Edson River Estates

(Pt. NW 5-54-16-W5M)

- Proposed Land Use Bylaw Amendment
- Proposed Subdivision
- Conceptual Scheme/Supporting Documentation
- Flood Risk Mapping Study (EXH Engineering Ltd.)
- Percolation Rates and Groundwater Conditions (EXH Engineering Ltd.)
- Groundwater Potential Assessment (Waterline Resources Inc.)

Prepared for:

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Submitted to:

Yellowhead County

(June 2006)

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1) Flood Risk Mapping Study:
Edson River and Bench Creek
Prepared by EXH Engineering Ltd.
{Note: Summary of Full Report}

2) Percolation Rates and Groundwater Conditions
Prepared by EXH Engineering Ltd.

3) Groundwater Potential Assessment
Prepared by Waterline Resources Inc.
{Note: Summary of Full Report}

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1) INTRODUCTION

The following is submitted in support of two applications. The first is an application to amend the Yellowhead County Land Use Bylaw No. 2.06 to redistrict 41.07 ha. ± of the NW ¼ of Section 5-54-16-W5M from RD – Rural District to CR - Country Residential District. The remainder of the quarter section (23.63 ha. ±) is not affected by this amendment application and will remain within the RD District. The second is a corresponding application to create an 8-lot multi-parcel country residential subdivision to be known as "Edson River Estates". Following are Figure 1 – Location Map, Figure 2 - Proposed Land Use Bylaw Amendment and Figure 3 – Concept Plan/Proposed Subdivision.

FIGURE 1 – LOCATION MAP

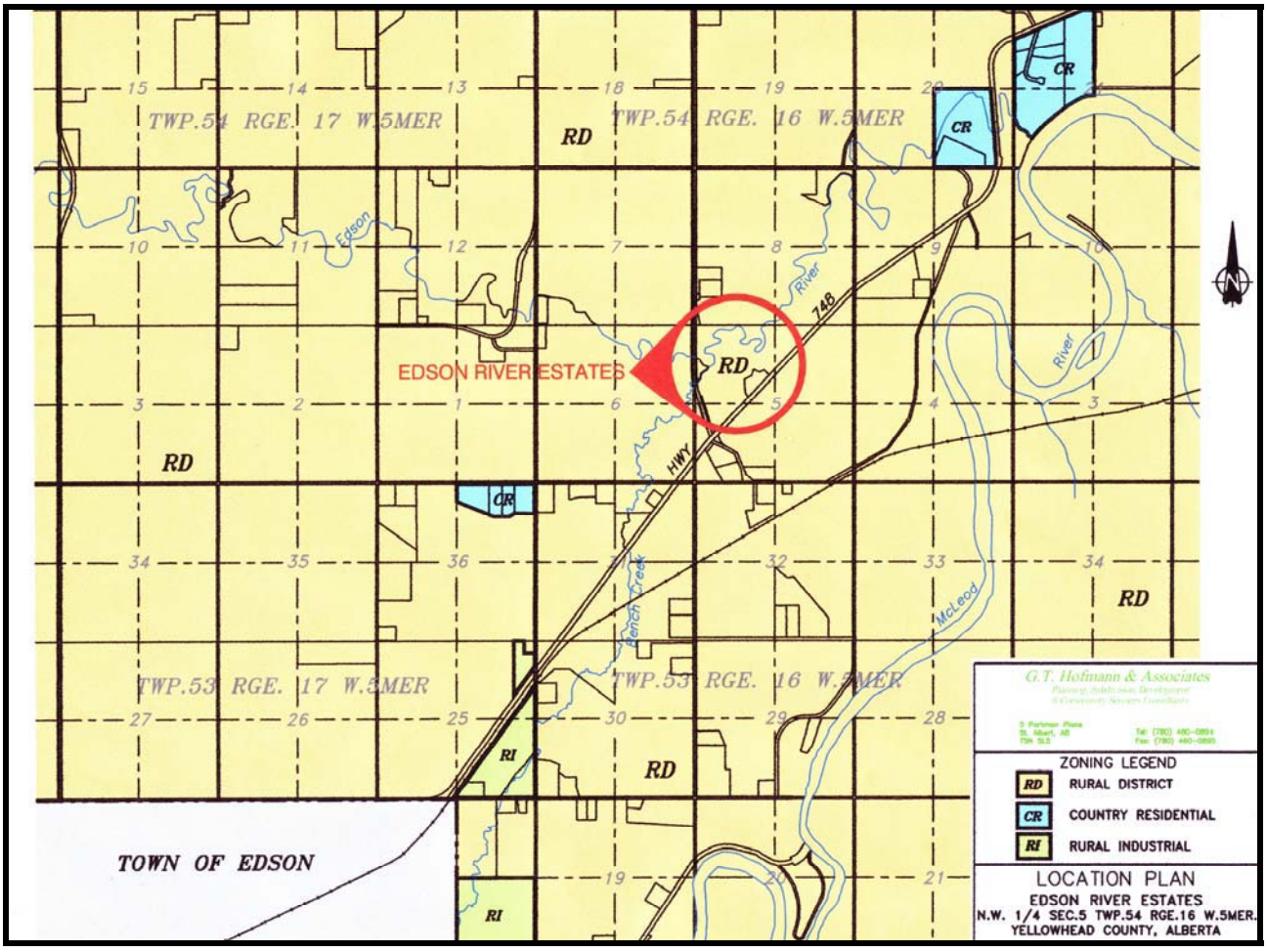


FIGURE 2 – PROPOSED LAND USE BYLAW AMENDMENT

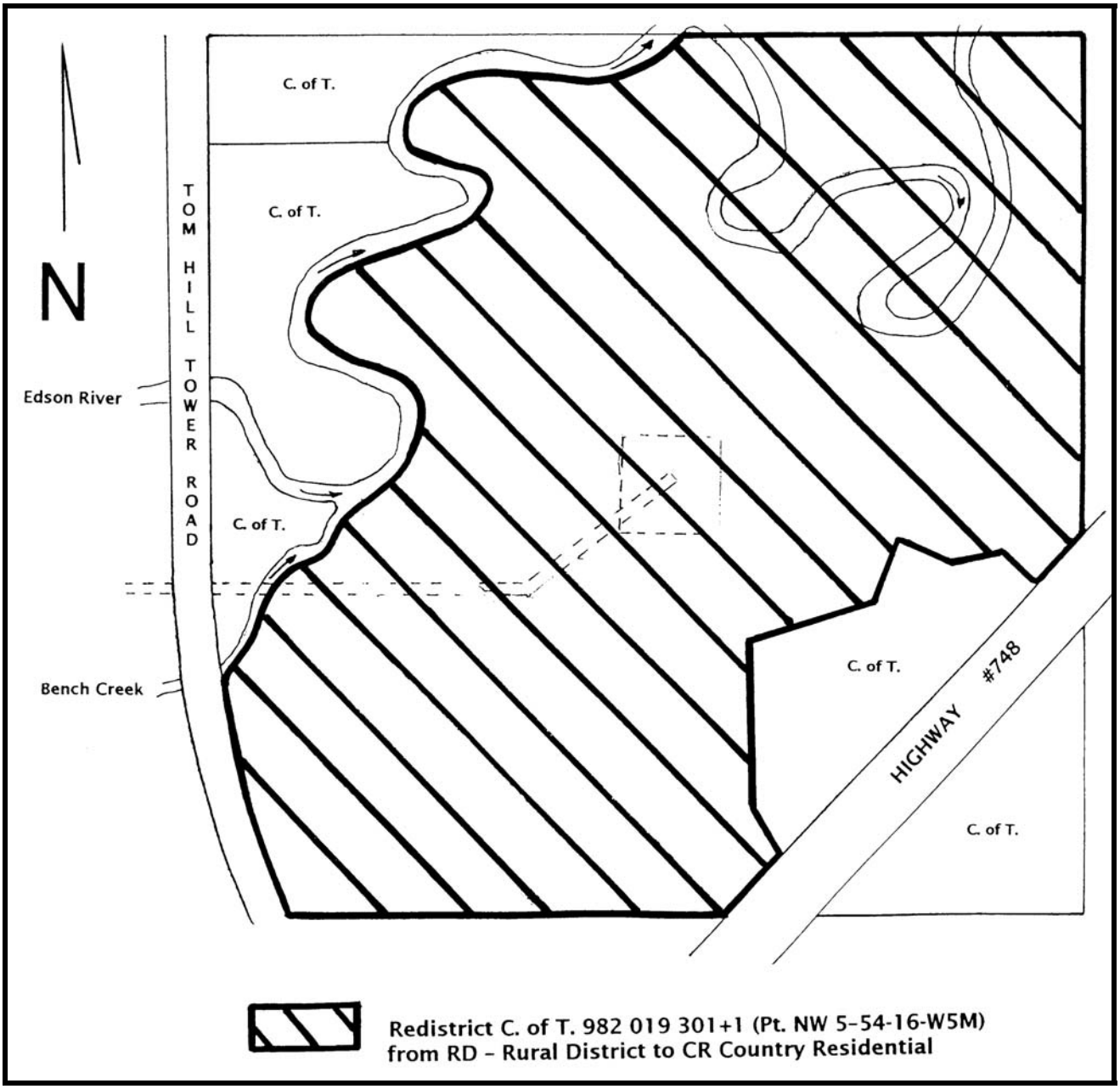
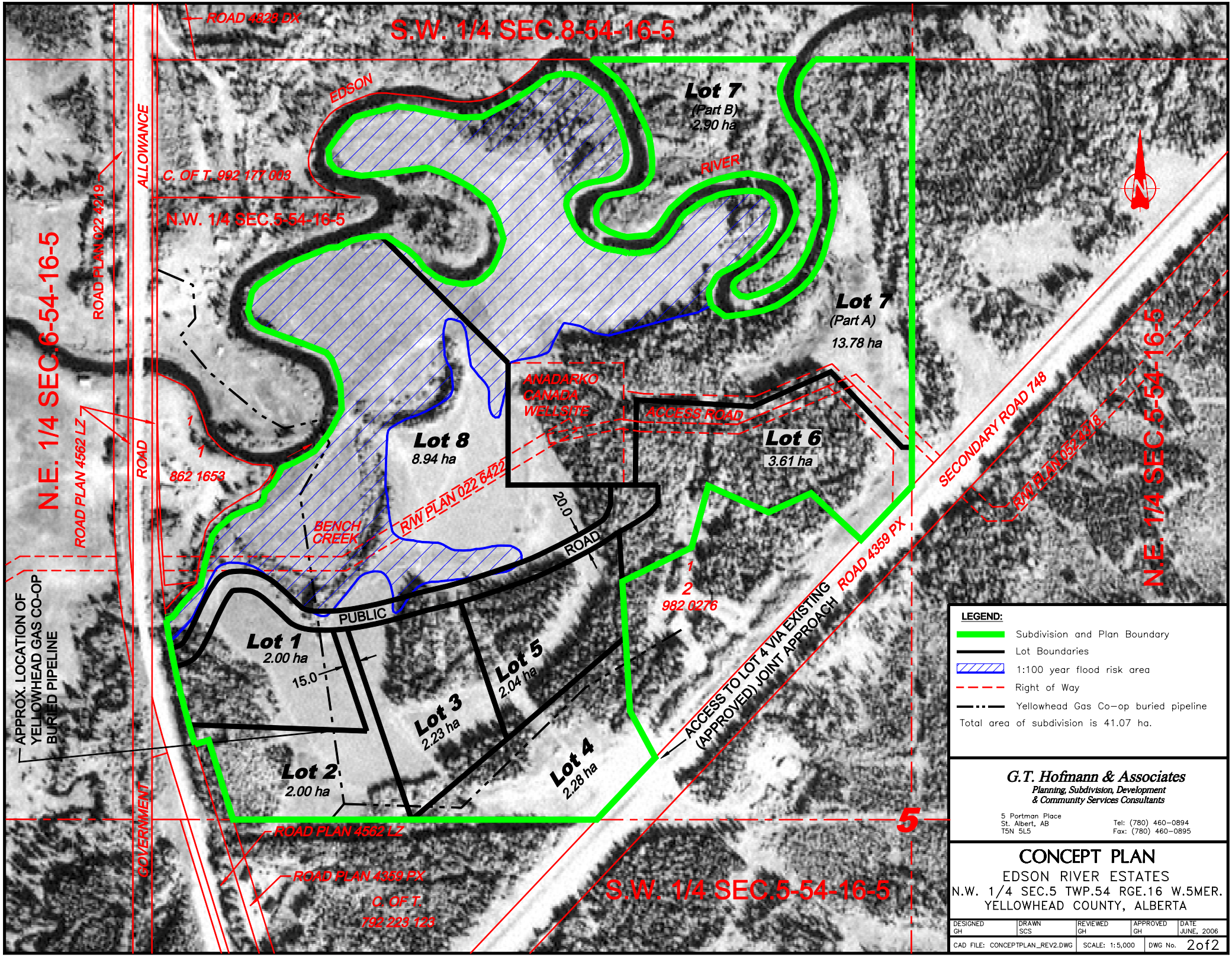


