ATTACHMENT 7

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SOIL SUITABILITY ANALYSIS

5753 Menzies Road, Duncan BC

PREPARED FOR:

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PREPARED BY:

MADRONE ENVIRONMENTAL SERVICES LTD.

February 15, 2024

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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SOIL SUITABILITY ASSESSMENT

5753 Menzies Road, Duncan BC

1 Introduction

Mr. Keith Grey ("the Client") has retained Madrone Environmental Services Ltd. ("Madrone") to complete a soil suitability analysis for his farm located at 5753 Menzies Road in Duncan, BC. The farm has an area of about 9.0 ha (22.3 acres) and is hereafter referred to as "the Property".

The Property is located within the provincial Agricultural Land Reserve (ALR)[1] and is therefore subject to the *Agricultural Land Commission Act* (ALC Act) and the *Agricultural Land Reserve Use, Subdivision and Procedure Regulation* (BC Regulation 171/2002; 'the Regulation'), in addition to the bylaws of the District Municipality of North Cowichan ("the Municipality").

The Client has requested that Madrone complete a soil suitability analysis to seek the approval of the Municipality to submit a Non-Adhering Residential Use Application to the ALC. The client intends to build a second additional dwelling (as defined by the ALC) on the Property.

Madrone has prepared reporting as part of the soil suitability analysis under reporting standards detailed in ALC Policy P-10[2] to facilitate the Client's application to the Municipality and ALC. The field investigator for this LCA Assessment and primary author of this report is Francis Durnin-Vermette, M.Sc., A.Ag., of Madrone. Mr. Durnin-Vermette was supervised on-field by qualified Professional Agrologist Harry Williams, P.Ag. Senior review was conducted by Gordon Butt, P.Ag. All Madrone qualified professionals (QPs) involved in this project are registered to practice with the BCIA and are in good standing with their professional organization.

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[1] Agricultural Land Commission. (n.d.). *Is My Property in the ALR webtool*. Retrieved August 22, 2023, from https://governmentofbc.maps.arcgis.com/apps/webappviewer/index.html.

[2] Agricultural Land Commission (2017). ALC Policy P-10 – Criteria for Agricultural Capability Assessments. Retrieved August 22, 2023, from https://www.alc.gov.bc.ca/assets/alc/assets/legislation-and-regulation/policies/alc_-_policy_p-10_-_criteria_for_agricultural_capability_assessments.pdf.

2 Background Information

2.1 Location and Assessment Area Description

The Property (9.0 ha, 22.3 acres) is located on 5753 Menzies Road in Duncan, BC. Civic information for the parent parcel of the assessment area, provided by the Municipality[3], is summarized below in **TABLE 1**. An orthographic aerial view map showing the Property and the surrounding area is presented in **FIGURE 1**. A closer look at the Property is presented in **FIGURE 2**. According to mapping provided by the ALC[4], the entirety of the assessment area is zoned for agriculture and is entirely within the ALR. The Property is bordered on the west side by Menzies Road and is otherwise surrounded by parcels in the ALR. Access to the hay field on the back of the property is through a gravel driveway extending from Menzies Road to the southern edge of the property. This is also to be the driveway for the proposed dwelling.

FIGURE 1.OVERVIEW OF DUNCAN. THE PROPERTY IS OUTLINED IN RED. FROM GOOGLE EARTH.

[3] District of North Cowichan (2023). North Cowichan Interactive Map. Retrieved December 19 2023 from https://www.northcowichan.ca/municipal-services/maps

[4] Agricultural Land Commission (2023). ALR Property and Map Finder. Retrieved December 19 2023 from https://www.alc.gov.bc.ca/alr-maps/.

FIGURE 2. AERIAL VIEW OF THE PROPERTY (OUTLINED IN RED). FROM GOOGLE EARTH.

TABLE 1. CIVIC INFORMATION FOR THE PROPERTY PROVIDED BY THE MUNICIPALITY.

CIVIC ADDRESS	5753 Menzies Rd
LAT/LONG	48.780318°, -123.770074°
PID	009-648-941
AREA	9.03 ha (22.3 acres)
LEGAL	PT SEC 17 R1 LYING N OF PL 5037 & E OF MENZIES RD EXC PLS 6901 BL521
ZONING	A1
ALR?	Yes

2.2 Climate

The nearest Environment Canada weather station with complete historical weather data[5] (1981 to 2010 Climate Normals; 30-year average) is Duncan Kelvin Creek Station (ID 1012573), located approximately 5.92 km away from the Property at an elevation of 1 m above sea level (masl). Weather station reports for this station are summarized below in **TABLE 2**. Frost-free days and effective growing degree days data were taken from the *Climate Capability Classification for Agriculture in British Columbia*[6] developed by the Ministry of Environment.

TABLE 2. 1981 TO 2010 CLIMATE NORMALS REPORTED BY DUNCAN KELVIN CREEK STATION (ID 1012573).

Parameter	Climate Normals
Annual precipitation (mm)	1361.2
Annual Rainfall (mm)	1289.2
Frost Free Period (FFP, average days)	164
Effective Growing Degree Days (EGDD, base temperature >5°C)	1158
Daily yearly average temperature (°C)	10.1
Days of precipitation (yearly; days with >5 mm rain)	75.2

[5] Government of Canada. (2023). Canadian Climate Normals 1981-2010 Station Data. Retrieved August 23th, 2023, from https://climate.weather.gc.ca/climate_normals/.

