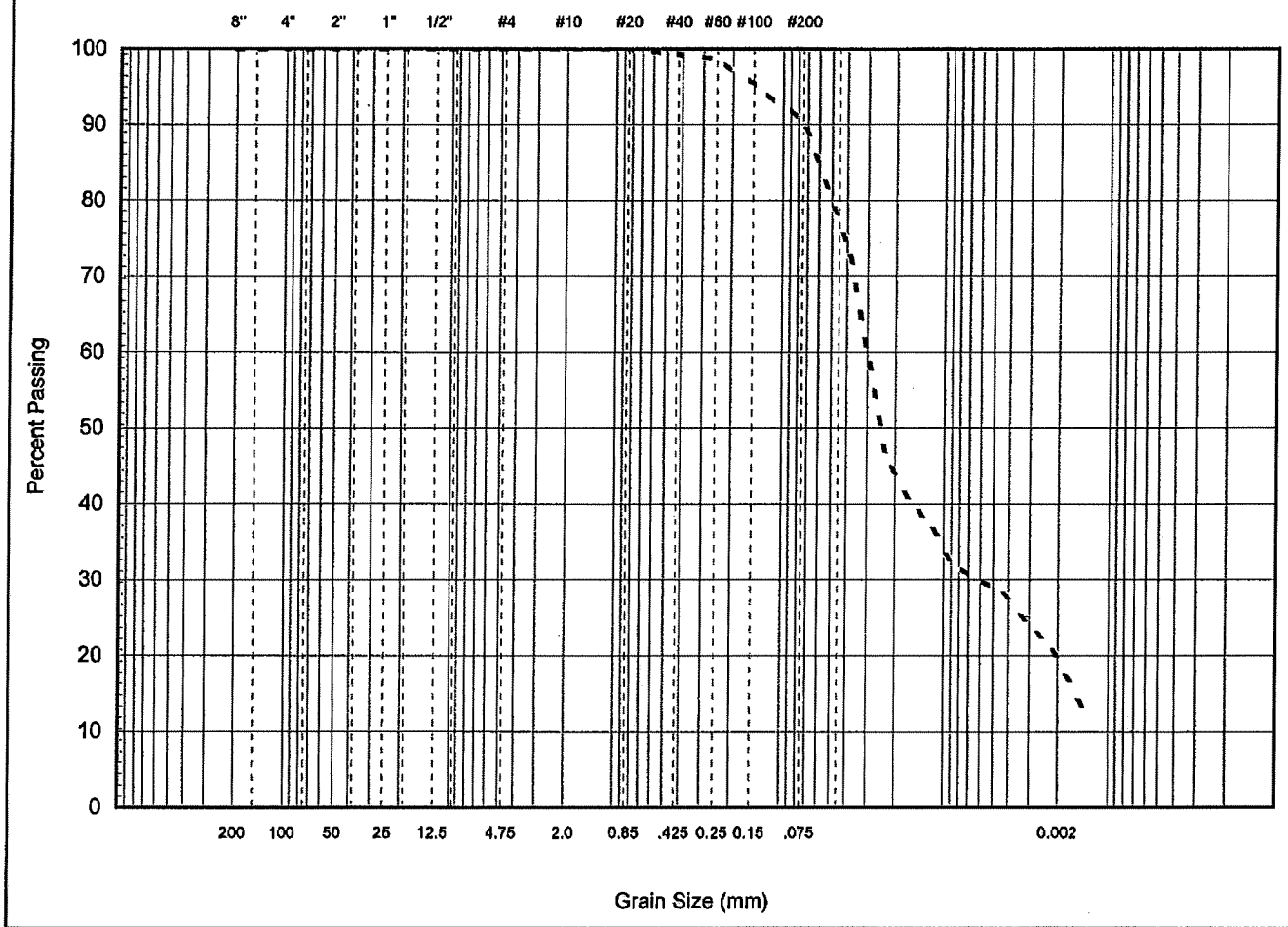
D10 =	0.0174	mm	**Gravel**	0	%
D30 =	0.0554	mm	**Sand**	35	%
D60 =	0.0721	mm	**Silt**	62	%
Cu =	4.15		**Clay**	3	%
Cc =	2.45				

Project No: BX10428-1200 **Client:** Hasegawa
Hole No: #3 09-011 **Sample:** Koegler
Depth (m): **Date:** October 9, 2009 **Tech:** AJ

HYDROMETER TEST

AMEC Earth & Environmental
a Division of AMEC Americas Limited

COBBLES	GRAVEL		SAND			SILT	CLAY
	Coarse	Fine	C	M	F		



Remarks:

Summary

D10 =	#N/A	mm	**Gravel**	0	%
D30 =	0.0061	mm	**Sand**	10	%
D60 =	0.0300	mm	**Silt**	71	%
Cu =	#N/A		**Clay**	19	%
Cc =	#N/A				

Project No: BX10428-1200 **Client:** Hasegawa
Hole No: #2 09-011 **Sample:** Koegler
Depth (m): **Date:** October 9, 2009 **Tech:** AJ

Hasegawa Engineering

ISSUED FOR USE

GEOTECHNICAL EVALUATION
PROPOSED KOEGLER SUBDIVISION
COUNTY OF LETHBRIDGE, ALBERTA

L12101618

September 2009

EBA Engineering Consultants Ltd.
p. 403.329.9009 • f. 403.328.8817
442 - 10 Street N • Lethbridge, Alberta T1H 2C7 • CANADA

TABLE OF CONTENTS

PAGE

FIGURES

APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by EBA Engineering Consultants Ltd. (EBA) for the proposed Koegler Residential Subdivision, to be located in the County of Lethbridge, Alberta.

The scope of work for the geotechnical evaluation was outlined through discussions with Mark Hasegawa of Hasegawa Engineering (Hasegawa). The objective of the evaluation was to determine the general subsurface conditions and stability of the slopes abutting the proposed subdivision in the area of the proposed development and to recommend appropriate minimum development setback distance requirements from the crest of the valley.

The minimum development setback distance requirements were established on a site specific slope stability assessment conducted for this site as part of the geotechnical evaluation, as well as a review of the recommended setback guidelines established by the City of Lethbridge Bylaw #5277, 'River Valley Area Redevelopment Plan' (RVARP), as adopted on July 26, 2004 by the City of Lethbridge.

Authorization to proceed with this evaluation was provided by Mark Hasegawa, on behalf of Dr. David Koegler.

2.0 PROJECT DETAILS AND SCOPE OF WORK

The property is located in the County of Lethbridge, Alberta, within the NW ¼ of Section 21, Township 8, Range 22, W4M. The subject area is shown on Figure 1. The proposed development is bounded to the south and west by tributary coulee valleys, comprising the Oldman River Valley, and to the north and east by undeveloped property.

Given the proximity of the adjacent slopes to the development, the scope of work for this evaluation included visual reconnaissance of the development site and surrounding slopes, as well as a geotechnical review of the adjacent slope's stability. As part of EBA's review of the RVARP guidelines, the evaluation also considered the recommendations pertaining to safe development setbacks as detailed in the study conducted by AMEC Earth and Environmental Limited (AMEC) entitled, "City of Lethbridge Phase II Development Setback Assessment Oldman River Valley Slopes", issued in November 2002.

3.0 SITE DESCRIPTION

3.1 SURFACE DESCRIPTION

Visual site reconnaissance was completed by EBA's geotechnical engineers, Mr. Nana Addo, E.I.T. and Mr. Trevor Curtis, E.I.T. on August 11, 2009. The development property was covered with prairie grasses, with an overall surface gradient towards the river valley, generally to the south/southwest. The north portion of

the site was noted to be in use as agricultural cropland. To the south/southwest of the site is a deeply incised coulee draw which extends towards the Oldman River Valley to the west. The depth of the coulee varies from prairie level in the northwest area of the site, increasing to a depth of approximately 40 m to the southwest of the site. Adjacent to this property, the upper portions of the slope appear to average approximately 4 horizontal to 1 vertical, with some localized steeper sections. The slope faces are well vegetated with prairie grasses, weeds, and some shrubs. Small, isolated surficial slumps were noted within the slope faces, attributed to surficial precipitation run-off.

As part of the evaluation, EBA reviewed aerial photographs taken of the project area between 1950 and present day. Our review indicates that the subject property has remained undeveloped with respect to structures or urban development, with the exception being the current Koegler residence. There appeared to be no evidence of significant slope instabilities within the adjacent slopes during this time period.

4.0 SUBSURFACE CONDITIONS

4.1 GEOLOGY

EBA reviewed published reports regarding the geological history of the Lethbridge area. A brief summary, in descending order, of the general stratigraphy is presented below.

- Lacustrine Deposit; a fine-grained lacustrine deposit overlies the Buffalo Lake Till, with thickness varying from non-existent to 8 m.
- Buffalo Lake Till; characterized by a lack of cohesion which often leads to slumping of this deposit. A single period of consolidation has resulted in the development of vertical stress cracks, well oxidized, with some limited bedding.
- Lenzie Silts; unit consists of buff, stratified, calcareous silt and silty sand. The deposit includes black or grey varved clays and poorly sorted till-like colluvium with coarse fragments. This is a glacial lake deposit that formed in a peri-glacial (prior to deposition of Buffalo Lake Till) lake environment as continental ice advanced. Overlying the cross-bedded sediments are lake clays deposited in thin, well-bedded laminae. The clay deposit developed as a glacier underwent a minor halt after advancing into the area.
- Labuma Till; columnar, massive till, which is hard as a result of consolidation pressure from overlying ice, deposited during Laurentide glaciation.
- Basal Till; massive till, hard, brown to grey.
- Saskatchewan Sands and Gravels; clean, well-sorted and bedded, rounded to subrounded river gravel deposit with a sandy matrix.

- Oldman Formation Bedrock; relatively massive, sedimentary deposit in both brackish and freshwater environments (non-marine), light grey to light brownish grey in colour, contains cross-bedded silty clay shales, siltstones, calcareous sandstones, ironstones, bentonitic clay and coal layers.