FIGURE 3 – CONCEPT PLAN/PROPOSED SUBDIVISION

- see next page -



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CONCEPT PLAN

EDSON RIVER ESTATES
N.W. 1/4 SEC.5 TWP.54 RGE.16 W.5MER.
YELLOWHEAD COUNTY, ALBERTA

DESIGNED	DRAWN	REVIEWED	APPROVED	DATE
GH	SCS	GH	GH	JUNE, 2006

CAD FILE: CONCEPTPLAN_REV2.DWG | SCALE: 1:5,000 | DWG No. 2of2

2) SETTING AND ADJACENT LAND USES

The subject land is located at the confluence of Bench Creek and the Edson River. The recently upgraded Tom Hill Tower Road forms the western boundary of the site and Highway No. 748 runs along the southeast boundary. For the most part, Bench Creek and the Edson River form the north boundary of the subject lands although a portion of the northeast corner is located on the north side of the Edson River and is therefore isolated from any legal or built public road access. The Location Map shows a number of country residential parcels dispersed throughout the area northeast of Edson including several more concentrated developments within the CR District.

The subject land consists of a lower portion, adjacent to Bench Creek and the Edson River which slopes gently upward to a modestly sloped embankment, at the top of which lies the second, upper portion which is at or close to the grade of Highway No. 748. Five parcels have been subdivided out of the quarter section over the past 35 years, all of which containing dwellings and related buildings.

The most recent subdivision was created in the late 1990's located in the southeast portion the quarter. This parcel gains direct access to Highway No. 748 via a joint approach approved by Alberta Transportation as part of that application. Proposed Lot 4 on the Concept Plan, after Page 2, which is immediately to the southwest of this existing parcel and is also located atop the embankment, will utilize this approved joint approach to Highway No. 748. As the Concept Plan also shows, the other seven proposed lots will be accessed via an internal subdivision road which will intersect with the Tom Hill Tower Road where the existing, approved access to the site is located.

An oil well is located in the centre of the subject land, owned/operated by Anadarko Cda. Corp. It is accessed via a lease road that runs due east up the embankment which then veers southeast to eventually connect with Highway No. 748 at the very extreme east boundary. The well site is connected to a pipeline within a ROW which runs briefly southwest from the well site and then due west across Bench Creek and underneath the Tom Hill Tower Road.

The subject land offers a beautiful and secluded residential setting within a relatively short distance of Edson. The proposed lots are in keeping with or slightly larger than nearby multi-parcel CR subdivisions.

3) LAND USE POLICY/BYLAW CONTEXT

The subject land is currently within the RD – Rural District of the Land Use Bylaw which allows for a maximum of five residential parcels per quarter. Since five CR parcels already exist within the quarter section, including one on the south east side of Highway No. 748, the creation of any additional residential parcels requires redistricting the subdivision area from the RD – District to the CR - District. In terms of compatibility with adjacent lands, it is important to note that several multi-parcel CR subdivisions exist within several kilometers of this proposal (to the northeast and to the southwest). It is also important to note that the subject land is outside the Edson Urban Fringe Policy Area stipulated in the County's Municipal Development Plan.

The CR – District requires a minimum parcel size of 1.0 hectare (~2.5 acres) and does not specify a maximum parcel size. All of the proposed lots are at least 2.0 hectares, each with a developable area of at least 0.4 ha. in accordance with County policy and Alberta Environment's Guidelines. This component is discussed further under Section 5 below, particularly with respect to sewage treatment and availability of potable water. Reference is made to percolation/near-surface water table testing conducting by EXH Engineering Ltd. and a Groundwater Potential Assessment conducted by Waterline Resources Inc. Section 4 addresses the 1:100 floodplains of Bench Creek and the Edson River.

4) LAND USE, SUBDIVISION DESIGN, DEVELOPMENT STANDARDS AND DENSITY

The LUB amendment and the proposed subdivision are intended to provide a supply of residential lots in an area strategically located northeast of Edson. Though an easy commute to Edson on high quality roads, the setting offers natural beauty, with the presence of two watercourses, as well as seclusion because of the topography, including an embankment between Highway No. 748 and seven of the eight lots. It is expected that the eight lots being proposed here will become fully occupied fairly quickly.

As mentioned, one of the proposed lots, Lot 4, will take advantage of a joint approach accessing Highway No. 748 located at its northeasterly boundary which was approved by Alberta Transportation when the existing, immediately adjacent parcel was created in 1998. As such, this proposal imposes no additional impact on Highway No. 748 in terms of new access points.

The other seven lots will be serviced with an internal subdivision road (approximately 625 m in length, 20 m wide) that will intersect with the recently upgraded Tom Hill Tower Road on the west side where the approved, existing access for the subject land is located. The internal road, which forms a cul-de-sac at the eastern terminus, will be built to the standards and satisfaction of Yellowhead County.

As mentioned above, an oil well is located in the centre of the subject land, owned/operated by Anadarko Cda. Corp. It is accessed via a lease road that runs due east up the embankment which then veers southeast to eventually connect with Highway No. 748 at the very extreme east boundary. Though this lease road accesses Highway No. 748, this access point is not proposed to be used to access any of the proposed lots. In fact, once the internal subdivision road is completed, the well site itself will have direct access to a public road at the terminus and the lease road will no longer be required to access the well site.

This is not to say that the physical road itself would no longer be required as it will serve as a dual private driveway heading upslope from the public road cul-de-sac to the building sites located on Proposed Lots 6 and 7, both near the eastern boundary of the quarter section atop the embankment. Using this good quality lease road as a dual private driveway eliminates the need to access Proposed Lot 6 via direct access to Highway No. 748. The County may want to consider utilizing the existing lease road access with Highway No. 748 as an alternate access point to the subdivision for emergency purposes only.

The well site is connected to pipeline within a ROW which runs briefly southwest from the well site across Proposed Lot 8 and then due west and across Bench Creek and underneath the Tom Hill Tower Road. The precise life span of this well site is unknown but it is assumed here that it will be in existence for as long it will take for the subdivision to develop. Thus, the west and south boundaries of the well site perimeter will be extensively landscaped/screened with relatively large, mature coniferous trees to ensure a visual buffer is present during all four seasons. The well site lease will be contained wholly within Proposed Lot 7.

The subdivision has been designed to take full advantage of the terrain and existing vegetation to provide as much spacing as possible between building sites in keeping with the intended nature/character of the subdivision. The flood risk areas of both Bench Creek and the Edson River had to be taken into account in the layout of the subdivision. To this end, EXH Engineering Ltd. was contracted to delineate the 1:100 year flood risk areas of Bench Creek and the Edson River (including flood fringe) which

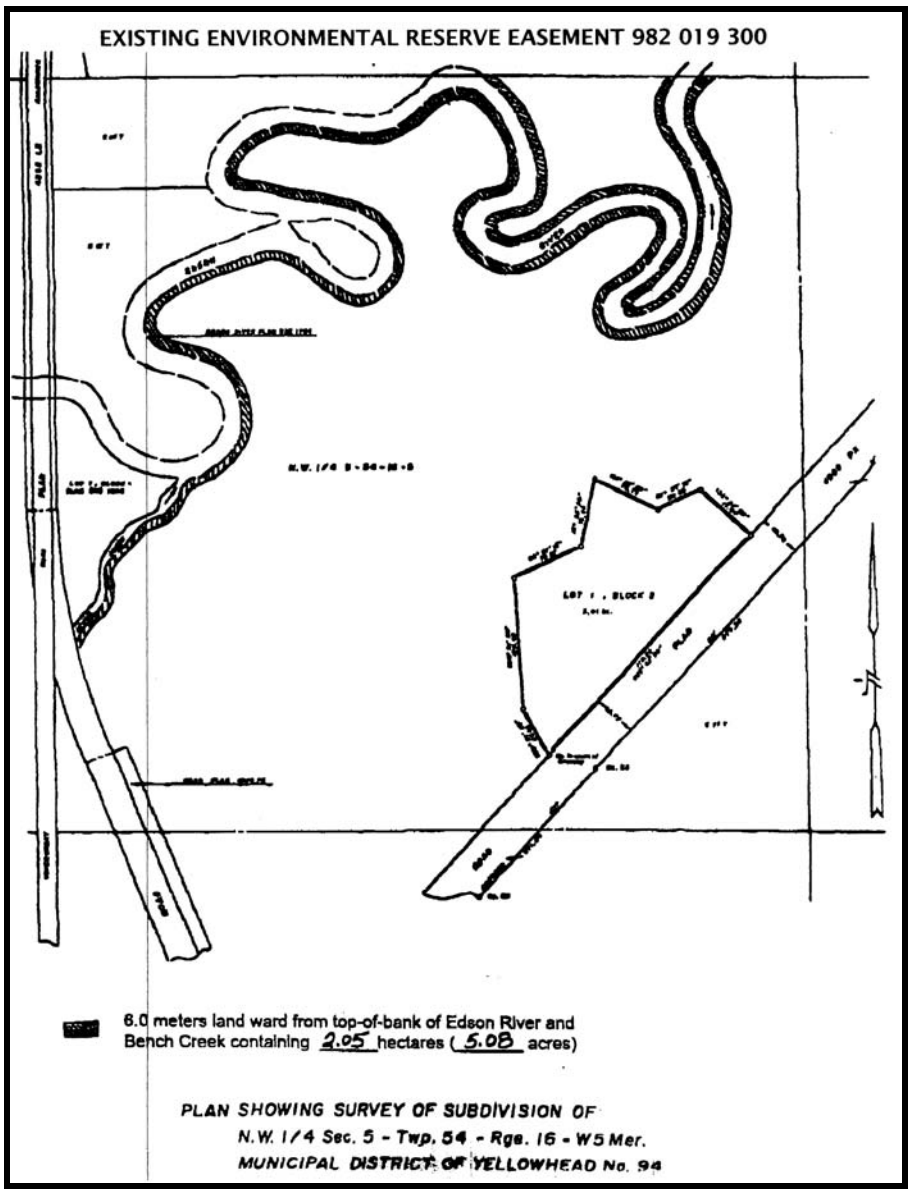
the Concept Plan after Page 2 shows. As far as accommodating flood risk is concerned, the subdivision layout proposed is based on the work conducted by EXH Engineering Ltd. Appendix 1 contains a full summary of the EXH Engineering Ltd. Flood Risk Mapping Study. A copy of the Full Report can be obtained from EXH Engineering Ltd.

