Agricultural Site Assessment and Farm Plan
For Bill Jones Horticultural Inc.
9360 Finn Road Richmond, B.C.

Prepared for

Bill Jones Horticultural Inc.

Prepared by:

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October 25, 2012

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Executive Summary

The following report provides details on the agricultural development of the property located at 9360 Finn Road Richmond, B.C. The proposed farm development includes 4 hectares of Filbert nuts, 4.6 hectares of caliper ornamental trees, 2.15 hectares of Christmas trees and 1.45 hectares of container nursery production.

To ensure there is adequate rooting depth for the caliper ornamental trees and the Filbert nut trees it is recommended that present surface drainage be improved by the expansion of the existing ditch in the centre of the property and that subsurface drainage be installed throughout the entire farm. In addition the soil level should be raised by 50 cm with high quality topsoil to ensure that the roots are well above the winter water table. The increase of 50 cm elevation is still below the surrounding municipal road elevations. This will give approximately 80 cm of rooting depth during the winter. This will be accomplished by importing 30 cm of topsoil plus crowning of the land to give adequate rooting depth.

The container nursery area should be constructed on a solid base and be raised 15 cm above the existing ground level to provide positive drainage. It is recommended that 50 cm of the existing soil be excavated and moved to either the caliper tree or Filbert nut area and that granular fill be added and then topped with 10 to 15 cm of gravel. This is the typical construction of nursery container beds to ensure adequate bearing strength for tractors and trucks and to provide a well drained growing area.

The proposed you cut Christmas tree production area will need to be sub-soiled and cultivated prior to planting but no additional topsoil is needed in this area.

Farm access roads need to be constructed to allow all weather access to all areas of the farm. The attached detailed drawing shows the roads around the perimeter of the property and an extension of the existing farm road through the centre of the proposed caliper tree field. The main perimeter road should be 4m in width to allow large semi trailer truck to access the caliper tree field. Drawings are provided in appendix VI for this road.

The combination of improved surface and subsurface drainage and the addition of high quality topsoil will provide growing conditions that are appropriate for production of caliper ornamental trees and Filbert nut trees. The installation of all weather access roads will ensure that the farm can harvest trees throughout the year without damaging the farm soil or having large trucks stuck in the fields. All of this will change what is presently an unproductive farm with a few pumpkins being grown for the Halloween market and much of the farm in weeds to a highly productive modern farming operation.

The total amount of topsoil and granular (not clay or silt) fill that will need to be brought onto the site is summarized in the table below.

Crop	**Area m^2**	**Topsoil m^3**	**Granular fill/Gravel**	**Total loose using Compaction Factor of 25% for topsoil and 30% for granular fill m^3**
Filberts	40359	12107 less 7273 from container area = 7806	0	9757
Caliper Trees	40359	13863	0	17329
Containers	14547	0	9455	12291
Total Topsoil before compaction				**27086**
Total Granular Fill before compaction				**12291**
Total soil and granular fill				**39377**

1.0 Introduction

McTavish Resource & Management Consultants Ltd. was retained by Bill Jones Horticultural Inc. to carry out an agricultural assessment on property located at 9360 Finn Road Richmond, B.C. (Figure 1). The purpose of the report is to:

- develop a farm plan that incorporates caliper tree production, container nursery production, 'You Cut' Christmas trees, and Filbert nut production,
- determine soil depth requirements for caliper ornamental tree and Filbert production (including additional topsoil requirements if needed),
- determine drainage requirements,
- provide technical information in the farm plan to assist the client in management decision making.

The farm was historically rented to a farmer who has produced pumpkins for the retail Halloween market, via operation of a pumpkin patch during the fall. The farm has been taken over by Bill Jones Horticultural Inc. by way of a 20 year lease on the land.

2.0 Site Location and Zoning

The property is located at 9360 Finn Road Richmond, B.C., the legal description is 6 SEC 15 BLK3N RG6W PL 38989 Except Plan 41056, 80324. The total area of the farm is 135257 m^2, or approximatlely13.5 Hectares. It is in the ALR and is zoned AG1.

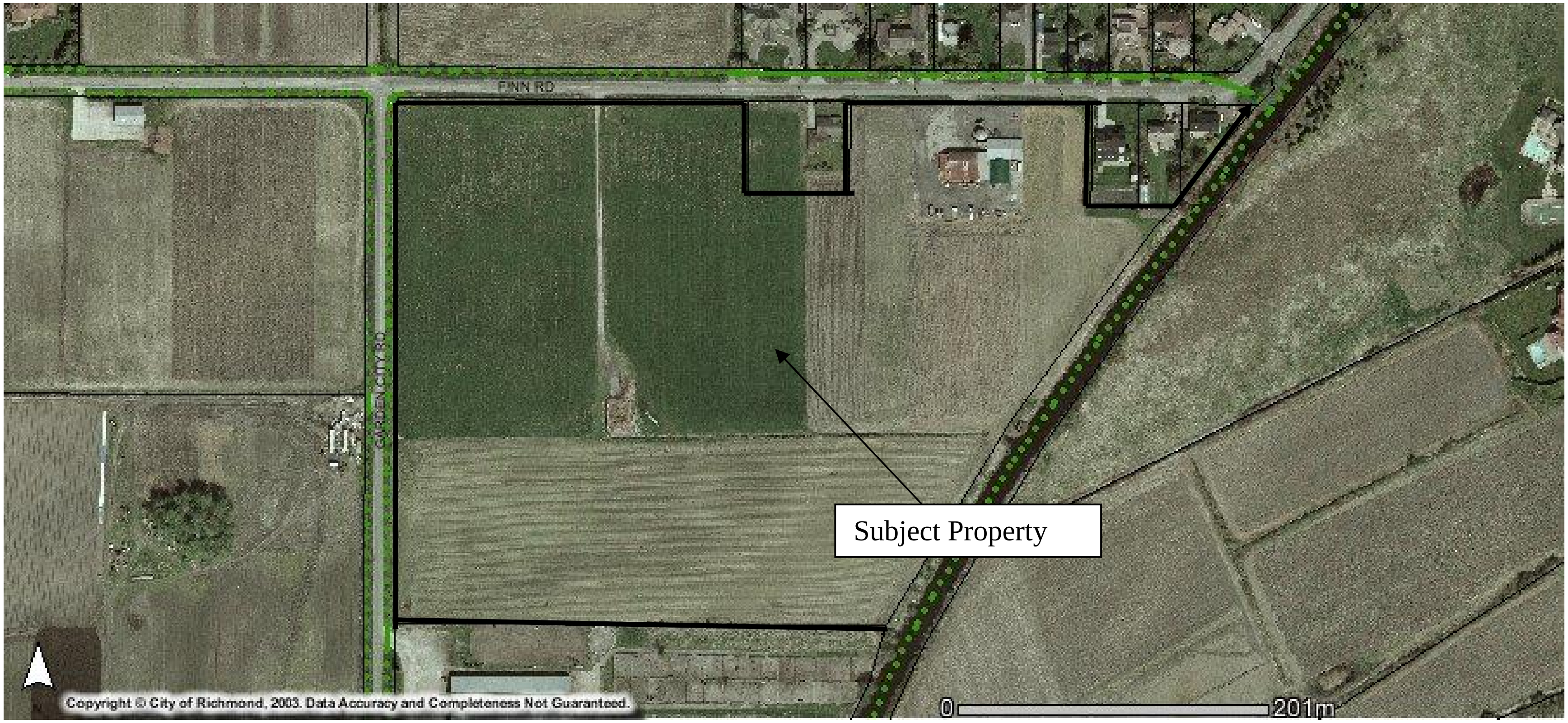

Figure 1 Site Location (inside black lines)

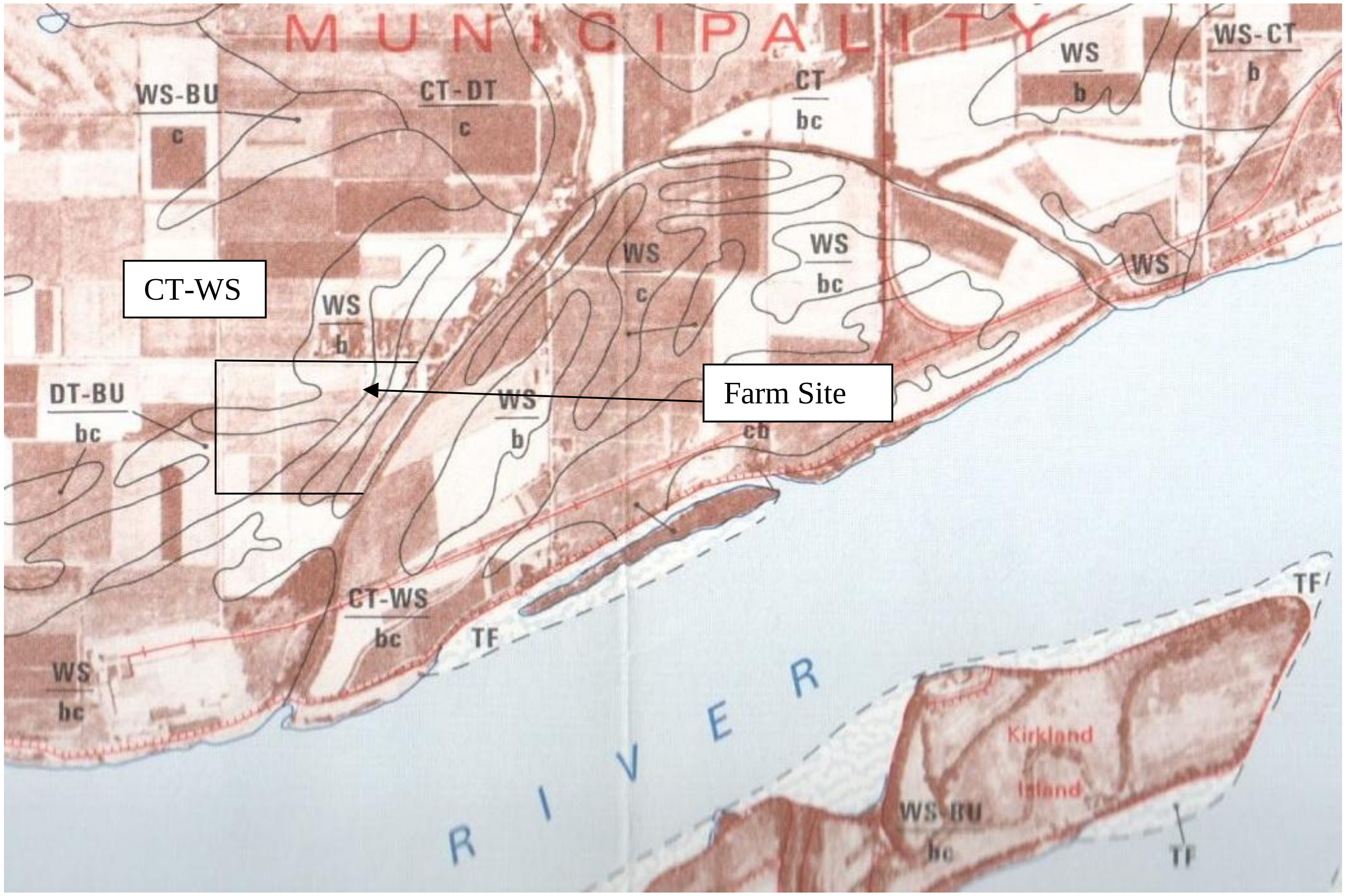

Figure 2 Soil Map of Site
Site Location Soils WS and DT-BU

3.0 Soils

Based on existing soil mapping, the soils on the site are in a polygons as shown in figure 2. The soils on the farm are mainly Westham, Blundell and Delta, with a small area of Crescent. Theses soils are all Gleysols formed from Fraser River deltaic deposits. These soils are described below and in Appendix I.

3.1 Description of Soils

Soil descriptions for each of the soil series found on the site are provided below. These descriptions are based on Luttmerding, H.A. 1981.[1] Appendix I provides details on these soils, the following provides a brief summary of key characteristics. Appendix II provides soil logs of sampling on the site. The sampling verifies the soil classification from existing maps. The site has a number of soil polygons that make the soils complex in terms of management and drainage. The soil polygons as seen in figure 2 include:

- A section of pure Westham soils
- A small tongue of Crescent/Westham (CT-WS) running through the middle and,
- A section on the west side of CT-WS
- A area of Delta/Blundell complex

3.1.1 Westham (WS)

Westham soils have a dark grayish brown, silty, cultivated surface layer about 20 cm thick, it is underlain by a silty zone about 20 cm thick that contains variable amounts of reddish to yellowish mottles. These soils are poorly drained, moderately pervious and have slow surface runoff and high water holding capacity. Water tables are near the surface during the winter, but if properly drained proved a moderate saturation free zone during the growing season.