[6] British Columbia Ministry of Environment. (1981). *Climate Capability Classification for Agriculture in British Columbia*. Retrieved August 23th, 2023, from https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/climatic_capability_for_agriculture_in_bc_1981.pdf.

Based on the above information, the assessment area has been mapped as Climate Capability Class 1 (Frost free period greater than 150 days in coastal areas and the effective growing degree days is greater than 825 for coastal areas). Climatic Capability Class is a shorthand ranking of specific limitations denoted by letters and preceded by numbers between the ideal (ranking of 1) and untenable (ranking of 7) indicating the severity of the limitation.

2.3 Topography and Geology

The elevation of the Property varies from 68 to 82 masl according to Google Earth elevation profiles. Topography across the Property varies from plains (0 - 5% slope) to moderate slopes (27 – 49%).

Geological bedrock mapping[7] indicates that the assessment area overlies Nanaimo Group undivided sedimentary rocks. Above this, surficial geology mapping indicates that the Property overlies Cenozoic marine deposits consisting of silt, clay, stony clay, and till-like mixtures with thicknesses up to 75 ft[8].

2.4 Mapped Hydrology and Drainage

Watercourse mapping provided by the City[9] indicates that there is one mapped watercourse within the boundary of the Property. On provincial maps the stream is labelled as Ironwood Creek, but Habitat Wizard has mapped it under the name Currie Creek. Streams in BC are defined geometrically according to Strahler stream order and stream magnitude[10]. Stream order describes the hierarchical position of the stream within the river system, with higher numbers indicating streams more closely connected to the watershed outlet. Stream magnitude is a count describing the number of tributaries flowing into a given stream segment. Ironwood Creek (or Currie Creek) has stream order 2 and magnitude 4 with stream length 12.72 km. The BC Ministry of Environment Stream Report[11] for the watercourse indicates that coho salmon, cutthroat trout, and steelhead have all been observed in the creek in the '80s.

2.5 Provincial Soils and Land Capability for Agriculture (LCA) Mapping

Note that provincial soils and agricultural capability mapping was done over a large area at a small scale (1:20,000) and was very likely not field verified. On the other hand, field investigations that involve

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[7] Government of British Columbia (2022). IMapBC - Geological Bedrock Layer. Retrieved August 23, 2023, from https://maps.gov.bc.ca/ess/hm/imap4m/.

[8] Geological Survey of Canada (1966). Map 14-1965. Surficial Geology of Duncan, British Columbia. Retrieved November 28, 2023, from https://cmscontent.nrs.gov.bc.ca/geoscience/PublicationCatalogue/GeoscienceMap/BCGS_GM2010-02.pdf

[9] Metro Vancouver (n.d.). *Sensitive Ecosystem Inventory Mapping Tool.* Retrieved August 23, 2023, from https://gis.metrovancouver.org/mvmaps/SEI.

[10] https://www2.gov.bc.ca/assets/gov/data/geographic/topography/fwa/fwa_user_guide.pdf

[11] Ministry of Environment Stream Survey, accessed August 23, 2023, from https://a100.gov.bc.ca/pub/reports/rwservlet?habitat_wizard_streams_report&p_title=%22Ministry%20of%20Environment%22&P_STREAM_ID=885683.

detailed soil descriptions (such as this project) should always be more accurate than generalized mapping products. The broad interpretation of soils and agricultural capability in this section does not take precedence over the site-specific field assessment in this report.

Provincial mapping (visualized in FIGURE 3) indicates that the Property consists of soils conforming to the Fairbridge Series. The physical properties of this soil series is provided in **TABLE 3**[12]. The corresponding agricultural capability rating is a Class 4 Aridity limitation (**4A**). The aridity (A) limitation applies to soils where crops are adversely affected by water insufficiency, either due to low precipitation or low water holding capacity, during the growing season.

Class 4 lands contain limitations which make it suitable for only a few crops, or the yield for a wide range of crops is low, or the risk of crop failure is high, or soil conditions are such that special development and management practices are required. The limitations may seriously affect one or more of the following practices: timing and ease of tillage, planting and harvesting, and methods of soil conservation.

FIGURE 3. PROVINCIALLY MAPPED SOILS AND LAND CAPABILITY FOR AGRICULTURE (LCA) RATINGS FOR THE PROPERTY. FROM GOOGLE EARTH.

TABLE 3. OVERVIEW OF PROVINCIAL SOILS AND LAND CAPABILITY FOR AGRICULTURE (LCA) MAPPING OF THE PROPERTY.

Soil association	Classification	Defining Characteristics	Associated Agricultural Limitations
Fairbridge	Gleyed Eluviated Dystric Brunisol	• Silt loam • Imperfectly drained • No coarse fragments • Undulating topography (2-15% slope) • Silty marine blanket parent material	4A

[12]BC Ministry of Environment. (1981). *Soils of Southeast Vancouver Island Duncan-Nanaimo Area MOE Technical Report 15*. Retrieved December 19 2023 from https://www.env.gov.bc.ca/esd/distdata/ecosystems/Soils_Reports/bc57_report.pdf#page=100

3 Field Investigation

Francis Durnin-Vermette, A.Ag. of Madrone and Harry Williams, P.Ag. of Madrone visited the Property for a field assessment on December 18, 2023. The soil suitability analysis consisted of the characterization of two detailed soil pits within the agricultural area of the property (SP1 and SP2 shown in **FIGURE 4**). SP1 was located on the proposed building site of the additional dwelling, and SP2 was located on agricultural soils used by the Client to grow orchard hay. The proposed building site was located by the Client for two main reasons:

1. The Client thought the location was the least-productive agricultural area of the Property, and therefore would be suitable to be used as the location of a dwelling, and
2. It was close to the southern edge of the property, where a farm road is planned to be built for access to the back of the farm and to the proposed building.