Clearly, in a case such as this, the design of the subdivision needs to ensure that the 1:100 year flood risk areas identified are avoided. First of all, as the Concept Plan shows, the north limit of the internal subdivision road follows the southern limit of the 1:100 year flood risk area. All but Proposed Lots 7 and 8 are completely outside the 1:100 year flood risk area. Secondly, as the Concept Plan also shows, sufficient space exists within Proposed Lots 7 and 8 outside the 1:100 year flood risk to provide a building site outside the 1:100 year flood risk determined by the EXH Flood Risk Report. As far as addressing the 1:100 year flood risk areas within Proposed Lots 7 and 8, several options were considered.

The first option, a Conservation Easement (CE), was dismissed as a CE is not normally used simply to protect development from a floodplain: more suitable means are available. The second option was to employ Environmental Reserve, either in the form of a lot (ER) or an easement (ERE). It should be noted that an ERE in the amount of 2.05 ha. ± is already registered against the subject lands (Caveat 982 019 300) covering 6.0 m landward from the top-of-bank of Bench Creek and the Edson River, established in 1998 as part of the application creating the existing parcel adjacent to Highway No. 748. See Figure 3 on Page 7.

The difficulty with utilizing either an ER or ERE exclusively to deal with this situation is that the Municipal Government Act requires that land taken as ER or ERE must be/remain in its natural state. Though the existing ERE area shown in Figure 5 qualifies in this regard and will remain in place, most of the area determined by EXH Engineering Ltd. to be within the 1:100 flood risk area (including flood fringe) is no longer in its natural state and has been cleared and used as pasture. Given the difficulties associated with using an ER or ERE to deal with most of the 1:100 year flood risk area in this case, a third option is proposed: a Restrictive Covenant (RC), running with the land, that will stipulate "no-build due to flood risk". This would be registered against the titles created for Proposed Lots 7 and 8 making it very clear to purchasers/builders/homeowners (and serve as a reminder to the County as Development Authority) that while these areas can be enjoyed, building/development within the portions of the lots covered by the RC is prohibited.

FIGURE 3 – EXISTING ENVIRONMENTAL RESERVE EASEMENT



It should also be noted, as the Concept Plan shows, that the title for Proposed Lot 7 will need to consist of a Part A, on one side of the Edson River, and a Part B on the other side. Though Part B of Proposed Lot 7 could not be subdivided from Part A without subdivision approval since Part B would have no legal/built public road access, a "no build" RC should be registered against the title for Proposed Lot 7 to also prohibit building/development on Part B due to the same lack of legal/built public road access.

In terms of municipal reserve (MR), Deferred Reserve Caveat (DRC) 982 019 302 is currently registered against the subject lands in the amount of 3.902 ha. This is the full amount of MR owing for these lands as it was calculated as part of the last subdivision in 1998. The amount of land named in ERE 982 019 300, as shown on the previous page, has already been factored into the amount of MR specified in DRC 982 019 302 (ie: 41.07 ha. ± minus 2.05 ha. ± ERE = 39.02 ha. ± X 10% = 3.902 ha. ± of MR). Since no additional ER or ERE is being (or can be) proposed here, nor is any MR land being proposed, cash-in-lieu of reserve land owing up to 3.902 ha. is proposed to be paid to the County as a condition of subdivision approval.

Apart from the existing oil well site and pipeline already discussed, a Yellowhead Gas Co-op natural gas line runs through a portion of the west and south sides of the subject land to service existing development on adjacent parcels. Circulation of these applications and supporting material to the AEUB will reveal if any sour gas or high pressure sweet gas facilities are present within adjacent lands that will have to be accounted for in the design and/or approval of the subdivision.

The current proposal will result in a population density well under 1.0 person per gross hectare (approx. 25 people within the subdivision area – 41.07 ha. - using an average household size of 3.25 persons). Even with a household size of four persons, the subdivision would still result in less than 1.0 person per gross hectare.

5) SERVICES

The results of the percolation and near-surface water table testing conducted by EXH Engineering Ltd. are presented in Appendix 2. Again, based on the information provided by EXH Engineering Ltd., as shown in Appendix 2, acceptable percolation rates (ie: between 5 and 60 minutes per inch) and water table conditions (2.0 m or lower) were found within their study area.

As far as groundwater is concerned, the Groundwater Potential Assessment prepared by Waterline Resources Inc. (see summary of Report in Appendix 3) concludes that underlying aquifers, particularly surficial ones, will meet the potable groundwater diversion required for the subdivision in accordance with the Water Act.

Should the owner/developer be responsible for developing a storm water management plan as part of the development agreement, it should be noted that the large parcels will provide for maximum on-parcel stormwater absorption/drainage. Moreover, the lay of the land is such that whatever overland storm water run off there would be could be easily channelled toward either Bench Creek or the Edson River.

It is understood that the owner/developer will be responsible for all utilities including electric power, natural gas, telephone, etc.

6) MUNICIPAL/SCHOOL AUTHORITY IMPACT

Yellowhead County will be in the position of being able to acquire a tax base (as compared to the existing, limited use) at comparatively little cost. Because of on-site servicing, the County would not be responsible for the maintenance of any municipal services. As there is no municipal reserve land being proposed, and development is protected from flood risk and isolation from legal/built public road access by way of a "no-build" RC in combination with the existing 6.0 m wide ERE, there will be no ownership of or on-going responsibility for such lands by the County.

Of course the County will become responsible for maintenance of the internal road, providing emergency services to the residents, and so forth. However, the low density of the subdivision itself should have little impact on the internal road. In addition, the County already incurs the costs of maintaining the existing roads in the area and this subdivision will provide 8 additional lots contributing to the tax base for maintenance and service provision.

In terms of impact on schools in the area, the subdivision will result in an estimated maximum of 16 school-aged children (assuming a maximum household size of four - ie: 32 people in total - with two school-aged children in each household). In reality, the number of school-aged children may be less. Regardless, the effect on the two school systems in the area is arguably negligible. In fact, the school bus service already provided to the existing residents in the area could be made more economic by increasing the number of children in the area.

7) CONCLUSION

The foregoing, in our opinion, provides sufficient information with which to evaluate and decide upon the LUB amendment and proposed subdivision. It also our position that it fully satisfies the need to undertake conceptual, advance planning in support of redistricting and subdivision applications.

In conclusion, we ask that the Council of Yellowhead County find this Conceptual Scheme and supporting documentation acceptable and proceed with the approvals we seek.

Respectfully submitted,

Greg Hofmann, M.A., ACP MCIP

APPENDIX 1) Flood Risk Mapping Study:
Edson River and Bench Creek
Prepared by EXH Engineering Ltd.
{Note: Summary of Full Report}

Flood Risk Mapping Study
For the Proposed
Edson River Estates Subdivision
NW 5-54-16-W5M, Yellowhead County

March 7, 2005

Prepared for:

J&A Logging Ltd.

Prepared By:

EXH Engineering Services Ltd.
Red Deer, Alberta

Project No. 1203394

EXH Engineering Services Ltd.

1.0 INTRODUCTION

EXH Engineering Services Ltd. (EXH) was retained by J&A Logging to carry out a study of the flood risk area for the proposed subdivision within NW 5-54-16-W5M in Yellowhead County. The purpose of this study is to determine the 1-in-100 year flood risk (floodplain) boundary of Bench Creek and the Edson River adjacent to the proposed subdivision. The boundary will determine the potential constraints on development within the site. The scope of work for this analysis is as follows:

- Estimate the flows along Bench Creek and the Edson River based upon frequency analysis from similar basins within the general area.
- Develop a hydraulic computer model of Bench Creek and the Edson River.
- Estimate the flood risk or floodplain boundary for the 1-in-100 year storm event for Bench Creek and the Edson River.
- Estimate the floodway and flood fringe boundaries during the 1-in-100 year storm event for both watercourses.
- Prepare maps identifying flood risk (floodway and flood fringe) areas adjacent to the Edson River and Bench Creek for the proposed subdivision.

The study will generally involve assessing the extent of flooding on the proposed development area resulting from a 1-in-100 year storm event.

2.0 STUDY AREA

The proposed subdivision (subject property) is approximately 8 kilometres northeast of the Town of Edson, Alberta. Please see Drawing 1203394-1 for general location details. The property is located within NW 5-54-16-W5M and within Yellowhead County. The subject property is mainly undeveloped, with either pasture fields or treed areas. The proposed development is located south and east of the Edson River and Bench Creek. The Edson River has a reach of approximately 1.5 km within the study area and traverses the quarter-section generally from west to east; whereas Bench Creek has a reach of approximately 300 m within the study area and traverses a small portion of the quarter section from southwest to northeast, until it joins with the Edson River. A local Yellowhead County road is located on the west side of the quarter-section. The road crosses the Edson River via a bridge (Bridge File 8128) and Bench Creek via a culvert located south of the Edson River (Bridge File 13647).

The subject property generally drains north towards the Edson River. Please see Drawing No. 1203394-2 in Appendix A for details.

3.0 TOPOGRAPHICAL MAPPING

The area was surveyed by EXH on November 10 and 14, 2004. A total of 24 cross-sections were taken across the Edson River and Bench Creek. Additional survey points were collected within the proposed development area to generate contours for the site.

Survey information could not be collected from areas north of the river or upstream of the site, as the land is privately owned; therefore, the additional cross-sections were estimated from cadastral datasheets, aerial photographs and topographical maps.

Additional cross-sectional information upstream, downstream and through the bridge and culvert was obtained from the bridge files (BF 8128 and BF 13647).

4.0 HYDROLOGY

4.1 BRIDGE FILES

There is a bridge located west of the property on the Edson River (BF 8128) at WNW-5-54-16-W5M. There is also a 5230 mm SPCSP (Structural Plate Corrugated Steel Pipe) culvert located directly south of the bridge on Bench Creek (BF 13647).

The bridge (BF 8128) has a design discharge rate of 200 m^3/s and a mean velocity of 1.4 m/s, based upon a 1-in-50 year maximum instantaneous discharge. The culvert (BF 13647) has a design discharge rate of 46 m^3/s and mean velocity of 2.99 m/s, also based upon the 1-in-50 year maximum instantaneous discharge.

4.2 STREAM FLOW DATA

The Edson River has a reach of approximately 1.5 km within the study area and meanders considerably. The drainage area has been estimated as 590 square km, with an average channel slope of 0.06% across the entire basin, based on 1:50,000 contour maps. The Edson River has an approximate slope of 0.12 % to 0.14 % through the study area. Bench Creek has a reach of approximately 300 m within the study area and has a drainage area of 113 square km. The average stream slope is estimated at 0.63% across the entire basin, based on 1:50,000 contour maps. Bench Creek has an approximate slope of 0.23 % through the study area.

There are no stream flow gauges located along either the Edson River or Bench Creek; therefore, flow frequencies for the two basins were estimated based on Station Frequency Analysis and then transposed to the respective basins.

Five stream gauges in the immediate area were examined and analyzed. These gauges include Embarras River near Weald (Station 07AF014), Sundance Creek near Bickerdike (Station 07AF010), Wolf Creek at Highway 16A (Station 07AG003), Lovett River near the Mouth (Station 07BA003) and Rat Creek at Cynthia (Station 07BA002). The data from these stations varied in length from 17 to 46 years. The maximum instantaneous discharges were either obtained directly from the available data or estimated from the available Maximum Daily discharges. Flow frequencies for each station were estimated using the HydroFreq program created by HydroTools Software. The Frequency analysis for each station is detailed in Appendix B.

These results were then transposed to the Edson River and Bench Creek, as shown in Appendix B. Based on the transpositions, the Embarras River, Wolf Creek, Lovett

Creek and Rat Creek produced relatively similar results for both the Edson River and Bench Creek. Based on these results the Edson River and Bench Creek were directly transposed from Rat Creek data, as all of the basins have similar characteristics and produced results that were comparable to the Alberta Infrastructure and Transportation flows for the two Bridge Files structures located immediately upstream of the subject property. Table 1 outlines the flow frequencies from the analysis.

