City of Richmond

Report to Committee

To:	General Purposes Committee	**Date:**	June 9, 2020
From:	Cecilia Achiam General Manager, Community Safety	**File:**	12-8080-12-01/Vol 01
Re:	**Soil Use for the Placement of Fill Application for the Property Located at 5800 No. 7 Road (Mahal)**		

Staff Recommendation

That the 'Soil Use for the Placement of Fill' application submitted by Paul Mahal (the "Applicant") proposing to deposit soil on the property located at 5800 No. 7 Road to transition a former cranberry bog to allow for the growing of vegetables and ornamental trees be authorized for referral to the Agricultural Land Commission (ALC) for the ALC to review and determine the merits of the proposal from an agricultural perspective as the Applicant has satisfied all of the City's current reporting requirements.

Cecilia Achiam
General Manager, Community Safety
(604-276-4122)

Att. 6

REPORT CONCURRENCE	
ROUTED TO:	**CONCURRENCE**
Engineering	☒
Policy Planning	☒
Sustainability	☒
Transportation	☒
SENIOR STAFF REPORT REVIEW	INITIALS:
APPROVED BY CAO	

Staff Report

Origin

The City of Richmond is in receipt of a 'Soil Use for the Placement of Fill' application for the property located at 5800 No. 7 Road (the "Property"). The intent of the application is to deposit soil for the purpose of transitioning a former cranberry bog, which the Applicant's agrologist-of-record has advised is agriculturally limited due to "soil wetness […], undesirable soil structure […], and fertility limitations due to high acidic soils and nutrient deficiencies." The Applicant intends to grow vegetables and ornamental trees following completion of the project.

The Property is situated within the Agricultural Land Reserve (ALR) and is subject to provisions of the *Agricultural Land Commission Act* and its regulations (the "Regulations"), and the City's *Soil Removal and Fill Deposit Regulation Bylaw No. 8094* (the "Soil Bylaw").

Pursuant to applicable Provincial regulations, a 'Soil Use for the Placement of Fill' application requires authorization from local government in order to be referred to the Agricultural Land Commission (ALC) for their review and approval. As such, this application must be submitted to the City for review and a decision from Council. Should the application be referred to the ALC and should it subsequently be approved by the ALC, the Applicant would be required to satisfy the City's requirements outlined in the Soil Bylaw before a soil deposit permit would be issued by the City.

The Applicant has satisfied all of the City's referral requirements for submission to the ALC.

This report supports Council's Strategic Plan 2018-2022 Strategy #2 A Sustainable and Environmentally Conscious City:

> *Environmentally conscious decision-making that demonstrates leadership in implementing innovative, sustainable practices and supports the City's unique biodiversity and island ecology.*
>
> *2.1 Continued leadership in addressing climate change and promoting circular economic principles.*
>
> *2.3 Increase emphasis on local food systems, urban agriculture and organic farming.*

Analysis

The Property is zoned AG1 (Agriculture). The Property contains an Environmentally Sensitive Area (ESA); however, the Applicant's proposal will not disturb the ESA. The current zoning permits a wide range of farming and compatible uses consistent with the provisions of the *ALC Act* and *Regulations* and the City's *Official Community Plan* and *Zoning Bylaw*. The Applicant is proposing to deposit 110,000 cubic metres of soil over approximately 9.0 ha of the 29.16 ha Property at an average depth of 1.3m.

Uses on Adjacent Lots

- To the North: ALR – Golf Course
- To the East: ALR – Residential
- To the South: ALR – Land is in agricultural production
- To the West: ALR – Land is in agricultural production

Table 1: Existing Information and Proposed Changes for the Property

Item	Existing
Owner(s)	Mahal Farms Ltd. (Paul Mahal; Nick Mahal; Kalvinder Mahal; and Satwant Grewal)
Lot Size	29.16 ha (72.05 acres)
Applicant	Paul Mahal
Authorized Agent	Carly Wilson, Hexcel Construction Ltd. (the "Agent")
Authorized Consultant	Jessica Stewart, P. Ag., GIT (Madrone Environmental Services Ltd.)
Current Land Uses	A portion of the Property is currently under production (nursery and vegetable crops)
Proposed Land Uses	Transition former cranberry field to vegetable farm and to grow ornamental trees
Official Community Plan Designation	Agriculture
ALR Designation	Property is within the ALR
Zoning	AG1
Riparian Management Area (RMA)	Yes – No disturbance proposed
Environmental Sensitive Area (ESA)	Yes – No disturbance proposed

Project Overview

The Applicant's family has farmed the Property since 1949 and is applying to deposit 110,000 cubic metres of soil over approximately 9.0 ha of the 29.16 ha Property at an average depth of 1.3m. The objective is to improve the agricultural capability to transition a field formerly used to grow cranberries to soil-based vegetable farming and ornamental trees. This would expand the farming operations on the Property which currently includes a nursery and vegetables crops.

The Applicant has provided a Farm Plan (the "Farm Plan") and a Soil Placement Plan (the "Placement Plan") developed by a qualified agrologist, Jessica Stewart, P. Ag., GIT, Madrone Environmental Services Ltd. (the "Agrologist").

The Farm Plan (Attachment 1) summarizes the following:

- Property assessment (ie. current soil and agricultural conditions);

- Soil importation and land preparation; and
- Proposed crops and reason(s) for diversification.

The Placement Plan (Attachment 2) summarizes the following:

- Site description and current land use;
- Land capability assessment (ie. current soil conditions);
- Agrologist recommendations regarding soil placement and management of the native topsoil which includes the stockpiling and re-use of the native topsoil;
- Current hydrology;
- Post-fill agricultural capability;
- Recommendations to ensure the project is satisfactorily completed; and
- Summary of the Agrologist's recommendations.

The proposed soil deposit area has remained fallow for the past three to four years. The Agrologist has advised that the current conditions in the proposed soil deposit area are considered to be excessively wet with the soil deemed to be highly acidic and nutrient poor. The Farm Plan states that should the project receive approval and the appropriate soil be imported/deposited as proposed, the addition of the soil will improve the agricultural capability from 4W limitation to a Class 2WF. As per the Agrologist, Class 2WF corresponds to minor limitations due to excess wetness and fertility. The fertility limitations can be further improved, as is proposed and noted in the reports, with soil amendments and careful soil testing.

The Applicant has advised that the project will take two years to complete. The timeline for completion is heavily dependent on ensuring the appropriate soil – as recommended by the Agrologist – is sourced to complete the project. Soil sourcing has not commenced at this time due to the considerable period of time involved with respect to the soil deposit application process and seeking approval from the City and ALC.

While there is no requirement in City bylaws, the Applicant and his Agent, Hexcel Construction, have offered an additional $100,000 security bond (Attachment 3) to be retained by the City until the Farm Plan has been implemented. The City will not return the bond until such time as the Agrologist has provided a report to the City confirming implementation of the Farm Plan.

Staff Comments

The proposal aligns with a number of Council endorsed strategies and direction including concerns about the use of Richmond soil. Other objectives satisfied by the project are described as follows:

- The Applicant's desire to utilize Richmond soil where possible provides for a reduction in carbon emissions as there will be a considerable decrease in mileage as trucks will not be traveling back and forth from City approved development projects to the Fraser Valley as is common practice;
- Following completion of the project, the Applicant's Farm Plan will include expansion of current vegetable growing operations in Richmond by up to 22 acres;

- The proposal to raise the Property to improve the agricultural viability is consistent with the City's current Flood Protection Management Strategy which identifies raising land levels within all areas of the City as a key overall long-term objective. At the January 27, 2020 Regular Council Meeting, Council made a referral for staff to review the FPMS and provide comments with regard to the raising of land, specifically as it relates to agricultural land and agricultural viability. Staff are preparing a response to this referral;
- The Applicant will be stockpiling and utilizing native topsoil to complete the project; and
- The Applicant will not be impacting the large portion of the Property designated as an Environmentally Sensitive Area

Richmond Food Security and Agricultural Advisory Committee (FSAAC) Consultation

The Applicant presented the proposal to the FSAAC on May 21, 2020. The FSAAC unanimously supported the proposal and passed the following motion:

> *That the Food Security and Agricultural Advisory Committee support the Soil Use for Placement of Fill Application at 5800 No. 7 Road subject to the applicant providing a performance bond equal to the revenue from tipping fees minus the cost to implement the farm plan.*

Agricultural Considerations

The City has been advised that cranberry production ceased on the Property in 2016 as the Owner was no longer able to sell his crop. The owners have since determined that they want to move away from cranberry farming and diversify operations. As an alternative to cranberries, the owners wish to expand the farm and grow vegetable crops and ornamental trees.

The Farm Plan identifies that the top 30 cm of native topsoil will be stripped and stockpiled to be used to cap the imported soil. The stripping and stockpiling would be completed prior to importation of soil to the site. This practice would be similar in nature to the Council endorsed project currently underway at 14791 Westminster Highway (Sixwest Holdings). Soil deposit permit (the "Permit") requirements would dictate that the Agrologist oversee the stripping and stockpiling to ensure the existing topsoil is not degraded.

Following completion of the proposed soil deposition, the Agrologist has noted that manure or compost in addition to lime may be required to improve and amend the pre-existing soil due to deficiencies in nutrients and soil acidity from the previously noted cranberry farming. Following project completion, the improvements to the Property will provide for a more diversified farm with more crop types to be sold locally on the Property.

In addition, the Applicant has submitted a Technical Memorandum (the "Soil Memo") regarding soil source sites (Attachment 4). The Soil Memo highlights that the objective is to utilize available Richmond soil to complete the project and outlines the benefits to using Richmond soil. As per the Soil Memo, "[o]btaining soils from more distant sources comes with significant environmental and social costs, such as increased vehicle emissions due to extensive travel…" It also provides additional information on soil types suitable to complete the project as well as the types of soil that should not be imported and source sites that should be avoided.

Bruce McTavish (MSc, MBA, PAg, RPBio) has reviewed the proposal from an agricultural perspective on behalf of the City and has no concerns regarding the soil assessment as it relates to the current conditions of the Property. In addition, Mr. McTavish has confirmed that the proposal meets all requirements of *ALC Policy P-10 - Criteria for Agricultural Capability Assessments.*

Drainage & Geotechnical Considerations

The Applicant has provided a Technical Memorandum (Drainage and Suitability of Excess Water Management Options) outlining water management options for the Property. The memorandum outlines current drainage issues for the Property and water management options for the Property.

As per the memorandum (Attachment 5):

> *"Seasonal high water table at, near or above ground surface would restrict land application of nutrient sources both during times of water table being above ground surface, but also during periods of generally high water table whereby precipitation /infiltration/ dispersion would result in direct transmission of nutrients to groundwater/nearby watercourse."*

In the opinion of the author of the memorandum (Thomas R. Elliot, PhD, P. Ag., P. Geo – Madrone Environmental Services Ltd), soil placement offers the best opportunity to improve the Property and current soil conditions. In addition, the City's current Flood Protection Management Strategy identifies raising land levels within all areas of the City as a key overall long-term objective, especially where such raising meets other objectives, such as agricultural viability. City Engineering staff have reviewed and are satisfied with the Placement Plan. Staff do not anticipate any negative impacts to City infrastructure or neighbouring properties following completion of the project.

A geotechnical report has not been required by the City as the soil deposition area will have a substantial setback of 6+ metres from property lines. Permit conditions will provide staff the latitude to request a geotechnical report at any time should the City consider it necessary.

Environmental Considerations

The proposed soil deposition area is outside of the Riparian Management Area located along No. 7 Road. There is no RMA within proximity to the proposed access point on Westminster Highway. Soil placement is not proposed to occur within an ESA located east of the soil deposition area (see Figure 3 within the Placement Plan). In addition, no trees will be impacted due to soil deposit operations.

As per Permit conditions, all work undertaken in or around a watercourse, must be completed in compliance with the *Water Sustainability Act*, under the guidance of a Qualified Environmental Professional (QEP). The City will require that erosion and sediment control measures (ESC) be installed and inspected by a QEP, if deemed necessary by staff.

Financial Costs and Considerations for the Applicant

Due to ongoing development within the City of Richmond and the Lower Mainland, developers and contractors must find a location (the "End Site") that will accept soil that needs to be excavated and removed off-site to facilitate development. Due to such demand, a market has been created in which End Site owners can generate income via tipping fees. Such fees are variable depending on the location, type and volume of soil, and season. Contractors are willing to pay a premium based on the location (the "Source Site") of the soil to the End Site in order to reduce considerable trucking costs.

Although End Site owners derive income due to such tipping fees, soil deposit projects are not without significant costs to the Permit holder. It is anticipated that this project may generate approximately $1.3 million in tipping fees. However, the income derived through tipping fees may be offset by costs estimated to be in excess of $940,000 due to upfront reporting expenditures, site preparation, project management (ie. soil monitoring), daily personnel and equipment costs, drainage upgrades, and final reporting expenses. An estimate of these costs has been provided by the Applicant and is provided in Attachment 6.

Following FSAAC's motion to support the proposal with the condition that the Applicant provide a bond in an amount estimated to be the potential in profit via tipping fees, the Agent has agreed to provide an additional $100,000 security bond. This bond will be held by the City until the Farm Plan is implemented. Staff have concluded that the $100,000 bond, while not the sum requested by FSAAC (estimated to be $400,000), is appropriate given that the Applicant will be expected to provide a significant performance bond to the ALC (see Security Bonds section). In addition, the estimated difference between cost and profit are volatile as tipping fees and project costs could vary due to unforeseen circumstances, especially due to the long duration of the project. This bond is not a requirement of the City's Bylaws but rather a submission from the Applicant that recognizes their commitment to the project and to farming this portion of Property.

Road and Traffic Considerations

A Traffic Management Plan (TMP) has been submitted to and reviewed by Transportation staff. Staff are satisfied with the TMP.

<u>Soil Deposit Permit Requirements and City Inspection and Project Oversight Protocols</u>

Should the proposal receive ALC and City approval, City staff will prepare a comprehensive Permit that sets out a number of conditions, including but not limited to:

- Oversight by a professional agrologist;
- Source site inspection requirements;
- On-site monitoring and reporting requirements;
- Requirements for protection of the RMA along the western property line;
- Measures needed to eliminate impacts, including drainage, to neighbouring properties and City infrastructure;
- Permitted hours/days of operation;

- An approved Traffic Management Plan; and
- Security deposits (further explained below).

Site monitoring, source site inspection and Qualified Professional reporting requirements are intended to be similar to the requirements for the Sixwest Holdings project. This will include an on-site monitor inspecting each load of soil prior to deposition on the Property. The Agrologist will be required to inspect and approve all source sites and maintain an accurate daily log of trucks depositing soil on the site. At the sole discretion of the City, alternate measures may be required (i.e. survey) in order to determine the volume of soil deposited on the Property.

In addition to the expected reporting requirements of an agrologist or other qualified professionals to the City and ALC, City staff will maintain proactive inspection and enforcement on the Property that will include the following:

- multiple site inspections per week of the Property at the onset of the project to ensure conditions of the Permit are being maintained;
- weekly site assessments to continue to be undertaken when soil importation is underway to ensure the Permit conditions are respected;
- meet on-site with the site supervisor a minimum of two times per month;
- maintain communication with the Agrologist and Agent on a regular basis;
- review reports to ensure conditions of the Permit are being satisfied; and
- advise the ALC of concerns relative to the project and request that ALC staff undertake inspections to ensure compliance with the approval conditions when deemed necessary by City staff.

Security Bonds

Should the soil deposit project receive approval, the City will require that the Applicant provide the following security bonds:

- $5,000 pursuant to s. 8(d) of the current *Boulevard and Roadway Protection Regulation Bylaw No. 6366* to ensure that roadways and drainage systems are kept free and clear of materials, debris, dirt, or mud resulting from the soil deposit activity;
- $10,000 pursuant to s. 4.2.1 of the current *Soil Removal and Fill Deposit Regulation Bylaw No. 8094* to ensure full and proper compliance with the provisions of this Bylaw and all other terms and conditions of the Permit; and
- In addition to the security bonds detailed above, the Applicant has also proposed a $100,000 bond to the City for implementation of the Farm Plan. Beyond completion of the soil project, this bond will provide security that the Farm Plan will be implemented.

In addition to the security bonds provided to the City, the ALC has the authority to require a performance bond to ensure that all required mitigation and monitoring measures are completed. The bond required by the ALC is also intended ensure the rehabilitation of the Property in the event the project is not completed. ALC performance bonds and the approved volumes from four previous approvals for projects within the City are as follows:

- $70,000 – 17,500$m^3$ (Athwal - approved May 2020)
- $160,000 – 48,000$m^3$ (City of Richmond - approved June 2017)
- $290,000 – 140,000$m^3$ (Sixwest Holdings - approved January 2017)
- $500,000 – 102,080$m^3$ (Sunshine Cranberry Farms Ltd. - approved January 2014)

As per the Permit conditions, security deposits will not be returned until all conditions as stated in the Permit and the ALC approval are satisfied in their entirety, to the satisfaction of the City. This will include confirmation that the Farm Plan has been completed as per a final report from the owner's agrologist-of-record. City staff is to conduct a final inspection and receive confirmation from the ALC that the project has been completed as per ALC approval prior to closing the file.

Alternatives to Council Approval

Should Council not authorize staff to refer the proposal to the ALC for their review and decision; the application will be considered to be rejected. Council may add additional recommendations for ALC consideration and/or conditions within a referral to the ALC, similar to conditions already provided within this report.

Financial Impact

None.

Conclusion

Staff is recommending that the 'Soil Use for the Placement of Fill' application for the Property located at 5800 No. 7 Road be endorsed and referred to the ALC to determine the merits of the proposal from an agricultural perspective as the Applicant has satisfied all of the City's current reporting requirements.

Mike Morin
Soil Bylaw Officer, Community Bylaws
(8625)

Carli Williams, P.Eng.
Manager, Business Licence and Bylaws
(4136)

Att. 1: Farm Plan (27 May 2020)
2: Soil Placement Plan (18 Mar 2019)
3: Letter of Commitment re. Farm Plan security bond (03 Jun 2020)
4: Technical Memorandum re. Soil Source Sites (07 Jan 2020)
5: Drainage & Suitability of Excess Water Management Options Technical Memorandum (27 Jan 2020)
6: Project Cost Table (Feb 2020)

Attachment 1

FARM PLAN

5800 No. 7 Road
Richmond, BC

FOR:

Mr. Paul Mahal
Mahal Farms Ltd.
5800 No. 7 Road, Richmond B.C.

BY:

Jessica Stewart, P.Ag., P.Geo.

Madrone Environmental Services Ltd.

March 18, 2019
Revised: May 27, 2020

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MADRONE
environmental services ltd.

FARM PLAN

5800 No. 7 Road Richmond, BC

1 Introduction

Madrone Environmental Services Ltd. (Madrone) was retained by Mr. Paul Mahal of Mahal Farms Ltd. (Mahal Farms) to prepare a Farm Plan for his property located at 5800 No. 7 Road in Richmond, BC (PID: 007-436-815). The Farm Plan will be submitted to the City of Richmond and the Agricultural Land Commission (ALC) as part of a Soil Deposit Permit Application.

The proposed vegetable farm will be established in approximately 9.0 ha of land in the northwest corner of the 29.5 ha property following improvement through proposed soil importation. Madrone has prepared a separate Soil Placement Plan that is intended to be read in conjunction with this farm plan.

The soil placement plan proposes to import approximately 110,000 m³ of good-quality fill over 9.0 ha of the property to improve soil wetness (predominantly 4W limitation), undesirable soil structure (3D limitation), and fertility limitations due to highly acidic soils and nutrient deficiencies (4F limitation). The intent of soil placement is to improve the aforementioned conditions that limit agricultural capability. After the addition of soil which will raise the existing land surface by an average of 1.3 m, followed by soil profile construction as Mr. Butt,P.Ag. and I have recommended, the agricultural capability will improve to an estimated 2WF.

The site of the proposed vegetable farm was previously used for cranberry farming up until 2016. After improving the agricultural capability of the land by soil importation, Mr. Mahal has proposed the following farm plans in this area instead of cranberries:

- Ornamental trees;
- Indian Vegetable varieties such as Indian carrots, peppers, squash, garlic, eggplant, and bhindi (okra);
- Other locally grown vegetables such as kale, sweet corn, and peas.

For this farm plan, I have selected two vegetable varieties to demonstrate establishment effort and costs; garlic and carrots. Mr. Mahal can grow multiple vegetable crops if desired or rotate in new crops after 2-3 seasons. Diversifying crop production can help the viability of the overall vegetable farm operation.

Paul Mahal of Mahal Farms is a third-generation farmer. His family has farmed the property since 1949. There are currently other active farming ventures on site – these are described in this report as well (Section 2). The property has active farm status with BC Assessment.

2 Area Description and Field Assessment

2.1 Location and Site Description

The farm will be established in the northwest corner of the property at 5800 No. 7 Road in Richmond, BC. The property is situated approximately 6.6 km east of Richmond centre on Lulu Island (**Figure 1, Appendix 2**). The legal description of the property is: Block 4N Part1 S Section 2 Range 5W Land District 36 Except Plan 27718. The Property Identification number is 007-436-815.

The northwest corner of the property was previously farmed for cranberries. The cranberries were sold in the Ocean Spray cranberry collective (**Photos 1 and 2**). To facilitate cranberry farming, there are berms (or dykes) established around the perimeter, as well as an irrigation canal/ditch on the south side of the proposed farm area (to flood the field as a wet harvest). As a legacy of cranberry farming, the native soil was found in our soil testing to be very acidic and severely deficient in both nitrogen and phosphorous. Another legacy of this farming activity is the diversity of mulches that were placed on the soil, including wood chips and sand.

The northeast corner of the property is approximately 5.1 ha in extent and is designated as an Environmentally Sensitive Area (ESA) by the City of Richmond, specifically "Old Fields and Shrublands". This area was previously farmed for trees (abutting the east side of the cranberry field). There are no plans to further develop this portion of the property. City of Richmond mapping[1] also shows that the southeast portion of the property is still situated in the ESA but as of 2018 is being farmed for ornamental trees.

Approximately 1.7 ha of land in the northern parcel will not be farmed due to City of Richmond 15 m Riparian Management Area (RMA) setbacks from the watercourse (ditch) along No. 7 Road and the irrigation canal located through the centre of the property.

PHOTO 1. WET HARVEST OF CRANBERRIES ON THE PROPERTY. DATE OF PHOTO UNKNOWN, VIA THE BC CRANBERRY MARKETING COMMISSION[2].

The remaining southern half of the property is actively farmed by either Mahal Farms or is leased to local farmers. The current farming uses reported by Mahal Farms are vegetables (field and greenhouse), hedging cedar (field-based near No. 7 Road), and tree nurseries (container and caliper trees). A 2018 Google™Earth Pro image shows that at least 0.75 ha of the property is occupied by greenhouses, situated in the approximate centre of the southern portion of the lot (**Photo 3**).

[1] http://map2.richmond.ca/Html5Viewer_2_0/Index.html?viewer=RIM City of Richmond Interative Map. Accessed November 3, 2018.

[2] https://heritagebc.ca/south-asian-canadian-location/mahal-cranberry-farm-richmond/ Mahal Cranberry Farm Photo, Hertitage BC. Accessed November 3, 2018.

PHOTO 2. LOOKING DUE EAST ACROSS THE FORMER CRANBERRY BOG. THIS PHOTO IS FROM EARLY OCTOBER DURING A PARTICULARLY WARM AND DRY PERIOD.

2.2 Zoning and Adjacent Land Uses

The property is 29.5 ha and is zoned AG-1 (Agricultural) according to Richmond Zoning Bylaw 2011. The property is in the Agricultural Land Reserve (ALR).

The surrounding area has a mix of uses, including but not limited to:

- Forage and cereal crops;
- Wineries (Lulu Island Winery Ltd.);
- Specialty plants (Hawaiian Botanicals and Water Gardens);
- Dense residential (to the east);
- Golf courses (to the north and northwest);
- Multiple vegetable farms (both open field and greenhouse) and tree nurseries.

PHOTO 3. PANORAMIC VIEW OF THE FIELD AND GREENHOUSES SITUATED JUST WEST OF THE CENTRE OF THE PROPERTY AT WESTMINSTER HIGHWAY. THIS IMAGE IS FROM 2017 VIA GOOGLE ™MAPS.

2.3 Landform, Topography & Drainage

The property is near level with a reported elevation (on the west side of the property) of 1.65 m above sea level (a.s.l.)[3]. The surrounding area is part of the Fraser River delta and features broadly flat terrain that is at or near sea level. There is no topographic land survey available for the property at this time. The dykes that surround the proposed farm area have been raised above the natural grade of the land. Using Google™Earth Pro imagery, I have calculated the area occupied by the dykes to be approximately 1.6 ha.

There is no bedrock in this area. The floodplain is characterized by silty to silt clay loam up to 2 m thick overlying up to 15 m of deltaic and tidal flat deposits (Fraser River sediments). Post-glacial bog, swamp and shallow lake deposits have also been mapped in this area by Armstrong (1980); these are the post-glacial Salish Sediments. In our soil assessment we found that parent materials correlate well to the Fraser River sediments only.

[3] http://a100.gov.bc.ca/pub/mascotw/protected/final_long.html?Q_GCM_NO=274696 Geodetic Control Marker Number 274696. GeoBC Reference Systems and Survey Monuments. Accessed November 3, 2018

There are no mapped watercourses within the property. The entire west side of the property is bound by the No. 7 Road ditch, which is classified as a watercourse and riparian management area by the City of Richmond Official Community Plan Bylaw 9000, Section 9.0[4]. The RMA has a 15 m setback, as measured perpendicular from top-of-bank. The setback is to remain free from development unless authorized by the City of Richmond[5].

The irrigation canal on the property is not designated as a watercourse and does not have connectivity to the No. 7 Road ditch. There are no plans to alter the irrigation canal, either following soil placement or establishment of the farm. It is used for the farming ventures on the southern half of the property, as described above.

2.4 Native Soils and Land Capability for Agriculture

Madrone conducted a soil assessment in October of 2018 for our Soil Placement Plan. We found that the soils on the property correlate best with the Delta soil series of Luttermerding (1980), who described these soils as "moderately-fine to fine textured deltaic deposits and have a silt loam to silty clay loam textures". Delta soils are poorly drained and often subject to seasonal ponding. In our soil assessment, we observed mottling caused by high seasonal water tables in the subsoil.

We found the dominant soil limitation to be excess water (W), specifically a 4W limitation due to uniformly poorly drained soils. During the growing season, the water table will be within the rooting zone, restricting the range of crops that can be successfully grown without managing water (via installing drainage systems or raising the land surface via fill).

A second, less serious limitation is present in the native soils due to a dense Btg horizon. The dense subsoils cause an impediment to root growth ("root-restricting horizon"). For the majority of the assessed area, this correlated to a 3D limitation.