FIGURE 4. LOCATIONS OF SOIL PITS (SP) 1 AND 2 DUG AS PART OF FIELD INVESTIGATION, AS WELL AS A SITE PLAN BASED ON COMMUNICATION FROM THE CLIENT. THE APPROXIMATE PROPERTY IS OUTLINED IN RED. FROM GOOGLE EARTH

Photos taken during the field assessment showing the landscape and current land-use on the Property are presented in *Appendix D*. We confirmed that the structures and land-use observed in recent aerial imagery (dated 2023) conform to present conditions. No streams were observed on the assessment area. At the time of the site visit, the assessment area contained a large field planted with grass.

3.1 Climate Capability and Soil Moisture Balance

Site-specific climatic capability for agriculture was determined using field observations from the five test pits which were similar and assumed to be representative of the climatic influence on soils distributed throughout the assessment area. Soil texture from detailed soil pits, estimates for coarse fragment content, and soil moisture class were used in conjunction with regional climate data to calculate the available water storage capacity (AWSC) and soil moisture deficit (SMD) values for the upper 50 cm of each of these soil profiles. The results were used to determine Site-specific climatic and soil capability ratings for agriculture in the assessment area which have been summarized in *Appendix B*. A description of agricultural/climatic capability classifications are found in *Appendix C*.

3.2 Soil Characteristics

Soil classification at field test pits (*Appendix A*) on the assessment area indicate that the field-verified soils conform to the description of the Fairbridge soil association across the agricultural area of the Property.

Soils of the Fairbridge soil association are typically classified as Gleyed Eluviated Dystric Brunisols. They are imperfectly to moderately well drained with a typical surface texture of silt loam that grades to silty clay loam at depth. Fairbridge soils are typically free of coarse fragments. They frequently have a perched water table in the winter months evidenced by mottling below 50cm. Dense subsoil layers restrict perviousness and may present a root restricting layer if the soil is shallow enough.

In our field assessment SP1 was determined to be a Gleyed Dystric Brunisol, and SP2 was determined to be a Gleyed Sombric Brunisol. In a basic sense, this means that SP2 evidenced a deeper and richer topsoil that is more productive and is more appropriate for farming. SP1, on the other hand, displayed evidence of a seasonally perched water table up to 20 cm below the surface, poorer drainage, and poorer structure. We took samples of the soils for fertility analysis at a depth of 20 to 30 cm. The results from this analysis are in *Appendix D*. These results indicate that SP1 contains less plant nutrients (N, P, K) and organic matter than SP2. In general, this means that the soils in SP1 are less fertile than SP2.

3.3 Revised Land Capability for Agriculture

In total, *two LCA polygons has been delineated for the agricultural area of the Property* (**FIGURE 5**) which have been assigned unimproved and improved LCA ratings in **TABLE 4**. This LCA polygon does not conform to what has been previously mapped in the area by the Province. The revised LCA for the Properties was determined by information collected from both soil test pits (SP1 to SP2), and the assessment of local landforms, drainage, and vegetation. Madrone used information such as landscape, vegetation and topography to infer the likely LCA from the presumed soils present.

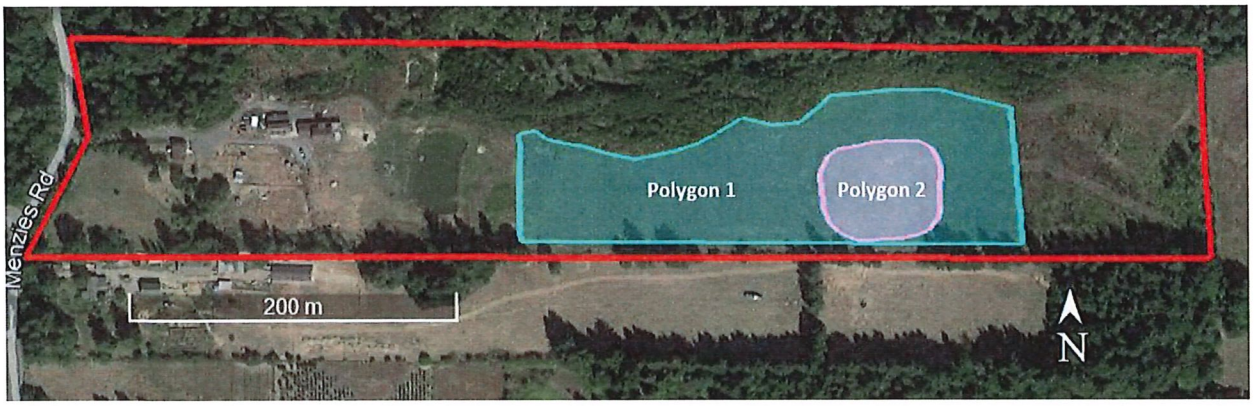

FIGURE 5. REVISED POLYGONS OF SOIL SERIES AND AGRICULTURAL CAPABILITY FOR ASSESSMENT AREA. DESCRIPTIONS FOR POLYGONS 1 AND 2 ARE GIVEN IN TABLE 4. FROM GOOGLE MAPS.