Table 1 - Flow Frequency Estimates for Edson River and Bench Creek

RETURN PERIOD	EDSON RIVER UPSTREAM OF CONFLUENCE WITH BENCH CREEK MAXIMUM INSTANTANEOUS FLOW (CMS)	BENCH CREEK UPSTREAM OF CONFLUENCE WITH EDSON RIVER MAXIMUM INSTANTANEOUS FLOW (CMS)	EDSON RIVER DOWNSTREAM OF CONFLUENCE WITH BENCH CREEK MAXIMUM INSTANTANEOUS FLOW (CMS)
1:2	23.4	5.7	29.1
1:5	50.8	12.5	63.3
1:10	82.0	20.2	102.2
1:20	126.6	31.2	157.7
1:25	144.7	35.6	180.3
1:50	215.8	53.1	269.0
1:100	316.6	77.9	394.5
1:200	458.6	181.5	571.4

Based on the above analysis, the 1:00 year maximum instantaneous flood flow of 316.6 cms (cubic metres per second) was used for the Edson River upstream of its confluence with Bench Creek and a flow of 77.9 cms was used for Bench Creek upstream of its confluence with the Edson River. Downstream of the confluence of these two watercourses, a 1:100 year maximum instantaneous flow of 394.5 cms was used in the analysis.

5.0 RIVER HYDRAULIC MODELLING

Water surface profiles were computed using the HEC-RAS program (Version 3.1.2, April 2004), a program developed by the Hydrologic Engineering Centre of the US Army Corp of Engineers. The HEC-RAS model uses the following assumptions:

- Flow is steady, gradually varied and one-dimensional;
- The streambed is rigid with minimal material movement;
- The direction of flow is normal to the orientation of the cross-section; and

- The channel slope is relatively flat, with a maximum gradient of 10%.

The following sections outline the input data required for the HEC-RAS program.

5.1 CROSS-SECTION DATA

In order to properly assess the channel, cross-sections are required at regular intervals along the channel reach. As outlined in a previous section, a total of 24 cross-sections were obtained: 9 from Bench Creek and the remaining along Edson River. Of these, 17 cross-sections were selected to be entered into the model, based upon the location and quantity of data collected. The cross-sections were normal to the flow of the channel. Additional data points were interpolated, as needed, to ensure that sufficient data for modelling was included. For example, survey data from the privately owned property north of the channels could not be obtained, and, therefore, had to be interpolated from cadastral data, air photographs and topographic maps. Please see Drawing No. 1203394-3 for cross-section locations.

5.2 JUNCTION

Bench Creek flows into Edson River within the proposed development area. The model requires that the reach length across the junction for each section be entered. The reach length is defined as the length of the stream that is assumed to be uniform with respect to discharge, depth, area, and slope. For the cross-sections entered, the reach for the junction at Bench Creek was 0 m and was 1225 m for the Edson River.

5.3 BRIDGES AND CULVERTS

As noted earlier, there is a bridge and a bridge-sized culvert located within the study limits, along the Yellowhead County local road. Hydraulic and geometrical information on these structures was obtained from the bridge plan files noted previously.

In order to model a bridge or culvert, 4 cross-sections are required to properly define the channel. The first cross-section should be located sufficiently downstream of the structure such that the flow is not affected by the structure. The second and third cross-sections should be located immediately downstream and upstream of the structure, respectively. The final cross-section should be located sufficiently upstream such that the flow is not affected by the structure. As survey data could not be obtained upstream of the bridge, these cross-sections were interpolated for existing bridge cross-section data. For this analysis, the bridges and culverts were modelled as an equivalent channels with similar hydraulic characteristics.

5.4 HYDRAULIC PARAMETERS

The HEC-RAS program requires hydraulic parameters for the channel and overbank areas. For the channel, the program uses Manning's coefficient to determine friction losses and expansion and contraction coefficients to determine transition losses. For

the overbank areas, friction losses are also determined using the Manning's coefficient.

The expansion and contraction coefficients are used to determine head losses from widening and narrowing along the channel. Table 2 outlines the contraction and expansion coefficients recommended in the HEC-RAS program. The program defaults to 0.1 for contraction coefficient and 0.3 for expansion coefficient.

Table 2 – Typical Contraction and Expansion Coefficients

CONTRACTION AND EXPANSION COEFFICIENTS	CONTRACTION	EXPANSION
No transition loss computed	0.000	0.000
Gradual transitions	0.100	0.300
Typical Bridge sections	0.300	0.500
Abrupt transitions	0.600	0.800

As Edson River and Bench Creek do not appear to have abrupt changes along the reach being analyzed for this project (except at the location of the bridge and culvert), it was assumed that the default contraction and expansion coefficients of 0.1 and 0.3 respectively would be sufficient. The cross-sections upstream and downstream of the bridge and culvert were assumed to have the coefficients for the typical bridge section. The cross-sections upstream of the junction were assumed to have the highest coefficients of 0.6 for contraction and 0.8 for expansion. This is due to the widening of the channels at the junction.

Manning's roughness coefficient, also know as Manning's n, is required to determine frictional loss along the channel and structures. Manning's n is influenced by the geometry of the channel, channel bed composition, vegetation and the degree of meandering for the channel. Table 3 outlines the typical Manning's n values as obtained from the HEC-RAS program.

Table 3 – Typical Manning's Roughness Coefficients for Natural Streams

TYPE OF CHANNEL AND DESCRIPTION	MANNING'S 'N'		
	MINIMUM	NORMAL	MAXIMUM
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but more weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d", but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080

TYPE OF CHANNEL AND DESCRIPTION	MANNING'S 'N'		
	MINIMUM	NORMAL	MAXIMUM
h. Very weedy reaches, deep pools or floodways with heavy stands of timber and brush	0.070	0.100	0.150
2. Flood Plains			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated Areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, but few trees, little undergrowth flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070

For this analysis is the following Manning's Roughness Coefficients were used.

Table 4 – Manning's Roughness Coefficients for Project

CHANNEL TYPE	EDSON RIVER	BENCH CREEK
Main Channel	0.045	0.045
Pasture Overbank	0.050	0.050
Lightly Brushed Overbank	0.050	0.050
Moderately Treed Overbank	0.10	0.10

5.5 ASSUMPTIONS AND DESIGN CONSTRAINTS

Various assumptions must be made and design constraints examined in order to model this reach of the Edson River and Bench Creek as outlined below:

- Flows from Bench Creek do not spill into the Edson River upstream of the county road.
- Flows from the Edson River do not spill into Bench Creek upstream of the county road.
- The bridge and culvert will be modelled as a channel with similar hydraulic characteristics.
- Accurate stream flow data or known water levels are **not** available for the site. The available data cannot be used to calibrate the model as it does not correlate to the exiting geodetic survey data or the estimated flow data for the site.
- Boundary conditions for the Edson River and Bench Creek will use the normal depth method and assumes that the energy slope equals the average channel slope or the water surface slope.

5.6 ANALYSIS CALIBRATION

The floodplain analysis was undertaken using the above noted information, assumptions and design constraints. The geometric and stream flow data was entered into the HEC-RAS program and run to provide an initial flood level estimate. The model could not be calibrated to known water levels as there are no known water levels which correlate to the geodetic survey data for the site. Therefore, a sensitivity analysis was undertaken to assess the degree of confidence in the computed water surface profiles. The main parameters examined were the Manning's roughness coefficient and the assumed energy slope.

In general, increasing the Manning's roughness by 50% increased upstream water surface elevations on both Bench Creek and Edson River by approximately 0.5 metres, and increased downstream elevations on the Edson River by approximately 0.4 metres.

Increasing the energy slope by 50% did not significantly change the upstream water surface elevations for Edson River and Bench Creek, and decreased the downstream water surface elevation on the Edson River by approximately 0.3 metres. Decreasing the energy slope by 50% increased the upstream water surface elevations for Edson River and Bench Creek by approximately 0.1 metres, and increased the downstream water surface elevation on the Edson River by approximately 0.6 metres.

Based on the above analysis, it was speculated that the model provided a reasonable representation of the 1:100 year flood elevations across the respective river and creek reaches. However, the mapping of the flood risk boundary should take into account potential variances in water surface elevations due to the lack of known water levels for these watercourses.

6.0 ESTIMATED WATER SURFACE PROFILES

The water surface profiles for the 10, 50 and 100-year return periods were estimated based on the model developed above. Table 5 outlines the water surface elevations at the various cross-section stations for each watercourse.

Table 5 – Estimated Water Surface Profiles for Edson River and Bench Creek

River & Cross-Section	1:10 Year Flow	1:50 Year Flow	1:100 Year Flow	1:100 Year Flow with Safety Factor *
Bench Creek				
0+261	861.27	862.20	862.68	863.98
0+243	861.15	861.79	861.95	862.25
0+233	861.23	862.12	862.54	862.84
0+208	861.22	862.09	862.51	862.81
0+110	861.22	862.10	862.53	862.83
0+084	861.22	862.10	862.52	862.82
0+037	861.22	862.10	862.52	862.82
0+000	861.22	862.10	862.52	862.82
Edson River				
1+450	861.31	862.37	862.90	863.20
1+424	861.29	862.18	862.58	862.88
1+402	861.28	862.25	862.70	863.00
1+364	861.21	862.04	862.40	862.70
1+240	861.20	862.08	862.50	862.80
1+215	861.12	862.00	862.44	862.74
0+896	860.66	861.65	862.13	862.43
0+550	860.17	861.26	861.82	862.12
0+000	859.48	860.67	861.27	861.57

* Based on the lack of known water elevations, a factor of safety should be applied to the estimated water surface elevations by adding 0.3 metres to the 1:100 year flood event. This would provide additional routing for an approximate 10% increase in 1:100 year flow rates or a 25% increase in Manning's n values.

Details of the analysis results are found in Appendix C. Profile plans and cross-section plans, with the corresponding water surface elevations are also shown in Appendix C.

7.0 FLOOD RISK MAPPING

The following terminology has been adopted by the Technical Committee, Canada-Alberta Flood Damage Reduction Program (FDRP):

- **Flood Risk Area** The flood risk area is the area which would be inundated by the design flood. In Alberta, the adopted design flood is the so called 1:100 year

flood, which is an extreme event, having a one percent chance of being equalled or exceeded in any year. The flood risk area includes the floodway and the flood fringe. These two terms are discussed below.

- **Floodway** The floodway is that part of the flood risk area where the flood waters are deepest, fastest and most destructive. It is a constricted channel area within which the entire flood may be conveyed without raising water levels or increasing the flow velocities beyond specified limits.
- **Flood Fringe** The flood fringe is the outer portion of the flood risk area, adjacent to the floodway. The water in the flood fringe is generally shallower and flows more slowly than in the floodway. Conditions are generally less hazardous in the floodway.

Under the FDRP, the following hydraulic criteria have been adopted for determining the floodway limits:

- The water surface profile should not exceed 0.3 metres above the design flood under existing floodplain conditions.
- In general, all areas where the depth of flooding exceeds 1 metre, or the flow velocity exceeds 1 metre/second, become part of the floodway. However, in order to achieve a hydraulically smooth floodway boundary, some areas with depths and velocities exceeding these criteria may become part of the flood fringe.
- In reaches where the existing mean channel velocities are excessive, the floodway constriction should be minimized such that velocities are not further increased.
- In reaches of supercritical flow, no encroachment may be introduced.
- In the case of ice jam flooding, areas with depths of flooding of 1 metre or more become part of the floodway.
- In areas where dykes or levees define the effective flow path of a stream, no encroachment beyond the dyked area is allowed.

These criteria are intended to limit the flood hazard in the flood fringe and to minimize increases in upstream water levels. Please see Appendix D for additional information.

Based on the above noted criteria, the estimated flood risk area for the Edson River and Bench Creek on the subject property is shown in Drawing No. 1203394-3. The estimated floodway on the subject property is shown in Drawing No. 1203394-4.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to identify the 1:100 year floodplain or flood risk boundary for the Edson River and Bench Creek within the subject property. Based on the information provided to EXH, and the assumptions contained herein, these boundaries have been estimated and are shown of the various drawings within the report.