As part of our agricultural assessment, we collected soil samples for soil testing (nutrients and salinity). Soil nutrient testing performed by AGAT Labs shows that there is an additional agricultural limitation of fertility (4F) due to very strong acid soils with pH

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[4] https://www.richmond.ca/__shared/assets/OCP_9000_environment34172.pdf Main 2041 Official Community Plan - Bylaw 9000 - Schedule 1. Accessed November 3, 2018

[5] https://www.richmond.ca/__shared/assets/info_2332212.pdf Riparian Management Areas – Multifamily Residential, Commercial and Industrial Developments. Accessed November 3, 2018

ranges between 3.75 to 4.31 and nutrient deficiencies, specifically nitrogen and phosphorus. There was no salinity limitation reported for the native soils, which was unexpected given the tidal environment of the Fraser River delta. High soil salinity may exist at a deeper depth (> 1m) in this area.

To improve the agricultural capability of the land, we proposed to import soil to the site to increase the elevation of the land by an average of 1.3 m and introduce a well-draining, loose growing medium with improved fertility. We determined that soil importation will improve the Class 4W/4F/3D limitations to a Class 2WF and support a broad variety of soil-based agricultural crops, including vegetables.

3 Soil Placement, Post-Filling Land Preparations

3.1 Soil Importation

Elevating the land by an average of 1.3 m and introducing a well-draining and fertile soil over 9.0 ha corresponds to a proposed importation volume of approximately 110,000 m^3. As detailed in the Soil Placement Plan report[6], the deposited fill material should ideally be a medium-textured loam or sandy loam (less ideal but acceptable in lesser quantities: silty loam and loamy sand) with less than 10% coarse fragments which are defined as sediment sizes 2.5 cm or larger).

If the imported soil contains a high density of coarse fragments such that it presents a significant problem, then stone removal must be carried out to enable proper cultivation. Tractors and other farm machinery, including precision seeders, can be damaged by excessively stony fills. This can be avoided if loads of soils are inspected for stone content prior to off-loading on the property. In our soil placement plan, we supplied an example standard operating procedure (SOP) that could be adopted to minimize the importation of stony fills to the site.

Prior to placement, the upper 30 cm of native topsoil will be stripped and stockpiled. The depth to the native topsoil was found to vary between our soil pits on site and in some places is 20 cm deep (shallow). We have applied the 30 cm stripping parameter to acquire the majority of the topsoil but a small quantity of subsoil will ultimately be “grabbed” by the machine.

[6] Soil Placement Plan for 5800 No. 7 Road, Richmond, BC. Madrone Environmental Services. January 22, 2019.

Following fill placement, the land will be graded with subtle 1-2% slopes to the east and west; we recommend a crown in the centre of the 9.0 ha field to facilitate a drainage divide but the contractor can vary the grading as the project proceeds to ensure the fill drains prior to topsoil placement, which will occur after the subsoil is placed.

3.2 Land Preparation

As part of land preparations prior to crop establishment, the soil will be tilled or plowed to reduce the density of the fill and topsoil. This will also provide a loose growing bed for the eventual vegetable crops. It is recommended that the plowing or tilling be completed at least one month before seeding any crops. I will describe specific pre-planting plans for each crop in Section 4 – Farm Planning.

Following tilling, soil nutrient and pH testing should be conducted over the entirety of the 9.0 ha area to determine the need for applications of manure or compost and lime[7] due to nutrient imbalances or overly acidic or alkaline soils respectively. Manure or compost should be surface applied (preferably in the spring, though fall seeding of vegetables may dictate earlier application before heavy rains commence) and worked into the upper 20 cm to 30 cm of soil via plowing, roto-tilling or disking. Since most of the vegetables will be grown in raised beds, bedmaking will also be done after the soil is decompacted and tilled.

The City of Vancouver landfill in Delta sells nutrient-rich compost to the public, produced on site from public yard and garden waste. This organic fertilizer option is a sustainable and locally convenient option but can be expensive at $8/m^3. There are many other options for organic soil amendments, including locally sourced chicken and mushroom manure. We discourage applying wood shavings, saw dust, or wood chips as organic amendments. Except when judiciously applied as mulch on the soil surface.

4 Farm Planning

Mr. Mahal of Mahal Farms intends to convert his former cranberry field into a vegetable and ornamental tree farm. For this farm plan, I have selected two vegetable varieties (specifically from a list of desired Indian vegetable varieties that Mr. Mahal supplied to Madrone) and describe the basic establishment tasks and costs of each crop.

[7] For lime applications, I strongly suggest utilizing a 'lime calculator' or chart to determine the lime requirements to correct acidity of the soil, based on its pH and soil buffer pH.

For simplicity, I have divided the proposed 9.0 ha farm area into three fields with an extent of 3.0 ha each (for the first year, one 3.0 ha field can remain vacant due to high initial investments costs of establishing each crop). Each plot is approximately 160 m (east-west) by 185 m (north-south). Mr. Mahal may decide to plant more than two crops and vary the proportions of each crop depending on demand, prices, and difficulty of farming a particular crop. He may also rotate the crops over a period of several years to manage nutrients and prevent the build-up of crop-specific resistant weeds and pests.

I understand that Mr. Mahal resides on the farm and has relatives also residing nearby. For costing estimates however I have assumed that Mahal Farms will hire farm workers for all farming activities, including planting, preparation, and harvest. The cost of farm labour is accounted for in this farm plan as it will form a significant portion of the establishment, maintenance, and harvesting costs. The costs of the soil placement are not included in this farm plan.

4.1 Garlic Crop

Garlic can be grown in open fields or in greenhouses. For this farm plan, I have assumed an open field environment for the garlic as the cost of greenhouses may be considerable (Quonset greenhouse structures can be affordable but will likely still require building permits, which can carry a considerable initial cost as well as time investment).

Garlic is a perennial plant that requires a cold period to initiate growth. For cool climates such as that in coastal British Columbia, garlic is generally planted during the fall and harvested the following summer. It is possible to plant in the spring in the South Coast region – this can be achieved by placing bulbs in cold storage prior to planting. This will encourage proper development of the bulbs[8].

If cold storage is not possible, close monitoring of early spring temperatures will be necessary to ensure it is cool enough for the cloves to develop adequate root systems. There are no set temperature thresholds for garlic cold storage, though this should be cool enough to simulate local fall temperatures.

[8] http://www.omafra.gov.on.ca/english/crops/facts/09-011w.htm Ontario Ministry of Agriculture, Food, and Rural Affairs. Garlic Production Fact Sheet. Accessed December 10, 2018

There are several varieties of garlic grown in British Columbia. White skin garlic is popular in grocery stores whereas varieties such as pink-skinned varieties such as Spanish Roja are sold in farmer's markets and roadside stands (**Photo 4**, below)[9].

The field should be prepared prior to planting of the cloves. Soil testing can determine whether the pH is ideal for garlic planting. The soil pH should range from 6.0 - 7.5 for garlic. This crop will certainly require lime applications to the soil prior to planting.

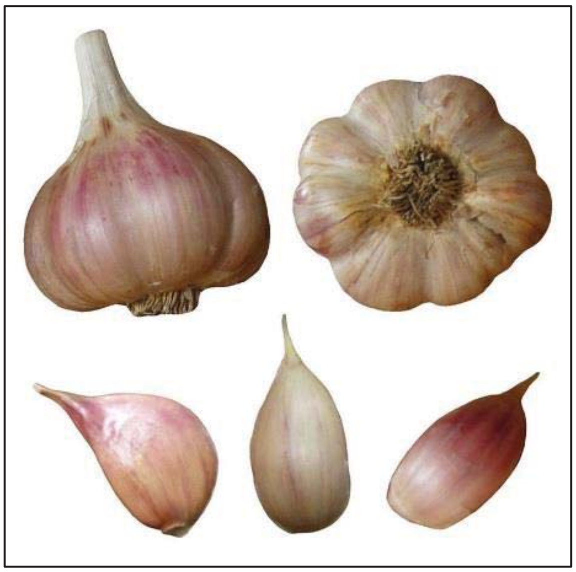

PHOTO 4. SPANISH ROJA GARLIC VARIETY FROM THE MANITOBA, CANADA GARLIC "SEED" SELLER JOHN BOY FARMS. PHOTO COURTESY OF JOHN BOY FARMS AT: HTTPS://GARLICSEED.CA/COLLECTIONS/ALL-VARIETIES/PRODUCTS/SPANISH-ROJA

4.1.1 Garlic Planting Plan

Garlic bulbs can be purchased by reputable garlic sellers throughout North America. The bulbs are separated (or cracked) by hand or by machine to obtain individual cloves that can then be propagated. Cracking by hand is less damaging but requires high labour inputs. The separation of the cloves from the bulbs should not be done until shortly before planting to avoid deterioration. I have assumed for this farm plan that a machine will be purchased to split the bulbs.

[9] https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables/garlic BC Ministry of Agriculture Garlic Production Guide. Accessed December 10, 2018

A single clove will produce an entire garlic bulb, but cloves must be planted every season in the interests of preserving genetic stock. The clove should be planted with the pointed end facing up at a depth of 3 to 5 cm – cloves placed in an incorrect orientation may develop but with misshapen bulbs and shoots[8]. Depending on weed control methods (such as tilling), rows can be planted as close as 20 cm, with garlic clove plant spacing of 7 to 12 cm within the row[10].

If the 3.0 ha field (160 m x 185 m) is planted using the above parameters, this equates to a maximum of 925 rows oriented east-west, with 1300 plants per row (low density planting at 12 cm between plants). Accounting for row breaks for farm machinery (i.e. tractors), as well as adequate spacing between adjacent crops (carrots, eggplants, okra, beans) in the interests of pest and weed management, I have reduced the planting parameters to 800 rows with 1000 plants per row. This equates to 800,000 garlic plants.

The entire 3.0 ha field is intended for garlic cultivation however, it is not necessary to plant the full extent of the field in the first season. A preliminary crop that is a fraction of this size can be grown in the first season and expanded as the farm grows. For this farm plan, I will use an estimated crop size of 200,000 plants for the first season. This is still a significant initial establishment and will allow for Mahal Farms to determine which varieties respond well to local growing conditions, and assess demand for certain cultivars (i.e. Russian Red, Italian Purple, Spanish Roja, and Music varieties).

Garlic can be planted in single rows or in multi-row beds and the beds themselves may be raised or flat. Note this estimate does **not** take into account the any loss of garlic plants to disease, stunted growth, or poor aesthetic characteristics. For example, hardneck varieties require scape removal to ensure high yield of the bulbs. Retention of the scape can reduce the bulb size by up to 30%.

To protect the young cloves against freeze-thaw (if fall planting) or temperature fluctuations (if spring planting) mulch should be applied to the beds at a depth of at least 10 cm. Mulching will also help maintain even soil moisture. Recommended mulch materials include alfalfa, swamp grass, shredded leaves and reeds. The application of grain straw is not advised due to the potential for host mites to attack the young garlic cloves. Harsh winters (with cooler than seasonal temperatures and/or above average snowfall) may dictate the need for additional mulch application – this can be pulled back in the spring.

[10] https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables/garlic BC Ministry of Agriculture Garlic Production Guide. Accessed December 10, 2018

4.1.2 Irrigation for Garlic Plants

The property area is designated as 3A (1) in the Climatic Capability for Agriculture scheme of Coligado, 1980[11]. Class 3 aridity limitations indicate drought or aridity between May 1 and September 30 resulting in moisture deficits, which are limiting to plant growth and could require moderately intensive management.

Summer moisture deficits will initially have to be offset by irrigation; a new drip irrigation system can be employed (short intervals every day). For a farm of this size, hand watering by a pump is not practical. Basic research shows that drip irrigation costs approximately $1 per metre[12]. Thus initial irrigation installation costs will be considerable.

Garlic bulbs are shallow rooted and as a result are susceptible to moisture stress. A garlic bulb will require between 2.5 and 5.0 cm of water per week, with sandy soils requiring the upper limit of this estimate (the native soils on site would require the lower limit)[13]. The bulbs should not be irrigated in the last two weeks before harvesting.

4.1.3 Weeds, Pests, and Disease Management

Prior to planting, weed management will be required as garlic yields are sensitive to weed competition. Tilling between rows and applications of herbicides (pre-emergence and post-emergence) will be required if weed growth presents an issue at planting time. Between herbicide applications, mulching can reduce weed development and assist with maintaining moisture around the young cloves while they develop into bulbs.

A common herbicide for annual grasses and broadleaf weeds that affect garlic crops is Devrinol 50-DF. This can be applied at a rate of 2.24 to 4.5 kg/ha.Herbicide should only be applied once per season and weeds must be well tilled into the soil prior to planting of garlic cloves.

[11] https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/climatic_capability_for_agriculture_in_bc_1981.pdf Climatic Capability for Agriculture in BC. Coligado, 1981.

[12] http://www.irrigationdirect.ca/Drip-Irrigation-Kits-For-Row-Crops-Using-Drip-Tape/ Canadian drip irrigation sales - $275 for 300 m installation kit. December 10, 2018

[13] https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables/garlic BC Ministry of Agriculture Garlic Production Guide. Accessed December 10, 2018.

Garlic pests and diseases include fusarium basal plate rot, penicillium mould, leek moth, and bulb and stem nematode[14]. Tests can be done on the soil prior to planting to detect many of these pests. Control recommendations include using clean seeds, clean irrigation water, and rotation on all fields with a non-host crop every three years.

The cost of herbicides, pesticides, and insecticides largely varies and their use will greatly depend on the quality of the seed (i.e. disease-free) and local growing conditions. For this farm plan I have included the cost of herbicides for weed management but not pesticides in the event that Mahal Farms wishes to be an organic farm (and utilize natural integrated pest management strategies).

4.1.4 Garlic Harvesting

The harvest time depends on whether the garlic was planted in the fall or spring. If a fall harvest is undertaken (the most common method), the first garlic bulbs will be ready for harvest the following spring or early summer. Garlic maturity is indicated by browning and drying of the leaves. A good point to harvest is once 30% to 50% of the leaves have died back. If the bulbils are to be harvested (scape is retained), then it is recommended to harvest later than normal. The bulbils will be ready once they are pushing their capsules open.

The garlic may be hand harvested or mechanically harvested by tractor. There are specialized machines and machine implements available for both planting and harvest but these require a high initial investment. For this reason, I have assumed that bulbs will be harvested by manual farm labour for the first season.

Once harvested, curing can be facilitated by tying and hanging or in the field by using covered vegetable bins. The purpose of curing is to increase storage life by minimizing microbial and fungal infection and water loss. Once cured, both the tops and roots of the garlic should be removed. Curing lasts approximately one month. I have accounted for the curing costs in my cost establishment table for Garlic.

4.2 Carrot Crop

Mahal Farms has indicated interest in planting Indian carrot varieties. Indian carrots are non-hybrid, natural varieties such as Purple (or black) carrots or “kali gajar” and red

[14] http://www.omafra.gov.on.ca/english/crops/facts/09-011w.htm Garlic production guide – Ontario Ministry of Agriculture, Food and Rural Affairs. Accessed December 10, 2018

carrots or "desi gajar". Orange carrots commonly found in grocery stores are a result of selective plant breeding in Europe, specifically the Netherlands, in the 17th century[15].

PHOTO 5. RED CARROTS USED IN INDIAN CUISINE.

PHOTO 6. PURPLE CARROTS FOUND IN NORTHERN INDIA.

Regardless of the specific cultivars grown, the establishment inputs are similar. There may be slight variations in costs for the seeds as Indian carrot varieties are less commonly grown. Rare varieties should be ordered well in advance of planting to ensure availability.

[15] https://www.zmescience.com/other/purple-carrots-21032011/ ZME Science, "Purple Carrots". Accessed December 10, 2018

Only reputable sellers should be selected. **Pre-treated seeds can be purchased to avoid significant crop loss from insects and disease (i.e. coated by protectant fungicide or insecticides).**

4.2.1 Carrot Planting Plan

A 3.0 ha field can be prepared for carrot cultivation following final soil placement. Prior to planting, the soil should be tested for nutrients (particularly P, N, and K) and amended with fertilizers if needed. Carrots will tolerate a pH range of 5.5 – 7.0 but an ideal range is between 6.0 and 6.8.

The field can be prepared by running a roto-tiller or chisel plow through the tested and amended soil. The soils should be worked to a depth of 30 to 40 cm for good root penetration of the carrot plants (a chisel plow may be best for this).

Optimal seeding times depend on how well-draining the field is. The placement of soil according to our placement plan will improve drainage and allow earlier seeding. Carrots can be planted in well-draining fields in mid-March (if soil temperatures exceed 7°C) but no later than the beginning of July. Seeds can be sown at 3 week intervals for continuous harvest.

Carrot seeds are sown shallowly due to their small size; approximately 5 mm deep, with 4 seeds per 2 cm[16]. The seeds are planted in raised beds that are at least 10 cm high. The BC Ministry of Agriculture Crop Production Guide (Carrots)[17] recommends seeding in rows of 3, with each row being 46 to 48 cm apart. These form a single bed. This can be done by using a precision seeder with a special shoe that seeds 3 lines per row. Belts allow 6 to 7 seeds per 30 cm of line. Using this method, approximately 7 kg/ha of coated seed are required, resulting in a final population of about 1,000,000 plants/ha.

4.2.2 Irrigation

The soil should be well-irrigated prior to planting. Following planting, the surface of the soil should be kept moist until seeds germinate, which takes approximately 14-21 days

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[16] https://www.westcoastseeds.com/products/deep-purple West Coast Seeds. Deep Purple Seeds. Accessed December 10, 2018

[17] https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables/carrots BC Ministry of Agriculture Crop Production Guides – Carrots. Accessed December 10, 2018

(long germination). An overhead sprinkler system can be utilized for the 3.0 ha carrot crop.

Irrigation systems should be designed and operated in accordance with the BC Sprinkler Irrigation Manual[18]. Sprinkler irrigation products are available through several large companies in the Lower Mainland, including Southern Irrigation and WaterTec North America. Using a conservative estimate of $750 per hectacre[19], I have estimated that overhead sprinklers for the 3.0 ha carrot crop will run approximately $2250.

4.2.3 Weeds, Pests, and Disease Management

Carrots compete poorly with weeds and without proper weed management (which can host carrot pests such as nematodes) yields can be reduced by up to 90%. Weeds also reduce harvest efficiency.

According to the Ontario Ministry of Agriculture, Food, and Rural Affairs "Weed Management in Carrots" Factsheet[20]:

"There are two separate periods in the life cycle of the carrot crop when weed control is very important. These are 1) early season - the Critical Weed-free Period and 2) late season - the harvest period (Figure 1). During the critical weed-free period, weeds are controlled to protect yield, and, during the harvest period, weeds are controlled to facilitate crop harvestability and future production."

For carrots, herbicide can be incorporated into the soil prior to planting (i.e. with a chisel plow). A suitable herbicide is trifluralin (Bonanza 480); this can be applied 3 weeks before planting and incorporated thoroughly within 24 hours to 8 to 10 cm deep[21]. Post-emergence weeds can be treated with many types of herbicides including Select (clethodim), Guardsman/ Agricultural Weedkiller No. 1, and Excel Super

[18] https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/water/irrigation/sprinkler-irrigation-manual B.C. Sprinkler Irrigation Manual. Accessed December 10, 2018

[19] http://calag.ucanr.edu/Archive/?article=ca.v050n01p11 Farmers describe irrigation costs, benefits: Labor costs may offset water savings of sprinkler systems. December 10, 2018

[20] http://www.omafra.gov.on.ca/english/crops/facts/09-045w.htm Ontario Ministry of Agriculture, Food, and Rural Affairs "Weed Management in Carrots" Factsheet. December 10, 2018

[21] https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables/carrots BC Ministry of Agriculture Crop Production Guides – Carrots. Accessed December 10, 2018

(fenoxaprop-p-ethyl). Alternatively, if Mahal Farms wishes to obtain organic farm status, they may wish to utilize an integrated pest management system and manage weeds using labour and machinery instead of pesticide sprays.

Carrot plants can be killed by insects, in particular the carrot rust fly (or carrot maggot) and wireworms, which are the larva of click beetles (the name comes from the act of the larva becoming rigid as wire when squeezed by hand). The following methods may be undertaken to prevent plant damage and death[22]:

Carrot Rust Fly

- The avoid the worst infestation period, consider not planting the first carrot seeds until the start of June;
- Use a floating row cover or garden fabric over the crop (carrot rust fly cannot fly very high);
- Use predatory nematodes in the spring, when the larvae are most active.

Wireworm

- Ensure carrot beds are raised and well-drained (the larva prefer moist soils);
- Interplant with mustard leaf, which dries the roots of the carrots (discouraging wireworms from eating the roots) and acts as a flavour deterrent;
- As for Carrot Rust Fly, consider purchasing predatory nematodes to kill larva when they emerge from eggs in the spring.

There are numerous diseases that affect carrots, including aster yellows (spread by aster leafhoppers), foliar blights, root-knot nematode, black root rot, and rusty root (lateral root dieback). Aster yellows in particular affect crops situated near forage legume fields, weedy areas (i.e. ditches), or and crops such as lettuce. This is why crops should be well-spaced in the field, leaving plenty of room between plants and nearby ditches, woodlands, and neighbouring fields and properties. If aster yellows symptoms (indicated by yellowing followed by bronzing of foliage, hairy roots, stunted growth) are evident, insecticide application will be required.

[22] https://www.westcoastseeds.com/products/deep-purple West Coast Seeds, Carrot Diseases and Pests. Accessed December 10, 2018

Carrots are highly susceptible to root knot nematodes. These can be prevented by testing the soil for nematode populations and fumigating in the fall (or before planting in the spring, as long as average soil temperatures exceed 10°C or soil temperatures at 15 cm are at least 13°C)[23]. The soil should be loose; any clods or lumps must be broken up with a tractor prior to fumigation. The soil should also be moist.

Common fumigants include Basamid and Vapam. The BC Vegetable Guide: Planting section on Soil Fumigation[24] recommends applying Basamid at rates of 325 to 500 kg per hectare and to a depth of at least 15 cm. The fumigant can be applied by hand (gloved) and by a fertilizer spreader for larger fields. Prior to seeding, soils should be well aerated following fumigation.

4.2.4 Carrot Harvesting

Carrots will mature in approximately 75 days from seeding. With seeding between April and mid-July (note: sowing of seeds should be delayed until early June if soil testing returns high populations of nematodes), carrots can be harvested between July and November.

The flavour of the carrot is best when the colours are bright and well-developed. Harvesting a mature, adequate-sized carrot also ensures sweetness and good storage potential. The two methods of harvesting carrots are: 1) by using a machine to pull carrots by the tops and topping them in the field, or 2) by hand cutting the stem and using a digger to bring the carrots to the surface. Topping of the stem involves removing the foliage and retaining approximately 2.5 to 5 cm of the stem[25].

Carrots can be left under soil during the winter or stored in cold storage at temperatures just above freezing (frozen carrots will become damaged and therefore should be removed

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[23] https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables/carrots BC Ministry of Agriculture Crop Production Guides – Carrots. Accessed December 10, 2018

[24] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agriservicebc/production-guides/vegetables/planting_bc_vegetable_production_guide.pdf BC Ministry of Agriculture Vegetable Production Guide: Planting. Accessed December 10, 2018

[25] https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/horticultural-crops/vegetables/carrot-production Government of Saskatchewan Agriculture, Natural Resources, and Industry, Carrot Production Guide. Accessed December 10, 2018

from fields as well if an early winter and harsh temperatures occur)[26]. Mahal Farms can store the carrots on site if they have refrigerators.

4.3 Irrigation and Water Sources

Richmond experiences a moisture deficit during the summer months[27] and as such, irrigation may be necessary (Land Capability limitation: 2A). To determine actual crop-specific water requirements and irrigation schedules, such factors as temperature, humidity, soil type, crop age and health, stage of crop development and presence or absence of mulch must be considered. I have described the water needs of each crop in this farm plan but detailed irrigation schedules are beyond the scope of this report.

The property has a large, approximately 10 m wide irrigation canal that runs through the approximate centre (**Figure 1**). This canal also has a pump house. There is thus adequate water for irrigation needs on site. Nearby ditches on No. 7 Road and Westminster Highway are kept artificially high by the City of Richmond during the summer and early fall.

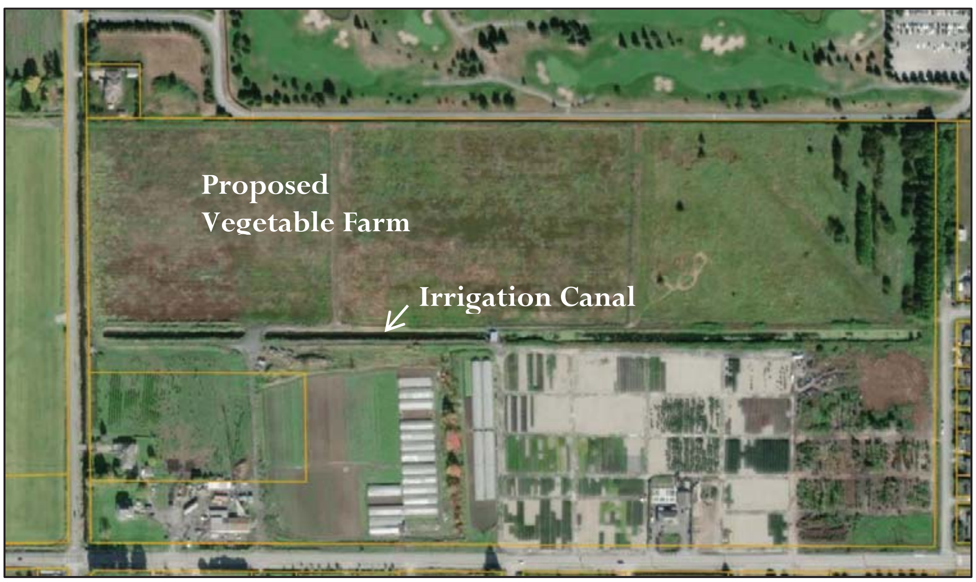

FIGURE 1. IRRIGATION CANAL SITUATED THROUGH THE CENTRE OF THE PROPERTY. OVERHEAD SPRINKLER SYSTEMS AND DRIP IRRIGATION CAN BE CONNECTED TO THIS. MAP IMAGERY FROM IMAPBC 4.0.

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[26] https://www.westcoastseeds.com/products/deep-purple West Coast Seeds, Harvesting Information, Purple Carrots. Accessed December 10, 2018

[27] http://climate.weather.gc.ca/climate_normals/index_e.html Richmond Nature Park climate station. Accessed December 10, 2018

5 Farm Establishment Costs

Following soil placement, the establishment of the vegetable crops will require a number of inputs including land preparation, soil nutrient testing, the purchase of materials and machine time (fuel, machinery use and repair costs), as well as the initial investment of large stocks of plants and seeds.

Estimating costs of farming is largely speculative; costs not included in this farm plan include farm marketing (i.e. signs), permit costs for roadside stands, specialty farm products such as bird netting (for protection of shallow carrot seeds, for example), or consulting costs for nutrient and pest management, for example.

Mr. Mahal has assisted with this farm plan by providing a list of desired crop types he wishes to grow and contribute to his community in Richmond. I have calculated the estimated costs of soil preparation, seeds or plants, planting, and harvest of both a garlic crop and a carrot crop (Mr. Mahal may plant more as the farm becomes established), as well as estimated other costs to take into account for the farm as a whole, such as irrigation and soil testing.