3.1.2 Delta (DT)

Delta soils have a very dark gray to black, friable to firm, cultivated surface that is about 20 cm thick and usually contains 10 to 20% organic matter. These soils are poorly drained, have moderately pervious and have slow surface runoff and high water holding capacity. The water table is near the soil surface during most of the winter but recedes somewhat during the summer.

3.1.3 Blundell (BU)

Blundell soils have an organic, cultivated surface layer about 25cm thick, which is black to very dark brown, friable and well decomposed. They are poorly to very poorly drained, moderately pervious and have a high water holding capacity and slow surface runoff. The water table is near or at the surface most of the year, withdrawing to about

[1] Luttmerding, H.A. 1981. Soils of the Langley-Vancouver Map Area. BC Ministry of Environment.

1m during the latter part of the growing season. With drainage and in particular winter water table control, a variety of crops can be grown on these soils.

3.1.4 Crescent (CT)

Crescent soils have a friable to firm, dark grayish brown, silty, cultivated surface of about 20 cm thick which is underlain by about 20 cm of dark gray, firm, silty material. Crescent soils are moderately poorly, to poorly drained, are moderately pervious, have slow surface runoff and high soil water holding capacity. These soils are considered to be among the best agricultural soils in the Lower Mainland and almost all climatically suited crops can be produced if adequate drainage is provided.

3.2 Comments on Land Use

The present land use, as mentioned in the introduction, is a retail pumpkin patch with part of the field in forage with large percentage that has gone to weed. This weedy area is not being used for any productive agriculture, as seen in figure 3.

Figure 3 Present State of the Land

3.3 Present Land Capability based on Mapping

The land capability for agriculture mapping shown in figure 4 indicates that part of the farm is 4W (8:2WT 2:3WN) and a section classed as 4W (7:2WD 3:3WN) On-site observation verifies this classification.

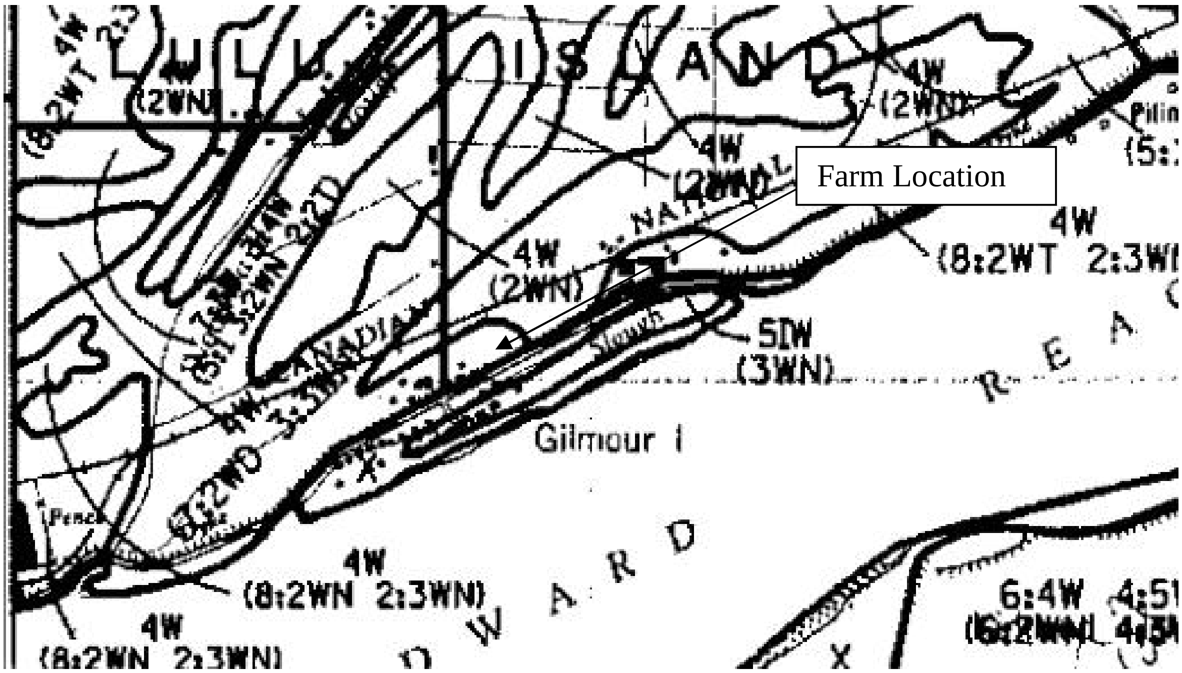

Figure 4 Land Capability for Agriculture

The classification in the brackets (noted in figure 4) is the improved classification. The critical issue in these types of soils is to provide adequate drainage to keep winter water tables low and thus maintain the higher improved ratings as shown in the mapping. Land capability classes found on this site (based on existing mapping) are described briefly below.

The entire site has an unimproved rating of 4W which indicates frequent or continuous occurrence of excess water during the growing period causing moderate crop damage and occasional crop loss. Water level is near the soil surface during most of the winter and/or until late spring preventing seeding in some years, and the soils are very poorly drained. Class 2 land, which most of the farm can be improved to, has minor limitations that constitute a continuous minor management problem or may cause lower crop yields or a slightly smaller range of crops compared to Class 1. On this site the major improved limitations are excess water (W), salinity (N) and low imperviousness (D).

3.4 On Site Soil Observations

A total of 22 on-site soil pits were installed May of 2012, (figure 5) with sampling locations shown in figure 6. The on-site work confirms the soil mapping and the published land capability classifications. Samples were conglomerated based on similar soils series and sent to Exova labs in Langley for nutrient, pH, electrical conductivity, organic matter and particle size analysis. Detailed soil logs are provided in Appendix II, lab reports are provided in Appendix III and a summary of soil results provided in table 1.

Figure 5 Typical Soil Sampling Pit

Figure 6 Soil Sampling Sites

Sample Site	N	p	k	S	pH	EC	OM	texture
	ppm	ppm	ppm	ppm		dS/m	%	
111-114 A	4	>60	447	10	6.8	0.14	7.3	
112, 114 C horizon	<2			11	4.7	0.11	0	
113, 116, 118, 119 C	4			5	5.7	0.06	0	silty clay
115, 116, 118, 119 B	8			22	4.8	0.2	0	silty loam
116, 117, 118, 119 A	8	>60	154	11	6.1	0.1	7.6	clay loam
123 sand lens	9			7	4.8	0.14	0	
124-127 A	<2	36	110	5	5.6	0.07	6.5	
124-127 B	<2			25	4.7	0.12	0	silt loam
124-127 C	<2			4	6.5	0.07	0	clay loam
133 B	13			47	4.5	0.33	0	
133 C	3			8	7	0.09		
133 A	8	14	47	189	3.7	0.84	3.4	
Average					5.41	0.19		

Table 1 Summary of Soil Test Results

From table 1 it can be seen that the average pH is 5.41. The pH can be increased by the addition of lime so that the average is at least 6.0, other than site 133. Sulphur and salt content is not excessive in the soil. Macro nutrients are all low but this can be improved by the addition of manure, compost or chemical fertilizers.

4.0 Site Topography and Drainage

A detailed plan showing elevations and contours is provided included as a large fold out map with this report. The surface is very close to flat with an average drop of 20 cm from west to east. There are surface ditches running along the road to the south of the property and a large regional ditch (Woodward Slough) running along the north side of the property.

5.0 Assessment of Land Capability

Based on overall site observations including drainage and a review of the existing mapping the author believes the property has an unimproved rating of 4W as shown on the land capability mapping.

5.1 Assessment of Improved Land Capability

The major goal in improving the land capability on this site will be the ability to improve winter drainage to keep the water table below the root zone of field trees for a significant portion of the year. The improved capability based on mapping will be 8:2WT 2:3WN and a section classed as 7:2WD 3:3WN. This indicates that for a large portion of the farm the land can be improved to Class 2 land with the major limiting factor being excess water (W). The descriptions of 2W, N and D are described below:[2]

2W is defined as" Occasional occurrence of excess water during the growing period causing slight crop damage, or the occurrence of excess water during the winter months adversely affecting deep rooted perennial crops. Water level is rarely, if ever, at the surface and excess water is within the upper 50 cm for only short periods (less than 2 weeks) during the year."

2N is defined as "Only salt sensitive crops are adversely affected. Soils have low (2mS/cm) salt content from 50 to 100 cm." Based on soil testing only one sample site, (133), had salt that would be of concern in the upper 50 cm, so 2N or better is applicable."

2D is defined as "A root restricting layer occurs within 50 to 75 cm of the mineral soil surface, or the upper 25 cm has a lightly sticky wet consistence and usually has a texture of silty clay loam or clay loam or sandy clay or the slowest permeability is usually 0.5 to 1.0 cm/hr in the upper 100 cm." This improved classification is correct as in some of the sample sites there was a dense silt or silty clay layer between 55 and 70 cm below the surface that will be root restricting.

To obtain the improved Class 2 capability the farm will need to improve surface and subsurface drainage. It is also recommended that surface elevations be raised for the proposed caliper/ornamental and Filbert trees to ensure adequate root zone depth above the winter water table.

6.0 Agricultural Plan

The farmer (Bill Jones) has contacts in Asia who will take all the dried filbert's that can be produced by the farm and also has extensive experience in the nursery landscape supply business. He is presently in negotiations with a large Asian developer to be the sole source of landscape plants for upcoming developments in Richmond. Therefore

[2] Henk E., & I Cotic. 1983. Land Capability Classification for Agriculture. BC Ministry of Agriculture and BC Ministry of Environment.

based on the site analysis and the operational needs of Jones Nursery, an agricultural plan has been developed for the production of caliper ornamental trees and ornamental plants in containers for the landscape industry, filbert nuts for off shore sales and a small area for ‘You Cut Christmas Trees. The recommended farm layout is shown in figure 7 and detailed layout is provided as a fold out map as part of this report.

Successful operation of this farm for nut and tree production will necessitate the installation of subsurface drainage, improvement of surface drainage, raising the land through the use of topsoil addition and building container nursery beds. The following section reviews the steps necessary for the improvements on this farm and provides an overview of production/management issues to be addressed.

6.1 Filbert Production

Approximately 4.0 hectares (10 acres) are to be assigned to filbert production. The section of the farm designated for this is shown in figure 7 and runs along the southern property boundary. This area has the best drainage due to the existence of old subsurface drain lines that discharge into a road ditch along Garden City Road. The soil sampling sites included in this area are 124 to 130 and the summer water table at all of these sites was at 90 cm or lower. However, the winter water table is significantly higher as indicated by the mottling at approximately 30 cm (12 inches). The mottles give an approximation of the water table fluctuations and height during the winter rainy season. This high of a winter water table would not allow for the proper root development of Filbert trees.

Filberts have historically been grown in Mediterranean countries (Turkey being the largest producer) and need relatively well drained soils to survive. “Filberts like sun and deep, well-drained soil. They will do okay in shallower soils, but watering becomes an important concern.”[3] With the winter water table at 30 cm (with subsurface drainage) on this farm it will likely cause problems to the tree roots and therefore it is recommended that an addition of 30 cm of topsoil be placed on top of the existing soil elevation and the planting beds be crowned. Creating a well drained site will lead to successful production as can be seen by the small orchard located on Sidaway Road in Richmond (see figure 8).

To address the increase of soil for Filbert production, it is suggested that rather than bringing in all off-site topsoil, that soil stripped from the area that will be used for a container nursery (noted in figure 7) be transferred to increase the elevation of the Filbert field. The soil stripped from the proposed container nursery area should be stripped to 50 cm (20 in.); the A horizon depth ranges for 30 to 40cm and the underlying soil texture is similar so it is recommended that 50 cm be removed and transferred to the Filbert field. Appendix V provides cross-sections of the proposed Filbert orchard.