Development of a country residential subdivision within the 1:100 year floodway is not recommended based of the criteria and guidelines provided by Alberta Environment and

the Canada-Alberta Flood Damage Reduction Program. Residential subdivision development within the 1:100 year flood fringe area could be undertaken, provided this development is undertaken according to FDRP guidelines and the works do not impact the flood elevations in the upstream reaches. Analysis of the impacts of any development within the flood fringe has not been undertaken in this study. Further hydraulic analysis of any development within the flood fringe would be required before any development could proceed in the flood fringe area.

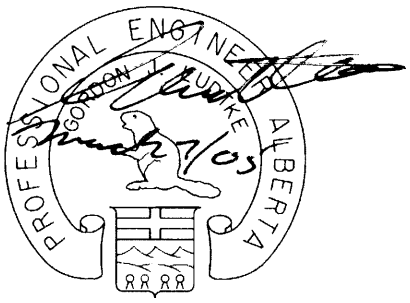
Please note that it is not recommended that any residential development occur near the confluence of the Edson River and Bench Creek. A portion of land immediately south and southeast of the confluence is less than 1.0 metres below the estimated 1:100 year flood level. However, given the proximity of this land to both main channels of these watercourses, the potential for severe damage from flooding and erosion as a result of floods and ice jams is extremely high. Raising this site may prevent flooding on this portion of this land and allow future development; however, the raising of this site and the development of an access road may increase flood levels on upstream lands and the adjoining residence, located to the west. The potential impacts of undertaking this type of work were beyond the scope of this study.

9.0 CLOSURE

This report has been prepared based upon the best information available at the time, and the assumptions stated herein. Estimates and conclusions may change with the availability of more detailed information.

This report has been prepared for the exclusive use of J&A Logging. Use by third parties, or for purposes other than as stated herein, or for other sites or site conditions, is not permitted without the express written permission of EXH Engineering Services Ltd.

Sincerely;



PERMIT TO PRACTICE
EXH ENGINEERING SERVICES LTD.
Signature _____
Date _____
PERMIT NUMBER: P 5347
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Gordon J. Ludtke, P.Eng.
EXH Engineering Services Ltd.

Appendix A
Figures and Drawings

No.	Date	Revision	By	App
1	March 2006	ISSUED FOR REVIEW	GL	

Permit

Engineer's Stamp

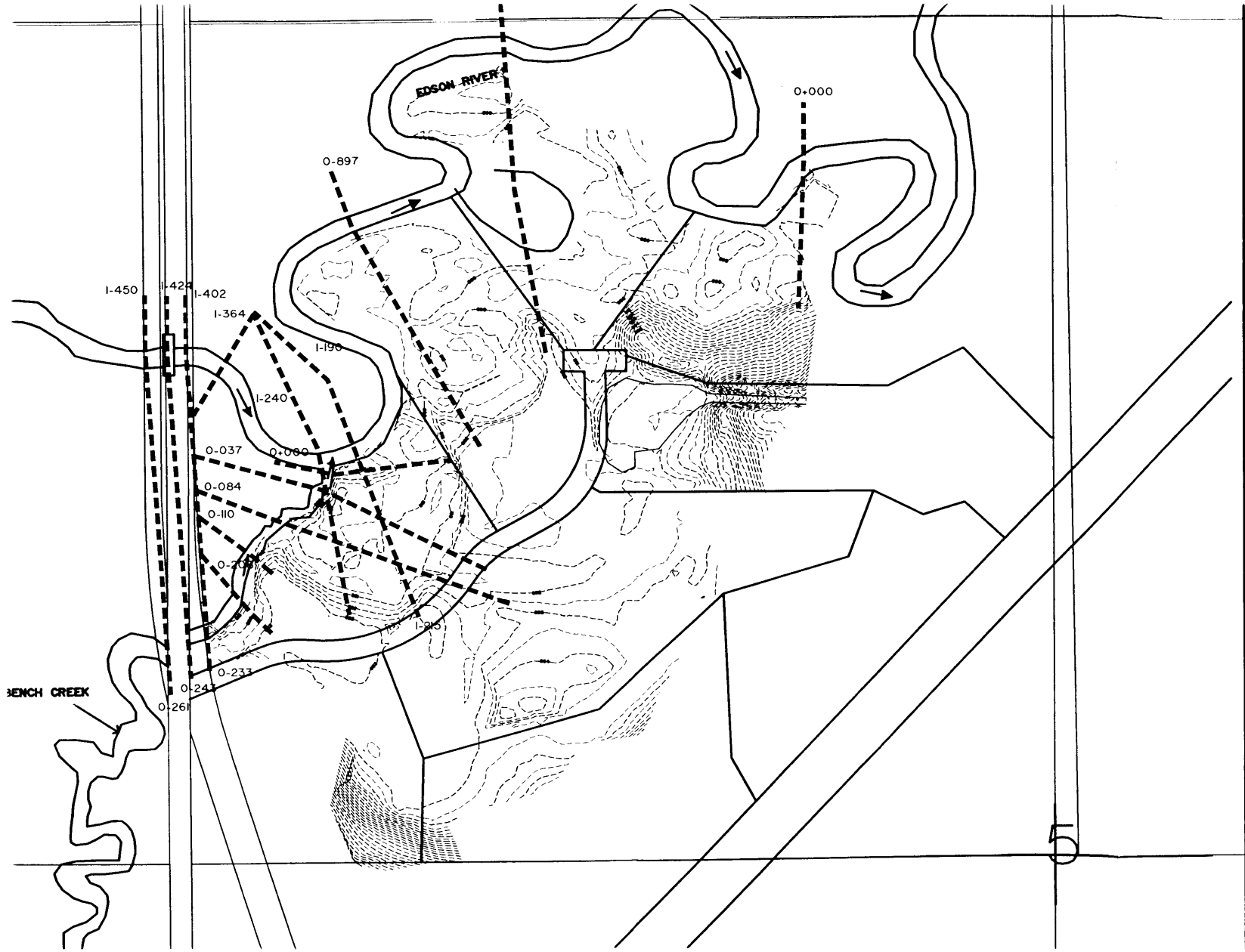
EXH Engineering Services Ltd.

Project

J & A LOGGING
EDSON RIVER ESTATES

Drawing

SITE PLAN
NW 5-54-16-W5M



NOTES:

1. CONTOURS ARE IN METERS.
2. CONTOURS ARE SPACED AT 0.5 METER INTERVALS.
3. TO BE VIEWED IN CONJUNCTION WITH THE FLOOD RISK MAPPING STUDY FOR THE PROPOSED EDSON RIVER ESTATED DATED MARCH 7, 2005.

No.	Date	Revision	By	App.
1	March 2005	ISSUED FOR REVIEW	GL	

Permit

Engineers Stamp

EXH Engineering Services Ltd.

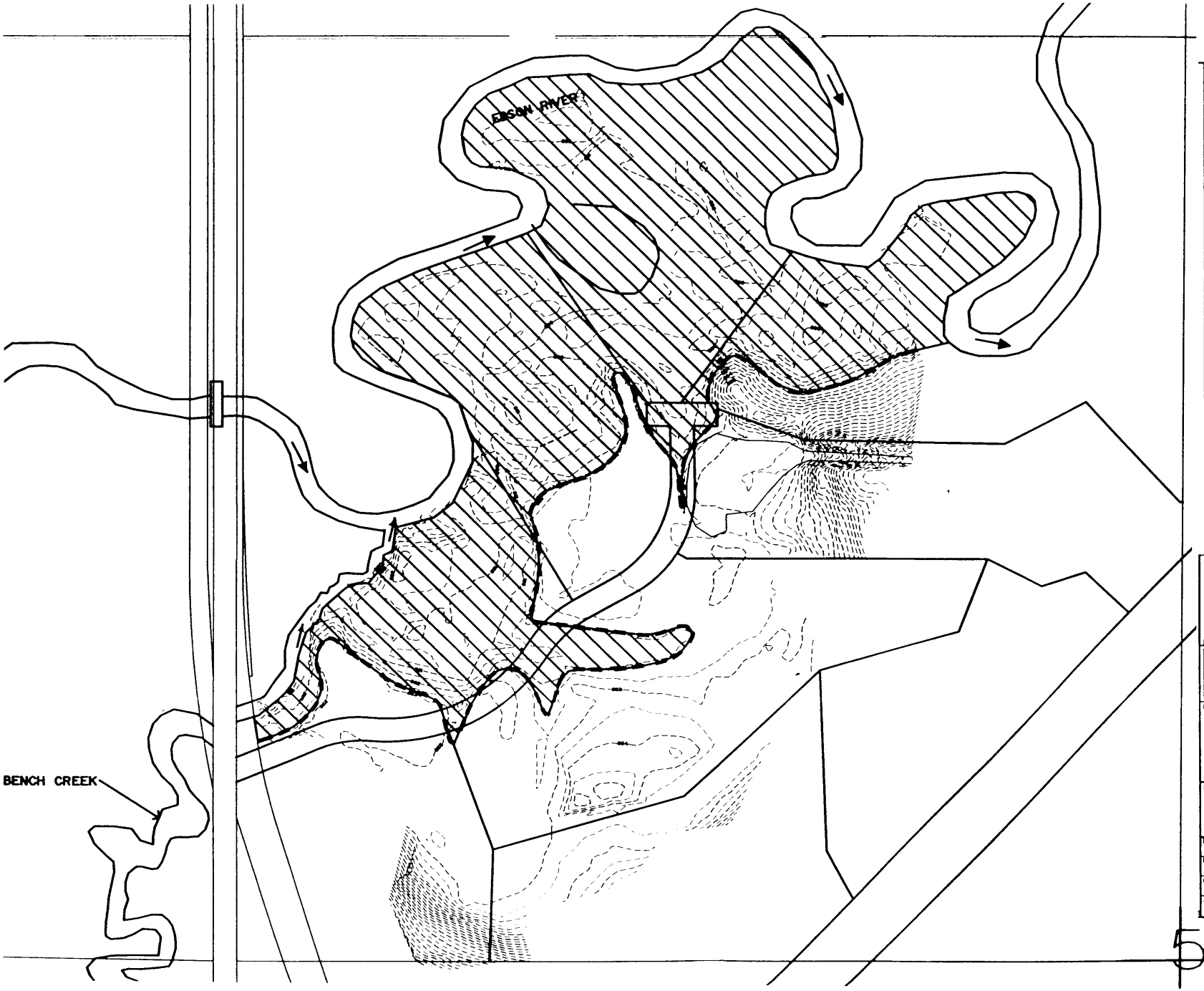
Project

J & A LOGGING
EDSON RIVER ESTATES

Drawing

CROSS SECTIONS ALONG EDSON RIVER & BENCH CREEK

Designed	Scale	Date
GJL	1:2000	MARCH 2005
Drawn	Project No.	Contract No.



NOTES:

1. CONTOURS ARE IN METERS
2. CONTOURS ARE SPACED AT 0.5 METER INTERVALS.
3. TO BE VIEWED IN CONJUNCTION WITH THE FLOOD RISK MAPPING STUDY FOR THE PROPOSED EDSON RIVER ESTATED DATED MARCH 7, 2005.