As previously mentioned, Mahal Farms will hire farm workers for the farm establishment. I have assumed labour costs at $15.00 per hour (manual labour, hand harvesting), and $22.00 per hour for machine labour. These estimates are higher than the reported wages to the Agricultural Labour Pool[28]. I understand from Mr. Mahal and other farmers that I have worked with in the Richmond area that acquiring manual farm labour is very difficult and thus high wages may be required to attract employees. These costs are shown in Tables 1 and 2 (for each crop) in Appendix 1.

5.1 Garlic

The available field size for garlic cultivation is approximately 160 m by 185 m (3.0 ha). At low density planting and adding in space between rows for row breaks as well as spacing between the adjacent vegetable crops, approximately 800,000 garlic cloves (producing a single bulb each) could conceivably be planted in the prepared field. For this farm plan, I have proposed an initial planting that is one-quarter this, or 200,000 garlic cloves in the initial planting. A percentage of the bulbs will not be harvested due to disease or poor growth characteristics.

[28] http://www.agri-labourpool.com/wage-info.aspx Agricultural Labour Pool, Industry Wage Information for the Lower Mainland. Accessed January 30, 2019

Garlic is not propagated by seed and as such garlic is sold by the bulb (although this is called a "seed" by some suppliers). I have researched Canadian garlic "seed" sellers and found that garlic bulb prices vary between varieties and bulb sizes. The variation can be between $1.85 per bulb for small bulb of common varieties such as Russian Red, to approximately $4.85 for jumbo bulbs[29]. I will use an average price of $2.00 per bulb to account for a variety of garlic types that may be grown on the property. The cost decreases if purchased as a large bulk order (i.e. 10 bulbs or more).

The number of clove 'seeds' in each bulb differs greatly between garlic varieties – between 4 and 20 seeds in cases. A good average estimate is 10 cloves per bulb. Thus for 200,000 plants, it may be necessary to purchase up to 20,000 bulbs. **This would translate to an initial bulb investment of $40,000.**

It is important to note that garlic bulbils from the first harvest can be retained to propagate more garlic – this would negate the need to purchase new bulbs for the second season.

In the Lower Mainland, garlic can fetch $14/lb in local markets (2017 prices). Wholesale/bulk prices are $9/lb[30]. The wholesale crop value of 200,000 garlic bulbs (approximately 28,000 lbs[31] of garlic) before all machine and material costs is roughly $250,000. Shortages in competing markets (i.e. United States, China, South American countries) can result in higher prices. If only half of the crop is ultimately harvested and sold at wholesale prices, revenue of $125,000 could be expected.

5.2 Carrots

For the proposed establishment of a carrot farm, I have calculated the estimated level of effort and basic costs for growing and harvesting a 3.0 ha crop amounts to approximately $60,000.

Using 7 kg per hectare of covered seed produces approximately 1,000,000 plants per ha, or over 3 million carrots for a 3.0 ha planted field. If a medium-sized carrot is approximately 0.15 lb, this translates to a potential yield of 450,000 lbs. Carrots can be

[29] https://garlicseed.ca/collections/all-varieties John Boy Farms online garlic seed prices for 2018/2019. Manitoba, Canada. Accessed December 10, 2018

[30] http://organicpricetracker.ca/index.php/getprice/lower-mainland-bc/27 Organic Price Tracker. Accessed December 10, 2018

[31] 1 lb of garlic equates to approximately 7 bulbs (both hardneck and softneck varieties) https://sowtrueseed.com/how-much-seed-garlic-do-i-need/ Accessed December 10, 2018

seeded at intervals such that harvest occurs at continuous intervals as the plants mature. Carrots that are coloured other than orange are often marketed as "rainbow carrots" and sold in bunches in grocery stores. Rainbow carrots fetch between $3 and $4 a bunch, which is approximately 2 lbs (bagged) for a price of $1.50 per pound[32]. Prices may differ at farmer's markets and local specialty stores such as Whole Foods Market and Fruiticana.

If approximately 50% of the crop is harvested (or 225,000 lbs) in good condition and sold for $0.75 per lb, this amounts to revenue of approximately $168,000. Mahal Farms may sell their carrot crop to a farmer's market or distributor for a reduced profit but overall, the financial viability of a carrot farm is good ($60,000 establishment and harvesting costs vs. potential revenue for 50% of a harvested crop using provincially-recommended spacing and expected yields).

5.3 Other Costs – Applicable to All Crops

Soil Testing

Local laboratory nutrient and pH testing is approximately $1500 per crop area – reputable labs such as Exova and AGAT Labs charge no less than $1000 for soil testing (major nutrients, available) and pH testing. Consultants hired to conduct soil sampling will charge at least $500 for field work and reporting. Thus soil testing costs (nutrients, pH) will amount to approximately $3000 for the initial establishment of two crops in the 9.0 ha site.

Soil testing may need to be conducted an on annual basis to identify persistent nutrient deficiencies and potentially improve crop yields. Thus this cost may be repeated each season.

Pest and Nutrient Management, Farm Supplies, Marketing, Accounting

The success of the first crops may dictate the need for professional assistance if pests and poor yields (due to poor nutrients) become an issue. I have not included these costs for the initial establishment of the proposed crops at this time.

[32] https://thehealthybutcher.com/organic-rainbow-carrots-2-lb.-bag.html Organic Rainbow Carrots Bag. United States retailer "The healthy butcher". Accessed February 1, 2019

I have assumed that Mahal Farms employs a bookkeeper or accountant for their current farm operations. These costs have not been quantified in this report. Similarly, costs related to the marketing of the farm products (i.e. farmers market sales, U-pick, or roadside stand signage), purchase of office supplies, and the purchase of miscellaneous farm equipment such as containers or pallets, twine for tying garlic, and temporary shed structures for cold vegetable storage and curing may be considerable.

6 Conclusions

Mahal Farms wishes to convert a pre-existing cranberry farm (last farmed in 2016) into a vegetable farm that occupies 9.0 ha of the northwest corner of their property. Prior to establishing vegetable crops, they wish to overcome a combination of agricultural limitations that include excess wetness (4W limitation), undesirable soil structure (3D limitation), and soil infertility (due to high acidity and low nitrogen and phosphorus, 4F limitation).

We proposed that in order to improve the land, 110,000 m^3 of good-quality soil imported to the site and prepared according to our accompanying Soil Placement Plan report will enable soil-based agriculture for vegetable crops.

Mahal Farms wishes to diversify their farm by growing vegetables used predominantly in local Indian cuisine and improve the supply of locally grown produce. In the winter of 2018, Canadian news outlets reported that 2019 grocery prices would rise and "vegetables will see the biggest price jumps — between four and six per cent".[33]

According to the City of Richmond[34], "cranberries are the most dominant crop in Richmond, with almost 858 ha (2,120 ac) in production. In 2011, Richmond accounted for approximately 33% of BC's cranberry acreage." Blueberries are next at over 556 ha in production during the 2011 year, and third place is "Other hay" crops comprising 320 ha of production (**Figure 2**, below). Thus moving away from cranberry production will also help Mahal Farms diversify the City of Richmond's crops and improve the supply of local fresh vegetables. I understand that Mahal Farms recently retained a consultant to view their old cranberry farm and were advised that new cranberry plants would cost

[33] https://business.financialpost.com/news/economy/average-family-to-pay-400-more-for-groceries-next-year-report-estimates Big Price Spikes Ahead For Vegetables As Average Family Pays $400 More For Groceries Next Year, Report Predicts. Financial Post. December 4, 2018

[34] https://www.richmond.ca/plandev/planning2/agriculture/about.htm About Agriculture in Richmond. Accessed December 4, 2018.

approximately $25,000 USD (plants are purchased from the United States) per acre at this time. For a 22 acre cranberry bog this would be approximately $550,000 USD.

Land Used in Crop Production - Top 10				
Crop	Hectares	% of crops	% of census farms	% of ALR
Cranberries	858	38.9%	11.4%	21.5%
Blueberries	556	25.2%	33.2%	13.9%
Other Hay	320	14.5%	8.1%	8.0%
Potatoes	88	4.0%	2.8%	2.2%
Cabbage	64	2.9%	4.7%	1.6%
Strawberries	57	2.6%	2.4%	1.4%
Sweet Corn	52	2.4%	4.7%	1.3%
Chinese Cabbage	51	2.3%	10.0%	1.3%
Pumpkins	25	1.1%	5.2%	0.6%
Squash and Zucchini	21	1.0%	7.1%	0.5%
Total	2,092	94.7%	89.6%	52.4%

FIGURE 2. RICHMOND'S TOP CROPS BY LAND USED IN THEIR PRODUCTION, 2011

The accompanying tables (Appendix 1) shows costs related to the establishment effort, level of management and production value for both a 1.0 ha (first crop) garlic crop and 3.0 ha carrot crop.

I estimate that total costs for the land preparation, planting/seeding, and maintenance of both crops amounts to approximately $160,000 for the first year. There is an additional cost of approximately $3000 related to soil testing at the start of the farm establishment (prior to planting and seeding). This is necessary to determine fertilizer and lime amendment quantities, if required.

Other costs such as pest and disease management (consulting, testing, purchase of insecticides and pesticides, fumigating, purchase of predatory nematodes) may be considerable in the first few seasons while the farm is established.

In order to maintain farm status with BC Assessment, the total farm sales required by Mahal Farms (which is 29.5 ha in extent) is $2,500 plus five per cent of the actual value of any farm land in excess of 4 hectares[35]. According to BC Assessment[36], the land was assessed in July of 2018 at $4,085,914. Using this metric, the farm would be required to report farm sales of over $210,000. Currently, several crops (nursery trees, cedar hedging, greenhouse and field vegetables) are being produced and sold from the southern half of the property thus Mahal Farms is meeting the minimum farm gate sales required by BC Assessment without this vegetable farm establishment.

Using both conservative estimates of yields and prices (wholesale), I have determined that in the 2021 tax year (assuming 2020 soil placement, land preparation, and planting/seeding), planting only two vegetables crops will generate approximately $293,000 in revenue (assuming only 50% of each crop is ultimately harvested and sold due to mortality, disease etc.) and require approximately $163,000 in establishment costs, for an estimated profit of $130,000 for the first year. It is important to note that the purchase costs of the garlic bulbs (estimated at $40,000 for the first planting) is a one-time cost as garlic bulbils can be propagated by retaining the cloves for a fixed period of time, before they need to be replaced.

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[35] https://info.bcassessment.ca/Services-products/property-classes-and-exemptions/farm-land-assessment/farm-classification-in-british-columbia/Apply-for-farm-classification BC Assessment: Classifying Farm Land. Accessed January 3, 2019

[36] https://www.bcassessment.ca/ BC Assessment. Accessed January 3, 2019

A vegetable farm at Mahal Farms will contribute locally-grown vegetables to Richmond consumers and contribute towards diversifying the crop types grown in Richmond's farmland and the Agricultural Land Reserve.

Prepared by:

**This is a digitally signed duplicate of the official manually signed and sealed document.*

BRITISH COLUMBIA 3050 Jessica Stewart P.Ag. INSTITUTE OF AGROLOGISTS

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Professional Agrologist and Geoscientist

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Gordon Butt, M.Sc.
Professional Agrologist

MADRONE ENVIRONMENTAL SERVICES LTD.

APPENDIX 1

Cost Tables – Crop Establishment and Harvesting

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Table 1. Estimated Costs of Establishing a Garlic Crop (First Planting: 1 ha)

Farming Activity/Requirement	Description of Work	Units or Machine Time	Unit Costs	Total ($C, 2019 estimated)
Site Preparation	Tilling or rotovating field, applying manure, mulching	24 hours/ha x 1.0 ha	$110/hr[a]	$2400
	Machine Costs (Rental, Fuel[c])	12 hours/ha x 1.0 ha	$25/hr	$300
Planting, 400 rows x 500 plants (low density planting, ¼ of field)	Purchase garlic bulbs (one-time purchase)	20,000 bulbs (10 cloves per bulb – 200,000 cloves)	$2.00/bulb[d]	$40,000
	Cracking bulbs for cloves (machine)[e]	$1000 for a splitting machine, 400 kg/hr	$1000/machine	$1000
	Plant garlic cloves	200 hrs/ha x 1.0 ha	$15/hr[f]	$3000
Fertilizer (Compost, Lime)[g]	Purchase	Compost: 150 yards/1.0 ha Lime: 50 lbs/1.0 ha	Compost - $40/yard Lime - $1.50/lb	$3000 $75
Herbicide (napropamide)	Purchase	2kg/ha x 1.0 ha	$30/kg	$60
	Application (Pre-Emergence)	12 hrs/ha x 1.0 ha	$15/hr	$180
Maintenance Of Crop During Growing	Weed control, additional applications of fertilizer, herbicide.	48 hours/ha x 1.0 ha	$15/hr	$720
Harvest[h]	Hand harvest labour, tying, curing	3000 hours x 1.0 ha	$15/hr	$45,000
Irrigation (Drip)	Purchase & Installation by Irrigation Company (Local)	$1/ m planted x 5000 m (first planting at 60 m x 80 m)	$1/m	$5000
TOTAL				$100,000 (rounded)

[a] $22.00 per hour machine labour cost per employee, 5 employees for the 1.0 ha field establishment (labour intensive).

[b] Soil testing costs from a reputable testing laboratory such as Exova, AGAT Labs. Current 2019 pricing.

[c] February 2019 Diesel Price in Richmond is $1.33/L, via https://www.gasbuddy.com/Station/77015

[d] Average price per bulb from online retailer John Boy Farms. https://garlicseed.ca/collections/all-varieties

[e] A garlic bulb splitting machine can be purchased for approximately $1000 and process up to 400 kg of garlic in 1 hour.

[f] $15.00 per hour manual labour cost per employee.

[g, h] Fertilizer costs, units, and labour inputs for planting and harvesting are via: Southwest British Columbia Small-Scale Farm Enterprise Budget: Garlic. Kwantlen Polytechnic University. https://www.kpu.ca/sites/default/files/ISFS/Garlic.pdf

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Table 2. Estimated Costs of Establishing a 3.0 ha Carrot Crop

Farming Activity/Requirement	Description of Work	Units or Machine Time	Unit Costs	Total ($C, 2019 estimated)
Site Preparation	Chisel plow field, management of weeds, applying fertilizer, irrigating prior to planting (5 employees)	12 hours/ha x 3.0 ha	$110/hr	$4000
	Machine Costs (rental, fuel)	12 hours for 3.0 ha field	$25/hr	$300
Planting	Purchase carrot seeds (pre-treated)	7 kg/ha x 500,000 seeds/kg = 3.5 million seeds[a]	$70 per 25,000 seeds[b]	$9800
	Purchase precision seeder (tractor mounted)	$4000 for a tractor mounted seeder	$4000/machine[c]	$4000
	Plant carrot seeds with precision seeder	4 hrs/ha x 3.0 ha	$50/hr[d]	$600
Fertilizer[e]	Purchase	70 kg/ha - Nitrogen x 3.0 ha 40 kg/ha – Potash x 3.0 ha	$0.55/kg $0.40/kg	$120 $50
	Application	Continuous applications over growing period (weekly)	$66/hr	Estimated $1000
Herbicide (trifluralin, Bonanza 480)	Purchase	1.25 L/ha x 3.0 ha	$10/L	$40
	Application (applied with 100 L/ha of water at 275 kPa), 2 employees	3 hrs/ha x 3.0 ha	$30/hr	$270
Maintenance of crop during growing period, after harvesting	Weed control, additional applications of herbicide, pesticide. Assessing carrot crop for pests such as nematode (prior to planting), fumigating.	50 hrs /ha x 3.0 ha	$15/hr	$2250
Irrigation	Purchase of overhead sprinkler system	$750/ha x 3.0 ha	$750/ha	$2250
	Installation of irrigation, 3 employees	12 hrs/ha x 3.0 ha	$45/hr	$1600
Harvest	Machine harvest of carrots using carrot harvester (attached to tractor), topping carrots, cold storage	100 hrs / ha x 3.0 ha	$110/hr	$33,000
TOTAL				$60,000

[a] Number of seeds determined via the BC Ministry of Agriculture Crop Production Guide for Carrots (planting spacing) and size of field at 3.0 ha.

[b] Deep Purple Carrot price from West Coast Seeds: https://www.westcoastseeds.com/products/deep-purple

[c] Precision Seeder, Tractor Mounted. https://woodwardcrossingscountrybasics.com/product/jph-4-jang-seeder/

[d] Combined cost of $22/hr machine labour, 1 employee and 25/hr machine costs (fuel, maintenance)

[e] Fertilizer prices are current to 2019 in North America, via https://farmdocdaily.illinois.edu/2018/09/fertilizer-prices-higher-for-2019-crop.html

APPENDIX 2

Maps

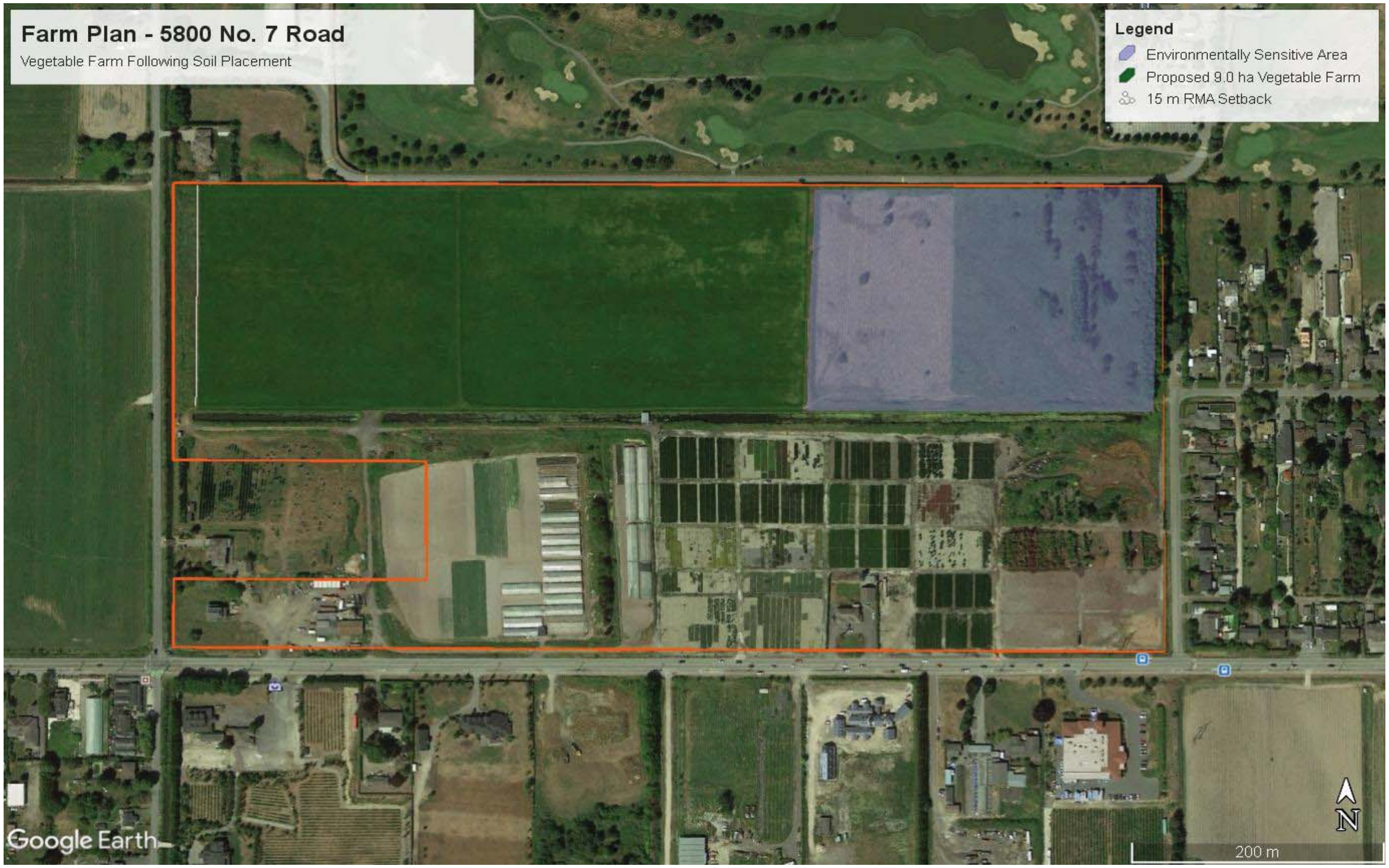

FIGURE 1. OVERVIEW OF 5800 NO. 7 ROAD ON GOOGLE™EARTH PRO. THE 15 M RIPARIAN MANAGEMENT AREA (RMA) SETBACK FROM THE NO. 7 ROAD DITCH IS SHOWN, AS IS THE ENVIRONMENTALLY SENSITIVE AREA (ESA) IN THE 5.1 HA RECTANGLE IN THE NORTHEAST CORNER OF THE PROPERTY. THE VEGETABLE FARM AREA IS 9.0 HA.

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environmental services ltd.

SOIL PLACEMENT PLAN

5800 No. 7 Road, Richmond, BC

FOR:

Mahal Farms Ltd., Mr. Paul Mahal
c/o Mr. Ron Wilson
Hexcel Construction Ltd.

BY:

Jessica Stewart, A.Ag., G.I.T.
Gordon Butt, M.Sc., P.Ag., P.Geo.
Madrone Environmental Services Ltd.

March 18, 2019

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Synopsis

Mahal Farms Ltd., the owner of the property at 5800 No.7 Road, proposes to import approximately 110,000 m^3 of good-quality fill over 9.0 ha of land located in the un-farmed northwest portion of the 29.5 ha property to improve soil wetness (predominantly 4W limitation), undesirable soil structure (3D limitation), and fertility limitations due to highly acidic soils and nutrient deficiencies (4F limitation).

The intent of soil placement is to improve the aforementioned conditions that limit agricultural capability. After the addition of soil which will raise the existing land surface by an average depth of 1.3 m, followed by soil profile construction as we have recommended, the agricultural capability will improve to a 2WF.

Mahal Farms intends to engage Hexcel Construction Ltd. to source and import the soil. We have proposed the following basic plan for the site:

1. Prior to any importation, strip approximately 0.2 - 0.3 m of the existing topsoil (and overlying peat, vegetation, woodchips, and compost) over the 9.0 ha area. This approximates to 36,000 m^3. This can proceed in stages as determined by the earthworks contractor.
2. All stripped soil should be stockpiled on site for later use. No soil shall be stockpiled in proximity (<10 m) to property lines or ditches. There is a required 15 m setback from the riparian management area (RMA) on the west side of the property at No. 7 Road.
3. Import good-quality soil (as described in this report in Sections 5.2 and 5.3) on the stripped land, which is level with slopes less than 2% and situated at elevations less than 2 m above sea level.
4. Sourced soil should consist of clean soil from an uncontaminated source; it should have less than 20% coarse fragments, should not be clay-rich (<20%), and should not contain any non-soil material. Madrone can assist with screening soil sites for potential contaminants (desktop preliminary studies and site visits) and assessing coarse fragment content of incoming soil loads. Sites should also be checked for potential invasive plant species.

5 The final surface after completion of fill placement should be graded with an even 1-2% grade; we recommend sloping the soil to the east and west, with a crown in the centre. As the project nears competition, drainage will be assessed and the drainage plan revised if needed (i.e. ponding observed and ditches installed within the placement area to direct drainage where preferred).

6 The original topsoil (stripped) should be spread evenly over the final graded surface in such a way as to avoid compaction.

7 After spreading the surface should be seeded with an appropriate forage mix to prevent erosion and maintain soil fertility. Manure and liming will be necessary to improve soil nutrients and acidity. We recommend soil testing after amending the soil to assess nutrients prior to any planting.

8 The soil placement operation should be monitored at regular intervals through the process. We recommend monitoring reports every 3000 m^3 in the first year of the project, in addition to extra monitoring visits required by the City of Richmond at their request.

9 Once complete a final report should be issued on the condition and final, improved land capability of the filled area. This is required by the ALC for the return of security bonds posted for the duration of the project.

SOIL PLACEMENT PLAN

5800 No. 7 Road, Richmond, BC

1 Introduction

Hexcel Construction Ltd (Hexcel) retained Madrone Environmental Services Ltd. (Madrone) on behalf of Mahal Farms Ltd. (the property owners) to prepare a Soil Placement Plan for a portion of the property located at 5800 No. 7 Road, Richmond B.C. (**Figure 1**). In addition to preparing a placement plan that adheres to local bylaws[1] and the Agricultural Land Commission (ALC) Act[2], (and specifically Policy L-23[3]) a Soil Placement Plan comprises a soil survey of the existing property, soil and climatic restrictions to agriculture, as well as a determination of the land capability for agriculture based on our field assessment.

Previously, Mahal Farms applied to the ALC for subdivision approval; their intent in this application was to divide the 29.5 ha (73 acre) property into two lots (referred to as Lot A, north and Lot B, south in application documents). According to a City of Richmond report[4] prepared by the Agricultural Advisory Committee Meeting conducted on November 15, 2015, Mahal Farms wished to subdivide the lot into two parcels to "manage its financial risk and liability by aligning its land holdings with its separate [farm] enterprises". This report was provided to the ALC for their review of the proposal.

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[1]https://www.richmond.ca/__shared/assets/BL809447443.pdf Soil Removal and Fill Deposit Regulation Bylaw No. 8094. City of Richmond. Accessed October 15, 2018

[2]http://www.bclaws.ca/Recon/document/ID/freeside/00_02036_01 BC Laws; Agricultural Land Commission (ALC) Act. Accessed October 15, 2018

[3]https://www.alc.gov.bc.ca/assets/alc/assets/legislation-and-regulation/policies/alc_-_policy_l-23_-_placement_of_fill_for_soil_bound_agricultural_activities.pdf Policy L-23, Placement of Fill For Soil Bound Agricultural Activities. ALC.

[4]https://www.richmond.ca/__shared/assets/_14_ALR_Appeal_Mahal_Farms43899.pdf *Agricultural Land Reserve Appeal Application by Mahal Farms Ltd. for Subdivision at 5800 No. 7 Road.* Report to Committee. City of Richmond, March 1, 2016. [Accessed October 15, 2018]

The ALC declined the subdivision proposal in July of 2016, finding that subdivision approval would not be consistent with the Agricultural Land Commission Act to preserve agricultural land, citing that subdividing the ALR into smaller parcels can limit agricultural opportunities on these lands.

Since this decision, Mahal Farms have revised their plans and now wish to farm the majority (9.0 ha) of the under-utilized northern parcel, (which is 15.8 ha total according to a land survey prepared in June of 2014 by J.C. Tam and Associates Land Surveyors, as part of the original subdivision application) **without** subdividing.

This plan pertains to approximately 9.0 ha of land located in the northwest corner of the property (the "soil placement area"). This part of the property was previously farmed for cranberries for Ocean Spray (cooperative); the last year of cranberry farming in this area was 2016 (two years ago). The northeast portion of the northern property parcel is approximately 5.1 ha and is designated as an Environmentally Sensitive Area (ESA)[5], specifically "Old Fields and Shrublands". This area will not be developed; it was previously used for growing ornamental trees. The southeast part of the property at Westminster Highway is also located in the City of Richmond ESA.