TABLE 4. OBSERVED SOIL CHARACTERISTICS AND REVISED LCA RATINGS BASED ON FIELD ASSESSMENT.

Soil polygon (ha/% of total Property)	Predominant soil association	Soil classification (subgroup)	Distinguishing characteristics	Unimproved LCA rating	Best improved LCA rating
Polygon 1 2.21 ha (24%)	Fairbridge	Gleyed Sombric Brunisol	Very high water holding capacity; highly productive upper horizons; 10% fine gravel content in the upper 20 cm; faint mottling evident in lower C horizon	**4A** 2P 2F	**2P**
Polygon 2 0.37 ha (4%)	Fairbridge	Gleyed Dystric Brunisol	Very high water holding capacity; sticky consistence in the upper 25 cm; mottling evident in subsoil; simple slopes of about 6%	**4A** 3D 2T	**3D** 2T
Total area mapped: 2.58 ha (29%)					

The revised polygons both contain a Class 4 aridity (A) limitation. This limitation is defined based on the propensity for soils to cause droughtiness to crops planted in them. Land in Class 4 has limitations that require special management practices or severely restrict the range of suitable crops, or both. The aridity limitation is improvable through irrigation, depending on the texture of the soils in question. In this Property, because the soils are fine with high water-holding capacity, they are maximally improvable to Class 1.

Polygon 1 contains a Class 2 stoniness (P) limitation. This limitation occurs when there is an amount of coarse gravels in the upper 25 cm of the soil that cause disturbances to agriculture, either due to water retention, damage to farm machinery (e.g. plows), poor fertility, or inadequate rooting medium. This limitation is not improvable due to the small size (fine gravel) of the coarse fragments. This polygon also contains a class 2 fertility (F) limitation. This limitation occurs in soils with minor nutrient imbalances, inadequate nutrient holding ability, or moderate acidity/alkalinity limitations in the upper 50 cm. this limitation is completely improvable with routine additions or fertilizer and/or other soil amendments. **As such, the best improved rating for Polygon 1 is 2P.**

Polygon 2 contains a Class 3 poor structure (D) limitation. This limitation occurs when the soil structure impedes agricultural capability for various reasons. In this case, the clayey texture and wet sticky consistence of the soil in the upper 25 cm cause poor perviousness in the rooting zone of the soil, which is further evidenced by the lack of roots below 10 cm. This limitation may be improvable with plowing or otherwise altering the soil structure, however since this has not been demonstrated for this soil in the past it must be assumed to be unimprovable. This polygon also contains a Class 2 topography (T) limitation. This limitation occurs when the soil occurs on slopes that impede agricultural production. Polygon 2 occurs on an area of the Property with gently undulating slopes of about 6%, which may present a minor problem for

farm machinery access. This limitation is unimprovable. **Therefore, the best improved rating for Polygon 2 is 3D**.

4 Discussion

4.1 Soil Suitability for Agriculture

Based on the field assessment, there did appear to be highly heterogeneous soils on the Property. Although the two soil pits were not dug too far apart, there was a large difference in their characterization and also their agricultural limitations. Based on this, we delineated two different Land Capability for Agriculture (LCA) polygons; Polygon 1 represents the main hay-farming area of the Property, and Polygon 2 represents the proposed building footprint of the additional dwelling, as communicated by the Client. Indeed, the agricultural capability of Polygon 1 was higher than of Polygon 2, due mostly to poor soil structure and a topography limitation in Polygon 2. **Therefore, we believe that the Client chose a suitable site for their additional dwelling (Polygon 2)** because it is not the most productive agricultural area of the farm, and it is located proximal to the edge of the Property where a farm access road is proposed to be built (see **FIGURE 4**).

If there are any questions about the statements and/or recommendations contained in this report, please contact the undersigned authors.

Sincerely,

MADRONE ENVIRONMENTAL SERVICES LTD.
Prepared by:

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APPENDIX A

SOIL PROFILE DESCRIPTIONS

Soil Pit 1 (SP1)		
Soil Association: Fairbridge **Classification: Gleyed Dystric Brunisol**		
Horizon	**Depth (cm)**	**Description**
Ap	0 to 10	Silty clay texture; moderate coarse granular structure with coarse angular blocky clods of clay; moist: very firm consistence; no coarse fragment content; moderately to poorly drained; no mottling; abundant fine roots; 10YR 5/4 (Yellowish brown); gradual smooth boundary
Bm	10 to 20	Silty clay texture; strong coarse blocky structure with coarse angular blocky clods of clay; moist: very firm consistence; wet: sticky consistence; poorly drained; no mottling; no roots; 10YR 3/3 (Dark brown); distinct smooth boundary
C	20 to 100	Heavy clay texture; hard planar structure; wet: sticky consistence; no coarse fragment content; very poorly drained; some coarse 10YR5/6 (Yellowish Brown) faint mottles; 10YR 5/2 (Grayish brown)
Notes: Located within proposed building location. Slate rock found on surface nearby; grasses growing sparsely around soil pit area.		