LEGEND:

LIMIT OF 100 YEAR FLOOD RISK AREA (INCLUDES FLOODWAY AND FLOOD FRINGE)

PERMIT TO PRACTICE
EXH ENGINEERING SERVICES LTD.
Signature
Date
PERMIT NUMBER: P 6347
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

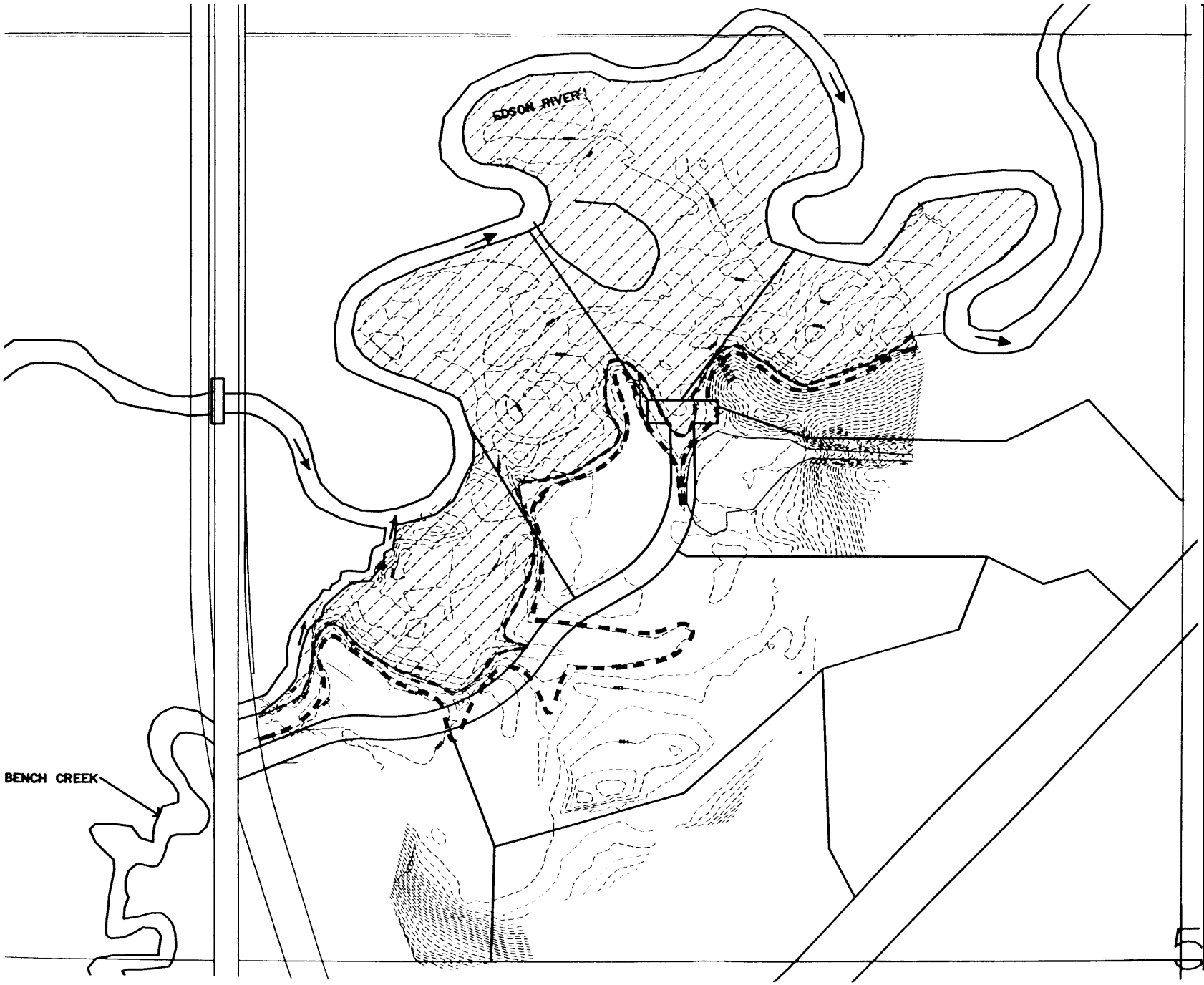
Permit | Engineering Stamp

EXH Engineering Services Ltd.

Project
J & A LOGGING
EDSON RIVER ESTATES

Drawing
FLOOD RISK AREA
EDSON RIVER & BENCH CREEK

Designed	Scale	Date
GJL	1:2000	MARCH 2005
Drawn	Project No.	Contract No.
MRS	1203394	
Checked	Drawing No.	Revision
Approved	1203394-4	0



NOTES:

1. CONTOURS ARE IN METERS.
2. CONTOURS ARE SPACED AT 0.5 METER INTERVALS.
3. TO BE VIEWED IN CONJUNCTION WITH THE FLOOD RISK MAPPING STUDY FOR THE PROPOSED EDSON RIVER ESTATES DATED MARCH 7, 2006

LEGEND:

LIMITS OF 1:100 YEAR FLOOD RISK AREA (INCLUDING FLOOD FRINGE)

LIMITS OF 1:100 YEAR FLOODWAY

No.	Date	Revision	By	App.
1	March 2006	ISSUED FOR REVIEW		

PERMIT TO PRACTICE
EXH ENGINEERING SERVICES LTD.
Signature
Date
PERMIT NUMBER: P 5347
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

PROFESSIONAL ENGINEERS AND GEOSCIENTISTS ALBERTA

Permit | Engineers Stamp

EXH Engineering Services Ltd.

Project

J & A LOGGING
EDSON RIVER ESTATES

Drawing

FLOODWAY BOUNDARY
EDSON RIVER & BENCH CREEK

Designed	Scale	Date
G.J.	1:2000	MARCH 2006
Drawn	Project No.	Contract No.
MRS	1203394	
Checked	Drawing No.	Revision
Approved	1203394-5	0

APPENDIX 2) Percolation Rates & Groundwater Conditions
Prepared by EXH Engineering Ltd.

EXH Engineering Services Ltd.

EDSON OFFICE
4730 - 3rd Avenue
Edson, Alberta T7E 1C2
Telephone: (780) 712-5000
Fax: (780) 712-4339
E-mail: edson@exheng.com

Steven Jonasson
Box 6543
Edson, Alberta
T7E 1T9

Sept. 16, 2003

ATTENTION: Steve Jonasson

RE: Percolation Rates and Ground Water Conditions
NW 5-54-16-5

The percolation rates of all 6 test holes fall within the allowable rates of 3.8 to 45 minutes/2.5 cm (or 1.5 to 17.7 min/cm) for a test hole diameter of 150mm, see attached.

The water table corresponding to the first two test holes was measured to be at 2.00 m below ground surface. No water was found in the other two water table test holes at 2.4 m below ground surface. The perk test and water table test was performed on September 12, 2003.

Should you have any questions, please call our office at (780) 712-5000. Thank you for using our services.

Sincerely,

Ahmad Elsayed, E.I.T

/attachments

cc Doug Laboucane, EXH Engineering Services Ltd.
cc Brent Shepard, Yellowhead County

PERCOLATION TEST

DATE: SEPTEMBER 12/03

TEST HOLE	INITIAL TIME	FINAL TIME	INITIAL HEIGHT (MM)	FINAL HEIGHT (MM)	DROP (MM)	TIME INTERVAL (MIN)	RATE MIN/CM	RATE MIN/2.5CM	AVG. MIN/2.5CM
1	12:17	12:49	465	514	49	32	6.53	16.59	
1	12:50	1:21	404	467	63	31	4.92	12.50	
1	1:52	2:28	410	490	80	36	4.50	11.43	
1	2:29	2:59	416	477	61	31	5.08	12.91	
PERC. RATE									12.3
2	12:21	12:53	457	527	70	31	4.43	11.25	
2	12:54	1:24	434	536	102	30	2.94	7.47	
2	1:25	1:53	437	520	83	28	3.37	8.57	
2	1:54	2:30	428	527	99	36	3.64	9.24	
2	2:33	2:54	428	490	62	21	3.39	8.60	
PERC. RATE									8.8
3	12:26	12:56	445	497	52	30	5.77	14.65	
3	12:57	1:28	417	480	63	31	4.92	12.50	
3	1:29	1:59	396	460	64	30	4.69	11.91	
3	1:58	2:36	448	528	80	38	4.75	12.07	
PERC. RATE									12.2

PASS RANGE: 1.5 - 17.7 MIN/CM OR 3.8 - 45 MIN/2.5CM (150MM or 6" Diameter)

PERCOLATION TEST

DATE: SEPTEMBER 12/03

TEST HOLE	INITIAL TIME	FINAL TIME	INITIAL HEIGHT (MM)	FINAL HEIGHT (MM)	DROP (MM)	TIME INTERVAL (MIN)	RATE MIN/CM	RATE MIN/INCH	AVG. MIN/2.5CM
4	12:31	12:58	452	547	95	27	2.84	7.22	
4	1:00	1:30	465	559	94	30	3.19	8.11	
4	1:31	2:00	464	554	90	29	3.22	8.18	
4	2:01	2:42	462	582	120	41	3.42	8.68	
PERC. RATE									8.3
5	12:43	1:11	469	528	59	28	4.75	12.05	
5	1:12	1:38	444	504	60	26	4.33	11.01	
5	1:39	2:07	457	518	61	28	4.59	11.66	
PERC. RATE									11.6
6	12:45	1:13	464	524	60	28	4.67	11.85	
6	1:14	1:40	449	502	53	26	4.91	12.46	
6	1:41	2:09	456	514	58	28	4.83	12.26	
PERC. RATE									12.2

Water Table#	Depth	Water Level	Date
1	2.4	2.0	Sept. 12/03
2	2.4	No Water	Sept. 12/03
3	2.4	No Water	Sept. 12/03

Note: Water Level measured from existing ground level.
Measurements are in meters.

APPENDIX 3) Groundwater Potential Assessment
Prepared by Waterline Resources Inc.
{Note: Summary of Full Report}

Waterline Resources Inc.

Waterline Resources Inc.
2017 – 48 Avenue S.W.
Calgary, Alberta
Canada, T2T 2T6
Tel: (403) 273-3564
Fax: (403) 273-3527
Email: info@waterlineresources.com

July 4, 2003
WL03-965

Steven Jonasson
Box 6543
Edson, Alberta
T7E 1T9

Attention: Steven Jonasson

Dear Mr. Jonasson:

RE: GROUNDWATER POTENTIAL ASSESSMENT, Proposed 8 Lot Residential Subdivision Development, NW-05-054-16-W5M, Near Edson, Alberta

INTRODUCTION

Waterline Resources Inc. (Waterline) is pleased to present the results of the groundwater potential assessment for a proposed development to be located in NW-05-054-16-W5M, between the Edson and McLeod Rivers, northeast of Edson, Alberta (the subject area) (Figure 1). The developer has proposed a subdivision consisting of 8 residential lots within the subject area (see subdivision layout plan included in Appendix A).

Hydrogeological information for the site, and the surrounding area was assembled and reviewed to complete this preliminary assessment. Information sources included the 2003, Alberta Environment (AENV) Provincial Water Well Record database (database) and relevant and readily attainable published geology and hydrogeology maps and reports.

INVESTIGATION GUIDELINES

This study was completed in general accordance with the 1994 AENV publication "interim Guidelines For The Evaluation Of Groundwater Supply For Unserviced Residential Subdivisions Using Privately Owned Domestic Water Wells". These guidelines are recommended for use for unserviced residential subdivisions where the water supply will be provided by privately owned domestic water wells and, where the number of residential parcels within one quarter section is six or more.

As stated in the guidelines, the principle of sustainable development should guide the utilization of groundwater resources. Specifically, the guidelines state that: "the threat of groundwater shortages and contamination grows with the density of wells and their collective demand on the local groundwater resources". The guidelines also state that as a component of a General Municipal Plan, groundwater availability could be mapped and used as criteria for locating future unserviced residential subdivisions. In any area, continued development of the groundwater resource can ultimately exceed recharge of the aquifers causing groundwater mining, which can

result in decreasing water levels. A regional assessment would have to be completed by/for regulatory authorities in order to assess these impacts on the aquifer system. The results of this type of study should be adopted into groundwater management criteria for future use in locating and managing other developments within the County. This philosophy has been incorporated into the Province of Alberta's Water Act (the Act), which came into force January 1, 1999. The Act sets up the framework for the future development of "Water Management Plans" within defined watersheds. This approach is also consistent with AENV's move to a wellhead protection and integrated watershed management philosophy.