The remaining 1.7 ha of land in the northern parcel will not be farmed due to City of Richmond 15 m Riparian Management Area setbacks[6] from the watercourse (ditch) along No. 7 Road and the irrigation canal located through the centre of the property (**see Figure 2**), which is south of the proposed soil placement area.

The planned use of the property is to develop the northwest corner into productive soil-based farmland for vegetable crops, specifically, Indian Vegetable varieties, for which there is a high demand in the Richmond area. However, with evidence of excess free water in the soil (class W limitation), dense, root-restricting subsoils (class D limitation), and acidic and nutrient deficient subsoil conditions (Class F limitation), the owners of the property are seeking a permit to deposit good-quality subsoil to improve the land capability for agriculture. The native topsoil on site is good quality (as described in our soil assessment in Section 4 of this report) and will be stripped, stockpiled, then re-spread over the placed soil. The plan is located in Section 5 of this report.

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[5] https://maps.richmond.ca/rim/ City of Richmond Interactive Map V1.11. Accessed October 11, 2018

[6] https://www.richmond.ca/__shared/assets/info_2332212.pdf Riparian Management Areas. City of Richmond. Accessed October 15, 2018

2 Site Description

The proposed soil deposit site is located in the northwest corner of the property at 5800 No. 7 Road in Richmond, BC, approximately 6.6 km east of Richmond centre on Lulu Island (**Figure 2**). The property is bound to the north by Mayfair Lakes Golf and Country Club, to the west by No. 7 Road, to the south by Westminster Highway, and to the east by a dense residential area.

The legal description of the property is: Block 4N Part1 S Section 2 Range 5W Land District 36 Except Plan 27718. The Property Identification number is 007-436-815. The property is 29.5 ha (73 acres) in extent. The property is zoned AG1 (Agricultural) according to the Richmond Zoning Bylaw 2011 and the property is within the Agricultural Land Reserve (ALR).

The property does not form a complete rectangular parcel as there is a separate 2.0 ha (5.0 acres) property parcel on the southwest side with the civic address of 5780 No. 7 Road. This parcel is also owned by Mahal Farms. The legal description of this property is Block 4N Part1 S Section 2 Range 5W Land District 36 Except Plan 27718 (PID: 007-436-815). This Soil Placement Plan does not include this separate property despite its location and ownership.

2.1 Historical Land Use – Airphoto Review

According to Mr. Paul Mahal, the property has been farmed by the Mahal family since they purchased the farm in 1949. The residence located in the southwestern corner of the property is a heritage farmhouse known as "Rathburn House". Currently, two of eight family members (third generation farmers) reside on the property (in separate residences with different residential addresses than 5800 No. 7 Road) and are active in the farming operations on site.

We obtained aerial photographs (airphotos) from the Geographic Information Centre at the University of British Columbia to review the historical farm use of the property. The airphotos we received span the time period of 1938 to 2009. We supplemented these photos with two airphotos from 2013 and 2016, available through the City of Richmond Interactive Map program[7]. The airphotos were reviewed by Sharon Podesta, P.Ag. of Madrone; the observations are summarized in Table 1, below.

[7] https://maps.richmond.ca/rim/ Richmond Interactive Map program. Accessed October 27, 2018

Table 1. Airphoto Interpretation

Year	Site (5800 No. 7 Road, Richmond)	North	South	East	West
2016 (Richmond Interactive Map)	Agricultural: cranberry fields along the north half of the property, a drainage ditch oriented east-west in the approximate middle of the Site, and greenhouses/rows of plants, sheds, a house along the southern side of the property. The southeastern side of the property looks unused but the soil is disturbed. A small portion of the area is shown as 5780 No. 7 Road and has a house and some rows of crops visible, but it takes up less than 25% of the total area of the site.	Mayfair Lakes Golf and country Club, a few houses, a barn or greenhouse, some accessory/shed/outbuildings; Highway 91 abuts the golf course to the north.	Houses and agriculture (greenhouses, fields). Lulu Island Winery is to the southeast.	Kartner Road and a residential development. Smaller parcels with single family homes and lawns. No cultivation visible.	No. 7 Road, followed by 2 fields and a dwelling, followed by greenhouses and more fields.
2013 (Richmond Interactive Map)	No change.	No change.	No change (other than a couple of the houses in 2016 are under construction or not there in 2013).	No change.	No change.
2009 (SRS 7964 - 484)	No change.	No change.	No change.	No change.	No change.

Year	Site (5800 No. 7 Road, Richmond)	North	South	East	West
2002 (SRS 6600 - 268-269)	North side: the northwest and middle cranberry fields are present; shifting use in northwest corner (cranberry production not consistent). There is a small drainage ditch running northwest to southeast and some access roads or access paths. The drainage ditch still bisects the property in the approximate middle. Southwest corner: buildings are present, as well as a field and crops. South-middle: Fill has been placed and spread, greenhouses are not yet present. A couple access roads are visible running north-south. The dwelling/building along Westminster Highway is still present here (though in the present it is now surrounded by nursery plants). Southeast: a house is visible and the rest of the area has nursery plant rows with a couple of access paths.	No change.	No change.	No change.	No change. (Greenhouses not present)
1997 (FFC VCR9700 L-4 #110-111)	North half: Fields - not clear if they are in use but very different from the 3 distinct cranberry fields that are present in 2016 airphotos. Drainage ditch still bisects the middle (between north and south halves). Southwest corner: buildings in the corner as today, some soil disturbance around the house (perhaps a crop rotation or change). South-middle and southeast: House fronts on Westminster highway, nursery plants apparent from green rows.	No change.	No change - the large houses present today are not there.	No change.	No change.
1991 (FF 9131 #.80-.81)	North half: Fields with some patches of vegetation. No clear pattern of cultivation. Ditch bisects the property in the middle (first airphoto appearance; therefore constructed sometime between 1984 and 1991). Southwest corner: a house and trailer or shed, and some small cultivated fields oriented north-south. Southeast corner: The house fronts on Westminster highway and is surrounded by a green field, no pattern of cultivation. The area to the east of the house appears to have rows of plants or trees and there is a patch of fill just northeast of the house.	No change.	No change.	No change.	No change.

Year	Site (5800 No. 7 Road, Richmond)	North	South	East	West
1984 (15BC 84013 No 188-189)	The house and trailer/shed has been built in the southwest corner. The rest of the property consists of fields, and the drainage ditch bisecting the property later is not visible (a smaller ditch may be there, but it isn't readily visible as in later years). There is no house fronting on Westminster Highway.	Fields and a house and a barn/sheds or accessory buildings. The area encompassed by the golf course at present appears to be a vacant field, with no natural lakes or any water present.	No change.	No change.	No change.
1979 (BC7901 6 No. 112-113)	House fronts on No. 7 Road and there are a few sheds/accessory buildings and a barn, plus a second house that appears to have driveway access from Westminster Highway. The rest of the property is fields and the large drainage ditch is NOT present in the middle of the property running east-west. It may be a hay field/cattle (the southwestern field has cattle in it.) There are small access roads around each of the fields (in the form of tracks, not proper roads). Some darker patches in the east fields might be wetness but it not obvious.	Same as 1984. The field appears to be cultivated for hay - there are tractor tracks throughout but no obvious crops.	Lots of greenhouses and nursery type properties, where presently there are fields.	The residential developme nt and roads are there, but it isn't as densely developed as it appears later. Same basic layout and use though.	Fields and a dwelling .
1975 (BC5650 0061-0062)	No change.	No change.	No change.	No change.	No change.
1969 (BC5320-070-071)	No change. Some dark patches which could be wetness are seen throughout the fields. There is also a strip that runs northwest to southeast in the northeast corner of the Site that appears to be pooled water. **The northeast field has the most evidence of wetness (dark patches)**	No change. Drainage ditches are seen around the fields. .	No change	Residential developme nt is still there but much less dense.	No change. Some wet patches in the field are visible.

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Year	Site (5800 No. 7 Road, Richmond)	North	South	East	West
1963 (BC5063: 233-234)	The only access to the house is from Westminster Highway in the southwest corner. 2 houses are present and some sheds, but it appears that the barn is not in place. The rest of the Site is fields. There are apparently small drainage ditches running throughout the property but no obvious flooding or dark patches.	No change.	Greenhouses are not present (maybe a few small ones). Mostly houses and fields fronting on Westminster Highway.	Small residential development (1 house) and fields.	Fields and agricultural dwellings.
1954 (BC 1672: 69)	No change - a few dark patches in the southeastern field and what appears to be a remnant stream running northwest to southeast in the northeastern corner of the field. Some dark patches in the south-central field as well.	No change.	All fields and a dwelling.	Fields and a couple houses fronting on Westminster Highway. No residential development or Kartner Road yet.	Fields and drainage channels (perhaps altered natural streams)
1949 (BC 782:32-33)	No change. The property has numerous dark patches throughout the western fields and lines which could be natural drainages here until development altered their paths.	No change. A drainage is apparent running northwest to southeast and intersects the Site in the northeast corner.	Fields, no change.	No change.	No change.
1938 (A5937:69)	No change.	No change.	No change.	No change.	No change.

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2.2 Current Land Use – Property and Surrounding Area

The northern half (approximate) of the property is not actively farmed as of the 2016 field season. It was previously farmed for cranberries (for Ocean Spray) and ornamental trees. The southern half is currently (as of the time of this report) farmed by either Mahal Farms or by farmers leasing the land. The current farm uses in the southern portion are:

- Vegetables (field and greenhouse);
- Hedging cedar (field-based near No. 7 Road); and
- Nursery (container and caliper trees).

The surrounding area is actively farmed. There is currently a large forage crop farm located across No. 7 Road to the west and hobby farms, nurseries, specialty plant growers, and a winery to the south across Westminster Highway[8].

2.3 Climate

The nearest Environment Canada weather station is at Richmond Nature Park[9], located approximately 3.5 km to the west at an elevation of 3 m above mean sea level. The records from 1981 to 2010 show a mean annual precipitation of 1262 mm, a daily average temperature of 11°C (among the highest in Canada), and 2244 effective growing (> 5°C) degree days (Environment Canada, 2011).

Due to the distribution of when precipitation falls, the property is designated a 3A(1) in the Climatic Capability for Agriculture scheme of Coligado, 1980. Class 3 aridity limitations indicate drought or aridity between May 1 and September 30 resulting in moisture deficits, which are limiting to plant growth and could require moderately intensive management. This will dictate that certain crops will require irrigation for dry periods in mid-summer to early fall.

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[8] Farm Activity information in the surrounding area gathered by data from City of Richmond Interactive Map Program, BC Assessment, and Google Earth Pro imagery for 2018.

[9] http://climate.weather.gc.ca/climate_normals/index_e.html Richmond Nature Park climate station. Accessed October 15, 2018

By incorporating meteorologic data from Richmond Nature Park spanning the period of 1981 – 2010, the cumulative moisture deficit can be calculated by subtracting mean annual precipitation (reported above) and the evaporation potential of the area, which is a function of temperature, windspeed, and solar radiation. Using the ClimateWNA_Map model from UBC Forestry[10], the cumulative moisture deficit is calculated to be 181 mm/year – which corresponds to the 3A aridity limitation of climate capability.

The Thermal class assigned in the same report is 1, meaning there are no significant temperature limitations during the growing season.

2.4 Landscape and Topography

The property is situated on the Fraser River delta and features flat topography with no visually discernible slopes or natural terrain features such as bedrock or streams. A Geodetic Control Marker (GCM) located at No. 7 Road on the west property line is situated at 1.65 m above sea level (a.s.l.)[11]. This is the main topographic information I have found for this area; there are no topographic land survey data or contours available from iMapBC or the Richmond Interactive Map. This topographic elevation data was used to prepare our soil volume cross-sections.

There are dykes located in the northern half of the property; these were constructed for the cranberry farm. The area of the dykes is approximately 1.6 ha (4.0 acres). To accurately determine the elevation of the dykes relative to the native land, a topographic survey would need to be performed[12]. An approximately 10 m wide irrigation canal also runs through the centre of the property, oriented east-west. It terminates approximately 10 m from both the east and west property lines; **the canal does not connect to the No. 7 Road ditch**. There are farm machinery access roads on either side of the canal; these run across the dykes as well. The proposed soil importation area is east of the No. 7 Road ditch and north of the irrigation canal.

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[10] http://www.climatewna.com/ClimateWNA.aspx ClimateWNA_Map. Accessed October 15, 2018

[11] http://a100.gov.bc.ca/pub/mascotw/protected/final_long.html?Q_GCM_NO=274696 Geodetic Control Marker Number 274696. GeoBC Reference Systems and Survey Monuments. Accessed October 15, 2018

[12] Note that there is very little elevation differences over the property; the area lies at 1.65 m GSC according to the Geodetic Control Marker on No. 7 Road at the property line.

The surficial geology of this area was mapped by Armstrong (1980) as Fraser River Sediments, specifically overbank silty to silt clay loam up to 2 m thick overlying up to 15 m of deltaic and tidal flat deposits.

The very southwest corner of the property is mapped as post-glacial Salish Sediments. These sediments are composed of bog, swamp and shallow lake deposits. More specifically, these deposits are characterized by organic rich sandy to clay loams 15 to 45 cm thick overlying Fraser River deltaic and tidal flat deposits.

The description of surficial geology conforms well to our field observations of silt loams and silty clay loams (Fraser River Sediments). We did not observe significant differences in surficial geology (indicated by soil texture) in our soil survey, nor did we observe bog, swamp, or shallow lake deposits that are characteristic of the Salish Sediments mapped by Armstrong (1980).

We found the following native vegetation in the northern half of the property during our field assessment:

- Hardhack (Spiraea douglasii)
- Sheep sorrel (Rumex acetosella);
- Cultivated Cranberry (Vaccinium macrocarpon);
- Reed canary grass (Phalaris arundinacea);
- Paper birch (Betula papyrifera);
- Orchard grass (Dactylis glomerata);
- Silverweed (Argentina anserina);
- Bulrush (Typha latifolia);
- Canada thistle (Cirsium canadensis);
- Vetch weed (Vicia sp.).

2.5 Published Soils and Land Capability Data

This section of the report summarizes the characteristics of the surveyed soils and the Land Capability for Agriculture (LCA) ratings for the property. LCA ratings describe the general suitability of the land for agriculture as seven classes for mineral soil and seven classes for organic soil. The capability classes are modified into subclasses when limitations to agriculture exist. There are twelve subclasses for mineral soils and nine subclasses for organic soils. A detailed description of LCA rating classes and subclasses is provided in Appendix C.

The soils in this area were mapped by Luttmerding in the 1980's. The soil maps were printed at a scale of 1:25,000 and are based on a reconnaissance level soil survey and air photo interpretation and represent a broad interpretation of soils and agricultural capability. We provide a site-specific assessment of the agricultural capability of the property in Section 3, below.

Existing soil survey maps indicate that the soils in the assessment area are most commonly the Blundell and Delta soil series (Luttmerding, 1980), with the majority of the property mapped as 70% Delta soils and 30% Blundell soils. According to the Province of B.C. Soil Information Finder Tool (SIFT)[13] which is based on data collected from Provincial Soil Surveys, the assessed capability of land for agriculture for the Delta and Blundell soil complex is Class 4W.

The Canadian Soil Information Service (CanSIS)[14] describes the Delta soil series (the predominantly-mapped unit here) as poorly drained:

"Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are the main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils…. 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."***

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[13] https://www2.gov.bc.ca/gov/content/environment/air-land-water/land/soil/soil-information-finder Soil Information Finder Tool. Accessed October 15, 2018

[14] http://sis.agr.gc.ca/cansis/soils/bc/DLT/sad~~/A/description.html CanSIS. Accessed October 15, 2018

The subcategory, W, indicates excess free water present during the growing season that potentially inhibit plant growth or damage crops (Coligado, 1980). Soils with a Class 4W limitation are amenable to improvement through drainage or well-draining fill, with the SIFT data indicating a potential mixed Class 2 and/or 3 improved status for this property.

Other limitations for the Blundell and Delta soils include:

- salinity (N, due to tidal environment of the deeper horizons) and;
- undesirable soil structure (D, due to firm and clay-enriched subsoils with low perviousness)

Blundell Soilscan be improved to mixed 30% Class 3N and 70% 2N. Delta Soils can be improved to 2D.

The soils are organized into associations, groups of soils that occur together on the same parent material, to form a land pattern (SCWG, 1998). In this case the above mentioned soils are formed from deltaic sediments. Soil properties are summarized in Table 2.

Table 2. Summary of Mapped[15] Soil Properties

Soil Series	Parent Material	Texture	Drainage	Classification
Blundell	10 – 40 cm organic material over medium-textured deltaic deposits	Poorly decomposed organic surface with medium grained sandy silt loam under layering. Saline and peaty conditions present.	Poor to very poor; high groundwater table	Rego Gleysol
Delta	Medium to moderately fine-textured deltaic deposits	Silt loam or silty clay loam grading to silty clay loam or silty clay. Saline conditions present.	Poor; high groundwater table	Orthic Humic Gleysol

3 Soils and Land Capability for Agriculture Assessment

Gordon Butt, P.Ag., and Jessica Stewart, A.Ag. visited the property on October 10, 2018 to carry out a detailed soil survey. Conditions were clear with excellent visibility. We were met on site by Mr. Mahal of Mahal Farms. Hexcel had brought an excavator on site for our soil investigation.

[15] Based on mapping by Luttmerding (1980) and the Soil Information Finder Tool; actual soils on site are described in Section 4.0 of this report.

We described soil profiles in eight excavated soil pits that ranged in depth from 0.8 m to 1.3 m. Soil pit locations were randomly chosen in the northern part of the property and were marked by GPS in the field (**Figure 2** in Appendix A). Detailed observations of soil properties, including soil texture, drainage, consistency, structure, colour, horizon classification and thickness, and evidence of gleying or mottling were noted during our assessment. Soil Pit Descriptions and photos are located in Appendix B.

We made additional surface observations in the areas around the test pits, such as the location of ditches, vegetation, and other features such as dykes and irrigation canals.

Based on my soil profile descriptions, we correlated the site soils to soils described in the Soils of the Langley-Vancouver Map Area, MoE Technical Report 15 (Luttmerding, 1980). The report also provides Land Capability for Agriculture (LCA) ratings for the assessment area. In this section we indicate our LCA ratings for the property that is proposed to receive soil, which are summarized in Table 3 below.

We also collected eight soil samples for laboratory testing, specifically for nutrient, salinity, and textural analysis. The samples were taken at random sites from the northern parcel (soil placement area) to depths of up to 0.8 m. As such, the sampled horizons include the Btg or IIBg horizons we observed in our soil pits (subsoils sampled only). All soil samples were collected using lab-provided containers. The sealed samples were placed in a cooler and delivered under chain-of-custody documentation to AGAT Laboratories in Burnaby.

3.1 Soils – Determined from Assessment

The soils described in all eight pits correlate best with the Delta soil series of Luttermerding (1980), who described these soils as “moderately-fine to fine textured deltaic deposits and have a silt loam to silty clay loam textures”. He further stated that Delta soils are poorly drained and often subject to seasonal ponding. We stress that where differences occur in soils mapping, our findings should be accepted due to the much higher sampling density (i.e. not based on airphoto interpretation and soil surveys over large areas).

We observed mottling caused by high seasonal water tables in the subsoil; mottling starts at 20-25 cm below the surface for most soil pits, with the exception of Pit 7 (12 cm below surface) and Pit 8 (60 cm below the surface). Mottling and oxidized root channels are encountered in the Btg horizon, which is a firm to very firm horizon that restricts root growth (Class D limitation). This soil is agriculturally limited by both 1) excess free water and 2) dense subsoils/undesirable soil structure in the Btg horizon.

Wetness subclass information can be found in Appendix C.

Table 3. Summary of Soil Observations from Pit Investigation

Test Pit	Textures (by horizon)	Drainage and LCA Class	Soil Classification	Correlation
1	Silt loam, silty clay loam, fine sandy loam, to loamy sand	Poorly-drained, Class 4W, 3D	Orthic Luvic Gleysol	Delta
2	Sandy loam, silty clay loam, silt loam, to fine sandy loam containing lenses of fine sand.	Poorly-drained, Class 4W, 3D	Orthic Luvic Gleysol	Delta
3	Silt loam (-silty clay loam), silty clay loam, silt loam, to (very) fine sandy loam	Poorly-drained, Class 4W, 3D	Orthic Luvic Gleysol	Delta
4	Silt loam, silty clay loam, fine sandy loam	Poorly-drained, Class 4W, 3D	Orthic Luvic Gleysol	Delta
5	Sandy loam, silty clay loam, silt loam, to fine sandy loam	Poorly-drained, Class 4W, 3D	Orthic Luvic Gleysol	Delta
6	Sandy loam, silty clay loam, silty clay loam, to (very) fine sandy loam	Poorly-drained, Class 4W, 3D	Orthic Luvic Gleysol	Delta
7	Silt loam, silty clay loam, silty clay loam, to loamy sand. Fine.	Poorly-drained, Class 4W, 3D	Orthic Luvic Gleysol	Delta
8	Sandy loam, silt loam (-silty clay loam), silty clay loam, to fine to medium, sand	Poorly-drained, Class 4W, 2D	Orthic Luvic Gleysol	Delta

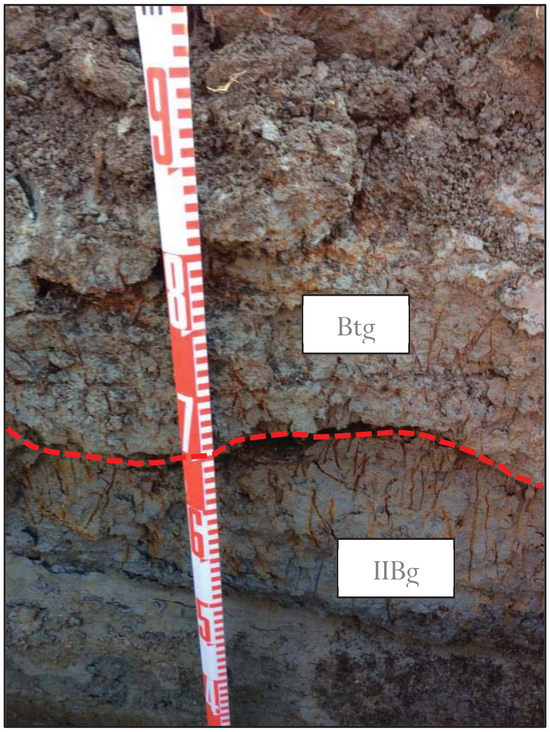

PHOTO 1. THIS PHOTO SHOWS THE SUBSOIL PROFILE OF PIT 1.

Note strong angular blocky structure, generally grey matrix colours and lack of roots. The distinction between Btg and IIBg represents a difference in the deposition mode; the Btg was developed from finely textured shallow marine deposits; the coarser textured IIBg was developed from river deposits.

PHOTO 2. LOOKING DUE WEST ACROSS THE MAHAL FARM (PROPOSED SOIL PLACEMENT AREA).

Vegetation includes Hardhack, Sheep sorrel, Cultivated Cranberry Reed canary grass (Phalaris arundinacea), and Orchard grass.

PHOTO 3. WOOD SHAVINGS PRESENT AT THE TOP OF THE AH LAYER IN SOIL PIT 7.
These were brought in for the cranberry farm previously located here. Cranberries have not been harvested since 2016. We did not observe these shavings anywhere else on the property during our assessment.

3.2 Soil Nutrient, pH, and Salinity Analysis

Soil analytical results generated by AGAT Laboratories of Burnaby, B.C. are presented in Table 4 for the eight samples collected by Mr. Butt on site. Copies of AGAT's full analytical laboratory reports are contained in Appendix D. The results of the nutrient, pH and salinity tests are discussed as follows. Note that the eight samples do not correlate to the eight test pits (i.e. they are located at various points of the northern parcel but not from the pits themselves). The soil samples are from subsoils, not topsoils.

3.2.1 Nitrate (NO_3-N)

The concentration of nitrate in the tested soil is a good indicator of how much nitrogen is available to plants. Nitrate is present in agricultural soils either as a result of direct addition (manure) or due to microbial fixation and transformation of soil nitrogen to nitrate.

The B.C. Ministry of Agriculture 2017 study titled "Tracking Post-Harvest Soil Nitrate in Agricultural Fields in the Hullcar Valley[16], B.C."[17] describes nitrogen in agricultural soils as follows:

[16] This is near the City of Vernon in the Okanagan.

[17] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/nutrient-management/technical-reports/soil-

"Nitrogen may be added to soil as a crop nutrient that is required by plants in large amounts, and crops take up N as nitrate from the soil root zone. In addition to plant uptake, microbes can 'immobilize' nitrate and make nitrate part of soil organic N, the largest portion of N in soil, or the nitrate can be lost from the root zone of the soil by leaching or by transformation into gases that escape into the atmosphere.

Various factors control the rates of uptake, transformations, or losses of N. For example, favourable soil temperatures and moisture conditions during the growing season promote the microbial conversion of organic N to nitrate and the plant uptake of nitrate (biological processes). Rainfall or irrigation water favours nitrate leaching (physical process) any time the infiltrating water exceeds the water-holding capacity of soil or when the water flows through burrows or cracks in the soil (Jarvis 2007). ***The producer's goal is to manage nitrate for crop uptake or to keep nitrate in the soil root zone for later crop uptake."***

The required soil nitrate-nitrogen (NO3-N) for specific crops varies from crop to crop but in general, a concentration range of 10-50 mg/kg is desired[18]. Within this range, 20-40 mg/kg is considered optimal for most crops, including the vegetables that Mahal Farms intends to farm here.

The soil analysis shows that available nitrate is less than 5.0 mg/kg (also equivalent to 5.0 ppm[19]) for all soil samples. Six out of eight of the samples have nitrate that is actually below the reported laboratory detection limit of 2.0 mg/kg. **These analyses show that nitrate is severely limited in these subsoils[20].** Sampling was done in the fall, approximately two years since the last crop rotation of cranberries. The soils have not been amended by fertilizers since the last rotation.

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nutrient-studies/post-harvest_nitrate_study_-_final_report_-_sep_2017.pdf Tracking Post-Harvest Soil Nitrate in Agricultural Fields in the Hullcar Valley, B.C. Accessed November 19, 2018

[18] http://www.horiba.com/us/en/application/material-property-characterization/water-analysis/water-quality-electrochemistry-instrumentation/support/application-support/application-notes/ion/nitrate/soil-nitrate-measurement-for-determination-of-plant-available-nitrogen/ Accessed November 19, 2018

[19] Mg/kg is roughly equivalent to ppm: we use both in this report as these units are both used in soil BC Ministry of Agriculture and other pertinent publications.

[20] We expect that the nitrate-nitrogen in topsoils will be much higher.

3.2.2 Phosphorus

According to the United States Department of Agriculture[21] after nitrogen, phosphorus (P) is often the most limiting nutrient for crop and forage production. The primary role of phosphorus in plants is to store and transfer energy produced by photosynthesis for use in growth and reproductive processes. Phosphorus loss in soils is mainly associated with erosion and runoff rather than leaching out of the root zone (via rainfall or irrigation processes).