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[3] Washington State University, Spokane County Extension. (2005) Filbert Culture Publication C037

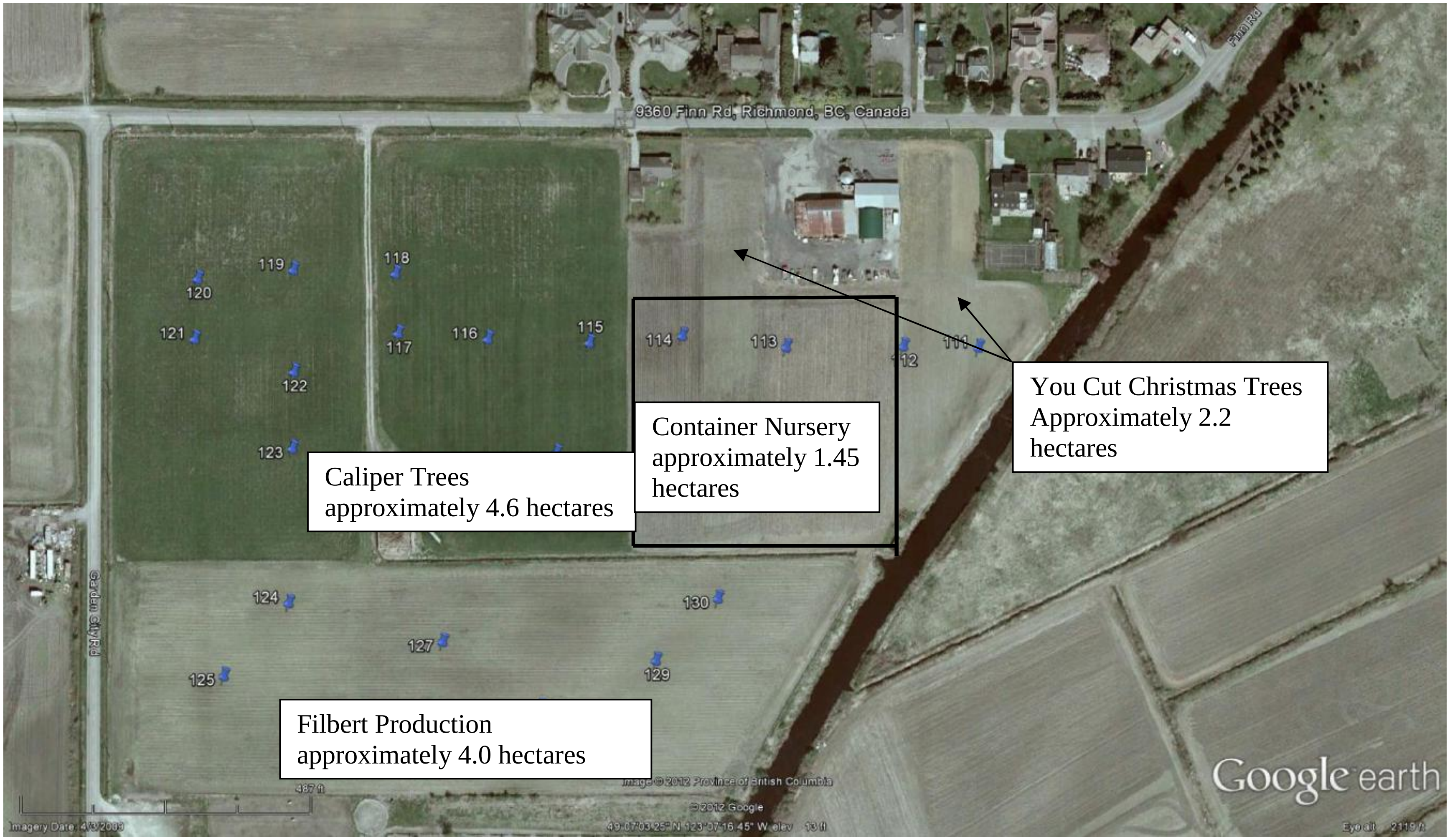

Figure 7 Farm Layout

6.1.1 Variety Selection for Filberts

Filberts are susceptible to Eastern Filbert blight, which nearly destroyed all the Filbert production in Western North America. Over the last 10 years the University of Oregon has developed a number of blight resistant varieties. It is critical that resistant or immune varieties be planted or the plantation will fail. Table 2 provides information on various varieties that are available in the market and their susceptibility to Eastern Filbert Blight.

Susceptible	**Intermediate**	**Resistant**	**Immune**
• Daviana	• Barcelona	• Tonda di	• Santiam
• Ennis	• Butler	• Giffoni	• VR series
• TGDL	• Hall's Giant	• Gem	• Gamma
• Casina	• Willamette	• Lewis	• Delta
• Negret		• Clark	• Epsilon
• Dundee		• Sacajawea	• Zeta
• Newburg			• Yamhill
• Tonda			• Jefferson
• Romana			• Eta
			• Theta
			• Dorris
			• York
			• Felix

Table 2 Filbert Variety Susceptibility to Eastern Filbert Blight.[4]

6.1.2 Management and Disease Control

It is recommended that the book titled "Growing Hazelnuts in the Pacific Northwest" be obtained as it is the best guide to best management practices for Filbert production in the Pacific Northwest that is available from University of Oregon Extension.[5] This comprehensive guide to hazelnut production includes topics on production costs and returns, hazelnut varieties, nut development, pollination, blanks and flower cluster losses, purchasing planting stock, propagating planting stock, locating the orchard, orchard design, establishing a new orchard, orchard floor management, training and pruning, orchard nutrition, pest management, harvesting, washing and drying nuts, and storage.

6.1.3 Expected Filbert Yields

The most recent data available on Filbert yields is from the National Agricultural Statistics Service of the US Dept of Agriculture. The report states that on production sites where an average of 120 trees per acre were planted within the Pacific Northwest

[4] http://oregonstate.edu/dept/botany/epp/EFB/links.htm
[5] http://extension.oregonstate.edu/catalog/abstract.php?seriesno=EC+1219

(Washington and Oregon) that the average yield in tons/acres between 1998 to 2007 was 1.16 tons/acre. *Planning for Profit for Hazelnuts* published by the BC Ministry of Agriculture uses 2500 lb/acre as their target yield (see appendix IV). More detailed data is provided in Appendix IV.[6] It should be noted that commercial yields will not occur until at least four years after planting and full production will likely not be obtained until year 7.

Figure 8 Successful Filbert Plantation Sidaway Road Richmond BC

6.2 Caliper Tree Production

Caliper trees are commonly supplied as street/ornamental trees on landscape projects. These trees are field grown and harvested using a tree spade that digs a large root ball and places it in a wire basket as shown in figure 9 and 10. The average width of the root ball will range from 91 – 23 cm (36 to 48 in.) for the trees that will be grown on this farm. The depth of the root ball is 2/3 the width. This means that the rooting depth of the trees will range from 24 to 31 inches (61 to 77 cm). In order to provide fields that will allow rooting to this depth, subsurface drainage must be installed and the fields raised and crowned. It is recommended that the fields be raised an average of 30 cm (12 inches) by addition of topsoil plus crowned to provide an additional 20 cm elevation to provide adequate rooting depth above the winter water table. To ensure that the tree digging equipment does not break drain lines they should be placed deeper than 1 m and preferably 1.2m if the drain outlets allow this. Drainage design will be outlined in Section 7.

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[6] National Agricultural Statistics Service – USDA (2008) Hazelnut Tree Report http://www.nass.usda.gov/Statistics_by_State/Oregon/Publications/Fruits_Nuts_and_Berries/hz%20full%20report.pdf

Figure 9 Tree Spade digging Tree

Figure 10 Tree in Wire Basket

6.2.1 Tree Spacing

The spacing of the trees will be dependent on the species and the intended size at harvest. Spacing must be designed to allow machine access to the trees for harvest and enough room for canopy development. An example of adequate spacing and the crowing of beds is shown in figure 11.

Figure 11 Caliper Tree Spacing and Bed Crowning

6.3 Container Nursery Production

Container nursery production, whether under poly houses or in open beds as shown in figure 12, requires raising of the beds in wet areas and the placement of adequate gravel to ensure a clean and dry growing surface. It is recommended that the land where the container production is to occur have the soil stripped to a depth of 50 cm. This will capture the topsoil (A horizon) and a portion of the subsoil (B horizon) which can be moved to the Filbert or Caliper tree production areas. The area that has been stripped of topsoil should have the volume replaced by clean granular fill and capped with crushed gravel. The beds should be raised approximately 15 cm above ground level to ensure adequate drainage. The plan indicates 1.45 hectares of container production or about 3.6 acres. This will require stripping and moving 7273m^3 of soil to other locations on the farm and replacing with clean granular fill (cannot be clay or silt) and topping this with approximately 10 to 15 cm of gravel (2182m^3).

Figure 12 Typical Container Nursery Bed

Adequate irrigation water is as important as drainage for successful container production. Three factors determining the irrigation requirement for container-grown crops:

Evapotranspiration (ET)
This the amount of water lost due to plant transpiration and substrate evaporation. It represents the amount of water that needs to be resupplied through irrigation (or rain). ET is affected by weather and changes daily.

Capture Factor (CF)
Is a measure of the plant canopy's capacity to channel sprinkler irrigation water that would otherwise fall between containers into the container. As CF changes, irrigation rates can be adjusted accordingly. CF is not applicable for drip and directed-spray irrigation systems, which deliver water directly to the container.

Distribution Uniformity (DU)
Is a measure of the sprinkler irrigation system's ability to deliver water uniformly throughout the irrigated area. As uniformity decreases, irrigation rates must be increased accordingly if all areas within the irrigation zone are to receive the recommended amount of water.

Based on the above variables water volume requirements will have to be determined once the species, container size and the irrigation method has been selected. In general the following should be the method of irrigation:

- Caliper trees – Drip irrigate or if possible sub-irrigate using drain lines (this will depend on ditch water levels in the summer)
- Filberts – Drip irrigate
- Containers – overhead impact sprinklers unless growing in #10 size pots or larger

6.4 You Cut Christmas Trees

Since the site is presently being used for pumpkin sales and therefore has a proven retail presence it is part of the farm plan to develop a small You Cut Christmas tree operation on approximately 2.2 hectares of the farm. Trees grown on the farm would be marketed direct to the public by way of a typical 'You Cut' operation where the customers and their families can come to the site and cut their own trees.

6.4.1 Christmas Tree Species Selection

Choosing the right Christmas tree species must be carefully considered prior to planting. The species must suit the site with respect to soil depth, drainage, fertility and texture. Investigate the potential market for each species that will suitably grow on the site and make decisions accordingly. Growing more than one species will permit some diversity and flexibility at market time. Depending on the size they are planted out at, some faster growing species such as Douglas and Balsam Fir allow harvest by year 4 after planting and others following by year 6. Typical trees used for Christmas trees include:

- Pine - Eastern white pine, Scots pine
- Spruce - Colorado blue and green varieties, White, and Engelman,
- Fir - Balsam, Concolor, Douglas,

6.4.2 Christmas Tree Irrigation and Drainage

If subsurface drainage is installed all the above species will grow successfully on this site.
The following web site provides detailed information on each species and the advantages and disadvantages of each: http://www.canadianchristmastrees.ca/species.html

Commercial Christmas trees must be pruned and sheared annually from the first growing year through to harvest. This is done to increase foliage density and improve shape. Pruning and shearing are demanding since they must be done by hand within a certain time frame to ensure maximum bud production. It is also recommended that temporary irrigation be available to ensure survival during the planting year.

6.4.3 Christmas Tree Planting Density

The area planted each year for Christmas trees should be based on a 5 to 6 year rotation, thus 1/5 of the allocated area should be planted each year. The strategy to maximize returns and minimize weed control is to plant at a relatively tight spacing and not install roads. At 1.5 x 1.5 m (5 x 5ft.) spacing, 1742 trees per acre can be planted. Based on a planting area of approximately 1 hectare (2.5 Acres), ½ acre per year or 871 trees per year will be planted each year. By harvesting every other tree each ½ acre can be used produce trees of different harvest sizes.

6.4.4 Christmas Tree Spacing

Spacing within rows is usually determined by species characteristics and the size to which they will be grown. Pines generally have relatively broad crowns. A spacing of 1.5-1.6 m (5 to 6 ft) between trees within rows is needed if trees are to be grown to a height of 6 to 8 feet. Spruces, true firs and Douglas- fir usually have narrower crowns, thus, a spacing of 1.2 -1.5 m (4 to 5 ft.) within rows should be adequate for growing 1.6 - 2.4 m (6 - 8-ft) trees.

