APPLICATION NO. AA0304

THE REMAINDER OF BLOCK 564
NANOOSE DISTRICT

REPORTS SUBMITTED BY THE APPLICANT

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RECEIVED

January 7, 2003

Regional District of Nanaimo
Community Services
6300 Hammond Bay Road
Nanaimo, BC
V9T 6N2

Attention: Mr. Bob Lapham – General Manager of Development Services

Dear Bob:

Re: Block 564, Nanoose District
Official Community Plan and Zoning Bylaw Amendment Application

In response to your letter of 21 October 2002 regarding our Official Community Plan and Zoning Bylaw Amendment Application for a comprehensive rural recreational development on Block 564, we are pleased to provide the following information for your review and consideration:

1) 6 copies of our revised development concept and land use summary;
2) a brief discussion of the policy context;
3) 6 copies of a geotechnical assessment prepared by EBA Engineering Consultants Ltd.;
4) 6 copies of a hydrogeological assessment for water supply study prepared by EBA Engineering Consultants Ltd.;
5) 6 copies of an environmental assessment prepared by EBA Engineering Consultants Ltd.;
6) 6 copies of a letter from Mr. Nick Vandermolen of the Ministry of Transportation;
7) material regarding our Stakeholder Information Meeting dated 11 December 2002; and
8) a completed Community and Site Impact Review Form.

It is our understanding that upon satisfactory review of this material by the Regional District, that the Regional District will be holding a Public Information Meeting on 30 January 2003.

1. Revised Concept Plan and Policy Context

Based upon the initial responses that we have received to date from both Regional District staff and the community representatives that attended our Stakeholder Meeting, we have made 2 significant adjustments to our Concept Plan, briefly described as follows:

a) The bare land strata cluster housing concept for the south east corner of the site has been removed and has been replaced with conventional minimum 1 ha fee simple lots. In so doing, the overall lot yield has been reduced by 20 from 178 to 158.

b) The internal dedicated greenway has been extended to include linkages to the small wetland in the south east corner, and to the Craig Creek riparian corridor. This results in an increase of 35 acres in the overall green space component in the public domain from 250 acres to 285 acres, equating to 32% of the entire property.

One issue that was raised in the letter relates to conformity with the policy framework of the existing RDN Growth Management Plan. We believe that Policy 3B - *Opportunities for "clustering" development through the principles of "open space subdivision" will be emphasized in rural areas* – epitomizes our proposed development concept. On our site of 900 acres, we have clustered the development by retaining approximately 285 aces in its natural condition. The policy speaks to identifying environmentally sensitive areas and then arranging development areas to respect same. Our proposal clearly recognizes the Englishman River, Craig Creek, and the small wetland as environmentally sensitive areas and provides for said areas to become part of the public domain. The *"open space subdivision"* design that we have pursued will clearly provide for an enhanced approach to environmental protection compared to the alternative approach of developing the lands in accordance with current zoning regulations, that being 20 acres parcels.

Another issue that was raised pertains to comparing our proposed development concept with the 20 acre subdivision approach. While the 20 acre conventional subdivision approach is clearly less onerous to us from an approval and infrastructure perspective, it compares poorly to our proposed development from an environmental perspective. The conventional approach would result in no land being dedicated in the public domain other than road allowances. This would mean that the Englishman River valley would be held by a number of private parties, and while portions of the valley may not be developable for buildings, the land could be used for a number of resource type activities as permitted under the current Zoning Bylaw. We believe that the protection that would be gained for the Englishman River valley in exchange for the clustered type of rural development that we are proposing is the type of balanced tradeoff that local governments should be pursuing.

2. Geotechnical Assessment

EBA Engineering Consultants Ltd. conducted a geotechnical assessment of the site to determine whether there are particular areas of the site that may be subject to hazardous conditions. Please note that the lot numbers referenced in the assessment are those from our current subdivision application with the Ministry of Transportation. We apologize for any inconvenience.

In reviewing the report you will note that the engineer has recommended the following:

a) that a 15 meter building setback be established from the existing crest of slope for the majority of the upland along the Englishmen River;

b) that for the area immediately downstream from the confluence of the Englishman and South Englishman Rivers, the building setback be determined by:
   i) surveying a line that is at a slope of 2 horizontal to 1 vertical from the edge of the river where the river is at the foot of the slope; or
   ii) establishing the building setback as 15 meters;

   whichever is the greater; and
c) that other than for the specific area noted in item (b), the 15 meter setback could be relaxed based upon site specific investigation.

We would expect that these recommendations would be incorporated within a 219 restrictive covenant.

3. Conceptual Storm Water Management Plan

EBA Engineering Consultants Ltd. is in the process of completing a conceptual storm water management plan for the proposed development as a means of demonstrating that storm water discharge can be adequately managed. Upon completion of the report, we will forward a copy to the Regional District for review. Preliminary observations are as follows:

a) A review of soils data indicates that the majority of the property is covered by free-draining granular soil. These soils are well suited to infiltration of stormwater using best management practices. (i.e soak away pits, infiltration basins, swales). Locally, in the southern portion of the site, the soils are silty in texture which are not well suited to infiltration of stormwater; and
b) The approach for stormwater management is to take maximum advantage of the opportunity for infiltration of stormwater to the ground. This has the advantage of helping maintain the low flows in the Englishman River via groundwater discharge in the valley slopes. The south eastern corner of the property lies within the watershed of Craig Creek. In this area, a wet detention pond (i.e. biofiltration wetland) may be used to attenuate stormwater peak flows, filter suspended solids prior to discharge, and provide additional wildlife habitat.

4. Hydrogeological Assessment for Water Supply

In our initial submission, we noted that we would be serving each lot with an individual well. Upon further consideration, and based upon comments provided by Regional District staff, we have decided to pursue a community water system as the method of water supply.

EBA Engineering Consultants Ltd. conducted a hydrogeological assessment for water supply study for the proposed development, the intent of which is to demonstrate that there is a sufficient supply of potable water to serve the proposed development. The following is a brief description of the study's key findings:

a) an extensive confined aquifer has been identified beneath the site (Lower Aquifer), similar to other aquifers that are used as the primary potable water supply on the east coast of Vancouver Island between Lantzville and Courtenay;
b) the analysis indicates there is a very high probability that the Lower Aquifer can sustain long-term pumping to meet the required demand of the proposed development;

c) based upon **water quality** data from other wells, the groundwater should be well-suited for domestic consumption, recognizing that treatment may be required for aesthetic reasons;
d) based upon computer simulations, long-term pumping (i.e. 50 years) of the Lower Aquifer to meet the design requirements of the subdivision may produce **drawdowns** in the order of 1.0 to 3.5 metres in existing domestic wells located in the Lower Aquifer and directly adjacent to the proposed subdivision. This represents about 3 to 12 % of the 30 meters of available drawdown in these wells and is not anticipated to cause extensive interference or detrimentally effect operation of existing wells. Lesser drawdown would occur in wells at increasing distance from the proposed subdivision. As experience has shown, actual average water demand in the study area would result in drawdowns that would probably be significantly less;
e) long-term pumping of the Lower Aquifer is not anticipated to significantly effect low flows in the **existing watercourses** - Englishman River, South Englishman River or Craig Creek; and.
f) the flows in the Englishman River, South Englishman River and Craig Creek (particularly the low flows) will be influenced to a greater degree by absorption of **wastewater and stormwater** than due to pumping of the Lower Aquifer, however no significant impacts to water quality of the Englishman River, South Englishman River and Craig Creek are anticipated from wastewater and stormwater.

5. Environmental Assessment

EBA Engineering Consultants Ltd. conducted an environmental assessment of the subject property, the intent of which is to identify the key environmentally sensitive features and the measures that should be pursued to protect such features. The following is a brief description of each of the key conclusions and recommendations:

a) **Hydrology** - There are three surface water features on the site; the Englishman River, Craig Creek and a small unnamed wetland. The following setbacks are recommended to protect water resources (including fisheries):
   i) Englishman River - a 15 m. setback from the top-of-bank;
   ii) Craig Creek - a 15 m. setback from the top-of-bank; and
   iii) Unnamed Wetland - a 15 m. setback from the winter high water mark;
b) **Hydrogeology** - Results of the modelling indicate that if recommendations are followed in this report, there will be no impacts from significant changes to water quantity (i.e. flows) or water quality (i.e. nutrient/ pollutant loading) to the Englishman River, unnamed wetland or Craig Creek;
c) **Vegetation** - The entire site has been extensively logged. While there are 3 areas of "Old Forest" (100 -150 years) as defined by a regional Sensitive Ecosystem Inventory (SEI), the areas have been logged in the eastern portion of the site. To protect Old Forest areas, it is recommended that air photo interpretation be completed and identified areas be subject to appropriate protection;
d) **Fisheries** - Fish habitat was found within the Englishman River containing 6 species of salmon, rainbow and cutthroat trout, Dolly Varden and a variety of coarse fish. Craig Creek does not have a record of anadromous fish above the Island highway but areas adjacent to the property are still considered fish habitat as they drain into fish bearing waters. In order to protect fisheries values on the site it is recommended that

protection of the Englishman River and Craig Creek corridors be pursued with non disturbance setbacks as outlined in item (a) above; and

e) **Wildlife and Biodiversity** – Since the site has been previously logged and cleared wildlife habitat values have been reduced. The area with the greatest wildlife and biodiversity importance is the riparian corridor surrounding Craig Creek, the wetland and the Englishman River. In order to protect wildlife values on the site, it is recommended that:
   i) a raptor nest survey be conducted within proposed development areas prior to clearing;
   ii) environmental corridors be maintained linking the Englishman River, Craig Creek, and unnamed wetland riparian areas and adjacent greenspace (i.e. ALR lands); and
   iii) areas of high wildlife values, biodiversity and containing potentially rare and endangered species be preserved within the Englishman River corridor, Craig Creek corridor, Old Forest area and unnamed wetland area.

In reviewing our revised Concept Plan, we have adhered to the recommendations from our environmental consultant. We are also prepared to enter into 219 restrictive covenants to provide further protection.

6. Stakeholder Information Meeting – December 11, 2002

On 11 December 2002 we invited a number of interested parties to a meeting at the Island Hall at which we presented and discussed our proposed development concept. Approximately 50 people attended the meeting, including a number of our neighbours along Rascal Lane, representatives from various environmental organizations, and members of various property owner associations. We had invited representatives from the City of Parksville and the Nanoose First Nation, but neither organization was present at the meeting. A copy of the attendees and the notes from the meeting are attached.

The meeting was very useful for ourselves because it helped us further understand the various issues associated with the proposed development as seen by various groups in the community. The following is a brief summary of the key issues raised at the meeting:

- tree protection on private land;
- concerns regarding cluster housing area in south east corner;
- impact of development and new water system on existing water supplies – Englishman River and Rascal Lane wells;
- transportation impacts of the development;
- drainage and flooding impacts of the development;
- keeping of domestic livestock and associated impacts on surface and groundwater sources;
- alternative access for emergency vehicles;
- impact on adjacent ALR land;
- various types of impacts on Rascal Lane properties; and
- geotechnical concerns along top of escarpment.

The various studies that we have conducted as so previously described address a number of the **technical issues**. In removing the **cluster housing** concept, we have responded to those who has expressed concern.

Regarding **transportation impacts**, we have attached a letter from the Ministry of Transportation as so requested by the Regional District. The letter states that:

a) the proposed development will not impact operation of the Craig Bay interchange; and

b) the Kaye Road intersection should continue to operate adequately.

Concerning the impact of the **keeping of domestic livestock** on the water resource, it is our understanding that the Regional District's current zoning regulations permit the keeping of domestic livestock (ie horses, goats, cows, etc.) on residential properties provided that the lot size is a minimum of 1 ha. However there are apparently no specific regulations addressing the number of animals that may be permitted. This is an item that we are discussing amongst ourselves as to how this issue could be better managed. Should the Regional District have any thought on this issue, they would be most welcome.

At the meeting we provided an opportunity for anyone who attended to provide written comments on our proposal. Unfortunately we did not receive many comments, but those who did respond indicated the following:

- good balance of environmental and development interests;
- don't extend Rascal Lane and remove cluster housing;
- establish setbacks from top of bank of escarpment for septic field
- access for eco-tourism opportunity; and
- impact of development on water quality and drainage.

We have also been apprised of a letter from one of the property owners on Rascal Lane of their concerns with the proposal.

To conclude, this letter and the accompanying reports attempt to address our understanding of the various issues raised in the your letter dated 21 October 2002 and those raised at the Stakeholder Information Meeting. We look forward to discussing this material with Regional District staff on 15 January 2003 and in presenting it to the community on 30 January 2003.

Yours truly,

Jerry Bordian

Attachments:

1) *Revised Concept Plan and Land Use Summary*

2) *Geotechnical Assessment – EBA Engineering Consultants Ltd.*

3) *Hydrogeological Assessment for Water Supply Study – EBA Engineering Consultants Ltd.*
4) *Environmental Assessment – EBA Engineering Consultants Ltd.*
5) *Letter from Mr. Nick Vandermolen of the Ministry of Transportation*
6) *Notes and Sign In Sheet: Stakeholder Information Meeting – December 11, 2002*
7) *Community and Site Impact Review Form*

cc: Brent Kapler - Englishman River Land Corporation
Michael Rosen - Planning Consultant
John Balfour - EBA Engineering Consultants Ltd.
Tim Bekhyus - EBA Engineering Consultants Ltd.
Gilles Wendling - EBA Engineering Consultants Ltd.
Glen Darychuk- Khangura Engineering Ltd.

HYDROGEOLOGICAL ASSESSMENT FOR PROPOSED SUBDIVISION

PARKSVILLE, B.C.

Project No. 0805-5887561

July 23, 2002

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

HYDROGEOLOGICAL ASSESSMENT FOR PROPOSED SUBDIVISION
PARKSVILLE, B.C.

Prepared for:

TEXADA LAND CORPORATION

Vancouver, B.C.

Prepared by:

EBA ENGINEERING CONSULTANTS LTD.

Vancouver, B.C.

Project No. 0805-5887561

July 23, 2002

Distribution:	Texada Land Corp.	4 copies
	EBA Engineering	1 copy

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1.0 INTRODUCTION

Texada Land Corp. (TLC) has recently purchased a property approximately 362 ha in size located near Parksville on Vancouver Island (See Figure 1) and is in the process of applying to the Region District of Nanaimo (RDN) to rezone the property. The goal of the rezoning application is to create a number of small acreage (2.5 acres and larger) residential building lots as well as some denser cluster-type dwellings.

It is proposed to develop on-site septic systems for disposal of domestic wastewater from the housing developments on the property. During an initial meeting to discuss the rezoning application, the RDN expressed a concern over the potential for septic systems to detrimentally effect water quality in the adjacent Englishman River. It is understood that an intake for river water may be established on the Englishman River in future to provide additional water supply to customers within the regional district.

TLC retained EBA Engineering Consultants Ltd. (EBA) to perform a preliminary hydrogeological assessment of the property and proposed development. The objective of this work is to provide an assessment of the suitability or limitations of the site for development of on-site septic systems and to provide comments and conclusions relating to the potential for septic systems to detrimentally alter river water quality.

The scope of EBA's assessment involved the following:

- review of topographic plans and conceptual layout drawings for the proposed subdivision;
- a reconnaissance of the property;
- interpretation of stereo-paired aerial photographs to identify the probable types and distribution of soils across the site, drainage features, unstable or potentially unstable slopes and related surficial geologic features that may influence septic systems or land development generally;
- excavation and logging of 13 test pits dug using a mechanical excavator;
- collection of flow and water quality data for the Englishman River from government sources; and,
- preparation of this report.

2.0 SITE AND PROPOSED DEVELOPMENT

The property is irregular in shape and is bounded along the north by the Island Highway and along the west by the South Englishman River and Englishman River (see Figure 2). Present land use in the surrounding area is a mixture of undeveloped forest, residential, agricultural and industrial. Residential and agricultural properties bound the property to the east. New residential developments are under construction on the southern boundary of the property. A permitted woodwaste disposal site is under operation by Weyerhauser, the previous owners, at the northern limit of the property.

Based on topography, the site can be divided into three distinct areas: 1) the valleys of the South Englishman River and Englishman River and adjacent slopes; 2) the flat-lying central and northern portion of the property; and, 3) the gently to moderately sloping southern portion of the property.

A conceptual layout plan for the proposed development is presented in Appendix A. The primary features of the proposed development plan include:

- A park along the river valleys;
- 134 acreage (2.5 acres and larger) properties located in the north and southwestern area of the property;
- four larger acreage properties; and,
- a cluster development (40 dwellings) located in the southeast part of the property.

The acreage lots would be served by on-site septic systems and drilled water wells. The cluster development would be served by a community septic system and water system developed from on-site groundwater sources (i.e well or well field).

3.0 SOILS AND DRAINAGE

A recent aerial photograph of the property superimposed with interpretation of surficial soils and other terrain features is presented on Figure 3. The interpretation of soils and terrain features is based on the BC Terrain Classification System. A legend indicating the terms used for the terrain classification is presented on Table 1.

As described above, 13 test pits, distributed across the property, were excavated to provide first hand observations of the soils and to supplement and confirm the aerial photograph interpretation. Records of the observations in the test pits are included in Appendix B. Test pit observations were also supplemented by observations of soil exposures on slopes in active and inactive gravel pits on the property and review of selected water well records (Appendix C).

3.1 Soils

Like the topography, soils on the property can be divided into three general regions. The central and northern flat-lying portion of the property is underlain by deposits of sand and gravel of glaciofluvial origin. It has been extracted for aggregate from pits during construction of the Island Highway and at other times. Although the full thickness of the sands and gravels was not determined during this study, they exceed the depth of the test pits (2.4 to 3.7 m deep) at test pit locations TP-6 through TP-13, inclusive (Figure 2). In the Ministry of Highways gravel pit located on the north side of the powerlines, sand and gravel is exposed in slopes estimated to be in excess of 5 m in height. The well log for well 50036, located near the north end of the property indicates 21 m (70 feet) of sand and gravel underlain by silty blue clay.

The river valleys are underlain by recent alluvial material. The eastern slopes of the river valley are likely composed of sands and gravels similar to those described above. Some minor evidence of instability was identified from the aerial photographs on the outside bends of the Englishman River where the river is undercutting the base of the slope (see Figure 3 and Table 1). Although the interpretation of the aerial photographs suggests that the slope instability is localized and would not pose a significant limitation to the proposed development, this should be examined by a qualified geotechnical engineer in order to provide recommendations for building development near the crest of the valley slopes.

The southeastern gently to moderately sloping portion of the property is underlain by a mantle of granular soils (sand, gravel, sand and gravel). The granular soils ranged from about 0.9 m to 1.6 m thick at the test pit locations (TP-1 through TP-5, inclusive) excavated in this area of the site. The granular soils are underlain by silt with variable amounts of sand and gravel.

3.2 Drainage

There are two primary drainage features associated with the site: 1) the South Englishman River and Englishman River described above; and, 2) Craig Creek that flows across the southeast corner of the site (Figure 2).

A number of drainage ditches have been developed adjacent to roads and trails located on the property. With the exception of ditches located in the extreme southeast corner of the property, these ditches were dry at the time of EBA's site reconnaissance on July 9, 2000.

Standing water was observed at a depth of several metres below grade in the Ministry of Transportation and Highways gravel pit located adjacent to the powerlines. Standing water was also observed at somewhat shallower depth in an inactive gravel pit located about 150 m northwest from location TP-6.

Based on the granular nature of the soils and moderate precipitation in the Parksville area, the majority of precipitation is expected to infiltrate. Consequently, drainage ditches are only expected to contain flow intermittently.

4.0 HYDROGEOLOGICAL ASSESSMENT

The goal of the hydrogeological assessment is to provide comments and conclusions regarding the potential of septic systems constructed for the proposed development to detrimentally alter water quality in the Englishman River. This is evaluated in the context of use of the river water as a future drinking water source. The assessment consists of three parts that are described in more detail below.

4.1 General Principles of Septic Systems

Household septic systems are in widespread use in British Columbia for disposal of domestic wastewater. The basic components of the system are a septic tank and drainfield. The septic tank is used to separate solids from the wastewater and to provide anaerobic (oxygen deficient) treatment of the wastes. The drainfield is used to distribute the liquid into the soils where further treatment occurs as the wastewater infiltrates through the soils eventually reaching the watertable.

There are a variety of treatment processes that occur in the soil. Examples of treatment processes that occur in the soil beneath the drainfield include:

- filtering (removal) of suspended solids in the wastewater in the pores of soil;
- conversion of ammonia to nitrate under the presence of aerobic (oxygen rich) conditions above the watertable;
- removal of pathogens (i.e. harmful bacteria and viruses) by filtering as the wastewater flows through porespaces in the soil.

In cases where the water table is close to surface, or pervious soils are thin, adequate treatment may not occur and wastewater may emerge on the ground surface prior to treatment. For the subject property, soils are granular in nature and well drained. Therefore, "shortcircuiting" of wastewater to the ground surface is considered highly unlikely.

4.2 Setback Distances From Surface Water

The BC Health Act Sewage Disposal Regulation (SDR) for small systems and the Municipal Sewage Regulation for large systems govern the siting and design of septic systems in British Columbia. The SDR and MSR specify a minimum setback (MSR) distance between a drainfield and surface water of 30 m. This is intended to be protective of water quality in the surface water system. In general, the greater the travel distance between a drainfield and the receiving water that the groundwater discharges to, the higher the level of treatment that occurs.

In certain areas of the province, for example, the lakes in the Okanagan, surface water has been identified as very susceptible to nutrients (e.g. phosphorous) found in septic system wastewater. In these areas, designated as "Environmental Control Zones", the SDR was modified to include increased setbacks of up to 150 m from surface water.

Therefore, in certain instances where surface water is identified as particularly vulnerable, there may be a required setback of up to 150 m. Three topographic profiles have been prepared and are shown on Figure 4. The locations of the sections are presented on the site plan, Figure 2. Setback distances of 30 m (minimum required under the Health Act) and 150 m (maximum required under the Health Act within an Environmental Control Zone) are indicated on the profiles (Figure 4). Considering the conceptual layout plan (Appendix A), the nearest septic systems to the South Englishman River or Englishman River will be located near the crest of the valley slopes as indicated conceptually on the profiles (Figure 4). As shown, the setback distances from the rivers are considerably larger than the most stringent regulatory requirements (i.e. within an Environmental Control Zone).

Based on the above, it is concluded that setback distance are protective of water quality for parameters such as pathogens in the river water. It is also noted that river water naturally will contain pathogens such as coliform bacteria and that treatment (e.g. chlorination) is a normal requirement for any surface water system used in BC for municipal water supply.

Although it was not specifically part of EBA's terms of reference, it is noted that there are also setback requirements from a septic field and a water well used as a drinking water source. These setback requirements are addressed in the Health Act and also through guidelines used by local health offices. These requirements can be met by proper siting of drilled wells on the proposed building lots and must normally be demonstrated as part of the subdivision approval process.

4.3 Nitrate Loading To Englishman River

Nitrate is a chemical parameter associated with domestic wastewater that is also regulated in drinking water for health reasons. An estimate of the loading of nitrate to the Englishman River was prepared, using a set of highly conservative assumptions, as part of this assessment. This assessment consisted of the following steps:

1. the loading of nitrate was determined for a single septic system;
2. the total nitrate loading was determined by multiplying the loading from a single septic system by the proposed total number of dwellings in the development (178 dwellings – see layout plan, Appendix A);
3. the concentration of nitrate in Englishman River was calculated based upon both mean monthly low flows and mean monthly discharge rates measured at gauging stations in the river;
4. the resulting concentration was then compared with both ambient nitrate concentrations measured in the river and the drinking water limit for nitrate (10 mg/L expressed as N).

Supporting calculations complete with references for sources of information and assumptions showing the predicted nitrate loading to the Englishman River are presented in Appendix D. These calculations are considered to be conservative for the following reasons:

- the calculations assume that all groundwater drainage from the proposed development will discharge into Englishman River. In fact, some groundwater drainage may flow towards Craig Creek or towards the Straight of Georgia;
- the assumed nitrate strength of 40 mg/L is considered to be conservative (i.e. relatively high) based on our experience with numerous similar projects throughout BC;

- the assumed discharge rate to the septic field is 1364 L/day/dwelling (design value for three bedroom house from Health Act). Our experience indicates that actual flow rates tend to be smaller. For example, in a recent study completed by EBA for the nearby community of Lantzville, actual water consumption (excluding summer irrigation demand) ranges from approximately 430 to 860 L/day per dwelling.

Based on the above conservative assumptions, the nitrate loading from the proposed development could result in an increase in the nitrate concentration in the Englishman River of up to 0.09 mg/L during the low flow period in the Englishman River. This would correspond to the month of August when mean monthly discharge rates decline to 1.26 m^3/s (Table 2). For comparison, this estimated maximum concentration is more than 100 times lower than the drinking water limit for nitrate (10 mg/L as N).

As shown in Appendix D, the average predicted nitrate concentration in the river (corresponding to average monthly flows) is 0.01 mg/L. This compares with typical ambient levels of nitrate in the river as measured by BC Ministry of Water, Land and Air Protection (see Table 2).

5.0 SUMMARY AND CONCLUSIONS

Based on the investigations and analysis described in this report, development of septic systems for the proposed development are not anticipated to detrimentally effect water quality in the Englishman River. As is the case for any proposed subdivision, further work will be necessary at the subdivision approval stage to establish that suitable soils conditions exist on each proposed lot and that water wells are sited appropriately with respect to proposed septic fields.

Respectfully submitted,

EBA ENGINEERING CONSULTANTS LTD.

Prepared by

John Balfour, P.Eng.
Senior Hydrogeologist

PROFESSIONAL
PROVINCE OF
JOHN BALFOUR
BRITISH COLUMBIA
ENGINEER

Reviewed by

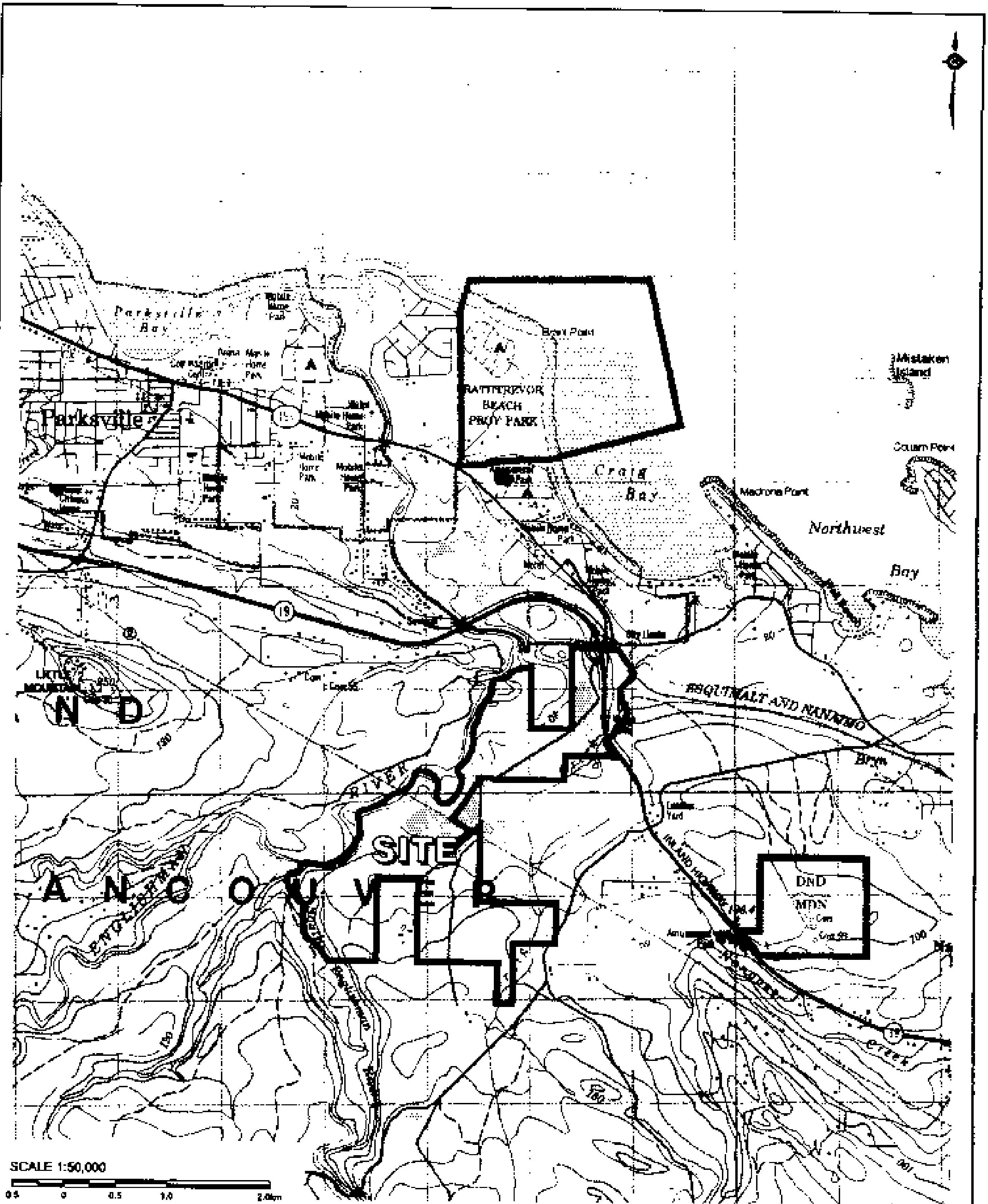
for Gilles Wendling, Ph.D., P.Eng.
Senior Hydrogeologist

6.0 REFERENCES

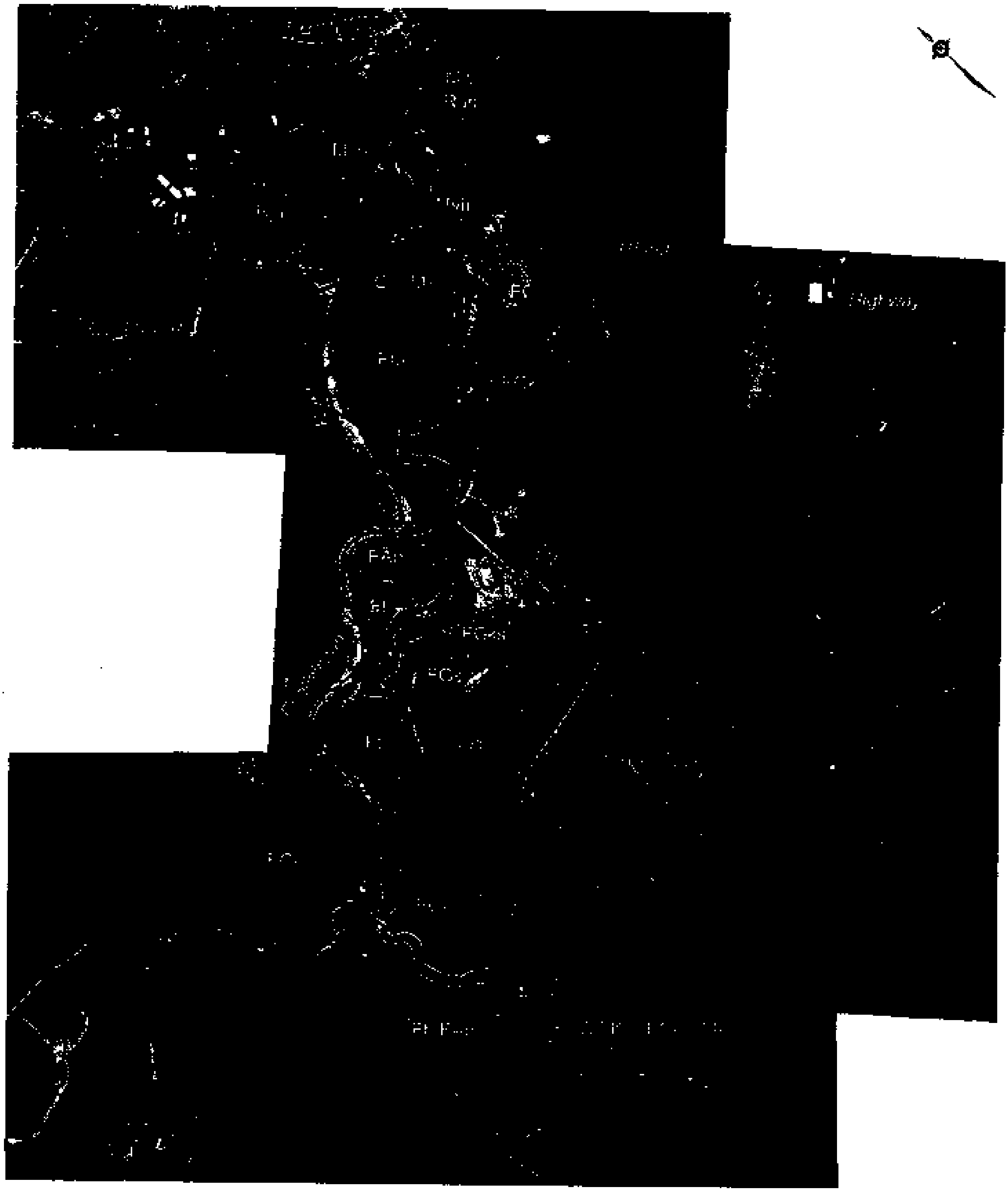
L.W. Canter and R.C. Knox, "Septic Tank System Effects on Ground Water Quality" 1986. Lewis Publishers

Terrain Classification System for British Columbia (Revised Edition) 1988. B.C. Ministry of Environment and Ministry of Crown Lands.

EBA Engineering Consultants, "Harby Road Well Field Management Phase 1 – Final Report, Lantzville, BC", February 11, 2002. Report prepared for Lantzville Improvement District, Lantzville, BC.



EBA Engineering Consultants Ltd.			PROJECT: PROPOSED PARKSVILLE SUBDIVISION	
CLIENT: TEXADA LAND CORPORATION			TITLE: SITE LOCATION PLAN	
DATE: 2002/17/20	DWN. JAB	CHKD. JB	FILE NO. 0805-5887581	FIGURE 1

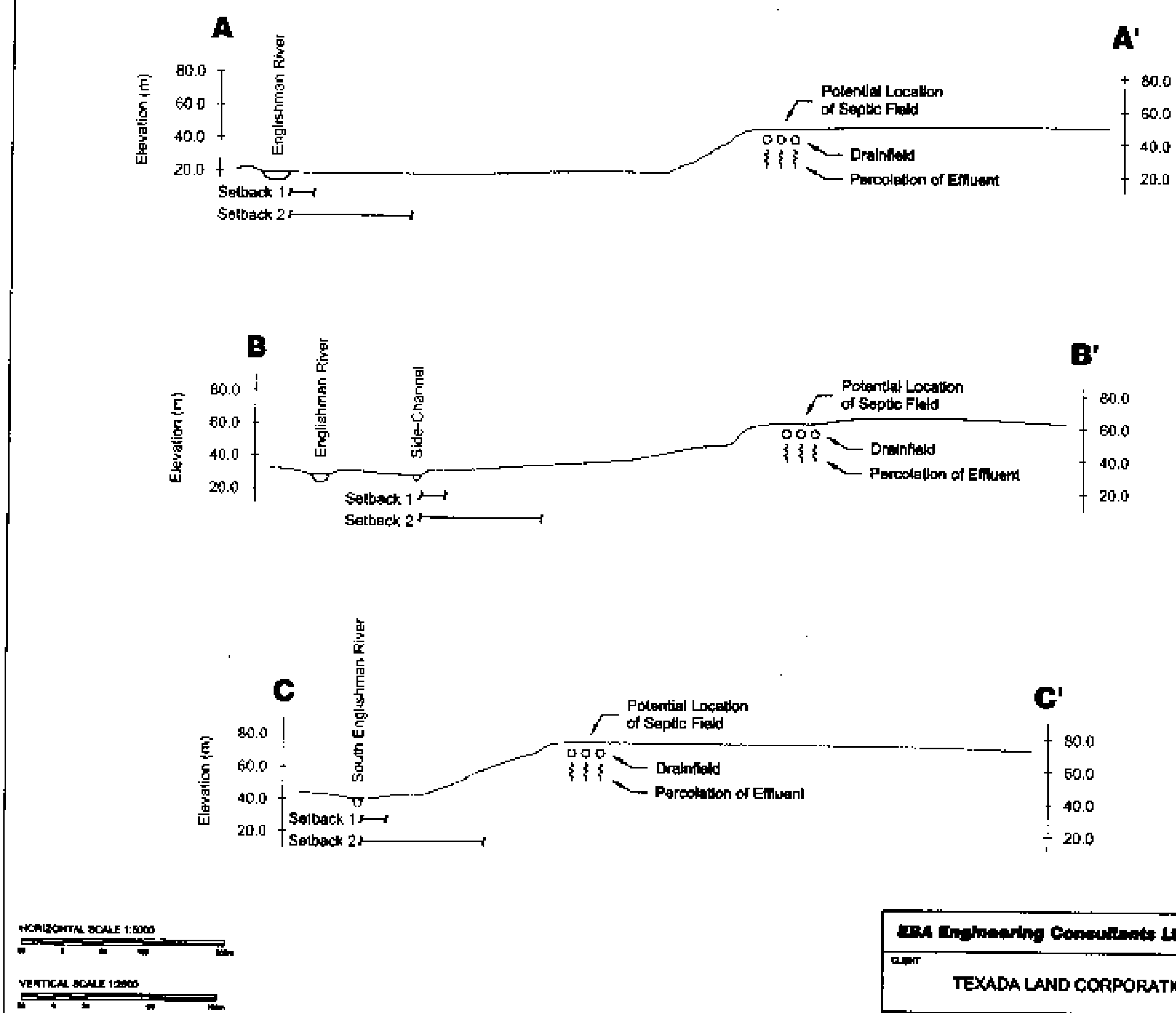


SCALE 1:25,000 (Approximate)

200 0 200 600 1000m

Note: Refer to Table 1 for Terrain Classification Legend

EBA Engineering Consultants Ltd.	PROJECT: PROPOSED PARKSVILLE SUBDIVISION
CLIENT: TEXADA LAND CORPORATION	TITLE: AERIAL PHOTOGRAPHS WITH TERRAIN CLASSIFICATION
DATE: 2002/17/20 DWN. JAB CHKD JB	FILE NO. 0805-5887561 FIGURE 3



LEGEND

Setback 1 — Required Setback from Surface Water = 30m (BC Health Act)

Setback 2 — Maximum Setback for a Septic System in an Environmental Control Zone = 150m (BC Health Act)

Note: Location of Profiles shown on Figure 2

EBA Engineering Consultants Ltd.	PROJECT: PROPOSED PARKSVILLE SUBDIVISION
CLIENT: TEXADA LAND CORPORATION	TITLE: TOPOGRAPHIC PROFILES
DATE 2002/17/20 · DWN JAB · CHKD JB	FILE NO. 0805-5597981 · FIGURE 4

TABLE 1
Legend For Terrain Classification System

Simple Terrain Unit

surficial material→ **Ft** ←surface expression

Complex Terrain Unit

unit consists of 60% WGju **6WGju4FGj** unit consists of 40% FGj

Stratigraphic Terrain Unit

till mantle is overlying **Mw**
undulating, hummocky bedrock **Ruh**

* potentially unstable terrain unit

SURFICIAL MATERIALS		
Symbol	*Name*	*Description*
C	colluvium	Products of mass wastage
F	fluvial	River deposits
FA	fluvial "active"	Active river channel
FG	glaciofluvial	Fluvial materials deposited by meltwater streams
M	morainal (till)	Material deposited directly by glaciers
R	bedrock	Bedrock covered by less than 10cm
WG	glaciomarine	sediments of glacial origin deposited in a marine environment

SURFACE EXPRESSION		
Symbol	*Name*	*Description*
b	blanket	A mantle of unconsolidated materials; >1m thick
h	hummocky	Hillocks and hollows; irregular plan; 27-70%
j	gentle slope	Unidirectional surface; 6-26%
k	moderately steep	Unidirectional surface; 50-70%
p	plain	Unidirectional surface; 0-5%
s	steep	Steep slopes; >70%
t	terraced	Stepped topography and benchlands
u	undulating	Hillocks and hollows; irregular in plan; 0-26%
v	veneer	Mantle of unconsolidated material; 10 cm to 1 m thick
w	mantle of variable thickness	Surficial material of variable thickness; 0 to about 3 m

TABLE 2
Monthly Discharge and Selected Water Quality Data for the Englishman River

FLOW DATA

Month	Mean Monthly Discharge (m^3/s) [1]
Jan	20.80
Feb	25.41
Mar	15.83
Apr	13.89
May	11.40
Jun	7.24
Jul	3.11
Aug	1.26
Sep	1.44
Oct	9.85
Nov	26.11
Dec	29.25
Annual	**13.70**

WATER QUALITY DATA

Sampling Date	Nitrate (NO_3) Dissolved (mg/L) [2]
12/05/98	0.007
19/05/99	0.004
14/12/99	0.095
15/11/00	0.032
06/11/01	0.034
Average	**0.034**

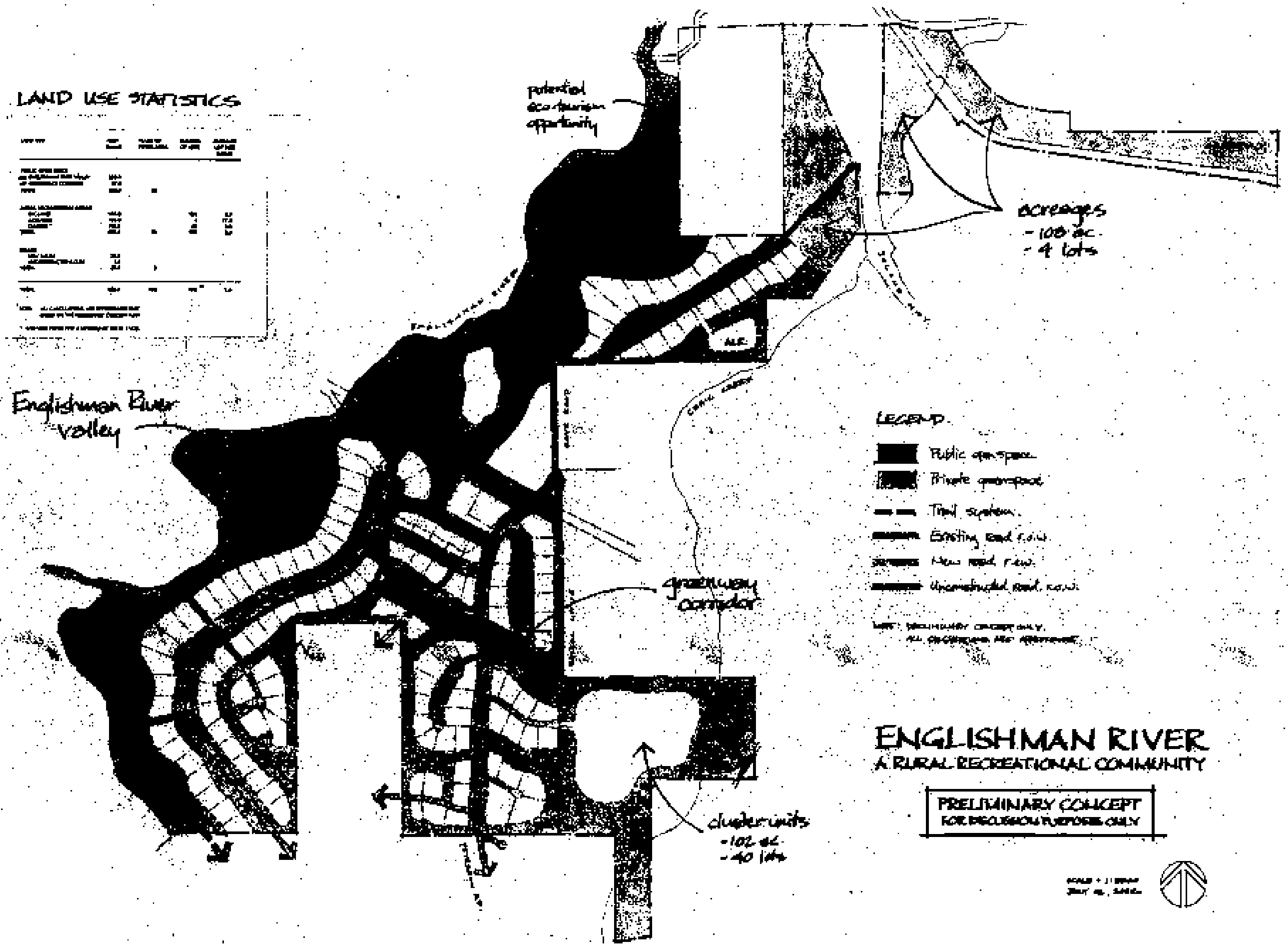
Sources:

(1) Englishman River Water Allocation Plan, Nov. 1994, BC MELP Water Mgmt Branch, Vancouver Island Region, Nanaimo, BC.

(2) Email from Ministry of Water, Land and Air Protection, dated July 18, 2002.

APPENDIX A

CONCEPTUAL LAYOUT PLAN


LAND USE STATISTICS
potential eco-tourism opportunity
acreages
- 108 ac.
- 4 lots
Englishman River valley
LEGEND
Public openspace
Private openspace
Trail system
Existing road r.o.w.
New road r.o.w.
Unconstructed road r.o.w.
greenway corridor
cluster units
- 102 ac.
- 40 lots
ENGLISHMAN RIVER
A RURAL RECREATIONAL COMMUNITY
PRELIMINARY CONCEPT
FOR DISCUSSION PURPOSES ONLY

APPENDIX B

TEST PIT LOGS

Test Pit Logs
BLK. 564 Nanoose LD

Test Pit 1

0.00 – 0.30m SAND, fine to medium-grained, some gravel, medium to coarse, subrounded, brown, loose, dry.

0.30 – 0.53m ORGANICS, wood, roots, some silt, some sand, fine-grained, loose, black, damp to moist.

0.53 – 0.86m SAND, fine to medium-grained, trace to some gravel, medium, loose, reddish brown, damp.
@ 0.71m light brown colour.

0.86 – 3.20m SILT, trace of sand, fine to coarse-grained, trace to some organics, soft, light grey, orange streaks, moist.
* Grab sample collected @ 0.90m
@ 1.22m consistency is stiff.
@ 1.57m boulder encountered, 0.6m diameter. Occasional cobbles with depth.
@ 2.44m trace of clay, moist.

3.20 – 3.40m SAND, medium to coarse-grained, trace to some gravel, trace to some cobbles, trace of silt, dense, brown, wet.

Test Pit 2

0.00 – 0.43m SAND, GRAVEL & COBBLES, fine to coarse-grained, trace of organics (rootlets), subrounded, loose, brown, dry.

0.43 – 0.61m ORGANICS, wood, some sand, fine-grained, some silt, loose, black, moist.

0.61 – 0.76m SAND, fine-grained, trace of gravel, small, loose, brown, damp.

0.76 – 1.58m SAND, fine-grained, silty, soft, light brown, damp.

1.58 – 2.44m SILT, sandy, fine to medium-grained, trace of gravel, small, trace of cobbles, soft, damp to moist.
@ 2.35m moist to wet.

2.44 – 2.69m SILT, trace to some sand, medium to coarse-grained, trace of gravel, small to medium, some cobbles, occasional boulders, very stiff, grey, moist (TILL).

Test Pit 3

0.00 – 0.30m SAND, GRAVEL & COBBLES, fine to coarse-grained, trace of organics (rootlets), subrounded, loose, brown, dry.

0.30 – 1.52m GRAVEL & COBBLES, coarse, subrounded, some sand, fine to coarse-grained, occasional boulder, loose, brown, damp.

1.52 – 2.29m SILT, trace of sand, fine to coarse-grained, trace of gravel, small, stiff, grey and light brown, moist.

2.29 – 2.59m SAND & SILT, fine to coarse-grained, trace of gravel, medium, hard, moist to wet.
* Grab sample collected @ 2.30m

2.59 – 2.90m SILT, sandy, fine to coarse-grained, gravelly, medium to coarse, some cobbles, stiff, brown, moist.

Test Pit 4

0.00 – 0.30m SAND & GRAVEL, fine to coarse-grained, some cobbles, subrounded, loose, brown, dry.

0.30 – 0.61m ORGANICS, wood and roots, some sand, fine-grained, some silt, loose, black, moist.

0.61 – 0.89m SAND, fine to medium-grained, some gravel, medium to coarse, trace of cobbles, occasional boulder, loose, reddish brown, damp.

0.89 – 1.52m SILT, sandy, fine to coarse-grained, trace to some gravel, trace of organics (black colour), soft, light grey and light brown, moist.
@1.22m consistency is firm.

1.52 – 2.90m SILT, trace of sand, fine to coarse-grained, trace of gravel, small, trace of cobbles, occasional boulder, hard, grey and black, damp (TILL).
* Grab sample collected @ 1.55m

Test Pit 5

0.00 - 0.36m SAND & GRAVEL, fine to coarse-grained, trace of organics (rootlets), trace of cobbles, subrounded, loose, brown, dry.

0.36 – 0.74m GRAVEL, medium to coarse, sandy, fine to coarse-grained, occasional cobble, subrounded, loose, brown, dry.

0.74 – 0.86m SAND, medium to coarse-grained, trace of gravel, small to medium, occasional cobble, loose, brown, moist.

0.86 – 1.27m ORGANICS, wood and roots, some sand, fine to coarse-grained, some silt, loose, black, moist.

1.27 – 2.90m SILT, trace of sand, fine to coarse-grained, trace of gravel, soft, light brown, moist (TILL).
@ 1.47m consistency is firm, trace of organics.
@ 1.52m large granite boulder encountered.

2.90 – 3.05m SILT, trace to some sand, coarse-grained, trace to some gravel and cobbles, stiff, brown, damp.

Test Pit 6

0.00 – 0.38m SAND, fine to coarse-grained, some gravel, medium, subrounded, some organics (rootlets), loose, brown, dry.