The availability of phosphorus to plants depends on factors such a soil pH, soil texture and mineralogy[22]. The B.C. Ministry of Agriculture Sustainable Agriculture Management Branch states that a soil pH of 6.0 to 7.0 is the optimum range for phosphorus availability. As soil pH increases above 7.0, or decreases below 6.0, phosphorus binds with cations (i.e., calcium, aluminum, or iron) and becomes unavailable for immediate plant uptake. Phosphorus is bound by clay particles and oxides in low pH soils[23].

According to the B.C. Ministry of Agriculture “Phosphorus Considerations for Nutrient Management” Factsheet[24], the optimal range of phosphorus in soils is between 41 – 75 ppm (41-75 mg/kg of tested soil).

In our survey, phosphorus concentrations ranged from 7 mg/kg to 47 mg/kg for the eight samples. Six out of eight of samples are below the optimal rates for soil phosphorus. The

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[21] https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053254.pdf Accessed November 19, 2018

[22] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/nutrient-management/response_to_comments_questions_2011__p_seminars_final_july2013.pdf Ministry of Agriculture: Phosphorus Seminars, 2011. Accessed November 19, 2018

[23] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/nutrient-management/response_to_comments_questions_2011__p_seminars_final_july2013.pdf Accessed November 19, 2018

[24] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/nutrient-management/631500-4_phosphorus_considerations_factsheet_no6_sep2010.pdf Phosphorus Considerations for Nutrient Management Factsheet. Accessed November 19, 2018

soils are thus limited by phosphorus availability as well. We emphasize that these results are for the tested subsoils.

3.2.3 Potassium

Phosphorus (P) and potassium (K) are two of the three macronutrients (the other being nitrogen) required by plants for optimum growth. They are required in larger amounts compared to the micronutrients (e.g., zinc, iron, boron, etc.)[25].

B.C. Ministry of Agriculture classifies 0 to 80 ppm (or mg/kg) of Potassium in soils as "low"[26]. Optimal potassium concentrations are reported between approximately 131 and 175 ppm or mg/kg.

Of the eight soil samples, only one has a "very high" potassium concentration of 329 mg/kg. Two other samples have "moderate" potassium concentrations that are below optimal, and the remaining five samples have "low" to "very low" potassium concentrations that are not optimal for plant growth of any crop.

3.2.4 Sulphur

Sulphur (S, along with magnesium, iron, manganese, copper and zinc) is sometimes deficient in soil for optimum crop production. Soil pH is also lowered (when desired) using elemental sulphur, sulphuric acid, aluminum sulfate and iron sulfate (ferrous sulfate)[27].

The optimal sulfur range in soils is reported to be between 20 and 35 mg/kg (or ppm)[28]. The soils we sampled on site have sulfur concentrations ranging from 3 to 33 mg/kg.

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[25] https://www.uaex.edu/publications/PDF/FSA-2118.pdf Accessed November 19, 2018

[26] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/600-series/634200-2_soil_test_p_and_k_interpretations.pdf Accessed November 19, 2018

[27] file:///U:/Nutrient%20Management_BC%20Vegetable%20Production%20Guide.pdf Nutrient Management_BC Vegetable Production Guide.pdf Accessed November 19, 2018

[28] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/600-series/631004-1_sulphur_deficiencies_in_central_bc.pdf Sulphur Deficiencies in Central British Columbia. Accessed November 19, 2018

Seven of the eight samples have low to very low concentrations outside of the optimal range (7-20 mg/kg); only one sample has an optimal sulphur concentration for crops.

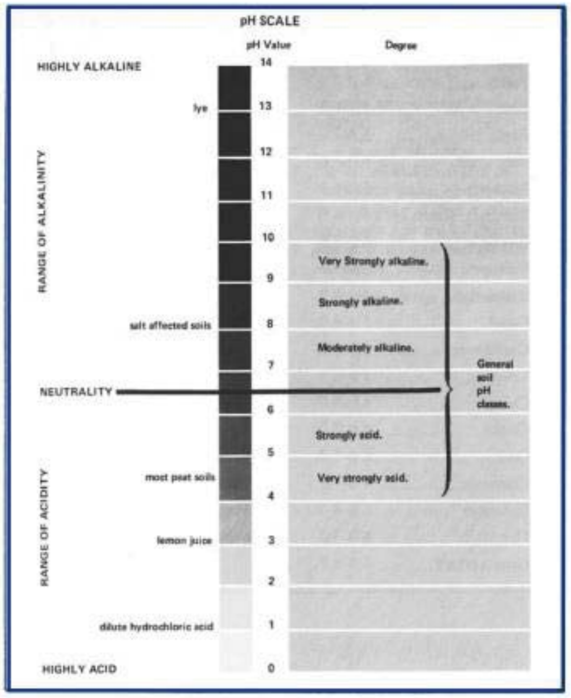
In the B.C. Ministry of Agriculture soil factsheet titled "Sulphur Deficiencies in Central British Columbia", it is reported that *"serious economic losses have occurred when crops have failed to respond to nitrogen fertilizer when soil sulphur levels were low. Knowledge of available soil sulphur levels is important in formulating appropriately balanced fertilizer blends that avoids crop failures".*

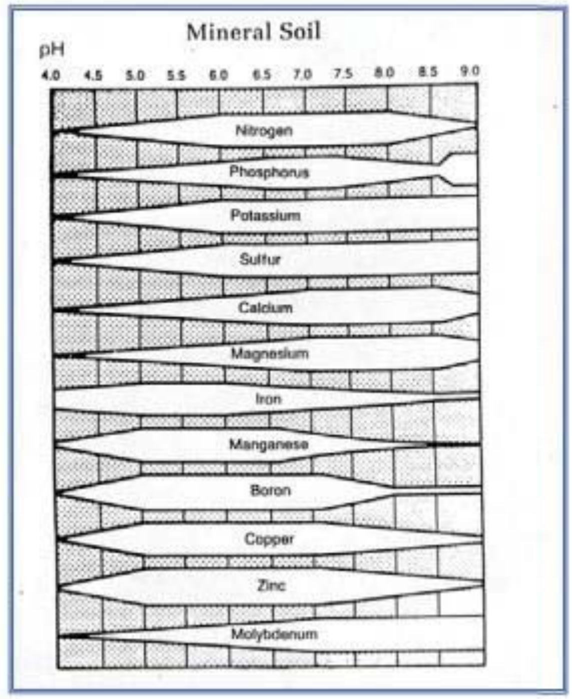
3.2.5 PH (Acidity Or Alkalinity)

According to the B.C. Ministry of Agriculture Soil pH Factsheet:

> *"Soil pH refers to the degree of acidity or alkalinity of the soil. [The] pH scale shows how pH numbers relate to acidity or alkalinity. The scale ranges from 1 to 14, pH 7.0 being the neutral point. A reading below 7.0 indicates the degree of acidity; a reading above pH 7.0 indicates the degree of alkalinity. Soil pH is normally determined on all agricultural soil samples sent to soil testing laboratories. Materials are available that when applied to the soil will change the pH to a point more favourable for crop production. These materials are referred to as soil amendments."*

According to our laboratory test results, the soil pH of our eight samples range from 3.75 to 4.31. This range is defined on the Soil pH factsheet as "very strongly acid". This range is characteristic of most peat soils (Fibrisols, Mesisols, and Humisols) but our surveyed soils were not found to be peaty. Soil pH influences the solubility of plant nutrients and thus, their availability to plants. Low pH values in mineral soils correlate to unfavourable influence on element availability (readily available forms).





DRAWING 1 (LEFT). SOIL PH SCALE AND GENERAL SOIL PH CLASSES (BLACK BRACKET).
DRAWING 2 (RIGHT). SOIL PH INFLUENCE ON AVAILABILITY OF NUTRIENTS (MINERAL SOILS).

For reference, optimal soil pH's for crops that Mahal Farm's intends to grow are as follows:

Vegetables (General): 6.5-8.0
Asparagus: 6.5-8.0
Broccoli, Cabbage: 6.0-7.0
Beans, Peas: 6.0-7.0
Potato: 5.0-6.5

As such, the soils in their current state are too acidic for optimal vegetable crop yields and would require amendments such as lime to raise the pH ideally to 6.0. Liming depends on the pH of the imported soil and highlights the need for soil nutrient testing prior to any spreading of manure or other amendments. To summarize, the native subsoils are very infertile for a combination of low N, P and very low pH and this is a further reason that soil importation is required to improve the agricultural viability of this portion of the property for vegetable crops (desired by Mr. Mahal).

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Table 4. Summary of Soil Analyses – Nutrients Package (8 samples)

		Soil Sample Description / Sample Number							
		18.0429-1	18.0429-2	18.0429-3	18.0429-4	18.0429-5	18.0429-6	18.0429-7	18.0429-8
Parameter	Unit								
Available Nitrate (NO3-N)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	5.0	2.5
Available Phosphorus (P)	mg/kg	42	7	47	12	19	15	24	24
Available Potassium (K)	mg/kg	62	63	68	42	329	63	114	81
Available Sulphur (SO4-S)	mg/kg	11	3	9	6	33	8	7	20
pH (1:1 extraction)	pH units	3.95	4.24	3.97	4.12	4.31	4.11	3.75	3.82
Electrical Conductivity (1:1: extraction)	dS/m	0.14	0.06	0.1	0.07	0.2	0.08	0.13	0.13
Organic Matter (W-B Wet Oxidation)	%	7.58	2.18	5.53	2.74	14.3	2.79	3.34	16.5

3.2.6 Salinity

As mentioned in Section 3.5, both the Delta and Blundell soil series mapped in this area by Luttemerding (1980) have salinity limitations due to their origin as deltaic deposits in a tidal zone. Salinity (N) is identified as a land capability limitation subclass, and includes soils affected by soluble salts that can restrict the range of crops grown. The salt content of soils is tested by creating a water-saturated paste and measuring the electrical conductivity. This value is commonly reported as mS/cm (millisiemens per centimeter).

Our electrical conductivity results ranged from 0.06 to 0.20 mS/cm for the eight samples tested. This correlates to a class 1, or no limitation for crop growth due to salinity. There is no salinity limitation found in the sampled soils, which was not expected for these soils. High salinity values may be confined to the deep horizons (> 1 m) that were not sampled on site. However the proposed crops for this area are shallow-rooted vegetables that will not be affected by salinity in subsoils of greater depth than 1 m.

4 Land Capability for Agriculture

4.1 Land Capability for Agriculture of the Property

Using the specific criteria presented in Land Capability Classification for Agriculture in British Columbia (Kenk and Cotic, 1983), we rated the agricultural capability of the proposed soil deposit area, which is dependent upon the existing soil and site conditions.

Based on our soil pit observations, we found the dominant soil limitation to be excess water (W), specifically a 4W limitation due to uniformly poorly drained soils. During the growing season, the water table will be within the rooting zone, restricting the range of crops that can be successfully grown without managing water (via installing drainage systems or raising the land surface via fill). Excess water limitations are determined based on soil drainage characteristics, the duration that the water saturates the soil, and the season of the soil saturation. Soil saturation characteristics are defined based on the presence of redoximorphic features in the soil profile (mottling, oxidized root channels, red and orange colours).

We also determined there is a significant limitation in the native subsoils, namely impediment to root extension due to high bulk density (the Btg horizon). This is rated as Class 3D for seven of the eight soil pits we investigated. This can be improved to a 2D overall (although this would not improve the next limitation, which is fertility) with sufficient deep ploughing or ripping to break up the dense subsoil. Deep ripping must be done when the soil is as dry as possible, generally Mid to late summer). It may be required more than once, since soils can regain high bulk densities over time.

The soil pit sites did not show evidence of other limitations, due to erosion, salinity, stoniness, bedrock, topographic or permafrost.

Finally, the soil nutrient testing performed by AGAT Labs shows that there is an additional agricultural limitation of fertility (4F) due to very strong acid soils with pH ranges between 3.75 to 4.31 and nutrient deficiencies.

4.2 Improvement

The 4F limitation can only be improved to the next most serious limitation, which is excess water 4W in the northern proposed fill area. We are seeking to improve the fertility limitation by importing high quality fills, then re-spreading topsoil. Note that cranberries require low pH, but cranberries are not an economic crop[29] at the present time.

Improvement of the 4W limitation will be challenging. Drainage requires ditches with water levels lower than that in the field; and because water levels are high through the winter months throughout Richmond, it is not practical to achieve any relief of high water tables. Furthermore, the ditches on No. 7 road have mapped connectivity to fish habitat in the Fraser River. Control would depend on regional drainage and pumping to areas with lower winter water tables. Drainage is further impeded by the surrounding dykes (installed for cranberry cultivation) which impede drainage in spring and fall.

Fertility limitations can be ameliorated through liming although initial amounts of lime may be large. On-going fertilization will be required in addition to the application of micro-nutrients through spraying of crops.

[29] We understand that currently there is an oversaturated market for both blueberries and cranberries.

Local blueberry farmers operating in poorly-drained, native soils have reported (to Madrone) the following complications during farming operations:

- The development of deep ruts in the ground by harvest machinery if hand harvesting is not performed;
- Resulting damage to farm equipment when stuck, and further damage to surrounding plants when machinery needs to be towed out;
- Narrow harvest windows means hand-harvest is not ideal (machine-harvest for optimum crop harvest);
- Difficulty of acquiring labourers for hand-harvest of crops.

Given the significant constraints for drainage improvement we suggest that the most practical way of improving the soil is to import clean subsoil and cover with a minimum of 0.3 m of good quality topsoil or organic soil stripped from the study area, stockpiled and re-spread over the surface after grading. Any soil imported would have to be monitored to ensure it does not contain:

- Excessive coarse gravel, cobbles or stones;
- Contaminants;
- Foreign material;
- Excessive clay; or
- Other undesirable substances.

4.3 Soil Management Recommendations

Soils described in the Langley-Vancouver soil survey have been sorted into soil management groups according to soil characteristics that are significant for agricultural production. Soil management recommendations describe general types and levels of management inputs required to overcome soil limitations to crop production (Bertrand *et al.*, 1991; Luttmerding 1984).

The Delta soil series is a member of The Delta soil management group . The soils are mainly friable to firm silt loam, with poorly drained soils and high water holding capacity. The high water tables associated with Delta soils are usual during winter and early parts of the growing season. Surface ponding is common, which all contribute to the deterioration of surface soil structure and can result in fungal infection to crops.

Unfortunately, subsoiling will not improve water movement due to the high water tables and considerable drainage installations and/or pumping of water out of drainage ditches would be necessary to improve rooting distribution and depth.

The Delta soils have high to very high nutrient holding capability and a surface-layer of high organic content (Bertrand *et al*., 1991; Luttmerding, 1984). Our soil survey shows that our soils are in fact highly deficient in N, P an S and have a very low pH, so that even though they have a high nutrient holding capacity, they are in fact quite infertile, except for the shallow surface organic horizon, which contains most of the nutrients in the soil.

5 Soil Placement Plan

We recommend that soil placement proceed through a series of well-defined steps.

Step 1. Protection of water courses

The first step on this property is to install any erosion and sediment control (ESC) measures on site and have these assessed for effectiveness prior to the arrival of any machinery on site. We also recommend measuring and flagging the 15 m setback from the Riparian Management Area (RMA) situated on the west side of the fill area; this is measured from the top of the bank of the No. 7 Road ditch. Madrone can assist with flagging this setback prior to any earthworks activities on site, to ensure that the RMA is not disturbed.

Step 2. Preparation for fill

Following proper placement of ESC measures, the earthworks operators will proceed strip approximately 0.3 m of the topsoil (**but not the nutrient-deficient subsoils**) This can occur in stages, with some areas being stripped and filled with soil prior to other areas; we will defer the exact sequence of topsoil stripping and storage to the earthworks operators.

All stripped topsoils and organics should be stored in stockpiles on site, preferably in rows directly next to their source fill areas so as not to mix sourced fills and topsoils. The limited removal of topsoils is prescribed so as to not extend into the local water table while conducting a fill operation.

Step 3. Importation and monitoring of soil

Next, good quality well-draining (i.e. loam, sandy loam) soil ideally sourced from local sites (Richmond, Vancouver South, and Burnaby) is spread over the deposit area, graded to an average depth of **1.3 m**, and graded. Finally, the stockpiled topsoil will be spread over the fill. The intent of soil placement is to construct a consistent soil profile that is suited to vegetable, soil-based agriculture across the filled area.

We estimate that approximately 110,000 m^3 of fill will be spread over the site area of 9.0 ha. Deposited soil will be placed with slightly varying thicknesses, although an average final grade (above the existing grade, which varies by approximately 0.3 m) of 1.3 m is desired. We recommend sloping the fill to the east and west such that it drains into the ditches (west) and ESA (east) areas. All fill will be confined within the pre-existing berms/dykes constructed around the fill area.

There will be slight settling of fill material through time, however if a primarily mineral-fill (i.e. not organics) is used, there will be minimal disruption of the intended final grade.

5.1 Topsoil Management

The topsoil on the property should be retained and managed such that it can be used at the surface of the constructed soil profile. It is important to ensure no topsoil resources are lost to erosion and that topsoil quality is not degraded while it is stored. Topsoil should be stored for the duration of the project.

Topsoil stockpiles can be placed directly on the existing land surface and adjacent to the fill area. They should be no more than 5 m high, with 2:1 (horizontal to vertical) slopes. They should be constructed such that water cannot accumulate on the surface. Topsoil stockpiles should be seeded with an acceptable mix of grass and legume seeds if they are allowed to stand for longer than six months, otherwise they should be covered with straw or plastic to protect the topsoil from wind erosion.

To ensure topsoil does not become compacted, it should be handled only with moisture contents equivalent to field capacity–the moisture content of a soil after free water drainage has ceased. For practical purposes, field capacity for the soils on site usually occurs 36 hours after a saturating rainfall.

We recommend stripping the topsoil in all areas to ensure there is sufficient topsoil for constructing the final soil profile. The uppermost 0.2 to 0.3 m represents the growing portion of the in-situ soil and should be conserved.

Prior to topsoil stripping, Madrone should be contacted by Hexcel to ensure that the proper depth is excavated. Deep excavations are discouraged as this will result in too much of the Btg horizon being mixed into the topsoil. This soil is firm to very firm and is not a desirable growing medium (i.e. within 0.5 m of the surface). Our analysis shows that subsoils are also highly infertile. Excavating subsoils and mixing them with topsoil will result in 'dilution' of the topsoil and reduction of its value in reconstructing the soil profile. It may be necessary to import additional topsoil, compost, manure, or other suitable organic-rich amendment to achieve the objectives of a final soil that will be highly suitable of supporting soil-bound agriculture.

5.2 Sourced Soil

5.2.1 Physical Properties of Acceptable Source Soil

Soil sourced and brought to site should be coarse-textured, preferably sandy loam or loamy sand, to promote subsurface drainage. Soils containing high clay content or coarse fragments larger than fine gravels (2.5 cm or greater) are not desirable and should be avoided. Soils should be checked for these parameters ideally before arriving on site to ensure they are suitable as subsoils. If stony soils are unintentionally brought onto the site, the soils should be raked or sorted to remove the stones. A standard operating procedure (SOP) can be followed – an example SOP has been included in Appendix F.

Soils should be free of foreign or non-soil material and uncontaminated. Foreign material includes but is not limited to concrete, asphalt, waste, garbage, and lumber. As a large quantity of soil is sourced from properties featuring recently-demolished residences, we advise Hexcel and any contracted earthworks operators to check that demolished house waste has been removed from the source site prior to any excavations and transfers of soil to the property.

5.2.2 Chemical Properties of Acceptable Fill Material

All imported fill must meet the Soil Standards for Agricultural Land (Column II of Schedule 5 of Contaminated Sites Regulation[30] of the *Environmental Management Act*).

Contaminated soils must not be used as fill. The supplier should warrant that the source soil is free from contamination. Fill should not come from areas that have histories of industrial or commercial land use. If contaminated fill material is brought onto the site, Mahal Farms will assume liability for remediating the site or removing the contaminated material. We encourage Mahal Farms and Hexcel to include an agreement that assigns liability for contaminated soils.

Currently, Madrone conducts a desktop environmental assessment as well as a site visit to assess for any visible non-soil material and invasive species in each fill site. We also recommend obtaining Phase 1 reports for large sites (i.e. >3000 m^3 of soil) that are less than 2 years old from contractors. If a Phase 1 report is not available, we encourage Hexcel to contact Madrone for a pre-importation site assessment and desktop study.

We recommend that all fills be inspected before it is imported to the receiving site.

5.3 Constructed Soil Profile

The constructed soil profile will have approximately 0.3 m of stockpiled topsoil at the surface. Below this, the upper 0.3-0.5 m of the subsoils should consist of soil fill that meets the criteria for Land Capability Class 1; these are listed in Table 5. The key parameters that must be met to achieve this capability class are textures of loam, sandy loam, loamy sand, and organic matter content greater than 2%.

[30] http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/375_96_07

Table 5. Criteria for Land Capability Class 1

Source of Criteria	Soil Parameter	Subsoil 40-80 cm	Topsoil 0-40 cm
Land Capability Classification for Agriculture in British Columbia	Soil Moisture Deficiency	N/A	<40 mm
	Available water storage capacity	>45 mm	>76 mm
	depth to root-restricting layer	N/A	>75
	texture	coarser than silty clay loam	fine sandy loam, silt loam, loam
	permeability	>1.0 cm/hour	>1.0 cm/hour
	erosion	N/A	not eroded or very slightly eroded
	salinity	<2 mS/cm	<2 mS/cm
	inundation	N/A	no damage to crops
	stoniness	<20% total (>2.5 cm) and <5% cobbles and stones (>7.5)	<5% total (>2.5 cm) and <.01% cobbles and stones (>7.5)
	topography	N/A	simple slopes <5% complex slopes <2%
	excess water	soils are freely draining	no damage to crops
	fertility	N/A	no restriction to crop growth
Modified from ALC reclamation criteria	reaction	5.0 to 7.5	5.5 to 7.0
	base saturation	20-80%	30-60%
	texture	<30% clay and <80% sand	sandy loam, loam
	moist consistence	friable or loose	friable
	organic C	0.5-2%	>2%

This subsoil must be placed on the graded surface. Soils destined to form the profile within 40 cm of the surface should either be free of cobbles and stones OR removed by screening or crushing to meet these criteria.

Weed or invasive species control should be practiced, under the direction of the monitoring Agrologist. After the soil profile has been constructed, the site should be inspected to determine if further treatments are necessary before establishing the crop. If subsoils remain compacted, then the Professional Agrologist may prescribe decompaction, using ripper or chisel blades. Decompaction should extend to a depth of 60 cm.

Finally in preparation for crop establishment, a top-dressing of organic amendment will be applied. Such an amendment will add further organic matter to enhance the physical structure (‘tilth’), nutrient and moisture retention in the upper part of the soil profile, but will also encourage the development of a microbial community that can facilitate nutrient transformation. This can be compost or manure that meets certain criteria. **Products of**

wood-processing such as wood shavings, sawdust or wood chips are not appropriate.

All amendments should be tested through laboratory analysis prior to application; in addition, top-dressings of amendments should undergo experimentation by application of 'test areas' a year before widespread application. Typical application rates should be in the order of 10 Tonnes per acre or 2.5 T/ha.

6 Hydrology

There are no mapped or observed natural watercourses on site. The property features an irrigation canal through the centre but surface flow to this is blocked by the presence of raised dykes. Placed soil can be graded with a local topographic high through the approximate centre, and subtle slopes (1-2%) to the east and west. This will allow surface and subsurface (<0.5 m) water to flow east and west towards the ESA and the No. 7 Road ditch, respectively.

With proper runoff management (i.e. gently sloping stockpiles and final soil profiles), we do not anticipate that the hydrology of this area will change. The land will be raised by approximately 1.0 m, which will effectively raise the upper growing medium above seasonally ponded waters and high water tables. **The site should be assessed for the need for subsurface drainage when the site fill is complete or nearly complete. If it is deemed necessary, subsurface drainage will be installed.**

The only shared property line with the soil will be to the north; these are Mayfair Lakes golf course and a 0.25 hectare residential property to the northwest. **Drainage will not be directed towards these sites.** We recommend that soil placement in the north side of the property is ideally performed during the drier weather periods (i.e. late spring to early fall, after heavy precipitation) to ensure that surface erosion and run-off is limited while the soil profile is constructed and the surface is seeded. If wet conditions prevail, machinery can move to work on other parts of the site, for example.

There will be a required 15 m setback from the No. 7 Road ditch; silt fencing will be installed along the perimeter of soil on the west side to prevent surface run-off to the ditch. The RMA will not be disturbed during site activities (including removal of any vegetation in this area).

7 Post-Fill Land Capability for Agriculture

Following proper soil placement as per our recommendations, we estimate that the post-fill Land Capability for Agriculture ratings will improve from Class 4W with excess water limitations to a Class 2W with minor excess water limitations. The undesirable soil structure/root restricting layer limitation (3D) will be eliminated or improved to 2D. The existing subsurface will then be too deep to affect the growth of crops (undesirable Btg horizon is >0.75 m below the surface, as per the Land Capability Classification for Agriculture criteria).

Finally, the fertility limitation due to acidic and nutrient deficient subsoils in the upper 0.5 m will be completely resolved (no limitation) with the placement of good-quality, more alkaline soil (ideally pH 5.0 to 6.5). The topsoil can also be limed following placement to reduce natural acidity in this horizon. We will test the final reclaimed soil to assess nutrient status and pH; if additional amendments are necessary they will be done.

8 Summary of Recommendations

Mahal Farms intends to engage Hexcel Construction Ltd. to source and place the soil on site. We have proposed the following basic plan for the site:

1. Prior to any importation, strip between 0.2 and 0.3 m of the existing topsoil (and overlying peat, vegetation) over the 9.0 ha area. This approximates to 36,000 m^3. This can proceed in stages as determined by the earthworks contractor.
2. All stripped soil should be stockpiled on site for later use. No soil shall be stockpiled in proximity (<10 m) to property lines, ditches, or riparian areas (RMA along No. 7 Road).
3. Placing locally sourced (if possible), good-quality soil on the stripped land, which is level with slopes less than 2% and situated at elevations less than 2 m above sea level.
4. Sourced soil should consist of clean soil from an uncontaminated source; it should have less than 10% coarse fragment, should not be clay-rich, and should not contain any foreign material. Madrone can assist with screening soil sites for potential contaminants (preliminary studies) and assessing coarse fragment content of incoming soil loads. Sites should also be checked for potential invasive plant species.
5. The final surface after completion of fill placement should be graded with an even 1-2% grade; we recommend sloping the soil to the east and west, with a crown in the centre.

6. The original topsoil (stripped) should be spread evenly over the final graded surface in such a way as to avoid compaction.
7. After spreading the surface should be seeded with an appropriate forage mix to prevent erosion and maintain soil fertility. Manure and liming will be necessary to improve soil nutrients and acidity of the Ah/Ap horizon. We recommend soil testing after amending the soil to assess nutrients prior to any planting.
8. The soil placement operation should be monitored at regular intervals through the process.
9. Once complete a final report should be issued on the condition and final, improved land capability of the filled area.

8.1 Monitoring

Should your soil placement application be jointly approved by the ALC and the City of Richmond, the terms of the soil deposit permit will indicate that Madrone is expected to conduct inspections of the site and materials and to provide inspection reports. Mahal should contact Madrone before it begin any site preparation work or soil placement to develop a monitoring schedule that meets the conditions of its permit and conforms to our recommendations for the site.