The Act also addresses household diversions directly under Section 23 (3) which states that a person residing within a subdivision on a parcel of land has the right to commence and continue the diversion of water only if *"a report certified by a professional engineer, professional geologist or professional geophysicist, as defined in the Engineering, Geological and Geophysical Professions Act, was submitted to the subdivision authority as part of the application for subdivision under the Municipal Government Act, and the report states that the diversion of 1,250 cubic metres of water per year for household purposes under section 21 for each of the households within the subdivision will not interfere with any household users, licensees or traditional agriculture users who exist when the subdivision is approved."*

Relevant to the proposed development in the subject area, the Act specifies that the diversion of 1,250 m^3/year per household (household use as defined in the Act) for the proposed new undeveloped lots should not interfere with any household users, licensees or traditional agriculture users who exist when the subdivision is approved. Therefore, the objective of this study is to render a professional opinion, based on a review of readily available information, whether aquifers underlying the proposed 8 undeveloped lots in the subject area can sustain production of 10,000 m^3/year (1,250 m^3/year/lot x 8 lots) or continuous production of approximately 4.2 imperial gallons per minute (Igpm), and whether managed diversion of that groundwater will negatively impact existing users of the groundwater resource, as defined in the Act.

Waterline's opinion presented herein is based on the assumption that existing domestic users in the area, and users proposed at the site will utilize less than or equal to 1,250 m^3/year/lot obtained at a daily rate of less than or equal to (1,250 m^3/year/lot ÷ 365 days) 3.43 m^3/day/lot, or 753 imperial gallons per day per lot (AENV, September 1998). The 1994 AENV publication "Interim Guidelines For The Evaluation Of Groundwater Supply For Unserviced Residential Subdivisions Using Privately Owned Domestic Water Wells" indicates that residential water needs are estimated to be 0.23 - 0.68 m^3/day/person (50 - 150 imperial gallons per day (Igpd) per person) with an average of 0.27 m^3/day/person (60 Igpd per person[1]). Therefore, the average Alberta family may utilize up to 1.35 m^3/day (300 Igpd; 493 m^3/year).

GEOLOGY

The shallow surficial geology of the study area is mapped as clay over bedrock, as well as sand and gravel infill in buried channels which are mapped beneath the subject area (Vogwill, 1983).

[1]www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/wwg407?opendocument

Bedrock beneath the site is mapped as the Paskapoo Formation; a thick bedded, calcareous, cherty sandstone; siltstone and mudstone with some coal occurring near the base of the formation (Vogwill, 1983).

The geology recorded on water well completion records, available from the AENV water well database (2003), is consistent with the regional geologic mapping and is logged as clay, sand and some gravel overburden sediments, 5 to 30 m thick, underlain by layers of shale and sandstone. Figure 2 presents a geological fence diagram (cross-section) orientated approximately north-south, extending through the subject quarter section. The cross-section location is shown on Figure 1. The cross-section includes soil and bedrock stratigraphy data obtained from four water wells completed in the subject area; AENV Well ID No. 447668 (McGill), 393896 (Day), 447600 (Alvin) and 389013 (Carter).

HYDROGEOLOGY

AENV Provincial Water Well Database

The AENV database lists a total of 55 water well records within a 2 km radius centred in NW-05-054-16-W5M. However, only a subset of the records listed in the AENV database typically represent water wells currently in operation. Information for all records is summarized, in tabular format, in Table 1, Appendix A. Complete drilling reports are also provided in Appendix A for wells listed in the AENV database and located within the search area. The records indicate that groundwater use in the area is primarily for domestic consumption, with lesser use indicated for stock watering, and industrial purposes.

Well Completion Depth and Static Water Level

Water wells in the search area, for all intended water uses, appear to be completed within 3.1 to 182.9 m below ground level (m bGL) (10 to 600 ft bGL), with a calculated average depth of 48.5 m bGL (159 ft bGL), in sandstone units of Paskapoo Formation (Vogwill, 1983). Static water levels, measured in area wells following construction, were commonly in the 1.5 to 54.2 m bGL (5 to 178 ft bGL), with a calculated average static water level depth of 17.7 m bGL (58 ft bGL). Shallow groundwater is expected to flow to the east sub-parallel to the McLeod River.

Aquifer Depth and Well Yield

Although the main water bearing units developed for domestic water supplies in the subject area are fractured sandstones in the Paskapoo Formation, alluvial gravels deposits account for a significant groundwater resource that appears to be under-utilized in the area where the groundwater yield probability[2] within the bedrock and surficial deposits underlying NW-05-054-

[2] Yield Probability refers to the average expected yields of a well based on best available data at the time of map compilation; due to data shortcomings and special conditions, local discrepancies between predicted and actual yields are inevitable. Multi-aquifer completions may be necessary to obtain the yields indicated (Vogwill, 1983)

16-W5M, including the sections to the north, is mapped by Vogwill (1983) as 114 to 455 L/min (25 to 100 Igpm). Although Vogwill (1983) reduced the bedrock yield probability estimate to 23 to 114 L/min (5 to 25 Igpm) within the southern half of section 05, gravel deposits extending south to the McLeod River may provide significantly higher yields from wells completed in those deposits.

Limited duration well tests, completed by the drilling contractors following well construction, on wells located within the 2 kilometre record search area surrounding NW-05-054-16-W5M, have been conducted in the range of 14 to 273 L/min (3 to 60 Igpm), with a calculated average test rate of 91 L/min (20 Igpm). Therefore, the well tests appear to indicate that the single well yields fall within the range of groundwater yield probability mapped for the bedrock in the area by Vogwill (1983).

Water wells constructed within the coarse-grained alluvial sediments, associated with the Edson and McLeod Rivers, may have higher sustainable yields than those wells completed in the bedrock, due to the potentially high permeability of these deposits and the influence of the rivers that may act as a source of recharge to the adjacent shallow aquifers. The limited development of surficial aquifers within the study area may be due to the limitations in drilling technique, where historically, the majority of wells were drilled using mud rotary technology that is better suited for bedrock completions. The use of bentonite mud during well completion can plug the natural formation, effectively reducing the permeability of the formation and reducing well yield. In order to effectively and efficiently complete a well in unconsolidated sand and gravel deposits, the formation must be accurately sampled and analyzed for grain size to allow for proper well screen design. A cable tool drilling rig, or an air rotary drilling rig equipped with a drill-through casing hammer are better suited technologies for overburden well completions.

Groundwater Quality

Based on the Vogwill (1983), the glacial overburden and bedrock hydrochemistry in the subject area is mapped as having a total dissolved solids (TDS) concentration of less than 500 mg/L, with a dominant carbonate-bicarbonate and sodium-potassium character for groundwater sources from the bedrock aquifers, and a dominant carbonate-bicarbonate and calcium-magnesium character for groundwater sourced from the overburden sand and gravel aquifers. Based on chemical data provided in AENV's water well database, groundwater sampled from bedrock wells located within the general study area exhibits a TDS concentration between 337 and 546 mg/L. The groundwater quality is generally of similar chemical character to that described by Vogwill (1983). No records were obtained for wells completed in the alluvial gravel deposits. Copies of selected AENV chemistry records are provided in Appendix A.

CONCLUSIONS AND RECOMENDATIONS

- Information available from published reports and from the AENV database indicates that the majority of wells completed in the study area are relatively deep (average depth 48.46 m; 159 ft), and are completed in the Paskapoo Formation, across multiple aquifers.

- The estimated yield probability from wells completed in bedrock within the general study area is mapped as 23 to 455 L/min (5 to 100 Igpm). Based on well records in the AENV database, the average yield from bedrock wells located in the 2 kilometre search area surrounding NW-05-054-16-W5M, is calculated at 91 L/min (20 Igpm). The well tests indicate that single well yield from bedrock wells fall within the range of the safe yields mapped for the area.

- The limited development of surficial aquifers within the study area may be due to the limitations in drilling technique, where historically, the majority of wells were drilled using mud rotary technology that is better suited for bedrock completions. The use of bentonite mud during well completion can plug the natural formation, effectively reducing the permeability of the formation and reducing well yield. In order to effectively and efficiently complete a well in unconsolidated sand and gravel deposits, the formation must be accurately sampled for grain size analysis to allow for proper well screen design. A cable tool drilling rig, or an air rotary drilling rig equipped with a drill-through casing hammer, are better-suited technologies for overburden well completions.

- Although the groundwater development has focussed on bedrock aquifers, the potential for groundwater resource development from surficial aquifers is considered significant.

- The groundwater resource development potential appears to be relatively high, and existing water well records support the conclusion that aquifers underlying the proposed development in NW-05-054-16-W5M will meet the groundwater diversion requirement of the proposed residential development (10,000 m^3/year; 4.2 Igpm) as specified in the Act, without impacting existing users. Independent of this professional opinion, the proponent should be aware that some municipal governments require aquifer testing and analysis (i.e., a pumping test) as a condition of subdivision approval.

- Waterline's conclusion is based on the assessment of potential impacts on local aquifers while only considering present resource utilization and utilization proposed for the subject development. This conclusion assumes that existing and proposed users do not over-exploit the groundwater resource by excessive short-term use and maintain consumption within the residential water needs as presented in the Provincial Guidelines.

- Based on the available data reviewed during this study, the groundwater quality in the study area appears to have a TDS concentration of the order of 337 to 546 mg/L; with the analyses indicating a sodium bicarbonate dominant groundwater sourced from bedrock aquifers, and a calcium bicarbonate dominant groundwater sourced from surficial aquifers. This evaluation is based on limited available chemistry information and a full suite of chemistry analysis would be needed to further confirm the quality of groundwater at the subject site.

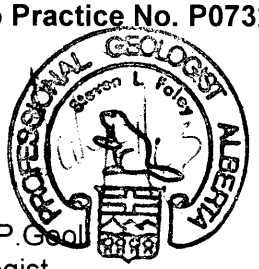
CLOSURE

The present study should be combined with the results of any future site-specific hydrogeological investigations, should they be completed, to gain a more complete understanding of the site-specific aquifer conditions underlying the study area. This will allow for the results of the present study to be updated, as necessary, and will serve to promote groundwater resource management and protection in the area for current and future users.

The findings presented in this report are based upon a review of published maps and reports, and information available from the AENV water well database. This report is intended for use in support of the application for subdivision under the Municipal Government Act, and should not be considered as a Water Management Plan or as a Phase 1 Environmental Site Assessment. The enclosed study has been carried out in accordance with generally accepted hydrogeological practices. No other warranty is intended or implied.

Respectfully submitted

Waterline Resources Inc.
APEGGA Permit To Practice No. P07329



Steve Foley, M.Sc., P.Geol.
Principal Hydrogeologist

Reviewed by:

Jamie Wills, M.Sc., P.Geol.
Principal Hydrogeologist

REFERENCES

Alberta Environment, June 27, 1994. Interim Guidelines For The Evaluation Of Groundwater Supply For Unserviced Residential Subdivisions Using Privately Owned Domestic Water Wells. LUB FILE: 3000-G1-W1.

Alberta Environment Natural Resources Provincial Water Well Database, 2003.

AENV, September 1998. Draft Environmental Guidelines for the Review of Subdivisions in Alberta. Standards and Guidelines Branch, Environmental Assessment Division, Alberta Environment.

Vogwill, R.I.J., 1983. Hydrogeology of the Edson Area, Alberta. Alberta Research Council, Earth Science Report 79-07.

APPENDIX 4) Application Forms and Existing Certificate of Title

YELLOWHEAD COUNTY

Application No._____

APPLICATION FOR AMENDMENT TO THE

YELLOWHEAD COUNTY
LAND USE BYLAW NO. 7.98

I/WE hereby make application to amend the Yellowhead County Land Use Bylaw No. 7.98.