0.38 – 1.60m GRAVEL, SAND & COBBLES, medium to coarse, subrounded, trace of organics (rootlets), loose, brown, dry.
@ 1.12m no organics, occasional boulder encountered.
*Grab sample collected @ 1.52m

1.60 – 3.20m SAND, coarse-grained, some gravel, small, trace of cobbles, subrounded, loose, brown, moist to wet.

3.20 – 3.51m SAND & GRAVEL, coarse-grained, loose, brown, moist.

Test Pit 7

0.00 – 0.41m SAND, very fine-grained, trace of gravel, small, trace of silt, loose, light brown, dry.

0.41 – 1.42m SAND, medium-grained, trace of gravel, small, homogeneous, loose, yellowy brown, damp to moist.

1.42 – 2.59m SAND & GRAVEL, coarse-grained, loose, brown and grey, moist to wet.
@ 1.98m trace of cobbles, small
@ 2.24m aquifer encountered, heavy groundwater seepage.

Test Pit 8

0.00 – 0.41m SAND, GRAVEL & ORGANICS (roots), fine-grained, trace of silt, loose, black, damp.

0.41 – 1.98m SAND, GRAVEL & COBBLES, medium to coarse-grained, subrounded, loose, brown, damp.

1.98 – 3.35m SAND, coarse-grained, some gravel, small to coarse, some cobbles, loose, brown, damp.
@2.21m medium to coarse-grained, trace of gravel, medium, occasional cobble, loose, yellowy brown, moist.
@ 2.90m some gravel, medium.

Test Pit 9

0.00 – 0.91m SAND, GRAVEL, COBBLES, BOULDERS & ORGANICS (roots), medium to coarse-grained, subrounded, loose, dark brown, dry.

0.91 – 2.36m SAND, medium-grained, occasional small gravel, homogeneous, loose, yellowy brown, damp.
@ 2.01m trace to some gravel, small to medium, trace to some cobbles, small.

2.36 – 3.28m SAND & GRAVEL, medium to coarse-grained, medium, some cobbles, small, some boulders, loose, damp.

Test Pit 10

0.00 – 0.91m SAND, fine-grained, trace of silt, trace of organics (rootlets), trace of gravel, small, loose, brown, damp.
@ 0.13m medium-grained, homogeneous occasional cobbles.

0.91 – 1.28m SAND, fine-grained, silty, trace of gravel, trace to some cobbles, soft, grey with orange streaks, moist.

1.28 – 2.38m SAND, GRAVEL & COBBLES, medium to coarse-grained, small to coarse, subrounded, brown, loose, dry.
@ 2.01m moist to wet.
@ 2.13m large boulder encountered.
@ 2.38m too many boulders to continue with a backhoe.

Test Pit 11

0.00 – 0.43m SAND & ORGANICS (rootlets), fine to medium-grained, trace to some silt, trace to some gravel, medium, subrounded, loose, brown, dry.

0.43 – 2.44m SAND & GRAVEL, fine to medium-grained, medium, cobbly, subrounded, loose, brown, dry.
@ 0.89m coarse-grained, trace to some small cobbles, orange-brown and grey, damp.

2.44 – 3.35m SAND, coarse-grained, trace to some gravel, medium, loose, grey with a trace of brown colour.

Test Pit 12

0.00 – 0.30m SAND, GRAVEL & ORGANICS (rootlets), very fine-grained, medium, trace of silt, loose, brown, dry.

0.30 – 1.47m SAND, GRAVEL & COBBLES, coarse-grained, medium, subrounded, loose, brown and grey, damp.

1.47 – 2.44 SAND, coarse-grained, gravelly, medium, occasional cobbles, loose, brown, dry.

2.44 – 3.40m GRAVEL, medium, sandy, medium to coarse-grained, trace of cobbles, subrounded, loose, brown, damp.

Test Pit 13 (Completed by Others)

0.00 – 0.46m SAND & ORGANICS (roots), fine-grained, some gravel, small, trace of silt, occasional cobble, subrounded, loose, brown, dry.

0.46 – 1.83m GRAVEL & SAND, medium to coarse-grained, some cobbles to cobbly, subrounded, loose, brown, dry.

APPENDIX C

WELL RECORDS

BRITISH COLUMBIA

Well Tag Number 000000003673

Owner: G DAVIS

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot 172 Plan Lot
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F029414 Well 1

Well Use Domestic
Construction Method Dug
Diameter 0.0 inches
Well Depth 17.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19500101

Driller Unknown
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow
Static Level UNK feet

Water Utility
Lithology Info Flag
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
SOFT.

From 0 To 0 Ft. Gravel and hardpan w/clay at the bottom

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000003710 Owner: G DAVIS Address: Area: WELL LOCATION: NANOOSE Land District District Lot 168 Plan Lot Township Section Range Indian Reserve Meridian Block Quarter Island BCGS Number (NAD 27) 092F029414 Well 2 Well Use Domestic Construction Method Dug Diameter 0.0 inches Well Depth 17.0 feet Elevation 0 Bedrock Depth UNK feet Screen from 0 to 0 feet Slot Size 1 Slot Size 2 Slot Size 3 Slot Size 4	Construction Date 19500101 Driller Unknown License Number PRODUCTION DATA AT TIME OF DRILLING: Well Yield 0 Artesian Flow Static Level 8 feet Water Utility Lithology Info Flag Pump Test Info Flag File Info Flag Sieve Info Flag Screen Info Flag Water Chemistry Info Flag Field Chemistry Info Flag Site Info (SEAM) Other Info Flag

GENERAL REMARKS:
SOFT. VERY LOW IN SUMMER.

From 0 To 0 Ft. Gravel, hardpan, clay at the bottom

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000046550

Owner: BRIAN WHITTA

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot 170 Plan Lot
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F029414 Well 3

Well Use Domestic
Construction Method Unknown Constru
Diameter 6.0 inches
Well Depth 46.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19801104

Driller Kalicum Drilling
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 5 USGM
Artesian Flow
Static Level 34 feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:

From	0	To	6	Ft.	Till
From	6	To	30	Ft.	Clay
From	30	To	46	Ft.	Sand and gravel
From	46	To	48	Ft.	Clay

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000003989

Owner: GILBERT

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot Plan Lot
Township Section Range
Indian Reserve Meridian Block 564
Quarter
Island
BCGS Number (NAD 27) 092F029431 Well 1

Well Use Domestic
Construction Method Dug
Diameter 3.0 inches
Well Depth 0.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19500101

Driller Unknown
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow
Static Level UNK feet

Water Utility
Lithology Info Flag
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
HARD

From 0 To 0 Ft. No log given.

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000014406

Owner: MCMILLAN BLODELL

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot 169 Plan Lot
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F029432 Well 1

Well Use Commercial and Industrial
Construction Method Drilled
Diameter 8.0 inches
Well Depth 246.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19550101

Driller PACIFIC WATER WELLS
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow
Static Level 138 feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
HARD - HIGH SULPHUR.
YIELD 75 GPM (NOTE: MEASURED AGAIN AND SHOWED 50 GPM)

From	0	To	2	Ft.	Gravel and sand
From	2	To	18	Ft.	Clay
From	18	To	75	Ft.	Very tight gravel - with clay sand and
From	0	To	0	Ft.	silt binder
From	0	To	0	Ft.	Some water 50'-55'
From	75	To	108	Ft.	Silty brown clay, some gravel
From	0	To	0	Ft.	Boulders at 84'
From	108	To	116	Ft.	More binding clay
From	116	To	187	Ft.	Silty brown clay, some gravel - into
From	0	To	0	Ft.	water at 187'
From	187	To	192	Ft.	Very dirty silty sand
From	192	To	223	Ft.	Layers of clean blue and brown sand
From	223	To	224	Ft.	Clay
From	224	To	243	Ft.	Clean coarse sand, odd fine lense of
From	0	To	0	Ft.	clay
From	243	To	246	Ft.	Hard blue clay .

16 rows selected.

BRITISH COLUMBIA

Well Tag Number 000000039363

Owner: MACMILLAN BLOEDEL

Address: NORTHWEST BAY CAMP

Area: PARKSVILLE

WELL LOCATION:
NANOOSE Land District
District Lot 169 Plan Lot
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F029432 Well 2

Well Use Unknown Well Use
Construction Method Drilled
Diameter 6.0 inches
Well Depth 242.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 224 to 242 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19780308

Driller Drillwell Enterprises
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 35 GPM
Artesian Flow
Static Level 148 feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
WATER A BIT SULPHURY, 35 GPM.

From	0	To	18	Ft.	Clay
From	18	To	187	Ft.	Till, silty gravel
From	0	To	0	Ft.	Some layer of clay
From	0	To	0	Ft.	Boulder at 162'
From	187	To	223	Ft.	Silty fine sand gray (silty brown)
From	223	To	224	Ft.	Clay
From	224	To	242	Ft.	Sand med. gray
From	0	To	0	Ft.	Some gravel at 236-237'

8 rows selected.

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000050036

Owner: NORM MCCURRIE CONST

Address: WEIGH SCALES

Area: SOUTH PARKSVILLE

WELL LOCATION:
NANOOSE Land District
District Lot Plan Lot
Township Section Range
Indian Reserve Meridian Block 564
Quarter
Island
BCGS Number (NAD 27) 092F029434 Well 1

Well Use Domestic
Construction Method Drilled
Diameter 6.0 inches
Well Depth 178.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 174 to 178 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19820318

Driller FYFE'S WELL DRILLING
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 20 GPM
Artesian Flow
Static Level 100 feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
SPOKE WITH PEOPLE IN WEIGH SCALE BDG.THERE APPEARS TO BE A WATER WELL STICKING UP FROM GROUND, BUT THEY SEEM TO THINK THEY'RE GETTING THEIR WATER FR. FRENCH CR

From	0	To	70	Ft.	Brown sand and gravel
From	70	To	120	Ft.	Silty blue clay and water
From	120	To	170	Ft.	Brown sand and gravel
From	170	To	180	Ft.	Coarse sand, gravel and water

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000019878

Owner: PARKSVILLE WEIGH SCA

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot Plan Lot
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F039212 Well 10

Well Use Unknown Well Use
Construction Method Drilled
Diameter 6.0 inches
Well Depth 91.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 84 to 89 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19660301

Driller PACIFIC WATER WELLS
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 4 GPM
Artesian Flow
Static Level 55 feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
4 GPM. PUMPING AT 80 FT. FROM SURFACE.

From	0	To	8	Ft.	Gravel hardpan
From	8	To	55	Ft.	Dry coarse gravel
From	55	To	75	Ft.	Silty sand and gravel
From	75	To	89	Ft.	Brown sand and gravel
From	89	To	91	Ft.	Fine blue sand

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000041520

Owner: VILLAGE OF PARKSVILL

Address: WEIGH SCALES

Area: PARKSVILLE

WELL LOCATION:
NANOOSE Land District
District Lot 564 Plan 33339 Lot 9
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F039212 Well 15

Well Use Unknown Well Use
Construction Method Drilled
Diameter 6.0 inches
Well Depth 95.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 81 to 90 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19790101

Driller DOGWOOD DRILLING
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 25 GPM
Artesian Flow
Static Level 59 feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:

From	0	To	6	Ft.	Sand, gravel and boulders
From	6	To	64	Ft.	Dry sand and gravel
From	64	To	76	Ft.	Damp sand and gravel
From	76	To	83	Ft.	Coarse water-bearing sand and ground
From	0	To	0	Ft.	(brown)
From	83	To	90	Ft.	Blue w.b. sand and gravel (quite loose
From	0	To	0	Ft.	& clean)
From	90	To	95	Ft.	Fine silty brown sand with clay lenses
From	0	To	0	Ft.	
From	0	To	0	Ft.	Pulled pipe back to 90', set screen and
From	0	To	0	Ft.	started developing

11 rows selected.

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000003855

Owner: M TURNER

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot 171 Plan Lot
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F029434 Well 2

Well Use Domestic
Construction Method Other
Diameter 8.0 inches
Well Depth 6.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19500101

Driller Unknown
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow
Static Level UNK feet

Water Utility
Lithology Info Flag
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
SOFT.

From 0 To 0 Ft. Gravelly

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000036470

Owner: FARRELLS BOAT CO LTD

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot 56 Plan 11289 Lot 2
Township Section Range
Indian Reserve Meridian Block
Quarter SE
Island
BCGS Number (NAD 27) 092F029441 Well 6

Well Use Unknown Well Use
Construction Method Drilled
Diameter 6.0 inches
Well Depth 165.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19770101

Driller DOGWOOD DRILLING
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 5 GPM
Artesian Flow
Static Level 98 feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:

From	0	To	0	Ft.	Well # 3
From	0	To	17	Ft.	Brown dirt and some pebbles
From	17	To	20	Ft.	Clay
From	20	To	62	Ft.	Hardpan with some layers of dry gravel
From	62	To	64	Ft.	Fine sand
From	64	To	75	Ft.	Clay
From	75	To	93	Ft.	Fine sand with small pebbles
From	93	To	118	Ft.	Moist clay and pebbles
From	118	To	121	Ft.	Fine sand and gravel with large clay
From	0	To	0	Ft.	lenses (1.5 GPM)
From	121	To	140	Ft.	Dirty silty clay with small sand lenses
From	140	To	155	Ft.	Hard blue clay
From	155	To	158	Ft.	Sand and gravel with clay lenses
From	158	To	165	Ft.	Coarse clean sandy gravel (very small
From	0	To	0	Ft.	clay lenses)
From	0	To	0	Ft.	4.5 GPM
From	0	To	0	Ft.	
From	0	To	0	Ft.	Yield 4.5 GPM

18 rows selected.

BRITISH COLUMBIA

Well Tag Number 000000033192

Owner: FARRELLS BOAT CO LTD

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot 56 Plan 11289 Lot 2
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F029441 Well 7

Well Use Unknown Well Use
Construction Method Drilled
Diameter 0.0 inches
Well Depth 280.0 feet
Elevation 0
Bedrock Depth UNK feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19750811

Driller DOGWOOD DRILLING
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow
Static Level UNK feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:
ALL CASING WAS RECOVERED AND HOLE ABANDONED (DRY HOLE).

From	0	To	0	Ft.	Well # 2
From	0	To	4	Ft.	Back fill to level site
From	4	To	67	Ft.	Light brown hardpan
From	67	To	135	Ft.	Blue hardpan with small sand lenses
From	135	To	173	Ft.	Combinations of clay, sand and silt
From	0	To	0	Ft.	lenses in layers of 1" to 4" thickness
From	0	To	0	Ft.	(material has small quantity of water)
From	173	To	188	Ft.	Tight cemented gravel with small silt
From	0	To	0	Ft.	lenses
From	188	To	234	Ft.	Silty blue clay
From	234	To	280	Ft.	Blue clay

11 rows selected.

Date entered to WELL

BRITISH COLUMBIA

Well Tag Number 000000033079

Owner: FARRELLS BOAT CO LTD

Address:

Area:

WELL LOCATION:
NANOOSE Land District
District Lot 56 Plan 11289 Lot 2
Township Section Range
Indian Reserve Meridian Block
Quarter
Island
BCGS Number (NAD 27) 092F029441 Well 8

Well Use Unknown Well Use
Construction Method Drilled
Diameter 6.0 inches
Well Depth 600.0 feet
Elevation 0
Bedrock Depth 357 feet
Screen from 0 to 0 feet
Slot Size 1 Slot Size 2
Slot Size 3 Slot Size 4

Construction Date 19750731

Driller DOGWOOD DRILLING
License Number

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield 0
Artesian Flow
Static Level UNK feet

Water Utility
Lithology Info Flag Y
Pump Test Info Flag
File Info Flag
Sieve Info Flag
Screen Info Flag
Water Chemistry Info Flag
Field Chemistry Info Flag
Site Info (SEAM)
Other Info Flag

GENERAL REMARKS:

From	0	To	3	Ft.	Topsoil and gravel
From	3	To	5	Ft.	Fine brown gravel
From	5	To	9	Ft.	Brown clay with some pebbles
From	9	To	87	Ft.	Blue hardpan with some large boulders
From	87	To	94	Ft.	Coarse dry brown sand and gravel
From	94	To	163	Ft.	Tight blue hardpan with small boulders
From	163	To	185	Ft.	Very fine brown soupy sand with clay
From	0	To	0	Ft.	lenses (material is W.B. but cannot be
From	0	To	0	Ft.	be screened because of clay content)
From	185	To	381	Ft.	Light blue clay
From	381	To	387	Ft.	Small gravel and silt lenses in fine
From	0	To	0	Ft.	"clay"
From	387	To	426	Ft.	Broken shale with small quartz
From	426	To	460	Ft.	Brown shale with small quartz lenses
From	460	To	600	Ft.	Brown shale (saline -salt- water encoun-
From	0	To	0	Ft.	tered in shale
From	0	To	0	Ft.	
From	0	To	0	Ft.	Hole was backfilled with Ready Mix
From	0	To	0	Ft.	cement to 400'
From	0	To	0	Ft.	330' casing was recovered from hole
From	0	To	0	Ft.	(hole abandoned)
From	0	To	0	Ft.	(70' casing and shoe left in hole)

22 rows selected.

APPENDIX D

BASIS FOR ESTIMATING NITRATE LOADING TO ENGLISHMAN RIVER

Typical characteristics of Domestic Sewage[1]

Parameter	mg/L
Total nitrogen	40
Organic nitrogen	14.5
Ammonia nitrogen	25
Nitrate nitrogen	0.5

Assuming all nitrogen in sewage is converted to nitrate in the ground, the maximum nitrate concentration in groundwater = 40 mg/L as N.

Sewage volume produced

	L/day	m^3/day
Per three-bedroom household[2]	1364	1.4
By development	2.4E+05	242.8

Calculation assumes the development has a maximum 178 households.

Nitrate nitrogen mass produced per day

= Concentration x Volume

	mg/day	kg/day
Per household	5.5E+04	0.055
By development	9.7E+06	9.710

Mean monthly discharge from the Englishman River

Flow	m^3/sec	L/day
Annual mean	13.8	1.2E+09
Minimum	1.3	1.1E+08

Predicted Nitrate Concentrations in Englishman River due to Loading from Septic Systems

= Mass / Volume

Flow	mg/L
Annual mean	0.01
Minimum	0.09

Nitrate Nitrogen drinking water standard[3]

Parameter	mg/L
Nitrate nitrogen	10

Notes:

1. L. Canter & R. Knox (1986) - Septic tank system effects on ground water quality - Lewis Publishers, Inc. (Page 47)
2. BC Sewage Disposal Regulation
3. BC Approved water quality guidelines 2001

Preliminary Hydrogeological Assessment
of
Water Supply for Proposed Rural Residential
Subdivision

Block 564 Parksville, B.C.

Project No. 0805-5887561.001

January, 2003

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

PRELIMINARY HYDROGEOLOGICAL ASSESSMENT
OF
WATER SUPPLY FOR PROPOSED RURAL RESIDENTIAL SUBDIVISION

BLOCK 564 PARKSVILLE, B.C.

Submitted To:

ENGLISHMAN RIVER LAND CORPORATION

Vancouver, B.C.

Prepared by:

EBA ENGINEERING CONSULTANTS LTD.

Nanaimo, B.C.

Project No. 0805-5887561.001

January, 2003

Distribution:		
	Regional District of Nanaimo	6 copies
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	Englishman River Land Corporation	2 copies
	EBA Engineering Consultants Ltd.	2 copies

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Tel: (250) 756-2256 - Fax: (250) 756-2686 Email: nanaimo@eba.ca - Web Site: www.eba.ca

SPECIAL NOTE:

This report has been issued on January 8, 2003. At the time of issue, documentation of the methods used to develop and calibrate a numerical groundwater flow model used in this report is incomplete. This documentation, which forms Appendix C of this report is not included with this report and will be issued as an Addendum. This documentation is being done for completeness of the report in the event that this report is to be critiqued by persons qualified in hydrogeology. In the opinion of the persons who have prepared this report, the lack of documentation in Appendix C will not alter the conclusions and findings of this report.

EXECUTIVE SUMMARY

A hydrogeological assessment was conducted to evaluate the probability of obtaining a groundwater supply for a proposed residential subdivision located near Parksville, B.C. This study is one of several being conducted by the owners, Englishman River Land Corporation, in support of an application to the Regional District of Nanaimo (RDN) to re-zone the property. The proposed development site (Block 564, Nanoose District) comprises approximately 362 ha (895 acres) directly east of the Englishman and South Englishman Rivers. The land is presently zoned for lots of minimum 8 ha (20 acre) size and the proposed rezoning would permit lots of minimum 1 ha (2.5 acre) size.

Following input from local residents and stakeholders, the present subdivision plan would involve approximately 160 lots with dedication of the river valleys to parkland. All lots would be served by standard on-site drainfields for disposal of domestic wastewater. A community water supply would be developed from groundwater aquifers.

The terms of reference for the hydrogeological assessment were developed from requirements of the RDN and are summarized as follows:

1. Is there a high probability that an adequate water supply (both adequate quantity and quality) can be obtained from groundwater aquifers to meet the required demand for the proposed subdivision and is this water supply sustainable over the long-term?
2. If a water supply is developed, will it or will it not result in detrimental effects on surface water systems, for example, decreased low flows in the Englishman River?
3. If a water supply is developed, will it or will it not result in detrimental effects on existing or future wells pumping from the same aquifer?

Scope of the Study

The scope of the present hydrogeological assessment involved the following:

- collection of relevant information on local and regional hydrogeological conditions such as well logs, water quality reports and published geological reports;
- preparation of maps and cross sections showing the estimated thickness and lateral boundaries of aquifers and their relationship to surface water systems;
- preparation of a conceptual hydrogeological model detailing the geometry of the aquifer systems, sources of recharge and hydraulic relationship between the aquifers and surface water systems;
- preparation of a numerical finite-difference groundwater model that was used to simulate the drawdown effect of long-term pumping of one aquifer; and
- preparation of a technical report describing the evaluation methods used, the results obtained and the conclusions reached.

Presence of Aquifers

Two aquifers, referred to as the Upper Aquifer and Lower Aquifer were identified on the property and surrounding area during this study.

The Upper Aquifer is an unconfined or water table aquifer and is exposed at surface across much of the property. This aquifer has a saturated thickness of about 5 m and consists of sand and gravel that has been utilized historically as a source of construction aggregate. The Upper Aquifer has not been identified as a target aquifer for water supply for the proposed subdivision due primarily to its small saturated thickness. The Upper Aquifer is important, however, in providing absorption of stormwater, domestic wastewater and in maintaining baseflows in surface water systems.

The Lower Aquifer is composed of a well-recognized surficial geologic formation known as Quadra Sand. A layer of silty sand till overlies the Quadra Sand and acts as a confining layer separating the Upper Aquifer and Lower Aquifer. The Quadra Sand unit is commonly used for water supplies on the east coast of Vancouver Island extending from Lantzville east of the study area to Comox to the northwest. Regionally in this area, the Quadra Sand supplies potable water to a population in excess of 10,000 people.

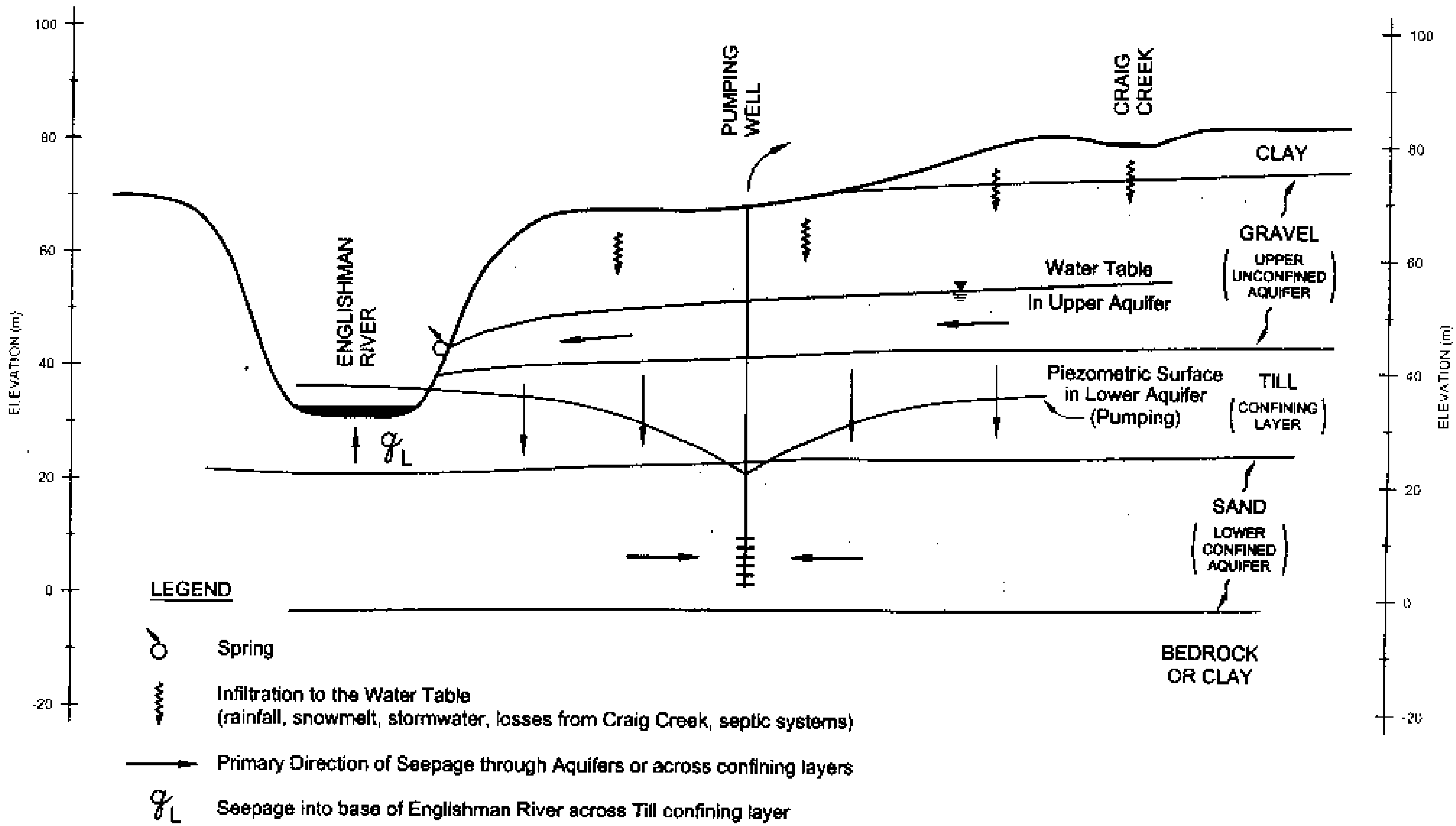
At the north end of Block 564, the Lower Aquifer is in excess of 20 m in thickness. In the central portion of Block 564 wells have only penetrated the top few metres of the aquifer and its entire thickness has not been determined. Interpretation of well records plotted on maps and cross sections indicates that the Lower Aquifer is regionally extensive in the study area.

Water Quality

Water quality in the Lower Aquifer was assessed from test results in a well located directly adjacent to the subject property and also from multiple samples collected from 28 other nearby municipal wells that also pump from the Quadra Sand. Results indicate that the Lower Aquifer is well suited as a drinking water source. Depending on localized water quality conditions, treatment for removal of iron and manganese may be required.

Numerical Groundwater Model

Prior to constructing a numerical (computer-based) groundwater flow model, considerable effort was expended developing a conceptual understanding of the aquifers, confining layer and their hydraulic relationship with the surface water systems (i.e. South Englishman River, Englishman River and Craig Creek). Figure ES-1 (see following page) summarizes the main hydraulic processes governing interaction between the aquifers and surface water systems when the Lower Aquifer is pumped.



NOTE: Drawing is not to Scale
For conceptual purposes only

EBA Engineering Consultants Ltd.		PROJECT	PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY
CLIENT	ENGLISHMAN RIVER LAND CORPORATION	TITLE	HYDRAULIC INTERACTIONS OF AQUIFERS AND RIVER UNDER PUMPING CONDITIONS
DATE 2002/12/20	DWN. JAB CHKD. JB	FILE NO. 0805-5887561.001	FIGURE ES-1

Points of significant importance from this conceptual model are as follows:

- Water pumped from the Lower Aquifer will initially come from storage in the aquifer. Over the long-term, downward leakage from the Upper Aquifer, across the silty sandy till Confining Layer will control the rate of recharge.
- The presence of the till Confining Layer will greatly restrict direct hydraulic communication between the South Englishman River, Englishman River, Craig Creek and the Lower Aquifer during pumping.
- The Lower Aquifer appears to be hydraulically connected to the Englishman River adjacent to the northern part of the property.
- The Upper Aquifer is important in sustaining baseflows in the South Englishman and Englishman Rivers as indicated by seepage from this aquifer discharging via springs into the river valleys.

The numerical groundwater flow model was constructed using the finite-difference computer program Visual MODFLO. This program is widely used by the US Geological Survey, US EPA, educational institutions and consulting firms worldwide. A three-layer model incorporating the Lower Aquifer, Confining Layer and Upper Aquifer was used. Results of the simulations of aquifer pumping for a 50 year period indicate that long-term pumping is sustainable and will not result in aquifer dewatering or excessive drawdown in pumping wells.

<u>Effect of Pumping on Existing Wells</u>

The effect of long-term aquifer pumping on existing domestic wells was evaluated using the numerical computer model and standard analytical solutions for drawdown in confined aquifers. The largest drawdowns will be experienced in wells pumping from the Lower Aquifer directly adjacent to the property with drawdown decreasing with greater distance from the property. In other words, the largest effect from pumping will be experienced close to the proposed new pumping wells.

At the location of the nearest existing domestic wells, located about 500 m from the proposed pumping wells, drawdowns are estimated to range from about 1.0 to 3.5 metres after 50 years of pumping. For comparison, based on reviewing well records, existing domestic wells have about 30 m of available drawdown (the height of the water column in the well that is available for pumping from the aquifer). Therefore, pumping of the proposed new wells may cause drawdowns in the order of 3 to 12 percent of available drawdown. This is not expected to cause excessive interference or detrimentally effect operation of existing domestic wells.

<u>Effects of Pumping on Rivers and Creeks</u>

Seepage from the Lower Aquifer discharges to the Englishman River across the Confining Layer over much of the southern area of the property. Over the northern reach of the river the Lower Aquifer "daylights" at the base of the valley slopes and groundwater discharges directly into the base of the river. In other words, the Englishman River is a "gaining stream".

To evaluate the effect of aquifer pumping on the river, the reduction in seepage from the aquifer under pumping conditions was determined. The results of this analysis were then compared with the magnitude of low flows measured in the Englishman River. The results of the analysis suggest that low flows may decrease by as much as 0.6% declining from 1.260 m^3/s to 1.252 m^3/s. This reduction is not considered to be significant and is likely within the accuracy of the gauge used to measure river flows.

Summary of Conclusions

The primary conclusions made from this study are as follows:

1. A regionally extensive confined aquifer of Quadra Sand (Lower Aquifer) has been identified beneath the study site. Similar aquifers are used extensively for municipal water supply on the east coast of Vancouver Island between Lantzville and Courtenay serving as the primary water source for in excess of 10,000 people.

2. Hydraulic analysis indicates there is a very high probability that the Lower Aquifer can sustain long-term pumping to meet the required demand of the proposed 160 lot subdivision.

3. Review of water quality data from wells pumping from the Quadra Sand indicates the groundwater should be well-suited for domestic consumption. Depending on local aquifer water quality, iron and manganese, which have guidelines in water supplies for aesthetic reasons, may require treatment.

4. Based on computer simulations and analytical solutions, long-term pumping (i.e. 50 years) of the Lower Aquifer to meet the design requirements of the subdivision (3.5 m^3/day/connection) may produce drawdowns in the order of 1.0 to 3.5 metres in existing domestic wells located in the Lower Aquifer and directly adjacent to the proposed subdivision. This represents about 3 to 12 percent of the 30 m of available drawdown in these wells and is not anticipated to cause extensive interference or detrimentally effect operation of existing wells. Less drawdown would occur in wells at increasing distance from the proposed subdivision. As experience has shown that actual average water demand in the study area is closer to 1 m^3/day/connection, actual drawdowns would probably be significantly less.

5. Long-term pumping of the Lower Aquifer is not anticipated to significantly effect flows in the Englishman River, South Englishman River or Craig Creek. This is due to the presence of a confining layer of clay or till that significantly attenuates hydraulic interaction between the surface water systems and the Lower Aquifer. Calculations indicate that low flows in the Englishman River may decrease by as much as 0.6% which is probably within the accuracy of the gauge used to measure the river flows. This magnitude of change in flow is not anticipated to detrimentally effect use of the river as aquatic habitat.

6. The flows in Englishman River, South Englishman River and Craig Creek (particularly the low flows) will likely be influenced to a greater degree by absorption of wastewater and stormwater than due to pumping of the Lower Aquifer. This is due to the fact that the Upper

Aquifer will absorb wastewater and stormwater from the proposed development and the Upper Aquifer is in direct hydraulic communication with the South Englishman River and Englishman River through seepage zones and springs in the river valley and with the lower portions of Craig Creek through the water table.

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TABLES

FIGURES

APPENDICES

PHOTOGRAPHS

1.0 INTRODUCTION

This report describes the results of a preliminary hydrogeological assessment for water supply for a proposed rural residential subdivision located near Parksville, British Columbia. This assessment has been conducted by EBA Engineering Consultants Ltd. (EBA) on behalf of the owners, Englishman River Land Corporation (ERLC), to determine the likelihood of obtaining water supply for the proposed development from groundwater aquifers underlying the property.

The proposed development site (Block 564, Nanoose District) lies within the Nanaimo Regional District (RDN) and comprises approximately 362 ha (895 acres) adjacent to the Englishman River (Figure 1). The land is presently zoned for a minimum 8 ha lot size. ERLC has applied to the RDN to re-zone the property to allow for a different type of development with smaller lot sizes. As part of the RDN's rezoning process, they have requested ERLC to carry out certain studies to evaluate servicing requirements and potential environmental impacts from the subdivision. This report has been prepared to evaluate water supply for the property from aquifers.

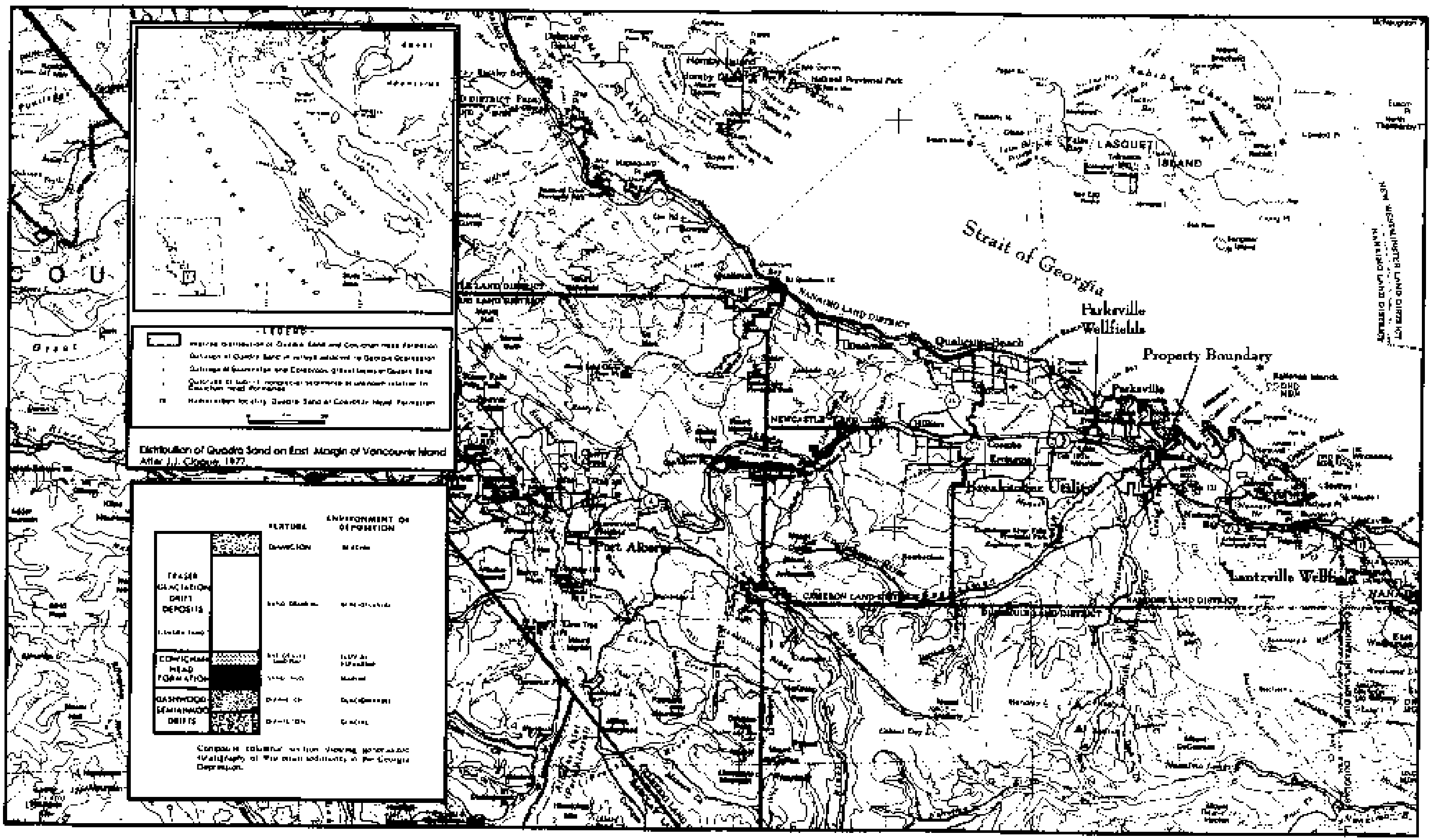
2.0 DESCRIPTION OF SITE AND PROPOSED DEVELOPMENT

2.1 Topography and Surface Soils

Block 564 is an irregular-shaped property approximately 362 ha in size. It is bounded along the west side by the South Englishman and Englishman Rivers and to the east by Craig Creek (Figure 2). The Strait of Georgia lies approximately 1.5 km to the north.

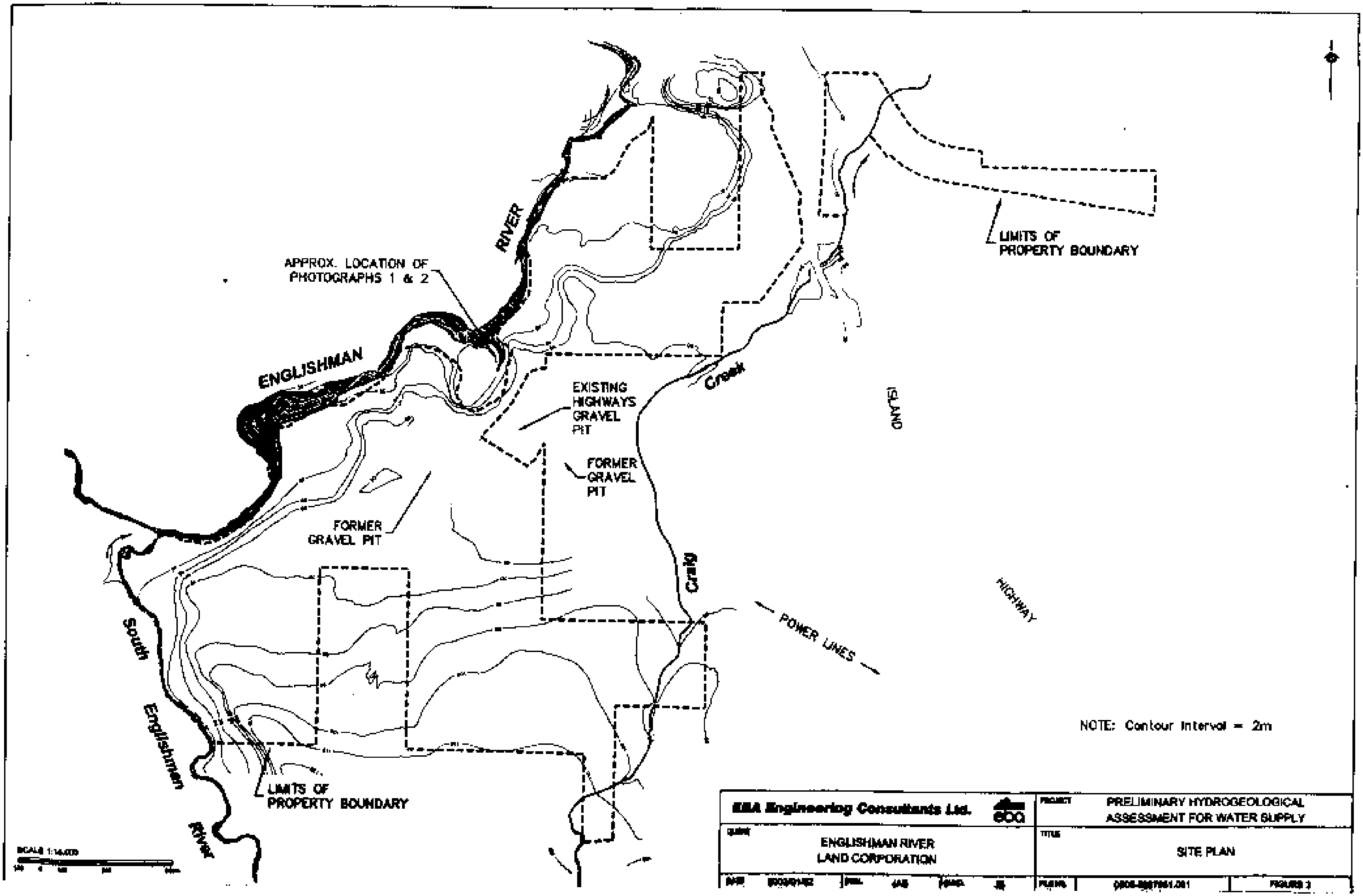
Topographically, the site can be divided into three zones as follows:

- The southern zone which is characterized by gentle to moderate slopes. Previous work including test pit observations and interpretation of aerial photographs (EBA, 2002a) indicated this area of the property is covered primarily by silty soils at surface;
- The steep sided valleys of South Englishman River, Englishman River and Craig Creek (east of the Island Highway); and,
- The remainder of the property which is characterized by flat-lying topography. This area, which accounts for the majority of the acreage, is underlain by granular soils that have been used historically as a source of construction aggregate.



EBA Engineering Consultants Ltd.

PROJECT	PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT	ENGLISHMAN RIVER LAND CORPORATION
TITLE	REGIONAL TOPOGRAPHIC PLAN
DATE: 2002/11/22 · DWN: VI · CHKD: JB	0808-5007551.001 · FIGURE 1


ENGLISHMAN
RIVER
APPROX. LOCATION OF PHOTOGRAPHS 1 & 2
LIMITS OF PROPERTY BOUNDARY
EXISTING HIGHWAYS GRAVEL PIT
FORMER GRAVEL PIT
FORMER GRAVEL PIT
Creek
Craig
ISLAND
HIGHWAY
POWER LINES
South
Englishmen
River
LIMITS OF PROPERTY BOUNDARY
NOTE: Contour Interval = 2m
EBA Engineering Consultants Ltd.
PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY
ENGLISHMAN RIVER LAND CORPORATION
SITE PLAN

Elevations across the upland areas range between about 110 m above sea level (m-asl) at the southern end of the property to 45 m-asl at the north end near the Island Highway. In the base of the river valleys, the elevation of the South Englishman River is about 48 m-asl at the upstream (southern) limit of the property and at the downstream (northern) limit of the property, the elevation of the Englishman River is about 15 m-asl.

2.2 Surface Water Drainage

The Englishman River is an important salmon-producing stream on the mid-east coast of Vancouver Island. The watershed has all species of salmon and is designated a sensitive stream by the BC government under the Fish Protection Act.

The Englishman River is a community watershed supplying drinking water during the summer months to Parksville and surrounding areas via an intake in the lower Englishman River. There are currently 37 water licenses (October 1994) within the Englishman River Water Allocation Plan Area (Boom and Bryden 1993). These licenses are concentrated in the lower part of the Englishman River and Morison Creek. About 85% of the drinking water for Parksville and the surrounding area currently comes from groundwater sources.

In 1998, the Arrowsmith Dam was completed to improve the fish habitat and domestic water supply. The dam is a joint venture with Arrowsmith Water Services, City of Parksville, Town of Qualicum Beach and the Regional District of Nanaimo. Half of the water stored will be used to increase or maintain flows for fisheries purposes (LGL Ltd., 2001).

According to flow data collected at the Water Survey Canada hydrometric station near Parksville (08HB002), the mean monthly discharge of the Englishman River varies between a minimum of 1.26 m^3/s in August and a maximum of 29.25 m^3/s in December, resulting in an annual mean of 13.7 m^3/s.

Craig Creek originates approximately 3 km south of the property and flows in a north direction to discharge into the Georgia Strait. Craig Creek is not presently gauged and flow data are not available.

2.3 Preliminary Subdivision Layout

A preliminary layout concept for the proposed subdivision is presented in Appendix A. As originally proposed, the concept involved four large acreage properties (average size 27 acres) at the north end of the site, 134 lots averaging 3 acres in size and approximately 40 dwellings clustered in the southeast corner of the property for a total of 178 lots. Following input from local residents and stakeholders at a meeting in Parksville during

December, 2002, ERLC has proposed to replace the 40 cluster units with approximately half the number of dwellings (i.e. 20 lots) on lots of about 3 acre size. Therefore, for the purpose of this report, water demand has been determined on the basis of 160 lots.

3.0 SCOPE OF WORK

The scope of work for this hydrogeological assessment was designed to address the following terms of reference:

1. Is there a high probability that an adequate water supply (both adequate quantity and quality) can be obtained from groundwater aquifers to meet the required demand for the proposed subdivision and is this water supply sustainable over the long-term?
2. If a water supply is developed, will it or will it not result in detrimental effects on surface water systems, for example, decreased low flows in the Englishman River?
3. If a water supply is developed, will it or will it not result in detrimental effects on existing or future wells pumping from the same aquifer?

To answer these questions, the following work program was carried out:

- Relevant information on local and regional hydrogeologic conditions was collected. This included published geologic reports, well logs, water quality reports and information on surrounding municipal water systems from our in-house files;
- Maps and cross sections were prepared to identify the thickness and lateral boundaries of aquifers and to determine the relationship between the aquifers and surface water systems;
- Field reconnaissance was carried out in the Englishman River valley to observe geologic exposures and features such as springs on the valley slopes;
- A conceptual hydrogeologic model was developed detailing the geometry of the aquifer systems, sources of recharge and hydraulic relationship with surface water systems;
- A numerical finite-difference groundwater flow model was developed and used to simulate the effect of aquifer pumping at the required design demand for a period of 50 years;
- All results were interpreted within the context of the terms of reference described above; and
- This technical report was prepared describing the evaluation methods used, the results obtained and the conclusions reached.

4.0 REGIONAL HYDROGEOLOGIC CONDITIONS

4.1 General

The study area lies within the narrow coastal lowland on the east coast of Vancouver Island. This lowland is bounded by Georgia Strait to the north and east and by mountainous terrain (Vancouver Island Range) to the west.

The coastal lowland is in the rainshadow of the Vancouver Island Range resulting in warm, dry summers and wet, mild winters. Total annual precipitation published by Environment Canada for two nearby weather stations (Nanaimo Airport and Qualicum River) range from 1144 to 1293 mm.

4.2 Bedrock

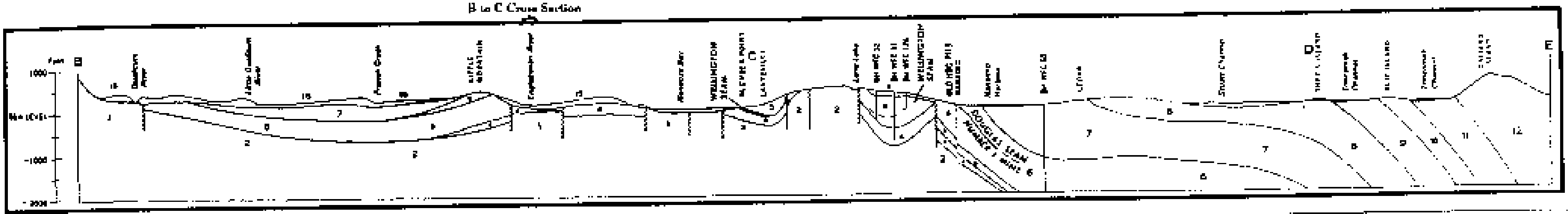
Based on information reported by the Geological Survey of Canada (1969), bedrock in the study area consists of tuff and breccia, limestone, argillite, quartzite and greenschist underlying sandstone, shale, coal and minor conglomerate of the Comox Formation (Figure 3). Based on our experience in this region, wells drilled into bedrock aquifers are generally capable of supplying domestic needs for single dwellings. High yielding bedrock wells, capable of meeting the demand requirements of a large subdivision, are very uncommon.

According to the geologic map, the valleys of the Englishman River and South Englishman River follow geologic faults in the vicinity of Block 564. Local faulting of the bedrock may enhance the permeability of the rock mass such that locally, bedrock aquifers may produce somewhat greater yields to wells when compared to zones of bedrock that are not faulted. Fractured bedrock may also play a role in the lateral transfer of groundwater.

4.3 Overburden Deposits

The soil deposits in this part of Vancouver Island have three main origins (glacial, marine and fluvial). The type, thickness and extent of the various overburden deposits is a function of the sequence of geologic events that occurred (e.g. rise and drop of sea level, advancement and melting of the glaciers during the various glacial episodes, erosion and deposition caused by streams, etc.).