Monitoring visits should be scheduled to coincide with important project milestones and randomly when the site is active. The important milestones are:

- The installation of Erosion and Sediment Control measures on site, including the flagging of the RMA to the west of the fill area along No. 7 Road;
- At the start of topsoil stripping to ensure that an appropriate amount of topsoil is being stripped; we have indicated in our report that this is roughly 0.2 to 0.3 m. This will likely require the use of a smaller excavator with a smaller bucket;
- After extreme storm events to inspect stripping and stockpiled soil and the ESC measures;
- Once the fill has been graded, prior to spreading topsoil. If this proceeds in a sequence (i.e. cells are stripped and soil is placed in sequence), we will inspect each soil placement prior to the spreading of soil to ensure that there is no undesirable debris or high quantities of coarse fragments;
- When the reclaimed soil profile has been constructed.

Furthermore, we will inspect the site for the spread of any invasive plant species or soil erosion and transport issues (i.e. stockpiles sloping too steeply, resulting in rill erosion).

8.2 Reporting

We recommend preparing periodic monitoring reports every 3000 m^3 of imported soil during the first year, and reports every 5000 m^3 after the first year if there are no significant project issues (such as excessive soil stoniness, invasive species spread). In addition, a closure report should be prepared once the project is complete. The report should include an assessment of the final land capability for agriculture ratings and a comparison between the initial and final LCA ratings. It should contain an estimate of the volume of fill placed and details about fill source site. We recommend that accurate and complete records of all fill brought to the site, including truck counts, be kept. We are aware that Hexcel is currently completing a similar project on Westminster Highway and is informed of, and prepared for, the reporting and record-keeping requirements described in this plan.

9 Conclusions

Mahal Farms, with the assistance of earthworks experts Hexcel, proposes to place approximately 110,000 m^3 of good-quality fill over 9.0 ha of the northwest portion of the property to improve soil wetness, undesirable soil structure, and soil fertility (due to high acidity) limitations. This will enable soil-based agriculture for vegetable crops.

The primary intent of soil placement is to improve drainage conditions that limit agricultural capability. By raising the land (and as a result, introduce1.3 m of a good growing medium), the undesirable soil structure and fertility (due to high acidity) limitations are also improved. This proposal will also allow Mahal Farms to diversify their crop rotations, from cranberries to vegetables, particularly varieties used in Indian cuisine such as chili peppers, eggplants, and indian carrots.

Prepared by:

**This is a digitally signed duplicate of the official manually signed and sealed document.*

BRITISH COLUMBIA INSTITUTE OF AGROLOGISTS 3050 Jessica Stewart P.Ag.

Jessica Stewart, A.Ag., G.I.T.

Field assessment and supervision:

**This is a digitally signed duplicate of the official manually signed and sealed document.*

BRITISH COLUMBIA INSTITUTE OF AGROLOGISTS B.C.I.A. Gordon Butt, P.Ag. 302

PROFESSIONAL GEOSCIENTIST PROVINCE OF G. BUTT BRITISH COLUMBIA

Gordon Butt, M.Sc., P.Ag, P.Geo.

10 References

Armstrong, J. E. (1980). Surficial geology, Vancouver, British Columbia. Geological Survey of Canada, Map 1486A.

BC Ministry of Forests and Range and BC Ministry of Environment. (2010). Field Manual for Describing Terrestrial Ecosystems Land Management, 2nd Edition, Handbook Number 25.

BC Ministry of Environment, Lands, and Parks and BC Ministry of Forests. (1998). Field Manual for Describing Terrestrial Ecosystems Land Management, Handbook Number 25.

Bertrand, R. A., G. A. Hughes-Games and D. C. Nikkel. (1991). Soil Management Handbook for the Lower Fraser Valley. BC Ministry of Agriculture, Fisheries and Food, Abbotsford, BC.

Climatology Unit. (1981). Climate Capability for Agriculture in British Columbia. APD Technical Paper 4. Air Studies Branch, BC Ministry of Environment, Victoria, BC.

Coligado, M. C. (1980). Climate Capability for Agriculture Map 92G/SE Langley, BC.

Kenk, E. and I. Cotic. (1983). Land Capability Classification for Agriculture in British Columbia, MOE Manual 1, Ministry of Environment and Ministry of Agriculture, Kelowna.

Luttmerding, H. (1980). Soils of the Langley-Vancouver Map Area, Report No. 15, Vol. 1: Soil Map Mosaics and Legend Lower Fraser Valley (Scale 1:25000), BC Ministry of Environment, Victoria, BC.

Luttmerding, H. (1981). Soils of the Langley-Vancouver Map Area, Report No. 15, Vol. 3: Description of the Soils, BC Ministry of Environment, Victoria, BC.

Luttmerding, H. (1984). Soils of the Langley-Vancouver Map Area, Report No. 15, Vol. 5: Agriculture Soil management Groups, BC Ministry of Environment, Victoria, BC.

Luttmerding, H. (1986). Land Capability for Agriculture Langley-Vancouver Map Area. BC Ministry of Environment, Victoria, BC.

Mapping Systems Working Group MSWG. (1981). A Soil Mapping System for Canada Revised. Land Resource Research Institute, Contribution No. 142. Agriculture Canada, Ottawa, ON.

Ministry of Agriculture (B.C.) Sulphur Deficiencies in Central British Columbia: Soil Factsheet. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/600-series/631004-1_sulphur_deficiencies_in_central_bc.pdf

Poon, D. and Code, L. (2017) Tracking Post-Harvest Soil Nitrate in Agricultural Fields in the Hullcar Valley. B.C. Ministry of Agriculture.

Soil Classification Working Group SCWG. (1998). The Canadian System of Soil Classification 3rd ed. Research Branch. Agriculture and Agri-Food Canada, Ottawa, ON. Publ. 1646.

11 Limitations

The evaluations contained in this report are based on professional judgment, calculations, and experience. They are inherently imprecise. Soil, agricultural, hydrological, and drainage conditions other than those indicated above may exist on the site. If such conditions are observed, Madrone should be contacted so that this report may be reviewed and amended accordingly.

The recommendations contained in this report pertain only to the site conditions observed by Madrone at the time of the inspection. This report was prepared considering circumstances applying specifically to the client. It is intended only for internal use by the client for the purposes for which it was commissioned and for use by government agencies regulating the specific activities to which it pertains. It is not reasonable for other parties to rely on the observations or conclusions contained herein.

Madrone completed the field survey and prepared the report in a manner consistent with current provincial standards and on par or better than the level of care normally exercised by Professional Agrologists currently practicing in the area under similar conditions and budgetary constraints. Madrone offers no other warranties, either expressed or implied.

APPENDIX A

Maps & Figures

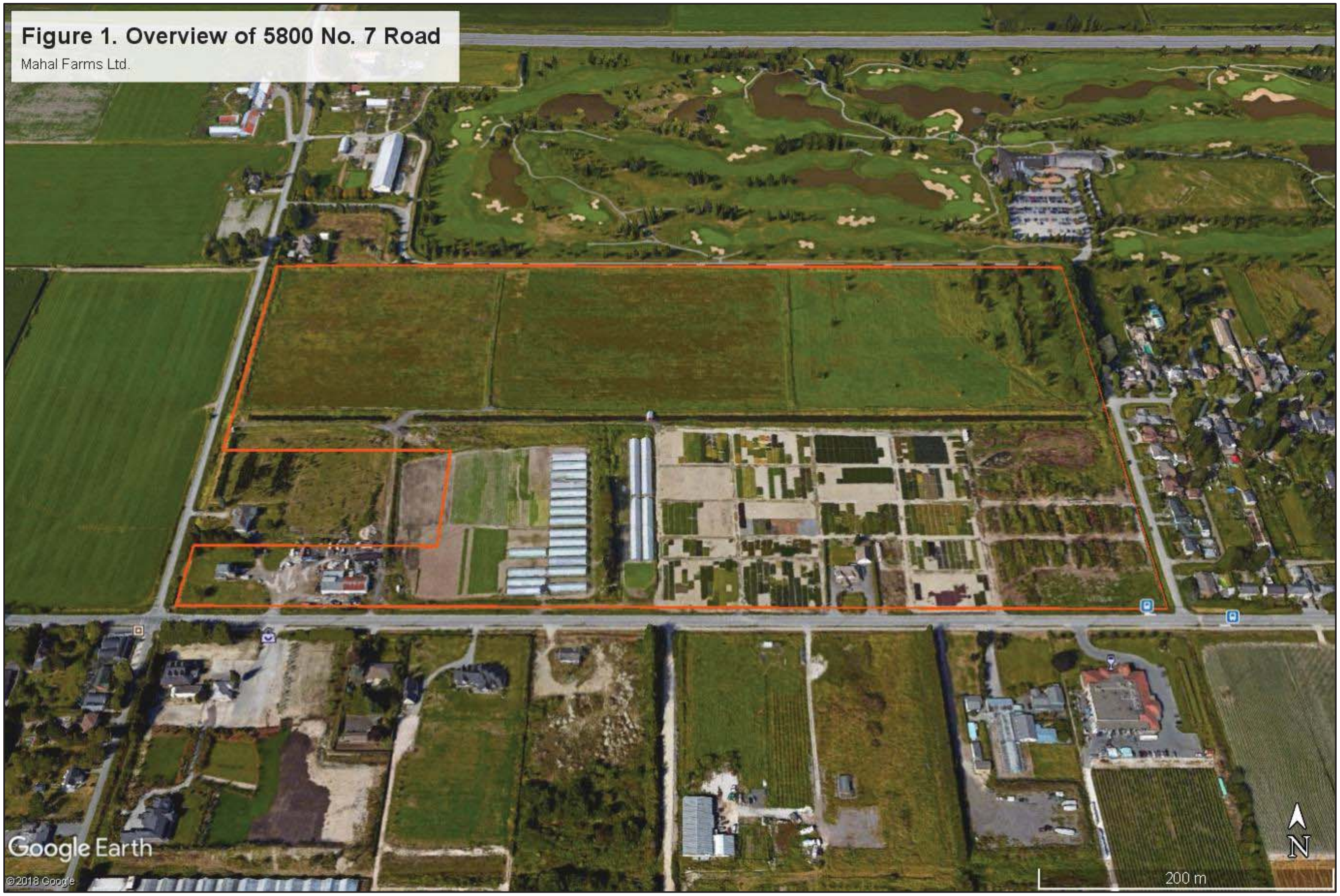


FIGURE 1. OVERVIEW OF 5800 NO. 7 ROAD

FIGURE 2. SOIL PIT PLACEMARKS

PROJECT: Soil Deposit Assessment: 5800 No. 7 Road			LOCATION: Richmond, BC	DOSSIER: 18.0429
CLIENT: Mahal Farms Ltd. & Hexcel Construction Ltd.	ASSESSED BY: Jessica Stewart, A.Ag., G.I.T.	ASSESSMENT DATE: October 10, 2018	DRAWN BY: Jessica Yellowlees	

FIGURE 3: Soil Deposit Plan & RMA Setback

All feature positions as shown are approximate

NOTES

—ALL DISTANCES AND MEASUREMENTS ARE IN METRIC UNITS

—All volumes are approximations and calculated areas do not reflect the legal dimensions of the property.

NOT FOR CONSTRUCTION

HEXCEL CONSTRUCTION LTD.
7119 River Road, DELTA, BC V4G 1A9
TEL: 604-946-8744 FAX: 604-946-8704

REV'N	DATE	BY	DESCRIPTION
0	Dec/17	REH	INITIAL SKETCH

CONTACT NUMBERS

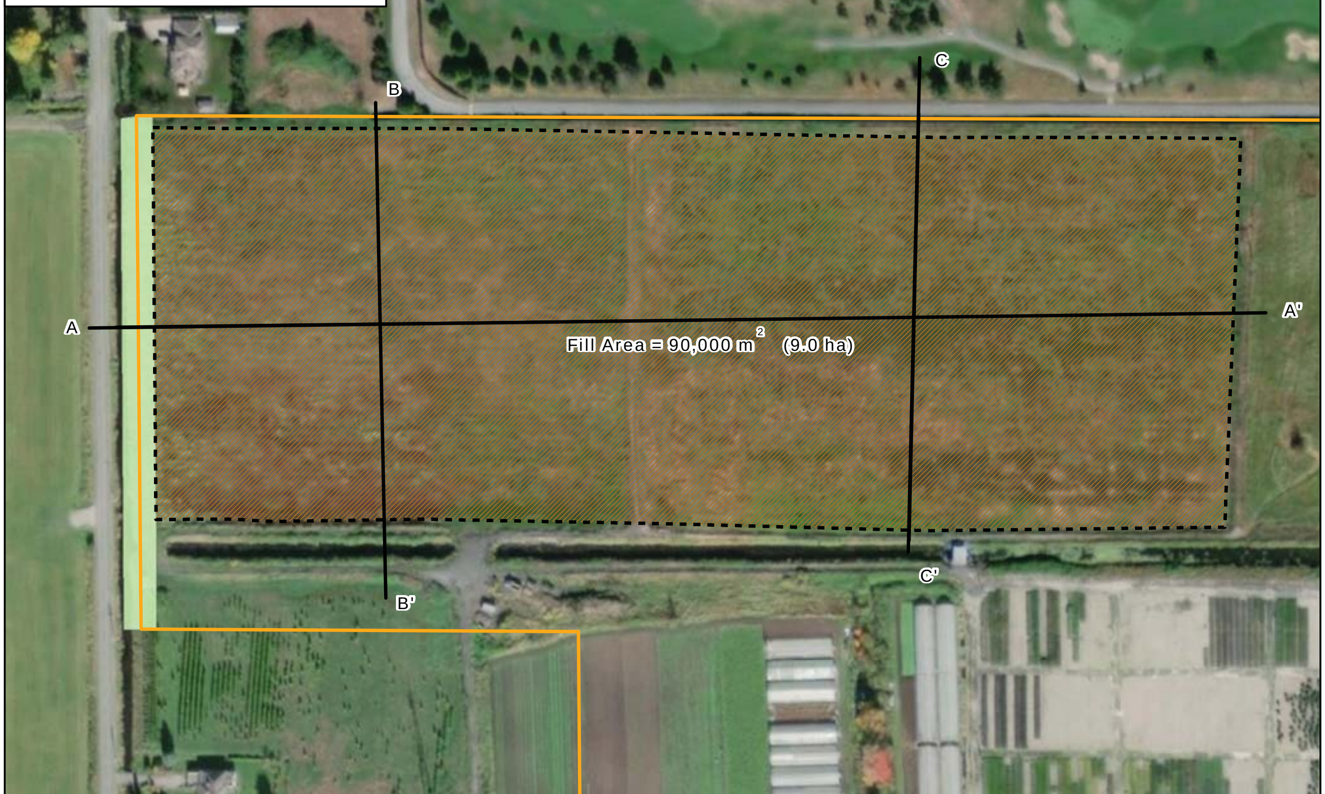
HEXCEL SUPERINTENDENT
SCOTT LYTLE
CELL: 604.834.6940

TITLE: TOPOGRAPHIC SURVEY
7 Road & Westminister Hwy.
RICHMOND

PROJECT No:	7 Rd.	DRAWING No:	
DRAWN:	Dec 6 / 2017	SHEET No:	1 OF 1
CHECKED:		SCALE:	AS SHOWN

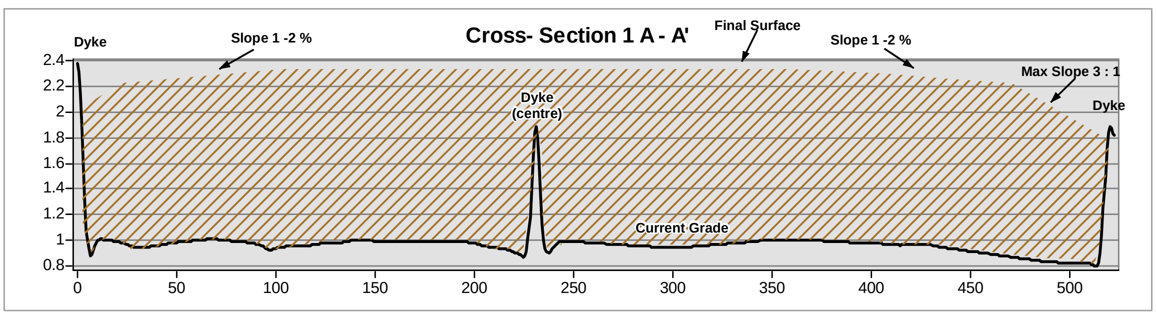
MADRONE	**PROJECT:** Soil Deposit Assessment: 5800 No. 7 Road	**LOCATION:** Richmond, BC	**CLIENT:** Mahal Farms Ltd. & Hexcel Construction Ltd.	N
	ASSESSED BY: Gordon Butt, M.Sc., P.Ag., P.Geo. & Jessica Stewart, A.Ag., G.I.T.	**ASSESSMENT DATE:** October 10, 2018	**DRAWN BY:** Jessica Yellowlees	**DOSSIER:** 18.0429

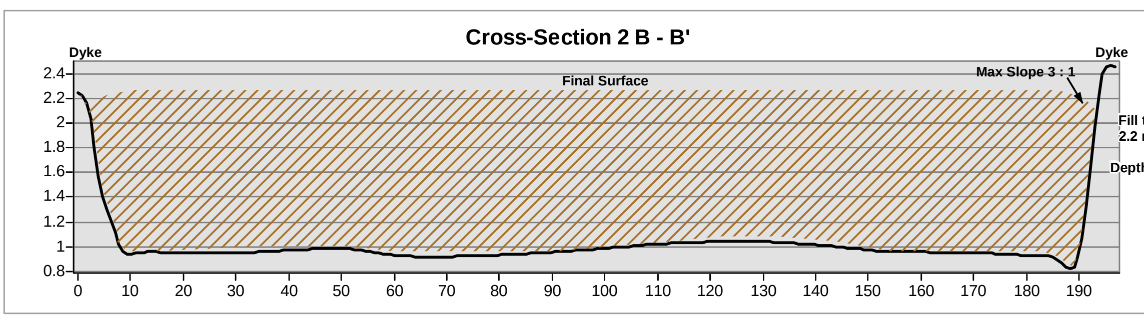
FIGURE 5: Cross-Sections

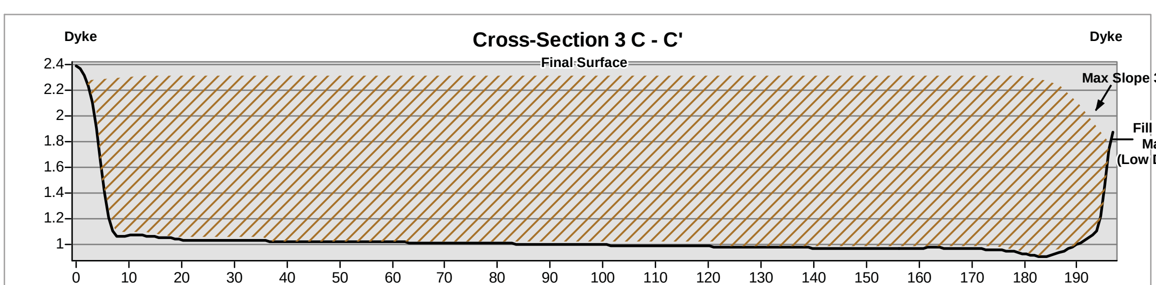


Project Line
Riparian Setback- RMA (15m)
Fill Area
Cross-Section Line
All feature positions as shown are approximate

0 50 100 150 200 m
1:2,250







GP – 140

Cross-Section Legend
Current Soil Grade
New Surface Following Soil Importation

MADRONE
environmental services ltd.

APPENDIX A

Soil Pit Descriptions & Photographs

Pit 1 – Soil Profile Description (Placemark 1, Figure A2)

Property	Value
Pit Depth	1.3 m
# of soil horizons	5
Horizon	Depth (m)
Of	+12-0
Ap	0-0.2
Btg	0.2-0.6
IIBg	0.6-0.88
IICg	0.88-1.25
IIICg	1.25+
Water table depth	1.3 m
Soil type	Mineral with 12 cm of overlying peat
Overall classification	Orthic Luvic Gleysol
Parent material origin	Deltaic overbank deposits over fluvial sands
Land Capability (unimproved)	4W, 3D

Comments: 12 cm of reddish-brown to black fibric peat overlying. Mottling starts at 20 cm below the surface (oxidized root channels). Excess free water due to high water tables; surface water during growing season due to poor surface drainage. Water table encountered at 1.3 m. Btg horizon is a Silty Clay Loam that is firm to very firm. There are very few, very fine to fine roots in the Btg horizon. There is an undesirable soil structure limitation.

Soil Textures, Pit 1:

Horizon	Soil Texture
Ap	Silt loam
Btg	Silty clay loam
Bg	Fine sandy loam
IICg	Sandy loam (-loamy sand)
IIICg	Medium sand

Pit 2 – Soil Profile Description (Placemark 2, Figure 2)

Property	Value
Pit Depth	1.3 m
# of soil horizons	4
Horizon	Depth (m)
Of	+12-0
Ap	0-0.25
Btg	0.25-0.57
BCg	0.57-1.12
IICg	1.12-1.3+
Water table depth	1.3 m
Soil type	Mineral with 12 cm of overlying peat
Overall classification	Orthic Luvic Gleysol
Parent material origin	Deltaic overbank deposits over fluvial sands
Land Capability (unimproved)	4W, 3D

Comments: Same Btg horizon as Pit 1 – firm to very firm with oxidized root channels. Silty clay loam (light grey, faint blue mottles) grades to silt loam (medium grey, prominent orange mottles). Mottling (faint) starts at 25 cm below the surface.

Soil Textures, Pit 2:

Horizon	Soil Texture
Ap	Sandy loam (different from Pit 1)
Btg	Silty clay loam
BCg	Silt loam
IICg	Fine sandy loam, lenses of fine sand.

Pit 3 – Soil Profile Description (Placemark 3, Figure 2)

Property	Value
Pit Depth	1.4 m
# of soil horizons	4
Horizon	Depth (m)
Of	+10-0
Ap	0-0.3
Btg	0.3-0.8
BCg	0.8-1.3
Cg	1.3-1.4+
Water table depth	1.4 m
Soil type	Mineral with 10 cm of overlying peat
Overall classification	Orthic Luvic Gleysol
Parent material origin	Deltaic overbank deposits over fluvial sands
Land Capability (unimproved)	4W, 3D

Comments: Mottling starts in Ap horizon (<30 cm); watertables are higher here during the growing season. The Btg horizon is firm to very firm (dense subsoil, root restricting layer).

Soil Textures, Pit 3:

Horizon	Soil Texture
Ap	Silt loam (-silty clay loam)
Btg	Silty clay loam
BCg	Silt loam
Cg	(Very) Fine sandy loam

Pit 4 – Soil Profile Description (Placemark 4, Figure 2)

Property	Value
Pit Depth	1.4 m
# of soil horizons	3
Horizon	Depth (m)
Of	+10-0
Apgj	0-0.4
Btg	0.4-0.8
BCg	0.8-1.4+
Water table depth	Below 1.4 m
Soil type	Mineral with 12 cm of overlying peat
Overall classification	Orthic Luvisolic Gleysol
Parent material origin	Deltaic overbank deposits over fluvial sands
Land Capability (unimproved)	4W, 3D

Comments: Buried log encountered in Ap horizon (ploughed). Oxidized root channels and faint orange mottling in the Ap horizon; perched watertables during growing season indicated. No water encountered at bottom of pit.

Soil Textures, Pit 4:

Horizon	Soil Texture
Apgj	Silt loam
Btg	Silty clay loam
BCg	Fine sandy loam

Pit 5 – Soil Profile Description (Placemark 5, Figure 2)

Property	Value
Pit Depth	1.4 m
# of soil horizons	4
Horizon	Depth (m)
Of	+10-0
Ah	0-0.15(0.3)
Btg	0.15(0.3)-0.66
BCg	0.66-0.96
Cg	0.96-1.4+
Water table depth	1.4 m
Soil type	Mineral with 12 cm of overlying peat
Overall classification	Orthic Luvic Gleysol
Parent material origin	Deltaic overbank deposits over fluvial sands
Land Capability (unimproved)	4W, 3D

Comments: The Ah horizon depth is variable; it is between 15 and 30 cm thick and the contact with the Btg horizon is wavy. Water was encountered at 1.4 m and quickly filled the pit. There was seepage in the BCg and Cg horizons. The BCg horizon is firm and the Btg is firm to very firm, as for the previous four soil pits. Mottling starts in the Btg horizon in this pit. Sand in Ah layer not native: brought for cranberry bog.

Soil Textures, Pit 5:

Horizon	Soil Texture
Ah	Sandy loam
Btg	Silty clay loam
BCg	Silt loam
Cg	Fine sandy loam

Pit 6 – Soil Profile Description (Placemark 6, Figure 2)

Property	Value
Pit Depth	1.2 m
# of soil horizons	
Horizon	Depth (m)
Of	+10-0
Ah	0-0.2(0.25)
Btg	0.2(0.25)-0.6
Bg	0.6-0.7
Cg	0.7-1.2+
Water table depth	1.2 m
Soil type	Mineral with 12 cm of overlying peat
Overall classification	Orthic Luvic Gleysol
Parent material origin	Deltaic overbank deposits over fluvial sands
Land Capability (unimproved)	4W, 3D

Comments: Mottling within 20 cm of the surface (oxidized root channels and faint orange mottles). As for Pit 5, sand in Ah layer not native: brought for cranberry bog. Seepage at base of pit (1.2 m). As for previous pits, the Btg horizon is firm to very firm.

Soil Textures, Pit 6:

Horizon	Soil Texture
Ah	Sandy loam.
Btg	Silty clay loam
Bg	Silty clay loam
Cg	(Very) fine sandy loam

Pit 7 – Soil Profile Description (Placemark 7, Figure 2)

Property	Value
Pit Depth	1.3 m
# of soil horizons	5
Horizon	Depth (m)
Of	+12-0
Ah	0-0.12
Btg	0.12-7
Bg	0.7-1.3
Cg	1.3+
Water table depth	1.3 m
Soil type	Mineral with 12 cm of overlying peat
Overall classification	Orthic Luvic Gleysol
Parent material origin	Estuarine environment
Land Capability (unimproved)	4W, 3D

Comments: Thin Ah layer here. Wood shavings at surface for cranberry farm. Btg is very firm. Mottling starts within 12 cm of the surface. Estuarine environment suggested in lower C horizon; poorly-graded and well-sorted sand. There is decomposed plant matter in the Bg horizon.

Soil Textures, Pit 7:

Horizon	Soil Texture
Ap	Silt loam
Btg	Silty clay loam
Bg	Silty clay loam
Cg	Loamy sand. Fine.

Pit 8 – Soil Profile Description (Placemark 8, Figure 2)

Property	Value
Pit Depth	1.6 m
# of soil horizons	5
Horizon	Depth (m)
Of	+20-0
Ap	0-0.6
Btg	0.6-0.95
BCg	0.95-1.5
Cg	1.5-1.6+
Water table depth	1.6 m
Soil type	Mineral with 12 cm of overlying peat
Overall classification	Orthic Luvic Gleysol
Parent material origin	Deltaic overbank deposits over fluvial sands
Land Capability (unimproved)	4W, 2D

Comments: thickest Ah horizon encountered of all pits (as a result, dense subsoils are not encountered until 60 cm below the surface). Btg horizon is firm to very firm and grey with prominent orange mottles. Seepage at base of the pit.