Spacing between rows of trees is governed by species characteristics and equipment to be used in operations. Once trees are planted, spacing is set, and efficiency of operations will be affected for at least the time needed to grow one crop of trees and longer if new seedlings are replanted (interplanting) as older trees are harvested.

Row widths should be at least .6 m (2 ft.) and preferably .9 m (3 ft.) wider than the widest piece of equipment that must travel between the rows. Consideration should be given not only to what type of equipment is to be used immediately (often determined by what is on hand or what is least expensive) but also to what will probably be used in the future. A standard spacing is often set at 1.5 -.16 m (5 to 6 ft) between rows to accommodate self-propelled, non-riding type mowers.

Table 3 provides information on the number of trees per acre based on the spacing at time of planting.[7] *The Ohio State University Christmas Tree Producers Manual* and the Canadian Christmas Tress Association provide excellent information on the production of Christmas trees.

Number of Trees Per Acre for Different Spacings in Christmas Tree Plantings			
Spacing (feet)	**Number of Seedlings**	**Spacing (feet)**	**Number of Seedlings**
4 x 4	2722	5 x 8	1089
4 x 5	2178	6 x 6	1210
4 x 6	1815	6 x 7	1037
4 x 7	1556	6 x 8	908
Spacing ft.	**Plants/acre**	**Spacing ft.**	**Plants/acre**
4 x 8	1361	7 x 7	889
5 x 5	1742	7 x 8	778
5 x 6	1452	8 x 8	681
5 x 7	1245	8 x 9	605

Table 3 Christmas Tree Spacing

7.0 Field Preparation

All fields will need subsurface drainage to draw down the water table as much as possible; this is discussed in Section 8.0. This section (Field Preparation) outlines the need for additional topsoil and the development of gravel beds for nursery container production.

7.1 Filbert Field

To ensure adequate rooting depth, and freedom from winter flooding, this area should be raised approximately 30 cm (12 in.). This will give approximately 80 cm (31 in.) that should be above the winter water table. During a large part of the year the water table with the topsoil addition and subsurface drainage should be well below 1m (3.2 ft.). The total amount of topsoil needed to raise the entire area 30 cm is 12107 m^3 when finished or about 12,107 m^3 loose topsoil assuming 25% compaction. 15133 of which 5400 m^3 (7063 yd^3) will come from stripping the area for the container nursery. The field will be crowned so that the centre where the trees are planted will be higher than 50 cm above existing grade and it will slope of towards the inter spacing roads as seen in the drawings provided in appendix V.

[7] Ohio State University Extension. (1991) Ohio Christmas Tree Producers Manual Bulletin 670. http://ohioline.osu.edu/b670/b670_14.html

7.2 Caliper Tree Field

The caliper tree field will need to be raised by a minimum of 30 cm (12 in.) as discussed in Section 6.2, resulting in the need for 13863 m^3 of additional topsoil (compacted) or 17329 m^3 loose assuming 25% compaction.. This, with the installation of subsurface drainage and crowning, will ensure a rooting depth free of water for most of the year to a depth of a minimum of 80 cm (32 in.).

7.3 Container Area

The container area will have 50 cm (20 in.) of the topsoil stripped and moved to the Filbert field and clean granular fill brought in as a replacement to raise the area 15 cm (6 in.) above existing grade. This will require 50 cm + 15cm or 65 cm (26 in.) of combined fill and gravel cover. Based on the area of 14547 m^2 the total volume required for the container area is 9455 m^3 of fill and gravel, or 12291 m^3 loose assuming 30% compaction.

7.4 Christmas Tree Area

Field preparation for the Christmas tree area will only require cultivation, sub-soiling and the installation of subsurface drains.

7.5 Summary of Topsoil and Fill requirements

It is critical that the soil placed in the Filbert and Caliper tree field is of similar texture as the existing soil or is an organic soil that can be mixed into the exiting soil without any detrimental impacts on the existing soil.

The existing soils are Rego Gleysols peaty phase (Blundell); Ortho Humic Gleysols saline phase (Delta) and Rego Humic Gleysols: saline phase (Westham). All of these have organic Ah horizon and thus the addition of high organic topsoil should not cause a layered soil to develop. The additional topsoil will need to thoroughly cultivated into the existing topsoil and this process will have to be monitored closely to ensure that a layer of different soil textures is not created. Layering of soils causes drainage problems which would defeat the purpose of the work being proposed.

It is also recommended that a stock pile of additional topsoil be available so that it is available for replacement after the trees have been dug. This is a critical component of good nursery management to ensure that “soil mining.” not occur.

Crop	Area m^2	Topsoil m^3	Granular fill/Gravel	Total loose using Compaction Factor of 25% for topsoil and 30% for granular fill m^3
Filberts	40359	12107 less 7273 from container area = 7806	0	9757
Caliper Trees	40359	13863	0	17329
Containers	14547	0	9455	12291
Total Topsoil before compaction				**27086**
Total Granular Fill before compaction				**12291**
Total soil and granular fill				**39377**

Table 4 Topsoil and Fill Requirements

Another important consideration for the soil requirements is the low macro nutrient levels; these should be increased by the addition of manure or compost prior to planting of any trees. The addition of chicken manure would provide high rates of nitrogen, phosphorus and potassium. Since phosphorus and potassium are relatively immobile, the addition by way of manure will have a long lasting effect on levels and availability in the soil. Additional nitrogen is usually lost in the soil within the first year of application, so appropriate timing before planting will provide at least one year of nitrogen needs for the trees.

7.5.1 Use of Broiler Manure for Organic Matter and Nutrients

Detailed calculations of the amount of chicken manure that could be added to this site were done using the BCMAF Nutrient management planning calculator. Analysis was carried out using a forage crop to develop base numbers, as many of the fields will be in cover crops due to the 5 year rotational planting of caliper and Christmas trees. Based on the soil analysis and using standard provincial numbers of broiler manure, the farmer can add 15 tonnes per hectare to meet the nitrogen needs of grass forage. This will result in excess phosphorus of 109 kg P_2O_5 per hectare but inadequate potassium that will have to be added at 162 kg K_2O/ha. The addition of manure at this rate will build up a reservoir of phosphorus and potassium that will reduce the amount of fertilizer need once the tree crop is planted.

A second model was developed to determine manure additions once trees are in the ground. It should be noted that this will apply only to the Filbert and Caliper trees and access to application on the Christmas trees will be limited due to the spacing. Nitrogen is the nutrient of major concern for both crop growth and pollution potential. For this reason nitrogen needs are used as the main variable for determination of manure additions.

To develop requirements the following sources of information were used:

- Nutrient uptake by blueberry crops as provided in the Berry Nutrient Management Model from BCMAF (table 5)
- Nutrient requirements for ornamental landscape plants provided by Enova Labs
- Nutrient requirements for timber poplar provided by Enova

	Recommended annual nitrogen		
Field age (years)*	g N/plant	kg N/ha	lb N/ac
1 - planting year	6	22	20
2	8.5	30	27
3	14	52	46
4	23	81	72
5	28	104	93
6	31	119	106
7	40	148	132
8	45	163	145

Table 5 Annual nitrogen recommendations for blueberry plants at different ages
(Based on 3700 plants/ha (1480 plants/acre), e.g. 0.9 m x 3 m *3 ft x 10ft)

The average nitrogen addition for average growth of ornamental crops provided by Exova labs is 103 lbs/acre. If an ornamental crop on average is in a 4 year rotation, the blueberry recommendation would be 72lbs/acre at year 4. The recommendations from Exova for timber Poplar are on average 88 lbs/acre for optimum growth. The average of the three different data sets is 88 lbs/acre of N. Since this is for average growth, it is the author's opinion that nitrogen additions could be 100 lbs/acre if some of it is provided by slow release fertilizer or it is added in 2 separate applications during the growing season.

Nitrogen addition by way of manure was modeled using 15 yd^3/ha or 6 yd^3/acre, (this is the maximum recommended by BCMAF) this will provide 47 kg/ha of N (42 lbs/acre), thus an additional 26 kg (58 lbs) per acre needs to be added by way of chemical fertilizer. Since the nitrogen levels on all fields are extremely low this application rate of nitrogen can be used for all fields on the farm. Since nitrogen is the most critical nutrient, the amount of manure added needs to be closely monitored to determine chemical nitrogen additions. In addition soil testing should be carried out on a routine basis along with yearly fine tuning of nutrient additions.

8.0 Drainage

The east field that is designated for Filberts has an old subsurface drainage system that is still functional; however it is recommended that additional new subsurface drains be installed. All other fields are without subsurface drainage and they will need subsurface drains installed.

The soils on this site are in the Delta Soil Management Group that has a drain spacing recommendations of 14m. Drain depth should be a minimum of 1 m with 1.2m installed where possible. These soils will have improved drainage with sub-soiling, though care must be taken not to subsoil to depths that will interfere with drain lines. Prior to the installation of subsurface drainage, sub-soiling all fields is recommended.

A detailed drainage design will be done but is beyond the scope of this report. However the following criteria will need to be used in the design:

- Drainage coefficient 21 mm/day (.083 in./day) to maintain 50 cm (20 in.) water table depth to allow field work in March and a crop tolerance of 3 days.
- Manning's coefficient of roughness = .016 for big O drain pipe
- Use 15 cm (6 in.) pipe to ensure maximum velocity and volumes are not exceeded

Surface drainage is also important and the surface needs to slope such that surface water runs to the road ditch on Garden City Road, the farm centre ditch or Woodward slough. Figure 13 and the drawings attached show the surface drainage and centre ditch extensions that need to be implemented.

There will be no negative impact on surrounding properties in terms of increased water. The site drainage will be enhanced and both surface and subsurface drainage will reduce any water that may have historically moved to the adjoining property.

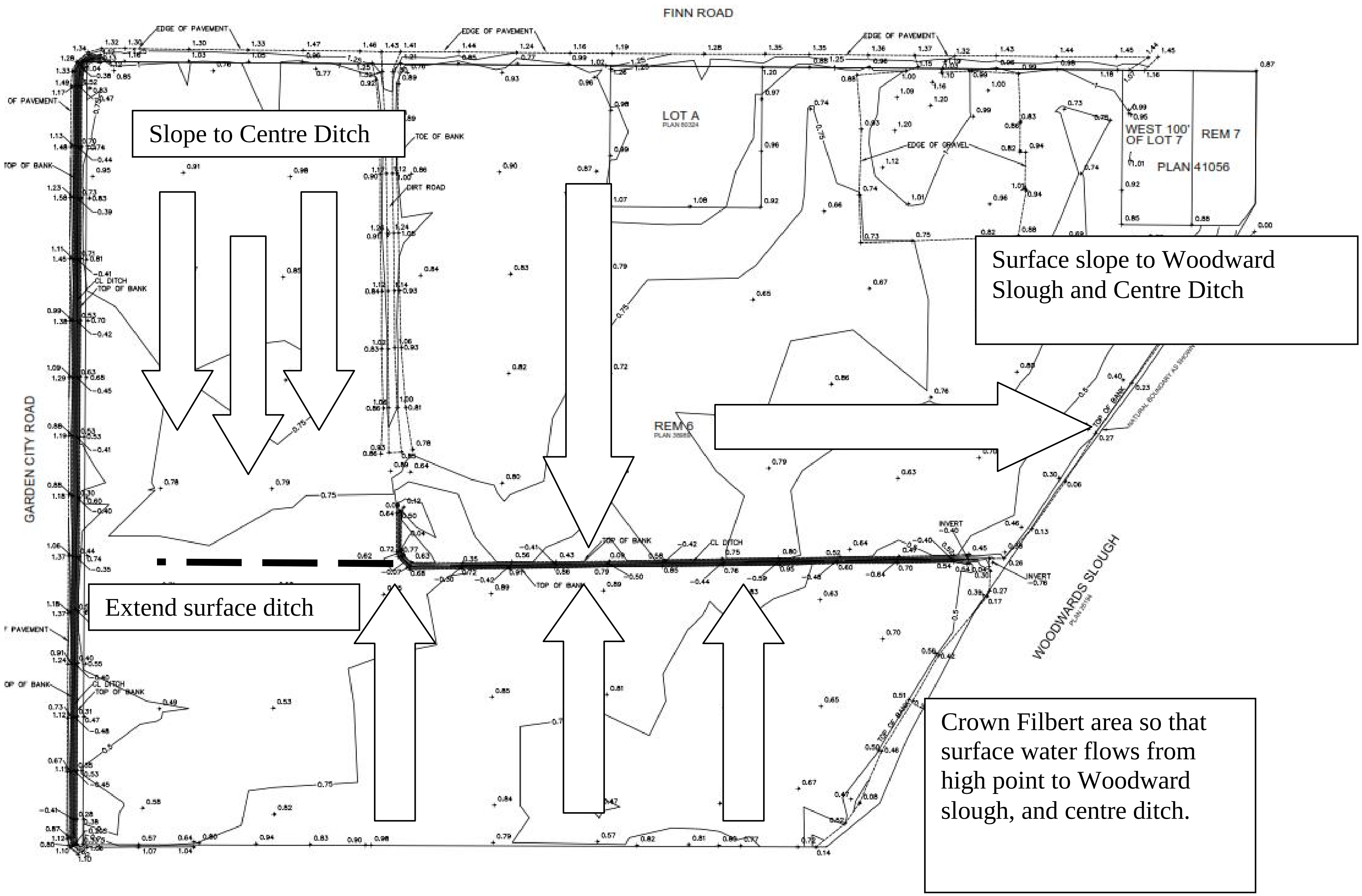


Figure 13 Surface Drainage

9.0 Construction of Farm Access Roads and Berms

To access the caliper trees and the Filbert area a perimeter access road will need to be constructed and the current central road extended to the eastern property line. Efficient harvest of caliper trees requires large wagons and flat bed trucks to be loaded on the site. To do this efficiently it is recommended that the perimeter road be wide enough and with wide enough corners for a flat deck trailer to drive in a circular fashion around the farm. This will require the top of road width to be 4m and with side slops of 2:1, the road should be slightly higher than the ground elevation to prevent flooding and improve stability.