Property Limits through B to C Cross Section



LEGEND

Geologic Description

CENOZOIC

15 — Glacial and postglacial deposits

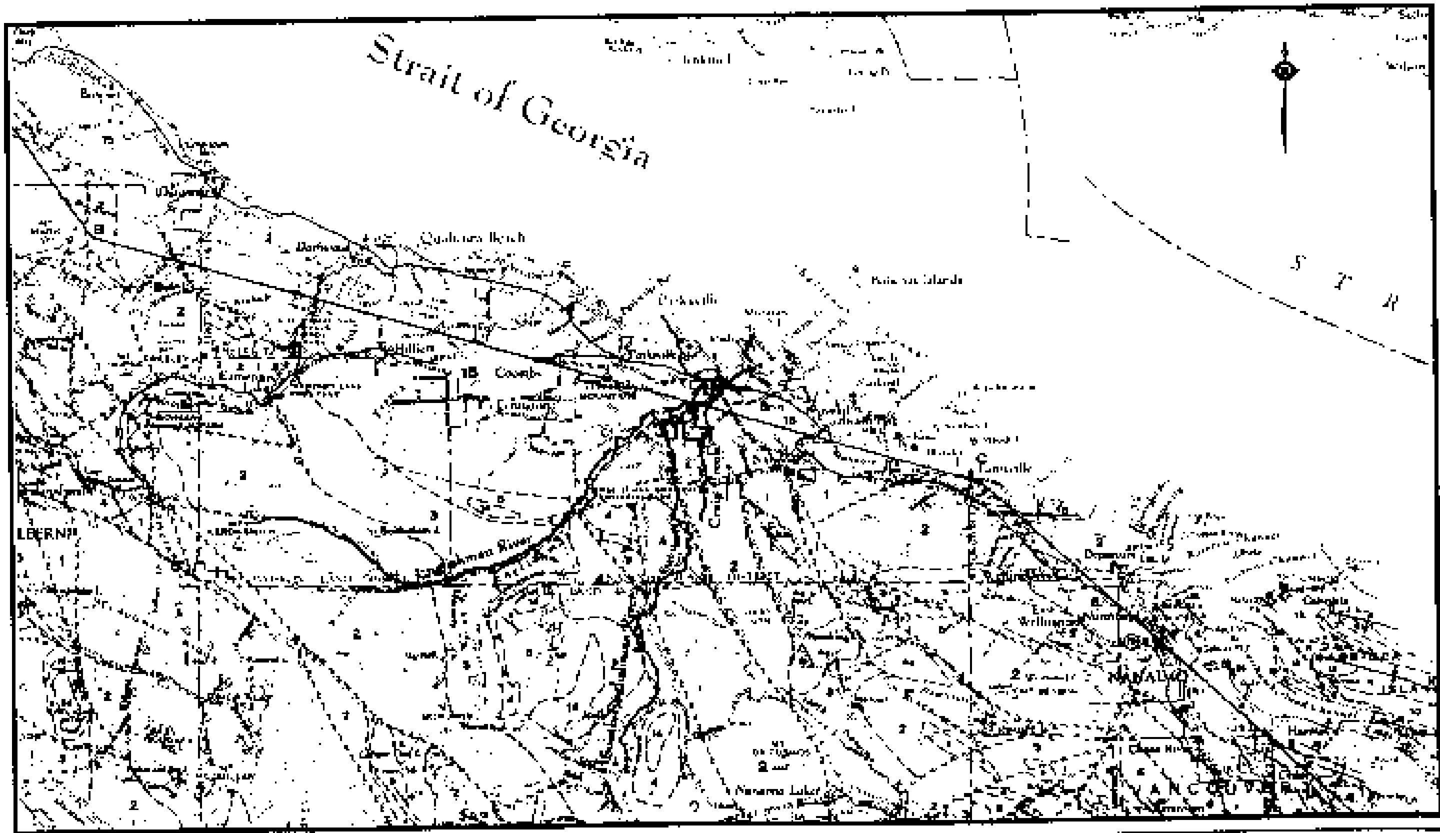
MESOZOIC

4 — COMOX FORMATION: sandstone, shale, coal, minor conglomerate; 4a, BENSON MEMBER: conglomerate, greywacke

PALEOZOIC

1 — Tuff and breccia, limestone, argillite, quartzite; greenschist

Property Boundary



Source of map: Geology of the Upper Cretaceous Nanaimo Group, Vancouver Islands, British Columbia, Geological Survey of Canada, Paper 69-25

Scale 1:250 000 Échelle

EBA Engineering Consultants Ltd.	PROJECT: PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT: ENGLISHMAN RIVER LAND CORPORATION	TITLE: REGIONAL BEDROCK GEOLOGY
DATE: 2002/11/20 DWN: YL CHKD: JB	FILE: 0805-0807861.001 FIGURE 3

According to Clague (1977), on the southeast coast of Vancouver Island, the overburden deposits consists of three formations (see inset map and surficial geologic profile after Clague on Figure 1). One of these three formations, the Quadra Sand, consists of horizontally and cross-stratified, well sorted sand, minor silt, and gravel. It is overlain by till and related glacial sediments deposited during the Fraser glaciation and is underlain by fluvial, estuarine, and marine sediments deposited during the preceding nonglacial interval. The Quadra Sand plays an important role in the subsurface hydrogeology because it can store and transmit groundwater, and has a high potential as a drinking water source.

The Quadra Sand is commonly used for water supply for communities on the east coast of Vancouver Island. Table 1 provides some information on water systems relying on Quadra Sand aquifers, from Comox to Lantzville.

Table 1: Water Systems Relying on Quadra Sand Aquifers

Area	Comox	Parksville	Lantzville
Number of wells	> 1000	> 200	> 20
Population served	> 3000	> 5000	> 3000
Yield of most productive wells	> 2000 L/min	> 700 L/min	> 500 L/min
Years in operation	> 50 years	> 20 years	> 20 years
Notes: ">" means greater than. L/min = litres per minute			

As shown, these aquifers provide the primary drinking water source to a population in excess of 10,000 people and have been doing so for a period of decades.

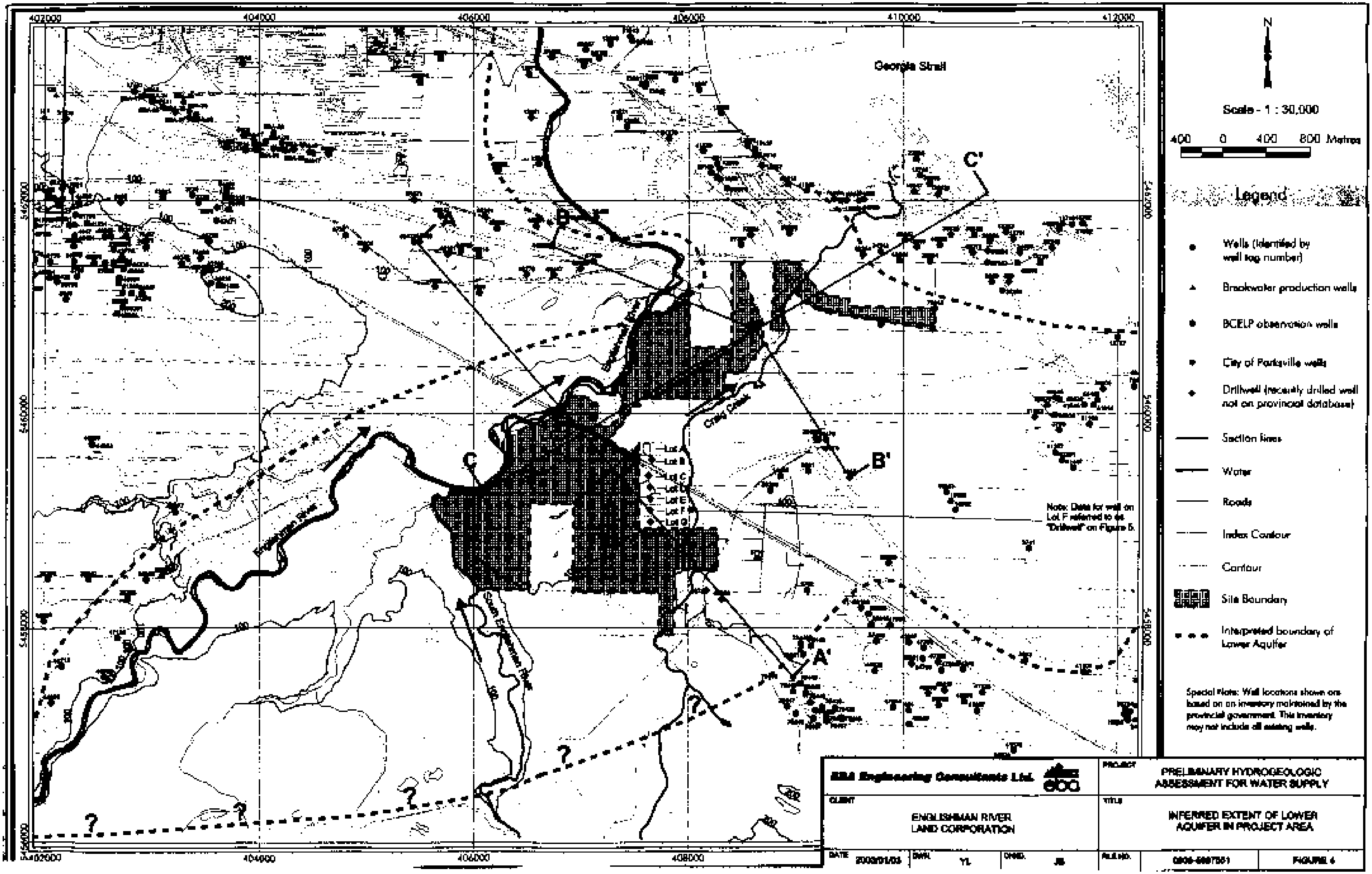
5.0 LOCAL HYDROGEOLOGIC CONDITIONS

An understanding of local hydrogeological conditions was developed from review of well logs, preparation of maps and cross sections, and reconnaissance in the Englishman River Valley. A map showing water well locations, cross section locations, drainage features and other details is presented on Figure 4. Hydrogeologic cross sections AA', BB' and CC' are presented on Figures 5, 6 and 7, respectively.

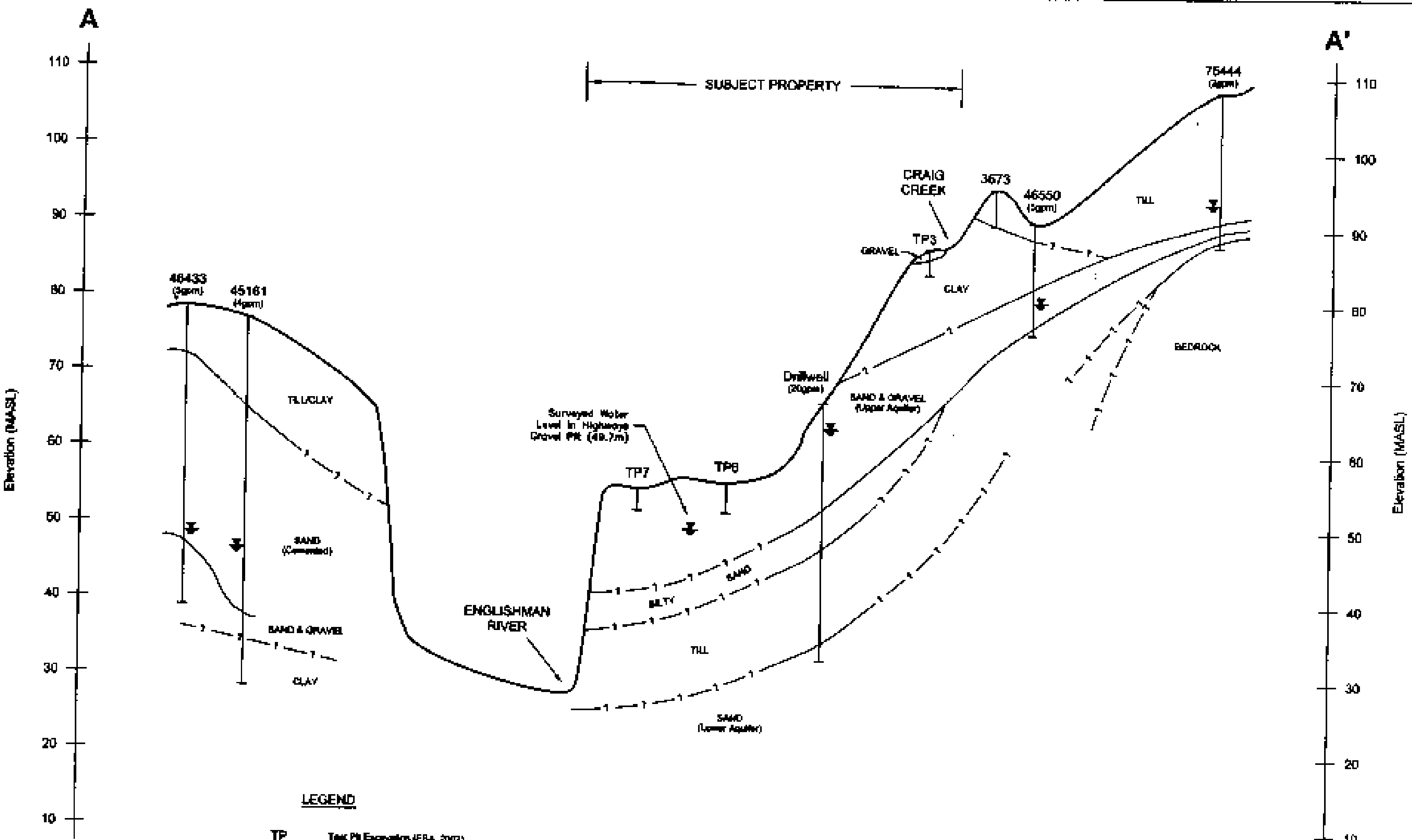
Based on review of this information, the following units have been identified, as described from surface downwards (Table 2):

Table 2 - Summary of Soil and Bedrock Deposits In Study Area

Designation	Description	Thickness	Comments
Unit 1	Upper till	absent to 20 m	Craig Creek flows atop this unit across southern part of study area (see Figure 5)
Unit 2	Upper sand and gravel	up to 20 m	This unit exposed across much of site. Has been used historically for construction aggregate. Saturated thickness is about 5 m on the subject property.
Unit 3	Middle till	up to 20 m	This unit acts as a confining layer for Unit 4
Unit 4	Lower sand	up to 30 m	This unit is interpreted to be Quadra Sand
Unit 5	Lower till/clay	up to 5 m	
Unit 6	Bedrock	not applicable	Predominantly shale and sandstone



EBA Engineering Consultants Ltd.				PROJECT	PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY	
CLIENT: ENGLISHMAN RIVER LAND CORPORATION				TITLE	INFERRED EXTENT OF LOWER AQUIFER IN PROJECT AREA	
DATE 2003/01/03	DWN. YL	CHKD. JB		FILE NO.	0808-6607551	FIGURE 4



LEGEND

TP — Test Pit Excavation (EBA, 2002)

Depth to Water (reported on drill log)

TILL — Stratigraphy interpreted based on information available from Ministry of Water, Land and Air Protection database.

45161 — Well Tag number (Ministry of Water, Land and Air Protection database)

(6gpm) — Estimated yield of Well in gpm (reported on drill log)

Note: Elevations of top of Borehole estimated from TRIM Maps

HORIZONTAL SCALE 1:20,000

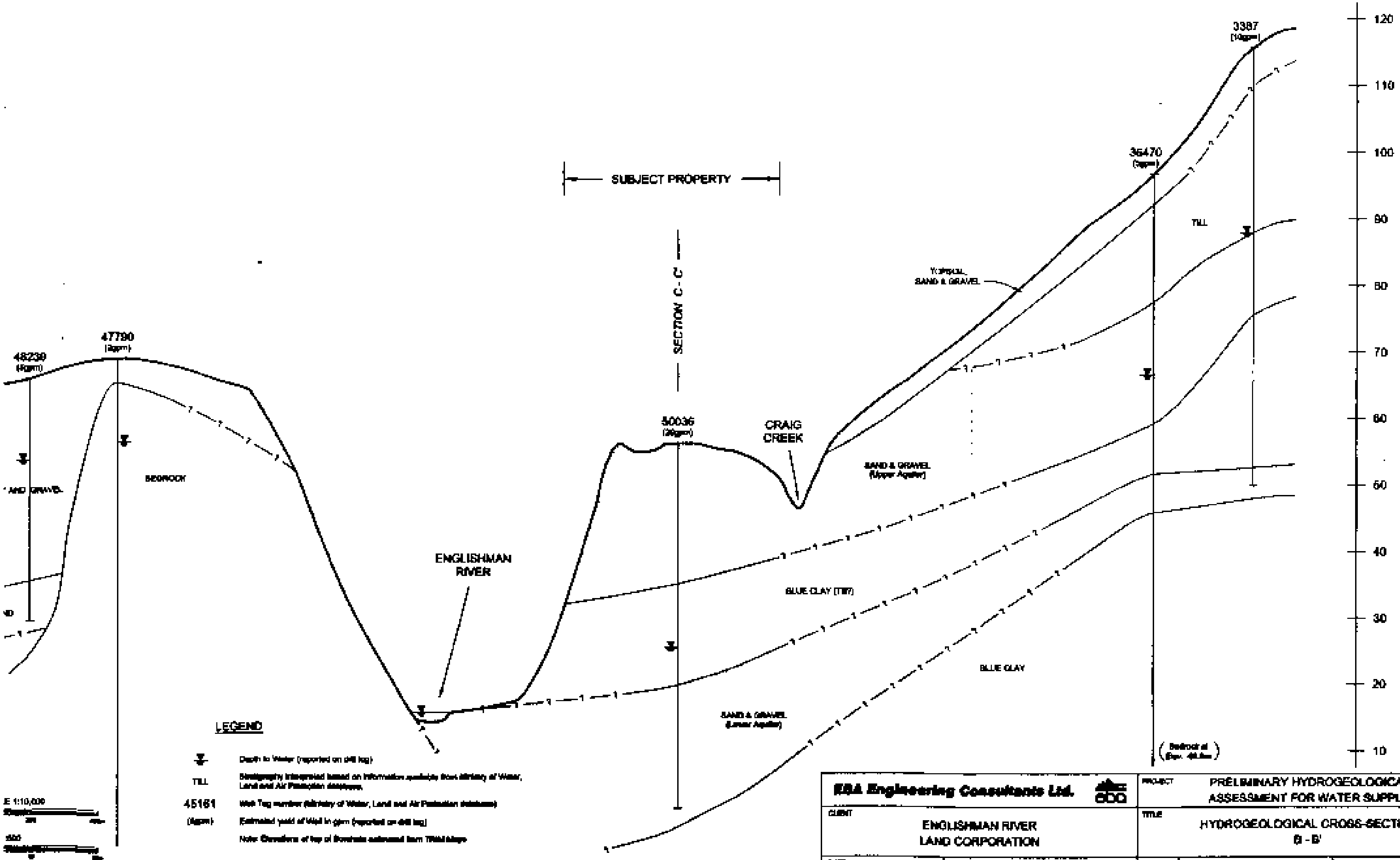
VERTICAL SCALE 1:500

EBA Engineering Consultants Ltd.

CLIENT: ENGLISHMAN RIVER LAND CORPORATION

PROJECT: PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY

TITLE: HYDROGEOLOGICAL CROSS-SECTION A - A'



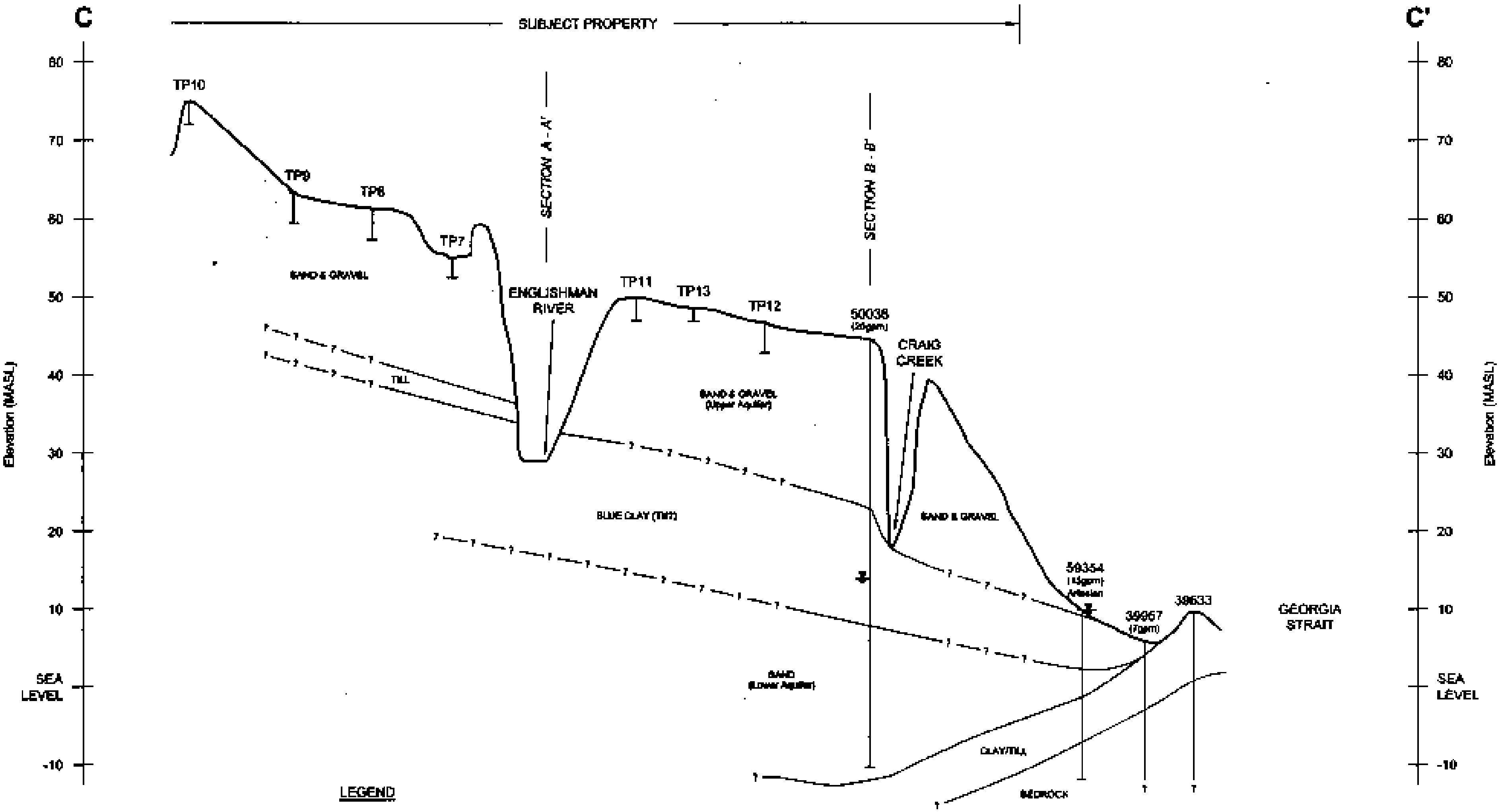
LEGEND

- Depth to Water (reported on drill log)
- TILL — Stratigraphy interpreted based on information available from Ministry of Water, Land and Air Protection database.
- 45161 — Well Tag number (Ministry of Water, Land and Air Protection database)
- (4gpm) — Estimated yield of Well in gpm (reported on drill log)
- Note: Elevations of top of Borehole estimated from TRIM Maps

E 1:10,000

EBA Engineering Consultants Ltd.

CLIENT	ENGLISHMAN RIVER LAND CORPORATION
PROJECT	PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY
TITLE	HYDROGEOLOGICAL CROSS-SECTION B - B'
DATE	2002/11/22
DWN.	JAB
CHKD.	JS
FIGURE	4



LEGEND

TP	Test Pit Excavation (EBA, 2002)
↓	Depth to Water (reported on drill log)
TILL	Stratigraphy interpreted based on information available from Ministry of Water, Land and Air Protection database.
45161	Well Tag number (Ministry of Water, Land and Air Protection database)
(5gpm)	Estimated yield of Well in gpm (reported on drill log)
	Note: Elevations of top of Borehole estimated from TRIM Maps

HORIZONTAL SCALE 1:20,000

VERTICAL SCALE 1:500

EBA Engineering Consultants Ltd.

CLIENT: ENGLISHMAN RIVER LAND CORPORATION

PROJECT: PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY

TITLE: HYDROGEOLOGICAL CROSS-SECTION C - C'

FILE NO. 0805-6687661.001

FIGURE 7

Unit 2 and Unit 4 are the two units that are permeable enough to store and transport groundwater and could potentially provide a drinking water source for the proposed subdivision. However, Unit 2 presents some limitations: i) it is locally only partially saturated (the saturated thickness of the aquifer is typically about 5 m - see Figure 5) and ii) groundwater being transported through Unit 2 probably plays a key role in supplying water to the local streams (the Englishman River and Craig Creek). Therefore, any long term extraction of groundwater from Unit 2 could potentially reduce the baseflow of these streams, depending on the location of the wells completed in this unit.

Unit 4 is interpreted to be the Quadra Sand. The horizontal extent of Unit 4 in the study area, interpreted from well records, is presented on Figure 4. Being confined, fully saturated and of a relatively large extent, Unit 4 has the highest potential to provide a reliable source of drinking water.

Throughout the remainder of this report, the following terminology is used to refer to Units 2, 3 and 4.

- Unit 2: Upper Aquifer
- Unit 3: Confining Layer
- Unit 4: Lower Aquifer

Exposures of soils on the slopes of the river valleys were examined during a reconnaissance by our staff in November, 2002. Near vertical exposures of hard silty sandy till were observed along the South Englishman River and within the southern reaches of the Englishman River to a point approximately 500 m downstream of the powerline crossing. This silty sandy till is interpreted to be the Confining Layer (Unit 3). From this point 500 m downstream of the powerline crossing to the northwest corner of the property, sand and gravel is exposed in the base of the river valley. This sand and gravel is interpreted to be an outcropping of the Lower Aquifer. At the northwest corner of the property, where the Englishman River changes course towards the northwest, bedrock is exposed in the river valley. Examples of exposures of the Lower Aquifer and Confining Layer are illustrated on Photographs 1 and 2, respectively.

Photo 1: (Above) Showing lower sand and gravel at junction of backwater channel and main stem of Englishman River approximately 500m downstream of powerline crossing. This may represent an outcropping of the Lower Aquifer.

Photo 2: (Left) Showing near vertical hard silty sandy till and minor spalling off face of deposit near same location as Photo 1 above. This represents the Confining Layer between the Upper Aquifer and Lower Aquifer.

6.0 HYDROGEOLOGICAL ASSESSMENT

Based on the interpretation of local hydrogeological conditions as described above in Section 5.0, the hydrogeological assessment has focussed on the suitability or limitations of developing a water supply for the proposed subdivision from the confined Lower Aquifer. In accordance with the terms of reference, the assessment has involved evaluation of the following:

- Water quality in the Lower Aquifer relative to applicable guidelines for drinking water;
- Ability of the Lower Aquifer to supply the required water demand over the long-term;
- Effect of pumping on drawdown in existing or future new wells constructed nearby the property in the Lower Aquifer; and,
- Effect of pumping on surface water systems, particularly low flows.

6.1 Water Quality

A water sample was collected from a well in the Lower Aquifer near the north boundary of the property on November 20, 2002. This well is located at the Ministry of Transportation and Highways weigh scale facility where the Island Highway bisects the property (Well Tag No. 50036 - See Figures 4 and 6 for location). A copy of the analytical report from the testing of this well is included in Appendix B. The results from the testing of this sample, as well as existing data for multiple samples collected from 28 nearby municipal wells that draw from the Quadra Sand are compared with Canadian and provincial guidelines for drinking water quality on Table 3.

Based on review of this extensive water quality database, and from our previous experience in the area, water quality in the Lower Aquifer is well suited as a drinking water source. The only parameters which do not meet guidelines are iron and manganese which may exceed the aesthetic objectives in localized areas. It is noted that the sample from the weigh scale well and samples from the Lantzville system have iron and manganese concentrations that meet the guidelines but some samples from the Parksville area are above the guidelines for iron and manganese.

Based on these results, it is expected that the water quality in the Lower Aquifer will be well suited for drinking water. Depending on localized water quality conditions in the aquifer, treatment for iron and manganese may be required.

TABLE 3

Comparison of Water Quality to Drinking Water Guidelines

Parameter	Unit	Guideline	Reason [1]	Ministry of Transportation and Highway Weigh Scale Well
Physical Parameters				
pH	pH units	6.5 - 8.5	AO	8.06
Color True	CU	15	AO	<5
Conductivity	µS/cm	700	BCAWQG	279
Total Dissolved Solids	mg/L	500	AO	159
Turbidity	NTU	1	MAC	1.9
Anions				
Chloride	mg/L	250	AO	10.6
Fluoride	mg/L	1.5	MAC	0.08
Sulphate	mg/L	500	AO	9
Nutrients				
Nitrate Nitrogen	mg/L as N	10	MAC	<0.1
Nitrite Nitrogen	mg/L as N	1	MAC	<0.1
Total Metals				
Antimony	mg/L	0.006	IMAC	<0.0005
Arsenic	mg/L	0.025	IMAC	<0.001
Barium	mg/L	1	MAC	<0.02
Boron	mg/L	5	IMAC	<0.1
Cadmium	mg/L	0.005	MAC	<0.0002
Chromium	mg/L	0.05	MAC	<0.002
Copper	mg/L	1	AO	0.1
Iron	mg/L	0.3	AO	0.21
Lead	mg/L	0.01	MAC	0.007
Magnesium	mg/L	700	BCAWQG	8.6
Manganese	mg/L	0.05	AO	0.007
Mercury	mg/L	0.001	MAC	<0.0002
Selenium	mg/L	0.01	MAC	<0.001
Sodium	mg/L	200	AO	11
Uranium	mg/L	0.02	IMAC	<0.0001
Zinc	mg/L	5	AO	0.09

Notes:

1) The reason for the guideline is either MAC (maximum allowable concentration), IMAC (interim maximum allowable concentration) or AO (aesthetic objective).

CDWS - Canadian Drinking Water Standards (2001)

BCAWQG - BC Approved Water Quality Guidelines (1998)

TABLE 3 (continued)

Comparison of Water Quality to Drinking Water Guidelines

Parameter	Unit	Guideline	Reason [1]	Lantzville Wells [2]			
				MIN	MAX	MEAN	COUNT
Physical Parameters							
pH	pH units	6.5 - 8.5	AO	6.7	8.5	7.38	34
Color True	CU	15	AO	<5	10	N/A	26
Specific Conductance	µS/cm	700	BCAWQG	7	339	231	35
Total Dissolved Solids	mg/L	500	AO	64	230	156	35
Turbidity	NTU	1	MAC	<0.1	12	N/A	28
Anions							
Chloride	mg/L	250	AO	11.8	50.2	25.5	34
Fluoride	mg/L	1.5	MAC	<0.05	0.61	N/A	34
Sulphate	mg/L	500	AO	0.95	17.6	8.73	35
Nutrients							
Nitrate Nitrogen	mg/L as N	10	MAC	0.4	3.31	0.784	30
Nitrite Nitrogen	mg/L as N	1	MAC	<0.0005	0.056	N/A	31
Total Metals							
Antimony	mg/L	0.006	IMAC	<0.015	0.03	N/A	29
Arsenic	mg/L	0.025	IMAC				
Barium	mg/L	1	MAC	0.002	0.009	0.006	31
Boron	mg/L	5	IMAC	0.0138	0.22	0.130	32
Cadmium	mg/L	0.005	MAC	<0.0001	0.002	N/A	31
Chromium	mg/L	0.05	MAC	<0.0005	0.007	N/A	32
Copper	mg/L	1	AO	<0.001	0.338	N/A	32
Iron	mg/L	0.3	AO	<0.003	0.24	N/A	34
Lead	mg/L	0.01	MAC	<0.002	0.035	N/A	32
Magnesium	mg/L	700	BCAWQG	0.26	10.5	7.66	33
Manganese	mg/L	0.05	AO	<0.001	0.016	N/A	35
Mercury	mg/L	0.001	MAC	-	-	-	-
Selenium	mg/L	0.01	MAC	<0.0005	0.5	N/A	32
Sodium	mg/L	200	AO	<0.0001	20.2	12.0	33
Uranium	mg/L	0.02	IMAC	-	-	-	-
Zinc	mg/L	5	AO	<0.002	0.087	N/A	33

Notes:

1) The reason for the guideline is either MAC (maximum allowable concentration),
IMAC (interim maximum allowable concentration) or AO (aesthetic objective).
CDWS - Canadian Drinking Water Standards (2001)
BCAWQG - BC Approved Water Quality Guidelines (1998)
2) Statistics calculated based on multiple samples from 6 wells.
Arsenic is not shown for Lantzville because the detection limit is above the CDWS.
'-' Denotes parameter not analyzed.

TABLE 3 (continued)

Comparison of Water Quality to Drinking Water Guidelines

Parameter	Unit	Guideline	Reason [1]	Wells near Parksville [2,3]			
				MIN	MAX	MEAN	COUNT
Physical Parameters							
pH	pH units	6.5 - 8.5	AO	5.55	8.25	7.37	32
Color True	CU	15	AO	-	-	-	-
Conductivity	μmhos/cm	700	BCAWQG	119	420	260	26
Total Dissolved Solids	mg/L	500	AO	98	282	182	26
Turbidity	NTU	1	MAC	-	-	-	-
Anions							
Chloride	mg/L	250	AO	<0.5	30	9.6	31
Fluoride	mg/L	1.5	MAC	<0.03	0.24	N/A	22
Sulphate	mg/L	500	AO	<0.5	14.7	3.71	29
Nutrients							
Nitrate Nitrogen	mg/L as N	10	MAC	<0.04	89	N/A	18
Nitrite Nitrogen	mg/L as N	1	MAC	<0.001	0.002	N/A	17
Total Metals							
Antimony	mg/L	0.006	IMAC	-	-	-	-
Arsenic	mg/L	0.025	IMAC	-	-	-	-
Barium	mg/L	1	MAC	-	-	-	-
Boron	mg/L	5	IMAC	-	-	-	-
Cadmium	mg/L	0.005	MAC	-	-	-	-
Chromium	mg/L	0.05	MAC	-	-	-	-
Copper	mg/L	1	AO	-	-	-	-
Iron	mg/L	0.3	AO	<0.01	2.8	0.38	33
Lead	mg/L	0.01	MAC	-	-	-	-
Magnesium	mg/L	700	BCAWQG	3.2	23.9	12.70	24
Manganese	mg/L	0.05	AO	<0.0005	0.26	N/A	32
Mercury	mg/L	0.001	MAC	-	-	-	-
Selenium	mg/L	0.01	MAC	-	-	-	-
Sodium	mg/L	200	AO	4	48	9.2	28
Uranium	mg/L	0.02	IMAC	-	-	-	-
Zinc	mg/L	5	AO	-	-	-	-

Notes:

1) The reason for the guideline is either MAC (maximum allowable concentration), IMAC (interim maximum allowable concentration) or AO (aesthetic objective).

CDWS - Canadian Drinking Water Standards (2001)

BCAWQG - BC Approved Water Quality Guidelines (1998)

2) Statistics calculated based on multiple samples from 22 wells.

3) Data are from a confidential report prepared by EBA.

'-' Denotes parameter not analyzed.

6.2 Long-term Sustainability of Aquifer Pumping

The following methodology was used to assess the long-term sustainability of aquifer pumping:

1. The water demand for the subdivision was determined.

2. A conceptual hydrogeological model was developed integrating the geometry and hydraulic interactions of the Lower Aquifer, Confining Layer and Upper Aquifer with the surface water systems.

3. A numerical finite-difference groundwater flow model was constructed and calibrated to existing (i.e. non-pumping) conditions.

4. Transient simulations were performed using the calibrated model to predict drawdown in the Lower Aquifer after 50 years of pumping at the design water demand. These simulations also accounted for pumping due to existing domestic wells identified during the course of this study.

5. The results from the computer simulations of long-term pumping were reviewed to determine the ability of the Lower Aquifer to sustain pumping at the required yield without dewatering (i.e. "drying out") the aquifer.

As was noted previously in Section 2.3 of this report, the original subdivision proposal was to include water supply for 180 lots. Following results from a public information meeting in December 2002, ERLC chose to revise the number of proposed lots downwards to 160. The modeling work done was originally developed on an understanding of 180 lots and due to the schedule requirements of this project, time has not been available to re-run computer simulations with the lower water demand (103 USgpm) for 160 lots. Therefore, as the computer simulations have been carried out on the basis of demand from a 180 lot subdivision (about 120 US gpm), the results can be viewed as conservative. In other words, the potential drawdown in nearby wells or decreases in flows to adjacent rivers would be less than those predicted using the design water demand for a 180 lot subdivision.

The results from each of the five steps listed above are described below.

6.2.1 Design Water Demand

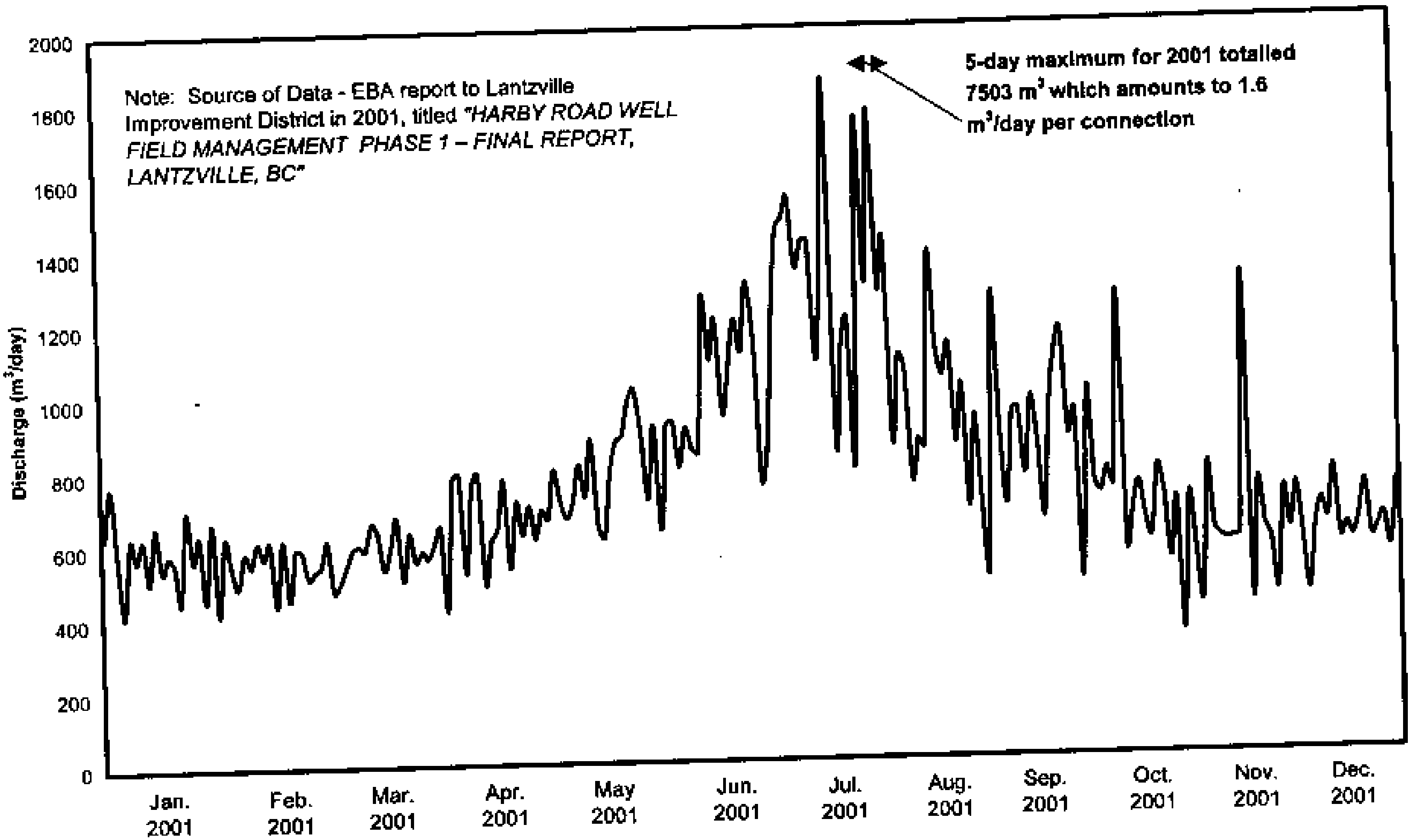
Based on communications with the RDN, subdivisions must be served with a water supply of 3.5 m^3/day/connection. Based on 160 lots, the required water demand is then 560 m^3/day. Expressed in units commonly used in aquifer pumping studies, this equates to a groundwater pumping rate of 103 US gallons per minute (US gpm).

For the purpose of elevating the long-term sustainability of aquifer pumping studies, the design demand of 103 US gpm has been used. However, based on our experience with other water systems in the area, actual water demand is typically significant less than 3.5 m^3/day/connection. Actual daily discharge from the Harby Road wellfield which supplies approximately 950 connections in Lantzville is presented on Figure 8. As shown, during 2001 the maximum 5 day demand equated to approximately 1.6 m^3/day/connection, less than half of the design demand. Average daily demand is closer to 1.0 m^3/day/connection.

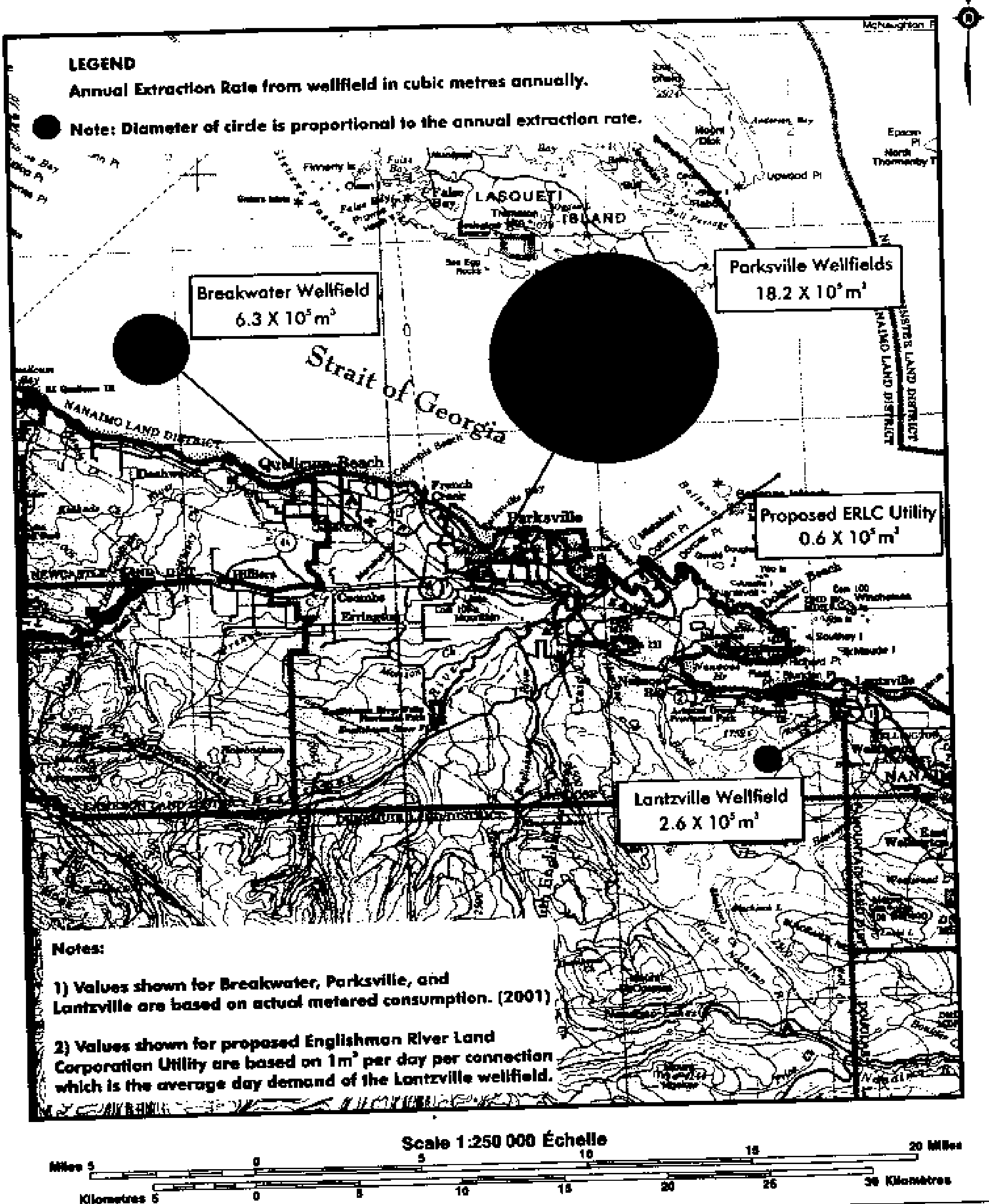
To put the design demand of the proposed subdivision in context with other municipal systems drawing from Quadra Sand aquifers, they are compared graphically on Figure 9. Values for the Breakwater Wellfield, Parksville Wellfields and Lantzville Wellfield are based upon actual metered consumption during 2001. For comparison purposes, the demand for the proposed water system was calculated based on 1 m^3/day/connection, the average daily demand of the Lantzville system. As shown, the water demand for the proposed subdivision is small relative to existing utilities. Given that conditions such as climate and aquifer recharge rates are relatively similar in this region, Figure 9 illustrates that the proposed utilization of the aquifer for this development is of low intensity relative to similar aquifers in the area.

6.2.2 Conceptual Hydrogeologic Model

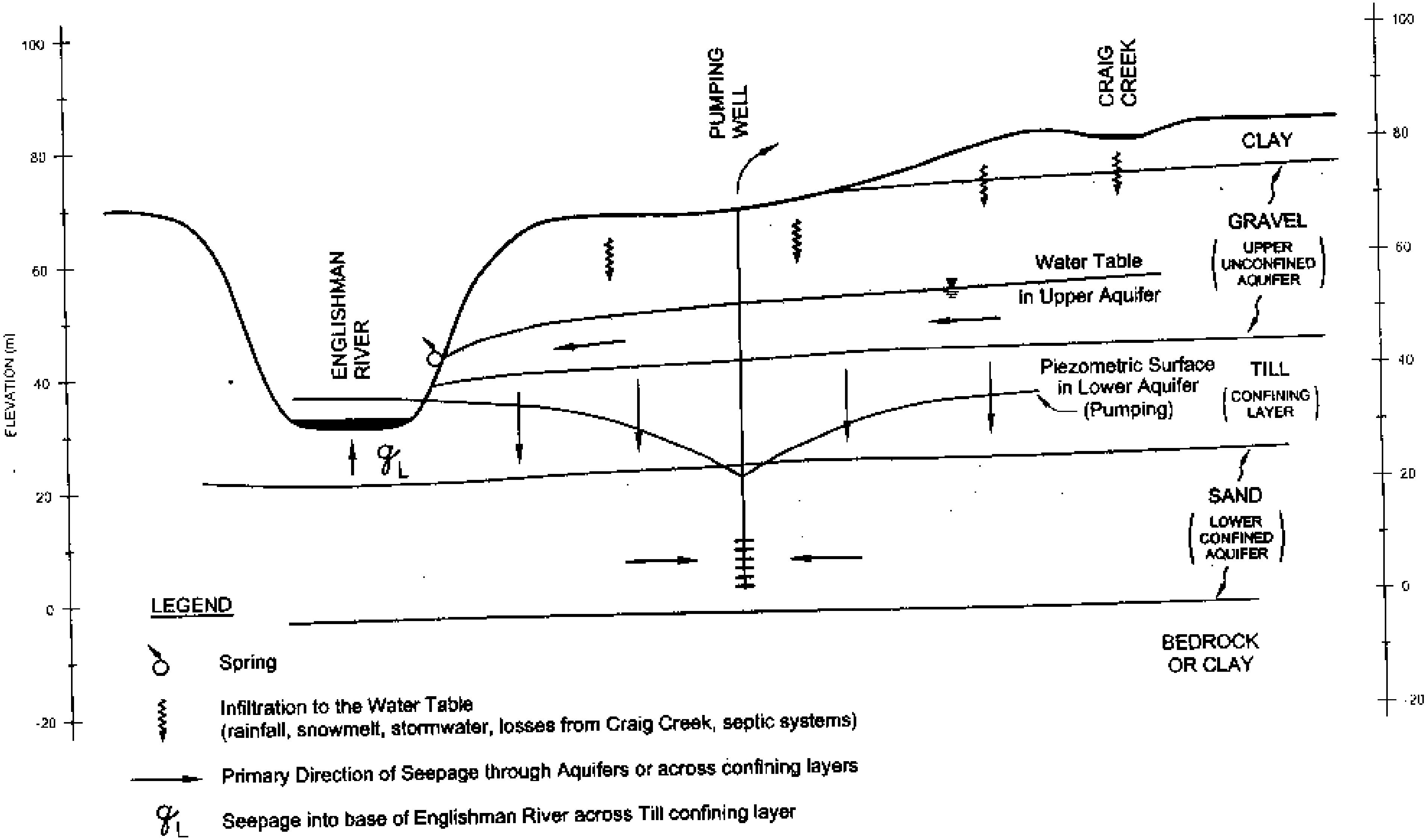
A simplified hydrogeologic interpretation showing the hydraulic interactions between the aquifers and surface water systems during pumping of the Lower Aquifer is presented on Figure 10. The following interpretations are made with reference to the conceptual model.