Soil Textures, Pit 8:

Horizon	Soil Texture
Ap	Sandy loam
Btg	Silt loam (-silty clay loam)
BCg	Silty clay loam
Cg	Fine to medium, wet sand

APPENDIX C

Land Capability for Agriculture Overview

Land Capability for Agriculture (LCA) in BC is a classification system that groups agricultural land into classes that reflect potential and limitations to agriculture. The classes are differentiated based on soil properties, landscape, and climate conditions. The system considers the range of possible crops and the type and intensity of management practices required to maintain soil resources but it does not consider suitability of land for specific crops, crop productivity, specific management inputs or the feasibility of implementing improvements.

There are two land capability hierarchies, one for mineral soils and one for organic soils. Each hierarchy groups the land into seven classes that describe the range of suited crops and required management inputs. The range of suited crops decreases from Class 1 to Class 7 (Class O1 and O7 for Organic soils) and/or the management inputs increase from Class 1 to Class 7. For example, Class 1 lands can support the broadest range of crops with minimal management units.

Lands in Classes 1 to 4 are considered capable of sustained agricultural production of common crops. Class 5 lands are considered good for perennial forage or specially-adapted crops. Class 6 lands are good for grazing livestock and Class 7 lands are not considered capable of supporting agricultural production.

LCA Classes are subdivided into subclasses based on the degree and kind of limitation to agriculture. Subclasses indicate the type and intensity of management input required to maintain sustained agricultural production and specify the limitation. For example, lands rated Class 2W have an excess water limitation that can be improved by managing water on the site. Most lands are rated for unimproved and improved conditions. Unimproved ratings are calculated based on site conditions at the time of the assessments, without irrigation. Past improvements are assessed as part of the unimproved rating. Forested lands are assessed assuming they are cleared. Improved ratings are assigned assuming that existing limitations have been alleviated. Generally, improvement practices taken into account are drainage, irrigation, diking, stone removal, salinity alleviation, subsoiling, intensive fertilization and adding soil amendments.

LCA CLASSES

Table A describes the characteristics of each mineral and organic soil class. Mineral soil classes are 1–7 and organic soil classes are O1–O7.

Table A. LCA Classes

Class	Description	Characteristics
1 01	No or very slight limitations that restrict agricultural use	Level or nearly level. Deep soils are well to imperfectly drained and hold moisture well. Managed and cropped easily. Productive.
2 02	Minor limitations that require ongoing management or slightly restrict the range of crops, or both	Require minor continuous management. Have lower crop yields or support a slightly smaller range of crops that class 1 lands. Deep soils that hold moisture well. Managed and cropped easily.
3 03	Limitations that require moderately intensive management practices or moderately restrict the range of crops, or both	More severe limitations than Class 2 land. Management practices more difficult to apply and maintain. Limitations may: Restrict choice of suitable crops. Affect timing and ease of tilling, planting or harvesting. Affect methods of soil conservation.
4 04	Limitations that require special management practices or severely restrict the range of crops, or both	May be suitable for only a few crops or may have low yield or a high risk of crop failure. Soil conditions are such that special development and management conditions are required. Limitations may: Affect timing and ease of tilling, planting or harvesting. Affect methods of soil conservation.
5 05	Limitations the restrict capability to producing perennial forage crops or other specially adapted crops (e.g. Cranberries)	Can be cultivated, provided intensive management is employed or crop is adapted to particular conditions of the land. Cultivated crops may be grown where adverse climate is the main limitation, crop failure can be expected under average conditions.
6 06	Not arable, but capable of producing native and/or uncultivated perennial forage crops	Provides sustained natural grazing for domestic livestock. Not arable in present condition. Limitations include severe climate, unsuitable terrain or poor soil. Difficult to improve, although draining, dyking and/or irrigation can remove some limitations.
7 07	No capability for arable culture or sustained natural grazing	All lands not in class 1 to 6. Includes rockland, non-soil areas, small water-bodies.

LCA SUBCLASSES FOR MINERAL SOIL

LCA Classes, except Class 1 which has no limitations, can be divided into subclasses depending upon the type and degree of limitation to agricultural use. There are twelve LCA subclasses to describe mineral soils (Table B). Mineral soils contain less than 17% organic carbon; except for an organic surface layer (SCWG, 1998).

Table B. LCA Subclasses for Mineral Soil

LCA Subclass	Map Symbol	Description	Improvement
Soil moisture deficiency	A	Used where crops are adversely affected by droughtiness, either through insufficient precipitation or low water holding capacity of the soil.	Irrigation
Adverse climate	C	Used on a subregional or local basis, from climate maps, to indicate thermal limitations including freezing, insufficient heat units and/or extreme winter temperatures.	N/A
Undesirable soil structure and/or low perviousness	D	Used for soils that are difficult to till, requiring special management for seedbed preparation and soils with trafficability problems. Includes soils with insufficient aeration, slow perviousness or have a root restriction not caused by bedrock, permafrost or a high watertable.	Amelioration of soil texture, deep ploughing or blading to break up root restrictions. Cemented horizons cannot be improved.
Erosion	E	Includes soils on which past damage from erosion limits erosion (e.g. Gullies, lost productivity).	N/A
Fertility	F	Limited by lack of available nutrients, low cation exchange capacity or nutrient holding ability, high or low Ph, high amount of carbonates, presence of toxic elements or high fixation of plant nutrients.	Constant and careful use of fertilizers and/or other soil amendments.
Inundation	I	Includes soils where flooding damages crops or restricts agricultural use.	Diking
Salinity	N	Includes soils adversely affected by soluble salts that restrict crop growth or the range of crops.	Specific to site and soil conditions.
Stoniness	P	Applies to soils with sufficient coarse fragments, 2.5 cm diameter or larger, to significantly hinder tillage, planting and/or harvesting.	Remove cobbles and stones.
Depth to solid bedrock and/or rockiness	R	Used for soils in which bedrock near the surface restricts rooting depth and tillage and/or the presence of rock outcrops restricts agricultural use.	N/A
Topography	T	Applies to soils where topography limits agricultural use, by slope steepness and/or complexity.	N/A
Excess Water	W	Applies to soils for which excess free water limits agricultural use.	Ditching, tilling, draining.
Permafrost	Z	Applies to soils that have a cryic (permanently frozen) layer.	N/A

LCA SUBCLASSES FOR ORGANIC SOIL

Organic soils are composed of organic materials such as peat and are generally saturated with water (SCWG, 1998). Subclasses for organic soils (Table C) are based on the type and degree of limitation for agricultural use an organic soil exhibits. There are three subclasses specific to organic soils. Climate (C), fertility (F), inundation (I), salinity (N), excess water (W) and permafrost (Z) limitations for organic soil are the same as defined for mineral soil.

Table C. LCA Subclasses for Organic Soil.

LCA Subclass	Map Symbol	Description	Improvement
Wood in the profile	B	Applies to organic soils that have wood within the profile	Removal
Depth of organic soil over bedrock and/or rockiness	H	Includes organic soils where the presence of bedrock near the surface restricts rooting depth or drainage and/or the presence of rock outcrops restricts agricultural use	N/A
Degree of decomposition or permeability	L	Applies to organic soils that are susceptible to organic matter decomposition through drainage	N/A

APPENDIX D

Soil Analytical Results – AGAT Labs

Unit 120, 8600 Glenlyon Parkway
Burnaby, British Columbia
CANADA V5J 0B6
TEL (778)452-4000
FAX (778)452-4074
http://www.agatlabs.com

CLIENT NAME:	MADRONE ENVIRONMENTAL 202 - 2790 Gladwin Road ABBOTSFORD , BC V2T 4S7 (604) 504-1972
ATTENTION TO:	Gordon Butt
PROJECT:	18.0429
AGAT WORK ORDER:	18V404140
SOIL ANALYSIS REVIEWED BY:	Dana Solari, Lab Reporter
DATE REPORTED:	Nov 14, 2018
PAGES (INCLUDING COVER):	8
VERSION*:	1

Should you require any information regarding this analysis please contact your client services representative at (778) 452-4000

*NOTES
VERSION 1: Sample receipt temperature 9°C.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

Unit 120, 8600 Glenlyon Parkway
Burnaby, British Columbia
CANADA V5J 0B6
TEL (778)452-4000
FAX (778)452-4074
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18V404140
PROJECT: 18.0429

CLIENT NAME: MADRONE ENVIRONMENTAL
SAMPLING SITE:

ATTENTION TO: Gordon Butt
SAMPLED BY:

Nutrients Package 5

DATE RECEIVED: 2018-10-31

DATE REPORTED: 2018-11-14

			SAMPLE DESCRIPTION:	18.0429-01	18.0429-02	18.0429-03	18.0429-04	18.0429-05	18.0429-06	18.0429-07	18.0429-08
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29
Parameter	Unit	G / S	RDL	9666663	9666668	9666669	9666670	9666671	9666672	9666673	9666674
Available Nitrate (NO3-N)	mg/kg		2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	5.0	2.5
Available Phosphorus - P	mg/kg		1	42	7	47	12	19	15	24	24
Available Potassium	mg/kg		8	62	63	68	42	329	63	114	81
Available Sulfur (SO4-S)	mg/kg		3	11	3	9	6	33	8	7	20
pH (1:1 Extraction)	pH Units		N/A	3.95	4.24	3.97	4.12	4.31	4.11	3.75	3.82
Electrical Conductivity (1:1 Extraction)	dS/m		0.05	0.14	0.06	0.10	0.07	0.20	0.08	0.13	0.13
Organic Matter (W-B Wet Oxidation)	%		0.30	7.58	2.18	5.53	2.74	14.3	2.79	3.34	16.5

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

9666663-9666674 Analysis based on dry weight
Note: Available Nitrate-N performed by subcontracted laboratory.

Analysis performed at AGAT Calgary (unless marked by *)

Certified By: D. Solani

AGAT Laboratories
Unit 120, 8600 Glenlyon Parkway
Burnaby, British Columbia
CANADA V5J 0B6
TEL (778)452-4000
FAX (778)452-4074
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18V404140
PROJECT: 18.0429

CLIENT NAME: MADRONE ENVIRONMENTAL
ATTENTION TO: Gordon Butt
SAMPLING SITE:
SAMPLED BY:

Soil Analysis - Texture

DATE RECEIVED: 2018-10-31
DATE REPORTED: 2018-11-14

			SAMPLE DESCRIPTION:	18.0429-02	18.0429-06
			SAMPLE TYPE:	Soil	Soil
			DATE SAMPLED:	2018-10-29	2018-10-29
Parameter	Unit	G / S	RDL	9666668	9666672
Particle Size Distribution (Sand)	%		2	3	7
Particle Size Distribution (Silt)	%		2	61	53
Particle Size Distribution (Clay)	%		2	36	40
Soil Texture				Silt Clay Loam	Silt Clay

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Calgary (unless marked by *)

GP – 158

Certified By: D. Solani

Unit 120, 8600 Glenlyon Parkway
Burnaby, British Columbia
CANADA V5J 0B6
TEL (778)452-4000
FAX (778)452-4074
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AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 18V404140
PROJECT: 18.0429

CLIENT NAME: MADRONE ENVIRONMENTAL
SAMPLING SITE:

ATTENTION TO: Gordon Butt
SAMPLED BY:

Soil Salinity - Basic

DATE RECEIVED: 2018-10-31

DATE REPORTED: 2018-11-14

Parameter	Unit	G / S	RDL	18.0429-01	18.0429-02	18.0429-03	18.0429-04	18.0429-05	18.0429-06	18.0429-07	18.0429-08
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29	2018-10-29
				9666663	9666668	9666669	9666670	9666671	9666672	9666673	9666674
pH (Saturated Paste)	pH units		0.1	4.8	5.0	4.9	5.0	5.1	5.0	4.7	4.6
Electrical Conductivity (Saturated Paste)	dS/m		0.01	0.17	0.09	0.12	0.11	0.35	0.12	0.16	0.26
Saturation Percentage	%		0.5	75.4	58.9	72.4	62.5	94.8	60.7	68.9	79.0
Calcium, Soluble	mg/L		1	11	5	9	6	18	5	9	16
Potassium, Soluble	mg/L		2	<2	<2	<2	<2	17	<2	3	5
Magnesium, Soluble	mg/L		1	4	2	4	2	11	2	3	7
Sodium, Soluble	mg/L		2	13	7	6	11	15	13	11	12
Calcium, Soluble (mg/kg)	mg/kg		1	8	3	7	4	17	3	6	13
Magnesium, Soluble (mg/kg)	mg/kg		1	3	1	3	1	10	1	2	6
Potassium, Soluble (mg/kg)	mg/kg		2	<2	<2	<2	<2	16	<2	2	4
SAR (Soil)				0.85	0.67	0.42	0.99	0.69	1.24	0.81	0.63
Sodium, Soluble (mg/kg)	mg/kg		2	10	4	4	7	14	8	8	9

GP_159

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Vancouver (unless marked by *)

Certified By: D. Solani

AGAT Laboratories

Unit 120, 8600 Glenlyon Parkway
Burnaby, British Columbia
CANADA V5J 0B6
TEL (778)452-4000
FAX (778)452-4074
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: MADRONE ENVIRONMENTAL
AGAT WORK ORDER: 18V404140
PROJECT: 18.0429
ATTENTION TO: Gordon Butt
SAMPLING SITE:
SAMPLED BY:

Soil Analysis

RPT Date: Nov 14, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Soil Salinity - Basic															
pH (Saturated Paste)	9672240	IH20181	6.7	6.8	1.5%	< 0.1	97%	80%	120%						
Electrical Conductivity (Saturated Paste)	9672240	IH20181	6.14	6.29	2.4%	< 0.01	97%	80%	120%						
Saturation Percentage	9672240	IH20181	37.1	36.9	0.5%	< 0.5	100%	80%	120%						
Calcium, Soluble	9672240	IH20181	647	620	4.3%	< 1	96%	80%	120%	100%	85%	115%			
Potassium, Soluble	9672240	IH20181	16	15	6.5%	< 2	84%	80%	120%	99%	85%	115%			
Magnesium, Soluble	9672240	IH20181	196	188	4.2%	< 1	110%	80%	120%	102%	85%	115%			
Sodium, Soluble	9672240	IH20181	565	526	7.1%	< 2	97%	80%	120%	100%	85%	115%			
Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.															
Nutrients Package 5															
Available Phosphorus - P	9666670	9666670	12	12	2.5%	< 1	103%	80%	120%	94%	80%	120%	NA	80%	120%
Available Potassium	9666670	9666670	42	39	6.8%	< 8	92%	80%	120%	87%	80%	120%	87%	80%	120%
Available Sulfur (SO4-S)	9666671	9666671	33	32	2.1%	< 3	109%	80%	120%	101%	80%	120%	NA	80%	120%
pH (1:1 Extraction)	2157	6663	3.95	3.90	1.3%	N/A	101%	90%	110%						
Electrical Conductivity (1:1 Extraction)	2157	6663	0.14	0.14	NA	< 0.05	99%	80%	120%						
Organic Matter (W-B Wet Oxidation)	9666663	9666663	7.58	7.39	2.5%	< 0.30	91%	80%	120%	NA	80%	120%	96%	80%	120%
Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.															
Soil Analysis - Texture															
Particle Size Distribution (Sand)	9675844		48	48	0.0%	< 2	110%	80%	120%						
Particle Size Distribution (Silt)	9675844		29	29	0.0%	< 2	89%	80%	120%						
Particle Size Distribution (Clay)	9675844		23	23	0.0%	< 2	103%	80%	120%						
Comments: If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.															

Certified By: D. Solani

AGAT Laboratories
Unit 120, 8600 Glenlyon Parkway
Burnaby, British Columbia
CANADA V5J 0B6
TEL (778)452-4000
FAX (778)452-4074
http://www.agatlabs.com

Method Summary

CLIENT NAME: MADRONE ENVIRONMENTAL
PROJECT: 18.0429
SAMPLING SITE:

AGAT WORK ORDER: 18V404140
ATTENTION TO: Gordon Butt
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Available Nitrate (NO3-N)	SOIL 0110; SOIL 0120; SOIL 0130	SHEPPARD 2007, ALBERTA AGRICULTURE 1988	DISCRETE ANALYZER
Available Phosphorus - P	SOIL 0110; SOIL 0120; SOIL 0130	SHEPPARD 2007, ALBERTA AGRICULTURE 1988	DISCRETE ANALYZER
Available Potassium	SOIL 0110; SOIL 0120; SOIL 0131; INST 0140	SHEPPARD 2007, ALBERTA AGRICULTURE 1988	ICP/OES
Available Sulfur (SO4-S)	SOIL 0110; SOIL 0120; SOIL 0131; INST 0140	SHEPPARD 2007, KOWALENKO 1993	ICP/OES
pH (1:1 Extraction)	SOIL 0110; INOR 401 0120; SOIL 0260	SHEPPARD 2007; HENDERSHOT 2008 S	PH METER
Electrical Conductivity (1:1 Extraction)	SOIL 0110; INOR 401 0120; SOIL 0260	SHEPPARD 2007; HENDERSHOT 2008 S	CONDUCTIVITY METER
Organic Matter (W-B Wet Oxidation)	SOIL 0480; SOIL 0110; SOIL 0120	Skjemstad 2008	SPECTROPHOTOMETER
Particle Size Distribution (Sand)	SOIL 0520; SOIL 0110; SOIL 0120	JONES 2001	HYDROMETER
Particle Size Distribution (Silt)	SOIL 0520; SOIL 0110; SOIL 0120	JONES 2001	HYDROMETER
Particle Size Distribution (Clay)	SOIL 0520; SOIL 0110; SOIL 0120	JONES 2001	HYDROMETER
pH (Saturated Paste)	LAB-181-4022	BC MOE Lab Manual Section B	PH METER
Electrical Conductivity (Saturated Paste)	LAB-181-4022	BC MOE Lab Manual Section B	CONDUCTIVITY METER
Saturation Percentage	LAB-181-4022	BC MOE Lab Manual Section B	GRAVIMETRIC
Calcium, Soluble	LAB-181-4022, MET-181-6106	BC MOE Lab Manual Section B	ICP/OES
Potassium, Soluble	LAB-181-4022, MET-181-6106	BC MOE Lab Manual Section B	ICP/OES
Magnesium, Soluble	LAB-181-4022, MET-181-6106	BC MOE Lab Manual Section B	ICP/OES
Sodium, Soluble	LAB-181-4022, MET-181-6106	BC MOE Lab Manual Section B	ICP/OES

AGAT Laboratories

120 - 8600 Glenlyon Parkway
Burnaby, BC
V5J 0B6
P: 778.452.4000 • F: 778.452.4074

Laboratory Use Only

Arrival Temperature: 9°c

AGAT Job Number: 18V404160

Notes:

Chain of Custody Record

Report Information

Company: MADRONE ENVIRONMENTAL
Contact: GORDON BUTT
Address: 202-2790 GLADWIN RD. ABBOTSFORD BC
Phone: 604 504 1972 Fax: 604 504 1912
AGAT Quote #:
Client Project #: 18.0429

Report Information

1. Name: GORDON BUTT
   Email: gordon.butt@madrone.ca
2. Name:
   Email:

Report Format

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

Turnaround Time Required (TAT)

Regular TAT ☐ 5 to 7 working days
Rush TAT ☐ Day 2 - 100% ☐ Day 3 - 50% ☐ Day 4 - 25%

Date Required:

PLEASE CONTACT LABORATORY IF RUSH REQUIRED SAMPLE SUBMISSION CUT OFF FOR EFFECTIVE DATE BY 3 PM

Invoice To Same as above Yes ☑ No ☐

Company:
Contact:
Address:
Phone: Fax:
PO/AFE#:

Requirements *(Please Check)*

☐ BC CSR Soil: ☐ AL ☐ IL ☐ PL ☐ CL ☐ RL

☐ BC CSR - Water: ☐ DW ☐ AW ☐ IW ☐ LW

PARTICLE SIZE: 02 + 06
NUTRIENTS: ALL
Schedule 11 *(Please Specify)* SALINITY: ALL
CCME *(Please Specify)*
Other *(Please Specify)*

LABORATORY USE (LAB ID #)	SAMPLE IDENTIFICATION	SAMPLE MATRIX	DATE/TIME SAMPLED	COMMENTS - SITE SAMPLE INFO. SAMPLE CONTAINMENT	NUMBER OF CONTAINERS	PRESERVED (Y/N)	HAZARDOUS (Y/N)	Hold for: ☐ 60 DAYS
9646663	18.0429-01	SOIL	OCT 29: 14:00					
668	-02	"	"					
669	-03	"	"					
670	-04	"	14:15					
671	-05	"	"					
672	-06	"	14:30					
673	-07	"	"					
674	-08	"	"					

Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time
		[signature]	

Page ____ of ____

Nº: 027397

GP – 162

Document #: DIV-186 1500.003

Date Revised: July 16, 2015

AGAT Laboratories

SAMPLE INTEGRITY RECEIPT FORM - BURNABY

Work Order # 18V404140

RECEIVING BASICS:

Received From: LOOMIS Waybill #: ______

SAMPLE QUANTITIES:

Coolers: 1 Containers: 8

TIME SENSITIVE ISSUES:

Earliest Date Sampled: Oct 29, 2018 ALREADY EXCEEDED? Yes (No)

NON-CONFORMANCES:

3 temperatures of samples* and average of each cooler: (record differing temperatures on the CoC next to sample ID's) ***use jars when available**

(1) 10 + 9 + 9 = 9 °C (2) ___+___+___=____°C (3) ___+___+___=____°C (4) ___+___+___=____°C

Was ice or ice pack present: Yes (No)

Integrity Issues:

Account Project Manager: ______ have they been notified of the above issues: Yes No

Whom spoken to: ______ Date and Time: ______

ADDITIONAL NOTES:

GP – 163

APPENDIX E

Inclusion in Fill Importation Assessment reports

For each source site, the owner/operator of the receiving site should secure a written Soil Acceptance Agreement with the parties responsible for supplying and transporting soils. The agreement should specify that

1 The imported soil must not contain:

  a any contaminants in concentrations that exceed the standards in Schedule 7, Column III of the Contaminated Sites Regulation under BC's Environmental Management Act, or

  b any hazardous waste as defined in the Hazardous Waste Regulation of the Environmental Management Act,

2 The imported soil must not have been transported onto the donor site from another site,

3 The owner of the receiving site has the right to test and/or require the supplier to test for contaminants and soil texture, and to inspect the source site,

4 The supplier will provide *all* available site contamination reports pertaining to the imported soil and that at minimum a Preliminary Site investigation Phase 1 (or Stage 1) or Phase 2 (or Stage 2) report will be provided for any source site that is an industrial, government or large residential development,

5 The parties supplying/transporting soils are responsible for removing any soils and remediating any resulting contamination if the soils are found to be contaminated or if the supplier failed to supply all available site contamination reports pertaining to the imported soil, and

6 Any loads arriving at the site without proper documentation of the source of the soil and evidence of Soil Acceptance Agreement for the source site will be refused entry.

Entrance to the receiving site should be controlled and records should be maintained that identify the source of each load and the parties supplying/transporting the load. Consideration should be given to requiring security deposits from the suppliers/transporters.

APPENDIX F

STANDARD OPERATING PROCEDURE: STONY SOILS IN IMPORTED FILLS

Objective

The objective of the SOP is to ensure soils in the upper 50 cm of the fill meet stoniness standards for Class 2P limitations; that is:

A. Total coarse fragment content (>2.5 cm or 1 inch): **less than 10%;**

B. Cobbles and stones (>7.5 cm or 3 inches): **less than 1%.**

We recognize that the identification of stoniness may be difficult; therefore this SOP identifies measures at different stages in the importation of fill. Following all measures in this SOP will reduce the chance that stony soils will be incorporated in the fill.

Measures to be Implemented

Control of stoniness will be accomplished by measures implemented at

A. the source site,

B. upon entry to the receiving site;

C. at the dump site on the property.

The measures are:

1 inspect soils before dumping and keep them in separate stockpiles for either processing (stone removal) or later removal from site;

2 treat soils that have more than 1% cobbles and stones using a rake;

3 ensure that soils that have more than 10% gravel (2.5 to 7.5 cm) are buried at least 50 cm from the final grade of the fill.

Procedures

1 At **source site**. Fill with excessive coarse fragments will be identified at the source site and separated from non-stony soils. **Only non-stony soils will be delivered** to the fill site.

2 At **receiving site entrance**. All fill that contains excessive coarse fragments (based on visual inspection) will be identified upon entry and dumped separately from the fill, for removal or processing later. If stony soils are suspected in a load, this must be communicated to the project supervisor.

3 At **receiving site, at dumping site**. As fill is being dumped it must be inspected for stoniness, relative to the above standards. If the soil does not meet the standards, it must be removed from the fill and stockpiled separately for removal or processing later.

4 All separated stockpiles of stony material must be inspected, and the decision to remove or process should be made by the site supervisor.

5 All cobbles and stones greater than 7.5 cm or 3 inch diameter should be removed using the specially designed rake. After processing, the cobbles and stones should occupy less than 1% of the volume of soil. (fragments less than 7.5 cm cannot be removed by the rake).

6 If coarse fragments between 2.5 cm and 7.5 cm (1 and 3 inches) occupy more than 10% of the soil volume, after removal of cobbles and stones, the soil should only be used as a subsoil and should not be placed within 50 cm of the final grade of the fill.

The stoniness content of all fill will be assessed during routine site inspections by Madrone after every increment of 3000 m^3 fill volume (recommended volume – may be adjusted according to the project).

HEXCEL CONSTRUCTION • LTD.

7119 River Road, Delta, British Columbia V4G 1A9 Tel : 946-8744 • Fax: 946-8704

City of Richmond
6911 No. 3 Rd
Richmond, BC V6Y 2C1

June 3, 2020

RE: Soil Use for the Placement of Fill Application for the Property Located at 5800 No. 7 Road (Mahal)

To whom it may concern,

In response to the FSAAC committee motion supporting the soil deposit proposal for the property and their recommendation that we provide a performance bond to ensure the proposed Farm Plan is implemented, Hexcel Construction is prepared to provide a returnable surety bond or letter of credit in the amount of $100,000.00 specifically to ensure the implementation of the Farm Plan.

This offer is contingent upon project approval by both the City and the ALR.

If you have any questions about this matter, please contact Ron Wilson at 604-946-8744.

Sincerely,

Ron Wilson
President
Hexcel Construction Ltd

Attachment 4

TECHNICAL MEMORANDUM

Soil Source Sites for the Proposed Soil Placement at 5800 No. 7 Road, Richmond, BC

FOR:

Mr. Paul Mahal, Mahal Farms Ltd.
&
Mr. Ron Wilson, Hexcel Construction Ltd.

BY:

Jessica Stewart, P.Ag., P.Geo.
Madrone Environmental Services Ltd.