Applicant: Name Greg Hofmann Telephone 780 460-0894
Address 5 Portman Pl. St. Albert, AB

Owner of Land: Name Steven & Natilie Jonasson Telephone 723-0181
Address Box 6543, Edson, AB T7E 1T9

Land Description: Certificate of Title 982 019 301 + 1
Pt. NW 1/4 Section 5 Twp. 54 Range 6 West of 5 Meridian
Lot _____, Block _____, Reg. Plan No. _____
Area of above-described parcel of land to be redistricted 41.07 ha ±

Amendment Proposed
FROM RD - Rural Dist. TO CR - County Residential

Reasons in support of Application for Amendment

See attached Conceptual Scheme, Proposed Subdivision and supporting technical information.

I/We enclose $200.00 being the application fee, payable to Yellowhead County.

June 21/06 _____
DATE SIGNATURE OF APPLICANT(S)

_____ _____
DATE SIGNATURE OF LANDOWNER(S)

This personal information is being collected under the authority of Municipal Government Act, Being Chapter M-26 R.S.A., 2000 and will be used to process amendments to the Land Use Bylaw No. 7.98. It is protected by the privacy provisions of the Freedom of Information and Protection of Privacy Act, Chapter F-18.5 R.S.A., 2000. If you have any questions about the collection of this personal information, please contact the Director of Planning, Yellowhead County, 2716-1 Ave., Edson AB T7E 1N9, (780) 723-4800.

RETURN COMPLETED APPLICATION FORM TO:

Yellowhead County

2716 - 1st. Avenue, Edson, Alberta T7E 1N9
Ph. (780) 723-4800
Fax (780) 723-5066
Email info@yellowheadcounty.ab.ca

APPLICATION FOR SUBDIVISION APPROVAL (Check which applies) ___ By plan of subdivision ___ By other instrument	**For Office Use Only**	
	Date of receipt of Form A as complete	File No.
	Fees Submitted:	

THIS FORM IS TO BE COMPLETED IN FULL WHEREVER APPLICABLE BY THE REGISTERED OWNER OF THE LAND THAT IS THE SUBJECT OF THIS APPLICATION OR BY AN AUTHORIZED PERSON ACTING ON HIS/HER BEHALF

1. **Name(s) of registered owner(s) of land to be subdivided** Steven & Natilie Jonasson
   Address and phone no. Box 6543, Edson, AB, T7E 1T9 780 723-0181

2. **Authorized person(s) acting on behalf of registered owner(s)** Greg Hofmann, ACP, MCIP
   Address and phone no. G.T. Hofmann & Assoc. 5 Portman Pl. St. Albert, AB T8N 6L5

This personal information is being collected under the authority of Section 653 of the Municipal Government Act, Being Chapter M-26.1 R.S.A., 2000 and will be used to process the subdivision application. It is protected by the privacy provisions of the Freedom of Information and Protection of Privacy Act, Chapter F-15.5 R.S.A., 2000. If you have any questions about the collection of this personal information, please contact the Director of Planning, Yellowhead County, 2716-1 Ave., Edson, AB, T7E 1N9, (780) 723-4800

3. **LEGAL DESCRIPTION AND AREA OF LAND TO BE SUBDIVIDED (ie: existing titled area)**

All/part of the NW 1/4 Section 5 twp. 54 range 16 west of 5th meridian

Being all/part of lot ____ block ____ Reg. Plan No. ____ Certificate of Title No. 982 019 301 +1

Municipal Address (if applicable) ____

Area of above-described parcel of land to be subdivided (ie: existing titled area) 41.07 ha ±

4. **LOCATION OF LAND TO BE SUBDIVIDED**

a. Is the land situated immediately adjacent to the municipal boundary? Yes ____ No X
   If "Yes", the adjoining municipality is ____

b. Is the land situated within 0.5 miles of the right-of-way of a Highway? Yes ✓ No ____
   If "Yes", the Highway is No. ____, the Secondary Road is No. 748

c. Is the land situated within 0.5 miles of a river, watercourse, lake or other permanent body of water, or a canal or drainage ditch? Yes ✓
   No ____ If "Yes", state its name Bench Creek & Edson River

d. Is the proposed parcel within 1.5 km of a sour gas facility? Yes ____ No ____

5. **EXISTING AND PROPOSED USE OF LAND TO BE SUBDIVIDED**

a. Existing use of land Pasture, Bush

b. Proposed use of land **PLEASE INDICATE THE SIZE AND EXACT USE(S) OF:**

   (a) The parcel(s) being created: 8-lot Country Residential Subd.

   (b) The remainder (remnant) of the existing titled area: ____

c. The land use district ("zoning") applied to the existing titled area under the Land Use Bylaw Accompanying application to redistrict from RD to CR in the Land Use Bylaw

6. PHYSICAL CHARACTERISTICS OF LAND TO BE SUBDIVIDED

a. Describe the nature of the topography of the land (e.g. flat, rolling, steep, mixed, etc.) mixed (benchs, slopes)

b. Describe the nature of the vegetation and water on the land (e.g. brush, tree stands, etc. - sloughs, creeks, etc.)
mixture of pasture and tree stands

c. Describe the kind of soil on the land (e.g. sandy, loam, clay, etc.) _____

7. EXISTING BUILDINGS ON THE LAND PROPOSED TO BE SUBDIVIDED

Describe any buildings, historical or otherwise, and any structures on the land and whether they are to be demolished or moved
N/A

8. WATER SERVICES

a) Existing Source of Water: groundwater

b) If the application will result in six or more lots on the quarter section in total, according to Section 23(3)(a) and (b) of the Water Act (Provincial Statutes) an application for subdivision is considered incomplete until one of the following requirements regarding water supply for the proposed subdivision is submitted. Please check one (or more) of the following:

1. ___ Proposed water supply to new lots by a licensed (surface) water distribution system
2. ✓ Proposed water supply to new lots by individual water wells, and
   i. ✓ Attached to the application is a report certified by a Professional Engineer, Hydrologist or Geophysicist which states that there is sufficient water to supply 1250 cubic metres of water per year to each proposed lot, and that the proposed diversion will not interfere with any existing household user, licensees, or traditional agricultural users who currently exist, or
   ii. ___ The diversion of water by water wells for each proposed lot conforms with an applicable, approved water management plan.

9. SEWER SERVICES

a) Existing sewage disposal: N/A

b) Proposed sewage disposal: on-site sewage treatment

10. REGISTERED OWNER OR PERSON ACTING ON HIS/ HER BEHALF

I(we) Greg Hofmann being the registered owner(s) ___, OR authorized to act on behalf of the registered owner(s) ✓, do hereby certify that the information given on this form is full and complete and is, to the best of my(our) knowledge, a true statement of the facts relating to this application for subdivision approval.

Signature(s) _____

Date June 21/06

THE FOLLOWING INFORMATION MUST ALSO BE INCLUDED IN SUPPORT OF YOUR APPLICATION WHICH WILL NOT BE CONSIDERED COMPLETE AND PROCESSED UNTIL SUPPLIED:

a) A complete application form.

b) An accurate sketch of the proposed subdivision area to include:
   i) An approximate location, dimensions, areas and boundaries of the proposed subdivision.
   ii) North arrow.
   iii) An approximate location of all existing buildings (temporary and permanent), driveways and road approaches on the property with their distances to existing and proposed property lines.
   iv) An approximate location of existing wells, septic fields, fences, trees and any permanent bodies of water on the land.
   v) The sketch is to be drawn with a straight edge as accurately as possible.

c) Application Fee.

d) A complete Authorization/ Right of Entry form.

ALBERTA REGISTRIES

LAND TITLE CERTIFICATE

S

LINC	SHORT LEGAL	TITLE NUMBER
0027 347 376	5;16;54;5;NW	982 019 301 +1

LEGAL DESCRIPTION

THE NORTH WEST QUARTER OF SECTION FIVE (5)
TOWNSHIP FIFTY FOUR (54)
RANGE SIXTEEN (16)
WEST OF THE FIFTH MERIDIAN
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

	HECTARES	ACRES MORE OR LESS
A. PLAN 4562LE - ROAD	1.19	2.93

B. ALL THAT PORTION DESCRIBED AS FOLLOWS: COMMENCING AT THE SOUTH EAST CORNER OF THE SAID QUARTER SECTION; THENCE NORTHERLY ALONG THE EAST BOUNDARY TO INTERSECTION WITH THE EASTERLY LIMIT OF ROAD PLAN 403LE; THENCE SOUTH WESTERLY ALONG SAID LIMIT TO INTERSECTION WITH SOUTH BOUNDARY OF SAID QUARTER SECTION; THENCE EASTERLY ALONG THE SOUTH BOUNDARY TO THE POINT OF COMMENCEMENT,

CONTAINING	4.34	10.71
C. PLAN 4359PX - ROAD	1.88	4.65

D. THE BED AND SHORE OF THE EDSON RIVER AS SHOWN ON PLAN 8321734 AND THE BED AND SHORE OF BENCH CREEK AS SHOWN ON PLAN 8621653,

CONTAINING	4.81	11.89
E. ALL THAT PORTION OF THE SAID QUARTER SECTION WHICH LIES TO THE NORTH WEST OF THE LEFT BANK OF THE EDSON RIVER AND EAST OF ROAD PLAN 4562LE,		
CONTAINING	6.37	15.74
F. PLAN 8621653 - SUBDIVISION	1.43	3.53
G) PLAN 9820276 - SUBDIVISION	3.61	8.92

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: YELLOWHEAD COUNTY

REFERENCE NUMBER: 942 346 434

REGISTERED OWNER(S)

REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
982 019 301	19/01/1998	SUBDIVISION PLAN		

OWNERS

STEVEN JONASSON

AND
NATALIE JONASSON
BOTH OF:
GENERAL DELIVERY
EDSON
ALBERTA T7E 1T1
AS JOINT TENANTS

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
822 133 832	16/06/1982	UTILITY RIGHT OF WAY GRANTEE - YELLOWHEAD GAS CO-OP LTD.
982 019 300	19/01/1998	CAVEAT RE : ENVIRONMENTAL RESERVE EASEMENT CAVEATOR - MUNICIPAL DISTRICT OF YELLOWHEAD NO. 94. 2716 - 1ST AVENUE EDSON ALBERTA T7E1N9 NATURE OF INTEREST CORRECTED FROM ENVIRONMENTAL RESERVE TO ENVIRONMENTAL RESERVE EASEMENT (DATA UPDATED BY: 982189357)
982 019 302	19/01/1998	CAVEAT RE : DEFERRED RESERVE CAVEATOR - MUNICIPAL DISTRICT OF YELLOWHEAD NO. 94. 2716 - 1ST AVENUE EDSON ALBERTA T7E1N9
002 080 390	29/03/2000	CAVEAT RE : SURFACE LEASE UNDER 20 ACRES CAVEATOR - ANADARKO CANADA CORPORATION. FIFTH AVENUE PLACE 425-1 STREET SW PO BOX 2595 STN M CALGARY ALBERTA T2P4V6 AGENT - SHAWN BROWN (DATA UPDATED BY: CHANGE OF NAME 002231635)
002 280 319	25/09/2000	CAVEAT RE : ROAD WIDENING CAVEATOR - YELLOWHEAD COUNTY. 2716-1ST AVENUE EDSON ALBERTA T7E1N9
002 294 326	05/10/2000	UTILITY RIGHT OF WAY GRANTEE - ANADARKO CANADA CORPORATION.
042 251 870	17/06/2004	UTILITY RIGHT OF WAY GRANTEE - ANADARKO CANADA CORPORATION.

TOTAL INSTRUMENTS: 007

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN ACCURATE REPRODUCTION OF THE CERTIFICATE OF TITLE REPRESENTED HEREIN THIS 17 DAY OF DECEMBER, 2005 AT 12:29 P.M.

ORDER NUMBER:4247688

CUSTOMER FILE NUMBER: 5786