Soil Pit 2 (SP2)		
Soil Association: Fairbridge **Classification: Gleyed Sombric Brunisol**		
Horizon	**Depth (cm)**	**Description**
Ap	0 to 10	Silty clay loam texture; moderate granular structure; moist: friable consistence; 10% fine gravel content; moderately drained; abundant fine to coarse roots; 10YR 3/3 (Dark Brown) to 10YR 3/4 (Dark yellowish brown); gradual smooth boundary
Bfj	10 to 25	Silty clay loam texture; moderate granular structure; moist: friable consistence; 10% fine gravel content; moderately drained; few fine to coarse roots; 5YR 4/6 (Yellowish red); gradual smooth boundary
BC	25 to 45	Silty clay texture; coarse granular structure; moist: firm consistence; no coarse fragment content; poorly drained; no roots; 10YR 5/3 (Brown); distinct smooth boundary
C1	45 to 65	Heavy clay texture; coarse planar structure; moist: hard consistence; wet: sticky consistence; no coarse fragment content; very poorly drained; no mottles; 10YR 5/2 (Grayish brown); gradual smooth boundary
C2	65 to 115	Heavy clay texture; coarse planar structure; moist: hard consistence; wet: sticky consistence; no coarse fragment content; very poorly drained; some coarse faint 10YR 6/6 (Brownish yellow) mottles; 10YR 5/2 (Grayish brown)
Notes: Located within main hay farming area. Clay skins noted in C horizon. High agricultural potential; grasses growing abundantly nearby.		

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APPENDIX B

SOIL MOISTURE BALANCE AND CLIMATIC CAPABILITY RATINGS

Table 5. SOIL MOISTURE BALANCE AND CLIMATIC CAPABILITY RATINGS (UPPER 50 CM).

	SOIL MOISTURE BALANCE								CLIMATE CAPABILITY RATING	
SITE & SOIL HORIZON	TOTAL DEPTH	MATRIX TEXTURE	MATRIX AWSC[1]	MATRIX FRACTION[2]	CF ADJUSTED AWSC[3]	INTERVAL AWSC[4]	CLIMATE MOISTURE DEFICIT[5]	SOIL MOISTURE BALANCE[6]	UNIMPROVED MOISTURE SUBCLASS[7]	IMPROVED MOISTURE SUBCLASS[7]
SP1	**cm**	**FIELD**	**mm/cm**	**FIELD**	**mm/cm**	**mm**	**mm**	**mm**		
Ap	10	Silty clay	2	1	2	20				
Bm	10	Silty clay	2	1	2	20				
C	30	Heavy clay	2	1	2	60				
						100	-304	-204	4A	1
SP2										
Ap	10	Silty clay	2	1	2	20				
Bfj	15	Silty clay	2	1	2	30				
BC	25	Silty clay	2	1	2	50				
C1	5	Heavy clay	2	1	2	10				
						110	-304	-194	4A	1

CF Coarse Fragments > 2.0 mm diameter
1 Based on MOE Manual 1 Land Capability Classification for Agriculture in British Columbia, Section 9.4, pp. 46
2 Based on Field Estimation of Coarse Frags (%) (100%-Estimated% = Amount capable of storing H2O)
3 AWSC of fraction <2.0 mm = Matrix AWSC x Matrix Fraction
4 AWSC of horizon/interval = Depth x Adjusted AWSC
5 Based on Climate Capability Classification for Agriculture in British Columbia
6 Upper 50 cm soil texture-based AWSC (Climate Moisture Balance) + (Interval AWSC) = Deficit (negative) or Surplus (positive)
7 Based on Land Capability Classification for Agriculture, MOE Manual 1

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APPENDIX C

LAND CAPABILITY FOR AGRICULTURE, SOIL ASSOCIATIONS, & SOIL TYPES

Land Capability for Agriculture Overview

The *Land Capability Classification for Agriculture in BC*[13] 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 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 organic soil class definitions are equivalent in relative capabilities and limitations for agricultural use to those defined for mineral soils.

The range of suited crops decreases from Class 1 to Class 7 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. There are fewer subclasses for organic soils than for mineral soils (see below).

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 considered are drainage, irrigation, diking, stone removal, salinity alleviation, intensive fertilization and adding soil amendments.

[13] BC Ministry of Environment and Ministry of Agriculture and Food (1983). Land Capability Classification for Agriculture in British Columbia MOE Manual 1. Retrieved December 14, 2022, from https://www.alc.gov.bc.ca/assets/alc/assets/about-the-alc/alr-and-maps/agricultural-land/land_capability_classification_for_agriculture_in_bc.pdf.

LCA Classes and Characteristics for both Mineral and Organic Soils.

Class	Description	Characteristics
1	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	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	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: o Restrict choice of suitable crops o Affect timing and ease of tilling, planting or harvesting o Affect methods of soil conservation
4	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: o Affect timing and ease of tilling, planting or harvesting o Affect methods of soil conservation
5	Limitations that restrict capability to produce perennial forage crops or other specially adapted crops (e.g. cranberries)	• Can be cultivated, provided intensive management is employed or crop is adapted to the 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	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	No capability for arable culture or sustained natural grazing	• All lands not in Class 1 to 6 • Includes rockland, non-soil areas, small waterbodies

LCA Subclasses

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 and nine LCA subclasses to describe organic soils, as summarized below. Mineral soils contain less than 17% organic carbon; except for an organic surface layer[14].