4.2 MINING ACTIVITY

Research was conducted to review the existence of mine workings within the boundary of the subject site. The literature search included documents contained within EBA's in-house library, including publications by ERCB (1988) (now EUB), the Galt Museum (Lethbridge), the Glenbow Museum (Calgary), the Provincial Archives (Edmonton), and various other documents regarding the coal mining industry in the Lethbridge area. The records do not indicate any mine workings within the development footprint.

5.0 SLOPE STABILITY EVALUATION

5.1 GENERAL

EBA's scope of work included a review of the present stability of the coulee slopes abutting the perimeter limits of the site (primarily south and west perimeters), and of any potential future slope instability affecting development on the property (i.e., setback requirements).

The recommendations for stability analyses and appropriate development setback limits, as presented in Bylaw #5277 (referenced in Section 1.0) were also reviewed by EBA and incorporated as part of EBA's recommendations. The slope stability analysis and review is discussed in the following sections. The minimum Factor of Safety (FOS) used for slope instability affecting the property was 1.5, which is considered acceptable by current engineering practices.

5.2 PRESENT SLOPE STABILITY

The present stability of the slopes adjacent to the development area has been reviewed, based on site reconnaissance and analytical techniques for circular and block failures. Visual observations of the slopes in the project area indicate the slopes are currently stable, as evidenced by a lack of recent slope instability (visual reconnaissance and aerial photograph review).

It is noted that the slopes in the Lethbridge area are susceptible to instabilities, with the failure plane, both on the top of the Lenzie Silts layer, as well as in the upper till (Buffalo Lake Till).

The current stability of the slopes adjacent to the project site have been evaluated by means of limit equilibrium analyses. It is noted that potential failure surfaces (block or circular) within the upper till deposit, along the top of the Lenzie Silts layer, as well as deeper seated failures, have been analyzed. Figure 1 depicts the elevation contours of the adjacent slopes, which were used in the analysis to derive typical slope profile cross-sections. The contours were taken from an aerial photograph provided by Hasegawa to EBA.

Representative soil parameters were selected for the analytical review. It should be noted that these parameters are in general agreement with those assumed in the AMEC stability analyses and have been developed from a collaboration of local geotechnical experience.

Slope stability analyses on the slope, using representative soil parameters, indicate that the existing slopes are stable, satisfying the existing visual evidence noted during the site reconnaissance. The analyses indicate FOS for shallow slope face failures are slightly higher than 1.0 for the slopes. With respect to moderate depth instability affecting the slope crests (at the contact elevation or within the Lenzie Silts layer), the FOS is approximately 1.1 to 1.2. For deep seated failures within the lower clay till, the minimum Factor of Safety affecting the slope crest is approximately 1.5. From this analysis, it appears that a theoretical slope failure along the contact elevation of the Lenzie Silts layer and overlying Buffalo Lake Till deposit, appears to be the governing slope failure mechanism for the slopes of this study, with regards to establishing a safe development setback distance from the Top of Bank[1].

5.3 IMPACT OF DEVELOPMENT ON SLOPE STABILITY

The relatively steep river valley slopes in the Lethbridge area rely upon low degrees of soil saturation for stability. Any increase in the level of soil saturation reduces the stability of the slopes.

Development of the site will bring about changes in the factors which contribute to the present stability of the slopes. Evaporation of soil moisture will be reduced by the presence of ground cover such as buildings and roadway structures. Irrigation and possible leakage of water from underground utilities or septic disposal fields, in addition to water retention within stormwater management facilities, will increase the amount of water infiltrating the site subsoils. This combination of reduced evaporation of subsoil moisture and increased infiltration of water to the subsoils is considered to be the most significant influence of development on the factors that contribute to the present stability of the slopes. Increasing soil moisture content produces a reduction in the total cohesion, as the apparent cohesion is reduced or lost, and an increase in the pore pressure ratio reduces the effective stress. The result is a corresponding decrease in the Factor of Safety. Post development conditions, including a general increase in soil saturation have been considered in this stability analysis.

---

1 Top of Bank: means the line where the general trend of the slope changes from greater than 15% to less than 15%, as determined by field survey.

5.4 DEVELOPMENT SETBACK REQUIREMENTS

Based on the stability analysis and findings during the site reconnaissance, as well as assumed post development groundwater conditions, appropriate development setbacks were derived for the natural slopes, with the setback limits measured from the natural Top of Bank.

In addition, two other factors were given consideration in determining the recommending minimum development setback limits for this development. The first was taking into account the recommendations of the City of Lethbridge Bylaw #5277, specifically with regards to translational failures along the top of the Lenzie Silts deposit. Where the Lenzie Silts contact elevation is encountered, the worst case scenario for an instability impacting property at the Top of Bank is represented by a 4H:1V assumed failure line, extending from the contact elevation at the slope face to the existing ground surface at prairie level.

The second factor would require a minimum setback distance of 6 m from the Top of Bank to protect developed property from shallow crest failures.

The contact elevation of the Lenzie Silts deposit has been taken by EBA as Elevation 900.0 m. This contact elevation is based on published data from the AMEC report conducted as part of the development of City Bylaw #5277.

Based on the various aspects of the slope stability analysis conducted for the development as provided in this report, a development setback line using the minimum requirements of Bylaw #5277 is recommended. That is, a setback line from the Top of Bank, established by extending a 4H:1V line from topographic elevation 900.0m is considered prudent. Where this line extends less than 6.0 m from the Top of Bank, the recommended setback distance shall be reconfigured to 6.0 m.

5.5 RECOMMENDED DEVELOPMENT GUIDELINES

Figure 1 presents the minimum recommended setback line, as established from the geotechnical evaluation findings noted in this report. It is noted that the specified Top of Bank line depicted on the figure was taken from information provided by Hasegawa Engineering. It has been assumed that this line was established based on the definition for Top of Bank provided in this report.

Precautionary measures which should be included in the consideration of this development (with respect to slope stability issues) are outlined as follows.

- Any fill excavated during development should not be disposed of within the development restriction zone unless directed otherwise after a review by the project geotechnical engineer. The development restriction zone is the area of land between the development setback line and the Top of Bank and on the slopes.

- Positive grading should be provided to ensure surface drainage from the development is directed as either sheet flow over the crest of the slopes or away from the slopes into a stormwater management facility.
- All utilities and plumbing should be carefully installed and inspected to ensure they are in good working order.
- Irrigation within the restrictive development zone should be prohibited.
- The development recommendations of this geotechnical report should be closely adhered to.

The upper coulee slopes should be treated as a restricted development zone. This involves:

- No excavation on the valley slope without review by a geotechnical engineer;
- No clearing of vegetation;
- No fill to be placed on the crest of the slopes or on the slopes;
- No water is to be discharged directly on to the slope face; and
- Maintain vegetation cover along the crest and on the slope.

Notwithstanding the setback distances recommended, some sloughing and slope movements will occur. The development will result in a general increase in the degree of saturation of the site subsoils which may cause minor sloughing of the top portion of the slope. The setback distance is not intended to prevent failure of the slope but rather to prevent such failures from directly affecting developed areas of the site.

6.0 REVIEW OF DESIGN AND CONSTRUCTION

EBA should be given the opportunity to review details of the design and specifications, related to geotechnical aspects of this project, prior to development of the site.

7.0 LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation of the findings of a field reconnaissance and a review of existing geotechnical data in EBA's records, including previous reports and historical air photos. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, EBA should be notified and given the opportunity to review our current recommendations in light of new findings. Recommendations presented herein may not be valid if an adequate level of monitoring is not provided during development of the site.

This report and its contents are intended for the sole use of Dr. David Koegler and his agents, Hasegawa Engineering. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report

when the report is used or relied upon by any Party other than Dr. Koegler, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement and in the General Conditions provided in Appendix A of this report.

8.0 CLOSURE

We trust this report satisfies your present requirements. We would be pleased to provide further information that may be needed during design and to advise on the geotechnical aspects of specifications for inclusion in contract documents. Should you require additional information or monitoring services, please do not hesitate to contact our office.

Respectfully submitted,
EBA Engineering Consultants Ltd.

Prepared by:

Nana K. Addo, E.I.T.
Project Engineer

Reviewed by:

PROFESSIONAL ENGINEER ALBERTA
MARC J. SABOURIN
Sept 8, 09

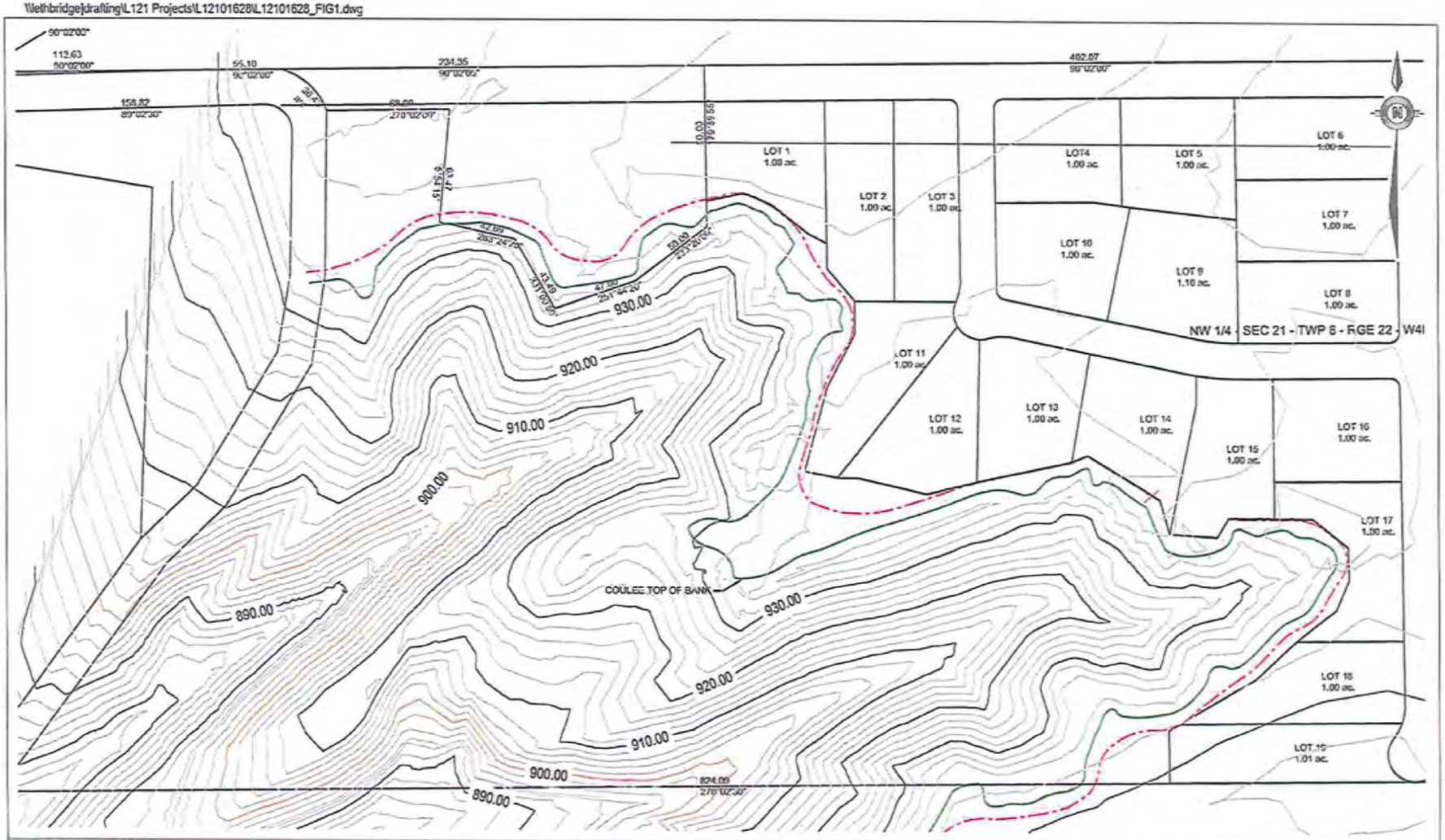
Marc Sabourin, P.Eng.
Senior Project Director