EBA Engineering Consultants Ltd.						PROJECT	PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY
CLIENT	ENGLISHMAN RIVER LAND CORPORATION					TITLE	DAILY DISCHARGE FROM HARBY ROAD WELL FIELD (2001)
DATE	2002/12/20	DWN.	JAB	CHKD.	JB	FILE NO.	0805-5887561.001 — FIGURE 6



EBA Engineering Consultants Ltd.				PROJECT	PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT: ENGLISHMAN RIVER LAND CORPORATION				TITLE	COMPARISON OF EXISTING AND PROPOSED GROUNDWATER EXTRACTION RATES FROM QUADRA AQUIFERS
DATE: 2002/11/22	DWN. YL	CHKD. JB		FILE: 0805-5887561.001	FIGURE 9



NOTE: Drawing is not to Scale
For conceptual purposes only

EBA Engineering Consultants Ltd.		PROJECT	PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY
CLIENT	ENGLISHMAN RIVER LAND CORPORATION	TITLE	HYDRAULIC INTERACTIONS OF AQUIFERS AND RIVER UNDER PUMPING CONDITIONS
DATE 2002/12/20	DWN. JAB CHKD. JB	FILE NO. 0805-5887561.001	FIGURE 10

Lower Aquifer

- The primary source of recharge to the Lower Aquifer is downwards leakage across the till Confining Layer from the Upper Aquifer;
- Due to the high hydraulic head in the Lower Aquifer, groundwater seeps upward (see Figure 10) into the base of the Englishman River (i.e. the Englishman River is a "gaining stream");
- Upwards leakage into the Lower Aquifer from underlying till, clay or bedrock is neglected resulting in a conservative approach for aquifer recharge;
- Actual field observations suggest that the Lower aquifer may "daylight" on the valley slopes north of the powerline crossing resulting in a localized unconfined aquifer condition. For the purpose of evaluating the sustainability of long-term aquifer pumping, this has been ignored resulting in a more conservative (i.e. lower) assumption of aquifer recharge. However, for the purpose of evaluating the effect of pumping on the river system, the potential for hydraulic communication between the Lower Aquifer and river has been analyzed using a cautionary approach.

Upper Aquifer

- Seepage from the Upper Aquifer discharges on the slopes of the South Englishman and Englishman River valleys which helps maintain summer baseflows in the rivers;
- In response to pumping, there will be downwards vertical water losses from the Upper Aquifer via leakage across the Confining Layer;
- Infiltration of stormwater and discharge from septic systems will add recharge to the Upper Aquifer.

South Englishman and Englishman Rivers

- As noted above, seepage into the rivers from the Lower Aquifer will decrease in response to drawdown caused by pumping.
- Under conditions of pumping the Lower Aquifer, the Upper Aquifer will continue to be an important source of water discharge to the river valleys. Provided stormwater is managed to take advantage of infiltration to the Upper

Aquifer, the amount of water discharging to the river valleys under conditions of subdivision development is not expected to change significantly from presently existing conditions and may actually increase.

Craig Creek

- Across the southern portion of the property Craig Creek is perched atop a layer of till. In this area the creek is hydraulically isolated from the pumped Lower Aquifer by two layers of till and little hydraulic interaction is expected (i.e. pumping of the Lower Aquifer is not expected to have any influence on baseflow).
- Across the northern portion of the property Craig Creek is incised into the Upper Aquifer (see Figures 6 and 7). In this area, stormwater discharged to ground and discharge from septic systems will contribute beneficially to baseflows in Craig Creek.

6.2.3 Aquifer Parameters

Transmissivity (T) and storage coefficient (S) are physical properties of aquifers that govern the release of water from storage and transmission of water. These terms are defined on Figure 11.

Representative values for aquifer parameters determined from analysis of aquifer pumping tests on municipal supply wells constructed in the Quadra Sand in the Parksville area are summarized on Table 4. Mean values for aquifer parameters are as follows:

- Transmissivity 8.7×10^{4} m^2/s
- Hydraulic Conductivity 1.9×10^{4} m/s
- Storativity 2.1×10^{3} (dimensionless)
- Aquifer thickness 7.2 m

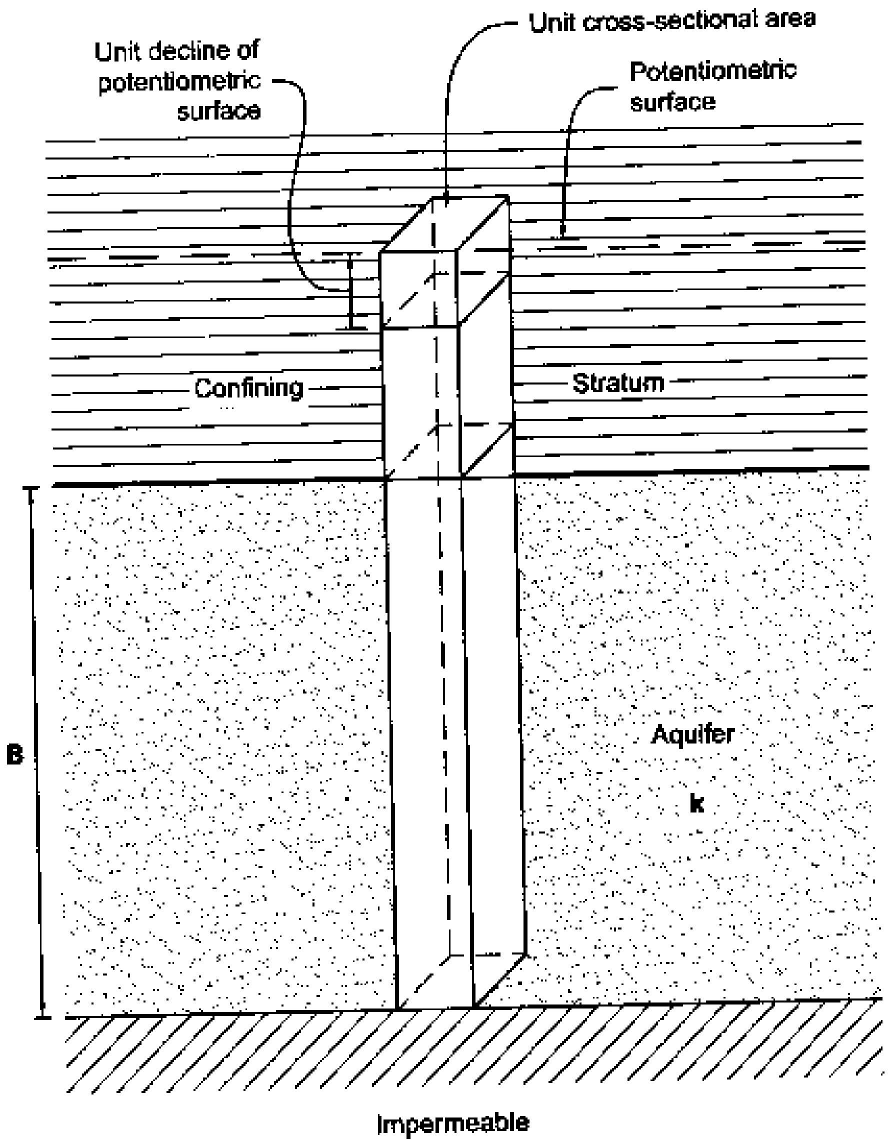
The average aquifer thickness (7.2 m) from this database is somewhat less than the 20 to 30 m thickness interpreted from well logs near the north end of the property. As a general rule, a thicker aquifer is capable of yielding greater quantities of water to wells.

B = Aquifer Thickness

k = Hydraulic Conductivity of Aquifer

T = Aquifer Transmissivity
= kB

S = Storativity
= Amount of water released from storage in aquifer per unit of cross-sectional area under unit decline in potentiometric surface



NOTE: After Freeze and Cherry (1979)

EBA Engineering Consultants Ltd.				PROJECT	PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY
CLIENT	ENGLISHMAN RIVER LAND CORPORATION			TITLE	DEFINITION OF AQUIFER PARAMETERS
DATE 2003/01/03	DWN. JAB	CHKD. JB		FILE NO. 0805-5887561.001	FIGURE 11

TABLE 4
ESTIMATED VALUES OF AQUIFER PARAMETERS FOR QUADRA SANDS

	Mean	Minimum	Maximum	Number of Measurements
Aquifer Data [2]				
Hydraulic Conductivity (m/s) [1]	1.9E-04	2.1E-06	1.4E-03	21
Transmissivity (m^2/d) [1]	8.7E-04	9.3E-05	3.7E-03	21
Storativity [1]	2.1E-03	1.0E-04	3.3E-03	4
Aquifer Thickness (m)	7.2	0.9	45	21
Well Data [2]				
Specific Capacity (L/s/m)	0.78	0.080	2.4	21
Discharge Rating (L/s)	4.5	1.7	12	21
Discharge Rating (USgpm)	72	28	185	21

Note:

1 Geometric mean calculated, otherwise, remainder of mean values are arithmetic means.

2 Data source from a confidential EBA report for wells in Parksville, BC.

Another parameter that is very important to the recharge of the Lower Aquifer under pumping conditions is the vertical hydraulic conductivity of the silty sand till Confining Layer. This parameter, which is very difficult to measure in the field (due to the great expense and effort involved) controls the rate of vertical leakage across the Confining Layer from the Upper Aquifer. Because the Lower Aquifer is "confined" by a till layer, leakage governs the rate of recharge. The rate of leakage from the Upper Aquifer governs the rate at which the aquifer can be pumped over the long-term without causing excessive drawdown and ultimately, dewatering.

EBA recently completed a very detailed pumping test in a confined aquifer overlain by a similar silty sand till confining layer in the Vancouver area (EBA 2002c). This test involved pumping an aquifer for a period of 8 weeks and observing the hydraulic response in over 80 monitoring wells including numerous wells installed in the confining layer. Based on this work a value of 1×10^{-8} m/s for the vertical hydraulic conductivity of the silty sandy till was determined. This value was used in the numerical model for the vertical hydraulic conductivity of the Confining Layer.

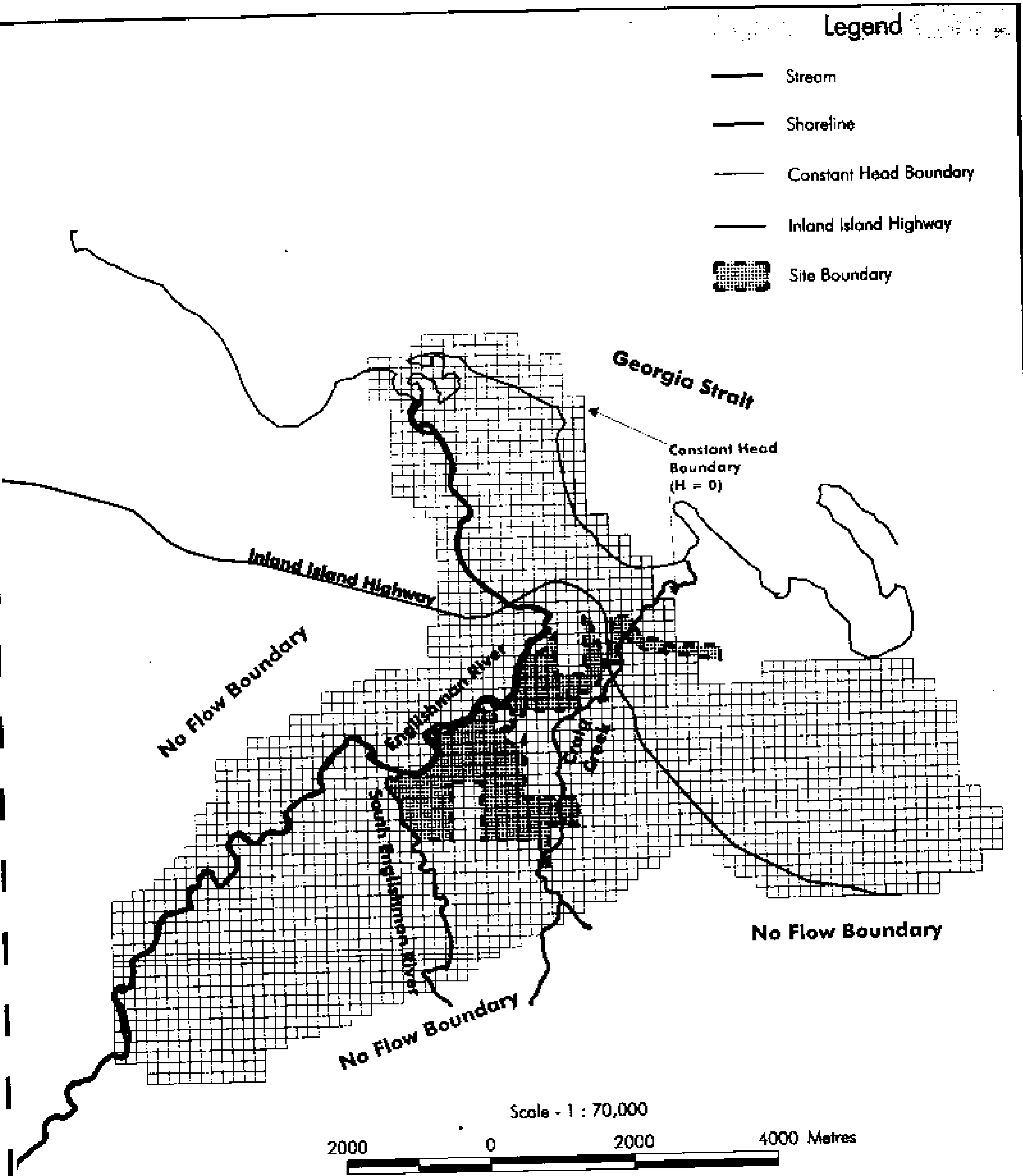
Data from municipal wells in the Parksville area have yields ranging from 28 to 185 USgpm with an average of 72 USgpm. Therefore, it is reasonable to expect that the required demand for the subdivision could be obtained from two wells each pumping at about 51.5 USgpm.

6.2.4 Numerical Groundwater Flow Model

A description of the methodology used to construct and calibrate the numerical groundwater flow model is contained in Appendix C. A brief summary of the approach and discussion of results are provided below.

6.2.4.1 Geometry of Aquifers and Boundary Conditions

The interpreted horizontal extent of the Lower Aquifer and boundary conditions are presented on Figure 12. All boundaries of the aquifer are assumed to be no flow boundaries with the exception of a segment to the north of the property where the aquifer is in direct hydraulic connection with Georgia Strait. No flow boundaries along the perimeter of the Lower Aquifer imply that no recharge



EBA Engineering Consultants Ltd.	PROJECT	PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT: ENGLISHMAN RIVER LAND CORPORATION	TITLE	FINITE DIFFERENCE MESH AND BOUNDARY CONDITIONS FOR LOWER AQUIFER
DATE 2003/01/03 · DWN. YL · CHKD. JB	FILE NO. 0805-5887561.001	FIGURE 12

enters the aquifer from the peripheral regions; all recharge is via leakage from above through the Confining Layer. At the northern limit of the model, the boundary condition is assigned a constant head of 0.0 m corresponding to mean sea level.

A map depicting the thickness of the Lower Aquifer is presented on Figure 13. As shown, there is a lack of data on the continuity and thickness of the Lower Aquifer to the south and southwest of the site. Near the north end of the property, aquifer thicknesses of 20 to in excess of 40 m have been identified from well records.

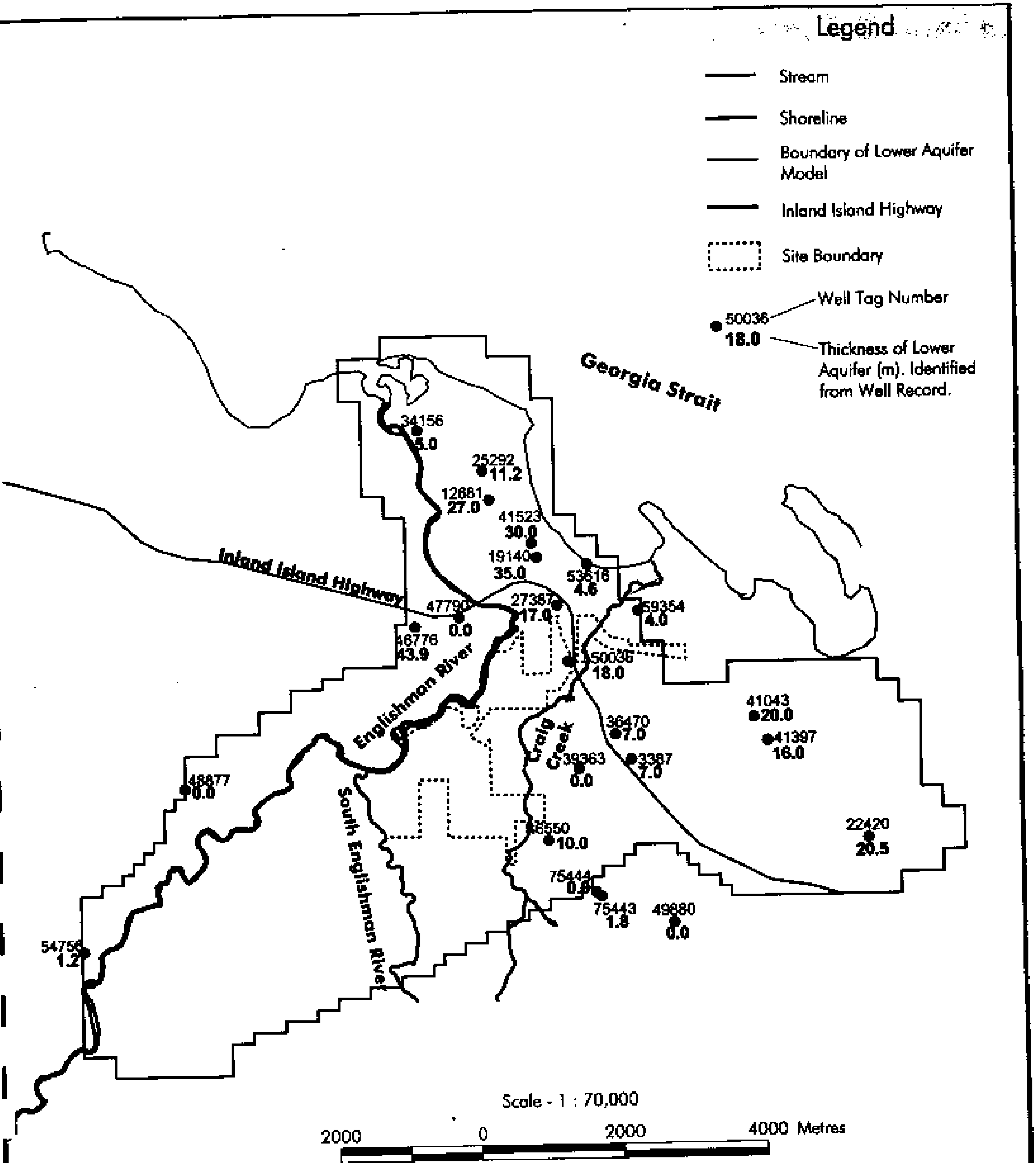
The estimated horizontal extent and boundary conditions assigned to the Upper Aquifer are presented on Figure 14. For the purpose of evaluating the long-term sustainability of Lower Aquifer pumping, the primary role of the Upper Aquifer is to provide a "reservoir" of groundwater supplying vertical leakage across the Confining Layer (refer to Figure 10). Simulation of actual flow conditions in the Upper Aquifer including discharge through a seepage face in the Englishman River valley would require considerable additional data and analysis and is not required in order to answer the terms of reference for this study.

For the reasons discussed above, the boundary conditions for the Upper Aquifer were simplified to include the following processes:

- Areal recharge of 282 mm/yr was applied over the northwestern portion of the Lower Aquifer. This corresponds approximately to the area where granular soils (Upper Aquifer) are exposed at surface. The value of 282 mm/yr for recharge was developed from an estimate of annual recharge in the Parskville area using the Thornthwaite water balance method;

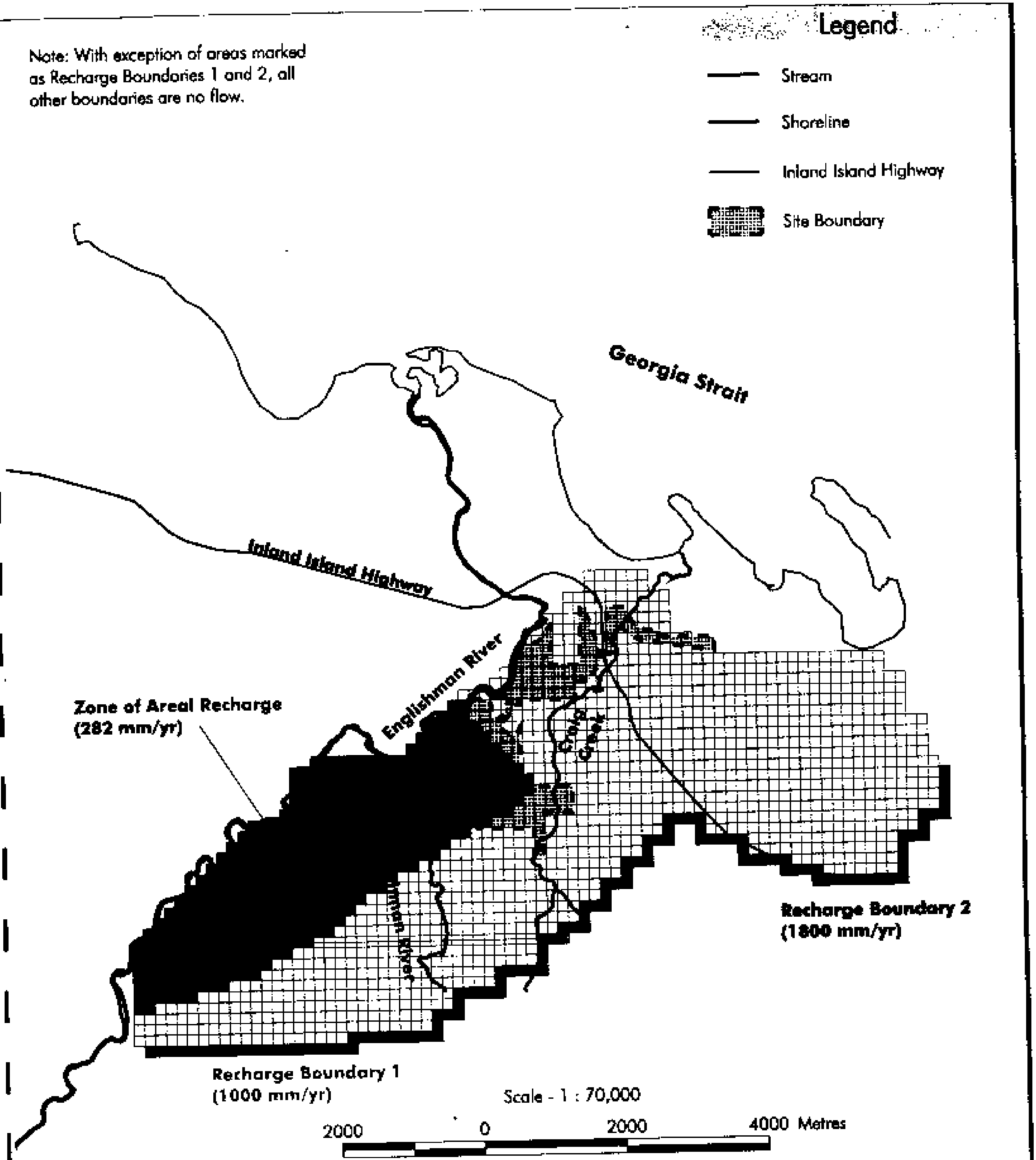
- Areal recharge has not been applied over the remainder of the Upper Aquifer as interpretation of well records indicates that it is covered by a till layer that will limit infiltration rates;

- Recharge has been applied along the southern boundary of the Upper Aquifer. This recharge corresponds to groundwater seepage flowing into the study area from areas to the south. The rates of recharge were developed based upon simple calculations of groundwater flux using Darcy's law and subsequent changes made during calibration of the steady state model.



EBA Engineering Consultants Ltd.	PROJECT: PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT: ENGLISHMAN RIVER LAND CORPORATION	TITLE: INTERPRETED THICKNESS OF LOWER AQUIFER (m)

DATE	DWN.	CHKD.	FILE NO.	
2003/01/03	YL	JB	0805-5887561.001	FIGURE 13



EBA Engineering Consultants Ltd.				PROJECT	PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT ENGLISHMAN RIVER LAND CORPORATION				TITLE	FINITE DIFFERENCE MESH AND BOUNDARY CONDITIONS FOR UPPER AQUIFER
DATE 2003/01/03	DWN. YL	CHKD. JB		FILE NO. 0805-5887561.001	FIGURE 14

6.2.4.2 Aquifer Parameters

Aquifer parameters used in the numerical model were initially selected using the information summarized in Table 4 and were modified, where appropriate, during the calibration stage. Final values used in the calibrated model are described in Appendix C.

6.2.4.3 Model Calibration

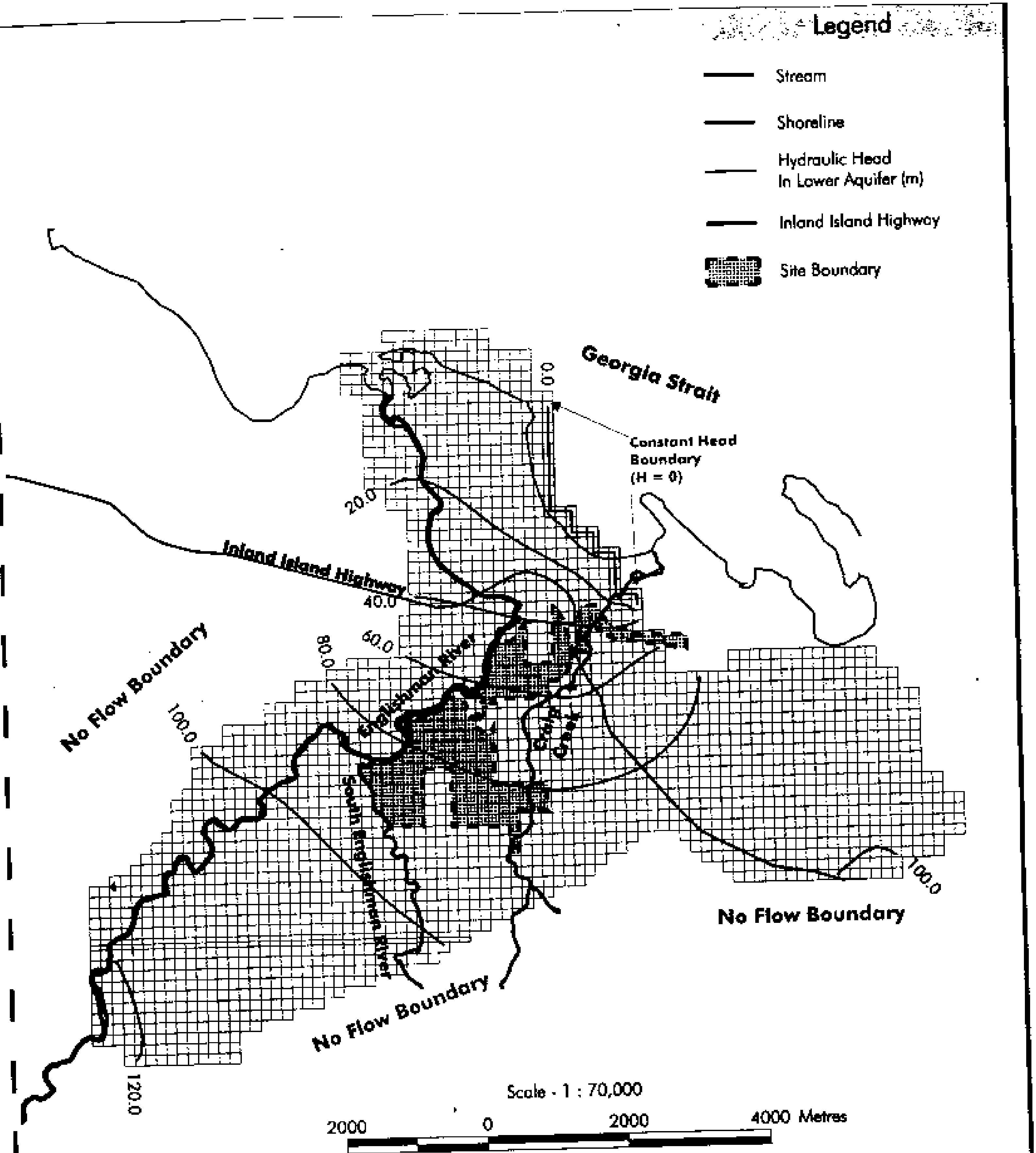
Model calibration refers to the processes whereby adjustments are made to initial values of aquifer parameters, recharge, etc. until a better match to observed conditions is obtained. In this case the model was calibrated to match observed water levels (i.e. hydraulic head) in wells completed in both the Lower Aquifer and Upper Aquifer.

The elevation of the piezometric surface in the Lower Aquifer resulting from the calibrated steady-state (i.e. non-pumping) model is presented on Figure 15. The calibrated steady-state model has a relatively good agreement with actual observed water levels in Lower Aquifer wells.

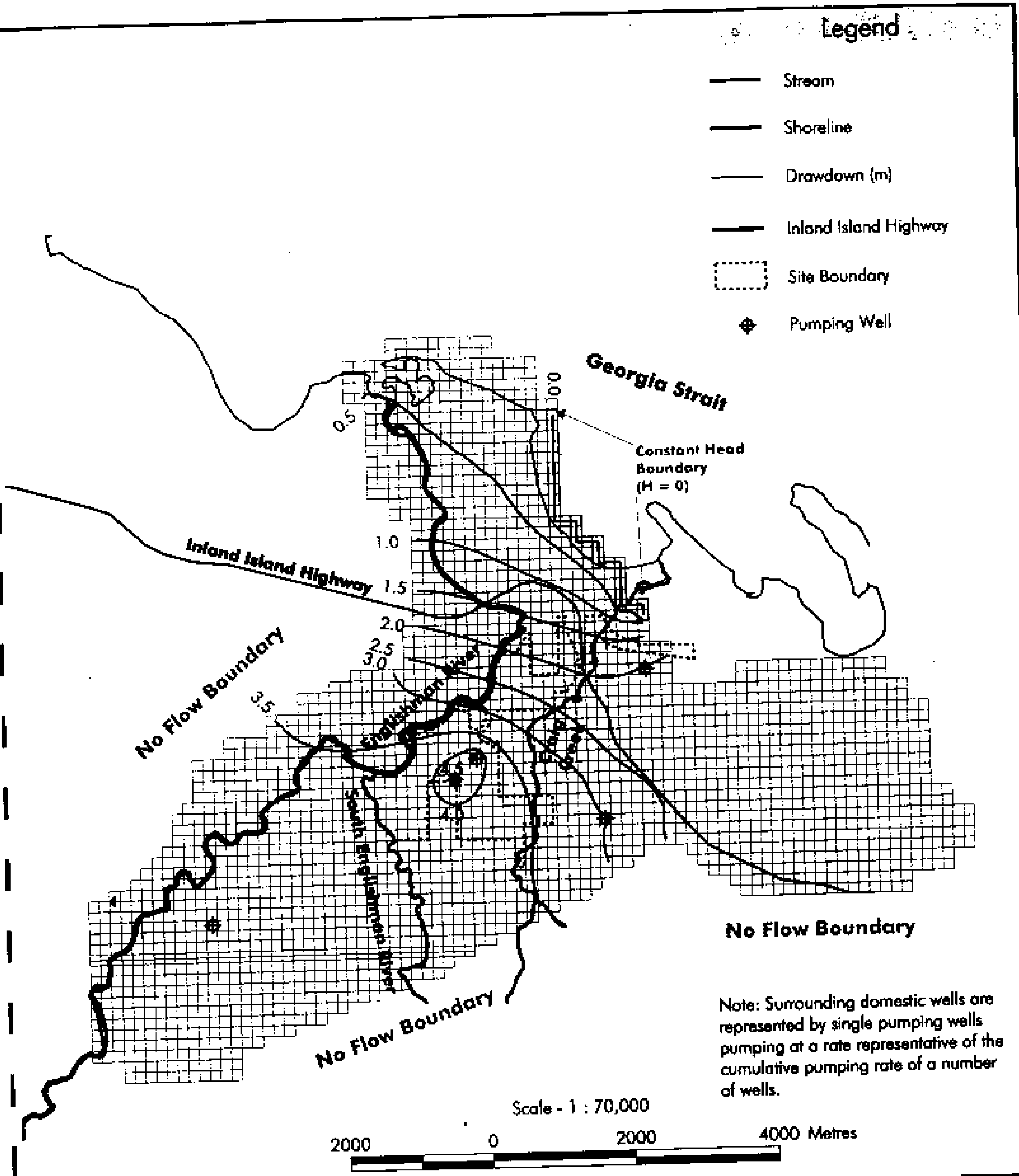
6.2.4.4 Simulation of Long-Term Pumping

As described previously, due to relatively recent changes (i.e. December 2002) in the number of proposed lots, the simulation of long-term pumping was carried out using a pumping rate of 120 US gpm (based on 180 lots).

Contours of predicted drawdown in the Lower Aquifer after 50 years of pumping are presented on Figure 16. It is noted that drawdown in the Lower Aquifer will have essentially equilibrated to the changes induced by pumping in a period much less than 50 years. In other words, pumping for 75 or 100 years or longer would not produce significantly different estimated drawdowns than those shown on Figure 16.



EBA Engineering Consultants Ltd.		PROJECT: PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT: ENGLISHMAN RIVER LAND CORPORATION		TITLE: HYDRAULIC HEAD IN LOWER AQUIFER (STEADY STATE, NON - PUMPING)
DATE 2003/01/03	DWN. YL / CHKD. JB	FILE NO. 0805-5887561.001 / FIGURE 15



Note: Surrounding domestic wells are represented by single pumping wells pumping at a rate representative of the cumulative pumping rate of a number of wells.

EBA Engineering Consultants Ltd.			PROJECT	PRELIMINARY HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY
CLIENT ENGLISHMAN RIVER LAND CORPORATION			TITLE	ESTIMATED DRAWDOWN IN LOWER AQUIFER AFTER 50 YEARS OF PUMPING
DATE 2003/01/03	DWN. YL	CHKD. JB	FILE NO. 0805-5887581.001	FIGURE 16

The pumping of the Lower Aquifer by existing domestic wells was included in the simulation presented on Figure 16. Based on the distribution of existing wells shown on Figure 4, groups of wells were represented by a single pumping well in these areas pumping at the aggregate rate of all wells. For the purpose of this analysis, it was assumed that each domestic well pumps at a rate of 2 USgpm. Therefore, for example, if 10 domestic wells were located in a particular region, these were replaced by one well pumping at 20 USgpm.

As shown on Figure 16, maximum drawdowns of up to 3.5 m. are predicted near the property boundary. Drawdowns in the order of 1.0 to 2.5 m are predicted as far away as the Island Highway. These drawdowns should, however, be viewed as conservative. Examples of why these drawdown estimates are considered to be conservative include:

- The pumping rate assumed is based on 180 lots, not 160; and,
- A design demand of 3.5 m^3/day/connection has been used while experience suggests that actual average day demand is closer to 1.0 m^3/day/connection.

6.3 Drawdown in Existing Wells

Under certain conditions where a number of wells located in relatively close proximity are pumping from the same aquifer, drawdown produced in the aquifer from the pumping of one well may cause excessive drawdown in neighboring wells. Excessive drawdown may result, for example, in a pump breaking suction, exposing a well screen to air causing fouling or other effects that hamper operation of the well or cause requirements for increased maintenance.

The procedure used to evaluate the effects of pumping the proposed new wells involved first calculating the aquifer drawdown at the positions of existing wells and second, comparing the drawdown with the available drawdown in the existing wells. Available drawdown is the height of the water column in the well less an allowance to maintain submergence of the pump.

Drawdown in the Lower Aquifer was estimated from the numerical model for 50 years of pumping and contour lines depicting drawdown are shown on Figure 16. As an independent check on the results of the model, an analytical solution (Hantush – Jacob) for drawdown in a leaky confined aquifer was also used to determine aquifer drawdown at different radial distances from a pumping well after 20 years and 50 years of pumping. A brief description of the Hantush – Jacob calculations is provided in Appendix D. A summary of the results from the analytical solutions is provided in Table 5 below.

Table 5

Summary of Distance – Drawdown Results from Hantush – Jacob Analysis

Distance to Observation Point from New Pumping Well (m)	Aquifer Drawdown (m)
100	2.8
500	1.2
2000	0.2
Note: Calculations are for pumping a single well at 103 USgpm for 50 years	

The closest domestic wells are located a distance of approximately 500 m from the proposed new wells. Based on the results presented in Table 5 and the drawdown contours shown on Figure 16, drawdowns in the order of 1.0 to 3.5 m may occur at the locations of existing domestic wells.

One nearby domestic well constructed in the Lower Aquifer is the well identified as "Drillwell" (the name of the drilling contractor) on Figure 5. Using this well as an example, the available drawdown is in the order of 30 m. Drawdowns of 1.0 to 3.5 m in this well (due to the proposed pumping) would correspond to about 3 to 12 percent of the available drawdown. Based on our experience, this amount of drawdown would not cause excessive interference or detrimentally effect operation of existing domestic wells.

As shown on Table 5, less drawdown would occur at greater separation from the proposed pumping well(s). As was discussed in Section 6.2, experience has shown that actual demand is typically less than the design demand that was used as a basis for these calculations. It is therefore considered that the actual drawdowns would likely be less than those estimated.

6.4 Effect of Pumping on Surface Water Systems

Based on water levels measured in wells and results from the site reconnaissance it is apparent that groundwater from the Lower Aquifer discharges into the Englishman River system. In other words, the river is a "gaining stream". As a result of aquifer pumping, the amount of seepage reporting to the river will decrease as water is captured by the pumping wells. A portion of this water will return to the river via the Upper Aquifer following discharge of domestic wastewater from septic systems and subsequent renovation of the effluent in the ground. The method used to estimate changes in river flows due to groundwater pumping was as follows:

1). The quantity of water seeping to the river under existing (i.e. non-pumping) conditions was determined;

2). The reduction in seepage to the river as a result of pumping was determined; and

3). The resulting reduction in river baseflow was determined and compared to low flows gauged in the Englishman River.

It is recognized that two cases apply to river discharge from the Lower Aquifer.

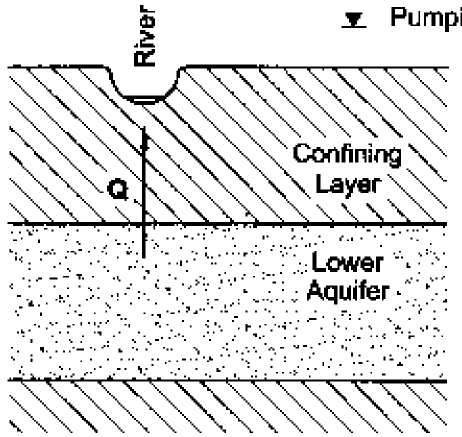
Case 1: Along the southern reach of the study area, groundwater flows upward across the till Confining Layer. This is the case shown on Section AA' (Figure 5).

Case 2: Along the northern reach of the study area, groundwater flows directly from the Lower Aquifer into the river. This is the case shown on Cross Section BB' (Figure 6).

The conceptual models and supporting calculations for groundwater seepage into the river for Case 1 and Case 2 are presented on Figure 17. In both cases, conservative assumptions have been used. The results are compared to low flows in the Englishman River and to the design water demand on Table 6.

▼ Non-pumping head in Lower Aquifer

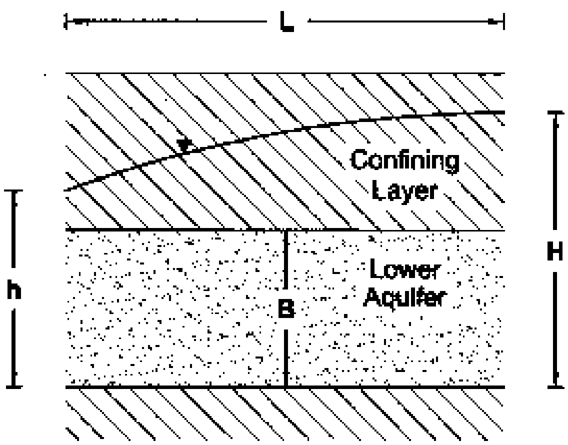
▼ Pumping head in Lower Aquifer



	Definition	Non-pumping	Pumping
Q	Seepage Flow	0.0299 m^3/s	0.0279 m^3/s
K	Vertical Hydraulic Conductivity of Confining Layer	$1x10^{-8}$ m/s	
i	Upward Hydraulic Gradient	4.4 m/m	4.1 m/m
A	Width of River *X* Length of River Valley where Aquifer is confined	680,000 m^2 (200m X 3400m)	

$$Q = KiA$$

A. Section of Confined Lower Aquifer



CONFINED FLOW FROM A LINE SOURCE TO A DRAINAGE TRENCH

	Definition	Non-pumping	Pumping
Q	Seepage Flow	0.0286 m^3/s	0.0229 m^3/s
X	Length of River Valley where Aquifer is unconfined	1000 m	
K	Hydraulic Conductivity of the Lower Aquifer	$1x10^{-4}$ m/s	
B	Thickness of the Lower Aquifer	20 m	
H	Hydraulic Head in the Lower Aquifer	30 m	28 m
h	Hydraulic Head in the Lower Aquifer at the River	20 m	
L	Distance to where no Drawdown is produced by Drainage Trench (assumed to be distance to well 50036 from edge of River Valley as shown on Figure 6)	700 m	

$$Q = \frac{XKB(H - h)}{L}$$

B. Section of Unconfined Lower Aquifer

REF: Powers, J.P., 1992, Construction Dewatering New Methods and Applications

EBA Engineering Consultants Ltd. eba			PROJECT	PRELIMINARY HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY	
CLIENT ENGLISHMAN RIVER LAND CORPORATION			TITLE	METHODOLOGY FOR CALCULATING REDUCTION OF SEEPAGE FLOW TO ENGLISHMAN RIVER UNDER PUMPING CONDITIONS	
DATE 2003/01/03	DWN. JAB	CHKD. JS	FILE NO.	0805-5887561.001	FIGURE 17

Table 6

Comparison of Seepage to Englishman River Under Pumping and Non-Pumping Conditions

Low Flow in Englishman River		1.26 m^3/s	
Design Water Demand (160 lots)		0.0064 m^3/s (103 USgpm)	
	Non-Pumping	***Pumping***	***Difference***
Flow to river along confined section of river (Case 1) (m^3/s)	0.030	0.028	0.002
Flow to river along unconfined section of river (Case 2) (m^3/s)	0.029	0.023	0.006
Total Reduction in seepage to River (m^3/s)			0.008

As shown above, the total estimated reduction in seepage to the river under pumping conditions is 0.008 m^3/s. This estimate is slightly in excess of the design water demand (0.0064 m^3/s) which suggests that the calculations probably overestimate the reduction in seepage. To put these results in the context of the river low flows, pumping could potentially result in a reduction of the river low flow from 1.260 m^3/s to 1.252 m^3/s, a reduction of about 0.6%. This reduction is not considered to be appreciable and is likely within the accuracy of the river gauge. A reduction of this magnitude is not anticipated to detrimentally effect use of the river for aquatic habitat.

7.0 CONCLUSIONS

The primary conclusions made from this study are as follows:

1. A regionally extensive confined aquifer of Quadra Sand (Lower Aquifer) has been identified beneath the study site. Similar aquifers are used extensively for municipal water supply on the east coast of Vancouver Island between Lantzville and Courtenay serving as the primary water source for in excess of 10,000 people.

2. Hydraulic analysis indicates there is a very high probability that the Lower Aquifer can sustain long-term pumping to meet the required demand of the proposed 160 lot subdivision.

3. Review of water quality data from wells pumping from the Quadra Sand indicates the groundwater should be well-suited for domestic consumption. Depending on local aquifer water quality, iron and manganese, which have guidelines in water supplies for aesthetic reasons, may require treatment.

4. Based on computer simulations and analytical solutions, long-term pumping (i.e. 50 years) of the Lower Aquifer to meet the design requirements of the subdivision (3.5 m^3/day/connection) may produce drawdowns in the order of 2 to 4 metres in existing domestic wells located in the Lower Aquifer and directly adjacent to the proposed subdivision. This represents about 3 to 12 percent of the 30 m of available drawdown in these wells and is not anticipated to cause extensive interference or detrimentally effect operation of existing wells. Less drawdown would occur in wells at increasing distance from the proposed subdivision. As experience has shown that actual average water demand in the study area is closer to 1 m^3/day/connection, actual drawdowns would probably be significantly less.

5. Long-term pumping of the Lower Aquifer is not anticipated to significantly effect flows in the Englishman River, South Englishman River or Craig Creek. This is due to the presence of a confining layer of clay or till that significantly attenuates hydraulic interaction between the surface water systems and the Lower Aquifer.

6. The flows in Englishman River, South Englishman River and Craig Creek (particularly the low flows) will also be influenced by absorption of wastewater and stormwater. This is due to the fact that the Upper Aquifer will absorb wastewater and

stormwater from the proposed development and the Upper Aquifer is in direct hydraulic communication with the South Englishman River and Englishman River through seepage zones and springs in the river valley and with the lower portions of Craig Creek through the water table.

8.0 RECOMMENDATIONS

It is understood that if re-zoning of Block 564 proceeds, ERLC will proceed with subdivision application and will create a water utility. Responsibility for operation of the utility will then be assumed by RDN.

Based on this understanding, two recommendations follow from this study.

1. As part of the requirements to create a water utility, it will be necessary to prove the water source. This will involve the drilling of one or more production wells, performing an aquifer pumping test(s) and analyzing water samples to determine water quality. It is recommended that following completion of this field work, the conclusions of this report be reviewed in light of the new information to ensure that the assumptions and conclusions of this report remain valid.

2. The Englishman River and Craig Creek are important aquatic habitat and adequate baseflows in these systems are important for fish survival. Groundwater discharge from the Upper Aquifer is significant in maintaining adequate baseflows and the methods used in managing stormwater from the proposed subdivision are important in the water balance for this aquifer. For these reasons it is recommended that stormwater management for the proposed subdivision take maximum advantage of the ability of the granular soils exposed on site to infiltrate stormwater and maintain baseflows in the rivers and streams.

9.0 ACKNOWLEDGMENTS

Brent Kapler of Englishman River Land Corporation provided much assistance with logistical arrangements during this study and assisted in collecting background information on water quality and well records.

Attendees at the Stakeholders' information meeting in Parksville on December 11, 2002 provided valuable comments on water-related issues and we have attempted to address all relevant points made during the meeting in this report.

The numerical groundwater model in this report was prepared by Shelley Bayne, M.Sc. and Thierry Carriou, M.Sc., P.Eng. of EBA. Preparation of graphics in this report was done by York Law and Jon Bokic.

Respectfully submitted,

EBA ENGINEERING CONSULTANTS LTD.

PROFESSIONAL PROVINCE OF Jan 8/03 JOHN BALFOUR BRITISH COLUMBIA ENGINEER

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Reviewed by:

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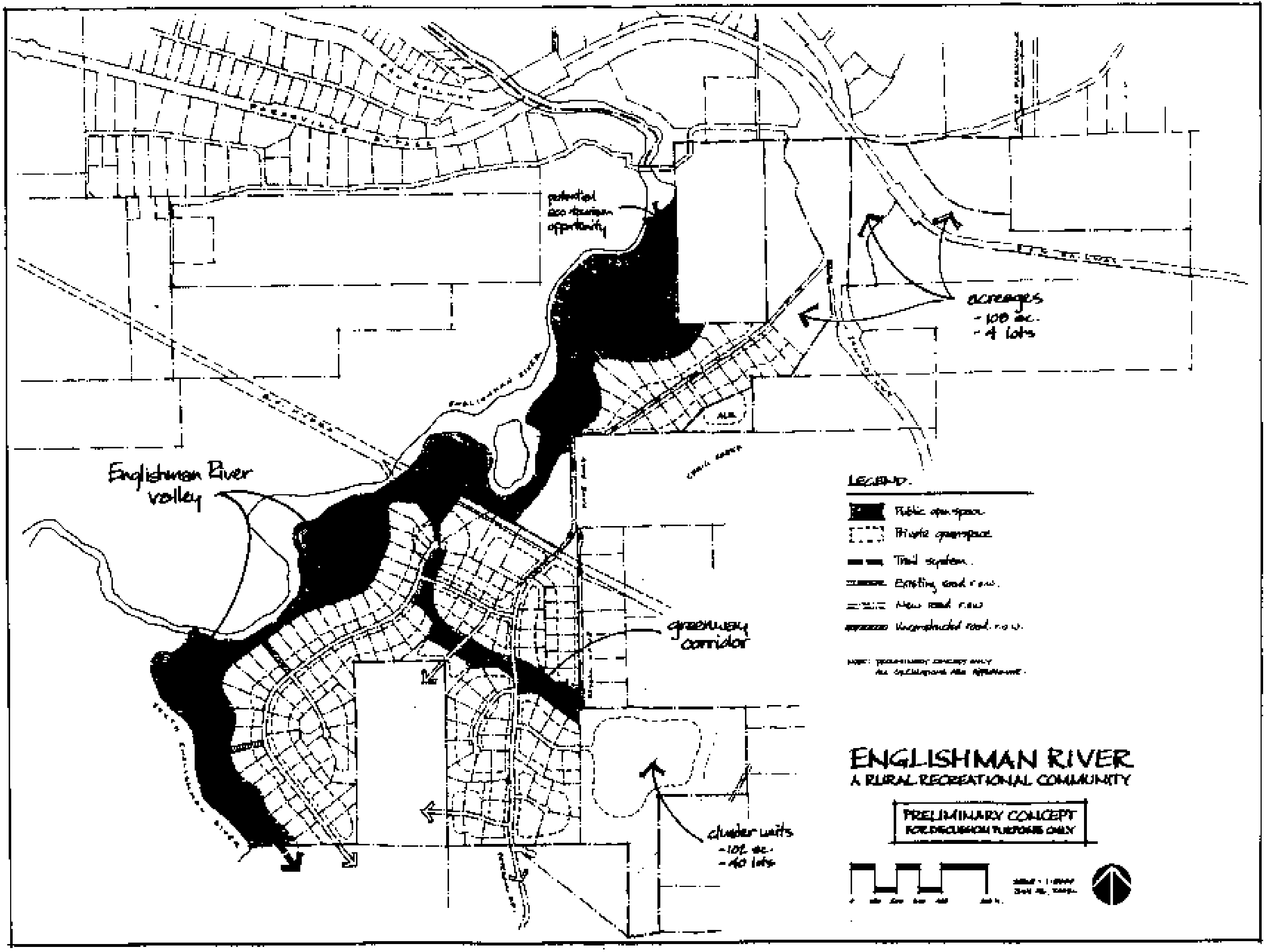
APPENDIX A

Conceptual Layout for Subdivision


ENGLISHMAN RIVER
A RURAL RECREATIONAL COMMUNITY
PRELIMINARY CONCEPT
FOR DISCUSSION PURPOSES ONLY
LEGEND.
Public open space.
Private openspace.
Trail system.
Existing road r.o.w.
New road r.o.w.
Unconstructed road r.o.w.
Englishman River valley
potential eco-tourism opportunity
acreages
-108 ac.
-4 lots
greenway corridor
cluster units
-102 ac.
-40 lots
ENGLISHMAN RIVER

APPENDIX B

Water Quality Test Reports

CHEMICAL ANALYSIS REPORT

Date: January 2, 2003

ALS File No. S2657a

Report On: Englishman River Water Analysis

Report To: **EBA Engineering Consultants Ltd.**
Fifth Floor, Suite 500
1100 Melville Street
Vancouver, BC
V6E 4A6

Attention: **Mr. John Balfour**, Senior Hydrogeologist

Received: November 21, 2002

ALS ENVIRONMENTAL
per:

Miles Gropen, B.Sc. - Project Chemist
Heather A. Ross-Easton, B.Sc. - Project Chemist

REMARKS

File No. S2657a

The submitted water samples met the Canadian Drinking Water Guidelines for all parameters analysed.