Revised: January 7, 2020

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DOSSIER: 18.0429

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TECHNICAL MEMORANDUM

Soil Source Sites for the Proposed Soil Placement at 5800 No. 7 Road, Richmond, BC

1 Introduction

The City of Richmond (CoR) has requested a technical memorandum to accompany a previously-submitted soil deposit application for 5800 No. 7 Road, Richmond (referred to as 'the Property' or 'the Site'). The memorandum will be submitted to the CoR Food Security and Agricultural Advisory Committee (FSAAC) and the General Purposes Committee (GPC) for their review when considering the project, which entails the placement of 110,000 m^3 of soil over 9.0 ha of land.

The client, Hexcel Construction Ltd. (Hexcel), has retained Madrone Environmental Services (Madrone) to prepare this memorandum. Madrone also prepared the Soil Placement Plan and Farm Plan for the Property, which is owned by Mahal Farms Ltd.[1] (Mahal Farms). Mahal Farms has hired Hexcel to manage the project on their property, including all soil sourcing and earthworks operations.

This technical memorandum is to describe the proposed soil source sites for the project. The Agricultural Land Commission (ALC) has made it a condition of soil deposit permits in general that only agriculturally-suitable soil is used, that is, soil that does not contain prohibited materials and does not result introduce new agricultural limitations to the receiving site (such as stoniness limitations, for example). The ALC does not specify what types of soil the landowner (granted approval) is to bring to the site as this is at the direction of the agrologist.

[1] Mr. Paul Mahal has been the representative of Mahal Farms for the project.

2 Project Background

2.1 Rationale and Volume

Madrone (Jessica Stewart, P.Ag. and Gordon Butt, P.Ag.) prepared a Farm Plan and Soil Placement Plan for the Property on behalf of Mahal Farms and Hexcel in March of 2019. These documents were submitted to the ALC and the CoR, along with a Schedule C (Application for Soil Removal/Fill Deposit)[2], a Traffic Management Plan, and a Cost Estimates Table (for the project). The project has not been formally reviewed by the FSAAC or the GPC at this time.

The Soil Placement Plan included an assessment of the existing agricultural limitations of the land subject to the placement proposal, which comprises approximately 9.0 ha of land in the northwest corner of the 29.5 ha property (much of the remainder of the property is farmed as nursery and greenhouse operations). Our assessment found that the current limitations are excess wetness (predominantly 4W limitation), undesirable soil structure (3D limitation), and fertility limitations due to highly acidic soils and nutrient deficiencies (4F limitation).

This area was formerly used for cranberry farming and as such, there are currently berms constructed around the entirety of the placement area. These further act to confine water in this area. We proposed improving the existing limitations by importing approximately 110,000 m^3 of soil to an average depth of 1.3 m. Hexcel has prepared drawings prepared by their land surveyor that show the proposed depths and grades of the placement.

2.2 Type of Soil to be Imported

Our plan envisions the placement of coarse-textured, preferably sandy loam or loamy sand, to promote good sub-surface drainage. Fine sandy loams and loams are also acceptable textures for placement (minor: sandy clay loam, if clay is less than 30%). **Soils should have less than 30% clay and less than 80% sand.**

The soil to be placed has been termed 'the mineral horizon' by Hexcel. The replaced native topsoil is termed 'the growing medium'. Essentially, the growing medium is elevated through placement of a **mineral** soil.

[2] https://www.richmond.ca/__shared/assets/BL809447443.pdf City of Richmond. Soil Removal and Fill Deposit Regulation. Bylaw No. 8094.

FIGURE 1. SOIL TEXTURE TRIANGLE (CANADIAN SYSTEM OF SOIL CLASSIFICATION) WITH THE IDEAL SOIL TEXTURES OUTLINED IN RED. IDEALLY, WE ARE LOOKING FOR LESS THAN 80% SAND AND LESS THAN 30% CLAY.

All topsoil on site will be salvaged and placed over the imported soil at the end of the project. If the volume of salvaged topsoil is insuffient[3] to complete the project (as determined by a professional agrologist), it may be necessary to import compost, manure, or other suitable organic-rich amendment to achieve the objectives of a final soil that will be highly suitable of supporting soil-bound agriculture (the intended farm use following placement is vegetable farming, specifically, indian vegetable varieties).

Insuffient topsoil would be determined by assessing the thickness of the re-spread native topsoil (which will most likely be done in sections as the project progresses). If the thickness is consistently less than 20 cm, we will either import additional topsoil or apply organic amendments to placed soil. **If additional topsoil is imported, this will be done such that the final volume does not exceed 120,000 m^3 (i.e. the salvaged**

[3] From our soil assessment done in 2018, we excavated eight soil pits on site and found adequate topsoil in these however, native topsoil thickness may vary outside of these assessed areas (i.e. may be less than 20 cm thick) and some may also be lost due to to inadvertent mixing with mineral soil during the salvage process. This can be minimized by ensuring salvage is complete before importing mineral soil to the site.

topsoil volume will be assessed and if required, we will adjust the total amount of mineral soil imported to the site down such that the total volume of imported mineral soil and topsoil does not exceed the permitted amount).

We understand the FSAAC and GPC have previously requested only importing **alluvial** soils to soil deposit sites. Alluvial by definition refers to loose sediments that have been eroded, transported, and deposited within a non-marine setting by water in some form. Sediments deposited by streams or rivers associated with glaciers, ice sheets, or ice caps are known as glaciofluvial sediments. These are commonly found in the Fraser Valley. By using the term 'alluvial', there may be great confusion amongst the earthworks contractor and the agrologist tasked with finding such source soils. **This will also exclude appropriate soils of glaciofluvial origin, or aeolian (wind-blown silts and fine sand) origin, for example.**

As such, I have only described ideal soil textures rather than specifying exact soil parent materials for this project. Soil textures can be assessed by an agrologist for suitability prior to importing as part of the screening process that we have implemented with Hexcel for similar projects.

Aside from soil texture, we have indicated in our Soil Placement Plan that sourced soils should have an organic matter content greater than 0.5% and less than 5% (to avoid post-deposit settlement due to decomposition of organic matter). Imported topsoil (if required) will have an organic matter content greater than 2%. Source soils with organic matter >5% should be reserved for topsoil, if brought to the site.The agrologist can make a determination of organic matter content through soil testing preferably during the screening process before the soil reaches the site (to avoid importing soils that do not meet the requirements).

2.3 Soil to be Rejected

Soils containing the following will be rejected during our screening process:

1 High clay content (generally glaciomarine, glaciolacustrine in origin), i.e. greater than 30% clay, including silty clay loams, clay loams (clay soil has never been observed by Madrone in the field in Richmond);

2 High organic content (peat soils such as Humisols, Mesisols, or Fibrisols, which are found in abundance in Richmond, are at or near 100% organic matter);

3 Excessive (i.e. >20% by total volume) quantities of coarse fragments (sized 2.5 cm or greater) – coarse gravels should comprise less than 10% by volume if placed in the upper 0.5 m of the deposit[4]. Cobbles (7.5 – 25 cm) and stones (>25 cm) should comprise less than 1% to meet a Class 2P limitation for stoniness. If stony soils are unintentionally brought onto the site, the soils should be raked or sorted to remove the stones. A standard operating procedure (SOP) has been provided to Hexcel in a separate document and can be supplied to the FSAAC and the GPC if requested. A higher percentage of coarse fragments can be placed below 0.5 m (i.e. 20% maximum);

4 Materials prohibited by the Agricultural Land Commission Act - Agricultural Land Reserve Use Regulation[5], including:

   a. Construction or demolition waste, including masonry rubble, concrete, cement, rebar, drywall and wood waste;
   b. asphalt;
   c. glass;
   d. synthetic polymers;
   e. treated wood;
   f. unchipped lumber.

Currently, there is a large number of potential soil source sites being brought to our attention in the screening process that are small property parcels featuring recently-demolished residences. I strongly advise avoiding these sites for future projects as frequently, there is demolition debris mixed in the soil. Screening this material is possible but due to the small size of the parcels, may not be worth the effort for a small volume of recovered soil.

---

[4] The Land Capability Classification for Agriculture in B.C. MOE Manual defines stoniness as the sieved portion of of coarse fragments in the upper 25 cm. We have expanded this to the upper 50 cm of the horizon, which is beyond the current criteria by 25 cm. https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/land_capability_classification_for_agriculture_in_bc_1983.pdf

[5] http://www.bclaws.ca/civix/document/id/complete/statreg/30_2019#section36 ALC Act – Land Use Reserve Regulation. Accessed December 16, 2019

3 Proposed Source Sites

At this time, Hexcel has numerous projects it is undertaking within the City of Richmond and in adjacent municipalities, including Delta and Burnaby. These projects include development sites at hospitals, marinas, old shopping centres, and post-secondary institutions.

We (Hexcel and Madrone) jointly propose that soil will come from development sites that contain predmoninantly mineral soil that is primarily sandy in texture (see Figure 1 for reference). Development sites in peat bogs (organic soils) and industrial lands should be rejected as there is a low probability that these sites will yield favourable soils for the project. Commercial sites (such as parking lots and marina's) may be suitable if at least a Phase 1 study has been conducted and shown the probability of contamination to be low, and the soil has been buried by concrete or asphalt that is stripped away prior to excavations.

Source sites should be free of invasive species, in particular, Japanese knotweed (*Fallopia japonica*) and Scotch broom (*Cytisus scoparius*).

Currently, Madrone conducts source site screening on behalf of Hexcel. These sites are assessed prior to importation for the following conditions:

1. Whether invasive species are present on the site, in particular, if they are situated near excavations;
2. Whether there are prohibited materials mixed in the soil (i.e. demolition debris); and
3. Whether the soil is texturally suitable as a mineral horizon, specifically, does not contain more than 30% clay, more than 80% sand, and does not comprise purely peat soils (organic matter less than 5% for mineral soil).

If the following conditions are found, we advise the landowner, the City of Richmond, and the earthworks contractor in writing and recommend rejecting the site. Furthermore, Madrone conducts a desktop environmental site assessment (which we call a Phase 1-lite) for each site if a Phase 1 study has not been conducted already (for larger sites, this generally has already been done and as such, we greatly prefer these sites for source soils. I expand on this in Section 4, below).

4 Hexcel – Proposal to Import Only Richmond Soils

Hexcel has expressed interest in importing soils only from within the City of Richmond to its various project sites (including the subject Property for the placement proposal). The rationale for this is to reduce the volume of soil leaving the city limits for projects in other municipalities, particularly in the Fraser Valley.

Obtaining soils from more distant sources comes with significant environmental and social costs, such as increased vehicle emissions due to extensive travel, and increasing congestion on Highway 1 in the Fraser Valley due to increased truck traffic. Furthermore, due to the long distances that the material is transported, we cannot verify in a timely fashion where the material actually came from (i.e. same day screening is difficult if source and receiving sites are several hours apart). There is also considerations of wear and tear on Highways and roadways between municipalities if material is trucked long distances.

Madrone supports this proposal for several reasons:

1 **The number of source sites is drastically reduced due to large size of the projects that these soils originate from.**

For example, the Atmosphere project at No.3 Road and Alderbridge Way will produce over 200,000 m^3 of soil, according to Hexcel's calculations. These is nearly double the soil that we require for the 5800 No. 7 Road placement project. Although some soil may be rejected (due to containing, for example, contaminants or high volumes of coarse fragments which tends to be gravel placed during construction), much of the soil for the project could be sourced from these sites.

A reduction in the number of source sites will assist the agrologist greatly in their screening efforts. There will certainly be Phase 1 environmental Site Assessments (ESA) for projects of this scale, which would negate the need for soil testing. The agrologist will not be required to travel long distances to assess multiple sites, which can be time-consuming and cost-prohibitive to the clients and landowners.

2 **Reduction in time to complete the project.**

The ALC has recently reduced the timelines it allows for soil placement projects, from 3 years to 2 years. Therefore, it is imperative that soil is sourced quickly and efficiently. If soil can be sourced locally from large projects, the time it will take to complete the project will be greatly reduced. There will be less travel time for trucks due to the shorter distances.

A reduction in project time will also correlate to a reduced nuisance to locals who oppose truck traffic around the project area, lower costs to the client and landowner (who are required to pay for earthworks, screening by an agrologist, safety controls on the road ect.), and reduced time between topsoil stripping and replacement (topsoil stockpiles left over multiple years will be subject to erosion and reduction in organic content due to lack of vegetative cover).

Please contact the undersigned with any questions regarding this memorandum.

This is a digitally signed duplicate of the official manually signed and sealed document.

Jessica Stewart, P.Ag, P.Geo.

Attachment 5

TECHNICAL MEMORANDUM

Drainage and Suitability of Excess Water Management Options for Proposed Soil Placement at 5800 No. 7 Road, Richmond, BC

FOR:

Mr. Paul Mahal, Mahal Farms Ltd.
&
Mr. Ron Wilson, Hexcel Construction Ltd.

BY:

Thomas R Elliot PhD P.Ag P.Geo.
Jessica Stewart, P.Ag., P.Geo.
Madrone Environmental Services Ltd.

January 27, 2020

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TECHNICAL MEMORANDUM

Drainage and Suitability of Excess Water Management Options for Proposed Soil Placement at 5800 No. 7 Road, Richmond, BC

1 Introduction

The City of Richmond (CoR) has requested a technical memorandum pertaining to drainage and suitability of water management options to accompany previously-submitted soil deposit application for 5800 No. 7 Road, Richmond (referred to as 'the Property' or 'the Site'). The memorandum will be submitted to the CoR Food Security and Agricultural Advisory Committee (FSAAC) and the General Purposes Committee (GPC) for their review when considering the project, which entails the placement of 110,000 m^3 of soil over 9.0 ha of land.

The client, Hexcel Construction Ltd. (Hexcel), has retained Madrone Environmental Services (Madrone) to prepare this memorandum. Madrone also prepared and previously submitted: Soil Placement Plan, Farm Plan, Traffice Management Plan, and a Soil Source Site Technical Memo for the Property, which is owned by Mahal Farms Ltd.[1] (Mahal Farms). Mahal Farms has hired Hexcel to manage the project on their property, including all soil sourcing and earthworks operations. Hexcel is experienced at managing such projects (both type and scale) within the City of Richmond.

[1] Mr. Paul Mahal has been the representative of Mahal Farms for the project. He is a third-generation farmer – his family has farmed this property continuously since 1949.

The Soil Placement Plan included an assessment of the existing agricultural limitations of the land subject to the placement proposal, which comprises approximately 9.0 ha of land in the northwest corner of the 29.5 ha property (much of the remainder of the property is farmed as nursery and greenhouse operations). Our assessment found that the current limitations are excess wetness (predominantly 4W limitation), undesirable soil structure (3D limitation), and fertility limitations due to highly acidic soils and nutrient deficiencies (4F limitation). A 4W limitation is defined as:

> *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, or the soil is very poorly drained.*[2]

This technical memorandum is to describe the local drainage conditions and suitability of water management options for the Property. The Agricultural Land Commission (ALC) generally requires that soil deposit operations result in an improvement of the existing limitations to the prominent Land Capability for Agriculture ('Land Capability'), and does not result introduce new agricultural limitations to the receiving site (such as stoniness limitations, for example). The ALC does not specify how to accomplish an improvement to the assessed existing Land Capability, as this is at the direction of the Property owner, Farm Operator and their consulting Qualified Professional (QP) Agrologist(s).

2 Project Background

2.1 Context of Property Drainage Conditions

The property is bound to the north by Mayfair Lakes Golf and Country Club, to the west by No. 7 Road, to the south by Westminster Highway, and to the east by a dense residential area. There are drainage ditches to the south, east and west; and a significant drainage ditch to the north.

There are no nearby watercourses (natural streams, rivers, groundwater springs) which would cause inundation due to flood waters.

[2] Land Capability Classification for Agriculture in BC, 1983. https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/land_capability_classification_for_agriculture_in_bc_1983.pdf

The excess water limitation to agriculture, noted in the previous Madrone Farm Plan and Soil Placement Plan, results from high local groundwater conditions and poor regional conveyance of water within drainage infrastructure due to the low-lying, and therefore low-gradient, context.

Historical aerial photo review presented in the Madrone Soil Placement Plan demonstrates a history of excess water that was previously used for cranberry farming. Since approximately 1991, farm operations appear to move away from Cranberries and a central ditch-line was established to further address the excess water condition. However, the historic drainage activities on the Property have not resolved the excess water condition, made apparent by late planting season surficial water observable in aerial imagery dating as far back as 1949.

From the review of historic aerial imagery and historic crop types (grown on the Property), it is apparent that the Property has been subject to excess water conditions for much of the historic use as a farm-plot. Furthermore, it is likely that the changing precipitation timing and volumes associated with Climate Change impact current agricultural land capability, which will only increase in the future as per predictions[3] adopted by the Province of BC.

The proposed soil placement area is contained within previously-constructed soil berms[4] (in the 1940's) intended to facilitate flooding of cranberries during the fall wet-harvest. The berms cannot be deconstructed without significant impacts to surrounding drainage infrastructure, such as the ditch on No. 7 Road. Removing the berm material (which is compacted soil) would require a soil removal permit with the CoR. Removing the berms would also not improve the high water tables evidently persisting in this area, nor would this result in improvement to the remaining assessed agricultural limitations of nutrient deficiencies and high acidity (4F) and undesirable soil structure (3D limitation).

2.2 Applicable Regulations

The Agricultural Environmental Management Code of Practice (AEMCoP) Division 4 (Section 48 – 60) governs the land application of nutrient sources to agricultural parcels

[3] PCIC Climate Prediction Portal: https://pacificclimate.org/analysis-tools/pcic-climate-explorer

[4] These are not dykes – dykes are for flood protection (i.e. Fraser River freshet) whereas these berms were constructed to contain water pumped into the field to harvest cranberries in the fall.

experiencing excess water conditions. Specifically, Section 49 (Prohibitions on applications to land) of the AEMCoP indicates that:

> *(1) A person must not apply nutrient sources to land*
> ***(a) on which there is standing water or water-saturated soil,***
> *(b) on ground in which the top 5 cm of soil is frozen so as to be impenetrable to manually-operated equipment,*
> *(c) on a field having at least 5 cm of ice or snow over at least 50% of its area, or*
> ***(d) at a rate of application, under meteorological, topographical or soil conditions, or in a manner, that may cause nutrient sources or contaminated runoff, leachate or solids to enter a watercourse, cross a property boundary or go below the seasonal high water table.*** [emphasis is added]

After clarification with the Ministry of Environment and Climate Change Strategy (MoECCS), it was determined that:

- Inundation due to flooding does not discount application of nutrient sources (fertilizers, compost, wood residue, etc.), which allows for continued use of floodplains as agricultural lands so long as nutrients are not applied during flood-conditions;
- Seasonal high water table at, near or above ground surface would restrict land application of nutrient sources both during times of water table being above ground surface, but also during periods of generally high water table whereby precipitation/infiltration/dispersion would result in direct transmission of nutrients to groundwater/nearby watercourse[5].

Since the utilization of agricultural land generally requires addition of nutrient sources to ensure economic growth of crops (particularly following continuous harvest, which depletes the soil of nutrients), and the Property context discussed in Section 2.1 of this document (specifically the definition of the 4W limitation) characterizes a land parcel subject to excess water conditions, it is apparent that AEMCoP Section 49(1)(d) does prohibit nutrient application within the critical early- to mid-season vegetative growth fertilization window. This prohibition limits the potential crop types to short-season forage and grains, and further restricts the timing of nutrient application which may result in application timing that does not coincide with crop demand. It is noted that the

[5] It is noted by Madrone that planners at the the City of Richmond define all ditches within the city as watercourses (i.e. watercourse crossing application required for all ditch crossings such as driveway crossings and culverts) due to the low-lying topography and connectivity to the Fraser River and numerous, intermediate fish-bearing tributiaries.

property directly across from the Mahals (the May family farm, at 5031 No. 7 Road) is in fact, currently farmed for forage and grains. This is readily visible on aerial imagery on Google™Earth Pro and recent airphoto imagery from the City of Richmond Interactive Map (RIM)[6].

2.3 Excess Water Management Options

2.3.1 Subsoiling & Drainage Ditching

Subsoiling is the careful disruption of massive soil structure that otherwise restricts infiltration and lateral movement of water within soil. It is typically most effective for soils that were deposited under marine or lacustrine conditions that have subsequently experienced a decrease in the regional water table. Subsoiling is a temporary improvement to infiltration and subsurface conveyance because the subject soils are typically fine-grained (e.g. silt or clay), which 'heal' or reconstitute as a massive unit (following saturation) which has a low level of infiltration and conveyance.

Subsoiling is best paired with incorporation of organic matter and potentially soil amendments (sand, gypsum, etc.) which will support development of a granular soil structure that facilitates infiltration and subsurface conveyance. Subsoiling is conventionally utilized where there is ditching to receive the newly mobilized water, which then conveys the water emerging to surface toward larger watercourse (such as the Fraser River) or the ocean.

2.3.2 Drainage Tile

Drainage Tile[7] is a series of perforated pipes, often within a fabric filter 'sock' to prevent mobilization of fine-grain silt/clay particles, installed at depth to collect and convey subsurface water to ditching along a 1 – 2% gradient. Drainage tile functions entirely through subsurface conveyance of water to the perforated pipe, and subsequent gravity-driven drainage to ditching. The spacing of drainage tile is adjusted based on the soil texture, while the depth is varied depending on local water table elevation and intended crop type. Drainage tile does not function when the water level in the receiving drainage ditch is higher than the drainage tile.

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[6] https://maps.richmond.ca/rim/ City of Richmond – Richmond's Interactive Map (RIM).

[7] The term 'Drainage Tile' is becoming an outdated term in agriculture but it is used frequently by the ALC.

2.3.3 Berm & Pumping

Berming is intended to prevent floodwater (i.e. overland water) from inundating a land parcel. Berming is ineffectual when addressing excess groundwater emerging to surface, as the source of water (i.e. the water table) continues to contribute to the land parcel – potentially at a rate which is greater than the rate of evacuation. Evacuation is typically driven by 'trash pumps' which are high volume discharge pumps driven by an Internal Combustion Engine (ICE).

While it is possible to artificially suppress a local groundwater table through a combination of drainage tile & ditching (i.e. collection of water), berming (i.e. prevention of overland inundation), and evacuation via pumping – it must be noted that continuous operation of ICE pumps to achieve this is not an acceptable best practice for agriculture due to issues of reliability, local hydrologic function, and cost. Furthermore, the location receiving evacuated water must be able to accommodate the volume, and if not there is a high likelihood that the evacuated waters will impact other agricultural operators in the area or re-inundate the land parcel due to an increased hydraulic gradient/water level that would overwhelm the berm or subsurface hydraulic conveyance.

2.3.4 Soil Placement

The removal of topsoil, placement of soil with suitable quality for agricultural purposes, and replacement of salvaged topsoil (the 'growing medium', now elevated) generally increases the land level above the regional water table, and the resulting capillary fringe within the placed soil. The disrupted native topsoil is often recommended to receive soil amendment with organic matter and be subject to a rotational nitrogen-fixing cover-crop under no-till conditions for a period of 1 to 3 years in order to re-establish soil structure and function. After which, assessment of drainage conditions and soil structure will guide any further requirement for water management infrastructure, such as installation of drainage tile.

It is critical to recognize that placement of quality soil is a solution to excess water conditions resulting from a high local water table that permanently addresses the agricultural limitation. Further, Soil Placement – when Climate Change is accounted for by the QP Agrologist making recommendations on depth of placed soil – is a method of Climate Adaptation that does not require continual input beyond initial establishment.

3 Suitability of Excess Water Management Options for 5800 No. 7 Road

3.1 Subsoiling & Drainage Ditching

The local excess water conditions are driven by seasonal high water tables and sustained by low conveyance within the regional drainage network. As such, the water table at or near surface during the planting and initial fertilization windows prevents machine access and, according the AEMCoP S.49, early- to mid-season nutrient application.

Subsoiling and drainage ditching within 5800 No.7 Road has a low level of suitability due to the excess waters mobilized (via subsoiling) and accumulated (via ditching) within the agricultural parcel being unable to drain from the area due to the limitation in regional conveyance.

Therefore, subsoiling and drainage ditches will result in 5800 No.7 Road – having a 4W limitation – being out-of-compliance with AEMCoP should the Farm Operator attempt to grow economic crops (such as Indian vegetables discussed in the Farm Plan prepared for CoR) that require nutrient application during the early- to mid-season.

This method of excess water management is not recommended.

3.1.1 Drainage Tile

Similar to the issue of subsoiling and drainage ditching wherein regional conveyance limits efficacy, the installation of drainage tile will result in 5800 No.7 Road – having a 4W limitation – being out-of-compliance with AEMCoP Section 49 should the Farm Operator attempt to grow economic crops that require nutrient application during the early- to mid-season.

This method of excess water management is not recommended.

3.1.2 Berm & Pumping

Due to 5800 No.7 Road being subject to excess water resulting from high seasonal water tables, the inability of regional drainage network to convey evacuated waters, and the reliability/cost – the use of berms and pumping is poorly suited to improve the excess water limitation. Furthermore, unless pumping is continued throughout the growing season, the land parcel will be prohibited from receiving nutrient application in accordance with AEMCoP Section 49.

This method of excess water management is not recommended.

3.1.3 Soil Placement

The context of 5800 No.7 Road provides for soil placement that will have low impact to local hydrology, no displacement of water to adjacent agricultural land, and a permanent improvement to the Class 4W limitation to agricultural capability. This excess water management option is the only pathway which will allow the farm operator to pursue economic crops which require nutrient application while meeting Section 49 of the AEMCoP.

Soil placement is the recommended method of excess water management for 5800 No.7 Road.

Please contact the undersigned with any questions regarding this technical memorandum.

**This is a digitally signed duplicate of the official manually signed and sealed document.* 	**This is a digitally signed duplicate of the official manually signed and sealed document* 
Thomas R Elliot PhD P.Ag P.Geo.	Jessica Stewart, P.Ag, P.Geo
Hydrologist	

Soil Use for the Placement of Fill Application for the Property Located at 5800 No. 7 Road (Mahal)

Cost Estimates	
Erosion Sediment Control Installation	**$35,000**[i]
Ongoing Project Reporting by Agrologist (per 3,000m^3)	**$12,000 ($500 per month typical, can be up to $1,000 per month if more visits required)**
Earthworks costs (Project management, load inspector, machine/labour costs, fuel, traffic management)	**$29,120 per month OR $720,000**
Farm Plan implementation	**$160,000**
ALC application fee (if proposal is forwarded to the ALC)	**$1,500**
Final topographic survey	**$5,000**
Final Agrologist Report	**$2,000 - $3,000**
Final Geotechnical Report (if required)	**$2,000 - $4,000**
Project Cost Estimate (does not include upfront costs)	**$940,000***
Upfront Cost to Date	**$13,500****
Potential Tipping Fee Income ($85-$95 per load)	**$1,335,714 – $1,492,857 (estimate)**

[i] Installation costs depends on the duration of project and the materials, supplier and the labour required to install and repair when required/needed

*Proponent has estimated that this project will take approximately two (2) years to complete. Costs will not be consistent every month (i.e. earthworks may be reduced in the winter during high precipitation events which correlates to reduced soil importation activity)

**Upfront costs include Farm Plan, Soil Placement Plan, Traffic Management Plan, two technical memorandums and City application fee