/rcm

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date Sept 8, 09
PERMIT NUMBER: P245
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

FIGURES

\\lethbridge\drafting\L121 Projects\L12101628\L12101628_FIG1.dwg



LEGEND

- DEVELOPMENT SETBACK LINE
- TOP OF BANK
- LENZIE SILTS LAYER EL. 900 m

0 50 100 150m

SCALE 1:3000

CLIENT

Hasegawa Engineering

DEVELOPMENT SETBACK LINE ASSESSMENT KOEGLER SUBDIVISION

SITE PLAN

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
L12101618	LCH	TC	0

OFFICE: Lethbridge

DATE: September 8, 2009

Figure 1

APPENDIX

APPENDIX A GEOTECHNICAL REPORT - GENERAL CONDITIONS

GEOTECHNICAL REPORT – GENERAL CONDITIONS

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

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgemental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

8.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

9.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

10.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

11.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

12.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

13.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

14.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

A TETRA TECH COMPANY

February 14, 2011

ISSUED FOR USE
EBA FILE: L12101937

Hasegawa Engineering
1220 – 31 Street North
Lethbridge AB T1H 2R7

Attention: Mr. Mark Hasegawa

Dear Sir:

Subject: Geotechnical Evaluation
Proposed Koegler Subdivision Slope and Setback line
County of Lethbridge, Alberta

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by EBA, A Tetra Tech Company (EBA), for the proposed Koegler Subdivision to be located in the County of Lethbridge, Alberta.

The scope of work for this evaluation was outlined in a proposal issued to Mr. Mark Hasegawa of Hasegawa Engineering (Hasegawa) on January 19, 2011 (EBA File PL12101937). This work is a follow up to a slope stability geotechnical evaluation (desktop study) conducted on this site by EBA in 2009 (EBA File No. L12101618). The desktop study presented a minimum development setback limit from the Top of Bank (defined in the L12101618) of the adjacent river valley slopes. The objective of this evaluation was to determine the general subsurface conditions in the area of the proposed development and to confirm the contact elevation of the Lenzie Silts deposit assumed in the 2009 report. If the results of the borehole exploration program do not agree with the assumptions made in the 2009 report, appropriate design and construction recommendation were to be amended.

Authorization to proceed with the work was provided by Mr. Mark Hasegawa, on behalf of Dr. David Koegler.

2.0 SCOPE OF WORK

The work scope for this evaluation comprised the installation of three geotechnical boreholes, a laboratory program to assist in classifying the subsurface soils, and a report to interpret the findings and to confirm the assumptions and recommendations in the 2009 report provided by EBA.

EBA, A Tetra Tech Company
442 - 10 Street North
Lethbridge, AB T1H 2C7 CANADA
p. 403.329.9009 f. 403.328.8817

3.0 GEOTECHNICAL FIELD AND LABORATORY WORK

The fieldwork for this evaluation was carried out on January 24, 2011, using a truck-mounted drill rig contracted from Chilako Drilling Services Ltd. of Coaldale, Alberta. The rig was equipped with 150 mm diameter solid stem continuous flight augers. EBA's field representative was Mr. Jackson Meadows, C.E.T.

Three boreholes (11BH001 through 11BH003) were installed in total across the property. The boreholes were drilled close to Top of Bank of the adjacent river valley slopes, to depths of 35.0 m. The approximate borehole locations are shown on Figure 1.

In all of the boreholes, disturbed grab samples were obtained at 600 mm intervals. In addition, Pocket Penetrometer Tests were generally performed on selected disturbed clay soil samples. All soil samples were visually classified in the field and the individual soil strata and the interfaces between them were noted. The borehole logs are attached. An explanation of the terms and symbols used on the borehole logs is also attached.

Slotted 25 mm diameter PVC standpipes were installed in each of the boreholes in order to monitor groundwater levels. Auger cuttings were used to backfill around the standpipes and they were sealed with bentonite chips.

The locations of the boreholes within the proposed footprints were laid out on site based on the proposed borehole plan by EBA. The geodetic ground elevations (Elevation) and the boreholes locations were surveyed and provided to EBA by Hasegawa. The borehole elevations at ground surface are shown on the borehole logs.

Classification tests, including natural moisture content and Atterberg Limits, were subsequently performed in a laboratory, on samples collected from the boreholes, to aid in the determination of engineering properties. The results of the laboratory tests are presented on the borehole logs.

4.0 SUBSURFACE CONDITIONS

4.1 General

The general subsurface stratigraphy for the property was comprised of a surficial layer of topsoil, underlain by a lacustrine clay deposit, in turn underlain by two glacial till layers. Between the two glacial till deposits, sand and/or silt with laminated high plastic clay layers (Lenzie Silts deposit) were noted in the boreholes. The following subsections provide a summary of the stratigraphic units encountered at the project site at the specific borehole locations. A more detailed description is provided on the borehole logs.

4.2 Subsurface Conditions

A surficial layer of topsoil was encountered at the boreholes, with a thickness of approximately 100 mm. Underneath the topsoil layer, a lacustrine clay deposit was encountered in the 11BH003, extending to a depth of 2.8 m below the ground, but was not noted in the other two boreholes. The clay was described as silty, some sand, moist to very moist, firm to very stiff, medium plastic, and brown with white precipitates. High plastic clay inclusions and gravel pockets were occasionally noted within the clay layer.

Underlying the clay layer in 11BH003 and the topsoil layer in 11BH001 and 11BH002, a clay till layer was encountered to depths of approximately 29 m below ground level. In 11BH001 and 11BH002, a sand layer was noted at the bottom of the till sheet, between approximately 21 m and 29 m below ground level. The clay till was generally described as silty, some sand, trace gravel, damp to moist, very stiff to hard, medium plastic, and light brown with coal and oxide specks and thin sand lenses. High plastic clay inclusions, sand/silt lenses, and gravel pockets were generally noted within the clay till matrix. Moisture contents, taken on samples of the clay till, were determined to range between 7.9% and 28.6%. The results of Atterberg Limit testing (9 tests) carried out on the clay till soil indicated medium plasticity for the clay till with high plastic clay inclusions. The sand layer was described as silty, poorly graded, medium-grained, moist, and light brown, occasionally with high plastic clay inclusions.

Below the upper clay till deposit, clay and/or silt layers were encountered in 11BH001 and 11BH003, with thinner sand lenses in 11BH002. Beneath these layers a second clay till deposit was encountered in 11BH001 and 11BH002. The lower clay till deposit was described similar to the upper clay till layer except for the color, which was described as grey or mottled grey/brown. The lower till layer was encountered to the full depth penetrated in the boreholes.

4.3 Groundwater Conditions

At the time of drilling, no seepage and sloughing was encountered at the borehole locations. The groundwater level was measured on February 1, 2011. The following table summarizes the groundwater monitoring data and standpipe installation details.

Table 4.3: Groundwater Monitoring Data

Borehole Number	Depth of Standpipe (m)	Borehole Elevation (m)	Groundwater Monitoring Data February 1, 2010	
			Depth to Groundwater (m)	Groundwater Elevation (m)
11BH001	35.0	900.99	DRY	DRY
11BH002	35.0	901.65	DRY	DRY
11BH003	35.0	900.74	DRY	DRY

5.0 DISCUSSION AND CONCLUSIONS

Based on EBA's review and understanding of the geology in the Lethbridge area, two major glacial events occurred, in between which a pro-glacial lake formed, resulting in deposition of the Lenzie Silts deposit. During advancement and retreat of the last glacier the Lenzie Silts deposit was over-ridden, resulting in a variance in its' contact elevation and stratigraphic profile. From the information collected from the boreholes installed for this evaluation, EBA's analysis has resulted in determining that the contact elevation (geodetic datum) of the Lenzie Silts deposit is at approximately Elevation 905.0 m.

EBA's 2009 evaluation (L12101618) determined the contact elevation to be Elevation 900.0 m. This was based on taking the contact elevation contour from City of Lethbridge Bylaw #5277 (Amec Study report

included as part of the Bylaw) and subtracting 5 m, as per Clause 3.5.1.3 of the Bylaw. Reducing the contour elevation by 5 m is required where no subsurface exploration is conducted at a site.