To reduce visual impacts the topsoil stripped during road building will be used to construct a small berm that will be planted with Cedar trees. The suggested road design is shown in appendix VI.

10.0 Site Management

Good site management will be critical for the success of the topsoil/fill operation and the final use of the site for agricultural production.
The following activities must take place:

- Monitor the incoming topsoil to ensure that it meets the soil textural requirements of the site.
- Monitor the incoming granular fill to ensure that there are is not concrete, asphalt, plastic or other non-soil materials mixed with the fill
- Monitor to ensure that there are no contaminants in any of the fill brought to the site.
- Monitor to ensure that there is no large woody debris or other non-mineral components in the fill.
- Ensure that the truck wash facility is operating properly and that sediment is removed from wash water before entering waterways.
- Install silt fencing to protect all ditches.
- Safely manage truck traffic entering and leaving the site off of Ladner Trunk Road.

The farmer has agreed and it is assumed it will be a condition of the permit that a Professional Agrologist will carry out regular monitoring and oversight and that they will have the authority to stop topsoil or fill hauling to the site if there are issues with the topsoil, fill quality or environmental concerns on the site.

10.1 Soil Stockpiling

Since topsoil will be delivered for storage as a replacement after tree digging it is important that it is properly stored.

- Compaction will be minimized by minimizing vehicle traffic when stockpiling and ensuring soils are not handled when wet
- Stockpiles will be constructed to heights of 4 m (13 ft.) or less with 2 H: 1 V slopes.
- The shape of the stockpile should provide for positive drainage (i.e. sufficiently sloped to prevent puddling or ponding), to minimize water infiltration into the pile.

10.2 Sediment Control

- Sediment will be controlled by the installation of silt fences along all waterways.
- The on-site agrologist will also make decisions to halt the fill operation if weather conditions are so wet that excess sediment is being produced from the site that the sediment control fences cannot handle.
- All sediment will be removed from truck wash water prior to discharge.

10.3 Dust Control

- All tires will be washed which will reduce dust during dry periods and minimize dirt on Finn Road or Garden City Road.
- Access roads will be watered on a regular basis during dry periods to minimize dust.

10.4 Management of Topsoil and Fill Quality

Management of topsoil and fill quality is critical for the success of this site and to meet the legal requirements of the ALC and the City of Richmond. This section expands on the comments made in section 8.0.

- Mineral topsoil must be a silt loam, clay loam, loam or an organic soil to ensure it does not cause any issues with soil layering.
- There cannot be any granular fill that has any probability of hydrocarbon or metal contamination. This requires the fill operator to be certain of the origin of all fill.
- There cannot be any concrete, asphalt, plastic or other non granular soil/gravel contaminants in the fill. It is understood that occasionally a piece of asphalt or concrete or other material may be in a load, but is the responsibility of the fill operator to spot this on dumping and remove it prior to spreading of the fill. The on-site staff must be fully briefed and trained on the importance of ensuring no contaminants enter the site.
- If there are more than 50 truck loads originating from a source site, the fill should be inspected at the point of origin by a professional agrologist or other qualified professional prior to entering the fill site.

Appendix I Detailed Soil Descriptions

WESTHAM SOILS

Location and Extent: Westham soils occur only on the lowlands of Delta Municpality, mainly on Westham and Crescent Islands, and in the southern part of Richmond Municipality. There are about 1520 ha of pure map units and 570 ha of soil complexes dominated by Westham soils. Most complexes are with Crescent and Blundell soils.

Topography and Elevation: Westham soils vary in topography from nearly level or slightly depressional to gently undulating with slopes up to 2 percent. They all lie less than 5 m above sea level amd usually occur at slightly lower elevations than the adjacent, better drained Crescent soils and are slightly higher than the associated, more poorly drained Blundell soils.

Parent Material and Texture: Westham soils have developed from medium to moderately fine textured deltaic deposits of the Fraser River, usually 1 m or more thick, over sand. Surface, subsurface and subsoil textures are mostly silt loam with some variation to silty clay loam. The lower subsoil is sometimes loam or fine sandy loam and usually grades to sand with increasing depth. Moderately to strongly saline conditions are usual below 50 to 100 cm depth and substantial amounts of compounds high in sulphur are also usually present.

Soil Moisture Characteristics: Westham soils are poorly drained. They are moderately pervious and have slow surface runoff and high water holding capacity. Watertables are near the surface during the winter months but, in most areas, ditches, subsoil drains and pumping provide a moderate saturation-free zone during the growing season. Some sub-irrigation is possible through watertable control during dry summer periods. In depressional areas surface ponding occurs during periods of heavy rains.

General Soil Description: Westham soils have a dark grayish brown, silty, cultivated surface layer about 20 cm thick which is moderately structured and friable to firm when moist. It is underlain by a silty zone about 20 cm thick which is mainly massive, firm to friable, and contains variable amounts of reddish to yellowish mottles. This zone grades to 50 cm or more of dark gray to gray, silty material that is firm, massive, and contains common to many, mainly yellow mottles as well as hard, reddish to brownish tubules around old root channels. The lower part is usually saline. Massive, dark gray, saline, fine or medium sand occur below 1 m or more. Soil reaction usually ranges from strongly to slightly acid in the surface (depending on the amount of liming) and is extremely acid in the subsurface and subsoil. Soil classification generally is ***Rego Humic Gleysol:saline phase*** although areas of Orthic Humic Gleysol:saline phase are included where the subsurface structure is moderately well developed. On some of the small islands near the mouth of the Fraser River, the underlying sands usually occur between 50 and 100 cm from the surface rather than below 1 m as is the usual case. These areas are mapped as a shallow variant of Westham soils.

Commonly Associated Soils: Crescent and Blundell soils often occur in close association with Westham soils. Crescent soils usually lie at slightly higher landscape positions than do Westham soils, are slightly better drained and are non-saline in the upper 1 m. Blundell soils, on the other hand, usually lie slightly lower than do Westham soils, are more poorly drained and are usually saline at depths below 50 cm from the surface. They also have organic surfaces that are 15 to 40 cm thick.

Vegetation: Essentially all areas of Westham soils are cleared and cultivated; most climatically suited crops are produced (except those perennials very susceptible to "wet feet" over the winter months). Rooting is confined mainly to the upper 70 cm and is limited below that by saturated and saline soil conditions.

BLUNDELL SOILS (BU)

Location and Extent: Blundell soils occur only in Richmond and Delta Municipalities. There are about 190 ha of pure map units and 570 ha of soil complexes dominated by Blundell soils. The complexes are mainly with Delta, Westham and Annis soils.

Topography and Elevation: Level to very gently undulating with slopes less than 2 percent is the usual topography of Blundell soils. They are usually slightly depressional in relation to adjacent soils and lie at elevations less than 3 m above sea level.

Parent Material and Texture: Blundell soils have developed from shallow organic deposits (15 to 40 cm thick) overlying medium-textured, stone-free, Fraser River deltaic deposits. Surfaces consist of 15 to 40 cm of well-decomposed (humic) organic material containing admixed silt. The subsurface texture is silt loam. This grades in the subsoil to medium or fine sand below depths of about 1 m. On some of the small islands in the mouth of the Fraser River the sands may occur at depths between 50 and 100 cm. The deposits become saline below depths of 75 to 100 cm from the surface and at these depths also usually contain substantial amounts of compounds high in sulphur.

Soil Moisture Characteristics: Blundell soils are poorly to very poorly drained. They are moderately pervious and have high water holding capacity and slow surface runoff. The watertable is near the surface for most of the year, withdrawing to about 1 m during the latter part of the growing season. Water accumulates on the surface during and after heavy rains.

General Soil Description: Blundell soils have an organic, cultivated surface layer about 25 cm thick, which is black to very dark brown, friable and well-decomposed. It is underlain by about 50 cm of massive, grayish-brown, silty material containing occasional vertical cracks and a few reddish-brown to yellowish-red mottles. This grades to about 50 cm of massive, dark gray, silty material which contains hard, reddish and brownish tubules around old root channels, is saline and contains compounds high in sulphur in the lower part. Below about 120 cm depth, dark gray, massive, saline sand occurs. Soil reaction is extremely acid throughout. Soil classification is ***Rego Gleysol:saline and peaty phase***.

Commonly Associated Soils: Delta, Westham and Annis soils usually occur in close association with Blundell soils. Delta and Westham soils differ from Blundell soils by having silty rather organic surface textures. Annis soils have surfaces similar to Blundell soils but the subsurface mineral soil is clayey rather than silty. The subsoil of Annis soils is also usually non-saline.

Vegetation: The Blundell soils are essentially all cleared and cultivated. The few, small, remaining uncleared areas support black cottonwood, willow and a variety of shrubs. Rooting is generally limited to about 50 cm depth by high groundwater tables.

General Land Use Comments: (1) Blundell soils are mostly used for forages, field peas and other field crops. With improved drainage, especially winter watertable control, a wider variety of crops, particularly perennials, is possible. Liming to improve the very acid conditions is also favourable. Salinity in the subsoil is usually sufficiently deep to have little adverse effect on most crops. (2) Poor bearing capacities and high

DELTA SOILS (DT)

Location and Extent: Delta soils are common in central and western Delta Municipality and central Richmond Municipality. There are a total of 1130 ha of pure map units and 1720 ha of soil complexes dominated by Delta soils. The complexes are mainly with Spetifore, Blundell and Ladner soils.

Topography and Elevation: Delta soils are very gently undulating with slope gradients less than 3 percent. Some areas have been partially levelled. Elevations lie between 1 and 3 m above sea level.

Parent Material and Texture: The parent material of Delta soils is medium to moderately fine textured Fraser River deltaic deposits, usually 100 cm or more deep and overlying medium or fine sand. Surface textures are mostly silt loam, varying sometimes to silty clay loam. The subsurface is usually silty clay loam while the upper subsoil is again silt loam. The lower subsoil textures change to sand, loamy sand or interbedded sand and silt. Below 75 cm depth, the soils are generally saline and contain substantial amounts of compounds high in sulphur.

Soil Moisture Characteristics: Delta soils are poorly drained. They are moderately pervious and have slow surface runoff and high water holding capacity. The watertable is near the soil surface during most of the winter but recedes somewhat during the summer. Temporary surface ponding during heavy rainfall is common in the slight depressions.