RESULTS OF ANALYSIS - Water File No. S2657a

Sample ID		D.O.T. W. Scale Well A
Sample Date		02 11 20
Sample Time		12:30
Physical Tests		
Colour	(CU)	<5
Conductivity	(uS/cm)	279
Total Dissolved Solids		159
Hardness	CaCO3	113
pH		8.06
Turbidity	(NTU)	1.9
Dissolved Anions		
Alkalinity-Total	CaCO3	121
Chloride	Cl	10.8
Fluoride	F	0.08
Sulphate	SO4	9
Nutrients		
Nitrate Nitrogen	N	<0.1
Nitrite Nitrogen	N	<0.1
Total Metals		
Aluminum	T-Al	<0.01
Antimony	T-Sb	<0.0005
Arsenic	T-As	<0.001
Barium	T-Ba	<0.02
Boron	T-B	<0.1
Cadmium	T-Cd	<0.0002
Calcium	T-Ca	31.2
Chromium	T-Cr	<0.002
Copper	T-Cu	0.10
Iron	T-Fe	0.21
Lead	T-Pb	0.007
Magnesium	T-Mg	8.6
Manganese	T-Mn	0.007
Mercury	T-Hg	<0.0002
Potassium	T-K	0.8
Selenium	T-Se	<0.001
Sodium	T-Na	11
Uranium	T-U	<0.0001
Zinc	T-Zn	0.09

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

Appendix 1 - REGULATORY CRITERIA

File No. S2657a

Health Canada

Summary of Guidelines for Canadian Drinking Water Quality, April 2002.
All limits are Maximum Acceptable Concentration (MAC) unless otherwise indicated.
Limits expressed as milligrams per litre except pH, Turbidity, Colour, and Coliform Bacteria.

		Lower Limit	Upper Limit		Notes
Physical Tests					
Colour	(CU)	-	15	CU	1
Total Dissolved Solids		-	500	mg/L	1
Hardness	CaCO3	-	-		2
pH		6.5	8.5		1
Turbidity	(NTU)	-	5	NTU	1, 4
Dissolved Anions					
Chloride	Cl	-	250	mg/L	1
Fluoride	F	-	1.5	mg/L	
Sulphate	SO4	-	500	mg/L	1, 5
Nutrients					
Nitrate Nitrogen	N	-	10.0	mg/L	
Nitrite Nitrogen	N	-	1.0	mg/L	
Total Metals					
Antimony	T-Sb	-	0.006	mg/L	6, 7
Arsenic	T-As	-	0.025	mg/L	6
Barium	T-Ba	-	1.0	mg/L	
Boron	T-B	-	5.0	mg/L	6
Cadmium	T-Cd	-	0.005	mg/L	
Chromium	T-Cr	-	0.05	mg/L	
Copper	T-Cu	-	1.0	mg/L	1, 3
Iron	T-Fe	-	0.3	mg/L	1
Lead	T-Pb	-	0.01	mg/L	3, 7
Manganese	T-Mn	-	0.05	mg/L	1
Mercury	T-Hg	-	0.001	mg/L	
Selenium	T-Se	-	0.01	mg/L	
Sodium	T-Na	-	200	mg/L	1
Uranium	T-U	-	0.02	mg/L	6
Zinc	T-Zn	-	5.0	mg/L	1, 3

1 Aesthetic Objective (AO) (taste, odour, appearance, etc.)
2 Maximum not established, levels > 200 mg/L are considered poor but may be tolerated.
3 At point of consumption.
4 1 NTU maximum allowed for water entering distribution systems.
5 There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L.
6 Interim Maximum Acceptable Concentration (IMAC)
7 First drawn water may be high, flush system before sampling.

Appendix 2 - METHODOLOGY File No. S2657a

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Colour in Water

This analysis is carried out using procedures adapted from APHA Method 2120 "Color". Colour (true colour) is determined by filtering a sample through a 0.45 micron membrane filter followed by analysis of the filtrate using the platinum-cobalt colourimetric method.

Recommended Holding Time:
Sample: 2 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Conductivity in Water

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

Recommended Holding Time:
Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Solids in Water

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total dissolved solids (TDS) and total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter. TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius. TSS is determined by drying the filter at 104 degrees celsius. Total solids are determined by evaporating a sample to dryness at 104 degrees celsius. Fixed and volatile solids are determined by igniting a dried sample residue at 550 degrees celsius.

Recommended Holding Time:
Sample: 7 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Appendix 2 - METHODOLOGY (cont'd) File No. S2657a

Conventional Parameters in Water

These analyses are carried out in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA). "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

pH in Water

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

Recommended Holding Time:
Sample: 2 hours
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Turbidity of Water

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

Recommended Holding Time:
Sample: 2 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Alkalinity in Water by Colourimetry

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

Recommended Holding Time:
Sample: 14 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Appendix 2 - METHODOLOGY (cont'd) File No. S2657a

Dissolved Anions in Water by Ion Chromatography

This analysis is carried out using procedures adapted from APHA Method 4110 "Determination of Anions by Ion Chromatography" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Anions are determined by filtering the sample through a 0.45 micron membrane filter and injecting the filtrate onto a Dionex IonPac AG17 anion exchange column with a hydroxide eluent stream. Anions routinely determined by this method include: bromide, chloride, fluoride, nitrate, nitrite and sulphate.

Recommended Holding Time:
Sample: 28 days (bromide, chloride, fluoride, sulphate)
Sample: 2 days (nitrate, nitrite)
Reference: APHA and EPA
For more detail see ALS Environmental "Collection & Sampling Guide"

Fluoride in Water

This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode.

Recommended Holding Time:
Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:
Sample: 6 months
Reference: EPA

Appendix 2 - METHODOLOGY (cont'd) File No. S2657a

For more detail see: ALS "Collection & Sampling Guide"

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorption and/or fluorescence spectrophotometry (EPA Method 7470A/7471A/245.7).

Recommended Holding Time:
Sample: 28 days
Reference: EPA
For more detail see ALS Environmental "Collection & Sampling Guide"

End of Report

APPENDIX C

Description of Methodology and Assumptions Used for Numerical Model

(In Preparation)

APPENDIX D

Summary of Drawdown Calculations Using Analytical Solutions

Appendix D

Analytical Solutions for Aquifer Drawdown Using Cooper-Jacob and Hantush Methods

Background

Analytical solutions developed by Cooper and Jacob (1946)[i] and Hantush and Jacob (1955)[ii] were used to estimate the drawdown in the Lower Aquifer at selected distances from the proposed pumping wells. Analytical solutions use mathematical equations that have been derived to represent specific conditions of flow within the subsurface. Each analytical method is restricted by certain assumptions that usually over simplify the true conditions within an aquifer. The use of the solutions in this case, however, provides a means of completing an independent verification of the estimated drawdowns derived from the numerical model.

To facilitate the calculation of the drawdown in the aquifer, EBA has assumed that there is a single pumping well operating that extracts 6.32×10^{-3} m^3/s (103 USgpm) over a course of 20 years and 50 years. The aquifer parameters used in our calculations are derived from our summary of Quadra Sand aquifer parameters included in Table 4 in the main body of the text. In the case of the leaky aquifer solution (Hantush and Jacob), a value of 1×10^{-8} m/s has been used for the vertical hydraulic conductivity of the confining layer.

Cooper-Jacob Analytical Solution

The Cooper-Jacob solution is an approximation of the Theis (1935)[iii] solution for a confined aquifer and is governed by the same assumptions as Theis. These assumptions are as follows:

1) The aquifer is uniform in character and the hydraulic conductivity is the same in all directions;
2) The aquifer is uniform in thickness and infinite in area;
3) The formation receives no recharge from any source;
4) The pumped well penetrates the full thickness of the aquifer;
5) The water removed from storage is discharged instantaneously when the head is lowered;
6) The pumping well is 100% efficient;
7) All water removed from the well comes from aquifer storage;
8) Laminar flow exists in the well and aquifer; and,
9) The piezometric surface has no slope prior to pumping.

The Cooper-Jacob solution is represented by the following equation:

$$s = \frac{0.183Q}{T} \log \frac{2.25Tt}{r^2S}$$

Where: s = drawdown in m, Q = pumping rate in m^3/day, T = transmissivity in m^2/day, S = storativity, r = distance in m from the centre of a pumped well to where the drawdown is measured and t = time since pumping started in days

The accuracy of this approximation is typically within 1% of the Theis solution when u<0.03 (small radial distance or large time) where $u = r^2S/4Tt$. For each value of r and t used, the u value was less than 0.03 (largest value of u was 0.001).

Hantush-Jacob Analytical Solution

This solution assumes that pumping has continued for a significant period of time and that most of the groundwater flowing to the pumping well originates from water leaking through the confining layer. The assumptions upon which this solution is based are summarized below.

1) The confined aquifer has been assumed to be horizontal and extends infinitely in a radial direction. The confined aquifer and confining layer are homogeneous and isotropic.
2) The initial piezometric surface in the confined aquifer is horizontal and extends infinitely in the radial direction. The piezometric surface in the unconfined aquifer (overlying the confining layer) is horizontal and extends infinitely in the radial direction. The water level in the unconfined aquifer remains constant during pumping.
3) Groundwater density and viscosity are constant.
4) Groundwater flow can be described by Darcy's Law.
5) Groundwater flow in the confining layer is vertical and in the pumped aquifer is directed radially towards the well. (This assumption is valid when $m'/B<0.1$.)
6) The pumping and observation wells are screened over the entire aquifer thickness.
7) The pumping rate is constant.
8) Head losses through the well screen and pump intake are negligible.
9) The pumping well has an infinitesimal diameter.
10) The confined aquifer is compressible and completely elastic. The confining layer is incompressible.
11) Storage in the confining layer is neglected.

The Hantush-Jacob method is represented by the following equations:

$$s = \frac{Q}{2\pi T} K_0\left(\frac{r}{B}\right) \qquad where: \quad B^2 = \frac{Tm'}{K'}$$

and where K_o is obtained from the leaky well function of r/B, m' = thickness of the confining layer in metres and K' = vertical hydraulic conductivity through the confining layer. The data table summarizing values of K_o was obtained from Fetter (1994).

Results

The Cooper-Jacob approximation suggests that the well will induce a drawdown within the lower aquifer of approximately 6.1m at 100m from the pumping well, 4.5m at 500m from the pumping well and 3.1m at a distance of 2000m from the well after 20 years of pumping. EBA also calculated the Cooper-Jacob approximation for a well pumping for 50 years and found that the drawdown increased to approximately 6.6m at 100m from the pumping well, 5m at 500m from the pumping well and 3.6m at a distance of 2000m from the pumping well.

The Hantush-Jacob solution suggests that the well will induce a drawdown within the lower aquifer of approximately 2.8m at 100m from the pumping well, 1.2m at 500m from the pumping well and 0.2m at 2000m from the pumping well.

A summary of the results is attached in Table D1.

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[i] Cooper, H.H., and Jacob, C.E. (1946), *A Generalized Graphic Method for Evaluating Formation Constants and Summarizing Well Field History*. Transactions, American Geophysical Union, Vol. 27, No. 4, pp. 526-534.

[ii] Hantush, M.S. and Jacob, C.E. (1955), *Non-steady Radial flow in an Infinite Leaky Aquifer*, Transactions, American Geophysical Union, Vol. 36, No. 1, pp. 95-100.

[iii] Theis, C.V. (1935), *The relation between lowering of the piezometric surface and rate and duration of discharge of a well using groundwater storage*. Transactions, American Geophysical Union, V.2, pp. 519-524.

Table D1: Results of Cooper-Jacob and Hantush-Jacob Analytical Solutions

TIME PERIOD	DISTANCE TO OBSERVATION POINT FROM NEW PUMPING WELL	COOPER-JACOB METHOD [1]	HANTUSH-JACOB METHOD [2]
	(m)	DRAWDOWN (m)	DRAWDOWN (m)
20 YEARS	100	6.1	2.8
	500	4.5	1.2
	2000	3.1	0.2
50 YEARS	100	6.6	2.8
	500	5.0	1.2
	2000	3.6	0.2

1 Cooper, H.H., and Jacob, C.E. (1946), A Generalized Graphic Method for Evaluating Formation Constants and Summarizing Well Field History. Transactions, American Geophysical Union, Vol. 27, No. 4, pp. 526-534.

2 Hantush, M.S. and Jacob, C.E. (1955), Non-steady Radial flow in an Infinite Leaky Aquifer, Transactions, American Geophysical Union, Vol. 36, No. 1, pp. 95-100.

APPENDIX C

NUMERICAL GROUNDWATER MODEL

Appendix C

Description of Methodology for Development of a Numerical Groundwater Model, Block 564, Parksville, BC

This technical appendix is supplied as an Addendum to EBA's report titled "Preliminary Hydrogeological Assessment of Water Supply for Proposed Rural Residential Subdivision, Block 564, Parksville, BC" dated January, 2003. This appendix describes the methodology used to develop a numerical groundwater model. The model was used to assess the response of a confined aquifer to long term pumping.

Model Development

EBA gathered and reviewed all available information pertaining to geologic, hydrologic, climatologic and topographic conditions in the vicinity of the proposed area of development (the Property). Using this information, EBA developed a conceptual hydrogeologic model of subsurface conditions in the vicinity of the Property.

The purpose of the conceptual model was to identify relevant features and parameters that would influence the development of a 3D numerical groundwater model for the area. This included the following: thickness and areal extent of each aquifer, potential boundary conditions, and recharge/discharge zones. Construction of the conceptual model also allowed EBA to thoroughly review existing data available to calibrate the model.

The numerical model was created using ModFlow software. Three distinct layers, simulating the Upper Aquifer, confining layer and Lower Aquifer were utilized. The areal extent and thickness of the Upper Aquifer and confining layer were discretized using available borehole data. Due to limited stratigraphic data, the lateral extent and thickness of the Lower Aquifer was not descretized using borehole data. Instead, the cross-sectional profile of the Lower Aquifer along Section AA[1] (Figure 5 of main text of report) was assumed to be constant throughout the model. This cross-section was projected northeast and southwest along the Englishman River valley based upon the slope of the confining layer. Limited borehole data suggest the Lower Aquifer pinches out towards the east, along Georgia Strait, but extends north and south along the coastline (as per the results of the aquifer mapping program completed by the BC Ministry of Water, Lands and Air Protection).

The initial aquifer boundaries were defined utilizing EBA's understanding of the overall hydrogeologic setting. The boundaries were then modified during model calibration, (as necessary) to remain consistent with the conceptual model. EBA applied areal (vertical) recharge over approximately 25% of the Upper Aquifer where the aquifer does not appear to be overlain by glacial till. The areal recharge values applied were derived from a water balance estimation (Thornthwaite method) completed as part of a previous EBA study of the Parksville area. EBA also applied lateral recharge to the Upper Aquifer along the southern aquifer boundary. The lateral recharge rates initially applied to the model were calculated using the Darcy equation. Hydraulic gradient, hydraulic conductivity and aquifer thickness assumptions were obtained from existing well information along the south aquifer boundary. Lateral recharge rates were modified during model calibration (as necessary) to optimize the predictive accuracy of the model. EBA chose not to apply areal recharge to the Lower Aquifer, instead we allowed the numerical model to calculate vertical leakage through the confining layer, as this seemed the most conservative approach (due to the lack of available calibration data). In the adopted steady state model, recharge to the Lower Aquifer occurs only via leakage through the confining layer.

Discharge from the model is represented by a constant head line boundary along Georgia Strait in the northeastern portion of the Lower Aquifer. Due to limited hydrogeologic interpretations available regarding the Englishman River and Craig Creek, these were not explicitly simulated in the numerical model at this time. Our understanding of the hydraulic interaction between the Lower Aquifer and Englishman River suggests the model predictions will be conservative[1] due to this assumption.

Model Calibration

The first stage of model calibration was to establish a "steady state" base model. Under steady state, conditions are static and representative of the equilibrium reached in the recharge, leakage and discharge sources in the groundwater regime. EBA selected three existing wells completed within the Lower Aquifer and one existing well completed within the Upper Aquifer as hydraulic head calibration locations for the numerical model. In the absence of project specific field data, EBA utilized water levels from the original well logs of the BC Ministry of Water, Lands and Air Protection Water Well (BCMWLAP) database.

Following each consecutive model calibration run, EBA compared the piezometric levels reported in the BCMWLAP well logs with the numerical model output. The model calibration accuracy was calculated from piezometric head comparisons using residual mean, absolute mean and normalized root mean square (RMS) error. EBA modified the model parameters[2] until an optimum level of accuracy was attained. EBA relied exclusively upon static water level calibration for this model. Transient head calibration could not be performed due to a lack of aquifer test (i.e. pump test) data. Water balance calibration of the model (i.e. Englishman River baseflow) was beyond the scope of this preliminary investigation. Table C-1 outlines the hydrogeologic parameters used in the adopted steady state numerical model.

[1] The drawdowns predicted by the model from the pumping of the Lower Aquifer will likely be greater than actual observations, due to zero recharge to the Lower Aquifer from the rivers.

[2] Parameters modified during calibration included lateral recharge to the Upper Aquifer, confining layer hydraulic conductivity and discharge boundary constant head.

The adopted steady-state model suggests the northern arm of the aquifer controls discharge to Georgia Strait through physical constriction of the aquifer (decreased width and thickness). Observations by EBA suggest the lower reach of the Englishman River may actually be a discharge zone for the Lower Aquifer.

Sensitivity Analysis

A brief analysis of the numerical model was undertaken to establish which hydrogeologic parameters are most sensitive. Sensitivity analysis helps to identify which areas of the model require additional data or refinement. Table C-2 summarizes the sensitivity runs conducted as part of this analysis. EBA varied hydraulic conductivity, recharge and discharge constant heads as part of the analysis.

The sensitivity analyses suggest that increasing the hydraulic conductivity of the Upper Aquifer, confining layer, and Lower Aquifer reduces the piezometric head estimation error. However, increase of the hydraulic conductivity beyond the adopted model values results in "dewatered" (i.e. dry cell) conditions. Dewatered conditions result from too much lateral flow in the Upper and Lower Aquifer and excessive leakage through the confining layer. The sensitivity analysis suggests a steady-state water balance of approximately 15,000 m^3/day through the model (i.e. recharge and discharge equal to 15,000 m^3/day) is optimal. This water balance results in an estimation error of about +11m (Table 2) based upon the four observation points. On average, the model is expected to over estimate piezometric heads by about 11m. This adopted steady-model was used as the basis for all transient simulations.

Transient Simulations

Transient simulations were performed to quantify changes in the groundwater regime (i.e. water level, groundwater flow direction, gradients and water balance) from the extraction of groundwater from the aquifer.

Transient models were developed using a staged approach. The initial goal of the transient model was to simulate presently existing long-term groundwater extraction from the Lower Aquifer. This was simulated by assigning a fixed pumping rate[3] to three "image" wells, located in the centroid of areas with concentrations of pumping wells (according to the BCMWLAP database). The simulations were run for a period of 20 years to simulate drawdowns within the aquifer to the present day. Once these conditions were established, EBA inserted two new pumping wells into the model at their approximate design locations (to service the proposed subdivision). This transient model was run for a period of 50 years to simulate the effects of additional long-term pumping on the local groundwater regime. Each proposed pumping well was set to extract water at a conservative rate of 327 m^3/day (60 USgpm). This is equivalent to a design water

[3] The pumping rate assigned to the image wells was equal to 17, 5 and 7 m^3 /day (total extraction rate of 29 m^3/day) based upon an assumption of 1 m^3/day per existing connection.

demand of 3.5 m^3/day/connection for a 180 lot subdivision. The total rate of groundwater extraction from the model, including existing and proposed wells is estimated at 683 m^3/day.

The results of the transient model suggest current groundwater extraction from the aquifer induces a maximum drawdown of about 0.3m at the existing "image" well pumping centers. The maximum drawdown within the boundary of the Property from current pumping is estimated at about 0.1m. The 50 year simulation of pumping from two new wells in the proposed subdivision suggests a maximum drawdown of about 5m will be induced at the proposed wells. This drawdown is equivalent to approximately 10 - 15% of available drawdown beneath the Property. The simulation results also suggest that drawdowns up to 4m may be experienced in the existing domestic wells directly adjacent to the proposed subdivision (along Rascal Lane). This represents about 7 to 13% of the available drawdown in these wells. Based upon our current understanding of the aquifer, drawdown will likely decrease with increasing distance from the proposed subdivision towards the northeast. Drawdown in the Lower Aquifer will likely remain at about 4m towards the southwest.

Numerical Model Verification

EBA also completed analytical modeling to verify the validity of the output provided by numerical modeling. Drawdown versus distance from each well estimated using simplified aquifer geometry (e.g. constant thickness, infinite areal extent, zero recharge, etc.) and two analytical equations, Cooper-Jacob[4] and the Hantush-Jacob[5]. These results were explained in Appendix D of the report. The results of the analytical solutions bracketed the results of the numerical analysis. Although, the results from the numerical analysis were slightly closer to those of the Hantush-Jacob solution, as is expected, due to the assumed leaky nature of the aquifer. Table C-3 presents the predicted drawdowns in the numerical model observation wells.

Limitations

This groundwater model was developed based upon information available at the time the work was conducted. It is believed to suitably represent a conservative estimate of the response of long-term pumping of the Lower Aquifer.

As identified in the recommendations of the report, if the rezoning application does proceed, it will be necessary at the subdivision stage to provide proof of the water supply involving the drilling and testing of wells on the property. At that time, the findings of the report should be reviewed in light of the new information to ensure that the assumptions and conclusion remain valid.

---

[4] The Cooper Jacob equation assumes the aquifer is fully confined (zero leakage) and that time and distance results in a "u" factor less than 0.02.

[5] The Hantush Jacob equation assumes the aquifer is leaky and that the "r/B" factor exceeds 0.01.

Table C-1: Model Parameters

Model Parameter	Value
Upper Aquifer	
Hydraulic Conductivity	1×10^{-4} m/s
Specific Storage	7×10^{-4} /m
Specific Yield	0.25
Effective Porosity	0.25
Total Porosity	0.3
Confining Layer	
Hydraulic Conductivity	1×10^{-8} m/s
Specific Storage	1×10^{-4} /m
Specific Yield	0.2
Effective Porosity	0.2
Total Porosity	0.25
Lower Aquifer	
Hydraulic Conductivity	1×10^{-4} m/s
Specific Storage	7×10^{-4} /m
Specific Yield	0.25
Effective Porosity	0.25
Total Porosity	0.3

Note: Model parameters were selected based on aquifer parameters as outlined in the report and were then calibrated within the model.

TABLE C-2: RESULTS OF SENSITIVITY ANALYSIS

MODEL PARAMETERS							OUTPUT									
HYDRAULIC CONDUCTIVITY			RECHARGE BOUNDARY			CONSTANT HEAD	WATER BALANCE		HEAD DIFFERENCE							
UPPER AQUIFER	CONFINING LAYER	LOWER AQUIFER	AREAL RECHARGE	SOUTH BOUNDARY	SOUTHEAST BOUNDARY	OCEAN	TOTAL IN	TOTAL OUT	UPPER AQUIFER	LOWER AQUIFER			ERROR			
									WTN 46550	WTN 50036	WTN DWELL	WTN 3367	RESIDUAL MEAN	ABSOLUTE MEAN	NORMALIZED RMS
[m/s]	[m/s]	[m/s]	[mm/yr]	[mm/yr]	[mm/yr]	[m]	[m³/d]	[m³/d]	[m]	[m]	[m]	[m]	[m]	[m]	[%]
SENSITIVITY ANALYSIS															
3E-04	1E-08	1E-04	262.8	1,500	1,600	0	Upper Aquifer Dry		No Output Results						
3E-04	1E-08	1E-04	262.8	1,806	1,608	0	10,724	10,725	-	15	-9	-42	-12	22	34
3E-04	1E-08	1E-04	262.8	2,826	1,608	0	23,560	23,560	31	46	32	2	28	28	42
3E-04	1E-08	1E-04	262.8	2,826	2,828	0	34,143	34,143	43	55	44	17	40	40	56
CONSTANT HEAD SENSITIVITY ANALYSIS															
3E-04	1E-08	1E-04	262.8	2,000	1,800	0	20,600	20,600	15	39	20	-9	16	20	31
3E-04	1E-08	1E-04	262.8	2,000	1,800	10	20,634	20,634	19	44	25	-8	21	23	37
3E-04	1E-08	1E-04	262.8	2,000	1,800	20	20,945	20,943	30	54	35	6	31	31	46
UPPER AQUIFER SENSITIVITY ANALYSIS															
1E-04	1E-08	1E-04	262.8	2,000	1,800	0	20,634	20,637	32	44	36	4	29	29	43
3E-04	1E-08	1E-04	262.8	2,000	1,800	0	20,600	20,600	15	39	20	-9	16	20	31
5E-04	1E-08	1E-04	262.8	2,000	1,800	0	Upp. and Low. Aquifer dry		No Output Results						
1E-03	1E-08	1E-04	262.8	2,000	1,800	0	Upper Aquifer Dry		No Output Results						
CONFINING LAYER SENSITIVITY ANALYSIS															
3E-04	*3E-09*	1E-04	262.8	2,000	1,800	0	20,634	20,634	49	41	26	6	31	31	46
3E-04	*1E-08*	1E-04	262.8	2,000	1,800	0	20,600	20,600	15	39	20	-9	16	20	31
3E-04	*3E-08*	1E-04	262.8	2,000	1,800	0	Upper Aquifer Dry		No Output Results						
LOWER AQUIFER SENSITIVITY ANALYSIS															
3E-04	1E-08	3E-05	262.8	2,000	1,800	0	20,634	20,634	113	124	121	89	112	112	150
3E-04	1E-08	1E-04	262.8	2,000	1,800	0	20,600	20,600	15	39	20	-9	16	20	31
3E-04	1E-08	3E-04	262.8	2,000	1,800	0	Upper Aquifer Dry		No Output Results						
CALIBRATED STEADY STATE RUN															
1E-04	1E-08	1E-04	262.8	1,000	1,800	0	18,444	18,442	8	32	14	-13	11	17	25

TABLE C-3: AVAILABLE DRAWDOWN IN LOWER AQUIFER OBSERVATION WELLS

WELL ID	WELL DEPTH		SCREEN COMPLETION		STATIC WATER LEVEL		HEIGHT OF WATER COLUMN	ESTIMATED INTERFERENCE FROM NEW WELLS	% OF AVAILABLE DRAWDOWN
	feet	metres	feet	metres	feet	metres	metres	metres	
50036	176	54.3	174	53.0	100	30.5	22.6	1.9	8%
3387	212	64.6	210	64.0	90	27.4	36.6	2.5	7%
LOT B (Drillwell)	116	35.4	106	32.3	10	3.0	29.3	3.8	13%

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

November 18, 2002

EBA File: 0805-5887561

Texada Land Corporation
1100 - 938 Howe Street
Vancouver, BC
V6Z 1N9

Attention: Mr. Brent Kapler

Subject: Proposed Subdivision Block 564

Introduction

This report is further to site inspection carried out on October 23, 2002 by Nigel Skermer, P.Eng. of EBA Engineering Consultants Ltd., accompanied by Brent Kapler. The weather was clear and access to the sites on foot were relatively unimpeded. A total of 6 hours was spent onsite inspecting riverside slopes. In general, the land is flat to gently sloping, except on the northwest and west boundaries where it borders respectively on the Englishman River and South Englishman River. Good exposures of soil were seen in gravel pits and on steep slopes flanking the river in places.

A more detailed description on the site is provided in the text of the main report, where airphoto interpretation is presented.

The purpose of this investigation is to assess potentially hazardous conditions as required by the Ministry of Transportation. This is an overview assessment for planning purposes. Detailed geotechnical investigation of plans for development of individual lots may differ from the broad recommendations contained herein, as discussed later.

Site Conditions

In general the site presents excellent foundation conditions with well drained sands and gravels overlying very dense salty sandy glacial till. No indications of major slope instability were observed anywhere on the site. In a few places on steep slopes of some of the promontories above the floodplain of the river, minor spalling of the hard glacial till was observed. This, however, appears to be a gradual process and the rate at which retrogression is taking place should not affect building development provided the appropriate setback distances are observed. This is dealt with further in the report. .

Details of some of the observations are discussed with respect to sites A to F and the lots shown in Figure 1.

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Site A - Lot 3

This is a promontory overlooking the floodplain of the Englishman River. It is about 30 m high and the uppermost slopes are as steep as 80 - 90 percent in places. A cap of sand, gravel cobbles and boulders overlies the hard silty sandy glacial till. Apart from minor spalling of the till on the west face of the promontory the site appear stable. It is not undercut by the river.

Site B - Lot 4

Although proposed only as public open space, this site presents good soil exposures. A trail leads down to the river where a backwater channel joins the main stem of the river. Soils exposed are sands and gravels over the hard glacial till which at river level is underlain by a lower sequence of sands and gravels. No seepage from the slopes was observed. Photos 1 and 2 show soil conditions at this location. Photo 2 shows the spalling process in the silty sandy glacial till typical of the conditions seen elsewhere in places.

Site C - Lot 7

This location is on the backwater channel of the Englishman River and again it is proposed open space. The crest of the slopes displays gradual sloughing 2 - 3 m high over colluvial slopes of 70 - 75 percent. No large scale instability is seen.

Site D - Lots 8 and 9

This is a promontory facing northwest over the floodplain of the Englishman River. An old access trail traverses the slope from top to bottom. Minor seepage was observed at the foot of the slope below the powerline to the north. Slopes are roughly 70 - 75 percent. No signs of instability were observed. Two (2) lots are proposed here.

Site E - Lot 12

This area is just downstream of the confluence of the South Englishman River with the main stem of the Englishman River. A rough vehicle trail runs due west down from the upper benchland to the confluence area and floodplain. The bottom of the trail is marked by notices "Soggy Bottom" and "Stairway to Heaven", probably mountain bike signs. Halfway down "Soggy Bottom" trail the Englishman River runs close to the base of the slope with very steep drop offs to the river channel. In times of peak flooding the river could undercut the slope. A view looking west up the river from this location is shown in Figure 3. This site is the only area where significant amounts of seepage were observed. Seepage starts at the base of the upper sand and gravel and is seen emerging from the glacial till in a number of places along the trail marked "Soggy Bottom". Minor sloughing of the slopes is seen, although no large scale slope instability was observed. This is the one area, however, where more accurate survey of setback distances will be needed, see below.

Site F - Lot 16

This area is on the east flank of the South Englishman River where the ground is rising gradually towards the south boundary of the property. The slope flanking the river is benched, probably as a result of ancient down cutting by the river during deglaciation. No signs of instability are seen and the slopes appear quite stable down to the confluence with the main stem of the river.

Recommendations

With appropriate setback distances as outlined below the site is suitable for the proposed development with respect to slope stability.

The crest of the slope at the upper benchland is a well defined break in slope, seen everywhere on site.

- It is recommended for planning purposes that a 15 m setback be established from the existing crest of slope to the foundations of buildings at existing grades.
- However for Site E the setback distance should be established by a line surveyed at a slope of 2 horizontal to 1 vertical from the edge of the river where the river is close to the foot of the slope, or a setback distance of 15 m from the crest of the slope, whichever is greater.
- With the exception of Site E, these setback distances could be relaxed based on detailed investigation for individual lot specific development. Investigation should be performed on behalf of the owner by a registered B.C. professional engineer experienced in geotechnical engineering.

Care should be taken in laying out trails and new roads not to undercut existing slopes. Road drainage should not be discharged over slopes unless in closed pipes. Details of site development concerning slope cuts, fill and site drainage should be reviewed by EBA.

Closure

This assessment of slope stability conditions is based on site inspection. No subsurface investigation as been carried out for this purpose. No warranty expressed or implied by EBA is made that subsurface and characteristics are delineated.

Prepared by:

Nigel Skermer, M.Sc., P.Eng.
Geotechnical Consultant

Reviewed by:

Keith Kosar, Ph.D., P.Eng.
Manager, Geotechnical Group

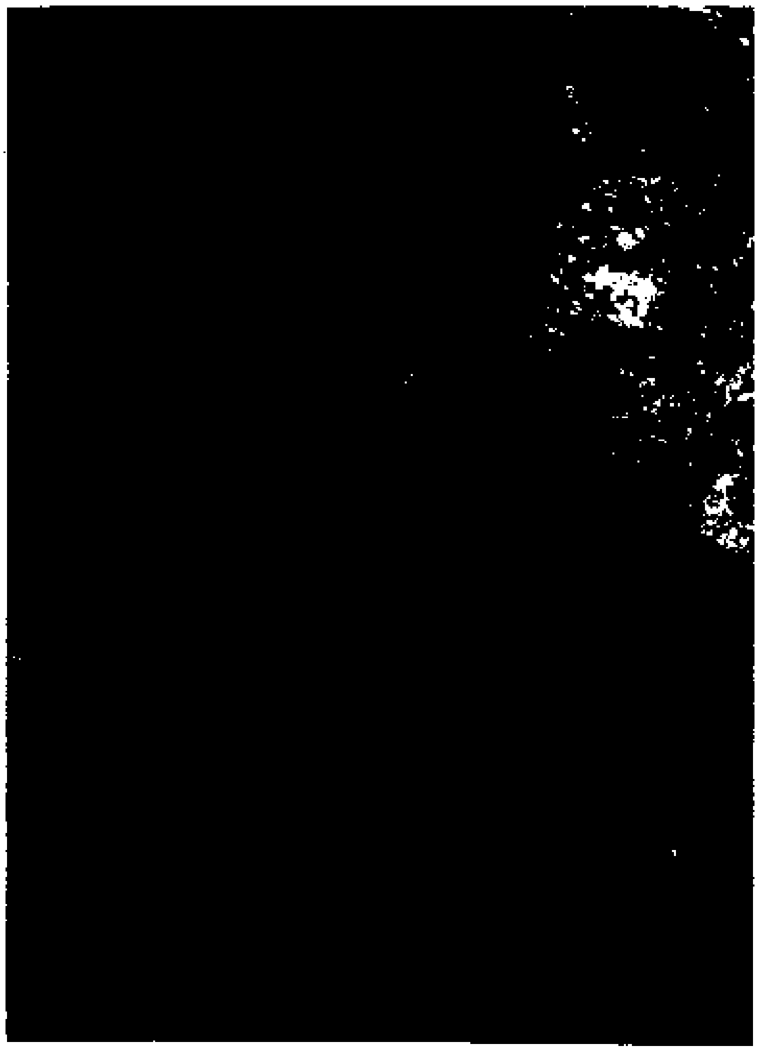


Photo 1: (Above) Site 'B' showing lower sand and gravel at junction of backwater channel and main stem of Englishman River.

Photo 2: (Left) Site 'B' showing near vertical hard silty sandy till and minor spalling off face of deposit.

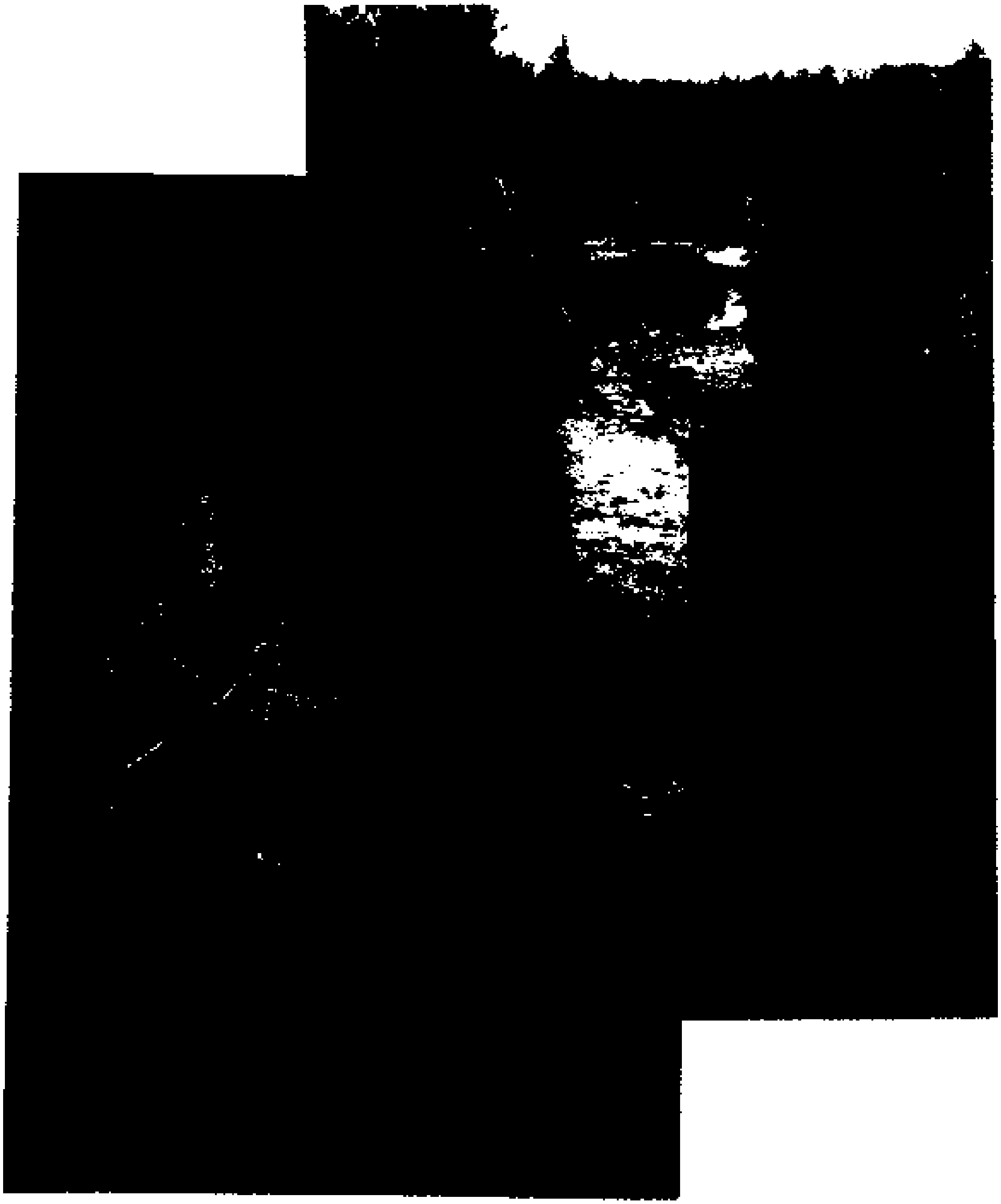
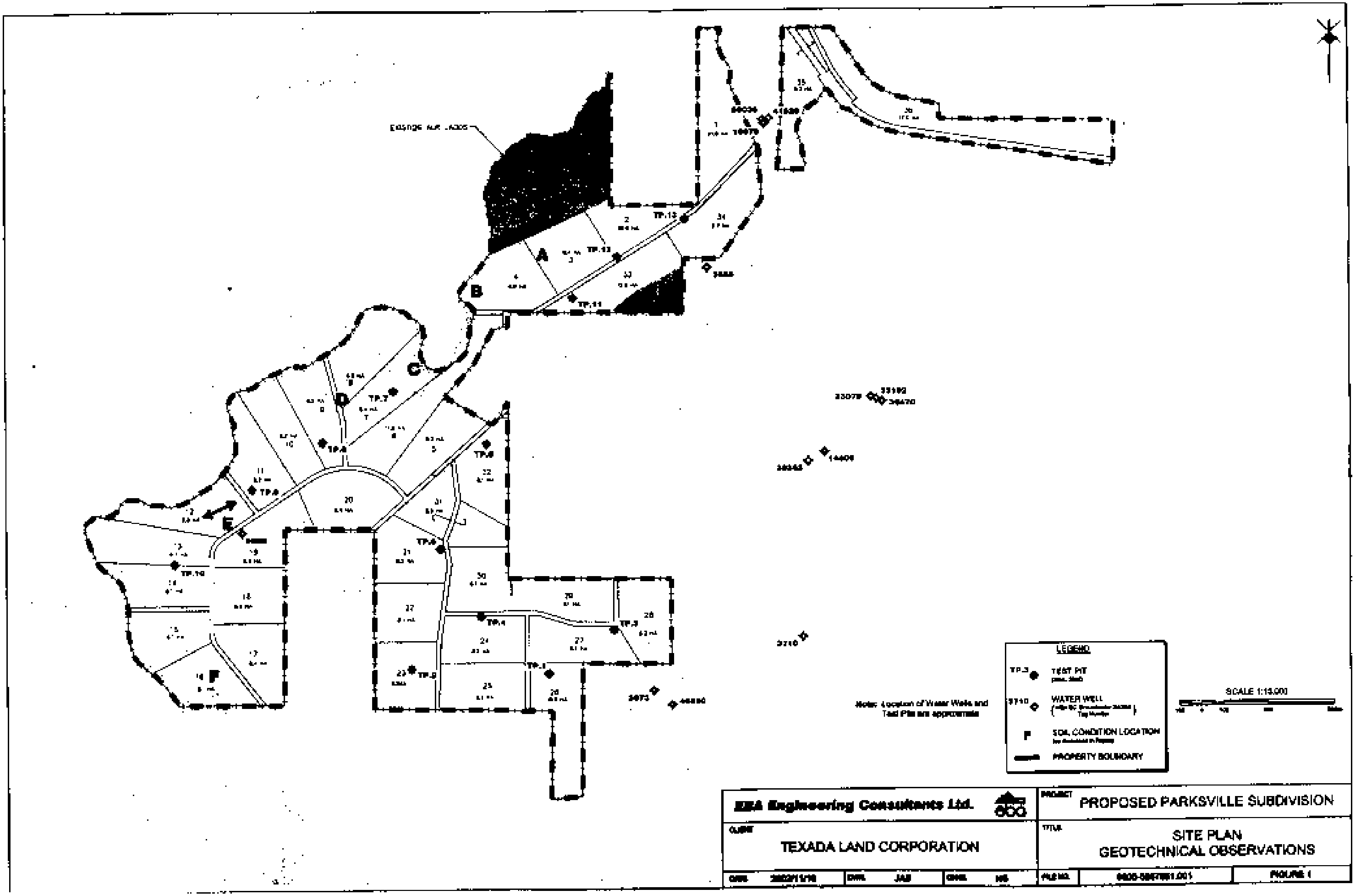


Photo 3: Site 'E' looking up Englishman River from top of very steep bank. View from "Soggy Bottom" trail.


EXISTING AGR. LANDS
A
B
C
D
E
F
TP.13
TP.12
TP.11
TP.7
TP.6
TP.8
TP.9
TP.10
TP.4
TP.3
TP.2
TP.1
33079
33182
36470
14406
3710
LEGEND
TEST PIT
WATER WELL
SOIL CONDITION LOCATION
PROPERTY BOUNDARY
Note: Location of Water Wells and Test Pits are approximate
SCALE 1:15,000
EBA Engineering Consultants Ltd.
CLIENT
TEXADA LAND CORPORATION
PROJECT
PROPOSED PARKSVILLE SUBDIVISION
TITLE
SITE PLAN
GEOTECHNICAL OBSERVATIONS
DATE 2002/11/18
DWN JAB
FIGURE 1

January 20, 2003

EBA File: 0805-5887561.001

Englishman River Land Corporation
1100 - 938 Howe Street
Vancouver, BC
V6Z 1N9

Attention: Mr. Brent Kapler

Subject: Preliminary Stormwater Management Plan Block 564, Parksville, BC

Dear Mr. Kapler:

As requested, EBA Engineering Consultants Ltd. (EBA) have prepared a preliminary conceptual stormwater management plan pertaining to the proposed re-zoning of Block 564, located near Parksville, B.C. The purpose of this report is to describe existing drainage conditions on the property and to identify general principles used in stormwater management. The objective of this report is to provide a concept-level plan for how stormwater may be managed from the proposed 160 lot subdivision.

1.0 BACKGROUND

Englishman River Land Corporation (ERLC) recently purchased a 362 ha property (Block 564, Nanoose District) and has applied to the Regional District of Nanaimo (RDN) to re-zone the property. As originally proposed, the re-zoning included a 40 dwelling unit "cluster" development. Subsequent to public input at the Stakeholder Information Meeting in Parksville during December, 2002, ERLC elected to drop the cluster dwellings and replace these with approximately half the number of 1 ha lots. A preliminary layout plan of the revised proposed residential development is presented on Figure 1.

In response to the re-zoning application, RDN indicated a number of studies to be completed by ERLC that pertain to servicing of the proposed development and environmental studies. The purpose of this report is to describe how stormwater may be managed on the site in accordance with good engineering practice and environmental principles.

2.0 TOPOGRAPHY, SOILS AND DRAINAGE

A site plan illustrating surface topography, shallow soils and drainage features is presented on Figure 2.

Topographically, the site can be divided into three zones. At the southern end of the property, surface slopes range from about 3% to 8%. Across most of the remainder of the property, with the exception of the relatively steep valley slopes, topography is flat-lying (slopes typically less than 1%). On the slopes of the South Englishman River and Englishman River, slopes range from near vertical exposures to less than 10 %.

The type, distribution and thickness of soils on the property have been assessed by field reconnaissance, interpretation of stereo-paired aerial photographs, recording soils observed in 13 test pit excavations and preparation of cross sections using water well records obtained from the provincial government (EBA 2002a, 2002b) (see Figures 3 and 4). Based on this information, it is concluded that sand and gravel soils several metres thick cover the western and northern part of the property (see Figure 2, 3 and 4). In the southern area of the property soils are predominately silty in texture although they are typically covered by a veneer of sand and gravel less than 1 metre in thickness.

The primary drainage features are the South Englishman River, Englishman River and Craig Creek. The Englishman River is used to augment municipal water supply in the area which is derived primarily from groundwater aquifers. All of these surface water systems provide important aquatic habitat for various fish species.

Surface drainage is poorly defined within the boundaries of the property. Two gravel pits (Existing Highways Gravel Pit and Former Gravel Pit east of property, Figure 2) had standing water during the summer of 2002. A former gravel pit located on the property south of the powerlines had a small height of standing water in the base during a survey conducted in November, 2002. A small wetland is located near the southern limit of the property. Roadside ditches along access roads and logging trails are the only other drainage features of significance on the site.

The interpreted drainage divide between Craig Creek and the Englishman River system is presented on Figure 2. In the southern area of the property where silty-textured soils are present, the divide has been estimated from topographic contours. In the northern end of the property the topography is essentially flat and the drainage divide is estimated based on the proximity to Craig Creek and Englishman River. In areas of the property covered by sand and gravel, most drainage (except perhaps during intense storms or under rapid snowmelt conditions) will infiltrate to the water table and flow as groundwater seepage to the river valleys.

Drainage conditions that are reported to be seasonally problematic occur on agricultural land in the vicinity of the former gravel pit directly southeast of the Ministry of Highways gravel pit (Figure 2). Based on discussions with local residents (B. Kapler per. comm.), it is understood that drainage from Rascal Lane and adjacent areas is directed to the vicinity of the former gravel pit at the foot (i.e. north end) of Rascal Lane. This area, which is a local topographic low point, is subject to periodic flooding in the wet season.

3.0 STORMWATER MANAGEMENT PRINCIPLES

The following are general principles for stormwater management in general and specific to conditions at Block 564:

- Maintain existing flows in river systems with particular attention to sustaining low (i.e. base) flows;
- Preserve water quality in the rivers and streams;
- Do not exacerbate existing off-site problematic drainage conditions and improve these where feasible and practical.

The general water balance conditions for the present (i.e. undeveloped) land surface and developed land surface are shown diagrammatically on Figure 5. For the developed land surface, the component of runoff is greater than for the undeveloped land surface due to the presence of roads, roofs, driveways and other hard surfaces. For the case where the runoff is managed, causing runoff water to be infiltrated to ground, the amount of infiltration to the water table will increase relative to the undeveloped land surface. If properly managed, infiltration of stormwater will assist in maintaining or increasing low flows in the river systems via groundwater seepage.

4.0 PRELIMINARY STORMWATER MANAGEMENT PLAN

A stormwater management plan specifies the amount of runoff that will be generated within a development area and details the facilities that will be used to convey and dispose of the stormwater. This preliminary stormwater management plan does not include details on the amount of runoff that will be generated from the proposed development and does not provide details of ditches and culverts that will be used to convey stormwater. The preliminary plan does indicate potential areas and types of facilities that may be used to treat (i.e. remove suspended sediment) and dispose of stormwater. A more detailed storm water management plan will be required as part of the subdivision process.