For the 2009 evaluation, the Development Setback Line was based on a 4H:1V slope line from Elevation 900 m or a minimum setback distance of 6 m. Figure 1 is taken from that study and as noted on the figure, the 6 m minimum setback distance is the governing factor for the majority of the line. Based on EBA's review of establishing a new development setback line using Elevation 905 m, the final recommended Development Setback Line, as depicted on Figure 1 does not materially change. It is EBA's recommendation therefore, that the recommended Development Setback Line established in EBA's 2009 report be used for the proposed development.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Hasegawa Engineering and their agents. EBA, A Tetra Tech Company, does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Hasegawa Engineering, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement. EBA's Geotechnical Report - General Conditions are attached.

7.0 CLOSURE

EBA trusts that this information satisfies your present requirements. If there are any questions regarding this report or if EBA can be of further assistance, please contact the undersigned at your convenience.

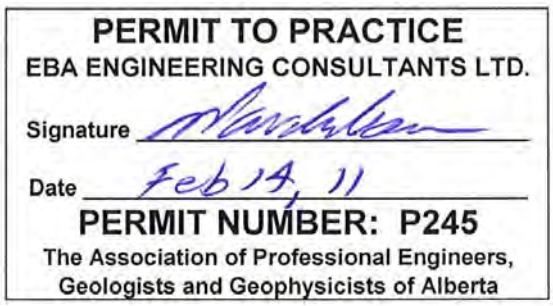
Sincerely,
EBA, A Tetra Tech Company

Jiejun Zhao, E.I.T.
Project Engineer
Engineering Practice
Direct Line: 403.329.9009 x238
jzhao@eba.ca

Marc J. Sabourin, P.Eng.
Senior Project Director
Engineering Practice, Prairie Region
Direct Line: 403.329.9009 x225
msabourin@eba.ca

/tlp

Attachments Figure 1: Borehole Location Plan
Borehole Logs
Geotechnical Report – General Conditions



Z:\Lethbridge\Drafting\L121_Projects\L12101937\L12101937_FIG1_R0.dwg [FIGURE 1] February 08, 2011 - 11:03:27 am (BY: HUGHES, LEANNE)

1.95
90°02'00"
112.63
90°02'00"
55.10
90°02'00"
234.35
90°02'00"
402.07
90°02'00"
20.12
90°02'00"
158.82
89°02'30"
36.43
arc
68.00
270°02'00"
90.00
179°59'55"
63.47
S 52°45'
402.28
359°58'50"
402.41
180°01'00"
824.00
270°02'30"

LOT 1
1.06 ac.
EXISTING LOT
3.15 ac.
LOT 2
1.00 ac.
LOT 3
1.00 ac.
LOT 4
1.00 ac.
LOT 5
1.20 ac.
LOT 6
1.20ac.
LOT 7
1.15 ac.
LOT 8
1.10 ac.
LOT 9
1.12 ac.
LOT 10
1.10 ac.
LOT 11
1.17ac.
LOT 12
1.08 ac.
LOT 13
1.06 ac.
LOT 15
1.08ac.
LOT 16
1.34 ac.
LOT 17
1.11 ac.
LOT 18
1.12 ac.
UTILITY/
PARK LOT
1.11 ac.
LOT 19
1.04 ac.
P.U.L.
0.28 ac.

RETENTION POND
35mx60mx2.1m
6.00 P.U.L.
15mx15mx2.5m
LAGOON OR CISTREN

NW 1/4 - SEC 21 - TWP 8 - RGE 22 - W4M

BH001
BH002
BH003

12.69
263°24'20"
43.49
331°10'50"
47.00
251°44'20"
80.60
293°28'00"

20.12 ROAD PLAN 6114 L.K.
EBA DEVELOPMENT
SETBACK LINE
4:1 SETBACK
LINE
COULEE TOP OF BANK

LEGEND

- BOREHOLE
- EBA DEVELOPMENT SETBACK LINE
- HASEGAWA ENGINEERING TOP OF COULEE SETBACK LINE
- COULEE TOP OF BANK

0 50 100m
SCALE 1:2500

NOTES
BASED ON DRAWING PROVIDED BY HASAGAWA CONSULTING PROFESSIONAL ENGINEERS

CLIENT
Dr. Koegler

PROPOSED KOEGLER SUBDIVISION

BOREHOLE LOCATION PLAN

eba
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
L12101937	LCH	TC	0

OFFICE	DATE
EBA-Riverbend	February 8, 2011

Figure 1

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 to 20%	0 to 4
Loose	20 to 40%	4 to 10
Compact	40 to 75%	10 to 30
Dense	75 to 90%	30 to 50
Very Dense	90 to 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (kPa)
Very Soft	Less Than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater Than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	- composed of thin layers of varying colour and texture.
Interbedded	- composed of altemate layers of different soil types.
Calcareous	- containing appreciable quantities of calcium carbonate.
Well Graded	- having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded	- predominantly of one grain size, or having a range of sizes with some intermediate size missing.

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS Liquid limit <50		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity
	SILTS Liquid limit >50		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
	CLAYS Above "A" line on plasticity chart negligible organic content Liquid limit <30		CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays
	CLAYS Above "A" line on plasticity chart negligible organic content Liquid limit 30-50		CI	Inorganic clays of medium plasticity, silty clays
	CLAYS Above "A" line on plasticity chart negligible organic content Liquid limit >50		CH	Inorganic clays of high plasticity, fat clays
	ORGANIC SILTS AND CLAYS Liquid limit <50		OL	Organic silts and organic silty clays of low plasticity
	ORGANIC SILTS AND CLAYS Liquid limit >50		OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

LABORATORY CLASSIFICATION CRITERIA

Classification on basis of percentage of fines

GW, GP, SW, SP
GM, GC, SM, SC
Borderline Classification requiring use of dual symbols

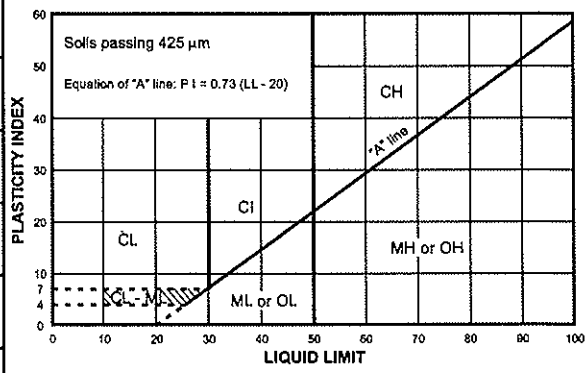
$C_U = D_{60}/D_{10}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
Not meeting both criteria for GW	
Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
Atterberg limits plot above "A" line or plasticity index greater than 7	

Less than 5% Pass 75 µm sieve
More than 12% Pass 75 µm sieve
5% to 12% Pass 75 µm sieve

$C_U = D_{60}/D_{10}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
Not meeting both criteria for SW	
Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
Atterberg limits plot above "A" line or plasticity index greater than 7	

For classification of fine-grained soils and fine fraction of coarse-grained soils.

PLASTICITY CHART



*Based on the material passing the 75 mm sieve
Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA

SOIL COMPONENTS

FRACTION	SIEVE SIZE PASSING	SIEVE SIZE RETAINED	DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS: PERCENTAGE	DESCRIPTOR
GRAVEL			>35 %	"and"
coarse	75 mm	19 mm	21 to 35 %	"y-adjective"
fine	19 mm	4.75 mm	10 to 20 %	"some"
SAND			>0 to 10 %	"trace"
coarse	4.75 mm	2.00 mm		
medium	2.00 mm	425 µm		
fine	425 µm	75 µm		
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL

Rounded or subrounded

COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm

Not rounded

ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

EBA Engineering Consultants Ltd.

PROJECT: KOEGLER SLOPE ASSESSMENT	CLIENT: HASEGAWA ENGINEERING LTD.	PROJECT NO. - BOREHOLE NO.
LOCATION: NW 1/4 SEC. 21-8-22 W4M	DRILL METHOD: 150mm SOLID STEM AUGER	L12101937 - 11BH001
CITY: LETHBRIDGE, AB	PROJECT ENGINEER: TREVOR CURTIS	ELEVATION: 935.99 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID (20 40 60 80)	STANDARD PENETRATION (N) (20 40 60 80) / UNCONFINED (kPa) (50 100 150 200) / POCKET PEN. (kPa) (100 200 300 400)	Elevation (m)
0	TOPSOIL - clay, silty, sandy, frozen, dark brown. roots, organics						
1	CLAY (TILL) - silty, some sand, trace gravel, damp to moist, very stiff, medium plastic, light brown with dark brown mottling, coal and oxide specks, thin sand lenses		B1	13.9			935.0
			B2				
2	... moist, stiff		B3				934.0
			B4				
3	... oxide staining, weathered		B5	15.6			933.0
			B6				
4	... trace to some sand, medium to high plastic		B7				932.0
5	... dark brown with grey mottling ... some sand, medium plastic, brown with dark brown mottling, high plastic clay inclusions		B8				931.0
6	... occasional sand pockets to 20mm		B9	15.8			930.0
			B10				
7			B11				929.0
			B12				
8	... oxide staining, weathered		B13	14.4			928.0
			B14				
9			B15				927.0
10	... very stiff		B16				926.0
			B17	14.2			
11	... trace to some sand, medium to high plastic, light brown with dark brown mottling, gypsum crystals		B18				925.0
			B19				
12	... trace sand, high plastic, laminated		B20				924.0
13			B21	28.6			923.0
	... some sand, medium plastic, light brown with dark brown mottling		B22				
14			B23				922.0
15	... occasional high plastic clay inclusions		B24				921.0
			B25	19.5			
16	... high plastic clay inclusions, thin silt lenses		B26				920.0
			B27				
17			B28				919.0
18	... sandy, damp to moist, low plastic, silt lenses, sand pockets to 50mm, light brown		B29	25.2			918.0
18.5	...some sand to sandy, moist, medium plastic, brown with dark brown		B30				