LCA Subclasses for Mineral Soils

LCA Subclass	Map Symbol	Description	Improvement
Soil moisture deficiency	A	Crops are adversely affected by drought either through insufficient precipitation or low water holding capacity of the soil.	Improvable through 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	This subclass is used for soils difficult to till, requiring special management for seedbed preparation and soils with trafficability problems for common farm implements. Also included are soils which have insufficient aeration, absorb and distribute water slowly, or have the depth of rooting zone restricted by conditions other than wetness (high water table) or consolidated bedrock or permafrost.	Can be improved to varying degrees by amelioration of soil texture, deep ploughing or blading to break-up root restricting layers. Soil can also be amended with compost to improve structure.
Erosion	E	Includes soils on which past damage from erosion limits agricultural use of the land because of the loss in productivity and the difficulty in farming land with gullies.	N/A; usually a continuing limitation.
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 bedrock and 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

[14] Agriculture and Agri-Food Canada (1998). Canadian System of Soil Classification. Retrieved December 12, 2022, from http://sis.agr.gc.ca/cansis/publications/manuals/1998-cssc-ed3/cssc3_manual.pdf.

LCA Subclass	Map Symbol	Description	Improvement
Permafrost	Z	Applies to soils that have a cryic (permanently frozen) layer.	N/A

LCA Subclasses for Organic Soils

LCA Subclass	Map Symbol	Description	Improvement
Wood in the profile	B	Layers of wood in the form of trunks, stumps, and branches occur in many organic soils; wood located within 50 cm of the surface can interfere with cultivation; buried wood may be well-decomposed or solid and large.	The amount of wood present is variable and difficult to remove or manage. Therefore the improved rating is equivalent to the unimproved rating
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
Depth of organic soil over bedrock and/or rockiness	H	The presence of bedrock near the surface restricts the depth of rooting and the feasibility of subsurface drainage, and / or the presence of rock outcrops restricts agricultural use.	Improvement of limitations due to bedrock near the surface and/or rockiness is not considered practical; therefore the improved rating is equivalent to the unimproved rating
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
Degree of decomposition - permeability	L	Degree of decomposition of the rooting zone probably of less importance to the overall capability than the lower part of the soil. The degree of decomposition of lower layers is important because of its effect on drainage, permeability, capillary rise of water and rate of subsidence.	Improvement of this limitation is not considered practical; therefore the improved rating is equivalent to the unimproved rating
Salinity	N	Includes soils adversely affected by soluble salts that restrict crop growth or the range of crops.	Specific to site and soil conditions
Excess Water	W	Applies to soils for which excess free water limits agricultural use (applicable to both mineral and organic soil).	Ditching, tilling, draining
Permafrost	Z	Applies to soils that have a cryic (permanently frozen) layer.	N/A

Soil Associations

Soils in British Columbia (where soil mapping has taken place) are grouped into distinct soil associations based on typical characteristics associated with particular pedogenic (soil-forming) factors. These associations are typically spatially limited to certain areas of the province. In this report, the provincially-mapped soil associations for the assessment area have been identified as follows[15]:

[15] BC Ministry of Environment. (1981). *Soils of Southeast Vancouver Island Duncan-Nanaimo Area MOE Technical Report 15.* Retrieved December 19, 2023, from https://www.env.gov.bc.ca/esd/distdata/ecosystems/Soils_Reports/bc57_report.pdf#page=100

FAIRBRIDGE SOILS (FB)

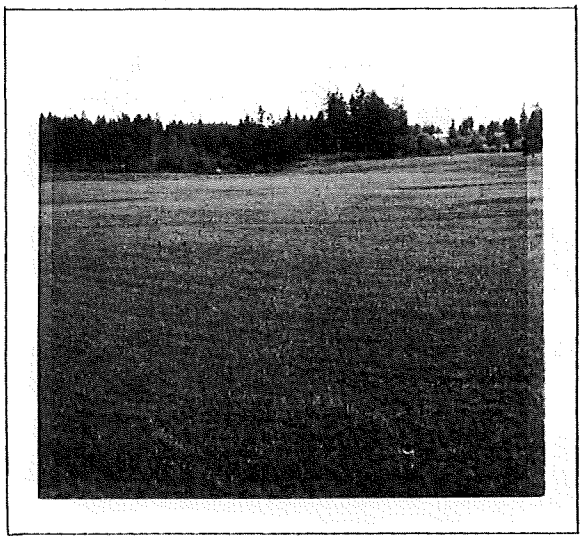


PLATE 4.16: FAIRBRIDGE SOIL LANDSCAPE

GENERAL COMMENTS

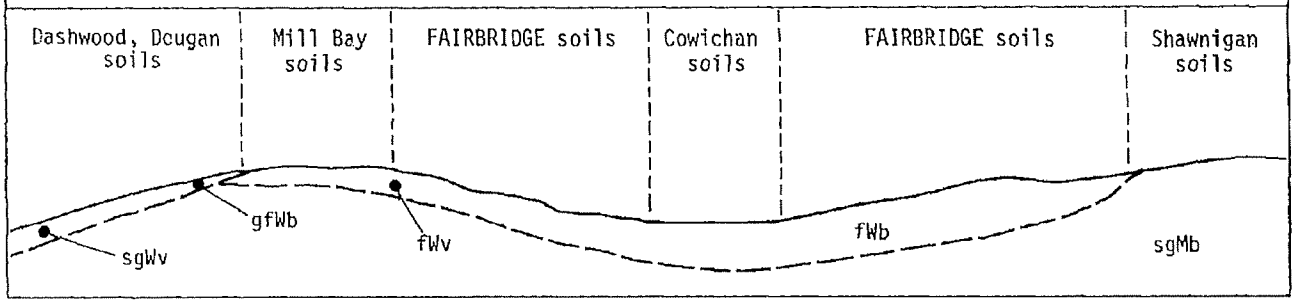
Fairbridge soils (6759 ha) occur below elevations of about 100 m. They occupy nearly level to moderate slopes within generally undulating areas of medium-textured deposits and are usually associated with Cowichan and Hillbank soils. These soils occur most extensively in the Duncan area. Fairbridge soils are imperfectly to moderately well drained and have a perched watertable during the winter months.