The basic approach proposed for stormwater treatment and disposal is twofold depending on the soil types present at the site. In areas where sand and gravel is exposed at surface, stormwater will be infiltrated to ground. Facilities used to infiltrate stormwater in these granular soils include the permeable bases of ditches, the former gravel pit located on site, and possibly other structures such as soak-away wells for roof drainage. These soils are judged to have a very high capability to absorb stormwater and the soils will filter any suspended sediment prior to groundwater seepage discharging into the river valleys. In areas where silty-textured surface soils are present, infiltration to ground of concentrated stormwater flows (e.g. road runoff) is not practical or feasible. In these areas it is proposed to either divert stormwater for disposal into the sand and gravel soils for absorption, or to discharge it to wet detention ponds located adjacent to creeks. Wet detention ponds are used to reduce the suspended sediment concentration in the stormwater (as the velocity is reduced in the pond) and the discharge "peaks" associated with the runoff are damped as stormwater surges are slowly released to the creek.

A preliminary concept plan illustrating the proposed stormwater disposal facilities and approximate areas of the subdivision to be served by these facilities is presented on Figure 6. As shown, it is proposed to use the on-site former gravel pit as an infiltration basin. This would serve as a stormwater disposal facility for much of the southern area of the property including all of the developed area within the Englishman River catchment and a portion of the area within the Craig Creek catchment. It is anticipated that diversion of stormwater in the Craig Creek catchment that would otherwise flow to Rascal Lane will assist in ameliorating the existing problematic drainage conditions at the foot (i.e. north end) of Rascal Lane. This will require further investigation during the preparation of a final stormwater management plan to demonstrate that the existing seasonal drainage problem in this area will be improved.

In the southeast corner of the property, a wet detention pond may be utilized to equalize stormwater flows prior to discharge into Craig Creek. Again, it will be necessary to provide the basis for determining the size and shape of this pond and outlet details during the final stormwater management plan.

The north end of the property is underlain by free-draining granular soils and facilities other than ditches may not be required for stormwater disposal. If disposal facilities are required, these may include an infiltration basin or wet detention pond near Craig Creek, depending on local soil conditions and the zoning of lands (e.g. ALR requirements).

5.0 CLOSURE

This report has presented a preliminary "concept-level" plan for management of stormwater for the proposed residential development of Block 564 located near Parksville, B.C. Based on this work, it is concluded that it will be both feasible and practical to manage stormwater on-site from the development, primarily through infiltration to the extensive sand and gravel deposits.

Providing the proposed re-zoning proceeds, it will be necessary to complete further detailed analysis during the subdivision process for the final stormwater management plan for the site.

Respectively submitted,

EBA ENGINEERING CONSULTANTS LTD.

Prepared by,

John Balfour, P.Eng.
Senior Hydrogeologist

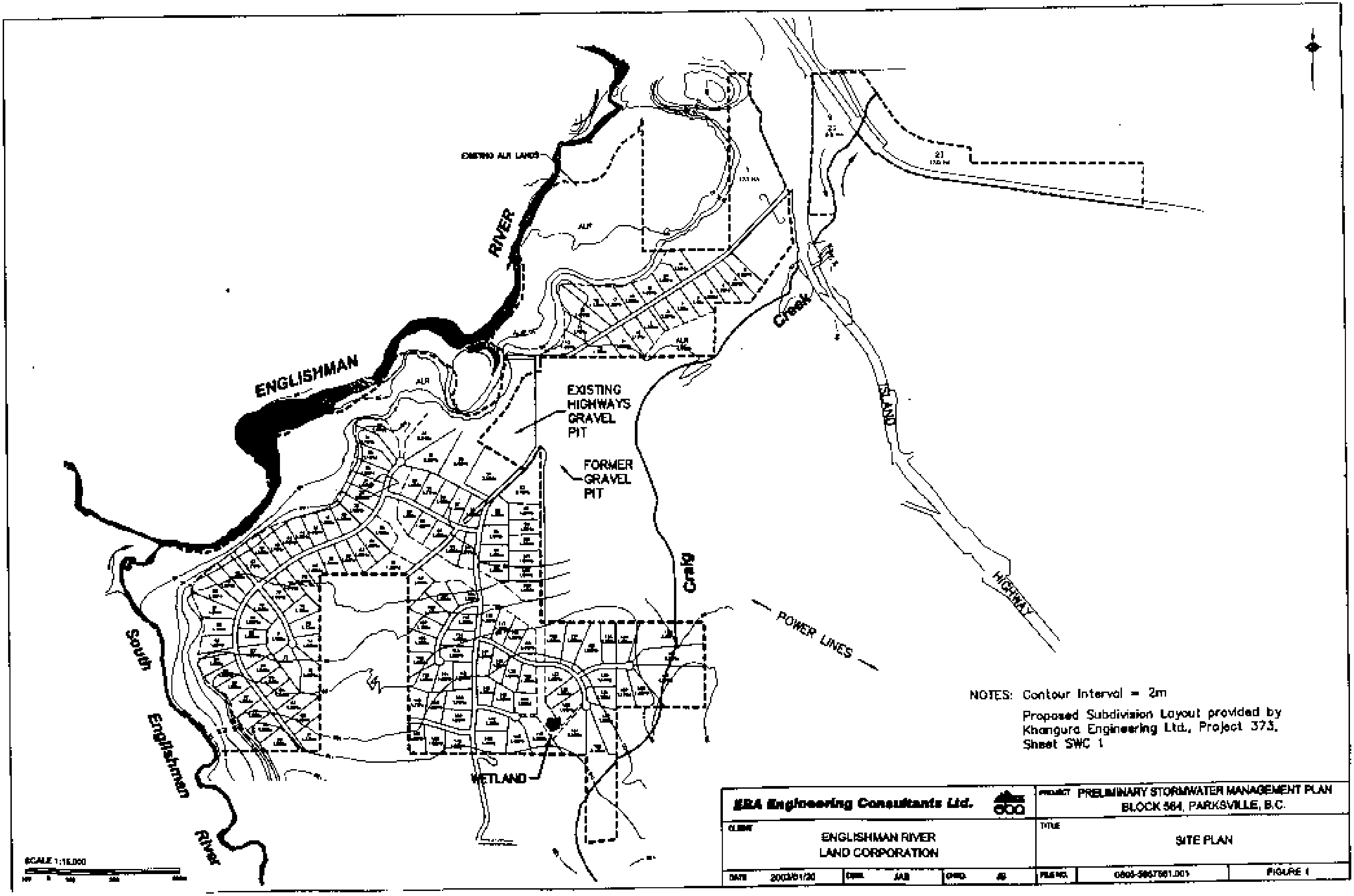
Reviewed by,

Gilles Wendling, P.Eng.
Senior Hydrogeologist

Tim Bekhuys, R. P. Bio.
Senior Biologist

Distribution:	Regional District of Nanaimo	6 copies
	Englishman River Land Corporation	2 copies
	Michael Rosen & Associates	1 copy
	Khangura Engineering	1 copy

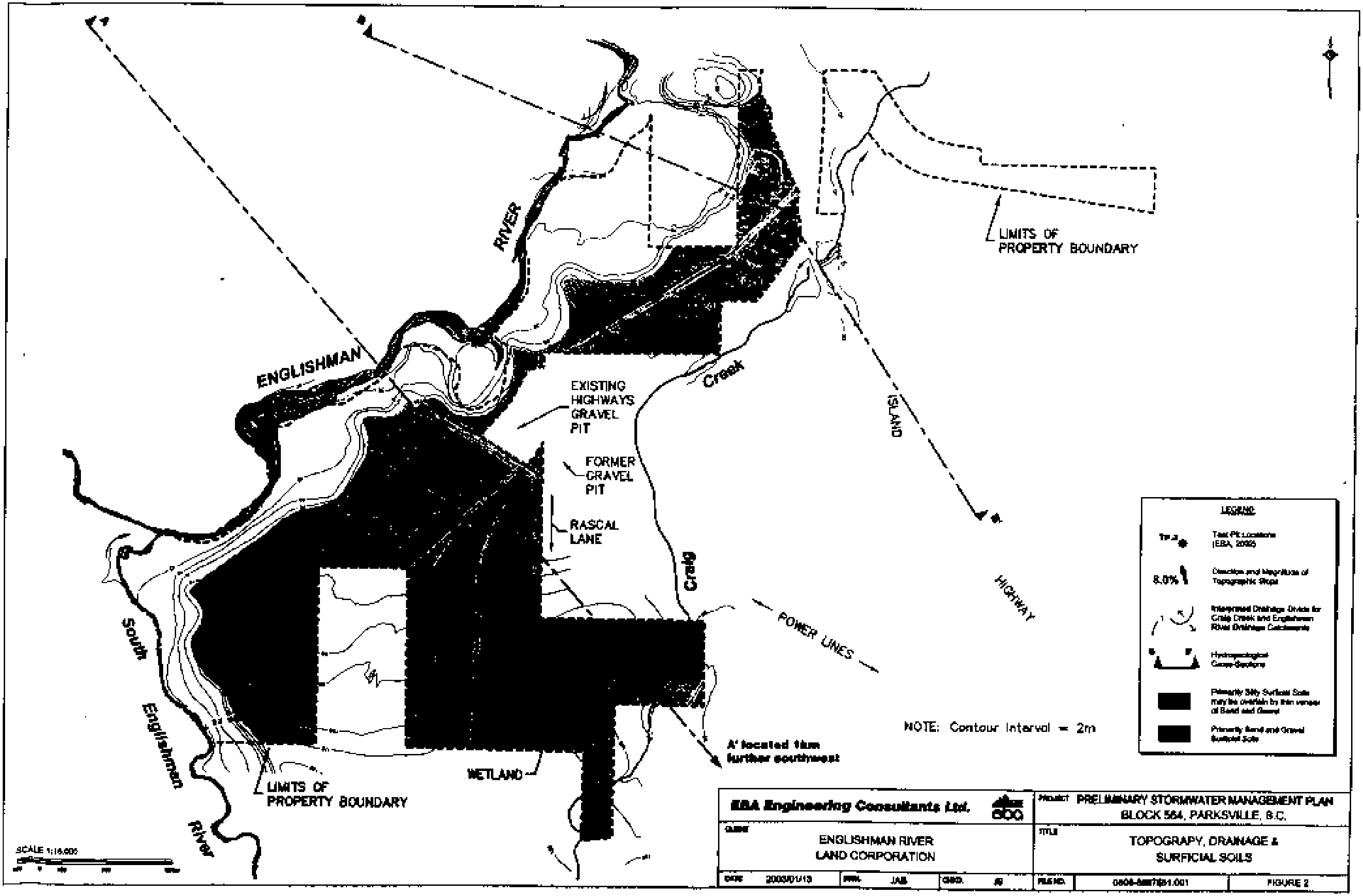
Attach: Figures 1 to 6

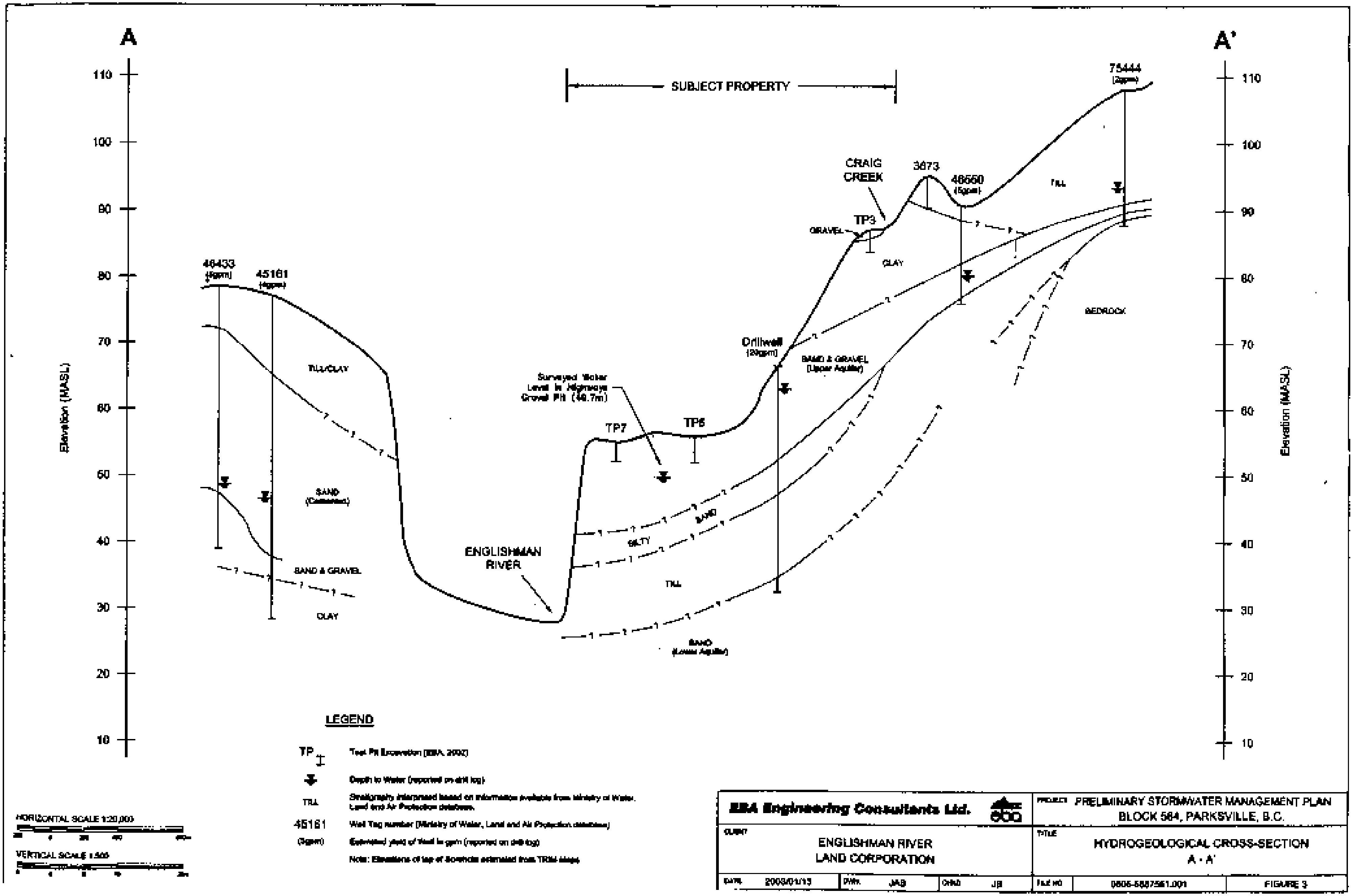


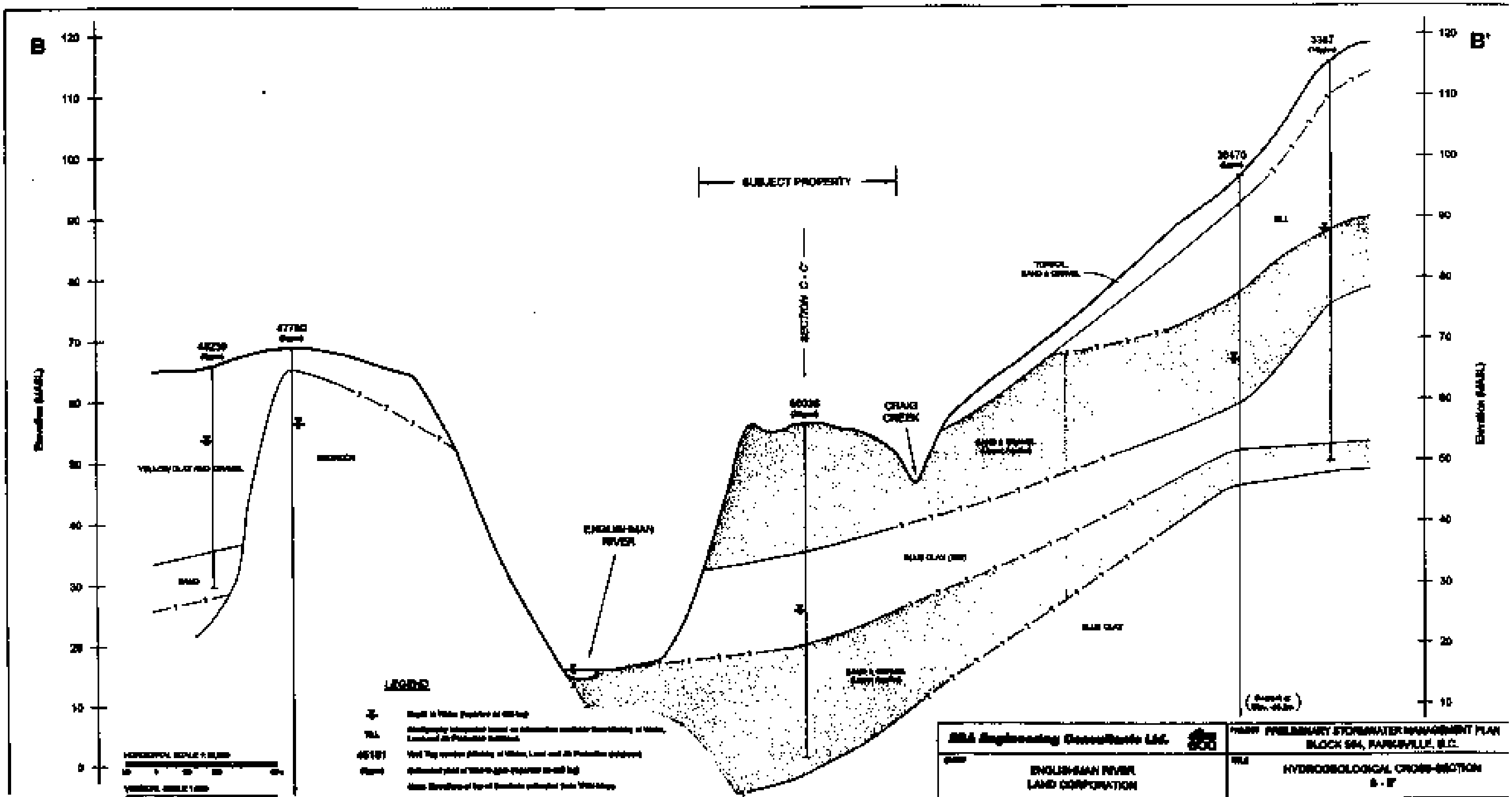
NOTES: Contour Interval = 2m

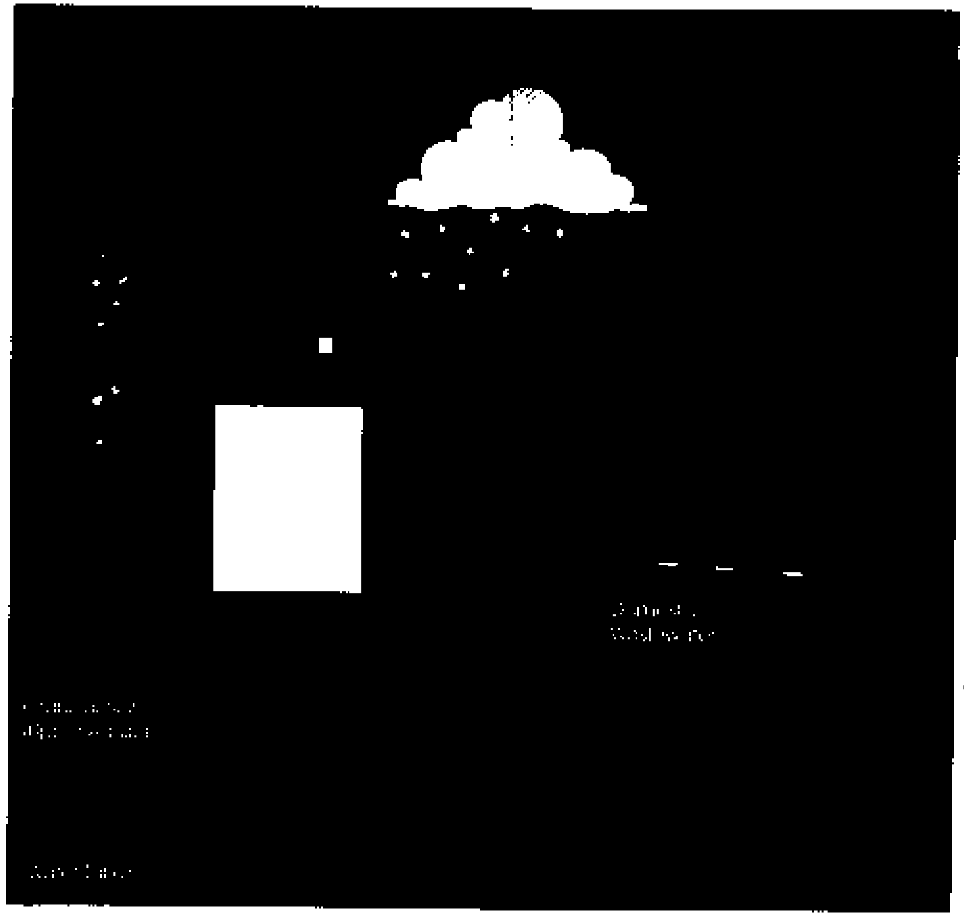
Proposed Subdivision Layout provided by Khangura Engineering Ltd., Project 373, Sheet SWC 1

EBA Engineering Consultants Ltd.		PROJECT PRELIMINARY STORMWATER MANAGEMENT PLAN BLOCK 564, PARKSVILLE, B.C.	
CLIENT ENGLISHMAN RIVER LAND CORPORATION		TITLE SITE PLAN	
DATE 2003/01/20	DWN. JAB	FILE NO. 0805-5667561.001	FIGURE 1


LIMITS OF
PROPERTY BOUNDARY
RIVER
ENGLISHMAN
EXISTING
HIGHWAYS
GRAVEL
PIT
FORMER
GRAVEL
PIT
RASCAL
LANE
Creek
Craig
ISLAND
HIGHWAY
POWER LINES
South
Englishman
River
WETLAND
LIMITS OF
PROPERTY BOUNDARY
A' located 1km
further southwest
NOTE: Contour Interval = 2m
LEGEND
8.0%
SCALE 1:16,000
EBA Engineering Consultants Ltd.
PROJECT PRELIMINARY STORMWATER MANAGEMENT PLAN
BLOCK 564, PARKSVILLE, B.C.
CLIENT ENGLISHMAN RIVER
LAND CORPORATION
TITLE TOPOGRAPY, DRAINAGE &
SURFICIAL SOILS
DATE 2003/01/13
DWN. JAB
CHKD.
FILE NO.
FIGURE 2


A
A'
SUBJECT PROPERTY
Elevation (MASL)
75444 (2gpm)
CRAIG CREEK
3673
46550 (5gpm)
TP3
GRAVEL
CLAY
TILL
BEDROCK
46433 (6gpm)
45161 (4gpm)
TILL/CLAY
SAND (Confined)
SAND & GRAVEL
CLAY
Surveyed Water Level in Highways Gravel Pit (48.7m)
TP7
TP5
Drillwell (20gpm)
SAND & GRAVEL (Upper Aquifer)
SAND
SILTY
TILL
ENGLISHMAN RIVER
SAND (Lower Aquifer)
LEGEND
TP Test Pit Excavation (EBA, 2002)
Depth to Water (reported on drill log)
TILL Stratigraphy interpreted based on information available from Ministry of Water, Land and Air Protection database.
45161 Well Tag number (Ministry of Water, Land and Air Protection database)
(3gpm) Estimated yield of Well in gpm (reported on drill log)
Note: Elevations of top of Borehole estimated from TRIM maps
HORIZONTAL SCALE 1:20,000
VERTICAL SCALE 1:500
EBA Engineering Consultants Ltd.
PROJECT PRELIMINARY STORMWATER MANAGEMENT PLAN BLOCK 564, PARKSVILLE, B.C.
CLIENT ENGLISHMAN RIVER LAND CORPORATION
TITLE HYDROGEOLOGICAL CROSS-SECTION A - A'
DATE 2003/01/13
DWN JAB
CHKD JB
FILE NO 0805-5887561.001
FIGURE 3


B
B'
Elevation (MASL)
SUBJECT PROPERTY
SECTION C - C'
CRAIG CREEK
ENGLISHMAN RIVER
TOPSOIL, SAND & GRAVEL
TILL
BEDROCK
YELLOW CLAY AND GRAVEL
SAND
BLUE CLAY
LEGEND
PRELIMINARY STORMWATER MANAGEMENT PLAN
BLOCK 564, PARKSVILLE, B.C.
HYDROGEOLOGICAL CROSS-SECTION
B - B'
ENGLISHMAN RIVER
LAND CORPORATION



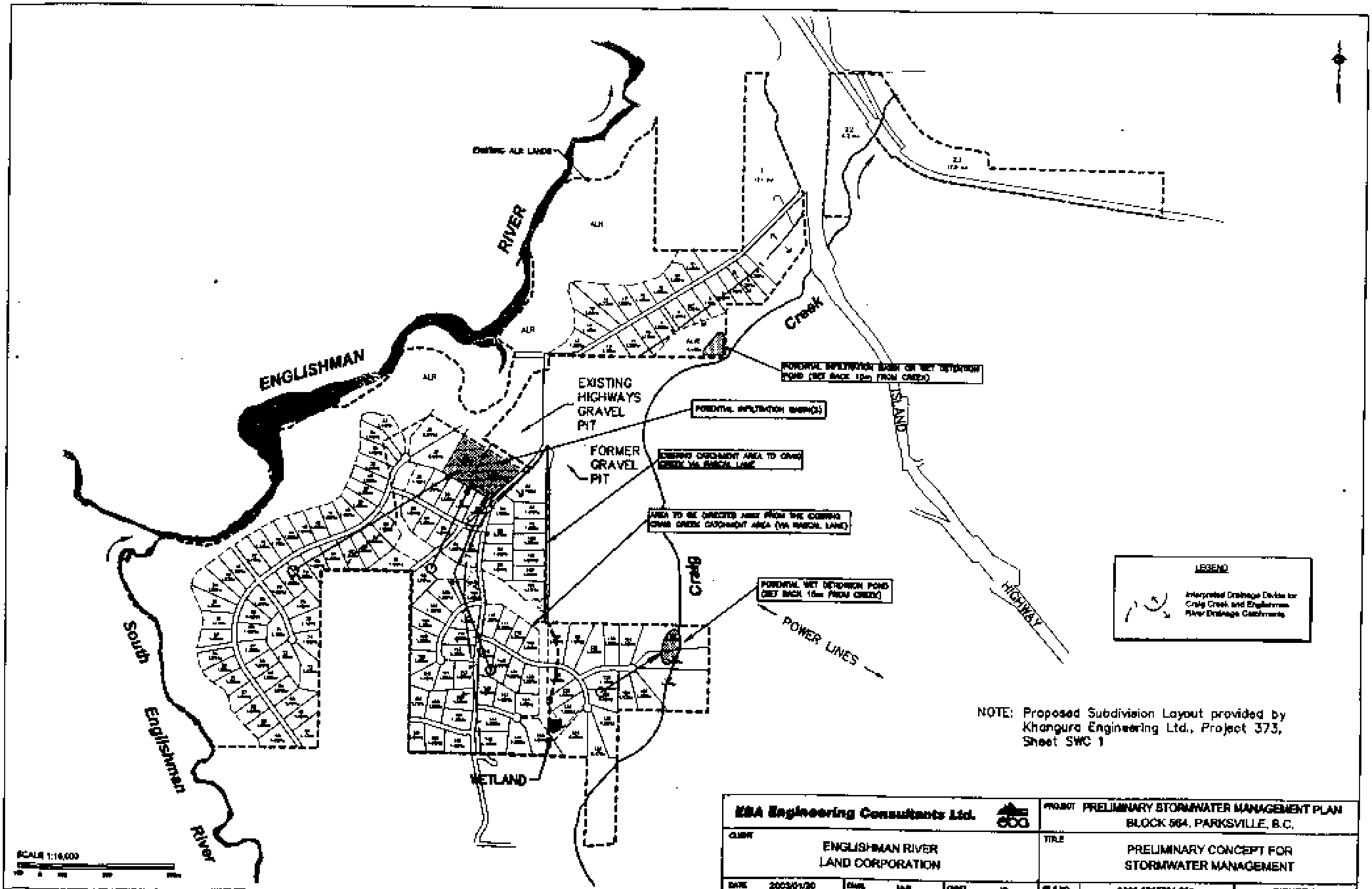
Notes:

1) General Water Balance Equation
   $P = ET + R + I$

2) For developed land surface ET decreases (due to less vegetative cover) and R increases (due to roofs, roads and other hard surfaces).

3) For developed land surface, magnitude of infiltration (I) depends on how stormwater runoff (R) is managed. For case where soils are used to absorb stormwater runoff, infiltration to the water table will be increased from developed land surface resulting in a beneficial effect on baseflow in rivers and creeks. Additionally, domestic wastewater (sourced from a deep confined aquifer) which is renovated in the subsurface, will contribute beneficially to baseflows.

EBA Engineering Consultants Ltd.					PROJECT	PRELIMINARY STORMWATER MANAGEMENT PLAN BLOCK 564, PARKSVILLE, BC
CLIENT	ENGLISHMAN RIVER LAND CORPORATION				TITLE	WATER BALANCE CONCEPTS FOR UNDEVELOPED AND DEVELOPED CONDITIONS
DATE	2003/01/02	DWN. JT	CHKD. JB		FILE	5557551.001 — FIGURE 5



NOTE: Proposed Subdivision Layout provided by Khangura Engineering Ltd., Project 373, Sheet SWC 1

EBA Engineering Consultants Ltd.					PROJECT	PRELIMINARY STORMWATER MANAGEMENT PLAN BLOCK 564, PARKSVILLE, B.C.	
CLIENT	ENGLISHMAN RIVER LAND CORPORATION				TITLE	PRELIMINARY CONCEPT FOR STORMWATER MANAGEMENT	
DATE	2003/01/30	DWN.	JAB	CHKD.	JB	FILE NO. 0805-5657361.001	FIGURE 6

ENVIRONMENTAL ASSESSMENT FOR THE ENGLISHMAN RIVER RURAL RESIDENTIAL COMMUNITY

Block 564 and District Lot 71
Regional District of Nanaimo

Project No. 0805-5887561.002

January, 2003

ENVIRONMENTAL ASSESSMENT FOR THE ENGLISHMAN RIVER RURAL RESIDENTIAL COMMUNITY

Block 564 and District Lot 71
Regional District of Nanaimo

Prepared for:

ENGLISHMAN RIVER LAND CORPORATION

Vancouver, B.C.

Prepared by:

EBA ENGINEERING CONSULTANTS LTD.

Vancouver, B.C.

Project No. 0805-5887561.002

January, 2003

EXECUTIVE SUMMARY

In October of 2002, EBA Engineering Consultants Ltd. (EBA) was retained to complete an Environmental Assessment of a proposed rural, residential community as part of rezoning application to the Regional District of Nanaimo (RDN). The study site is located at Block 564 and District Lot 71 within the Regional District of Nanaimo (RDN) near the city of Parksville, British Columbia on the southern side of the Englishman River. Terms of Reference for the Environmental Assessment were supplied by the RDN. The following summarizes the pertinent recommendations from our Environmental Assessment report we completed for the above property:

1. **Hydrology** - There are three surface water features on the site; the Englishman River, Craig creek and a small, unnamed wetland. Based on our assessment and provincial and federal guidelines, the following setbacks are recommended to protect water resources (including fisheries) within the site :

    - Englishman River - a 15 m. setback from the top-of-bank. Top of bank varies within this ravine is defined as per the provincial, *Land Development Guidelines;*
    - Craig creek - a 15 m. setback from the top-of-bank. Top of bank varies is defined as per the provincial, *Land Development Guidelines;* and,
    - Unnamed Wetland - a 15 m setback from the winter high water mark.

2. **Hydrogeology** - Detailed groundwater modelling was completed by EBA available under separate cover. Results of the modelling indicate that if recommendations are followed in this report, there will be no impacts from significant changes to water quantity (i.e. flows) or water quality (i.e. nutrient/ pollutant loading) to the Englishman river, unnamed wetland or Craig creek.

3. **Vegetation** - The entire site has been extensively logged. There are three areas of "Old Forest" (100 -150 years) as defined by a regional Sensitive Ecosystem Inventory (SEI). Old Growth Forest it should be noted is >250 years old. The areas indicated on the SEI were ground-truthed and found to be extensively logged in the eastern portion of the site and therefore the SEI is no longer considered a valid planning tool for Old Forest. We recommend that to protect Old Forest areas, recent air photo interpretation be completed and identified areas be subject to appropriate protection:

4. **Fisheries** - Fish habitat is found within the Englishman river and Craig creek. The Englishman river is an important fisheries stream containing six species of salmon, rainbow and cutthroat trout, Dolly Varden and a variety of coarse fish. Craig creek does not have a

record of anadromous fish above the Island highway but areas adjacent to the property are still considered fish habitat as they drain into fish bearing waters. In order to protect fisheries values on the site we recommend:

- Protection of the Englishman river and Craig creek corridors as per 1 above.

5. **Wildlife and Biodiversity** - The site has been previously logged and cleared consequently reducing current wildlife habitat values. Based on our assessment, the area with the greatest wildlife and biodiversity importance is the riparian corridor surrounding Craig creek, the wetland and the Englishman river. A search of the Conservation Data Centre records for rare and endangered wildlife found no records on the site. Based on our detailed assessment, there are five rare and endangered (red listed) species that potentially occur within the site. These potentially occur in the Englishman River/ Craig creek corridor and wetland (Water Shrew, Purple Martin, Wolverine) and Old Forest area (Northern Goshawk and Keen's Long-eared Myotis). In order to protect wildlife values on the site, we recommend:

   - A raptor nest survey be conducted within proposed development areas prior to clearing;
   - Environmental corridors be maintained between the Englishman river-Craig creek-Unnamed wetland and adjacent greenspace (i.e. ALR lands); and,
   - Areas of high wildlife values, biodiversity and containing potentially rare and endangered species be preserved. This includes the Englishman river corridor, Craig creek corridor, Old Forest area and unnamed wetland area.

In conclusion, based on our assessment, there are four environmentally sensitive areas (see map): the Englishman river, Craig creek, an unnamed wetland and the Old Forest areas. Maintenance of the recommended provincial and federal setbacks from these four areas as described above, will protect all significant environmental resources in these areas. Use of standard Best Management Practices (BMP) during construction (i.e. Silt, Sediment and Erosion Control BMP) will result in minimal impacts.

Inclusion of an Environmental Corridor within the development plan will exceed current BMPs for habitat protection by the provincial and federal governments.

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LIST OF APPENDICES

1.0 INTRODUCTION

In November 2002, EBA Engineering Consultants Limited (EBA) was retained by Englishman River Land Corporation (Englishman River) to conduct an Environmental Impact Assessment (EIA) for a rezoning application for Parksville subdivision for the proposed rural residential community. The study site is located at Block 564 and District Lot 71 within the Regional District of Nanaimo (RDN) near the city of Parksville, British Columbia (Figure 1).

The report is intended to meet the environmental requirements for provincial and regulatory approvals, and those of the RDN. The objectives of this EIA are to:

1. Thoroughly inventory the biophysical resources of the study area. This includes:
   - environmentally sensitive features of the parcel including location of all watercourses, wetlands and significant areas of native flora and fauna, sensitive ecosystems, wildlife features and the presence of species at risk;
   - fish distribution and other aquatic presence/potential;
   - wildlife habitat values and presence;
   - soil types, site drainage and erosion patterns;
   - topographical features;
   - ecosystems and biological diversity; and,
   - adjacent land uses.
2. To assess the potential impacts of the proposed development on these resources, and;
3. To develop a impact management plan to avoid, mitigate or compensate for the identified impacts.

Concurrently, a geohazards assessment and a hydrogeological assessment are being conducted by EBA. The information obtained from these assessments is incorporated into the EIA study, and the project design, construction and operation management plans.

This report is divided into seven main sections: 1.0 Introduction, 2.0 Methods, 3.0 Proposed Project, 4.0 Biophysical Inventory, 5.0 Recommendations and Best Management Practices (BMP), 6.0 Recommended Studies and 7.0 References. Accompanying the report, figures (maps) can be located in Appendix A.

2.0 METHODS

The study is comprised mainly of a literature review and one site visit. The majority of the information needed to complete the EIA has been obtained through other sources. The literature review was conducted on the biophysical aspects of the study site for resource data including that of geology, soils, hydrology, vegetation, fisheries and wildlife. The outline of this report is based on the terms of reference contained in B.C. Ministry of Water, Land and Air Protection (2001) Best Management Practices – Land Development.

Development constraint maps were produced based on this information and the methods from TERA Planning Ltd. (TERA 1992). TERA's constraint process was based on McHarg (1969) Design with Nature and Rubenstein (1978) A Guide to Site and Environmental Planning. Since more information has been gathered since TERA's report, Conceptual Planning Study Environmental Component of Block 564 and District Lot 71, Nanaimo Regional District (1992), the constraint maps in this EIA have been augmented to consider and include this important biophysical information.

Biological constraints were analyzed by the same methods as TERA (1992), which was based on the criteria of the Resource Analysis Branch of the B.C. Ministry of Environment (1977) Resource Analysis for Urban Suitability: Vancouver North Slope. Again, these constraint maps have been modified since TERA (1992) with information from the Conservation Data Centre (CDC) on species at risk in the study area, Sensitive Ecosystems Inventory (SEI) which provide information on ecosystems with a higher abundance of rare plants and plant communities, Steven (1995) and a reassessment of archaeological and historical sites in the area through contact with the B.C. Ministry of Recreation and Culture, Archaeological Branch. The Environmentally Sensitive map is based on the importance and sensitivity of biophysical resources to disturbance or alteration.

A detailed description of the methodologies employed for each specific resource is below.

2.1 Soils

An overview of soils present in the study is provided. Soils were described in TERA (1992), which was based on Jungen *et al.* (1989).

2.2 Hydrology and Hydrogeology

The hydrologic processes information was a collection of data from TERA (1992), which obtained hydrological data from Inland Waters (1983) and historical records. Groundwater resource information was obtained from Halstead and Treichel (1966). For groundwater flows, soil type, slopes and airphoto analysis (1998) was used. Topography and air photo analysis was used to map site drainage and flows.

Information on Englishman River and Craig Creek water flows and hydrologic parameters was obtained from a B.C. watershed information database from B.C. Fisheries and Department of Fisheries and Oceans (DFO) Fish Wizard (2002a).

2.3 Vegetation

Vegetation classification and mapping was updated from TERA (1992), and original information obtained from Sensitive Ecosystems Inventory (SEI) maps provided by Englishman River Land Corporation, Green and Klinka (1994) and air photo (1998) interpretation.

The Conservation Data Centre was contacted to determine the presence of known rare plant species in the study area.

2.4 Fisheries

Fisheries information from Englishman River and Craig Creek was updated from TERA (1992) using B.C. Fisheries and DFO (2002a,b), which contain detailed fish inventories in watersheds of British Columbia. The presence of obstructions within these watersheds that potentially affect fish migration were also included in the maps, and this information was provided by B.C. Fisheries and DFO (2002b)

2.5 Wildlife

Detailed wildlife inventories were not conducted on site. Species presence was based on vegetation, habitat suitability and sensitive ecosystems inventories in the study area. The species at risk list was created using Stevens (1995) and TERA (1992) and the status was updated using Conservation Data Centre species at risk lists. The list also indicates which habitats in the study area possibly contain which species. TERA (1992) also provided important information regarding wildlife habitat suitability and constraints towards development.

The Conservation Data Centre was contacted to obtain a listing of rare element occurrences in the study area.

2.6 Biodiversity

Biodiversity was addressed in three ways:

- A comparison of wildlife species richness for each habitat;
- An assessment of landscape linkages present in and adjacent to the site; and,
- A review of the Sensitive Ecosystem Inventory (SEI) data (MELP and CWS (1997) and Ward *et al.* (1996)).

Wildlife species richness was calculated from a wildlife species list that was compiled from Stevens (1995) and TERA (1992). The species list contains all wildlife that may potentially occur on the site during any portion of the year.

2.7 Land-Use

Historical and current land-use information for the study area and surrounding lands was reviewed and is presented. This was based on air photo (1998) interpretation.

2.8 Best Management Practice (BMP)

An Environmentally Sensitive Areas map was created to integrate the physical constraints with that of the ecological constraints (see Section 2.8). The discussion of the Best Management Practice (BMP) is based on this map. The recommendations in the BMP are based on B.C. Ministry of Environment, Lands and Parks' Environmental Objectives, Best Management Practices and Requirements for Land Developments.

3.0 PROPOSED PROJECT

A conceptual layout plan for the proposed development is presented in Figure 2. The primary features of the proposed development plan include:

- 225 acres of public open space along the Englishman River;
- A green space corridor linking the wetland, Englishman River and Craig Creek;
- 178 residential dwelling units comprised of 134 acreage (2.5 acres and larger) properties located in the north and southwestern area of the property;
- four larger acreages; and,
- a 40 dwelling cluster development located in the southeast part of the property.

4.0 BIOPHYSICAL INVENTORY

The following sections describe the biophysical characteristics of the site.

4.1 Soils

Figure 3 shows the distribution of soil types across the study area. Soils are described according to the Canadian System of Soil Classification (Canada Soil Survey Committee 1998). Three soil orders are represented within the site and are described below.

4.1.1 *Regosols*

The regosols occur within Englishman River floodplain and are derived from recent alluvial deposits. They are so recent that these soils have not yet developed sufficient organic layers on their coarse, mineral soils to support abundant vegetation. Therefore, the physical limitations of the regosols due to flooding, erosion and summer drought make these soils vulnerable and limit their supportive capacity for forestry, other vegetation and/or agricultural activity. Soils, as mapped by Jungen *et al.* (1989) show some of the regosols grade into brunisols.

4.1.2 *Brunisols*

This is the dominant soil horizon, which occurs on the mid-bench within the study site. It is a soil, which has developed on coarse, surficial materials that rapidly drain. These soils have, in the past few thousand years, established a thin, organic layer over a moderately decomposed B-horizon. These soils are so rapidly drained that they show relatively low productivity for both forestry and agriculture. However, with improvement (irrigation), the agricultural potential can be increased to support a wide variety of crops (Class 2 Agricultural Capability). On the southern portion of the benchland, above 100 m above sea level, the glacio-marine deposits and tills begin to form the mineral layer of gleyed dystric brunisols. These have greater water holding capacity than the regosols and, therefore, show higher productivity in terms of forestry and agriculture. Where seepage occurs in this part of the property, as it does adjacent to Craig Creek, forestry productivity can be moderate to high and agricultural capability can reach Class 4 on an unimproved rating.

4.1.3 *Podzols*

Some podzols occur along the steeper portions along the escarpment of the study area. Here, lateral seepage has formed typical podzols soils. These are soils which have been able to establish a well developed organic horizon, well developed and decomposed B-horizon, and a distinct "ash layer" of the humo-ferric podzols. Most of these soils are productive forest soils and, because of their steepness, are considered unproductive agricultural soils.

4.2 Hydrology and Hydrogeology

There are two primary drainage features associated with the site: 1) the South Englishman River and Englishman River; and, 2) Craig Creek flowing across the south east corner of the site (Figure 4).

A number of drainage ditches have been developed adjacent to roads and trails located on the property. With the exception of ditches located in the extreme south east corner of the property, these ditches were dry at the time of EBA's site reconnaissance.

Standing water was observed at a depth of several metres below grade in the Ministry of Transportation and Highways gravel pit located adjacent to the powerlines. Standing water was also observed in an inactive gravel pit located about 250 m west of the former.

Based on the granular nature of the soils and moderate precipitation in the Parksville area, the majority of precipitation is expected to infiltrate. Consequently, drainage ditches are only expected to contain flow intermittently.

4.3 Vegetation

Most of the Englishman River watershed was logged in the early 1900's and again in the 1950's and 1960's (LGL Ltd. 2001). Within the last decade, a large portion of the study area was logged again (represented by the youngest vegetation age-class in Figure 5). All forested areas within the study site have been logged at one time, therefore the existing forested areas are all second growth. However, there are three sections of forest that are older (mature) second growth (>100 years). Two exist in the eastern central portion of the study site, and the other is in the northern portion of the site near the Island Highway (Figure 5). There are no old growth forest areas within the study site.

According the Ministry of Forests' Biogeoclimatic Ecosystem Classification (BEC) system, the proposed development exists in the Coastal Douglas Fir biogeoclimatic zone in the Moist Maritime sub-zone (CDFmm) (Green and Klinka, 1994). The CDFmm is restricted to low elevation (less than 150m) along southeast Vancouver Island, the Gulf islands and a narrow portion of the Sunshine Coast. The zone lies in the rainshadow of the Vancouver Island Mountains resulting in warm dry summers and mild wet winters.

Six different vegetation units are present in the study area:

- Douglas-fir – Salal (site series 01),
- Western redcedar/Hemlock – Swordfern (site series 04),
- Western redcedar – Snowberry (site series 07),
- Western redcedar – Skunk cabbage (site series 11);
- Transmission line vegetation (T); and,
- Unvegetated (U).

The first four vegetation units are primarily forested and are provincially-correlated sites series described in Green and Klinka (1994). The first two of these forested units were further sub-divided into four age classes that describe the stage of vegetation development (or vegetation succession) since clearing.

Each of the units is described below. The descriptions are based on Tera (1992), Green and Klinka (1995) and air photo interpretation.

4.3.1 Douglas-fir – Salal (01)

The Douglas-fir – Salal site series is zonal or characteristic site series in the CDFmm subzone. In the study area, it is found primarily in the benchland area. Most of these benchland areas have been recently logged, however, and so only a few older stands (>80 yrs) exist in the benchlands and in the lowlands alongside the Englishman River.

The dominant tree species in these areas are Douglas Fir (*Pseudotsuga menziesii*), which may also contain western redcedar (*Thuja placata*), western hemlock (*Tsuga heterophylla*) and rarely, grand fir (*Abies grandis*).

The dominant shrub species are salal (*Gaultheria shallon*), dull Oregon-grape (*Mahonia nervosa*) and salmonberry (*Rubus spectabilis*). The herb layer contains vanilla leaf (*Achlys triphyla*), bracken (*Pteridium aquilinum*) and swordfern (*Polystichum munitum*). The moss layer is dominated by electrified cat's tail moss (*Rhytidiadelphus triquetrus*), Oregon beaked moss (*Kindbergia oregana*) and step moss (*Hylocomium splendens*).

These sites have very poor to medium soil nutrient regimes and moderate soil moisture.

4.3.2 Douglas-fir/Bigleaf maple – Oregon grape (04)

The Western redcedar/Hemlock – Swordfern site series is found on the steep, valley slopes of the study area. It is dominated by western redcedar and western hemlock in the main canopy and swordfern in the understory. Other species in the canopy layer include Douglas-fir and occasional bigleaf maple *(Acer macrophylum)* on the top of the slopes. These stands were logged between 30 and 80 years ago.

The shrub layer consists of regenerating western hemlock and redcedar seedlings, Oregon grape, red elderberry and *Rosa* spp. The shrub layer is more developed on these slopes than in the Douglas-fir community.

Within the herb layer, swordfern, vanilla leaf and blackberry *(Rubus ursinus)* dominate. Other herbs include three-leaved foam-flower *(Tiarella trifoliata)*, cut-leaved foam-flower *(Tiarella laciniata)* and broad-leaved starflower *(Trientalis latifolia)*. The herb layer is moderately developed. Common mosses include *Stokesiella oregana* and *Rhizomnium glaberescens*.

4.3.3 Western redcedar – Snowberry (07)

The mixed forest type combining deciduous and evergreen trees is uncommon in the study area. Tree species include bigleaf maple, red alder, western hemlock, redcedar, Douglas-fir, and flowering dogwood; vine maple occurs as large shrubs or small trees. This vegetation type occurs in lowland areas adjacent to the Englishman River, so that seepage and ground water is often present, resulting in good tree growth and a well-developed understory. Thimbleberry, bracken and bleeding heart are three typical understory species. These shrub species are indicative of nitrogen-rich soils on water receiving sites of open canopy, early seral vegetation communities. They are often found on seepage sites as well. This area, in general, has unstable soils, prone to erosion by the river with a dense underbrush or wildflowers and shrubs.

4.3.4 *Western redcedar – Skunk cabbage (11)*

This site series includes the vegetation of wet areas, including depressions with high water table and seepage areas (e.g. on the lower portions of the escarpment). These sites are enriched by nutrients supplied by seepage water. Western redcedar grows abundantly along with bigleaf maple. Vine maple and dogwood frequently reach tree size. Depending on the wetness of the site, swordfern, lady fern, deer fern, skunk cabbage, foam flower, salmonberry, devil's club and red elderberry are characteristic subordinate species. The moss layer is poorly developed or lacking. Windfalls are common in these forests, even in protected ravines, because the soil, saturated by water, is loose and frequently shallow.

4.3.5 *Transmission line vegetation (T)*

The transmission line right-of-way is vegetated by a mixture of deciduous tree and shrub species. Young red alder, black cottonwood and a number of shrubs such as snowberry, hardhack, broom, blackberry, raspberry, and salal, as well as seedlings of Douglas-fir and hemlock form an arid scrubland. In the wetter portions of the Englishman River floodplain, the understory consists of salmonberry, willow and bracken.

4.3.6 *Unvegetated (U)*

Unvegetated (disturbed) areas include the roads, trails and sand and gravel extraction areas. These areas are generally sparsely vegetated because of anthropogenic disturbance to vegetation and soils.

4.3.7 *Plant Species of Concern*

The Conservation Data Centre has no records of rare plant species within the study area. The absence of records may reflect the absence of field inventory work rather than a true absence of rare plant species.

4.4 Fisheries

4.4.1 Fish Distribution and Potential

The study area encompasses the portions of the lower reaches of the Englishman River, as well as portion of the lower reaches of one of its tributaries, the South Englishman River, and portions of Craig Creek.

Englishman River

The current site layout is situated adjacent to the east of the lower Englishman River from a distance of approximately 1 km upstream of the Island Highway crossing to its confluence with the South Englishman River.