PROJECT: KOEGLER SLOPE ASSESSMENT	CLIENT: HASEGAWA ENGINEERING LTD.	PROJECT NO. - BOREHOLE NO.
LOCATION: NW 1/4 SEC. 21-8-22 W4M	DRILL METHOD: 150mm SOLID STEM AUGER	L12101937 - 11BH001
CITY: LETHBRIDGE, AB	PROJECT ENGINEER: TREVOR CURTIS	ELEVATION: 935.99 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID (20 40 60 80)	STANDARD PENETRATION (N) (20 40 60 80) / UNCONFINED (kPa) (50 100 150 200) / POCKET PEN. (kPa) (100 200 300 400)	Elevation (m)
18.5	mottling, occasional silt and sand pockets to 25mm						
19			B31				917.0
			B32				
20			B33	15.9			916.0
21	... sandy, low plastic		B34				915.0
	SAND - silty, trace clay, poorly graded, medium grained, moist, light brown		B35				
22	damp to moist, occasional high plastic clay inclusions		B36				914.0
			B37	8.9			
23	... fine grained, moist		B38				913.0
24			B39				912.0
			B40				
25			B41	4.7			911.0
			B42				
26			B43				910.0
27			B44				909.0
			B35	15.3			
28	CLAY (TILL) - silty, trace to some sand, trace gravel, moist, stiff, medium plastic, brown, coal and oxide specks, silt inclusions, weathered		B46				908.0
29	... brown with grey to grey brown mottling, high plastic clay inclusions, laminated		B47	21.5			907.0
			B48				
30	SILT - trace clay, damp to moist, compact, low plastic, light brown, occasional high plastic clay inclusions		B49	11.8			906.0
	... thin sand lenses		B50				
31			B51				905.0
	CLY (TILL) - silty, some sand, trace gravel, moist, very stiff, medium plastic, grey to grey brown, coal and oxide specks, thinly laminated, occasional high plastic clay inclusions		B52				
32			B53	14			904.0
33			B54				903.0
			B55				
34			B56				902.0
35			B57	15.9			901.0
	End of Borehole @ 35.0 m						
	No Seepage or Sloughing on Completion Slotted PVC Standpipe Installed to 35.0m Borehole Measured Dry Feb. 1, 2011						
36							900.0
37							899.0

PROJECT: KOEGLER SLOPE ASSESSMENT	CLIENT: HASEGAWA ENGINEERING LTD.	PROJECT NO. - BOREHOLE NO.
LOCATION: NW 1/4 SEC. 21-8-22 W4M	DRILL METHOD: 150mm SOLID STEM AUGER	L12101937 - 11BH002
CITY: LETHBRIDGE, AB	PROJECT ENGINEER: TREVOR CURTIS	ELEVATION: 936.65 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID (20 40 60 80)	STANDARD PENETRATION (N) (20 40 60 80) / UNCONFINED (kPa) (50 100 150 200) / POCKET PEN. (kPa) (100 200 300 400)	Elevation (m)
0	TOPSOIL - clay, silty, sandy, frozen, dark brown. roots, organics						
	CLAY (TILL) - silty, some sand, trace gravel, very moist, very stiff, medium plastic, brown, coal and oxide specks		B1				936.0
1	... thin sand lenses		B2	24.3			
	... damp, light brown with dark brown mottling		B3				935.0
2	... occasional silt lenses		B4				
	... white precipitates		B5				934.0
3	... thinly laminated, high plastic clay inclusions		B6	7.9			
4	... moist		B7				933.0
	... oxide staining, weathered		B8				
5			B9			25599	932.0
	... trace to some sand, moist, high plastic, thin silt lenses, white precipitates		B10	14.5			931.0
6	... occasional sand pockets to 10mm		B11				
	... trace sand		B12				930.0
7	... silt and high plastic clay laminations		B13				
	... some sand, medium plastic		B14	16.5			929.0
8			B15				
			B16				928.0
9	... very stiff		B17				
			B18	16.9			927.0
10			B19				
			B20				926.0
11			B21				
	... trace sand, stiff, high plastic		B22	21.6			925.0
12			B23				
			B24				924.0
13	... light brown with dark brown mottling		B25				
			B26	16.7			923.0
14	... trace to some sand, damp to moist, very stiff, medium to high plastic, high plastic clay and silt inclusions		B27				
			B28				922.0
15			B29				
			B30	12.2			921.0
16							
							920.0
17							
							919.0
18							
18.5							

PROJECT: KOEGLER SLOPE ASSESSMENT	CLIENT: HASEGAWA ENGINEERING LTD.	PROJECT NO. - BOREHOLE NO.
LOCATION: NW 1/4 SEC. 21-8-22 W4M	DRILL METHOD: 150mm SOLID STEM AUGER	L12101937 - 11BH002
CITY: LETHBRIDGE, AB	PROJECT ENGINEER: TREVOR CURTIS	ELEVATION: 936.65 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID (20 40 60 80)	STANDARD PENETRATION (N) (20 40 60 80) / UNCONFINED (kPa) (50 100 150 200) / POCKET PEN. (kPa) (100 200 300 400)	Elevation (m)
18.5							918.0
19			B31				
			B32				917.0
20	... oxide staining, weathered		B33				
			B34	12.6			916.0
21			B35				
	SAND - silty, trace clay, poorly graded, fine grained, damp to moist, compact, light brown, occasional clay inclusions						915.0
22	... occasional silt pockets, no clay inclusions		B36				
			B37				914.0
23			B38	3.3			
			B39				913.0
24			B40				
			B41				912.0
25	... moist		B42	9.5			
	... damp to moist, brown		B43				911.0
26			B44				
			B35				910.0
27			B46	12.1			
	... occasional clay inclusions		B47				909.0
28			B48				
			B49	22.7			908.0
29	CLAY (TILL) silty, trace to some sand, trace gravel, damp to moist, very stiff, medium to high plastic, light brown with dark brown mottling, coal specks, high plastic clay inclusions, silt pockets		B50	20.9			907.0
30	... trace sand, moist, stiff, high plastic, thinly laminated, thin sand lenses		B51				
			B52	11.6			906.0
31	... some sand, medium plastic, oxide staining, weathered		B53				
			B54				905.0
32			B55				
			B56	14.2			904.0
33	... gravel sizes to 20mm, light grey, silt lenses and inclusions		B57				
							903.0
34							
	End of Borehole @ 35.0m						902.0
35	No Seepage or Sloughing on Completion Slotted PVC Standpipe Installed to 35.0m Borehole Measured Dry Feb. 1, 2011						
							901.0
36							
							900.0
37							

EBA Engineering Consultants Ltd.

LOGGED BY:	COMPLETION DEPTH: 35 m
REVIEWED BY: TC	COMPLETE: 1/24/2011
DRAWING NO: B2	Page 2 of 2

PROJECT: KOEGLER SLOPE ASSESSMENT	CLIENT: HASEGAWA ENGINEERING LTD.	PROJECT NO. - BOREHOLE NO.
LOCATION: NW 1/4 SEC. 21-8-22 W4M	DRILL METHOD: 150mm SOLID STEM AUGER	L12101937 - 11BH003
CITY: LETHBRIDGE, AB	PROJECT ENGINEER: TREVOR CURTIS	ELEVATION: 935.74 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID (20 40 60 80)	STANDARD PENETRATION (N) (20 40 60 80) / UNCONFINED (kPa) (50 100 150 200) / POCKET PEN. (kPa) (100 200 300 400)	Elevation (m)
0	TOPSOIL - clay, silty, sandy, frozen, dark brown. roots, organics						
	CLAY - silty, some sand, moist to very moist, firm, medium plastic, brown, white precipitates		B1	19.9			935.0
1	... moist, stiff, brown with dark brown mottling, occasional high plastic clay inclusion		B2				
			B3				934.0
2	... very stiff, occasional gravel pocket to 100mm		B4				
							933.0
3	CLAY (TILL) - silty, some sand, trace gravel, damp, hard, medium plastic, light brown, coal and oxide specks, thin sand lenses, white precipitates		B5	12.5			
			B6				932.0
4			B7				
							931.0
5			B8				
	... damp to moist, very stiff, light brown to brown		B9	10.6			930.0
	... some sand to sandy						
6	... thin silt lenses		B10				
			B11				929.0
7			B12				
	... some sand, light brown with dark brown mottling						928.0
8			B13	18			
			B14				927.0
9			B15				
							926.0
10			B16				
			B17	16.2			925.0
11			B18				
			B19				924.0
12	... high plastic clay inclusions						
	... moist		B20				923.0
13			B21	18.4			
			B22				922.0
14			B23				
	... occasional silt pockets		B24				921.0
15			B25	23.1			
							920.0
16			B26				
			B27				919.0
17	... 100mm gravel pocket at 16.8m		B28				
			B29	8			918.0
18							
18.5	SILT - sandy, trace clay, damp, dense, low plastic, light brown		B30				

PROJECT: KOEGLER SLOPE ASSESSMENT	CLIENT: HASEGAWA ENGINEERING LTD.	PROJECT NO. - BOREHOLE NO.
LOCATION: NW 1/4 SEC. 21-8-22 W4M	DRILL METHOD: 150mm SOLID STEM AUGER	L12101937 - 11BH003
CITY: LETHBRIDGE, AB	PROJECT ENGINEER: TREVOR CURTIS	ELEVATION: 935.74 m

SAMPLE TYPE: DISTURBED | NO RECOVERY | SPT | A-CASING | SHELBY TUBE | CORE

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID (20 40 60 80)	STANDARD PENETRATION (N) (20 40 60 80) / UNCONFINED (kPa) (50 100 150 200) / POCKET PEN. (kPa) (100 200 300 400)	Elevation (m)
18.5	CLAY - silty, trace sand, moist, very stiff, high plastic, dark brown, thin light brown silt lenses, laminated		B31				917.0
19			B32				916.0
20	... some sand, light brown with dark brown mottling, high plastic clay inclusions		B33	16.2			
21			B34				915.0
			B35				914.0
22	... trace sand, stiff to very stiff, high plastic, dark brown, thin light brown silt lenses and inclusions, slickensided		B36				
23	... light brown with dark brown mottling, oxide staining, laminated		B37	26.2			913.0
			B38				
24			B39				912.0
			B40				911.0
25	... some sand, medium plastic, high plastic clay inclusions		B41	22.9			
			B42				910.0
26			B43				
27	... trace sand, high plastic, dark brown, thin silt lenses		B44				909.0
			B35	23.4			908.0
28			B46				
29	... oxide staining		B47				907.0
			B48				906.0
30	CLAY - silty, some sand to sandy, moist, very stiff, medium plastic, brown		B49	24			
			B50	20.9			905.0
31	CLAY (TILL) - silty, some sand, trace gravel, moist, very stiff, medium plastic, dark brown, coal and oxide specks		B51				
32			B52				904.0
			B53				
33			B54	13.9			903.0
			B55				902.0
34							
35	End of Borehole @ 35.0m						901.0
	No Seepage or Sloughing on Completion Slotted PVC Standpipe Installed to 35.0m Borehole Measured Dry Feb. 1, 2011						900.0
36							
37							899.0

GENERAL CONDITIONS

GEOTECHNICAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA’s Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA’s Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA’s instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA’s instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

10.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

11.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

12.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

13.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

14.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX C
HYDROLOGICAL AND SITE DRAINAGE ANALYSIS

HYDROLOGICAL and SITE DRAINAGE ANALYSIS

NW ¼ 21 – 8 – 22 W4

Located at Sunset Acres near West Lethbridge, Alberta

PREPARED FOR:
David & Christine Koegler
16 Sunrise Road
T1J 4R9

PREPARED BY:
Hasegawa Engineering
Consulting Professional Engineers
A Division of 993997 Alberta Ltd.
1220 31st Street North
Lethbridge, AB T1H 5J8

HASEGAWA ENGINEERING

Consulting Professional Engineers

A Division of 993997 Alberta Ltd.