General Soil Description: Delta soils have a very dark gray or black, friable to firm, cultivated surface that is about 20 cm thick and usually contains between 10 and 20 percent organic matter. The surface is underlain by a grayish-brown, firm to very firm, silty to clayey zone, about 30 cm thick, which breaks to prismatic or blocky clods and contains some reddish-brown mottles. Underlying this is about 30 cm of dark gray or grayish-brown, massive, silty material containing common, reddish-brown mottles as well as light yellowish brown to yellow mottles in the lower part. The lower part is also often saline and high in sulphur compounds. This silty zone gradually grades to massive olive-gray, saline, sandy or silty material below about 100 cm. Soil reaction is extremely to very strongly acid throughout. Soil classification is ***Orthic Humic Gleysol:saline phase***.

Commonly Associated Soils: Ladner, Spetifore, Blundell, Westham, Guichon and Crescent soils usually occur in close association with Delta soils. Ladner soils differ from Delta soils by having well developed clay accumulation layers in the subsurface as well as being finer textured. Spetifore soils are similar to Delta soils except that they are saline at or near the surface. Blundell soils vary by having an organic surface. Guichon soils are sandy below 50 cm as well as being saline at or near the surface. Westham and Crescent soils contain lower amounts of organic matter in the surface; Crescent soils are also somewhat better drained than Delta soils.

Vegetation: All areas of Delta soils are cleared and cultivated. Rooting is partially restricted in the upper 50 cm by dense soil strata and is severely restricted at lower depths by high watertables.

General Land Use Comments: (1) Delta soils are good agricultural soils and are utilized for a variety of crops, including forages, cereal grain, potatoes, vegetables and some small fruits. Watertable control through artificial drainage, however, is required for optimum utilization. The saline subsoil conditions are usually sufficiently deep to not hinder most crops except possibly, near the boundaries with the more strongly saline Spetifore or Guichon soils. (2) Delta soils are poorly suited for urban and related uses. Soil bearing capacities are variable (usually low), high watertables preclude basements and similar excavations while underground utility installations are highly susceptible to corrosion if not adequately protected. High watertables and relatively slow permeability limit efficient operation of septic tank effluent disposal fields. (3) Delta soils are moderately to poorly suited for most forest crops. Sitka spruce is estimated to produce from 5 to 6 m^3 of wood/ha/yr.

Appendix II Soil Logs

Location	Depth inches	Comments
Wp111	0 – 11 11 – 20 20 - 36	Dark greyish brown – Friable Grey brown silt loam few mottles Grey silt Mottles common **Water at 20 inches**
Wp 112	0 – 16 16-22 22 – 36 28	Dark grey brown few yellow mottles Organic layer Dense grey silty clay Water at 28 inches
Wp 113	0 – 12 12 – 30 30 42	Dark brown friable silt loam Grey brown silt loam yellow red - yellow mottles common; root tubules common **Water piping through pit wall** Dense grey silt
Wp 114	0 – 14 14 – 20 20 -22 22 – 28 28 28 - 40	Dark grey brown silt – friable Grey brown silt few yellow-red mottles Sand lens Grey silt, dense, mottles common **Water table** Grey silt, dense, mottles common
Wp 115	0 – 12 12 – 20 20 – 30 30	Dark grey brown silt – silt loam friable – surface layer compacted and cracked due to management practices Grey brown silt friable; few reddish to red/yellow mottles; root channels Grey silty clay, massive, dense, mottles common **Water table**
Wp 116	0 – 16 16 – 27 27 – 48	Dark grey brown friable silt to silty loam Grey silt friable few yellow to red mottles Dense grey silty clay mottles common **Water table at 33 inches**
Wp 117	0 – 18 16 – 24 24 – 33 33	Dark grey brown silt; friable Dark brown friable organic layer Light greyish brown; friable; few yellowish red mottles Silty sand layer – decayed vegetation **Water Table at 30 inches**
Wp 118	0 – 10 10 – 16 16 – 34 34	Dark grey brown silt; friable Grey silt, friable; reddish mottles common Silty clay, few mottles; old root channels common **Water Table**

Wp 119	0 – 13 13 – 20 20 - 40	Dark brown silt, friable, surface compacted and cracked due to management practices Grey silt, friable, mottling common Dense silty clay, numerous roots in upper zone, no water to this depth
Wp 120	0 – 11 11 – 17 17 – 21 21 – 29 29 - 40	Dark grey brown silt – friable Grey silt, friable, few yellowish mottles Dense grey silt, few mottles Dense grey silt, mottles common **Dense silty clay, water entering pit at 32 inches**
Wp 121	0 – 12 12 – 18 18 – 21 21 – 33 33	Dark grey brown silt – friable Grey brown silt, friable, few mottles Sand lens, few red mottles Dense silty clay, few mottles **Water table**
Wp 122	0 – 10 10 – 19 19 – 28 28	Dark grey brown silt – friable Grey brown silt, friable, few mottles **Sand lens water piping through the sand** Grey clay, dense
Wp 123	0 – 10 10 – 16 16 – 20 20 – 25 25 – 32 32 - 36	Dark grey brown silt – friable Grey silt, friable, few mottles Grey silt, dense few mottles Sand lens Grey silty, friable Dense grey clay **Water table at 34 inches**
Wp 124	0 – 11 11 – 22 22- 32 34	Dark grey brown silt – friable, many roots Grey grown silt, friable, mottles common Dense grey clay yellow to red mottles common **Water Table**
Wp 125	0 – 9 9 – 15 15 – 36 36	Dark grey brown silt – friable Grey silt, mottles common, old root channels common Dense grey clay **Water Table**
WP 126	0 – 10 10 – 14 14 – 19 19 – 36 36	Dark grey brown silt – friable, many roots Dark brown organic layer Grey silt, many mottles, many root channels Grey clay, mottle common **Water Table**
Wp 127	0 -12 12 – 14	Dark grey brown silt – friable Dark brown organic layer

	14 – 19 19 - 36	Grey silt, friable, many mottles, many root channels **Clay, mottles common, water table 36 inches**
Wp 128	0 – 11 11- 17 17 – 23 23 - 42	Dark grey brown silt – friable Grey brown silty, friable Grey silt, root channels common, organic debris common Grey silty clay – water table not encountered
Wp 129	 0 – 13 13 – 20 20 – 25 25 - 36	Low point in field Dark grey brown silt – friable Grey silt, many yellow/red mottles Grey silt with much organic debris Blue grey clay – water table not encountered
Wp 130	0 – 13 13 – 19 19 – 23 23- 48	Dark grey brown silt – friable Grey silt, friable, few mottles Grey silt with much plant debris Grey clay; No water encountered
Wp 131	0 – 11 11 – 17 17 – 27 27 – 32 32	Dark grey brown silt – friable Silt bit dark red brown due to organics, few mottles Grey silty, friable Grey clay **Water at 32 inches**
Wp 132	0 – 15 15 – 19 19 – 30 30 - 35 35	Dark grey brown silt – friable Organic rich dark brown Grey silt friable, few mottles Grey clay **Water Table**
Wp 133	0 – 12 12 – 23 23 – 27 27	Dark grey brown silt – friable Grey silt, friable with much organic debris Grey silty clay, dense but with organic debris **Water table**

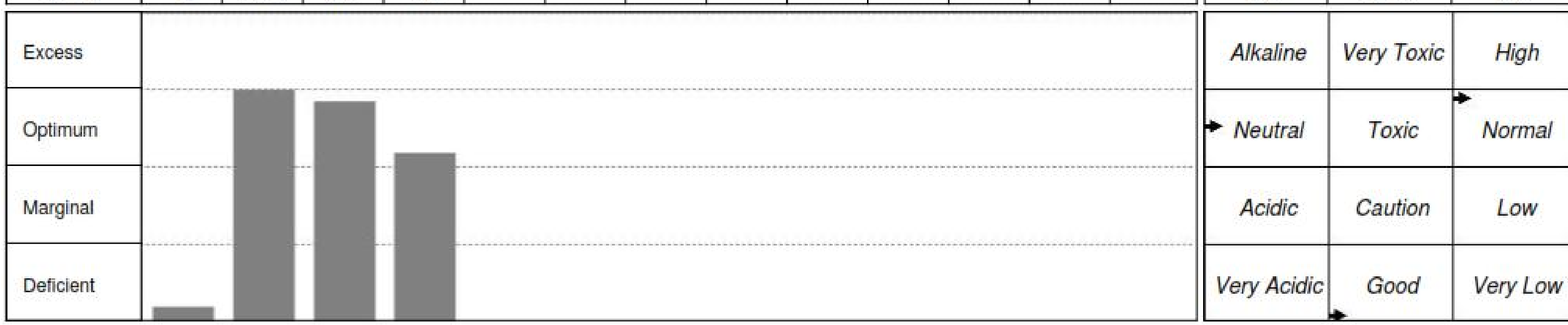
Appendix III Soil Chemical Analysis

Sites 111 to 114 A horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	111, 112, 113, 114,	Report Number:	1735338
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 10, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	4	>60	447	10										6.8	0.14	7.3	4040149



	N*	P	K	S**
Total lbs/acre	8	120	895	19
Estimated lbs/acre	15	120	895	39

Texture *n/a* Hand Texture *n/a*

Sand n/a Silt n/a Clay n/a

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

Sites 112 to 114 C horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	112, 114 C Horizon	Report Number:	1735343
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 09, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

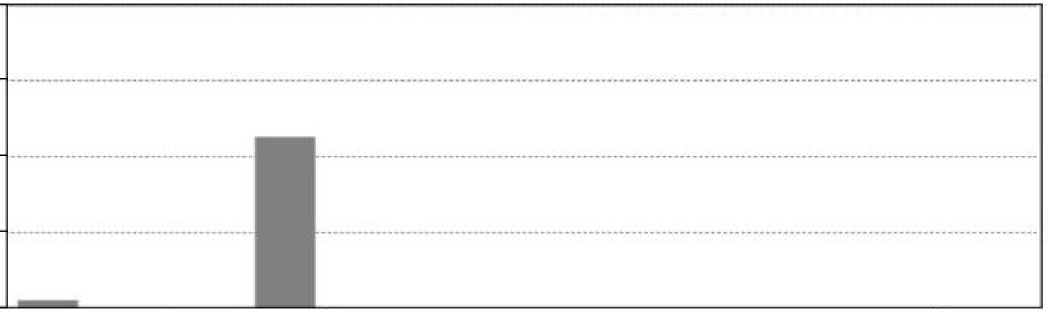
Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	<2			11										4.7	0.11		4040154

Excess

Optimum

Marginal

Deficient



pH	EC	OM
Alkaline	*Very Toxic*	*High*
Neutral	*Toxic*	*Normal*
Acidic	*Caution*	*Low*
Very Acidic	*Good*	*Very Low*

	N*	P	K	S**
Total lbs/acre	4			21
Estimated lbs/acre	8			43

Texture *n/a* Hand Texture *n/a*

Sand n/a Silt n/a Clay n/a

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

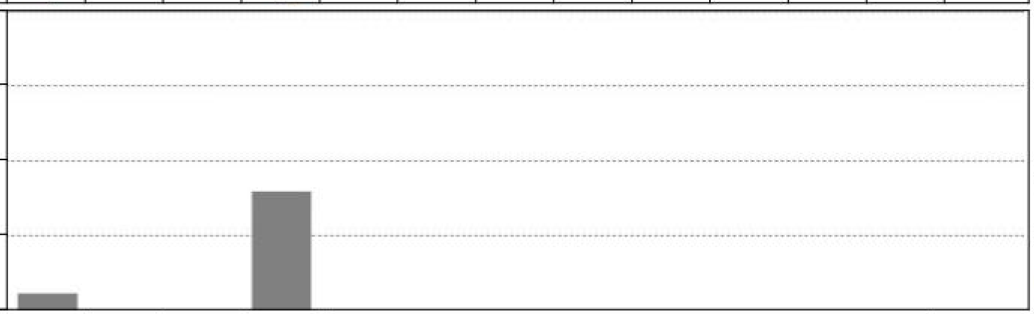
Sites 113, 116, 118, 119 C horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	113, 116, 118, 119,	Report Number:	1735348
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 10, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	4			5										5.7	0.06		4040158

Excess	
Optimum	
Marginal	
Deficient	



pH	EC	OM
Alkaline	*Very Toxic*	*High*
Neutral	*Toxic*	*Normal*
Acidic	*Caution*	*Low*
Very Acidic	*Good*	*Very Low*