Fairbridge soils have a dark yellowish brown surface horizon which contains many concretions. All horizons are stone-free and silt loam or silty clay loam in texture. The lower horizons are very compact and slowly permeable. The seasonally perched watertable causes prominent mottling in the lower horizons. These soils are dominantly classified as **Gleyed Eluviated Dystric Brunisols** with subdominant inclusions of Gleyed Dystric Brunisols and Gleyed Brunisolic Gray Luvisols and Gleyed Humo-Ferric Podzols.

Fairbridge soils are considered prime agricultural land with dairying and hay production being the main present land use. They are suitable for a wide range of crops but irrigation and fertilization are required for optimal yields. Soil moisture content should be carefully observed prior to cultivation since structure deterioration, increased surface erosion, and surface crusting and puddling can result if soil is cultivated when wet. Perched watertables during winter months may adversly affect some perennial crops.

Urban and related uses are constrained by perched watertables, slow permeability and generally low bearing strengths.

FAIRBRIDGE SOIL LANDSCAPE CROSS SECTION*

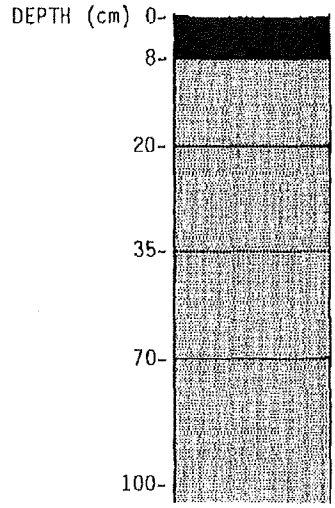


*see Table 3.1 for explanation of terrain symbols

LANDSCAPE CHARACTERISTICS

PARENT MATERIAL	:	silty marine blanket
TOPOGRAPHY	:	2-15%, undulating
ELEVATION RANGE	:	0 to 100 m asl
ASPECT	:	all
FLOOD HAZARD	:	no hazard
VEGETATION	:	Substantial areas of Fairbridge soils are cleared and cultivated mainly for pasture and hay production. Uncleared areas support mixed stands of second growth Douglas-fir, western red cedar, red alder, maple, and grand fir. The understory consists of a variety of shrubs usually dominated by salal.

TYPICAL FAIRBRIDGE SOIL PROFILE



Apcc - Dark yellowish brown (10 YR 4/4 m) silt loam; weak, fine to medium, subangular blocky to weak to moderate, very fine to fine subangular blocky; very friable, slightly sticky, slightly plastic; abrupt smooth boundary; medium acid; few, fine, durinodes throughout matrix; spherical.

$Bmcc_1$ - Strong brown (7.5 YR 5/6 m) silt loam; weak to moderate, medium, subangular blocky; very friable, slightly sticky, slightly plastic; gradual, smooth boundary; strongly acid; common, fine, durinodes throughout matrix, spherical

$Bmcc_2$ - Light yellowish brown (2.5 Y 6/4 m) silt loam; moderate, medium, subangular blocky; soft, very friable, slightly sticky, plastic; gradual, wavy boundary; strongly acid; common, fine, durinodes throughout matrix, spherical.

Btjgj- Pale yellow (2.5 Y 7/4 m) silt loam; common medium distinct mottles; moderate, medium to coarse, subangular blocky; slightly hard, sticky, plastic; diffuse wavy boundary; strongly acid.

Bgj - Yellowish brown (10 YR 5/4 m) silt loam; common fine prominent mottles; massive to moderate, fine to medium, angular blocky; firm, plastic; gradual smooth boundary; medium acid.

SOIL CHARACTERISTICS

DEPTH TO BEDROCK (cm)	: N/A
HUMUS FORM	: Mull
SOLUM DEPTH (cm)	: 100-130
DEPTH, THICKNESS AND TYPE OF RESTRICTING LAYER (cm)	: 70-100; compact lower horizons
ROOTING DEPTH (cm)	: 80-110
COARSE FRAGMENT CLASS	: 0
DEPTH TO AND TYPE OF WATERTABLE (cm)	: 70; seasonal perched
PERVIOUSNESS	: slow
SOIL DRAINAGE	: imperfectly
DEPTH TO SALTS (cm)	: N/A
SOIL TEXTURE	: silt loam, silty clay loam

SOIL PHYSICAL PROPERTIES	SOIL DEPTHS (cm)					
	No. of Samples	0-35	No. of Samples	35-70	No. of Samples	70-130
PERMEABILITY (CLASS)		moderate		moderate		slow
BULK DENSITY (g/cm^3)	5	1.13 (0.94-1.46)	6	1.38 (1.18-1.50)	3	1.54 (1.42-1.61)
AWSC (mm/cm)	6	25.4 (20.6-29.3)	5	22.3 (16.0-28.0)	3	22.7 (15.6-29.6)
AWSC (corr. for % CF) (cm/m)	6	25.4 (20.6-29.3)	5	22.3 (16.0-28.0)	3	22.7 (15.6-29.6)
% COARSE >7.5cm	5	0	5	0	5	0
FRAGMENTS <7.5cm	5	0-10	5	0-10	5	0-3
% PASSING # 4	7	91.7(84.0-100.0)			5	98.7 (96.1-100.0
SIEVES # 40	7	85.9(77.8-97.8)			4	96.7 (92.9-99.3)
#200	7	80.0 (70.0-92.3)			4	86.5 (74.4-96.7)
% SAND	22	11.5 (1.5-25.4)	21	10.3 (1.4-40.0)	15	7.4 (1.1-25.2)
% CLAY	22	32.0 (9.0-45.5)	21	27.0 (9.4-45.5)	14	26.4 (16.6-36.9)