Environmental
Agricultural
Structural
Civil
Municipal

1220 31st Street North, Lethbridge, AB T1H 5J8
Bus: 328-2686 Fax: 328-2728 E-mail: office@hasegawa.ca

December 7, 2009 **Our File #: 09-011**

Dave Koegler
16 Sunrise Road
Lethbridge, AB
T1J 4R9

Re: Hydrological and Site Drainage Analysis for Koegler Subdivision
Location: NW ¼ 21-8-22-W4

Dear Sir:

Attached please find the Hydrological and Site Drainage Analysis submitted for the proposed Koegler Subdivision located in the County of Lethbridge. This report and analysis was prepared under my direction and supervision.

We trust that the enclosed information meets your requirements. Please do not hesitate to contact our office if you have any questions.

Yours truly,

PROFESSIONAL ENGINEERS ALBERTA
MARK HASEGAWA

PERMIT TO PRACTICE
HASEGAWA ENGINEERING
Signature _____
Date 12/17/09
PERMIT NUMBER: P 8170
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Mark Hasegawa, P.Eng.
HASEGAWA ENGINEERING
Consulting Professional Engineers
MH/dd

TABLE OF CONTENTS

1.0 Introduction

On behalf of Dr. David Koegler, Hasegawa Engineering (HE) has completed this preliminary hydrological analysis at the subject site. The hydrological analysis includes the following major aspects:

1. On site layout, topography and conditions
2. Offsite topography
3. Precipitation and runoff analysis
4. Retention Pond storage size calculations

The site is located at Sunset Acres and borders West Lethbridge as shown in Figure 1 (Appendix A.)

2.0 Site Conditions

The site consists of land on the coulee top on either side of the Koegler residence. The proposed development would divide the site into 20 lots – 19 residential lots and one utility lot as shown in Figure 2 (Appendix A). Lot #1 is uncultivated land to the west of the Koegler residence; the remaining lots are to the east of the Koegler residence on land that currently is either crop land or uncultivated prairie. The existing ground ranges from approximately 0.3% to 5% slope. The development is surrounded by coulee side, agricultural land and several residences are near by.

3.0 Surface Runoff Design Criteria

3.1 Onsite Runoff

The total area of the property included in this analysis is approximately 26.4 acres (10.7 ha). It is anticipated that onsite runoff will be controlled by grading and a dry pond. Required retention volume has been based on a 24 hour/100 year storm event. The allowable storm water release rate is based on pre-development peak runoff flow during a 5 year/4 hour storm.

In order to determine the volume of runoff from each lot, surface runoff analysis was performed. Rainfall intensity data was obtained from the Atmospheric Environment Service of Environment Canada for a 100 year 24 hour storm event in the City of Lethbridge. This event produces a peak intensity of 115mm/hour at t=0.3 with a total rainfall depth of 110 mm and is used to size the runoff retention dry pond.

The development was divided into catchments as shown in Figure 3 (Appendix A.) Six catchments contains residential land and road right-of-ways, the remaining catchment is a utility lot. These catchments were entered into SWMM, a storm runoff software program developed by the United States Environmental Protection Agency and widely accepted for runoff analysis. Each parcel was analyzed using the slope of existing ground and a general drainage pattern established for that lot. The SWMM software was used to estimate the pre

and post-development volume of storm runoff for each parcel. The pre-development analysis simulated storm runoff assuming the original ground has 0% impervious surfaces and models runoff for a 5 year/4 hour storm and a 100 year/24 hour storm. Post-development analysis models the 100 year/24 hour storm event, but assumes that 25% of post development residential surfaces and an average of 35% of the road right-of-ways will be impervious and contribute to direct runoff. It was also assumed that contouring during development would result in a 1% slope. The resulting increase in post development runoff volume must be stored and so is used to size the retention pond located on the utility lot. Also, overland flow paths must be designed to accommodate this flow.

The peak storm runoff rate from each catchment area during a pre-development 5 year/4 hour storm is used to design post-development storm water release rates. Post-development runoff during the design storm event is then is maintained at pre-development rates by grading and storm water retention. Runoff from roads has been included in the storm water volume and although there will be some storage in the roadside ditches; the dry detention pond has been sized to accommodate all runoff during the design storm event.

3.2 Offsite Runoff

Land immediately bordering the proposed development generally slopes away, except near lots 15 and 16 where approximately 1.9 ha (4.7 acres) of land immediately to the north slopes toward the proposed development. Presently, there are no roadside ditches to intercept this offsite storm drainage - site work should be designed to either accommodate or bypass this runoff. Figure 1 (Appendix-A) shows existing land contours in the vicinity of the development.

4.0 Surface Runoff Results

4.1 100 yr/24 hr Storm: Comparing Pre and Post-Development Runoff

Initial design for the dry pond has been completed based on a 100 year/24 hour storm that produces 109.8 mm depth of rain and a rain volume of 1.18 ha·m over the development. The detention pond is sized to store the post-development increase in runoff volume expected for this site during the 100 year storm event.

The results of computer simulations for these storm events are provided in Table 1 of this section. As can be seen, the increase in runoff volume after development results in the need to store 2177 cubic meters of storm water. Results from the computer simulation also show the peak post-development flow; this flow can be attenuated through the dry pond. Key input parameters for SWMM analysis along with summaries of the computer simulations are attached in Appendix B.

Table 1: Runoff Analysis for 100 yr/24hr Storm

Catchment	Post Dev. Runoff (m^3)	Pre Dev. Runoff (m^3)	Difference (volume to be stored)	Post Dev. Peak Flow (m^3/sec)	Allowable Peak Flow (m^3/sec) based on 5yr/4hr storm predev. flow
1	286	221	65	0.140	0.016
2	1468	1015	453	0.747	0.034
3	1648	1308	340	0.827	0.037
4	1663	1049	614	0.842	0.020
5	784	542	242	0.393	0.016
6	825	628	197	0.415	0.052
Utility Lot	0.0* (266)	n/a**	266	0	n/a
		System	**2177**	**3.364**	**0.175**

***Computer modeling returns a value of zero because post development grading prevents runoff in this catchment – actual volume of standing water is 266 m^3.**
****Utility lot is included in catchment 3 during predevelopment modeling**

4.2.1 5 Year/4 Hour Storm Flow

In addition, computer modeling was also used to calculate the peak runoff rate for a predevelopment 5 year/4 hour storm that produces 38.1 mm depth of rain and a rain volume of 0.41 ha·m. Analysis was done to ensure that storm water retained in the detention pond is not released faster than the pre-development peak flow that occurs during this 5 year/4 hour storm. The flow rate from each catchment is shown in Table 2. A comparison with the post-development peak flow during the 100 year storm taken from Table 1 gives an indication of the runoff that will be attenuated through the dry pond.