The Englishman River contains Atlantic salmon (*Salmo salar*), chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), cutthroat trout (anadromous) (*Oncorhynchus clarki*), pink salmon (*Oncorhynchus gorbuscha*), rainbow trout (*Oncorhynchus mykiss*), sculpins (*Cottus* sp.), sockeye salmon (*Oncorhynchus nerka*), winter-run steelhead (*Oncorhynchus mykiss*), threespine stickleback (*Gasterosteus aculeatus*) and Dolly Varden (*Salvelinus namaycush*).

Use by anadromous fish species (all salmon species, sea-run cutthroat trout and steelhead trout) is limited to the lower 16 km of the river (TERA 1992). A 10 m high waterfall at the 16 km mark limits upstream migrations. Dolly Varden are only known to occur upstream of the waterfall (Weyerhaeuser 2002). Resident rainbow trout and cutthroat trout are found throughout the watershed. Coho and chum salmon have had the highest historic escapement of all the Pacific salmon in this watershed, and have had high escapement numbers in recent years. Pink and chinook salmon populations are enhanced by stocking, and spawning escapement for these species has also been high in recent years. The sockeye salmon stocks in the Englishman River are very small. Sockeye salmon and pink salmon distributions are restricted to the lower reaches (downstream of the Island highway), while coho, chum and chinook salmon are known to exist throughout the stream reaches bordering the subject site. Steelhead spawning escapement numbers are declining and have been below historic levels since the late 1990's. Cutthroat trout populations have been supplemented by stocking in the anadromous reaches.

Sculpins and threespine stickleback were only documented in the Englishman River estuary (B.C. Fisheries and DFO 2002a).

Atlantic salmon are escapees from ocean netpen operations, which have started to colonize the river.

South Englishman River

The southwest corner of the site layout is situated adjacent to the South Englishman River, from its confluence with the mainstream Englishman River to a distance approximately 1 km upstream. The lower 4.5 km of this stream are accessible by anadromous species (LGL 2001). A waterfall at this location restricts upstream fish migration.

The South Englishman River contains coho salmon, cutthroat trout (anadromous and resident) and winter-run steelhead trout. All three species appear to be wild and indigenous. No escapement data is available for this stream.

Craig Creek

Approximately 2 km of the length of Craig Creek is located adjacent to, or inside the subject site's eastern boundary. The lower 2.5 km of this stream are potentially accessible by anadromous species. Extensive land clearing above this reach has reduced flow levels, preventing fish access further upstream. However, the presence of two culverts downstream of the Island highway limits the known distribution of anadromous fish species to reaches downstream of these points (B.C. Fisheries and DFO 2002b)

Craig Creek contains coho salmon and sea-run cutthroat trout. Escapement data for coho salmon indicates a mean escapement for the period of 1984-1999 of 25 fish per year, with a maximum in that period of 120 fish. The highest escapement recorded was 400 fish in 1964 (B.C. Fisheries and DFO 2002b).

4.4.2 Fish Habitat

This section describes fish habitat constraints for the streams inside/adjacent to the subject site.

Englishman River

Low summer flows and high winter flows negatively impact summer rearing and overwintering habitat quality, respectively. The Arrowsmith Lake dam will help regulate stream levels during the low-flow period, however (LGL, 2001). Two sidechannels (by TimberWest and Weyerhaeuser) were constructed approximately 6 km upstream from the estuary in the 1990's. These channels are being used by juvenile coho salmon for overwintering (LGL, 2001), as well as by coho and chum salmon for spawning (DFO FISS database, 2002). A proposal to extend the TimberWest channel by 2,000 m is currently being reviewed (LGL, 2001).

Other habitat constraints noted in the DFO FISS database included the lack of riparian vegetation cover in the anadromous reaches of the watershed.

South Englishman River

LGL (2001) report that spawning habitat is limited in the lower South Englishman River due to the prevalence of a bedrock streambed. No other habitat constraints have been reported in the literature reviewed for this report.

Craig Creek

Fisheries constraints for Craig Creek include a series of beaver dams near the mouth, as well as two culverts downstream from the subject site. The first culvert is located under the old Island Highway and represents a 0.5 m drop. It may block both sea-run cutthroat trout as well as coho salmon. The second culvert is located underneath the railway embankment and may be passable during high water. Land clearing upstream of the Island highway (but outside of the subject site boundaries) has resulted in much reduced summer flows, limiting the habitat available to fish.

4.5 Wildlife

The study area contains a variety of vegetation types that support a range of wildlife species. The highly productive lowland and riparian forests associated with the Englishman River valley provide high quality wildlife habitat.

Since historical logging has taken place within the entire study area, much of the wildlife habitat has been lost especially in the upland areas. The conversion of older to younger forest structure and the subsequent changes in vegetation composition resulted in wildlife species composition changes. However, the riparian areas along the Englishman River where forests are older, vegetative species have for the most part, re-established to pre-logging conditions and therefore wildlife habitat value is higher.

A potential species list was created based on known habitat that is available in the study area (Appendix B). The actual number of species present in the study area is likely to be much lower than the 242 listed in Appendix B since it is based on regional and provincial wildlife distribution.

The study area has been classified into six vegetation units that equate to wildlife habitat based on TERA (1992).

4.5.1 Douglas-fir – Salal (01)

This wildlife habitat is of moderate value to wildlife with the exception of the 30 to 80 year old stands (01-2) which are of higher value. The poor diversity and high horizontal but low vertical stratification of vegetation in the tree, shrub and herb layers support moderate numbers and diversity of wildlife species. Common insectivores include the shrews, both of which enjoy the protection offered by the abundant surface litter. Of the granivores, deermice are prevalent, as are Douglas' squirrels.

This area may provide feeding sites for birds and mammals with the presence of standing or fallen dead material. The closed canopy provides protection from wind and snow and, hence, these habitat types provide an important winter forage site. In addition, the closed canopy provides cover from predators such as raptors, to small mammals.

This area, with its' relatively open understory, is important to browsers such as blacktail deer and Roosevelt elk. It is most important to deer during winter months where coarse gravel and boulder substrate create natural openings in the vegetation. In addition to utilizing salal as a forage item, deer also use the arboreal lichens such as *Alectoria* spp., *Bryonia* spp. and *Usnea* spp. Moderate to steep topography with southerly aspects below 700 m elevation are the most important deer habitat in the winter. Important forage species for deer include salal, false azalea and *Vaccinium* sp.

Elk use this habitat only in the young, seral stages (01-1) as a primary breeding and secondary feeding area. Older seral stages (01-2, 01-3 and 01-4) are used for secondary resting areas. Deer use this habitat most heavily in 01-1 areas as both a primary feeding and breeding area. Older sites are also used for both breeding and feeding, but not as extensively. Cougar use this habitat most heavily in the early seral stage, as well as in the 01-3 (80 to 100 year old) stage. The other seral stages (01-2 and 01-4) are also used for breeding and feeding but not as heavily. Ruffed grouse use this habitat as secondary breeding and feeding areas during all seral stages.

4.5.2 Douglas-fir/Bigleaf maple – Oregon grape (04)

The value of this habitat to wildlife species is relatively low. The poor diversity and general lack of vegetation within the shrub and tree layers support relatively low numbers and diversity of wildlife species. Typical small mammals include the shrews and deer mice.

Birds found within this habitat include thrushes, such as the hermit and Swainson's thrush, bark feeders and gleaners such as red breasted nuthatches and brown creepers, foliage feeders such as black capped chickadees, golden crowned sparrows and winter wrens.

Deer are resident within the study area and are actively hunted in the watershed as are blue and ruffed grouse.

4.5.3 Western redcedar – Snowberry (07)

Associated with the floodplain habitat and riparian habitat are wildlife species attracted to the relatively open canopy of the deciduous and coniferous trees and the dense undergrowth. The shallow, coarse-textured nature of the soil generally supports fewer small mammal species than the deeper forest soils, but larger mammals are relatively abundant. The site is important for deer, particularly in winter, when the undergrowth constitutes a significant source of food. The site is also important as a natal area for deer in the spring. The deciduous trees provide excellent habitat for breeding birds, especially warblers, vireos and other insectivorous birds, while the ground vegetation is attractive to ruffed grouse.

Elk and deer both use this habitat principally in the early seral stages as primary breeding and secondary feeding areas. Elk use the older seral stage for secondary breeding only, while deer will use all older seral stages for breeding. Cougar use all this habitat's seral stages as a secondary breeding and feeding area. This habitat is very important to ruffed grouse which use this area as a primary breeding and feeding area in all seral stages.

Of the 6 wildlife habitats present within the site, this area is the most important to wildlife.

4.5.4 Western redcedar – Skunk cabbage (11)

These areas are highly productive for wildlife. Use of the wetland-seepage sites is primarily during spring and summer months. Species groups which have an affinity to wetlands include songbirds, small mammals, as well as larger mammals such as bear and deer. Red alder and willows, common species within the seepage areas, provide food for black-capped chickadees in the form of catkins, while deer and ruffed grouse feed on the twigs and buds. Black bear will feed heavily on skunk cabbage during the spring.

Deer and cougar do not generally use wetland – seepage sites. Elk and ruffed grouse, however, use this area as a primary and secondary feeding habitat, respectively.

4.5.5 *Transmission line vegetation (T)*

This seral stage habitat is essentially a successional forest on regenerating clear cuts. The edges of the habitat provide excellent forage areas for deer and bear. However, the lack of cover and escape trees from B.C. Hydro maintenance of this right-of-way make utilization very low. Bears, however, may den in these areas if large stumps and logs are present.

Often, large areas of salmonberry, elderberry, huckleberry and other succulent shrubs are present as forage species. In winter its' wildlife value is limited due to the lack of forage and potential snow pack which reduces mobility of large mammals. The study area's xeric nature, being within the Vancouver Island mountain's rain shadow, and general lack of moisture has resulted in poor regeneration of this area's vegetation, further reducing use by wildlife.

This habitat is important to elk, deer and cougar, in that it is primary breeding and feeding habitat when there is sufficient shrub cover and vegetation. Ruffed grouse do not generally use this area.

4.5.6 *Unvegetated (U)*

These areas have little or no vegetation present and, consequently, are of very low value to wildlife. Ungulates and large carnivores may occasionally use roads as travel corridors.

4.5.7 *Wildlife Species of Concern*

The Conservation Data Centre has no records of rare wildlife species within the study area. The absence of records may reflect the absence of field inventory work rather than a true absence of rare wildlife species.

Red-listed (threatened) wildlife species (see shaded entries in Appendix B) potentially found in the study area include, Northern Goshawk (*Accipiter gentilis* ssp. *laingi*), Purple Martin (*Progne subis*), water shrew (*Sorex palustris* ssp. *brooksi*), Keen's long-eared myotis (*Myotis keenii*) and wolverine (*Gulo gulo* ssp. *vancouverensis*). The habitats on the study site, which these species may inhabit are described below.

Northern Goshawk ***(Accipiter gentilis*** **ssp.** ***laingi)***: Goshawks breed on Vancouver Island and generally build their nests in old growth or mature forests using the same territory year after year. The goshawk requires large expanses of forest tract, such as those along the Englishman River and it is probable that northern goshawk may nest within these areas.

Purple Martin ***(Progne subis)***: This species is associated with sheltered estuaries and harbours for nesting, but are found foraging in deciduous second-growth forests near ponds, power line rights-of-way and farmlands. It is probable that this species inhabits this site in the riparian zones of the Englishman River, Craig Creek, the wetland and the right-of-way stretching across the central portion of the study area. However, purple martins are increasingly using artificial nest boxes, so absence of the boxes may preclude the existence of this species.

Water Shrew ***(Sorex palustris*** **ssp.** ***brooksi)***: Water shrews are associated with the Coastal Douglas Forest biogeoclimatic zone and the study area exists within this species' known distribution on Vancouver Island. The water shrew lives on the edges of streams and wetlands. It is probable that this species may be found in Craig Creek, the small wetland and the riparian areas associated with those waterbodies.

Keen's Long-Eared Myotis ***(Myotis keenii)***: This species almost entirely lives along the coast of British Columbia, however most colonies have been found on the Queen Charlotte Islands. They roost in rock crevices and hollow trees, and hibernacula exist in cool, humid, and protected areas. Keen's Long-eared Myotis may exist in the older second growth forest areas along the Englishman River, although it is improbable.

Wolverine ***(Gulo gulo*** **ssp.** ***vancouverensis)***: The study site exists in areas of known former distribution of the wolverine. This species probably prefers alpine tundra, subalpine parkland and mountain forest, although the general biology of the wolverine remains poorly understood. Although it is improbable that this species inhabits the study area, it may occur in the riparian habitat along Englishman River and possibly, traverses the right-of-way.

4.6 Biodiversity

Biodiversity was addressed in three ways:

- A comparison of wildlife species richness for each habitat;
- A review of the Sensitive Ecosystem Inventory (SEI) data; and,
- An assessment of landscape linkages present in and adjacent to the site.

4.6.1 Wildlife Species Richness

Table I lists the number of species (species richness) for the three main forested habitats plus river and stream habitat for each taxonomic wildlife group. The numbers were calculated by summing the number of species in each habitat in Appendix B. The numbers are hypothetical since it is not known if each species actually occurs in the study area. The forested habitats all have a similar level of potential species richness, however, the riparian habitat Western Redcedar - Snowberry is potentially the most rich.

Table I. Potential wildlife species richness by habitat for each taxonomic group.

Habitat	Amphibians and Reptiles	Birds	Mammals	Grand Total
River/Streams	9	74	14	97
Fd - Salal and FdBg - Oregon grape	13	132	30	175
Cw - Skunk Cabbage	13	126	31	170
Cw - Snowberry	13	136	36	185

4.6.2 Sensitive Ecosystem Inventory

The SEI STET mapping is provided in Figure 6. Based on our ground-truthing of the SEI polygons they have been significantly changed since mapping occurred in 1997. Table II describes the sensitive ecosystems that are present in the study area. Four ecosystems were mapped in the study area. Three of the ecosystems are considered sensitive (Wetland, Riparian and Older Forest). The fourth unit (Older Second Growth) is not sensitive, but is included in SEI mapping for its contribution to biodiversity and wildlife habitat values (Ward *et al.*, 1997).

The Riparian and Older Forest units primarily occur in the Englishman River valley and are not likely to be affected by the development. There are three Older Forest polygons (N0973A, N0997 and N0999) outside of the river valley in the north end of the study area on either side of the Island Highway. A portion of polygon N0977 east of the island Highway has been cleared and could no longer be classified Older Forest.

The small swamp wetland in the south end of the study area was identified as a sensitive wetland (polygon N1058). Wetlands are rare in this region and it will be important to protect this area.

The remaining SEI polygons are identified as Older Second Growth Forest (polygons N1017 and N0998).

In the time since the SEI mapping was completed (some portions of the mapping dates back to 1994), land clearing has occurred and a significant amount of Older Second Growth areas have already been removed, especially for polygon N1017.

Table II. Sensitive ecosystems present in the study area.

Ecosystem	Description	Sub-Classes	Reason for Sensitivity
Wetland (WN)	Marshes, fens, bogs, swamps, shallow water, and wet meadows.	WN:sg Swamp	• Highly threatened: They are among the most threatened habitats in the world. • Rarity: Wetlands are naturally uncommon in this area because of the rain-shadow climate with its low annual precipitation and pronounced summer dry period. • High biodiversity: Wetlands support a high number of habitat niches which provide critical habitats for numerous species. • Vulnerability to changes in hydrology and water quality.
Riparian (RI)	Vegetated floodplains, stream and lake shores and gullies;	RI:1 Sparse/bryoid - moss and lichen dominated, <10% treed, <20% shrub/herb. RI:3 Shrub/herb – >20% shrub, <10% treed. RI:5 Young forest – self-thinning evident, 40 - 80 years old. RI:6 Mature Forest – 80 - 250 years old. RI:7 Older forest - >250 years old.	• High biodiversity: Riparian areas support a disproportionately high number of species for the area they occupy. • Aquatic Habitat Protection: Contribute to the ecological health of adjacent aquatic areas through shading, bank stability, and the addition of large logs into the stream or lake margin. • Wildlife corridors: Riparian ecosystems are often linear and may function as linkages or corridors within the broader landscape.

Ecosystem	Description	Sub-Classes	Reason for Sensitivity
Older forest (OF)	Forests older than 100 years.	OF:co - Coniferous forests. OF:mx - Coniferous stands with a deciduous component of >15%.	• Rarity: Only remnants exist of forests which were much more extensive throughout the study area only 150 years ago. • High biodiversity: Older forests support a rich community of wildlife, plant and invertebrate species. • Specialized habitats: Many species are dependent or associated with specific habitat features only found in older forests.
Older second growth forest (SG)	Second growth stands 60-100 years old. *Not a sensitive ecosystem specifically by have potentially high biodiversity and wildlife habitat values.*	SG:co - Coniferous forests. SG:mx - Coniferous stands with a deciduous component of >15%.	• Future older forests: Within 20 years, many of the second growth forests that were logged early this century will become older forests. • Landscape Connectivity: Older second growth forest stands provide connections between other natural areas that promote the movement and dispersal of many forest dwelling species across the landscape. • Buffers: Can minimize disturbance to sensitive ecosystems that occur within or adjacent to the forest patch.

Adapted from Ward et al. (1998)

4.6.3 Landscape Linkages

Landscape linkages are land corridors between undeveloped or protected habitat areas and are the focus of growing attention in the conservation of biological diversity (Hudson, 1991).

The Englishman River valley is an important natural corridor as it links with numerous natural areas to the west (including Mt. Arrowsmith) and the marine environment of Georgia Strait to the northeast.

Within the proposed development site, maintaining linkages between the Englishman River valley and the small swamp wetland in the south end of the site and with ALR land to the south and east of site would provide corridors for movement among different habitat types and would contribute to the maintenance of biodiversity in the region.

4.7 Land-Use

Present land-use in the surrounding area is a mixture of undeveloped forest, residential, agricultural and industrial. Residential and agricultural properties bound the property to the east. New residential developments are under construction on the southern boundary of the property. A permitted woodwaste disposal site is under operation by Weyerhauser, the previous owners, at the northern limit of the property.

5.0 RECOMMENDATIONS AND BEST MANAGEMENT PRACTICES

5.1 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are those areas that contain rare, unique or important species, habitats or ecological functions. ESAs require special management considerations.

Three ESAs were identified based on the analysis of the results presented in the previous sections:

- Small swamp wetland in the southern portion of the study area;
- The Englishman River and associated riparian habitats; and,
- Craig Creek and associated riparian area.

Figure 7 shows the location of ESAs in the study area.

5.2 Best Management Practices

Best Management Practices (BMPs) and recommendations are considered in two categories: Planning and Design, and Construction.

5.2.1 Planning and Design

The following BMPs and recommendations should be considered during the planning and design phase.

- Respect Environmentally Sensitive Areas (ESAs).
  - Small swamp wetland in the southern portion of the study area;
  - The Englishman River and associated riparian habitats;
  - Craig Creek and associated riparian area; and,
  - Older second growth (mature) forest areas.
- Establish a greenway between the swamp wetland in the south end with the Englishman River valley (Nordstrom 1990).
- Using recent air photographs, identify Old Forest area within the development site and subject these to appropriate protection.
- Environmental setback from streams, wetlands and older forests are:

- ➢ Englishman River: From top-of-bank, i.e. where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the break;
- ➢ Craig Creek: From top-of-bank, i.e. where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the break; and
- ➢ Wetlands: From the winter high water mark.; and
- ➢ Older Forest Ecosystem: From edge of re-mapped SEI polygon.

Other relevant concurrent studies include:

- A stormwater management plan has been completed by EBA for the site. This plan follows stormwater management BMP's presented in DFO (1993) and MWLAP (2001). The plan does not have any direct connections (i.e. outfalls) to waterbodies within the site and should not result in any impacts to water quality or quantity (i.e. flows) to waterbodies on the site.

- EBA was retained in 2002 to conduct a hydrogeological assessment of the proposed subdivision. Septic fields were evaluated as a means of sewage treatment, and based on the investigations and analysis described in this study, development of septic systems for the proposed development will not effect water quality in the Englishman River (EBA 2002).

- EBA was retained to complete a geotechnical analysis, which has identified building setbacks from the top-of-bank of the Englishman River the details of which are in the study given.

5.2.2 Construction

The following BMPs and recommendations should be considered during the construction phase.

- A silt, sediment and erosion control plan will provide sediment and runoff control and treatment BMP's as suggested in the DFO/MWLAP Land Development Guidelines for the Protection of Aquatic Habitats (DFO, 1993) and the Environmental Objectives, Best Management Practices and Requirements for Land Development for the Vancouver Island Region (MWLAP, 2001). This plan should be developed prior to construction.

6.0 RECOMMENDED STUDIES

A raptor survey on and around any development areas, (e.g. roads) prior to commencement of clearing is recommended for further study.

7.0 REFERENCES

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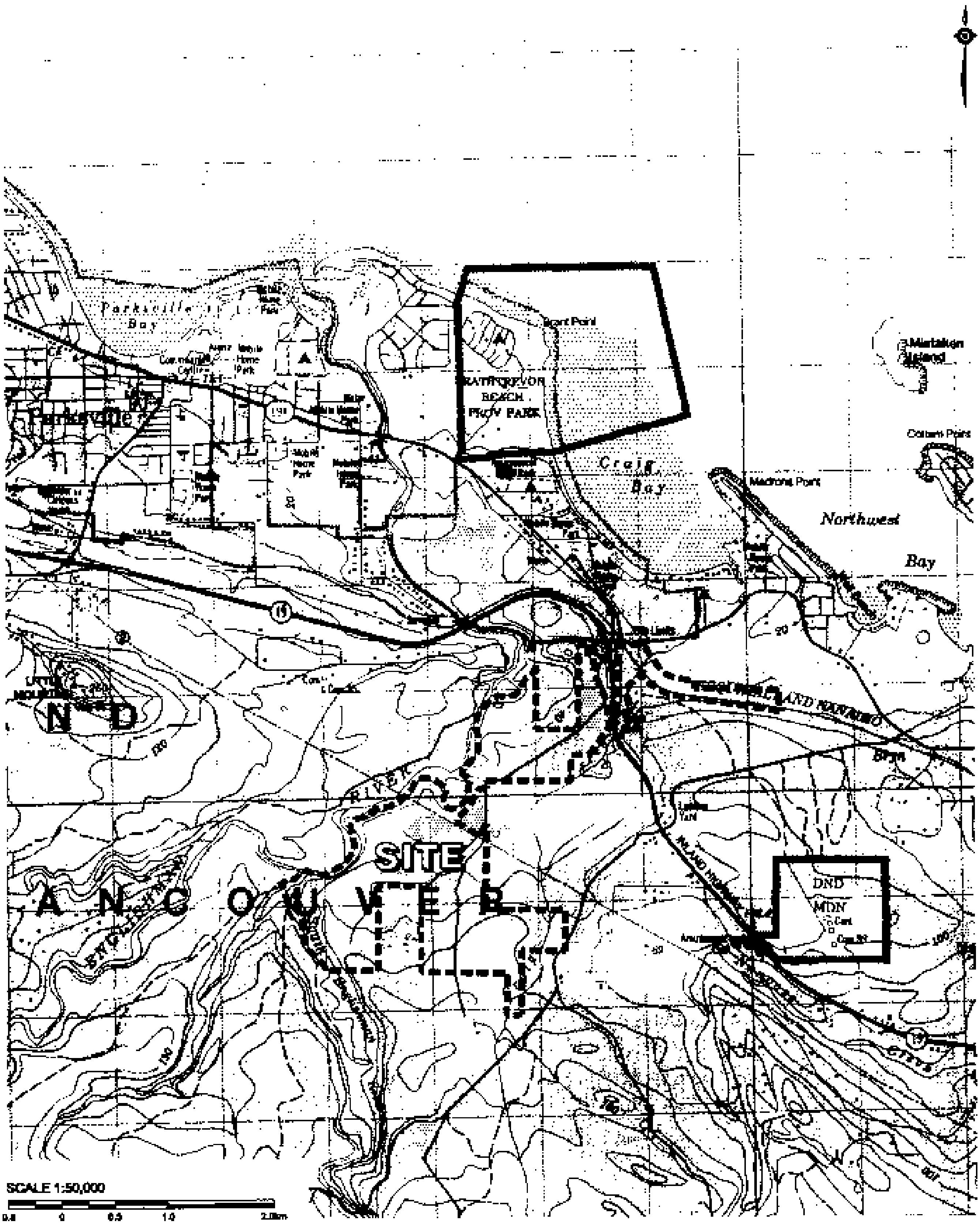
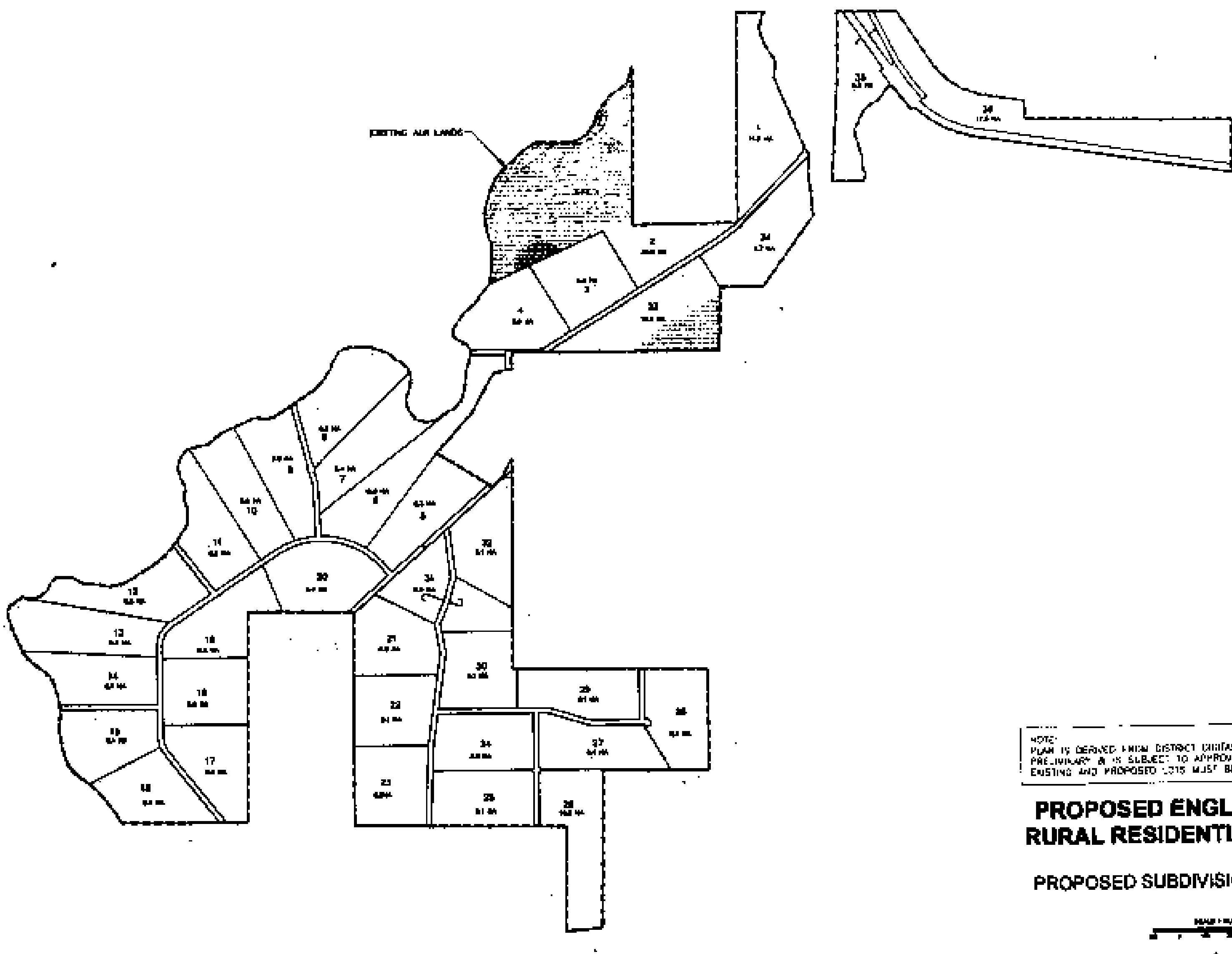


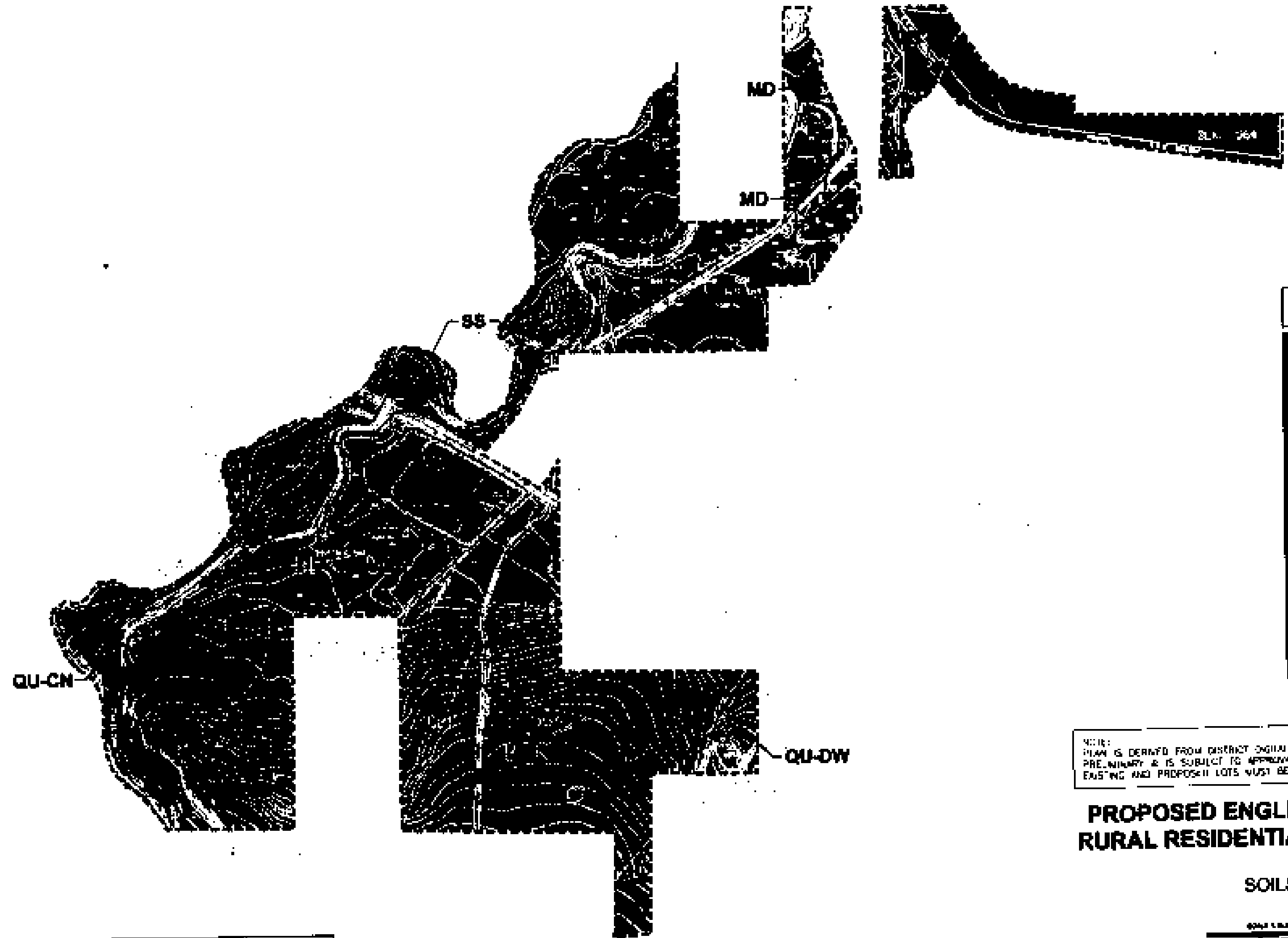
EBA Engineering Consultants Ltd.				PROJECT	ENGLISHMAN RIVER RURAL RESIDENTIAL COMMUNITY
CLIENT	ENGLISHMAN RIVER LAND CORPORATION			TITLE	SITE LOCATION PLAN
DATE 2002/11/20	DWN. JB	CHKD. JM		FILE NO. 0805-5887561.002	FIGURE 1



NOTE:
PLAN IS DERIVED FROM DISTRICT DIGITAL BASE MAPPING. LOT LAYOUT IS PRELIMINARY & IS SUBJECT TO APPROVAL OF ALL APPLICABLE AGENCIES. EXISTING AND PROPOSED LOTS MUST BE VERIFIED BY A BCLS

PROPOSED ENGLISHMAN RIVER RURAL RESIDENTIAL COMMUNITY

PROPOSED SUBDIVISION DEVELOPMENT



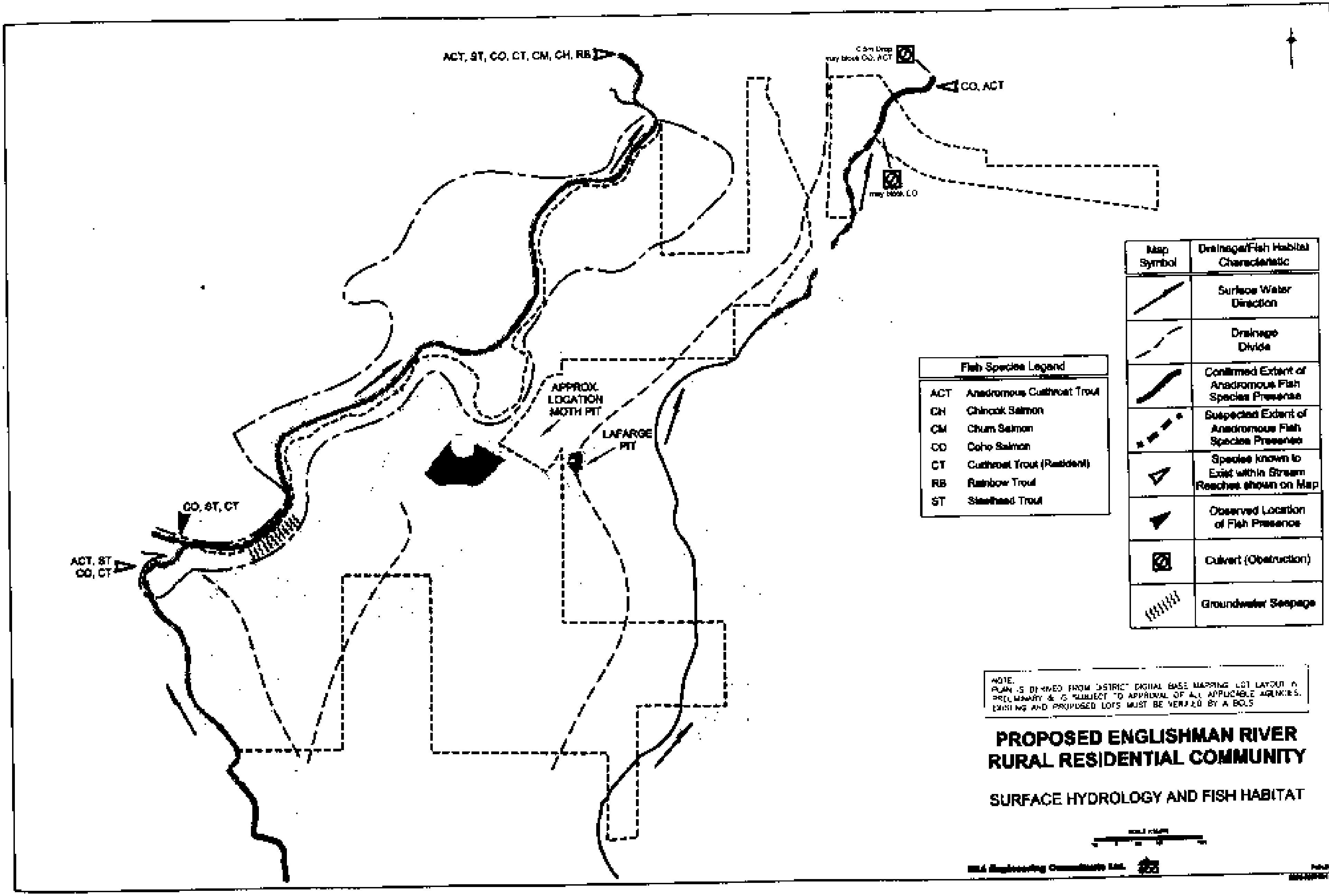
Map Symbol	Soil Name
	Baddis
	Dashwood
	Gravel Pit
	Qualicum
	Shawnigan
	Brigantine
	Bowser
	Tolmie
	Cassidy
	Chemainus
	Comiaken
	River Bar
	Gulley w/Slope > 45%
	Wood Waste Landfill

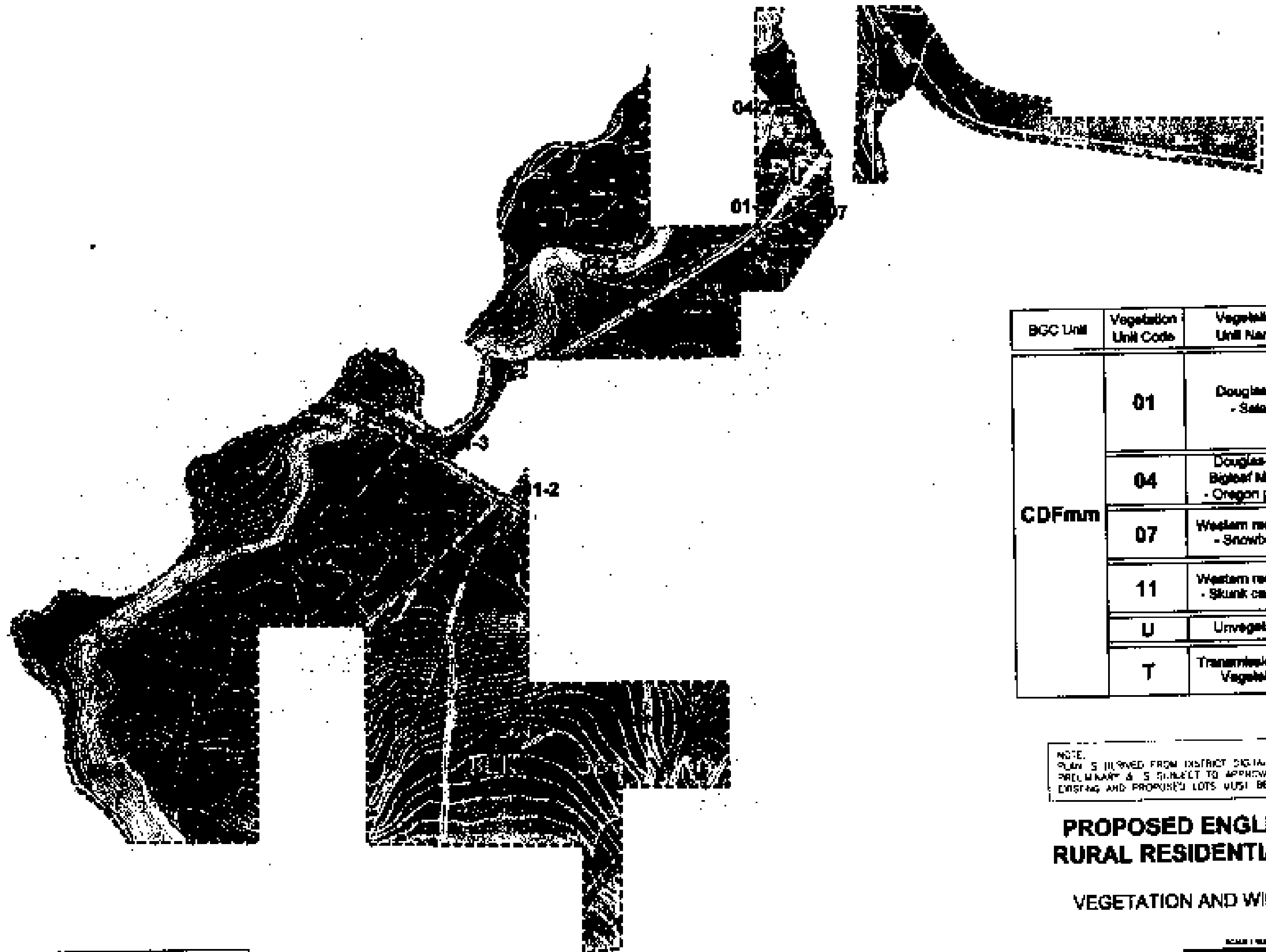
NOTE:
PLAN IS DERIVED FROM DISTRICT DIGITAL BASE MAPPING. LOT LAYOUT IS PRELIMINARY & IS SUBJECT TO APPROVAL OF ALL APPLICABLE AGENCIES. EXISTING AND PROPOSED LOTS MUST BE VERIFIED BY A BCLS

PROPOSED ENGLISHMAN RIVER RURAL RESIDENTIAL COMMUNITY

SOILS

EBA Engineering Consultants Ltd.


ACT, ST, CO, CT, CM, CH, RB
C 5m Drop
may block CO, ACT
CO, ACT
may block CO
APPROX. LOCATION MOTH PIT
LAFARGE PIT
CO, ST, CT
ACT, ST
CO, CT
Map Symbol
Drainage/Fish Habitat Characteristic
Surface Water Direction
Drainage Divide
Confirmed Extent of Anadromous Fish Species Presence
Suspected Extent of Anadromous Fish Species Presence
Species known to Exist within Stream Reaches shown on Map
Observed Location of Fish Presence
Culvert (Obstruction)
Groundwater Seepage
Fish Species Legend
ACT Anadromous Cutthroat Trout
CH Chinook Salmon
CM Chum Salmon
CO Coho Salmon
CT Cutthroat Trout (Resident)
RB Rainbow Trout
ST Steelhead Trout
NOTE:
PLAN IS DERIVED FROM DISTRICT DIGITAL BASE MAPPING. LOT LAYOUT IS PRELIMINARY & IS SUBJECT TO APPROVAL OF ALL APPLICABLE AGENCIES. EXISTING AND PROPOSED LOTS MUST BE VERIFIED BY A BCLS
PROPOSED ENGLISHMAN RIVER
RURAL RESIDENTIAL COMMUNITY
SURFACE HYDROLOGY AND FISH HABITAT



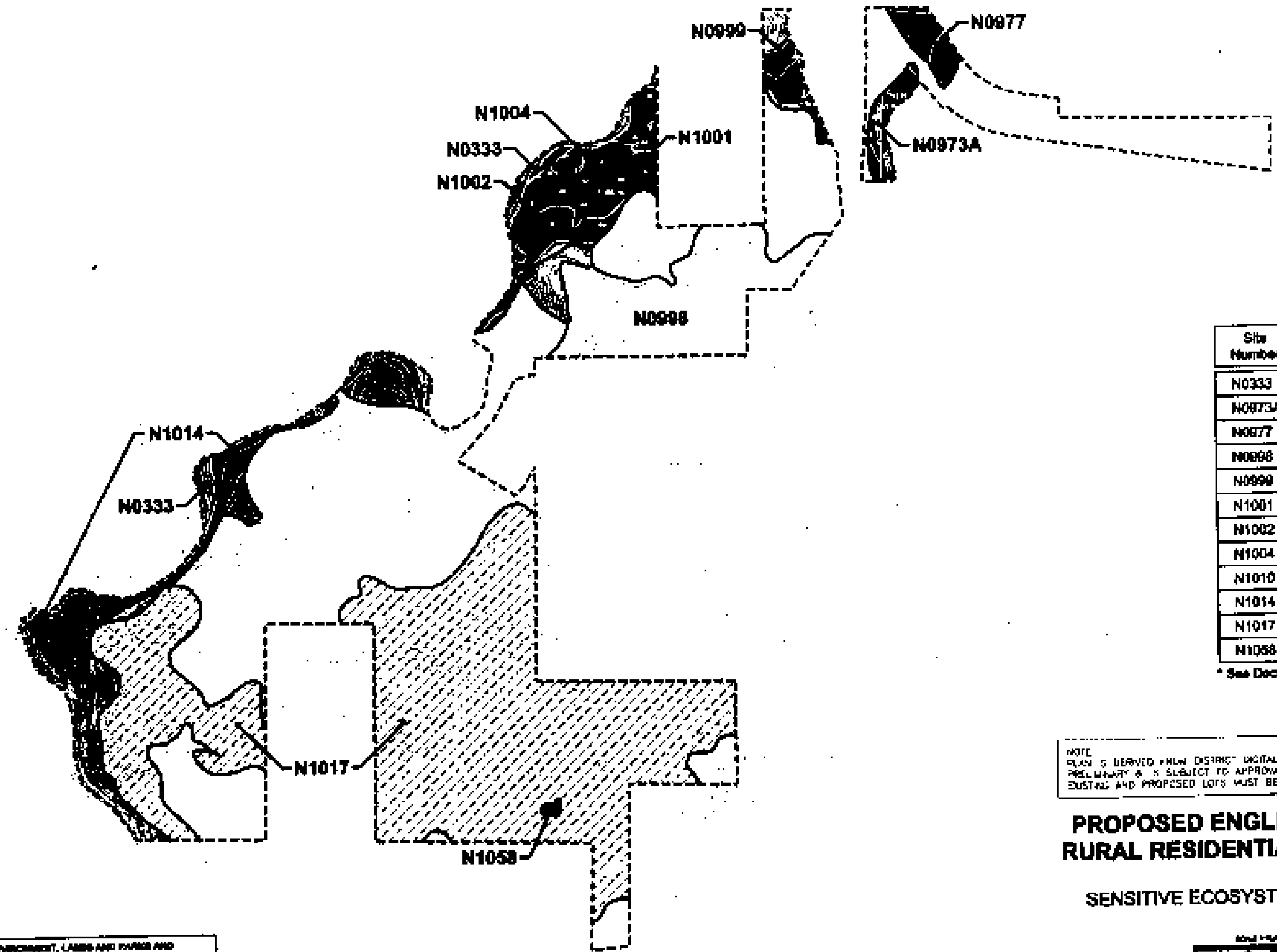
BGC Unit	Vegetation Unit Code	Vegetation Unit Name	Identifier	Age Class
CDFmm	01	Douglas-fir - Salal		0 - 30yrs
				30 - 80yrs
				80 - 100yrs
				> 100yrs
	04	Douglas-fir / Bigleaf Maple - Oregon grape	1	0 - 30yrs
				30 - 80yrs
	07	Western redcedar - Snowberry		
	11	Western redcedar - Skunk cabbage		
	U	Unvegetated		
	T	Transmission Line Vegetation		

NOTE:
PLAN IS DERIVED FROM DISTRICT DIGITAL BASE MAPPING. LOT LAYOUT IS PRELIMINARY & IS SUBJECT TO APPROVAL OF ALL APPLICABLE AGENCIES. EXISTING AND PROPOSED LOTS MUST BE VERIFIED BY A BCLS

PROPOSED ENGLISHMAN RIVER RURAL RESIDENTIAL COMMUNITY

VEGETATION AND WILDLIFE HABITATS

SOURCE: 1) DELINEATION BASED ON TRIM (1996) AND PHOTO-INTERPRETATION OF 1996 COLOUR AERIAL PHOTOGRAPHY.
2) VEGETATION CLASSIFICATION BASED ON GREEN AND KLINKA (1994) AND TRIM (1996).



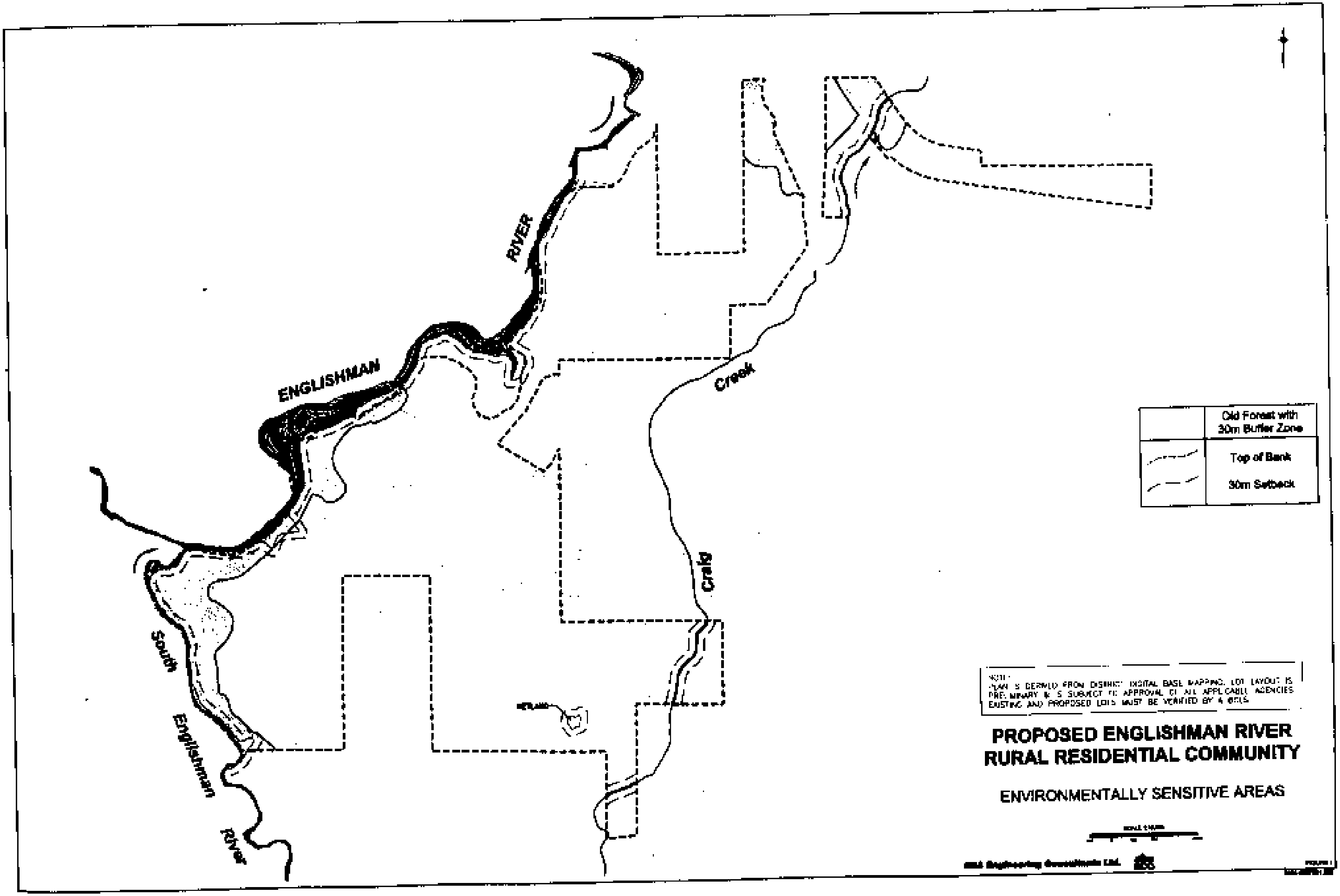
Site Number	Primary Ecosystem	Secondary Ecosystem
N0333		
N0973A		
N0977		
N0998	SG:co	
N0999		
N1001		
N1002		
N1004		
N1010		
N1014		RI:6
N1017	SG:co	OF:co
N1058		

* See Document for a description of Codes

NOTE
PLAN IS DERIVED FROM DISTRICT DIGITAL BASE MAPPING. LOT LAYOUT IS PRELIMINARY & IS SUBJECT TO APPROVAL OF ALL APPLICABLE AGENCIES. EXISTING AND PROPOSED LOTS MUST BE VERIFIED BY A BCLS.