SOIL CHEMICAL PROPERTIES	SOIL DEPTHS (cm)					
	No. of Samples	0-35	No. of Samples	35-70	No. of Samples	70-130
SOIL REACTION 1:1 H_2O	16	5.6 (5.3-6.3)	8	5.7 (5.2-6.4)	16	6.4 (5.3-7.2)
(pH) 1:2 $CaCl_2$	16	5.0 ((4.6-5.6)	8	5.1 (4.5-5.9)	16	5.6 (4.4-6.8)
CONDUCTIVITY mS/cm		N/A		N/A		N/A
ORGANIC CARBON (%)	14	3.7 (1.1-8.7)	8	0.8 (0.3-1.9)	9	0.3 (0.1-0.7)
NITROGEN (%)	16	0.09 (0.01-0.19)	8	0.04 (0.02-0.11)	13	0.02 (0.01-0.04)
EXCHANGE CAPACITY (meq/100g)	16	18.5 (9.3-37.8)	8	21.8 (15.6-29.2)	14	21.2 (16.9-31.5)
EXCHANGEABLE CATIONS - Ca	15	2.8 (0.4-6.6)	8	5.0 (0.3-17.1)	14	10.5 (0.3-17.2)
(meq/100g) - Mg	16	1.3 (0.2-3.4)	8	4.2 (0.1-8.3)	14	5.9 (0.1-11.1)
- Na	16	0.1 (0.1-0.3)	8	0.2 (0.1-0.4)	14	0.3 (0.1-0.5)
- K	16	0.3 (0.1-0.7)	8	0.2 (0.1-0.4)	14	0.1 (0.1-0.2)
PHOSPHORUS (ppm)	16	36.3 (2.3-111.5)	8	7.5 (2.9-24.4)	15	6.7 (2.4-13.2)
SULFUR (ppm)	14	2.7 (0.1-11.4)	7	2.6 (0.3-8.8)	10	1.6 (0.1-11.1)
% IRON	31	0.40 (0.07-0.82)				
% ALUMINUM	31	0.40 (0.12-0.08)				

SOIL PHASES/VARIANTS	
SOIL SYMBOL	SOIL DESCRIPTION
FBg	Gravelly phase; solum contains 20-50% gravel; usually occurs on seaward facing slopes.
FBg,l	Gravelly phase; solum contains 20-50% gravel; usually occurs on seaward facing slopes. Shallow lithic phase; bedrock (other than shale or siltstone) occurs within 50 to 100 cm of the surface.
FBg,w	Gravelly phase; solum contains 20-50% gravel; usually occurs on seaward facing slopes. Strongly mottled phase; wetter moisture regime in profile as evidence by prominent mottling within 50 cm of the surface. Seasonal perched water tables present. Landscape position not typical of Gleysolic soils.
FBl2	Shallow lithic phase; bedrock (other than shale or siltstone) occurs within 50 to 100 cm of the surface.
FBw	Strongly mottled phase; wetter moisture regime in profile as evidence by prominent mottling within 50 cm of the surface. Seasonal perched water tables present. Landscape position not typical of Gleysolic soils.

INFERRED SOIL PROPERTIES
FAIRBRIDGE SOILS

SOIL NAME SYMBOL	SOIL DEPTH (cm)	UNIFIED TEXTURE SYMBOL	AASHO TEXTURE SYMBOL	LIQUID LIMIT	PLASTICITY INDEX	SOIL ERODIBILITY K FACTOR
FB	0-100	ML	A-4	37.7 (26.5-50.7)	9.7 (6.5-14.4)	0.4 - 0.5

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APPENDIX D

SITE PHOTOS

FIGURE 6. PROXIMITY OF SP1 (FOREGROUND) AND SP2 (BACKGROUND).

FIGURE 7. PANORAMIC VIEW NORTH OF SP1.

FIGURE 8. VIEW SOUTH OF SP1.

FIGURE 9. VIEW WEST OF SP1.

FIGURE 10. VIEW EAST OF SP1.

FIGURE 11. PANORAMIC VIEW EAST OF SP2.

FIGURE 12. CLAY SKINS IN C HORIZONS OF SP2.

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APPENDIX E

SOIL REPORT

Pacific Soil Analysis Inc.

#5-11720 Voyageur Way, Richmond, B.C V6X 3G9 604-273-8226

Client: Madrone Environmental Sevices

Date: January 29, 2024

Sample Received on: January 15, 2024

				Total	Total		AVAILABLE				
		Estimated		Organic	Kjeldahl	Carbon	P	K	Ca	Mg	Na
	pH	E.C.	Lime Rqmt	Matter	Nitrogen	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sodium
Sample		mmhos/cm	lbs/1000sqf	(%)	(%)	Ratio	PPM				
SP1	6.0	0.16	x	5.8	0.08	42.3	50	115	1350	470	35
SP2	6.0	0.4	x	9.6	0.18	30.9	130	415	1400	310	10