Table 2: Peak Storm Runoff

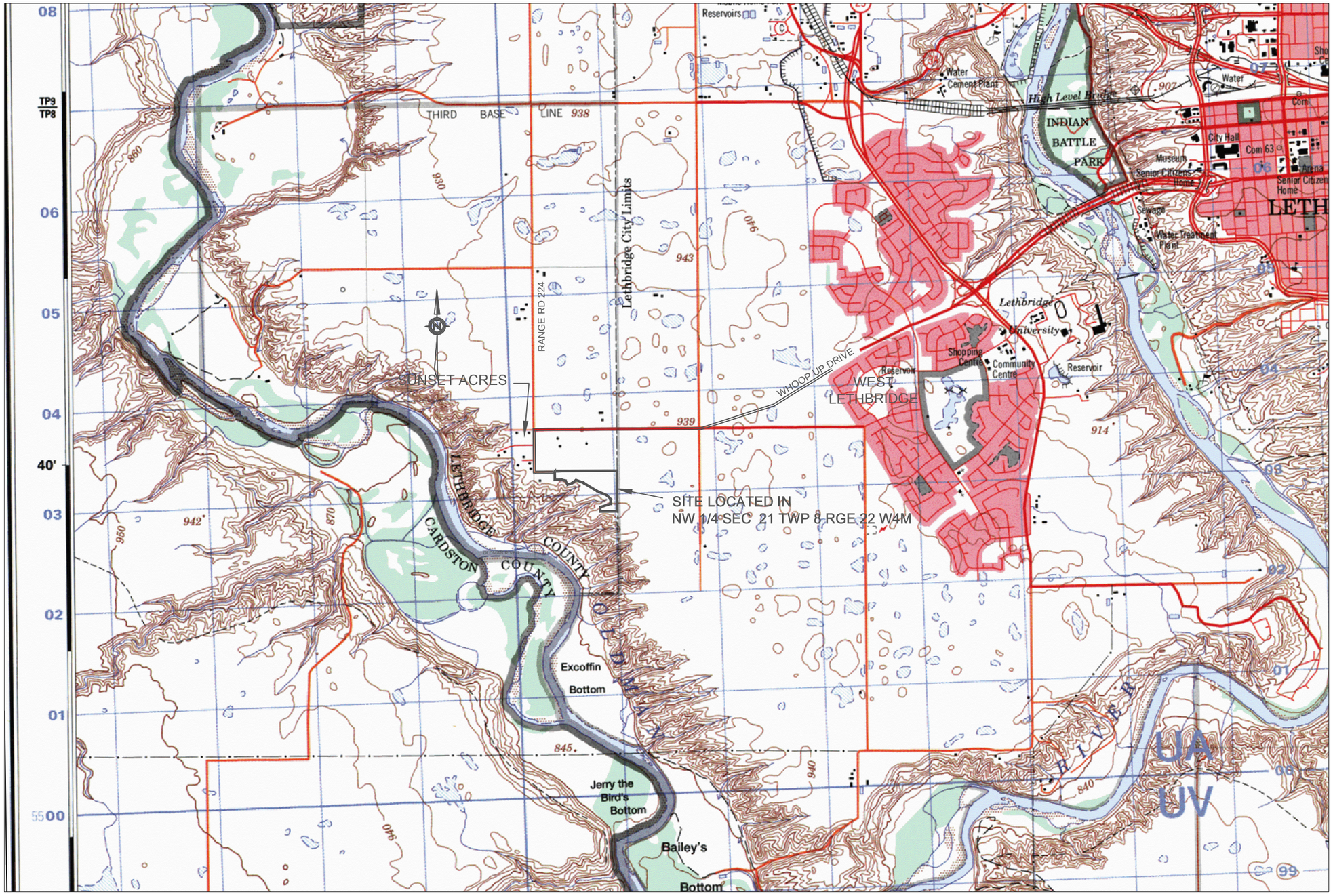
Catchment	Pre Dev. Peak Flow (m^3/sec)	Post Dev. Peak Flow 24hr/100yr Storm (m^3/sec)
1	0.016	0.140
2	0.034	0.747
3	0.037	0.827
4	0.020	0.842
5	0.016	0.393
6	0.052	0.415
Utility Lot	n/a	0
System	**0.175**	**3.364**

5.0 Conclusion

A dry pond needs to be provided for storage of runoff volume and flow rate in excess of the pre-development baseline. It is required to store approximately 2175 cubic meters and be located so that natural contours or site grading channel runoff to it. The increase in peak flow can be attenuated through the dry pond. As a rough indication of the dry pond size, Alberta Environment recommends that dry ponds have interior side slopes with a horizontal/vertical ratio of 4:1, 0.6 meters of freeboard and a maximum active water depth of 1.5 meters. Contouring the utility lot with 4:1 side slopes from the lot line to a depth of 2.1 meters (0.6 meters freeboard plus 1.5 meters active storage) would allow 3925 m^3 of storm runoff to be stored. With additional contouring to a depth of 3.5 meters, the required runoff could be stored in the bottom 1.5 meters. This would provide reserve storage for a total of 5850 m^3 storage and 0.6 m freeboard.

APPENDICES

APPENDIX A-FIGURES



PERMIT TO PRACTICE
HASEGAWA ENGINEERING
Signature _____
Date _____
PERMIT NUMBER: P8170
The Association of Professional Engineers, Geologists and Geophysicist of Alberta

PROFESSIONAL ENGINEER ALBERTA M. HASEGAWA

Notes:

Contractor to check and verify all dimensions before construction, any errors and omissions reported to Engineer immediately.

Drawing not to be used for construction until so approved.

Do not scale Drawing.

All construction shall be in accordance with the latest code, may it be construction, mechanical, etc. code.

Hasegawa Engineering
LETHBRIDGE OFFICE
1220 – 31 Street North
Lethbridge Alberta T1H 5J8
Ph: 328–2686
Fax: 328–2728
email: office@hasegawa.ca

CLIENT: DAVID KEOGLER

PROJECT TITLE: KEOGLER SUBDIVISION FEASABILITY ANALYSIS

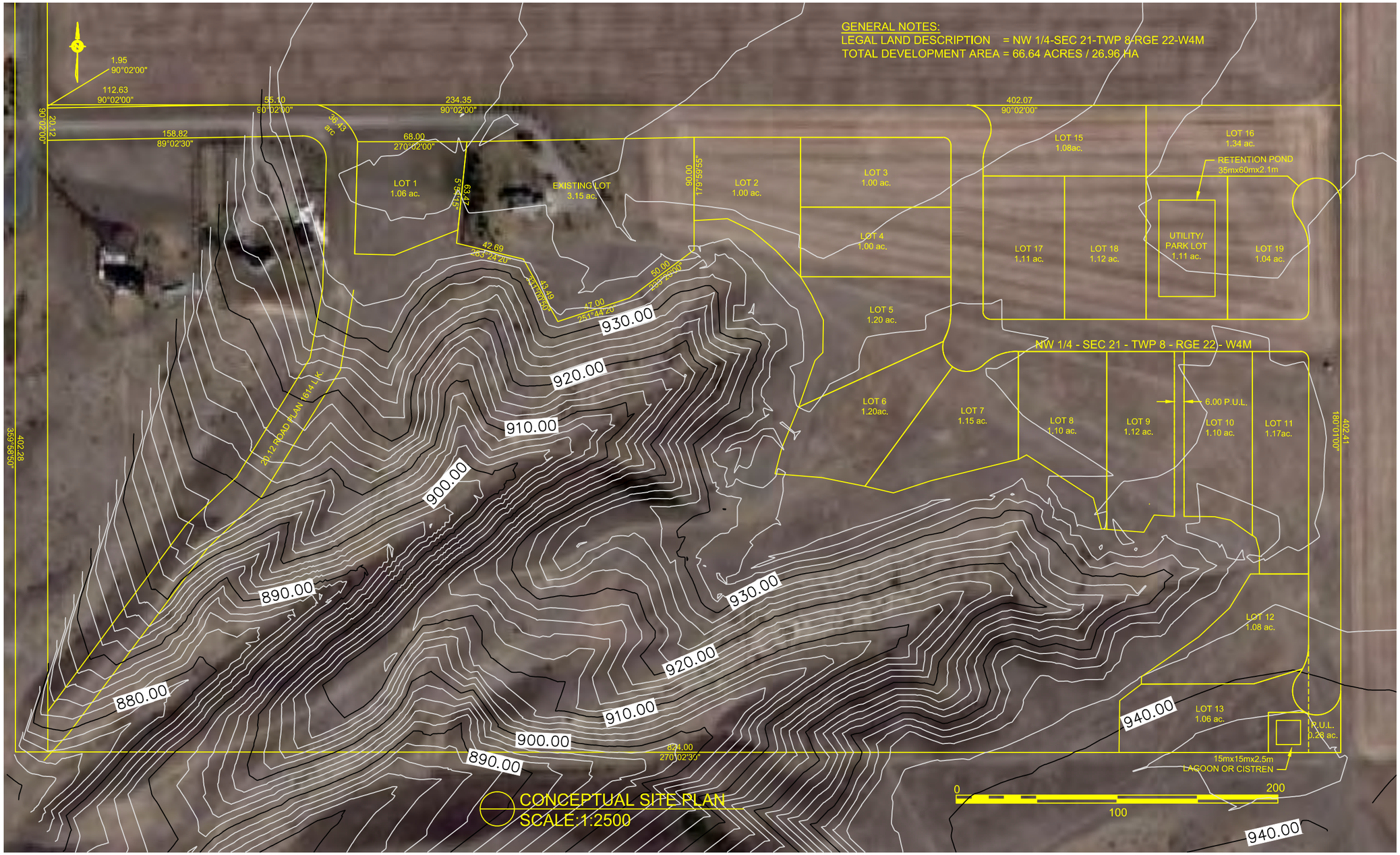
DRAWING TITLE: FIGURE 1

DRAWING STATUS: PRELIMINARY

No	Revision	Date	By

DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
DATE DRAWN	FEB 17, 11

PROJECT NO. 09011
SCALE 1:40000
SHEET NO. 1
VERSION 1



0 200 400

METERS 0 100 300 400

PERMIT TO PRACTICE
HASEGAWA ENGINEERING

Signature _____

Date _____

PERMIT NUMBER: P8170

The Association of Professional Engineers, Geologists and Geophysicist of Alberta

PROFESSIONAL ENGINEER ALBERTA M. HASEGAWA

Notes:

Hasegawa Engineering

LETHBRIDGE OFFICE
1220 – 31 Street North
Lethbridge Alberta T1H 5J8
Ph: 328–2686
Fax: 328–2728
email: office@hasegawa.ca