	N*	P	K	S**
Total lbs/acre	9			10
Estimated lbs/acre	18			21

Texture *Silty Clay* Hand Texture *n/a*

Sand 15.0 % Silt 51.0 % Clay 34.0 %

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

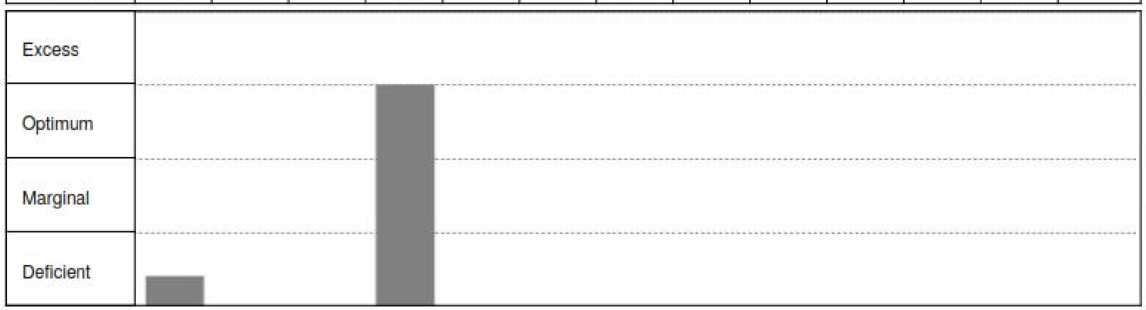
*Nitrate-N **Sulfate-S n/a = not analysed

Sites 115, 116, 118, 119 B horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	115, 116, 118, 119,	Report Number:	1735342
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 10, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	8			22										4.8	0.20		4040153



pH	EC	OM
Alkaline	*Very Toxic*	*High*
Neutral	*Toxic*	*Normal*
Acidic	*Caution*	*Low*
Very Acidic	*Good*	*Very Low*

	N*	P	K	S**
Total lbs/acre	16			43
Estimated lbs/acre	33			88

Texture *Silt Loam* Hand Texture *n/a*

Sand 21.0 % Silt 54.1 % Clay 24.9 %

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

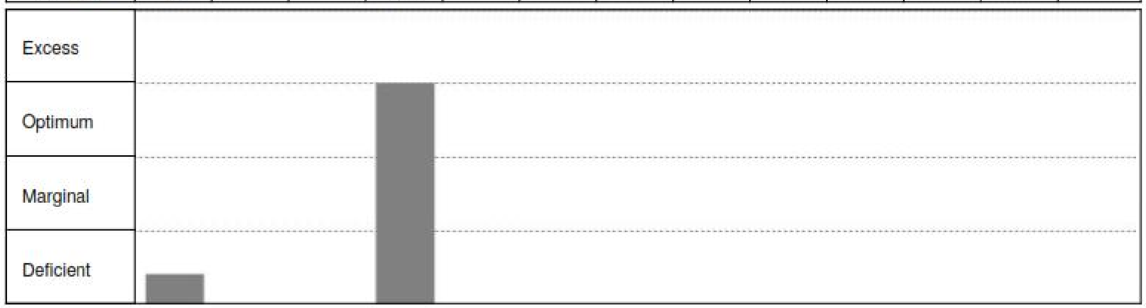
*Nitrate-N **Sulfate-S n/a = not analysed

Sites 116 to 119 A horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	115, 116, 118, 119,	Report Number:	1735342
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 10, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	8			22										4.8	0.20		4040153



pH	EC	OM
Alkaline	*Very Toxic*	*High*
Neutral	*Toxic*	*Normal*
Acidic	*Caution*	*Low*
Very Acidic	*Good*	*Very Low*

	N*	P	K	S**
Total lbs/acre	16			43
Estimated lbs/acre	33			88

Texture *Silt Loam* Hand Texture *n/a*

Sand 21.0 % Silt 54.1 % Clay 24.9 %

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	123 Sand Lens	Report Number:	1735341
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 09, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	9			7										4.8	0.14		4040152

pH	EC	OM
Alkaline	*Very Toxic*	*High*
Neutral	*Toxic*	*Normal*
Acidic	*Caution*	*Low*
Very Acidic	*Good*	*Very Low*

	N*	P	K	S**
Total lbs/acre	18			14
Estimated lbs/acre	37			30

Texture *n/a* Hand Texture *n/a*

Sand n/a Silt n/a Clay n/a

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

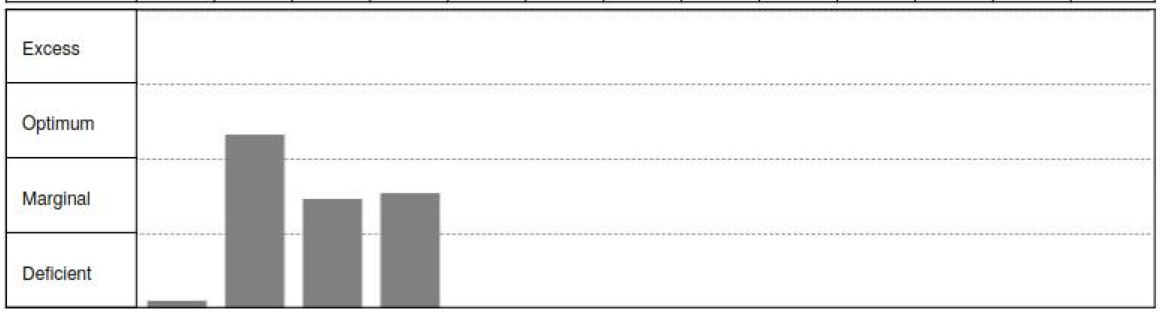
*Nitrate-N **Sulfate-S n/a = not analysed

Sites 124 to 127 A horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	124, 125, 126, 127,	Report Number:	1735339
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 10, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	<2	36	110	5										5.6	0.07	6.5	4040150



pH	EC	OM
Alkaline	Very Toxic	High
Neutral	Toxic	Normal
Acidic	Caution	Low
Very Acidic	Good	Very Low

	N*	P	K	S**
Total lbs/acre	4	73	220	10
Estimated lbs/acre	8	73	220	20

Texture *n/a* Hand Texture *n/a*

Sand n/a Silt n/a Clay n/a

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

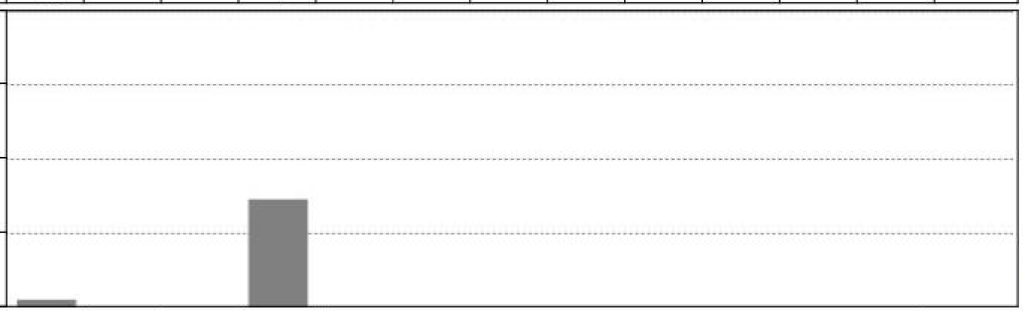
Sites 124 to 127 C horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	124, 125, 126, 127,	Report Number:	1735351
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 10, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	<2			4										6.5	0.07		4040160

Excess	
Optimum	
Marginal	
Deficient	



pH	EC	OM
Alkaline	*Very Toxic*	*High*
Neutral	*Toxic*	*Normal*
Acidic	*Caution*	*Low*
Very Acidic	*Good*	*Very Low*

	N*	P	K	S**
Total lbs/acre	4			9
Estimated lbs/acre	8			18

Texture *Clay Loam* Hand Texture *n/a*

Sand 21.0 % Silt 41.9 % Clay 37.1 %

Ammonium n/a

BS n/a

Ca n/a Mg n/a Na n/a K n/a

TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

Site 133 A Horizon

Farm Soil Analysis

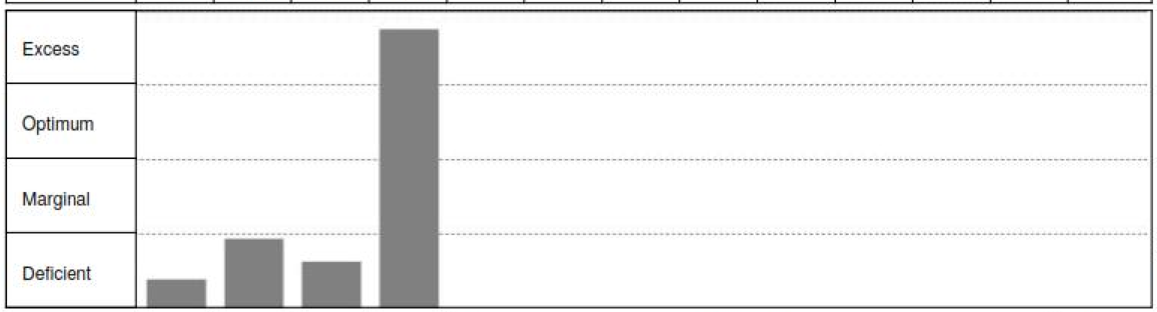
Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	133 A Horizon	Report Number:	1735340
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 10, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)

Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP
0" - 6"	8	14	47	189									

Soil Quality

pH	EC(dS/m)	OM(%)	Sample#
3.7	0.84	3.4	4040151



pH	EC	OM
Alkaline	Very Toxic	High
Neutral	Toxic	Normal
Acidic	Caution	Low
Very Acidic	Good	Very Low

	N*	P	K	S**
Total lbs/acre	15	28	94	379
Estimated lbs/acre	31	28	94	771

Texture *n/a* Hand Texture *n/a*
Sand n/a Silt n/a Clay n/a
Ammonium n/a

BS n/a
Ca n/a Mg n/a Na n/a K n/a
TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

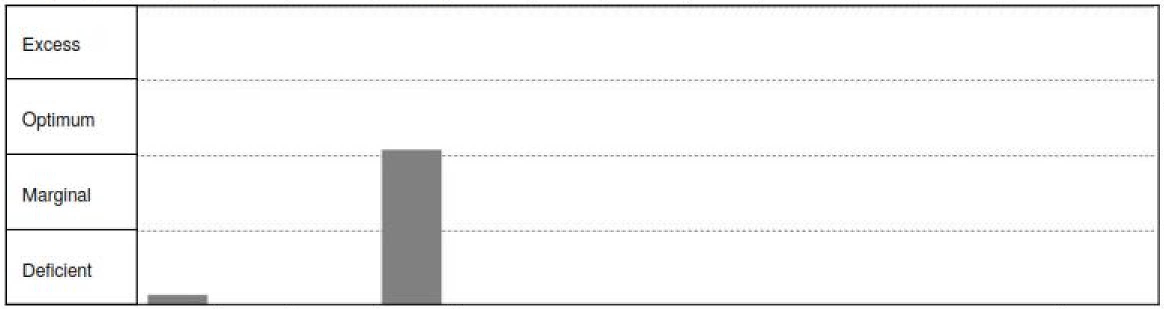
*Nitrate-N **Sulfate-S n/a = not analysed

Site 133 C Horizon

Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:		Lot Number:	868843
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	133 C Horizon	Report Number:	1735347
		Field Id:		Date Received:	May 07, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jun 06, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	May 09, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	3			8										7.0	0.09		4040157



pH	EC	OM
Alkaline	Very Toxic	High
Neutral	Toxic	Normal
Acidic	Caution	Low
Very Acidic	Good	Very Low

	N*	P	K	S**
Total lbs/acre	5			16
Estimated lbs/acre	11			34

Texture	*n/a*	Hand Texture	*n/a*				
Sand	n/a	Silt	n/a	Clay	n/a		
Ammonium	n/a						
BS	n/a						
Ca	n/a	Mg	n/a	Na	n/a	K	n/a
TEC	n/a			Na	n/a		
Lime	n/a	Buffer pH	n/a	Est. N Release	n/a	C:N Ratio	n/a