PROPOSED ENGLISHMAN RIVER RURAL RESIDENTIAL COMMUNITY

SENSITIVE ECOSYSTEMS INVENTORY


ENGLISHMAN
RIVER
Creek
Craig
South
Englishman
River
Old Forest with 30m Buffer Zone
Top of Bank
30m Setback
PROPOSED ENGLISHMAN RIVER
RURAL RESIDENTIAL COMMUNITY
ENVIRONMENTALLY SENSITIVE AREAS

Appendix B

List of Wildlife Species that could be Present in the Study Area Based on Habitat Availability.

Group	Common Name	Status [1]	River/Streams	Fd - Salal and FdBg - Oregon grape	Cw - Skunk Cabbage	Cw - Snowberry
Amphibians	Rough-skinned newt			x	x	x
Amphibians	Northwestern salamander			x	x	x
Amphibians	Long-toed salamander			x	x	x
Amphibians	Clouded salamander			x	x	x
Amphibians	Ensatina salamander			x	x	x
Amphibians	Western red-backed salamander		x	x	x	x
Amphibians	Western toad		x	x	x	x
Amphibians	Pacific treefrog		x	x	x	x
Amphibians	Red-legged frog		x	x	x	x
Amphibians	American bullfrog		x			
Amphibians	Northern Leopard frog	R	x			
Reptiles	Northern alligator lizard			x	x	x
Reptiles	Western garter snake		x	x	x	x
Reptiles	Northwestern garter snake		x	x	x	x
Reptiles	Common garter snake		x	x	x	x
Birds	Pacific loon		x			
Birds	Western grebe	R	x			
Birds	Clark's grebe		x			
Birds	American white pelican	R	x			
Birds	Double-crested cormorant	B	x			
Birds	American bittern	B	x			
Birds	Great blue heron	B	x			x
Birds	Green-backed heron	B	x			x
Birds	Black-crowned night-heron		x			
Birds	Tundra swan		x			
Birds	Trumpeter swan	B	x	x	x	
Birds	Mute swan		x			
Birds	Greater white-fronted goose		x			
Birds	Canada goose		x			
Birds	Wood duck		x			x
Birds	Green-winged teal		x			

Group	Common Name	Status [1]	River/Streams	Fd - Salal and FdBg - Oregon grape	Cw - Skunk Cabbage	Cw - Snowberry
Birds	Mallard		x			
Birds	Northern pintail		x	x	x	x
Birds	Blue-winged teal		x	x	x	x
Birds	Cinnamon teal		x			
Birds	Northern shoveler		x			
Birds	Gadwall		x			
Birds	Eurasian widgeon		x			
Birds	American widgeon		x			
Birds	Canvasback		x			
Birds	Redhead		x			
Birds	Ring-necked duck		x			
Birds	Greater scaup		x			
Birds	Lesser scaup		x			
Birds	Harlequin duck		x			
Birds	Oldsquaw	B	x			
Birds	Black scoter		x			
Birds	Surf scoter	B	x			
Birds	White-winged scoter		x			
Birds	Common goldeneye		x	x	x	x
Birds	Barrow's goldeneye		x	x	x	x
Birds	Bufflehead		x	x	x	x
Birds	Hooded merganser		x	x	x	x
Birds	Common merganser		x			x
Birds	Red-breasted merganser		x			
Birds	Turkey vulture	B		x	x	x
Birds	Osprey		x	x	x	x
Birds	Bald eagle	B	x	x	x	x
Birds	Northern harrier			x	x	x
Birds	Sharp-shinned hawk			x	x	x
Birds	Cooper's hawk			x	x	x
Birds	Northern goshawk subspp.			x	x	x
Birds	Northern Goshawk subsp. laingi	R		x	x	x
Birds	Swainson's hawk	B		x	x	x
Birds	Red-tailed hawk			x	x	x
Birds	Golden eagle			x	x	x
Birds	American kestrel			x	x	x

Group	Common Name	Status[1]	River/Streams	Fd - Salal and FdBg - Oregon grape	Cw - Skunk Cabbage	Cw - Snowberry
Birds	Merlin			x	x	x
Birds	Gyrfalcon	B	x			
Birds	Ring-necked pheasant			x	x	x
Birds	Blue grouse			x	x	x
Birds	Ruffed grouse			x	x	x
Birds	Wild turkey			x		
Birds	California quail			x	x	x
Birds	Mountain quail			x	x	x
Birds	Sandhill crane	B	x			
Birds	Killdeer		x			
Birds	Greater yellowlegs		x			
Birds	Lesser yellowlegs			x	x	x
Birds	Solitary sandpiper		x			
Birds	Spotted sandpiper		x			
Birds	Upland sandpiper	R		x		
Birds	Least sandpiper		x			
Birds	Common snipe		x			
Birds	Ring-billed gull		x			
Birds	California gull	B	x			
Birds	Western gull		x			
Birds	Arctic tern		x			
Birds	Marbled murrelet	B		x	x	x
Birds	Rock dove			x	x	x
Birds	Band-tailed pigeon			x	x	x
Birds	Mourning dove			x	x	x
Birds	Barn owl	B		x	x	x
Birds	Western screech owl	B		x	x	x
Birds	Great horned owl			x	x	x
Birds	Northern hawk owl			x	x	x
Birds	Northern pygmy owl subsp. swarthi	B		x	x	x
Birds	Barred owl			x	x	x
Birds	Great gray owl			x	x	x
Birds	Long-eared owl			x	x	x
Birds	Northern saw-whet owl subspp.			x	x	x
Birds	Common nighthawk		x	x	x	x
Birds	Vaux's swift		x	x	x	x

Group	Common Name	Status [1]	River/Streams	Fd - Salal and FdBg - Oregon grape	Cw - Skunk Cabbage	Cw - Snowberry
Birds	Anna's hummingbird			x	x	x
Birds	Calliope hummingbird			x	x	x
Birds	Rufous hummingbird			x	x	x
Birds	Belted kingfisher		x			
Birds	Lewis' woodpecker	B		x		x
Birds	Red-breasted sapsucker			x	x	x
Birds	Downy woodpecker			x	x	x
Birds	Hairy woodpecker subspp.			x	x	x
Birds	Three-toed woodpecker			x	x	x
Birds	Northern flicker			x	x	x
Birds	Pileated woodpecker			x	x	x
Birds	Olive-sided flycatcher			x	x	x
Birds	Western wood-pewee		x	x	x	x
Birds	Least flycatcher			x	x	x
Birds	Hammond's flycatcher			x	x	x
Birds	Dusky flycatcher			x	x	x
Birds	Western flycatcher complex			x	x	x
Birds	Eastern kingbird		x	x	x	x
Birds	Eurasian skylark			x	x	x
Birds	Purple martin	R	x	x	x	x
Birds	Tree swallow		x			
Birds	Violet-green swallow		x	x	x	x
Birds	Northern rough-winged swallow		x	x	x	x
Birds	Bank swallow		x			
Birds	Cliff swallow			x	x	x
Birds	Barn swallow			x	x	x
Birds	Gray jay			x	x	x
Birds	Steller's jay subspp.			x	x	x
Birds	Blue jay			x		
Birds	Clark's nutcracker			x		
Birds	Black-billed magpie		x	x	x	x
Birds	Northwestern crow			x	x	x
Birds	Common raven			x	x	x
Birds	Black-capped chickadee			x	x	x
Birds	Mountain chickadee			x	x	x
Birds	Chestnut-backed chickadee			x	x	x

Group	Common Name	Status [1]	River/Streams	Fd - Salal and FdBg - Oregon grape	Cw - Skunk Cabbage	Cw - Snowberry
Birds	Bushtit			x	x	x
Birds	Red-breasted nuthatch			x	x	x
Birds	White-breasted nuthatch			x	x	x
Birds	Pygmy nuthatch			x	x	x
Birds	Brown creeper			x	x	x
Birds	Bewick's wren			x	x	x
Birds	House wren			x	x	x
Birds	Winter wren			x	x	x
Birds	American dipper		x			
Birds	Golden-crowned kinglet			x	x	x
Birds	Ruby-crowned kinglet			x	x	x
Birds	Western bluebird			x		x
Birds	Townsend's solitaire		x	x	x	x
Birds	Veery				x	
Birds	Swainson's thrush			x	x	x
Birds	Hermit thrush			x	x	x
Birds	American robin			x	x	x
Birds	Varied thrush			x	x	x
Birds	Bohemian waxwing			x	x	x
Birds	Cedar waxwing			x	x	x
Birds	Northern shrike			x	x	x
Birds	European starling			x	x	x
Birds	Solitary vireo			x	x	x
Birds	Hutton's vireo	B		x	x	x
Birds	Warbling vireo			x	x	x
Birds	Red-eyed vireo			x	x	x
Birds	Tennessee warbler			x	x	x
Birds	Orange-crowned warbler			x	x	x
Birds	Nashville warbler			x	x	x
Birds	Yellow warbler			x		x
Birds	Magnolia warbler			x	x	x
Birds	Yellow-rumped warbler			x	x	x
Birds	Black-throated gray warbler			x	x	x
Birds	Townsend's warbler			x	x	x
Birds	Black-throated green warbler	B		x	x	x
Birds	Palm warbler	B		x	x	x

Group	Common Name	Status [1]	River/Streams	Fd - Salal and FdBg - Oregon grape	Cw - Skunk Cabbage	Cw - Snowberry
Birds	Northern waterthrush		x			x
Birds	MacGillivray's warbler			x		x
Birds	Common yellowthroat		x			x
Birds	Wilson's warbler			x	x	x
Birds	Yellow-breasted chat	R				x
Birds	Western tanager			x	x	x
Birds	Rose-breasted grosbeak				x	
Birds	Lazuli bunting		x			x
Birds	Rufous-sided towhee			x	x	x
Birds	Chipping sparrow			x	x	x
Birds	Savannah sparrow			x	x	x
Birds	Fox sparrow			x	x	x
Birds	Song sparrow			x	x	x
Birds	White-throated sparrow			x	x	x
Birds	Golden-crowned sparrow			x	x	x
Birds	White-crowned sparrow			x	x	x
Birds	Dark-eyed junco			x	x	x
Birds	Rusty blackbird		x			x
Birds	Brewer's blackbird		x			
Birds	Common grackle		x			
Birds	Brown-headed cowbird		x			
Birds	Northern oriole			x	x	x
Birds	Pine grosbeak subsp. carlottae	B		x	x	x
Birds	Purple finch			x	x	x
Birds	Cassin's finch			x	x	x
Birds	House finch			x	x	x
Birds	Red crossbill			x	x	x
Birds	White-winged crossbill			x	x	x
Birds	Pine siskin			x	x	x
Birds	American goldfinch			x	x	x
Birds	Evening grosbeak			x	x	x
Mammals	Common shrew		x			x
Mammals	Dusky shrew				x	
Mammals	Water shrew subspp.		x			x
Mammals	Water shrew subsp. brooksi	R	x			x
Mammals	Vagrant shrew			x	x	x

Group	Common Name	Status [1]	River/Streams	Fd - Salal and FdBg - Oregon grape	Cw - Skunk Cabbage	Cw - Snowberry
Mammals	Big brown bat			x	x	x
Mammals	Silver-haired bat			x	x	x
Mammals	Hoary bat			x	x	x
Mammals	California myotis			x	x	x
Mammals	Western long-eared myotis		x	x	x	x
Mammals	Keen's long-eared myotis	R		x	x	x
Mammals	Little brown myotis		x	x	x	x
Mammals	Long-legged myotis		x	x	x	x
Mammals	Yuma myotis		x	x	x	x
Mammals	Townsend's Big-eared bat	B		x	x	x
Mammals	Eastern cottontail					x
Mammals	Muskrat		x			
Mammals	Beaver		x	x	x	x
Mammals	Deer mouse			x	x	x
Mammals	House mouse			x	x	x
Mammals	Norway rat			x	x	x
Mammals	Black rat			x	x	x
Mammals	Northern flying squirrel			x	x	x
Mammals	Gray squirrel			x	x	x
Mammals	Red squirrel			x	x	x
Mammals	Gray wolf		x	x	x	x
Mammals	Cougar			x	x	x
Mammals	Wolverine subsp. vancouverensis	R	x	x	x	x
Mammals	River otter		x			x
Mammals	Marten			x	x	x
Mammals	Ermine subspp.			x	x	x
Mammals	Ermine subsp. anguinea	B		x	x	x
Mammals	Mink		x			x
Mammals	Raccoon			x	x	x
Mammals	Black bear subspp.		x	x	x	x
Mammals	Elk subsp. roosevelti	B		x	x	x
Mammals	Mule deer subsp. columbianus			x	x	x

[1] R = Red-listed (shaded); B = Blue-listed

REPORT ON THE RESULTS OF AN ARCHAEOLOGICAL OVERVIEW STUDY RELATING TO A SUBDIVISION PROPOSAL FOR THE BLOCK 564 LANDS, NANOOSE DIST.

Submitted to: The Englishman River Land Corp.
Vancouver, B.C.

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January 9, 2003

1.0 Introduction and Background

The following report outlines the results of an Archaeological Overview Study (OAS) carried out on behalf of the Vancouver based Englishman River Land Corporation and focused on lands comprising the Corporation's 900 acre subdivision proposal of Block 564, Nanoose District, near Parksville, B.C. (see Maps 1 and 2). The OAS was carried out by the Duncan B.C. based heritage consulting firm, The Bastion Group, under the direction of archaeologist Bjorn Simonsen. The latter was assisted in the field reconnaissance component of the project by Mike Edwards, of the Nanoose First Nation.

The *B.C. Archaeological Assessment Guidelines* document (published by the Archaeology and Registry Services Branch of the Ministry of Sustainable Resource Management - see Government of B.C., 1998), describes the objectives of an Archaeological Overview Study as a study that "... is intended to identify and assess archaeological resource potential or sensitivity within a proposed study area ..." and which makes "... recommendations concerning the appropriate methodology and scope of work for subsequent inventory and/or impact assessment (AIA) level studies...". The same "Guidelines" indicate that OAS projects normally include the following components:

- a review of previously completed archaeological, historic and ethnographic studies that are pertinent to the study area;
- a determination of archaeological resource potential and distribution for the study area;
- a preliminary assessment of anticipated development impacts on known or potential archaeological resources; and
- a report that outlines the findings of the study and which makes recommendations regarding the nature and scope of additional archaeological studies (usually at the AIA level).

The recently completed Block 564 lands AOS included all of the above, as well as a two-day archaeological field reconnaissance carried out by B. Simonsen and M. Edwards on December 30th., 2002, and January 3rd., 2003.

2.0 Description of Subject Lands

The Block 564 lands comprise approximately 900 acres which border the right bank (south side) of the Englishman River, just south of Parksville on Vancouver Island's east coast. The lands run southwards from the intersection of the Parksville Bypass and Old Island Highway, to a point approximately 2 kilometers up-river (see Maps 1 and 2). The inland extent of these lands away from the river bank varies from as little as 70 meters to one kilometer.

All parts of the Block 564 lands have been previously logged, with most areas only supporting juvenile stands of second - and even 3rd. growth - timber. Portions of these lands also contain large gravel pits and other remnants of past land development (see

MAP 1:

Portion of NTS Map 98 F/8 (1:50000) Showing Approximate Study Area Lands Outlined in Bold.

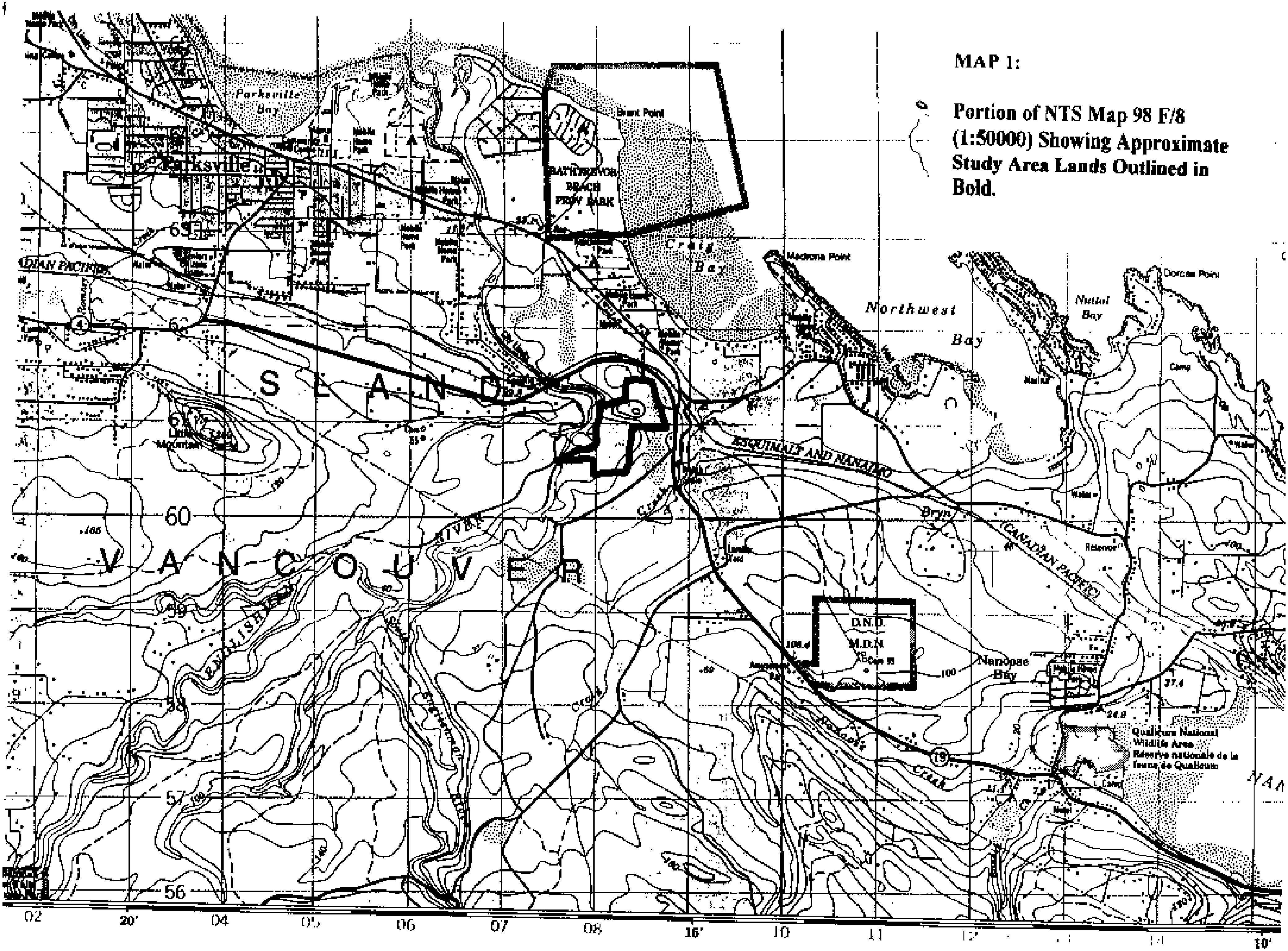


Figure 1: View of Englishman River bank and associated terrace feature in the vicinity of B.C. Hydro powerline. Such areas have archaeological potential

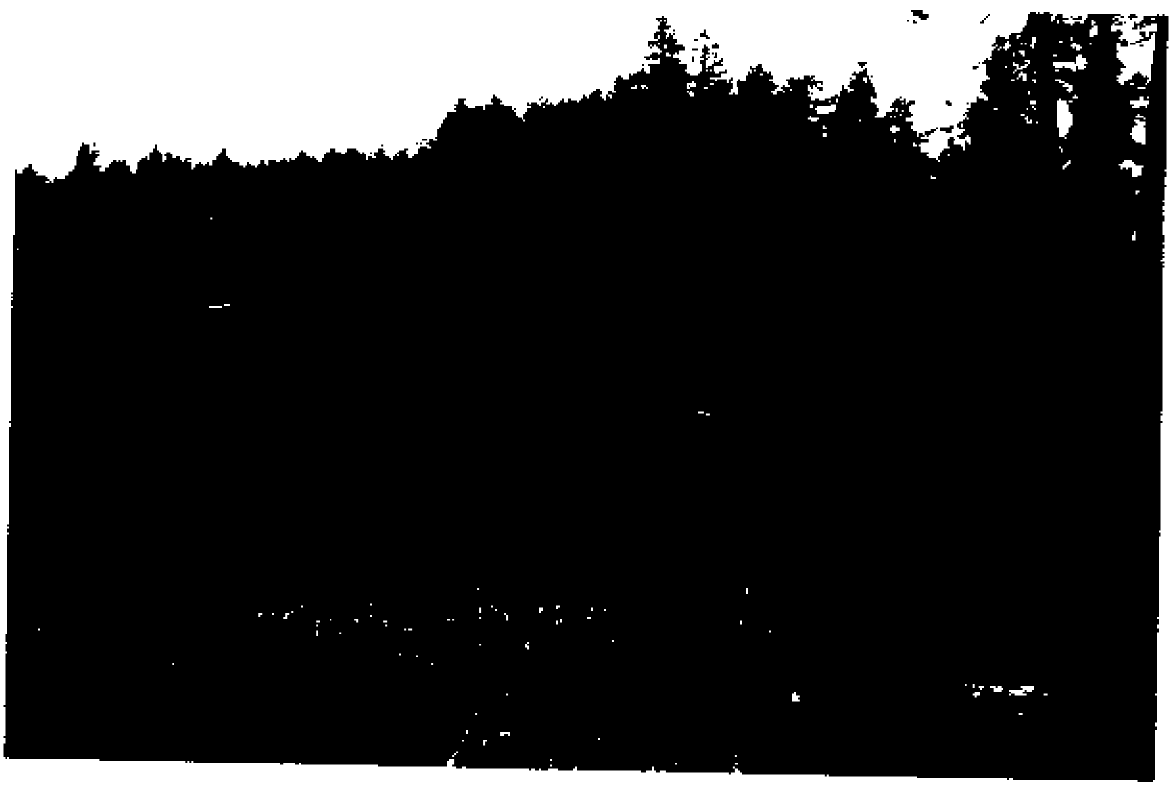


Figure 2: View of archaeological potential terrace features at the southwest end of the Block 564 Lands, above Englishman River.

Figures 2 - 4). It is safe to say, that virtually all parts of the 900 acre block has been altered in some way as a result of past land use during the past 100+ years. This includes much of the lands that border the banks of the Englishman River where natural erosion and extensive fisheries enhancement works (including the construction of spawning channels and stream deflection works) have altered many areas that may have had a potential for containing evidence of past aboriginal occupation and/or land-use, in the form of archaeological remains. The subject lands also support numerous trails and roads and are bisected by two major utility line corridors, namely a B.C. Hydro 500 Kv. transmission line and the Vancouver Island Natural Gas pipeline (see Map 2).

Where timber is still present, this consists mainly of juvenile stands of Douglas-fir, mixed with Hemlock and occasional small clumps of red cedar and balsam. Minimal old-growth stands of red cedar and Douglas-fir are found along the steep edges of river banks associated with the Englishman River and a small section of Craig Creek - the only other stream associated with the subject lands (see Map 2). The lack of substantial stands of old-growth timber is a major factor in determining a potential for the subject lands to contain culturally modified trees (CMTs) - which are protected under the B.C. Heritage Conservation Act if they pre-date the year 1846. Similarly, the large amount of land alteration and disturbances caused by past development activity within the study area greatly reduces the amount of lands that might otherwise be deemed to have a potential for containing archaeological evidence of past aboriginal use or occupation. For example, the removal of topsoil and underlying deposits in areas of past gravel extraction would have the effect of destroying all evidence of archaeological deposits or remains that may have existed in such locations.

3.0 Related Archaeological Investigations and First Nations Land-Use In the Study Area

Only one previous archaeological investigation has taken place within the Block 564 lands (based on our review of reports and archaeological site records from the general study area). This was an archaeological overview and impact assessment project carried out in advance of the construction of the Vancouver Island Gas Pipeline project in the early 1990s. The gas pipeline OAS and AIA studies (carried out by the Victoria based archaeological consulting firm of I.R. Wilson Consultants Ltd.) examined the proposed natural gas pipeline route through the subject lands but found no evidence of archaeological deposits or remains (I.R. Wilson et. al, 1989; I.R. Wilson, 1991). The pipeline right-of-way through Block 564 runs along the west side of the previously built B.C. Hydro transmission line corridor, with the exception of a small portion of pipeline at the south side of the Englishman River crossing. Here, the pipeline deviates slightly away from the main B.C. Hydro corridor along a low river terrace, but joins the normal right-of-way again just south of the crossing (see Map 2 for detail).

Although the I.R. Wilson gas pipeline AIA project found no archaeological evidence within Block 564 lands, it did find and document a site on an old river terrace feature, approximately one kilometer north of the Englishman River (I.R. Wilson, 1991; 170). This site (DhSb-37) is described in the B.C. Archaeological Site Registry database as a small occupation site containing stone artifacts and associated detritus material, both on the surface and in a sub-surface archaeological context. We must note here, that the Block 564 lands contain a number of physiographic features that are similar to the location of site DhSb-37 (see Figure 2 of this report) and some of these are considered to have archaeological site potential.

Three other previously recorded sites are found in close proximity to the Block 564 lands. These include site DhSb-05 - a petroglyph site located on a sandstone bluff at the upper end of the Englishman River canyon, immediately north of the subject lands - site DhSb-39 - a rock overhang (or "rock-shelter" feature) containing evidence of past human occupation - and site DhSb-41 - a small inland shell midden surface scatter and shallow deposit found within a triangular shaped piece of land lying on the west edge of the old island highway and the Parksville By-pass, just south of the E and N Railway crossing of the former highway right-of-way (see Millennia Research, 1995 for detail). Although a number of other reports and sources about past archaeological and anthropological studies in the Parksville/Englishman River area were reviewed in the course of the Block 564 OAS project, no additional information of relevance to our study was found in these sources.

Finally, two previously un-recorded archaeological deposits were found by the Bastion Group field reconnaissance team in the course of the recently completed AOS study. Although both sites are located just outside the boundaries of Block 564 (see Map 2), their presence provide further evidence of past aboriginal land-use in the study area. In both of these locations, surface shell midden matrix was found scattered on the surface. However, neither site appears to contain any sub-surface deposits or remains, based on our in-field observations. This should be confirmed by means of sub-surface examinations, at some future time.

The presence of previously documented archaeological sites in close proximity to the Block 564 lands suggests that similar site areas could be present within the latter lands, despite the effects of past land alteration activities. Our consultations with representatives of the Nanoose Nation - albeit brief - have also indicated that the Englishman River has been a major source of salmon for the Nanoose people, as well as for surrounding groups such as the Pentlatch and Snuneymuxw - throughout their history. Areas adjacent to the river provided game (mainly deer and elk) as well as numerous plant species used for food, medicine and for ceremonial activities. The timber resources of the area were also of great significance to the aboriginal people. Many First Nations from within the study area continue to utilize these natural resources - particularly the salmon resources of the Englishman River - on a regular basis. This being said, it must be pointed out that no specific information about traditional use areas within the Block 564 lands was provided to The Bastion Group in the course of the OAS study.

Figure 3: View of an abandoned gravel pit located within the Block 564 Lands

Figure 4: View of an exposed gravel bank along the side of a gravel pit in the Block 564 Lands. Such features provide good sub-surface exposures for an examination of potential archaeological deposits.

4.0 Archaeological Potential Areas

Following from the above discussion of what is known about archaeological site occurrences in the study area, together with observations and discoveries made by the Bastion Group field reconnaissance team during a two-day field examination of most areas within Block 564, we have determined that a total of 10 areas within the proposed subdivision lands contain a medium to high potential for containing archaeological evidence of past aboriginal land-use and/or occupation. These areas (shown on Map 2 of this report) may contain surface and/or sub-surface archaeological materials or deposits such as shell midden matrix (crushed and whole shell mixed with dark organic soils) or stone artifacts and/or detritus (stone chips and other by-products from the manufacture of stone artifacts).

Although a single petroglyph (figures incised into rock) site occurs on a sandstone outcrop in the vicinity of the Block 564 lands, we do not believe that there is any potential for additional sites of this type to be found within the actual subdivision lands since no similar outcrops were observed there - nor were there any rock shelter type features observed within these lands. There is also some potential for the subject lands to contain evidence of past forest utilization activities in the form of culturally modified tree features. These may include bark-stripped trees, scarring related to cambium bark gathering, pitch collection scarring and possibly evidence of plank removal and canoe tree procurement activities. Most such evidence is found in areas with good stands of old-growth red cedar, but may also be associated with Hemlock trees and, to a limited extent, Douglas-fir stands. Although no CMTs were observed in the course of a two-day field reconnaissance, it is our opinion that areas of old-growth forest along the banks of the Englishman River and a small section of Craig Creek have a good potential for such features to be found.

5.0 Conclusions and Recommendations

The previous sections of this report have shown that no previously recorded archaeological sites or features are situated within the proposed Block 564 subdivision lands and no such sites or features were found in the course of a two-day long field reconnaissance within the subject lands. However, we have also demonstrated that some areas of Block 564 have a potential for archaeological resources to be present (as shown on Map 2), but that this requires verification by means of a more thorough field examination.

Following from the above, it is our recommendation that an archaeological impact assessment (AIA) level of investigation be carried out, prior to the proposed 20 acre parcels being put on the market. This will ensure that any archaeological sites that may be found can be protected, either by means of legal covenants to restrict future development, or by excluding site areas from marketed parcels, or simply designated as being archaeologically non-significant and eliminated. The latter may require a significance evaluation level of archaeological investigation, as defined under the provincial AIA

"Guidelines", referenced earlier. This work must be carried out under the authority of a "Heritage Inspection Permit", issued by the Archaeology and Registry Services Branch under Section 14 of the B.C. Heritage Conservation Act.

An AIA level investigation of the subject lands will require a detailed examination of the ground surface and existing sub-surface exposures within the ten areas shown on Map 2. In addition to these examinations, it will be necessary to carry out a limited program of shovel (or machine auger) testing of some portions of terrace features contained within the ten areas, as well as examinations of old-growth timber stands within Block 564 for the presence of CMT features. We estimate that this work could be completed in about one week with a field crew of three persons.

6.0 References Cited

Government of B.C.

1998 *British Columbia Archaeological Impact Assessment Guidelines*
ed. by B. Apland and R. Kenny; Archaeology and Registry Services Branch, Victoria

Millennia Research

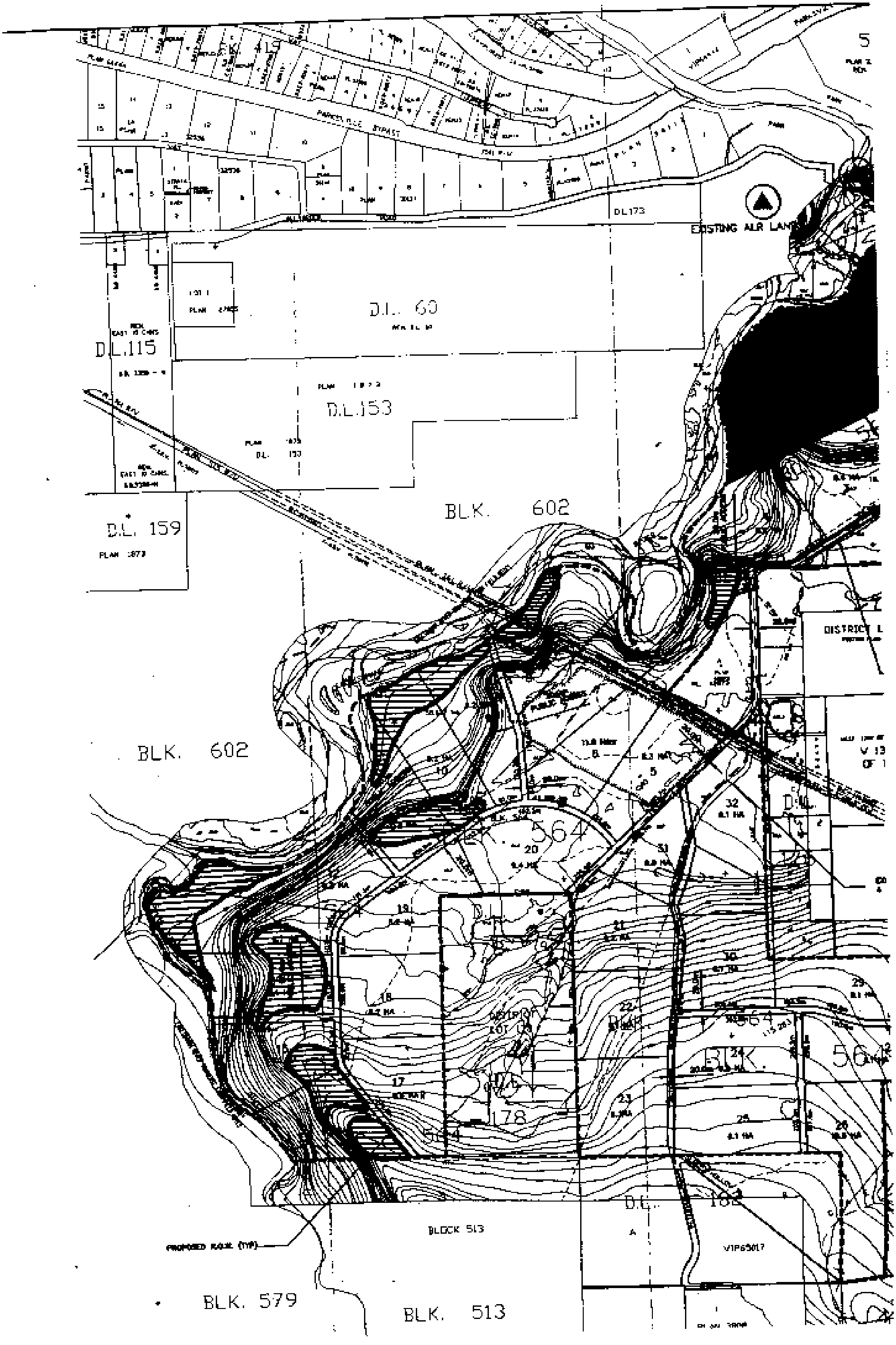
1995 *Archaeological Inventory and Impact Assessment; Vancouver Island Highway Project, Craig's Crossing, Parksville, B.C.*
Permit report 1995-036; on file with the Cultural Resource Library, Victoria

I.R. Wilson Consultants Ltd.

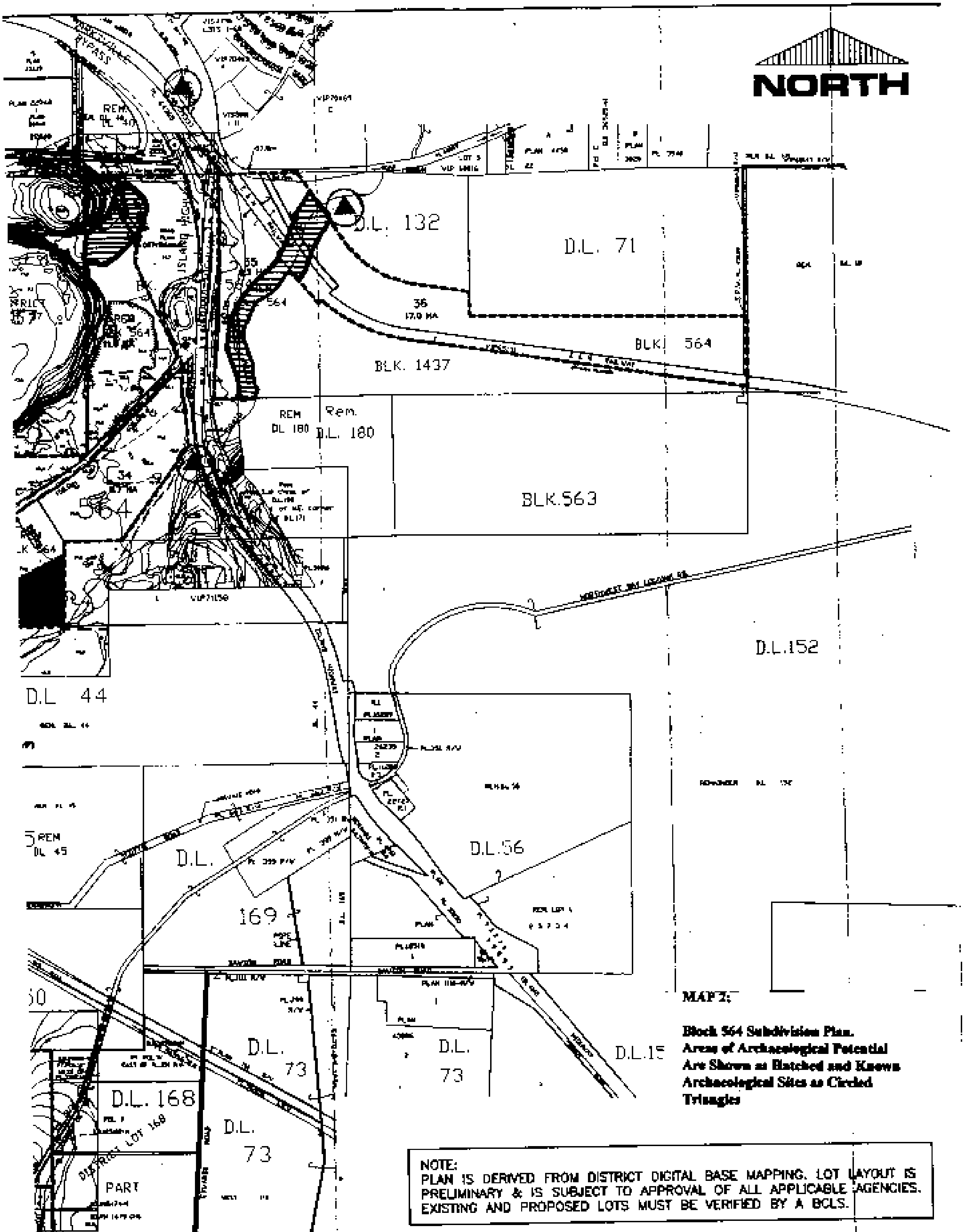
1991 *Heritage Resource Inventory and Impact Assessment; Vancouver Island Natural Gas Pipeline (Vols. I and II)*
Permit report 1989-77; on file with the Culture Resource Library, Victoria

I.R. Wilson, Randy Bouchard, and Dorothy Kennedy

1989 *Vancouver Island Natural Gas Pipeline Heritage Resource Overview*
Report on file with the Culture Resource Library, Victoria



D.L. 60
D.L.115
D.L.153
D.L. 159
PLAN 1873
BLK. 602
BLK. 602
DL173
EXISTING ALR LAN
DISTRICT L
BLK. 564
DISTRICT LOT 178
D.L. 178
D.L. 182
BLOCK 513
PROPOSED R.O.W. (TYP)
VIP65017
BLK. 579
BLK. 513
PARKSVILLE BYPASS



MAP 2:

Block 564 Subdivision Plan. Areas of Archaeological Potential Are Shown as Hatched and Known Archaeological Sites as Circled Triangles

NOTE:
PLAN IS DERIVED FROM DISTRICT DIGITAL BASE MAPPING. LOT LAYOUT IS PRELIMINARY & IS SUBJECT TO APPROVAL OF ALL APPLICABLE AGENCIES. EXISTING AND PROPOSED LOTS MUST BE VERIFIED BY A BCLS.

PROPOSED SUBDIVISION OF BLOCK 564, NANOOSE DISTRICT, PARKSVILLE BC

DEVELOPER:	ENGINEER:
5141 INVESTMENTS LTD. 11th FLOOR, 938 HOWE STREET VANCOUVER BC V6Z 1N9 TEL.:604-331-6018 FAX:604-331-6048	KHANGURA ENGINEERING LTD. 204-33119 SOUTH FRASER WAY ABBOTSFORD BC V2S 2B1 TEL.:604-852-4542 FAX:604-853-9625
SCALE: 1:5000 DATE : 02-10-25	

EBA Engineering Consultants Ltd.

Creating and Delivering Better Solutions

January 24, 2003

EBA File: 0805-5887561.001

Englishman River Land Corporation
1100-938 Howe Street
Vancouver, BC
V6Z 1N9

Attention: Mr. Brent Kapler

Subject: **Block 564, Parksville, B.C.**

As requested, EBA Engineering Consultants ltd. (EBA) has summarized the main findings from our previous reports on water supply and septic systems for Block 564 located near Parksville, B.C. We have also provided a response to additional questions/requests for clarification from the Regional District of Nanaimo following their review of these reports.

This letter is presented as a series of questions and responses below:

1). *Can the Lower Aquifer supply enough water for the subdivision over the long term?*

From our interpretation of well records, published reports and previous experience in the area, there is a confined sand and gravel aquifer underlying Block 564 and surrounding area. Based on experience with other municipal water systems drawing from aquifers of similar geologic origin, our review and synthesis of relevant data, a numerical groundwater model and analytical solutions, we conclude that there is a very high probability that the Lower Aquifer will be capable of supplying the required water demand for the foreseeable future.

The RDN requested clarification concerning how the pumped aquifer is recharged (i.e. how is the pumped water replenished?). Recharge is supplied by downwards leakage of water through a layer of silty sandy till about 20 m thick that overlies the Lower Aquifer.

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The rate of leakage is controlled by a variety of factors including the vertical hydraulic conductivity of the till confining layer and the hydraulic gradient across the confining layer. In general, the amount of leakage will be greatest near the proposed pumping wells (because the vertical gradient across the till confining layer is greatest at these locations) and the amount of leakage will decrease at increasing distance from the wells.

Recharge of the Lower Aquifer will occur on the property and also off the property on surrounding lands where the pumping causes sufficient drawdown to induce downwards leakage across the confining layer. The source of water for this leakage or recharge is contained in a near surface sand and gravel deposit referred to as the Upper Aquifer in our report. Sources of recharge for the Upper Aquifer comes from a variety of sources, including rain and snowmelt, losses from creeks and septic systems, both on-site and off-site. Comments relating to water quality in the Lower Aquifer and the effect of septic systems on water quality are discussed in questions 4 and 6.

Recharge will also be supplied by upwards leakage of water from soil and/or bedrock units that underlie the Lower Aquifer, but this was neglected in our analysis to be conservative. The concept of leakage across a confining layer of relatively low permeability (e.g. till) into a pumped aquifer is a well-understood concept that has been documented in the technical literature for decades (e.g. Hantush and Jacob (1955), Hantush (1956, 1960), Neuman and Witherspoon (1969, 1972)).

2). *Will pumping the Lower Aquifer effect low flows in the Englishman River?*

Yes, pumping from the groundwater aquifer will reduce flows in the Englishman River, but the amount is very small, relative to the low flows in river during the late summer. The most important period is the summer months when river flows are lowest. During the period of lowest flows, the flow in the Englishman River is about 1.26 cubic metres per second. Very conservatively, we have calculated that the flows in the river could be reduced by as much as 0.008 cubic metres per second, about 0.6% of the total river flow. This reduction in flow likely will not be measurable with the gauge used to measure the river flow and is unlikely to detrimentally effect use of the river for aquatic habitat.

3). *Will pumping the Lower Aquifer effect other existing wells?*

Yes, pumping the Lower Aquifer for the proposed subdivision will result in a drawdown (lowering of the piezometric surface) that extends off of the property. This will reduce the height of the water column in surrounding domestic wells that pump from the Lower Aquifer.

Generally, the amount of drawdown is greatest at the location of the pumping wells, and the drawdown diminishes with increasing distance away from the pumping wells. The amount of drawdown produced in existing domestic wells due to the proposed pumping wells (termed "interference drawdown") is estimated to range from about 1.0 to 3.5 metres (using conservative analysis) in the nearest domestic wells (located on Rascal Lane). The height of the water column in these wells is about 30 m. Therefore, the proposed pumping wells could produce an interference drawdown of up to about 12 percent of the available drawdown. This amount of interference drawdown is not considered to be excessive and is not anticipated or expected to detrimentally effect operation of existing domestic wells.

4). *Is the water quality in the Lower Aquifer suitable for drinking water?*

Based on results of a single chemical analysis from a Lower Aquifer well directly adjacent to Block 564 and multiple tests from 28 municipal wells in Parksville and Lantzville that pump from similar aquifers, water quality is expected to be well suited for drinking water. Depending on local water quality conditions, treatment for aesthetics (i.e. iron and manganese) may be required.

5). *Will septic systems cause pollution of the Englishman River?*

Household septic systems (i.e. drainfields) discharge domestic wastewater to the ground. Domestic wastewater may contain pathogens (e.g. bacteria or viruses potentially harmful to human health) or chemical parameters, for example nitrate (NO_3).

As wastewater seeps through soils, pathogens are filtered (i.e. prevented from moving with the water) due to constrictions in the pore spaces of soils. Nitrate on the other hand does not tend to react with the soil to any significant degree and therefore moves with the groundwater seepage through the aquifer.

The BC Ministry of Health regulates the design and construction of household septic systems in B.C. They have developed regulations that specify, among other things, the required setback distances between septic systems to drinking water wells and surface water. These setback distances are intended to be protective of human health and the environment.

Our previous analysis showed that the setback distances between the proposed building sites and the Englishman River (or Craig Creek) are well in excess of the minimum requirements of the Health Act Sewage Disposal Regulation. Based on this, it was concluded that the setback distances are protective for preventing pollution of the river water by pathogens.

Conservative calculations of the loading of nitrate to the river were performed. This analysis showed that using conservative assumptions for nitrate loading assuming 178 lots, the maximum increase in river water nitrate concentration (which occurs when the river has lowest flows) was 0.09 mg/L as N. Ambient nitrate levels in the river presently range between 0.004 mg/L as N and 0.095 mg/L as N with an average of 0.034 mg/L as N. The drinking water limit for nitrate is 10.0 mg/L as N.

Based on the above, it was concluded that septic system will not detrimentally effect water quality in the Englishman River or impair its use as a drinking water source.

6). *Will septic systems cause pollution of the Lower Aquifer?*

As discussed above in Question 5, domestic wastewater contains pathogens and chemical parameters such as nitrate that have guidelines for protection of health in drinking water. BC Ministry of Health has requirements for the siting and construction of wells so that health protection requirements are met. During the subdivision process, it will be necessary to demonstrate that these requirements will be met.

As was described above in Question 1, water from the Upper Aquifer leaks downward across a till confining layer to recharge the pumped Lower Aquifer. Since the Upper Aquifer is used for disposal of domestic wastewater, the RDN has asked if this downward leakage of water will result in pollution of the Lower Aquifer.

For the reasons discussed previously in Question 5, pathogens will be filtered in the soil profile and will not be capable of migrating through the Upper Aquifer, across the till confining layer and ultimately to the Lower Aquifer.

Because nitrate does not react with the soil, concentrations of nitrate will move downward with groundwater leakage across the confining layer. It is expected that detectable concentrations of nitrate will eventually migrate downward into the Lower Aquifer although this may take years to decades before increased nitrate levels are measurable in the Lower Aquifer.

We are unaware of any causes where a confined aquifer has been contaminated by nitrate in BC. In the Fraser Valley, unconfined aquifers have been contaminated by nitrate, due largely to intensive agriculture and associated manure wastes. In discussions with Ministry of Health personnel, they were also aware of elevated nitrate levels in a municipal well located near Whistler, B.C. that was attributed to septic systems. Again, the Whistler well is in an unconfined aquifer that is more susceptible to pollution by activities on the land surface (e.g. fertilizers, septic systems).

Nitrate data were also reviewed for existing municipal wells pumping from similar confined aquifers in the study area. In Lantzville, there is very little residential development (i.e. sources of nitrate) in the vicinity of the pumping wells. Based on multiple samples from six municipal wells, nitrate ranges from 0.4 to 3.31 mg/L as N with an average of 0.78 mg/L as N. In the Parksville area, there is generally more residential development in the vicinity of the pumping wells. Based on multiple samples from 19 wells in the Parksville area, nitrate ranges from 0.0025 to 1.7 mg/L as N, with an average of 0.73 mg/L as N. Many of these wells have been in operations for a number for years such that nitrate from surface sources could potentially migrate across confining layers and into the pumped aquifers.

Based on these results for wells pumping from confined aquifers in the study area, it is concluded that nitrate is present although generally at levels less than 1.0 mg/L as N (drinking water guidelines is 10 mg/L as N). These data suggest that similar nitrate levels may result in the Lower Aquifer at Block 564 over the long term. Although nitrate is not anticipated to be problematic for health reasons, it should be monitored routinely (e.g. annually) as part of the normal maintenance and monitoring of the proposed water system.

Respectfully submitted,

EBA ENGINEERING CONSULTANTS LTD.

Prepared by

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — JOHN BALFOUR — Jan 24/03

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