CLIENT
DAVID KOEGLER

PROJECT TITLE
KOEGLER SUBDIVISION FEASABILITY ANALYSIS

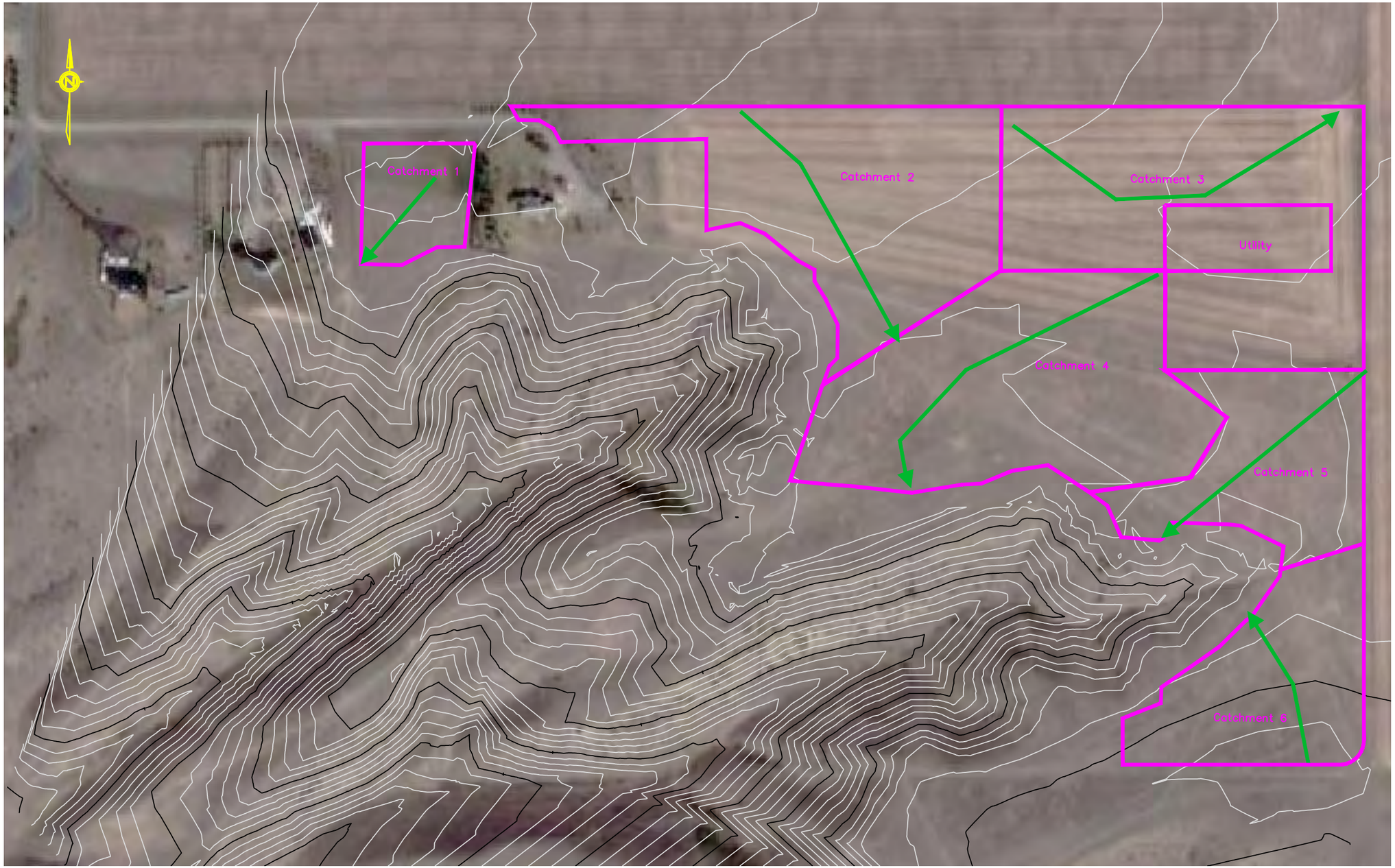
DRAWING TITLE
FIGURE 2
PROPOSED LOTS

DRAWING STATUS
PRELIMINARY

No.	Revision	Date	By

DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
DATE ISSUED	FEB 17, 11

PROJECT NO. 09011
SCALE 1:2500
SHEET NO. 2 REVISION 1



0 200 400

METERS 0 100 300 400

GREEN ARROWS INDICATE GENERAL PRE-DEVELOPMENT DRAINAGE DIRECTIONS

PERMIT TO PRACTICE
HASEGAWA ENGINEERING

Signature _____

Date _____

PERMIT NUMBER: P8170
The Association of Professional Engineers, Geologists and Geophysicist of Alberta

PROFESSIONAL ENGINEER ALBERTA R. HASEGAWA

Notes:

Contractor to check and verify all dimensions before construction, any errors and omissions reported to Engineer immediately.

Drawing not to be used for construction until so approved.

Do not scale Drawing.

All construction shall be in accordance with the latest code, may it be construction, mechanical, etc. code.

Hasegawa Engineering

LETHBRIDGE OFFICE
1220 – 31 Street North
Lethbridge Alberta T1H 5J8
Ph: 328–2686
Fax: 328–2728
email: office@hasegawa.ca

CLIENT
DAVID KOEGLER

PROJECT TITLE
KOEGLER SUBDIVISION FEASABILITY ANALYSIS

DRAWING TITLE
FIGURE 3
CATCHMENTS

DRAWING STATUS
PRELIMINARY

No.	Revision	Date	By

DESIGN	HE
DRAWN	DPB
CHECKED	HE
APPROVED	HE
DATE	FEB 17, 11

PROJECT NO. 09011
SCALE 1:2500
DRAWING NO. 2
REVISION 1

APPENDIX B-SWMM SUMMARIES

Key SWMM Input Parameters		
Area	Varies by subcatchment – see table below	
Width	Varies with subcatchment shape	
	Predevelopment	Post Development
% slope	Avg. of existing ground	1%
% Impervious	0	25 to 30*
Manning's N - impervious	0.01	0.015
Manning's N - pervious	0.15	.1
Depression Storage	0.05	0.05
% Impervious w/ no storage	25	25
Routed to:	100% to outlet	100% to outlet
Infiltration - Horton		
Max. infilt. rate = 75		
Min. infilt. rate = 7.5		
Decay constant = 4		
Drying time = 7		
Max. Vol = 0 (n/a)		

* Varies by catchment depending on area of road right of way within catchment

Catchment Details

CATCHMENT	TOTAL CATCHMENT AREA	RESIDENTIAL AREA	ROAD R.O.W.	Avg. % IMPERVIOUS
1	4533	4533	0	25
2	22480	14965	7515	28.3
3	25549	20262	5287	27.1
4	25561	18235	7326	27.9
5	12190	10017	2173	26.7
6	12777	9935	2842	27.2
utility lot	4081	4081	0	0
Totals	**107091**	**82028**	**25062**	

- Road right of ways are 1/3 gravel road at 80% impervious and 2/3 ditch at 10% impervious with 35% used as overall average
- Residential areas (1 acre lots) are 25% impervious
- Utility lot is included in catchment 3 for predevelopment modeling

Post Development 100year/24hour Storm

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.013)

****
Analysis Options
****
Flow Units ..... CMS
Infiltration Method ..... HORTON
Starting Date AUG-06-2009 00:00:00
Ending Date AUG-07-2009 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:15:00
Dry Time Step 01:00:00

********** Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	1.177	109.858
Evaporation Loss	0.000	0.000
Infiltration Loss	0.487	45.411
Surface Runoff	0.667	62.280
Final Surface Storage	0.027	2.517
Continuity Error (%)	-0.319	

********** Flow Routing Continuity **********	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Internal Outflow	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff Mltrs	Peak Runoff CMS	Runoff Coeff
Catch1	109.858	0.000	0.000	47.062	63.121	0.286	0.140	0.575
Catch2	109.858	0.000	0.000	44.883	65.309	1.468	0.747	0.594
Catch3	109.858	0.000	0.000	45.673	64.515	1.648	0.827	0.587
Catch4	109.858	0.000	0.000	45.143	65.048	1.663	0.842	0.592
Catch5	109.858	0.000	0.000	45.864	64.324	0.784	0.393	0.586
Catch6	109.858	0.000	0.000	45.600	64.589	0.825	0.415	0.588
Utility	109.858	0.000	0.000	44.575	0.000	0.000	0.000	0.000
System	109.858	0.000	0.000	45.411	62.280	6.675	3.364	0.567

Analysis begun on: Sat Aug 08 20:09:51 2009
Analysis ended on: Sat Aug 08 20:09:51 2009
Total elapsed time: < 1 sec

Pre-Development 100year/24hour Storm

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.013)

****
Analysis Options
****
Flow Units ..... CMS
Infiltration Method ..... HORTON
Starting Date AUG-06-2009 00:00:00
Ending Date AUG-07-2009 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:15:00
Dry Time Step 01:00:00

********** Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	1.177	109.858
Evaporation Loss	0.000	0.000
Infiltration Loss	0.704	66.683
Surface Runoff	0.476	44.440
Final Surface Storage	0.000	0.000
Continuity Error (%)	-0.241	

Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Internal Outflow	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff Mltrs	Peak Runoff CMS	Runoff Coeff
Catch1	109.858	0.000	0.000	61.657	48.757	0.221	0.121	0.444
Catch2	109.858	0.000	0.000	64.961	45.144	1.015	0.322	0.411
Catch3	109.858	0.000	0.000	65.921	44.147	1.308	0.376	0.402
Catch4	109.858	0.000	0.000	68.948	41.043	1.049	0.228	0.374
Catch5	109.858	0.000	0.000	65.653	44.424	0.542	0.160	0.404
Catch6	109.858	0.000	0.000	61.323	49.162	0.628	0.365	0.448
System	109.858	0.000	0.000	65.683	44.440	4.763	1.527	0.405

Analysis begun on: Sat Aug 08 12:30:22 2009
Analysis ended on: Sat Aug 08 12:30:22 2009
Total elapsed time: < 1 sec

Pre-Development 5yr/4hr Storm

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.013)

****
Analysis Options
****
Flow Units ..... CMS
Infiltration Method ..... HORTON
Starting Date AUG-06-2009 00:00:00
Ending Date AUG-06-2009 04:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:15:00
Dry Time Step 01:00:00

********** Runoff Quantity Continuity **********	Volume hectare-m	Depth mm
Total Precipitation	0.408	38.061
Evaporation Loss	0.000	0.000
Infiltration Loss	0.369	34.416
Surface Runoff	0.040	3.698
Final Surface Storage	0.000	0.000
Continuity Error (%)	-0.139	

********** Flow Routing Continuity **********	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.000	0.000
Internal Outflow	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff Mltrs	Peak Runoff CMS	Runoff Coeff
Catch1	38.061	0.000	0.000	32.460	5.724	0.026	0.016	0.150
Catch2	38.061	0.000	0.000	34.330	3.778	0.085	0.034	0.099
Catch3	38.061	0.000	0.000	34.691	3.409	0.101	0.037	0.090
Catch4	38.061	0.000	0.000	35.555	2.529	0.065	0.020	0.066
Catch5	38.061	0.000	0.000	34.595	3.507	0.043	0.016	0.092
Catch6	38.061	0.000	0.000	32.173	6.034	0.077	0.052	0.159
System	38.061	0.000	0.000	34.416	3.698	0.396	0.177	0.097

Analysis begun on: Sat Aug 08 12:31:41 2009
Analysis ended on: Sat Aug 08 12:31:22 2009
Total elapsed time: < 1 sec