*Nitrate-N **Sulfate-S n/a = not analysed

Appendix IV Filbert Production Information

Hazelnuts: Acreage, yield, production, price and value, 1930-2007

Year	Oregon					Washington [1]				
	Bearing acreage	Yield per acre	Harvested production	Price per ton	Value of production	Bearing acreage	Yield per acre	Harvested production	Price per ton	Value of production
	Acres	*Tons*	*Tons*	*Dollars*	*1,000 Dollars*	*Acres*	*Tons*	*Tons*	*Dollars*	*1,000 Dollars*
1930	2,500	0.12	300	340	102	380	-	-	-	-
1935	5,600	0.20	1,100	260	286	760	0.18	140	285	40
1940	9,300	0.29	2,700	240	648	1,650	0.31	510	300	153
1945	14,400	0.31	4,500	550	2,475	2,310	0.35	820	558	458
1950	23,100	0.23	5,350	350	1,872	2,300	0.19	440	354	156
1955	18,900	0.39	7,400	420	3,108	1,800	0.17	310	422	131
1960	17,600	0.48	8,400	420	3,528	1,500	0.37	550	422	232
1965	15,700	0.46	7,300	450	3,285	1,100	0.40	440	452	199
1970	15,800	0.55	8,750	570	4,988	500	1.02	510	571	291
1975	17,400	0.68	11,800	610	7,198	400	0.80	320	595	190
1980	21,600	0.70	15,100	1,151	17,386	400	0.75	300	1,181	354
1985	22,900	1.06	24,300	677	16,451	400	0.75	300	957	287
1986	24,500	0.61	14,900	724	10,788	400	0.50	200	895	179
1987	25,400	0.85	21,500	956	20,554	400	0.75	300	1,160	348
1988	26,100	0.62	16,300	853	13,904	400	0.50	200	891	178
1989	27,100	0.47	12,800	817	10,458	360	0.56	200	1,030	206
1990	27,000	0.80	21,500	783	16,835	300	0.67	200	880	176
1991	27,200	0.93	25,300	726	18,368	270	0.74	200	755	151
1992	26,800	1.03	27,500	552	15,180	230	0.87	200	620	124
1993	26,700	1.53	40,800	633	25,826	230	0.87	200	685	137
1994	27,200	0.77	21,000	834	17,514	200	0.50	100	900	90
1995	27,600	1.41	38,800	913	35,424	200	1.00	200	935	187
1996	28,200	0.67	18,900	837	15,819	150	0.67	100	900	90
1997	28,600	1.63	46,650	899	41,938	400	0.88	350	940	329
1998	29,100	0.53	15,400	964	14,846	430	0.23	100	960	96
1999	28,800	1.38	39,700	890	35,333	400	0.75	300	900	270
2000	28,300	0.79	22,300	890	19,847	350	0.57	200	960	192
2001	28,100	1.76	49,500	701	34,700	-	-	-	-	-
2002	29,200	0.67	19,500	1,000	19,500	-	-	-	-	-
2003	28,000	1.35	37,900	1,030	39,037	-	-	-	-	-
2004	28,400	1.32	37,500	1,440	54,000	-	-	-	-	-
2005	28,300	0.98	27,600	2,240	61,824	-	-	-	-	-
2006	28,200	1.52	43,000	1,080	46,440	-	-	-	-	-
2007	28,100	1.32	37,000	2,040	75,480	-	-	-	-	-

[1] Estimates discontinued in 2001

PLANNING FOR PROFIT

Province of British Columbia
Ministry of Agriculture, Fisheries and Food

Hazelnuts
Fraser Valley
Summer 1993

Agdex 242 - 810

Introduction

The planning process provides producers with the opportunity to look at their operation as a group of distinct enterprises. Alternative enterprises should be evaluated on the basis of **Contribution Margin,** taking into consideration resource constraints, market opportunity, risk and uncertainty.

The **Contribution Margin** must provide funds for interest, overhead and other indirect expenses as well as a return for living expenses, loan repayment and investment. These items should be included in the overall farm plan which will include a **Projected Income Statement** and **Projected Cash Flow Statement**.

Key Factors Affecting Profit

	Target
Quantity	2,500 lbs./acre
% X-Lg & Lg	75%
Price	$.85 - .95/lb.

These yield and quality targets reflect appropriate site selection and above average management in orchard fertility, variety choice, pollenizer selection and placement, weed and insect control and pruning.

Tree density and regular, proper pruning practices will improve yields and quality as well as tree vigor. Some growers opt to double plant initially to get high early yields and then remove half the trees in year 12. The costs and benefits of this alternative should be evaluated on an individual basis.

Marketing Alternatives

Marketing opportunities exist for hazelnuts sold through the processors to the wholesale and retail trade. There are also opportunities for farm sales (u-pick and picked), roadside stand and other direct markets. Hazelnuts have potential for higher returns through niche markets in the food industry or cottage industries.

Cash Flow Timing

	N	D	J	F	M	A	M	J	J	A	S	O
%Inc		30	50									20
%Exp						10			10		20	60

The above information indicates the timing of monthly flow of funds included in the Contribution Margin only. A complete **Projected Cash Flow** should include indirect expenses, capital sales and purchases, loans and personal expenses.

Rules of Thumb

Investment	$2,200 - $2,500/acre
Direct Expense % of Income	70 - 80%

The above indicators are provided for comparison purposes. They are set out as potential targets for hazelnut production.

Contact: BILL PETERS, P. Ag.
Nut Crop Specialist
Abbotsford
LORNE OWEN, P. Ag.
Farm Management Specialist
Abbotsford

HAZELNUTS
Target Yield - 2,500 lbs./Acre

Contribution Margin
1 Acre of Hazlenuts

Income

	Yield	Price	Unit	Income
X-Lg & Lg	1,875	$.90	lb.	$1,678
Med & Sm	625	.45	lb.	281
Total Income	**2,500**	**$.79**	**lb.**	**$1,959**

Direct Expenses

	Quantity	Price	Unit	Expense
Fertilizer				
46 - 0 - 0	250	$.34	kg	$85
Solubor	2.3	1.83	litre	5
Pest Control				49
Fuel Costs				21
Machinery Repair & Maintenance				62
Contracts & Custom Work				
Tissue Analysis				5
Harvesting	2,500	.10	lb	250
Processing & Marketing		.40	lb	1,000
Total Direct Expenses				**$1,477**
Contribution Margin*				**$483**

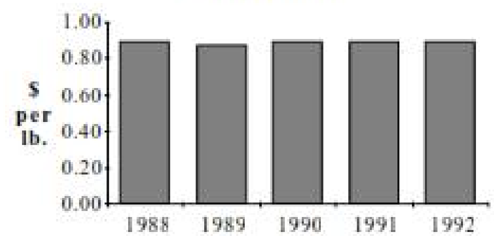
*Some indirect costs to be covered by the Contribution Margin are: costs of financing; owner/operator labour (pruning, fertilizing, spraying, mowing, etc.); and management.

Buildings and Machinery Replacement Cost
Total Farm Size – 40 Acres*

Hazelnut Trees	$21,500
Buildings	6,000
Tractors (60 Hp)	40,000
Flail, Sprayer etc.	14,500
Truck (3/4 ton)	13,000
Total	$95,000

*Smaller plantings would still incur these basic building & machinery costs.

Wholesale Pric
Large Hazelnut



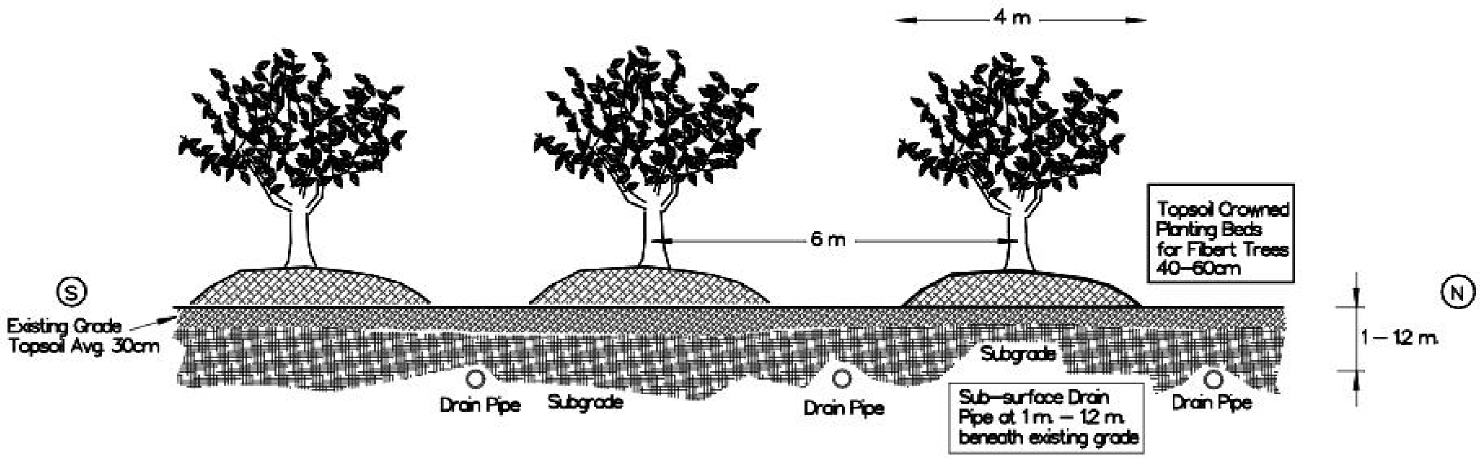
Contribution Margin – Sensitivity Analysis

The table below lists the changes to contribution margin as quantity of yield changes and average price received varies.

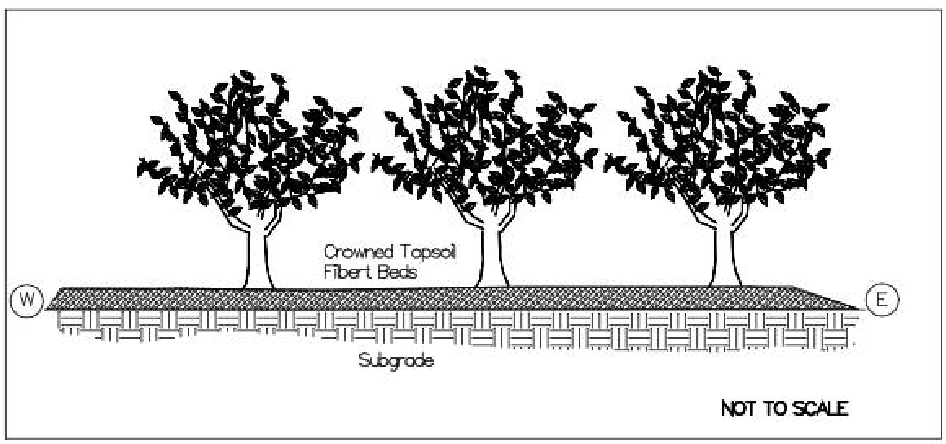
PRICE $/lb.	Yield Lbs. per Acre 1,500	2,000	2,500	3,000
.60	(77)	(27)	23	73
.70	73	173	273	373
.78	199	341	483	625
.90	373	573	773	973

This information is provided as a guideline only. Target yield indicates above average production. An individual crop plan should be developed by each producer. Planning forms may be obtained from your local office of the B. C. Ministry of Agriculture, Fisheries and Food.

Appendix V Cross Section Drawing Filbert Orchard

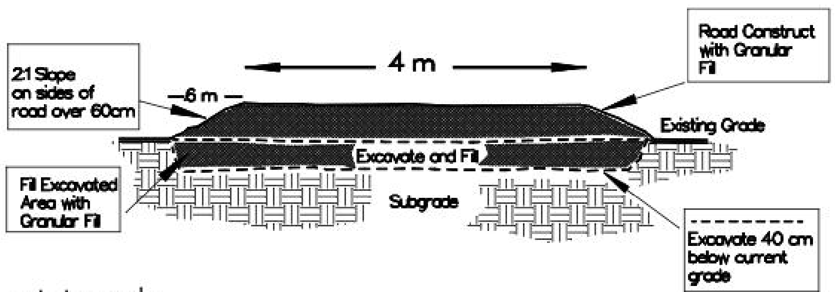


Client: Bill Jones Horticultural Inc. Street: 9360 Finn Road Town: Richmond, BC		Scale: 1cm = 1m
Contact: Bruce McTavish	Phone #: 604.240.2481	Date: 06.29.12
Designer: Liz Spring	Editor:	Plan #: Fibert Bed Section View



Appendix VI Farm Road Design

Constructed Roadway



not to scale

Client: Bill Jones Horticultural Inc.		
Street: 9360 Finn Road Town: Richmond BC		Scale: NTS
Contact: Bruce McTavish	Phone #: 604.240.2481	Date: 06.29.12
Designer: Liz Spring	Editor:	Plan #: Road Section View